

# CROATIA

## DECEMBER 2020 EARTHQUAKE

Rapid Damage and  
Needs Assessment



Government  
of the Republic  
of Croatia



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Rapid Damage and  
Needs Assessment

Prepared by



Facilitated by



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Disclaimer: This report summarizes the findings of a rapid damage and needs assessment that was led by the Government of Croatia, with technical assistance from the World Bank, following a series of earthquakes in December 2020. This assessment focuses on the December 29, 2020 earthquake. The assessment was carried out between January and March 2021, with data collection completed on February 26, 2021.

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# ABBREVIATIONS AND ACRONYMS

<b>AeDES</b>	Post-Earthquake Damage and Safety Assessment and Short-Term Countermeasures	<b>HAC</b>	Croatian Motoways Ltd (Hrvatske autoceste d.o.o.)
<b>ArcGIS</b>	Aeronautical Reconnaissance Coverage Geographic Information System	<b>HC</b>	Croatian Roads Ltd (Hrvatske ceste d.o.o.)
<b>BBB</b>	Build Back Better	<b>HCPI</b>	Croatian Center for Earthquake Engineering (Hrvatski centar za potresno inženjerstvo)
<b>CAB</b>	Current Account Balance	<b>HEP ODS</b>	Hrvatska Elektroprivreda Distribution System Operator Ltd (Hrvatska elektroprivreda - Operator distribucijskog sustava d.o.o.)
<b>CBS</b>	Croatian Bureau of Statistics	<b>HERA</b>	Croatian Energy Regulatory Agency (Hrvatska energetska regulatorna agencija)
<b>CDU</b>	Shared Services Center (Centar dijeljenih usluga)	<b>HOPS</b>	Croatian Transmission System Operator Ltd (Hrvatski operator prijenosnog sustava d.o.o.)
<b>CMRS</b>	Croatian Mountain Rescue Service	<b>HZMO</b>	Croatian Pension Insurance Institute (Hrvatski zavod za mirovinsko osiguranje)
<b>COE</b>	Council of Europe	<b>HZZ</b>	Croatian Employment Service (Hrvatski zavod za zapošljavanje)
<b>CP NIU</b>	Civil Protection National Intervention Unit	<b>ICT</b>	Information and Communication Technology
<b>CRC</b>	Croatian Red Cross	<b>INA</b>	Industrija Nafta d.d.
<b>CSO</b>	Civil Society Organization	<b>IT</b>	Information Technology
<b>CSS</b>	Croatian Seismological Survey at the Department of Geophysics, Faculty of Science, University of Zagreb	<b>JANAF</b>	Jadranski naftovod d.d.
<b>DA</b>	Defended Area	<b>LIDAR</b>	Light Detection and Ranging
<b>DaLA</b>	Damage and Loss Assessment	<b>LRSQU</b>	Local and Regional Self-Government Unit
<b>DEM</b>	Digital Elevation Model	<b>LSGU</b>	Local Self-Government Unit
<b>DRA</b>	Disaster Risk Assessment	<b>MoA</b>	Ministry of Agriculture
<b>DRB</b>	Danube River Basin	<b>MoCM</b>	Ministry of Culture and Media
<b>DRM</b>	Disaster Risk Management	<b>MoESD</b>	Ministry of Economy and Sustainable Development
<b>DRR</b>	Disaster Risk Reduction	<b>MoF</b>	Ministry of Finance
<b>EC</b>	European Commission	<b>MoH</b>	Ministry of Health
<b>EC8</b>	Eurocode 8	<b>Mol</b>	Ministry of Interior
<b>EE</b>	Energy Efficiency	<b>MoJPA</b>	Ministry of Justice and Public Administration
<b>EMS</b>	European Macroseismic Scale	<b>MoLPSFSP</b>	Ministry of Labor, Pension System, Family, and Social Policy
<b>EPEEF</b>	Environmental Protection and Energy Efficiency Fund		
<b>EU</b>	European Union		
<b>EUSF</b>	European Union Solidarity Fund		
<b>FCE</b>	Faculty of Civil Engineering of the University of Zagreb		
<b>FINA</b>	Financial Agency		
<b>GBS</b>	Government Service Bus		
<b>GDP</b>	Gross Domestic Product		
<b>GIS</b>	Geographic Information System		
<b>GNSS</b>	Global Navigation Satellite System		
<b>GPS</b>	Global Positioning System		

<b>MoPPCSA</b>	Ministry of Physical Planning, Construction, and State Assets	<b>TAST</b>	Technical Assistance and Support Team
<b>MoRDEUF</b>	Ministry of Regional Development and EU Funds	<b>UCPM</b>	Union Civil Protection Mechanism
<b>MoSE</b>	Ministry of Science and Education	<b>UNICEF</b>	United Nations Children's Fund
<b>MoSTI</b>	Ministry of the Sea, Transport, and Infrastructure	<b>VAT</b>	Value Added Tax
<b>MoTS</b>	Ministry of Tourism and Sport	<b>WDS</b>	Whole Day School
<b>MZLZ</b>	Zagreb International Airport (Međunarodna Zračna Luka Zagreb – Franjo Tuđman)	<b>WWTP</b>	Wastewater Treatment Plant
<b>PP&amp;E</b>	Plant, Property, and Equipment	<b>ZOSI</b>	Institute for Expert Evaluation, Professional Rehabilitation, and Employment of Persons with Disabilities (Zavod za vještačenje, profesionalnu rehabilitaciju i zapošljavanje osoba s invaliditetom)
<b>R&amp;D</b>	Research and Development	<b>ŽUC</b>	County Road Authority (Županijske ceste)
<b>RDNA</b>	Rapid Damage and Needs Assessment		
<b>RGNF</b>	Faculty of Mining, Geology, and Petroleum Engineering (Rudarsko-geološko-naftni fakultet)		
<b>SCADA</b>	Supervisory Control and Data Acquisition (Water Security)		
<b>SGA</b>	State Geodetic Administration		
<b>SMEs</b>	Small and Medium Enterprises		

*Note: There have been several changes in the official names of ministries. This report refers to line ministries with the most current name.*

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Between January and March 2021, some 300 officials and staff in central government ministries, regional and local governments, World Bank experts, and other stakeholders participated in the RDNA process. The RDNA working groups included officials and staff from 13 line ministries including MoPPCSA; Ministry of Science and Education (MoSE); Ministry of Health (MoH); Ministry of Culture and Media (MoCM); Ministry of Economy and Sustainable Development (MoESD); MoF; Ministry of Interior (MoI); Ministry of Regional Development and EU Funds (MoRDEUF); Ministry of Agriculture (MoA); Ministry of the Sea, Transport, and Infrastructure (MoSTI); Ministry of Labor, Pension System, Family, and Social Policy (MoLPSFSP); Ministry of Tourism and Sport (MoTS); and Ministry of Justice and Public Administration (MoJPA).

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# FOREWORD

In 2020 Croatia faced major natural disasters. Following the first devastating earthquake which struck Zagreb in March in the midst of the COVID-19 pandemic, the second devastating earthquake of a magnitude of 6.2 on the Richter scale hit the Sisak-Moslavina, Karlovac and Zagreb counties at the end of last year. The quake was strongly felt in most of Croatia and again in Zagreb, where it caused new progressive damage. Unfortunately, these two earthquakes also took eight human lives. The extent of the damage in Zagreb and its surroundings and in Banovina is estimated at around EUR 17 billion or HRK 129 billion, of which EUR 11.5 billion relates to Zagreb and the surrounding area, and EUR 5.5 billion to Banovina. This is four times the damage caused by the pandemic, which has so far cost HRK 34 billion, or 20 percent of the state budget. In other words, due to the consequences of the coronavirus and the two devastating earthquakes, Croatia was hit much harder than most other countries in the world, which had to face only the economic consequences of the epidemic. Therefore, our task in the coming years is to invest all available resources in economic recovery, the reconstruction of earthquake-affected areas and strengthening the resilience of our country against future crises and natural disasters.

The enthusiasm and solidarity of Croatian people from all parts of the country marked the first and most difficult days after the earthquake. This was shown in the synergy of engineers, architects, civil protection bodies, the army, but also volunteers who came to the rescue and selflessly provided support, thus complementing the efforts of the Government and all institutions and public services that acted from the first moment on the ground as first responders. Although the earthquake caused great physical damage, it also brought out the best in people and inspired a spirit of togetherness in helping unfortunate fellow citizens.

The experience of the Zagreb earthquake was only partly applicable in managing the situation in Banovina due

to its larger, sparsely populated geographic area. There were thus logistical difficulties which the system had to adapt to on a daily basis. Aware that we will need to work on repairing the damage for years to come and that we will have to provide major financial resources for reconstruction, from national, European and international funds, we promptly responded to all the challenges. While emergency measures included care, accommodation and emergency work, medium-term measures focused on the development of a legal framework for reconstruction, the assessment of damage, and the establishment of an institutional framework for reconstruction. We have taken all these steps and established an institutional framework to ensure a transparent and comprehensive reconstruction process and the implementation of construction works that will continue to be intensified. We have an obligation to carry out reconstruction to the highest standards and at the same time to revitalize the affected areas. We should use this natural disaster to encourage a new and large development cycle in Zagreb, in the surrounding counties and in Banovina, which have experienced several waves of destruction and suffering in the past thirty years and which deserve economic, social and demographic revitalization.

Besides the reconstruction of residential and family buildings, public, cultural, educational and other institutions and cultural heritage, we seek to provide all affected areas in this earthquake-prone area with state-of-the-art anti-seismic reinforcement. By giving support in the reconstruction process to many families, especially the most vulnerable groups, we want to create the preconditions for their return to their homes and for a better and safer life as soon as possible.

Therefore, it is up to us to do everything we can to make the reconstruction process as effective as possible for the benefit of our fellow citizens, and to provide the affected population of this area with a good life and a promising future.

*Andrej Plenković*  
Prime Minister

**6.2 M**  
earthquake

**December 29,  
2020**  
at 12:19 pm

**6 km**  
southwest of  
Petrinja

**7**  
fatalities

**15**  
people severely injured

**15,000**  
people temporarily displaced

**1.5 million**  
people exposed

**43,000**  
buildings damaged

**4.8**  
billion euros  
damage + losses



# EXECUTIVE SUMMARY



# EXECUTIVE SUMMARY



**On December 29, 2020, Sisak-Moslavina County in Croatia was struck by a 6.2 magnitude earthquake with the epicenter 6 km outside the town of Petrinja.** The earthquake was preceded by a 5.0 magnitude earthquake on December 28, 2020; and numerous aftershocks were recorded, including a 5.0 magnitude earthquake on January 6, 2021. The December 29, 2020 earthquake caused loss of lives as well as extensive physical, economic, and social impacts. Seven people died, 15 sustained severe injuries that required hospitalization, and dozens more suffered minor injuries due to the December 29, 2020, earthquake. By the end of February 2021, approximately 43,000 buildings were reported as damaged; and close to 25,000 of these have been inspected for usability by the civil engineers.<sup>11</sup> The earthquake affected the provision of public services and economic activities, with damage and loss of assets deeply disrupting livelihoods of thousands of people living across multiple counties. Several geological processes, including liquefaction, severely affected the natural environment and land stability of the area.

**The December earthquakes ended an extraordinary year for Croatia, due to compounding effects of a major earthquake in March 2020, COVID-19 pandemic, and economic challenges linked to these.** At country-level, COVID-19 response measures introduced since mid-March 2020 affected consumption, tourism, and business activity. The economic center of the country – Zagreb, along with surrounding areas – were severely impacted by the March 22, 2020 earthquake. At regional level, some of the counties impacted by the December 2020 events have experienced decades of lagging economic growth, facing socio-economic challenges, and recovering from years of conflict. Besides the most significantly impacted County of Sisak-Moslavina, damage was reported in the neighboring Karlovac County, Krapina-Zagorje County, Zagreb County, and the City of Zagreb. In some areas, buildings and infrastructure that were already in vulnerable condition due to the damage they incurred during the March 2020 earthquake, deteriorated even further.

1 Most recent figures can be accessed at [www.hcpi.hr](http://www.hcpi.hr)

**Understanding the disaster impacts is critical to identify priorities and principles for developing a strategic framework for resilient recovery and reconstruction and revitalization of the affected areas.** With this objective in mind and building on lessons learnt after the March 2020 earthquake, the Croatian government conducted between January and March 2021 a rapid damage and needs assessment (RDNA). This multi-stakeholder process was coordinated by the Ministry of Physical Planning, Construction, and State Assets (MoPPCSA), with support from the World Bank.

**This report provides a structured account of the earthquakes' sectoral, economic, and social impact, highlighting key findings and providing recommendations for recovery and reconstruction.** The report compiles damage, loss, recovery, and reconstruction estimates across 13 sectors for five administrative areas based on data provided by government officials and other assessment stakeholders. The RDNA sectoral estimates were used by the Government for Croatia's application to the European Union Solidarity Fund (EUSF) submitted to the European Commission (EC) during the RDNA process.

## Summary of Damage and Losses

**The overall impact of the December 29, 2020 earthquake was significant, totaling over EUR 4.8 billion, with Sisak-Moslavina County being most affected.** The total damages and losses across 13 sectors and five counties was estimated at EUR 4.8 billion, of which EUR 4.12 billion represents the value of damaged physical assets and EUR 714 million refers to losses.<sup>2</sup>As noted in Table 1, geographically, Sisak-Moslavina County (80 percent) was most affected, followed by Zagreb County (10 percent),

2 Damage is defined as the monetary value of fully or partially destroyed assets. It is initially assumed that assets will be restored to the same condition—in quantity and quality—that they were before the disaster. Losses are defined as the changes in the flows of goods and services that will not be forthcoming in the affected area until the destroyed assets are rebuilt, over the span of time that elapses from the occurrence of the disaster and the end of the recovery and reconstruction period. Losses include production of goods and services that will not be obtained, higher costs of operation and production, and the cost of the humanitarian assistance activities. See more under assessment methodology.

**Table 1.** Damage and losses by county (EUR, millions)

Administrative unit	Damage			Losses			Total		
	Public	Private	Total	Public	Private	Total	Public	Private	Total
Sisak-Moslavina County	646	2,635	<b>3,280</b>	166	354	<b>520</b>	811	2,989	<b>3,800</b>
Zagreb County	61	351	<b>412</b>	10	83	<b>93</b>	71	434	<b>505</b>
Karlovac County	73	202	<b>276</b>	8	26	<b>35</b>	81	229	<b>310</b>
Krapina-Zagorje County	30	61	<b>91</b>	3	10	<b>13</b>	33	71	<b>104</b>
City of Zagreb	15	48	<b>63</b>	9	27	<b>36</b>	24	75	<b>99</b>
<b>Total</b>	<b>824</b>	<b>3,298</b>	<b>4,122</b>	<b>196</b>	<b>500</b>	<b>696</b>	<b>1,020</b>	<b>3,798</b>	<b>4,818</b>

*Source:* Estimations by the assessment team using official information. *Note:* EUR 4.8 billion corresponds to the estimated damage and losses, based on data received as of February 26, 2021 and falling under the scope of this RDNA as agreed at the onset of this rapid assessment. Additional estimates have been done by the Government, some of which are captured in Annex 3 while some remain outside of this report.

Karlovac County (6 percent), Krapina-Zagorje County (2 percent), and the City of Zagreb (2 percent). For Zagreb County, Krapina-Zagorje County, and the City of Zagreb, only new damage and progressive damage caused by the earthquake was calculated, to avoid duplication with the damage caused by the earlier Zagreb earthquake which occurred in March 2020.<sup>3</sup>

3 Government of the Republic of Croatia. 2020. Croatia Earthquake: Rapid Damage and Needs Assessment 2020. [https://mgipu.gov.hr/UserDocsImages/dokumenti/Potres/RDNA\\_web\\_04082020.pdf](https://mgipu.gov.hr/UserDocsImages/dokumenti/Potres/RDNA_web_04082020.pdf)

**Almost 74 percent of the overall estimated damage and losses were sustained in the social sectors significantly impacting people's living conditions and quality of life.** Damage and losses across housing, health, education, social protection, and culture and cultural heritage sectors amounted to EUR 3.54 billion. The largest sector impacted by far is the housing sector with almost EUR 2.6 billion in damages and losses or over half of the total estimated disaster effects across all sectors.

**Damage and losses amounting to EUR 783 million**

**Table 2.** Damage and losses by sector (EUR, millions)

All sectors	Damage			Losses			Total		
	Public	Private	Total	Public	Private	Total	Public	Private	Total
<b>Housing</b>	56	2,433	<b>2,489</b>	2	107	<b>109</b>	58	2,540	<b>2,598</b>
<b>Health</b>	123	2	<b>125</b>	42	0.05	<b>42</b>	165	2	<b>167</b>
<b>Education</b>	153	1	<b>154</b>	20	0.10	<b>20</b>	173	1	<b>174</b>
<b>Social protection</b>	21	14	<b>35</b>	58	1	<b>59</b>	79	15	<b>94</b>
<b>Culture and cultural heritage</b>	62	410	<b>471</b>	24	14	<b>39</b>	86	424	<b>510</b>
<b>Business</b>	0	322	<b>322</b>	0	359	<b>359</b>	0	681	<b>681</b>
<b>Agriculture</b>	0	84	<b>84</b>	0	18	<b>18</b>	0	102	<b>102</b>
<b>Water and flood protection</b>	76	0	<b>76</b>	2	0	<b>2</b>	78	0	<b>78</b>
<b>Energy</b>	19	0	<b>19</b>	2	0	<b>2</b>	21	0	<b>21</b>
<b>Public administration and community infrastructure</b>	159	0	<b>159</b>	9	0	<b>9</b>	168	0	<b>168</b>
<b>Transport and communications</b>	87	2	<b>89</b>	22	1	<b>22</b>	109	2	<b>111</b>
<b>DRR and civil protection</b>	23	0	<b>23</b>	13	0	<b>13</b>	35	0	<b>35</b>
<b>Geology and land stability</b>	47	30	<b>77</b>	1	1	<b>2</b>	48	31	<b>79</b>
<b>Total</b>	<b>824</b>	<b>3,298</b>	<b>4,122</b>	<b>196</b>	<b>500</b>	<b>696</b>	<b>1,020</b>	<b>3,798</b>	<b>4,818</b>

*Source:* Estimations by the assessment team using official information.



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were recorded for productive sectors (business, agriculture) impacting economic activity and opportunities. Totalling EUR 681 million, the business sector (manufacturing and trade) was the second largest affected sector after housing. Due to the wide-ranging disruption of services, the business sector sustained the highest losses amounting to EUR 359 million or just over half of the total losses across all sectors.

**Damages and losses in the infrastructure sectors (transport and communications, energy, water and floods protection, and public administration and community infrastructure) accounted for EUR 378 million.** Out of these, the majority was recorded for public buildings (EUR 168 million) and transport and communication (EUR 111 million) affecting public administration services and connectivity.

**A total of EUR 114 million of damage and losses was recorded in the cross-cutting sectors.** Civil protection and disaster risk reduction (DRR) sustained EUR 35 million in damages and losses, while damage and losses in the geology and land stability area amounted to EUR 79 million due to liquefaction and sinkholes phenomena following the December events. The effects to the natural environment affect several sectors and have been quantified as part of respective sectoral assessments.

**The earthquake affected a total surface area of more than 11.2 million m<sup>2</sup> in buildings across all sectors.** The housing sector sustained most of the damaged surface area (73 percent), amounting to 8.2 million m<sup>2</sup>.

**In all five counties considered, the brunt of the disaster effects (almost EUR 3.8 billion) is recorded in the private domain.** Almost 80 percent of the damage and losses were sustained by households, communities, and businesses, including small to medium-size enterprises, individual farmers, and smallholders/traders. This is important aspect to consider in the recovery and reconstruction planning.

## Summary of Macroeconomic and Social Impact

**The macroeconomic impact of the December 2020 earthquake compounds multiple shocks and challenges that occurred in 2020.** Response to COVID-19 pandemic and its adverse economic effects and the devastating March and December earthquakes, aggravated the difficult economic and fiscal position. After relatively

steady economic growth in the previous years, Croatia's Gross Domestic Product (GDP) declined by 8.4 percent in 2020, which was the third largest downturn in the European Union (EU). This largely reflects the country's strong reliance on tourism making it vulnerable to adverse shocks such as the COVID-19 pandemic. The government response to the pandemic included a strong fiscal stimulus package to mitigate economic and social impacts of the pandemic. However, together with plunging tax revenues, Croatia's fiscal deficit surged, reaching an estimated 7.2 percent of GDP, derailing public debt adjustment plans.

**Given that the earthquake occurred at the end of 2020, most impact on the country's economic activity will be felt in 2021.** Initial estimates suggest that the earthquake may slow down Croatia's economic recovery by 0.3 percentage points compared to the baseline scenario which mainly reflects disruption of business activities in trade and manufacturing, higher operational cost due to demolition and debris and waste removal, and decrease in rent in damaged and severely damaged residential buildings. Negative economic effects of the earthquake in 2021 are expected to be partially offset by the reconstruction activities which are expected to intensify in

2022 and 2023, leading to somewhat stronger growth in these years compared to the baseline scenario. The deficit in 2021 is set to be higher by 0.2 percentage points due to immediate help to the private sector and decline in tax revenues. Whether the recovery will have significant adverse effect on public finances in the subsequent years will depend on the extent to which the recovery will be financed through grants.

**The social impacts of the earthquake are wide-ranging including direct and indirect consequences on different parts of society.** The earthquake resulted in seven fatalities; additionally, 15 persons sustained severe injuries that required hospitalization and dozens more suffered minor injuries. In the immediate aftermath of the earthquake, it was estimated that almost 15,000 people<sup>4</sup> lived in houses which were declared unusable or temporarily unusable in the most severely hit coun-

4 This estimation is taken from the program of measures for the renovation of buildings damaged by earthquakes for the areas of the City of Zagreb, Krapina-Zagorje County, Zagreb County, Sisak-Moslavina County, and Karlovac County, dated February 19, 2021, where it is stated that according to the Ministry of Interior (MoI) data, on January 12, 2021, a total of 2,214 unusable and 3,548 temporarily unusable buildings were recorded in which, according to the MoI projections, lived 4,438 and 10,059 people, respectively.



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ty—Sisak-Moslavina. Some of the affected people were housed in evacuation centers and temporary shelters, some moved to other parts of Croatia, and some decided to stay near their homes and were later housed in mobile homes or housing containers. It is estimated that in the first two months after the earthquake, 2,861 people left Sisak-Moslavina County. The local population—and in particular children, the elderly, and people with disabilities—suffered serious psychological trauma, which can be augmented by aftershocks.

**The earthquake significantly affected people’s access to public services, including health care and education, and also drinking water, and to a lesser extent electricity.** In the health sector, patients, medical staff, and nonmedical staff were affected. As a result of the earthquake, 622 staff members were temporarily unable to work and 96 staff members permanently. The most severe damage occurred at the general hospital in Sisak-Moslavina County, which is the main medical provider in the region and provides more than 185,000 medical services to patients annually. In Sisak-Moslavina

County, 15 schools were temporarily unusable, and 13 schools suffered heavy damage and were unusable, which significantly aggravated the education conditions for the 8,276 pupils in primary and secondary schools in the county. Due to geological processes, many people, especially low-income groups, who depend on the wells as a source of water are, since the events, not able to use them. Approximately 7,000 users in Sisak and its surroundings and 2,000 in Petrinja and the neighboring area faced power outages. Underlying conditions related to utilities and connectivity/networks infrastructure were aggravated by the earthquake.

**The compounded effects of the COVID-19 pandemic and the earthquake have a significant impact on 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 (houses) and capital, the reduction of income due to damaged infrastructure and loss of employment, the closure of schools, and so on. Out of the 70,000 people affected by the earthquakes, 13,000 are children. People



© Croatian Mountain Rescue Service (CMRS)

with disabilities reported facing challenges as they have difficulties accessing aid delivery points, moving around streets with roof debris risks, and reading warning signs. With many of the households relying on subsistence farming for food and small-scale trade, the earthquake's effect on livestock will have profound consequences for people's food security and living standards in the long term. A series of interviews with civil society organization (CSO) representatives in the earthquake-affected counties, as well as experience with similar disasters, suggest that women are disproportionately affected.

## Summary of Recovery and Reconstruction Needs

**Compared with the direct estimated damage and losses of EUR 4.8 billion, estimated recovery and reconstruction needs are substantially larger at EUR 8.4 billion.** Of this amount, EUR 2.38 billion (28 percent) is estimated for short-term needs, EUR 3.85 billion (46 percent) for medium-term needs, and EUR 2.17 billion (26 percent) for long-term needs, as shown in Table 3. The costs of the reconstruction and recovery needs are higher than the estimated damage and losses because they consider the

principles of 'building back better'<sup>5</sup> (BBB) to reduce future disaster risks and include functional improvements including energy efficiency (EE), fire safety, sanitation, and so on. The December earthquake, occurring within nine months of previous earthquake, highlights the country's vulnerability and the need to invest in multi-hazard risk reduction. Resumption of production, service delivery, and access to goods and services also contributes to the higher cost of the recovery and reconstruction needs, reflecting some of the underlying challenges and substantial investment needs of the affected areas to facilitate sustainable revitalization.

**The cost of recovery is greatest in the housing sector, totaling EUR 4.76 billion or over 56 percent of the overall recovery and reconstruction needs.** Housing is followed by the culture and cultural heritage sector (EUR 687 million), water and flood protection sector (EUR 514 million), and the business sector (460 million). Considering some of the essential public services for populations – namely health care, education, social protection, as well as public administration and community infrastructure, projected recovery and reconstruction needs are substantial amounting to EUR 1.28 billion.

5 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.

**Table 3.** Summary of recovery and reconstruction needs by sector (EUR, millions)

	All sectors	Short term	Medium term	Long term	Total
Social sectors	Housing	1,440	2,331	988	<b>4,758</b>
	Health	55	167	171	<b>393</b>
	Education	132	145	153	<b>429</b>
	Social protection	81	37	16	<b>134</b>
	Culture and cultural heritage	160	328	199	<b>687</b>
Productive sectors	Business	199	149	114	<b>462</b>
	Agriculture	74	66	51	<b>191</b>
Infrastructure sectors	Transport and communications	81	81	41	<b>203</b>
	Energy	29	22	22	<b>73</b>
	Water and flood protection	50	187	278	<b>514</b>
	Public administration and community infrastructure	50	174	95	<b>320</b>
Cross-cutting sectors	DRR and civil protection	44	59	25	<b>128</b>
	Geology and land stability	18	79	15	<b>112</b>
	<b>Total</b>	<b>2,381</b>	<b>3,847</b>	<b>2,176</b>	<b>8,404</b>

Source: Estimations by the assessment team using official information.

## Going Forward

**Identifying disaster impacts and recovery needs is critical to define a targeted strategy for rebuilding physical infrastructure, restoring people's livelihoods, and setting a path for sustainable revitalization.** Quantified data on the physical impact on critical sectors can guide overall resilient reconstruction and sustainable redevelopment, and prioritization of specific investments and activities. Considering geography, a clear priority is Sisak-Moslavina County given the scale of damage and losses. Considering sectors, housing and the business sectors are critical, given also the major burden born by households and businesses.

**The following five principles could guide the recovery and reconstruction going forward:**

- **Sustainable revitalization:** The series of earthquakes occurred in a region facing several underlying socio-economic challenges facing local communities and their livelihoods. The recovery and reconstruction process offers opportunities to improve livability, create new economic opportunities, and introduce green and sustainable approaches fitting needs of the existing and future communities.
- **Focus on the vulnerable and in need:** Recovery and reconstruction activities must be inclusive and equitable, taking into consideration poverty, social

inclusion, gender equity, and actions needed for the most disadvantaged social groups.

- **Resilience:** The recovery process needs include measures and activities to improve physical resilience through building back better and functional upgrades as well as capacity of the institutions, businesses, and communities to be better prepared for future events. Land use and spatial planning needs to be risk-sensitive and based on research and monitoring of the geological situation.
- **Coordination and coherence of approaches:** To identify synergies and complementarities, the short-, medium-, and long-term objectives should reinforce each other, align with sectoral reform programs, and with development plans at both national and local levels.
- **Monitoring and evaluation:** The recovery process should be measured against established targets/performance indicators and timelines; and monitored in a transparent process including consultation with the affected societies and groups.

**The prioritization process for recovery and reconstruction planning should consider the following key aspects:**

- Ensuring safety and security of people by continuing monitoring of geological/natural processes, and health risks (such as debris, buildings safety, and so on).



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- Addressing the most urgent and basic needs of the affected population (particularly vulnerable groups), including food and shelter/housing, public services, and economic activity restoration.
- Upgrading public access to basic services and markets, strengthening different facets of disaster and climate resilience, and using recovery to enforce reforms for sustainable results.

**Recovery and reconstruction planning can draw on actions taken following the March 2020 earthquake, including legal, engineering, institutional, and financial arrangements, and efforts conducted so far in response to the December events.** The government has already responded to the earthquake by financing emergency repairs, updating the regulatory framework for the reconstruction of damaged buildings developed after the March 2020 earthquake. During the first three months of 2021, Croatian authorities spent HRK 240 million (equivalent to EUR 31.6 million), including HRK 120 million (equivalent to EUR 15.8 million) of immediate intervention assistance funds<sup>6</sup> with further funds being secured.

#### Going forward, considering the principles and pri-

<sup>6</sup> <https://vlada.gov.hr/vijesti/vlada-odobrila-120-milijuna-kuna-pomoci-zupanijama-pogodjenim-potresom/31165>.

#### **orities outlined above, the following aspects should be considered:**

- Alongside central, regional, and local authorities, existing institutions dedicated to reconstruction efforts, such as Reconstruction Fund and the State Office for Housing and Reconstruction need to be closely involved in recovery and reconstruction process.
- The process needs to be aligned with strategic/development plans at different levels, including the 2030 National Development Strategy, to ensure linkages with broader reform programs.
- The recovery and reconstruction recovery process needs to be aligned with the National Recovery and Resilience Plan 2021-2026, which foresees financing of post-earthquake activities, as well as the different instruments under the EU's Multiannual Financial Framework 2021–2027, which can support the achievement of medium and long-term priorities.

The government has already initiated a long-term program of post-earthquake recovery by establishing the inter-ministerial working group tasked with drafting a comprehensive recovery strategy. The RDNA process, impact and needs estimations, and recommendations can serve as a basis for the next steps.



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# INTRODUCTION

# INTRODUCTION

## Country Disaster Risk Context

**C**roatia is located within the seismically highly active Alpine-Mediterranean region. Comprising the Pannonian basin, the Eastern Alps, and the Dinarides, this territory has a high potential of earthquake occurrences. The most earthquake-prone areas in Croatia are in the northwestern part and along the Adriatic coastal area. Croatia is vulnerable to the impacts of earthquakes due to a stock of infrastructure built before modern seismic codes and construction practice, with the first seismic code being passed in 1964. Although modern infrastructure is up-to-date with the standards of the modern Eurocode 8 (EC8), it is estimated that up to one-third of buildings in Croatia are not up to EC8.

**To date, several major earthquakes were recorded in central and northwestern Croatia.** The most recent event, prior to the December 2020 earthquakes, was a 5.5 magnitude earthquake which affected Zagreb and surrounding areas in March 2020. Occurring during a nationwide COVID-19 pandemic lockdown, the earthquake resulted in one fatality, 26 injuries, thousands of displaced people, and damages to about 26,000 buildings in the City of Zagreb, Krapina-Zagorje County, and Zagreb County. The RDNA, conducted focusing on three administrative areas and five key sectors (housing, health, education, culture and cultural heritage, and business), estimated the total cost at EUR 11.3 billion, with EUR 10.66 billion referring to destroyed physical assets and EUR 640 million to losses<sup>7</sup> Geographically, the most affected was the City of Zagreb. The total affected surface area was over 22.2 million m<sup>2</sup>, with 82 percent recorded in the housing sector (18.1 million m<sup>2</sup>).

**Croatia is also susceptible to other natural hazards.** Flooding is one of the most dangerous hazards in Croatia. Over half of Croatia's territory—accounting for 87 per-

cent of the Croatian population—is categorized as having a high to very high potential flood risk.<sup>8</sup>In central Croatia, recurring storms and wind, at times escalating into hail and heavy rainfall, contribute to the flooding of densely inhabited areas, including Croatia's capital, Zagreb. Croatia also experiences both extreme heat and extreme cold. In Croatia's mountainous regions, severe snowstorms are frequent. Croatia's coasts are prone to experiencing storms, cyclones, and intense winds such as the bora. Wildfires—mostly forest fires in the coastal regions—can be especially damaging. This was the case for the wildfire season of 2017 affecting the Adriatic coast. As climate change increasingly manifests itself, Croatia has been experiencing rising summer temperatures: for example, the heatwave of 2019 saw temperatures climb to over 40°C throughout Croatia. Droughts have therefore become increasingly commonplace, primarily affecting the Mediterranean and Eastern parts of Croatia, and causing over US\$1 billion in damages between 2010 and 2019.<sup>9</sup> Future projections indicate rising temperatures and decreasing rainfall, resulting in increases in heatwaves, droughts, and dry spells leading to wildfires.

## Socioeconomic Context

**The areas that were most affected by the December 2020 earthquake were Sisak-Moslavina County, Karlovac County, Krapina-Zagorje County, Zagreb County, and the City of Zagreb.** These areas have a combined population of over 1.55 million which accounts for approximately 37 percent of Croatia's population. They are situated in central and northwestern part of Croatia. Although geographically proximal, these areas have diverse levels of economic development. The affected area has been lagging economically. Karlovac and Sisak-Moslavina Counties were also severely affected by the Homeland War (1991–1995) which led to the introduction of measures for the reconstruction of the destroyed and

<sup>7</sup> See Government of the Republic of Croatia. 2020. *Croatia Earthquake: Rapid Damage and Needs Assessment 2020*. ([https://mgipu.gov.hr/User-Files/Images/dokumenti/Potres/RDNA\\_web\\_04082020.pdf](https://mgipu.gov.hr/User-Files/Images/dokumenti/Potres/RDNA_web_04082020.pdf))

<sup>8</sup> [https://www.voda.hr/sites/default/files/dokumenti/prethodna\\_procjena\\_rizika\\_od\\_poplava\\_2018\\_0.pdf](https://www.voda.hr/sites/default/files/dokumenti/prethodna_procjena_rizika_od_poplava_2018_0.pdf).

<sup>9</sup> World Meteorological Organization; United Nations Development Programme; United Nations International Strategy for Disaster Reduction; European Centre for Medium-Range Weather Forecasts; European Organisation for the Exploitation of Meteorological Satellites; European Meteorological Services Network. "Chapter 4: Meteorological, Hydrological and Climate Services to Support Disaster Risk Reduction and Early Warning Systems in Croatia." 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 (ROE); 2012.

damaged physical assets and for ensuring the conditions for the return of displaced persons and refugees. These areas have never fully recovered after the war.

**Sisak-Moslavina County** has seven cities and twelve municipalities, with Sisak as the county capital. Geo-strategically, it is located near the Sava River and with a railway connection to the port of Rijeka. The county is considered one of the lagging areas of development growth with an aging population and outmigration. It is a production- and export-dependent county, with more than 2,000 companies and 2,000 crafts. The main economic activity is the processing industry. The county is also well-known for rearing indigenous breeds of the Croatian Posavac and Croatian Coldblood horses as

well as for growing indigenous grape varieties such as škrljet. The county is rich in vibrant and diverse natural landscapes that have the potential to be major tourist attractions, such as the Lonjsko Polje Nature Park, the Topusko geothermal springs, and the unused iodine waters in Sisak. Due to Sisak's proximity to the Sava River, there are prospects of connecting the port of Rijeka via the Danube and Sava Rivers as well as by rail. Such connections would facilitate travel and transport to and from Central and Eastern Europe.

**Karlovac County** has five towns and seventeen municipalities, with Karlovac as the county capital. The county has a processing industry with food and beverage production activities, finished metal products, machinery

**Table 4.** Select socioeconomic indicators for the affected area

Administrative unit	Absolute value	Share in Croatia (%)
<b>Sisak-Moslavina County</b>		
Population (2019)	145,904	3.6
GDP (2018) (EUR, millions)	1,309	Index (Croatia = 100) 2.6
GDP (2018) per capita (EUR)	7,868	Index (Croatia = 100) 64.1
Unemployment rate (March 31, 2019) (%)	19.9	6.5
<b>Krapina-Zagorje County</b>		
Population (2019)	124,517	3.1
GDP (2018) (EUR, millions)	1,021	Index (Croatia = 100) 2.0
GDP (2018) per capita (EUR)	7,919	Index (Croatia = 100) 64.5
Unemployment rate (March 31, 2019) (%)	6.4	1.7
<b>City of Zagreb</b>		
Population (2019)	807,254	19.9
GDP (2018) (EUR, millions)	17,544	Index (Croatia = 100) 34.3
GDP (2018) per capita (EUR)	22,695	Index (Croatia = 100) 185.0
Unemployment rate (March 31, 2019) (%)	3.7	11.7
<b>Zagreb County</b>		
Population (2019)	309,169	7.6
GDP (2018) (EUR, millions)	3,011	Index (Croatia = 100) 5.9
GDP (2018) per capita (EUR)	9,710	Index (Croatia = 100) 79.1
Unemployment rate (March 31, 2019) (%)	6.3	4.0
<b>Karlovac County</b>		
Population (2019)	115,484	2.8
GDP (2018) (EUR, millions)	1,035	Index (Croatia = 100) 2.0
GDP (2018) per capita (EUR)	8,301	Index (Croatia = 100) 67.7
Unemployment rate (March 31, 2019) (%)	9.9	2.7

*Source: Croatian Bureau of Statistics (CBS). GDP (CBS in "Gross Domestic Product for Republic of Croatia, at NUTS 2013 - 2nd Level and by Counties" 2018); population (CBS in "Natural Change in Population - Review by Counties" 2019); unemployment rate (CBS in "Employment - Review by Counties" 2017, data for 2019); average monthly net salary (CBS in "Employment - Review by Counties," data for 2018).*

and equipment, rubber and plastic products, wood processing, and textile production and is home to various businesses. Bordering the Republic of Slovenia and the Republic of Bosnia and Herzegovina, it has significant comparative advantage for business and research; the most crucial business zones are connected to the ports of Rijeka, Zadar, and Split and the airport in Zagreb. These connections also augment tourism opportunities.

**Krapina-Zagorje County** includes seven cities and twenty-five municipalities, with Krapina as the county capital. The county's economy is predominantly export oriented and has a positive balance of foreign trade, with steadily increasing exports. As much as one-third of total revenues are generated in foreign markets, and the economy's foundation is the processing industry. The county is rich in many natural raw materials, including thermal springs. In recent years, increasing investments in the tourism sector were made. Several companies in the county operate within global groups and contribute to solid business results. There is a need for balanced and prolonged development that considers the area's diversity, strengthening of communal infrastructure, and preserving of the natural and cultural-historical values.

**Zagreb County** has nine cities and twenty-five municipalities, while its headquarters is located in Zagreb. The proximity of the border with Slovenia makes this area an essential crossroads for European traffic routes. The county is one of the most economically stable, fastest growing, and most developed regions in Croatia. The county has valuable natural potential, a qualified workforce, developed crafts, public administration availability, and excellent living conditions. Zagreb County provides opportunities for investments in energy systems, the food industry, agricultural production, and tourism. By investing in communal infrastructure, Zagreb County creates the preconditions for attracting new investors. The county has major investments into water supply systems, education, and entrepreneurship.

**The City of Zagreb** is the capital of Croatia and its largest city. It is also the economic, political, and cultural center of the country, generating 34.1 percent of its GDP. In 2018, 46.9 percent of Croatia's total investments in new fixed assets were achieved in the city. The wholesale and retail trade, the processing industry, and electricity and gas supplies are central industries in the city. As far as trade is concerned, the City of Zagreb accounted for 37.9



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percent of total exports and 59.2 percent of total imports to Croatia in 2018. There is a significant share of the total population of the City of Zagreb that is classified as highly educated. With the 10 percent growth in the city budget revenue, 20 percent of the total budget funds was allocated to education.

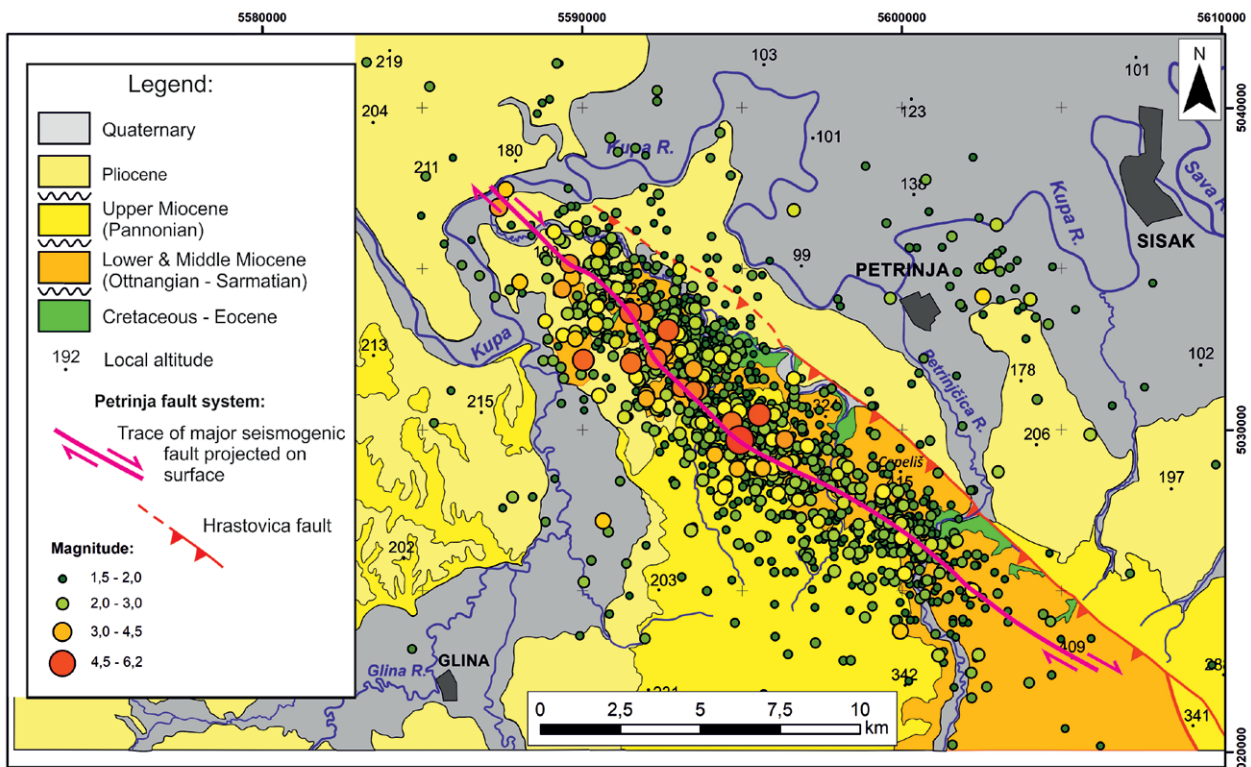
## Description of the December 2020 Earthquake

**On December 28, 2020, at 6:28 a.m., a magnitude 5.0 earthquake occurred with the epicenter near the town of Petrinja.** Several strong earthquakes followed on the same day. The next day, at 12:19 p.m., the area around Petrinja was struck by a devastating earthquake of local magnitude 6.2 killing seven people. This was followed by numerous subsequent aftershocks. The epicenter of

the 6.2 magnitude (local) main shock on the December 29, 2020, was some 6 km southwest of Petrinja, with the epicenter intensity estimated to VIII-IX° of the European Macroseismic Scale (EMS), classified as heavily damaging to destructive. The seismogenic source for the mainshock and most of the foreshocks and aftershocks is the 20 km long northwest-southeast striking dextral strike-slip fault located at about 7.5 km southwest of Petrinja (Figure 1). More detailed information is in Annex 2.

**The earthquake caused damage to buildings and infrastructure.** By the end of February 2021, approximately 43,000 buildings were reported as damaged; out of these, close to 25,000 have been inspected for usability by the civil engineers. Some 35 percent of the dwellings that were inspected were deemed completely or temporary unusable. While they are of lower intensity, the aftershocks experienced can cause additional damage and losses, including to the housing stock.

**Figure 1.** Simplified geological map of the Petrinja epicentral area



**Source:** Geological map is simplified and modified from Pikija, M. (1987): *Basic Geological Map of Yugoslavia*, 1:100.000, sheet Sisak, L 33-93. Fed. Geol. Survey, Beograd. Epicenter data are obtained from the Croatian Seismological Survey (CSS).

**Note:** The figure shows a part of the earthquake sequence (December 25, 2020, to February 15, 2021) and the main northwest-striking dextral seismogenic fault projected on the surface. The December 29, 2020, mainshock epicenter is shown by the largest red circle.

Estimates indicate that a total of 193 buildings in the health sector were damaged by the earthquake.<sup>10</sup> In the education sector, a total of 271 buildings were affected.<sup>11</sup> Infrastructure damage to roads, flood protection, and other types of infrastructure was also recorded as described in the sectoral assessment.

**Numerous ground failures, including liquefaction, surface ruptures, landslides, and cover-collapse sinkholes, occurred in the epicentral area and throughout the five affected counties.**<sup>12</sup> In the area hit by the destructive earthquake, over 100 cover-collapse sinkholes were recorded by the end of February 2021, mostly near the settlement of Mečenčani. Monitoring and analysis of their expansion started immediately after the main shock. Widespread occurrences of liquefaction were also recorded, which can cause significant damage to facilities; the soil underneath the foundations disappears, thus losing its load-bearing capacity and threatening the stability of buildings. A significant ground displacement has occurred, with the greatest displacement in the Petrinja area, Glina, and Sisak (see Annex 2). Initial measurements will be used to plan the activities and evaluate costs related to restoring the geodetic base, homogenizing cadastral plans, performing necessary cadastral-geodetic measurements, and preparing the guidelines for further research and actions related to land-use and spatial planning.

**The extent to which these post-seismic changes will affect the construction sector remains to be determined.** Considering that there are still aftershocks, subsequent damage to large infrastructure facilities is possible, with a risk of an adverse environmental impact. Sisak-Moslavina County has a total of 270.02 km of the main gas pipeline, with various diameters and pressure loads, as well as 15 metering and reducing stations. In the area of the Velika Ludina Municipality, there is an underground gas storage, 'Okoli', with the operating volume of about 350,000 m<sup>3</sup>. The storage and transport capacities are owned by the companies Jadranski naftovod d.d. (JANAF) and Industrija nafte d.d. (INA). JANAF's storage capacities in Sisak amount

10 Health buildings include health centers, hospital/clinics, health institutes, and pharmacies; includes public and private buildings

11 Education buildings include kindergartens, primary schools, secondary schools, higher education institutions, research institutes, adult education providers, student dorms, and pupil dorms.

12 Liquefaction is a phenomenon occurs on sandy, water-saturated soil when it loses its compactness and load bearing capacity transitioning into a liquid or semi-liquid state.

to 400,000 m<sup>3</sup> of oil, and the length of the oil pipeline is 155.41 km. In Sisak-Moslavina County, there are five water supply systems that are also endangered due to the possible occurrence of landslides, rockslides, and erosion. In the affected areas, Sisak-Moslavina and Karlovac counties are also facing the problem of contamination of land surfaces with mines as well as explosive or unexploded ordnances. Due to the inaccessibility of mine-suspected areas, they cannot be used for economic purposes, movement, residence locations, implementation of fire protection, state border surveillance, flood protection measures, and so on.

## Disaster Response

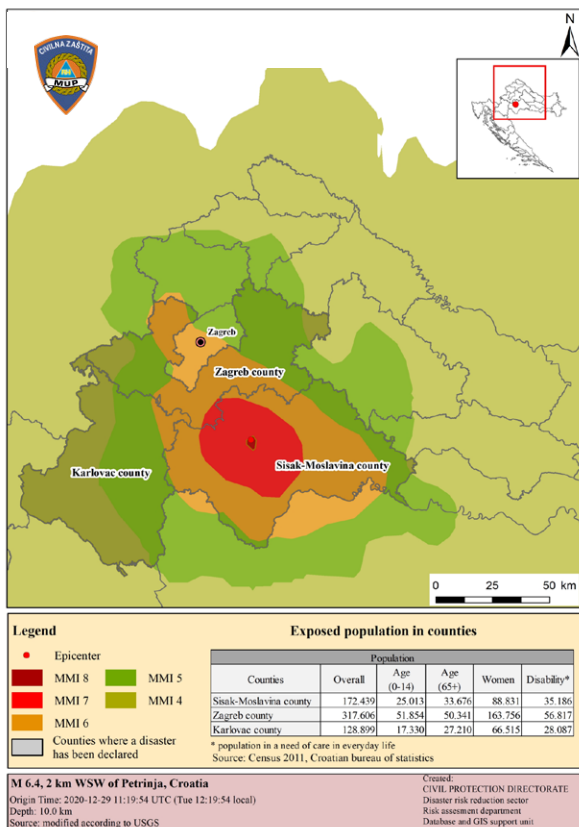
### *Immediate Government Response*

**On January 4, 2021, the Croatian Government declared a state of disaster for the following counties:** Sisak-Moslavina, Zagreb, and Karlovac, as per Figure 2. Four counties declared a state of emergency (Sisak-Moslavina, Karlovac, Krapina-Zagorje, and Zagreb). State of emergency was also declared in numerous municipalities (Figure 3). Sisak-Moslavina County declared a state of emergency for seven towns (Glina, Hrvatska Kostajnica, Kutina, Novska, Petrinja, Popovača, Sisak) and for 12 municipalities (Donji Kukuruzari, Dvor, Gvozd, Hrvatska Dubica, Jasenovac, Lekenik, Lipovljani, Majur, Martinska Ves, Sunja, Topusko, and Velika Ludina). Karlovac County declared a state of emergency for three towns (Karlovac, Ozalj and Slunj) and for seven municipalities (Lasinja, Barilović, Krnjak, Ribnik, Vojnić, Kamanje, and Draganić). Krapina-Zagorje County declared a state of emergency for one town (Klanjec) and for nine municipalities (Bedekovčina, Desinić, Krapinske Toplice, Lobar, Sveti Križ Začretje, Tuhelj, Kumrovec, Mače, and Marija Bistrica). Zagreb County declared a state of emergency for eight towns (Dugo Selo, Ivanić-Grad, Jastrebarsko, Samobor, Vrbovec, Zaprešić, Sveta Nedjelja, and Velika Gorica) and 19 municipalities (Bedenica, Bistra, Brckovljani, Brdovec, Jakovlje, Dubrava, Dubravica, Gradec, Luka, Kloštar Ivanić, Kravarsko, Marija Gorica, Pisarovina, Pokupsko, Pušća, Rakovec, Rugvica Klinča Sela, Orle, and Križ). The City of Zagreb did not declare a state of emergency following this earthquake.

**Civil protection structures, the army, firefighters,**



**Figure 2.** Counties where a state of disaster was declared after the earthquake near Petrinja

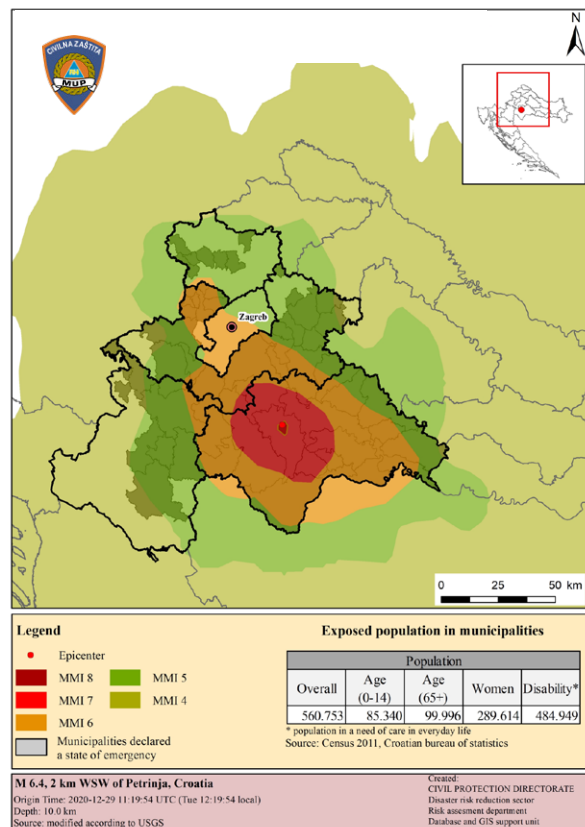


Source: Civil Protection Directorate, MoI.

mountain rescue services, and police immediately responded to the disaster. Relevant stakeholders were mobilized in the most direly affected areas. After the immediate rescue operations, personnel remained in the field to conduct preliminary damage estimates and aid in debris removal. However, the immediate emergency and humanitarian responses were hindered by various factors. Impediments ranged from the cold and rainy weather to the COVID-19 pandemic. Additionally, the large size of the affected area, as well as the significant distance in between villages, and the share of the population that was elderly and/or poor, augmented issues of coordination. The Croatian Red Cross (CRC), other CSOs, and numerous volunteers were distributing emergency supplies such as food, water, and blankets to the affected population.

**On December 28, 2020, engineers and experts visited**

**Figure 3.** Municipalities that declared a state of emergency after the earthquake near Petrinja



the sites to make preliminary damage estimates.<sup>13</sup> Supported by the Civil Protection Directorate, humanitarian aid was provided to the affected population along with donations; volunteer activities were organized to ensure the delivery of food, clothes, personal hygiene, sanitary, and other supplies as well as to aid in debris removal efforts. Following search and rescue operations, the Croatian Firefighting Association, the Croatian Mountain Rescue Service (CMRS), the Croatian Police, and the Croatian Army began removing construction materials; securing unstable locations; putting up container houses, mobile homes, and tent settlements; providing care and supplies such as food, potable water, and other items to the population; and working on remediating the damage. The Croatian Army recorded the critical infra-

<sup>13</sup> Including, but not limited to, the Faculty of Civil Engineering (FCE), Croatian Centre for Earthquake Engineering, Croatian Chamber of Civil Engineering, Croatian Chamber of Architects, Croatian Chamber of Chartered Geodetic Engineers, Croatian Chamber of Electrical Engineers, Croatian Chamber of Mechanical Engineers, and so on.

structure damaged by using unmanned aircraft systems. This assessment was conducted to obtain a preliminary damage estimation. The Ministry of Defense and the Armed Forces have been at the disposal of the population and the local community in the affected area. On March 1, 2021, the Tracing Service recorded that a total of 3,599 persons have left their place of residence; of these, 388 have been temporarily displaced within the area affected by the earthquake, while 2,883 have been temporarily displaced to other parts of Croatia. The location of 328 persons was being established at the time of the assessment.

**Following the Government of Croatia's declaration of a state of disaster for Sisak-Moslavina, Zagreb, and Karlovac Counties, efforts were made by the state administration to limit the administrative burdens placed on the affected population.** To that effect, Article 172 of the Enforcement Act exempts donations from enforcement. Similarly, enforcement debtors could request a postponement of the enforcement. State administration also organized and implemented a program of vaccination for COVID-19 for the civilians temporarily residing in the Petrinja barracks and the Croatian soldiers participating in removal of earthquake damages and debris. This was coordinated in cooperation with the Ministry of Health (MoH) and the Croatian Institute of Public Health.

**Within a week of the mainshock earthquake, the government provided emergency assistance in the form of EUR 15.8 million to be allocated toward efforts to mitigate the damages suffered by the affected counties.** Sisak-Moslavina County, having been the most severely hard-hit county, received a large proportion (EUR 13.2 million) of the emergency funds. The Deputy Prime Minister and Minister of Veterans was appointed to chair the high-level Civil Protection Committee. This committee was established to oversee the efforts to assuage the short-term damages and curb the long-term consequences of the earthquake. The website <https://potresinfo.gov.hr/> was established as the main online resource to keep track of the activities of the committee, the efforts of volunteers, and the aid donated, as well as information on how to donate or volunteer. In addition, the State Budget Treasury opened dedicated earthquake relief accounts to raise funds and the CRC contributed significant funds.

## *Initial Field Assessment*

**The initial post-earthquake damage and usability assessment survey of affected buildings was developed according to Italian experiences (Post-Earthquake Damage and Safety Assessment and Short-Term Countermeasures, [AeDES]) and adapted to local circumstances.** The inspection of usability and damage took place mainly in the entire Sisak-Moslavina County; however, a part of the engineers' teams also inspected the buildings in Zagreb County, Karlovac County, Krapina-Zagorje County, and the City of Zagreb. The inspections were performed by civil engineers in teams of two. During each assessment, engineers fill out the Collector GiS application (ArcGIS Online geoinformation platform, Collector)<sup>14</sup> which was developed after the earthquake in Zagreb on March 22, 2020. This application was upgraded and improved based on the experiences from the Zagreb earthquake while also adapted locally to the typology of buildings in the affected areas. The engineers entered necessary attributes, photos and damage data, and additional data needed to calculate the costs into the application. Data were automatically collected in the database and processed in the coordination center. Calculation of damages was based on the database.

## *Response from Volunteers*

**With the threat of continued aftershocks, and during the COVID-19 pandemic, volunteers and civil society groups came together, united in their efforts to aid the affected population.** Civil engineers, alpinists, sports associations, and ordinary citizens from all around Croatia and beyond stepped up to help alongside civil protection forces in the earthquake-stricken area. The volunteer efforts of the civil engineers from the Croatian Center for Earthquake Engineering (Hrvatski centar za potresno inženjerstvo, HCPI) supported the rapid inspections on the usability of buildings. The 'Ninja krovnjače' climbers and alpinists, alongside firefighters, worked tirelessly in the removal of debris such as fallen chimneys and collapsed infrastructure, eliminating possible perils for pedestrians. The CRC's Search Services organized urgent efforts to reconnect

14 ArcGIS Collector is a mobile data collection application used for easy data capturing on the field and returning them to the office. ArcGIS Collector, <https://www.esri.com/en-us/arcgis/products/arcgis-collector/overview>, accessed April 19, 2021.



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family members with those injured or separated during the earthquakes.

**These organized volunteers were supported by the civil protection forces; together, they worked to stabilize the situation on the ground, minimize short-term hazards and instability, and promote a quick return to normalcy in the affected areas.** The CRC provided invaluable support in the form of psychological services and continues to provide psychosocial support to the victims of the earthquake. Football fan groups organized clothing and food donations as well as journeyed to the affected areas in an overwhelming display of support. Similarly, hundreds of chefs volunteered, seeing the closure of their restaurants due to COVID-19 pandemic as an opportunity to provide direct assistance in the preparation and organization of meals and food supplies. Construction firms and workers selflessly volunteered their services and labor to support reconstruction efforts in the affected areas.

**The CRC's volunteers ranged from seasoned experts to youth who signed up specifically to assist in this event.** The volunteers worked incessantly to ensure that they distributed clothes and food and provided psychosocial

support to the affected population while promoting a message of solidarity that resounded throughout Croatia. Donations have flowed in from all parts of Croatia and the world; these have included clothing, financial aid, housing containers, and many other forms of material and psychological assistance. They established website resources that could support those affected in finding assistance and direct those interested in volunteering or donating to the appropriate channels, provided regular updates on the activities organized in the aftermath of the earthquakes, and gathered funds through their hotlines and donation centers.

### *Support from Partners*

Following the activation of the European Union Civil Protection Mechanism (UCPM) and communication with the Emergency Response and Coordination Center, 15 UCPM member countries—Slovenia, Italy, Slovakia, Hungary, Greece, Austria, Romania, the Czech Republic, Portugal, Bulgaria, Germany, France, Turkey, Lithuania, and Sweden—within the UCPM and Poland, the United



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States, and Montenegro bilaterally provided support.<sup>15</sup> Moreover, many cities and towns, CSOs, embassies, companies, and individuals from Croatia and abroad (including the Croatian diaspora) sent donations. The World Bank provided technical assistance for the RDNA and supported donations for the affected areas. Numerous countries expressed solidarity with Croatia. The United Nations Children’s Fund (UNICEF), the United Nations High Commissioner for Refugees, the Organization for Security and Co-operation in Europe, and the World Meteorological Organization expressed solidarity and readiness to provide assistance.

### Recovery Planning

**The Government’s recovery planning draws on the experience and efforts made following the March 2020 earthquake, including legal, engineering, institutional, and financial arrangements and aspects.**

**After the March 2020 earthquake, the government drafted and approved the Law on the Reconstruction of Earthquake Damaged Buildings in the City of Zagreb, Krapina-Zagorje County, and Zagreb County which was extended to Sisak-Moslavina County and Karlovac County in January 2021.**<sup>16</sup> The law covers the rehabilitation and upgrading of both public and private buildings and establishes four levels of rehabilitation and reconstruction.<sup>17</sup> The law was amended in January 2021 to include also the affected areas from the December 2020 earthquakes sequence.

**The recovery efforts following the December 2020 earthquake draw on the Program of Measures, also developed following the March 2020 earthquake.** The Program of Measures for the reconstruction of earthquake-damaged buildings in the affected areas establishes measures related to the reconstruction of public buildings, multi-apartment buildings, commercial build-

15 Provided 974 winter tents, 248 lamps with protection from PVC mesh (indoor), 8 balloons/towers for lighting 50,000–190,000 lux, 501 electric heaters, 4,890 folding beds, 3,844 sleeping bags, and 146 housing containers.

16 National Gazette 102/2020—approved in September 2020 and amended in January 2021.

17 This includes: (a) repair of nonstructural elements of buildings required for legal use and occupancy of a building, (b) repair of structural elements, (c) upgrade of structural elements, and (d) full rehabilitation and reconstruction.

ings, residential-business buildings, and family houses. The program prescribes Level 3 or 4 for public buildings reconstruction, depending on building purpose and importance/category.<sup>18</sup> Overall reconstruction for all public buildings is mandatory, considering basic buildings requirements such as structural safety, fire, health, EE, accessibility, and noise reduction.

**Following the December 2020 earthquake, the Central Office for Housing and Reconstruction** was made responsible for the demolition of family houses and building of replacement family houses exclusively in those areas where disaster was declared in Sisak-Moslavina County, Karlovac County, and Zagreb County. The state will cover 100 percent of expenses for structural reconstruction of private housing in the areas which were most severely hit by the December 2020 earthquake and for which a state of disaster was declared. The Central State Office for Reconstruction and Housing Care coordinates this housing plan, with the aim of securing high-quality and energy-efficient housing for all those affected.

**Moreover, the Reconstruction Fund was established in October 2020 following the Zagreb earthquake to coordinate reconstruction of privately owned buildings damaged by the earthquake and monitoring the implementation of the Program of Measures.** The fund is responsible for the reconstruction of multi-residential buildings in all four counties and the City of Zagreb and for family houses in the areas where national disaster after the December 2020 earthquake was not proclaimed. Expenses for structural reconstruction of family houses, residential and commercial buildings, and multi-apartment buildings and construction of substitute housing for families whose homes were declared uninhabitable/temporarily uninhabitable were set to be covered by public resources in the following manner: 60 percent by Croatia, 20 percent by counties, and 20 percent by the owners.

**Within three months of the December earthquakes, Croatian government applied for the EUSF to cover emergency intervention measures, temporary housing**

18 National Gazette 102/20 and 10/21. Hospitals, important services, and buildings of public and national importance are to be designed to meet Level 4 of reconstruction, while other public buildings (sport facilities, theaters, cinemas, kindergartens, schools, faculties, churches, and so on) should meet Level 3. National Gazette 127/2020 Guidelines prescribes the content and technical elements of designing documentation for each category of building defined in the Program of Measures.

**care for the affected populations, and the removal of debris, as well as the reconstruction of public infrastructure and public buildings.** This builds on the country's experience following the March 2020 earthquake, when Croatia was able to request and receive over EUR 680 million from the EUSF for recovery efforts, which is the second highest amount ever paid by the EUSF.<sup>19</sup> Public calls were published by the Ministry of Culture and Media (MoCM), MoH, and Ministry of Science and Education (MoSE) for the design documentation and works to be financed by funds from the EUSF received following the March 2020 earthquake.

**The government's medium-term plans also include co-financing of the reconstruction of damaged public infrastructure and apartment buildings.** These plans will be implemented using the National Recovery and Resilience Plan 2021-2026 and programs under the Multiannual Financial Framework 2021-2027. In consultation with the European Commission (EC), the Ministry of Regional Development and EU Funds (MoRDEUF) began amending the Operational Programme Competitiveness and Cohesion 2014-2020 to reallocate up to EUR 111 million of savings toward to the provision of permanent housing solution for the approximately 2,000 families who lost their homes.

## Assessment Objectives and Methodology

**The main objective of the RDNA is to assist the Government of Croatia in the assessment of the impacts of the earthquake by estimating damage and losses to inform a recovery strategy.** The RDNA helps inform complete rehabilitation and reconstruction of the damaged infrastructure and livelihoods while ensuring resilience to future disasters. The specific objectives of the RDNA are as follows: (a) estimate the sector-specific and overall multisectoral effect of the earthquake in the affected area, namely, Sisak-Moslavina, Zagreb,

19 Following the March 2020 earthquake, responding to the government's request, the World Bank provided timely technical assistance for a RDNA and helped prepare the Earthquake Recovery and Public Health Preparedness Project and a Development Policy Operation to ease the burden of the economic impacts. Project: <https://projects.worldbank.org/en/projects-operations/project-detail/P173998> Press release: <https://www.worldbank.org/en/news/press-release/2020/06/26/world-bank-supports-croatia-to-weather-difficult-times-caused-by-covid-19-pandemic-and-recent-earthquake>

Karlovac, and Krapina-Zagorje Counties and the City of Zagreb;<sup>20</sup> (b) assess multisectoral effects of the disaster and propose short-, medium-, and long-term recovery and reconstruction needs including reflected costs and timeline; and (c) integrate the seismic safety, BBB, EE, and DRR concepts into recommendations for a recovery and reconstruction strategy to improve future disaster resilience. The international damage and loss assessment (DaLA) methodology, which comprises the following key concepts, was used for the assessment:

- **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.
- **Recovery and reconstruction needs** are based on damages and losses in terms of recuperation of economic and human needs, livelihoods, access to services, means of production, security, and so forth. Needs consider BBB and DRR to reduce vulnerabilities and build resilience.

**The DaLA methodology was adapted to the requirements of the local context.** This RDNA methodology considered the approved Law on Reconstruction of Damaged Buildings in Zagreb and the Surrounding Area, the Program of Measures, and the government's assessment of damage and losses as part of its application to the EUSF. The RDNA focused on social, productive, infrastructure, and cross-cutting issues. The monetary values are expressed in euro, with exchange rate of EUR 1 = HRK 7.535846. All costs expressed include the national value added tax (VAT) (25 percent). More details are included in Annex 1.

**The RDNA draws on the data from the initial field assessment.** The following categories of building usability were employed when assessing the usability of buildings (see Table 5): U0 - usable without damage, building not damaged (white label); U1 - usable without limitation;

U2 - usable with a recommendation (green label); PN1 - temporarily unusable and requiring detailed inspection; PN2 - temporarily unusable with necessary emergency measures (yellow label); N1 - not usable due to external influences; and N2 - not usable due to damage (red label). 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](http://www.hcpi.hr), set up by volunteer civil engineers after the earthquake.

**The usability labels are correlated with the damage according to EMS-98 (grades 1 to 5) based on which costs of repair and renovation have been established** (Table 5). In line with best practices from post-earthquake reconstruction experiences (especially when it comes to buildings typologies such as unreinforced masonry and to a lesser extent confined masonry), costs were adopted in relation to the cost of construction of a replacement building. In determining the prices, developments related to reconstruction prices in Italy following the previous earthquakes were also taken into account (Dayala et al. 1997), depending on the typology of the damaged buildings and the principle that buildings are restored to their pre-earthquake condition with additional minimum interventions that need to be performed to strengthen the critical elements that led to the damage or partial collapse of a building.

**Table 5.** Usability and damage levels for buildings

		Type of building				
U0	U1	U2	PN1, PN2, N1	N2		
D0	D1	D2	D3	D4	D5	

Source: RDNA team.

20 Focus will be on any significant and clearly additional damages to avoid duplicate damages already accounted for in Zagreb RDNA following the March 2020 earthquake.



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# ECONOMIC AND SOCIAL IMPACT



# ECONOMIC AND SOCIAL IMPACT

## Macroeconomic Impact

### *Sector Overview and Baseline Data*

**B**efore the COVID-19 pandemic and earthquakes in March and December 2020, Croatia saw a steady but relatively slow economic growth. Real GDP only in 2019 reached the 2008 level of income. With 65.2 percent of the EU-27 average GDP per capita in 2019 (based on purchasing power parity), Croatia is the second-poorest country in the EU. The pre-pandemic growth was also linked to strong tourism performance which also made Croatia highly vulnerable to adverse shocks such as the current pandemic.

**The COVID-19 outbreak had a dramatic effect on the country's economic activity.** Croatia's real GDP contraction in 2020, at -8.4 percent compared to 2019, was

the third highest in the EU (after Spain and Italy). The effects of the pandemic were aggravated by the devastating earthquake that hit Zagreb and the surrounding areas in March 2020. The tourism sector was the most affected, which was reflected in a sharp drop in export of services. On the other hand, the decline in exports of goods was relatively low, following recovery of external demand in the second half of the year. Domestic demand also contracted, with government consumption being the only component to grow. Although fiscal support measures significantly mitigated the decline in real disposable incomes, reduction in household consumption was still significant due to a drop in consumer confidence. On the supply side, the effects of the pandemic were relatively uneven across sectors. Hospitality services strongly contracted, given the type of social distancing measures that were put in place and disruptive travel restrictions, leading to a decline in tourist arrivals. The decline in manufacturing activities was relatively low, while agri-



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culture and construction activities continued to increase compared to 2019.

## Effects of the Disaster

### DISASTER IMPACT ON GDP

**The losses linked with the December 2020 earthquake are projected to lower the country's real GDP growth by 0.3 percentage points in 2021 compared to the baseline.** This impact is 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 DaLA estimates show that businesses and real estate activities have been hit the hardest by the earthquake, but it also had a significant negative effect on many other activities. On the other hand, the reconstruction and recovery efforts are expected to partially offset the initial negative effects on economic activity and accelerate recovery in subsequent years primarily through a faster growth of the construction sector.

**On the expenditure side, the earthquake is expected to hit private consumption the hardest in 2021.** A decline in real disposable income (due to disrupted business activities, adverse wealth effects related to damaged residential property, and fall in imputed dwelling rent) had a negative impact on households' consumption levels. However, recovery and reconstruction activities could lead to higher capital investment, thereby, offsetting, to a certain extent, a decline in consumption. In nominal terms, GDP in 2021 is estimated to be lower by about EUR 170 million. In 2022 and 2023, positive effects of investment for reconstruction will dominate leading to slightly higher GDP growth rates compared to baseline (by 0.3 percentage points in both years). The earthquake is expected to have no significant impact on inflation.

### SECTORAL IMPACTS

**The earthquake has caused economic losses in some key sectors, especially for real estate, trade, and manufacturing activities.** The earthquake losses in terms of real estate activities are mainly due to fall in imputed dwelling rent in damaged and severely damaged residential property and higher operational cost related to demolition and debris removal. The total effects (damages and losses) are valued at EUR 2.6 billion, with total damage amounting to EUR 2.5 billion and total losses estimated at EUR 109 million.

**The earthquake also led to significant losses in the business sector, notably in trade and manufacturing, due to business interruption, and to a smaller extent, higher operational costs related to demolition and debris removal.** Recovery initiatives are expected to partially mitigate these losses, yet at the aggregate level, trade and manufacturing could still experience significantly lower growth in 2021 compared to the baseline. Firms also suffered large damages, including to equipment, especially in the manufacturing sector. Total damages are estimated at EUR 322 million, of which equipment replacement values account for around EUR 40 million. While damages have limited direct effect on GDP, they can lower firms' potential for growth until the reconstruction and/or replacement of production equipment is completed.

**Culture, health, education, utilities, and transport sectors, including government buildings, roads hospitals, and schools, have also suffered damages, causing disruptions in terms of service delivery for the affected communities.** Total damages in these sectors are estimated at EUR 1.4 billion, with damages to the public sector accounting for around two thirds of total costs. The losses have also been significant, arising from larger operational expenses related to debris removal, emergency responses, costs of reallocating essential services in other areas, and so on.

**Agriculture sector was also significantly impacted.** The earthquake caused large damages to farm buildings, machinery, and equipment, and resulted in annual losses to crop and livestock production with total damages and losses estimated at EUR 102 million. The damage to affected arable surface was a result of geological processes, including liquefaction, sinkholes, and landslides.

On the other hand, earthquake emergency responses and reconstruction efforts are expected to support recovery in the subsequent period, partly offsetting the decline in the economy, mainly through the construction sector and related services including transport and professional activities in 2021.

### DISASTER IMPACT ON FISCAL POSITION

**Even before the earthquake, public finances in Croatia were significantly stretched, mainly due to the COVID-19 pandemic.** During the three year period before the pandemic, Croatia had been running a small

fiscal surplus, but in 2020 the plummeting economic activity and the sizable fiscal support package for the private sector to contain the impact of COVID-19 led to a strong increase in fiscal deficit and public debt. To mitigate economic and social effects of the COVID-19 pandemic and the earthquake, Croatia has implemented a package of fiscal measures equivalent to nearly 3.5 percent of GDP. The measures, coupled with a steep decline in tax revenues due to the economic downturn, are estimated to have resulted in a fiscal deficit of 7.2 percent of GDP in 2020 and pushed the public debt-to-GDP ratio above 89 percent of GDP.

**Fiscal expectations for 2021–2023 are centered on the assumption of gradual rebound of economic activity, which would lead to a decline in fiscal deficit and put public debt on a declining path.** During this period, the fiscal deficit is expected to drop to -2.9 percent in 2021 and further to -2.1 percent in 2022 and -1.6 percent in 2023. This, in part, reflects recovery of tax revenues due to GDP growth, in particular revenues from VAT and

discontinuation of COVID-19 support measures. The earthquake adds additional challenge to the fiscal position. Expenditures to partially mitigate December earthquake damage and losses in 2021 could result in EUR 40 million of higher budget expenditures. When combined with the loss of revenues due to lower economic activity due to the earthquake, the general government deficit is projected to increase by an additional 0.2 percent of GDP compared to the pre-earthquake baseline. While public investments related to post-earthquake recovery and reconstruction are expected to intensify in 2022 and 2023, these investments will be mainly financed by EU grants, which means that no significant worsening of public finances would occur.

## DISASTER IMPACT ON BALANCE OF PAYMENTS

**In line with the relatively modest impact on GDP, the earthquake is projected to have small negative impact on the trade balance in the short-term.** The trade balance-to-GDP ratio is expected to slightly im-

**Table 6.** Macroeconomic indicators

Time period	2020	2021	2022	2023
<b>Macroeconomic Indicators</b>	Actual/estimate	Difference compared to baseline	Difference compared to baseline	Difference compared to baseline
<b>Output and prices</b>				
<b>Real GDP growth rate (percent and p.p.)</b>	-8.4	-0.3	0.3	0.3
<b>CPI inflation (percent and p.p.)</b>	0.2	0.0	0.0	0.0
<b>Deflator (percent and p.p.)</b>	0.4	0.0	0.0	0.0
<b>Fiscal position</b>				
<b>Total revenue (EUR million)</b>	23,163.9	-78.0	70.6	60.3
<b>Total revenue (percent of GDP)</b>	47.2	-0.2	0.1	0.1
<b>Tax revenue (EUR million)</b>	18,345.1	-78.0	70.6	60.3
<b>Non-tax revenue (EUR million)</b>	4,818.9	0.0	0.0	0.0
<b>Expenditures (EUR million)</b>	26,684.6	300.0	100.0	150.1
<b>Expenditures (percent of GDP)</b>	54.3	0.1	0.2	0.3
<b>Fiscal balance (percent of GDP)</b>	-7.2	-0.2	-0.1	-0.2
<b>External sector</b>				
<b>Current account balance (EUR million)</b>	-379.0	90.7	-95.2	-67.5
<b>Current account balance (percent of GDP)</b>	-0.8	0.2	-0.2	-0.1
<b>Exports (EUR million)</b>	20,470.6	0.0	0.0	0.0
<b>Exports (percent of GDP)</b>	41.7	0.0	0.0	0.0
<b>Imports (EUR million)</b>	24,035.2	-90.7	95.2	67.5
<b>Imports (percent of GDP)</b>	48.9	-0.2	0.2	0.1

Source: Estimates by the assessment team using official information.

prove in 2021 given the fall in domestic demand, while post-earthquake effects on export levels are expected to be negligible. In the 2022 and 2023 horizon, the accelerated reconstruction could lead to increase in imports of construction materials and equipment. Against this backdrop, current account balance (CAB) forecast now stands at 0.5 percent of GDP in 2021, 0.7 percent in 2022, and 2.0 percent in 2023 compared to the pre-earthquake baseline of 0.3 percent, 0.9 percent, and 2.2 percent, respectively. However, this could be offset by the EU reconstruction grants which would lead to improvement of current and capital account balance over the next two years compared to baseline levels.

## Summary

**The devastating earthquake—with the epicenter near the town of Petrinja—took place at the end of a difficult year for Croatia.** The COVID-19 pandemic, which resulted in travel restrictions and the imposition of strong social measures, had already caused a major economic crisis, reflecting Croatia's strong reliance on tourism. According to the first estimate provided by the CBS, in 2020 the economy contracted by 8.4 percent compared to 2019, the third-largest decline in the EU. In addition, the earthquake in March 2020 had caused economic distortions and significant problems in terms of public service delivery.

**Recent estimates indicate that the December earthquake has caused damages that are equivalent to 8.4 percent of 2020 GDP, of which 80 percent pertains to the private sector, while overall losses are equivalent to 1.5 percent of Croatia's 2020 GDP.** The damages were relatively far-reaching across economic sectors with the hardest hit being those linked to housing (real estate activities),<sup>21</sup> followed by culture and business sector (manufacturing and trade).

**Given that the earthquake took place at the end of 2020, its negative effects on economic activity are expected to be mainly seen in 2021.** Adverse effects on GDP growth for 2021 are estimated at -0.3 percentage points (compared to the baseline), largely reflecting costs

21 Housing activities are reflected in the real estate activities in the GDP categories. They affect GDP primarily through a reduction of imputed rent on owner occupied dwellings and rent revenues lost from property owners. In this chapter, sectoral losses are mapped into the GDP categories which may have a different labelling than the sectoral assessments.

in relation to private sector business interruptions equivalent of EUR 340.6 million, partly mitigated by reconstruction activities. Against this backdrop, the Croatian economy is projected to contract by 4.7 percent in 2021, compared to the pre-earthquake baseline projection of 5.0 percent, while in 2022 and 2023, GDP growth is expected to be somewhat higher due to reconstruction activities reaching 3.7 and 3.4 percent (compared to 3.4 and 3.1 percent respectively, as per the pre-earthquake forecast).

The earthquake is expected to put an additional strain on public finances, which were already under significant pressure. In terms of intervention assistance funds, the Croatian authorities have secured as part of their 2021 budget, HRK 120 million (equivalent to EUR 15.92 million); nearly the double of this amount has already been spent during the first three months of 2021. Given that imminent reconstruction activities are likely to be further supported by the EUSF, the resulting adverse fiscal effects could be contained in the forecasting horizon. The fiscal deficit is estimated to be higher by 0.2 percent of GDP in 2021 compared to the pre-earthquake baseline levels of 2.9 percent of GDP (fiscal deficit).

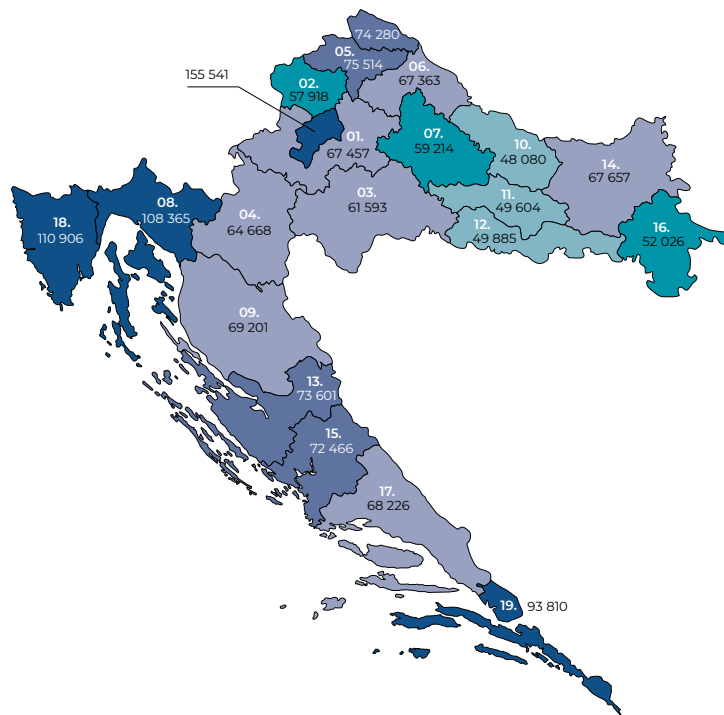
## Poverty, Social Inclusion, and Gender

### Sector Overview and Baseline Data

#### POVERTY

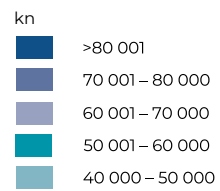
From an inclusion perspective, two of the most salient development challenges for Croatia are its relatively high poverty rates compared to the EU average and its large disparities in growth and poverty across different regions in the country. While the country's overall growth has been solid since the recovery from the financial crisis, the share of the population at risk of poverty is still higher than the EU average. In 2019, the most recent year of published figures, 18.3 percent of Croatians were at risk of poverty, a rate that is much higher than the EU average of 16.8 percent. The most vulnerable group is single-person households with at-risk-of-poverty rate of 45 percent. When these single-person households comprise an elderly (65 years of age or older), the at-risk-of-poverty rate reaches 50 percent, nearly triple the national average.

**Figure 4.** GDP per capita (2017)



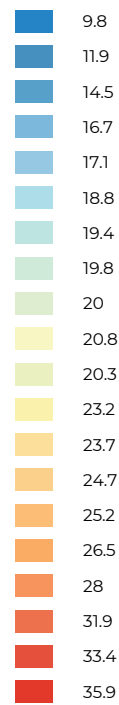
**COUNTIES**

- 01. County of Zagreb
- 02. County of Krapina-Zagorje
- 03. County of Sisak-Moslavina
- 04. County of Karlovac
- 05. County of Varaždin
- 06. County of Koprivnica-Križevci
- 07. County of Bjelovar-Bilogora
- 08. County of Primorje-Gorski kotar
- 09. County of Lika-Senj
- 10. County of Virovitica-Podravina
- 11. County of Požega-Slavonia
- 12. County of Slavonski Brod-Posavina
- 13. County of Zadar
- 14. County of Osijek-Baranja
- 15. County of Šibenik-Knin
- 16. County of Vukovar-Sirmium
- 17. County of Split-Dalmatia
- 18. County of Istria
- 19. County of Dubrovnik-Neretva
- 20. County of Međimurje
- 21. City of Zagreb



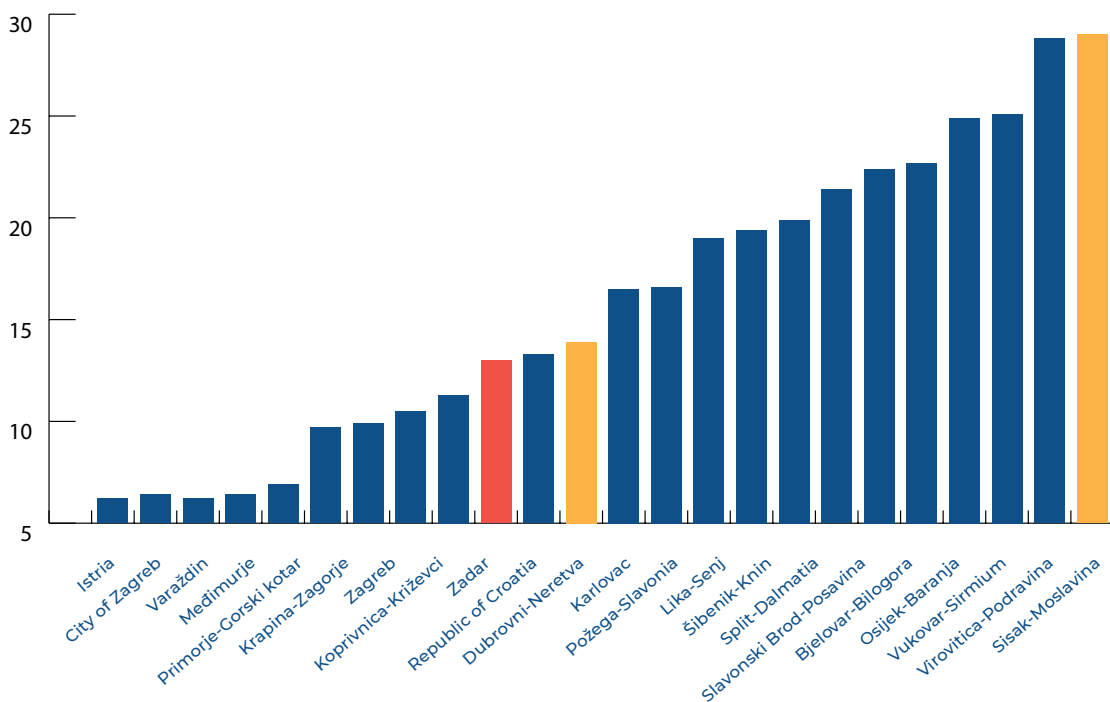
Source: <https://www.dzs.hr/HrvEng/publication/2020/12-01-03012020.htm>.

**Figure 5.** Income poverty at the county level



Source: CBS 2016.

**Figure 6.** Unemployment rate by county (2017)



Source: <https://www.hgk.hr/documents/trziste-rada5c52f766084a1.pdf>

Croatia already suffers from a relatively high poverty rate; additionally, the earthquake-affected counties—particularly Sisak-Moslavina County and Karlovac County—are among the poorest regions, with the lowest GDP per capita (Figure 4), most limited service delivery, and highest prevalence of at-risk-of-poverty rates (Figure 5). These counties are also characterized by high unemployment rates (Figure 6), and a high ratio of the elderly to working-age people. For example, in Sisak-Moslavina County, the number of retired people is higher than the number of employed people. About 14 percent and 12 percent of the population in Sisak-Moslavina County and Karlovac County, respectively, benefited from social assistance programs.

### VULNERABLE POPULATION

The areas struck by the earthquake have already suffered numerous calamities over the past 30 years. At some point parts of the population severely affected by the 1990s war—especially in Sisak-Moslavina County and Karlovac County—had to leave their homes or had their homes destroyed, with some of them later reconstructed in an inadequate way. Many have suffered from post-traumatic stress disorder. Deindustrialization has

also left a deep mark on the local population, leading to massive layoffs and pauperization. The area is also prone to natural disasters, including floods, landslides, and earthquakes. A combination of poverty, unfavorable demographics, and earlier trauma has resulted in a large part of the population having multiple vulnerabilities, including elderly people, children and youth, the chronically ill and people with disabilities, single-member households, families with many children, national minorities, and war veterans.

People living in Sisak-Moslavina County have faced particular hardship. The share of the population that is 65 years old and above is 19.53 percent, which makes the county one of the most demographically endangered in Croatia. In 2011, the share of the young population 14 years old or younger was only 14.51 percent. In 2008–2017, the population shrunk by 14.8 percent, making Sisak-Moslavina County one of the two Croatian counties with the largest relative decline in population. It was also the county with the greatest emigration pressure in the last decade; the migration balance with foreign countries in 2008–2017 stands at –12,952 people.

In Sisak-Moslavina County, the population density is 38.60 inhabitants per km<sup>2</sup>, which is significantly lower than the Croatian average (75.70 inhabitants per km<sup>2</sup>). For example, the city of Glina has 69 villages within a radius of 50 km. The rural areas are mostly sparsely populated and isolated, dominated by the elderly living in single-person households; this group is generally in greater socio-protective need but is more difficult to reach. Many people with disabilities also live in remote areas and without adequate facilities.

According to the 2011 population census, Sisak-Moslavina County is the third Croatian county by share of national minority members, with Serbs (12.18 percent), Bosniaks (1.43 percent), and Roma (0.85 percent) as most prominent among them.

### ACCESS TO BASIC SERVICES

In terms of access to basic services, the areas affected by the earthquake are some of the most deprived parts of the country, with several areas not having access to the public water and/or electricity. In Sisak-Moslavina County, 85.1 percent of the population is connected to the public water supply, which is below the Croatian average of 91 percent, and around 1.2 percent is connected to the local water supply sources. Those who are not connected to the public or local water supply use private wells or water tanks.

Road density—the ratio of the length of the county’s road network to its land area—is only 59 percent in Sisak-Moslavina County, the second lowest in the country. Fixed broadband density in Sisak-Moslavina County is also among the least developed in the country.

The lack of kindergartens, absence of transport to bring schoolchildren from rural areas to cities, and the lack of student homes have led many families with children or students to leave the area. Nearly 25 percent of students in Sisak-Moslavina County and Karlovac County failed the State Matura (secondary school) exams compared to less than 10 percent in Zagreb. The average Matura scores were also significantly lower in these counties. In addition, only two-thirds of Croatian adults residing in these counties have secondary or higher education, compared to nearly 90 percent in Zagreb.

In Sisak-Moslavina County, there is a shortage of doctors of all specializations, a lack of home care specialists, and the unavailability of services to conduct physical therapy

at home; additionally, the palliative care system is underdeveloped. With all the health care institutions located in major cities, health services are not easily accessible to the rural population. The average distance to a health center in this county is 9.3 km, the longest distance among all counties in Croatia. To go to doctors’ appointments, some of the elderly living in remote areas have no choice but to spend a good part of their income on taxi. The network of social services is also underdeveloped, and there is a chronic lack of professionals in the domain of psycho-social assistance.

### GENDER

Although Croatia has made significant progress in achieving gender equality, gaps persist and are aggravated by depopulation and intensive aging. These gaps persist, especially in terms of women’s access to economic opportunities, with many women being excluded from the labor market in rural settlements in the earthquake-affected counties. In addition, the dominant demographic processes in Croatia have been depopulation and intensive aging—with women making up the majority of the elderly (in Zagreb County and Sisak-Moslavina County, 73 percent of retirees are female).<sup>22</sup>

The World Bank’s Country Gender Assessment for Croatia suggests that rural women tend to suffer more in terms of poverty and employment, and as a result of lacking childcare- and elderly care.<sup>23</sup> Moreover, the poverty rate is disproportionately higher among households where the female is the primary breadwinner, and census data (2011) showed that 14 percent of families in Sisak-Moslavina County are single-mother families.

Other contributing factors to the gender gap in poverty rates are unemployment and the fact that women in Croatia earn 17–19 percent less than men. The majority of the unemployed in Sisak-Moslavina County are women (for example, in the city of Petrinja, 57 percent of the unemployed are women).<sup>24</sup> The wage gap between women and men often leads to a pension gap, making women in Croatia worse off than men and 35 percent poorer during retirement.<sup>25</sup>

22 Croatia Census 2011; Valerie Morrica, Tara Sharafudheen, Paul Andres Corral Rodas, Ursula Casabonne, and Zuzana Boehmova. 2019. Investing in Opportunities for All Croatia: Country Gender Assessment. World Bank Group.

23 Morrica et al. 2019.

24 URBACT. 2018. City of Petrinja Integrated Action Plan.

25 Morrica et al. 2019.



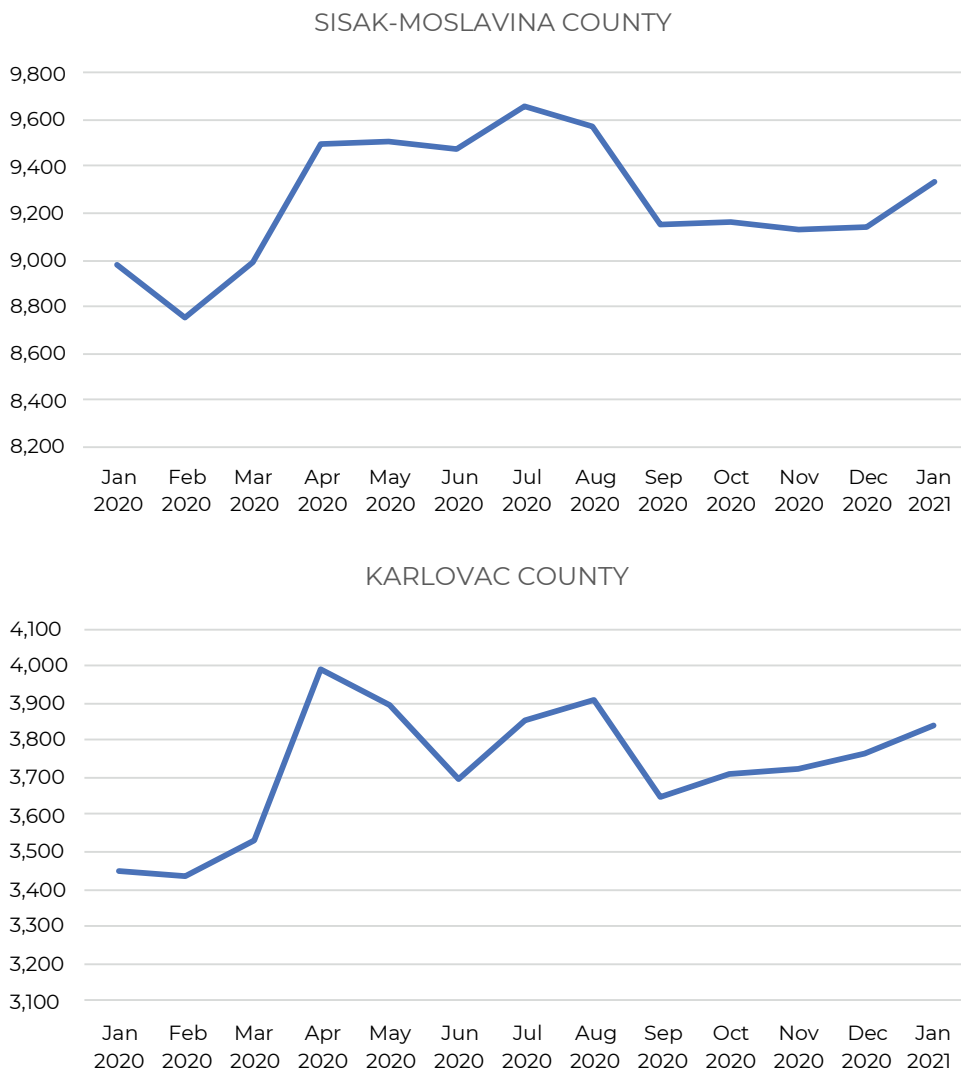
Additionally, the lack of affordable childcare, particularly in the earthquake-affected counties, appears to hinder women's participation in the labor force. Women often choose not to work or to work fewer hours to be able to provide unpaid care for children and elderly members of the family. Additionally, there are pronounced regional differences in the availability of childcare, and the day care coverage in Sisak-Moslavina County ranks 14 among the 21 Croatian counties.

## Disaster Impacts

### POVERTY

The devastating earthquakes, coupled with the ongoing COVID-19 pandemic, will likely cause an increase in poverty rates in Croatia. Physical damage from the earthquake and the disruption of economic activities and basic services are expected to severely affect residents in Sisak-Moslavina County and Karlovac County across multiple fronts. First, the damage or loss of assets (including housing) and capital can decrease residents' living standards. The entire center of the towns of Petrinja and Glina was destroyed, and many business

**Figure 7.** Number of unemployed people by month in Sisak-Moslavina and Karlovac Counties



Source: MoLPSFSP

premises were temporarily closed. Second, damaged infrastructure and businesses can result in job losses or a reduction in income for households. As the COVID-19 pandemic outbreak unfolded in March, Sisak-Moslavina County and Karlovac County experienced a sharp increase in the number of unemployed people (Figure 7). The earthquake in December added another blow to the counties' already dire situation as the number of unemployed people rose again in January 2021 and is expected to increase in the coming months. Third, the slow economic growth, scarcity of necessary goods, and uncertainty about the future can take a toll on people's welfare and mental health. Finally, the disruption of services such as schooling, health care, water supply, and heating could further aggravate the situation.

These factors not only disproportionately affect the poor living in the affected areas but also increase the risk of falling into poverty for those who are in vulnerable groups. Findings from the ongoing Rapid Assessment Survey conducted by the World Bank show that low-income people are more likely to suffer a reduction in in-

come after a crisis.<sup>26</sup> Additionally, in Croatia, the rate of savings to mitigate an income shock is low. As of December 2020, nearly 90 percent of Croatians in the bottom 40 percent of the income distribution had inadequate savings to weather the prolonged impacts of the crisis.

### VULNERABLE POPULATION

The local population—particularly children, the elderly, and people with disabilities—suffered serious psychological trauma. This is compounded by continued smaller earthquakes or aftershocks. People living in more remote areas suffered the immediate effects of the earthquake for a prolonged period, as relief—including alternative shelter—arrived later. According to the Society for Psychological Assistance, international experience shows that approximately 20 percent of those affected will suffer from mental health difficulties to a level that will prevent them from functioning privately or professionally, which

26 The World Bank conducted three rounds of a Rapid Assessment Phone Survey in Croatia in June 2020, December 2020, and March 2021 to monitor and measure the impacts of the COVID-19 crisis on Croatian's employment and financial well-being. The survey consists of 1,500 households and is representative at rural and urban levels.



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is approximately four times more than in the general population.

People living in containers, especially in container settlements set up in a relatively small area, often do not have adequate living space. As they are also traumatized and suffering financial hardship, it is to be expected that violent behavior and domestic violence may increase.

Out of the 70,000 people affected by the earthquakes, 13,000 are children. Due to earthquakes and the pandemic, many children are not attending school or kindergarten, which is inhibiting their mental health and socialization. Some attending online school have difficulty with internet access, which is generally weak in the area. Children living in alternative housing mostly lack adequate space to study. There are reports of teachers leaving not to return (according to UNICEF, a total of 20 in Sisak-Moslavina County departed in the first 50 days after the earthquake). Foster care families—49 of them in Sisak-Moslavina County—are also under significant pressure.

There is a high likelihood that, for some of those who temporarily moved to a different location, the reallocation will turn permanent. It is estimated that in the first two months after the earthquake, 2,861 people left Sisak-Moslavina County.

People with disabilities report facing challenges as they have difficulties accessing aid delivery points, moving around cities where tiles still fall from the roof, and reading warning signs. They also have trouble using alternative housing and receiving necessary information related to reconstruction and recovery as these are rarely adjusted to their specific needs.

With many of the households relying on subsistence farming for food and small-scale trade, the earthquake's effect on livestock will have profound consequences for people's food security and living standards in the long-term. More than 1,500 heads of livestock died and more than 227 heads of livestock in all categories were sold in the immediate aftermath, as the cost of maintaining them became too high. A lot of cattle escaped and did not return.

## ACCESS TO BASIC SERVICES

In terms of education, 3,123 children had to change schools as their schools were deemed unusable. It is of

prime importance that all the schools that have minor damage are renovated by the start of the autumn to avoid children enrolling in other counties; many children who start temporarily attending schools in the City of Zagreb or Zagreb County tend to remain there, which will lead to further depopulation of Sisak-Moslavina County.

Due to the tectonic movements amid the earthquake, a large number of people who used wells as a source of water cannot use them anymore. This especially affects low-income people, who are more likely to use the wells in the first place. Water and sanitation continue to be one of the prime concerns for the population affected by the earthquake. Sanitation is especially problematic because a high proportion of containers do not contain the appropriate sanitation, and people are forced to use communal toilets or go back to their houses, though it is potentially dangerous.

Approximately 7,000 users in Sisak and its surroundings and 2,000 in Petrinja and the neighboring area faced power outages. The weak broadband connection caused problems with the delivery of containers and aid services in general.

## GENDER

While there are no explicit gender data regarding the impacts of the earthquake, a series of interviews with CSO representatives in the earthquake-affected counties, as well as experience with similar disasters, suggest that women are disproportionately affected. Disasters tend to discriminate along generational and gendered lines, and indirect or secondary impacts of disasters make life worse for women. Several studies analyzing recovery from disasters have revealed that women are at greater risk to their recovery in the aftermath of disasters due to low-income levels and household composition. This vulnerability can be further aggravated by other elements of discrimination such as race.<sup>27</sup>

The earthquake and aftershocks caused strong psychological and emotional reactions in persons directly affected. There is an overwhelming feeling of exhaustion and there have been acute stress reactions; as a result, most women and men have reported insomnia, anxiety, and

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27 Vidili, Monica. 2018. *Why We Must Engage Women and Children in Disaster Risk Management*. World Bank Group [LINK](#)

fear in the aftermath.<sup>28</sup> These factors further exacerbate the women's risk of experiencing gender-related violence, which is traditionally underreported in Croatia.<sup>29</sup> In the earthquake-affected counties, CSOs report an estimated increase of 40 percent in the severity and frequency of gender-based violence in families; this is often a result of heightened fears, uncertainty, and the disrupted housing.<sup>30</sup> The number of, and funding for, safe houses is inadequate (for example, there is only one safe house in all of Sisak-Moslavina County), and the prevalent laws make it impossible for women to stay as long as they need in the safe houses. Disruptions in services have already triggered disturbing increases in domestic violence across countries affected by the COVID-19 pandemic; EU Member States reported up to a 60 percent increase in emergency calls by women subjected to violence by their intimate partners in April 2020, compared to April 2019.<sup>31</sup>

Gender equality usually also has a strong ethnic dimension, with Roma girls and women severely excluded from all levels of education and work; this especially affects one of Croatia's largest suburban settlements in Sisak-Moslavina County. Roma children who are of 'primary school age' did not have adequate home learning environments or established routines for long-term success at school even before the earthquake; in the aftermath, they are at particular risk of falling behind or not continuing/dropping out of school due to fears of earthquakes in combination with the COVID-19 measures.

## Reconstruction and Recovery Needs

### POVERTY

**The authorities need to pay special attention to ensure that recovery and reconstruction alleviate the impacts of the earthquake on the welfare of the poor and the vulnerable groups.** First, damaged facilities of social service providers, social welfare centers, health centers, and schools across the affected counties—particularly in Karlovac County and Sisak-Moslavina County—need to be reconstructed and renovated so that people in need

have uninterrupted access to these systems and benefit from modern safety and functionality requirements. Critical systems include health, education, and social services for children, people with disabilities, and the elderly. Restored functions of the critical public services need to be aligned with government priorities and strategic investments, including the deinstitutionalization of children and the development of community-based social services as well as broader reforms agendas (such as moving from multiple shift to single shift schooling).

Second, it is important to support Croatians' recovery from income losses incurred as a result of the earthquake through wage subsidies, social assistance payments, public work opportunities, unemployment benefits, and support for job preservation. Considering the simultaneous effects of the earthquakes and the COVID-19 pandemic, there is an opportunity to combine emergency social protection policies with post-disaster and recovery reconstruction policies to stimulate progress in poverty alleviation and inequality reduction going forward.

### VULNERABLE POPULATION

**Efforts by public authorities in partnership with civil society to reconstruct community infrastructure and activate human capital should be at the center of the recovery and revitalization process in the earthquake-struck areas.** Public authorities at all levels should support CSOs in their efforts to develop increased capacity for the provision of social services, including through mentoring and project-writing programs. Public works could be expanded to organizations providing psychosocial support, local associations, and humanitarian organizations. Additionally, programs that encourage the development of social entrepreneurship should receive sufficient attention. An essential measure will be strengthening the capacities of the local governments. Considerable efforts are needed to ensure there is an adequate number of persons in the broader social protection workforce, including social workers, psychologists, and social pedagogues; concomitantly, Croatia's continuous investment in their professional development will be crucial.

A strong prevention system will be necessary to tackle the wide-spread trauma of the affected population. Staff of schools, centers for social assistance, and primary health care centers should be capacitated and trained to provide the necessary information and guidance. This system should work in concomitance with efforts to pri-

28 UNICEF Country Office for Croatia Earthquake Situation Report #5, February 3rd, 2021.

29 Morrica et al. 2019.

30 Interview with the head of the Safe House in Sisak-Moslavina County (Ms. Senka F.), February 26, 2021.

31 Valerie Morrica, Celine Ferré, Lidija Japec, Nga Thi Viet Nguyen, Ana Šimundža, and Andrea Woodhouse. 2021. Croatian Women and the COVID-19 Pandemic - The Coronavirus Is Not Gender-Blind. World Bank Group.



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oritize those groups and individuals who are at greater risk, including those in container settlements, and to monitor and assist them in the long run.

Overall, communication on relief and reconstruction efforts should be highly transparent, proactive, reciprocal, and adjusted to the needs of vulnerable groups; it should also ensure that these groups are able to actively participate in these efforts. All services providers would need to closely coordinate and act according to a joint strategy, with clearly defined roles and divided responsibilities. A unified database of services users, to which both the state and CSOs can share data, would simplify coordination and enhance the quality of assistance provided to the vulnerable population. In planning for long-term housing solutions, the psychological well-being and preferences of household occupants should not be overlooked. At this point, most of the population are keen on staying on their own property and do not want to be resettled to a different area. Some would prefer not to go back to brick-built houses. Mobile houses of different types/materials and co-housing structures equipped with a broad range of community services could be options to consider.

## ACCESS TO BASIC SERVICES

**The quality provision of basic services is a precondition for the recovery and revitalization of the area.**

In the short run, containers need to be connected with the sewage network and wells cleaned to provide clean drinking water for the population using them as their water supply. Additionally, this would ensure preventing the spread of waterborne diseases, especially in the upcoming spring and summer months. In the longer term, coverage and quality of health care services need to be strengthened to accommodate more people in need, especially in the case of future disasters. In addition, key provision of basic services such as housing, water, gas, and heating requires continuous investments to ensure people have adequate level of living conditions.

In line with the county's development plan, kindergartens' capacities need to be expanded and new student dormitories built to address the needs of children and youth. To socialize and regain a sense of normalcy, children will need to start attending school and playing in playgrounds as soon as possible. Schools should have services that can provide instruction in emotional regulation and additional support for teachers and parents,

to provide a calm and stable environment for the children. Support should also be provided outside school premises; by building and equipping friendly spaces that cater to the children and youth, they could receive additional assistance, have leisure time, and engage in free-of-charge extracurricular programs. Including young people in reconstruction and recovery decision-making is necessary for their post-traumatic recovery and to avert their emigration. Broadband signal needs to be improved to facilitate participation in online classes.

Mobile teams organized by health and social ministries that reached out to vulnerable and isolated individuals during the relief phase could serve as a good starting point for developing similar activities on a regular basis, in partnership with local authorities and CSOs. Such teams could provide health services, free psychosocial assistance, legal aid, and information on the availability of services. Transport services for this segment of the population could also be included in such programs. Currently, CSOs are also provid-

ing this service, but their capacities should be strengthened.

## GENDER

**The resilient recovery of the earthquake-affected areas should also focus on ‘BBB for women’ in a COVID-19 context.** Recovery actions should be based on strengthening and increasing funding for local initiatives which specifically support women, such as safe houses and local and affordable childcare opportunities. Due to COVID-19, capacity building and feedback opportunities should also include online activities, courses, and consultations; they should specifically integrate women to ensure that their voices, specific needs, and concerns are heard and addressed. Initiatives include encouraging (elderly) women’s groups that monitor local government recovery actions. Other efforts include conducting participatory needs assessments to collect specific feedback and inputs from affected women; these assessments should collect data on women’s suggestions and needs in relation to the design of recovery actions and initiatives on preventing gender-based violence.

**Table 7.** Recovery needs by type of livelihoods aspects considered

Type of measures	Measure	Timeframe	Lead public authority
<b>Social protection disaster management</b>	Develop integrated or unified social protection registries, implement information systems that will integrate vulnerabilities and disaster risks mapping, and make these available to CSOs as well	Short term	MoLPSFSP
	Develop a national protocol for engagement with CSOs in disaster and recovery, with clearly defined roles and division of responsibilities	Short term	MoI
	Develop and implement cross-sectoral communication strategies on reconstruction and recovery for each vulnerable group, with their active participation and adjusted to their specific needs and abilities	Short term	MoI and MoLPSFSP
	Develop a social protection emergency framework and mainstream social protection in the national and sub-national DRM plans, including preparedness plans	Medium term	MoLPSFSP
<b>Citizen participation and transparency</b>	Set up an advisory body of representatives of local CSOs as partners in reconstruction and recovery planning	Medium term	National (MoI), LSGU
	Organize recovery-focused social entrepreneurship workshops for local SMEs, start-ups, and youth	Medium term	LSGU
	Organize twining and mentoring programs for local CSOs that provide social services and work with vulnerable groups, including in writing project applications	Long term	LSGU, National Foundation for Civil Society Development
	Publish all financial transactions and public procurement related to reconstruction and recovery on a dedicated website and in searchable format	Long-term	National (MoF), LSGU
	Develop a multiyear action plan for strengthening social services workforce (social workers, psychologists, social pedagogues, and others), including through partnering with universities and professional associations, and through provision of scholarships	Medium term	MoLPSFSP
	Extend the public works program throughout the recovery period and expand it to include work in the social sector and with CSOs	Medium term	MoLPSFSP
	Strengthen the capacities of the local government in domain of social investments planning processes and procedures through technical assistance, training, and partnership with the civil sector	Long term	LSGU

<b>Psychological assistance</b>	Continue providing psychosocial counselling for the affected population and vulnerable groups, including through mobile teams for psychological and psychiatric support	Long-term	National (MoF), LSGU
	Provide trauma prevention training to personnel of schools, centers for social assistance, and primary health care centers and set up programs through which they will provide information and guidance to citizens	Medium term	MoH, MoLPSFSP
	Provide adequate psychological support to relocated beneficiaries of social welfare institutions and prioritize their deinstitutionalization if applicable	Medium term	MoLPSFSP
<b>Children and youth</b>	Organize emotional regulation and trauma prevention instruction and counselling for school children, teachers, and parents	Medium term	MoSE MoH, and counties
	Organize additional mentorship support and spaces for learning with internet access for children at risk of falling behind such as children living in alternative housing and attending alternative school, children with disabilities, and Roma children	Medium term	MoSE, counties
	Build and equip new student dormitories and introduce fee subsidies and waivers for youth from low-income families	Medium term	LSGU
	Building and equip modern multifunctional children and youth centers and organize free-of-charge assistance, training, and extracurricular programs	Medium term	LSGU
	In partnerships with schools, organize town halls and policy labs with youth on reconstruction and recovery needs and incorporate their suggestions in revitalization actions	Medium term	Cities and municipalities
	Expand kindergartens capacities and increase fee subsidies for low-income families	Long term	Cities and municipalities
<b>Elderly and isolated population</b>	Permanently organize mobile teams for regular periodic reach-out to vulnerable and isolated individuals to provide free health and psychosocial assistance and legal aid information on right to and the availability of services and to document any humanitarian needs	Long term	Cities and municipalities
	Undertake needs assessments for transport of isolated communities and individuals (including transport to school for children and to health check-ups for the elderly) and develop permanent transport services, including through work programs that would employ women and vulnerable communities	Long term	MoSTI, MoLPSFSP, LSGU
	Set up or strengthen permanent home assistance services to elderly persons and persons with disabilities by CSOs mobile teams	Long term	LSGU
	Introduce telemedicine and health mobile teams to regularly cater for the needs of elderly rural citizens	Long term	MoH, LSGU
<b>Access to basic services</b>	Ensure full functionality of basic utilities in alternative housing (drinking water, heating, sewage, electricity, and waste collection)	Short term	MoESD, cities, and municipalities
	Address the shortage of doctors and care specialists and organize provision of physical therapy at home and of palliative care	Short term	MoH
	Develop DRM plans for providing universal service Hrvatska pošta d.d. to rural and isolated communities	Short term	MoSTI
	Permanently expand basic public and private utilities to all villages and households (drinking water, sewage, heating, electricity, and waste collection)	Medium term	MoESD, cities, and municipalities
	Support the use of green spaces around the reconstructed and new buildings in social, health, and education sectors to promote physical and mental health, biodiversity, and air quality; ensure access to persons with disabilities and persons with reduced mobility	Long term	MoPPCSA
<b>Poverty alleviation</b>	Provide social assistance to affected families (cash transfers, unemployment benefit, cash for work, and so on)	Medium term	MoLPSFSP
	Revive local economy and create jobs to ensure sustainable income for workers in affected areas	Long term	MoLPSFSP, MoRDEUF
	Support affected small business (loan, tax exemption, and so on)	Long term	MoESD, MoF
<b>Gender</b>	Provide funding for local initiatives which specifically support women (such as local and affordable childcare opportunities)	Long term	LSGU
	Expand programs for prevention of domestic violence and support to victims (including in alternative housing and through mobile teams) and dedicate sufficient staffing in social welfare centers and adequate facilities for safe houses	Short term	MoLPSFSP
	Facilitate participatory needs assessments to collect data on women's needs in relation to the design of recovery actions	Short term	LSGU
	Support engagement of women's groups to inform and monitor local government recovery actions	Medium term	LSGU

Source: Estimates by the assessment team using official information.





# SECTOR ASSESSMENTS





# SOCIAL SECTORS

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## HOUSING

### Sector Overview and Baseline Data

**A**bout 1.55 million people (over one-third of Croatia’s population) live in the five administrative units that were most severely affected by the series of earthquakes. The population of Sisak-Moslavina County is 172,439 (4 percent of Croatia’s total population) and, territorially, is the third-largest county in Croatia. The county has seven cities, 12 municipalities, and 456 settlements. The county’s population density is low, measuring only 38 people per km<sup>2</sup>, with settlements dispersed across the mountainous region. It is estimated that more than 25,000 residents left the county in the last decade. When coupled with the population decline that followed the 1991–1995 war in Croatia (a decrease of approximately 65,000 people between the 1991 and 2001 census), this has resulted in many houses in the area being deserted, uninhabited, and inadequately

maintained.<sup>32</sup> Karlovac County has a total population of 128,899 (3 percent of Croatia’s total population) living across five towns/cities, 17 municipalities, and 649 settlements. The population density is very low, with only 35 people per km<sup>2</sup>. Zagreb County, with a population of 317,606 inhabitants, has the second-highest housing stock among the five affected areas. These three areas for which a ‘state of disaster’ was declared register a total of 211,138 households, with an average of three members per household. Out of these, 62,487 households are in Sisak-Moslavina County, 47,465 in Karlovac County, and 101,186 in Zagreb County. A total of 96.7 percent of the residential units are owned by individuals, and 3.3 percent are owned by legal persons, including the state and local self-government units (LSGUs). The City of Zagreb accounts for more than half of the population in the affected area, registering a total of 384,333 housing units. Krapina-Zagorje County is the smallest of the five affected territories with a population of 132,892. The predominant type of housing stock in the county is a family house. Before the December 2020 earthquake, the residential

32 <https://www.hgk.hr/documents/demografija-po-zupanijama-konacno5c-41d3cf80bb7.pdf>

building stock in the City of Zagreb, Krapina-Zagorje County, and Zagreb County was already affected by the March 2020 earthquake.

**With regard to the construction quality in the affected area, the Croatian housing sector has undergone significant changes.** Before the 1920s, buildings were usually masonry buildings with wooden floors and roofs. Reinforced concrete ceilings were then gradually introduced starting in the 1930s. After 1964, when the first seismic regulations were introduced, masonry buildings were built with horizontal and vertical closure elements. After 1964 (and with the further modernization of the seismic regulations in 1981), load-bearing systems with reinforced concrete were used. Environmental standards have been in application since 2007, while structural Eurocodes have been in application since 2013.

### Effects of the Disaster (Damage and Losses)

**Housing was the most affected sector, accounting for the largest share of recorded damaged properties.** The housing sector constitutes a total of 72 percent of all the buildings reported as damaged by the earthquake, with the remaining 28 percent dispersed across other sectors. The most common category of damaged dwellings was family homes, as they constitute the biggest part of the overall housing stock. Residential buildings in the historic parts of Sisak, Petrinja, and Glina were a second category that suffered significant damage. Buildings in Zagreb, which had already been damaged in the March earthquake, suffered minor progressive damage. According to data collected by HCPI on February 21, 2021, the estimated total number of buildings in the housing sector damaged by the earthquake was 34,552 (35,194 when including

buildings that reported no damage, under U1) equating to 8,162,653 m<sup>2</sup>.<sup>33</sup> Out of the total of 34,552 buildings, about 75 percent were inspected, while data for 25 percent were extrapolated based on the results of damage inspections carried out before February 21, 2021.

**The number of buildings categorized as damaged according to their surface area and county is shown in Table 8.** The number of heavily damaged or completely destroyed buildings categorized as unusable was 2,785 (8.07 percent). Another 7,494 (21.71 percent) buildings suffered moderate damage and were categorized as temporarily unusable, while 24,243 (70.22 percent) buildings suffered slight damage and were categorized as usable. The majority of damaged residential units (85.25 percent) are located in Sisak-Moslavina County, where the most common category of damaged buildings was family homes.

**In the historic urban zones of Sisak, Petrinja, and Glina, 602 (53.23 percent) out of 1,131 inspected residential units suffered significant damage.** In the housing sector, 142 individual immovable cultural properties—that is, cultural heritage buildings—suffered some level of structural damage, and 103 of them were categorized as ‘temporarily unusable’ or ‘unusable’. In the City of Zagreb, 398 residential units were recorded as damaged; in part, this damage was part of the progressive damage incurred by buildings already weakened from the March 2020 Zagreb earthquake. Out of the 1,647 apartments and 1,745 family houses owned by the state and local self-government units, 585 (17.25 percent) were damaged in the earthquakes. Most of these apartments and houses were located in Sisak-Moslavina County.

33 HCPI. Note that these data were gathered while the assessment on the field was still ongoing.

**Table 8.** Number and surface area of damaged buildings in the housing sector by county

Administrative unit	No. of damaged public buildings			No. of damaged private buildings			Total no. of damaged buildings	Total damaged surface area in m <sup>2</sup>
	Light	Moderate	Heavy	Light	Moderate	Heavy		
Sisak-Moslavina County	373	151	53	20,020	6,366	2,468	<b>29,431</b>	6,607,567
Zagreb County	4	4	2	2,075	570	175	<b>2,830</b>	737,283
Karlovac County	31	5	0	1,099	213	35	<b>1,383</b>	567,855
Krapina-Zagorje County	5	0	0	362	84	29	<b>480</b>	99,665
City of Zagreb	0	0	0	274	101	23	<b>398</b>	150,283
<b>Total</b>	<b>413</b>	<b>160</b>	<b>55</b>	<b>23,830</b>	<b>7,334</b>	<b>2,730</b>	<b>34,522</b>	<b>8,162,653</b>

Source: Estimations by the assessment team using official information.

Administrative unit	Damage			Losses		
	Public	Private	Total	Public	Private	Total
Sisak-Moslavina County	51.29	2,075.43	<b>2,126.73</b>	2.23	92.01	<b>94.24</b>
Zagreb County	1.02	183.66	<b>184.68</b>	0.04	8.22	<b>8.27</b>
Karlovac County	3.27	113.62	<b>116.89</b>	0.10	4.64	<b>4.74</b>
Krapina-Zagorje County	0.03	25.65	<b>25.68</b>	0.00	1.19	<b>1.20</b>
City of Zagreb	0.00	35.04	<b>35.04</b>	0.00	0.55	<b>0.55</b>
<b>Total</b>	<b>55.61</b>	<b>2,433.41</b>	<b>2,489.02</b>	<b>2.38</b>	<b>106.62</b>	<b>109.00</b>

**Table 9.** Total damage and losses in the housing sector (EUR, millions)

Source: Estimations by the assessment team using official information.

The total cost of the consequences of the earthquake for residential buildings is estimated at EUR 2,598 million with the total damage and total losses estimated at EUR 2,489 million and EUR 109 million, respectively (Table 9). Close to 98 percent of the damage and losses in the housing sector are recorded as being tied to private dwellings; within these, Sisak-Moslavina County recorded most of the damage and losses (85 percent) that were incurred by the housing sector as a result of the earthquakes. Within the overall damage incurred by the housing sector, the damage to houses and residential buildings classified as cultural heritage amounts to EUR 459 million.

**Significant damage to family houses also occurred due to inadequate seismic designs and inadequate construction works.** Most of the damaged buildings in the settlements' historic centers (Sisak, Petrinja, and Glina) were built before the adoption of seismic regulations, and this is one of the key factors behind the vulnerability of the housing stock. The damage to other masonry buildings in the affected area was caused by a lack of maintenance and by reconstructions made without considering seismic regulations. For example, analyses found buildings with a lack of integrity between different construction units, a lack of horizontal and vertical closure elements, and an inherent weakness due to the materials used. The damage to family homes was partially caused by individual unprofessional construction and adaptation outside the system of organized reconstruction after the Homeland War, including upgrading without adequate seismic design, removal of load-bearing components, and other structural modifications. There is a general lack of understanding of seismic risk in the local communities, paired with a lack of initiatives aimed at raising awareness of damage prevention strategies.

**The recorded losses comprise costs related to the re-**

**moval of debris and the restoration of cultural heritage.** Other estimated losses pertain to the process of demolishing and removing the ruins of buildings that were totally damaged; these losses cover the surface area of 537,987 m<sup>2</sup>. Croatia has provided land plots to be used as recycling centers; the aim is to facilitate the process of removing buildings damaged by the earthquake whose structure was compromised and now threatens human safety. These plots will be used to dispose of, manage, and sort the collected waste in accordance with environmental and legal standards.

**While they are of lower intensity, aftershocks can cause additional damage and losses, including to the housing stock.** Damages also occur due to geological processes such as liquefaction, landslides, rockslides, lateral spreading, and ground cave-ins. Many sinkholes appear near family homes. Occurrences of liquefaction have also been recorded, threatening the stability of buildings.

### Disaster Impacts on the Affected Population

**The earthquake affected living conditions for thousands of people.** Approximately 4,000 families lost their homes and needed emergency shelter. While some sought refuge in other parts of Croatia with their friends and relatives, some have been relying on state and county shelters, including sports centers in Sisak, army barracks and tents in Petrinja, and a hotel in Topusko.

**Since many inhabitants voiced their reluctance to leave their homes, or their inability to do so because of the livestock they possessed, shelter has also been provided in the form of camper trailers and container houses.** Temporary accommodation for displaced people was provided through 1,954 housing containers/mobile housing

units (until March 1, 2021). It has been estimated that around 3,600 people will be temporarily displaced until their homes are rebuilt. The Central State Office for Reconstruction and Housing Care made 208 state-owned apartments available to provide temporary residence to persons and families who lost access to their only residential property due to the earthquake. A total of 76 fully equipped apartments had been provided to beneficiaries as of March 1, 2021. It has been estimated that the equipping and utilities expenses for the use of these state-owned apartments will cost around EUR 2.653 million.

## **Reconstruction and Recovery Needs**

**The Croatian legal framework was amended to allow for the process of reconstruction and provision of temporary housing to be implemented in Sisak-Moslavina and Karlovac Counties.** The framework was also amended to enable the remediation of additional damage caused by the December 2020 earthquakes in the City of Zagreb, Krapina-Zagorje County, and Zagreb Coun-

ty, where the support provided by the Reconstruction Fund was also needed. The Act on the Reconstruction of Earthquake-damaged Buildings on the Territory of the City of Zagreb, Krapina-Zagorje County, Zagreb County, Sisak-Moslavina County, and Karlovac County was adopted by the Croatian Parliament on February 5, 2021. Its adoption mobilized efforts to supply and set up temporary, mobile, and prefabricated facilities to house the affected population until the reconstruction efforts were completed. Sisak-Moslavina and Karlovac Counties were exempt from taking part in the reconstruction funding due to their weakened economies and their declaration as 'assisted areas' pursuant to a special regulation.

**The overall recovery and reconstruction needs are estimated at EUR 4,758.35 million over short, medium, and long term, whereas most of the needs will be related to reconstruction.** Reconstruction should be conducted in the shortest possible time to reduce the displacement period for those who have had to leave their homes. Throughout the displacement period, special attention should be paid to vulnerable groups such as children, women, the elderly, the poor, and



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persons with disabilities. An estimate of the costs of rebuilding completely and of rehabilitating infrastructure that was slightly or moderately damaged by the earthquake is included in the reconstruction estimates. A total of 584,113 m<sup>2</sup> will need to be rebuilt completely, while 7,578,540 m<sup>2</sup> will need to be rehabilitated due to light or moderate earthquake damage. The reconstruction process should adhere to the principles of BBB and improved EE. The reconstruction of the housing sector would also follow the general principles outlined in the final chapter of the RDNA report.

**Due to geological processes, the ground in many areas is not safe for reconstruction/new construction.** It may be needed to explore locations within the same neighborhood and/or plan for relocation, which is a complex process. This would require additional expert spatial and geo-mechanical assessments. The entire recovery process requires regular evaluation of progressive damage on buildings due to aftershocks. Additional education and training sessions for professionals and public should be conducted as proposed in the final section of this report.

**The following recovery interventions are to be implemented:** removal, transport, and recycling of construction waste from unusable buildings; geotechnical research works for the design of buildings' foundations of the existing houses and/or for the design of new (replacement) buildings in safe locations; reconstruction of buildings categorized 'usable' after structural inspection; reconstruction of buildings categorized 'temporarily unusable' after structural inspection; construction of replacement buildings with the use of prefabricated/semi-prefabricated building systems for buildings categorized 'unusable' after structural inspections (cost estimates include building designs); building design using sustainable and environment-friendly materials aligned with BBB and EE principles, considering circular economy, climate change, and earthquake resilience (for moderately damaged or temporarily unusable buildings where this additional cost of building design is foreseen to ensure they are rebuilt and renovated to a higher standard than before the disaster); and construction of infrastructure, buildings, and other facilities that enable the population in relocated areas to continue their daily life and work activities, aligned with new spatial plans.

**Table 10.** Total reconstruction and recovery needs in the housing sector in the short, medium, and long term (EUR, millions)

Reconstruction and recovery	Short	Medium	Long	Total
Removal, transport, and recycling of construction waste from unusable buildings	87.20	21.80	0.00	<b>109.00</b>
Reconstruction of houses and apartments categorized after structural inspection 'usable' (green)	859.24	1288.86	0.00	<b>2148.10</b>
Reconstruction of houses and apartments categorized after structural inspection according to the damage level as 'temporarily unusable' (yellow)	298.32	596.64	596.64	<b>1491.61</b>
Construction of replacement buildings with the use of prefabricated/semi-prefabricated building systems (red)	170.63	341.25	341.25	<b>853.13</b>
<b>Reconstruction subtotal</b>	<b>1,415.38</b>	<b>2,248.55</b>	<b>937.89</b>	<b>4,601.83</b>
Geotechnical research works for designing the foundations of new buildings —replacement building on the removed building location or on a new location	6.21	4.41	0.00	<b>10.62</b>
Building design with the use of sustainable and environment-friendly materials, considering circular economy, climate change, and earthquake resilience (yellow)	18.36	27.54	0.00	<b>45.90</b>
Construction of infrastructure, buildings, and other facilities to enable life and work of the population in relocated areas in accordance with new spatial plans	0.00	50.00	50.00	<b>100.00</b>
<b>Recovery subtotal</b>	<b>24.57</b>	<b>81.95</b>	<b>50.00</b>	<b>156.52</b>
<b>Total</b>	<b>1,439.95</b>	<b>2,330.50</b>	<b>987.89</b>	<b>4,758.35</b>

Source: Estimations by the assessment team using official information.

# HEALTH

## Sector Overview and Baseline Data

**Croatia's demographic and epidemiological profile is characterized by an aging population, with 20 percent of the population over 65 years of age, and a disease burden dominated by noncommunicable diseases.**<sup>34</sup>

Cardiovascular diseases and cancer are the two main causes of death, accounting for a total of 76 percent of all deaths among women and 72 percent among men. Standardized death rates from cardiovascular diseases were 1.8 times higher than the EU average, indicating the importance of strengthening the quality of primary care systems to better treat and manage chronic conditions.

**Service delivery is organized across three levels (primary, secondary, and tertiary care).** Table 11 provides an overview. Primary health care is provided by health care centers, general practitioners, pediatricians, gynecologists, occupational medicine specialists, community nursing, telemedicine, emergency medicine, institutions for home health care, palliative care, and pharmacies. Health care centers are the main providers of health care at the primary level. There are 49 health care centers in Croatia with 61 branches across counties. Health care at the secondary health care level is provided at 22 general hospitals, 18 special hospitals, six psychiatric hospitals, and three health resorts while health care at the tertiary level is provided at five clinical hospital centers, three clinical hospitals, and five clinics. The state health institutes are the Croatian Institute of Public Health, the Croatian Institute of Transfusion Medicine, and the Croatian Institute of Emergency Medicine. Branches of the Croatian Institute of Public Health and the Croatian Institute of Emergency Medicine are established at the county level (20 counties and the City of Zagreb).

**The Croatian health care system offers significant protection from the financial risks of health issues and offers good access to care, but the overall sustainability of the system remains a challenge.** Out-of-pocket payments, excluding voluntary health insurance, accounted for 10.5 percent of health expenditure in 2018, well below the EU average of 15.8 percent. Per capita health expenditure, at EUR 1,272 in 2017, was among the lowest in the

34 <https://data.worldbank.org/indicator/SP.POP.65UPTO?locations=HR&display=graph--%3E>.

**Table 11.** An overview of service delivery in the health sector

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

Source: MoH.

EU, where the average was EUR 2,884.<sup>35</sup> Croatia devotes 6.8 percent of its GDP to health, compared to the EU average of 9.8 percent. Nevertheless, the share of public expenditure, at 83 percent, is above the EU average. The share of self-reported unmet medical needs in Croatia stood at 1.6 percent, below the EU average of 2 percent.<sup>36</sup> However, self-reported unmet needs due to geographical distance are higher in Croatia than in any other EU Member States. The geographical distribution of health care infrastructure and human resources varies considerably and there are a number of hospitals close to each other offering the same types of services, which makes improving efficiency and sustainability key priorities of the health systems. Successive analyses of the health sector, conducted by the EC, World Bank, and other development partners, have highlighted the importance of health sector reforms to improve the effectiveness and efficiency of service delivery and the sustainability of the health system. For example, the limited pool of social health insurance contributors and high hospital debt levels raise concerns about the financial sustainability of the health care system.

**The March 2020 earthquake had already affected the health sector in Zagreb County, Krapina-Zagorje County, and the City of Zagreb.** In the areas affected by the December 2020 earthquake, there are 15 primary, 26 secondary, and eight tertiary facilities that serve approximately 8,400 patients. Among the health facilities listed in Table 12, 218 buildings had suffered previous damage in the March 2020 earthquake.

**There are a significant number of health care institutions in the earthquake-affected counties, but the health infrastructure and equipment does not fully**

35 [https://ec.europa.eu/health/sites/health/files/state/docs/2019\\_chp\\_hr\\_english.pdf](https://ec.europa.eu/health/sites/health/files/state/docs/2019_chp_hr_english.pdf).

36 [https://ec.europa.eu/health/sites/health/files/state/docs/2019\\_chp\\_hr\\_english.pdf](https://ec.europa.eu/health/sites/health/files/state/docs/2019_chp_hr_english.pdf).

**Table 12.** Overview of health facilities in the affected areas

Type of health provider	Number of buildings/ premises	Public	Private	Number of patients	Number of medical/ nonmedical workers	
					Male	Female
Primary	639	261	378	2,071,840	620	2,715
Secondary	113	101	12	1,200,631	1,419	5,386
Tertiary	3,185	3,185	0	5,275,962	3,896	18,467

Source: MoH.

**meet the needs of the counties' populations.** In all the counties affected by the earthquake, health care services are primarily provided in buildings that date back to the late nineteenth and early twentieth century. These buildings do not currently benefit from seismic risk protection. For example, around 80 percent of hospital buildings were built before the 1960s, before interventions to address seismic risks were part of the building design code. Only 5 percent of hospital buildings were built after 2000 and only 5 percent of old buildings benefited from structural intervention after 2000. Moreover, many of these buildings are either individually protected as cultural heritage or are located within the protected historic urban complex. The vulnerability of these buildings to earthquakes and their limitations in providing sustainable health services were highlighted by the earthquake. Also, most health care institutions are in larger cities and health services are not equally accessible to the whole population. In particular, the population in remote rural areas does not have the same quality of service as in urban centers, nor is it adequately connected to them.

### Effects of the Disaster (Damage and Losses)

**The earthquake significantly damaged health infrastructure and physical assets across the five affected counties.** In total, 63 buildings of primary care centers were affected by the earthquake and five were assessed as temporarily or permanently unusable. In the earthquake-affected area, there are 15 health care centers with 19 branches, totaling 274 buildings (190,567.12 m<sup>2</sup> gross area). Of these 274 buildings, 58 buildings had nonstructural damage, 4 buildings were assessed as temporarily unusable (yellow), and 1 building had heavy structural damage and was assessed as unusable (red) (Table 13).

**Secondary and tertiary care provision was also significantly affected:** 76 hospital buildings were directly affected by the earthquake and 15 were assessed as temporarily or permanently unusable. In the disaster-affected area, there are two clinical hospital centers, six clinics, four general hospitals, 19 special hospitals, and three psychiatric hospitals. From a total of 210 hospital buildings (808,062.14 m<sup>2</sup> gross area), 58 had nonstructural damage (green), 12 were assessed as temporarily unusable (yellow), and 3 as unusable (red). In addition, equipment in hospitals was also significantly damaged.

**The administration and regulation of public health is organized through state health institutes, which also suffered damages.** In the affected area, there were 18 health institutes operating in 116 buildings. Six buildings were left temporarily unusable and two buildings were left permanently unusable. Of the 443 pharmacies located in the earthquake-affected counties, 27 of them suffered damage, with 2 being deemed unusable. Damages also occurred to buildings in the private health sector.

**In total, the series of earthquakes' impact on the health system was estimated to have cost over EUR 167 million, of which EUR 125 million was a result of damage and EUR 42 million incurred due to losses** (Table 14 and Table 15). In terms of ownership, approximately 98.7 percent of the impact fell on the public sector, while 1.3 percent fell on the private sector. Of the total damage caused to infrastructure, EUR 80 million was damage to cultural heritage buildings and housing health care institutions.



**Table 13.** Number and surface area of damaged buildings in the health sector by type of institution

Subsectors	No. of damaged public buildings			No. of damaged private buildings			Total no. of damaged buildings	Total damaged surface area in m <sup>2</sup>
Health centers	58	4	1	0	0	0	<b>63</b>	74,174
Hospitals / clinics	58	9	2	3	3	1	<b>76</b>	223,470
Health institutes	19	6	2	0	0	0	<b>27</b>	22,384
Pharmacies	5	1	1	15	4	1	<b>27</b>	3,070
<b>Total</b>	<b>140</b>	<b>20</b>	<b>6</b>	<b>18</b>	<b>7</b>	<b>2</b>	<b>193</b>	<b>323,098</b>

Source: Estimations by the assessment team using official information.

**Table 14.** Total damage and losses in the health sector by type of health facility (EUR, millions)

Subsectors	Damage			Losses		
	Public	Private	Total	Public	Private	Total
Hospitals <sup>a</sup>	89.62	1.26	<b>90.88</b>	34.56	0.02	<b>34.58</b>
Health centers	21.05	0.00	<b>21.05</b>	1.87	0.00	<b>1.87</b>
Health institutes	11.54	0.00	<b>11.54</b>	5.62	0.00	<b>5.62</b>
Pharmacies	1.02	0.84	<b>1.87</b>	0.03	0.03	<b>0.06</b>
<b>Total</b>	<b>123.23</b>	<b>2.10</b>	<b>125.33</b>	<b>42.09</b>	<b>0.05</b>	<b>42.14</b>

Source: Estimations by the assessment team using official information.

Note: a) Includes clinical hospital centers, clinical hospitals, clinics, polyclinic, and special hospitals.

**Table 15.** Total damage and losses in the health sector by county (EUR, millions)

Administrative unit	Damage			Losses		
	Public	Private	Total	Public	Private	Total
Sisak-Moslavina County	78.89	1.72	<b>80.61</b>	37.37	0.04	<b>37.41</b>
Zagreb County	9.61	0.00	<b>9.61</b>	0.45	0.01	<b>0.46</b>
Karlovac County	22.95	0.37	<b>23.33</b>	0.44	0.00	<b>0.44</b>
Krapina-Zagorje County	4.77	0.00	<b>4.77</b>	0.28	0.00	<b>0.28</b>
City of Zagreb	7.01	0.00	<b>7.01</b>	3.55	0.00	<b>3.55</b>
<b>Total</b>	<b>123.23</b>	<b>2.10</b>	<b>125.33</b>	<b>42.09</b>	<b>0.05</b>	<b>42.14</b>

Source: Estimations by the assessment team using official information.

## Disaster Impacts on the Affected Population

In the administrative areas affected by the earthquake, 35 hospitals in 210 buildings with 23,098 employees (80 percent female and 20 percent male) provide more than 6 million medical services annually. As a result of the earthquake, some staff members were unable to provide services to their patients; 622 staff members were unable to do so temporarily and 96 staff members permanently. The most severe damage occurred at the general hospital in Sisak-Moslavina County; it is the main medical provider in

the region and provides more than 185,000 medical services to patients annually. All but one section of the hospital, with buildings in Sisak and Petrinja, were significantly damaged by the earthquake and deemed unsafe for patients. Hundreds of patients from these buildings had to be urgently evacuated to Zagreb, including COVID-19 positive patients who needed oxygen therapy. Only patients from the Gynecology Department, located in a building retrofitted in 2010 and not significantly damaged by the earthquake, were kept in Sisak. The Pediatric Department, located in a building constructed in 1959, was also severely damaged. The entire

building (with Departments of Pediatrics, Neurology, and Otolaryngology) was temporarily rendered unusable and 102 staff members, who provide 18,558 medical services annually, were temporarily unable to care for their patients.

**The earthquake will have lasting effects, and special care will need to be taken to cater to needs related to the evacuation of children and patients with limited mobility from damaged hospitals.** The Special Hospital for Chronic Diseases in Gornja Bistra, which houses children with special needs, was severely damaged and the patients were immediately transferred to the Naftalan Special Hospital in Ivanić-Grad for temporary accommodation. The COVID-19 pandemic has further hampered the functioning of the health care system; for example, in Sisak-Moslavina County, the cost of purchasing protective equipment has increased significantly, and new vaccination points had to be introduced. The earthquake's occurrence during the COVID-19 outbreak significantly affected vulnerable patients such as pregnant women and patients with mobility restrictions.

## Reconstruction and Recovery Needs

**Given the importance of health services to the population's needs and well-being, the health sector is likely to have more complex reconstruction needs and higher required expenditures are anticipated.** Upgrading historical buildings from no or limited earthquake resilience to the highest level of earthquake resilience, while also respecting BBB concepts to ensure that future health infrastructure is earthquake-resilient, will be technically demanding and costly. This is reflected in Table 16 and Table 17. The combination of COVID-19 and the impacts of the earthquakes highlights the importance of improving health sector infrastructure. This is a substantial undertaking that requires national coordination and oversight. Reconstruction in the sector should follow the overall reconstruction approach to enact positive changes and improvements in relation to the strategic planning of health infrastructure.

**Modernizing and rebuilding the sector's infrastructure—in line with international standards for earthquake resilience, the functionality required by modern medical practice, and environmental considerations such as EE—is a substantial undertaking.** Going for-

**Table 16.** Total reconstruction needs in the health sector by county (EUR, millions)

Administrative unit	Reconstruction needs		
	Public	Private	Total
Sisak-Moslavina County	146.13	2.65	<b>148.78</b>
Zagreb County	21.55	0.00	<b>21.55</b>
Karlovac County	36.12	0.74	<b>36.85</b>
Krapina-Zagorje County	14.13	0.00	<b>14.13</b>
City of Zagreb	21.90	0.00	<b>21.90</b>
<b>Total</b>	<b>239.83</b>	<b>3.38</b>	<b>243.22</b>

Source: Estimations by the assessment team using official information.

**Table 17.** Total reconstruction needs in the health sector by type of health facility (EUR, millions)

Subsectors	Reconstruction needs		
	Public	Private	Total
Hospitals <sup>a</sup>	176.53	2.02	<b>178.55</b>
Health centers	40.88	0.00	<b>40.88</b>
Health institutes	20.97	0.00	<b>20.97</b>
Pharmacies	1.46	1.36	<b>2.82</b>
<b>Total</b>	<b>239.83</b>	<b>3.38</b>	<b>243.22</b>

Source: Estimations by the assessment team using official information.

Note: a. Includes clinical hospital centers, clinical hospitals, clinics, polyclinic, and special hospitals

ward, the feasibility of investing in public asset insurance could be considered as a mechanism to decrease the financial exposure of both the central and local governments in the event of unfavorable circumstances in the future.

**The recovery strategy and needs are prioritized and sequenced over the short, medium, and long term.**

The main goal is to improve the quality of life by preserving and improving the health of each individual with an emphasis on the organization of comprehensive patient-centered care by providing preventive, curative, and rehabilitation care 24 hours a day, 7 days a week, 365 days a year. In the process of planning the needs of the health sector of all affected counties, three levels of planning were taken into account according to the Law on the System of Strategic Planning and Development Management of the Republic of Croatia and other existing activities related to them while also taking into

account the 2030 National Development Strategy, the EU programming period 2021–2027, and planning at the county and institution levels.

**Short-term recovery measures include** the implementation of emergency measures for insurance, protection and rapid construction works on less damaged buildings to restart the provision of health services and address the immediate health needs of the population; technical assessment of buildings and preparation of documentation for the reconstruction or demolition of completely damaged buildings so that the provision of services can be continued; provision of working conditions for employees in the health sector; provision of health services through mobile teams with a special focus on mental health and psychosocial treatment and rehabilitation; strengthening of communication systems and IT connectivity of primary and secondary health care institutions for more efficient access and flow of information and enabling multidisciplinary approach and active monitoring of patients in the system.

**Medium-term measures include** the rehabilitation and restoration of damaged facilities while increasing the

quality of the existing infrastructure of the health sector and technological modernization of equipment with the aim of reducing the risk of disaster while ensuring equal access to health care for all residents of the rural part of the county; ensuring adequate capacities for service delivery in terms of its continuity and in terms of meeting a potentially increasing demand for new services; implementation of targeted health promotion and disease prevention and interventions to control and mitigate the impact of existing and new disaster health risks; integration of care; establishment of educational centers; disaster risk reduction in health care institutions by developing adequate risk management plans.

**Long-term measures include** the reconstruction of the sector from a long-term perspective that includes the construction of new infrastructure for health care institutions together with the necessary modern equipment, considering the health needs of the population of affected counties; improvement of access to health care by increasing investment in human resources development while addressing the priority gaps in rural areas by offering packages that encourage staff to work in them; establishment of a system based on a comprehensive care model.



© Croatian Mountain Rescue Service (CMRS)

**Table 18.** Total reconstruction and recovery needs in the health sector in the short, medium, and long term (EUR, millions)

Reconstruction and recovery	Short	Medium	Long	Total
Reconstruction of infrastructure and physical assets including debris removal	35.44	58.57	149.21	<b>243.22</b>
Reconstruction Sub-total	35.44	58.57	149.21	<b>243.22</b>
Restore the ability to provide health services in community-, primary-, secondary-level institutions, to ensure working conditions for employees of the health sector and the availability of health services to citizens	4.68	22.70	0.00	<b>27.38</b>
Increasing the quality of existing infrastructure in the health sector and technological modernization of equipment with the aim of reducing the risk of disaster and ensuring continuity in the provision of health services	9.78	80.58	11.99	<b>102.34</b>
Ensuring equal access to health and health services for vulnerable groups by removing barriers to their use	0.34	0.94	0.00	<b>1.28</b>
Investing in additional capacities and human resources development in the health sector to meet the increased demands for health services due to the disaster and priority needs to meet the needs of rural areas with the offer of packages that encourage staff to work in them	1.36	0.00	9.61	<b>10.97</b>
Improving access to care and preventing institutionalization	0.60	4.25	0.13	<b>4.97</b>
Detailed seismic resilience assessment of health infrastructure system)	3.00	0.00	0.00	<b>3.00</b>
<b>Recovery subtotal</b>	19.75	108.46	21.72	<b>149.93</b>
<b>Total</b>	<b>55.19</b>	<b>167.03</b>	<b>170.93</b>	<b>393.15</b>

Source: MoH.

## EDUCATION

### Sector Overview and Baseline Data

Croatia's education sector includes preschool, primary, secondary (includes general and vocational education and training), and higher education.<sup>37</sup> Scientific research is conducted at higher education institutions and at 25 public research institutes. Education spending, at 4.7 percent of GDP (10.5 percent of government expenditure), is close to the EU average of 4.6 percent (10.2 percent of general government expenditure) (2017). The financing of preschool education falls mainly on local government bodies; the national government is the main provider of education services for all other levels. The majority of students attend state-owned schools—97.3 percent of primary and secondary schools and 80.3 percent of higher education institutions are state owned. The share of private education providers is significantly higher at the preschool level (43.3 percent).

**Nearly 50 percent of all schools in Croatia are multiple-shift schools, and 65 percent of all pupils nationwide still attend classes in shifts.** The lack of in-

frastructure is particularly evident in large cities such as Zagreb, where 75 percent of pupils attend classes in shifts; it is currently impossible to adhere to one-shift programs and expand instructional time. Following the nationwide implementation of curricular reform, the government intends to address the issue of the short average national instruction times through the implementation of the 'whole day school' (WDS) model.

**In the affected areas,** there are 231 kindergartens attended by 50,295 children, 520 primary schools attended by 117,166 pupils, 128 secondary schools attended by 52,629 pupils, 56 higher education institutions attended by 88,541 students, 21 research institutes, 194 adult education providers attended by 4,878 students, five student dorms attended by 7,462 students, and 22 pupil dorms attended by 3,000 pupils. Precise data are shown in the tables below which also include the number of education and other staff.

**In the earthquake affected area, all research institutes are concentrated in the City of Zagreb.** There are 21 public research institutes employing 1,649 scientists and 650 other staff. In all five counties, there are 194 adult education providers out of which 15 are public and 179 are private. In total, they have 4,878 learners

<sup>37</sup> In Croatia 'primary' means basic education, including primary and lower secondary grades (1–8).

and employ 2,727 teaching and 1,295 non-teaching staff. Student dorms are mostly concentrated in the City of Zagreb (4) with one located in Karlovac County. They are all public and house 7,462 students. There are pupil dorms in all affected counties, as shown in the Table 24.

**The five affected areas' education systems are different.** The City of Zagreb is the academic and scientific centre of the state and provides the best educational opportunities for students. In contrast, Sisak-Moslavina County and Karlovac County have experienced a sharp demographic decline in the number of students and classes, and this downward trend is expected to continue in the long-term. Sisak-Moslavina County and Karlovac County also suffered enormous damage to the entire education system during the war. Sisak-Moslavina County has made some advancements in the provision of educational services. Education for students with disabilities and members of the national minorities is provided in the entire County. Before the earthquake, the network of preschool institutions had



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**Table 19.** Overview of the education sector in Croatia

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

Source: MoSE administrative databases and CBS (2020).

Note: : a) Includes both central and satellite schools. b) Includes all faculties and academies of the University of Zagreb.

**Table 20.** Overview of kindergarten facilities in the five affected areas

Administrative unit	No. of Kindergartens	No. of buildings/premises	Public	Private	No. of pupils		No. of teaching staff or early childhood educators		No. of other staff members	
					Male	Female	Male	Female	Male	Female
Sisak-Moslavina County	19	46	18	1	1,798	1,691	5	404	22	202
Zagreb County	36	113	20	16	4,542	4,248	8	1,017	48	527
Karlovac County	18	31	16	2	1,348	1,254	2	267	19	136
Krapina-Zagorje County	31	50	26	5	1,433	1,263	1	297	11	127
City of Zagreb	127	324	63	64	16,956	15,762	51	3,798	215	1,714
<b>Total</b>	<b>231</b>	<b>564</b>	<b>143</b>	<b>88</b>	<b>26,077</b>	<b>24,218</b>	<b>67</b>	<b>5,783</b>	<b>315</b>	<b>2,706</b>

Source: MoSE administrative databases and CBS (2020).

**Table 21.** Overview of primary school facilities in the five affected areas

Administrative unit	No. of Primary Schools	No. of buildings/premises	No. of Public Schools	No. of Private Schools	No. of pupils		No. of teaching staff or early childhood educators		No. of other staff members	
					Male	Female	Male	Female	Male	Female
<b>Sisak-Moslavina County</b>	90	141	89	1	5,359	5,216	188	990	105	472
<b>Zagreb County</b>	127	171	126	1	12,889	12,272	328	1,986	165	891
<b>Karlovac County</b>	70	148	70	n.a.	4,145	4,111	128	744	67	344
<b>Krapina-Zagorje County</b>	84	115	84	n.a.	4,792	4,583	159	871	76	388
<b>City of Zagreb</b>	149	280	141	8	32,919	30,880	774	5,092	384	1,897
<b>Total</b>	<b>520</b>	<b>855</b>	<b>510</b>	<b>10</b>	<b>60,104</b>	<b>57,062</b>	<b>1,577</b>	<b>9,683</b>	<b>797</b>	<b>3,992</b>

Source: MoSE administrative databases and CBS (2020).

**Table 22.** Overview of secondary school facilities in the five affected areas

Administrative unit	No. of secondary schools	No. of buildings/premises	Public	Private	No. of pupils		No. of teaching staff or early childhood educators		No. of other staff members	
					Male	Female	Male	Female	Male	Female
<b>Sisak-Moslavina County</b>	13	28	13	0	2,088	1,933	193	331	34	142
<b>Zagreb County</b>	14	19	14	0	3,411	2,671	205	451	39	162
<b>Karlovac County</b>	13	26	13	0	1,900	1,895	159	325	34	143
<b>Krapina-Zagorje County</b>	10	19	10	0	2,117	2,142	164	362	41	167
<b>City of Zagreb</b>	78	135	60	18	16,878	17,594	946	2,355	206	813
<b>Total</b>	<b>128</b>	<b>227</b>	<b>110</b>	<b>18</b>	<b>26,394</b>	<b>26,235</b>	<b>1,667</b>	<b>3,824</b>	<b>354</b>	<b>1,427</b>

Source: MoSE administrative databases and CBS (2020).

**Table 23.** Overview of higher education institutions in the five affected areas

Administrative unit	No. of higher education institutions	No. of buildings/premises	Public	Private	No. of pupils		No. of teaching staff or early childhood educators		No. of other staff members	
					Male	Female	Male	Female	Male	Female
<b>Sisak-Moslavina County</b>	1	3	1	0	80	61	14	11	4	12
<b>Zagreb County</b>	3	3	0	3	2,199	1,599	-	-	-	-
<b>Karlovac County</b>	1	3	1	0	1,181	757	28	22	1	9
<b>Krapina-Zagorje County</b>	1	1	1	0	138	103	8	1	3	2
<b>City of Zagreb</b>	50	126	36	14	Public: 28,258 Private: 5,408	Public: 42,831 Private: 5,926	2,524	2,458	844	1,964
<b>Total</b>	<b>56</b>	<b>136</b>	<b>39</b>	<b>17</b>	<b>37,264</b>	<b>51,277</b>	<b>2,574</b>	<b>2,492</b>	<b>852</b>	<b>1,987</b>

Source: MoSE administrative databases and CBS (2020).

Administrative unit	No. of pupil dorms	No. of buildings/	Public	Private	No. of pupils
Sisak-Moslavina County	1	1	1	0	61
Zagreb County	1	1	1	0	103
Karlovac County	3	6	3	0	263
Krapina-Zagorje County	2	2	2	0	236
City of Zagreb	15	22	14	1	2,337
<b>Total</b>	<b>22</b>	<b>32</b>	<b>21</b>	<b>1</b>	<b>3,000</b>

**Table 24.** Overview of pupil dorms in the five areas affected areas

Source: MoSE administrative databases and CBS (2020).

been well-developed in Sisak-Moslavina County. While Zagreb County and Krapina-Zagorje County did not suffer extensive war damage and do not have a pronounced depopulation, they do not offer the same educational experience as the City of Zagreb. In the post-war period, the central government renovated most school buildings and equipment, trying to provide the best opportunity for students in these two counties. However, in both counties, the network of educational institutions and educational programs is suboptimal; for example, the high costs of student transportation are a burden on the students.

### Effects of the Disaster (Damage and Losses)

**The earthquake significantly damaged educational infrastructure and physical assets.** Sisak-Moslavina County and Zagreb County are counties which have suffered the most damage to educational facilities. According to the assessment of the usability of buildings and the information provided by the MoSE and regional and local authorities, 70 kindergartens, 160 primary schools, 32 secondary schools, three higher education institutions, and six pupil dorms were damaged by the December 2020 earthquakes—a total of 271 buildings (Table 25). All damaged buildings are public assets, apart from six kindergartens in Zagreb County. In Sisak-Moslavina County, 109 buildings were damaged, out of which 18 were marked as temporarily unusable and 14 as unusable. In Karlovac County, 40 buildings were damaged, out of which 2 were marked as unusable. In Zagreb County, 61 buildings were damaged, out of which 7 were marked as temporarily unusable and 2 as unusable. In Krapina-Zagorje County, 43 buildings were damaged, out of which 3 were marked as temporarily

unusable and 1 as unusable.<sup>38</sup> In the City of Zagreb, 18 buildings were damaged, out of which 1 was marked as temporarily unusable. The December earthquake contributed to further progressive damage for a school in Krapina-Zagorje County. Buildings in the City of Zagreb that suffered damage on December 29, 2020, were mostly located in the south or southeast suburban areas, and none of these buildings had reported damage after the March 2020 earthquake.<sup>39</sup> Immediately after the earthquake, in Sisak-Moslavina County, it was determined that 18 primary and secondary schools were usable with recommendation, 15 schools were temporarily unusable, and 13 schools suffered heavy damage and were unusable. This significantly aggravated the education conditions for the 8,276 pupils in primary and secondary schools in the county.

**Most of the damaged buildings classified ‘usable’/‘usable with recommendation’.** Some of these buildings will have to undergo significant repairs to non-structural elements, and in some cases, structural repairs will be needed before the buildings can become fully functional once again. There are 25 damaged cultural heritage buildings in the education sector, out of which 8 are individually protected cultural heritage buildings and 17 are located in the protected cultural heritage zones. Three individually protected cultural heritage buildings were marked as unusable and one was marked as temporarily unusable (all located in Sisak-Moslavina County); careful reconstruction will be required to preserve their cultural value.

**The total value of damage and losses in the education sector is estimated at EUR 174 million** (Table 26), with

38 This unusable building had already been marked as temporarily unusable during the Zagreb earthquake.

39 According to data in the Usability Assessment of Buildings Database of HCPI.

**Table 25.** Number and surface area of damaged buildings in the education sector by county and type of institution

Type of institutions	Total affected buildings	Total damaged surface area	Level of damage	Sisak-Moslavina County	Zagreb County	Karlovac County	City of Zagreb	Krapina-Zagorje County
Kindergartens	70	70,111		20	20 <sup>a</sup>	7	12	5
				2	2 <sup>b</sup>	0	0	0
				1	0	1	0	0
Primary schools	160	241,638		50	27	19	5	25
				13	5	0	1	3
				9	2	0	0	1
Secondary schools	32	93,385		6	4	9	0	6
				2	0	0	0	0
				4	0	1	0	0
Higher education institutions	3	10,925		1	0	1	0	0
				1	0	0	0	0
				0	0	0	0	0
Pupil dorms	6	14,591		0	1	2	0	3
				0	0	0	0	0
				0	0	0	0	0
<b>Total</b>	<b>271</b>	<b>430,650</b>		<b>109</b>	<b>61</b>	<b>40</b>	<b>18</b>	<b>43</b>

Source: Estimations by the assessment team using official information.

Note: a. 15 public and 5 private schools; b. 1 public and 1 private school; c. No damage was recorded to research institutes, adult education providers and student dorms.

62.6 percent in Sisak-Moslavina County, 11.9 percent in Karlovac County, 12.1 percent in Zagreb County, 10.7 percent in Krapina-Zagorje County, and 2.7 percent in the City of Zagreb. Only 0.54 percent of the value is related to the private sector. Of the total value, the damage to buildings and equipment is estimated at EUR 154 million while the losses amount to EUR 20 million. Approximately 23 percent of the total value of damage and losses is related to cultural heritage buildings (including both individually protected cultural heritage buildings and those located in the protected cultural heritage zones).

**The losses in the sector amount to over EUR 20 million.**

They include the costs for the demolition of unusable buildings (excluding cultural heritage buildings which will not be demolished), the removal and cleaning up of buildings (separately presented for cultural buildings), cultural heritage protection, the transportation of pupils to new locations, and other forms of progressive damage in the counties affected by the Zagreb earthquake. The progressive damage is included in the losses based on a calculation of the short-term countermeasures that will

be needed to remove potential hazards and prevent the further degradation of the buildings. Table 27 the distribution of damage and losses in the various education subsectors. It may be observed that primary schools were the most affected (accounting for 58.5 percent of the total value of damage and losses), followed by secondary schools (30.7 percent), kindergartens (6.6 percent), higher education (2.6 percent), and pupil dorms (1.6 percent).

Primary adult education and training for lower-level jobs in Sisak-Moslavina County are provided by two institutions: the Kutina Public Open University and the Kotva Secondary Vocational School in Sisak. The facilities of these institutions were not damaged by the earthquake and adult education has suffered no impediments.



Administrative unit	Damage			Losses		
	Public	Private	Total	Public	Private	Total
Sisak-Moslavina County	91.85	0.00	<b>91.85</b>	16.97	0.00	<b>16.97</b>
Zagreb County	19.89	0.00	<b>19.89</b>	0.74	0.00	<b>0.74</b>
Karlovac County	19.33	0.89	<b>20.22</b>	0.80	0.05	<b>0.85</b>
Krapina-Zagorje County	18.01	0.00	<b>18.01</b>	0.55	0.00	<b>0.55</b>
City of Zagreb	3.77	0.00	<b>3.77</b>	0.92	0.05	<b>0.97</b>
<b>Total</b>	<b>152.85</b>	<b>0.89</b>	<b>153.74</b>	<b>19.97</b>	<b>0.10</b>	<b>20.07</b>

**Table 26.** Total damage and losses in the education sector by county (EUR, millions)

Source: Estimations by the assessment team using official information.

Type of education facility	Damage			Losses		
	Public	Private	Total	Public	Private	Total
Kindergartens	10.03	0.89	<b>10.91</b>	0.48	0.05	<b>0.54</b>
Primary schools	89.11	0.00	<b>89.11</b>	12.61	0.01	<b>12.62</b>
Secondary schools	47.05	0.00	<b>47.05</b>	6.34	0.01	<b>6.35</b>
Higher education institutions	4.09	0.00	<b>4.09</b>	0.41	0.02	<b>0.43</b>
Pupils' dorms	2.57	0.00	<b>2.57</b>	0.13	0.00	<b>0.13</b>
<b>Total</b>	<b>152.85</b>	<b>0.89</b>	<b>153.73</b>	<b>19.97</b>	<b>0.09</b>	<b>20.07</b>

**Table 27.** Total damage and losses in the education sector by type of education facility (EUR, millions)

Source: Estimations by the assessment team using official information.

## Disaster Impacts on the Affected Population

**The earthquake left significant medium- and long-term impacts on the education system.** A total of 3,123 students were relocated to other schools to ensure that they continued to receive the appropriate educational services. This puts additional strain on the students, teachers, and parents, leading to increased learning losses. This may harm equity and lead to a decline in the quality of education. Children from disadvantaged socioeconomic backgrounds could be particularly affected. Relocation may also require schools to increasingly depend on multiple-shift teaching programs in host schools, thereby reducing the already low instruction times and making it more difficult to implement the WDS model. Furthermore, the damage to kindergartens may further reduce the already low participation rates in early childhood education and care.

**The educational staff also suffered damage both at a personal level—many having had their own homes damaged—and at a professional level, with schools being out of function.** These two factors, when compounded, could significantly reduce the quality of educational services in Sisak-Moslavina County and complicate the management of the educational system in the long run. The identifiable short-term risks could

produce a cascade effect that leads to long-term consequences. Given that a significant number of students need to be relocated due to unusable buildings, these relocated students will spend time traveling instead of learning. In turn, this implies that the quality of education as well as the social cohesion among students will be reduced, contributing to students' educational chances being reduced. In other affected areas, these risks are lower.

**The most pronounced impact is evident in Sisak-Moslavina County, especially in the cities of Petrinja, Glina, and Sisak.** In the medium term, the following elementary schools (ES) in Sisak-Moslavina County will be unusable: ES Dragutin Tadijanović in Petrinja, ES Mate Lovrak in Petrinja, and ES Glina. In the long term, the following elementary and secondary schools (SS) will be unusable: ES Ivan Kukuljević in Sisak, ES Galdovo, ES First elementary school in Petrinja, SS Petrinja, ES Ivan Goran Kovačić in Gora, SS Sisak, Sisak school of economics, Fran Lhotka music school in Sisak, Fran Lhotka music school in Sisak - Department in Petrinja, ES Katarina Zrinski elementary school in Mečenčani, SS Glina, Topolovac satellite school, Letovanić satellite school, Farkašić satellite school, Graboštani satellite school, and Nebojan satellite school. There is an increased need for technical staff because the work is taking place in school buildings with larger user space.

There is also a need to hire additional cooking staff to meet the state's pedagogical standards. Although many teachers and technical staff suffered damage to their private homes, this has not caused employees to seek jobs in other areas.

**Sisak-Moslavina County did not record a significant reduction in the educational services provided to children in vulnerable groups, but some students have been relocated.** For example, the Ivan Kukuljević ES in Sisak lost all the pupils from the Vrbina Children's Home, who had to move to another city because the Children's Home was damaged. In the county, students with disabilities are integrated in regular schools and in regular classes or in special classes at a regular school. These students experience additional disadvantages during online schooling due to the decreased availability of specific learning support services when learning from home.

**According to available data, 66 primary school students and 15 secondary school students requested a transfer from their school due to the earthquake.** The Sisak-Moslavina County management structures are trying to reorganize the provision of educational services to prevent students from leaving the county. Sisak-Moslavina County faces the challenges of organization of the student transport model and the associated costs. The cost of this service will increase significantly, as the number of students needing to be transported has increased by more than 3,000. As of now, some of these students attend classes according to model C (online classes) and it is difficult to calculate the potential additional cost when these students start attending classes in person. The 'one day/bus' service costs approximately EUR 415. Considering that an additional 60 buses will be needed, the daily costs would be approximately EUR 25,000. For the period of one school year (and most schools will have a longer renovation period), the cost would be over EUR 4 million per year (VAT included).

## Reconstruction and Recovery Needs

**The total needs for reconstruction and recovery have been estimated at EUR 429.3 million.** Of this amount, EUR 259.9 million is intended for reconstruction needs

(60.6 percent) and EUR 169.4 million for recovery needs (39.4 percent). Of the reconstruction needs, 8.7 percent are intended for the equipment and 91.3 percent for the buildings. The public sector accounts for a total of 99.4 percent of reconstruction and recovery needs, while the private sector accounts for 0.6 percent. Most of the reconstruction needs are estimated for Sisak-Moslavina County (53.1 percent), while 16.7 percent are estimated for Zagreb County, 12.9 percent for Krapina-Zagorje County, 13.4 percent for Karlovac County, and 3.9 percent for the City of Zagreb (see Table 28).

**The recovery strategy and needs are prioritized and sequenced over the short, medium, and long term.** One of the most significant aspects of the reconstruction of the education sector is to prevent the further depopulation of the affected counties; therefore, the strategy needs to focus on ensuring that unusable institutions are functional as soon as possible.

- **Short-term interventions** will focus on the more detailed structural assessments of damaged buildings (to continue in the medium term), followed by the retrofit of buildings, starting with 25 percent of

**Table 28.** Total reconstruction needs in the education sector by county (EUR, millions)

Administrative unit	Public	Private	Total
Sisak-Moslavina County	138.15	0.00	<b>138.15</b>
Zagreb County	34.70	0.00	<b>34.70</b>
Karlovac County	40.93	2.56	<b>43.49</b>
Krapina-Zagorje County	33.51	0.00	<b>33.51</b>
City of Zagreb	10.03	0.05	<b>10.08</b>
<b>Total</b>	<b>257.32</b>	<b>2.61</b>	<b>259.93</b>

Source: Estimations by the assessment team using official information.

**Table 29.** Total reconstruction needs in the education sector by subsector (EUR, millions)

Subsectors	Public	Private	Total
Kindergartens	23.59	2.57	<b>26.16</b>
Primary schools	151.08	0.01	<b>151.09</b>
Secondary schools	69.52	0.01	<b>69.53</b>
Higher educations	7.51	0.02	<b>7.53</b>
Pupil dorms	5.62	0.00	<b>5.62</b>
<b>Total</b>	<b>257.32</b>	<b>2.61</b>	<b>259.93</b>

Source: Estimations by the assessment team using official information.



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the severely damaged (red) buildings, 75 percent of the moderately damaged (yellow-label) buildings, and 20 percent of the slightly 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 HCPI,<sup>40</sup> the improvement of distance learning (to prepare 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 such as earthquakes.

- **Medium and long-term needs** will be focused on the reconstruction of infrastructure and physical assets. It is intended that another 75 percent of the severely damaged (red) buildings, 25 percent of the moderately damaged (yellow) buildings, and 20 percent of all buildings with green labels will be retrofitted in the medium term, while the rest (60 percent of all buildings with green labels) will be retrofitted in the long term. Nonstructural mitigation measures (such as the fixing of bookshelves and other equipment to walls) need to be carried

out to minimize nonstructural risks. HCPI will gradually develop to become fully operational, distance-learning practices will be further improved, and the psychological recovery program for disaster-traumatized children will continue further. The total renewal period would be five years.

- **During the recovery period**, and especially in the short and medium term, transport will be organized for pupils who attend damaged schools to nearby schools which have not been affected by the earthquake. The option of temporary containers to be used as alternative school premises will also be explored.

**Investments in reconstruction and recovery should also support the national structural reform goals of the education sector.** However, these reform objectives are long term and will take more time to implement than the total period calculated for the reconstruction and recovery process. The national structural reform goals include the following:

- **For early and preschool education:** The rate of participation in the preschool education in Croatia is still among the lowest in the EU. In addition, there are pronounced and systematic regional differences in the coverage of children in early and preschool programs, which deepen the gap between children

<sup>40</sup> The acquisition of an earthquake simulator and the establishment of HCPI have also been identified as priority actions following the Zagreb earthquake from March 2020, but these needs still remain valid and relevant.

in unfavorable socioeconomic positions and those in better socioeconomic positions. This is especially true for Sisak-Moslavina County. The goal of the reform is to ensure that all children have the possibility to participate in education, especially those in a socioeconomically disadvantaged position. This would increase their learning efficiency and their likelihood of continuing their education. This measure contributes to the achievement of the EU2020 target that 95 percent of all children over four years who have not yet started primary school are covered by preschool programs.

- **For primary and lower secondary education:** WDS model implementation. The reform aims to increase the quality of teaching and learning outcomes of students, especially for students from lower socioeconomic backgrounds (a large proportion of whom reside in Sisak-Moslavina County). This will be achieved by increasing the number of compulsory classes and introducing the WDS model with continuous teacher training and systematic external evaluation of learning outcomes. To achieve this goal, all elementary schools in Croatia need

to transition to one-shift schooling. This measure contributes to the achievement of the EU2020 target that the share of 15-year-olds with insufficient skills in reading, mathematics, and science be below 15 percent.

- **For upper secondary education:** Gymnasium programs aimed at further education are attended by about 30% of students in Croatia, which is among the lowest shares in relation to the average of EU member states of 52%. Vocational education programs are attended by 70 percent of students, which is one of the largest shares of students attending upper secondary vocational education programs in Europe. An additional problem for conducting quality teaching is the fact that 63 percent of high schools, accounting for 76 percent of high school students in Croatia, teach in two shifts. The goals of this reform include (a) an increase in the rate of participation in gymnasium programs, which should consequently have a positive impact on the rate of completion of higher education (which is also low compared to the EU average), and (b) the optimization, rationalization, and adaptation of vo-

**Table 30.** Total reconstruction and recovery needs in the education sector in the short, medium, and long term (EUR, millions)

Reconstruction and recovery	Short	Medium	Long	Total
Reconstruction of infrastructure and physical assets including debris removal	92.05	89.58	78.30	<b>259.93</b>
<b>Reconstruction subtotal</b>	92.05	89.58	78.30	<b>259.93</b>
Acquisition of a realistic earthquake simulator for training of children	1.00	0.00	0.00	<b>1.00</b>
Centre of Excellence for earthquake engineering	20.00	35.00	65.00	<b>120.00</b>
DRR and resilience education in schools aiming teachers, parents, and pupils	5.00	5.00	5.00	<b>15.00</b>
Structural assessment of damaged education facilities to update estimates of reconstruction and rehabilitation needs	3.00	2.00	0.00	<b>5.00</b>
Improving distance learning process in preparation of future disasters (information technology [IT] tools will be used in regular education as well)	3.00	3.00	3.00	<b>9.00</b>
Contingency plan for multi-hazard disasters including earthquakes (prevention and preparedness of education system)	1.00	0.00	0.00	<b>1.00</b>
Psychological recovery of disaster traumatized children—counselling, research, and long-term recovery	2.00	1.50	1.50	<b>5.00</b>
Resumption and continuation of service delivery (transportation of pupils)	4.45	8.90	0.00	<b>13.35</b>
<b>Recovery subtotal</b>	39.45	55.40	74.50	<b>169.35</b>
<b>Total</b>	<b>131.50</b>	<b>144.98</b>	<b>152.80</b>	<b>429.29</b>

Source: Estimations by the assessment team using official information.

cational education programs to the development needs of the economy. This measure contributes to the achievement of the EU2020 target that the employment rate of people with qualifications ages 20 to 64 is 82 percent.

**In the context of the renovation of educational infrastructure, the biggest challenge will be ensuring a quick process.** In case of an overly lengthy renovation process, students would be incentivized to enroll in other regions, and schools in Sisak-Moslavina County would not be able to fill the available places. Leaving the county is inevitable because the nearest secondary schools are in Zagreb County and the City of Zagreb. These students may not return once their schools are renovated, as they will be formally enrolled in other institutions. As a result, Sisak-Moslavina County is likely to face an even larger outmigration of its young population in the long term. The outmigration of local students will, in turn, result in teachers increasingly needing to be relocated to other regions, and the outflow of the working-age population will contribute to the region lagging even further in the coming years. Hence, population decline represents a significant challenge. To mitigate this increased risk, one of the measures that could be applied while schools are being rebuilt is the use of temporary container schools.

## SOCIAL PROTECTION

### *Sector Overview and Baseline Data*

**Social welfare is an organized activity that aims to aid socially vulnerable persons and persons in unfavorable personal or family circumstances.** This includes coordinating prevention programs, promoting change, and assisting in the provision of basic services to ensure adequate standards of living. These include providing support to individuals, families, and groups, with the aim of improving the quality of life and empowering the beneficiaries to independently provide for themselves as well as actively participate in society.

**The social welfare activity is performed by social welfare institutions, associations, religious communities, legal persons, small businesses, foster families, and individual persons as a professional activity.** The

MoLPSFSP supervises the performance of social welfare institutions. The activities of social welfare institutions are performed as a public service. Social welfare institutions include social welfare centers, welfare homes, community services centers, and home assistance centers. Social welfare activities are funded by the state budget as well as the regional and local government budgets. There are also funds accrued from the participation in the social services costs of beneficiaries and the persons mandated to support them, own income, donations, assistance, and other earmarked income. Apart from the social welfare providers, this chapter also includes the Croatian Employment Service (HZZ), the Croatian Pension Insurance Institute (HZMO), and the Institute for Expert Evaluation, Professional Rehabilitation, and Employment of Persons with Disabilities (ZOSI).

**The counties affected by the earthquake have large differences in their standards of living as well as their poverty and social inclusion rates.** The social welfare providers in the affected areas consist of: social welfare centers and providers of social services for adults with disabilities, adults with mental disabilities, children with special needs, pregnant women or parents with children up to the first year of age, children without parents or without adequate parental care, children with behavioral problems, elderly and seriously ill persons, victims of family violence, victims of human trafficking, homeless persons, and persons with alcohol, drugs, or other forms of addiction.

In the disaster-affected areas, there are 23 social welfare centers, 78 social service providers for adults with disabilities, 22 providers for children without adequate parental care, 256 providers for elderly and infirm persons, 12 providers for victims of family violence, one provider for victims of human trafficking, two providers for homeless persons, five providers for addicts, 53 providers of home assistance, 50 institutions of HZZ, 43 institutions of HZMO, and 9 institutions of ZOSI. These providers of social services and institutions employ 9,139 workers.

**Table 31.** Overview of social service providers and other institutions in the affected counties

Type of facility/institution	Number of service providers/institutions	Number of buildings/rooms	Public	Private	Number of users	Number of workers
<b>Persons with Disabilities Care</b>	<b>131</b>	<b>263</b>	<b>22</b>	<b>109</b>	<b>6,170</b>	<b>2,448</b>
Sisak-Moslavina County	25	20	6	19	960	201
Zagreb County	30	47	4	26	1,270	632
Karlovac County	13	37	2	11	785	251
Krapina-Zagorje County	18	41	4	14	1,060	445
City of Zagreb	45	136	6	39	2,195	919
<b>Child Care</b>	<b>22</b>	<b>61</b>	<b>13</b>	<b>15</b>	<b>1,261</b>	<b>509</b>
Sisak-Moslavina County	2	19	1	1	131	44
Zagreb County	3	4	1	1	108	39
Karlovac County	2	5	5	0	180	60
Krapina-Zagorje County	0	0	0	0	0	0
City of Zagreb	15	33	6	13	847	334
<b>Elderly Care</b>	<b>256</b>	<b>256</b>	<b>13</b>	<b>243</b>	<b>11,398</b>	<b>3,469</b>
Sisak-Moslavina County	38	38	2	36	1,020	352
Zagreb County	105	105	0	105	2,776	819
Karlovac County	14	14	1	13	974	342
Krapina-Zagorje County	20	20	0	20	625	204
City of Zagreb	79	79	10	69	6,003	1752
<b>Violence Victims Care</b>	<b>13</b>	<b>13</b>	<b>0</b>	<b>13</b>	<b>101</b>	<b>39</b>
Sisak-Moslavina County	1	1	0	1	15	3
Zagreb County	1	1	0	1	16	2
Karlovac County	1	1	0	1	15	5
Krapina-Zagorje County	1	1	0	0	8	2
City of Zagreb	9	9	0	9	47	22
<b>Social Welfare Centers</b>	<b>23</b>	<b>45</b>	<b>45</b>	<b>0</b>	<b>/</b>	<b>815</b>
<b>Homeless Care</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>1</b>	<b>2</b>	<b>3</b>
<b>Addiction Problems Care</b>	<b>5</b>	<b>5</b>	<b>0</b>	<b>5</b>	<b>70</b>	<b>7</b>
<b>Employment and Pension Insurance Institutes</b>	<b>102</b>	<b>102</b>	<b>102</b>	<b>0</b>	<b>0</b>	<b>1,840</b>

Source: MoLPSFSP.

## Effects of the Disaster (Damage and Losses)

The earthquakes caused significant damage to infrastructure and physical assets in the affected areas. A total of 49 facilities in Sisak-Moslavina County, 24 facilities in Zagreb County, 9 facilities in Karlovac County, and two facilities in Krapina-Zagorje County and were damaged. No new facilities were damaged in the City of Zagreb. The Sisak-Moslavina County was the most affected by this earthquake; 49 facilities providing social welfare services were damaged. Of these, 33 were deemed usable, 10 were deemed temporarily unusable and 6 were deemed unusable. Even before the earth-

quake, the county was one of the least developed ones in terms of social welfare services. This damage is therefore significantly costly in the Sisak-Moslavina County. In Zagreb County, of the 24 facilities that were damaged, 23 received a green label and 1 received a yellow label. In Karlovac County, 9 facilities were damaged; however, all facilities received a green label, so it will be possible to carry out the reconstruction in this county in a relatively short period. In Krapina-Zagorje County, the two facilities that were damaged received a green label, and it is expected that they will be reconstructed in a short period. Even if no new damage was recorded in the City of Zagreb, some of the earlier reported damage caused

**Table 32.** Number and surface area of damaged buildings in the social protection sector by type of institution

Type of facility/institution	Number of public buildings damaged			Number of private buildings damaged			No. of square meters
Social Welfare	2	0	1	0	0	0	900
Persons with Disabilities Care	2	1	0	1	0	3	13,240
Child Care	3	1	0	0	0	0	3,920
Elderly Care	26	5	1	30	5	3	54,447
Violence Victims Care	0	0	0	0	0	1	150
Employment and Pension Insurance Institutes	0	0	0	0	0	0	0
<b>Total</b>	<b>33</b>	<b>7</b>	<b>2</b>	<b>31</b>	<b>5</b>	<b>7</b>	<b>72,687</b>

Source: Estimations by the assessment team using official information.

by the Zagreb earthquake in March 2020 was further aggravated by the earthquake on several buildings.

**The disastrous consequences for the standard of living will only later become apparent, after the population is provided housing and their lives are no longer in danger.** The current priority is the reconstruction of houses. This will be followed by the need to furnish houses, purchase appliances, and other household items; only then is the increased need for material assistance, as well as the inflow of requests for all types of cash allowances in the social welfare centers, expected. The social welfare centers in Petrinja and Sisak were able to continue their work immediately after the earthquake because their premises remained undamaged, and people were provided their services without interruption. The social welfare center in Glina continued its work in the replacement premises since the center’s building was severely damaged in the earthquake.

**To alleviate the current difficult situation, social welfare centers received requests for one-off allowances.** A one-off allowance is granted to a single person or a household unable to secure the basic standard of living due to current financial difficulties, and pertaining to the birth or schooling of a child, sickness or death of a family member, a natural disaster, and the like; to be used for the purchase of essential household items or clothing and footwear, when it is not possible to ensure the procurement of such items in cooperation with humanitarian organizations; to a beneficiary of the ‘right to accommodation in a foster family’ who is attending primary or secondary school, for the purchase of necessary textbooks, unless that right was granted on another basis;

and to beneficiaries of temporary accommodation in crisis situations, for compensating transportation costs to the place of residence, one’s own or a foster family, a welfare home, another service provider, or another institution. It is granted as a right to cash allowance or a right to compensation in kind. A one-off allowance beneficiary does not have to be a guaranteed minimum allowance beneficiary.

**The access to social services is limited due to some service providers also being affected by the earthquake.**

The social welfare institutions in the affected areas were damaged and their beneficiaries were relocated to other appropriate institutions. A total of 487 beneficiaries were relocated to other social welfare institutions. There are notable differences in the costs of accommodation services among the various social welfare providers, according to the county to which they belong. For example, the building of Urbina Sisak Children’s Home, which provides social services to children without parents or without adequate parental care in Sisak-Moslavina County, was also damaged in the earthquake. The beneficiaries of the Urbina Sisak Children’s Home were temporarily relocated to a facility provided by the Children’s Home SOS Children’s Village in Lekenik.

**To assist the experts from the social welfare centers in Glina, Petrinja and Sisak—who were exposed to major trauma themselves—it was necessary to organize mobile teams of experts from social welfare centers across Croatia.** Members of mobile teams, together with the employees of social welfare centers, toured the area. To prevent social exclusion, they made sure to assist the elderly people who were unable to visit the centers.

Additionally, in cooperation with the Red Cross, field inquiries were carried out based on member reports; if required, interventions by the social welfare centers (including the provision of accommodation in a social welfare institution or the application for a one-off allowance, and so on) were performed.

**The earthquakes' impact on the standard of living included increased job losses and impediments to the proper operation of individuals' own crafts/companies.** The entire town centers of Petrinja and Glina were demolished, the business premises in which economic activities took place were rendered unusable, and the equipment was destroyed. As a result, many inhabitants lost both their homes and their jobs. Therefore, active job retention measures were implemented, including job retention subsidies for the areas affected by the earthquakes. Additionally, public works were organized in Sisak-Moslavina County that was most affected by

the earthquake. The goal of this measure was to include unemployed persons in activation programs for socially useful works. Target groups included persons disadvantaged in the labor market; persons older than 50 years registered for more than six months; persons registered as unemployed for three or more years; guaranteed minimum allowance beneficiaries registered as unemployed; persons older than 50 years registered for less than six months; persons older than 29 years registered for 12 to 36 months; young persons of up to 25 years registered for up to 36 months; young persons from 25 to 29 years registered for 6-36 months.

**It was proposed that 500 persons should be enlisted to participate in public works, according to the relevant branch office.** These persons are to be divided in the following categories: Branch office of HZZ in Sisak—150 persons; Branch office of HZZ in Petrinja—150 persons; Branch office of HZZ in Glina—80

Administrative unit	Damage			Losses		
	Public	Private	Total	Public	Private	Total
Sisak-Moslavina County	16.51	12.00	<b>28.51</b>	48.55	0.82	<b>49.37</b>
Zagreb County	2.37	1.06	<b>3.43</b>	5.21	0.05	<b>5.26</b>
Karlovac County	1.57	0.56	<b>2.13</b>	3.45	0.02	<b>3.47</b>
Krapina-Zagorje County	0.69	0.00	<b>0.69</b>	0.26	0.00	<b>0.26</b>
City of Zagreb	0.00	0.00	<b>0.00</b>	0.63	0.00	<b>0.63</b>
<b>Total</b>	<b>21.14</b>	<b>13.62</b>	<b>34.75</b>	<b>58.11</b>	<b>0.89</b>	<b>58.99</b>

**Table 33.** Total damage and losses in the social protection sector by county (EUR, millions)

Source: Estimations by the assessment team using official information.

Social protection subsectors	Damage			Losses		
	Public	Private	Total	Public	Private	Total
Children care	3.64	0.00	<b>3.64</b>	0.37	0.00	<b>0.37</b>
Elderly care	14.33	5.99	<b>20.31</b>	1.43	0.31	<b>1.74</b>
Persons with disabilities care	2.34	0.00	<b>2.34</b>	0.04	0.56	<b>0.60</b>
Social welfare	0.83	7.38	<b>8.21</b>	16.97	0.00	<b>16.97</b>
Violence victims care	0.00	0.25	<b>0.25</b>	0.00	0.02	<b>0.02</b>
Employment service	0.00	0.00	<b>0.00</b>	39.29	0.00	<b>39.29</b>
<b>Total</b>	<b>21.14</b>	<b>13.62</b>	<b>34.75</b>	<b>58.11</b>	<b>0.89</b>	<b>58.99</b>

**Table 34.** Total damage and losses in the social protection sector by sub-sector (EUR, millions)

Source: Estimations by the assessment team using official information.

Type of loss	Losses
Cost of increased one-off allowances	<b>16.69</b>
Cost of accommodation of beneficiaries in other institutions	<b>1.28</b>
Cost of required new employment and overtime	<b>0.22</b>
Cost of job retention subsidies	<b>37.16</b>
Cost of public works	<b>2.13</b>

**Table 35.** Specific losses in the social protection sector by type (EUR, millions)

Source: Estimations by the assessment team using official information.



persons; Branch office of HZZ in Hrvatska Kostajnica—30 persons; Branch office of HZZ in Sunja—30 persons; Branch office of HZZ in Gvozd—30 persons; and Branch office of HZZ in Dvor—30 persons.

**Overall, the total damage to physical infrastructure and losses in this sector have been estimated at EUR 94 million, out of which EUR 59 million refers to losses (Table 33 and Table 34).** Damage includes damage to buildings and equipment while losses include debris removal and other indirect costs such as one-off allowances provided by social welfare centers, relocation of beneficiaries from damaged children’s homes and the homes for the elderly, hiring new employees in social welfare institutions, job retention subsidies paid by the employment service and public works. Damage to equipment amounts to EUR 180 thousand. Apart from the losses recorded from debris removal, the sector has suffered various other indirect costs; these are broken down in Table 35.

## **Disaster Impacts on the Affected Population**

**The beneficiaries of social service providers whose facilities were damaged in the earthquake were relocated into other welfare homes throughout Croatia.** As a result, the number of beneficiaries in those homes was significantly reduced. Consequently, social service providers will have lower revenue compared to the period before the earthquake; this is expected to impede further operations. This will also affect the settlement of labor costs, which could result in the termination of employment contracts.

**Children, persons with disabilities, and elderly persons are particularly vulnerable groups of beneficiaries.** Persons who need assistance and care in their daily functioning and who could no longer stay in their home due to the earthquake were provided temporary accommodation with social service providers until the conditions for returning to their own household are met. Persons who remained in their own household or were placed in another form of organized accommodation were provided



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psychosocial assistance and support through mobile teams of CSOs. Elderly persons and persons with disabilities are still provided home assistance services.

**Social services provision is facing serious risks.** The impact of the earthquake, including the damage to facilities in which social services were provided or were planned to be provided in the forthcoming period, and the departure of the working age population, will aggravate the provision of existing social services and slow down the development of new ones. Additionally, services in new institutions are not fully adequate for the needs of new beneficiaries and, in the transition period until the reconstruction is completed, great efforts will need to be invested in equipping the existing facilities.

**In addition to its impact on the standard of living, poverty, and social exclusion, the earthquake significantly affects the psychosocial state of the population.** The facilities are in poor condition and each new aftershock causes new damage and new challenges for the social welfare system. Being constantly exposed to aftershocks, people are fearful, feel uncertainty, and are anxious; these emotions further interfere with their day-to-day functioning. There are several known cases where owners of houses that were not seriously damaged and were deemed usable are not staying in them because of fear. Children are particularly affected. If the trauma is not treated in a professional manner, an increase in violence, peer violence, depressive disorders, and so on. is expected in the long-term. In view of these, psychological assistance should be

provided to the population and, when the conditions allow, psychological support should continue to be provided as long as necessary. The Neuropsychiatric Hospital 'Dr. Ivan Barbot', Popovača, formed mobile teams for psychological and psychiatric support that operate in the towns of Sisak, Petrinja and Glina. Furthermore, in cooperation with UNICEF, teams were put together to regularly visit families with children to provide psychosocial support.

## **Reconstruction and Recovery Needs**

**Social welfare centers need to be reconstructed to provide beneficiaries with unobstructed access to their rights and services, with improved seismic resilience and EE.** New and reconstructed facilities should ensure access to persons with disabilities and persons with reduced mobility. Additionally, compensation must be provided for economic losses, which include job retention subsidies, one-off payments, public works, employment, overtime hours, and the accommodation of beneficiaries. The Vrbinja Sisak Children's Home, whose building suffered significant damage, will ensure that services to these children continue to be provided in the short term by purchasing a new house. Contemporarily, a social welfare institution needs to be constructed where accommodation, as well as new services for this beneficiary group (family counselling and assistance, individual counselling and assistance, day care) will be provided. After the new institution is constructed, the temporary house will continue to be used, but six new caretakers will need to be hired to look after



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the two buildings. For counselling services and assisting families and individuals, at least five experts (two social workers, two psychologists, and one social pedagogue) must be available to provide these services to families.

**The priority is to reconstruct and construct social welfare centers in Sisak-Moslavina County so that citizens have access to their services in the social welfare system.** Another priority is to ensure that social services are available to the same degree as, if not better than, before the earthquake, in all affected areas. This is especially necessary in relation to services provided in the Krapina-Zagorje and Sisak-Moslavina Counties for adults with mental impairments and in the Sisak-Moslavina County for elderly persons.

**Immediate investments should be made to salvage the institutions that are deemed to be only slightly damaged/requiring minor investments to ensure the timely provision of social services.** Temporary premises for the social welfare center in Glina need to be established to allow for social welfare activities to be carried out without interruption until the construction of a new, modern center. Additionally, another priority is to reconstruct the branch office of the Family Center of the Social Welfare Center in Sisak. Additionally, Sisak-Moslavina county will need to ensure that 116 places are freed up to accommodate the persons with disabilities (mental impairments), who were previously housed in welfare homes that are now unusable. Overall, the recovery priorities include ensuring additional capacity for the provision of services, reconstructing damaged facilities that are temporarily unusable, and preventing the outmigration of the workforce. There is

also a need to rebuild houses and apartments of social welfare system workers.

**The vision for recovery includes further development of the sector and intersectoral cooperation spanning over the short, medium, and long-term.** The strategic goals and priorities in the field of social welfare of the Sisak-Moslavina County are determined by the 2017-2020 County's Development Strategy and the 2015-2020 Plan for the Development of Social Services in Sisak-Moslavina County. A new county development strategy is being drafted; its goals and priorities will be harmonized with the 2030 National Development Strategy.

**Short-term measures** should focus on measures for recovery and reconstruction of damaged buildings:

- Urgent rehabilitation and equipping of damaged facilities for the safety of people and protection of facilities from further damage.
- Temporary provision of accommodation for beneficiaries of elderly homes or institutions that care for the disabled and those in need of constant care (beneficiaries could be relocated to other counties or to private providers).
- Preventing labor force loss by ensuring they are relocated to places where services are temporarily provided, either by providing transport or accommodation.
- Temporary in-home assistance through experienced existing associations until social welfare institutions are reinstated for providing these services.
- Psychological support to both beneficiaries and employees through cross-sectoral cooperation with health care institutions and health care professionals-volunteers.

**Table 36.** Total reconstruction needs in the social protection sector by county (EUR, millions)

Administrative unit	Reconstruction needs		
	Public	Private	Total
Karlovac County	3.56	1.15	4.71
Krapina-Zagorje County	1.40	0.00	1.40
Sisak-Moslavina County	31.30	20.68	51.98
Zagreb County	4.71	2.60	7.31
City of Zagreb	0.00	0.00	0.00
<b>Total</b>	<b>40.98</b>	<b>24.42</b>	<b>65.41</b>

Source: Estimations by the assessment team using official information.

**Table 37.** Total reconstruction needs in the social protection sector by subsector (EUR, millions)

Subsectors	Reconstruction needs		
	Public	Private	Total
Children care	6.12	0.00	6.12
Elderly care	29.02	12.11	41.13
Persons with disabilities care	4.53	11.95	16.47
Social welfare	1.32	0.00	1.32
Violence victims care	0.00	0.37	0.37
<b>Total</b>	<b>40.98</b>	<b>24.42</b>	<b>65.41</b>

Source: Estimations by the assessment team using official information.

- Preservation and improvement in the mental health of beneficiaries and eliminate/alleviate depression, organize educational programs in line with the interests of beneficiaries, programs related to current topics, and ensure active leisure time.
- Control and review the work and conditions of social welfare service providers.
- Build cooperation between the homes for the elderly, health care institutions and other social service providers to identify beneficiaries' current needs and ensure their satisfaction.

**Medium-term recovery measures** should seek to:

- Ensure adequate accommodation for beneficiaries and provide them with social services to the same extent before the earthquake.
- Further implement measures of intersectoral cooperation in the field of health care and expand them by introducing regular doctor's visits and periodic check-ups in the homes for the elderly.
- Establish and strengthen beneficiaries' relationships with family and friends, organize visits and foster their emotional stability while building intergenerational solidarity in the process.
- Develop and implement projects focused on improving the quality of social services in line with real needs.
- Raise the quality of all social services through continuous education of all workers in the social welfare sector.

**Long-term recovery measures** build on the short- and medium-term ones and are focused on improving the quality of life for social service beneficiaries:

- Provide apartment-type accommodation in the existing homes for the elderly under the supervision of beneficiaries.
- Provide wards for accommodation of beneficiaries with dementia and similar conditions,
- Provide mobile palliative care teams.
- Conduct continuous training of all service providers and the introduction of work permits.
- Ensure continuous training and implementation of protocol/behavioral exercises in case of disasters.
- Provide support to the community through volunteering in social service institutions (e.g. to encourage volunteering, introduce a rewarding system, and so on).

**Table 38.** Total reconstruction and recovery needs in the social protection sector in the short, medium, and long term (EUR, millions)

Reconstruction and recovery	Short	Medium	Long	Total
Reconstruction of infrastructure and physical assets including debris removal	20.30	32.17	12.93	<b>65.41</b>
<b>Reconstruction subtotal</b>	<b>20.30</b>	<b>32.17</b>	<b>12.93</b>	<b>65.41</b>
One-off allowance	16.69	0.00	0.00	<b>16.69</b>
Moving of beneficiaries	1.28	0.00	0.00	<b>1.28</b>
New employment in social care centers in the earthquake affected area	0.22	0.00	0.00	<b>0.22</b>
Job retention measures	37.16	0.00	0.00	<b>37.16</b>
Public works	2.13	0.00	0.00	<b>2.13</b>
Training of social welfare workers	0.11	0.11	0.05	<b>0.27</b>
Training of elderly care workers	0.37	0.37	0.19	<b>0.93</b>
A system for connecting all social services providers' IT systems and development of new modules	0.00	1.00	1.00	<b>2.00</b>
Psychological and psychiatric support (development of a system for recognizing mental health issues and providing adequate psychosocial support in social care institutions)	0.27	0.27	0.13	<b>0.67</b>
New jobs for home assistance and care services, whole day or half day stay for the elderly	1.88	1.88	0.94	<b>4.69</b>
Development of additional facilities for improving the quality of services (children's care, elderly care and persons with disabilities care)	0.72	0.96	0.72	<b>2.40</b>
<b>Recovery subtotal</b>	<b>60.82</b>	<b>4.58</b>	<b>3.03</b>	<b>68.43</b>
<b>Total</b>	<b>81.12</b>	<b>36.75</b>	<b>15.96</b>	<b>133.84</b>

Source: Estimations by the assessment team using official information.

- Encourage further development of services for the elderly and those in need of constant care, including assistance in the household and care provision, improve the availability of health care services and full-day and half-day stays for the elderly and those in need of care.
- Develop a system for identifying individuals with mental health problems and provide adequate psychosocial support in the social care system/institutions.
- Foster active living in the homes for the elderly through socializing and participation in cultural, sports and other events, organize visits to the resting places of deceased family members, and encourage family visits to strengthen mental and physical health as well as intergenerational connections.
- Build capacities of social services providers in applying for European and national projects.

**Total reconstruction and recovery needs in this sector have been estimated at EUR 134 million.** To ensure recovery in the social welfare system in the affected area, it is necessary to thoroughly develop intersectoral cooperation and a network of sustainable, accessible, and economically acceptable social services in the community, which meet the needs of individuals and their families. The following tables show the estimated reconstruction costs of physical infrastructure and soft recovery measures.

## CULTURE AND CULTURAL HERITAGE

### *Sector Overview and Baseline Data*

**Architectural heritage's forms and features in the affected area are informed by natural factors, the spatial organization of the feudal era, and the attributes of a militarized frontier under the Habsburg monarchy.** Zagreb County and Krapina-Zagorje County are characterized by small historical settlements and market towns with prominent parish churches, chapels, and isolated aristocratic estates with palaces and manors. Karlovac County and Sisak-Moslavina County are characterized by the remains of medieval towns governed by nobility and the numerous forts that made up the Vojna Krajina, a militarized defensive border region that existed from the fifteenth to nineteenth century. The counties include the historical urban hubs of Karlovac, Sisak, and Petrinja and several other smaller historical towns. The cities of Sisak, Petrinja, and Glina are home to cultural institutions and associations active in the domains of civil society as well as promoting culture and artistic creativity. The protected historic urban area of the City of Zagreb consists of two parts: the Upper Town (Gornji grad) and the Lower Town (Donji grad). The urban development of the Upper Town



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**Table 39.** Cultural heritage overview in the affected areas

Administrative unit	No. of immovable cultural properties	No. of listed cultural and historical areas and zones	No. of houses in cultural and historical areas	No. of movable cultural properties/collections
Sisak-Moslavina County	308	25+ Sisak archaeological zone	4,416	50
Zagreb County	307	28	1,936	101
Krapina-Zagorje County	214	13	1,177	77
Karlovac County	283	11	1,424	52
<b>Total</b>	<b>1,112</b>	<b>77</b>	<b>8,953</b>	<b>280</b>

Source: MoCM.

**Table 40.** Cultural institutions in the affected areas

Administrative unit	No. of museums	No. of archive facilities	No. of libraries	No. of cultural associations
Sisak-Moslavina County	5	1	18	380
Zagreb County	8	0	13	217
Krapina-Zagorje County	8	1	14	420
Karlovac County	3	1	7	320
<b>Total</b>	<b>24</b>	<b>3</b>	<b>52</b>	<b>1337</b>

Source: MoCM.

began in the Middle Ages and was completed by the beginning of the nineteenth century. Both parts are rich in religious buildings, town houses, and palaces. The Lower Town largely dates from the second half of the nineteenth and the beginning of the twentieth centuries and is partly the product of reconstruction following the devastating earthquake of 1880.

**Historically, the affected areas include the geographic regions of Pokuplje, Sisačka Posavina, Banovina, and Kordun.** The dominant determinants of spatial and cultural identity include small towns that started developing in the eighteenth century after the stabilization of the militarized frontier, lowland and upland rural settlements, with their traditional wooden houses and farm buildings, and the sacred buildings that occupy prominent positions inside and outside the settlements. The city of Sisak—the administrative and economic hub of the county—developed along the grid of Roman Siscia as a port on the Kupa River with a characteristic riverfront of residential/commercial buildings and port storage facilities and valuable nineteenth and twentieth century industrial heritage. The urban structure of Petrinja comprises harmoniously built and richly

furnished two-story public and residential buildings. The buildings are arranged around the square and park, with the parish church situated at the axis and along the streets that lead to the square. They are characterized by the vaulting of the commercial ground floors, the stones surrounding the portals, and the coloristic treatment of the façades. Prominent among the public buildings is the archival collection building, built during the baroque period. The historical center of Glina is characterized by the architecture of several notable two-story buildings and a series of residential and commercial single-story buildings within the orthogonal grid of streets.

### **Effects of the Disaster (Damage and Losses)**

**The December 2020 earthquakes severely damaged architectural heritage and cultural infrastructure in the affected administrative units.** Damage and losses include immovable and movable cultural property, museums, galleries, libraries, culture centers, and other cultural institutions and sacred heritage sites in the affected areas. Immovable cultural property includes individually listed buildings and areas listed as places of cultural and

**Table 41.** Damaged buildings in the protected historical urban zones

Urban Zone	Total number of damaged buildings in the protected historical urban zones	No.		%		No.		%	
		No.	%	No.	%	No.	%	No.	%
Petrinja	527	133	25	116	22	152	29		
Sisak	1,188	436	37	369	31	182	15		
Glina	387	148	38	131	34	102	26		

Source: Estimations by the assessment team using official information.

historical interest in central Croatia. Protected historical urban zones make up a part of the narrower city center in the larger cities in Sisak-Moslavina County, Petrinja, Sisak, and Glina (Table 41). Furthermore, the urban zone of the city of Sisak is also the archaeological zone Segestika-Siscia, as the city was built directly on the ruins of Roman Siscia and prehistoric Segestika covering an area of approximately 5 km<sup>2</sup> of a Roman city, including necropolises. The urban zone of Petrinja was the most affected; 51 percent of buildings suffered severe to total damage and more than 25 percent suffered moderate to low damage. In Sisak, there were also many damaged buildings within the urban zone, of which 15 percent received heavy damage, 31 percent suffered severe structural damage, and 37 percent suffered moderate to low damage. In the historical urban zone of the city of Glina, 26 percent of buildings suffered heavy damage, 31 percent suffered severe damage, and 37 percent suffered moderate damage.

**The 442 individual immovable cultural properties surveyed included 124 cultural heritage buildings (28 percent) that suffered heavy structural damage (Table 42).** These buildings refer to all cultural heritage buildings including those in the sectors of education, health, public administration and community infrastructure, business, housing, and culture. The largest number of damaged cultural heritage buildings refers to sacral buildings, mainly churches and chapels. In the historical core of Petrinja, several buildings listed as cultural property saw structural collapse and the caving in of the roof and upper story walls. In other historical buildings, in addition to the collapse of chimneys and gable walls, there was heavy damage to vertical load-bearing masonry structures, with wooden floor structures falling apart, and plaster falling off walls and ceilings. Notably, the vaulted structures of the ground floors—characteristic of most buildings erected in the eighteenth and early nineteenth century—largely escaped collapse, with most of the vaults—in spite of some

**Table 42.** Number of damaged individually protected cultural heritage buildings

Types of cultural heritage buildings	No.	No.	No.
Religious buildings	77	77	52
Cultural institutions buildings	10	8	3
Public institutions buildings	6	9	6
Housing and business	60	71	63
<b>Total</b>	<b>153</b>	<b>165</b>	<b>124</b>

Source: Estimations by the assessment team using official information.

cracks—retaining their geometry and stability.

**Outside urban areas, sacred edifices, and their attendant residential structures (parish/parochial houses) were the hardest hit buildings.** Most of the churches sustained heavy damage to load-bearing walls, the vaulting, and the walls of bell towers, threatening the overall stability of the buildings. Several churches saw structural collapse and the caving in of parts of the building, usually the bell tower, roof, vaulting, and sections of the perimetral walls. Very heavy damage was sustained by three baroque period churches: the St. Mary Magdalene Church in Sela near Sisak, the Blessed Virgin Mary Church in Pokupsko, and the Exaltation of the Holy Cross Cathedral in Sisak. The collapse of the bell tower during the earthquake led to the collapse of the vaulting and sections of the perimetral walls of the church in Žažina. In addition to these, many other buildings sustained heavy damage, and a great number of chapels, shrines, and parish houses were also damaged. Traditional wooden houses—owing to the properties of wood and the characteristic details of wooden structures—proved to be more resistant to earthquake damage and suffered damage in the form of scattered roof covering, the falling off of interior

plastering, and, in some cases, localized destabilization of wooden elements.

**Buildings in other counties sustained moderate to heavy damage, mostly very old sacred structures.** Zagreb County was the second most affected—39 sacred buildings and about 30 percent of the total individually listed immovable cultural properties in the county sustained heavy damage. The most extensive damage to a single listed cultural property in Karlovac County was observed at Karlovac’s Holy Trinity Church, its Franciscan Monastery, and its bell tower. Damage to buildings was also observed across Krapina-Zagorje County. The immovable cultural property that was damaged includes sacred buildings, palaces, and public buildings listed as cultural property. About 25 percent of the total listed immovable cultural properties—mostly sacred edifices—sustained damage.

**Progressive damage to 28 sacred and attendant residential buildings, three museums, and one palace in the City of Zagreb was reported.** Numerous minor cases of progressive damage to residential and public buildings in the historical core were also observed. Although progressive damage in the City of Zagreb did not change the usability categorization of the buildings, many sustained losses due to the cost of emergency measures to remove the damaged structural parts as

well as install supporting scaffolding to prevent further damage. In addition to cultural heritage buildings, the architectural complex of the stage production building of the Croatian National Theater was deemed temporarily unusable due to serious progressive damage. The stage production building is essential to the functioning of the theater, and in addition to storing equipment and props, it contains over 200,000 theatrical costumes that represent the cultural history of theater in Croatia.<sup>41</sup>

**Within this sector, there are 412 buildings, of which 227 are categorized as cultural heritage.** In addition to the already mentioned individually protected cultural property, buildings that serve the community—in terms of religion, cultural development, or through the preservation of intangible and tangible cultural heritage—were considered. It is especially important to point out that parish churches and community houses that mainly enable social gatherings to take place are the backbone of cultural life within small communities and villages. Within community homes, many cultural associations find the place to act and preserve the folklore values of the community.

41 Since all the experts of the MoCM were engaged in the damage assessment within the broad region of central Croatia (eight counties), there was no capacity to make a detailed assessment of the progressive damage in the City of Zagreb.

**Table 43.** Number and surface area of damaged buildings in the culture and cultural heritage sector by type

		No. of damaged public buildings			No. of damaged private buildings			Total damaged surface area in m <sup>2</sup>
Churches, chapels, and religious facilities	Cultural heritage	0	0	0	77	77	52	100,606
	Other	0	0	0	13	17	20	18,792
Libraries, reading rooms and theatres	Cultural heritage	1	0	1	0	0	0	2,740
	Other	8	1	3	0	0	0	5,917
Museums, galleries and archives	Cultural heritage	5	8	2	0	0	0	11,907
	Other	8	3	3	0	0	0	14,309
Community houses, cultural associations and other cultural institutions	Cultural heritage	4	0	0	0	0	0	2,826
	Other	57	28	24	0	0	0	42,309
Total	Cultural heritage	10	8	3	77	77	52	118,079
	Other	73	32	30	13	17	20	81,327
	All	83	40	33	90	94	72	199,406

Source: Estimations by the assessment team using official information.



**Table 44.** Total damage and losses in the culture and cultural heritage sector by type (EUR, millions)

Culture and cultural heritage sector		Damage			Losses		
		Public	Private	Total	Public	Private	Total
Religious buildings	Cultural heritage	0.00	353.50	<b>353.50</b>	0.00	12.79	<b>12.79</b>
	Other	0.00	56.22	<b>56.22</b>	0.00	0.71	<b>0.71</b>
Cultural institutions buildings	Cultural heritage	17.30	0.00	<b>17.30</b>	0.77	0.70	<b>1.47</b>
	Other	44.32	0.00	<b>44.32</b>	3.79	0.11	<b>3.90</b>
Archaeological survey (Siscia and Sigestica)	Cultural heritage	0.00	0.00	<b>0.00</b>	19.69	0.00	<b>19.69</b>
<b>Total</b>		<b>61.62</b>	<b>409.71</b>	<b>471.34</b>	<b>24.25</b>	<b>14.31</b>	<b>38.55</b>

Source: Estimations by the assessment team using official information.

**Sisak-Moslavina County incurred the greatest level of damage to movable cultural heritage.** Direct mechanical damage was observed on a small number of objects in churches and cultural/historical collections; the damage was found primarily on stone, marble and plaster sculptures, paintings, and ceramic items. Several organs in churches, as well as other instruments, sustained considerable damage. The buildings in which movables, such as in situ temporary protective wooden paneling, are located need better protection; otherwise, the inventory ought to be moved to safer temporary storage locations. Damage was observed in 93 percent of all inspected inventory (22 sacred inventories and all six cultural/historical collections), accounting for 60 percent of listed moveable cultural properties inspected.

**Damage or direct threats were observed at 50 percent of the inspected inventories (10 out of 20 inventories) in Zagreb County.** The significant damage sustained to buildings necessitates the protection of inventory in churches and chapels in Gorica Svetojanska, Mala Gorica (Sveta Nedjelja), Klake, and Pušća. The inventory ought to be disassembled, and a suitable storage facility must be provided. In Karlovac County, the damage is predominantly minor. However, urgent protective measures have been determined as necessary for 24 percent of the inspected inventories (9 out of 38 inventories). In Krapina-Zagorje County, 47 percent of the total listed movable cultural properties were inspected, with slight damage observed in 6 percent of the inspected inventories. Progressive damage of listed churches and monasteries and of public buildings in the City of Zagreb caused new damage to movable inventory where the inventory was not evacuated or protected by temporary

wooden paneling. Additional damage to a total of five sacred inventories and the historical equipment of one museum was observed.

**The total damage to the buildings for the culture and cultural heritage sector is estimated at EUR 471.3 million, of which 13 percent is in the public sector and 87 percent in the private sector, referring to sacral buildings.** These figures do not include damage to cultural heritage buildings in other sectors. Table 45 shows that most of the damage was suffered in Sisak-Moslavina County, with a total of EUR 233.1 million (50 percent) damage costs, followed by Zagreb County with EUR 157 million (33 percent), Karlovac County with EUR 53.7 million (11 percent), and Krapina-Zagorje County with EUR 27.5 million (5 percent).

**Losses are determined based on the degree of damage to the building and gross building area;** calculated costs include emergency measures to remove seriously damaged structural parts and debris and measures to preserve individually protected buildings and to prevent further building degradation. Additional losses are assessed from data collected from cultural institutions and include losses related to the evacuation of inventories, replacement spaces, and other specific costs related to institutional functionality. The damage to inventories of movable cultural goods was surveyed, mainly the sacral inventory (organ, altars, sculptures, and so on). To assess the costs, the evacuation, restoration, and the provision of an equipped replacement space were considered. Given that there is an invaluable archaeological site directly below Sisak, any intervention in the soil will require archaeological activities to

**Table 45.** Total damage and losses in the culture and cultural heritage sector by county (EUR, millions)

Administrative unit	Damage			Losses		
	Public	Private	Total	Public	Private	Total
Sisak-Moslavina County	50.64	182.47	<b>233.10</b>	21.80	5.54	<b>27.34</b>
Zagreb County	4.93	152.11	<b>157.04</b>	0.24	3.44	<b>3.69</b>
Karlovac County	4.99	48.69	<b>53.69</b>	0.25	1.50	<b>1.75</b>
Krapina-Zagorje County	1.06	26.44	<b>27.51</b>	0.44	0.85	<b>1.29</b>
City of Zagreb	0.00	0.00	<b>0.00</b>	1.52	2.97	<b>4.49</b>
<b>Total</b>	<b>61.62</b>	<b>409.71</b>	<b>471.34</b>	<b>24.25</b>	<b>14.31</b>	<b>38.55</b>

Source: Estimations by the assessment team using official information.

collect archaeological records and to preserve the artifacts of ancient civilizations. The area of archaeological interventions is calculated based on an estimate of the area of heavily damaged buildings that will need to be completely or partially removed.

**Total losses amount to EUR 38.553 million (Table 45).**

They include (a) emergency measures such as rubble removal and the installation of supporting scaffolding; (b) the removal of damaged church towers; (c) decomposition, cleaning, and storage of masonry bricks for the reconstruction of individually protected buildings; (d) the installation of wood covers in churches; (e) the relocation of sacral inventory and museum exhibits; (f) equipping of temporary storages for sacral inventory; (g) the restoration of damaged sacral inventory; (h) rental of temporary premises; and (i) an archaeological survey of Siscia and Sigestica. About 71 percent of total losses were in Sisak-Moslavina County, 10 percent in Zagreb County, 12 percent in the City of Zagreb, 5 percent in Karlovac County, and 3 percent in Krapina-Zagorje County.

### Disaster Impact on the Affected Population

Due to the COVID-19 pandemic, epidemiological measures were imposed by the national civil protection headquarters which restrict large gatherings, including visits to cultural institutions. Although these measures allow for religious rites to be observed, most churches are unusable and have been closed. The activities of cultural institutions in Sisak-Moslavina County that take place in historical buildings have been shut down. The inventories have been relocated to safe premises, with activities taking

place in limited scope. The Conservation Department of the MoCM for Zagreb County is operating with difficulty, as its building is temporarily unusable. The Conservation Department in Sisak is also facing operational difficulties on account of the enormous increase in workload resulting from the disaster.

**The impact of the earthquake in the culture sector must be calculated considering the exposure to the risk of further damage to individual building complexes.**

Such risk refers primarily to the penetration of water precipitation where roof damage has occurred due to widespread collapse of chimneys and the damaging or falling off of the roofing material. A possible risk is the collapse of destabilized sections of buildings in the historical centers of Petrinja, Sisak and Glina due to vibrations produced by earthquake aftershocks and heavy vehicles used in the process of repairing damaged buildings. A risk to immovable cultural property is the pressure to remove heavily damaged buildings, which would constitute a critical loss to the authenticity of cultural and historical areas.

### Reconstruction and Recovery Needs

The recovery and reconstruction needs in this sector include the systematic restoration of historical urban areas and individual cultural properties, the reconstruction of buildings that promote culture in general, improvement of resilience to earthquakes and other risks, and the application of EE measures to architectural heritage. Due to the extent of the earthquakes' destruction—particularly in the historical cities of Petrinja, Sisak, and Glina—the recovery process is based on sustainable development

considerations that include the revision of spatial planning and the preservation of cultural and historical areas implemented within urban transformation, especially at the margins of the historical city cores.

**The foreseen models of reconstruction—based on a conservation-based approach—depend on the level of damage sustained by heritage buildings.** The models include complete building repair, reconstruction that reintegrates original structures and materials, facsimile reconstruction of entire buildings, partial facsimile reconstruction, and replacement construction. The approach to conservation/restoration works of movable heritage is based on the preservation of parts of objects that embody its recognized value in an interrelationship of original materials and the appreciation of historical strata. It will also be necessary to improve the conditions for the storage and display of museum material and movable cultural heritage by considering earthquake-related risks as well as other risks that contribute to object degradation.

**Short-term recovery measures** include urgent activities which involve preserving of heavily damaged architectural heritage buildings, priority surveys by civil engineers and conservators, detailed recording and assessment of the sustained damage, photographic and 3D imaging, temporary structural stabilization, controlled dismantling and depositing of heritage buildings sections, and protection of the further degradation due to external

influences such as weather and vibrations from traffic. Furthermore, the evacuation of movable heritage objects (constituting public, private, and sacral inventories) from temporary storage locations into adequately equipped storage spaces, detailed documentation of inventories and damage record, and development of conservation and restoration works programs.

**Medium-term measures** include the systematic renovation of buildings within the sector with the following activities: (a) the establishment of an International Advisory Committee for the structural reinforcement of heritage buildings and properties; (b) the preparation of integrated conservation urban development plans for the historical cores of Sisak, Petrinja, Glina, and Hrvatska Kostajnica, as well as for the rural areas of Sisak-Moslavina County; (c) the retrofitting of these buildings, including through the reinforcement of structural and non-structural (decorative) elements and the installation of substitute elements or materials that are compatible with the historic building; and, (d) renovations measures. The renovation measures will aim to incorporate EE improvements, provide better access for persons with disabilities and people with reduced mobility, and ensure any other interventions which would raise the standard in the housing sector and re-think possible uses of historic buildings. The recovery of movable heritage property requires specialist trainings and workshops for disaster risk preparation and management that can (a) define guidelines and other relevant materials for



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all stakeholders, to ensure the proper implementation of the recovery process, and (b) upgrade the Cultural Heritage Information System of the MoCM that contains data on earthquake damage to cultural property and provides a platform for data collection for disaster risk assessment (DRA) and management.

**Long-term measures** include continued medium-term activities that concern the revitalization and urban transformation of the area, aligned with sustainable development principles. This includes the creation of a comprehensive master plan for the recovery of historical urban and rural areas. This plan will tackle the areas' resilience to earthquakes and other risks and consider cultural heritage as a resource for development. The result will include a long-term strategy based on a recognition and integral overview of natural and cultural resources as developmental potential. Long-term measures for movable heritage include the procurement of stands and museum showcases that absorb the effects of earthquake shocks and ensure optimal microclimatic conditions for the most important works of art/objects; conservation and restoration works on the damaged movable heritage; and, upkeep readiness measures on dealing with and protecting movable heritage in crisis situations, to be established through specialist training of conservators, restorers, curators, archivists, and

librarians as well as owners and users of cultural heritage.

**Additionally, the recovery process includes the following activities and measures:** developing a digital database for the cultural heritage that is at risk; organizing advanced training in seismic design, construction technologies, building materials, and numerical computations; establishing a diagnostic laboratory for pre- and post-earthquake responses for built heritage; and conducting feasibility studies on the installation of a seismic base isolation system for particularly valuable heritage buildings.

**Reconstruction needs for the culture and cultural heritage sector are estimated at approximately EUR 610.54 million, including needs related to movable heritage (Table 47).** Of these, 18 percent pertains to the public sector and 82 percent to the private sector. An additional EUR 76.76 million is needed for recovery projects in the sector (Table 48). In terms of the geographical distribution of reconstruction costs, the largest proportion will be required by Sisak-Moslavina County (50 percent), followed by Zagreb County (31 percent), Karlovac County (12 percent), Krapina-Zagorje County (6 percent), and the City of Zagreb (1 percent). These figures do not include the recovery needs of cultural heritage buildings in other sectors.



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**Table 46.** Total reconstruction needs in the culture and cultural heritage sector by county (EUR, millions)

Administrative unit	Public	Private	Total
<b>Sisak-Moslavina County</b>	89.93	210.39	<b>278.49</b>
<b>Zagreb County</b>	8.45	180.21	<b>188.42</b>
<b>Karlovac County</b>	8.16	64.33	<b>72.24</b>
<b>Krapina-Zagorje County</b>	2.16	30.86	<b>32.58</b>
<b>City of Zagreb</b>	1.52	3.03	<b>4.54</b>
<b>Total</b>	<b>110.22</b>	<b>500.32</b>	<b>610.54</b>

Source: Estimations by the assessment team using official information.

**Table 47.** Movable heritage reconstruction needs by county (EUR)

Administrative unit	Movable heritage	Total
<b>Sisak-Moslavina County</b>	Churches and monasteries	<b>73,827</b>
	Museum and galleries	<b>30,493</b>
<b>Zagreb County</b>	-	<b>/</b>
<b>Karlovac County</b>	Churches and monasteries	<b>56,000</b>
<b>Krapina-Zagorje County</b>	Churches and monasteries	<b>39,330</b>
<b>City of Zagreb</b>	Churches and monasteries	<b>57,333</b>
<b>Total</b>		<b>256,983</b>

Source: Estimations by the assessment team using official information.

**Table 48.** Total reconstruction and recovery needs in the culture and cultural heritage sector in the short, medium, and long term (EUR, millions)

Recovery Projects	Short	Medium	Long	Total
Reconstruction of infrastructure and physical assets including debris removal	122.11	305.27	183.16	<b>610.54</b>
<b>Reconstruction subtotal</b>	<b>122.11</b>	<b>305.27</b>	<b>183.16</b>	<b>610.54</b>
Cost of specialists: Advisory Committee for the Structural Reinforcement Approach to the Historic Buildings	0.50	0.30	0.20	<b>1.00</b>
Master plan for recovery of historical urban and rural areas in Sisak-Moslavina County which includes resilience to earthquakes and other risks and sees cultural heritage as a resource in development.	5.00	3.00	2.00	<b>10.00</b>
Conservation recovery plan for the city of Sisak, with the earthquake reduction scheme and EE measures	0.25	0.15	0.10	<b>0.50</b>
Conservation recovery plan for the city of Petrinja with the earthquake reduction scheme and EE measures	0.25	0.15	0.10	<b>0.50</b>
Conservation recovery plan for the city of Glina with the earthquake reduction scheme and EE measures	0.25	0.15	0.10	<b>0.50</b>
Conservation recovery project for the city of Hrvatska Kostajnica with the earthquake reduction scheme and EE measures	0.25	0.15	0.10	<b>0.50</b>
Diagnostic laboratory for pre- and post-earthquake responses for built heritage	30.00	18.00	12.00	<b>60.00</b>
Advanced training in seismic design, construction technologies, building materials, and numerical computations	0.50	0.30	0.20	<b>1.00</b>
Education and training materials	0.03	0.02	0.01	<b>0.06</b>
Development of database for heritage at risk	1.25	0.75	0.50	<b>2.50</b>
Feasibility studies of seismic base isolation system installation for particularly valuable heritage buildings	0.10	0.06	0.04	<b>0.20</b>
<b>Recovery subtotal</b>	<b>38.38</b>	<b>23.03</b>	<b>15.35</b>	<b>76.76</b>
<b>Total</b>	<b>160.49</b>	<b>328.30</b>	<b>198.51</b>	<b>687.30</b>

Source: Estimations by the assessment team using official information.



# PRODUCTIVE SECTORS

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## BUSINESS

### Sector Overview and Baseline

#### Data

**A** The business sector in Croatia is dominated by small and medium enterprises (SMEs). Micro and small businesses constituted 98.6 percent of the total firms in 2019, while SMEs together made up 99.7 percent of the total businesses. In 2019, SMEs employed almost three-quarters (72.2 percent) of all employees in business entities, generated 58 percent of total revenue, and accounted for 53 percent of exports.

Among the earthquake-affected areas, most business activity is concentrated in the City of Zagreb (Table 49). Businesses registered in the City of Zagreb account for 33 percent of all active firms in Croatia, with another 6 percent registered in Zagreb County. The remaining three counties—Krapina-Zagorje, Karlovac, and Sisak-Moslavina—each account for approximately

2 percent of the total businesses (approximately 2,300 businesses per county). The City of Zagreb also accounts for the largest share of sales revenues (61 percent, which is more than all other counties combined) and 39 percent of exports (Figure 8); it should be noted that half of

**Table 49.** Structure of business sector by size in the affected areas (2019)

Administrative unit	Total firms	Proportion (in %)		
	All sizes	Micro and small	Medium	Large
Sisak-Moslavina County	2,308	98.7	1.0	0.3
Karlovac County	2,323	98.5	1.2	0.3
Zagreb County	9,019	98.4	1.3	0.3
Krapina-Zagorje County	2,344	97.7	2.1	0.2
City of Zagreb	45,608	98.4	1.2	0.4
Rest of Croatia	74,661	98.8	1.0	0.2
<b>Total</b>	<b>136,260</b>	<b>98.6</b>	<b>1.1</b>	<b>0.3</b>

Source: Financial Agency, FINA 2019.

Croatia's large firms are headquartered in the capital.

**In addition to limited liability companies, many crafts are located in the areas affected by the earthquake.**

Out of 90,788 crafts registered in Croatia at the end of 2020, 19.5 percent were located in the City of Zagreb, 6.2 percent in Zagreb County, 3 percent in Krapina-Zagorje County, 2.5 percent in Sisak-Moslavina County, and 2.2 percent in Karlovac County (Figure 9). Crafts are important providers of employment and self-employment in Croatia—by the end of February 2020, crafts employed

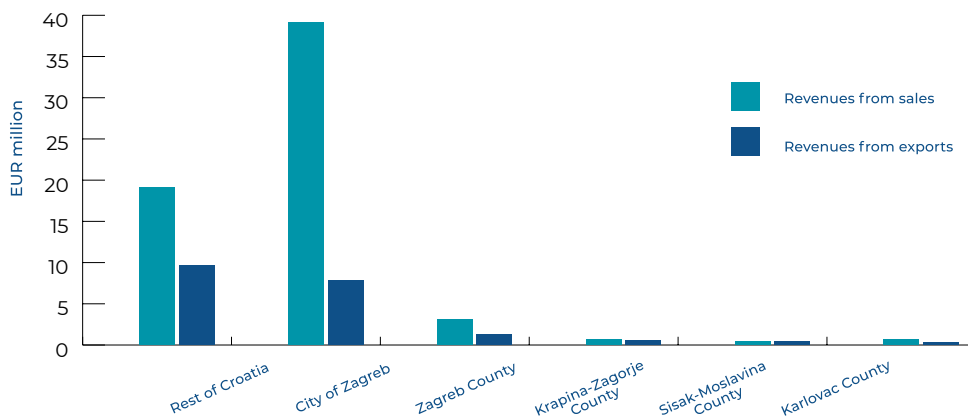
over 182,000 people in Croatia, of which 94,000 were employees and the remainder were owners.

**In terms of revenues, wholesale and retail trade and manufacturing are the largest sectors in the affected areas.**

Figure 10 shows the operating revenues of firms in the five affected areas by sector.<sup>42</sup> The trade and manufacturing sectors generate the most revenues in the affected areas, accounting for 62 percent of operating revenues

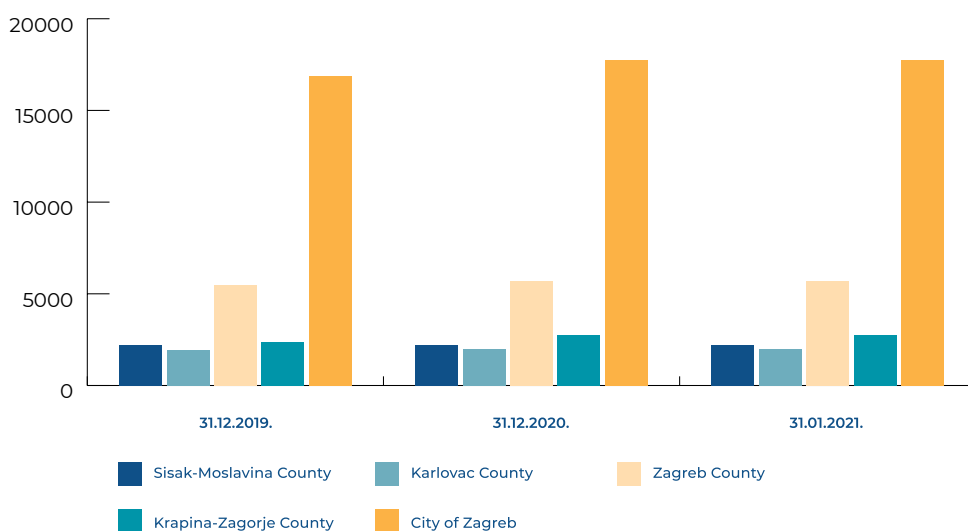
<sup>42</sup> Sectors are defined according to the statistical classification of economic activities in the European Community (NACE Rev. 2).

**Figure 8.** Sales and exports in earthquake-affected areas by county (2019, EUR millions)



Source: Financial Agency, FINA 2019.

**Figure 9.** Number of crafts in Croatia in the affected areas (2019-2021)



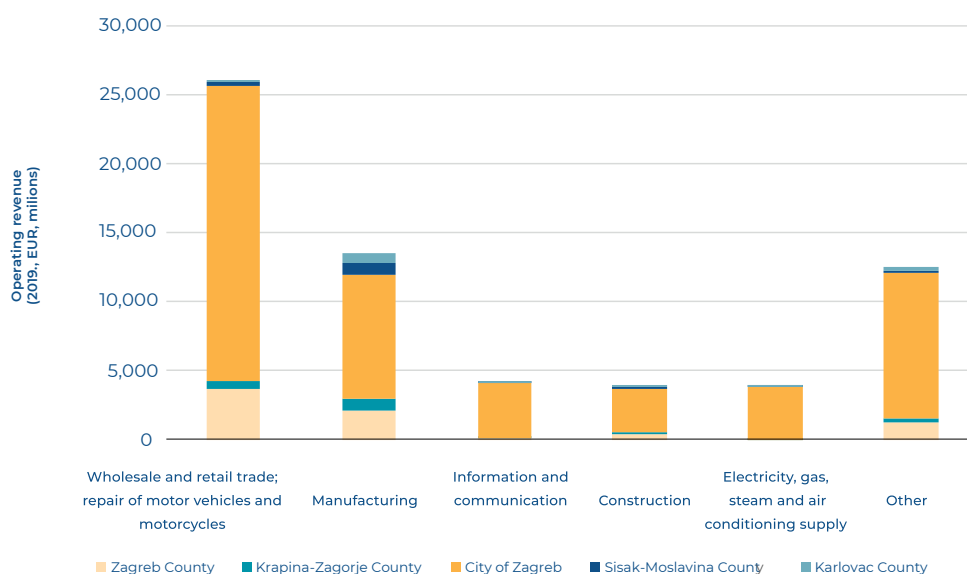
Source: Croatian Craft Register, Printout: 12/02/2021.

and 69 percent of export revenues in 2019. These are followed by information and communication construction and the supply of electricity, gas, and air conditioning. Within the manufacturing sector, food manufacturing figures among the largest sectors in all counties, except for Krapina-Zagorje. Other important industries include petroleum products (City of Zagreb), fabricated metal products (Zagreb County, Krapina-Zagorje, and

Karlovac County) and chemicals (Sisak-Moslavina). Firms in the affected areas account for 72 percent of all wholesale and retail trade revenues and 56 percent of all manufacturing revenues in Croatia.

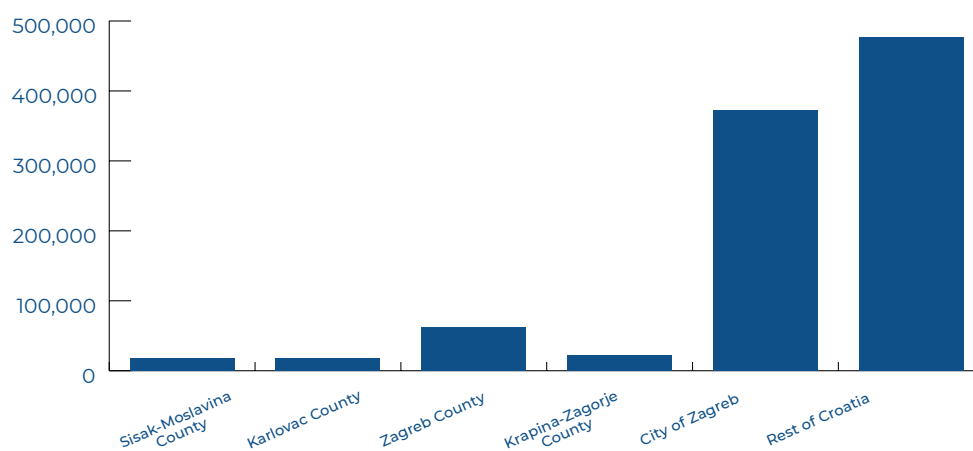
**Before the earthquake, all affected areas had registered an increase in the number of employees in the business sector.** The affected areas account for 44.5 percent

**Figure 10.** Operating revenue in earthquake-affected areas by sector (2019, EUR, millions)



Source: Financial Agency, FINA 2019.

**Figure 11.** Number of employed persons in the business sector in each affected area



Source: Financial Agency, FINA 2019.



of employed persons in Croatia; of these, most are situated in the City of Zagreb (38.4 percent) (Figure 11). From 2018 to 2019, the number of employees in the business sector increased in all counties, most notably by 9.4 percent in the City of Zagreb and 8.5 percent in Zagreb County. Despite these positive developments, smaller counties have been facing serious demographic challenges with significant socio-economic repercussions at a local level. For example, in 2019, the working age population in Sisak-Moslavina County decreased by 27,646 people compared to 2001. In 2019, the average monthly net salary of employees working for local businesses in the Sisak-Moslavina County amounted to EUR 618 (HRK 4,657), which represents a 4.5 percent increase compared to 2018 levels - EUR 592 (HRK 4,446). This county-level average is still 23.3 percent lower than the average monthly net salary of employees of entrepreneurs in 2019 at the national level – which was at EUR 772 (HRK 5,817).

## Effects of the Disaster (Damage and Losses)

**Sisak-Moslavina County had the largest damaged area in the business sector (in terms of m<sup>2</sup>).**<sup>43</sup> Its industry and facilities date back to former Yugoslavia, when Sisak was known for its industrial capacities. However, the transition process has taken its toll and the process of revitalization has been slow. More than 75 percent of the damaged area in the business sector was in Sisak-Moslavina County, and more than half of the infrastructure deemed as unusable (red) in the business sector was in this county. Almost all the industry reported as temporarily unusable (yellow) was based in Sisak-Moslavina

<sup>43</sup> Due to limited data availability, the damaged surface area in the business sector was calculated by combining different data sources, including Arc-GIS database of damage assessments across all sectors, damage claims reported by businesses through County Chambers of Commerce, damage claims from utility companies, and GIS analytics conducted by the Faculty of Geodesy, University of Zagreb.

**Table 50.** Surface area of damaged buildings in the business sector

Administrative unit				Total	
<b>Karlovac County</b>	Business / commerce / service	11,359	3,340	1,045	<b>15,744</b>
	Industry	50,910	5,780	26,811	<b>83,501</b>
	Total private	62,269	9,120	27,855	<b>99,245</b>
<b>Krapina-Zagorje County</b>	Business / commerce / service	37,523	6,140	1,364	<b>45,027</b>
	Industry	0	0	0	<b>0</b>
	Total private	37,523	6,140	1,364	<b>45,027</b>
<b>Sisak-Moslavina County</b>	Business / commerce / service	82,358	29,282	18,301	<b>129,941</b>
	Industry	381,074	144,620	27,055	<b>552,749</b>
	Total private	463,432	173,902	45,356	<b>682,690</b>
<b>Zagreb County</b>	Business / commerce / service	11,760	3,564	1,069	<b>16,393</b>
	Industry	4,703	1,425	428	<b>6,556</b>
	Total private	16,463	4,989	1,497	<b>22,949</b>
<b>City of Zagreb</b>	Business / commerce / service	39,851	8,942	3,534	<b>52,327</b>
	Industry	0	0	0	<b>0</b>
	Total private	39,851	8,942	3,534	<b>52,327</b>
<b>Total</b>	Business / commerce / service	182,851	51,268	25,314	<b>259,433</b>
	Industry	436,687	151,825	54,293	<b>642,805</b>
	<b>Total private</b>	<b>619,538</b>	<b>203,094</b>	<b>79,607</b>	<b>902,238</b>

Source: Estimations by the assessment team using official information.

**Table 51.** Total damage and losses in the business sector by subsector (EUR, millions)

Subsector	Damage			Losses		
	Buildings	Equipment, furniture	Total	Debris removal/demolition	Business interruption	Total
<b>Business/commerce/service</b>	70.63	75.17	<b>145.79</b>	5.80	151.60	<b>157.40</b>
<b>Industry</b>	135.43	40.85	<b>176.28</b>	12.26	188.54	<b>200.80</b>
<b>Total</b>	<b>206.06</b>	<b>116.02</b>	<b>322.08</b>	<b>18.06</b>	<b>340.14</b>	<b>358.20</b>

Source: Estimations by the assessment team using official information.

County. As noted further in Box 1 and based on the experiences from the Zagreb earthquake, businesses in the red and yellow categories will need some time before they are able to resume normal operations; this may be further complicated by Sisak-Moslavina’s poor economic situation. Table 50 provides an overview of the damaged surface area in the business, commerce, and service sub-sector and industry sub-sector on the level of counties.

**The estimated damage and losses in the business sector are substantial.** The total damage to businesses, which includes damage to buildings and equipment, is estimated at EUR 322 million (Table 51).<sup>44</sup> The estimated damage to buildings amounts to EUR 206 million (mostly in the industry sector), while the estimated damage to equipment amounts to EUR 116 million (mostly in the other business/commerce/service sector). Around 55 percent of the total damage pertains to industry, while the remainder was incurred in other business sectors such as offices, commerce, and other services. The estimated total loss amounts to EUR 358 million, of which 340 million pertains to business interruption.

**While businesses were affected in all five administrative units, most of the damage and losses are concentrated in Sisak-Moslavina County.** Of the estimated

total damage to businesses (EUR 322 million), 80.2 percent (EUR 258 million) pertains to Sisak-Moslavina County. Of this, EUR 143 million pertains to damage to buildings, while EUR 115 million is the estimated damage to equipment. In this county, 73 percent of the damage to buildings was incurred in industrial premises, followed by mixed business premises (14.3 percent) and office, retail, and other services (12.9 percent). According to the Chamber of Crafts of Sisak-Moslavina County, a total of 212 crafts were affected by the earthquake. Substantial damage to buildings was also incurred in Karlovac County, amounting to EUR 34 million, of which 89 percent pertains to industrial premises.

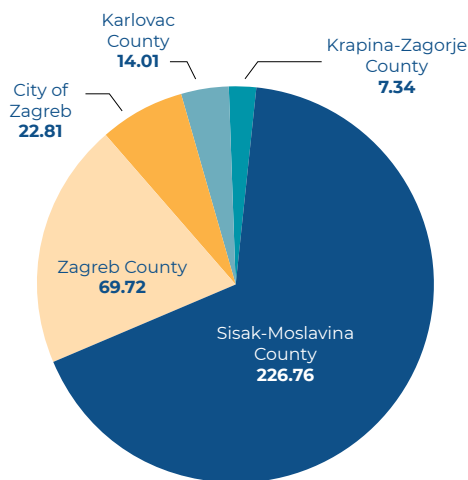
**Business premises in the City of Zagreb, which were already damaged in the Zagreb earthquake in March 2020, sustained additional damage.** Based on preliminary data, of 626 locations damaged in the March earthquake, the condition of 436 locations deteriorated due to additional damage following the earthquake. Out of those, 74 locations pertain to business premises (in full or in combination with other types of premises).

### *Disaster Impact on the Affected Population*

**The losses due to business interruption are largest in Sisak-Moslavina County; this is to be expected, considering the high damage incurred.** Estimated business interruption costs amount to EUR 340 million, with county figures shown in Figure 12, and they are relatively proportional to the damage presented in the

<sup>44</sup> Damage and losses were estimated using data on the damaged surface area, the level of damage (damage category), and estimated costs due to building damage, debris removal, removal of chimneys and roof tiles which may endanger passersby, or the environment and restoration costs. For buildings assessed as ‘unusable due to damage,’ alongside the aforementioned costs, additional costs related to demolition and disposal in the amount of EUR 98 per m<sup>2</sup> were added. Equipment costs are exclusively based on data collected by County Chambers of Commerce. No further extrapolation or estimates were done for damage on equipment, as it cannot be linked to the damaged surface area or the level of damage of the building itself.

**Figure 12.** Business interruption by county (EUR, millions)



Source: Estimations by the assessment team using official information.

previous section.<sup>45</sup> More than 66 percent of the business interruption losses are in Sisak-Moslavina County. There were also significant recorded losses in Zagreb County; this is to be expected given the county’s proximity to the epicenter and the fact that it is closer to the City of Zagreb, where the country’s economic activity is mostly concentrated.

**Businesses have already reported financial losses due to failed shipments and closures.** Businesses in Sisak-Moslavina County were asked to estimate financial losses until the expected reopening. While data are scarce, businesses reported estimated financial losses between EUR 130,000 and EUR 13 million. In manufacturing firms, these relate to unfulfilled orders and shipment delays due to earthquake damage, while in the retail trade and services sectors losses are mostly related to the closure of premises. Crafts estimated financial losses ranging between EUR 15,000 and EUR 55,000. 72 hospitality businesses (hotels, restaurants, and cafes) reported damaged equipment and inventory ranging between EUR 150 and EUR 100,000 and estimated operating losses

45 Assumptions made to calculate the business interruption loss include the following: (a) business facilities in the green category will not incur business interruption; (b) business facilities in the yellow category PN1 and PN2 will incur business interruption in 90 and 500 days, respectively; and (c) business facilities in the red category will incur business interruption in 1,000 days.

between EUR 1,000 and EUR 238,000. Box 1 provides further details on the disaster’s impact on businesses in Sisak-Moslavina County. According to data provided by the Tax Authority, 1,014 firms from the affected areas have already requested some form of relief or the deferral of their obligations as a result of the earthquake.

**The number of unemployed persons has continued to rise in the aftermath of the earthquake, which has disproportionately affected women.** Between December 2020 and January 2021, the number of unemployed persons in the affected areas grew by 1,284 people, 61.5 percent of whom were women. It must be noted that unemployment had already been on the rise before the December earthquakes, with the sharpest increase coinciding with the start of the COVID-19 pandemic and the resulting nationwide lockdowns (Figure 13). Compared to January 2020, the number of unemployed persons in the five analyzed administrative units increased by 8,671. As of February 22, 2021, the Ministry of Labor, Pension System, Family, and Social Policy (MoLPSFSP) reported receiving 1,208 requests for support for the preservation of 5,834 jobs in the earthquake-affected areas.



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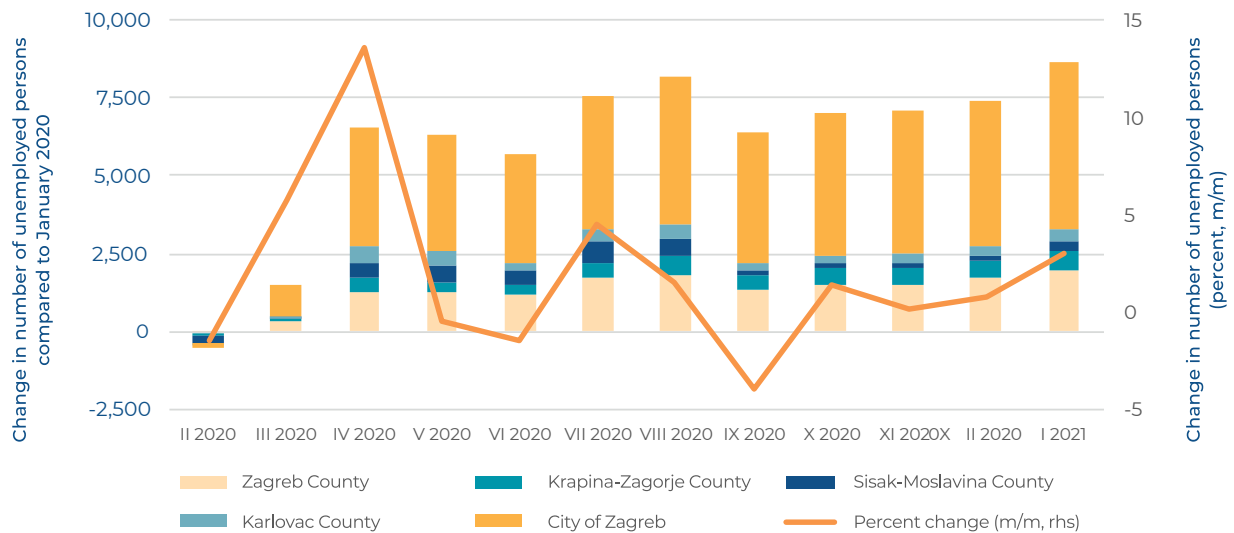
**Box 1.** Disaster impact in Sisak-Moslavina County

**P**reliminary data covering a sample of firms in Sisak-Moslavina County show significant damage in terms of infrastructure and equipment. The dataset collected by the Chamber of Economy of Sisak-Moslavina County contains information reported by businesses on the status of 186 firms (including 20 crafts) operating in 303 business premises. A third of them operate in the services sector, another third represents manufacturing firms, 12 percent operate in wholesale and retail trade, and 11 percent in the hospitality industry, while agriculture and tourism are each represented by 3 percent of firms. Out of 303 business premises, 100 were given the green label, 66 were labelled yellow,

70 red, and for 67 there were no data. Based on the experiences of the Zagreb earthquake, premises in the green category may continue operations soon after the earthquake, premises in the yellow category may need several months to resume operations, and premises in the red category may take a few years before they resume normal operations. Businesses estimated that the replacement value of equipment amounted to almost EUR 40 million, of which 69 percent pertained to the manufacturing sector. Businesses reported a broad set of damage to plants and equipment, for example, pipelines, cisterns, specialized machinery and tools, inventory, storage equipment, and office equipment.

Source: Sisak-Moslavina County Chamber of Economy.

**Figure 13.** Change in the number of unemployed persons in the affected counties



Source: MoLPSFSP.

## Reconstruction and Recovery Needs

**Reconstruction needs are estimated at almost EUR 462 million, which covers reconstruction costs of buildings and equipment as well as implementation of recovery measures.** Reconstruction needs amount to EUR 398.7 million, of which 41 percent pertains to the short term, 34 percent to the medium term, and 25 percent to the long term (Table 52). Reconstruction needs for equipment are expected to be more front-loaded, while the reconstruction of buildings is expected to be longer-term, especially for those with more severe damage. To ensure sustainability and resilience, reconstruction should follow the BBB concept, in line with best practices and standards in construction industry and EC8 building code regulations. Recovery needs, which include costs of soft support measures, are estimated at EUR 63 million.

**Recovery measures should provide an opportunity to raise the competitiveness and support the development of the region through productivity-enhancing interventions.** The overall vision of the post-earthquake business recovery needs in Croatia is to reinvigorate affected businesses while making sure that the disruption of employment is reduced to a minimum. Moreover, the process should stimulate new resilient investments and include digitalization and business innovations, thus strengthening overall business post-disaster competitiveness. The interventions should account for the following principles:

- Improving the competitiveness and growth potential of businesses through greater investment in research and development (R&D), higher levels of innovation, fostering of export potential, and further development of business networks and connectivity.
- Improving access to finance by broadening financing options for SMEs with simpler, less costly procedures.
- Promoting entrepreneurship by providing support for the establishment of new companies, increasing the number of active companies, and strengthening institutions that provide support to entrepreneurs to contribute to an inclusive development of districts affected by earthquake; preserving and developing traditional and artistic crafts businesses, including lifelong learning for crafts.
- Improving entrepreneurial skills by strengthening managerial capabilities, attracting and retaining employees, and supporting lifelong learning in SMEs, including through vocational training and management training for business start-ups for job seekers and entrepreneurs.
- Improving the business environment by continuing the work on reducing administrative burdens, facilitating business in areas affected by earthquake, and developing an environment of cooperative entrepreneurship and partnerships between businesses and authorities at the municipal and central levels.

**Short-term recovery measures are aimed at urgent re-**

**Table 52.** Total reconstruction and recovery needs in the business sector in the short, medium, and long term (EUR, millions)

Reconstruction and recovery	Short	Medium	Long	Total
Reconstruction of infrastructure and physical assets including debris removal	161.87	135.80	101.04	<b>398.72</b>
<b>Reconstruction subtotal</b>	161.87	135.80	101.04	<b>398.72</b>
Immediate post-disaster economy reactivation through financial mix support	30.00	10.00	10.00	<b>50.00</b>
Supporting disaster resilient business model innovations including temporary employment schemes	5.00	2.50	2.50	<b>10.00</b>
Support for enterprise recovery and employment promotion strategy in earthquake-affected communities	1.00	0.00	0.00	<b>1.00</b>
Revision of business safety standards and development of business-related resilience plans	1.00	1.00	0.00	<b>2.00</b>
<b>Recovery subtotal</b>	37.00	13.50	12.50	<b>63.00</b>
<b>Total</b>	<b>198.87</b>	<b>149.30</b>	<b>113.54</b>	<b>461.72</b>

*Source: Estimations by the assessment team using official information.*

**construction of damaged infrastructure and bridging short-term cash flow gaps.** The Croatian government already secured EUR 1.63 million (HRK 10 million) for a small-value aid scheme for micro and small business entities for earthquake remediation. Out of EUR 63 million for soft support measures, 59 percent is related to short-term interventions (Table 52). Short-term interventions include post-disaster financing rehabilitation of business premises, business premises rental, furnishing of the interior of business premises, procurement of machinery and equipment, and procurement of working capital needed to perform business activities. In addition to investments in physical property and working capital, short-term support should also be provided for business model innovations, employment support, business safety standards, and so on. Interventions to support entrepreneurship should target job seekers, in particular vulnerable groups.

**In the medium and long term, the focus of recovery measures should turn toward more targeted interventions to raise productivity and resilience of businesses in the affected areas.** Resources should be steered toward more efficient and more productive businesses to engage in both R&D and non-R&D-based innovations, digitalization of business operations, internationalization, and similar activities. Further, actions will be needed to foster a better business environment by reducing regulatory and administrative burdens to businesses. Resilience plans and municipal-level strategic development plans should complement the proposed measures and ensure the long-term sustainability of the recovery.

## AGRICULTURE

### *Sector Overview and Baseline Data*

**The agriculture sector in Croatia in general is characterized by many small family holdings—70 percent manage less than 5 hectares (ha) and only 5 percent utilize more than 20 ha.** The average size of an agricultural holding is 7 ha. About 30 percent of the agricultural holdings are managed by people over 65 years of age, and only 11 percent by people under 40. As per the farm register, the total number of holdings registered is around 170,000, out of which 98 percent are family farms characterized by relatively low land and labor productivity, investment levels, performance in the knowledge and innovation sector, and

level of education. About 21 percent of the holders have elementary school education, and 6 percent have secondary school education.

**In the areas affected by the December 2020 earthquakes, there are 46,000 agricultural holdings and 44,500 animal growers.** The total utilized agricultural area is around 200,000 ha, out of which 62 percent is arable land, 28 percent is grassland, and 4 percent has permanent crops. Around 10 percent of the land is state owned (20,000 ha) and rented by farmers. The average value of privately owned agricultural land is estimated at EUR 35,000 per holding (Table 53). In the affected area, livestock production currently registers 91,500 cows, 230,000 pigs, 125,000 sheep and goats, 11,600 horses and donkeys, and 4,200,000 chickens and other poultry. In this area, there are also 139,000 beehives. The estimated value of agricultural production in the affected areas is close to EUR 500 million. Most of the agriculture-related buildings are old animal stables and other facilities used to store machineries, equipment, feeding staff, and raw material. The average value for a building is around EUR 33,000, and for machinery and equipment, it is around EUR 24,000 per holding.



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**Table 53.** Overview of agriculture subsectors in the affected area

Agriculture subsectors in the affected areas	Sisak-Moslavina County	Zagreb County	City of Zagreb	Karlovac County	Krapina-Zagorje County
<b>Agricultural holdings (No.)</b>	9,389	14,506	6,375	6,720	8,988
<b>Surface area of agricultural land (in ha)</b>					
<b>Utilized area</b>	65,719	71,699	7,293	30,044	22,512
<b>Arable and</b>	40,642	47,980	5,066	18,340	10,642
<b>Grassland</b>	21,948	15,437	1,329	9,065	7,613
<b>Permanent crops</b>	1,578	3,001	352	640	1,695
<b>Greenhouses</b>	13	59	77	6	9
<b>Rental (state owned)</b>	12,174	6,547	994	361	6
<b>Livestock (No.)</b>					
<b>Animal growers</b>	10,525	12,781	1,707	6,953	12,547
<b>Cattle</b>	29,222	38,437	2,663	13,566	7,594
<b>Sheep and goats</b>	48,072	32,468	2,642	34,719	6,956
<b>Horses and donkeys</b>	6,199	2,753	699	1,205	706
<b>Pigs</b>	55,585	108,419	8,403	21,311	36,211
<b>Poultry</b>	375,885	1,474,449	820,131	213,301	1,332,154
<b>Beehive</b>	42,486	48,585	7,520	22,010	18,399
<b>Labour force (No.)</b>					
<b>Annual working units</b>	10,937	17,086	7,546	8,875	12,088
<b>Crafts and free lances (paid)</b>	334	380	144	187	114
<b>Legal entities (paid)</b>	584	685	919	777	84
<b>% of women in paid employment</b>	30	37	46	25	34
<b>Value of production (In EUR)</b>	136,544,300	163,219,100	32,113,500	91,796,400	99,675,500
<b>Agricultural assets, materials and supplies (EUR)</b>					
<b>Agricultural land</b>	192,746,800	437,063,700	128,310,000	140,155,000	215,674,900
<b>Farm buildings</b>	157,102,700	376,766,900	75,911,600	108,525,100	231,396,900
<b>Equipment and machinery</b>	147,303,700	281,150,200	70,346,000	101,490,700	121,831,900
<b>Stored crops</b>	37,140,500	78,201,800	11,911,200	62,361,600	36,202,800
<b>Agricultural inputs</b>	4,265,800	3,422,300	3,649,700	552,300	3,929,600

Source: MoA.

**In Sisak-Moslavina County, investments in agricultural production facilities were extensive.** In the affected counties, the agricultural sector is characterized by many small family holdings; 70 percent manage less than 5 ha and only 5 percent utilize more than 20 ha. The average farm size is only 4 ha. Small farmers producing small quantities of goods hardly meet the market standards required; they are more oriented toward ensuring they are self-sufficient and have limited interest in the market. Agricultural buildings are mostly of lower quality and there is an inadequate quantity of materials. The socioeconomic structure of the sector contributed to low farm incomes, reducing farmers' capacity to invest in development and modernization. Additionally, there

is continued migration of the rural population to other areas of Croatia and/or abroad.

### Effects of the Disaster (Damage and Losses)

**The earthquake caused significant damage to agricultural infrastructure and physical assets in the affected territories, to varying degrees.** The total number of damaged farm buildings is estimated to be 2,268; 90 percent of these are in Sisak-Moslavina County, and around 70 percent of all buildings were marked as temporarily or permanently unusable. In other four affected territories,

**Table 54.** Number and surface area of damaged farm buildings and storage facilities in the agriculture sector by county

Administrative unit	No. of damaged farm buildings and storage facilities on farms			Total no. of damaged buildings	Total damaged surface area in m <sup>2</sup>	Total estimated damage (EUR, millions)
Sisak-Moslavina County	570	703	766	<b>2,039</b>	394,634	68.91
Zagreb County	53	54	26	<b>133</b>	45,712	5.34
Karlovac County	47	26	12	<b>85</b>	28,591	4.71
Krapina-Zagorje County	5	5	1	<b>11</b>	531	0.10
City of Zagreb	0	0	0	<b>0</b>	0	0
<b>Total</b>	<b>675</b>	<b>788</b>	<b>805</b>	<b>2,268</b>	<b>469,468</b>	<b>79.06</b>

Source: Estimations by the assessment team using official information.

229 buildings were damaged or destroyed. Total damage to farm buildings and storage facilities amounts to EUR 79 million.

**Farmers reported damage to equipment and machinery in the amount of EUR 4.2 million** (EUR 4 million in Sisak-Moslavina county; EUR 100 000 in Zagreb County; and EUR 100 000 in the City of Zagreb). A total of 270 damaged items on agricultural holdings were reported in the three counties.

**The area affected by the earthquake is significantly involved in livestock production.** Many animals were

directly affected, suffering stress; some of the animals escaped from the stables and were later found, but most of the animals were stuck in the barns and severely injured or killed. Total damage to livestock amounts to EUR 1.2 million.

**The beekeeping sector suffered significantly from the earthquakes.** The earthquakes occurred in a moment of the year in which the bees were not active; therefore, this event not only directly damaged the beehives but also changed the regular annual cycle of the bees' lives. The losses for this subcategory are much more evident than in other types of livestock production. A total of



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**Table 55.** Total damage to livestock in the agriculture sector (EUR)

Administrative unit	Type of livestock												Total damage
	Cattle		Sheep and goats		Horses and donkeys		Pigs		Poultry		Beehive		
	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	No.	Value	
<b>Sisak-Moslavina County</b>	164	283,000	691	70,000	4	4,000	316	95,000	840	6,000	6,100	610,000	1,068,000
<b>Zagreb County</b>	1	2,000	3	300	0	0	16	5,200	40	300	500	50,000	57,800
<b>Karlovac County</b>	1	2,000	2	200	0	0	11	3,900	30	300	330	33,000	39,400
<b>Krapina-Zagorje County</b>	1	2,000	1	100	0	0	5	1,800	12	100	150	15,000	19,000
<b>City of Zagreb</b>	1	2,000	1	100	0	0	4	1,600	10	100	120	12,000	15,800
<b>Total</b>	<b>168</b>	<b>291,000</b>	<b>698</b>	<b>70,700</b>	<b>4</b>	<b>4,000</b>	<b>352</b>	<b>107,500</b>	<b>932</b>	<b>6,800</b>	<b>7,200</b>	<b>720,000</b>	<b>1,200,000</b>

Source: Estimations by the assessment team using official information.

7,200 beehives were damaged, out of which 6,100 in Sisak-Moslavina County, 500 in Zagreb County, 120 in the City of Zagreb, 330 in Karlovac County, and 150 in Krapina-Zagorje County. The total estimated damage incurred is EUR 720,000.

**The physical damage to agriculture was mainly caused by shifts on land surface.** This resulted in the destruction of stables and other farm buildings, as well as of machinery and equipment, such as damage to storage facilities used for feeding animals. Additionally, animals were injured and killed. The siloes and grain tanks have been destroyed or collapsed, and substantial animal feed was destroyed and moisturized. Owing to the immediate response of support services, especially of advisors and veterinarians, the distribution of animal feed was organized in two locations. Animal feed was donated from farmers from all over Croatia, and every farmer who lost animal feed

due to the earthquake was assigned a quantity that was proportional to the number and the category of animals reported. The distribution of donated animal feed was organized so that farmers and animal growers received a two-week supply of feed. Within three months, 860 tons of feed was donated, and 740 tons was distributed to farmers and animal growers.

**Sisak-Moslavina County was the only county to report agricultural damage, and the agricultural areas damaged due to liquefaction, sinkholes, or landslides are in different municipalities and cities.** Damage to agricultural land is hard to estimate because the risk of new sinkholes is such that the entire space between the sinkholes is not safe for utilization; therefore, the whole area is used for the calculation of losses and damage related to agricultural production. The same approach is used for recording damage from landslides; 50 earthquake-reactive

**Table 56.** Total losses in the agriculture sector (EUR)

Agriculture losses	Sisak-Moslavina County	Zagreb County	City of Zagreb	Karlovac County	Krapina-Zagorje County
<b>Agricultural land - annual loss from the damage on 1.400 hectares of affected arable land surface</b>	3,360,000	0	0	0	0
<b>Loss based on crop and livestock output for current year based on 2,000 affected agricultural holdings in all counties</b>			11,556,000		
<b>Farm buildings - debris removal</b>	2,626,495	245,905	0	209,840	4,212
<b>Total</b>			<b>18,002,452</b>		

Source: Estimations by the assessment team using official information.

landslides have been recorded so far. The damage to agricultural land should be reported for the total area of the landslide. This can be slightly increased depending on whether the landslide intersects a plot, so part of the plot has no access. The total damaged area in Sisak-Moslavina County is estimated to be 1,400 ha of arable land, and the estimated related annual losses in revenues are approximately EUR 3.360 million while losses in the long-term have not been estimated yet. Additionally, total losses in crop and livestock output for the current year based on 2,000 agricultural holdings which reported damage in the whole affected area is estimated at EUR 11.6 million. Medium- and long-term losses in agricultural output remain to be estimated. Table 56 shows losses related to damaged arable land, agriculture and livestock output, and debris removal.

The following tables show total damage in the agriculture sector by sub-sector and total damage and losses by county. All damage and losses in the sector are private. No damage was reported for fisheries and forestry sub-sectors.

**Table 57.** Total damage in the agriculture sector by sub sector (EUR, millions)

Subsectors	Damage
Farm buildings and storage facilities	79.06
Farm equipment and machinery	4.20
Livestock	1.20
<b>Total</b>	<b>84.46</b>

Source: Estimations by the assessment team using official information.

**Table 58.** Total damage and losses in the agriculture sector by county (EUR, millions)

Administrative unit	Damage	Losses
Sisak-Moslavina County	73.98	16.11
Zagreb County	5.50	1.00
Karlovac County	4.75	0.86
Krapina-Zagorje County	0.12	0.02
City of Zagreb	0.12	0.02
<b>Total</b>	<b>84.46</b>	<b>18.00</b>

Source: Estimations by the assessment team using official information.

## Disaster Impacts on the Affected Population

**The earthquakes highlighted the existing risks and vulnerabilities of life in the agricultural sector.** Damage to agricultural resources will result in a further decline in income and will have significant impact on the sustainability of many small farms. The earthquake directly and indirectly affected more than 2,000 farms; direct damage to farm buildings and land will indirectly have a longer-term impact on the economic recovery of agricultural holdings. More than 90 percent of the damage occurred in Sisak-Moslavina County, and the remaining 10 percent of the damage relates to other counties. Aftershocks created additional fear and insecurity for reconstruction and revitalization plans. These difficult conditions have significantly affected young people who were planning to take over the ownership and management of agricultural holdings.

**At the time of the RDNA, approximately 70 percent of farm buildings and storage facilities were marked as temporarily or permanently unusable.** Further assessments will establish how they will be categorized to establish the total value of the damage. There will be a need for thorough investigations and evaluations that can determine what changes occurred on the ground surface to determine the plausibility of constructing in these areas again. Only after new sinkholes that have appeared are examined and authorities have given their approval will the further utilization of these areas be possible. Also, all injured and killed animals will need to be replaced, so that farmers and animal growers can resume their activities. The estimation of the losses incurred in Sisak-Moslavina County, across the 1,400 ha of land recorded as damaged, must consider that such losses could be irrecoverable for several years or permanently.

## Reconstruction and Recovery Needs

**Agriculture is a great potential for the economy of the affected counties.** The recovery process can be based on the inherent conditions of this area and the proximity of the City of Zagreb as a potential market for sale of the agricultural products. These counties have moderate continental climate, including moderately cold winters, warm summers, and a relatively favorable annual precipitation schedule. In recent times, there are increas-



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ingly obvious changes with longer periods of drought or periods with high rainfall, which has a negative impact on agriculture. There are 16 soil types (10 automorphic soil types and 6 hydromorphic soil types). To use their full potential and improve the physicochemical and biological characteristics, it is necessary to apply certain interventions of hydrotechnical and agrotechnical reclamation such as irrigation and drainage systems, calcification, calization, and phosphatization depending on the soil type. There is a need to increase the humus as well, so the practice of green fertilization or cultivation of clover-grass mixtures in a wider crop rotation should be introduced to enrich the soil with organic matter. The relief, climate, and soil indicate the possibility of growing various field, fruit, vegetable, and fodder crops, some of which are significantly profitable. Nevertheless, areas not suitable for growing profitable crops can be used for cattle breeding. An additional potential that exists in this area is the reintroduction to the culture of areas that have not been used for agricultural activities for many years. Given that there is no pollution on these areas that causes the use of fertilizers or pesticides, the development of organic farming should certainly be given priority. Technical assistance/advice on organic growing, suitability of specific crops, and market penetration could help support such efforts.

**Damages to agricultural areas caused by liquefaction, sinkholes, or landslides on agricultural fields require monitoring coordinated between agricultural and other experts, meaning that the final scope of the affected area will be assessed at a later point.** In some areas, damages will contribute to permanent relocation of agricultural activities, so the use of other areas will require arranging and cultivation of the surrounding land that is currently not used for agricultural purposes nor is of environmental value. Apart from reconstruction of damaged assets, there is a need for investments in the activities that give added value to agricultural production—from processing meat, milk, fruit, and vegetables to rural tourism—and support the improvement of the competitiveness of agricultural producers in the area. The reconstruction is an opportunity to modernize the sector in the affected regions in an integrated way where investments in buildings and assets are done based on actual potential for improvement of productivity and competitiveness of family farms beyond their past activities and considering engagement in alternative production activities, such as organic production and circular economy activities. This could be done as a menu of options with differential technology packages that are provided along with infrastructure investments.

**The Agriculture Sector Recovery Plan** will be followed

with (a) institutional strengthening and capacity building to sustainably improve land use and diversify agricultural production and (b) development-oriented recovery interventions, which would include addressing urgent needs to maintain and restore the productivity in the sector and income of the affected population, by supporting producers to link to value chains. The immediate response would aim at protecting the affected areas before the next cropping season while restoring production capacity, meeting the seasonal needs (spring/summer crops), and bridging the gaps in stocks of animal feed. Development-oriented recovery interventions would focus on building back better and modern stables, storage and other facilities, irrigation, and drainage infrastructures as well as agriculture production systems and increasing farming households and local communities' resilience to weather related shocks.

**Based on the RDNA findings, the recovery plan combines the following activities required for facilitating the recovery of the agricultural livelihoods as well as activities that contribute to the mainstreaming of DRR best practices (and management) in this sector across the affected areas (see Table 59):**

- Relief measures to mitigate earthquake damage for agricultural inputs and feedings to be supplied to restart agricultural production.
- Replacement and procurement of animals.
- Support replacement of lost or damaged agricultural assets (buildings, machinery, and equipment) and consider additional infrastructure (for example, storage facilities such as those with solar panels and information platform to ensure monitoring and traceability of production) that can support the aggregation of local

production and its distribution to domestic markets.

- Financial services to support, rehabilitate or introduce micro-enterprise recovery and development and create employment opportunities for the residents of affected areas.
- Implementation of support measures for certain categories of farmers, for example, small farmers, young farmers, and diversification activities on holdings.
- Agricultural support services for agricultural rehabilitation, advisory services, farming schools, technical expertise, capacity-building training, and so on.
- Development of support tools to enable the economic recovery of disaster-affected producers/improvement of the targeting of support toward disaster-prone producers.
- Strengthening of the capacity of the MoA and relevant agencies, to deliver national legislation, policies, and strategies on DRR, through technical advice, human resources and expertise, training, practical tools, and services.
- Assessment of the possibilities for improvement of the agricultural insurance system, enabling coverage of farmers in higher-risk areas.
- Development of subsidy system which compensates farmers for limited activities in disaster-prone areas.
- Capacity building and support to national, local, and regional governments for the development of DRAs and risk reduction plans.

**Overall, reconstruction and recovery needs amount to EUR 191.4 million.** Recovery measures account for EUR 95.16 million and the physical reconstruction of damaged agricultural buildings following BBB totaling EUR 96.21 million.



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**Table 59.** Total reconstruction and recovery in the agriculture sector in the short, medium, and long term (EUR, millions)

Reconstruction and recovery	Short	Medium	Long	Total
Reconstruction of infrastructure and physical assets including debris removal	35.44	58.57	149.21	<b>243.22</b>
<b>Reconstruction subtotal</b>	<b>35.44</b>	<b>58.57</b>	<b>149.21</b>	<b>243.22</b>
<b>Extraordinary relief measures to mitigate earthquake damage:</b>				
Agricultural inputs and replacement and procurement of livestock and beehives	0.80	0.00	0.00	<b>0.80</b>
Replacement and procurement of livestock and beehives	0.00	0.40	0.20	<b>0.60</b>
Support replacement of lost or damaged agricultural buildings, machinery and equipment	10.80	8.40	3.80	<b>23.00</b>
Support for restoration of agricultural land and production potential	2.30	2.30	1.90	<b>6.50</b>
<b>Recovery and development support to the disaster affected population:</b>				
Financial services to support, rehabilitate or introduce micro-enterprise recovery and development and create employment opportunities for the residents of affected areas	0.70	0.00	0.00	<b>0.70</b>
Agricultural support services for agricultural rehabilitation, extension services, farming schools, technical expertise, capacity building training, etc.)	0.00	0.50	0.00	<b>0.50</b>
Development of support tools to enable the economic recovery of disaster affected producers	0.00	0.00	0.20	<b>0.20</b>
Support measures for small farmers, young farmers, and diversification activities on holdings	4.50	4.50	4.50	<b>13.50</b>
Sectoral support measures for investment in land improvement, long term asset and innovation technologies	15.10	15.10	15.10	<b>45.30</b>
Compensations for farmers with limited activities in disaster prone areas	1.68	1.00	0.68	<b>3.36</b>
<b>Limited institutional capacity on regional and local level to address agricultural disasters:</b>				
Strengthen the capacity of the MofA and relevant agencies, to deliver national legislation, policies and strategies on disaster risk management, through technical advice, human resources and expertise	0.10	0.00	0.00	<b>0.10</b>
Develop Agricultural Sector-specific national strategies on disasters risk reduction across agriculture, forestry and natural resource management	0.00	0.10	0.00	<b>0.10</b>
Support policies, laws and management systems (incl. digitalization) that improve the resilience of the agricultural sector in the future	0.00	0.00	0.50	<b>0.50</b>
<b>Recovery subtotal</b>	<b>35.98</b>	<b>32.30</b>	<b>26.88</b>	<b>95.16</b>
<b>Total</b>	<b>74.46</b>	<b>65.97</b>	<b>50.93</b>	<b>191.37</b>

Source: MoA.



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## TRANSPORT AND COMMUNICATIONS

### TRANSPORT

#### Sector Overview and Baseline Data

**L**ocated on two corridors of the EU Transport Network, the Mediterranean Corridor, and the Rhine - Danube Corridor, Croatia enjoys a favorable geographical-traffic position. In addition to these corridors, the core Trans-European Transport Network defines the main routes through which most goods and passengers pass, and the comprehensive Trans-European Transport Network provides access to the core network, within which the abovementioned main multimodal corridors have been identified. Transportation infrastructure in the affected area can be divided into the following transportation modes: railway, road, air, and inland waterways. The remaining state, county, and local road network is

similarly important to enable connectivity and trade within Croatia as well as outside of it.

The road network in Croatia has a total length of 26,713

**Table 60.** Overview of transport sector infrastructure in the affected area

Type of subsector (infrastructure and facilities)	km	Public	Private
Roads - motorways	377	317.8	59.2 <sup>a</sup>
Roads - state roads	1,457	1,457	-
Roads - county	2,226	2,226	-
Roads - local	1,987	1,987	-
Roads - unclassified	-	-	-
Railroads	808	808	-
Tramway	120	120	-
Inland waterways	140	140	-

*Source:* Croatian Bureau of Statistics, *Statistics in Line 2020*, *Transport and Communications - Road Infrastructure, Road Traffic Volume, HŽ Infrastruktura - Network report 2021, RAZVOJNA STRATEGIJA*.

*Note:* a. Maintenance is managed privately but ownership of the asset is public.

**Table 61.** Overview of transport sector buildings in the affected area

Type of sub-sector (buildings)	No.	Square meters (m <sup>2</sup> )	Public	Private	No. of employees		Average no. of passengers annually
					Male	Female	
<b>Train stations and terminals</b>	138	58,500	138	-	1,668	470	3,932,807
<b>Management buildings (railroads)</b>	46	21,533	46	-	589	124	-
<b>Bus terminals</b>	7	-	3	4	-	-	-
<b>Port authority buildings</b>	10	13,211	10	-	4	2	1,917

Source: Croatian Bureau of Statistics, *Statistics in Line 2020.*, *Transport and Communications - Road Infrastructure, Road Traffic Volume, HŽ Infrastruktura - Network report 2021, RAZVOJNA STRATEGIJA.*

km consisting of 1,422 km of motorways, 7,307 km of state roads, 9,371 km of county roads, and 8,447 km of local roads. The management of the motorways is entrusted to public company Croatian Motorways (HAC), which reports to MoSTI and prepares the motorways development programs and financing plans. Additionally, BinaIstra and Autocesta Zagreb-Macelj (AZM) manage motorways through concessions. The management of the state roads is entrusted to public company Croatian Roads (HC), which reports to MoSTI and prepares the state roads development programs and financing plans. The management of the county and local roads is entrusted to County Road Authority (ŽUC) for every county which reports and prepares the county and local roads development programs and financing plans. County and local roads in the area of large cities (more than 35,000 inhabitants) and cities of county centers are categorized as unclassified and managed by the cities of Zagreb, Krapina, Sisak, and Karlovac.

**The management of the railway infrastructure network in Croatia is entrusted to public company HŽ Infrastruktura.** The company reports to MoSTI and is responsible for traffic management and operation and for rehabilitation, maintenance, and construction of railway infrastructure. The railway infrastructure network consists of 55 railway corridors including 30 international, 8 regional, and 17 local railways with a total length of 2,617 km and maintains 536 stations and stops, 1,505 level crossings, 109 tunnels, and 544 bridges. HŽ Putnički prijevoz is a Croatian public company for passenger transport in domestic and international traffic. Currently, there are 821 passenger trains operating, 70 in international and 751 in domestic traffic. There is a planned increase to 851 trains for the 2020–2021 timetable on the railway network.

**HŽ Cargo is a Croatian public company in charge of the transport of goods by railway freight.** In the last three months of 2020, before the earthquake in Sisak-Moslavina County, 3 percent of the total HŽ Cargo transport was from the section of the railway RK-Sisak Caprag - Volinja. In the sector affected by the earthquake, there are buildings that were given to HŽ Cargo from the Republic of Croatia for management, which house employees of HŽ Cargo who carry out transport commercial work, wagon loading and unloading operations, and inspection and maneuvering of wagons as well as employees of the Tehnički servisi željezničkih vozila d.o.o. who carry out the work of repairing locomotives. Of these, two buildings are in Zagreb County and three buildings in Sisak Moslavina County.

**Air transport in Croatia is operated on the network of international and certified airports.** In the earthquake affected area, air transport infrastructure is located at one international airport (Zagreb International Airport [Međunarodna Zračna Luka Zagreb - Franjo Tuđman, MZLZ]) and three smaller certified airports.

Table 60 provides the length of motorways, state roads, county roads, local roads, railways, and inland waterways in kilometers in the area affected by the December 2020 earthquakes.

## Effects of the Disaster (Damage and Losses)

**Following the earthquake, emergency inspections identified significant damage to the road networks in the affected areas.** Damage to pavement, infrastructure (bridges, overpasses, viaducts, passages, and so on),

and road furniture was recorded on motorways, state roads, county roads, and local and unclassified roads. The greatest extent of the damage was identified on the road network in Sisak-Moslavina County.

**Pavement damage (to a greater and lesser extent) was identified on approximately 2,853 km, accounting for more than 50 percent of the total road network length in the stated counties and the City of Zagreb.** The most evident damage is on the local and unclassified road network. Earthquake damage has the following

characteristics: transverse and mesh cracks on asphalt pavements; breaking of concrete on bridges, viaducts, and overpasses; damage to girders and abutments; deformations of bearings and transition devices; damage to the road/railway facilities and the management buildings; and the occurrence and opening of landslides. For methodology of the assessment, see Annex 1.

**Regarding railway infrastructure, at the time of the RDNA, damage was reported on two bridges on the M502 Zagreb GK-Sisak-Novska line in the city of**

**Table 62.** Overview of damage to physical infrastructure in the transport sector

Type of subsector (no. of damaged infrastructure and facilities)	Sisak-Moslavina County				Zagreb County				Karlovac County				City of Zagreb				Krapina-Zagorje County				
	Pavement / track	Landslides	Bridges	OTHER	Pavement / track	Landslides	Bridges	OTHER	Pavement / track	Landslides	Bridges	OTHER	Pavement / track	Landslides	Bridges	OTHER	Pavement / track	Landslides	Bridges	OTHER	
<b>ROADS</b>	<b>Motorways</b>	-	-	4	13	-	-	11	27	-	-	12	3	-	-	18	20	-	-	-	-
	<b>State</b>	1	8	8	10	-	4	1	4	-	2	-	-	-	-	-	-	-	-	-	-
	<b>County</b>	13	4	3	-	-	9	5	-	-	-	-	-	-	-	-	-	3	10	1	-
	<b>Local</b>	15	4	2	-	-	3	2	-	-	-	-	-	-	-	-	-	-	3	-	-
	<b>Unclassified</b>	1031	13	1	3	24	14	1	-	-	2	1	-	-	-	-	-	42	26	2	2
<b>Railroad bridges</b>	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>Waterways</b>	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Source: Estimations by the assessment team using official information.

**Table 63.** Number and surface area of damaged buildings in the transport sector by county and type of building

Type of building	Total affected buildings	Total surface area	Level of damage	Sisak-Moslavina County	Zagreb County	Karlovac County	City of Zagreb	Krapina-Zagorje County
<b>Bus terminals</b>	2	972	High	2	0	0	0	0
			Medium	0	0	0	0	0
			Low	0	0	0	0	0
<b>Railway terminals and stations</b>	50	40,651	High	3	4	0	4	0
			Medium	14	1	1	2	2
			Low	19	0	0	0	0
<b>Management buildings</b>	80	42,939	High	2	2	1	14	0
			Medium	10	2	2	2	0
			Low	28	1	3	8	5
<b>Total</b>	<b>132</b>	<b>84,562</b>		<b>78</b>	<b>10</b>	<b>7</b>	<b>30</b>	<b>7</b>

Source: Estimations by the assessment team using official information.



**Sisak in Sisak-Moslavina County.** One bridge is temporarily closed due to earthquake damage, and on the other there are speed limits. No earthquake damage to railway infrastructure was reported in Karlovac County, Zagreb County, Krapina-Zagorje County, and the City of Zagreb. Damage and losses to railway infrastructure were calculated based on the direct damage assessment conducted by appointed certified structural engineers. Based on the initial damage assessment, detailed rehabilitation documentation was commissioned, and works are under way to establish safe rail operations. There was also damage to inland waterway facilities on management buildings and shipyard docks.

**The earthquake damage will result in the closure of certain sections of the road network, and traffic will be temporarily regulated during the rehabilitation period.** This will chiefly be in relation to the sections where landslides, depressions, and damage to the load-bearing structures of bridges occurred. It is estimated that the increase in maintenance activities over the next 10 years on the road network will generate a loss of EUR 12.715 million. In Sisak-Moslavina County, the network of local and unclassified roads accounts for 10 percent of the total length of the network. In Krapina-Zagorje County, Karlovac County, and Zagreb County, it accounts for 1.5 to 3 percent of the length of the road network. A new risk that the road network is facing is an expected increase in its use, axle load, and heavy vehicle traffic volume due to extensive reconstruction of earthquake affected area which is already under way. It is therefore expected that there will be an increased intensity in maintenance works for unclassified, local, county, and state roads.

**The total estimated losses from uncollected tolls of Hrvatske Autoceste amounted to EUR 875,564 as of February 23, 2021.** Additionally, Autocesta Zagreb Macelj expressed a loss of EUR 4,757 from uncollected tolls accrued by humanitarian vehicles.

**The preexisting risks in the road and railways infrastructure became increasingly notable, especially in Sisak-Moslavina County, during and after the earthquakes.** The main risks are the infrastructure being old and the lack of investments in its maintenance. The possibility of new earthquakes that could damage the existing old road and railway infrastructure aggravates these risks. Another important risk is not having enough

**Table 64.** Total damage and losses in the transport sector by county and subsector (EUR, millions)

Administrative unit	Subsector	Damage	Losses	Total
Sisak-Moslavina	Road	39.90	11.40	51.30
	Rail	20.20	1.60	21.70
	Water	3.30	0.40	3.60
Krapina-Zagorje County	Road	4.40	1.40	5.80
	Rail	0.30	0.04	0.40
	Water	-	-	-
Karlovac County	Road	1.20	1.80	3.00
	Rail	2.00	0.70	2.10
	Water	-	-	-
City of Zagreb	Road	1.60	1.40	3.00
	Rail	0.20	0.50	0.70
	Water	-	-	-
Zagreb County	Road	9.90	2.50	12.40
	Rail	1.50	0.03	1.50
	Water	-	-	-
<b>Total</b>		<b>84.40</b>	<b>21.00</b>	<b>105.40</b>

*Source: Estimations by the assessment team using official information.*

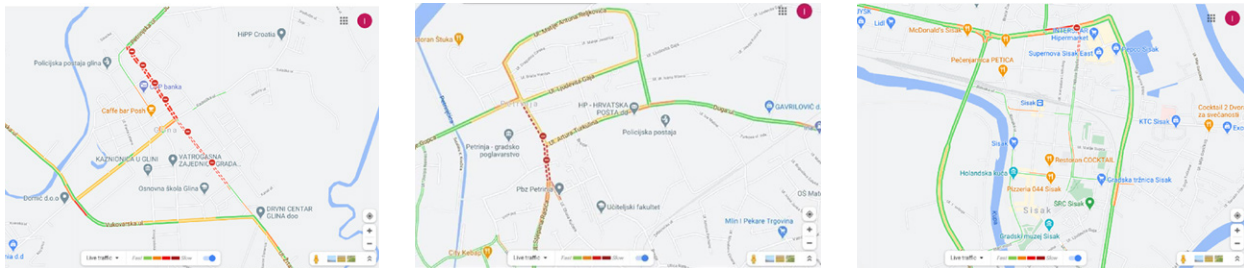
*Note: All damaged assets in the sector are public assets.*

financial resources or construction companies and labor to repair and rebuild new possible damage in the required time. New damage can manifest in the form of direct damage to infrastructure or in the form of the temporary closure of road sections and railway lines.

**HŽ Putnički prijevoz provided free transportation** to residents affected by the earthquake in Sisak-Moslavina County, to CRC volunteers, to members of the Civil Protection Headquarters and the Croatian Mountain Rescue Service (HGSS), and to representatives of other services involved in helping and repairing damage. Free transportation was provided until April 30, 2021, with a possibility of further extension.

**In relation to the waterways,** the position of berths and positioning systems and access to pontoons might have been disrupted due to the disturbed stability of embankments with observed landslide processes. The increased sedimentation in ports is possible; this would require additional control of moored vessels.

**Figure 14.** Map screenshots from the cities of Petrinja, Sisak, and Glina on March 24, 2021, showing transport interruptions



Source: Google Maps.

## Disaster Impact on the Affected Population

**Users of transport infrastructure in the affected areas experienced various disruptions.** Figure 14 shows locations in the town centers of Sisak, Petrinja, and Glina that have remained closed following the earthquake. However, towns and villages in Sisak-Moslavina are still accessible from Zagreb, Zagreb airport, the inland waterway port of Sisak, and destinations in other counties. The terrain and layout of the road network is such that—even though there are detours—accessibility, in principle, is presently provided.

**Localized damage (as well as any closures not related directly to earthquake damage, such as partial or full occupation of road pavement and sidewalks due to earthquake relief efforts or reconstruction) affects normal operation of the road network and road transport.**

These include the loss of traffic capacity and the resulting loss in travel time; traffic safety impacts from temporary traffic arrangements and/or from damage that is of a lower scale and thus not warranting immediate closure which may also include difficulty in the movement of pedestrians, cyclists, and other vulnerable road users; capacity and safety impacts resulting from any temporary arrangements made during repairs to the road infrastructure, inspections, and other works; businesses that customers can no longer easily access and/or where customers have reduced parking options may also indirectly suffer from the abovementioned disruptions to the local road networks; and the use of public transport and other more environment-friendly modes of transport may be affected, due to the emphasis on satisfying basic transport needs in the most convenient ways.

**As a result of the damage to, and the temporary closing**



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of, the Kupa Sisak railway bridge on the line M502 Zagreb GK-Sisak-Novska in the city of Sisak, starting on January 5, 2021, railway traffic was closed between the Sisak and Sisak Caprag stations (with a length of 4.5 km). Emergency temporary rehabilitation works were carried out and, on February 20, 2021, traffic was once again enabled on the section of the railway between the Sisak and Sisak Caprag stations. Due to the damage to this railway bridge, it was not possible to use the RK-Sisak Caprag railway from Sisak Caprag station. Instead, the RK-Novska-Sisak Caprag and the Volinja-Novska-RK railways were used; this increased the cost of transportation (due to the longer transport route and additional staff costs). Due to these closures, railway traffic was also redirected to the M103 Dugo Selo-Novska line. Since then, all passenger trains were replaced with buses on the following routes: (a) trains generally operating on the Sisak-Sunja-Novska route were replaced with buses between the Sisak and Sisak Caprag stations and (b) trains generally operating on the Sisak-Sunja-Volinja route were replaced with buses on the entire route from Sisak to Volinja. The earthquake did not disrupt railway traffic in Zagreb County, Karlovac County, Krapina-Zagorje County, and the City of Zagreb. The earthquake damage also resulted in HŽ Cargo's customer in Sisak Caprag, ABS d.o.o., ceasing operations. Additionally, INA is working with reduced capacity. As a result, HŽ Cargo recorded a reduction in the amount of freight transport in Sisak-Moslavina County, compared to the period before the earthquake.

## Reconstruction and Recovery Needs

**Recovery interventions in the roads sector included emergency repairs to restore connectivity and working order as soon as possible, while medium- and long-term reconstruction includes building back better and more resilient infrastructure.** As seen in Table 65, the reconstruction of buildings and infrastructure in the roads sector has been estimated at EUR 85.903 million. In the sector, unclassified roads have been affected by far the most. They are followed by state and county roads. Damage to the motorway network including motorway bridges, overpasses, and viaducts has been minor. It did not affect the mechanical resistance and stability of infrastructure nor had any impact on the traffic safety, so reconstruction is not estimated to be high. One motorway operational building

**Table 65.** Total reconstruction needs in the transport sector in the short, medium, and long term (EUR, millions)

Reconstruction needs	Short	Medium	Long	Total
Roads	34.36	34.36	17.18	<b>85.90</b>
Railways	43.64	43.64	21.82	<b>109.11</b>
Inland waterways	1.45	1.45	0.72	<b>3.62</b>
<b>Total</b>	<b>79.45</b>	<b>79.45</b>	<b>39.73</b>	<b>198.63</b>

Source: Estimations by the assessment team using official information.

(Lučko, Stupnik Municipality in Zagreb County) suffered extensive damage and will need to be completely rebuilt.

**In the railways sector, most reconstruction needs are concentrated in Sisak-Moslavina County.** Short-term needs (three months) related to railway infrastructure include general inspections of longer span bridges and temporary repair works on the two damaged bridges in Sisak-Moslavina County. Medium-term needs (two years) include detailed inspections of longer span bridges, production of technical documentation for the permanent repair and reinforcement of the Kupa Sisak bridge in the city of Sisak, and the permanent repair and reinforcement of the Kupa Sisak bridge. Long-term needs in the rail sector include the production of technical documentation either to facilitate the repair and reinforcement of existing bridges, tunnels, and culverts or to replace existing old bridges, tunnels, and culverts with new structures designed to match current regulations. This long-term need can be applicable to all four counties and the City of Zagreb and the estimated period of implementation is 15 years, but this assessment only calculates those needs that are within a five-year period. The overall priority need for Sisak-Moslavina County is the permanent repair and reinforcement of the Kupa Sisak railroad bridge in the city of Sisak. The main stakeholders in the railway recovery are Croatian railways and the Croatian government (Ministry of the Sea, Transport, and Infrastructure [MoSTI] and Ministry of Finance [MoF]). Other counties do not have recovery needs regarding the earthquake. As seen in Table 65, the reconstruction of buildings and infrastructure in the railways sector has been estimated at EUR 109.108 million. Reconstruction needs related to inland waterways infrastructure are estimated at EUR 3.622 million (Table 65).

## POST SERVICES AND COMMUNICATIONS

### Sector Overview and Baseline Data

**Hrvatska pošta is the leading postal service provider in Croatia.** Its network of 1,016 post offices across the country also makes it the provider of numerous other services which is most easily accessible to users. Hrvatska pošta is organized in four divisions and 11 management support offices: (a) the Postal Service Division is in charge of the transport, sorting and delivery of postal items; (b) the Network Division manages the network of post offices; (c) the Express Services Division is in charge of express delivery; and (d) the Support Services Division is in charge of real property, accounting, controlling, and the maintenance and modernization of post offices. The ownership of assets is public.

**Table 66.** Overview of the number and surface area of post offices in the affected area

Administrative unit	No.	Size in m <sup>2</sup>	No. of employees
Sisak-Moslavina County	30	6,411.97	95
Karlovac County	33	3,196.96	82
Zagreb County	64	44,224.27	535
Krapina-Zagorje County	35	4,823.14	71
City of Zagreb	74	42,771.67	481

Source: Hrvatska pošta d.d.

**Public services in mobile networks are provided by three operators:** Hrvatski telekom; A1 Hrvatska; and Telemach Hrvatska. Fixed network services are provided by numerous providers, but only four operators are significant at the national level (considering the number of users). Hrvatski telekom and A1 Hrvatska are currently the only two operators providing bundled services in both fixed and mobile networks.

### Effects of the Disaster (Damage and Losses)

**The earthquake caused significant damage to the infrastructure of post offices and post office buildings and physical assets in the affected areas.** This included (a) damage to partition walls, ceilings, and linings of

post offices and post office buildings; (b) serious horizontal and vertical cracks found inside buildings, at the joints of the ceiling slab and load bearing walls; (c) damage to the structural elements of buildings; and (d) rupture of the protective layer of the beam reinforcement. Damage to buildings has also been reported by the mobile network operator A1 Hrvatska.

**In the first three months of 2021, the financial losses that were recorded in Sisak-Moslavina County for the two post offices that were still closed amounted to EUR 354,342.** These losses were calculated based on the results from the previous year. Other post offices that were temporarily closed in the affected areas were only closed for a few working days and were therefore not calculated in the losses. Despite all the problems caused by the earthquake, Hrvatska pošta, as a universal service provider, had to respond quickly and adapt to the new circumstances. Disruptions of delivery times and post office working hours were resolved as soon as conditions allowed. In case of new earthquakes affecting Croatia, Hrvatska pošta will be able to organize its business to fulfill its obligation as a universal service provider; however, the reorganizations may put a number of inhabitants in a less favorable position, as there might be bigger distances to travel to reach the nearest post office. Adapting to new conditions will require reorganizing delivery/access points, reorganizing delivery routes, operating on longer distances than is optimal and usual, and other efforts; this will place a significant financial burden on Hrvatska pošta.

**Table 67.** Number and surface area of damaged post office buildings by county

Administrative unit	No. of damaged buildings		Total of damaged surface in m <sup>2</sup>
	Post office	Post buildings	Post office / buildings
Sisak-Moslavina County	7	5	4,713.68
Karlovac County	0	0	0
Zagreb County	6	2	38,744.96
Krapina-Zagorje County	1	0	182.34
City of Zagreb	3	2	25,214.75

Source: Estimations by the assessment team using official information.

Administrative unit	Damage			Losses		
	Public	Private	Total	Public	Private	Total
Sisak-Moslavina County	2.37	1.52	<b>3.89</b>	0.35	0.87	<b>1.22</b>
Zagreb County	0.41	0.00	<b>0.41</b>	0.00	0.00	<b>0.00</b>
Karlovac County	0.00	0.00	<b>0.00</b>	0.00	0.00	<b>0.00</b>
Krapina-Zagorje County	0.02	0.00	<b>0.02</b>	0.00	0.00	<b>0.00</b>
City of Zagreb	0.00	0.03	<b>0.03</b>	0.16	0.00	<b>0.16</b>
<b>Total</b>	<b>2.80</b>	<b>1.55</b>	<b>4.35</b>	<b>0.52</b>	<b>0.87</b>	<b>1.38</b>

**Table 68.** Total damage and losses in the communications sector by county (EUR, millions)

Source: Estimations by the assessment team using official information.

## Disaster Impact on the Affected Population

Users of postal services within the affected areas experienced disruptions in line with the impacts described above. Because of the earthquake, some of the post offices were temporarily closed and were only reopened after experts cleared the safety issues in the post office buildings. Postal deliveries were irregular; although it was most notable for items that had preestablished delivery dates that were not met, this lag in deliveries affected all items.

The recovery process in this sector will require the reconstruction of damaged post offices and post-office buildings which will be conducted in line with BBB and EE principles. The total reconstruction cost over a five-year period amounts to EUR 4.786 million, of which EUR 2.959 is public and EUR 1.827 is private (Table 69).

**Table 69.** Total reconstruction needs in the communications sector in the short, medium, and long term (EUR, millions)

	Short	Medium	Long	Total
<b>Reconstruction needs</b>	1.91	1.91	0.96	<b>4.79</b>

Source: Estimations by the assessment team using official information.

## Reconstruction and Recovery Needs



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# ENERGY

## Sector Overview and Baseline Data

The electricity distribution network in Croatia is managed through the public utility HEP-Distribution System Operator Ltd (Hrvatska elektroprivreda – Operator distribucijskog sustava, HEP ODS d.o.o.). HEP ODS manages and operates a large network of medium- and low-voltage transmission lines, substations, and associated infrastructure throughout Croatia. HEP ODS physically connects with the final electricity customers, who are then served by a variety of different electricity supply entities in Croatia. HEP ODS has 21 electricity distribution areas across Croatia that enable users to access and use the network. The value of HEP ODS infrastructure and property books exceeds EUR 1.7 billion. In 2017 and 2018, annual capital expenditure exceeded EUR 130 million, annual revenues were about EUR 500 million, and net profits exceeded EUR 65 million.

The electricity transmission network in Croatia is managed, operated, and owned by the Croatian Transmission System Operator Ltd (Hrvatski operator prijenosnog sustava - HOPS d.o.o.). The company is responsible for a large network of high-voltage transmission lines, substations, and associated infrastructure throughout Croatia, including cross-border connections with neighboring countries. HOPS operates as an independent operator, providing nondiscriminatory services to all users of the transmission system. HOPS' network connects to the medium- and

low-voltage electricity distribution networks managed by the public utility HEP ODS, which in turn connects with the electricity customers. HOPS manages over 7,800 km of transmission lines (at 110, 220, and 400 kilovolts [kV]). The value of HOPS' infrastructure and property book is almost EUR 800 million. In 2018 and 2019, annual capital expenditure exceeded EUR 50 million, annual revenue exceeded EUR 200 million, and net profits exceeded EUR 17 million.

There are two main natural gas distribution utilities and four district heating utilities serving the earthquake affected areas.<sup>46</sup> Some of the district heating infrastructure is old and obsolete, and there is a lack of resources to perform maintenance and upgrades.

In Sisak-Moslavina County, with a population of over 110,000, there are over 60,000 electricity customer accounts, most of which belong to households. The transmission network in the county comprises eight substations, 18 segments of high-voltage transmission lines, and eight building structures (Table 88). No significant damage was reported for other counties apart from one administrative building located in the City of Zagreb.

<sup>46</sup> Natural gas distributors: MONTCOGIM - PLINARA d.o.o.; and GPZ Opskrba (Zagreb). District heating companies: HEP Toplinarstvo (City of Zagreb, Zagreb County, and the city of Sisak); Gradska toplana (city of Karlovac); Top Terme (Topusko, Sisak-Moslavina County); SKG (Ogulin, Karlovac County).

**Table 70.** Overview of the electricity distribution and transmission infrastructure in Sisak-Moslavina County

Type of energy subsector	Type of infrastructure	Sisak-Moslavina County
Electricity Distribution system level	Lines (0.4 to 35 kv) and connectors within distribution grid (km)	5,132
	HV/MV substations (no.)	3
	Switchyards (no.)	3
	20/0,4 kV transformation points (no.)	987
	Buildings	9
Electricity Transmission system level	Lines 110kV 220kV	188km 248km
	Sub-stations	8
	Out of which 400/110 kV	1
	220/110kV	2
	110/x kV	5
Buildings	8	

Source: MoESD.



© Croatian Mountain Rescue Service (CMRS)

## Effects of the Disaster (Damage and Losses)

The earthquakes mainly caused damage to the electricity distribution and transmission subsectors (see Table 71 and Table 72). These subsectors were most damaged in Sisak-Moslavina County, with minor damage also recorded in the City of Zagreb. The assessment is largely based on information from the MoESD, HEP ODS, and HOPS. No significant damage was reported for the natural gas supply and district heating subsectors.

The damage to the energy facilities managed by HEP ODS-Elektra Sisak in Sisak-Moslavina County was estimated at 13.6 million, as shown in Table 71. The assessment was prepared on the basis of a field survey. Temporary solutions were applied to ensure the supply of electricity to customers in the first 48 hours after the earthquake. It was necessary to urgently rebuild electricity facilities (substations, lines, cables, and low voltage network) that were either completely destroyed or risked collapsing. The damaged facilities endangered the electricity supply and the security of workers who were performing maintenance and reconstruction activities. The estimated damage reflects the urgent costs of repair of these facilities in the first phase.

The damage to the electricity transmission network (substations, transmission lines, and so on) in Sisak-Mo-

slavina County was estimated at EUR 4.2 million, as shown in Table 71. The cost of cleaning up and readying the sites for reconstruction is included in the individual estimates. Although most of the reported damage was in Sisak-Moslavina County, one other building—the Žerjavinec Network Centre located in the administrative scope of the City of Zagreb—was also damaged. HOPS reported that in the directly affected area, there were no generation units on the transmission network that could not produce due to interruptions in transmission routes. Only the following outages occurred:

- Nuclear power plant Krško. There was an automatic shutdown of the power plant at the time of the earthquake due to the protective procedures of the power plant. After a systematic inspection and testing of the equipment, no earthquake damage was found and the power plant was synchronized to the grid on December 30, 2020, at 11:35 p.m.
- EL-TO Zagreb PTA1. There was an automatic shutdown of the unit at the time of the earthquake due to the protective procedures of the power plant. The aggregate was synchronized to the network the same day at 1:39 p.m.
- EL-TO Zagreb PTA2. There was an automatic shutdown of the unit at the time of the earthquake due to the protective procedures of the power plant. The aggregate was synchronized to the network the same day at 2:09 p.m.

**Table 71.** Total damage in the energy sector (in million EUR)

Type of energy subsector	Type of Infrastructure	Sisak-Moslavina County		City of Zagreb	
		No.	Damage	No.	Damage
<b>Subtotal</b>		<b>13.65</b>			
<b>Electricity distribution system level</b>	Substations 20/04 kV	148	4.12	-	-
	Lines, cables, low voltage network	40	3.08	-	-
	Other facilities and equipment	7	6.09	-	-
	Buildings	2	0.36	-	-
<b>Subtotal</b>		<b>4.21</b>		<b>0.83</b>	
<b>Electricity transmission system level</b>	Lines	1	0.08	-	-
	Sub-stations	8	1.81	-	-
	Out of which: 400/110 kV 220/110 kV 110/kV	1	0.86	-	-
		2	0.63	-	-
		5	0.32	-	-
Buildings	2	2.32	1	0.83	
<b>Subtotal</b>		<b>17.86</b>		<b>0.83</b>	
<b>Total</b>		<b>18.69</b>			

Source: Estimations by the assessment team using official information.

**Table 72.** Lost revenue in electricity transmission and distribution (EUR, millions)

Name of provider	HEP ODS	HOPS	Total
<b>Fee</b>	1.34	0.48	<b>1.82</b>
<b>VAT<sup>47</sup></b>	0.17	0.06	<b>0.24</b>
<b>Total</b>	<b>1.52</b>	<b>0.54</b>	<b>2.06</b>

Source: MoESD.

**The preliminary estimated financial losses to HEP ODS following the earthquake’s mainshock are approximately EUR 1.3 million before VAT.** Such losses amount to less than 1 percent of the annual revenue of HEP ODS.

**The preliminary estimated financial losses to HOPS following the earthquake’s mainshock are approximately EUR 475,000 before VAT.** The losses also amount to less than 1 percent of the annual revenue of HOPS. These losses are based on calculations of uncharged bills between January and March 2021. Table 72 depicts these losses for both the distribution utility (HEP ODS)

and the transmission utility (HOPS).

**In addition, as per the Croatian government’s decision, electricity generation expenses were not being charged to household customers in the most severely hit municipalities from January to March 2021.** According to the website of the Civil Protection Directorate, the overall estimated losses in the electricity supply chain (generation, transmission, distribution, and supply) amount to over EUR 6 million (including the above-estimated fees for HOPS and HEP ODS).<sup>48</sup> Moreover, the government additionally exempted household customers in these most severely hit municipalities from the costs of natural gas supply from January to March 2021. Initial estimates of lost revenue in the electricity generation, natural gas supply, and district heating supply are not calculated into the overall losses under this sectoral report.<sup>49</sup>

**Since the damaged electricity distribution assets are managed and largely owned by HEP ODS, no disruptions**

47 VAT for electricity energy distribution is 13 percent.

48 This EUR 6 million is quite consistent with data reported by the two main electricity supply companies serving the earthquake-affected area, HEP Elektra and HEP Opskrba, which reported almost EUR 4.2 million and EUR 170,000, respectively.

49 The initial estimated lost revenue from natural gas supply is EUR 1.1 million; from district heating supply, lost revenue is estimated to be EUR 800,000.



**of the governance and social processes that will lead the recovery process are expected.** Given the limited scale of the damage, HEP ODS has the financial capacity to implement BBB practices for those damaged assets. Moreover, local authorities will provide administrative support for the reconstruction works to help expedite the process. Importantly, attention should be paid to any costs that are to be borne by customers—especially low-income households—in reconnecting their homes or businesses to the distribution network. Support should be provided to those struggling to meet these additional costs. These costs may include the cost of replacement meters, indoor and outdoor wiring, electricity protective equipment, or damaged electrical appliances. As of March 4, 2021, a total of 1,937 temporary container-type housing units for customers who cannot currently live in their homes were set up and connected to electricity. With an average cost of approximately EUR 500 per connection, the total cost is EUR 1 million.

**Since the damaged electricity transmission assets are managed and owned by HOPS, no disruptions of the governance and social processes that will lead the recovery process are expected.** Given the limited scale of the damage, HOPS has the financial capacity to implement ‘BBB’ practices for those damaged assets. Additionally, the local authorities will provide administrative support for the reconstruction works to help expedite the process.

**The natural gas supply and district heating subsectors have not reported any significant damage, but given the age of the existing infrastructure used by district heating companies, possible damage and further deterioration of infrastructure may be detected in later stages.** Unlike smaller district heating networks, excluding HEP Toplinarstvo, the electricity and natural gas networks in Croatia are managed by well-established utilities with considerable financial capacity to repair the damage and cushion revenue disruptions from the earthquake. Certain infrastructure may have insurance coverage to partially offset the cost of repairs and reconstruction efforts. These network utilities are regulated by an independent regulator Croatian Energy Regulatory Agency (HERA), and they follow the major technical and performance standards common in the EU. Croatian electricity utilities follow EU network codes and guidelines based on EU Regulation 2019/94 relating to electric market, system operations, and connections. In addition, Croatian electricity utilities follow electricity

standards (such as ISO14001:2015, ISO 50001:2011) and the Common Grid Model Exchange Standard for exchanging process data/models of electricity power networks between electricity transmission system operators. The natural gas utilities follow quality management systems such as ISO 9001:2000, information security management system ISO 27001, and energy management system ISO 50001.

**HEP ODS restored electricity services within 12 hours of the earthquake to 90 percent of approximately 50,000 customer accounts.** The services for the remaining customers were restored in the subsequent two days as an example of a utility with adequate capacity and emergency preparedness. No significant damages were reported for the electricity generation subsector. The following table shows total damage and losses in this sector for the two counties which reported damage. The ownership of damaged assets is public.

**Table 73.** Total damage and losses in the energy sector by county (EUR, millions)

Administrative unit	Damage	Losses
Sisak-Moslavina County	17.86	2.06
City of Zagreb	0.83	0.00
<b>Total</b>	<b>18.69</b>	<b>2.06</b>

Source: Estimations by the assessment team using official information.

## Disaster Impacts on the Affected Population

**In Sisak-Moslavina County<sup>50</sup>, the earthquakes’ damage to the electricity distribution network was limited and will not have major medium- and long-term impacts on the population in the affected areas.** The preliminary cost estimates of the damage, depicted in Table 71, were substantially lower than HEP ODS’ annual capital expenditure, which amounts to around EUR 130 million in recent years. According to HEP ODS, immediate reconstruction works were completed. Importantly, the damage presents an opportunity to enhance quality and expand access of electricity services to consumers in the

50 This section focuses solely on Sisak-Moslavina County, as information for other affected areas was not available at the time of the RDNA.

affected areas (in which there are over 55,000 household accounts), particularly for low-income households.<sup>51</sup>

**The earthquake damage to the electricity transmission network was limited and will not have major medium- and long-term impacts on the population in the affected areas.** The preliminary cost estimates of the damage, depicted in Table 71 and Table 72, were substantially lower than HOPS' annual capital expenditure, which amounts to over EUR 50 million in recent years. As per HOPS, the reconstruction works to ensure that all damaged transmission network elements are operating are expected to be completed by the end of December 2021 and all reconstruction works are expected to be completed in the next five years.

## Reconstruction and Recovery Needs

**Reconstruction needs reported by HEP ODS related to the energy distribution infrastructure are estimated at over EUR 10 million.** In the medium term, additional investments will be required to increase the infrastructure quality; these investments will amount to approximately EUR 8 million. Also, in the medi-

um term, in addition to servicing the listed energy facilities, it will be necessary to provide funds for the rehabilitation of damaged buildings or construction of replacement buildings (such as the administrative building of Elektra Sisak, the building of 110/35 kV Pračno, and the residential building in Vrbina). More detailed assessments of the exact amount of financial resources needed for the reconstruction of individual power facilities are still ongoing and may further refine the results presented in this report. Various projects will need to be phased out in the long term to repair the damage caused by the earthquake and to raise the level of quality and security of supply in the distribution area of Elektra Sisak. Considering these needs, HEP ODS has estimated that approximately EUR 20–25 million would need to be provided, in the form of financial resources, to realize all the projects.<sup>52</sup>

**HOPS estimated that the investments required to upgrade the electricity transmission infrastructure with BBB approaches amount to EUR 61 million.** These investments consider upgrades that will ensure that the infrastructure has more seismic resistance as well

51 According to the Civil Protection Directorate website, there were about 150,000 electricity customer accounts that were affected by the December 2020 earthquake.

52 HEP ODS' total long-term plant, property, equipment (PP&E) were almost EUR 2 million (2018). So, EUR 27 million is about 1.5 percent of HEP ODS total PP&E. In 2017 and 2018, HEP ODS capital expenditures were approximately EUR 132 million and EUR 126 million, respectively.

**Table 74.** Total reconstruction needs in the energy sector (EUR, millions)

Type of energy subsector	Type of Infrastructure	Sisak-Moslavina County		City of Zagreb	
		No.	Value	No.	Value
	<b>Total</b>		<b>10.48</b>		
Electricity distribution system level	Substations 20/04 kV	64	2.32	-	-
	Lines, cables, low voltage network	40	5.50	-	-
	Other facilities and equipment	2	2.65	-	-
	<b>Total</b>		<b>61.07</b>		<b>1.08</b>
	Lines				
Electricity transmission system level	Sub-stations (subtotal)	5	58.06	-	-
	Out of which 400/110 kV	1	8.29	-	-
	220/110kV	2	39.81	-	-
	110/x kV	2	9.95	-	-
	Buildings	2	3.02	1	1.08
<b>Subtotal</b>			<b>71.55</b>		<b>1.08</b>
<b>Total</b>			<b>72.63</b>		

Source: MoESD.

as other sector-specific risk reduction considerations.<sup>53</sup> Most investments were already a part of HOPS' 10-year Development Plan (2021–2030).

Reconstruction needs in this sector over the short, medium, and long term are shown in Table 75.

<sup>53</sup> The estimates are based on the currently available data while a more detailed assessment of the exact amount of financial resources needed for the reconstruction may further refine the results presented in this report.

**Table 75.** Total reconstruction needs in the energy sector in the short, medium, and long term (EUR, millions)

	Short	Medium	Long	Total
<b>Reconstruction</b>	29.05	21.79	21.79	<b>72.63</b>

*Source: Estimations by the assessment team using official information.*

## WATER AND FLOOD PROTECTION

### WATER SUPPLY AND SANITATION Sector Overview and Baseline Data

**Public water supply systems in Croatia can connect up to 94 percent of the total population (4 million inhabitants), and 86 percent, or about 3.5 million inhabitants, are actually connected.** There are large differences in the development levels of the public water supply systems of different counties, towns, and municipalities. While the connection potential in large cities ranges from 95 to 100 percent, rural areas have a lower percentage of potential connection. Croatia's access to quality drinking water is adequate, but, due to various reasons (mainly economic), connection to the public water supply system is not satisfactory. Local service providers still supply a part of



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the population, with large variations in the quality among different regions. The largest problem of the public water supply system is water losses due to irregular maintenance and old infrastructure (average 50 percent losses at the national level).

**Compared with public water supply, public sewerage is less developed.** It can connect up to 57 percent of the Croatian population (2.4 million inhabitants), and 53 percent, or about 2.1 million inhabitants, are actually connected. Access to adequate levels of wastewater treatment amounts to 38 percent. The accelerated development of the public sewerage system is under way, by extending the regional and secondary networks and achieving the required treatment level.

**There are 36 public water service providers operating in the affected areas, and most of them are engaged both in the public water supply and public sewerage.** The sole founders and owners of all public services providers are LSGUs. They manage public service suppliers through the company's assembly, which consists of representatives of the founding LSGUs, while the company is directly managed by the company's director. The owners of water utility infrastructure are public water services providers. Since the water sector in Croatia is highly fragmented and inefficient, an integral reform of the water services sector was launched to strengthen its implementation capabilities and investment capacity as well as its the financial and technical self-sustainability. Public water supply and

sewerage systems in Sisak-Moslavina County, Karlovac County, Krapina-Zagorje County, Zagreb County, and the City of Zagreb are organized through eleven, nine, five, eleven, and one provider, respectively.

**The connection rate to public water supply and sewerage systems across the affected area varies.** In Sisak-Moslavina County, a total of 129,480 inhabitants are connected to the public water supply system (75 percent). Water for human consumption is mostly abstracted from underground karst aquifers, except for the surface abstraction from the Kupa River for the town of Sisak and the alluvial water abstraction site for the municipality of Dvor. A total of 72,539 inhabitants are connected to the public sewerage system (42 percent). In Karlovac County, a total of 117,263 inhabitants are connected to the public water supply system (91 percent). A total of 40,762 inhabitants are connected to the public sewerage system (31 percent). In Krapina-Zagorje County, a total of 99,493 inhabitants are connected to the public water supply system (75 percent). In this county, there are numerous local water supply systems that are not managed by public water service providers. A total of 31,629 inhabitants are connected to the public sewerage system (24 percent). In Zagreb County, a total of 240,514 inhabitants are connected to the public water supply system (76 percent). A total of 136,730 inhabitants are connected to the public sewerage system (46 percent). In the City of Zagreb, a total of 752,984 inhabitants are connected to the public water supply system (95 percent). A total of 744,048 inhabitants

**Table 76.** Overview of the water supply and sanitation sector in the affected area

Water supply and sanitation sector	Sisak-Moslavina County	Karlovac County	Krapina-Zagorje County	Zagreb County	City of Zagreb
<b>Water supply</b>					
Abstraction sites (water intake structures) (no.)	13 (51)	30 (64)	76 (107)	25 (66)	10 (105)
Length of public water supply system (km)	2,080	2,613	3,165	3,195	3,201
Household connections	44,414	41,073	40,163	68,077	91,412
Water potabilization plants (no.)	25	28	16	45	37
Conveyance systems (km)	554	1,887	621	1,113	332
Storage systems	28	65	108	65	59
Distribution networks (km)	1,526	726	2,544	2,082	2,869
<b>Sanitation</b>					
Length of public sewerage system (km)	537	272	304	916	2,114
Wastewater treatment plants (WWTPs) (no.)	3	6	6	8	1

Source: MoESD.

are connected to the public sewerage system (92 percent).

**As opposed to urban areas, the population in the rural areas uses wells and individual sewerage systems.** In the rural areas of the affected counties, the population predominantly uses water from their own wells and mostly uses individual sewerage systems (such as sump pits and septic tanks).

## Effects of the Disaster (Damage and Losses)

**There was material damage to water and wastewater systems, to administrative buildings, and the office equipment of public water service providers.** The damage to the buildings and/or equipment was reported by seven public service providers (Privreda d.o.o. in Petrinja, Sisački vodovod d.o.o. in Sisak, Vodovod Glina d.o.o. in Glina, JP Komunalac d.o.o. in Hrvatska Kostajnica, Komunalac - Dvor d.o.o. in Dvor, Vodoopskrba d.o.o. in Hrvatska Dubica, and JPK Jasenovačka voda d.o.o. in Jasenovac) to 13 buildings, including seven administrative buildings and six warehouses. All damaged buildings are in Sisak-Moslavina County and are categorized as public property. None of them are categorized as cultural heritage. Six of the affected buildings have minor damage (46 percent) followed by four with moderate (31 percent) and three with heavy damage (23 percent). Severely damaged buildings are located in Petrinja, Glina, and Hrvatska Kostajnica.

**The total affected surface area of damaged administrative buildings and warehouses is 5,381 m<sup>2</sup>.** Moderately damaged buildings take up 2,360 m<sup>2</sup> (44 percent) followed by 1,899 m<sup>2</sup> (35 percent) of buildings with minor damage and 1,122 m<sup>2</sup> (21 percent) of buildings with heavy damage. It is important to note that some public water service pro-

viders share administrative and warehouse premises with other utility service providers or municipalities.

**Out of the 11 public water service providers in Sisak-Moslavina County, 9 reported damage amounting to EUR 49.872 million:** Privreda d.o.o. in Petrinja, Sisački vodovod d.o.o. in Sisak, Vodovod Glina d.o.o. in Glina, JP komunalac d.o.o. in Hrvatska Kostajnica, Komunalac - Dvor d.o.o. in Dvor, Vodoopskrba d.o.o. in Hrvatska Dubica, Vodoopskrba i odvodnja Topusko d.o.o. in Topusko, JPK Jasenovačka voda d.o.o. in Jasenovac, and Moslavina d.o.o. in Kutina. In addition to damage to public providers' administrative buildings and office equipment (valued at EUR 2.867 million), there was damage to water supply systems (valued at EUR 31.111 million), sewerage systems (valued at EUR 15.572 million), and the connection of containers to water supply and sewerage (valued at EUR 213,333). The damage to water supply systems includes the main and secondary water supply pipelines (breakages, defect repairs), pumping stations (collapse of facilities, damage and breakage of pumps, damage and breakage of electrical and measuring equipment), household connections (breakage of pipelines, destroyed water meters and water reinforcement, and destroyed connections to the newly built water supply system), water storage (cracked walls as well as damage to the electrical equipment and measuring devices), water abstraction sites (the collapse of facilities, damage and breakage of pumps, damaged and destroyed electrical and measuring equipment, and breakage of supply pipelines), rehabilitation of local water supply systems, drinking water laboratories (damage to laboratory equipment due to it falling down and by materials), and water conditioning system (damage to facilities, equipment, valve equipment in manholes, and cracked roads inside the plant). The damage to sewerage systems includes the main and secondary col-

**Table 77.** Number and surface area of damaged administrative buildings in the water and sanitation sector

Type of institutions	Level of damage	Sisak-Moslavina County	Total number	Sisak-Moslavina County	Total surface area
Administrative buildings and warehouse facilities of the public service providers	Minor	6	13	1,899	5,381
	Moderate	4		2,360	
	Heavy	3		1,122	

Source: Estimations by the assessment team using official information.

lectors (breakages, longitudinal breakages, collapse, depressions, settlements), pumping stations, retention basins, and stormwater overflows (destroyed electronics and pumps), household connections (breakages of connecting sewer pipes), and the WWTP (collapse and clefts on the ground of the plant location, a crack on the plant or plant joints, concrete that has fallen off from the reservoir, outlet manholes separated from the basin, cracking of the insulation membrane, and loss of basin water impermeability).

**Out of the nine public water service providers in Karlovac County, damage was reported by one:** Vodovod i kanalizacija d.o.o. in Ogulin. The service provider reported damage to the main collectors in the estimated value of EUR 50,000. Damage included longitudinal cracks and depressions of asphalt roadways due to pipe breakages on the main sewerage collectors, cracks and depressions of asphalt roadway around the manhole covers of the main collectors and collapsing of manhole covers due to the settlement of concrete slabs, frequent pipe blockages on sewerage collectors due to pipe breakage, leakage of fecal contents through manhole covers onto the roadway or leakage of contents into the underground, reduced wastewater flow to the WWTP due to high losses in the pipes of the sewer collector caused by ruptures, and an increased amount of stone material causing pump downtime at some pumping stations.

**Out of the four public water service providers in Krapina-Zagorje County, damage was reported by one:**

KRAKOM - Vodoopskrba i odvodnja d.o.o. in Krapina. The service provider reported damage to the main collectors (the separation of sewerage pipes due to ground movement) valued at EUR 125,000.

**Of the twelve public water service providers in the Zagreb County, three reported damage:** VG Vodoopskrba d.o.o. in Velika Gorica, Vode Pisarovina d.o.o. in Pisarovina, and Vodoopskrba i odvodnja Zaprešić d.o.o. in Zaprešić in the amount of EUR 1.654 million. Damage to water supply systems was reported in the estimated value of EUR 1.640 million, whereas damage to the sewerage systems was reported in the estimated value of EUR 13,333. Damage to the water supply systems includes the main and secondary water supply pipelines (water turbidity, settlement, breakages), household connections (water turbidity, breakages), water storage tanks (landslide), and water abstraction sites (pump operation downtime, cracking of the wall around the door to the water conditioning facility). Damage to the sewerage system includes the WWTP (cracking of the facility wall situating coarse and fine screens).

**The public water service provider in the City of Zagreb reported damage to the sanitation system.** Vodovod i odvodnja d.o.o. in Zagreb needed to carry out emergency rehabilitation of the breakage in the waterproofing of the lining, due to water leakage from the left water chamber of the water storage Biškupec. The cost of repairing the damage is EUR 118,396.

**Overall, the total estimated amount of damage to the wa-**

**Table 78.** Overview of damage to infrastructure in the water and sanitation sector

Water Supply and Sanitation Sector	Sisak-Moslavina County	Karlovac County	Krapina-Zagorje County	Zagreb County	City of Zagreb
<b>Water supply</b>					
Water abstraction sites (no.)	9	0	0	2	0
Water conditioning plants (no.)	9	0	0	0	0
Conveyance systems (% of km)	70%	0	0	10%	0
Water storage systems (no.)	13	0	0	1	0
Distribution networks (% of km)	70%	0	0	10%	0
<b>Sanitation</b>					
Sewerage network (km)	10.30	1.20	1.13	0	0
Wastewater treatment plants (no.)	2	0	0	1	0

Source: MoESD.

ter utility infrastructure equals EUR 51.819 million: EUR 48.844 million is damage to water and sewage infrastructure, EUR 2.867 million to administrative buildings and warehouses, and EUR 113,571 to equipment. About 63.2 percent is damage to water supply (EUR 32.752 million), 30.64 percent to sanitation infrastructure (EUR 15.878 million), and 5.74 percent to administrative buildings and warehouses of the public service providers.<sup>54</sup> About 97.6 percent of all damage occurred in Sisak-Moslavina County.

54 The damage (and the rehabilitation carried out on the public water supply and sewerage networks) cannot be expressed in kilometers until detailed surveys are carried out and the reconstruction needs are determined.

**Table 79.** Estimation of damage to infrastructure and property in the water and sanitation sector (EUR)

Estimation of damage to infrastructure and physical property	EUR
<b>Buildings and office equipment</b>	<b>2,975,260</b>
Administrative buildings and warehouses	2,861,688
Office equipment and furniture	113,572
<b>Water supply</b>	<b>32,751,772</b>
Main water supply pipelines	11,717,500
Pumping stations	555,000
Secondary water supply pipelines	6,652,500
Household connections	2,613,750
Water storage	2,867,500
Water abstraction site	1,402,500
Rehabilitation of local water supply systems	5,066,250
Laboratory for drinking water	61,250
Water conditioning system	1,332,500
<b>Works on emergency establishment of water supply</b>	<b>60,000</b>
<b>Works on emergency establishment of water supply</b>	<b>15,878,396</b>
Main collectors	4,932,500
Pumping stations, retention basins and stormwater overflows	271,250
Secondary collectors	8,345,000
Household connections	1,218,750
WWTP	823,750
Storage	266,250
Equipment	166,250
<b>Connection of containers to water supply and sanitation</b>	<b>213,333</b>

Source: MoESD.

**Recurrent earthquakes have caused disruptions to the supply of water and increased the need to implement emergency measures to restore normal water supply.** Due to the damage, the number of failures has significantly increased; additionally, in the failed systems, the intensity of leakages has increased, and it has been found that new failures still occur. The phased implementation of failure detection activities and their remediation has been launched to solve this problem.

**An urgent need to undertake technical measures to establish ecologically sound wastewater collection with adequate quality has also arisen.** This includes the preparation of studies, failure (defect) detection, interventions, equipment repairs, flushing and cleaning of the systems, water sampling, surveys (such as closed circuit television, geodetic surveys), geodetic measurements, geo-mechanical surveys, and changes to conceptual and detailed designs.

**Emergency interventions in Sisak-Moslavina County and Zagreb County were reported by water utilities companies.** In Sisak-Moslavina County, activities included the detection of failures, their micro-locating, the development of plans and mathematical models, geodetic surveys and measurements, geo-mechanical surveys, closed circuit television surveys, mechanical works and repairs of electricity cabinets and automation at pumps, unplugging and pumping out of gullies and septic tanks, flushing of water supply pipelines, water sampling, and cleaning of collectors. Also, emergency works were carried out to establish a water supply source in the city of Petrinja, since the entire water supply system was interrupted due to the interruption of supply from the abstraction site Pecki in Petrinja and the necessary supply was urgently ensured from Sisak. In Zagreb County, a pump at the pumping station was serviced and parts of the automation and IT components at the station were replaced to establish uninterrupted water supply. In addition, urgent preparation of studies for the rehabilitation and reconstruction of water supply and sewerage systems in a long-term sustainable manner has been initiated, including revisions to conceptual and detailed designs.

**Overall, total losses amount to EUR 1.490 million, out of which the total cost of emergency interventions is EUR 1.291 million.** Three public water service providers from Sisak-Moslavina County reported the costs of

emergency interventions in the amount of EUR 1.287 million while the estimated cost of similar measures in Zagreb County is EUR 4,083. Debris removal amounts to EUR 199,262. There were losses in the revenues of public services providers; however, estimates are not available.

**Management and social processes were predominantly affected in Sisak-Moslavina County where water service providers suffered severe damage to administrative buildings and equipment.** Out of the seven affected water service providers, Privreda d.o.o. in Petrinja and Vodovod Glina d.o.o. in Glina were hit the hardest. Management structures needed to be adjusted to the new circumstances while all services providers succeeded in retaining all their personnel. Despite the negative impact on the management structures, there was no disruption in the supply of water for human consumption after the earthquake. With the assistance of public water services providers from other counties, damage to the water utility infrastructure was detected and temporarily repaired, so that the public water supply was established immediately after the earthquake. The only remaining problem is ensuring the potability of the drinking water in Hrvatska

Kostajnica; however, this problem will be solved soon.

**Although both the management and the personnel were affected, their operations were reorganized efficiently and will be able to lead the recovery process.**

This is especially true for the services providers Sisački vodovod d.o.o. in Sisak, Privreda d.o.o. in Petrinja, and Vodovod Glina d.o.o. in Glina that have adequate staffing capacities. Other suppliers, such as JP Komunalac d.o.o. in Hrvatska Kostajnica, Komunalac - Dvor d.o.o. in Dvor, and Vodoopskrba d.o.o. in Hrvatska Dubica, will be assisted in recovery projects by Hrvatske vode and the competent ministry. In other counties and the City of Zagreb, the management structure and social processes were not affected.

**In the affected area, water utility infrastructure is old, with significant losses in the public water supply system which is why many EU co-funded projects have been launched to improve water utility infrastructure.**

Sisak-Moslavina County, with recorded 54 percent of losses, has ongoing projects in Petrinja, Kutina and Novska, while projects Sisak 2, Popovača and Voloder,

**Table 80.** Estimation of losses in the water and sanitation sector (EUR)

Estimation of Losses	EUR
<b>Water supply</b>	<b>753,750</b>
Development of water supply studies	31,250
Failure detection	343,750
Development of emergency plans and plans for the systemic start-up of new construction network	8,750
Repair of defects - water supply	41,250
Flushing of water supply pipelines	13,750
Eater sampling	8,750
Water supply - purchasing water from the Sisak water supply system	227,500
Pumping stations	18,750
Transformer stations	57,500
Water truck interventions	2,500
<b>Sanitation</b>	<b>537,500</b>
Development of studies - sewerage	6,250
Detailed determination of existing state/damage	380,000
Development of a plan and program for measurements and implementation of measurements of basic hydraulic parameters	33,750
Development of a mathematical model of the existing state with calibration of the sewerage system	33,750
WWTP - obtaining of permits, geodetic measurements, geo-mechanical works, and development of modifications to conceptual and detailed designs	83,750

Source: MoESD.



Glina, Slunj, and Lekenik are in preparation. Karlovac County, with 62 percent of losses, has an ongoing project in Karlovac-Duga Resa, while a project Ogulin is being prepared. Krapina-Zagorje County, with 37 percent of losses, has a project in Zabok - Zlatar, while projects in Krapina, Hum na Sutli, Pregrada and Krapinske Toplice are being prepared. In Zagreb County, where losses are 26 percent, projects include the Regional Water Supply System Zagreb East in Rugvica-Dugo Selo, Jastrebarsko, Vrbovec, Zaprešić, Ivanić Grad, and Velika Gorica, while projects in Sveti Ivan Zelina - Brckovljani, the Water Supply System Velika Gorica, Jakovlje, Mala Buna, and Klinča Sela are being prepared. In the City of Zagreb, losses in the public water supply system amount to 48 percent. A water utility infrastructure construction project is being prepared and will be co-financed from EU funds.

**The earthquake has led to further deterioration of both public water supply and sewerage systems in the four counties, and, in the long term, detailed surveys and designs will be needed for reconstruction.** In Sisak-Moslavina County, due to the breakage in the pipeline, the public water supply stopped functioning properly, and there were water losses in individual wells. Since earthquakes of lower intensity are still present, subsequent damage continues to occur. In Karlovac County, the service area of Vodovod i kanalizacija d.o.o. in Ogulin was further degraded. There were problems in the functioning of the public sewerage system, where the collectors broke and were clogged, and the manholes collapsed. In Krapina-Zagorje county, the earthquake further damaged the water utility infrastructure in the service area of KRAKOM - Vodoopskrba i odvodnja d.o.o. in Krapina. There were also problems with the public sewerage system, where sewerage pipes were separated from the main collectors due to ground movement. In Zagreb County, due to breakage in the pipeline, there were problems with the public water supply system. In the whole area, the public water service providers have been promptly resolving equipment failures, breakages in the network, and damaged connections in residential buildings and business entities as well as connecting temporary container facilities to the public water supply and public sewerage system. In the City of Zagreb, the earthquake did not cause problems in the functioning of the public water supply and public sewerage systems. However, damage to the waterproofing of the water chamber was reported. Table 81 and Table 82 summarize the total damage and losses in the affected area by county and by type of facility.

**Table 81.** Total damage and losses in the water and sanitation sector by county (EUR, millions)

Administrative unit	Damage	Losses
Sisak-Moslavina County	49.87	1.49
Karlovac County	0.05	0.00
Zagreb County	1.65	0.004
Krapina-Zagorje County	0.13	0.00
City of Zagreb	0.12	0.00
<b>Total</b>	<b>51.82</b>	<b>1.49</b>

Source: Estimations by the assessment team using official information.

**Table 82.** Total damage and losses in the water and sanitation sector by type of facility (EUR, millions)

Type of facility	Damage	Losses
Administrative buildings and equipment	2.98	0.20
Water supply	32.75	0.76
Sanitation	15.88	0.54
Connection of containers to water supply and sewerage	0.21	0.00
<b>Total</b>	<b>51.82</b>	<b>1.49</b>

Source: Estimations by the assessment team using official information.



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While beyond the scope of this assessment, authorities may also assess how the damaged and associated costs have affected future investments plans, including those related to alignment to Drinking Water Directive, Urban Wastewater Treatment Directive, and the Sewage Sludge Directive. The following damage and loss estimates include public assets only.

## **Disaster Impacts on the Affected Population**

**In Sisak-Moslavina County, there was increased water turbidity at some water abstraction sites pumping groundwater which are located closer to the epicenter.** Also, a well collapsed. The earthquake caused damage to individual water supply systems (private wells), which were significantly damaged or collapsed. As a result, these users now need to be connected to public wastewater systems, which creates additional pressure on the systems needing to ensure the provision of sufficient water quantities. Despite the damage, public service providers immediately ensured a supply of potable water. In some areas, it was recommended that the people boil water as a preventive measure. Significant water losses have affected the business operations of public water service

providers, who cannot bear the costs of increased system rehabilitation and reconstruction on their own. Due to the large water losses as well as the actual and potential ruptures of regional pipelines, challenges could also manifest in ensuring sufficient quantities of water for human consumption, particularly in summer periods.

**Due to the damage to private wells, there is an increased need for new connections to the public water supply system.** The network also needs to be extended to areas that were not supplied with water from public water supply systems before the earthquake. In these areas, access to drinking water is limited; this issue was resolved in the short term by using water tankers and providing bottled water. However, such measures are not sustainable in the long term. To establish a public water supply system in these areas, significant funds will be required.

**The consequences of damage to the public sewerage system could have an impact on human health and the environment.** A part of the sewerage network and facilities collapsed, and their denivelation will result in reduced flow velocity, more intense disposal of suspended solids, more intense emission of odors locally, and the reduced hydraulic conductivity of individual sections,



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which will be felt at higher intensity precipitation. At separated pipe connections, groundwater flows into the system increasing the hydraulic load, while wastewater in its untreated form also leaks into the underground endangering the quality of the surface water and groundwater bodies. In some longer sections, there are faults to the surface depth of up to 0.5 m, which could potentially indicate more significant damage was sustained. Some manholes suffered structural damage to their side walls, bottom, and connecting and collecting canals. Leakage and groundwater infiltration into the sewerage system were also observed. At some pumping stations, structural damage was observed that may cause limitations to the system use and have consequences for human health and the environment due to direct wastewater discharges into the recipients. Despite the damage, WWTPs are presently functional. However, if left unrepaired, the damage may cause further deterioration and incapacitate the functionality of the treatment system, thus endangering the status of water bodies due to leakages of untreated wastewater from the system. Due to the denivelation of the terrain on which the construction of a WWTP was planned, under the project for Petrinja agglomeration financed by EU funds, a new geodetic survey and geo-mechanical investigation works will be necessary. The findings from these will be the basis for assessing the modifications needed on the previously developed designs.

**In the most affected areas of Sisak-Moslavina County, namely, Petrinja, Glina, Sisak, and Hrvatska Kostajnica, housing containers need to be constantly connected to the public water supply and sewerage systems.** This puts considerable pressure on public water service providers, in terms of both maintenance and provision of necessary materials. At present, it is not known whether this disaster affected the sources of thermal water in the municipality of Topusko, which are central to the development of tourism in the area.

**In Karlovac County, the provision of water service was interrupted within the public sewerage systems of the Ogulin agglomeration.** It is estimated that the system will not be functional again for six months to a year. During this period, the population will have limited access to public sewerage systems. The damage done can lead to sanitary wastewater leaking into the environment, which would have an adverse impact on the status of water, human health, and the environment.

**Private wells and local water supply systems were damaged in Zagreb County, which calls for an extension of the public water supply system to a wider area.** At present, access to water for human consumption in the areas where there is no public water supply is limited. In the short term, water supply has been ensured with water tankers. In the town of Zaprešić, the interior load-bearing wall of the inlet pumping station at the central WWTP was damaged. Currently, the damage has not affected the functioning of the system and does not pose a risk for the population and the environment. However, if the required repairs are not done in the short term, the load-bearing wall of the pumping station building could collapse, which would prevent further operation of the WWTP. The inability to treat the wastewater and the discharge of untreated wastewater into the Sava River might lead to an adverse impact on the state of that body of water.

Krapina-Zagorje County and the City of Zagreb did not report major damage which would pose a threat for the population or the environment.

## **Reconstruction and Recovery Needs**

**The immediate recovery needs equal the reported damage while the medium- and long-term needs include investments from long-term plans.** Short-term measures which will be implemented within one year equal the total damage, except in the case of administrative buildings and equipment where the reconstruction already includes BBB elements. Those needs which will be implemented in two to three and four to five years include the planned investments into the public water utility system aimed at improving its functionality and cost-effectiveness according to the principle of BBB. However, it should be noted that investment capacities of public water service providers in the earthquake-hit areas have been significantly reduced due to losses in operating income because of emergency measures and a reduction in the provision of water services.

**Regarding the recovery of the public water supply system, it is necessary to intensify the implementation of the water loss reduction program.** Hrvatske vode has been implementing the program since 2018 in cooperation with the public water service providers. Under this program, water supply pipelines with the highest

losses are undergoing reconstruction. Also, a system of control and management for quicker rehabilitation, ‘supervisory control and data acquisition’ (SCADA), will be established, and physical protection will be provided to water abstraction sites (fences and a supervisory system to prevent the access of unauthorized personnel), including training of staff for using new technologies.

**The public water supply system will need to be extended more quickly since, due to the earthquake, individual wells are mostly no longer in function.** The extension of the public water supply systems to the areas without such access will be co-funded by EU funds as part of the water and wastewater infrastructure development. Since the ground continues to shake, additional analyses will

**Table 83.** Total reconstruction needs in the water and sanitation sector (EUR, millions)

Administrative unit	Reconstruction needs
Sisak-Moslavina County	130.86
Karlovac County	42.07
Zagreb County	142.82
Krapina-Zagorje County	45.81
City of Zagreb	83.45
<b>Total</b>	<b>445.02</b>

Source: Estimations by the assessment team using official information.

**Table 84.** Total reconstruction and recovery needs in the water and sanitation sector in the short, medium, and long term (EUR, millions)

Recovery and reconstruction needs	Short	Medium	Long	Total
Emergency reconstruction of damaged administrative buildings; replacement of damaged office equipment	4.75	0.00	0.00	<b>4.75</b>
Emergency rehabilitation measures of water supply network and reconstruction of damaged water utility facilities, SCADA, preparation of project documentation, monitoring the status of water abstraction sites, rehabilitation measures for the main pipelines and secondary networks, execution of water supply connections, terrain rehabilitation measures due to landslides, rehabilitation of pumps at water abstraction sites, rehabilitation of ruptures in waterproofing of the lining water chambers of water storage	14.92	0.00	0.00	<b>14.92</b>
Emergency rehabilitation measures of water supply network, emergency reconstruction of water supply facilities, SCADA, preparation of project documentation, monitoring the status of water abstraction sites, extension of the public water supply system, construction of main regional pipelines, priority water losses reduction program including rehabilitation and reconstruction of water supply pipelines where the largest water losses have been determined, training of provider staff to implement new technologies	0.00	105.83	0.00	<b>105.83</b>
Water losses reduction program which includes rehabilitation and reconstruction of water pipelines where the largest losses have been found, SCADA implementation, training of provider staff to implement new technologies, construction of main water pipelines; further water losses reduction program, extension of the public water supply system to areas where unavailable	0.00	0.00	146.26	<b>146.26</b>
Emergency rehabilitation measures for the public sewerage system, including regional and secondary sewerage pipelines, pumping stations, vacuum manholes and household connections; emergency rehabilitation measures for damaged WWTPs; preparation and update of project documentation; emergency rehabilitation measures for the public sewerage system due to settlements and breakages of sewerage pipes and downtime in the operation of pumping stations; emergency rehabilitation measures for sewerage pipes; emergency rehabilitation measures for WWTPs	5.15	0.00	0.00	<b>5.15</b>
Rehabilitation and reconstruction of existing sewerage pipelines where the largest damage has been determined (settlement, breakage, separation); designs for the rehabilitation of the WWTP and parts of secondary sewerage; rehabilitation and reconstruction of damaged WWTPs; extension of public sewerage system, including WWTPs; repairs on pumping stations; reconstruction works on the main collector pipelines, major longitudinal cracks and damage to gravity pipelines; rehabilitation of asphalt due to cracks on roads and around collectors; rehabilitation of roads and pavements in case of cracks due to settlements above collectors length = 500 m;	0.00	60.84	0.00	<b>60.84</b>
Further extension of public sewage system and wastewater treatment system	0.00	0.00	107.3	<b>107.3</b>
<b>Total</b>	<b>24.78</b>	<b>166.67</b>	<b>253.56</b>	<b>445.02</b>

Source: Estimations by the assessment team using official information.

Note: The estimate of medium- and long-term investment needs in water supply facilities is harmonized with data from the [Multi-annual program for the construction of water utility facilities \(voda.hr\)](#) in the subject area—with a correction considering the damage and cost increase of works performance.

be required to adjust the planned projects to the new circumstances. Another factor which will need to be considered when planning the extension of the network is a decreasing population of the county.

**Reducing the risk of interrupted water supply from the public water supply systems for more than 24 hours needs to be given special focus.** Such interruptions are possible if main water supply pipelines burst in inaccessible ground (for example, main pipeline Novo Selište water abstraction site in Sisak, main pipeline Pašino Vrelo water abstraction site in Kostajnica (near Mečenčani), and main pipeline from the Pecki water abstraction site toward Petrinja).

**The recovery needs related to the public sewerage system refer to short-term rehabilitation of damages and the long-term extension of the network.** Emergency rehabilitation has been necessary to prevent significant surface water and groundwater pollution due to untreated wastewater leaking into the environment. This particularly refers to the untreated wastewater leaking in the sanitary water source protection zones. The extension of the network will be co-financed with the EU funds for the

development of public wastewater infrastructure.

**Recovery activities need to aim at a full normalization and improvement of public water supply and sewerage services in the earthquake-hit areas.** Access to water for human consumption and wastewater collection is one of the most important preconditions for the normalization of life, return of the displaced population, and a recovery of economy. Total recovery needs in the sector have been estimated at EUR 445 million. Table 83 and Table 84 provide the total estimate of reconstruction needs by county and by short, medium, and long term.

## FLOOD PROTECTION

### Sector Overview and Baseline Data

**Hydrographically, the territory of Croatia belongs to the Adriatic Sea basin and the Black Sea basin.** Under the Water Act, it is divided into two river basins districts: (a) the Danube River basin (DRB) district and (b) the Adriatic river basin. The DRB district has abundant groundwater resources and a dense and branched net-



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work of surface watercourses, particularly in its Pannonian part. The largest rivers—with a basin surface of more than 10,000 km<sup>2</sup>—are Danube, Sava, Drava, Mura, and Kupa; the large rivers—with a basin surface of 1,000 to 10,000 km<sup>2</sup>—are Dobra, Korana, and Glina (Kupa tributaries); Krapina, Ilova-Pakra, Česma, Orjava, Bosut, and Una (Sava tributaries); Karašica-Vučica (Drava tributary); and Baranjska Karašica, and Vuka (Danube tributaries). In the eastern part of Pannonian Croatia, the Sava River, with its northern tributaries, flows along the southern border and receives significant right tributaries from the neighboring country (Una, Vrbas, Ukrina, and Bosna), the Drava River, with its southern tributaries, runs along the northern border, and the Danube River with its western tributaries flows along the eastern border of Croatia. There are also about 50 rivers in the Sava sub-basin and about 15 rivers in the Drava and Danube sub-basins which have a middle-size basin surface (100 to 1,000 km<sup>2</sup>).

**According to the Water Act and the National Flood Defense Plan, Hrvatske vode oversees planning, organizing, financing, and implementing flood defense measures.** In Croatia, flood defense is organized by the 34 defended areas (DA), and these fundamental territorial units for flood defense conduct all the operational flood defense activities. Flood protection systems consist of a large number of water regulation and protection structures (such as embankments, revetments, artificial river

channels, relief canals, lateral canals, drainage tunnels, dams with storage reservoirs, flood gates, flood retention basins, pumping stations, multiple purpose reservoirs, stilling pools, and erosion and flash flood protection structures) and amelioration drainage water structures (canals with related pumping stations, drainage, concrete culverts, outlets with tide gates, syphons, multiple purpose reservoirs, chutes, anti-erosion lining, gates and other related structures, devices, and equipment). The drainage of amelioration surfaces is an integral part of flood defense.

**In the earthquake-hit area, flood defense is carried out in nine DAs (DAs 5, 7, 8, 9, 10, 11, 12, 13, and 14).** In these nine DAs, which belong to the DRB district, there is a total of 1,079.44 km of embankments and 21 pumping stations built as the main water regulation and protection structures for flood defense, not including big flood retention basins such as Lonjsko polje.

**Flood defense in Sisak-Moslavina County is carried out in DAs 5, 9, and 10, which include the towns of Sisak, Petrinja Glina, Hrvatska Kostajnica, Kutina, and Popovača.** It also includes the municipalities of Martinska Ves, Lekenik, Sunja, Hrvatska Dubica, Velika Ludina, Jasenovac, Dvor, Lipovljani, Topusko, Gvozd, Majur, and Donji Kukuruzari. In total, this territory has a population of approximately 170,000. The Sava River



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**Table 85.** Overview of the flood protection sector in the affected area

Flood protection sector	Sisak-Moslavina County	Karlovac County	Krapina-Zagorje County	Zagreb County	City of Zagreb
Flood dike (km)	516.85	73.26	0	407.18	82.15
Pumping station (pc)	8	1	0	12	0

Source: MoESD.

runs through the central part of DA 10, where the major part of flood defense activities takes place. With its riverbed particularities and tributaries, the Sava River causes the formation of vast flood zones known as Lonjsko polje and Ribarsko polje; presently, they have storage volumes of approximately 500,000,000 m<sup>3</sup>. The length of the embankments constructed on the waters of the first and second order in these three DAs is 516.85 km. The county has eight pumping stations.

**Flood defense in Karlovac County is carried out in DA 11, which includes the towns of Karlovac, Ozalj, Ogulin, Duga Resa, and Slunj and 17 municipalities, with approximately 130,000 inhabitants.** DA 11 runs in Karlovac County for 3,626 km<sup>2</sup> and accounts for 81 percent of all DAs in Croatia. DA 11 also runs through a part of Zagreb County (for 630 km<sup>2</sup> or 14 percent of DA 11) and a small part of Lika-Senj County (231 km<sup>2</sup> or 5 percent of DA 11). Five rivers (Kupa, Korana, Dobra, Mrežnica, and Glina) and six torrential watercourses (Kupčina, Munjava, Radonja, Dretulja, Utinja, and Lička Jasenica) flow through DA 11. Additionally, 320 watercourses of the second order, including Reka, Volavčica, Okićnica, Vrnjika, Kuplenski potok, Tounjčica, Malunjčica, Stojnica, Jasenački potok, Znanovit-Brebernica, and Jaševica, all flow through DA 11. The length of the embankments constructed on the waters of the first and second order in DA 11 is 73.26 km. The county has one pumping station.

**Flood defense in Krapina-Zagorje County is implemented in DA 12, which includes the towns of Donja Stubica, Klanjec, Krapina, Oroslavlje, Pregrada, Zabok, and Zlatar and 25 municipalities, with approximately 133,000 inhabitants.** DA 12 runs through Krapina-Zagorje County territory for 1,224 km<sup>2</sup> as well as Zagreb County. In Krapina-Zagorje County, there are no embankments built on the watercourses of the first and second order. The main flood defense structure is the Burnjak flood retention basin (with a volume of

1,800,000 m<sup>3</sup>), which regulates the water waves of the Burnjak stream, a tributary of the Topličina watercourse.

**Flood defense in Zagreb County is carried out in seven DAs (DAs 7, 8, 9, 11, 12, 13, and 14).** The total length of the embankments constructed on the watercourses of the first and second order is 407.18 km. The county has 12 pumping stations.

**Flood defense in the City of Zagreb is carried out in DA 14, which covers 641.36 km<sup>2</sup>.** The main watercourse on which the flood defense measures are implemented is the Sava River. The total length of the embankments built in the City of Zagreb is 82.15 km.

### Effects of the Disaster (Damage and Losses)

Damage to regulation and protection water facilities (flood defense facilities) were recorded only in Sisak-Moslavina County. In DA 10, in Sisak-Moslavina County, there were 11,250 m of partially damaged embankments (publicly owned) and no pumping stations. The earthquake caused significant damage to the regulation and protection water facilities. Of the total estimated damage and losses of EUR 24.8 million, EUR 2.8 million relates to emergency interventions to establish temporary flood defense systems at the sites of damaged embankments that were no longer functional, EUR 21 million relates to direct damage to the embankments, and EUR 1 million refers to additional losses incurred during the execu-

**Table 86.** Total damage and losses in the flood protection sector (EUR, millions)

Administrative unit	Damage	Losses
Sisak-Moslavina County	23.8	1.00

Source: Estimations by the assessment team using official information.

tion of emergency interventions (Table 86). Apart from the establishment of the second line of flood defense, emergency interventions also include the establishment of necessary access roads. The material for these was provided from reserves intended for active flood defense. The costs incurred during emergency interventions will include the costs of removing the second line of flood defense after the planned repair of damage to the embankments.

**Significant embankment damage occurred** in the left Sava embankment (at D.10.3., D.10.4.), the right Kupa embankment (D.10.37., D.10.38.), the left Kupa embankment (D.10.31.), the Lonja-Strug flood relief channel right embankment (D.10.16), the Eastern embankment of Letovanić fish pond (D.10.33.), the left Petrinjčica embankment (D.10.46.), the right Glina river embankment (D.10.38), and the left Sunja river embankment (D.10.25.). A detailed assessment of the damage to specific sections of the embankments was also conducted.

**Emergency flood defense measures were declared on December 30, 2020, for Sisak-Moslavina County because of detected damage to regulation and protection**

**water facilities in the area of the Banovina small river basin.** Hrvatske vode immediately started with emergency repairs of critical damage to the embankments. Emergency interventions will ensure the continued functioning of the flood defense system until a planned rehabilitation of the damage to embankments is conducted. During emergency interventions involving the execution of access roads and establishment of the second line of defense, material intended for active flood defense was used, including geotextiles, geo-grids, jumbo bags, sand-filled bags, backfill fine-grained stone material, crushed stone, nylon, and box barriers. This resulted in the additional costs of materials used for executing access roads and costs of materials used to establish the second flood defense line.

**Emergency interventions related to the reestablishment of a functional flood defense system and rehabilitation of damaged regulation and protection water facilities require additional involvement by governance structures and employees as well as additional funds from entities other than Hrvatske vode, such as Vodoprivreda Sisak d.d. in Sisak and the competent ministry.** Still, due to sufficient human and material resources and



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good organization, the functioning of the flood defense system was not jeopardized. Considering that Hrvatske vode is responsible for flood protection measures and that there was no damage in the City of Zagreb and in counties other than Sisak-Moslavina that would negatively affect governance structures and social processes in the water sector, the ability of these governance structures to conduct reconstruction and reestablish sector functionality is not in question.

## **Disaster Impacts on the Affected Population**

**Since the earthquakes caused dike damage, emergency steps were taken to establish the second line of flood defense as a temporary measure in all the locations where the damage was noticed.** Establishing the second line of flood defense includes the installation of box barriers as well as supporting activities such as the construction of access roads in critical locations. Taking emergency action is needed to prevent a damaging flood event or a new large-scale disaster if water levels rise in the rivers in the earthquake-hit area. By establishing a temporary flood defense system, continuous protection of the human health and property from floods is ensured. This inhibits the earthquake's negative impact on the water sector's ability to properly function.

**In Sisak-Moslavina County, there is a risk that aftershocks or high-water levels will reveal new dike damage which was not identified through visual inspection and surveys.** For that reason, all available human and material resources of the Sector for Protection from Adverse Effects of Water are continuously deployed to timely detect and repair the damage. The damage identified so far is not significant enough to substantially disrupt the plans for the improvement of the flood defense system in this area, but all the critical locations (14) will have to be permanently repaired/reconstructed as soon as possible.

## **Reconstruction and Recovery Needs**

**The recovery and reconstruction needs relate to Sisak-Moslavina County, as it was the most severely hit.** To protect the water sector from suffering prolonged

adverse effects in the aftermath of the earthquake, the county's short-term needs include the establishment of a temporary flood defense system in locations where embankments were damaged. The second flood defense line consists of temporary embankments built using box barriers and access roads in the following 13 locations: (a) Brest Bridge together with the right embankment of the Kupa River upstream from the Petrinjica estuary, (b) Palanjek, (c) Galdovo, (d) Petrinja 1 (Petrinjčica estuary-Krnjica, Krnjica, Nova Drenčina), (e) Stara Drenčina 1, (f) Tišina Erdedska, (g) Hrastelnica, (h) embankment of Lonjsko polje retention basin near Mahovo pumping station, (i) Stara Drenčina 2, (j) Letovanić fishpond, (k) Petrinja 3 (Petrinjčica left embankment), (l) Glina, and (m) Sunja. Once the damaged flood defense structures are fully rehabilitated, these constructed second flood defense lines will have to be removed. The construction of access roads, the construction of the second flood defense line, and its removal will cost approximately EUR 3.8 million.

**This should be followed by geo-mechanical investigations, geodetic surveying, and the preparation of projects related to the maintenance of damaged embankment sections.** Works, estimated at EUR 21 million, will be carried out based on this maintenance project. The embankments on the damaged sections have to be rehabilitated in accordance with civil engineering rules and Croatian legislation; the rehabilitation needs to ensure that the damaged sections are functional and safe and that they meet all the necessary requirements during their design life. Reconstruction activities are carried out by Hrvatske vode, which hires contractors and service providers through public procurement procedures. The works are expected to be carried out from the beginning of 2021 until September 2022.

**Medium- and long-term needs focus on upgrading water regulation and protection facilities.** From 2023 to 2024, construction, reconstruction, and upgrading of water regulation and protection structures including embankments, revetments, artificial river channels, dams, flood gates, flood retention basins, and pumping stations are planned with the estimated value of EUR 20 million. From 2025 to 2026, another EUR 20 million is planned for water regulation and protection facilities projects. Possible financing sources include national funds, EU funds, and loans. The planned projects are in accordance with both the existing and

**Table 87.** Total reconstruction needs in the flood protection sector in the short, medium, and long term (EUR, millions)

Sisak-Moslavina County	Short	Medium	Long	Total
<b>Reconstruction</b>	24.8	20	24	68.8

Source: Estimations by the assessment team using official information.

the upcoming Multi-Annual Program of Constructing Water Regulation and Protection Facilities and Amelioration Facilities. The program includes individual projects for water regulation and protection facilities and amelioration facilities, implementation methods and time frames, actors, investment amounts, and prioritization criteria (where applicable). Table 87 shows the total cost of reconstruction needs in Sisak-Moslavina County, amounting to EUR 68.8 million, over the five-year recovery period.

**Going forward, the level of protection against the adverse effects of water in Croatia needs to be improved.** Frequent floods occurring in the last decade have significantly increased the flood risk in many areas of Croatia. In the future, the situation might worsen due to the observed unfavorable hydrological trends caused by global climate change. Such changes have led to Croatia recording extremely high precipitation volumes, often in short periods, resulting in extreme water levels. Water management systematically makes priority investments related to protecting insufficiently prepared cities and settlements from floods. Floods are a natural phenomenon that cannot be avoided, but by taking various preventive structural and nonstructural measures, flood risks can be reduced.

**Floods are one of the most dangerous natural disasters and can cause loss of human lives, material damage, the devastation of cultural property, and environmental damage.** Although the intensive construction of protection systems, especially in the second half of the twentieth century, significantly reduced the risk of flooding, recent experience shows that floods can occur unexpectedly, water levels can be higher than expected, and they can last for longer than water systems can handle. To tackle these extreme hydrological conditions, it is necessary to carry out the much-needed reconstructions and upgrades of the system to reduce flood risks to a minimum.

## PUBLIC ADMINISTRATION AND COMMUNITY INFRASTRUCTURE

### Sector Overview and Baseline Data

**This sector includes public administration at the national, regional, and local levels; the judiciary, land administration, and cadaster; and sports infrastructure and other public buildings relevant to the local community.** The state administration system's purpose is to ensure the legal, efficient, and effective performance of the state administration's tasks, guided, and supervised by the Government of Croatia. The state administration's tasks are performed to allow citizens to exercise their Constitutional rights and their interests, protected by law. State administration bodies, ministries, and public administrative organizations are established for performing these tasks. The state administration system coordinates services and synchronizes the function of state offices. The different sections of the state administration can be organized, based on their main features, into public administration, judiciary, education, science and technology, culture, health care, social welfare, sports, citizens' associations, political parties, religious communities, and other organizations. The system includes ministries, directorates, institutes, specialized offices, and other public administration offices. Certain state administration tasks are entrusted to local and regional self-government units (LRSGUs) depending on the nature of the tasks and interest of citizens.

**The country's territorial organization is determined by the Act on the Territories of Counties, Towns, and Municipalities in Croatia.** Counties are units of regional self-government, and municipalities and cities are units of LSGUs. Their territory is determined by law. Croatia's territory comprises 576 LRSGUs. Among these, there are 20 counties (regional self-government units), the City of Zagreb, with the status of a county, and 128 towns and 427 municipalities (LSGUs). Overall, there were 6,773 settlements in Croatia as of August 2017.<sup>55</sup> The system of central settlements is vital to en-

55 Pursuant to the data of the Register of Territorial Units held by the State Geodetic Administration (SGA).

**Table 88.** The number of towns, municipalities, and settlements in Croatia and in the affected area

Administrative unit	City	Municipality	Settlement
Sisak-Moslavina County	7	12	453
Zagreb County	9	25	694
Karlovac County	5	17	649
City of Zagreb	1		70
Krapina-Zagorje County	7	25	423
<b>Total</b>	<b>29</b>	<b>79</b>	<b>2219</b>
<b>National figure</b>	<b>128</b>	<b>427</b>	<b>6,773</b>
Percentage (out of national figure)	22	18	33

Source: SGA.

ensuring the availability of services to be provided to the population. Maintaining their social infrastructure network directly affects the stability of population density and the spatial homogeneity; it is a prerequisite for the economic and social development of an area. The uneven regional development is a consequence of a combination of natural, geographical, and historical condition and, more recently, of unfavorable demographic trends.

**The area for which a state of disaster was declared includes 21 towns and cities, 54 municipalities, and 1,796 settlements.** These account for 16 percent of all towns and cities, 12 percent of municipalities, and 26 percent of settlements in Croatia. The entire affected area includes 29 towns and cities (22 percent), 79 municipalities (18 percent), and 2,219 settlements (33 percent of settlements in Croatia) (Table 88).

### **Effects of the Disaster (Damage and Losses)**

**Due to the earthquake, a total of 324 buildings with a total surface area of 440.358 m<sup>2</sup> used by the state administration bodies and other institutions in this sector were damaged (Table 89).** Out of those damaged buildings, 222 (364,566 m<sup>2</sup>) are in Sisak-Moslavina County, 25 (24,560m<sup>2</sup>) in Zagreb County, 76 (50,772m<sup>2</sup>) in Karlovac County, and 1 (460 m<sup>2</sup>) in the City of Zagreb. Krapina-Zagorje County did not suffer progressive damage from this earthquake in this sector. Among the damaged buildings, six are classified as cultural heritage (6,443 m<sup>2</sup>).



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**Table 89.** Number and surface area of damaged public administration and community buildings by county and type of institution

Type of institutions	Total affected buildings	Total surface area	Level of damage	Sisak-Moslavina County	Zagreb County	Karlovac County	City of Zagreb	Krapina-Zagorje County
State bodies and organizations, local and regional self-government bodies and organizations, local committees, tax administration	161	115,816		45	5	40	0	0
				27	2	5	0	0
				31	0	6	0	0
Sports infrastructure	40	84,911		18	1	7	0	0
				11	0	0	0	0
				2	1	0	0	0
Courts, penal institutions, cadaster offices	26	21,817		4	2	1	1	0
				6	1	1	0	0
				10	0	0	0	0
Institutions and infrastructure important to the local community	97	217,813		34	10	12	0	0
				14	2	4	0	0
				20	1	0	0	0
<b>Total</b>	<b>324</b>	<b>440,358</b>		<b>222</b>	<b>25</b>	<b>76</b>	<b>1</b>	<b>0</b>

Source: Estimations by the assessment team using official information.

### STATE ADMINISTRATION BODIES AND LOCAL AND REGIONAL SELF-GOVERNMENT BODIES AND ORGANIZATIONS

The assessment established that 161 public purpose properties with a surface area of 115,816 m<sup>2</sup> were damaged, with 37 suffering heavy damage, 34 moderate damage, and 90 slight damage. The estimated total damage equals EUR 80.181 million. Additionally, losses amount to EUR 4.925 million. Institutions were left without the equipment and access to basic resources required for their proper functioning; however, they continued to function in substitute premises and mobile offices, performing their core activities under these new circumstances. These affected institutions include local administration offices, tax administration offices, registry offices, and other institutions.

### SPORTS INFRASTRUCTURE

Regarding outdoor and indoor sports grounds with bleachers and accompanying buildings, 40 properties, with a total surface area of 84,911 m<sup>2</sup>, were damaged in the Sisak-Moslavina, Karlovac, and Zagreb Counties. Out of these, 3 (1,420 m<sup>2</sup>) suffered heavy damage (red), 11 (3,123 m<sup>2</sup>) moderate damage (yellow), and 26 (80,368 m<sup>2</sup>) slight damage (green). The total costs incurred amount to EUR 20.685

million. Additionally, losses amount to EUR 674,818.

In Sisak-Moslavina County, sport clubs in the city of Petrinja presently do not have a single sports facility where they could carry out their activities, while in the city of Sisak, there are far too few time slots available in sports facilities where it is still possible to practice sport. The facilities that are still usable were opened to provide shelter after the earthquake for the affected population and to collect, store, and prepare the received aid for distribution to the affected areas, which caused additional damage (to lavatories, floors, and so on). Moreover, the city of Karlovac lacks adequate sports infrastructure and numerous risks associated with the existing infrastructure, especially those concerning safety, quality, and resilience to earthquakes. This is especially the case in the existing sports halls damaged in the earthquake, which, although usable, face significant risks of further damage due to aftershocks and pose safety risks for users.

### COURTS, PENAL INSTITUTIONS, AND CADASTER OFFICES

Within the affected areas, Croatia owns various courts and penal institutions, including the County Court in Sisak; the Municipal Court in Sisak with permanent offices in Petrinja, Glina, and Hrvatska Kostajnica; and the Mu-

municipal Court in Novi Zagreb with the permanent office in Zaprešić; the Probation Office in Sisak; the prisons in Sisak and Karlovac; the Penal Institution in Glina; and the Commercial Court in Zagreb. These properties cover a total surface area of 13,000 m<sup>2</sup>. Out of these, 17 were significantly damaged (accounting for 85 percent of the total properties), and most of these buildings (around 52 percent) were deemed unusable.

The penitentiary in Glina suffered significant damage, with five of its buildings being deemed unusable (red), including the Dormitory building that was recommended for demolition. The Sisak prison was closed altogether. Additional costs were incurred, tied to the transfer of prisoners to other prisons in the country (82 inmates were relocated from Glina and 48 from Sisak). A total of EUR 13,854 was spent on inmate relocation due to the earthquake. Further, to avoid potential riots in the damaged prisons, additional judicial police officers were sent to Glina immediately after the earthquake.

Judges and clerks have been alternating between working from home and at the court due to a lack of temporary space.<sup>56</sup> The County Court and Municipal Court in Sisak never ceased operations, although some relocation efforts had to be made. Although some time was invested on clearing the buildings and the limited space has caused backlogs, these will not result in significant costs long term. Permanent offices in Petrinja of the Municipal Court of Sisak are not in use because of damage and will need to be secured and reinforced as the building of the court is cultural heritage, while the other permanent addresses were deemed to be in good condition.

The earthquake caused significant damage to the business premises used by the SGA such as cadaster offices in Sisak, Petrinja, Glina, Hrvatska Kostajnica, Zaprešić, Donja Stubica, and Zagreb. Around 10 cadaster offices, land registry offices, and related premises in the affected counties were deemed temporarily or permanently unusable. The cadaster offices in Glina and Sisak were moved to new locations due to the damage they suffered, generating additional costs. None of the employees of the SGA or land registry offices, which are located in the court premises, were seriously injured, but affected staff were moved to nearby offices

<sup>56</sup> Judges and lawyers reported that they encountered technical difficulties during the past few months given that the e-communication portal was frequently disrupted and because of the lack of adequate equipment which prevented them from working from home.

where possible or are following ‘working from home’ orders. Many land administration services were transferred online (e-services), so the impact on land administration services may not be too severe.

Overall, with respect to the business premises of courts, penal institutions, and cadaster offices, a total of 26 properties with a surface area of 21,817 m<sup>2</sup> were damaged, 10 of which suffered heavy damage, 8 suffered moderate damage, and 8 suffered slight damage. The estimated total damage amounts to EUR 22.575 million. Additionally, losses amount to EUR 1.542 million.

### INSTITUTIONS AND INFRASTRUCTURE IMPORTANT TO THE LOCAL COMMUNITY

Markets, local offices, sports clubs, associations, public tourism infrastructure, morgues, cemeteries, landfills, recycling centers, and other municipal business and warehouse premises were damaged. Out of the total of 97 properties evaluated, 21 were deemed heavily damaged, 20 were moderately damaged, and 41 required im-

**Table 90.** Total damage and losses in public administration and community infrastructure by county (EUR, millions)

Administrative unit	Damage	Losses
Sisak-Moslavina County	131.70	7.97
Zagreb County	9.63	0.35
Karlovac County	16.87	0.81
Krapina-Zagorje County	0.00	0.00
City of Zagreb	0.30	0.00
<b>Total</b>	<b>158.51</b>	<b>9.13</b>

Source: Estimations by the assessment team using official information.

**Table 91.** Total damage and losses in public administration and community infrastructure by subsector (EUR, millions)

Subsector	Damage	Losses
State administration buildings	80.18	4.93
Sports infrastructure	20.69	0.67
Courts, penal institutions, cadastre offices	22.57	1.54
Institutions and infrastructure important to the local community	35.07	1.98
<b>Total</b>	<b>158.51</b>	<b>9.13</b>

Source: Estimations by the assessment team using official information.

mediate repairs. Also, this damage includes damage to monuments in 15 local cemeteries. The total cost of the damaged 217,813 m<sup>2</sup> equals EUR 35.066 million, out of which 49,274 m<sup>2</sup> refers to damage to buildings and 168,538.32 m<sup>2</sup> to damage to monuments in cemeteries. Additionally, losses amount to EUR 1.984 million.

**Overall, the total damage suffered by the state administration bodies, judicial bodies, cadaster offices, sports facilities and institutions, and infrastructure important to the local community amounts to EUR 158.507 million.**

A total of 56,331 m<sup>2</sup> of state and local institutions were heavily damaged (red), while 384,027 m<sup>2</sup> (yellow and green) require remediation due to slight or moderate damage. Within the overall damage to this sector, the damage to cultural heritage buildings and other sector-related institutions amounts to EUR 8.362 million. Certain losses were also recorded, which include the demolition of collapsed buildings (EUR 6.389 million), removal of construction debris (EUR 2.527 million), and preventive infrastructure on cultural heritage buildings (EUR 210,206). This sector includes only public assets.

## **Disaster Impact on the Affected Population**

**The regional and local government institutions and offices, which provide essential services for the local community, were severely affected by the earthquake.**

Many city and municipality offices, courts, cadaster, tax offices, and other locally relevant institutions were left without their premises and basic resources. Prison facilities which were damaged needed to ensure that inmates were relocated to other facilities across Croatia to prevent potential threats to security. Judges and clerks, as well as cadaster employees, switched to working from home when possible. The cadaster offices were moved to new locations so that access for citizens to cadaster was promptly restored. Many services have been transferred online.

**Efforts were made by the state administration to limit the administrative burden placed on the affected population.** Donations were exempt from enforcement. Similarly, enforcement debtors were allowed to request a postponement of the enforcement. Additionally, to alleviate and recompense the civil servant and public officials in the areas affected by the earthquake who had

to work overtime, the government granted them 10 days of paid leave. To that end, additional help was sent to the affected towns, including Glina, to support the employees in the form of legal assistance and support in discussions on damage and reconstruction.

Since February 22, 2021, five field offices and two mobile teams from MoPPCSA have been operating in the affected area with the aim of helping citizens fill out reconstruction applications and deal with other issues of administrative nature. State bodies and organizations continued to work in temporary premises and mobile offices, trying to ensure the proper functioning of their core activities under new circumstances.

## **Reconstruction and Recovery Needs**

**Community management activities, as a function of the state administration, usually take place through state bodies and organizations and local and regional self-government bodies and organizations.** These bodies and organizations are responsible for ensuring that an emergency system for the provision of housing, rehabilitation, and reconstruction is established in the aftermath of a disaster. To ensure that the population will remain in the affected areas in the long term while rehabilitating the affected zones, it is essential that institutions and infrastructures that cater to the key needs of the local community are functioning and are in good condition. The area in question comprises approximately 1,800 of the most vulnerable settlements, making this issue even more challenging. Due to the variation among settlements, reconstruction should be approached on a case-by-case basis and with the active participation of all entities within the state administration system.

**Several cadaster and land registry offices will require repairs and reconstruction.** Land registry offices are usually housed within the courts' buildings, so repairs and reconstruction efforts for these buildings are under the jurisdiction (and budget) of the relevant ministry or local authorities. For the cadaster offices, there is a similar situation for most buildings; however, the SGA is responsible for the Glina Scan Center and Scan Depo. Repair and reconstruction needs are being identified for the SGA Scanning Center, Scan Depo in Glina, and Cadaster Office Sisak. Until full rehabilitation has been

completed, state administration bodies will need to continue their work in the substitute premises and mobile offices. This temporary setup should still enable the full functioning of the core activities for the population.

**The recovery process of justice-related infrastructure and the restoration of its services in the affected area will need to consider a national plan for building a stable and resilient IT infrastructure.** In addition, the recovery of justice-related infrastructure will need to consider new design standards for court facilities that are more in line with the Council of Europe (COE) recommendations and best practices. The existing electronic case management system ('eSpis') is a good starting point for further digitalization and modernization of the justice system. Certain challenges in maintaining and developing a digital database in the justice system will be resolved with the Government Service Bus (GBS)—that is, the Shared Services Center (CDU), the government's 'cloud' IT infrastructure—which is expected to standardize all its digital services, better connect various databases, centralize the information and communication technology (ICT) system, and increase the safety of data. All judicial system applications will need to be integrated into the CDU. Also, the existing network infrastructure used for home-based work will need to be strengthened, and the speed and connectivity of digital services in all areas where judicial services are offered will need to be

improved. These advances in the digitalization are expected to speed up court procedures and create adequate preconditions for online court hearings.

**Accessibility to sports facilities is an important factor that determines the quality of life and general welfare of the population, especially in terms of health improvement, disease prevention, and social inclusion.** It is important to recognize the connection between sport and other areas such as education as well as its contribution to tourism and local economic development. The 2030 National Development Strategy also promotes health and active lifestyle in all age groups, especially the young, through sports and recreation, as well as the improvement of sports and recreational infrastructure quality and accessibility. In addition, the 2019–2026 National Sports Program highlights sports facilities as an important precondition for any sport activity. One of the program's objectives focuses on ensuring that there is an adequate number of sports premises and the related equipment to meet the social and sports needs of a given community. Regarding the need for reconstruction and recovery in the sports sector, it is important to consider its broad social impact alongside the needs of the local population (and local sports communities). The planning of sports infrastructure reconstruction should be coordinated and comprehensive. To ensure that the actual sports needs of local communities are met, it is



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necessary to increase the accessibility of sports structures and enable a systematic improvement of sports infrastructure in the earthquake-affected area, including construction, reconstruction, equipment, maintenance and safety aspects.

**Overall, as seen in Table 92, reconstruction and recovery needs amount to EUR 320 million over a five-year period for all the affected counties and subcategories within this sector.** Recovery interventions include the following activities (see Table 92 for more information):

- Relocation of unusable public administration offices to alternative premises and/or mobile units to enable smooth provision of public services, with ensured access for persons with disabilities.
- Removal, transport, and recycling of construction waste from unusable buildings.
- Reconstruction of business premises, offices, sports

facilities, and buildings categorized as usable,

- Reconstruction of business premises, offices, sports facilities and buildings categorized as temporarily unusable and construction of replacement buildings (in case of unusable buildings), using sustainable and environment-friendly materials in accordance with BBB and EE principles, considering circular economy, climate change, and earthquake resilience.
- Conducting an expert spatial analysis which combines sectoral analyses such as engineering, geological, geotechnical, geophysical, and hydrogeological research, conservation studies, analysis of buildings, existing spatial plans and their implementation, existing infrastructure, social and economic analyses; and so on). These expert analyses would further inform land use planning and amendments to spatial plans in the affected area considering the zones newly susceptible to liquefaction, landslides, and sinkholes, as well

**Table 92.** Total reconstruction and recovery needs for public administration and community infrastructure in the short, medium, and long term (EUR, millions)

Reconstruction and recovery	Short	Medium	Long	Total
Removal, transport and recycling of construction waste from unusable buildings	7.30	1.83	0.00	<b>9.13</b>
Reconstruction of business premises, offices, sports facilities and buildings categorized as usable	24.18	56.43	0.00	<b>80.61</b>
Reconstruction of business premises, offices, sports facilities and buildings categorized as temporarily unusable	7.57	22.71	7.57	<b>37.86</b>
Construction of replacement buildings (in case of unusable buildings)	10.66	63.93	31.97	<b>106.56</b>
<b>Reconstruction subtotal</b>	<b>49.71</b>	<b>144.90</b>	<b>39.54</b>	<b>234.15</b>
Development of an expert multi-sectoral spatial analysis for land use planning and drafting of amendments to spatial plans in the affected area	0.00	1.33	0.00	<b>1.33</b>
Drafting amendments to county spatial plans and spatial plans for municipalities/cities and more detailed plans	0.00	7.27	4.84	<b>12.11</b>
Design and construction of new national, regional and local government buildings, using sustainable and eco-friendly materials, taking into consideration circular economy, climate change and earthquake resilience	0.29	0.86	0.29	<b>1.44</b>
Construction of infrastructure, accompanying buildings and other facilities related to national, regional and local government in accordance with the new spatial plans (in relocated areas)	0.00	20.00	20.00	<b>40.00</b>
Temporary multipurpose sports facilities	0.40	0.00	0.00	<b>0.40</b>
Long-term comprehensive solutions related to sports facilities in Petrinja, Sisak and Karlovac (multi-purpose sports centers)	0.00	0.00	29.10	<b>29.10</b>
Local sports programs related to long-term comprehensive solutions in sports (annual costs of sports programs for the three centers with 10 programs per center)	0.00	0.00	1.20	<b>1.20</b>
<b>Recovery subtotal</b>	<b>0.68</b>	<b>29.47</b>	<b>55.43</b>	<b>85.58</b>
<b>Total</b>	<b>50.40</b>	<b>174.37</b>	<b>94.97</b>	<b>319.73</b>

Source: Estimations by the assessment team using official information.



as the existing landslides, cover-collapse sinkholes, liquefaction instances and other threats/geohazards.

- Based on the results of the expert multi-sectoral spatial analysis, a competent national authority will provide guidelines for the development of a new generation of spatial plans considering the results of sectoral analyses and development needs of the earthquake-affected area.
- Drafting of amendments to county spatial plans and spatial plans for municipalities/cities and more detailed plans.
- Design and construction of new national, regional, and local government and self-government buildings, with the use of sustainable and environment-friendly materials, considering circular economy, climate change and earthquake resilience.
- Construction of infrastructure, accompanying buildings and other facilities related to national, regional, and local government in accordance with the new spatial plans (in relocated areas).
- Establishment of seismic risk certification system for buildings in legislation related to construction.
- Ensuring temporary multisport facilities for the local population, especially children and young people, as a short-term measure (an example of such intervention is a temporary tent for the Gymnastics Club Petrinja and a tent for table tennis and karate organized as a part of the “Friends in Action” program implemented by the Croatian Olympic Committee and the Union of Sports Associations and Federations in Sisak-Moslavina County).
- Finding comprehensive long-term solutions for sports facilities is necessary because only a small share of them can be rehabilitated completely and quickly due to the extent of damage, threats posed by adjacent severely damaged buildings, the fact that they are housed in cultural heritage buildings, or simply because many do not meet the regulations, standards, and norms of international sports federations for individual sports or groups of sports. A proposed solution includes building new multi-functional sports centers with swimming pools in Petrinja, Sisak, and Karlovac which would meet the needs of professional athletes, but also schools, universities, and the local community, as well as open doors to national and international competitions and the promotion of new sports in the community.
- Introducing local sports programs alongside new

sports infrastructure which would create new jobs for professionals and other staff (the average annual cost of implementing a sports program in a sports and recreation center with a swimming pool amounts to approximately EUR 40 thousand).

- Investment in public tourist infrastructure, including visitors’ centers, thematic routes, and so on, to increase the popularity of tourist sites in the disaster-affected area (around 50 such investments).

## WASTE MANAGEMENT

### *Sector Overview and Baseline Data*

**The total annual amount of waste (industrial and municipal) in Croatia is estimated to be approximately 5.5 million tons.** Hazardous waste accounts for 3 percent (175,000 tons) of the total amount of generated waste. The largest producers of waste in Croatia are households and the construction sector; together, they generate 46 percent of the total annual amount of waste in Croatia. The average Croatian citizen generates 444 kg of municipal waste (1,811,617 tons) (2019), which ranks Croatia among the countries with the lowest waste generation in the EU (the EU average was 502 kg per capita in 2019). The recycling rate for municipal waste accounts for 30 percent, while the most common municipal waste treatment process is landfilling. The total annual amount of waste generated in the affected areas in 2019 was 2,073,604 tons, of which 72 percent can be attributed to industrial waste (1,496,491 tons) and 28 percent to municipal waste (577,113 tons). Construction waste accounted for 523,821 tons.

**The services for the collection of municipal waste in the earthquake-affected areas are provided by 40 municipal waste companies.** All LSGUs are covered by organized collection, while population coverage ranges from 96 to 100 percent. Other than ‘door-to-door’ collection, municipal waste can also be disposed of in containers placed in public areas and recycling yards. Further, 68 recycling yards are available in the area. There are 17 active landfills for municipal waste and one landfill for industrial waste in the city of Kutina (a phosphogypsum landfill). No landfill for construction waste is within the area or easy reach; however, asbestos construction waste can be disposed of at two cassettes (one in Karlovac County and one in the

**Table 93.** Municipal waste management in the affected areas (2019)

Administrative unit	Produced municipal waste	No. of municipal waste companies	Population coverage with municipal waste collection (%)	Waste treatment	No. of active landfills	No. of recycling yards
<b>Sisak-Moslavina County</b>	43.811 t (28% of total produced waste)	12 - owned by LGUs	96	23% recovery, the rest disposed at landfills	5	13 (7 stationary, 6 mobile)
	254 kg of municipal waste citizen/year					
<b>Karlovac County</b>	43.612 t (37% of total produced waste)	11 - owned by LGUs; 2-private	98	20% recovery, the rest disposed at landfills	3	7 (5 stationary, 2 mobile)
	338 kg of municipal waste citizen/year					
<b>Krapina-Zagorje County</b>	31.362 t (22% of total produced waste)	6 - owned by LGUs 1-private	96	31% recovery, the rest disposed at landfills	4	11 (5 stationary, 6 mobile)
	236 kg of municipal waste citizen/year					
<b>Zagreb County</b>	98.161 t (27% of total produced waste)	7 - owned by LGUs 2-private	100	32% recovery, the rest disposed at landfills	5	14 (12 stationary, 2 mobile)
	309 kg of municipal waste citizen/year					
<b>City of Zagreb</b>	1.94	1 - owned by city	100	39% recovery, the rest disposed at landfills	1	23 (12 stationary, 11 mobile)
	1.94					

Source: MoESD.

**Table 94.** Overview of pre-disaster data on typical post-earthquake waste flows: annual generated waste (in tons) in the affected areas (2019)

Type of waste	Sisak-Moslavina County	Karlovac County	Krapina-Zagorje County	Zagreb County	City of Zagreb
<b>Mixed municipal waste</b>	29,880	29,753	18,866	55,914	200,924
<b>Construction waste</b>	36,995	27,477	22,592	112,939	323,818
<b>Asbestos waste<sup>a</sup></b>	124	444	320	1,244	641
<b>Bulky waste</b>	1,036	2,620	1,544	7,887	16,442
<b>End of life vehicles</b>	2,991	1,877	2,154	3,709	7,281
<b>Waste tires</b>	421	704	679	1,178	7,224
<b>Waste from electrical and electronic equipment</b>	206	395	1,228	2,378	19,208
<b>Textile waste</b>	51	360	2,338	369	1,286
<b>Hazardous waste</b>	6,639	2,229	18,485	20,016	12,005
<b>Medical waste</b>	88	114	147	195	2,762
<b>Carcasses of domestic animals</b>	1,334	2,881	1,142	33,291	15,357
<b>Total</b>	156,410	119,481	140,829	366,701	1,290,183

Source: MoESD and EPEEF.

Note: a. Average amount for 2009–2015.

**Table 95.** Overview of waste treatment capacity in the affected areas (2019)

Waste treatment companies	Sisak-Moslavina County		Karlovac County		Krapina-Zagorje County		Zagreb County		City of Zagreb	
	No.	Capacity	No.	Capacity	No.	Capacity	No.	Capacity	No.	Capacity
Active landfills (remaining capacity in tonnes) <sup>a</sup>	5	10,843	3	103,416	4	85,955	5	2,043,961	1	1,295,000
Cassettes for asbestos waste (remaining capacity in m <sup>3</sup> )	0	0	1	5,792	0	0	0	0	1	6,000
Facilities for construction waste recycling (mineral construction waste crushers) (t/year)	0	0	2	250,800	2	210,000	1	80,000	2	301,000
Biogas plants (t/year)	0	0	0	0	0	0	2	72,500	2	27,033
Composting plants (t/year) <sup>a</sup>	2	29,700	0	0	0	0	1	27,300	3	47,000
Treatment facilities for sterilization of medical waste (t/year)	2	3,504	0	0	3	125	0	0	1	2,544
Rendering plants (t/day)	0	0	0	0	0	0	0	0	1	10

Source: MoESD.

Note: a. Data 2020.

City of Zagreb, approximately 100 km and 60 km respectively). The LSGUs are responsible for municipal waste management and they often establish utility companies (only two private utility companies operate in the earthquake-damaged area). The management of landfills is also the responsibility of LSGUs. The management of special categories of waste is to a large extent organized by the Environmental Protection and Energy Efficiency Fund (EPEEF) and is a responsibility of the waste producer.

## Effects of the Disaster (Damage and Losses)

**Waste utility companies in many cases share the premises with water and sanitation utility companies, and to avoid overlap, damage to infrastructure was calculated as part of the damage for the water sector.** Across all the affected areas, increased waste generation is expected, and thus an increase in the costs required for adequate and efficient waste collection and treatment is also expected. As a result, the risks of negative environmental impacts in case of inadequate waste management is likely to also increase. Table 96 presents an overview of debris removal costs across all sectors. To avoid overlapping,

these costs are calculated in the overall damage and loss estimates in the respective sectors. However, the data are presented in this chapter to illustrate the significance of amount of debris that has been accumulated as a result of the earthquakes' damage. When also considering all other waste types and streams that are likely to occur in the affected areas due to earthquake, it is expected that these costs will be even higher.

**It is to be expected that the largest amounts of waste—primarily construction waste (including asbestos roofing sheets), bulky waste, and mixed municipal waste—will be generated in Sisak-Moslavina County, where the largest earthquake damage was registered.** Additionally, the management of waste textiles has become a problem in Sisak-Moslavina County. Textile donated as humanitarian aid has been temporarily stored at various locations in the county. Preliminary analyses conducted by the State Inspectorate of Croatia, in coordination with the EPEEF, indicate that the quantities of textiles received from humanitarian aid significantly exceed the needs of the county. After the textiles are sorted, it is very likely that part of the textiles will become textile waste (mostly due to storage in inappropriate conditions as well as the condition of

donated textiles). Initial data gathered for 14 locations in the cities of Sisak, Petrinja, Glina, and Gvozd show that about 7,175.00 m<sup>3</sup> of unsorted textiles have been temporarily stored at these locations. The remaining locations and stored quantities are yet to be determined. Besides textile waste, an increased amount of packaging waste from the operations established for urgent assistance to the population (for example, kitchens for the preparation of meals) had been recorded. It is to be expected that increased quantities of electronic and electric waste will be generated during the post-earthquake recovery and reconstruction process (during clearing), although according to available data no significant increase has yet been recorded. At this point, larger amounts of industrial wastes are not likely to occur; however, removal and disposal of industrial chimneys will be a complex and demanding process that yet needs to be elaborated (including conducting waste composition analysis) as industrial chimneys may contain hazardous waste; eleven chimneys were reported as damaged and need to be removed in the near future for community safety reasons.

**In terms of losses, the increase in waste generation due to earthquake and post-earthquake recovery and reconstruction process in the damaged areas—in terms of waste collection, storage, and waste treatment ca-**

**capacity—is critical for Sisak-Moslavina County.** Though large clearing and construction interventions are yet to be expected, in organizational terms, municipal waste companies have already experienced increased operating and investment costs. Among other reasons, as a result of

- Overtime charges due to the increased workload, employment of additional workforce, and the increased cost of temporary workers (for example, just for the sorting of textiles, the utility company *Gospodarenje otpadom Sisak d.o.o.* had to temporarily employ 30 employees).
- Loss of income from January to March (as a result of users billing exemptions in some cities and municipalities as a post-earthquake measure, the inability to charge due to damage and temporary displacement of users, an so on).
- Increased transport fuel consumption and overall higher operational costs due to larger quantities of waste being generated and managed.
- Additional costs for repairing earthquake-damaged equipment.
- Ensuring of a sufficient number and the appropriate type of new equipment, which is necessary to manage the increased quantities of waste (vehicles, waste containers, protective work equipment). To serve the immediate needs, additional equipment was borrowed from other parts of Croatia short af-

**Table 96.** Overview of debris removal costs across all affected sectors (EUR, millions)

Sector	Sisak - Moslavina County	Karlovac County	Zagreb County	Krapina-Zagorje County	City of Zagreb	Total
Housing	91.69	4.62	7.89	1.20	0.55	105.95
Health	15.30	0.28	0.24	0.28	1.35	17.45
Education	3.19	0.48	0.78	0.53	0.92	5.90
Social protection	1.35	0.06	0.10	0.01	0.00	1.52
Culture and cultural heritage	2.99	0.55	1.05	0.31	1.46	6.37
Business	11.20	5.37	0.38	0.50	0.53	17.98
Agriculture	2.63	0.21	0.25	0.00	0.00	3.09
Transport and communications	1.73	0.06	0.03	0.04	0.04	1.90
Water and flood protection	0.20	0.00	0.00	0.00	0.00	0.20
Public administration and community infrastructure	7.97	0.81	0.35	0.00	0.00	9.13
DRR and civil protection	0.31	0.07	0.00	0.01	0.00	0.39
<b>Total</b>	<b>138.55</b>	<b>12.51</b>	<b>11.05</b>	<b>2.89</b>	<b>4.86</b>	<b>169.86</b>

Source: Assessment team using official information.



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ter the disaster. Some vehicles and equipment were also donated to utility companies operating in Sisak-Moslavina County. However, these intervention solutions are not sufficient to ensure efficient waste management in the long run, thus it is necessary to ensure the appropriate fleet and equipment.

In addition to the short-term increased investment and operating costs, utility companies are, in the long run, also facing risk of reduced revenues, mostly as a result of possible population emigration resulting in a smaller number of users of the municipal waste management services. Reportedly, negative trends in emigration have already started, however, their temporal scope is unknown.

### ***Disaster Impacts on the Affected Population***

**In Sisak-Moslavina County, a significant problem is the lack of adequate capacities for the storage and treatment of waste.** Although there are several private companies that have the capacity to take over earthquake-generated waste, additional infrastructure for storage and treatment will need to be provided for efficient and effective management of certain other types of waste. In Sisak-Moslavina County, five landfills are active; however, a number of these landfills do not have sufficient capacity to accept waste. For example, the city of Petrinja's landfill is expected to close in 2021, and the same is expected of the landfill in

the city of Sisak. Due to the limited dimensions of other landfills, it will be necessary to expand the existing capacities. In the same time, capacities for other phases in waste management such as separate collection, storage, recycling and disposal of construction and demolition waste is currently lacking (including but not limited to temporary storage facilities, crushers, separators, and so on) and also needs to be enhanced. Additionally, in Sisak-Moslavina County, there are no cassettes that accept asbestos waste while the first estimates for the cities of Sisak, Glina and Kutina show that approximately 191,583.50 m<sup>2</sup> of asbestos is still in use (predominantly asbestos roofing sheets). Though the exact quantities are yet to be determined, it is highly likely that the asbestos waste quantities generated during the recovery and reconstruction processes will be significant thus enlarging capacity for the processing of this type of waste, is necessary. Capacity shortages in recycling of plastic, not only in Sisak-Moslavina County, but on the national level, is another adverse risk that re-surfaced in the earthquake aftermath. This is especially so for plastics such as contaminated packaging waste and solid plastics from windows, furniture, and other products that showed to particularly problematic.

**A similar (capacity) problem exists in the treatment of medical waste.** While medical waste treatment capacities were previously found sufficient, due to COVID-19 outbreak in 2020, quantities of medical waste have increased exceeding the uptake levels of the processing system. Within the affected areas, only one hospital currently has the



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appropriate device for the sterilization of infective medical waste (capacity 85 tons per year).<sup>57</sup> As a rule, medical waste in Croatia is managed by private companies, which sterilize it and dispose of it in landfills or export it out of the country.

**With earthquake aftershocks and tremors, additional infrastructural damage and waste production cannot be ruled out.** On the service-user side, it is possible that waste collection services will be disrupted due to damage to access roads which can lead to further deterioration of environment, living conditions and possibly health of local population.

**Though the lack of treatment capacities was already evident in the affected area before the earthquake (especially in terms of construction waste, plastic, mixed municipal waste, and medical waste), it was further aggravated upon the disastrous events.** The main waste treatment process, both at the national level and in the affected areas, is reduced to waste disposal to landfills. This practice is not in line with the EU's waste management hierarchy that views landfilling as the least desirable waste treatment option whereas waste prevention, reuse, and recycling are considered the most desirable waste treatment options. To achieve compliance with the set EU requirements, Croatia plans to close all landfills that do not comply and establish waste management centers for municipal waste treatment (11 waste management centers in Croatia). However, there

have been various delays in executing these plans. Due to these delays, the available landfill capacities are quickly becoming insufficient. This has become particularly evident in the cities of Sisak and Petrinja.

Hazardous waste expected in the aftermath of earthquake include predominantly asbestos and household hazardous waste such as waste vehicles and machinery parts, electronic waste, oils, paints, contaminated packages, and so on. The lack of adequate capacities (especially for collection at source, lack of containers resulting in mixing of hazardous and non-hazardous types of wastes, and so on), along with general population's insufficient awareness of the (chain effect) negative environmental impacts and health risks from improper waste management, increase the risk of uncontrolled waste disposal (illegal dumping) and undesirable adverse impacts to human health and environment.

## **Reconstruction and Recovery Needs**

**The Croatian government has already taken first steps towards addressing the historical as well as earthquake-induced waste management issues.** On January 15, 2021, it adopted the 'Plan for the Implementation of Waste Management Measures After the Earthquake in Sisak-Moslavina County' previously prepared by the MoESD and EPEEF. Adequate budgetary actions followed the Plan; financial resources for emergency assistance, in the amount of EUR

<sup>57</sup> Opća bolnica Zabok (Zabok General Hospital).

6.6 million, were secured through the EPEEF. The implementation of measures will be monitored by the MoESD and the State Inspectorate of Croatia. The organizational capacities of the LSGUs have not been significantly impaired and they will therefore be able to lead the recovery process in the waste sector. Additionally, the support of the ministry, EPEEF and the State Inspectorate of Croatia will be of great importance to ensure the organization of waste management in the earthquake-affected areas.

**The short-term interventions** will focus on more detailed structural assessments of damaged waste management infrastructure, followed by the reconstruction of the damaged infrastructure (which will also continue also in the medium term). For Sisak-Moslavina County, in the short-term there are plans to employ additional labor force to sort textiles and other types of waste. This plan aims to reduce the quantities of waste that will be disposed of in landfills and to ensure, as much as possible, the reutilization and recycling of waste. Furthermore, it is necessary to ensure that adequate infrastructure is provided for the temporary storage of construction and bulky waste in the county.

**In the medium term, in Sisak-Moslavina County, it will be necessary to ensure that municipal waste management companies are able to technically and financially continue to function adequately.** This will be done by providing financial assistance to the utilities (local government units) to overcome the expected reduced revenues and increased costs generated by the earthquake (losses, exemptions from payment for services, and so on). In the medium term, it will also be important to equip these utilities with the necessary equipment (vehicles, waste bins,

and so on) to ensure the efficient collection of increased quantities of generated waste as well as to ensure there is an adequate infrastructure for the proper reutilization and recycling of useful fractions of waste (including recycling yards for construction waste). Analyses and assessments will be conducted, looking at the need for new post-earthquake legislation and plans required to ensure that clean-up can proceed expeditiously (for example, the adoption of a plan for reuse of construction materials/waste caused by earthquakes).

**In the long term, the remediation of all illegal landfills will need to be ensured.** Additionally, there will be continued efforts to support the education of the Croatian population on the principles of the waste handling and management as well as importance and principles of circular economy. Also, the technical and financial self-sufficiency of municipal waste management companies will be established to ensure that they are able to continue to function past the recovery phase. An exit waste management strategy will be developed, addressing possible future disasters; this will include creating a methodology to forecast amounts of waste that may be generated in such events as well as planning sufficient post-disaster waste management and treatment capacities (including capacities for waste storage) so as to achieve the EU waste management targets. This ought to be done by prioritizing waste prevention, reuse, and recycling. In addition, it is important to provide the affected population with preventive educational measures on correct separation and hand over waste, as well as raising public awareness on consequences of its uncontrolled disposal. The development of these preparedness measures for future disaster-events will start in the medium term and continue in the long-term period.



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## CIVIL PROTECTION AND DISASTER RISK REDUCTION

### *Sector Overview and Baseline*

#### *Data*

**T**he civil protection system in Croatia forms integral part of the homeland security system. The system coordinates participants and operational forces for preventive and operational action to protect and rescue people, animals, material and cultural assets, and the environment in the event of major accidents and disasters. Measures and activities are implemented by the government, the MoI, as the central state administration authority responsible for civil protection affairs; state administration authorities and other state authorities; the Croatian Armed Forces and the police; and LRSGUs. Measures and activities are implemented by the operational forces of the sys-

tem, which include the civil protection headquarters, firefighting operational forces, CRS operational forces, CMRS operational forces, associations, civil protection units and commissioners, site coordinators, and legal entities within the civil protection system. The operational forces also include professionals and volunteers who are an important human resource (fire, CMRS, and CRC) and coordinators at the location, units and commissioners of civil protection and associations of citizens and legal entities.

**During disasters, the civil protection system is managed by the government with the support of the Croatian civil protection headquarters.** During major accidents, the civil protection system is managed by the headquarters of LRSGUs. The Civil Protection Directorate of the MoI, in addition to the central office in Zagreb, consists of five regional civil protection offices (in Zagreb, Varaždin, Osijek, Rijeka, and Split) responsible for civil protection services in respective counties. Additionally, the directorate consists of four state intervention units for civil protection (located in Zagreb, Osijek, Rijeka, and Split). Operational forces



**Table 97.** Overview of firefighting resources in the areas affected by the earthquake

Administrative unit	No. of firefighting stations and/or warehouses	No. of firefighters (professionals and volunteers)	No. of firefighting intervention vehicles	Average age of firefighting intervention vehicles
Sisak-Moslavina County	164	4,769	305	24.68
Zagreb County	308	8,937	473	20.36
Karlovac County	125	3,268	230	23.16
Krapina-Zagorje County	98	3,205	212	22.74

Source: Mol.

exist at levels of the civil protection system (national, regional, and local). The activation of the operational forces of the civil protection system—in the event of a major accident or disaster—is carried out in accordance with the principle of subsidiarity. This means that the forces are activated first at the local level, where the emergency occurred, and then at the regional and national levels. The most important means of cooperation in the field of civil protection at the EU level is the UCPM which seeks to strengthen cooperation between the EU and the Member States and Participating States and to facilitate coordination in the field of civil protection.<sup>58</sup>

**The Croatian Firefighting Association, headed by the Chief Fire Commander, is the central state office in charge of firefighting.** The Chief Fire Commander answers to the government for the legality of the work of the Croatian Firefighting Association and for the equipment, organization, training and intervention readiness of fire service organizations, fire brigades, and firefighters in Croatia. The county fire brigades and the City of Zagreb Firefighting Association are under the responsibility of the Croatian Firefighting Association in terms of operations and implementation. The Croatian Firefighting Association is the budget user of the state budget, and budget regulations apply to budgetary processes. Fire brigades are divided into professional public fire brigades (with about 3,000 members) and voluntary fire brigades (with over 30,000 members). Table 97 presents an overview of firefighting forces in the affected area before the earthquake.

**Part of the buildings in the military barracks in Petrinja were newly built** (during 2009–2020) and

were used as command facility, education facility, and accommodation of members of the Croatian Armed Forces during and after working hours. Other buildings in the barracks were built before the 1990s and were in good condition before the earthquake.

**The CRC** enjoys special protection and care from Croatia and its work is based on the Civil Protection Act Article 29 and the CRC Act stating its role in achieving humanitarian goals and tasks in the field of protection and promotion of health, social welfare, health, and humanitarian education and advocates respect for international humanitarian law and the protection of human rights. Also, the CRC performs special obligations in situations of armed conflicts, major natural, environmental, technological, and other disasters, and epidemics with the consequences of mass casualties. The CRC has 111 municipal and town Red Cross local societies and 20 county Red Cross local societies with legal personality. The CRC has over 3,000 operational volunteer members across the entire country. In the area mostly affected by the earthquake, namely Sisak-Moslavina County, the CRC with its three city-level societies in

**Table 98.** Overview of the Croatia Red Cross personnel in the areas affected by the earthquake

CRC town level societies	Number of personnel
Glina	17
Hrvatska Kostajnica	32
Kutina	18
Novska	49
Petrinja	2
Sisak	19
Topusko	2
<b>Total</b>	<b>139</b>

Source: CRC.

58 See the Memorandum of Understanding between the EC and the Republic of Croatia on the participation of the Republic of Croatia in the “Financial Instrument for Civil Protection” signed on September 4, 2007 (Official Gazette - International Agreements 3/2008). It entered into force on May 26, 2008 (Official Gazette - International Agreements 5/2008).

Glina, Petrinja, and Sisak, was operating in the buildings owned by cities with personnel as per Table 98.

The CMRS is a nonprofit, national, voluntary, professional, humanitarian, and nonpartisan association. Its main objectives are accident prevention, rescue, and first aid in the mountains, other inaccessible areas, and emergency circumstances. The CMRS has about 1,000 rescuers and is organized in 25 stations located throughout Croatia. The CMRS brings together mountain rescuers who cover the entire territory of Croatia with its work being defined by the Law on the Civil Protection System and the Law on the CMRS, which was passed by the Croatian Parliament on June 30, 2006. CMRS activities are aligned with territorial principle through CMRS stations with Sisak-Moslavina County covered through the CMRS station Novska - sub-station Sisak. Before the earthquake, the building of the Sisak branch office was fully functional with the interior just recently renovated. The space consisted of a garage, storage, office, sanitary facilities, and space for working meetings as well as a yard for parking with 17 personnel using the entire space.

## Effects of the Disaster (Damage and Losses)

The DRR sector includes damages and losses to operational forces and participants in the civil protection system. During the response and early recovery efforts, a total of 25,068 persons were activated for 295,262 working hours (Table 99). Out of those, close to 100,000 working hours were spent during the rescue operations in the first week after the main-shock. A total of EUR 4.210 million in fees was paid for their activities, depending on the status of the activated person and the method of activation.

During the implementation of the rescue and early recovery measures and activities, a total of EUR 12.410 million was spent (Table 100). Of the total, EUR 2.893 million was spent by the MoI in relation to the organization of the base of operation 'Pigik' including construction works, the mobilization of members of civil protection, the installation and transport of containers and mobile homes, the establishment of sanitary support, provision of food for the population; setting up of insurance for facilities, the use of the Lekenik transit

**Table 99.** Emergency response and recovery

Operational forces and individuals	Rescue operations until January 3, 2021		Recovery operations as of January 4, 2021		Total	
	Personnel engaged	Hours engaged	Personnel engaged	Hours engaged	Personnel engaged	Hours engaged
<b>Civil Protection - MoI</b>	114	6,385	62	15,496	176	21,881
<b>Firefighters</b>	990	10,581	2,462	25,644	3,452	36,225
<b>CRC</b>	303	14,544	221	35,912	524	50,456
<b>CMRS</b>	1,070	14,229	1,689	28,567	2,759	42,796
<b>Croatian Center for Seismic Engineering</b>	840	33,600	1,855	50,085	2,695	83,685
<b>Utility companies</b>	2,186	5,154	192	36,180	4,497	45,101
<b>Ministry of Defense</b>	2,451	42	8,088	263	10,539	305
<b>Police - MoI</b>	399	12,691	27	2,122	426	14,813
<b>Total</b>	8,353	97,226	14,596	194,269	25,068	295,262

Source: Assessment team using official information.

**Table 100.** Cost of emergency operations (EUR, millions)

	Base of Operations	Technical and material resources	Fuel and energy	Personnel Daily Fees	Inventories, food in military base	Total
<b>Total</b>	2.89	1.96	0.48	4.21	2.87	12.41

Source: Assessment team using official information.

center and storage of equipment, the provision of animal food, and the provision of accommodation for the vulnerable population and foreign teams. Costs associated with the response and recovery operations was estimated at EUR 6.648 million; these were spent on energy (electricity and fuel); material and technical resources that got damaged, destroyed, spent, and scrapped; and overtime fees (mostly related to the damage assessment process conducted by HCPI). Moreover, EUR 2.869 million was spent on the renewal of the standard inventories of the CRC and the costs related to food preparation in the military base (between December 29, 2020 and February 7, 2021) for all the members of civil protection system responding to the earthquake disaster. During that period, a total of 88,295 rations of food were delivered to the civil protection personnel.

**A total of 20 buildings were damaged (without the information related to the buildings of the Ministry of Defense).** Most buildings are in Sisak-Moslavina County and more than half of them are owned by the MoI. A total of five buildings in the DRR sector have been reported to have sustained heavy damage.

**Reflective of the largest number of damaged buildings, the largest surface area of damaged buildings was re-**

**corded in Sisak-Moslavina County and is owned by the MoI.** The total affected surface area stands at 23,640 m<sup>2</sup>. Presently, information on the total surface area of the Ministry of Defense buildings that were affected by the earthquake is not available.

**Damage and losses in the DRR sector are estimated at EUR 22.973 million** (Table 102). This includes partially and fully destroyed buildings, including the costs associated with the equipment, furniture, office supplies, and the cleaning up (debris removal and demolition costs). Almost half of those costs are borne by the MoI (inclusive of Police and Civil Protection service), whereas the CRC costs account for one-third of the entire costs (particularly high expenses with the CRC as the first responders with the affected population were recorded with the equipment, furniture, fuel, transport, office-related, and COVID-19-related expenses). Equipment used by the CMRS is almost completely unusable (given that it was stored in a building that was heavily damaged) whereas, due to the extensive intervention operations and field usage, other equipment no longer meets safety standards (especially common equipment such as ropes, technical devices, and other equipment for work at heights).

**Table 101.** Number and surface area of damaged buildings in the civil protection and DRR sector by county and institution

Type of institutions	Total affected buildings	Total affected building area	Level of damage	Sisak-Moslavina County	Zagreb County	Karlovac County	City of Zagreb	Krapina-Zagorje County
<b>CRC</b>	3	930		1	0	0	0	0
				1	0	0	0	0
				1	0	0	0	0
<b>Firefighters</b>	5	2,410		2	0	0	0	0
				1	0	0	0	0
				2	0	0	0	0
<b>CMRS</b>	1	150		0	0	0	0	0
				0	0	0	0	0
				1	0	0	0	0
<b>MoI</b>	11	20,150		3	0	4	0	1
				2	0	0	0	0
				1	0	0	0	0
<b>Ministry of Defence<sup>a</sup></b>	n.a.	n.a.		n.a.	n.a.	n.a.	n.a.	n.a.
<b>Total</b>	<b>20</b>	<b>23,640</b>		<b>15</b>	<b>0</b>	<b>4</b>	<b>0</b>	<b>1</b>

*Source:* Estimations by the assessment team using official information. *Note:* a. Information on the number of buildings not available.

**Table 102.** Total damage and losses in the civil protection and DRR sector by county (EUR, million)

Administrative unit	Damage	Losses
Sisak-Moslavina	21.76	12.14
Zagreb County	0.40	0.31
Karlovac County	0.32	0.20
Krapina-Zagorje County	0.11	0.05
City of Zagreb	0.00	0.09
<b>Total</b>	<b>22.59</b>	<b>12.79</b>

Source: Estimations by the assessment team using official information.

**Table 103.** Total damage and losses in the civil protection and DRR sector by subsector (EUR, million)

Subsector	Damage	Losses
CRC	7.65	0.03
Firefighters	1.84	0.13
CMRS	0.26	0.02
MoI (Civil Protection and Police)	10.75	0.20
Ministry of Defense	2.09	0.00
Emergency operations	0.00	12.41
<b>Total</b>	<b>22.59</b>	<b>12.79</b>

Source: Estimations by the assessment team using official information.

The total costs incurred by the DRR sector are EUR 35.383 million. This includes the initial emergency response costs and overall damage and losses to physical infrastructure and equipment. Almost 96 percent of overall earthquake effects recorded in Sisak-Moslavina County.

## Disaster Impacts on the Affected Population

The consequences of the devastating mainshock in Sisak-Moslavina County were such that the county-level operational forces could not respond independently due to the insufficient human and material capacities available to them. This was further aggravated by the earthquakes' damage and effects in other parts of Croatia. Therefore, forces from other parts of Croatia and state-level forces including Civil Protection National Intervention Units (CP NIUs), National Intervention

Firefighting Unit, and Armed Forces were immediately activated. To support the affected population, after the December 29, 2020, earthquake, the CP NIU of the MoI was activated. The tasks of this unit were to implement the search and rescue operations from the ruins, assist the affected population, and coordinate operational activities with other basic forces of civil protection, namely the Croatian Army and the police.

On December 29, 2020, the CP NIU erected a base of operations at the 'Pigik' location with a role to safely accommodate tents for 100 members of the CP NIU and the mobile operations center with necessary infrastructure. The CP NIU was immediately joined by other services, and the base of operation was used for accommodation and food for members of the CP NIU (100 members) and accommodation, food, and work for members of the CRC, HCPI, CMRS, and civil protection of the city of Petrinja. The base of operation was active 24/7. Also, the CRC and CP NIU also had their warehouses containing equipment for the care of affected population, set up in the base of operation. Daily coordination meetings were held at the 'Pigik' operation base with the representatives of all the components involved in assisting the vulnerable population and coordinated by a representative of the Directorate of Civil Protection of the MoI. The space was later on expanded to accommodate trucks with accommodation containers to be later allocated to families with severely damaged houses.

As the seat of the Sisak-Moslavina Police Administration in the city of Sisak was heavily damaged by the earthquake, the police services were relocated to the building previously used by the Directorate of Civil Protection, the Croatian Mine Action Center in Sisak. However, even that building sustained damages so immediate repairs were undertaken. Also, faced with a lack of adequate space, Crime Police Service had to be relocated to three different locations. All said, it is evident that the functioning of the Sisak-Moslavina Police Administration is significantly hampered due to the damage caused to the facilities it used and is currently using.

During the relocation, there were short interruptions in the work of the Operational-Communication Center of the Police, but no negative consequences were noticed. The problems in functioning also arose with

the relocation of the prison, that is, the termination of the prison due to damage to the building, due to which the detainees were transported to the Zagreb Prison, which required additional involvement of police officers. The issue with inadequate number of human resources was also reflected in that, due to damage to their own property, three police officers requested and were granted transfer to other police administrations in February 2021. Although several police officers were in isolation or self-isolation due to the emergence of COVID-19, this issue did not have a significant impact on the normal operation of the police. Because four police vehicles were damaged in the earthquake and were temporary unusable and the police was requested to take part in many field interventions, there was a problem of insufficient official vehicles, especially those with off-road capabilities needed for approaching inaccessible remote settlements.

Croatian military forces have not faced major disruption of their regular activities following the damage to their building caused by the earthquake.

**Given that the CMRS building was heavily damaged and therefore unusable, the work of the branch office was difficult while the process of procuring two containers (for accommodation of personnel and equip-**

**ment for interventions) was under way.** In this context, the facilities of stations and branches are important to optimize the quality of work as starting intervention points where the necessary equipment and vehicles are located. To ensure the operation of the CMRS in the area of Sisak-Moslavina County, the Novska station organized the work such that the activities are carried out in the area of the Novska station itself or the branch office in Kutina. Part of the equipment was moved to Novska station and Kutina branch office whereas the personnel respond to the activities upon invitation and meet at pre-agreed posts. Overall operational coverage of the terrain in case of major actions or repeated disasters is organized through the national center of the CMRS in addition to the branch office. A challenge was the inability to have all the necessary material resources and equipment in one place (branch space), which can in some situations extend the time of arrival in the field, but as regular CMRS actions are not defined by urgency such as Emergency Medical Aid, such organized work can cover all possible situations with sufficient quality. The reconstruction of the Sisak branch office is a priority and only after the complete renovation, CMRS service in Sisak-Moslavina County will be at full operational level.

**Because three city-level societies in Glina, Petrinja, and Sisak buildings were heavily damaged by the**



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earthquake, they have been operating in temporary warehouses and tents, while the process of acquiring the double containers to be set up in Petrinja and Glina is under way. Members of the intervention teams, employees, and volunteers of the CRC received humanitarian aid in warehouses in Sisak, Glina, Petrinja, Hrvatska Kostajnica, Zagreb, and Rijeka; distributed humanitarian aid in the earthquake-affected area and different locations of evacuation sites, also in the central office in Zagreb; and collected data from all city Red Cross societies from all over Croatia to have a better picture of the vulnerable population. Vulnerable citizens within the earthquake-stricken area were given the opportunity to receive humanitarian aid in every city Red Cross society throughout Croatia whereas all branch officers extended their work hours. Also, trained Red Cross teams provided psychosocial support and in cooperation with theaters from the City of Zagreb held performances/theater plays for children in the evacuation centers. Finally, Zagreb Red Cross established a call center 0800 11 88 with an aim of informing the affected population and providing support.

## Reconstruction and Recovery Needs

Recovery and reconstruction in the sector should aim at reducing risks and increasing the resilience

of the population, as well as the local and regional governments, with particular focus on incorporating a risk-based approach within DRR. Events and activities that followed the 2020 December earthquake highlighted the urgent need to strengthen local and regional DRM capabilities. Furthermore, systematic interactions between the public and government need to be better coordinated. Response activities should be planned and based on evidence-based risk assessments. Recovery and reconstruction planning (readiness) should be prepared before a disaster, not after the earthquake happens. There is a clear need to develop a recovery plan that aptly integrates DRR and civil protection system.

### DISASTER RISK REDUCTION

The resilience of the local and regional governments alongside the general population needs to be strengthened through five priorities: (a) science-based local and regional risk identification and assessment, (b) local and national disaster management capability assessment, (c) co-financing of structural reinforcements, (d) risk awareness and hazard education, and (e) planning.

- Although earthquakes were identified as a priority risk in the affected area, secondary hazards triggered by earthquake, land subsidence, and landslides, and possible flooding due to damaged dikes and levees were not identified. The development of science-based local and regional risk identification



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and assessment needs to be the first step in creating a resilient society and the first step in the disaster management cycle. To obtain a robust and reliable risk assessment, a significant quantity of data would be required related to damage and loss, vulnerability, hazards, and so on.

- To ensure business continuity and adequate, timely response, governments need to establish starting points and recognize gaps in their DRM. For this, DRM capability assessments are needed.
- Structural reinforcement is a crucial activity that provides safe buildings. New legislation is needed to ensure the co-financing of structural reinforcement during energy refurbishment or for protected (historical heritage) or critical infrastructure buildings. Implementation of building codes for vulnerable buildings is also needed, especially in earthquake-exposed areas.
- Risk awareness and hazard education is the basis for the development of a resilient society. Raising awareness, implementing educational projects, and providing funding of CSOs dealing with soft activities of DRR are needed to strengthen societal resilience.
- Preparedness plans need to be developed following the risk assessment to enable timely response in case of a disaster. As a basis for restoration, recovery and reconstruction plans need to be created before the disaster based on all stakeholders' inclusion and integrated approach. Spatial plans need to reflect risk assessment findings.

### CIVIL PROTECTION SYSTEM

**Based on the lessons learned during the earthquake in Petrinja, immediate needs relate to the internal civil problem related to communication system, equipment, and buildings.** The communication system was based on 'very high frequency' (VHF) devices which were inadequate. Also, logistics support was an issue faced during the response operations in the field as special vehicles and mobile equipment for logistical support of members of the CP NIU were not adequate. To enable regional approach and successful response during operations by the four regional CP NIUs operating from Zagreb, Rijeka, Split and Osijek, it is necessary to build respective centers (bases) with warehouses, offices, and garages as well as space for training and maintenance of equipment and to procure additional technical means such as vehicles (special trucks) and

forklifts. The current premises in which the CP NIU reside are not adequate due to the insufficient capacity of the warehouse and do not have garages for vehicles, which makes it difficult to maintain them.

**Overall, the preparedness framework for efficient response should be improved in terms of** (a) capacity building (equipping, training and exercises) for the local civil protection units in the field of urban search and rescue; (b) establishment of the regional Technical Assistance and Support Teams (TASTs) to support information management and assessment activities for the regional civil protection headquarters; and (c) establishment of an information database with operational civil protection capabilities at the local, regional, and national levels.

**Along with relief activities, mental health and psychosocial support has become an imperative in all phases of the response.** Early mental health interventions and long-term psychosocial programming are key in prevention of further psychological disorders that might develop as consequence of disasters. Early mental health interventions include mobilization of specialized psychosocial support emergency response teams to provide psychological first aid and organize necessary psychosocial activities. With regard to this, long-term activities include employment of local psychosocial support experts to strengthen local capacity and organize community-based psychosocial activities based on continuous needs assessments of the affected population.

**Fire-fighting recovery activities cover a whole spectrum of activities** including rescue and fire suppression, immediate elimination of dangers and recovery actions of buildings that threaten to collapse (chimneys, roofs, balconies, gable walls, towers, and public buildings) or activities that enable citizens to remain in their homes after remediation of vital infrastructure, pumping of muddy wells, transporting of drinking water to vulnerable residents, reconnaissance and recording of condition of facilities, and delivery of food and humanitarian aid to endangered population. This can only be made possible by enhancing the functionalities in fire-fighting command and coordination centers and by enabling command, coordination, and management of fire service activities and cooperation with other emergency services and citizens.

**Table 104.** Total reconstruction and recovery needs in the civil protection and DRR sector in the short, medium, and long-term (EUR, millions)

Reconstruction and recovery	Short	Medium	Long	Total
Reconstruction of infrastructure and physical assets including debris removal	4.59	6.89	11.49	<b>22.97</b>
<b>Reconstruction subtotal</b>	4.59	6.89	11.49	<b>22.97</b>
<b>Emergency operations subtotal</b>	12.41	0.00	0.00	<b>12.41</b>
<b>Disaster Risk Reduction</b>				
Strengthening local and regional disaster management capability through development of risk assessments and databases, management capability assessments, risk reduction, recovery and reconstruction plans	4.45	3.00	0.00	<b>7.45</b>
Addressing DRR needs in all development planning, legislation on structural reinforcement, and spatial planning	0.00	1.40	0.00	<b>1.40</b>
Development of new risk awareness and hazard education programs and capacity building	3.00	0.00	1.60	<b>4.60</b>
<b>Disaster risk reduction subtotal</b>	7.45	4.40	1.60	<b>13.45</b>
<b>Civil protection system</b>				
Establishment of 4 regional civil protection centres for operational forces (including CP NIU)	5.00	10.00	5.00	<b>20.00</b>
Development of IT infrastructure and software solutions for a unified working platform for all civil protection operational forces	3.00	7.00	0.00	<b>10.00</b>
Development and upgrade of unified system of alerting and public informing in case of disasters	0.00	6.00	0.00	<b>6.00</b>
Training and equipment for CP NIU personnel (including vehicles)	5.00	3.00	2.00	<b>10.00</b>
Capacity building (equipping, training, and exercises) for the local civil protection units in the field of urban search and rescue (including information database on capabilities)	4.50	4.50	2.00	<b>11.00</b>
Establishment of the regional TAST (Technical Assistance and Support Teams) to support information management and assessment activities for the regional civil protection headquarters	2.00	2.00	1.00	<b>5.00</b>
Communication equipment for operational civil protection forces (including emergency communications vehicle with a system for establishing communication with the media and the public during a crisis situation)	0.00	8.00	0.00	<b>9.00</b>
Reconstruction and upgrades of 3 firefighting command centers and 3 fire stations	0.00	2.10	0.30	<b>2.40</b>
Firefighting equipment for earthquake rescue operations in depths and heights including fire-truck ladders, hydraulic platforms, and vehicles (rescue, water transport, and off-road)	0.28	3.43	1.08	<b>4.79</b>
Training and modernization of CMRS equipment for immediate disaster response (including compatible communication systems)	0.00	0.50	0.30	<b>0.80</b>
Establishment of a national CMRS training center for training operational forces in the field and strategic management	0.00	0.80	0.00	<b>0.80</b>
<b>Civil protection system subtotal</b>	19.78	47.33	11.68	<b>78.79</b>
<b>Recovery subtotal</b>	39.64	51.73	13.28	<b>104.65</b>
<b>Reconstruction and recovery total</b>	<b>44.23</b>	<b>58.62</b>	<b>24.77</b>	<b>127.62</b>

Source: Mol.

## GEOLOGY AND LAND STABILITY

### Sector Overview and Baseline Data

The five areas affected by the earthquakes lie in a transition zone between the Pannonian basin and the Di-

naric karst region. This transition zone is a geologically complex area; it has a historically and instrumentally recorded seismicity with several strong to catastrophic events, active tectonics, landscape, and groundwater dynamics. Table 105 provides an overview of the main types of bedrocks and superficial deposits as well as the major seismogenic sources and their expected maximal earthquake magnitudes. According to Croatia's DRA,



landslides are the only geohazard, other than earthquakes, that have a considerable impact to geology and land stability in the affected area; liquefaction was not foreseen by the DRA. Table 106 presents the main results obtained by the landslide risk assessment conducted for the five affected areas; this assessment was conducted by identifying landslide susceptibility and landslide risk.

**In terms of hydrogeology of the affected areas, the northwest-southeast continental watershed passes through the Dinaric karst area and divides Croatia into two catchment areas.** These include the Adriatic Sea basin, and the Black Sea basin within the DRB area. Hydrologically, the DRB in Croatia can be divided into three sub-basins: the sub-basins of the Drava and Danube Rivers in the north; and the Sava River sub-basin in

the south, partly straddling into the Dinaric karst region (including the Sava River tributaries of the Kupa and Una Rivers). The DRB region is therefore dominated by the wide and long alluvial valleys of the Sava and Drava Rivers, which gradually narrow toward the west and are filled with swamp and alluvial sediments<sup>59</sup> of considerable thickness (sediment that is deposited by rivers).

**The northern part of Sisak-Moslavina County is characterized by the floodplains of the Kupa and Sava Rivers (with the tributaries of the Glina, Maja, and Sunja Rivers).** The groundwater that accumulates in the sandy and gravelly aquifers is the main drinking water

59 Alluvial sediment – in this case it is a sediment deposited by rivers and on lake shores.

**Table 105.** Main types of bedrocks and deposits, as well as the major seismogenic sources and their expected maximal earthquake magnitude (M)

County and prevailing geology	Sisak-Moslavina County	Karlovac County	Krapina-Zagorje County	Zagreb County	City of Zagreb
	Pannonian basin	Karst Dinarides	Pannonian basin	Pannonian basin	Pannonian basin
<b>Superficial deposits</b>	marls, sands, silts and clays, locally limestones	carbonates, in the east part silts and clays	marls, sands, silts and clays, locally carbonates	marls, sands, silts and clays, locally carbonates and metamorphics	marls, sands, silts and clays, in the northwest part dolomites
<b>Bedrock</b>	carbonates, locally igneous and clastics	carbonates and clastics	carbonates, clastics and locally igneous	carbonates, clastics and locally metamorphic rocks	carbonates, and clastics
<b>Major seismogenic sources and expected maximum magnitude</b>	Petrinja composite source (M 6.5)	Žumberak boundary faults (M 5)	Ivanščica composite source (M 6.5)	North Medvednica composite source (M 6.5); Kašina Fault (M 6)	North Medvednica composite source (M 6.5)

Source: Faculty of Mining, Geology, and Petroleum Engineering (RGNF), University of Zagreb.

**Table 106.** Landslide risk assessment for the most probable scenario of multiple-occurrence regional landslide events triggered by heavy rainfalls

Administrative unit	Total County area (km <sup>2</sup> )	Areas susceptible to landslides		The most probable landslide event with catastrophic consequences <sup>a</sup>		
		(km <sup>2</sup> )	(%)	No. of affected cities or municipalities / Total no. of cities or municipalities	Consequences	Risk
<b>Sisak-Moslavina County</b>	4468	1804	40	17/19	catastrophic	very high
<b>Karlovac County</b>	3623	775	21	20/23	significant	high
<b>Krapina-Zagorje County</b>	1231	836	68	32/32	catastrophic	very high
<b>Zagreb County</b>	3062	850	28	29/34	significant	high
<b>City of Zagreb</b>	640	224	35	1/1	significant	high

Source: Mol, 2019.

Notes: a. The probability of a landslide event is medium.



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source in the rural areas of the county. Kupa floodplain sediments are prevalingly clay and sand, up to 100 m thick. Given its sedimentological characteristics, alluvial valleys are highly prone to liquefaction if triggered by high-intensity earthquakes; this was confirmed during the December 2020 earthquakes. Underneath the Sava-Kupa alluvial deposits, there are sediments of the Sava basin composed of sands, clays, and local gravels; these are first underlain by marls and sands, and then by limestones, sandstones and conglomerates. According to borehole data, the Sava basin sediments in this area are close to 3,000 m thick. Due to neotectonic activity along the NW-striking Petrinja-Pokupsko fault system, a part of the Sava basin sedimentary fill was uplifted and is presently exposed at the surface; it is on top of the Hrastovica hill, which extends for about 30 km in the northwest-southeast direction, some 4 km southeast of Petrinja. This fault system was already recognized as a major seismogenic source of this area.<sup>60</sup> The northwest-striking dextral Petrinja fault of this composite seismogenic source is responsible for the December 29, 2020 earthquake and for most of the pre- and post-shock events of the Petrinja 2020–2021 earthquake series.

**The southern part of Sisak-Moslavina County is characterized by the hilly landscape of the Zrinska and Trgovska Gora hills, with the highest peaks, respectively, at 616 and 629 m above sea level.** These hills

are separated by the narrow floodplain of the Žirovnica River and are both surrounded by the Glina, Maja, Sunja, and Una Rivers from the northwest to the southeast. The central part of the Zrinska Gora is at the surface composed of flysch sediments (conglomerates, sandstones, and shales) and surrounded by clastic sediments (conglomerates, sandstones, limestones, and marls) of the Pannonian basin affinity. According to the national landslide susceptibility assessment, 40 percent of the county has the geological and geomorphological preconditions for landslides. Locally, along its northeastern slopes, limestones are severely karstified, forming the karst landscape that is typical of the Dinaric karst area. In the northwestern part of the Sunja River floodplain, the karstified limestone bedrock is covered by 5–30-m thick alluvial-proluvial deposits<sup>61</sup> (sands, clays, and gravels) that are prone to suffosion (underground erosion) and can then result in the formation of cover-collapse sinkholes (dropout dolines). Other than landslides and liquefaction, cover-collapse sinkholes are the most dangerous geological hazard and risk in part of the Sisak-Moslavina County (in the Mečenčani and Borojevići villages), as confirmed by their sudden occurrence in large numbers (over 100) within a short period (in about 45 days) during the December earthquake series. Similar collapse sinkhole structures were also reported in the village of Strašnik, located in the earthquakes' epicentral area. The northwestern slopes of Zrinska Gora

60 It was named as the Petrinja composite seismogenic source (HRCS027) in the *European Database of Seismogenic Sources*.

61 Proluvial deposits - a sediment at the foot of a slope, typically of fractured rock, carried by an occasional torrent.

are mostly composed of marls, sands, and clays prone to slope instability and landslides.

**As far as the other counties are concerned, there are some areas which are considered to have a higher seismogenic potential than average.** In Zagreb County, those areas are (a) Vukomeričke Gorice hills which are included into the northwest part of the Petrinja composite seismogenic source (HRCS027 in the European Database of Seismogenic Sources) and (b) the western part of Mt. Medvednica, where the most prominent seismogenic source is the east-northeast-striking North Medvednica boundary fault, capable of generating 6.5 magnitude earthquakes. In the City of Zagreb area, beside the east-northeast-striking North Medvednica boundary fault, there is another seismogenic source known as the northwest-striking Kašina dextral fault, both capable of generating 6.5 magnitude earthquakes. Finally, in Krapina-Zagorje County, the most prominent seismogenic sources are the east-striking reverse and northwest-striking dextral faults surrounding the Mts. Ivanščica and Strahinjšica; they are capable of triggering 6.5 magnitude earthquakes.

### Effects of the Disaster (Damage and Losses)

**The earthquake caused significant changes in geology and land stability.** The physical phenomena, including liquefaction, sinkholes, and landslides, caused severe damage in several sectors, such as agriculture, housing, transport, water supply, and sanitation (Table 107).

**Sisak-Moslavina County has been the most severely affected by the changes in geology and land stability.**

After the 6.2 magnitude mainshock on December 29, 2020, the largest number of cover-collapse sinkholes occurred in the area of the Mečenčani-Borojevići villages. Within an area of 3.6 km<sup>2</sup>, seven sinkholes were recorded within eight days of the mainshock. More than 100 sinkholes have since been recorded, and the number continues to grow. The recorded sinkholes are of variable size and depth; they range from 0.5 m to approximately 30 m in diameter and from 0.4 m to approximately 12.5 m in depth. The location of sinkholes is also not uniform. Some collapsed close to houses and agricultural buildings (8 at the time of the assessment), some occurred near the water well-field Pašino Vrelo (the regional water supply facility for the community of Hrvatska Kostajnica) and some were dispersed across the agricultural land of the region. So far, seven people were evacuated or moved away from their houses due to the risk of sinkhole occurrence. Sinkholes' collapse caused decrease of the quality of ground water at the well-field Pašino Vrelo; the well was not in use for more than 60 days because of increased turbidity. People employed in agriculture were recommended to cease any further activities and to not go into affected fields to prevent human fatalities due to new sinkholes collapsing.

**Government emergency measures in Sisak-Moslavina County were initiated on January 13, 2021, to secure the area and find the nearest safe ground for mobile home installations.** These measures tested the appropriate geophysical methods aimed at (a) the recognition of the underground geological structure, (b) an investiga-

**Table 107.** Overview of effects in geology and land stability

Administrative unit	Liquefaction zones		Landslides		Sinkholes	
	No. of phenomena	Total area of all liquefaction phenomena (ha)	No. of phenomena	Total area of all landslide phenomena (ha)	No. of phenomena	Area affected by collapse-sinkholes phenomenon (ha)
Sisak-Moslavina County	52	1,410	63	8	109	360
Zagreb County	0	0	50	6	0	0
Karlovac County	0	0	5	0.5	1	0
City of Zagreb	0	0	1	100	0	0
Krapina-Zagorje County	0	0	80	3.2	0	0
Karlovac County	52	1,410	199	117.7	110	360

Source: RGNE, University of Zagreb.

tion of the sinkholes' morphology, (c) the recognition of underground karst features in bedrock as potential locations for the occurrence of cover-collapse sinkholes in the future, and (d) the delineation of safe and unsafe areas in the Mečenčani-Borojevići villages. As of February 25, 2021, the performed geophysical investigations included 8,895 m of electrical resistivity tomography profiling, 860 m of refraction seismic profiling, 230 m of reflection seismic profiling, 4,178 m of ground penetrating radar profiling, and 140 m of multichannel analysis of surface waves. In addition to geophysical profiling along the main roads, around the primary school and partly in agricultural fields, geological, hydrogeological, and geochemical investigations started on February 9, 2021. These investigations include the collection of geological field data; collection of GPS-derived locations of unreported and reported sinkhole locations; the installation of water level loggers in three piezometers (two in shallow alluvial aquifer and one in deep karst aquifer); and soil gas measurements of radon, thoron,<sup>62</sup> and CO<sub>2</sub> concentrations along profiles (approximately 200 m). Since the first geophysical investigations performed, all measured geophysical and geological data have been continuously stored into the common geographic information system (GIS) database set up at the RGNF at the University of Zagreb. This database needs to be further improved and aims to provide data for assessments on the effects of sinkhole disasters and the design of effective mitigation and adaptation measures; the data will also provide information to be used for the long-term recovery and reconstruction process. Besides cover-collapse sinkhole occurrences in the Mečenčani-Borojevići area, there is one sinkhole that collapsed near the village of Strašnik (in a field approximately 100 m away from the nearest house) and one sinkhole that collapsed in the village of Jošavica (also in a field approximately 300 m from the nearest house). Additionally, a sinkhole in the village of Vorkapić (community of Topusko) collapsed in an agricultural field (approximately 40 m from the nearest house).

**The earthquakes in Sisak-Moslavina County triggered a large number of landslides.** In total, 63 landslides were newly activated or reactivated. The size of the landslides' areas varies between 15 and 13,310 m<sup>2</sup> (with an average size of 1,300 m<sup>2</sup>). According to landslide volume,

62 Radon is a naturally occurring radioactive gas generated by the decay of uranium- and thorium-bearing minerals in rocks and soils. Rn (radon gas) and <sup>220</sup>Rn (thoron gas) are the most common isotopes of radon.

most phenomena can be classified as very small to small landslides, except for a few moderate-small landslides and one large-moderate landslide. The total area of all landslides is approximately 8 ha. Most landslides (about 40) are reactivations of existing landslides along roads (national, regional, local, and unclassified roads). Most very small and small landslides occurred in artificial and other types of superficial deposits along roads. The maximum landslide area was about 3,500 m<sup>2</sup>. Other than the landslides activated in the more common hilly environment, about 15 landslides were newly activated along riverbanks (of the Kupa, Sava, Glina and Maja old channel rivers). There were about 15 landslides in settlements which occurred in private properties and were distanced from roads. These landslides were irregularly distributed throughout the county. The biggest landslide occurred in the Prnjavor Čuntićki settlements (which administratively belong to the city of Petrinja). This large-moderate landslide was reactivated by the earthquake. About 10 landslides of different sizes were (re)activated in agricultural areas.

**All liquefaction zones were in Sisak-Moslavina County and were triggered by the 6.2 magnitude Petrinja earthquake.** The approximate number of liquefaction zones at the time of the assessment was 52, with a total area of about 1410 ha. The size of the liquefaction zones varies between 0.1 and 177.5 ha. According to the general soil profiles, the depth of the liquefied zones ranges from 3 to 15 m. During the liquefaction and in the following two months, the processes active in liquefaction zones included the formation of sand boils, the formation of surface ruptures (of different persistence) with or without lateral spreading, instant settlement and the tilting of buildings, and long-term consolidation settlement. Most of the liquefaction zones (about 75 percent) are located in agricultural areas. The rest are located in the construction areas of settlements. There are also a few liquefaction zones in the urban parts of Sisak, Petrinja, and Glina. All liquefaction zones developed in the alluvial deposits of the Kupa, Sava, Glina, and Maja Rivers within a maximum distance of 1 km. About 7 percent of the areas of liquefaction zones are below the river embankments of the three main rivers that are used for flood protection.

**In Zagreb County, about 50 landslides were newly activated or reactivated by the earthquakes.** The average size of the landslides was 1,500 m<sup>2</sup>. According to the

landslide volumes, most phenomena can be classified as very small to small landslides, except for a few moderate-small landslides. The total area of the landslides is approximately 6 ha. All landslides are a result of the reactivation of existing landslides and they are located along national, regional, local, and unclassified roads. They developed in artificial and other types of superficial deposits.

**In Karlovac County, the earthquake shocks triggered the only known sinkhole occurrence with a diameter of 1.5–2 m and depth of about 17 m.** However, it is an isolated case, and, for practical reasons, the sinkhole area was calculated as 0 ha and was not further elaborated. After the mainshock, one sinkhole was reported in the village of Gornje Bukovlje. It was found on December 30, 2020, and most probably collapsed a day before, during or soon after the mainshock. This sinkhole was already known before the earthquake as one of the many sinkholes that formed in this typical Dinaric karst area.

**Approximately five landslides were newly activated or reactivated in the Karlovac area following the earthquakes.** The expected average size of these landslides was 1,000 m<sup>2</sup>. According to the landslide volume, most phenomena can be classified as very small to small landslides and, in some cases, moderate-small landslides.

The total area of the landslides was approximately 0.5 ha. All landslides were a result of the reactivation of existing landslides along national, regional, local, and unclassified roads. They developed in artificial and other types of shallow deposits.

**In the City of Zagreb, there was no information about activation of new or reactivation of existing shallow landslides triggered by the earthquakes.** However, there was an instrumentally recorded evidence of the displacement of the largest landslide in Croatia, the Kostanjek landslide, after the mainshock on December 29, 2020. Kostanjek is large deep-seated active landslide (with an approximate volume of 32x106 m<sup>3</sup>). This landslide is located in the densely populated urban zone of the City of Zagreb.

**Approximately 80 landslides were newly activated or reactivated by the earthquakes in Krapina-Zagorje County.** The expected average size of the landslides is 400 m<sup>2</sup>. According to the landslide volumes, most phenomena can be classified as very small to small landslides and, in some cases, moderate-small landslides. The total area of all the landslides is approximately 3.2 ha. All landslides are result of the reactivation of existing landslides along national, regional, local, and unclassified roads, and they developed in artificial and other types of superficial deposits.

Administrative unit	Damage			Losses		
	Public	Private	Total	Public	Private	Total
Sisak-Moslavina County	45.75	29.13	<b>74.88</b>	0.57	0.77	<b>1.34</b>
Zagreb County	0.00	0.00	<b>0.00</b>	0.27	0.00	<b>0.27</b>
Karlovac County	0.00	0.00	<b>0.00</b>	0.32	0.00	<b>0.32</b>
Krapina-Zagorje County	0.00	0.00	<b>0.00</b>	0.11	0.00	<b>0.11</b>
City of Zagreb	0.92	0.92	<b>1.84</b>	0.06	0.00	<b>0.06</b>
<b>Total</b>	<b>46.66</b>	<b>30.05</b>	<b>76.72</b>	<b>1.32</b>	<b>0.77</b>	<b>2.09</b>

**Table 108.** Total damage and losses related to geology and land stability by county (EUR, millions)

Source: RGNF, University of Zagreb.

Phenomenon	Damage			Losses		
	Public	Private	Total	Public	Private	Total
Liquefaction	43.70	28.14	<b>71.84</b>	0.22	0.13	<b>0.34</b>
Sinkholes	0.48	0.31	<b>0.79</b>	0.82	0.47	<b>1.29</b>
Landslides	2.49	1.60	<b>4.09</b>	0.29	0.17	<b>0.46</b>
Hydrogeological Monitoring (Groundwater)	0.00	0.00	<b>0.00</b>	0.00	0.00	<b>0.00</b>
<b>Total</b>	<b>46.66</b>	<b>30.05</b>	<b>76.72</b>	<b>1.32</b>	<b>0.77</b>	<b>2.09</b>

**Table 109.** Total damage and losses related to geology and land stability by phenomenon (EUR, millions)

Source: RGNF, University of Zagreb.



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**Damage and losses incurred by the phenomena affecting geology and land stability are cross-sectoral.**

Overall, in all affected counties, costs of the damage (for example, damage to agricultural land, houses, roads, and embankments) and losses (disruption of services and the estimation of its duration; cleaning of debris, sand, and so on; emergency measures for securing the areas, and so on) have in part already been reported through the agriculture, housing, transport, water and sanitation, and flood protection sectors. For example, the damage and losses caused by the activation of landslides on public roads are discussed in the transportation sector, and the damage and losses on agricultural fields are discussed in the agriculture sector. To avoid duplicate data, these damage and losses are expressed as 0 (zero) in Table 108 and Table 109. Damage is calculated as the costs of the remediation of the environment after the landslides, sinkholes, and liquefaction phenomena. Such costs include geotechnical and geophysical investigation (site investigation), urgent measures, the remedial measure designs, and construction works. The losses include the cost of soft recovery works that were necessary for the remediation of disturbances in physical land structures, such as airborne laser scanning (for the documentation

of all losses) and monitoring of geohazards (sinkholes and landslides).

### *Disaster Impacts on the Affected Population*

**Other cover-collapse sinkholes (one each in Strašnik, Jošavica, and Topusko), although sporadic, have formed due to a geological setting similar to the one in the Mečenčani-Borojevići area (karstified limestone bedrock covered by soil or clastic sediments).** However, they are presently not considered as a direct natural risk for these villages because they are in fields hundreds of meters away from the houses. In these areas (around the Strašnik and Jošavica villages), there are numerous gentle and circular-shaped depressions observed in the landscape; these could be considered as indicators of future collapse sinkhole formations. Thus, it is possible to expect that in the future there will be more collapse sinkhole occurrences and they will possibly be closer to houses. This would increase the present-day level of risk for these villages and agricultural buildings, thereby impeding efficient work in the agricultural fields.

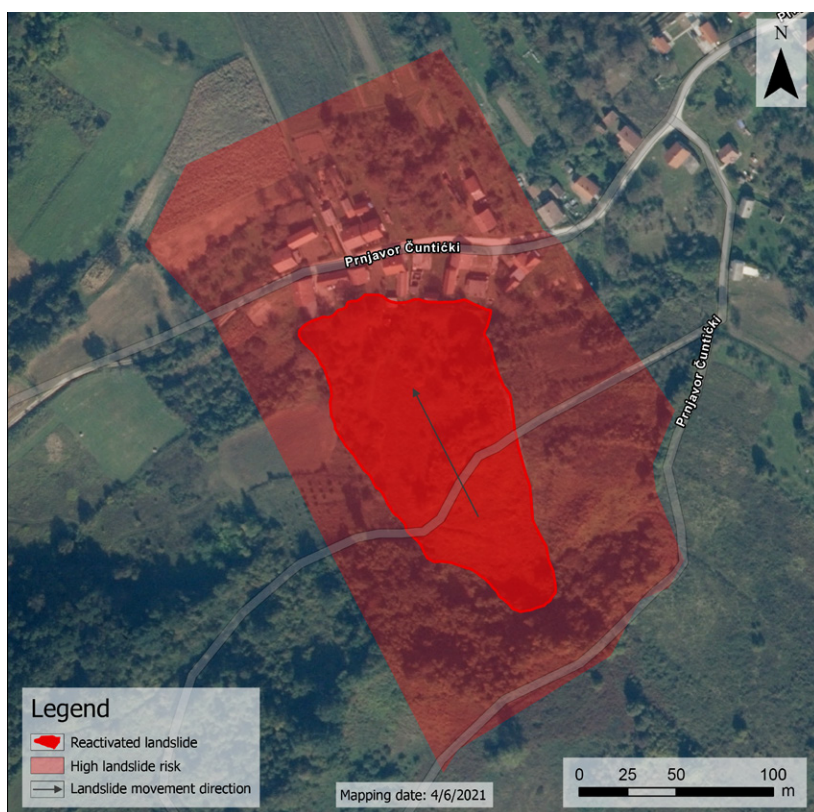
**The high risk and vulnerability of roads are a direct consequence of inadequate design and construction of all types of roads which were built over 50 year ago and were not constructed to be resistant to earthquakes.** The risks and vulnerability of these elements that are exposed to the 15 newly activated landslides along the riverbanks (of the Kupa, Sava, Glina, and Maja old river channels) are related to the highly vulnerable natural slopes of the river channel that are in an unstable and dynamic condition. The vicinity of unclassified roads, holiday and family houses, and other private properties to these unstable slopes has resulted in them being exposed to risks; additionally, due to the retrogressive enlargement of the very small to small landslides, these risks are increasing.

**The risks and vulnerability to landslides in settlements are a result of the lack of landslide maps that can indicate landslide-prone areas that must be avoided when constructing or in phases of physical planning.** The worst case is in the Prnjavor Čuntićki settlement, where more than 10 houses were built on an existing large-moderate landslide that was (re)activated by heavy rainfall in 2018 and again by the December 2020 earthquakes (Figure 15). Very small to small landslides that

were (re)activated on roads mainly resulted in disturbances to transportation along national, regional, local, and unclassified roads; in a few cases, they also resulted in the temporary interruption of transportation.

**The risks of and vulnerability to landslides in agricultural areas are also caused by the lack of landslide maps that can indicate landslide-prone areas that ought to not be considered as appropriate for agricultural activities.** The worst case is in the Dangube settlements, where several hectares of orchards and pastures were damaged by densely distributed landslides. Further tremors will continue to cause new physical changes to landslides and the surrounding areas, affecting people's livelihoods and the functioning of agricultural and other activities.

**Agricultural areas and settlements located in liquefaction zones have become at-risk zones after the earthquakes.** New settlements (with or without the formation of new cracks) are natural process that will happen in liquefaction zones over time (two months or more). Aftershocks continued to cause changes in the environment; these changes will affect people's livelihoods, the agriculture sector, and other activities. The damaged



**Table 15.** Position of a reactivated landslide in the Prnjavor Čuntićki village endangering more than 10 houses at the foot of the landslide

*Source:* RGNE, University of Zagreb.  
*Notes:* Landslide contour identified based on interpretation of Light Detection and Ranging (LIDAR) Digital Elevation Model (DEM) maps (donated by CADCOM Ltd. in February 2021).

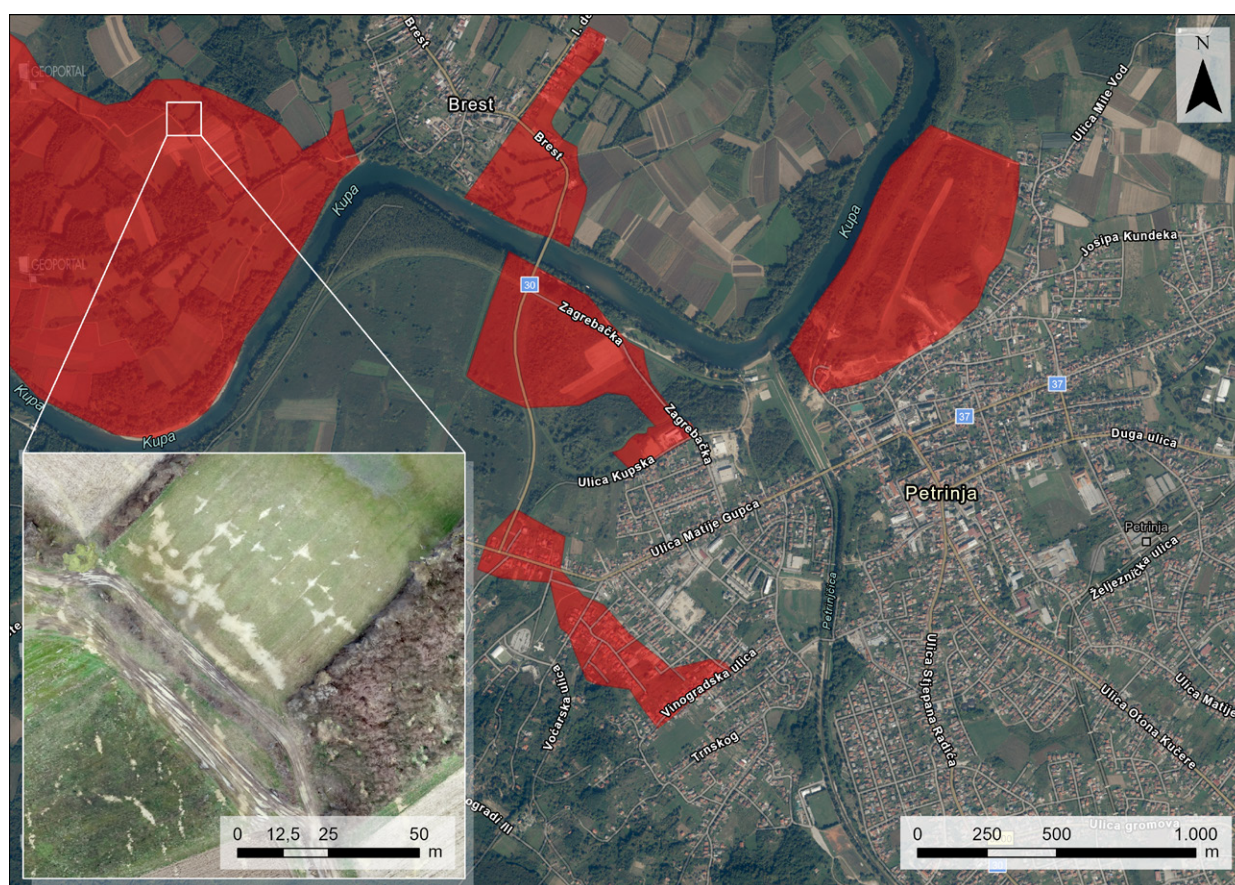
river embankment is increasing the risk of flooding in all the liquefaction zones because its reconstruction is technically more complex and will take more time. Due to interruptions of transportation, the local affected community will not have access to their houses and/or their agricultural properties.

**The long-term impact on geology and land stability could become serious without the remediation and stabilization of landslides.** The large-to-moderate Prnjavor Čuntički landslide will mainly affect the population due to the possible damages to and/or demolition in at least 10 houses located at the foot of the landslide, where the landslide mass will be deposited after the landslide collapses. Very small to small landslides that were (re) activated on private properties will mainly affect the population as a result of the damage to houses and loss of livelihoods they could cause. The immediate, short-term social impact will be the loss of people’s properties and livelihoods, and in the longer-term, there will be

possible impacts on their mental health. The landslides (re)activated on private agricultural land could cause a disturbance in farming activities as a result of the loss of stable land in the short-term. In the long-term, this could result in the complete neglect of productive land.

**Liquefaction could also have many adverse consequences.** Liquefaction processes activated on private agricultural land could cause a disturbance in farming activities as a result of the loss of stable land in the short-term. In the long-term, this could negatively affect agricultural activities as a result of the formation of lateral spreading with wide, open cracks that could lead to the complete neglect of the parts of productive land that were affected. The impact of liquefaction processes on infrastructure (buildings, roads, pipelines, and so on) depends on the construction type. The short-term impact is the initial damage caused by the fracturing and initial settlement. The long-term impact will be the consolidation of the settlement that causes additional

**Figure 16.** Part of the liquefaction inventory map



**Source:** RGNE, University of Zagreb. **Notes:** Red polygons depict liquefaction phenomena activated by the earthquake. The enlarged detail shows surface manifestation of liquefaction (ruptures with sand boils).



damage to all types of constructions. Liquefaction will most severely affect the river embankment, causing initial damage, fracturing, and the initial settlement. In the long-term, liquefaction will also cause additional damage and, if the embankment were to collapse, the possible cascade effect of flooding.

**The high risk and vulnerability of the urban area of the City of Zagreb is a result of the large, deep-seated Kostanjek landslide.** In turn, this is a direct consequence of the Kostanjek landslide activity. The landslide was displaced during the earthquake; this implies that the earthquake negatively influenced the landslide's stability. The risks arising from this landslide are documented by the continuous instrumental monitoring established in 2010 that showed slow but constant landslide movements. More than 500 private houses—and the associated population—as well as some industrial buildings and facilities are at risk. The high value of the land in the urban part of the City of Zagreb and the high risk of landslides imply that there is an urgent need for landslide remediation through structural measures that will stop further displacement and decrease risks for all stakeholders. The impact of the large deep-seated active Kostanjek landslide in Zagreb could be catastrophic if the landslide were to collapse; it could result in the destruction of physical property and, possibly, casualties.

**In Zagreb County, Karlovac County, and Krapina-Zagorje County, landslides mainly affected the transport sector.** The impact of very small to small landslides that were (re)activated on roads caused disturbances in transportation, and only in a few cases, transport was interrupted. The high risk and vulnerability of the roads are due to inadequate design and construction of all types of roads.

## Reconstruction and Recovery Needs

**Short-term recovery needs predominantly apply to Sisak-Moslavina County.** An adequate planning of recovery needs is quite demanding, both in terms of the selection of proper risk mitigation measures and the timing of their implementation. One of the most challenging areas—due to the quite complex current situation and high natural risk—is the Mečenčani-Borojevići villages, where cover-collapse sinkhole occurrences

strongly affected housing, the regional groundwater supply facility (Pašino Vrelo well-field), and agricultural land:

### Short-term needs include the following:

- Ensuring the safety of the inhabitants residing in the 100 houses that were endangered by the high risk of the cover-collapse sinkholes occurrence in the Mečenčani and Borojevići villages by providing replacement houses.<sup>63</sup> To reduce risks, if the space is used for purposes other than housing and residence, due to the high risk of collapse of new sinkholes in adverse conditions (such as changes in groundwater levels or new earthquakes), the rehabilitation of sinkholes is recommended.
- Ensuring the safety of the inhabitants residing in the 10 houses that were endangered by the high-risk landslide in Prnjavor Čuntićki by providing replacement houses.<sup>64</sup> The rehabilitation of this landslide area may not be recommended, due to the high risk of landslide collapse either during the implementation of geotechnical works and surveys or during unfavorable conditions (such as intense precipitation or earthquake shocks).

### Medium-term needs apply to all the affected counties and include the following:

- Producing landslide maps with information on the evidence gathered on the existing landslides (landslide inventory maps) and landslide susceptibility/hazard maps. These maps are to be used for regional and local application by the regional and local governments, serving as informative, advisory, and legislative documents to be used in physical and land use planning. Regional landslide maps are necessary for the entire area of all five affected counties (13,024 km<sup>2</sup>), and local landslide maps are necessary for areas with the preconditions for sliding (4,489 km<sup>2</sup>). The maps can be produced within two years.
- Producing liquefaction maps with information on susceptibility/hazard for regional and local application by the regional and local governments to serve as informative, advisory, and legislative doc-

<sup>63</sup> All potential population relocation and new housing costs for area of high sinkhole risk in Mečenčani and Borojevići settlements are covered in the housing sector of this document.

<sup>64</sup> All potential population relocation and new housing costs for area of high landslide risk in Prnjavor Čuntićki settlement are covered in the housing sector of this document.

uments for land use planning. Regional and local liquefaction maps are necessary for the areas with alluvial deposits in all the affected counties (2,820 km<sup>2</sup>). Regional maps can be developed based on existing data, while local maps require additional site investigation. The maps can be produced within two to three years. The actors involved will include the regional and local governments as well as the physical planning sector.

- Producing sinkhole maps with information on evidence of existing sinkhole phenomena (sinkhole inventory map) and sinkhole susceptibility/hazard for regional and local application by the regional and local governments to inform physical and land use planning. Regional and local sinkhole maps are necessary for the areas with Badenian deposits in all the affected counties (385 km<sup>2</sup>). Regional maps can be developed based on existing data, and local maps require additional site investigation appropriate for zonation purposes. The maps can be produced within two years.
- Since regular measurements of the groundwater levels are conducted with a total of 242 piezometers in Sisak-Moslavina, Zagreb, Krapina-Zagorje and Karlovac Counties which are poorly spatially distributed, it is necessary to establish a representative groundwater monitoring network for all aquifers with intergranular porosity, main springs (in karst areas), and especially near water well fields. Medium-term needs include the construction of at least 70 piezometers with a total length of 2,000 m. The objective of the groundwater monitoring network is to provide data to estimate the long-term state and trends of groundwater in the affected counties, and provide input for the water policy planning, regulatory agencies, and the public.
- Conducting a geotechnical investigation to assess the liquefaction potential in settlement areas of Sisak-Moslavina, Zagreb and Karlovac Counties, for evaluating construction conditions. In construction areas of the settlements (existing/planned) within a zone of high liquefaction susceptibility, it is obligatory to perform geotechnical investigations to evaluate liquefaction potential in wider zones that are unique in relation to liquefaction preparatory factors. Results will be used for design and performance of geotechnical measures to improve the foundation soil in the wider construction area.

**Long-term needs apply to all the affected counties and include the following:**

- Mitigating the risks of the cover-collapse sinkhole hazard in the Mečenčani-Borojevići area and to prevent the potential loss of human lives and properties and potential damage in land and infrastructure, implementation of modern and adequate methods of hydrogeological, meteorological, geophysical, and geotechnical monitoring is needed. This complex monitoring should consider (a) hydrodynamic conditions of groundwater, (b) rainfall and air pressure, (c) underground monitoring by different geophysical methods, and (d) covering material monitoring through different geotechnical methods and field and laboratory tests.
- Conducting seismic-geotechnical microzonation for regional and local application to produce a series of maps for the entire affected area, namely for each of the 19 municipalities/cities in Sisak-Moslavina County, 34 municipalities/cities in Zagreb County, 32 municipalities/cities in Krapina-Zagorje County,

**Table 110.** Total recovery needs related to geology and land stability by phenomenon (EUR, millions)

Phenomenon/Intervention	Recovery Needs
Liquefaction	21.69
Sinkholes	3.80
Landslides	7.97
Hydrogeological monitoring	0.78
All phenomena scanning	0.98
<b>Total</b>	<b>35.22</b>

Source: RGNE, University of Zagreb.

**Table 111.** Total recovery needs related to geology and land stability by county (EUR, millions)

Administrative unit	Recovery Needs
Sisak-Moslavina County	22.20
Zagreb County	4.67
Karlovac County	5.13
City of Zagreb	1.28
Krapina-Zagorje County	1.94
<b>Total</b>	<b>35.22</b>

Source: RGNE, University of Zagreb.



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and 22 municipalities/cities in Karlovac County to be used for land use planning and construction purposes. The maps need to contain information about seismicity, seismotectonics and seismically induced effects (shaking, landslides, liquefaction, sinkholes), and geotechnical parameters. All maps should be prepared in the appropriate scale and in accordance with relevant international/European recommendations and standards. The microzonation can be performed within five years.

- Conducting stakeholder education on seismic-geotechnical microzonation and other geohazard maps for regional and local application for regional, local, and national governments, policy and decision-makers, and the public. The education can be performed within five years. The proposal encompasses three educations for a total of 20 stakeholder groups (1 regional and 19 local administrative units).

Recovery needs in the affected areas are summarized

in Table 110 and Table 111 along with the associated costs displayed by county and by type of phenomenon, respectively. Total reconstruction needs equal the interventions reported as damage under disaster effects above. Both reconstruction and recovery needs prioritized across a short, medium, and long-term are shown in Table 112.

**Table 112.** Total reconstruction and recovery needs related to geology and land stability in the short, medium, and longterm (EUR, millions)

	Short	Medium	Long	Total
<b>Reconstruction</b>	<b>11.59</b>	<b>65.12</b>	<b>0.00</b>	<b>76.72</b>
<b>Recovery</b>	<b>6.82</b>	<b>13.60</b>	<b>14.80</b>	<b>35.22</b>
<b>Total</b>	<b>18.41</b>	<b>78.73</b>	<b>14.80</b>	<b>111.94</b>

*Source: Estimations by the assessment team using official information.*





# RECOVERY AND RECONSTRUCTION

# RECOVERY AND RECONSTRUCTION

**T**otal reconstruction and recovery needs to address the impacts of the December 2020 earthquake are estimated to reach **EUR 8.4 billion**. Of this amount, EUR 2.38 billion (28 percent) is estimated for short-term needs, EUR 3.85 billion (46 percent) for medium-term needs, and EUR 2.17 billion (26 percent) for long-term needs, as shown in Table 3. A total of EUR 7.4 billion is needed for reconstruction of structural measures related to full and/or partial damage to physical infrastructure whereas the recovery needs with inclusive nonstructural measures are estimated at EUR 1 billion. From geographic perspective, Sisak-Moslavina County accounts for 80 percent of the overall reconstruction and recovery needs.

From sectoral perspective, the housing sector accounts for over 56 percent of the overall reconstruction and recovery needs. Across the affected areas, the highest reconstruction and recovery needs are estimated in the social sectors (71 percent of the total needs), followed by infrastructure, productive, and cross-cutting sectors. The housing sector represents the greatest needs totaling EUR 4.76 billion of the overall recovery and reconstruction needs, followed by the culture and cultural heritage (EUR 687 million), water and flood protection (EUR 514 million), and the business sector (EUR 462 million). Reconstruction and recovery needs in the infrastructure sectors total EUR 1.1 billion. For productive sectors, the overall damage and losses recorded are EUR 653 million, with the business sector being the only affected sector in the



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RDNA with estimated needs lower than disaster effects, which is due to high estimates in business interruption. A total of EUR 240 million of needs was estimated in the civil protection and DRR, and geology and land stability.

## Vision and Guiding Principles

**The vision for reconstruction should emphasize resilient reconstruction and sustainable redevelopment.** This includes the use of sustainable and environment-friendly materials, taking note of the circular economy and climate change whereas the overall recovery process, which requires the revitalization of all the affected areas, will also seek to bring benefits to the entire community. Such benefits will especially be in relation to the mitigation of future disasters through seismically resistant retrofitting and construction. This process will also help in strengthening the local economy by starting reconstruction works and providing subsidies to the affected companies and the population returning to the area, as well as attracting new professional and living opportunities.

**The recovery process should include measures and activities to improve capacity of institutions, businesses, and the communities to be better prepared for future events.** The December events revealed different levels of vulnerability and preparedness capacity among stakeholders and sectors. Ensuring that all sectors are resilient and the population is ready to manage disaster risks in a more effective way is critical to reduce disaster impacts. Comprehensive DRM planning needs to be embedded into sectoral strategies and investment both at national and local community levels covering the different sectors at risk.

**Even though Croatia has recent experience with the Zagreb earthquake and therefore with the institutional arrangements for the implementation of recovery and reconstruction programs, every disaster event is different.** While a set of guiding principles and lessons learned emerge from the Zagreb earthquake, these need to be adapted to best fit the new setup. The following guiding principles are proposed:

- **Sustainable revitalization.** Post-earthquake reconstruction provides an opportunity to revitalize the

affected areas by focusing also on critical investments that can drive economic development, such as the business environment and employment opportunities, quality of public services, and livability.

- **Resilience:** Structural measures, such as improved safety and accessibility, functional modernization and upgrading, and EE, need to be combined with strengthening the knowledge and capacity of institutions for DRR and response. This includes education about disaster and climate change risks, reconstruction practices, and training to leading and supporting actors in disaster response. Raising citizens' awareness of mitigation measures to decrease the risks of disasters and how to act in emergencies is critical. Broader, business continuity planning, as well as research, education, and pilot projects on the use of renewable and environmentally acceptable materials as well as on the principles of the circular economy for safer, earthquake-resistant construction, can help provide information and tools for different stakeholders to be better prepared for next disasters. Besides earthquakes, these measures should encompass also other hazards to the extent possible, considering climate change impacts. Given the local context and possibility of progressive damage due to geological processes and/or future aftershocks, the entire recovery process calls for continued monitoring and spatial and geo-mechanical assessments as relevant. The development of specific technical assessments is necessary for risk-informed land use, planning, and safe reconstruction/construction.
- **Focus on the vulnerable and those in need:** The process of reconstruction should be focused on the benefits of the whole community, addressing the needs of different segments of society, business/local economy actors, especially those most in need. Recovery and reconstruction activities must be inclusive and equitable, taking into consideration poverty, social inclusion, gender equity, and actions needed for the most disadvantaged social groups. This can be achieved through the engagement of all levels of government, academia, the private sector, and civil society to promote resilient livelihoods supporting the most vulnerable and reduce future disaster risks.
- **Coordination and coherence of approaches:** To identify synergies and complementarities, the short-, medium-, and long-term objectives and targets should reinforce each other, and aligned with sectoral reform programs, as well as development plans

at both national and local levels.

- **Monitoring and evaluation.** Recovery and reconstruction processes need clear allocation and division of funds and clarity over the use of different funding instruments available. To ensure “value for money”, the recovery process needs to be monitored against established targets and timelines and in consultation with the affected societies and groups.

## Prioritization of Needs

### The prioritization process for recovery and reconstruction planning needs to consider different time frames.

In the aftermath of the earthquake, the focus is on planning recovery and reconstruction activities that respond to the immediate effects of the disaster noted as part of short-term needs. A priority in the short-term is ensuring the safety and security of the affected population and addressing the most urgent and basic needs of the affected population (particularly vulnerable groups), including food and shelter/housing, public services, and economic activity restoration. The medium- and long-term actions and investment should focus on upgrading public access to basic services and markets, strengthening different fac-

ets of disaster and climate resilience, and using recovery to enforce reforms for sustainable results.

**Given the range of 13 respective sectors and five geographic areas as part of this RDNA process, the recovery setting is characterized by multiple demands across every sector and affected area.** Quantified data on the physical impact on critical sectors can guide overall resilient reconstruction and sustainable redevelopment, and prioritization of specific investments and activities. Considering geographic focus, a clear priority is Sisak-Moslavina County given the scale of damage and losses. Considering sectors, housing and the business sector deserve special attention. The following are key highlights across the assessed sectors with more details in respective sectoral assessments:

- **Poverty, social inclusion, and gender.** Special attention needs to be paid by the authorities to ensure that recovery and reconstruction process alleviate the impacts of the earthquake on the welfare of the poor and the vulnerable groups. Efforts by public authorities in partnership with civil society to reconstruct community infrastructure and activate human capital should be at the center of the recovery and revital-



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ization process in the earthquake-struck areas. The quality provision of basic services is a precondition for the recovery and revitalization of the area. The resilient recovery of the earthquake-affected areas should also focus on 'BBB for women' in a COVID-19 context.

- **Housing.** Highest needs are recorded with the housing sector. As an immediate need, it is of utmost importance to prevent additional damage to housing stock, especially due to aftershocks to the further weakening of buildings that have sustained structural damage. In the long term, it will be necessary to establish housing conditions that are in accordance with recent scientific findings regarding the resistance of structures to seismic stress. The reconstruction of damaged housing will also need to consider the social, cultural, sanitary, environmental (including EE), and other aspects appropriate for a modern living.
- **Health.** Considering the COVID-19 pandemic, which poses a considerable threat, the recovery of the health sector should also be considered a priority at first with a short-term goal of restoring the capacities of the health sector as quickly as possible. The long-term strategy needs to consider overall Croatian health system recovery enabling its resilience to disasters and pandemic risks, modernization of facilities, and improving the strategic planning of health infrastructure.
- **Education.** One of the most significant aspects of the reconstruction of the education sector is to prevent the further depopulation of the affected counties. Efforts should focus on ensuring that unusable institutions are functional as soon as possible. Investments in reconstruction and recovery should also support the national structural reform goals of the education sector, even though reform objectives are long term and will take more time to implement than the total period calculated for the reconstruction and recovery process.
- **Social protection.** Social welfare centers need to be reconstructed to provide beneficiaries with unobstructed access to their rights and services, with improved seismic resilience and EE. New and reconstructed facilities should ensure access to persons with disabilities and persons with reduced mobility. Additionally, compensation must be provided for economic losses, which includes job retention subsidies, one-off payments, public works, employment, overtime hours, and the accommodation of beneficiaries.
- **Culture and cultural heritage.** The recovery and reconstruction needs in this sector include the systemat-

ic restoration of historical urban areas and individual cultural properties, the reconstruction of buildings that promote culture in general, improvement of resilience to earthquakes and other risks, and the application of EE measures to architectural heritage. The recovery process needs to consider revisions to spatial planning, and the restoration of historical areas need to be aligned with urban transformation.

- **Business.** The sector's recovery will require well-targeted financial support for firms that can drive growth, create jobs, and be competitive. 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. Greater attention will need to be given to preventive measures, including business safety standards to mitigate the potential effects of similar disasters in the future.
- **Agriculture.** There is great potential for the economy of the affected counties which needs to be considered in the recovery process to benefit from the inherent conditions of this area, the proximity of the City of Zagreb as a potential market for sale of the agricultural products, and other aspects.
- **Transport and communication.** Besides emergency repairs to restore connectivity and working order, medium- and long-term reconstruction includes building better and more resilient infrastructure to a range of hazards.
- **Water and flood protection.** Access to water for human consumption and collection of wastewater is critical for normalization of life, return of the population that has left, and recovery of economy in the earthquake-hit region. In the medium to long term, the extension of the public water supply systems to the areas without access to such systems needs to be prioritized. Regarding flood protection, besides immediate measures to ensure safety, medium-term needs include the construction, reconstruction, and upgrade of water regulation and protection structures. Going forward, the level of protection against the adverse effects of water in Croatia needs to be improved.
- **Energy.** The sector demonstrated a level of capacity to quickly restore services. Going forward, energy investments consider upgrades that need to be prioritized to ensure that the infrastructure is resilient to the impacts of disaster and climate change impacts.
- **Public administration and community infrastructure.** Besides the reconstruction of infrastructure

considering seismic resilience and EE and the restoration of services, the earthquakes showed the need to invest in stable and resilient IT infrastructure. If adequately built and maintained, facilities important to community life can play a significant role in improving livability, health, and social inclusion and during emergency response can provide shelter and support to the affected populations.

- **Waste management.** The Croatian government has begun the recovery process and the preparations for the 'Plan for the Implementation of Waste Management Measures after the Earthquake in Sisak-Moslavina County'. While planning post-disaster waste management, it is necessary to ensure that there are sufficient waste treatment capacities and prioritize waste prevention, reuse, and recycling. It is also important to provide the affected population with preventive educational measures on how to properly separate and hand over waste and educate the public about the dangers of uncontrolled disposal.
- **Civil protection and DRR.** Recovery and reconstruction in the sector should aim for reducing risks and increasing the resilience of the population and local

and regional governments, with particular attention to the integrated scientific-based approach to DRR. The 2020 earthquakes highlighted the urgent need to strengthen local and regional DRM capabilities. This includes (a) greater engagement between the public and government that needs to be better coordinated, (b) use of risk assessment to plan response activities, (c) strengthening of recovery and reconstruction planning (readiness), and (d) greater awareness on DRR and civil protection system among authorities and the general public.

- **Geology and land stability.** Immediate recovery should focus on providing scientific evidence related to geology and land stability to ensure people's safety due to the threat that liquefaction, sinkholes, and landslides pose for the population. Significant efforts should be invested in the mapping and seismic-geotechnical microzonation of the whole affected area for liquefaction, landslides, and sinkholes and identifying areas which are prone to these natural phenomena (geohazards). The findings will feed into the recovery process of other sectors and their planned future developments.



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## Going Forward

**The Croatian government is responsible for the strategic allocation of resources during recovery process in line with the legal framework that covers all aspects of both the material and social recovery.** The recovery and reconstruction planning can draw on actions taken following the March 2020 earthquake, including legal, engineering, institutional, and financial arrangements, and efforts conducted so far in response to the December events. The government has already responded to the earthquake by financing emergency repairs, updating the regulatory framework for the reconstruction of damaged buildings developed after the March 2020 earthquake. During the first three months of 2021, Croatian authorities spent HRK 240 million (equivalent to EUR 31.6 million)<sup>65</sup>, with further funds being secured, including HRK 120 million (equivalent to EUR 15.8 million) worth of intervention assistance funds.

**Going forward, in light of the principles and priorities above, the following aspects should be considered:**

- Along central, regional, and local authorities, existing institutions dedicated to reconstruction efforts, such as Reconstruction Fund and the State Office for Housing

and Reconstruction need to be closely involved in this process.

- The recovery process needs to be aligned with strategic/development plans at different levels, including the 2030 National Development Strategy, to ensure linkages with broader reform programs.
- The recovery and reconstruction recovery process needs to be aligned with the National Recovery and Resilience Plan 2021-2026, which foresees financing of post-earthquake activities, as well as of the different instruments under the EU's Multiannual Financial Framework 2021-2027, which can support the achievement of medium and long-term priorities.

**The government has already initiated work on the long-term program of post-earthquake recovery by establishing the inter-ministerial working group tasked with drafting a comprehensive Recovery Strategy.** In doing so, by building on preparatory reconstruction activities already taken in the field and using the RDNA process as a basis, the government will be able to develop an overall strategic approach for a full revitalization of the area affected by the earthquake. The RDNA process, impact and needs estimations, and recommendations can serve as a basis to facilitate the next steps, with recommendations evaluated and adapted to best fit the strategic action plan.

<sup>65</sup> <https://vlada.gov.hr/vijesti/vlada-odobrila-120-milijuna-kuna-pomoci-zupanijama-pogodjenim-potresom/31165>.





# ANNEXES

# ANNEXES

## Annex 1. Additional Information on the RDNA Methodology

### Field Assessment

**T**he initial post-earthquake damage and usability assessment survey of the affected buildings was developed according to Italian experiences [Post-Earthquake Damage and Safety Assessment and Short-Term Countermeasures or AeDES] and adapted to local circumstances. Three hours after the 5.2 magnitude earthquake on the December 28, 2020, experts from the FCE were invited by the Civil Protection Directorate of the MoI to inspect the damage to buildings caused by the earthquake and assess their usability. A wider team of experts (approximately 15) with the experience from the Zagreb March 2020 earthquake was mobilized, and the following morning, with the help of officials from the City of Petrinja, a hub was established in Petrinja for coordinating damage and usability assessment of buildings. On December 28, 2020, the most experienced engineers inspected the critical infrastructure buildings, and, in addition, put in place the organizational structure (applications, equipment, and so on) for the arrival of a large number of engineers who volunteered in damage assessment whereas the invitations were sent by the Chamber of Civil Engineers, Architects and Court Experts. On December 29, 2020, there were already approximately 50 expert engineers deployed in the field assessing damages when another, stronger, earthquake struck and left some of the engineers buried under rubble, suffering minor injuries. The second earthquake of December 29, 2020 with 6.2 magnitude caused even more damage which resulted in an even larger response from volunteer engineers willing to take part in damage and usability assessment. After a few days, the number of engineers exceeded 1,000, and more than 1,700 were registered through the damage assessment system at the time of RDNA. Coordination centers were established in Glina, Sisak, and Zagreb. Given the COVID-19 pandemic circumstances, it was especially difficult for engineers to work in the field and in the coordination centers.

The inspection looking at usability and damage levels focused mostly on Sisak-Moslavina County; however, part of the engineers' teams also inspected buildings in Zagreb County, Karlovac County, Krapina-Zagorje and the City of Zagreb. The inspections were performed by civil engineers in teams of two. During each assessment, engineers filled in the Collector GIS application (ArcGIS Online geoinformation platform, Collector, ArcGIS) which was developed after the March 2020 earthquake. This application was upgraded and improved based on the experiences from the March 2020 earthquake and adapted locally to the typology of buildings in the affected area. The engineers entered all the necessary attributes, photos, and damage data, as well as all additional data needed to calculate the costs into the application. All the data were automatically collected in the database and processed in the coordination center. Based on the database, the calculation of damages was done. The methodology for assessing earthquake damage and usability was developed according to the Italian experience [AeDES] and adapted to the local conditions. The damage assessment is based on the EMS-98 scale.

As of March 8, 2021, the inspections have taken place over a duration of 70 days and 37,276 buildings were inspected out of a total of 48,941 buildings, which were flagged as potentially damaged/petitioned for more in-depth inspections.<sup>66</sup> This represents 75.6 percent of inspected buildings out of the overall number of usability inspection requests. Most of the inspections were carried out in the most affected areas of Sisak-Moslavina County. The primary goal was to inspect the critical infrastructure and severely damaged buildings to ensure that the most vulnerable population could find alternative accommodation (if needed). Also, it was necessary to ensure the functioning of the most important institutions. Moreover, the aim of the inspection was to raise awareness of the imminent danger posed by damaged parts of buildings to prevent accidents and ensure the safety of people living in the buildings and nearby areas.

<sup>66</sup> <https://www.hcpi.hr/> as viewed on March 8, 2021.

**Table 113.** Usability and damage levels for buildings

Type of building					
U0	U1	U2	PN1, PN2, N1	N2	
D0	D1	D2	D3	D4	D5

## N1

### Unusable – due to external impact

**Explanation:** The building is dangerous due to the possibility of collapsing massive parts of the neighboring building (most often gable walls and massive chimneys). Due to such a danger, it is recommended not to stay in such buildings at all (especially given the large number of earthquake recurrences).

## N2

### Unusable – due to damage

**Explanation:** The building has major damage to the load-bearing system, there are collapses of load-bearing and non-load-bearing elements. It is recommended not to enter and stay in the building. This does not necessarily mean that the building must be demolished - such decisions are made in the later stages.

## PN1

### Temporarily unusable – detailed examination required

**Explanation:** The building has moderate damage with no danger of collapsing. The load-bearing capacity of the building is partially impaired. It is not recommended to stay in the building, ie citizens stay in such building at their own risk. A shorter stay in the building is possible, with the advice of a construction expert regarding the necessary measures and restriction of stay (depending on the danger). The construction expert makes recommendations to eliminate the hazards.

## PN2

### Temporarily unusable – necessary emergency measures

**Explanation:** The building has moderate damage without the danger of collapsing, but it cannot be used due to the potential danger of collapsing certain elements from the building itself. The construction expert identifies emergency intervention measures and gives instructions to users. Until the measures are implemented, the building or part of it is not usable (for example, the roof). Temporary unusable can only apply to some parts (units) of the building.

## U0

### Usable without damage (no damage)

## U1

### Usable without limitation

**Explanation:** The building can be used. The building is undamaged or has minor damage that does not pose a danger to the load-bearing capacity and usability of the building.

## U2

### Usable with recommendation for treatment

**Explanation:** The building may be used in accordance with the intended purpose, except in certain parts where there is an immediate danger to a part of the building. The construction expert gives recommendations for removing hazards (for example chimneys) and recommendations to users for temporarily limiting the stay in certain parts of the building. Once the danger has been removed, the building can be used without restrictions.



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**The following categories of building usability were used when assessing and filling in the forms:** U0 - usable without damage – building not damaged (white label), U1 - usable without limitation, U2 - usable with a recommendation (green label), PN1 - temporarily unusable - detailed inspection required, PN2 - temporarily unusable - necessary emergency measures (yellow label), N1 - not usable - due to external influences, N2 - not usable - due to damage (red label). All civil engineers who carried out the inspections underwent a brief training. Interested residents and civil engineers were able to access all necessary information on the website [www.hcpi.hr](http://www.hcpi.hr), set up after the earthquake by volunteer civil engineers.

**Usability labels are correlated with the damage according to EMS-98 (grades 1 to 5) based on which costs of repair and renovation have been established (Table 113).** According to the experience of reconstruction in previous earthquakes of a similar typology of buildings, which is mainly unreinforced masonry and to a lesser extent confined masonry, the following costs were adopted, which are expressed in relation to the cost of construction of a replacement building. In determining prices, developments related to reconstruction prices in Italy following the previous earthquakes were also considered (Dayala

et al. 1997), however depending on the typology of the damaged buildings. Reconstruction prices are formed according to the principle that the buildings are restored to their pre-earthquake condition with additional minimum interventions that need to be performed to strengthen the critical elements that led to the damage or partial collapse of a building.

For buildings belonging to category U1, the cost of reconstruction was 5 percent of the price of the replacement building; for category U2 this cost was 20 percent; for moderately to severely damaged buildings under categories PN1, PN2 and N1, the cost of reconstruction was 40 percent as related to the return of the working condition and 60 percent of the replacement building as related to BBB reconstruction needs; and for heavily and very heavily damaged buildings, the construction of replacement buildings is planned because their renovation is not cost-effective. The cost of removing such buildings has been foreseen.

**The prices of replacement buildings (family houses, multi-residential buildings, hospitals, schools, kindergartens, and so on) are aligned with the current situation on the market.** In addition to the mentioned costs, the



cost of cleaning up/debris removal was calculated in the amount of 5 EUR/m<sup>2</sup> for U1 and U2, 10 EUR/m<sup>2</sup> for PN1, PN2 and N1 and 15 EUR/m<sup>2</sup> for N2. For buildings which are protected cultural heritage, the cost has been increased by 40 percent and demolition is not foreseen for such heavily damaged buildings. An additional cleaning up cost is foreseen for these assets.

All the information from the database derived from the engineers' damage assessments were also made available to local government (city level) and national government institutions to enable them to take actions in accordance with the identified hazards.

## RDNA

**The main objective of the RDNA was to assist the Government of Croatia in the assessment of the impacts of the earthquake by estimating damage and loss financial costs to inform a recovery strategy.** The RDNA sought to inform complete rehabilitation and reconstruction of damaged infrastructure and livelihoods while ensuring resilience to future disasters. The specific objectives of the RDNA were as follows: (a) estimate the sector specific and overall multi-sectoral effect of the earthquake in the affected area namely Sisak-Moslavina, Zagreb, Karlovac and Krapina-Zagorje Counties and the City of Zagreb<sup>67</sup>; (b) assess multi-sectoral effects of the disaster and propose early, medium and long-term recovery and reconstruction needs including reflected costs and timeline; and (c) integrate the seismic safety, BBB, EE and DRR concepts into recommendations for a recovery and reconstruction strategy to improve future disaster resilience. The international DaLA methodology<sup>68</sup>, which comprises the following key concepts, was used for the assessment:

- **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 opera-

tional 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 DaLA methodology was adapted to the local context**, taking into consideration the approved the Law on Reconstruction of Damaged Buildings in Zagreb and the Surrounding Area, Programme of Measures, as well as the Croatian Government's assessment of damage and losses as part of application to the EUSF. The RDNA focused on social, productive, infrastructure, and cross-cutting issues. Social sectors included: housing, health education, social protection, and culture and cultural heritage. Productive sectors included: business and agriculture. Infrastructure sectors included: transport and communications, energy, water and flood protection, public administration and community infrastructure, and waste management. Cross-cutting areas included: civil protection and DRR, and geology and land stability. The monetary values are expressed in EUR, with exchange rate of 1 EUR = 7.535846 HRK.

**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 FCE, and the World Bank.** Following the training on the methodology and scope of the RDNA, officials and experts from the government, the University of Zagreb's FCE and the World Bank technical teams formed working groups and sector teams. The teams also included members who completed the RDNA training during the RDNA conducted in the aftermath of the 2020 March earthquake. These joint teams undertook an intensive exercise of data collection and verification in just over several weeks. The assessment takes into account damages related to the December 28, 2020 earthquake with the main earthquake being December 29, 2020, throughout February 21, 2021 when the last update was taken from HCPI database and the data on the latest usability status was taken.<sup>69</sup> If some buildings reported twice, the 'worse' assessment was taken into account.

67 Focus will be on any significant and clearly additional damages to avoid duplicate damages already accounted for in Zagreb RDNA following the March 2020 earthquake.

68 For more information: Jovel, Roberto J.; Mudahar, Mohinder. 2010. Damage, Loss, and Needs Assessment Guidance Notes : Volume 1. Design and Execution of a Damage, Loss, and Needs Assessment. World Bank, Washington, DC. World Bank. <https://openknowledge.worldbank.org/handle/10986/19047>

69 <https://www.hcpi.hr/>.

**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 was also provided by the CBS 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 collected and analyzed by Zagreb University's FCE as part of the preliminary damage assessment. Costs related to damages to furniture, equipment and goods were also accounted for across several sectors, whereas losses are calculated in regard to the costs of debris removal, demolition, preventive infrastructure, displacement and temporary accommodation, increased social welfare, job retention measures, emergency response costs in terms of overtime accrued, and changes in economic flow in business sector.

**Other available data was also taken into consideration (particularly in terms of baseline information) to provide robust estimates** (see also sectoral details section below), including information from various government

institutions, CSOs, and private sources. Likewise, social vulnerability, accessibility to public services, and gender aspects were included as much as possible throughout the sectoral analyses. The assessment considered the macro-economic and human impacts of the earthquake. Besides damage and losses, the sector teams identified recovery needs for each sector and provided recommendations for increased resilience in their respective sector. The RDNA process included the collection of relevant data and documentation demonstrating the impact of the earthquake.

**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.** The damage and losses differ substantially between the sectors due to the specificity of their corresponding calculations. All costs expressed in EUR with national VAT (25 percent). Damage considers the number of damaged buildings and the total area in m2 to have suffered different levels of damage as noted above. The economic value of damage is calculated by using the average value of repair costs corresponding to different usability levels (green, yellow and red), drawing on prices established by the Law on Reconstruction of Damaged Buildings in Zagreb and the Surrounding Area,



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the Programme of Measures, and importantly, based on the experience of reconstruction in previous earthquakes of a similar typology of buildings particularly the Italian examples of L'Aquila and Emilia Romagna also connected to the use of AeDES methodology. 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). These were evaluated as flat rate values depending on the extent of damage and the specifics of individual buildings.

**Based on the estimation of damage and losses, as well as qualitative impacts, each sector identified recovery and reconstruction needs.** The needs identified form the basis for determining short-, medium-, and long-term interventions. Reconstruction and recovery needs are articulated with priorities, sectoral stakeholders, estimated costs, and a recovery timeline to form the basis for an elaborate recovery strategy. Such strategy and more detailed plan should outline institutional arrangements, available financial mechanisms, and monitoring and evaluation tools. The costs consider the reconstruction of destroyed assets, provision of services, improved specifications, and DRR measures. It is assumed that the BBB principle will be used in the rehabilitation and reconstruction of damaged buildings, as well as improvements in EE. 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 is established in line with the relevant regulations.

**Recovery needs primarily aim to restore and subsequently improve basic services across all affected sectors compared to the pre-disaster level or better.** This means resumption of access to services and goods as basic needs of all affected individuals, families, and communities, as well as restoration of governance and social processes with a goal of revitalizing and improving institutions and policies by strengthening the capacity of sectoral leads in managing the recovery process. Reconstruction measures should strengthen existing infrastructure as well as institutional capacity to mitigate earthquake risks is a key factor in improving the community's resilience in the future. In this context, BBB and EE approaches were applied to the recovery and reconstruction needs.

## *Additional Details for Select Sectoral Damage and Loss Assessments*

### **POVERTY, SOCIAL INCLUSION, AND GENDER**

This sector assessment focuses on four key aspects of the impacts of the earthquake on people's livelihoods: poverty, characteristics of vulnerable population, level of access to basic services, and gender. The assessment draws on sectoral information, consultations with national and local public officials, international and Croatian CSOs, and national and international research to provide background information, document the impacts of the earthquake, and propose key recommendations to support the sustainable and resilient recovery of people's livelihood.

### **CULTURE AND CULTURAL HERITAGE**

Losses were determined based on the degree of damage to the building and gross building area, which include emergency measures of removing seriously damaged structural parts and removal of debris as well as preventive measures for the preservation of individually protected buildings to prevent further building degradation. For standard buildings, which are protected cultural heritage, the cost has been increased by 40 percent and demolition is not foreseen for such heavily damaged buildings. For churches due to the complexity of structural elements like wall height, large vaults, and arches, as well structures as towers and domes are taken into account with structural coefficient varying between 2 and 3.5 depending on complexity of elements.

The cost of losses includes cleaning up/debris removal that are the same as in other sectors, an additional losses consider heritage preservation and protection of further degradation like emergency measures such the installation of supporting scaffolding, removal of damaged church towers, decomposition, cleaning, and storage of masonry bricks for the reconstruction of heritage buildings as well as long period of recovery process that includes restoration of art works on churches. Additional losses collected from cultural institutions include losses related to the evacuation of inventories, replacement space as well as other specific costs related to the institution functionality. The damage to inventories of movable cultural goods was surveyed, mainly sacral inventory (organ, altars, sculptures, and so on). Considered costs included evacuation, restoration, equipping for and provision of replacement space.

Additional losses cost for heritage buildings were counted in the amount of 5 EUR/m<sup>2</sup> for U1 and U2, 10 EUR/m<sup>2</sup> for PN1, PN2 and N1 and 15 EUR/m<sup>2</sup> for N2. For chapels and churches, this loss is increased due to before mentioned reasons to 15-45 EUR/m<sup>2</sup> for U1 and U2, 30-80 EUR/m<sup>2</sup> for PN1, PN2 and N1 and 45-120 EUR/m<sup>2</sup> for N2.

## BUSINESS

**Damage assessment:** Due to the limited availability of data within the business sector, the assessment of direct damage focuses on damage occurred in the buildings (housing sector). The basis for the formation of the assessment of direct material damage to buildings as a result of the earthquake were the following documents: (a) ArcGIS database of damage assessments across all sectors; (b) list of damage claims from the Chamber of Commerce by counties; (c) list of damage claims from the Utility companies; and (d) GIS analytics conducted by the Faculty of Geodesy, University of Zagreb.

**Limitations of data:** Each of the following databases has its drawbacks and shortcomings in terms of data availability. (a) As a substructure of the purpose of the inspected buildings, the ArcGIS database does not have a completely separate sector of business and production, and it very often overlaps with the sectors of housing, agriculture, public usage). Among these, it is not possible to unambiguously single out the buildings that make up the business sector, and therefore this database was used as a basis for considering the total area and the relationship of the business sector with the housing sector. (b) The list of claims of the Chamber of Commerce by counties contained a list of economic entities that responded to the invitation to report damages within the appropriate deadline. Also, the primary need of these tables of the Chamber of Commerce was to collect direct damage to the equipment, and therefore these tables usually did not contain the sqm of damaged areas. Information on direct damage to equipment was used from this database, and it was used as a corrective for damage analysis in SM County. (c) The lists of reported damages of the Utility companies referred to the inventory of the level of damage to buildings for the purpose of exemption from payment of utility fees, but these covered only certain regions within Sisak-Moslavina County, while other counties were not represented. This database was used as a control sample of areas for Sisak-Moslavina County by municipalities. Finally, (d) the GIS analytics conducted by the Faculty of Geodesy contained analytics that only covered Sisak-Moslavina

County, Karlovac County and Zagreb County, while the City of Zagreb and Krapina-Zagorje County were not analyzed. This database was used for the identification of areas of industry, and business purposes for Sisak-Moslavina County, Karlovac County, which were corrected by available information from previously elaborated databases.

**Based on the data, the following conclusions were drawn on the total area of damaged buildings in the business sector:** damages incurred, costs of removal of rubble and reconstruction costs were estimated on the basis of table for buildings for business purposes, and a table for buildings for industrial purposes. Using RDNA tables (as per methodology above) for each m<sup>2</sup> of the building with the corresponding level of damage, the costs of damage caused by building damage, the cost of removing rubble, chimneys and roof tiles that can endanger the environment and passers-by, the cost of restoration were estimated. For buildings that were assessed as “unusable due to damage” in the earthquake, in addition to the costs of damage, removal of rubble and reconstruction, the costs of demolition and disposal at the landfill in the amount of 98 €/m<sup>2</sup> was added.

**Damage assessment for the equipment** was based solely on damage reports collected by the Chamber of Commerce. These reports were reviewed to avoid duplication, and values were added to the report. No damage projection was made in the damage assessments of the equipment because the damage to the equipment cannot be related to the square footage or the level of damage to the building.

## AGRICULTURE

**Pre-disaster baseline data for five counties** drew on data sources including the following: number of agricultural holdings; Farm register, October 2020 (Paying Agency); Utilized agricultural area divided by the category of land use, number of plots per holding; LPIS, Farm register, October 2020 (Paying Agency); number of animal growers; animal register, December 2020 (MofA); Number of livestock per categories, separately for cattle, pigs, sheep and goats, donkeys and horses, poultry; Animal register, December 2020 (MofA); Number of beehives, Beekeeping union, December 2020; Labour force – paid employment in crafts and free lances and legal entities, gender balance in paid employment; CBS, March 2020; Labour force – annual work unit (Preliminary FADN standard results 2019, February 2020, total labor input in AWU);

Value of production expressed in total standard output per holding multiply by the number of holdings in each county affected (Preliminary FADN standard results 2019, February 2020, total standard output); and Agricultural assets, materials and supplies, total estimated value per holding multiplying by the number of holdings in each county affected (preliminary FADN standard results 2019, February 2020, closing value of agricultural land, farm buildings, machinery, stocks of material and agricultural products).

**The assessment of the damages and estimated values,** drew on for (a) agricultural land on the number of damaged agricultural area due to liquefaction, sinkholes or landslides; estimation in hectares based on total area affected; and information from the RGNE; for (b) Farm buildings and storage facilities on the number of damaged objects on holdings collected by the advisors and veterinarians directly from the farmers (farm visits and contacts) using google.doc and web application; for (c) Mechanization and equipment on the number of damaged in items on holdings collected by the advisors and veterinarians directly from the farmers (farm visits and contacts) using google.doc and web application, and the estimation value based on baseline value of machinery and equipment (FADN standard results 2019 – average value of mechanization and equipment); and for (d) Livestock by categories of livestock and the number of injured or killed animals collected by the advisors and veterinarians directly from the farmers (farm visits and contacts) using google.doc and web application; estimation based on market value by category of animals in 2019 (Market Information System, MoA); and estimation of annual losses in production by category of animals (SO 2013 coefficients).

**The damage based on current losses in crop and animal production on damaged areas is included** (calculation is based on 2,000 agricultural holdings which reported damage), and total amount of EUR 11.556 million is estimated as a percentage (30 percent) from the total output in agriculture for all five counties in the affected area (based on the preliminary FADN research for 2019 average output for Sisak-Moslavina County was EUR 19,260). Additionally, only in Sisak-Moslavina County agricultural area is recorded as damaged due to liquefaction, sinkholes or landslides, and the estimated area is 1,400 hectares. Estimated damage due to this year's losses are calculated in amount of EUR 3.360 million (based on corn as the predominant crop). However, if it is a matter of permanent

damage to certain plots, then this value can be multiplied by a certain number of years (10 or 20 years).

## TRANSPORT

**Transport:** Damage assessment of road infrastructure was performed by means of a survey issued by MSTI to all public road managers. All managers including highway administration, state road administration, county road administration and municipality administration have given reports on road damage including the information on road ID, location, length and type of damage and damage cost. Damage cost has been based on main and unscheduled survey performed by authorized legal entities. Reports have been constructed by authorized civil engineers and cost estimate is based on market cost for particular type of work. Damages and losses on railway infrastructure have been calculated as a result of direct damage assessment by appointed certified structural engineers. Based on initial damage assessment, detailed rehabilitation documentation has been ordered and works are under way to establish safe rail operations. Damage to inland waterway facilities is present on management buildings and on shipyard dock. Damages and losses on inland waterway facilities have been calculated as a result of direct damage assessment by appointed certified structural engineers.

**Roads:** Damage assessment of road infrastructure has been performed through a survey issued by MSTI to all public road managers. All managers including highway administration, state road administration, county road administration and municipality administration have given reports on road damage including the information on road ID, location, length and type of damage and damage cost. Damage cost has been based on main and unscheduled survey performed by authorized legal entities. Reports have been constructed by authorized civil engineers and cost estimate is based on market cost for particular type of work.

**Railways:** Damages and losses on railway infrastructure have been calculated as a result of direct damage assessment by appointed certified structural engineers. Based on initial damage assessment, detailed rehabilitation documentation has been ordered and works are under way to establish safe rail operations.

**Inland waterways:** Damage to inland waterway facilities is present on management buildings and on shipyard dock.



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Damages and losses on inland waterway facilities have been calculated as a result of direct damage assessment by appointed certified structural engineers.

**Buildings:** The methodology implemented for the damage and loss calculation in buildings is based on the general methodology adopted for all sectors, with the exception of: (a) the buildings of operators HŽ Cargo, HŽ Putnički prijevoz, and the Sisak port authority, which were evaluated based on the damage assessment report of certified structural engineers; and, (b) certain buildings that were designated for demolition by HŽ Infrastruktura due to extensive damage; since there were no reconstruction efforts, only the demolition costs were calculated.

## ENERGY

Damages in the sector were calculated for HEP ODS and HOPS. For the HEP- Operator distributor System Ltd, the process followed multiples steps. First, the state of the infrastructure before the earthquake was recorded based on data review on cities and municipalities, number of households, number of inhabitants and number of settlements. An overview of the medium voltage network (10 kV, 20 kV and 35 kV) and its separation into overhead and under-

ground was conducted. A low voltage network 0.4 kV and its separation into overhead and underground networks were inspected. Afterwards, a report was prepared on the number of overhead and underground connections. An overview of the number of electricity facilities included (a) Substations of energy 110/35 kV, 110/20 kV, 35/20 kV and 20 kV; (b) Switches 20 kV; and (c) Substations distribution 20/0,4 kV and 10/0.4 kV. Measuring points (customers) of electricity were considered including high voltage, medium voltage, households, public lighting, entrepreneurs. Data on administrative buildings were presented based on the number of floors and surfaces in m<sup>2</sup>. On the basis of field assessment, damage to HEP-ODS power plants was assessed. In the first 48 hours following the earthquake, the supply of electricity to customers was ensured. Immediately after the earthquake it is necessary to rebuild electricity facilities, for example power lines, transformer cable stations and low voltage networks that are either completely destroyed or are in such a state that they are threatened with collapse and they threaten the stability of the supply of electrical energy. In the immediate phase, the value of the rehabilitation of these facilities was estimated and valued at HRK 82 million (approximately EUR 10.90 million). Consumption levels were compared with



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the same time interval in the day before the earthquake itself or the same days of the week before the earthquake. Based on this, it can be estimated that the financial loss of compensation for the transmission and distribution network in the observed time is approximately HRK 86,000 (approximately EUR 11,400).

Based on the list of cities and municipalities defined by the Civil Protection Headquarters, located in the three counties Sisak-Moslavina, Karlovac and Zagrebacka, HEP ODS has produced a list of accounting measuring points belonging to distribution areas: Elektra Sisak, Elektra Karlovac, Elektra Križ and Elektra Zagreb. Estimates of electricity consumption and the amount of compensation for the use of the network are based on data from the corresponding last period, January-March 2020, with an estimate of an average increase of 10 percent in consumption for these categories of network users in the period January-March 2021. The estimate of the increase in consumption is based on the increase in the peak load of the distribution area of Elektra Sisak in January 2021 compared to January 2020. Fee for the use of the transmission and distribution network for the period January - March 2021, by cities, municipalities was taken into account. The

VAT amount and total amount for the fee for the use of the transmission and distribution network for the period January - March 2021, was calculated according to the tariff models of the network user.

For HOPS, an assessment of the duration of the interruption of electricity supply was made, as well as an estimate of loss of electricity per substation. This considered estimated loss due to interruption and uncollected mesh, estimated losses due to non-distributed energy produced, the state of infrastructure on the quake-hit area, before the earthquake (transformer stations, power lines, administration buildings); and damage to infrastructure at individual transformer stations (including TS 400/110 kV Tumbri, TS 220/110 kV Mraclin, TS 220/110/6.3 kV TE Sisak, TS 110/20/10 kV Siscia, TS 110/35/33/6 kV Steel-Works, TS 110/35 kV Pračno, TS 110/10(20) kV Petrinja, and TS 110/20 kV Glina).

### **WATER AND FLOOD PROTECTION**

The assessment of the earthquake damages to the water and sanitation sector were made by the technical experts of the public water service providers based on: already incurred costs, estimates based on both the previous

experience and expert knowledge, and reconstruction estimates received. In some cases, damage assessments were made based on studies prepared by court experts

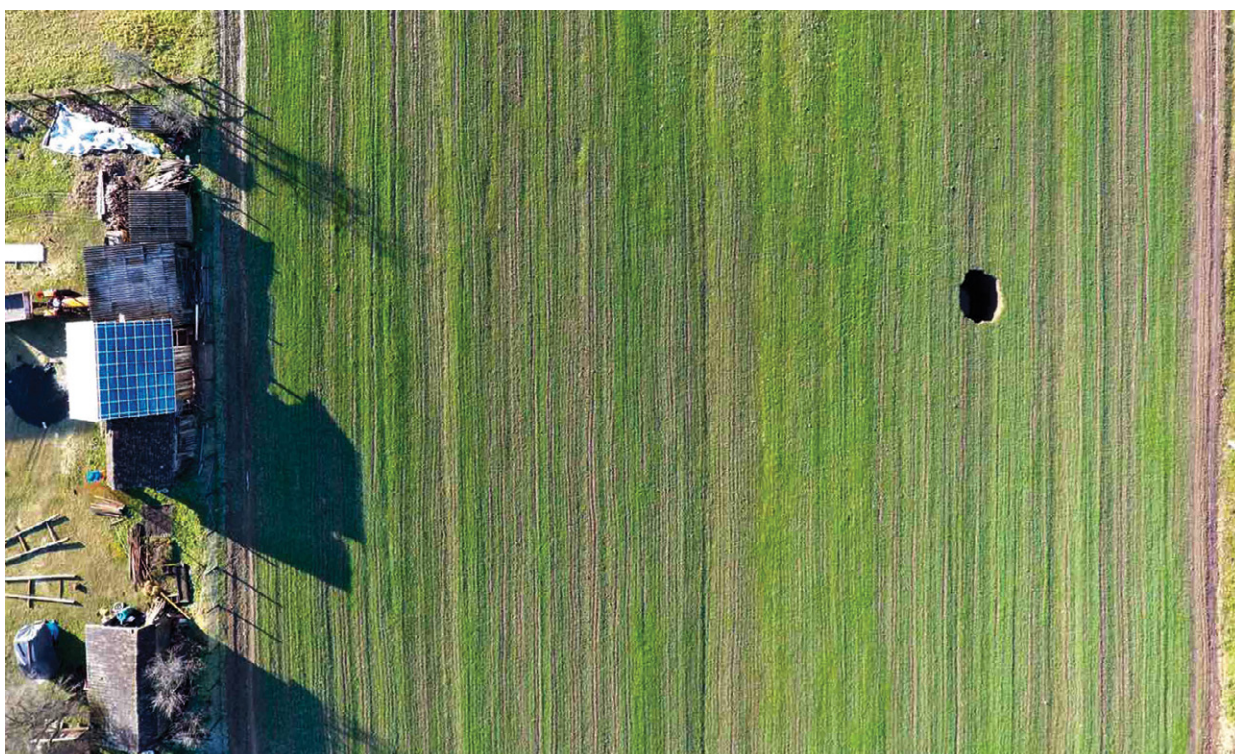
In order to collect data on the damage sustained, the public water services providers were contacted immediately after the event. They submitted the required data in tables provided and developed by the Ministry of Economy and Sustainable Development (MoESD) that included the type of damage, a brief description of damage, estimated cost amounts and their cost estimation methodology. All submitted data on the damage are based on estimates made by public services providers or rehabilitation bids, since they currently do not have available data based on studies, with the exception of Privreda Petrinja d.o.o., that based its cost estimates on studies by a legal assessor. In addition, the damage to the administrative buildings, warehouses and office equipment were assessed using a uniform methodology for all sectors. Damage to buildings in the water and sanitation sector refers only to the administrative buildings and warehouses of the public water service providers that reported damage to the MoESD.

Related to flood protection, damage assessments were

made by the expert services of Hrvatske vode company, which assessed damages in the field, collected photos, and other documentation. As part of the assessment, all damages were clearly recorded and documented across the identified locations. Also, information on emergency interventions to protect people, their property and the environment, and options for repairing identified damages, were collected with cost estimates. The results were validated by expert services in *Hrvatske vode company*.

Hrvatske vode company is the legal entity for water management in Croatia, with activities determined by the Water Act (and their main activity is flood *protection*). The company performs, among others, the following activities: flood risk assessment, monitoring the state of watercourses and the state of regulatory and protective water structures; investment activities in the construction and maintenance of regulatory and protective water structures; supervision over the construction and maintenance of regulatory and protective water structures; flood risk management; management and supervision and implementation of preventive; and regular and emergency flood defense.

After the earthquakes, expert services of Hrvatske vode



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company, comprising of engineers of different profiles, participated in filed damage assessments and organized 24/7 duty work and professional surveillance across the affected areas. This followed an order of the the director of the Water Management Department (VGO) for the Middle and Lower Sava to conduct a field inspection of all water structures in the area managed by the competent Water Management Department. All ten Water Management Offices (VGI) submitted inspection reports with the observed damages. The submitted reports showed that the majority of the damage occurred in the area of BP 10 - the area of the small Banovina basin. Preliminary results of the inspection indicated seven locations of significant damage to the Sava and Kupa embankments. Considering the extent of the damage, and in order to preserve the functionality of the flood defense system at BP 10, extraordinary flood protection measures were declared and daily tours of water structures and 24/7 duties were ordered, in accordance with the National Flood Defense Plan. In January 2021, after additional aftershocks, during the inspection of a total of 320 km of defensive embankments in the area of BP 10, new damage to water structures was identified, which increased the number of locations to thirteen.

Also, detailed analyses of damage to water structures were performed by civil, hydraulic, geo-mechanical and geodetic engineers. The study which was developed as a result of these analyzes contains cartographic presentation of the location of individual damages, photo documentation, dimensions of the affected area, potential causes, emergency response to preserve the functionality of the flood defense system and proposals for final reconstruction. The study also contains estimates of the costs of active flood defense, including emergency

interventions, the costs of preparing a reconstruction project with geotechnical survey work, laboratory testing and geotechnical study, and an estimate of the cost of reconstruction works. In estimating the costs, data on the values of similar works on the construction of water structures that were contracted on the basis of public procurement in the last five years were used. The study passed the quality control of Hrvatske vode's professional services. Periodic inspection tours of water structures have been conducted. The most critical damage was repaired or a second line of defense was built. Across all activities, daily reports have been prepared detailing the work performed (with tabular, cartographic and photo documentation) across all damage sites.

### **PUBLIC ADMINISTRATION AND COMMUNITY INFRASTRUCTURE**

For courts and penitentiary facilities, damage to equipment and furniture has been calculated based on its prices from procurement contracts. Losses related to the relocation of inmates from damaged prisons to other such facilities around Croatia have been calculated by multiplying the mileage and working hours of judicial police.

### **GEOLOGY AND LAND STABILITY**

The rehabilitation costing methodology was based on experience with similar landslide structures. Prices were set by an expert with relevant experience. The methodology for determining the prices of remediation was based on an assessment of possible future remediation measures for liquefaction as currently, there is no geotechnical data for the exact determination of the method of remediation. For price ratios, standard relations for research and design in geotechnics were used.

## Annex 2. Seismic Risk Context and the December 2020 Earthquake

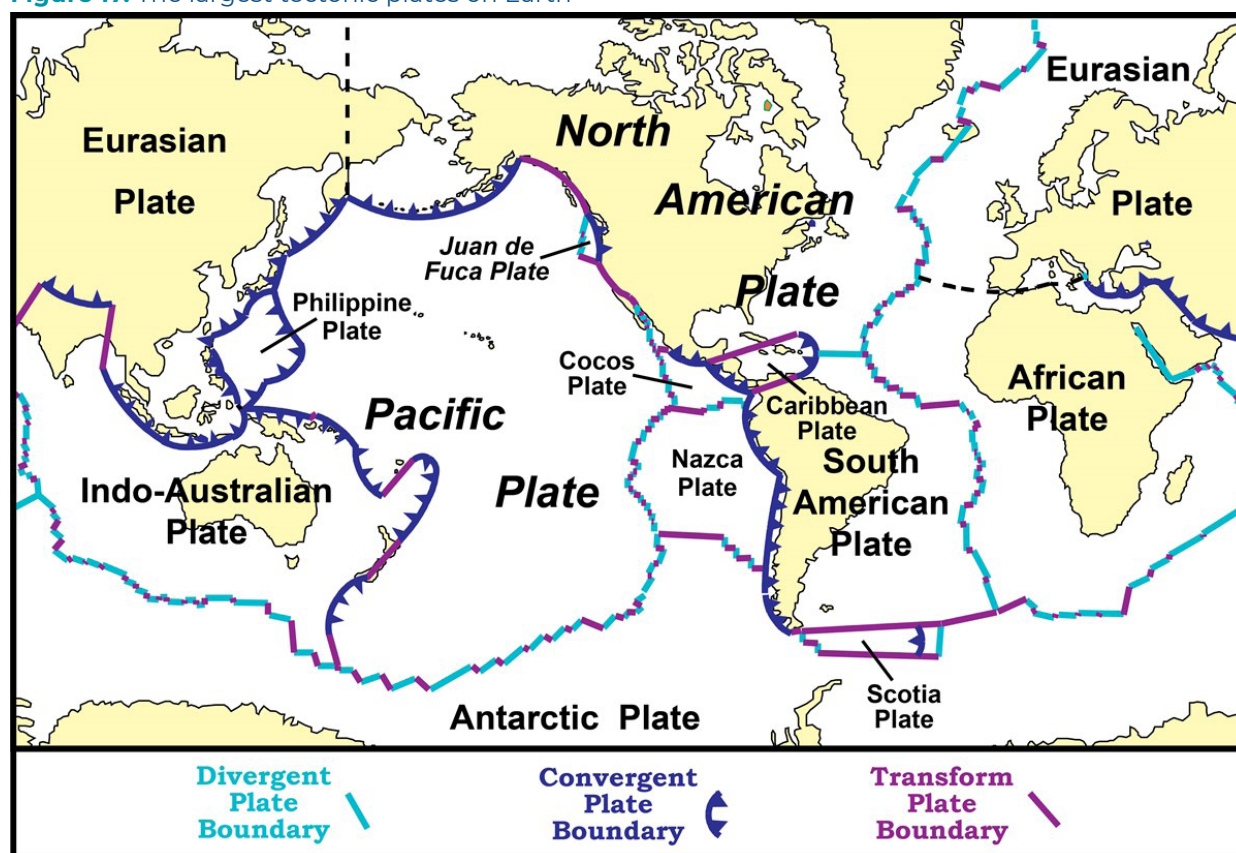
### EARTHQUAKE GENESIS

An earthquake is the result of a sudden release of stored energy in the Earth's crust that is transmitted by seismic waves. The accumulation of elastic energy occurs due to the movement and interaction of lithospheric tectonic plates, composed of the Earth's crust and the uppermost part of the mantle, at an average velocity of a few millimeters per year (Figure 17). Earthquakes most commonly occur along fractures or fracture zones between two blocks of rocks, called faults. Faults accommodate relative movements of rock blocks within the crust. These movements may occur rapidly by generating earthquakes – or may occur slowly, in the form of creep. Faults may

range in length from a few centimeters to thousands of kilometers. The fault surface can be horizontal, vertical, or inclined with an arbitrary angle of dip and a dip direction.

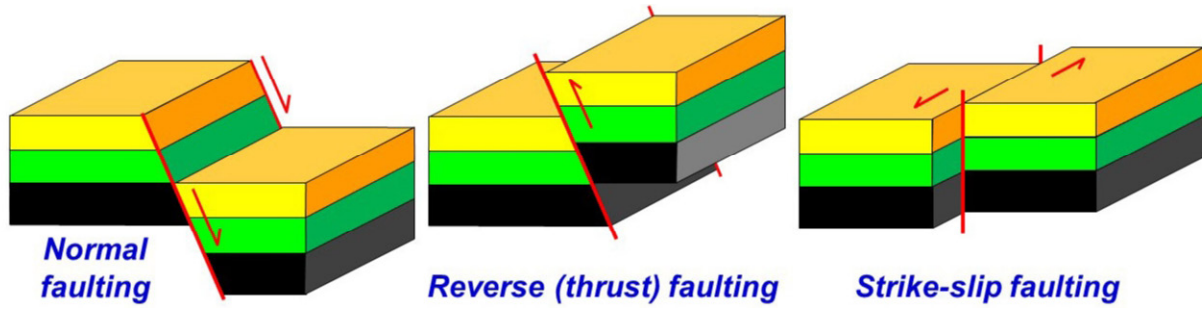
During an earthquake, a relative displacement of rock blocks occurs along a fault by a fault-slip. Depending on the fault-slip direction, there are three main types of faults: a normal fault is the one in which the hanging wall (a rock block above the fault plane) moves down with respect to the footwall (a rock block below the fault plane); a reverse fault is the one in which the hanging wall moves up with respect to the footwall, and, a strike-slip fault is the one where rock blocks on opposite sides of the fault slip horizontally relative to each other. In case of strike-slip faults relative displacements can be sinistral (left-handed) or dextral (right-handed). Most of strong and damaging earthquakes occur at tectonic plate boundaries: normal faults prevail along divergent plate boundaries, reverse faults prevail along convergent boundaries and strike-slip faults prevail along transform plate boundaries (Figure 18). However, as tectonic stresses generated at particular

Figure 17. The largest tectonic plates on Earth



Source: National Park Service, <https://www.nps.gov/subjects/geology/plate-tectonics-evidence-of-plate-motions.htm>, last accessed 5 March 2021.

**Figure 18.** Types of faults



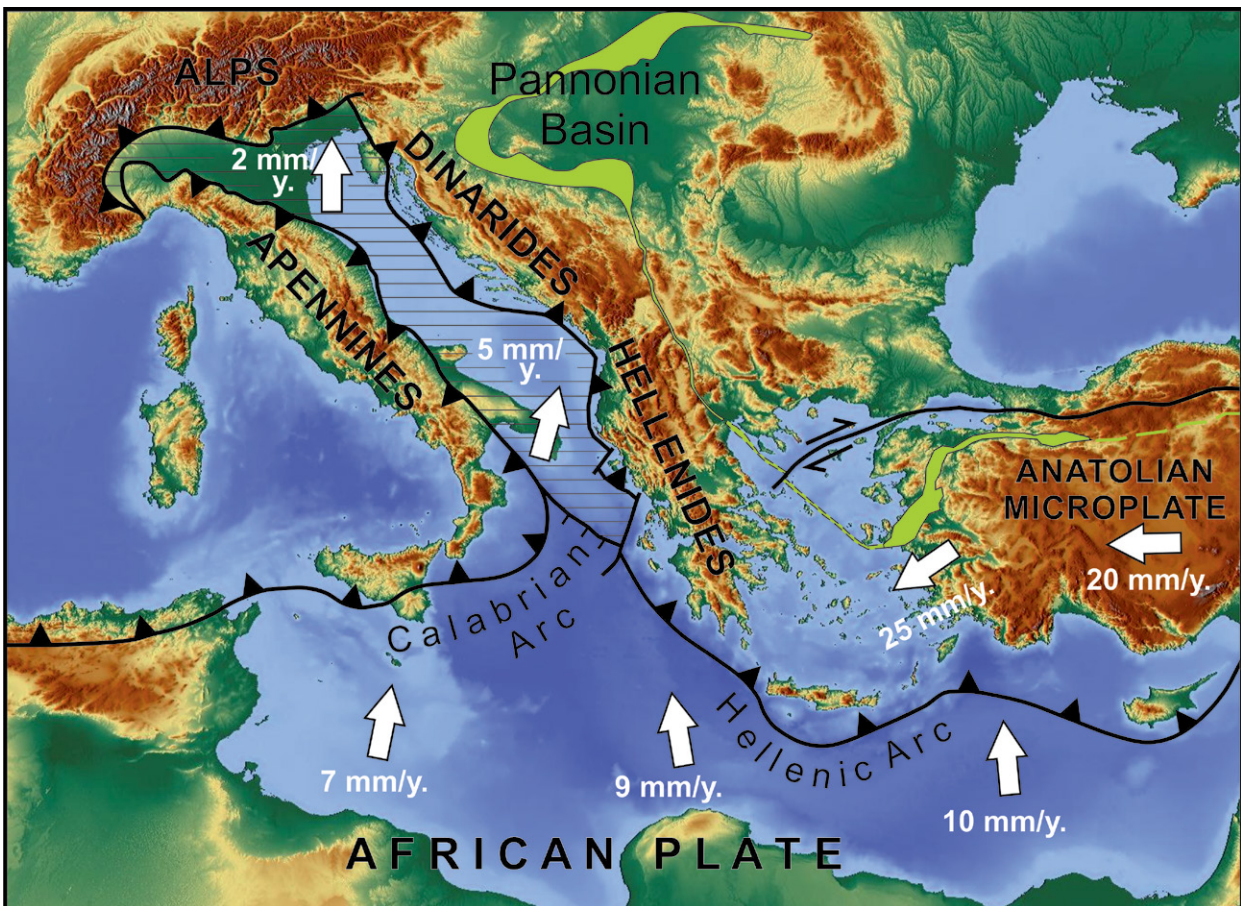
**Source:** Faults (tectonic), Coal Mining Geology, Kentucky Geological Survey, University of Kentucky ([uky.edu](http://uky.edu)), (<https://www.uky.edu/KGS/coal/coal-mining-geology-fault.php>), last accessed 5 March 2021.

plate boundaries could be also transferred within the crust into internal parts of a plate, earthquakes can also occur some hundreds of km away from the plate boundaries.

**SEISMIC RISK IN CROATIA**

The active tectonics of the entire area of Croatia, including the wider Pokupsko-Petrinja-Sisak epicentral area, is

**Figure 19.** Geodynamic sketch of the Eastern Mediterranean



**Source:** Compiled from Handy et al. 2019<sup>70</sup>; McClusky et al. 2000<sup>71</sup>; Reilinger et al. 2006<sup>72</sup>; Schmid et al. 2020<sup>73</sup>; Weber et al. 2010<sup>74</sup>.

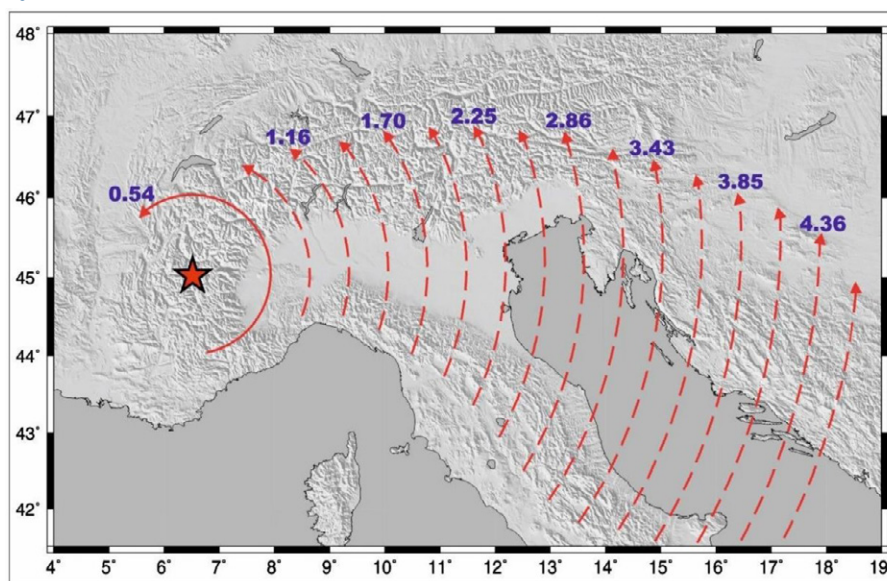
**Note:** The figure shows the main tectonic boundaries and GPS-derived velocities relative to a stable Eurasia. The relatively stable foreland of the Adriatic microplate is indicated by horizontal lines. The Sava suture zone along which the Adriatic microplate collided with Eurasia is shown in light green.

driven by the ongoing convergence between the Adriatic microplate (Adria) and the European plate (Figure 19). According to the velocity rates derived from Global Positioning System (GPS), this convergence amounts to approximately 2–5 mm per year. Most of this convergence is taken up within the external Dinarides thrust belt, near the Adriatic Sea coast and its hinterland. However, a part of the convergence is transferred into the internal Dinarides and the southwestern margin of the Pannonian basin, as noted by the historically and instrumentally recorded strong and destructive earthquakes in northern Croatia (such as the Zagreb earthquakes in 1880 and 2020) and in northern Bosnia and Herzegovina (such as the Banja Luka earthquake in 1969).

- 70 Handy, M.R., Giese, J., Schmid, S.M., Pleuger, J., Spakman, W., Onuzi, K., Ustaszewski, K. (2019). Coupled crust-mantle response to slab tearing, bending, and rollback along the Dinaride-Hellenide orogen, *Tectonics*, 38, 1–26.
- 71 McClusky, S., Balassanian, S., Barka, A., et al. (2000). Global Positioning System constraints on plate kinematics and dynamics in the eastern Mediterranean and Caucasus, *Journal of Geophysical Research*, 105 (B3), 5695–5719.
- 72 Reilinger, R., McClusky, S., Vernant, P., et al. (2006). GPS constraints on continental deformation in the Africa–Arabia–Eurasia continental collision zone and implications for the dynamics of plate interactions, *Journal of Geophysical Research* 111, B05411.
- 73 Schmid, S.M., Fügenschuh, B., Kounov, A., et al. (2020): Tectonic units of the Alpine collision zone between Eastern Alps and western Turkey, *Gondwana Research*, 78, 308–374.
- 74 Weber, J. Vrabec, M., Pavlović-Prešeren, P., Dixon, T., Jiang, Y., Stopar, B. (2010): GPS-derived motion of the Adriatic microplate from Istria Peninsula and Po Plain sites, and geodynamic implications, *Tectonophysics*, 483, 214–222.

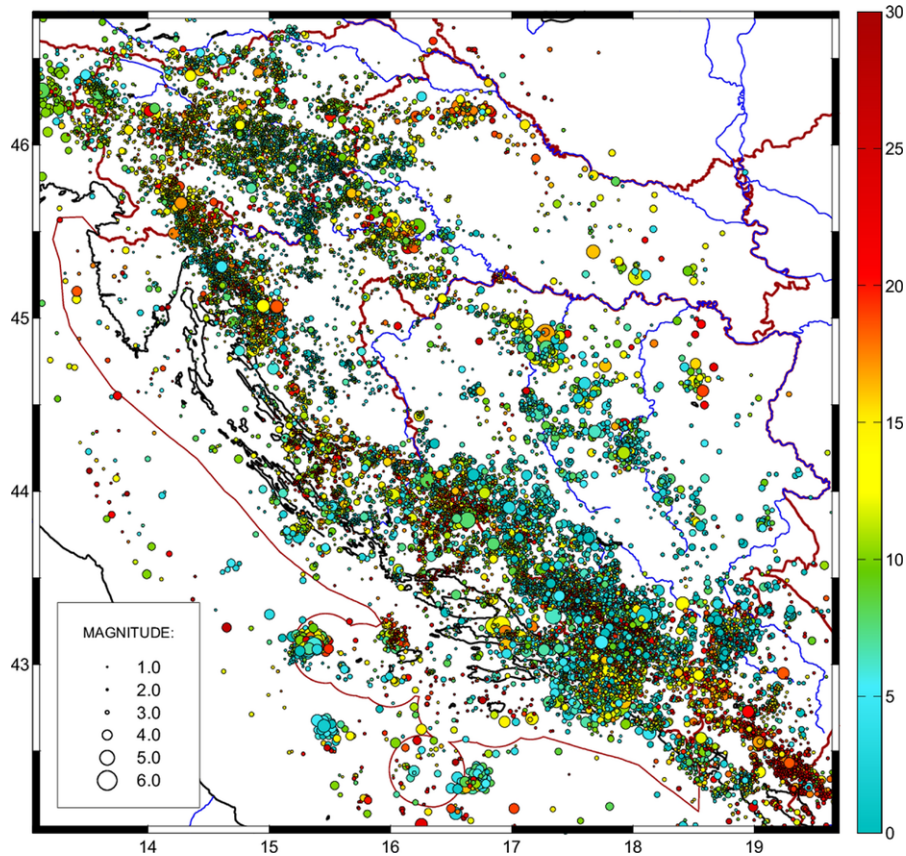
**Earthquakes in Croatia occur due to an ongoing convergence between the Adriatic (Adria) and European plates, at GPS-derived velocity rates of Adria with respect to a stable Europe amounting to c. 2 – 5 mm/year** (Figure 20). As the Croatian territory extends over different regions with respect to their geological setting and the past and ongoing tectonics, earthquakes in Croatia are not uniformly distributed across the country (Figure 21). The most of historically and instrumentally recorded seismic events are in Dalmatia (Dubrovnik – Split – Zadar region), partly along the Adriatic coast and its hinterland, and in Hrvatsko Primorje (Rijeka – Senj area) that both belong to the external Dinarides fold-thrust belt. In that part, the most of seismogenic faults belong to the NW-SE striking Dinaric fault system largely composed of reverse and dextral strike-slip faults. The rest of seismicity mostly occur in the north-western part of the country, within a transitional area between the Dinarides, Alps and the Pannonian basin area (the Zagreb area and its wider surroundings). Here, the seismogenic faults are prevailingly E-W to NE-SW striking reverse faults (for example, the Northern Medvednica boundary fault responsible for the Zagreb, March 22, 2020 earthquake) and NW-SE striking faults characterized by a dextral (right-handed) sense of slip (for example, the Petrinja dextral fault responsible for the 2020 – 2021 Petrinja earthquake sequence).

**Figure 20.** Trajectories of GPS-derived velocities of Adriatic microplate with respect to a stable Europe in mm/year



Source: After Weber et al., 2010.

**Figure 21.** Distribution of epicenters in Croatia in period 1908 – 2019 with magnitude  $M \geq 1.0$ .



*Source:* Dasović, I., Herak, D., Herak, M., et al. (2020): About earthquakes in Croatia. *Vijesti, Croatian Geological Society*, 57/1, 4-27, (in Croatian).

*Note:* Map of earthquake epicenter for period 1908–2019 and local magnitudes  $M \geq 1,0$  calculated with at least 10 data for earthquake phase onset and resulting confidence of the epicenter location better than  $\pm 4$  km. The size of the circles denotes the events' magnitude and the color marks the hypocenter depth in kilometres. These data are taken from the Croatian Earthquake Catalogue and they are representative only for Croatian territory.

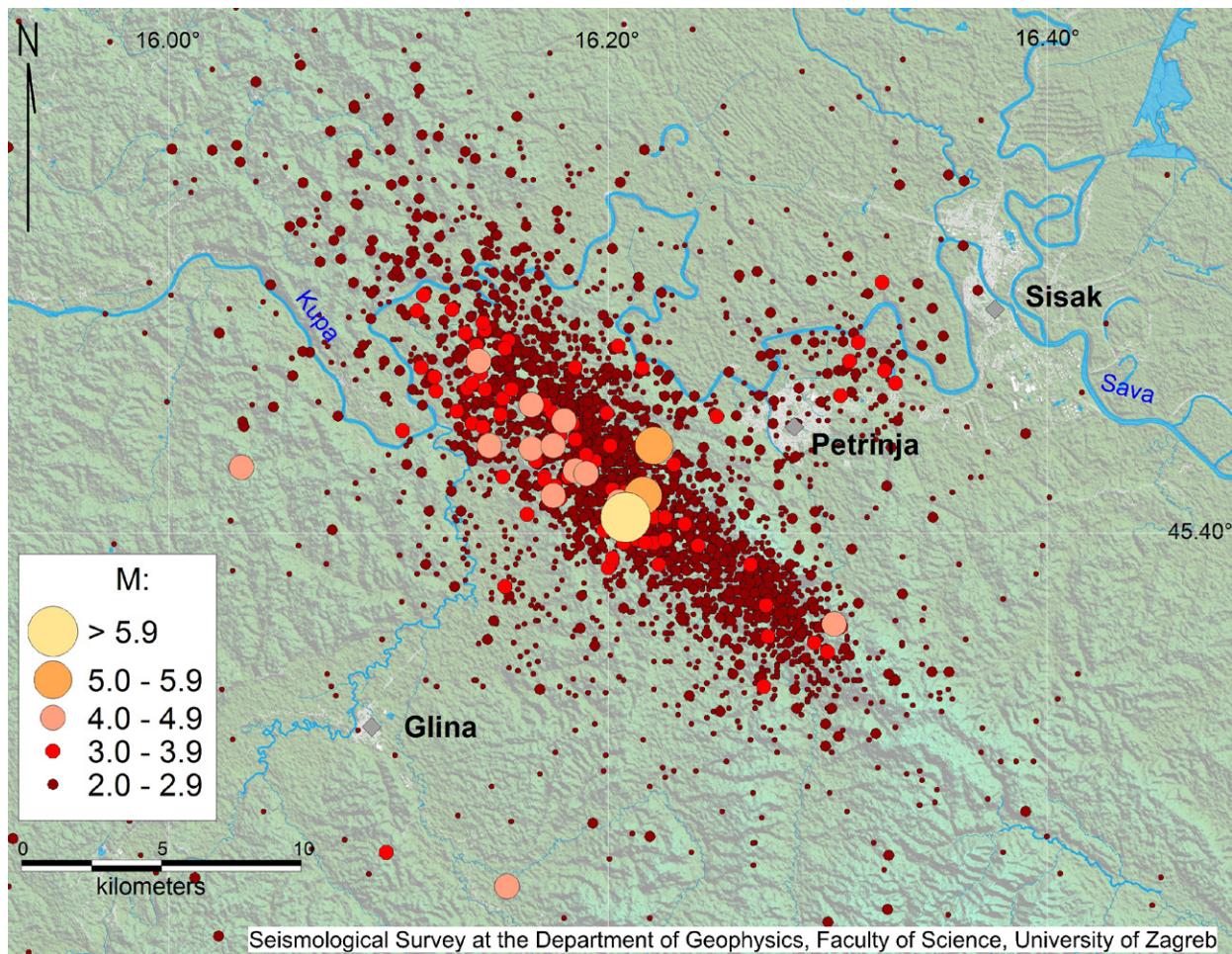
### DECEMBER 2020 EARTHQUAKE – SEISMOLOGICAL SITUATION

**On December 29, 2020 at 12:19 p.m. a devastating earthquake of magnitude 6.2 on the Richter scale occurred in the vicinity of Petrinja, Central Croatia.** This earthquake is one of the two strongest earthquakes in the Republic of Croatia ever instrumentally recorded since 1909. It was felt throughout Croatia and in the

surrounding countries, and the intensity in the epicenter was estimated at VIII-IX degrees on the European EMS scale (Figure 22). The day before, on December 28, 2020, two strong 5.0 and 4.7 magnitude earthquakes occurred in the same area at 6:28 a.m. and 7:49 a.m., respectively, followed by a strong 4.1 magnitude earthquake at 7:51 a.m. and a series of weaker events.



**Figure 23.** Map of earthquake epicenters in the Petrinja epicentral area in the period from December 28, 2020 to February 15, 2021



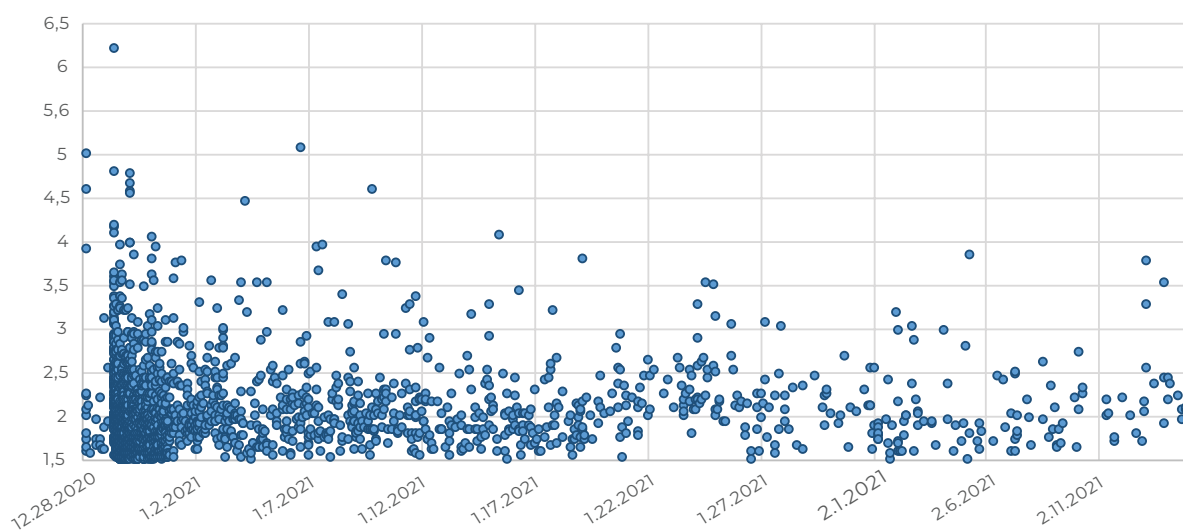
Source: CSS.

The main earthquake of December 29, 2020 was followed by many subsequent earthquakes of various magnitudes (Figure 24). A total of 964 earthquakes of magnitude 2.0 or greater were recorded. Of these, one earthquake had a magnitude greater than 6.0, two earthquakes had magnitudes between 5.0 and 5.9, there were thirteen earthquakes of magnitude between 4.0 and 4.9, 98 earthquakes of magnitude between 3.0 and 3.9

and 846 earthquakes of magnitude between 2.0 and 2.9 (Figure 25 and Table 114). Most of the seismic events recorded and analyzed between December 2020 and March 2021 were attributed to the Petrinja composite seismogenic source, which has maximum expected moment magnitude of 6.5.<sup>75</sup> In the same period, there was also an extremely large number of earthquakes (slightly less than 3,000) of magnitude 1.3 to less than 2.0 (Figure 26).

<sup>75</sup> Known in the European Database of Seismogenic Faults under the code HRCS027, see Basili, R., Kastelic, V., Demircioglu, M. B., et al. (2013): The European Database of Seismogenic Faults (EDSF) compiled in the framework of the Project SHARE. [http://diss.rm.ingv.it/share-edsf/SHARE%20WP3.2\\_Database.html](http://diss.rm.ingv.it/share-edsf/SHARE%20WP3.2_Database.html)

**Figure 24.** Time distribution of earthquakes by magnitude from December 28, 2020 to February 15, 2021



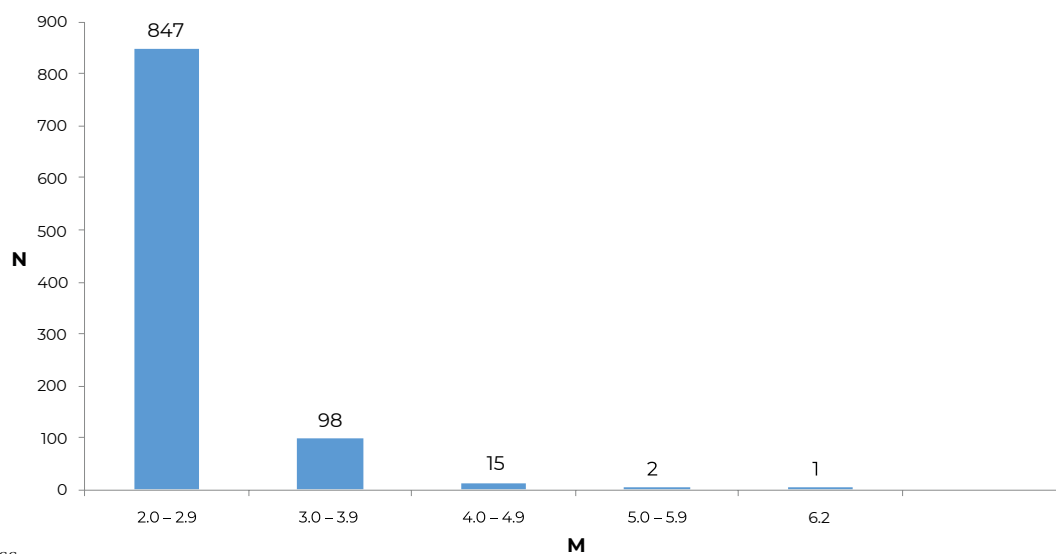
Source: CSS.

Magnitude (Richter scale)	Number of earthquakes
2.0 – 2.9	847
3.0 – 3.9	98
4.0 – 4.9	15
5.0 – 5.9	2
6.0 – 6.9	1

**Table 114.** Distribution of earthquakes by magnitude classes in the period from December 28, 2020 to February 28, 2021

Source: CSS.

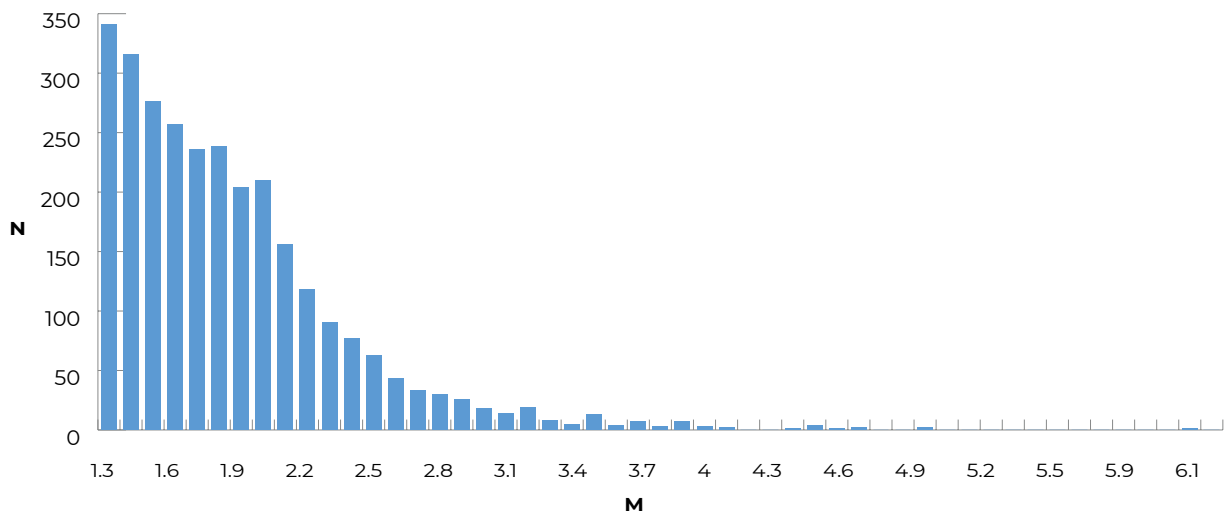
**Figure 25.** Distribution of earthquakes of 2.0 magnitude or greater from December 28, 2020 to February 28, 2021 by magnitude



Source: CSS.



**Figure 26.** Distribution of earthquakes of 1.3 magnitude(M) or greater from December 28, 2020 to February 28, 2021 by magnitude



Source: CSS. Notes: N = number; M = magnitude.

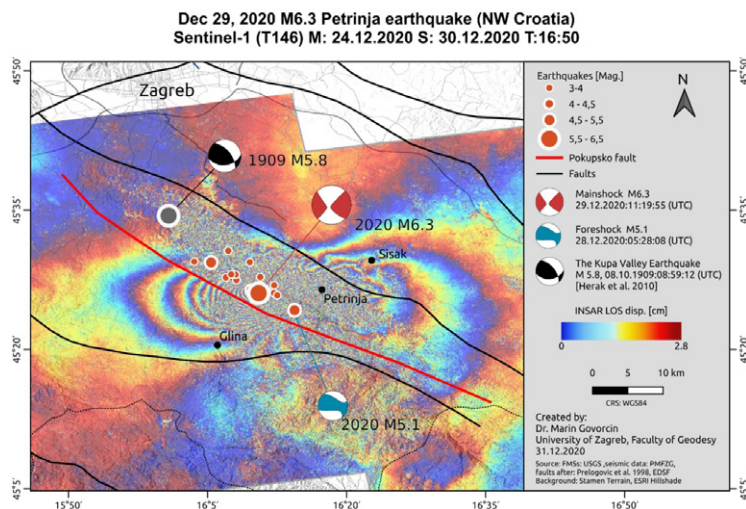
As for the Petrinja 2020-2021 earthquake sequence, according to the distribution of epicenters and calculated focal mechanism solutions released by numerous seismological institutions (Figure 27), it is clear that the seismogenic source for the mainshock and the most of foreshocks and aftershocks was the NW-SE striking dextral fault located at about 6 km distance SW

of Petrinja. Based on the analysis of satellite images of the co-seismic surface deformation in the Petrinja epicentral area carried out by the Faculty of Geodesy, University of Zagreb, it is estimated that the western fault block moved approx. 35 cm to the northwest, and the eastern block of the fault moved approx. 28 cm to the southeast (Figure 28).<sup>60</sup>



**Figure 27.** Focal mechanism solutions of the mainshock on December 29, 2020 at 12:19 p.m. of the earthquake sequence.

Source: GCMT – Global Centroid-Moment-Tensor, GFZ – GeoForschungsZentrum Potsdam, INGV – Istituto Nazionale di Geofisica e Vulcanologia, IPGP – Institut de Physique du Globe de Paris, OCA – Observatoire de la Côte d’Azur, USGS – United States Geological Survey.



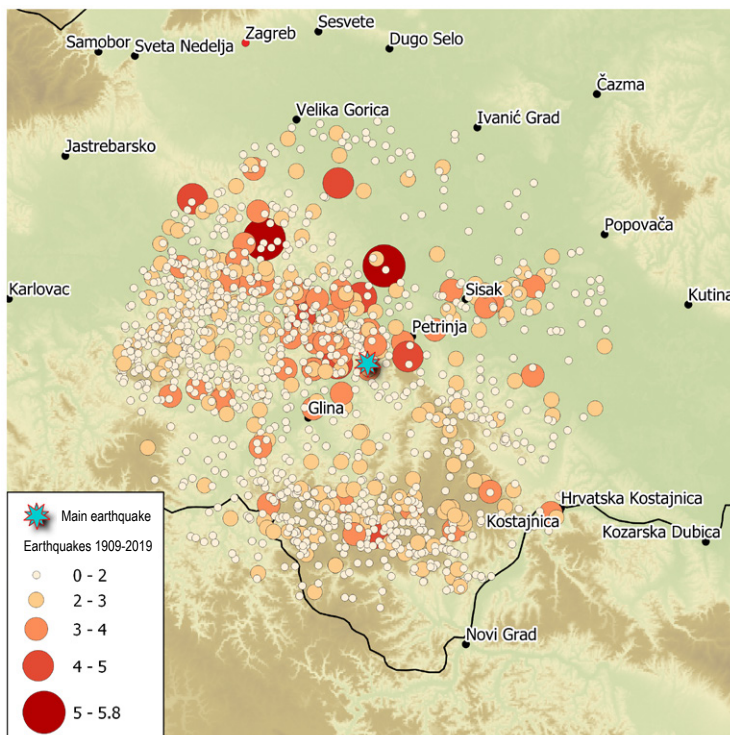
**Figure 28.** Map of surface displacements obtained by two observations (prior and after earthquake) by Sentinel-1 system satellite radar interferometry for the earthquake

**Source:** Faculty of Geodesy, University of Zagreb, Link, last accessed 5 March 2021). The displacement of the terrain is shown in fringes of blue-red color, where each fringe represents a displacement of 2.8 cm in the direction and at the angle of observation of the satellite.

### SEISMICITY OF THE PETRINJA EPICENTRAL AREA

In the Petrinja epicentral area, approximately 20 km northwest of the mainshock of December 2020 – March 2021 earthquake series, a very strong earthquake with magnitude 5.8 occurred on October 8, 1909, named as the Pokuplje earthquake. By analyzing that earthquake, seismologist, and geophysicist Andrija Mohorovičić dis-

covered the boundary of the Earth's crust and mantle, the so-called Mohorovičić discontinuity. Not long after that, on January 28, 1910, a 5.3 magnitude earthquake occurred approx. 15 km north-northeast of the Pokuplje earthquake of the same seismic series. The Croatian Earthquake Catalogue contains 1,364 earthquakes in this area, which occurred in the period between 1909 and 2019 (Figure 29).



**Figure 29.** Map of epicenters of historical earthquakes and the mainshock of December 29, 2020

**Source:** CSS.

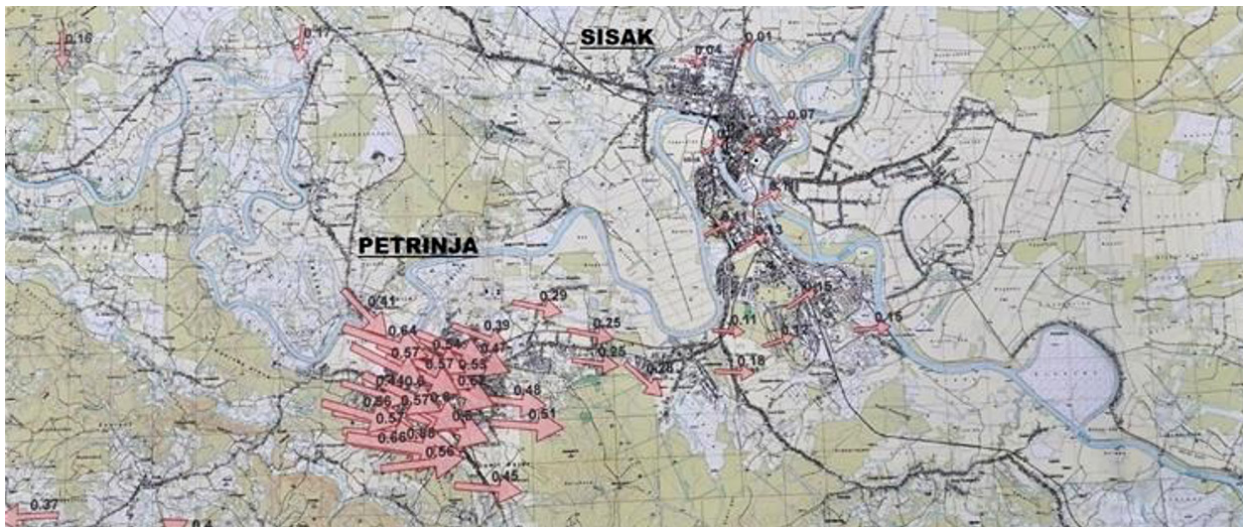
## EARTHQUAKE IMPACTS

**A significant ground displacement has occurred during the Petrinja 2020-2021 earthquake sequence.** In January 2021, officials from the SGA performed preparatory actions and precise control satellite measurements using the Global Navigation Satellite System (GNSS) in the towns of Glina, Petrinja and Sisak (Figure 30). It was determined that the greatest displacement is shown by points in the Petrinja area, with a mean displacement of 45 cm in the southeast direction. Mean displacements for Glina are 10 cm in the northwest direction and 10 cm in the eastern direction for the area of Sisak (Table 115). Additionally, a height shift of 10 cm (lowering of the ground) for the area of the town of Glina was determined.

These initial official results will be used to plan the activities and costs related to restoring the geodetic base, homogenizing cadastral plans, performing necessary cadastral-geodetic measurements, and preparing the guidelines

for further research and actions. These will be used for reconstruction and to establish precise coordinate definitions of space. The extent to which these post-seismic changes will affect the construction sector remains to be determined. Considering that there are still aftershocks, subsequent damage to large infrastructure facilities is possible, with a risk of an adverse environmental impact. Sisak-Moslavina County has a total of 270.02 km of the main gas pipeline, with various diameters and pressure loads, as well as 15 metering and reducing stations. In the area of the Velika Ludina Municipality, there is an underground gas storage, “Okoli”, with the operating volume of about 350,000 m<sup>3</sup>. The storage and transport capacities are owned by the companies JANAF and INA. JANAF’s storage capacities in Sisak amount to 400,000 m<sup>3</sup> of oil, and the length of the oil pipeline is 155.41 km. In Sisak-Moslavina County, there are five water supply systems that are also endangered due to the possible occurrence of landslides, rockslides, and erosion.

**Figure 30.** Horizontal displacements of geodetic control points



Source: SGA, February 2021.

**Table 115.** Minimum, maximum, and mean values of displacement of geodetic control points

Displacements (m) HTRS96/TM	HP Petrinja			HP Glina			HP Sisak			~ 10 – 15 km from EPICENTER		
	ΔE	ΔN	ΔH	ΔE	ΔN	ΔH	ΔE	ΔN	ΔH	ΔE	ΔN	ΔH
MIN.	0.10	-0.29	-0.16	-0.07	0.02	-0.22	0.01	0.00	-0.12	-0.37	-0.31	-0.17
MAX.	0.86	0.04	0.10	0.03	0.10	-0.04	0.15	0.08	0.07	0.53	0.40	0.14
MEAN VALUE	0.45	-0.15	-0.01	-0.02	0.06	-0.10	0.09	0.04	-0.05	0.01	0.01	-0.02

Source: SGA, February 2021

## Annex 3. Damage, Losses, and Needs in Other Counties

This annex summarizes damage and losses to several counties outside the scope of this RDNA which was collected and reported by local authorities to MoCPPSA. Earthquake damage affecting individually protected cultural property was recorded in Bjelovar-Bilogora County, Koprivnica-Križevci County, Međimurje County, Varaždin County, and Brod-Posavina County. The most severe damage was found in Bjelovar-Bilogora County because of the proximity to the epicentral region. Most of the damage is concentrated in churches and religious buildings, followed by several public and residential buildings.

The largest surface area of damaged cultural heritage buildings was recorded in the Varaždin County while the largest number of damaged buildings was recorded in Bjelovar-Bilogora County. In the northern counties of Varaždin and Međimurje, there are predominantly

**Table 116.** Number of individually protected and damaged immovable cultural assets in other counties

Administrative unit	No. of individually listed immovable cultural assets	No. of damaged individually listed immovable cultural assets
Bjelovar-Bilogora County	180	41
Koprivnica-Križevci County	136	24
Međimurje County	55	10
Varaždin County	190	28
Brod-Posavina County	115	10

Source: MoCM.

Baroque or Gothic churches retrofitted in the Baroque period with high architectural and artistic value boasting rich religious inventory and valuable wall paintings. Among the public buildings, significant damage was recorded at the Batthyany castles in Ludbreg, the Erdody Castle in Novi Marof, and the Croatian National Theater building in Varaždin, manifested predominantly by cracks in arches and lintels.

**Table 117.** Number and surface area of damaged cultural heritage buildings in other counties

County		No. of damaged public buildings			No. of damaged private buildings			Total damaged surface area in m <sup>2</sup>
Bjelovar-Bilogora County	Religious buildings	0	0	0	4	26	0	17,130
	Public institutions	1	1	0	0	0	0	1,548
	Housing and business	0	0	0	4	5	0	3,555
Koprivnica-Križevci County	Religious buildings	0	0	0	13	5	0	8,572
	Public institutions	5	0	0	0	0	0	2,687
	Housing and business	0	0	0	1	0	0	1,375
Međimurje County	Religious buildings	0	0	0	11	0	0	6,179
	Public institutions	1	0	0	0	0	0	17,700
	Housing and business	0	0	0	0	0	0	0
Varaždin County	Religious buildings	0	0	0	17	3	0	12,068
	Public institutions	5	1	0	0	0	0	32,699
	Housing and business	0	0	0	4	1	0	9,077
Brod-Posavina County	Religious buildings	0	0	0	7	1	0	9,224
	Public institutions	2	0	0	0	0	0	1,839
	Housing and business	0	0	0	0	0	0	0
<b>Total</b>		<b>14</b>	<b>2</b>	<b>0</b>	<b>61</b>	<b>41</b>	<b>0</b>	<b>123,652</b>

Source: MoCM.

Administrative unit	Damage			Losses		
	Public	Private	Total	Public	Private	Total
Bjelovar-Bilogora County	1.22	55.21	<b>56.43</b>	0.05	1.73	<b>1.78</b>
Koprivnica-Križevci County	1.24	18.47	<b>19.72</b>	0.05	0.58	<b>0.63</b>
Međimurje County	8.19	9.99	<b>18.18</b>	0.33	0.31	<b>0.64</b>
Varaždin County	16.86	25.60	<b>42.46</b>	0.68	0.84	<b>1.52</b>
Brod-Posavina County	0.85	19.85	<b>20.70</b>	0.03	0.61	<b>0.65</b>
<b>Total</b>	<b>28.36</b>	<b>129.13</b>	<b>157.48</b>	<b>1.15</b>	<b>4.07</b>	<b>5.22</b>

**Table 118.** Damage and losses to cultural heritage buildings in other counties (EUR, millions)

Source: MoCM.

	Short	Medium	Long	Total
<b>Reconstruction</b>	<b>39.28</b>	<b>98.20</b>	<b>58.92</b>	<b>196.40</b>

Source: MoCM.

**Table 119.** Total reconstruction needs related to cultural heritage buildings in other counties (EUR, millions)

Administrative unit	Public	Private	Total
Bjelovar-Bilogora County	1.72	81.08	<b>82.81</b>
Koprivnica-Križevci County	1.24	22.45	<b>23.69</b>
Međimurje County	8.19	9.99	<b>18.18</b>
Varaždin County	18.60	27.49	<b>46.09</b>
Brod-Posavina County	0.85	24.78	<b>25.63</b>
<b>Total</b>	<b>30.60</b>	<b>165.80</b>	<b>196.40</b>

Source: MoCM.

**Table 120.** Reconstruction needs related to cultural heritage buildings in other counties by county (EUR, millions)

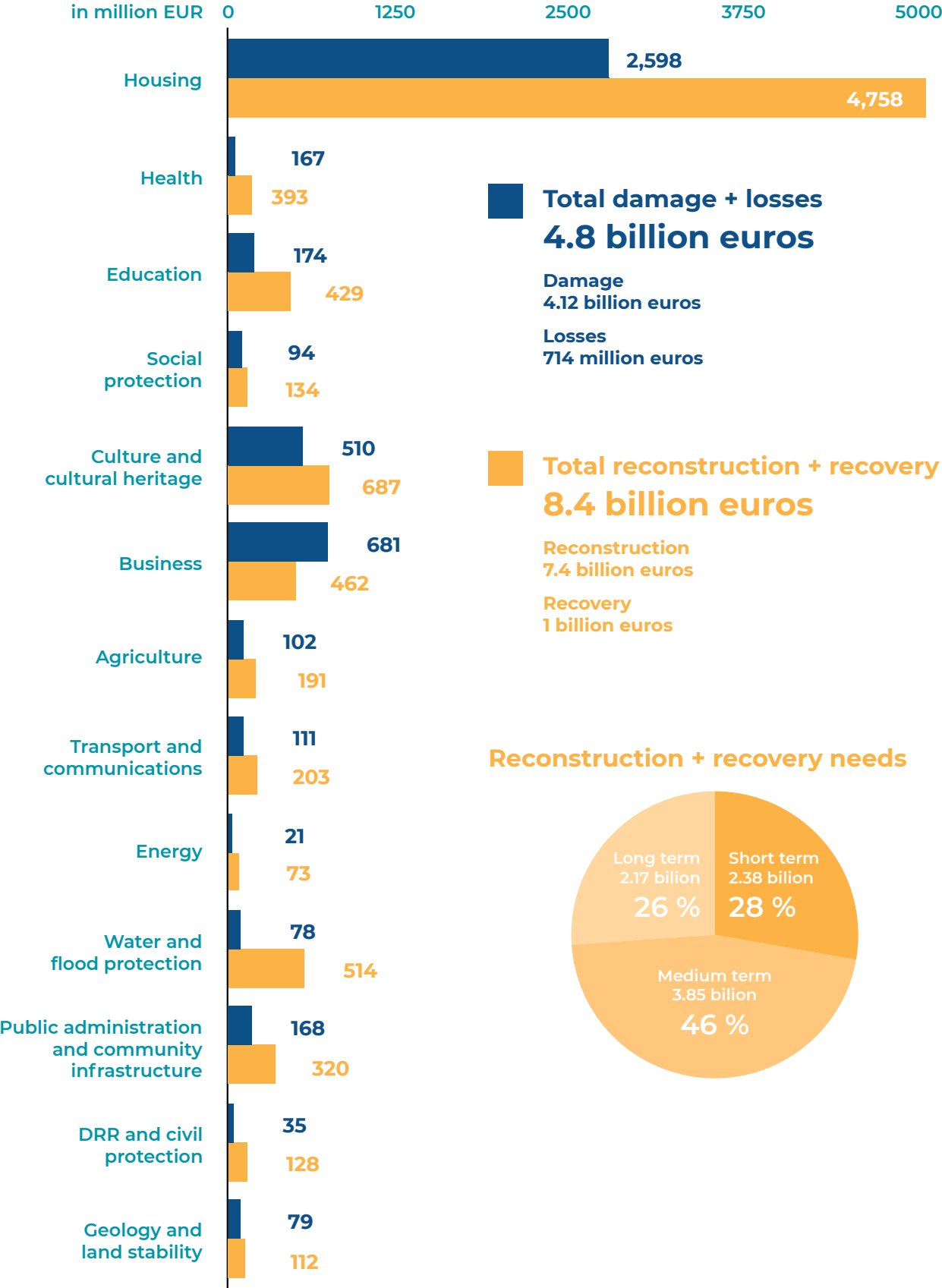
In Bjelovar-Bilogora and Koprivnica-Križevci Counties, a total of 65 individually protected cultural assets was found to be damaged. Most of the damage relates to religious buildings of all confessions. Several of these churches were built in the Middle Ages, which, later on, was subject to a stylistic transformation in the eighteenth and nineteenth centuries. There are also churches from the Baroque and Classicist period. In Brod-Posavina County, in addition to valuable religious buildings and complexes, damage was recorded to the Museum of Brod-Posavina and to the school that is built within the Fortress of Brod.

Total damage to the cultural heritage buildings for these counties is estimated at EUR 157.5 million, of which 18 percent is in the public sector and 82 percent in the private sector. The table above shows that most of the damage was recorded in Varaždin County

with a total of EUR 42.5 million (27 percent) and Bjelovar-Bilogora County with EUR 56.4 million (36 percent), followed by Međimurje County with EUR 18.2 million (12 percent), Koprivnica-Križevci County with EUR 19.7 million (13 percent), and Brod-Posavina County with EUR 20.7 million (13 percent). Total losses amount to EUR 5.2 million.

**Reconstruction of damaged cultural heritage buildings in other counties will require complying with the already mentioned restoration guidelines for such assets.** Reconstruction needs related to these buildings in other counties are estimated at approximately EUR 196.4 million with 16 percent related to public and 84 percent to private assets (Table 119 and Table 120). Concerning geographical distribution of reconstruction costs, the largest proportion will be concentrated in Bjelovar-Bilogora County and Varaždin County.

# Relationship between Damage + Losses & Reconstruction + Recovery





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