NATURAL DISASTERS

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Natural disasters pay us unwelcome visits year after year: earthquakes, floods, hailstorms, frosts, droughts, or landslides. Prevention and protection from them is a very important question for development and the future because even if there is no major disaster, they consume two to three percent of Slovenia's annual GDP every year.

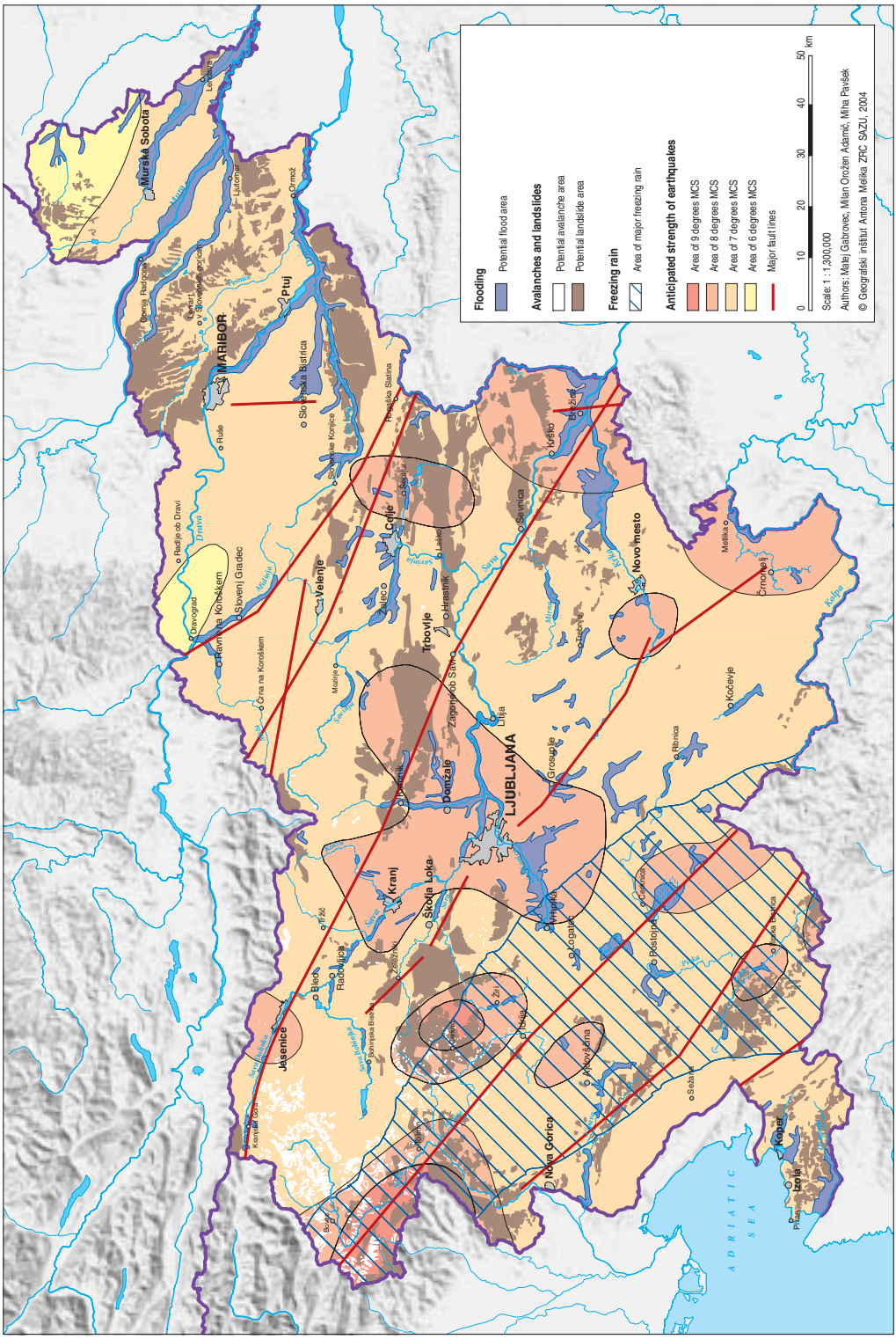
Because Slovenia is a country of great regional diversity, we find very diverse natural phenomena and a broad palette of natural disasters. There is no reason to think that natural disasters occur more frequently today than in the past, but we are undoubtedly more sensitive or vulnerable to their consequences. The Ljubljansko Barje moor and its margins started to become more intensely settled only in the middle of the last century, and the rise in the number of people employed in non-agricultural sectors greatly increased the population density in the valleys.

It is characteristic that Slovenia suffers relatively few casualties in natural disasters, but the material damage they cause is great. Most deaths occur in avalanches (37%), followed by earthquakes (30%), lightning (13%), floods (12%), storms (6%), and other natural disasters (2%). It is estimated that an exceptional earthquake in the area of Ljubljana could result in 1,000 or more casualties. It has been over one hundred years since the last major earthquake shook Ljubljana and its surrounding area in 1895. How bad the consequences would be today from a possibly even stronger earthquake depends on how prepared we are for it. The earthquake will be the only impartial evaluator of our anti-earthquake protection measures and earthquake-safe construction.

The most threatened areas in Slovenia, where earthquakes up to 9° MCS can be expected (500-year recurrent period) are the Tolmin and Idrija areas, which encompass 1.79% of the surface of Slovenia where 0.54% of Slovenia's population lives. Part of the Ljubljana area, which otherwise lies in the 8° MCS zone, ranks in the 9° MCS zone relative to its microseismic regionalization. Areas of 8° MCS, where substantial earthquakes effects can still be expected, encompass 21.37% of Slovenia where 32.56% of the population lives. (The MCS scale, which is still a part of Slovenia's legislation, is gradually being replaced by the European EMS earthquake scale.)

Slovenia experiences valley and torrential floods, flooding on karst polje, and sea floods. We distinguish between ordinary or regular floods (one- to ten-year flood intervals) that are not ranked among natural disasters and major catastrophic floods (ten-year and longer flood intervals) that are. Floods threaten almost 3,000 km^2 of Slovenia. The majority are valley floods (237,000 ha) in about thirty major flood areas. Sea floods and karst polje floods are less extensive (70,403 ha). The most frequent causes of floods are violent downpours and the rapid melting of snow. Another very important cause of flooding lies in the local conditions of very dissected hilly areas and the impermeable bedrock of hills that accelerates the rapid run-off of water into the valleys. By clearing forests, cultivating the land, and building almost 6,000 settlements, a road and railway network, and other structures, man has greatly changed the natural drainage conditions. Great changes in flood areas were also caused by the abandonment and deterioration of flourmills, sawmills, and their accompanying structures (dams) after World War II, especially in the years between 1945 and 1955.

The torrential character of rivers and streams has also been intensified by numerous local water management projects and artificial embankments that mostly accelerate the rapid flow of the water. While they protect individual settlements, industrial buildings, roads, and bridges, the destructive effects of the water have increased downstream because of them. Where floods are a regular phenomenon, meadows, pastures, and groves of trees are usually found, which are the most economic forms of land


Flooding
Potential flood area
Avalanches and landslides
Potential avalanche area
Potential landslide area
Freezing rain
Area of major freezing rain
Anticipated strength of earthquakes
Area of 9 degrees MCS
Area of 8 degrees MCS
Area of 7 degrees MCS
Area of 6 degrees MCS
Major fault lines
0 10 20 30 40 50 km
Scale: 1 : 1,300,000
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Murska Sobota
MARIBOR
Ptuj
Slovenska Bistrica
Ruše
Radlje ob Dravi
Dravograd
Slovenj Gradec
Prevalje
Črna na Koroškem
Velenje
Celje
Laško
Hrastnik
Trbovlje
Zagorje ob Savi
Litija
Sevnica
Krško
Brežice
Novo mesto
Metlika
Črnomelj
Kočevje
Ribnica
LJUBLJANA
Grosuplje
Domžale
Vrhnika
Logatec
Postojna
Cerknica
Ilirska Bistrica
Kranj
Škofja Loka
Tržič
Radovljica
Bled
Bohinjska Bistrica
Jesenice
Železniki
Žiri
Idrija
Cerkno
Tolmin
Kobarid
Nova Gorica
Ajdovščina
Sežana
Koper
Izola
Piran
ADRIATIC SEA

◄ *Figure 1: Natural disaster threat.*

use in these conditions. Into these areas, however, settlements have expanded with residential housing and industrial buildings, railway lines, roads, and bridges that restrain floodwaters with their dikes and thus further increase the danger of catastrophes. With the excessive squeezing of floodwaters by built-up areas and other human encroachments, the destructive power of floodwaters can intensify greatly. This situation occurred with the floods in Celje in 1954 and in the Upper Savinja Valley in 1990.

About 7% of the population of Slovenia lives on land threatened regularly by floods, and more than a quarter of the population has their land, production means, and so forth in areas of major 50-year-interval floods. If the settling in these areas increases at the same rate as between 1961 and 1991, we can expect that floods will present a threat to more than a third of the population of Slovenia at the beginning of the next millennium.

Table 1: Major flood areas in Slovenia.

Flood areas	Areas of regular flooding at 1- to 10-year intervals (in ha)	Areas of catastrophic flooding at 10- to more than 50-year intervals (in ha)	Greatest extent of flooded land (in ha)
Ljubljansko Barje	2,353.10	5,681.10	8,034.20
Dravinja River	3,511.00	3,043.00	6,554.00
Krka River	5,167.00	1,012.20	6,179.20
Lower Savinja Valley	3,157.90	1,130.90	4,288.80
Sava River between Krško and Bregana	2,210.20	1,244.50	3,454.70
Sotla River	2,692.70	558.50	3,251.20
Cerkniško polje	–	–	2,600.00
Kolpa River	659.00	1,387.00	2,046.00
Pšata River	614.20	898.80	1,513.00
Pivka River	–	–	1,151.80
Planinsko polje	–	–	1,100.80
Rižana and Badaševica rivers	–	–	1,077.00
Kočevsko-Ribniško polje	305.00	733.00	1,038.00
Mirna na Dolenjskem	787.90	188.90	976.80
Dragonja and Drnica rivers	–	–	900.00
Hudinja River	370.00	393.00	763.00
Mislinja River	63.30	685.30	748.60
Dobrepolje with Rašica	134.40	490.00	624.40
Bloke Plateau	331.80	258.40	590.20
Poljanska Sora River	–	–	590.00
Grosupeljsko-Radensko polje	84.50	425.20	509.70

In recent years, there has been little snow in Slovenia. However, it was exceptionally abundant in the 1951–1952 winter (Ljubljana 146 cm). Many roads were impassable, and the main road toward Gorenjska was closed for five days, as was the railway line between Jesenice and Nova Gorica. In some places, people were cut off from the rest of the world for even longer periods. There was a general mobilization in Ljubljana to clear the streets. The negative effects of snow differ not only according to the thickness of the snow cover but also to the time of year and where the snow falls. A long-lasting and

thick snow cover can cause great damage in the forests, and in 1952 more than 100,000 m^3 of wood was destroyed.

Table 2: Victims of avalanches between 1777 and 1996.

Casualties	Reliable data	Unreliable data
Mountaineers, hunters, soldiers	71	17
In the open and on ski slopes	25	2
On roads and tracks	88	11
Inside buildings	285	157
Total	469	187

Frosts on fruit trees are frequent in Slovenia at the end of winter and in early fall. Spring frost damages blossoms and reduces the yield. Every 50 to 55 years, invasions of cold air cause frost on fruit trees with major damage.

Hail typically falls on very limited surface areas. It is usually accompanied by a strong wind that considerably increases the damage already caused by the hail. Hailstorms cause the greatest damage in northeastern Slovenia, and Goriška Brda is also greatly threatened.

Figure 2: Demolished building at the end of Sv. Peter Street, today's Trubarjeva Street (Hefler, W., 1895, NUK). Buildings were not destroyed completely during the Ljubljana earthquake, but great damage was caused by falling chimneys, and walls and vaulted ceiling constructions cracked, particularly in those parts of the city where the structure of the ground was most vulnerable. Of 1,373 damaged buildings, only forty-nine were later pulled down. After the earthquake, a law was passed that required a suitable distribution of walls and the installation of iron reinforcing in the brick walls of new buildings.

Although Slovenia has areas that have almost the most precipitation in Europe and although the greater part of its territory receives more than 1,200 mm of precipitation per year, longer periods with little precipitation occur every few years. The basic reason for drought in Slovenia is a relative lack of precipitation, which is mainly the consequence of the fluctuation in annual quantities of precipitation and its varied distribution throughout the year. The occurrence of drought is also heavily influenced by regional characteristics such as permeable carbonate rock in karst regions, steep slopes with a thin layer of soil, soils with little retention capacity, etc. The influence of meteorological factors on droughts in Slovenia is most obvious in the karst region. Water is already scarce here in normal years because it disappears into the heavily fissured bedrock.

The largest part of Slovenia in covered by an area with thirty to forty stormy days every year that stretches from central Slovenia eastwards and at the same time like a tongue down the valley of the Sava River toward the northwest. The mountainous western part of Slovenia is most threatened by storms with forty to fifty stormy days a year and a maximum number in Skalnica near Nova Gorica with more than sixty stormy days every year. The areas of Goriška Brda and Trnovski gozd have fifty to sixty stormy days annually. The summer months of June, July, and August receive 75% of the storms.

The damage caused by wind in Slovenia is considerably greater than we thought until recently. Strong winds are a regular companion of major downpours and thunderstorms. Hurricane winds and tornados are rare in the continental part of Slovenia. On August 23, 1986, a wind with a velocity above 17.2 m/s (8 on the Beaufort scale) ravaged the Notranjska region from Hotedršica to Vrhnika, across Bevke and Podpeč, to the southern margins of the Ljubljansko Barje moor. The bora, Slovenia most famous destructive wind, sweeps across the high Dinaric plateaus and down to the valleys and warm coastal areas. An extremely strong northwest and north foehn wind reaches extreme velocities mainly in the Soca Valley and the Gorenjska region.

Sleet strikes frequently, particularly in southeastern Slovenia and in transitional areas between the Mediterranean world and the interior. It causes the most damage to trees, forests, and a wide variety of infrastructure objects. Along with meteorological conditions, relief conditions are of great importance. Observations show that the intensity of sleeting can vary significantly and changes within short distances. During one catastrophic sleet storm that caused great damage to the electric power grid, the ice coating electric power lines exceeded 50 mm. Sleet thicker than this is rare and occurs approximately once every 30 years. The weight of the thickest measured sleet in Slovenia reached from five to 7.2 kilograms per meter of power line. Weak sleet up to 5 mm thick is frequent throughout Slovenia and occurs in southeastern Slovenia almost every year. Heavier sleet from one to two centimeter thick also occurs here every few years.

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