EUROPE AND CENTRAL ASIA

Country Risk Profiles FOR Floods and Earthquakes

WORLD BANK GROUP

GFDRR
Global Facility for Disaster Reduction and Recovery

The International Bank for Reconstruction and Development
The World Bank Group
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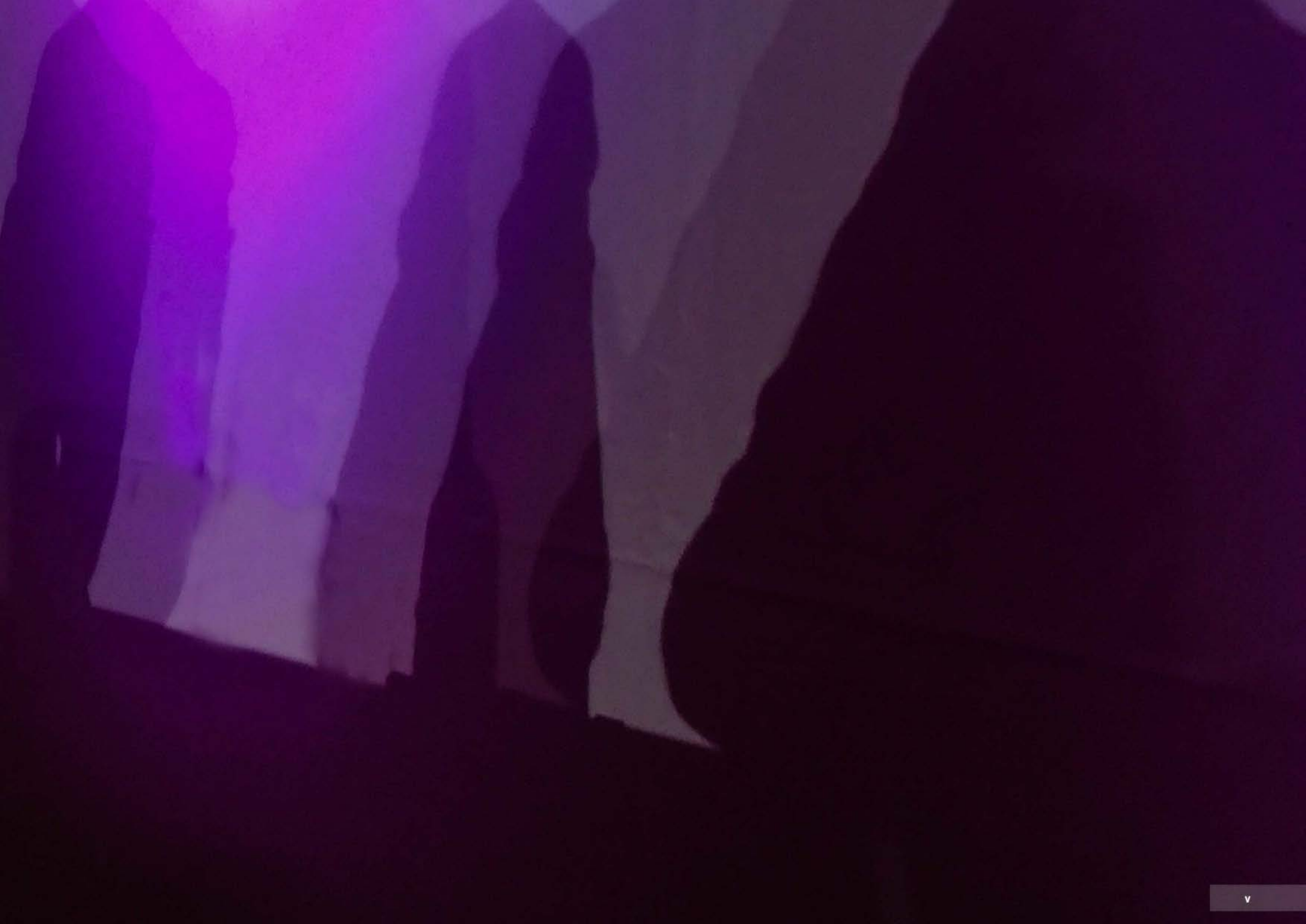

Introduction

The Europe and Central Asia[1] (ECA) region is affected regularly by natural hazards, such as floods, earthquakes, droughts, landslides, and wildfires. Although catastrophic events are not as frequent as in other parts of the world, in the last three decades alone, this region experienced close to 500 significant floods and earthquakes that caused 50,000 fatalities, affected nearly 25 million people, and resulted in US$80 billion in damage.[2] In fact, close to 30 percent of the capitals of the ECA countries have been at one time or another devastated by earthquakes and floods.

The historical record of large disasters goes back to ancient Greece, where an earthquake in Crete destroyed Alexandria (Figure 1). Much more recently, in 1838, massive floods destroyed Pest, Hungary, and in the 1960s, earthquakes devastated Skopje, the former Yugoslav Republic of Macedonia (1963), and Tashkent, Uzbekistan (1966). The impacts of these disasters are pervasive. They displace and kill people, destroy property, incapacitate industries, disrupt day-to-day life, and often affect the economic development of countries for years after the event.

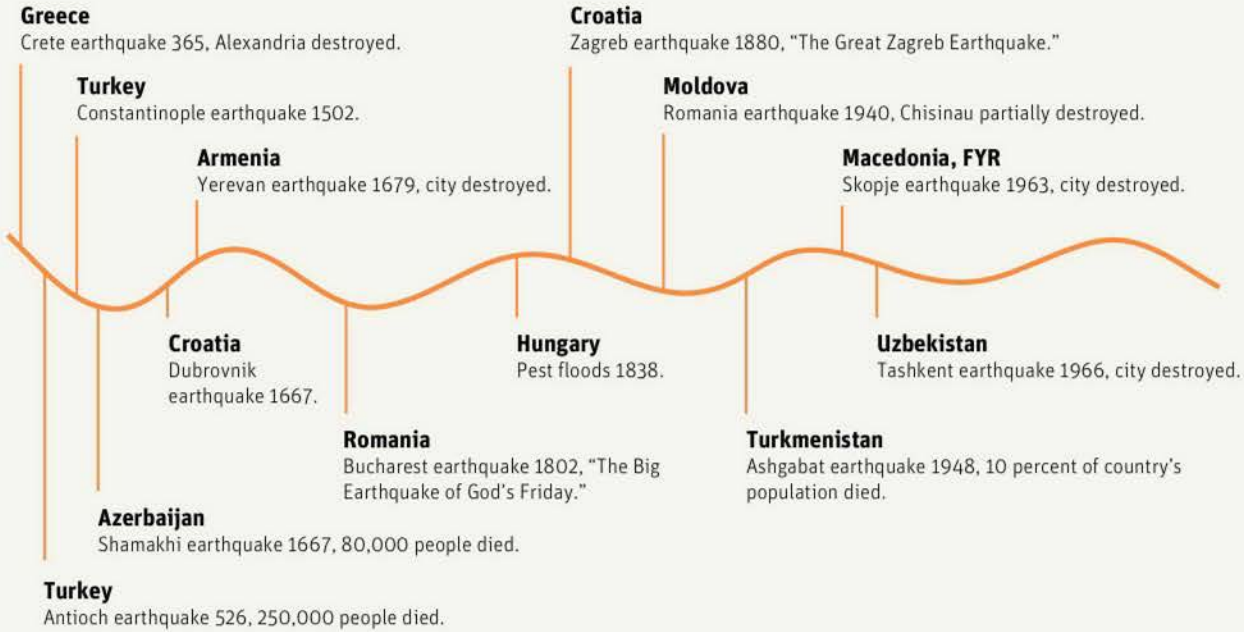

Figure 1. A chronology of significant disasters affecting the ECA region.

The impacts of natural hazards will most likely become even larger in the future due to changes in climate and growth in populations and economies. Most countries in ECA are expected to experience economic growth in the near future. The combination of this growth with old building stock, (unplanned) urbanization, and increased exposure creates conditions conducive to natural disasters. If governments do not act to reduce their exposure and vulnerability to them, their countries' risks will increase dramatically.

Previous country-level risk estimates in the ECA region were based in part on records in the EM-DAT International Disaster Database, which are based in turn on observations of historical events. This information provides little insight into the probability of event occurrence, however, as the data are incomplete and of uneven quality, and they lack homogeneity. More robust risk estimates require additional data.

The country risk profiles for floods and earthquakes presented in this publication are based on quantitative risk assessments derived using global flood and earthquake models.

1. In this publication, we follow the World Bank classification of ECA countries:
Baltic States: Belarus, Estonia, Latvia, Lithuania, Poland
Caucasus States: Armenia, Azerbaijan, Georgia
Central Asian States: Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan, Uzbekistan
European Union States: Bulgaria, Croatia, Cyprus, Czech Republic, Greece, Hungary, Moldova, Romania, Slovakia, Ukraine
Russia
South East European States: Albania, Bosnia and Herzegovina, Kosovo, FYR Macedonia, Montenegro, Serbia, Slovenia, Turkey

2. D. Guha-Sapir, R. Below, Ph. Hoyois, EM-DAT: International Disaster Database, Université Catholique de Louvain, Brussels, Belgium, www.emdat.be.

The objectives are to inform governments of the levels of risk their countries face and facilitate discussions on how they can become more resilient to both current and future risk.

COUNTRY RISK PROFILES

The profiles for the ECA countries presented here indicate the flood and earthquake risks to which the countries are exposed on national and provincial levels. Annual averages are often used to convey the gross domestic product (GDP) and population at risk. The annual average affected GDP is defined as the affected GDP per year, averaged over many years. Since the annual average does not represent the impact of a single event, it is important to realize that much larger impacts can be caused by less frequent, more intense events.

Box 1. Return Periods

A 100-year flood means that in any given year there is a 1 percent chance of a flood of a large magnitude occurring. It does not mean that a 100-year flood will occur every 100 years. It is possible to have two 100-year floods in the same or concurrent years. The same is true for a 250-year earthquake; there is a 0.4 percent chance of a 250-year earthquake occurring in any given year.

The first page of each profile provides an overview of the country and its risk. At the top is a short summary listing population and GDP and, in terms of both absolute numbers and percentages, the population and GDP affected by, respectively, a 100-year flood and a 250-year earthquake. Also provided are the capital loss and fatalities, in absolute amounts and percentages, expected from a 250-year earthquake. These figures give an immediate indication of how much risk a country is facing in case of an extreme, but less frequent, event. As explained in the methodology and limitation sections of this introduction, the uncertainties in the absolute risk estimates are large. Therefore, the absolute risk estimates have been rounded to one significant digit. The percentages in the summary at the top of the first page, however, are based on the unrounded risk estimates.

The table on the first page shows the 10 provinces—or all provinces, if the country has fewer than 10—most at risk, as ranked by the annual average GDP affected by floods or earthquakes, as a percentage of each province's GDP. The accompanying map uses color to display the GDPs of all the provinces. Note that a map of population at risk will look very similar to that of GDP at risk, as the correlation between the two characteristics is high. The sizes of the colored discs represent the relative amounts of the provinces' GDPs affected annually by floods (blue) and earthquakes (orange).

The middle pages of each profile assess the country's flood and earthquake risks in greater detail. The map shows the annual average affected GDP of the country relative to its provinces' GDPs, which can be used to identify the provinces with high percentages of GDP at risk annually. The vertical bars on the maps represent the percentages of GDP affected by a 10- and 100-year flood or earthquake, respectively. This risk information can be used to identify the provinces expected to be vulnerable to more extreme, but less frequent, events. In addition, a horizontal line across the bars indicates the percentage of annual average affected GDP.

The final page displays information on the current annual average risk of fatalities and capital loss from earthquakes. Like the table on the first page, rose diagrams show these data for the top 10 provinces, or for all provinces if the country has fewer than 10. In addition, exceedance probability curves are provided for flood and earthquake risk. An exceedance curve represents the probability of exceeding any given amount of affected GDP. The line depicts the exceedance probability curve for 2015 conditions, whereas a striped band spans the range of exceedance probabilities consistent with a set of socioeconomic and climate scenarios projected for 2080.

METHODOLOGY

For all the countries in the ECA region, population and GDP affected by floods and earthquakes are estimated at provincial[3] and country levels for different return periods (2, 5, 10, 25, 50, 100, 250, 500, and 1,000 years) and as annual averages. The earthquake results also include information on return periods of 1, 20, and 200 years. Affected population and affected GDP are defined as those experiencing flood water at any depth or ground motion intensities equal to or greater than Modified Mercalli Intensity (MMI) VI. Estimates are calculated in absolute numbers and relative to the population or GDP of the province or country. In this publication, we mainly portray the relative numbers, since they are better indicators for comparing the impact of a disaster on communities. In addition, the earthquake model was used to estimate fatalities and capital losses. Capital losses represent the estimated cost of replacing and repairing damage to gross capital stock—that is, the fixed assets in a country.

Any consideration of major investments to reduce risk or increase resiliency needs to take into account changes in risk caused by climate change and socioeconomic developments. For this reason, risk information has been generated not only for current conditions and exposure, but also for conditions in 2080, according to two climate scenarios defined by Representative Concentration Pathways (RCPs) for climate change and two socioeconomic conditions defined by Shared Socioeconomic Pathways (SSPs) for socioeconomic trends. Climate is presumed to have no impact on seismic risk, so the earthquake model considers changes in 2080 exposure only by modeling all five SSPs.[4]

3. Model results have been calculated at administrative level 1 and at country level. In this publication, we will refer to administrative level 1 as provincial level.

4. For more information on the RCPs, see M. Meinshausen, S. J. Smith, K. V. Calvin, J. S. Daniel, M. L. T. Kainuma, J.-F. Lamarque, K. Matsumoto, et al., "The RCP Greenhouse Gas Concentrations and Their Extension from 1765 to 2300." *Climatic Change* 109 (2011; special issue): 213–41, DOI:10.1007/s10584-011-0156-z. For information on the SSP scenarios, see a special issue of the journal *Climate Change on Shared Socioeconomic Pathways* (2014), e.g., N. Nakicenovic, R. J. Lempert, and A. C. Janetos, "A Framework for the Development of New Socio-economic Scenarios for Climate Change Research: Introductory Essay," *Climatic Change* 122 (2014; special issue): 351–61. DOI:10.1007/s10584-013-0982-2.

The uncertainty in projections of climate and socioeconomic conditions is large and becomes larger as the projections reach farther into the future. The spread in outcomes for the risk estimates reflects the uncertainty due to changes in climate change scenarios and socioeconomic development and to the variability of the different climate models used to estimate flood risk.

A detailed description of the methodology and models used in this publication is given in the technical annex at the end.

LIMITATIONS

The information presented in the profiles is meant to inform governments of the levels of river flood and earthquake risk in their countries and to facilitate discussions with them on the need to reduce these risks and increase resilience to natural disasters. Estimates given in terms of fatalities, affected population, affected GDP, and capital loss provide a first impression of the risk in each country and the risk ranking of its provinces. As the information is produced using global flood and earthquake risk models, it is important to be aware of the limitations of the methodologies used for both hazards.

The national decision makers for whom these risk assessments are intended can use them to focus attention on areas of their countries at high risk and support the prioritization of studies for further quantifying it. The assessments should not be used for the design of risk reduction measures, such as flood protection, retrofitting of buildings, or risk-informed urban planning. Such measures require more detailed and calibrated models that include vital information on local conditions, such as river profiles, current flood defenses, local building standards, and soil characteristics, as well as information on exposure, such as the occupancy and construction of local structures and the vulnerability of structures to forces generated by a peril. They also require the extensive engagement of local experts and stakeholders.

The population and GDP affected by floods and earthquakes have been assessed only as a function of hazard and exposure; vulnerability is not taken into account. In other words, as indicated above, population and GDP are considered affected once they experience flood water at any depth or ground motion intensities equal to or greater than MMI VI. In reality, the effect of a flood or earthquake on a population or an economy depends on depth of the water or the intensity of the ground motion. The actual impact of 2 meters of flood water, for example, is likely to be significantly greater than that of 10 centimeters of flood water, but the model results will show the same amounts of affected GDP for both 2 meters and 10 centimeters of water.

Another limitation is associated with the Global Flood Risk with IMAGE Scenarios (GLOFRIS) model, which can be used to assess large-scale river flood risks as well as global risks, although it does not assess coastal, flash, or urban floods. Because information on flood defenses is sparse on a global scale, the version of GLOFRIS used for this publication does not account for flood protection measures and will therefore overestimate the affected population and GDP for return periods lower than the design protection level of existing flood defenses. This in turn leads to an overestimation of the annual average affected population and GDP.

In general, uncertainties in absolute flood risk estimates are large[5], while estimates of relative changes in risk under different scenarios or variability across space are more robust.[6,7]

5. H. Apel, B. Merz, and A. H. Thieken, "Quantification of Uncertainties in Flood Risk Assessments," *International Journal of River Basin Management* 6 (2008): 149–62, DOI: 10.1080/15715124.2008.9635344; H. De Moel and J. C. J. H. Aerts, "Effect of Uncertainty in Land Use, Damage Models and Inundation Depth on Flood Damage Estimates," Natural Hazards 58 (2011): 407–25, DOI: 10.1007/s11069-010-9675-6; B. Merz, H. Kreibich, R. Schwarze, and A. Thieken, "Assessment of Economic Flood Damage," *Natural Hazards and Earth Systems Sciences* 10 (2010): 1697–1724, DOI:10.5194/nhess-10-1697-2010.

6. P. Bupeck, H. De Moel, L. M. Brouwer, and J. C. J. H. Aerts, "How Reliable Are Projections of Future Flood Damage?" *Natural Hazards and Earth System Sciences* 11 (2011): 3293–3306, DOI: 10.5194/nhess-11-3293-2011.

7. A detailed description of the limitations of the GLOFRIS model can be found in H. Winsemius and P. Ward, "Flood Risk Profiles Europe–Central Asia Region," Final project report to the Global Facility for Disaster Reduction and Recovery (GFDRR), World Bank, no. 1209814-000-ZWS-0002, 2014.

The earthquake risk results include estimates of fatalities and capital loss, in addition to the affected population and GDP. The additional information is generated using vulnerability functions that convert ground motion into fatality and damage estimates.[8]

The country risk profiles also mention significant historical events and their associated fatalities, affected population, and damage inflated to 2015 dollars, which provides context for interpreting the modeled impacts. When comparing historical events, however, one should not only inflate the dollars, but also account for the growth of a country's population and wealth over time; to do so, one can either use risk models or normalize historical records.

A few of the profiles also include modeled estimates of the fatalities and damage that would be caused by a historical earthquake if it were to occur today. The 1969 Banja Luka earthquakes in Bosnia and Herzegovina, for example, caused 14 deaths and $50 million in damage. If one corrected just for inflation, the damage today would be more than $300 million in 2015 dollars. Because of population growth, urbanization, and increased wealth, however, both the damage and fatalities would actually be much greater. Model estimates suggest over 400 fatalities would occur, and the damage would be approximately $4 billion—over 20 percent of Bosnia and Herzegovina's GDP. These figures could be even larger with future growth in population and wealth if appropriate efforts are not made to increase resilience to earthquakes. Similar arguments can be made for flood damage and mitigation of future flood risk.

REGIONAL RISK INFORMATION

All the regions in ECA are significantly exposed to both floods and earthquakes. Floods pose the highest risk for the Baltic States, the European Union States, and the Russian

8. A detailed description of the methodology can be found in J. E. Daniell, "Development of Socio-economic Fragility Functions for Use in Worldwide Rapid Earthquake Loss Estimation Procedures," doctoral thesis, Karlsruhe Institute of Technology, Karlsruhe, Germany, 2014.

	FLOOD		EARTHQUAKE	
	Annual average affected population	**Annual average affected GDP (million US$)**	**Annual average affected population**	**Annual average affected GDP (million US$)**
Baltic States	800,000	9,000	50,000	600
Caucasus States	300,000	800	600,000	2,000
Central Asian States	1,000,000	4,000	2,000,000	5,000
European Union States	2,000,000	20,000	1,000,000	20,000
Russian Federation	2,000,000	20,000	200,000	1,000
South East European States	1,000,000	9,000	2,000,000	20,000

Table 1. *Annual Average Affected Population and GDP for Floods and Earthquakes.*
SOURCE: VALUES FROM MODEL RESULTS OF THIS STUDY.

Federation, and while the Caucasus States, the Cental Asian States and the South East European states are more affected by earthquakes (see Table 1).

A ranking of the ECA countries by the annual average GDP[9] affected by floods (Figure 2) and earthquakes (Figure 3) shows that average annual affected GDP among the countries varies over an order of magnitude. For floods, the country with the highest annual average affected GDP is the Russian Federation ($20 billion), followed by Poland and Turkey. For earthquakes, it is Turkey ($10 billion), followed by Romania and Greece.

The annual average GDP affected by floods and earthquakes seems small relative to the total GDP of each country; it is generally less than 5 percent. Figures 4–7, however, show that the impact of more intense and less frequent events, such as 100-year floods or 250-year earthquakes, quickly becomes more significant.[10] For example, the GDP affected by a 100-year flood is estimated at $60 billion in Russia (Figure 4), and that of a 250-year earthquake is estimated at $300 billion in Turkey (Figure 6).

The view of risk is very different if one ranks countries by the percentage of affected GDP rather than absolute GDP. From this perspective, the country to which a 100-year flood poses the greatest risk is, by far, FYR Macedonia, with nearly 20 percent of its GDP affected (Figure 5). The countries at greatest risk from earthquakes are Armenia, Albania and Georgia, in that order, with over 88 percent of their respective GDPs affected by 250-year events (Figure 7).

9. Annual average affected GDP is estimated by averaging the affected GDP by individual floods or earthquakes over a long period of time.

10. A 100-year flood has a return period of 100 years, which means the probability of a flood's occurring is 1 percent per year. A 250-year earthquake has a return period of 250 years, which means the probability of an earthquake's occurring is 0.4 percent per year.

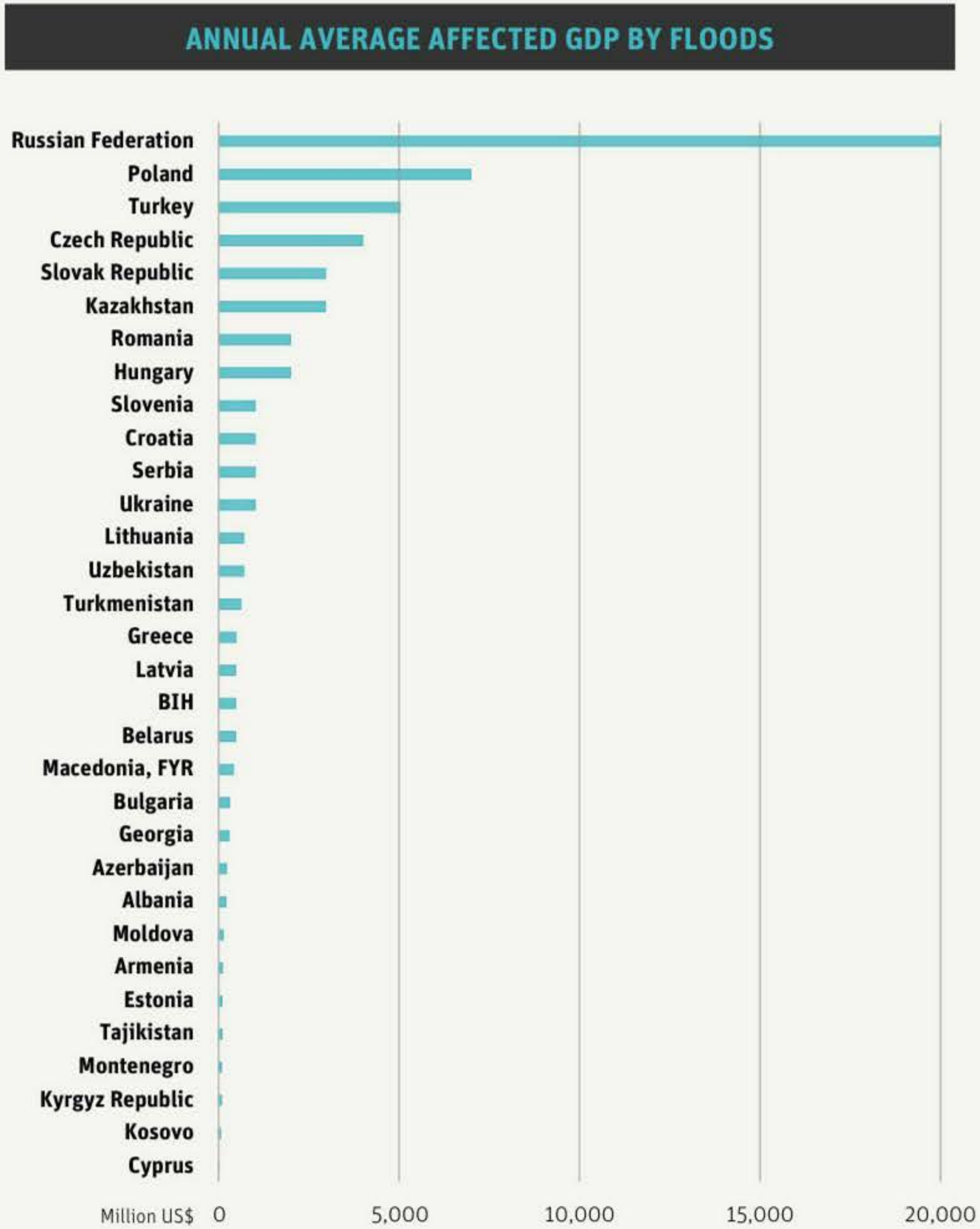

Figure 2. *Annual Average GDP Affected by Floods.*
SOURCE: VALUES FROM MODEL RESULTS OF THIS STUDY.

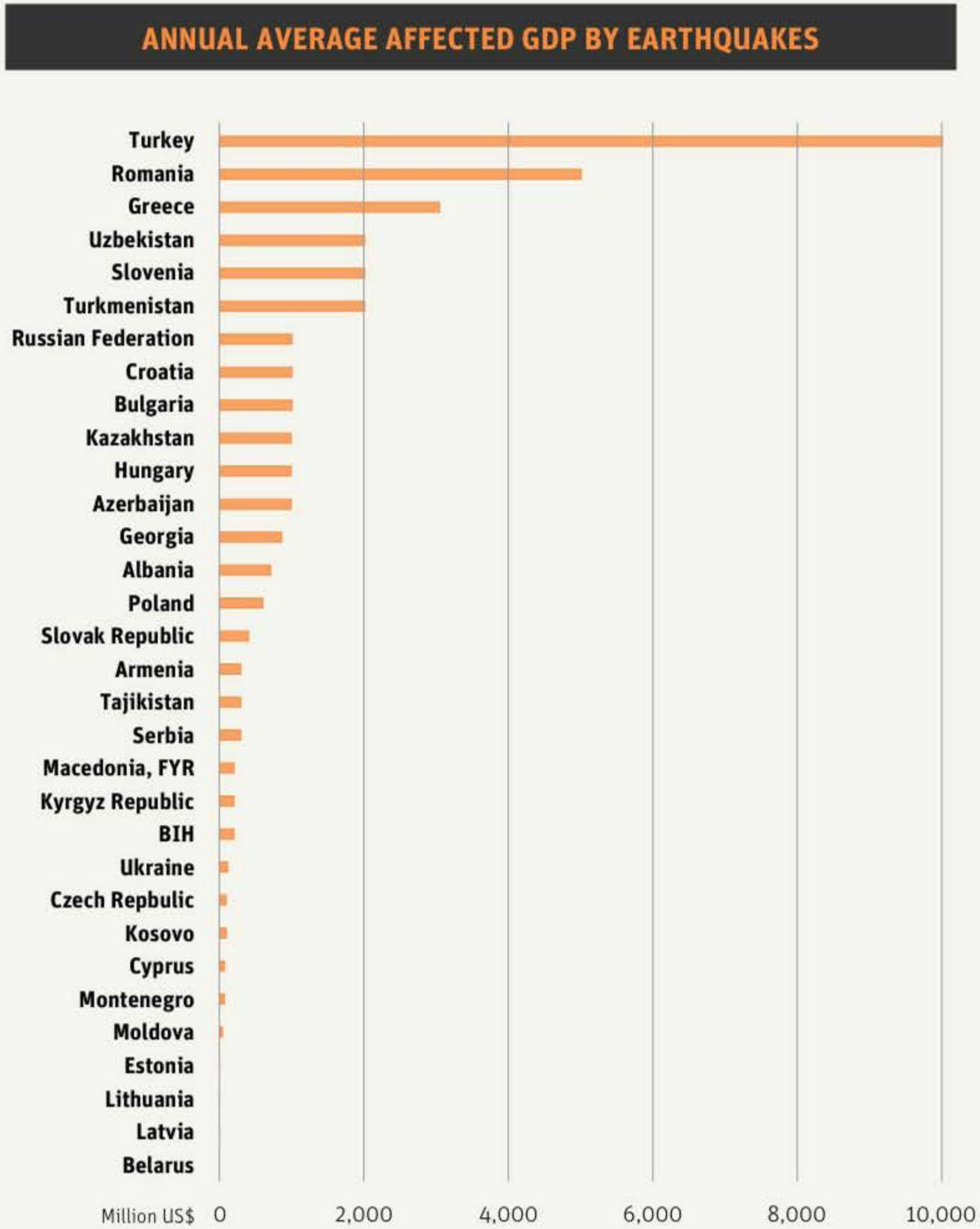

Figure 3. *Annual Average GDP Affected by Earthquakes.*
SOURCE: VALUES FROM MODEL RESULTS OF THIS STUDY.

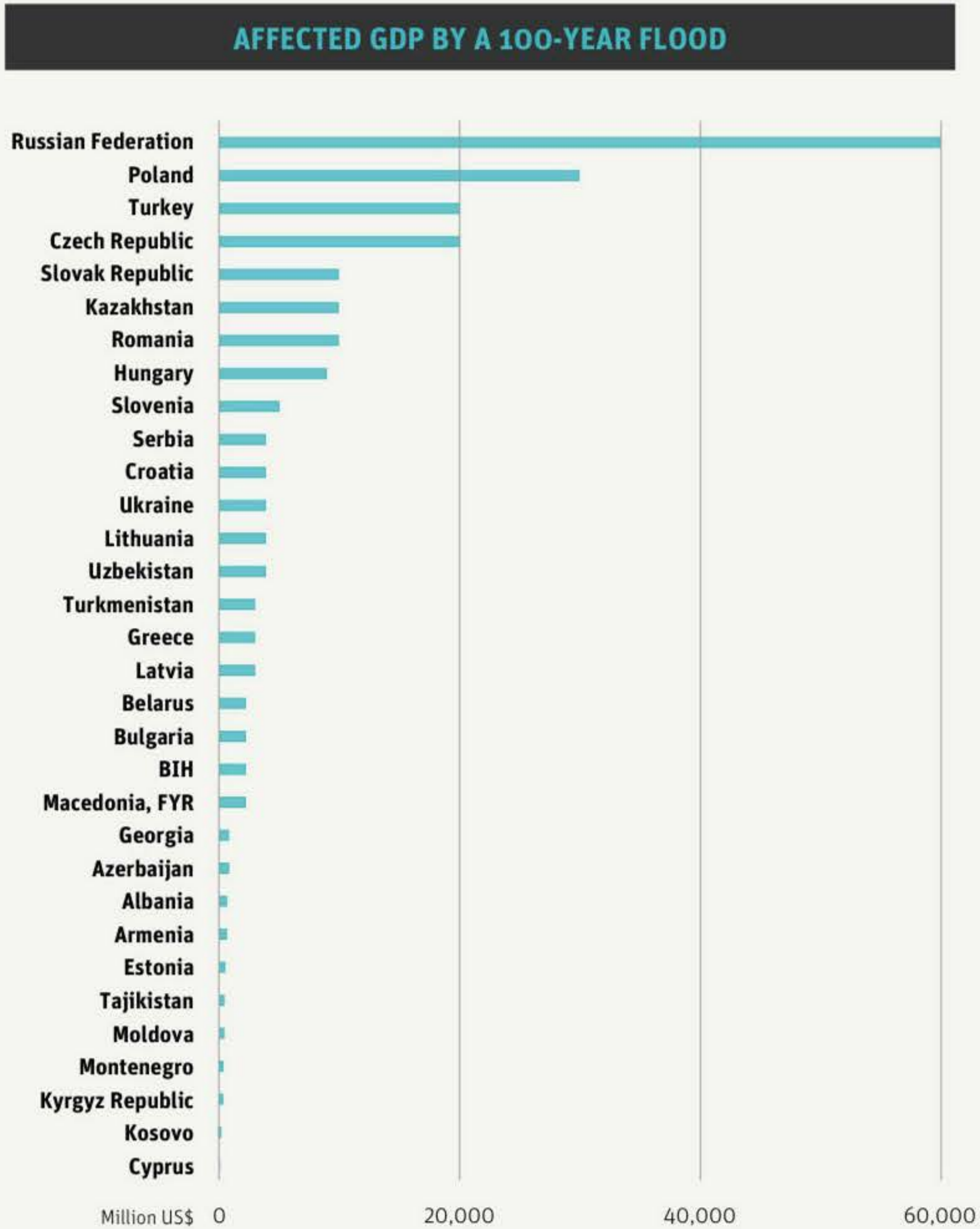

Figure 4. *GDP Affected by a 100-year Flood.*
SOURCE: VALUES FROM MODEL RESULTS OF THIS STUDY.

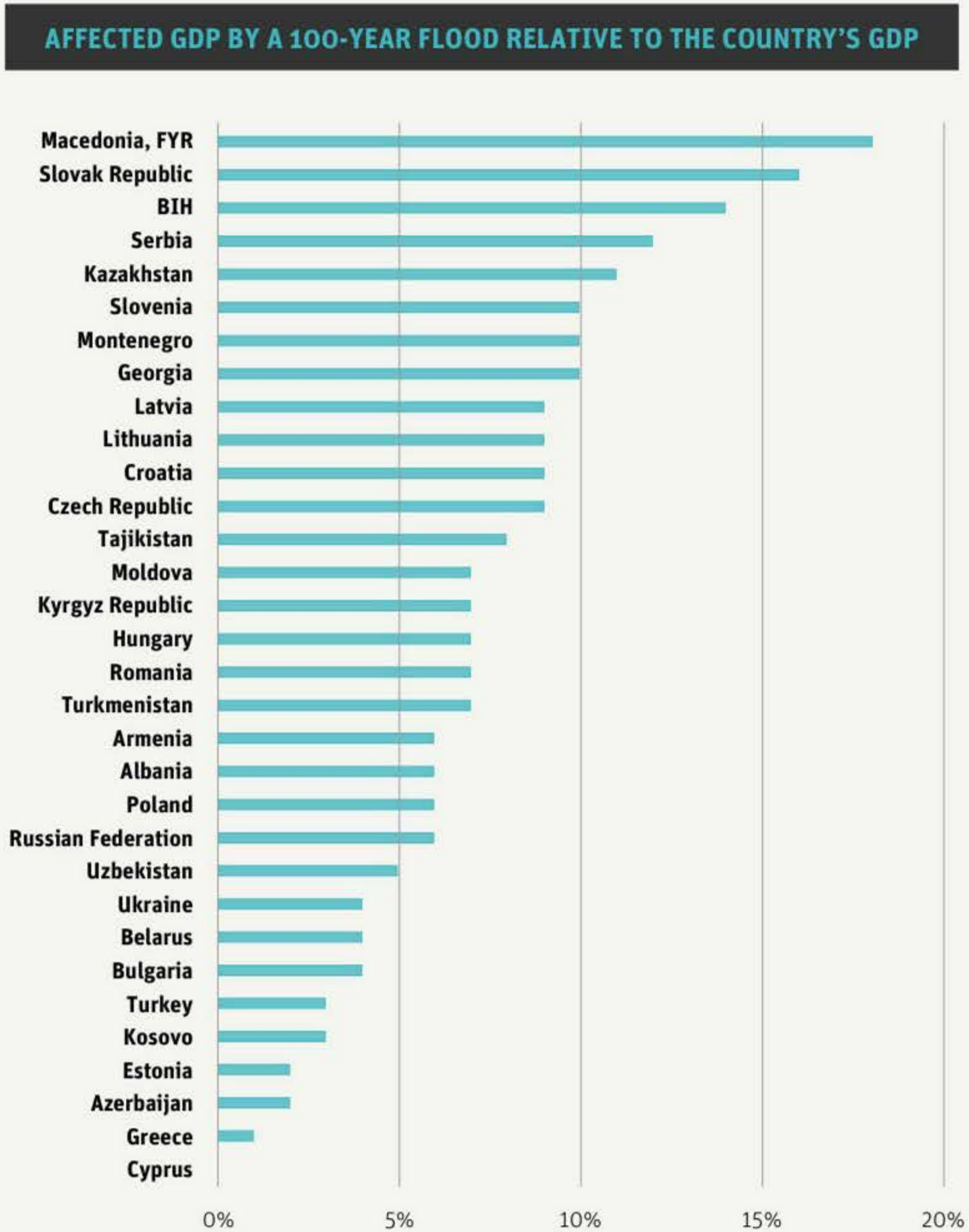

Figure 5. *GDP Affected by a 100-year Flood Relative to the Country's GDP.*
SOURCE: VALUES FROM MODEL RESULTS OF THIS STUDY.

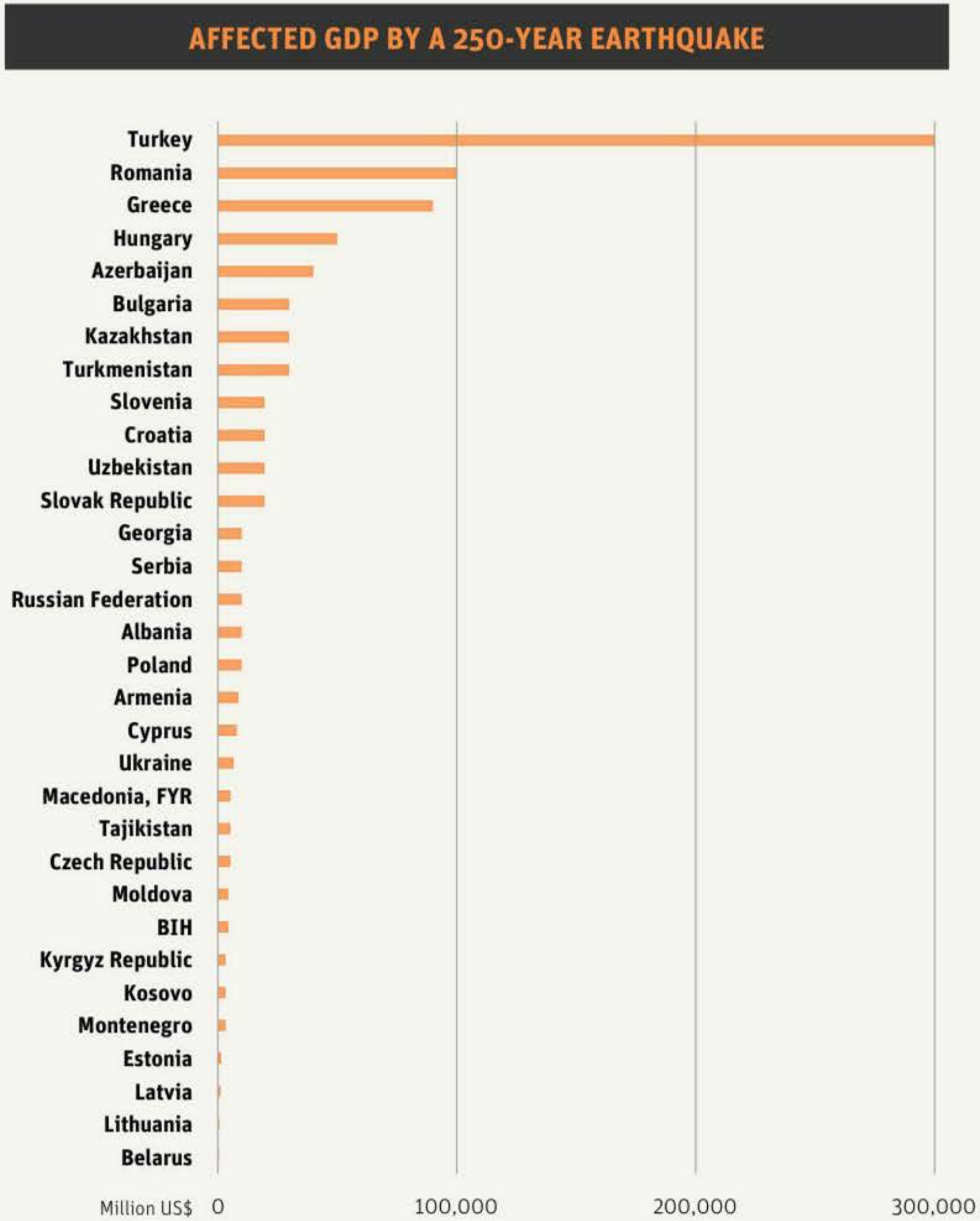

Figure 6. *GDP Affected by a 250-year Earthquake.*
SOURCE: VALUES FROM MODEL RESULTS OF THIS STUDY.

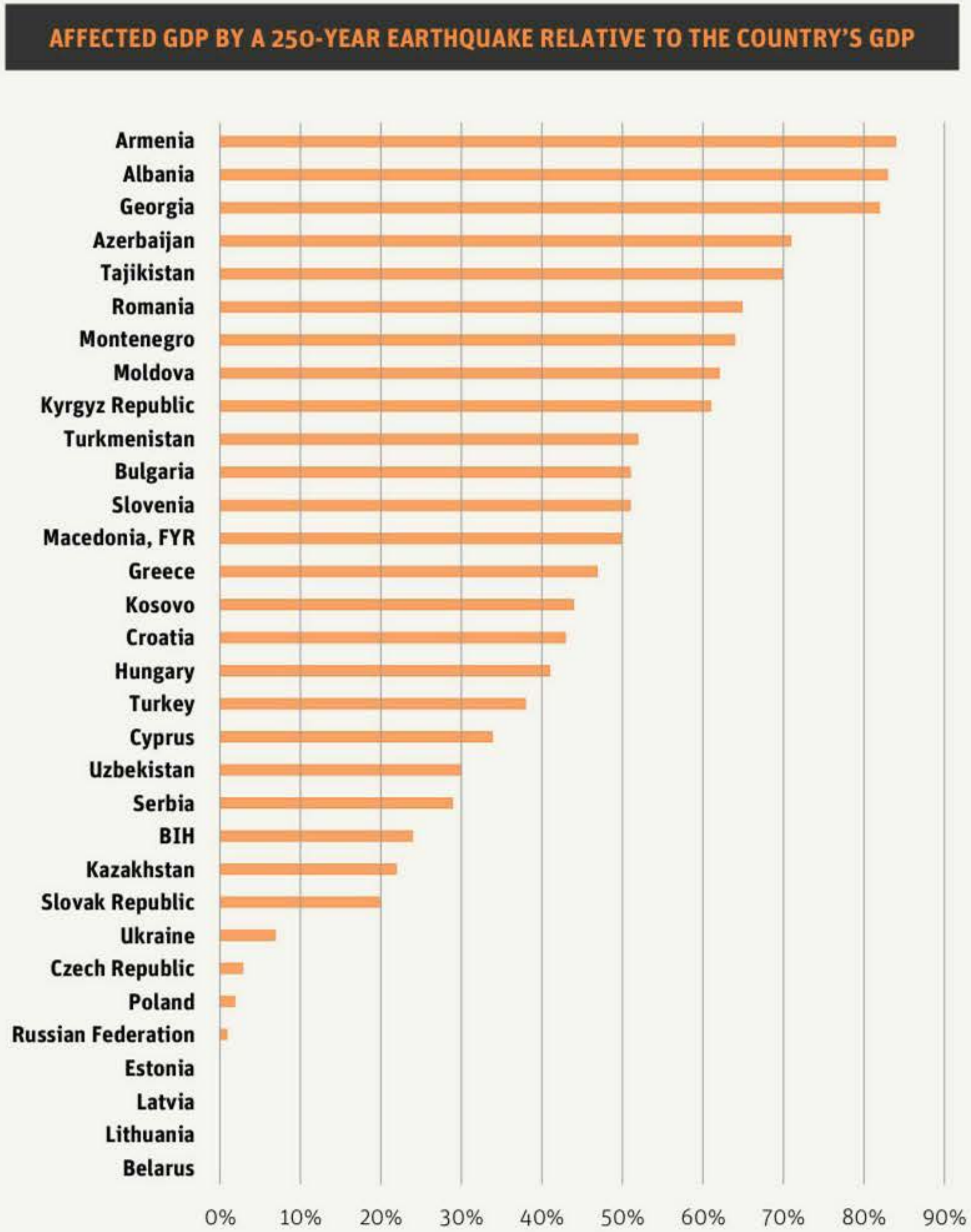

Figure 7. *GDP Affected by a 250-year Earthquake Relative to the Country's GDP.*
SOURCE: VALUES FROM MODEL RESULTS OF THIS STUDY.

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EUROPE AND CENTRAL ASIA (ECA) RISK PROFILES

Albania

	AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
GDP $11.6 billion*	$700 million (6%)	$10 billion (83%)	$2 billion (18%)
Population 2.9 million*	200,000 (7%)	2 million (79%)	3,000 (<1%)

*2015 estimates

Albania's population and economy are exposed to earthquakes and floods, with earthquakes posing the greater risk of a high impact, lower probability event. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

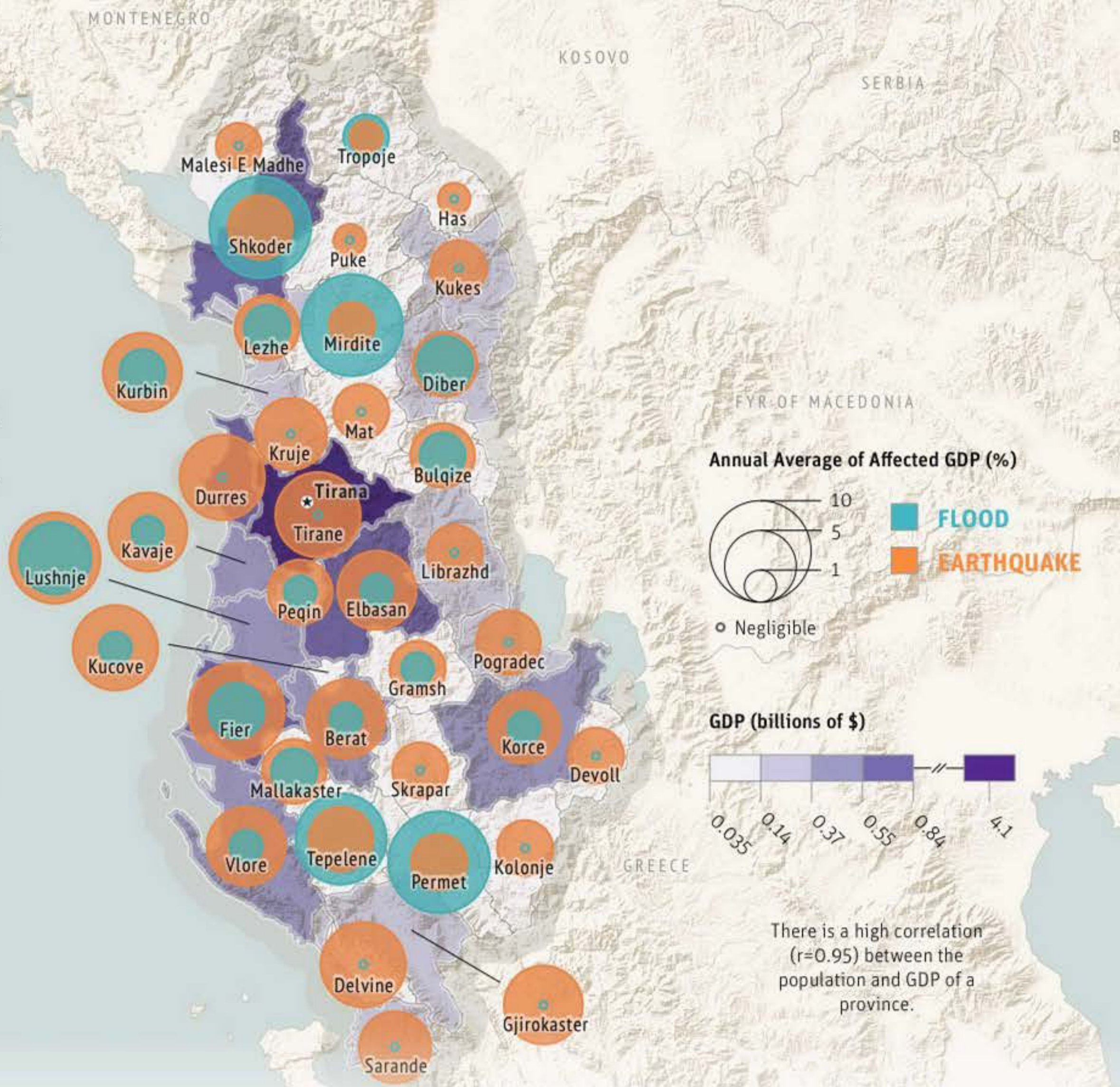
Just over half of Albania's population lives in urban environments. The country's GDP was approximately US$11.6 billion in 2015, with close to 70 percent derived from services and with industry and agriculture generating the remainder. Albania's per capita GDP was $3,990.

This map displays GDP by province in Albania, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of floods is Shkoder, and the one at greatest risk of earthquakes is Fier. In absolute terms, the province at greatest risk of floods is also Shkoder, and the one at greatest risk of earthquakes is Tirane.

TOP AFFECTED PROVINCES

FLOOD ANNUAL AVERAGE OF AFFECTED GDP (%)		EARTHQUAKE ANNUAL AVERAGE OF AFFECTED GDP (%)	
Shkoder	14	Fier	9
Mirdite	10	Lushnje	8
Permet	10	Tirane	7
Tepelene	8	Durres	7
Lushnje	5	Kucove	7
Fier	3	Delvine	7
Diber	3	Kavaje	6
Kurbin	2	Gjirokaster	6
Tropoje	2	Vlore	6
Mallakaster	2	Kurbin	6



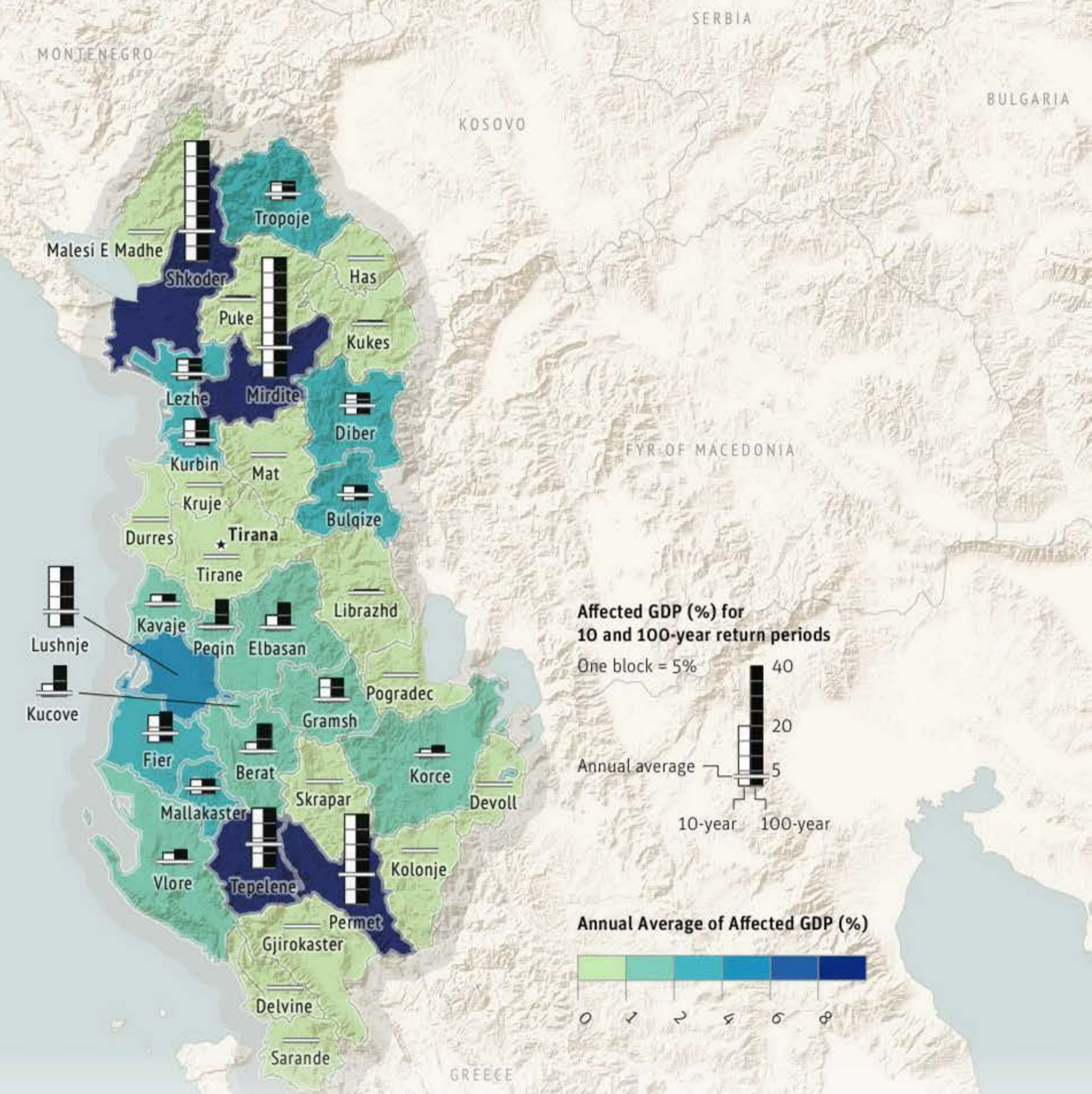
The most deadly flood in Albania since 1900 occurred in 1992. It killed 11 Albanians and caused close to $12 million in damage. Flooding in 2002 caused one fatality but about twice the damage ($23 million) of the 1992 flood. Damaging flooding also took place on the Drina River in 2010.

This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in Albania is about 50,000 and the annual average affected GDP about $200 million. Within the various provinces, the 10- and 100-year impacts do not differ much, so relatively frequent floods have large impacts on these averages.



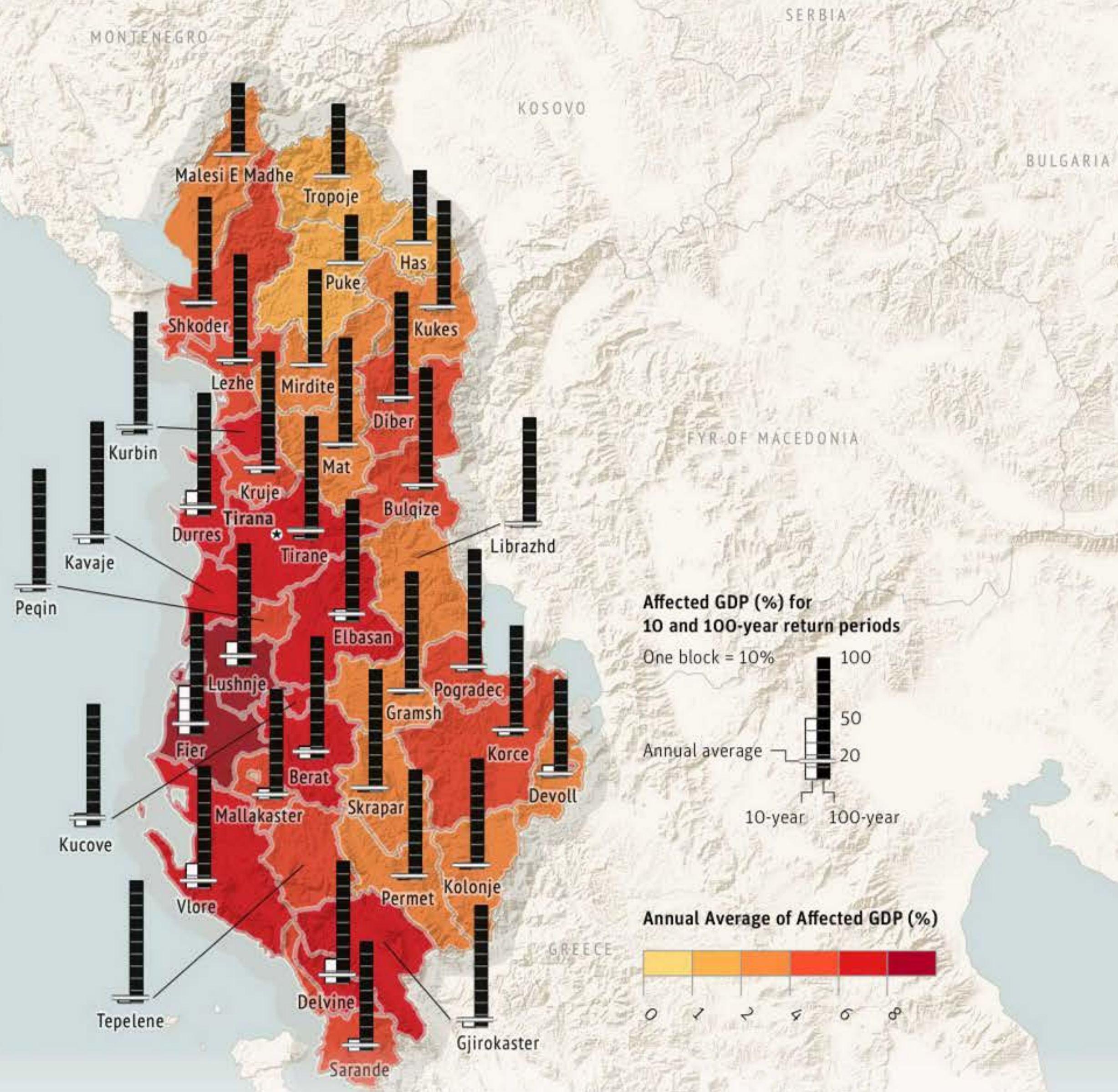
Albania's most deadly earthquake since 1900 took place in 1920 in Tepelene, with a magnitude of 6. The earthquake and the tsunami that followed caused about 600 fatalities. Since then, Albania has experienced many earthquakes of varying severity. A significant earthquake that occurred in 1967 caused 18 fatalities and $140 million in damage.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

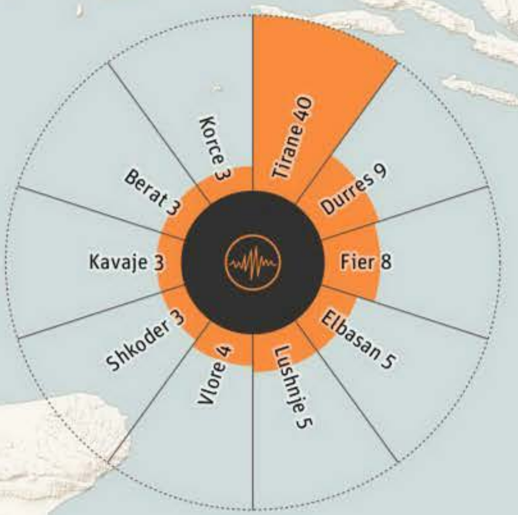
When an earthquake has a 10-year return period, it means the probability of occurrence of an earthquake of that magnitude or greater is 10 percent per year. A 100-year earthquake has a probability of occurrence of 1 percent per year. This means that over a long period of time, an earthquake of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year earthquake will occur exactly once every 100 years. In fact, it is possible for an earthquake of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make larger contributions to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

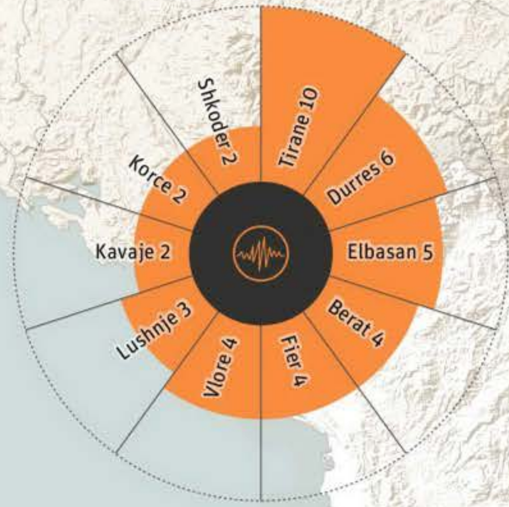
The annual average population affected by earthquakes in Albania is about 200,000 and the annual average affected GDP about $700 million. The annual averages of fatalities and capital losses caused by earthquakes are about 50 and about $100 million, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause nearly 3,000 fatalities and $2 billion in capital loss (about 20 percent of GDP).



EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS (MILLIONS $)

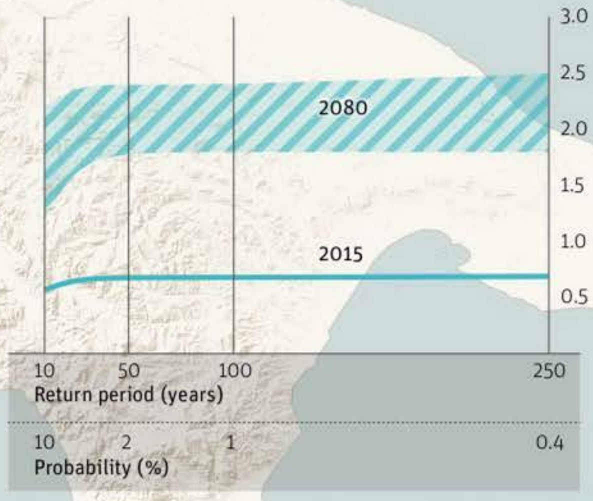


EARTHQUAKE
ANNUAL AVERAGE FATALITIES

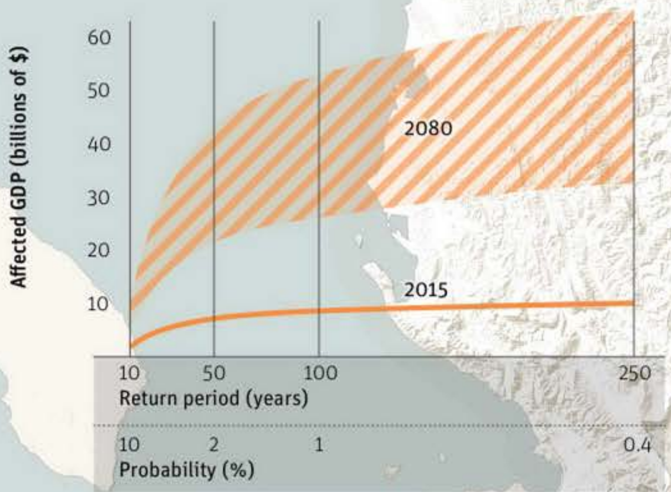


The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Tirane, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if Albania had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $700 million. In 2080, however, the affected GDP from the same type of event would range from about $2 billion to about $2.5 billion. If Albania had experienced a 250-year earthquake event in 2015, the affected GDP would have been about $10 billion. In 2080, the affected GDP from the same type of event would range from about $30 billion to about $60 billion, due to population growth, urbanization, and the increase in exposed assets.

All historical data on floods and earthquakes are from, respectively, D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be, and the National Geophysical Data Center/World Data Service (NGDC/WDS), Significant Earthquake Database (National Geophysical Data Center, NOAA), doi:10.7289/V5TD9V7K. Damage estimates for all historical events have been inflated to 2015 US$.

Armenia

	AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
GDP $10.7 billion*	$700 million (6%)	$9 billion (84%)	$6 billion (57%)
Population 3.0 million*	200,000 (6%)	2 million (76%)	11,000 (<1%)

*2015 estimates

Armenia's population and economy are exposed to earthquakes and floods, with earthquakes posing the greater risk of a high impact, but lower probability event. The model results for present-day risk presented in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 dollars.

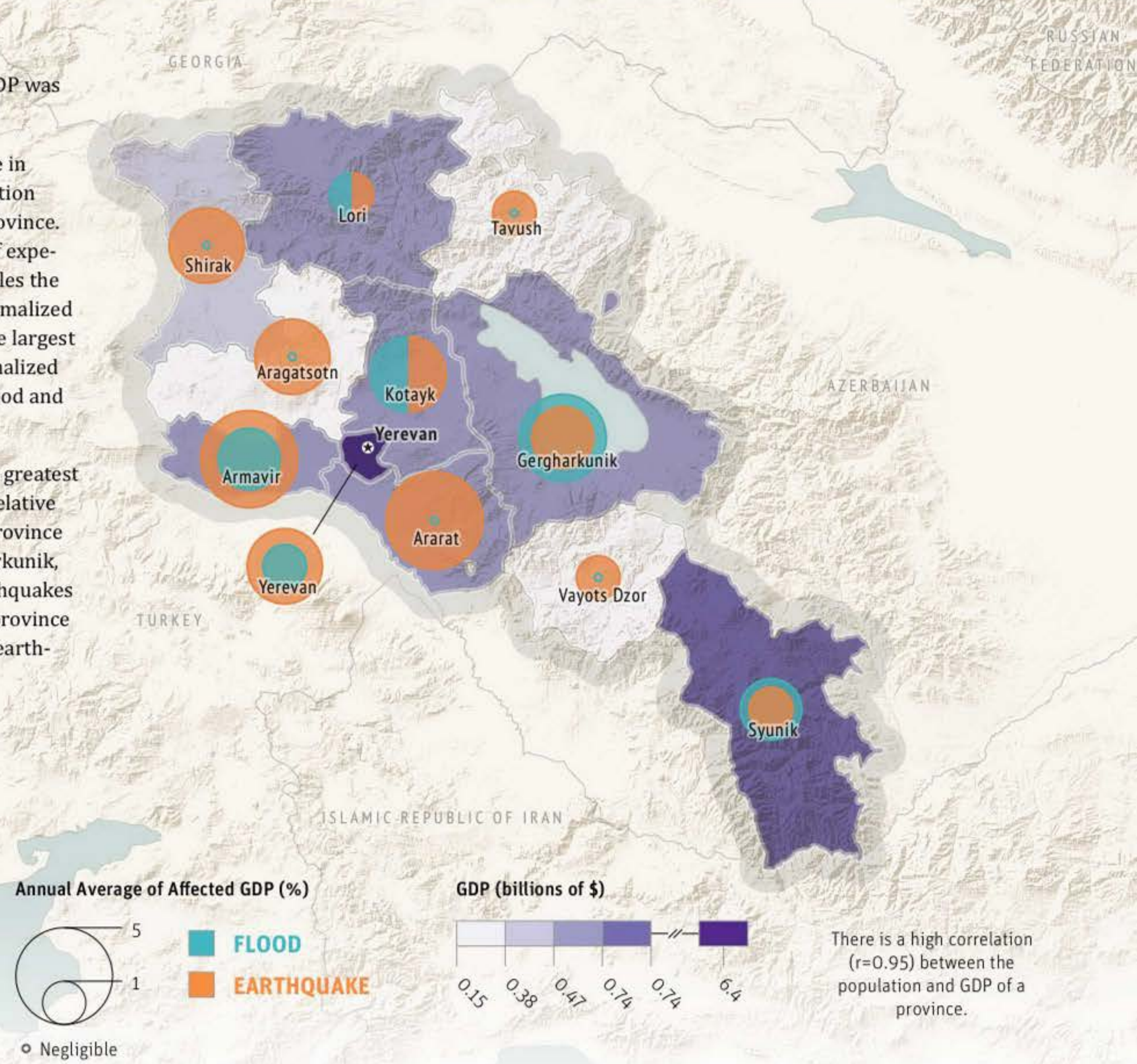
More than 60 percent of Armenia's population lives in urban environments. The country's GDP was approximately US$10.7 billion in 2015, with most derived from services and industry (together about 80 percent) and agriculture generating the remainder. Armenia's per capita GDP was $3,550.

This map displays GDP by province in Armenia, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of floods is Gergharkunik, and the one at greatest risk of earthquakes is Armavir. In absolute terms, the province at greatest risk of both floods and earthquakes is Yerevan.

TOP AFFECTED PROVINCES

FLOOD ANNUAL AVERAGE OF AFFECTED GDP (%)		EARTHQUAKE ANNUAL AVERAGE OF AFFECTED GDP (%)	
Gergharkunik	4	Armavir	5
Kotayk	3	Ararat	5
Syunik	2	Yerevan	3
Armavir	2	Shirak	3
Yerevan	1	Aragatsotn	3
Lori	1	Kotayk	3
Ararat	1	Gergharkunik	2
Vayots Dzor	0	Vayots Dzor	1
Tavush	0	Lori	1
Shirak	0	Syunik	1



There is a high correlation (r=0.95) between the population and GDP of a province.

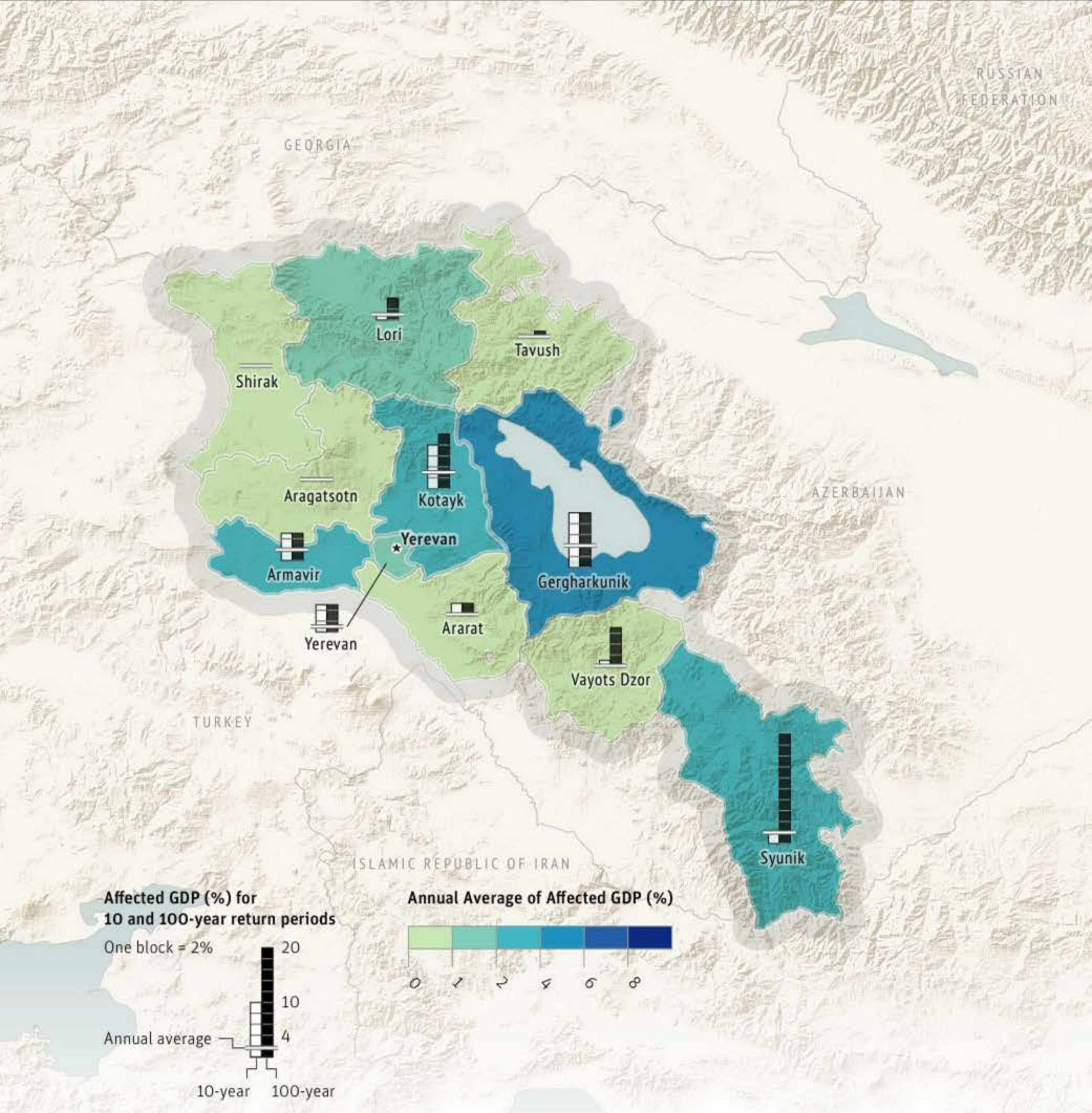
The most devastating flood in modern Armenia since it gained its independence in 1991 occurred in 1997. It killed four people, affected about 7,000, and caused $12 million in damage.

This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in Armenia is about 40,000 and the annual average GDP about $100 million. For most provinces, in which the impacts from 10- and 100-year floods do not differ much, relatively frequent floods have large impacts on these averages. For the few in which the 100-year impacts are much greater than the 10-year impacts, less frequent events make a significant contribution to the annual average of affected GDP.



Armenia's worst earthquake since 1900 took place in 1988 in Spitak, with a magnitude of 6.8. It caused about 25,000 fatalities and more than $30 billion in damage. A 1931 earthquake in Zangezur, with a magnitude of 6.3, killed over 2,800 people.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

When an earthquake has a 10-year return period, it means the probability of occurrence of an earthquake of that magnitude or greater is 10 percent per year. A 100-year earthquake has a probability of occurrence of 1 percent per year. This means that over a long period of time, an earthquake of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year earthquake will occur exactly once every 100 years. In fact, it is possible for an earthquake of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

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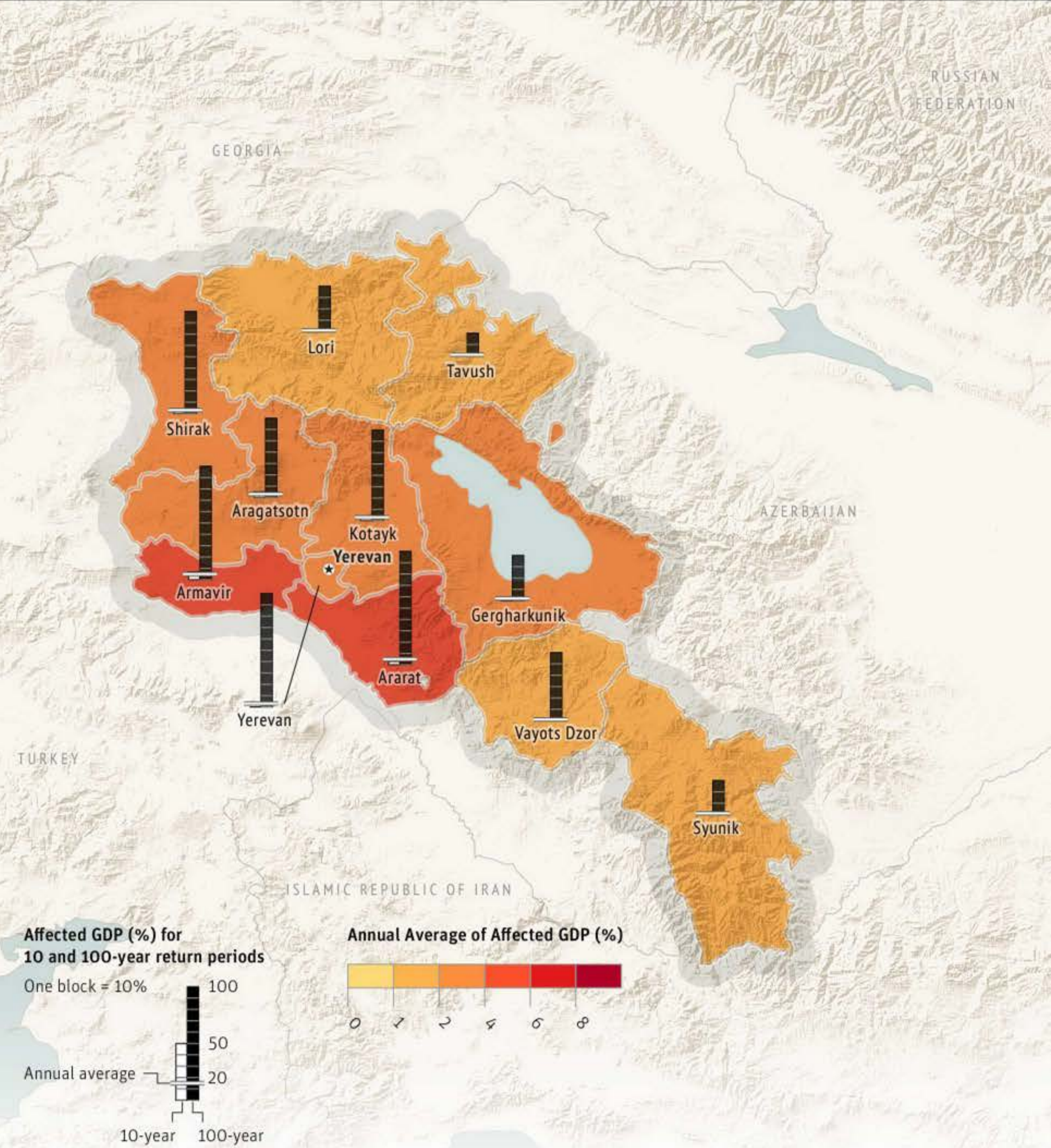
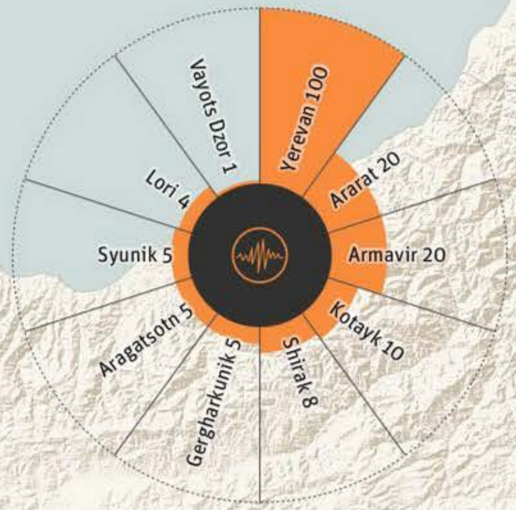
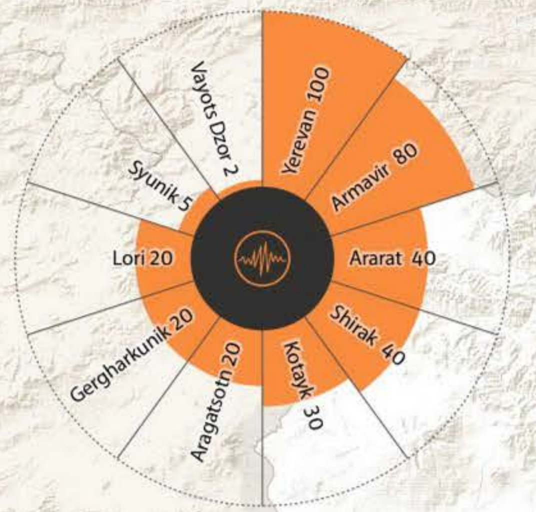
The annual average population affected by earthquakes in Armenia is about 90,000 and the annual average affected GDP about $300 million. The annual averages of fatalities and capital losses caused by earthquakes are about 400 and about $200 million, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause nearly 10,000 fatalities and $6 billion in capital loss (about 60 percent of GDP).



EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS (MILLIONS $)

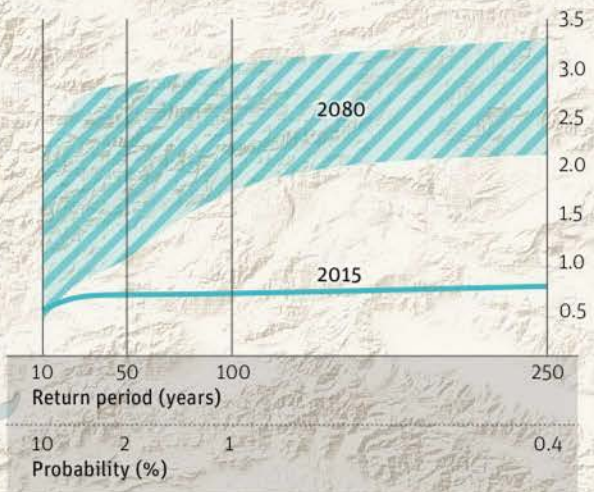


EARTHQUAKE
ANNUAL AVERAGE FATALITIES

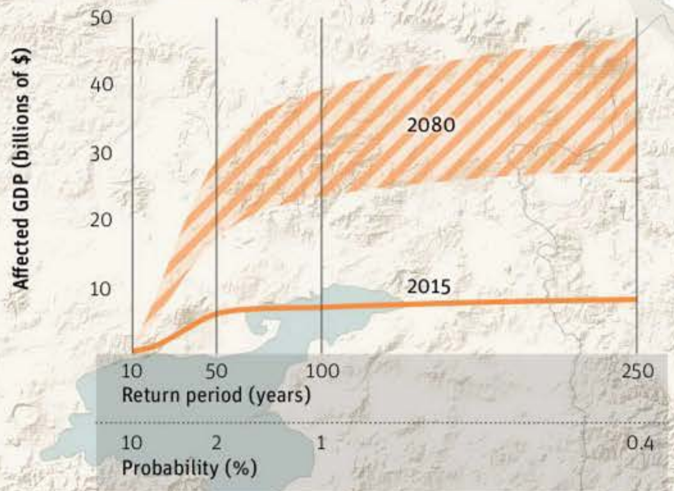


The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Yerevan, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if Armenia had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $700 million. In 2080, however, the affected GDP from the same type of event would range from about $2 billion to about $3 billion. If Armenia had experienced a 250-year earthquake event in 2015, the affected GDP would have been about $9 billion. In 2080, the affected GDP from the same type of event would range from about $30 billion to about $50 billion, due to population growth, urbanization, and the increase in exposed assets.

All historical data on floods and earthquakes are from, respectively, D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be, and the National Geophysical Data Center/World Data Service (NGDC/WDS), Significant Earthquake Database (National Geophysical Data Center, NOAA), doi:10.7289/V5TD9V7K. Damage estimates for all historical events have been inflated to 2015 US$.

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EUROPE AND CENTRAL ASIA (ECA) RISK PROFILES

Azerbaijan

GDP $54.6 billion*

Population 9.7 million*

	AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
GDP	$1 billion (2%)	$40 billion (71%)	$6 billion (11%)
Population	500,000 (5%)	3 million (34%)	40,000 (<1%)

*2015 estimates

Azerbaijan's population and economy are exposed to earthquakes and floods, with earthquakes posing the greater risk of a high impact, lower probability event. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

Just over half of Azerbaijan's population lives in urban environments. The country's GDP was approximately US$54.6 billion in 2015, with close to 60 percent derived from industry, most of the remainder generated by services, and agriculture making a small contribution.

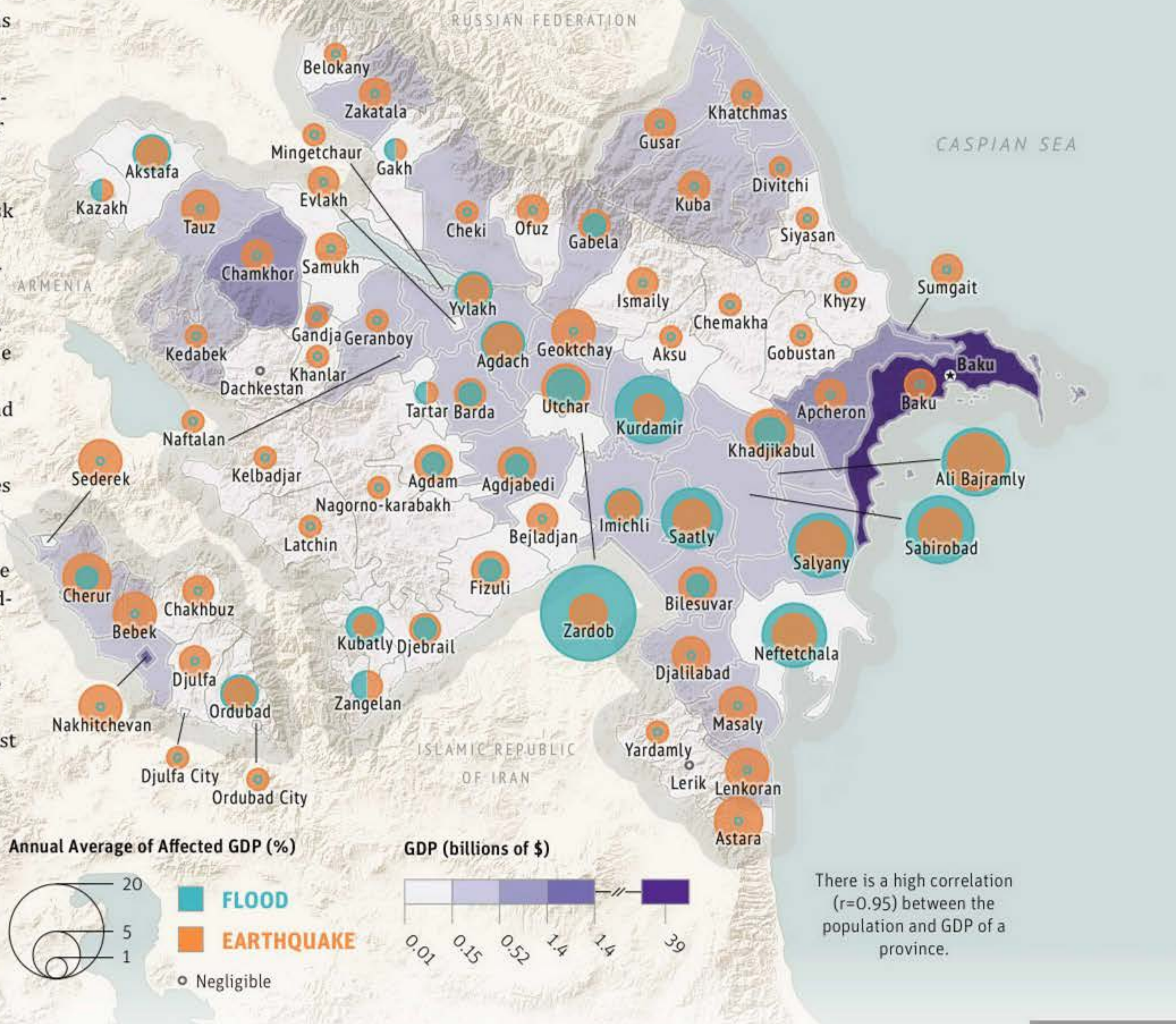
TOP AFFECTED PROVINCES

FLOOD ANNUAL AVERAGE OF AFFECTED GDP (%)		EARTHQUAKE ANNUAL AVERAGE OF AFFECTED GDP (%)	
Zardob	24	Ali Bajramly	6
Ali Bajramly	11	Astara	5
Sabirobad	10	Salyany	5
Kurdamir	10	Cherur	5
Neftetchala	9	Utchar	5
Salyany	9	Khadjikabul	5
Saatly	8	Geoktchay	4
Agdach	4	Neftetchala	4
Ordubad	3	Lenkoran	4
Akstafa	3	Sabirobad	4

Azerbaijan's per capita GDP was $5,630.

This map displays GDP by province in Azerbaijan, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of floods is Zardob, and the one at greatest risk of earthquakes is Ali Bajramly. In absolute terms, the province at greatest risk of floods is Ali Bajramly, and the one at greatest risk of earthquakes is Baku.



There is a high correlation (r=0.95) between the population and GDP of a province.

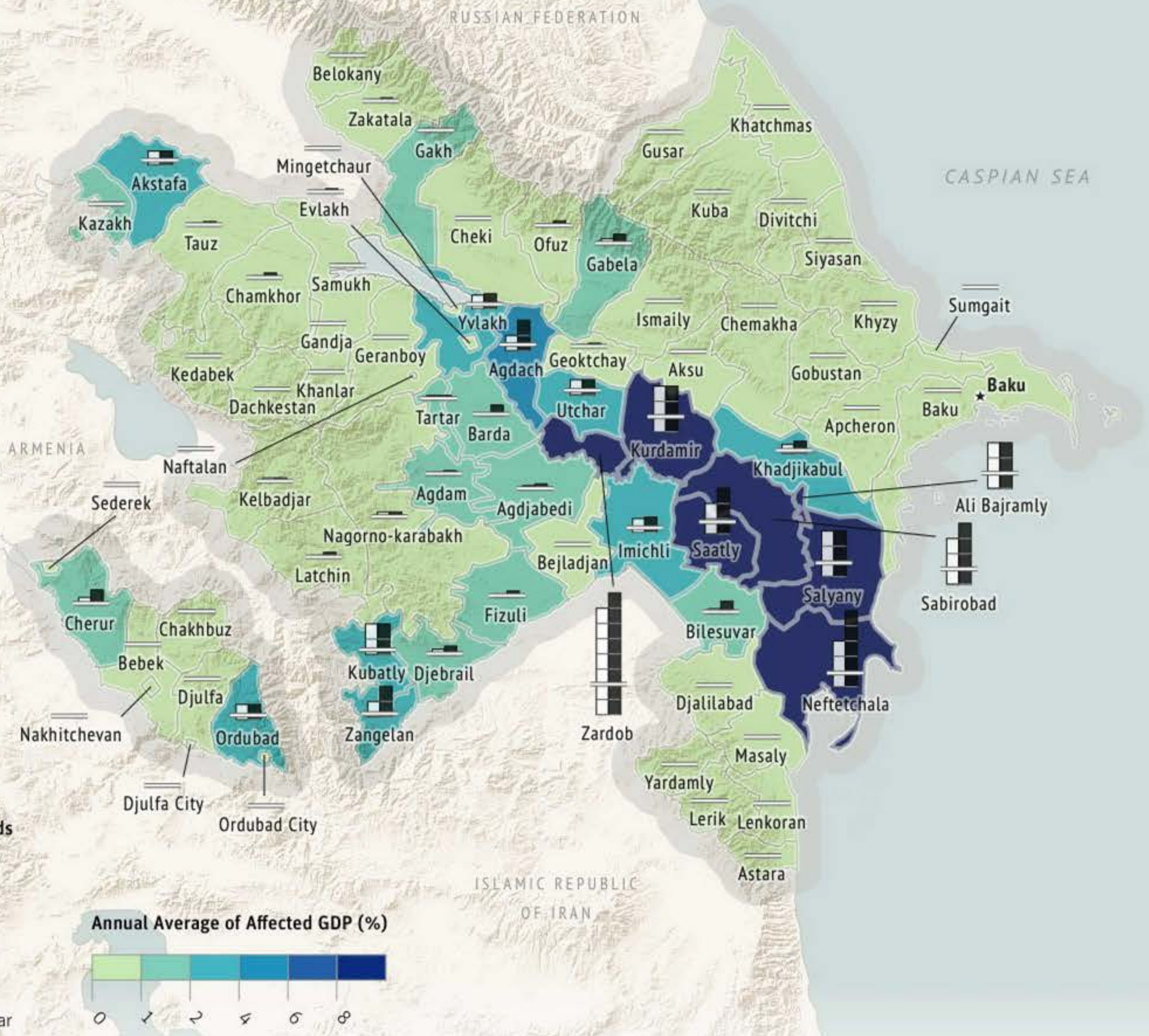
The most devastating floods in modern Azerbaijan since it gained its independence in 1991 occurred in 2003, affecting more than 30,000 people and causing over $70 million in damage. Floods in 1995 affected over 1.5 million people and caused about $30 million in damage.

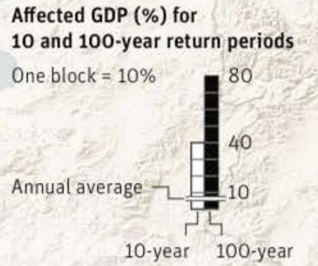
This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in Azerbaijan is about 100,000 and the annual average affected GDP about $300 million. Within the various provinces, the 10- and 100-year impacts do not differ much, so relatively frequent floods have large impacts on these averages.





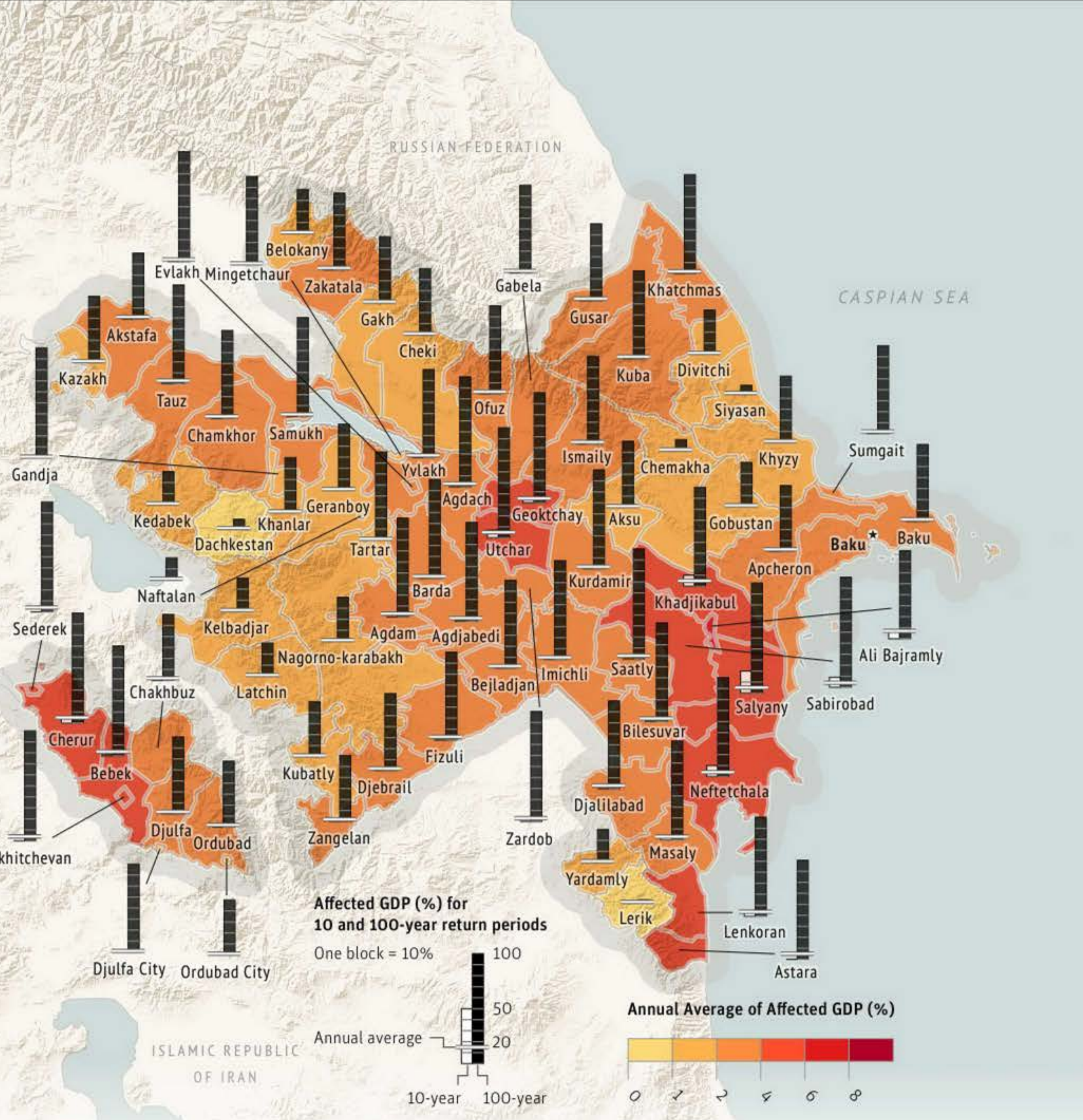
Azerbaijan's worst earthquake in recent decades took place in 2000 in the capital city of Baku, with a magnitude of 6.8. It caused more than 30 fatalities and over $10 million in damage. A 1999 earthquake caused one death and nearly $7 million in damage. The most deadly known earthquake in Azerbaijan's history occurred in 1667 or 1668 and caused around 80,000 fatalities.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

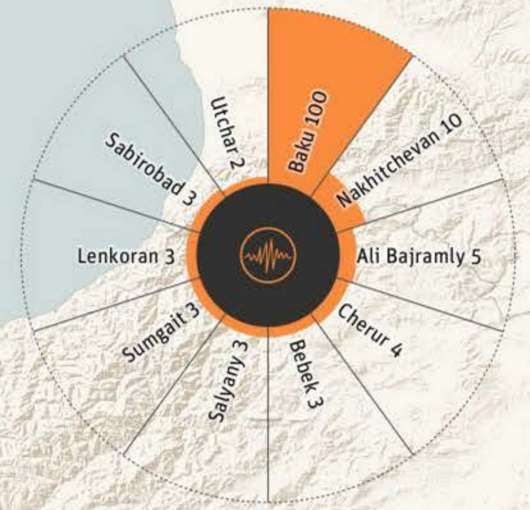
When an earthquake has a 10-year return period, it means the probability of occurrence of an earthquake of that magnitude or greater is 10 percent per year. A 100-year earthquake has a probability of occurrence of 1 percent per year. This means that over a long period of time, an earthquake of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year earthquake will occur exactly once every 100 years. In fact, it is possible for an earthquake of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make larger contributions to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

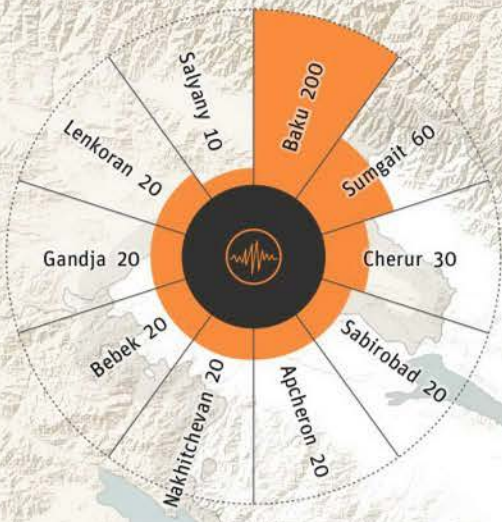
The annual average population affected by earthquakes in Azerbaijan is about 200,000 and the annual average affected GDP about $1 billion. The annual averages of fatalities and capital losses caused by earthquakes are about 800 and about $200 million, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause nearly 40,000 fatalities and $6 billion in capital loss (about 10 percent of GDP).



EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS (MILLIONS $)

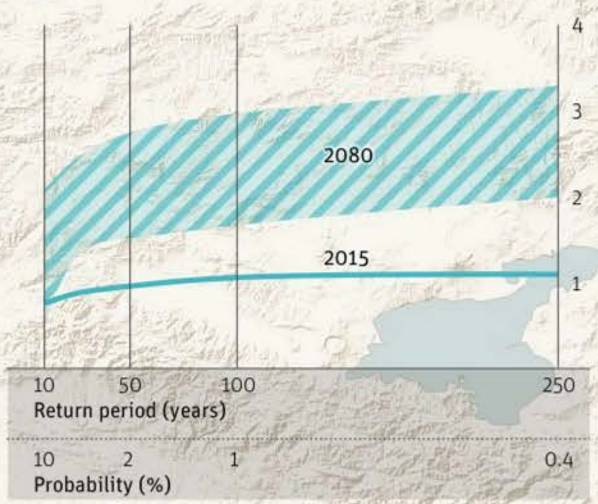


EARTHQUAKE
ANNUAL AVERAGE FATALITIES

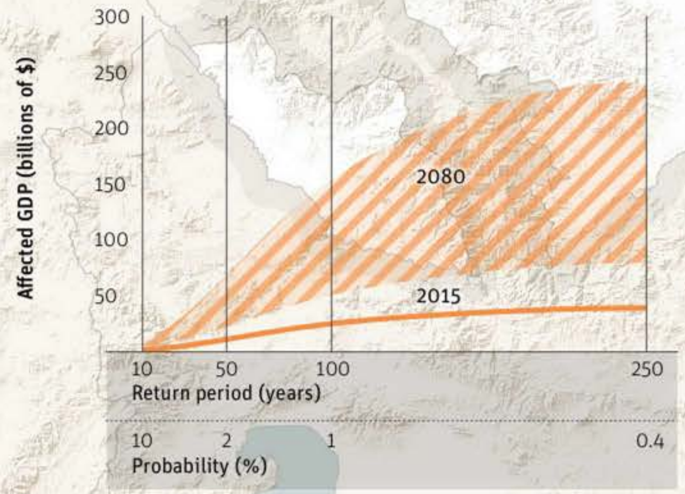


The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Baku, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if Azerbaijan had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $1 billion. In 2080, however, the affected GDP from the same type of event would range from about $2 billion to about $3 billion. If Azerbaijan had experienced a 250-year earthquake event in 2015, the affected GDP would have been about $40 billion. In 2080, the affected GDP from the same type of event would range from about $80 billion to about $240 billion, due to population growth, urbanization, and the increase in exposed assets.

All historical data on floods and earthquakes are from, respectively, D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be, and the National Geophysical Data Center/World Data Service (NGDC/WDS), Significant Earthquake Database (National Geophysical Data Center, NOAA), doi:10.7289/V5TD9V7K. Damage estimates for all historical events have been inflated to 2015 US$.

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EUROPE AND CENTRAL ASIA (ECA) RISK PROFILES

Belarus

GDP $56.8 billion*

Population 9.2 million*

	AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
GDP	$2 billion (4%)	$30 million (<1%)	$20 million (<1%)
Population	400,000 (5%)	6,000 (<1%)	0 (<1%)

*2015 estimates

Belarus' population and economy are exposed to earthquakes and floods, with floods posing the greater risk. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

Just over 75 percent of Belarus's population lives in urban environments. The country's GDP was approximately US$56.8 billion in 2015, with close to 90 percent derived from industry and services, and agriculture making a small contribution. Belarus's per capita GDP was $6,160.

This map displays GDP by province in Belarus, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative and absolute terms, the province at greatest risk of both floods and earthquakes is Vitebsk.

TOP AFFECTED PROVINCES

FLOOD

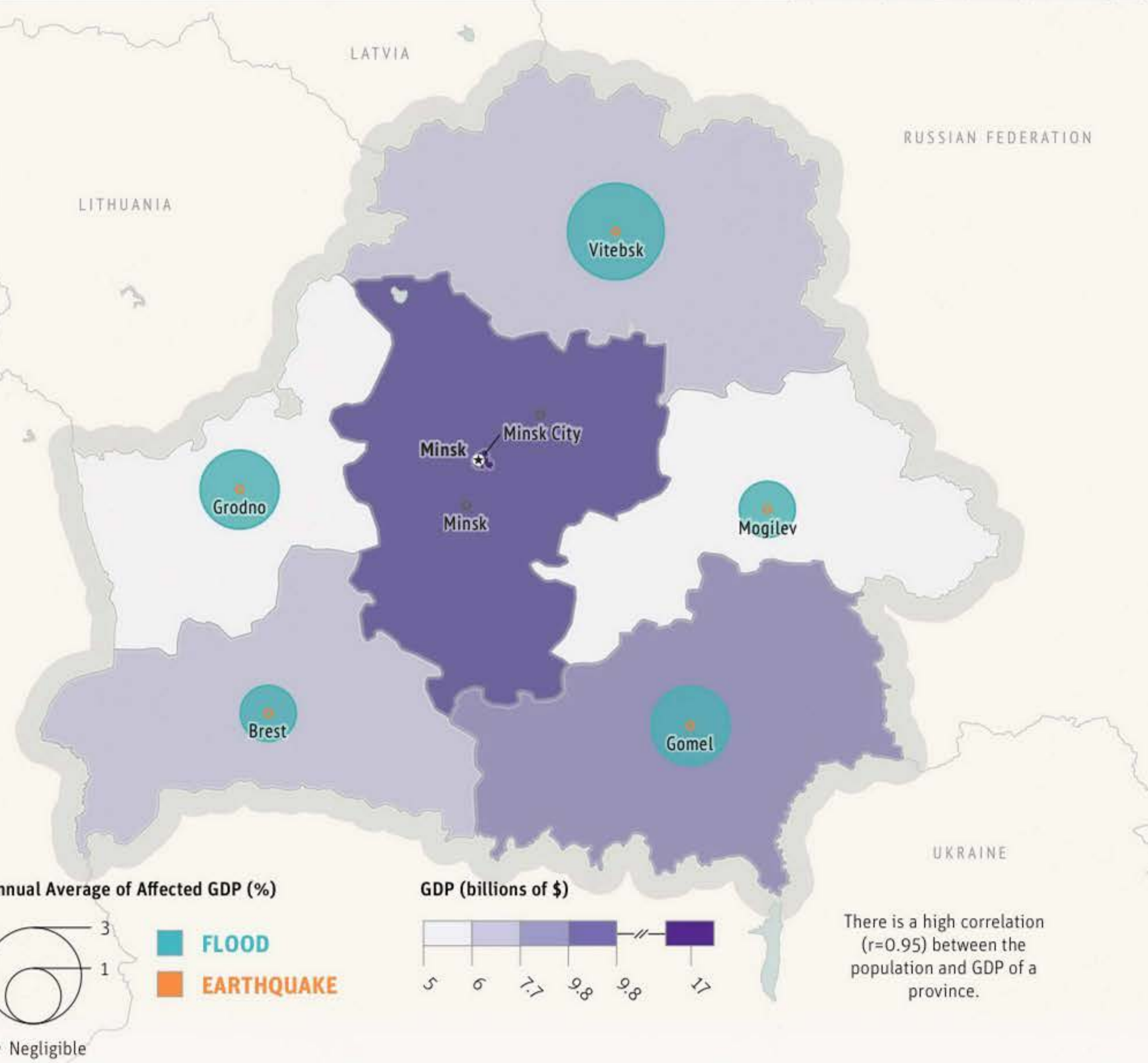
ANNUAL AVERAGE OF AFFECTED GDP (%)

Vitebsk	3
Gomel	2
Grodno	2
Brest	1
Mogilev	1
Minsk	0
Minsk City	0

EARTHQUAKE

ANNUAL AVERAGE OF AFFECTED GDP (%)

Vitebsk	0
Grodno	0
Mogilev	0
Minsk City	0
Minsk	0
Brest	0
Gomel	0



There is a high correlation (r=0.95) between the population and GDP of a province.

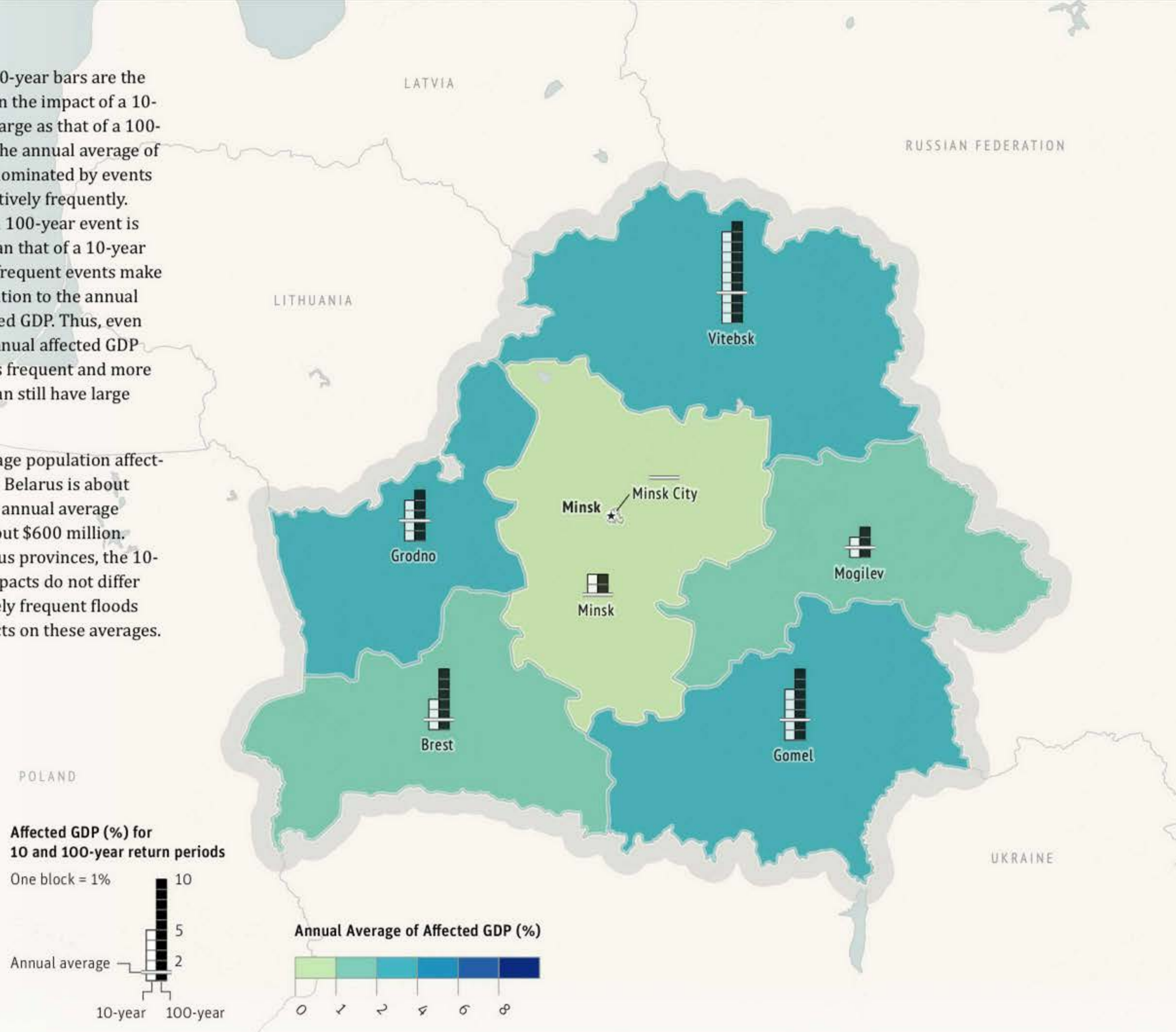
The most damaging flood in Belarus since it gained its independence in 1991 occurred in 1993, affecting approximately 40,000 people and causing at least $150 million in damage. Flooding in 1999 killed two people, affected more than 2,000, and caused over $5 million in damage.

This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in Belarus is about 100,000 and the annual average affected GDP about $600 million. Within the various provinces, the 10- and 100-year impacts do not differ much, so relatively frequent floods have large impacts on these averages.



Belarus's worst earthquake since 1900 took place in 1908.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

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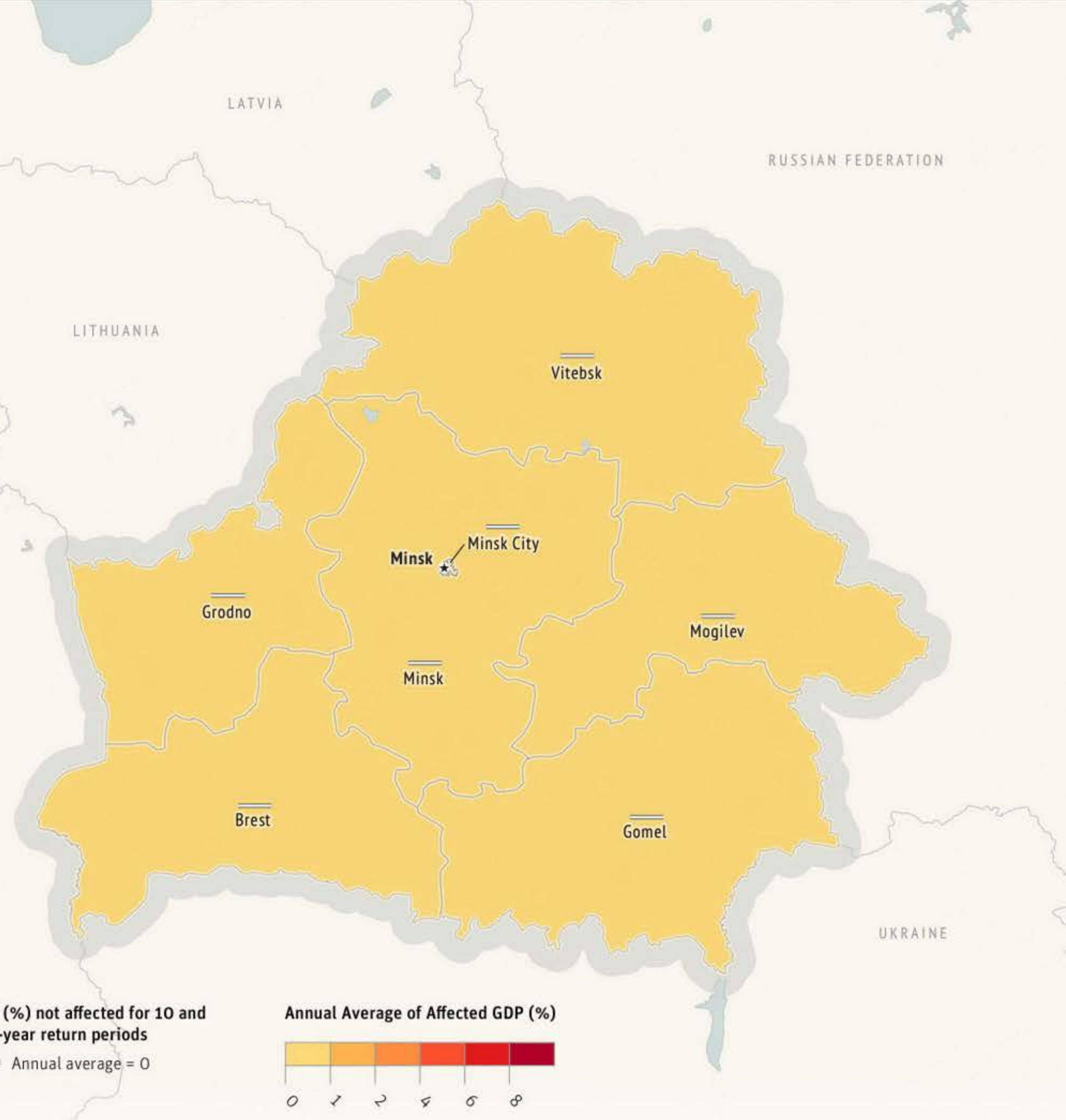
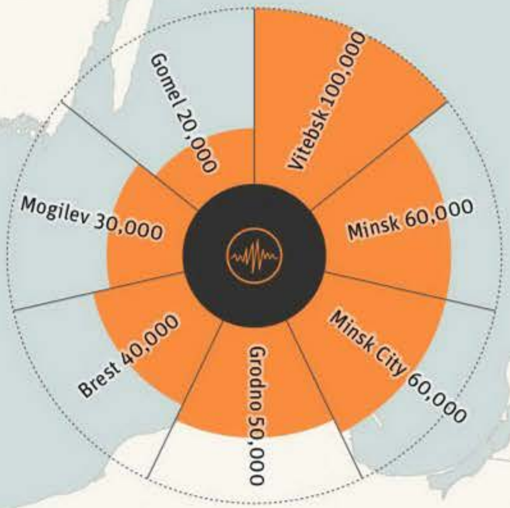
The annual average population affected by earthquakes in Belarus is about 100 and the annual average affected GDP about $800,000. The annual averages of fatalities and capital losses caused by earthquakes are less than one and about $400,000, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause about $20 million in capital loss (less than 1 percent of GDP).



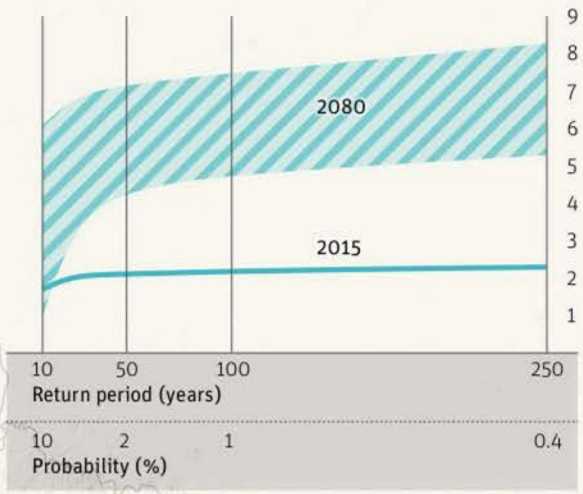
EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS ($)



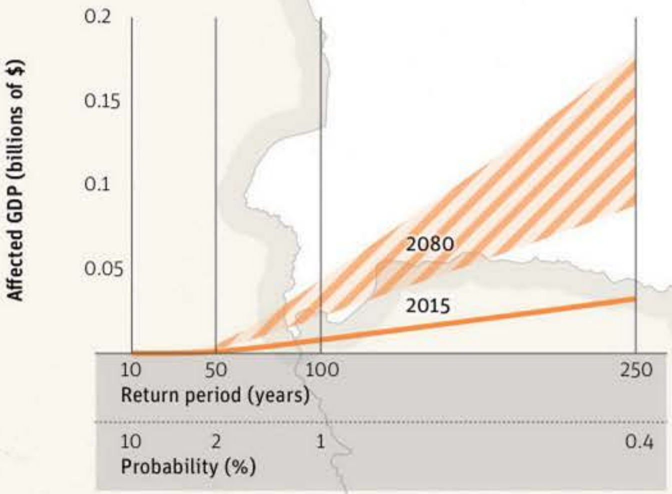
EARTHQUAKE
ANNUAL AVERAGE FATALITIES

The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Vitebsk.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if Belarus had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $2 billion. In 2080, however, the affected GDP from the type of same event would range from about $5 billion to about $8 billion. If Belarus had experienced a 250-year earthquake event in 2015, the affected GDP would have been about $30 million. In 2080, the affected GDP from the same type of event would range from about $90 million to about $200 million, due to population growth, urbanization, and the increase in exposed assets.

All historical data on floods and earthquakes are from D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be; the National Geophysical Data Center/World Data Service (NGDC/WDS), Significant Earthquake Database (National Geophysical Data Center, NOAA), doi:10.7289/V5TD9V7K; and J. Daniell and A. Schaefer, "Eastern Europe and Central Asia Region Earthquake Risk Assessment Country and Province Profiling," final report to GFDRR, 2014. Damage estimates for all historical events have been inflated to 2015 US$.

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EUROPE AND CENTRAL ASIA (ECA)
RISK PROFILES

Bosnia and Herzegovina

GDP $15.3 billion*

Population 3.8 million*

AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
$2 billion (14%)	$4 billion (24%)	$1 billion (7%)
500,000 (14%)	700,000 (19%)	300 (<1%)

*2015 estimates

Bosnia and Herzegovina's population and economy are exposed to earthquakes and floods, with floods posing the greater risk. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

Nearly 50 percent of Bosnia and Herzegovina's population lives in urban environments. The country's GDP was approximately US$15.3 billion in 2015, with about 90 percent derived from services and industry, and agriculture making a small contribution. Bosnia and Herzegovina's per capita GDP was $4,030.

This map displays GDP by province in Bosnia and Herzegovina, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of both floods and earthquakes is Republika Srpska. In absolute terms, the province at greatest risk of floods is also Repuplica Srpska, and the one at greatest risk of earthquakes is Federacija Bosne I Hercegovine.

TOP AFFECTED PROVINCES

FLOOD

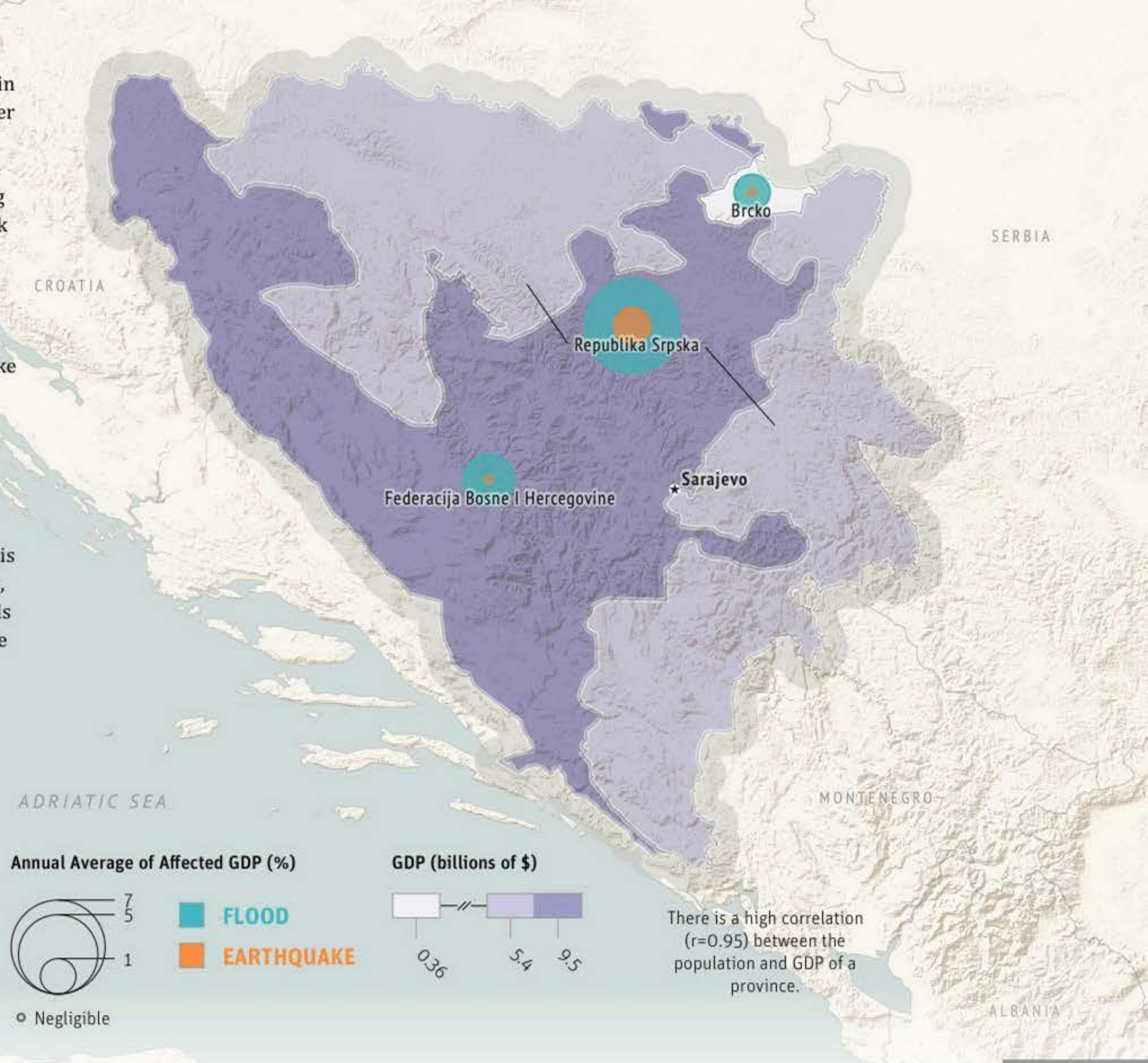
ANNUAL AVERAGE OF AFFECTED GDP (%)

Repuplika Srpska	6
Federacija Bosna i Hercegovina	2
Brcko	1

EARTHQUAKE

ANNUAL AVERAGE OF AFFECTED GDP (%)

Repuplika Srpska	1
Federacija Bosna i Hercegovina	0
Brcko	0



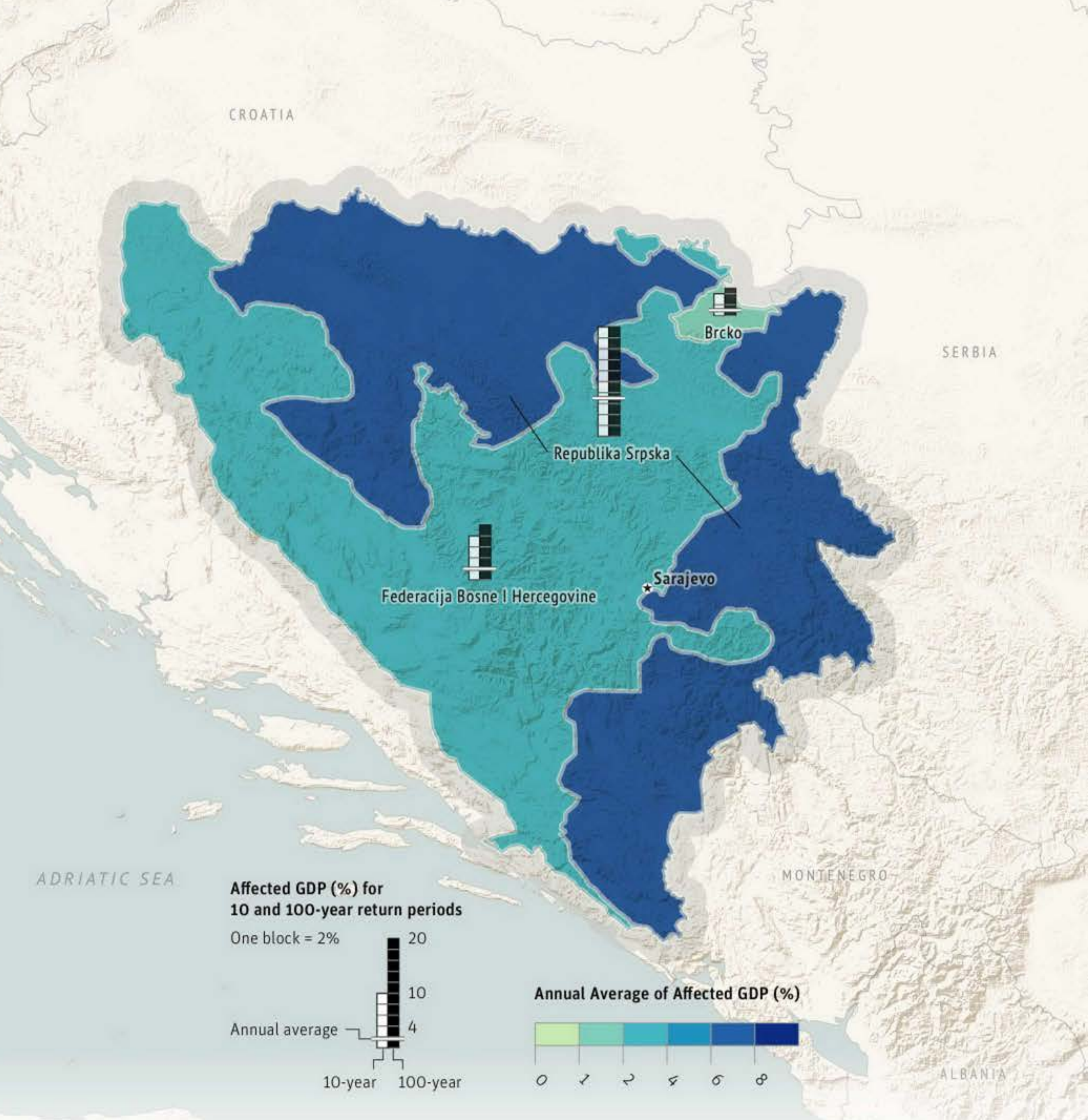
The most deadly and devastating flood in Bosnia and Herzegovina since it gained its independence in 1992 occurred in 2014. It affected 1 million people and caused 25 fatalities and close to $450 million in damage. Flooding in 2010 caused three deaths and close to $95 million in damage.

This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in Bosnia and Herzegovina is about 100,000 and the annual average affected GDP about $600 million. Within the various provinces, the 10- and 100-year impacts do not differ much, so relatively frequent floods have large impacts on these averages.



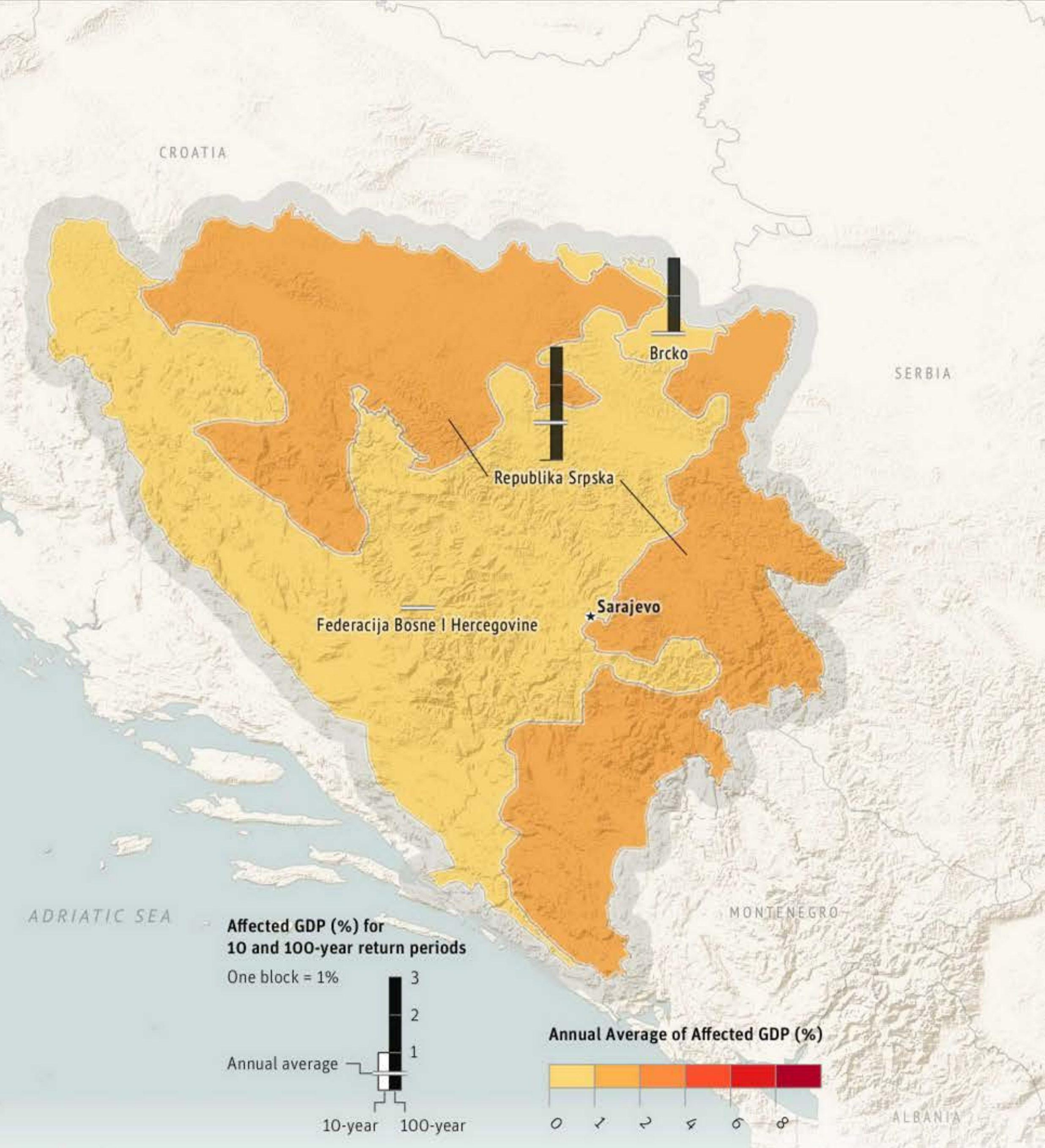
Bosnia and Herzegovina's worst earthquake since 1900 took place in 1969 in Banja Luka, with a magnitude of 6. It caused 14 fatalities and over $300 million in damage. If the same earthquake were to occur today, it would cause an estimated death toll over 400 and more than $4 billion in damage, based on present-day exposures.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

When an earthquake has a 10-year return period, it means the probability of occurrence of an earthquake of that magnitude or greater is 10 percent per year. A 100-year earthquake has a probability of occurrence of 1 percent per year. This means that over a long period of time, an earthquake of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year earthquake will occur exactly once every 100 years. In fact, it is possible for an earthquake of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

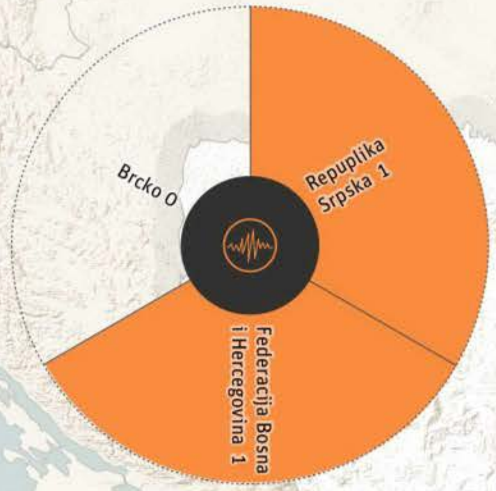
If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make larger contributions to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by earthquakes in Bosnia and Herzegovina is about 40,000 and the annual average affected GDP about $200 million. The annual averages of fatalities and capital losses caused by earthquakes are about five and about $50 million, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause nearly $1 billion in capital loss (about 7 percent of GDP).



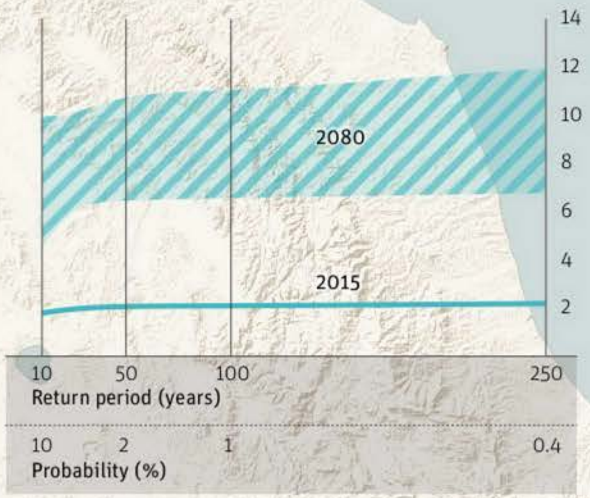
EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS (MILLIONS $)

EARTHQUAKE
ANNUAL AVERAGE FATALITIES

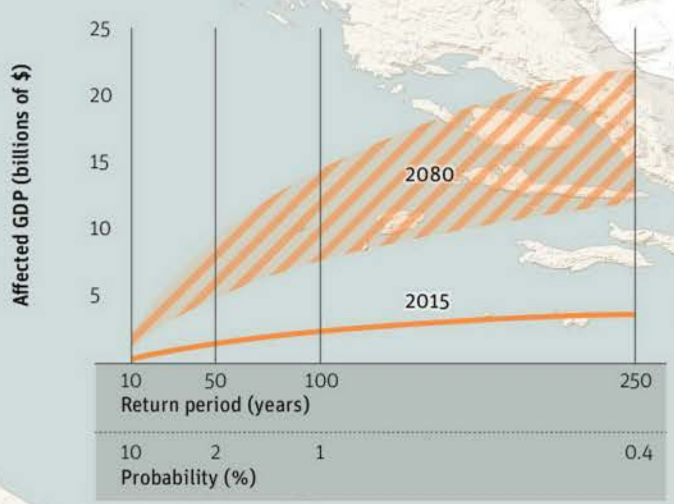


The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Federacija Bosne I Hercegovine, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if Bosnia and Herzegovina had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $2 billion. In 2080, however, the affected GDP from the same type of event would range from about $7 billion to about $10 billion. If Bosnia and Herzegovina had experienced a 250-year earthquake event in 2015, the affected GDP would have been about $4 billion. In 2080, the affected GDP from the same type of event would range from about $10 billion to about $20 billion, due to population growth, urbanization, and the increase in exposed assets.

All historical data on floods and earthquakes are from D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be; the National Geophysical Data Center/World Data Service (NGDC/WDS), Significant Earthquake Database (National Geophysical Data Center, NOAA), doi:10.7289/V5TD9V7K; and J. Daniell and A. Schaefer, "Eastern Europe and Central Asia Region Earthquake Risk Assessment Country and Province Profiling," final report to GFDRR, 2014. Damage estimates for all historical events have been inflated to 2015 US$.

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EUROPE AND CENTRAL ASIA (ECA) RISK PROFILES

Bulgaria

GDP $58.4 billion*

Population 7.1 million*

	AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
GDP	$2 billion (4%)	$30 billion (51%)	$4 billion (8%)
Population	400,000 (5%)	2 million (34%)	5,000 (<1%)

*2015 estimates

Bulgaria's population and economy are exposed to earthquakes and floods, with earthquakes posing the greater risk of a high impact, lower probability event. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

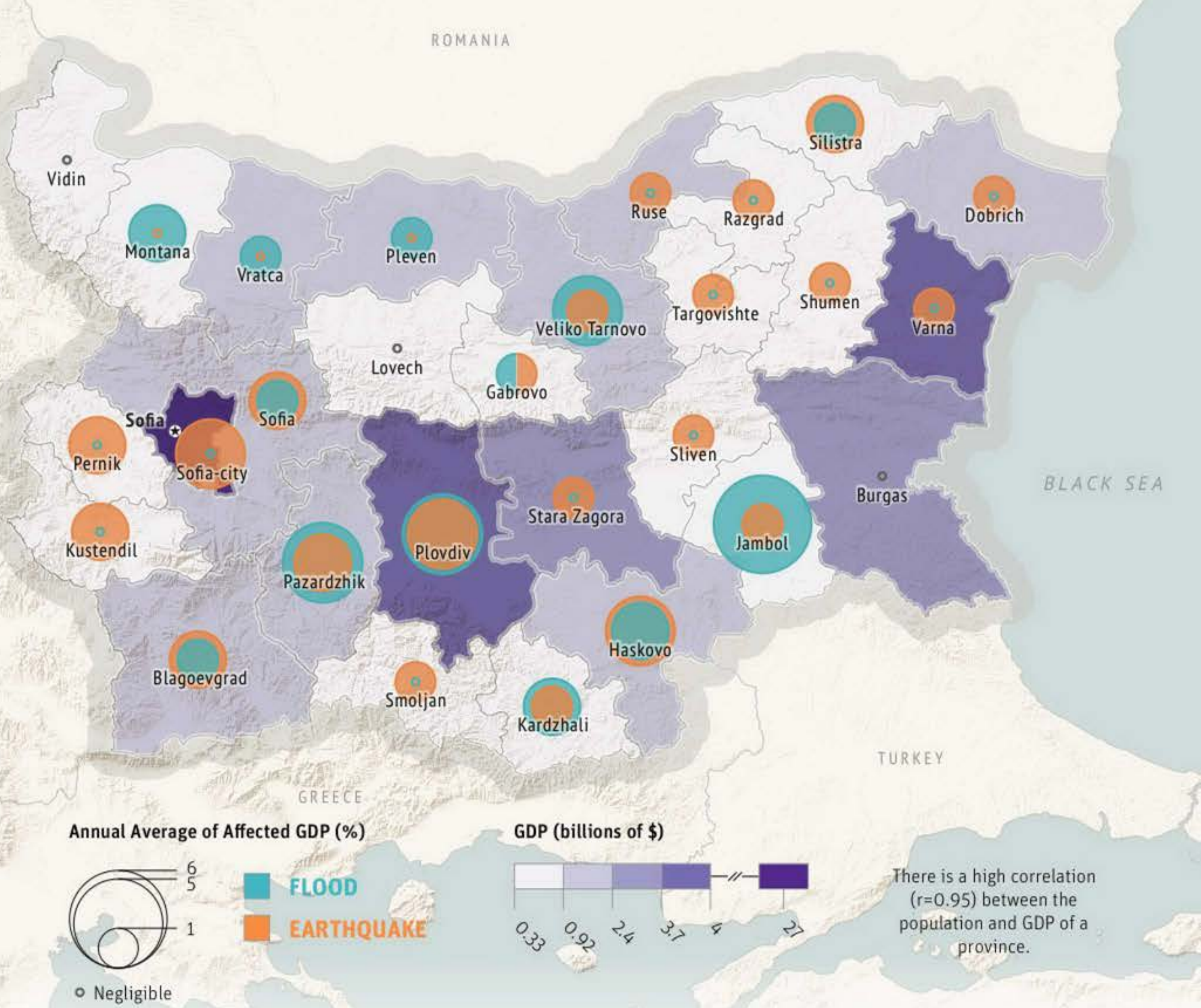
Close to 75 percent of Bulgaria's population lives in urban environments. The country's GDP was approximately US$58.4 billion in 2015, with over 60 percent derived from services, most of the remainder generated by industry, and agriculture making a small contribution. Bulgaria's per capita GDP was $8,210.

This map displays GDP by province in Bulgaria, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of floods is Jambol, and the one at greatest risk of earthquakes is Plovdiv. In absolute terms, the province at greatest risk of floods is Sofia-city, and the one at greatest risk of earthquakes is Sofia-city.

TOP AFFECTED PROVINCES

FLOOD ANNUAL AVERAGE OF AFFECTED GDP (%)		EARTHQUAKE ANNUAL AVERAGE OF AFFECTED GDP (%)	
Jambol	6	Sofia-city	3
Plovdiv	4	Plovdiv	3
Pazardzhik	4	Haskovo	3
Veliko Tarnovo	3	Pernik	2
Montana	2	Kustendil	2
Kardzhali	2	Blagoevgrad	2
Haskovo	2	Pazardzhik	2
Pleven	1	Sofia	2
Vratca	1	Silistra	2
Silistra	1	Stara Zagora	1



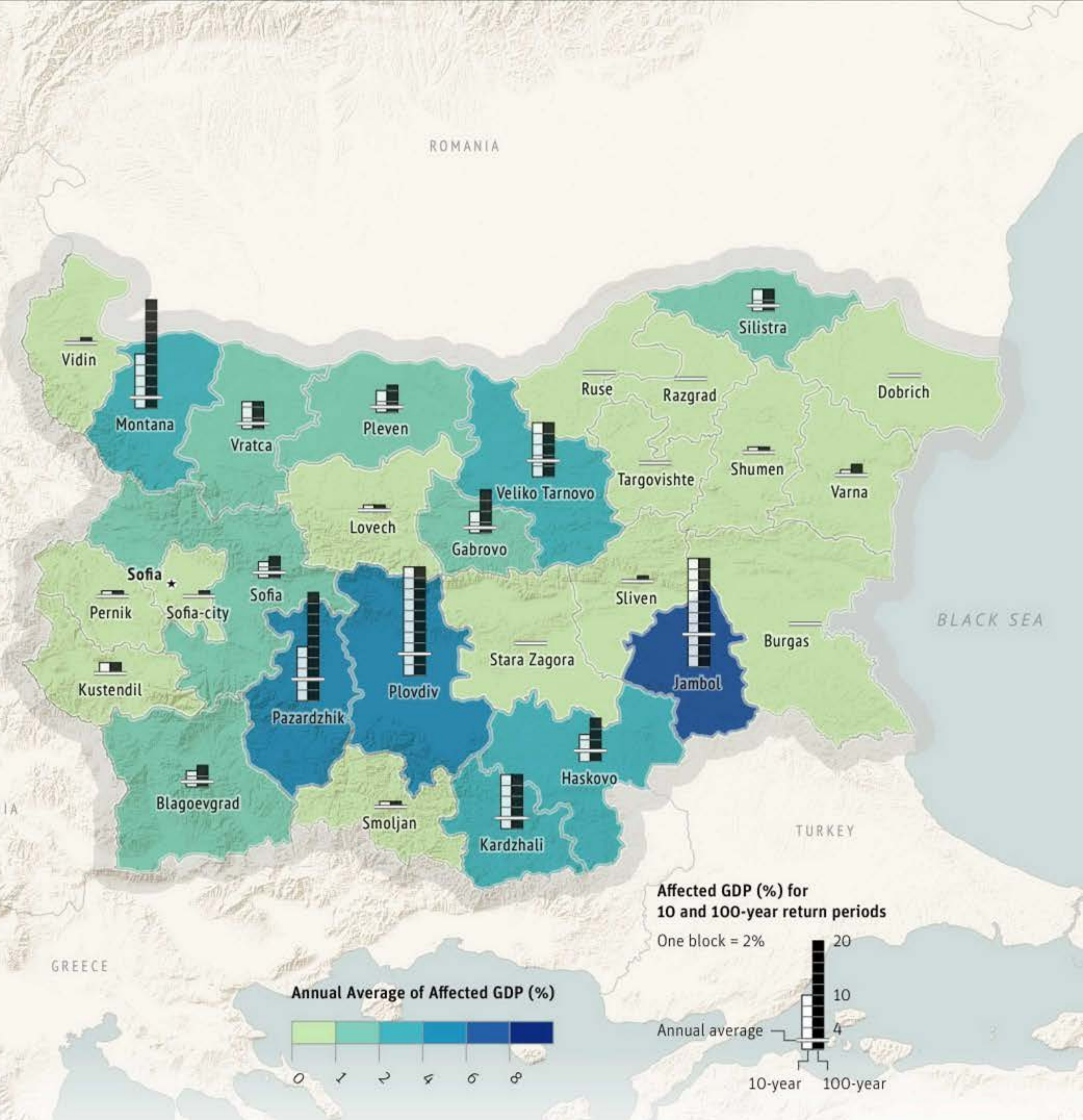
In 2005, a series of floods in Bulgaria caused 30 fatalities and about $600 million in damage in less than three months' time, while flooding in 2014 caused at least 15 deaths and approximately $400 million in damage.

This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in Bulgaria is about 80,000 and the annual average affected GDP about $400 million. Within the various provinces, the 10- and 100-year impacts do not differ much, so relatively frequent floods have large impacts on these averages.



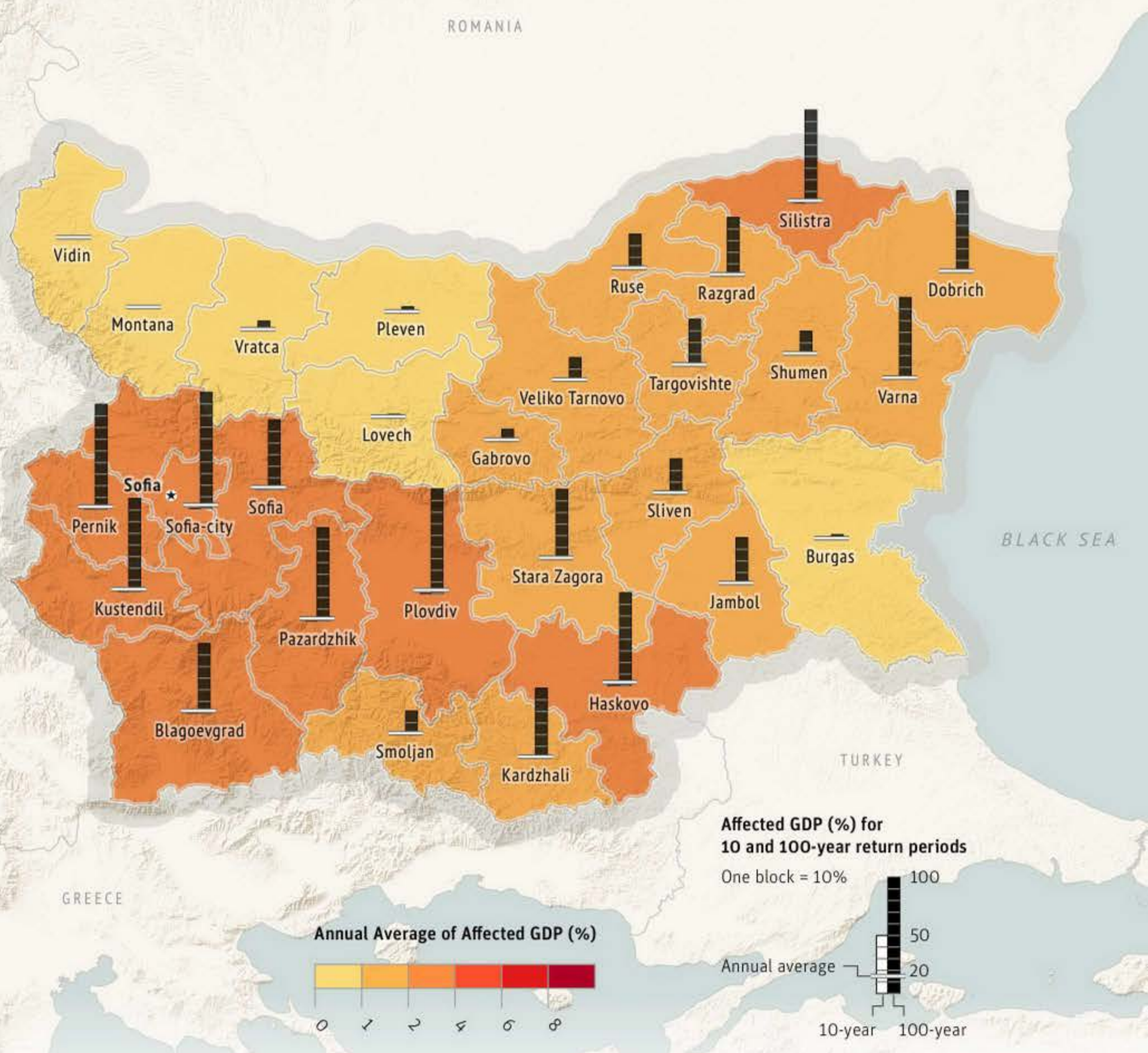
Bulgaria's worst earthquake since 1900, with a magnitude of 7, took place in 1928 in Plovdiv. It caused over 120 fatalities and left more than 260,000 people homeless. An earthquake in 1977 caused 20 deaths.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

When an earthquake has a 10-year return period, it means the probability of occurrence of an earthquake of that magnitude or greater is 10 percent per year. A 100-year earthquake has a probability of occurrence of 1 percent per year. This means that over a long period of time, an earthquake of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year earthquake will occur exactly once every 100 years. In fact, it is possible for an earthquake of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

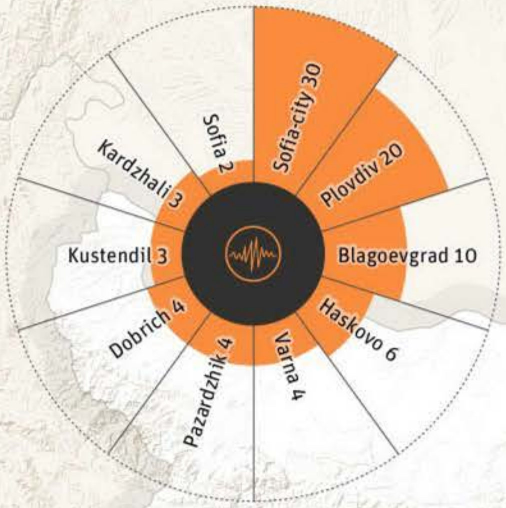
If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make larger contributions to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by earthquakes in Bulgaria is about 100,000 and the annual average affected GDP about $1 billion. The annual averages of fatalities and capital losses caused by earthquakes are about 100 and about $100 million, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause nearly 5,000 fatalities and $4 billion in capital loss (about 8 percent of GDP).



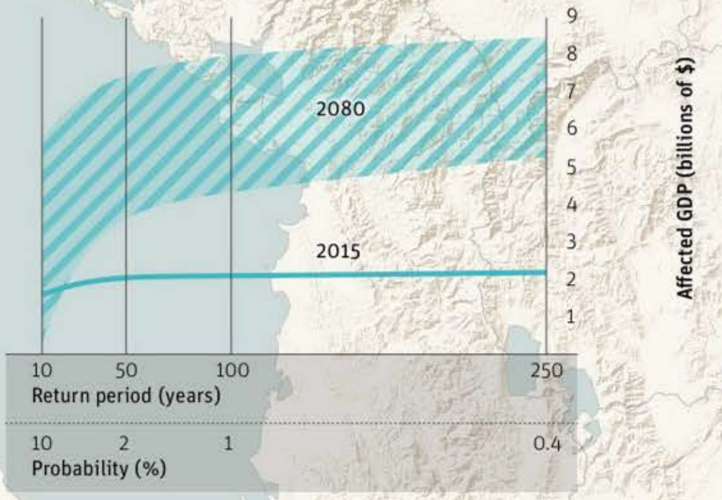
EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS (MILLIONS $)

EARTHQUAKE
ANNUAL AVERAGE FATALITIES

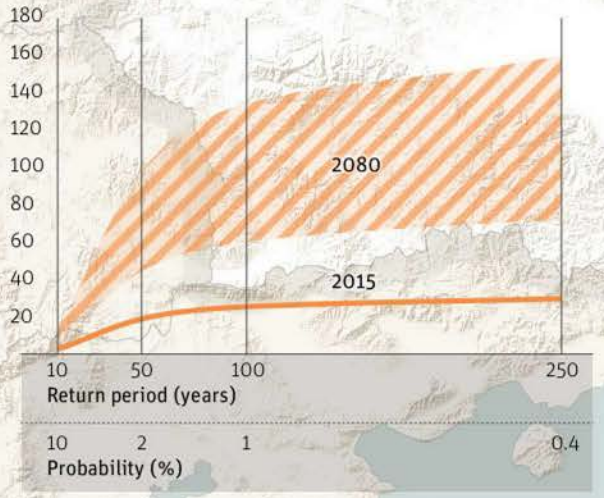


The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Sofia-city, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if Bulgaria had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $2 billion. In 2080, however, the affected GDP from the same type of event would range from about $4 billion to about $8 billion. If Bulgaria experienced a 250-year earthquake event in 2015, the affected GDP would have been about $30 billion. In 2080, the affected GDP from the same type of event would range from about $70 billion to about $160 billion, due to population growth, urbanization, and the increase in exposed assets.

All historical data on floods and earthquakes are from D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be; the National Geophysical Data Center/World Data Service (NGDC/WDS), Significant Earthquake Database (National Geophysical Data Center, NOAA), doi:10.7289/V5TD9V7K; and J. Daniell and A. Schaefer, "Eastern Europe and Central Asia Region Earthquake Risk Assessment Country and Province Profiling," final report to GFDRR, 2014. Damage estimates for all historical events have been inflated to 2015 US$.

WORLD BANK GROUP GFDRR

EUROPE AND CENTRAL ASIA (ECA) RISK PROFILES

Croatia

GDP $47.6 billion*

Population 4.2 million*

	AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
GDP	$4 billion (9%)	$20 billion (43%)	$5 billion (11%)
Population	400,000 (10%)	1 million (31%)	1,000 (<1%)

*2015 estimates

Croatia's population and economy are exposed to earthquakes and floods, with earthquakes posing the greater risk of a high impact, lower probability event. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

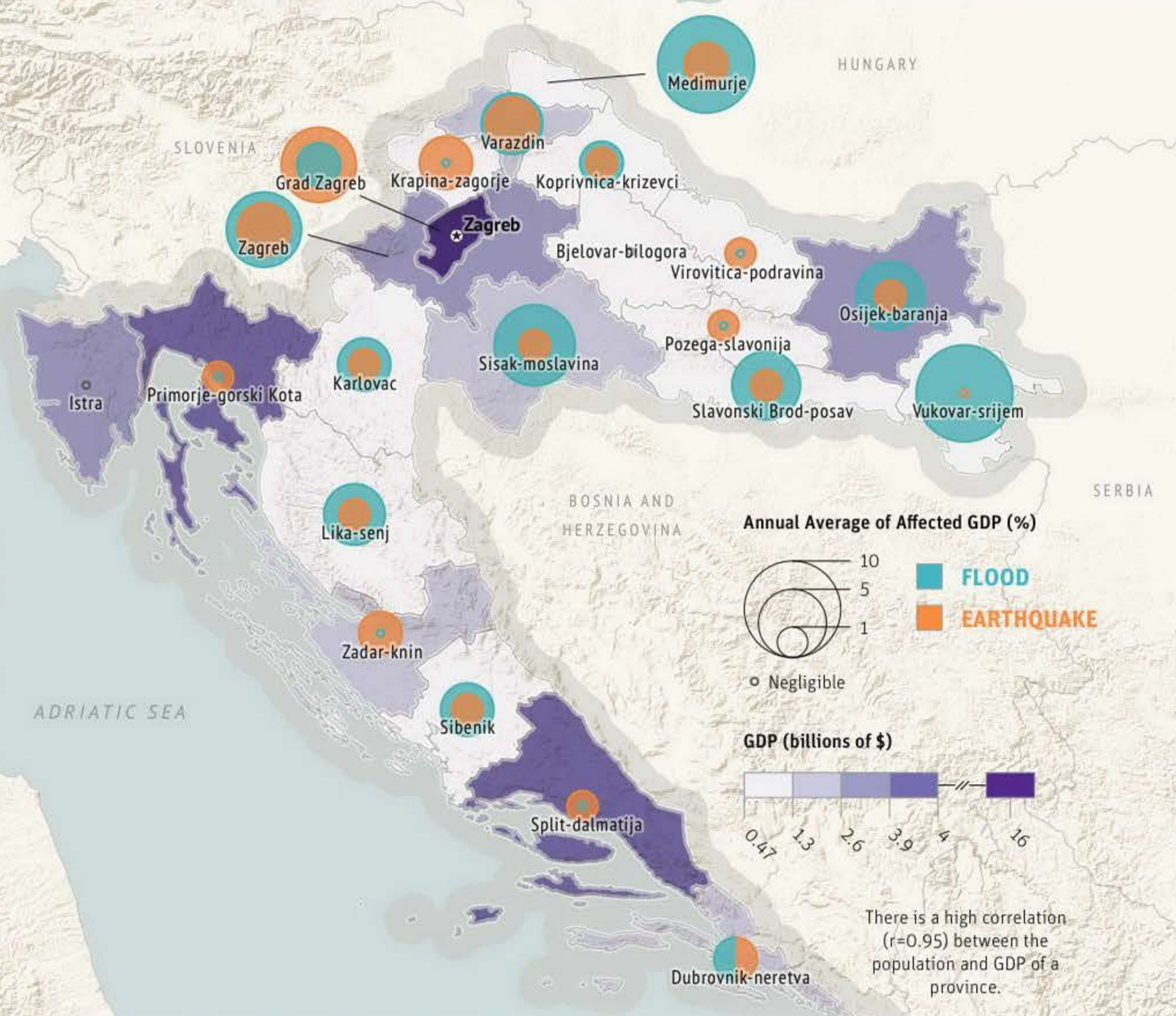
Nearly 60 percent of Croatia's population lives in urban environments. The country's GDP was approximately US$47.6 billion in 2015, with close to 70 percent derived from services, most of the rest generated by industry, and agriculture making a small contribution. Croatia's per capita GDP was $11,300.

This map displays GDP by province in Croatia, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of floods is Medimurje, and the one at greatest risk of earthquakes is Grad Zagreb. In absolute terms, the province at greatest risk of both floods and earthquakes is Grad Zagreb.

TOP AFFECTED PROVINCES

FLOOD ANNUAL AVERAGE OF AFFECTED GDP (%)		EARTHQUAKE ANNUAL AVERAGE OF AFFECTED GDP (%)	
Medimurje	12	Grad Zagreb	6
Vukovar-srijem	10	Zagreb	4
Sisak-moslavina	7	Krapina-zagorje	3
Zagreb	6	Varazdin	3
Slavonski Brod-posav	5	Medimurje	2
Osijek-baranja	5	Dubrovnik-neretva	2
Lika-senj	4	Zadar-knin	2
Varazdin	4	Karlovac	1
Karlovac	3	Sibenik	1
Sibenik	3	Koprivnica-krizevci	1



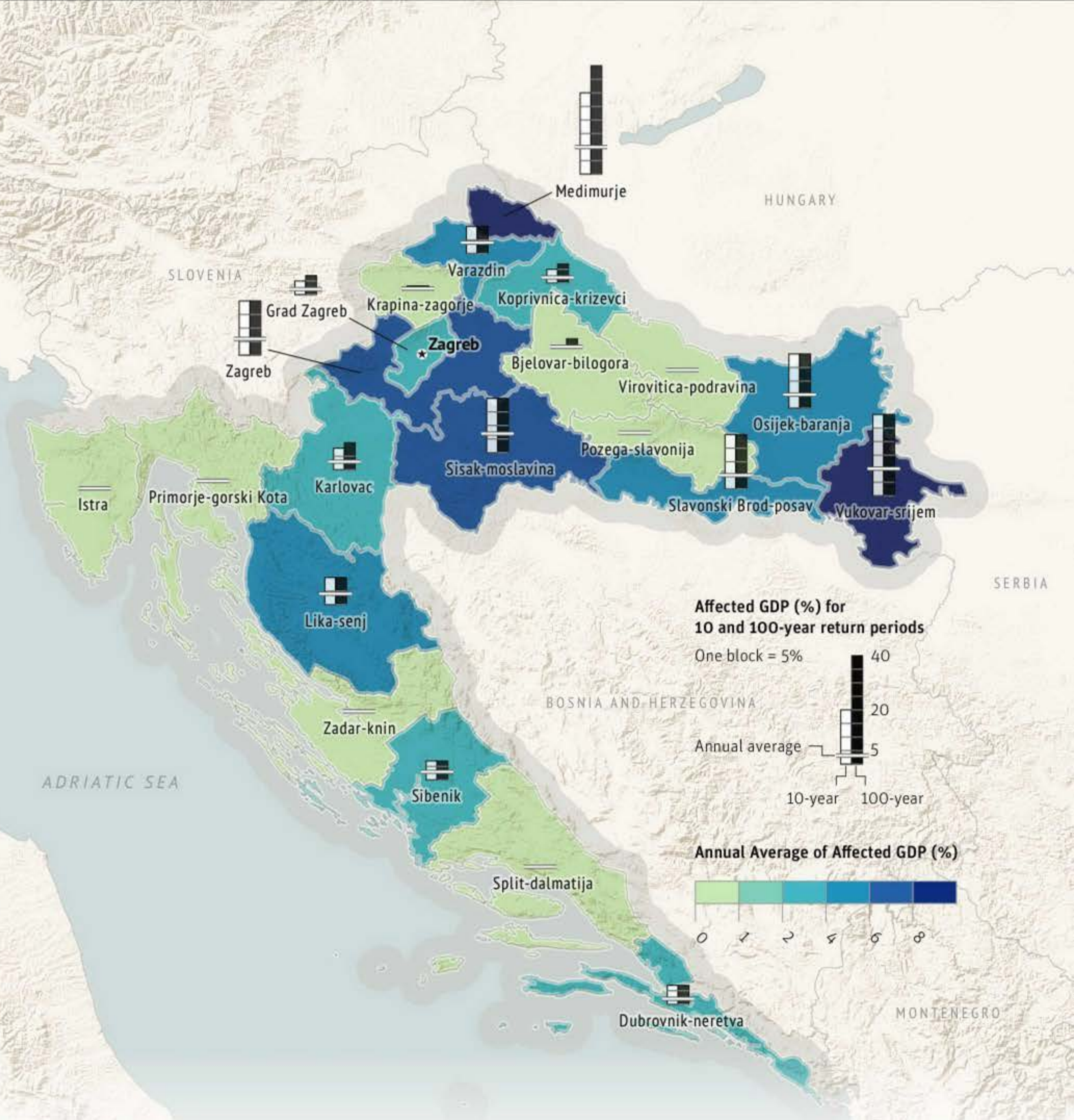
In the last 15 years, Croatia was hit by several floods, most of them with relatively minor impacts. Flooding in 2014 killed three people and affected over 9,000.

This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in Croatia is about 100,000 and the annual average affected GDP about $1 billion. Within the various provinces, the 10- and 100-year impacts do not differ much, so relatively frequent floods have large impacts on these averages.



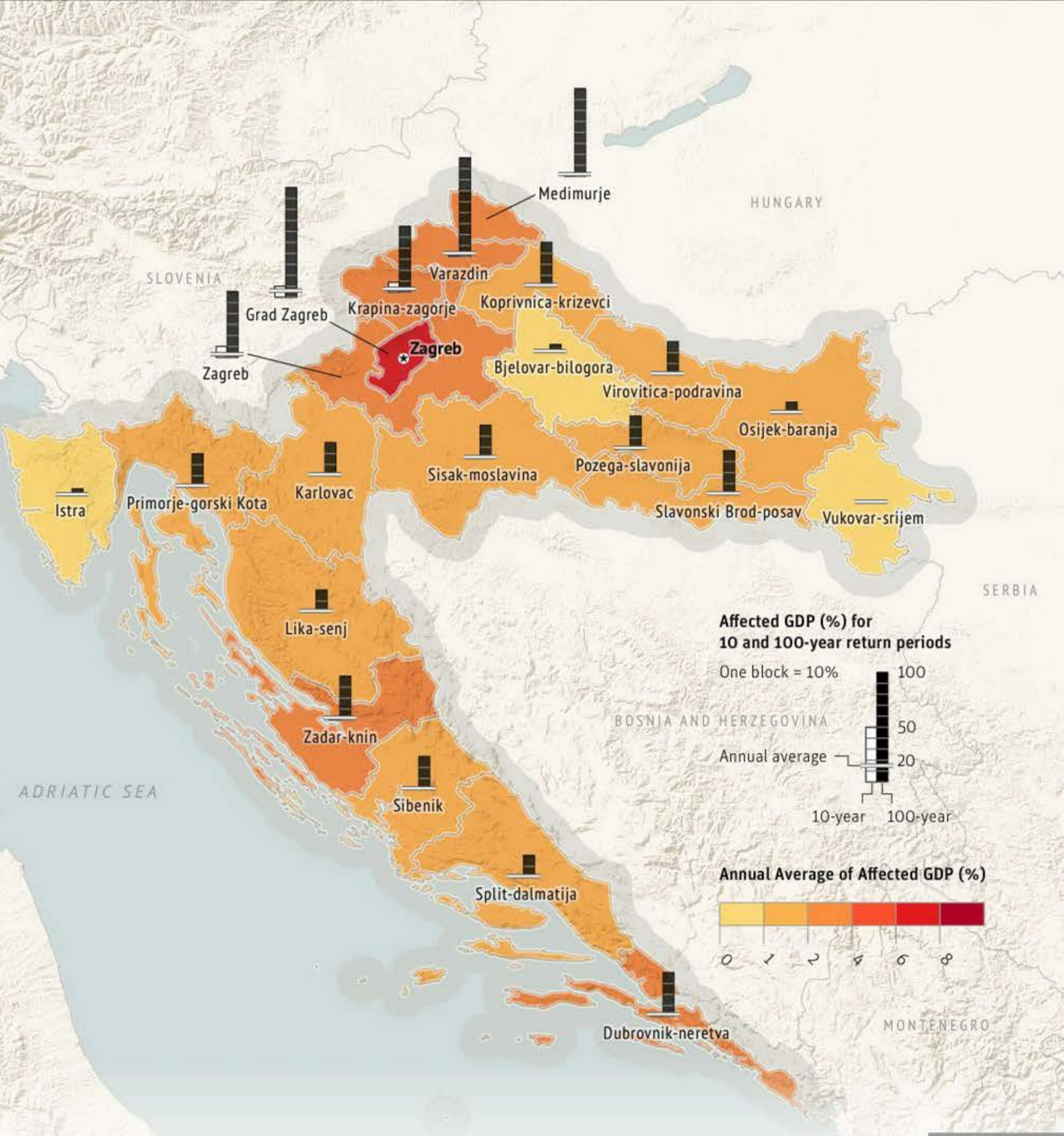
Croatia's worst earthquake took place in 1667 in Dubrovnik, with an estimated magnitude of 7.2. More than 3,000 people were killed, and Dubrovnik (with 5,000 homes at the time) was completely destroyed. If the same earthquake were to occur today, its estimated death toll would be more than 1,500 and its damage over $7 billion. Other, more recent earthquakes included one in 1927 in Slovac and another in 1962 in Podgora.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

When an earthquake has a 10-year return period, it means the probability of occurrence of an earthquake of that magnitude or greater is 10 percent per year. A 100-year earthquake has a probability of occurrence of 1 percent per year. This means that over a long period of time, an earthquake of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year earthquake will occur exactly once every 100 years. In fact, it is possible for an earthquake of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

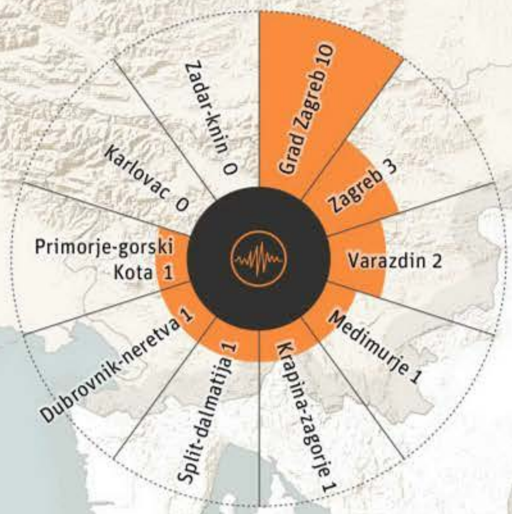
If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make larger contributions to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by earthquakes in Croatia is about 100,000 and the annual average affected GDP about $1 billion. The annual averages of fatalities and capital losses caused by earthquakes are about 20 and about $300 million, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause nearly 1,000 fatalities and $5 billion in capital loss (about 10 percent of GDP).



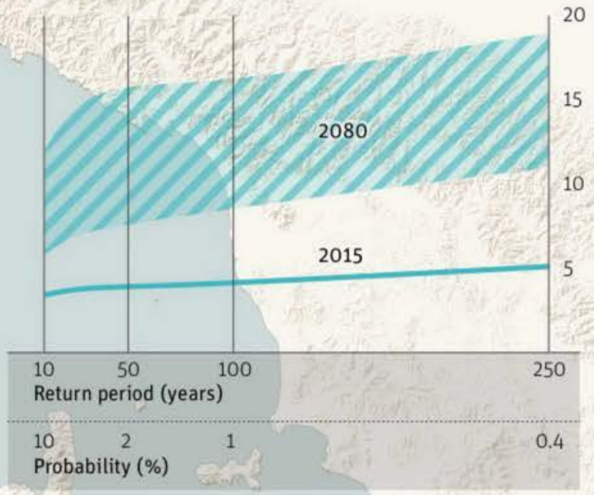
EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS (MILLIONS $)

EARTHQUAKE
ANNUAL AVERAGE FATALITIES



The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Grad Zagreb, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080

The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if Croatia had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $4 billion. In 2080, however, the affected GDP from the same type of event would range from about $9 billion to about $16 billion. If Croatia had experienced a 250-year earthquake event in 2015, the affected GDP would have been about $20 billion. In 2080, the affected GDP from the same type of event would range from about $50 billion to about $100 billion, due to population growth, urbanization, and the increase in exposed assets.

All historical data on floods and earthquakes are from D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be, and J. Daniell and A. Schaefer, "Eastern Europe and Central Asia Region Earthquake Risk Assessment Country and Province Profiling," final report to GFDRR, 2014. Damage estimates for all historical events have been inflated to 2015 US$.

WORLD BANK GROUP GFDRR

EUROPE AND CENTRAL ASIA (ECA) RISK PROFILES

Cyprus

GDP $20.3 billion*

Population 1.2 million*

	AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
GDP	$40 million (<1%)	$7 billion (34%)	$800 million (4%)
Population	4,000 (<1%)	400,000 (32%)	1 (<1%)

*2015 estimates

Cyprus's population and economy are exposed to earthquakes and floods, with earthquakes posing the greater risk of a high impact, lower probability event. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

Just over 70 percent of Cyprus's population lives in urban environments. The country's GDP was approximately US$20.3 billion in 2015, with over 80 percent derived from services, most of the remainder generated by industry, and agriculture making a small contribution. Cyprus's per capita GDP was $16,600.

This map displays GDP by province in Cyprus, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of floods is Gazimağusa (Famagusta), and the one at greatest risk of earthquakes is Famagusta. In absolute terms, the province at greatest risk of floods is Gazimağusa (Famagusta), and the one at greatest risk of earthquakes is Nicosia.

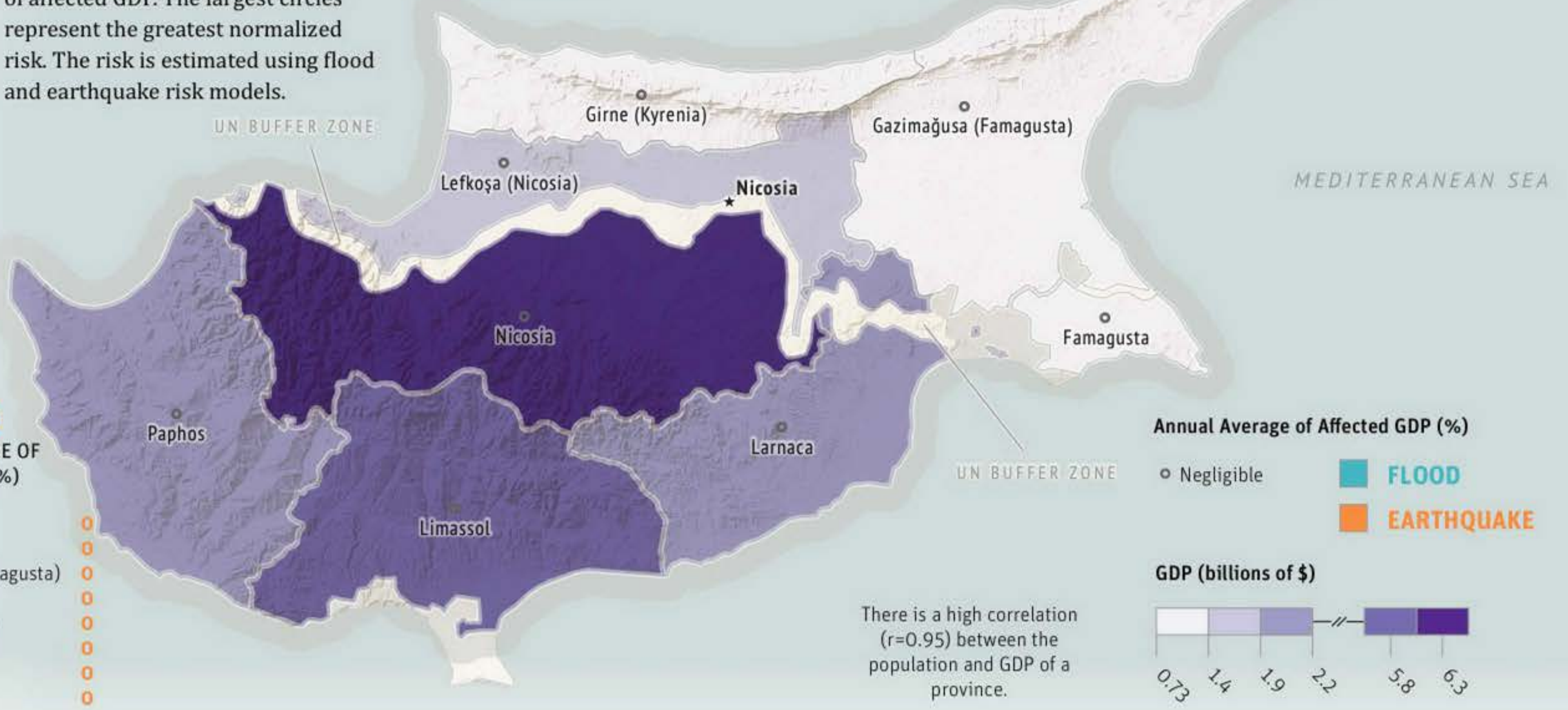
TOP AFFECTED PROVINCES

FLOOD
ANNUAL AVERAGE OF AFFECTED GDP (%)

Gazimagusa (Famagusta)	0
Lefkosa (Nicosia)	0
Girne (Kyrenia)	0
Famagusta	0
Larnaca	0
Limassol	0
Nicosia	0
Paphos	0

EARTHQUAKE
ANNUAL AVERAGE OF AFFECTED GDP (%)

Famagusta	0
Larnaca	0
Gazimagusa (Famagusta)	0
Paphos	0
Lefkosa (Nicosia)	0
Nicosia	0
Girne (Kyrenia)	0
Limassol	0



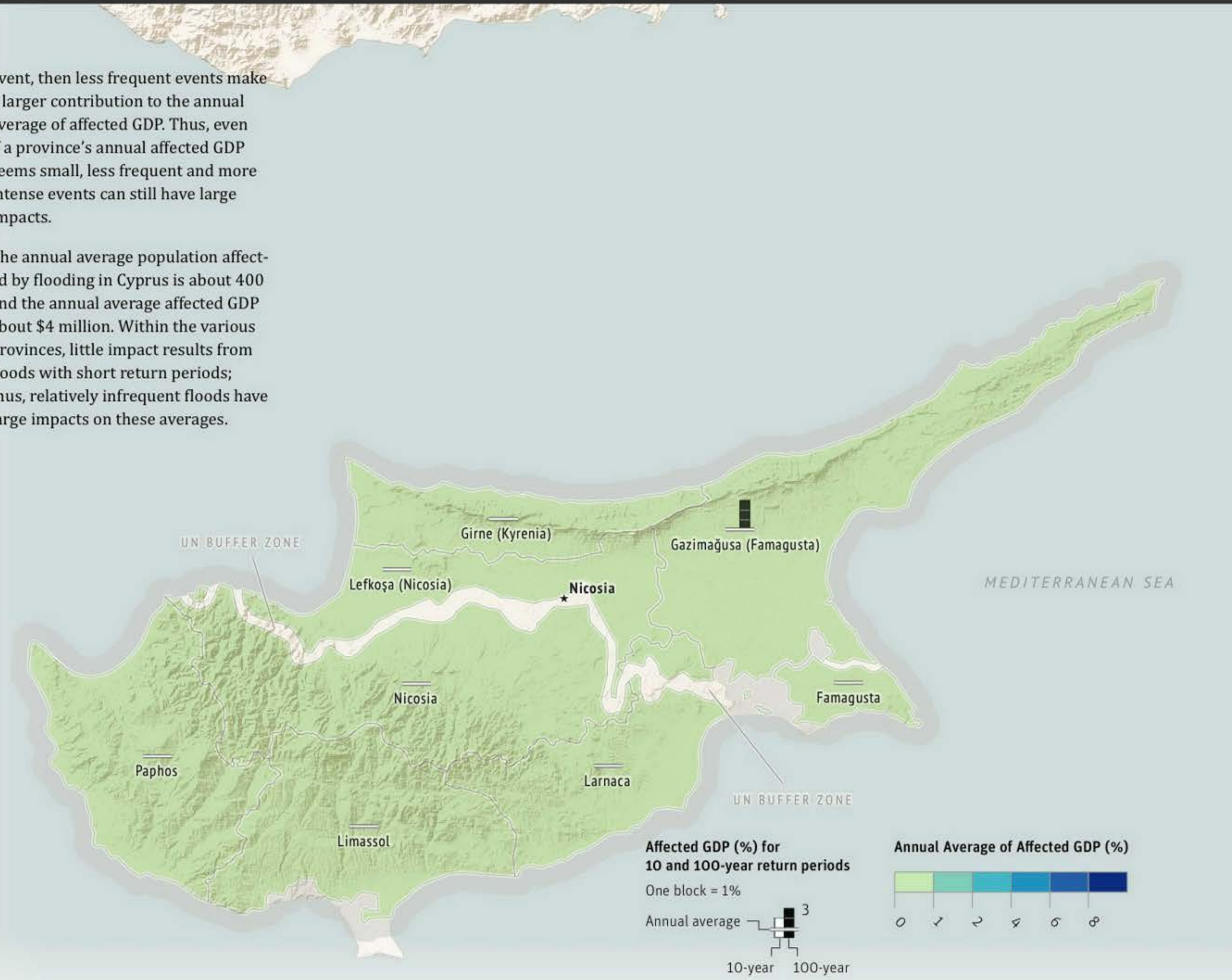
There is a high correlation (r=0.95) between the population and GDP of a province.

This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in Cyprus is about 400 and the annual average affected GDP about $4 million. Within the various provinces, little impact results from floods with short return periods; thus, relatively infrequent floods have large impacts on these averages.



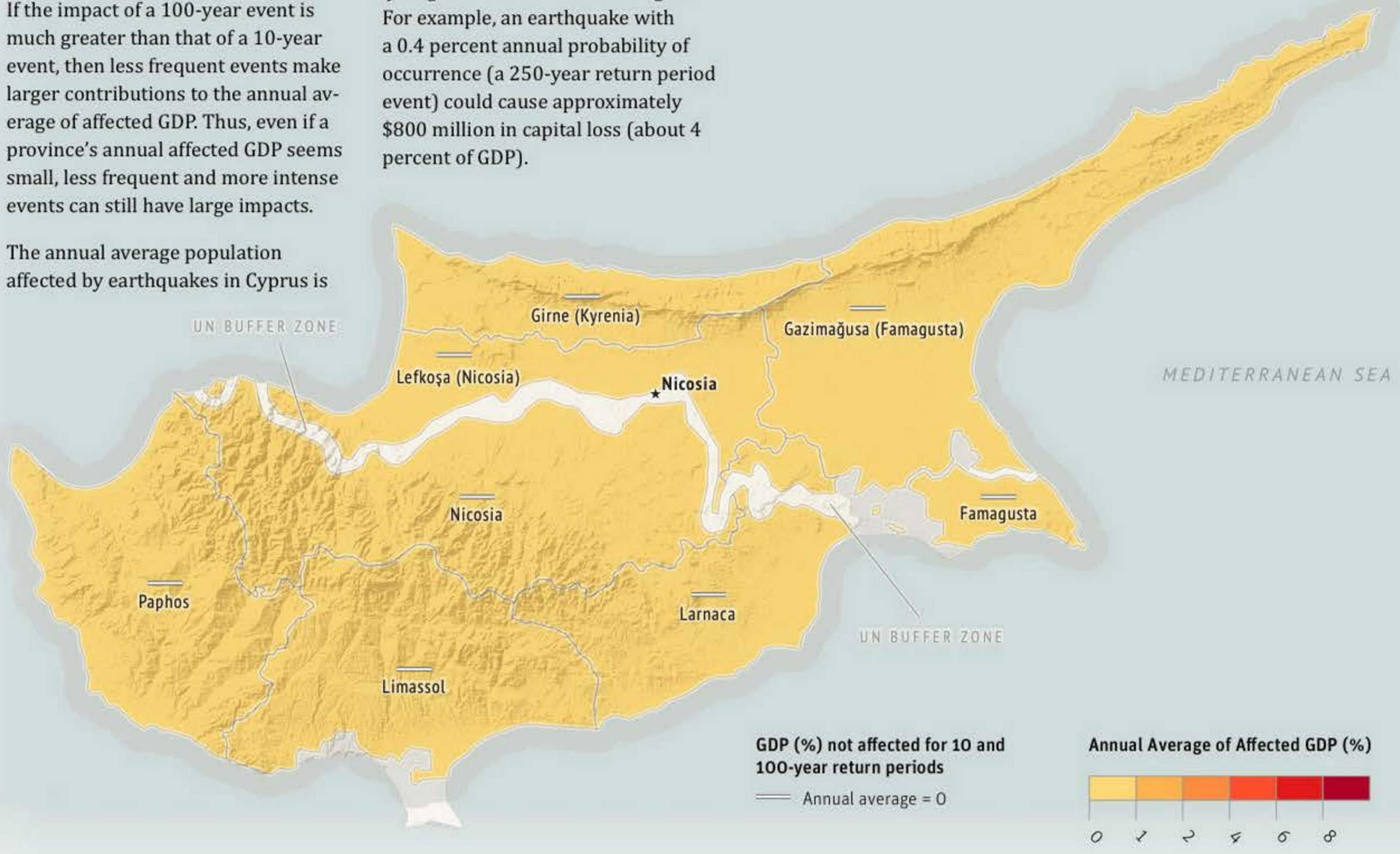
Cyprus's worst earthquake since 1900 took place in 1953 in Paphos, with a magnitude of 6.5. The earthquake caused about 40 fatalities. More recently, a 1995 earthquake caused two fatalities and nearly $7 million in damage. A major earthquake occurred in 1222, causing substantial damage and triggering a tsunami.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

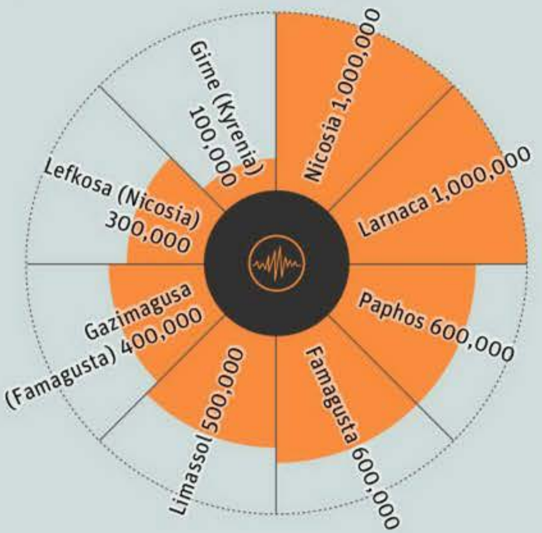
When an earthquake has a 10-year return period, it means the probability of occurrence of an earthquake of that magnitude or greater is 10 percent per year. A 100-year earthquake has a probability of occurrence of 1 percent per year. This means that over a long period of time, an earthquake of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year earthquake will occur exactly once every 100 years. In fact, it is possible for an earthquake of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make larger contributions to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

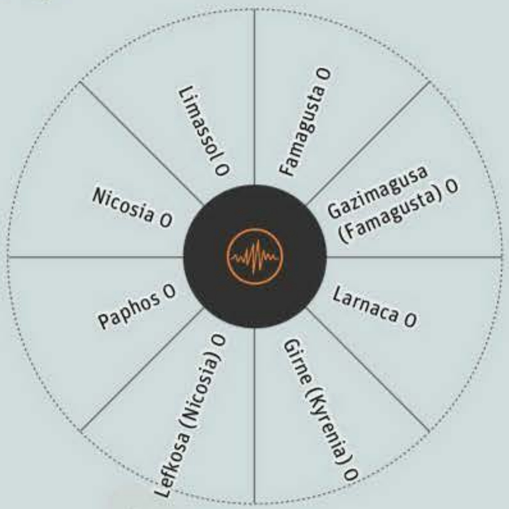
The annual average population affected by earthquakes in Cyprus is about 5,000 and the annual average affected GDP about $70 million. The annual averages of fatalities and capital losses caused by earthquakes are less than one and about $10 million, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause approximately $800 million in capital loss (about 4 percent of GDP).



EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS ($)

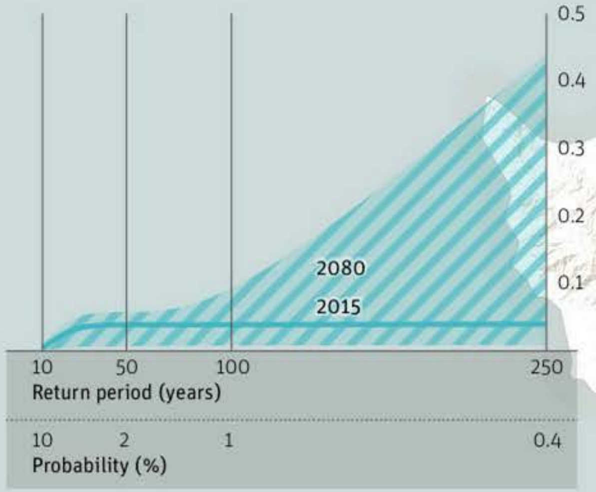


EARTHQUAKE
ANNUAL AVERAGE FATALITIES

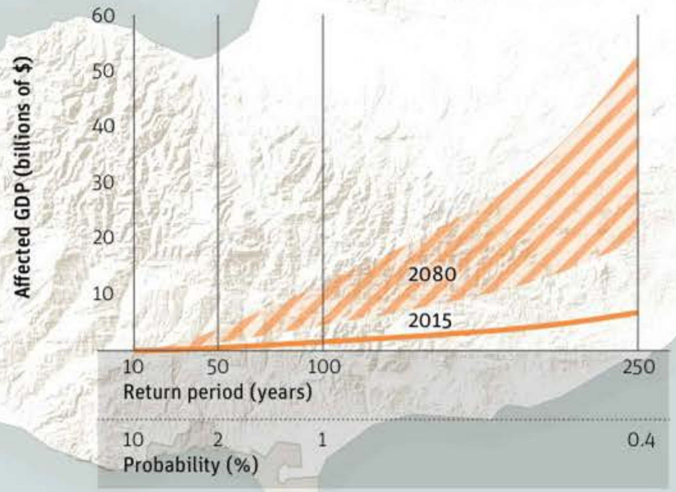


The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Nicosia, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if Cyprus had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $40 million. In 2080, however, the affected GDP from the same type of event would range from about $8 million to about $60 million. If Cyprus had experienced a 250-year earthquake event in 2015, the affected GDP would have been about $7 billion. In 2080, the affected GDP from the same type of event would range from about $20 billion to about $50 billion, due to population growth, urbanization, and the increase in exposed assets.

All historical data on earthquakes are from the National Geophysical Data Center/World Data Service (NGDC/WDS), Significant Earthquake Database (National Geophysical Data Center, NOAA), doi:10.7289/V5TD9V7K, and J. Daniell and A. Schaefer, "Eastern Europe and Central Asia Region Earthquake Risk Assessment Country and Province Profiling," final report to GFDRR, 2014. Damage estimates for all historical events have been inflated to 2015 US$.

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EUROPE AND CENTRAL ASIA (ECA) RISK PROFILES

Czech Republic

GDP $183 billion*

Population 10.5 million*

	AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
GDP	$20 billion (9%)	$5 billion (2%)	$700 million (<1%)
Population	1 million (9%)	300,000 (3%)	0 (<1%)

*2015 estimates

The Czech Republic's population and economy are exposed to earthquakes and floods, with floods posing the greater risk. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

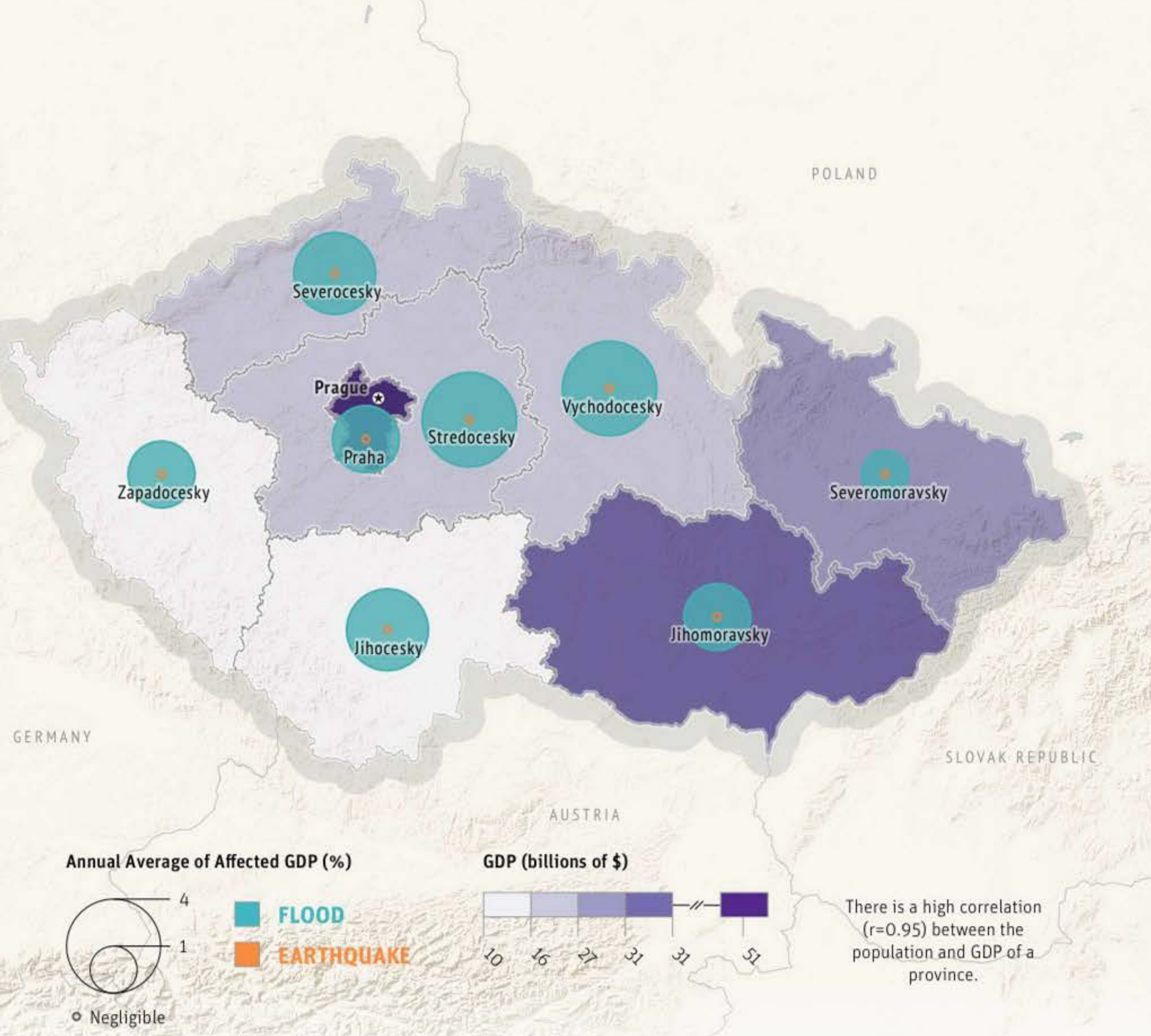
Close to 75 percent of the population of the Czech Republic lives in urban environments. The country's GDP was approximately US$183 billion in 2015, with 60 percent derived from services, most of the remainder generated by industry, and agriculture making a small contribution. The Czech Republic's per capita GDP was $17,300.

This map displays GDP by province in the Czech Republic, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of floods is Stredocesky, and the one at greatest risk of earthquakes is Severomoravsky. In absolute terms, the province at greatest risk of floods is Praha, and the one at greatest risk of earthquakes is Severomoravsky.

TOP AFFECTED PROVINCES

FLOOD ANNUAL AVERAGE OF AFFECTED GDP (%)		EARTHQUAKE ANNUAL AVERAGE OF AFFECTED GDP (%)	
Stredocesky	4	Severomoravsky	0
Vychodocesky	4	Zapadocesky	0
Severocesky	3	Vychodocesky	0
Jihocesky	3	Severocesky	0
Zapadocesky	2	Jihomoravsky	0
Jihomoravsky	2	Jihocesky	0
Praha	2	Stredocesky	0
Severomoravsky	1	Praha	0



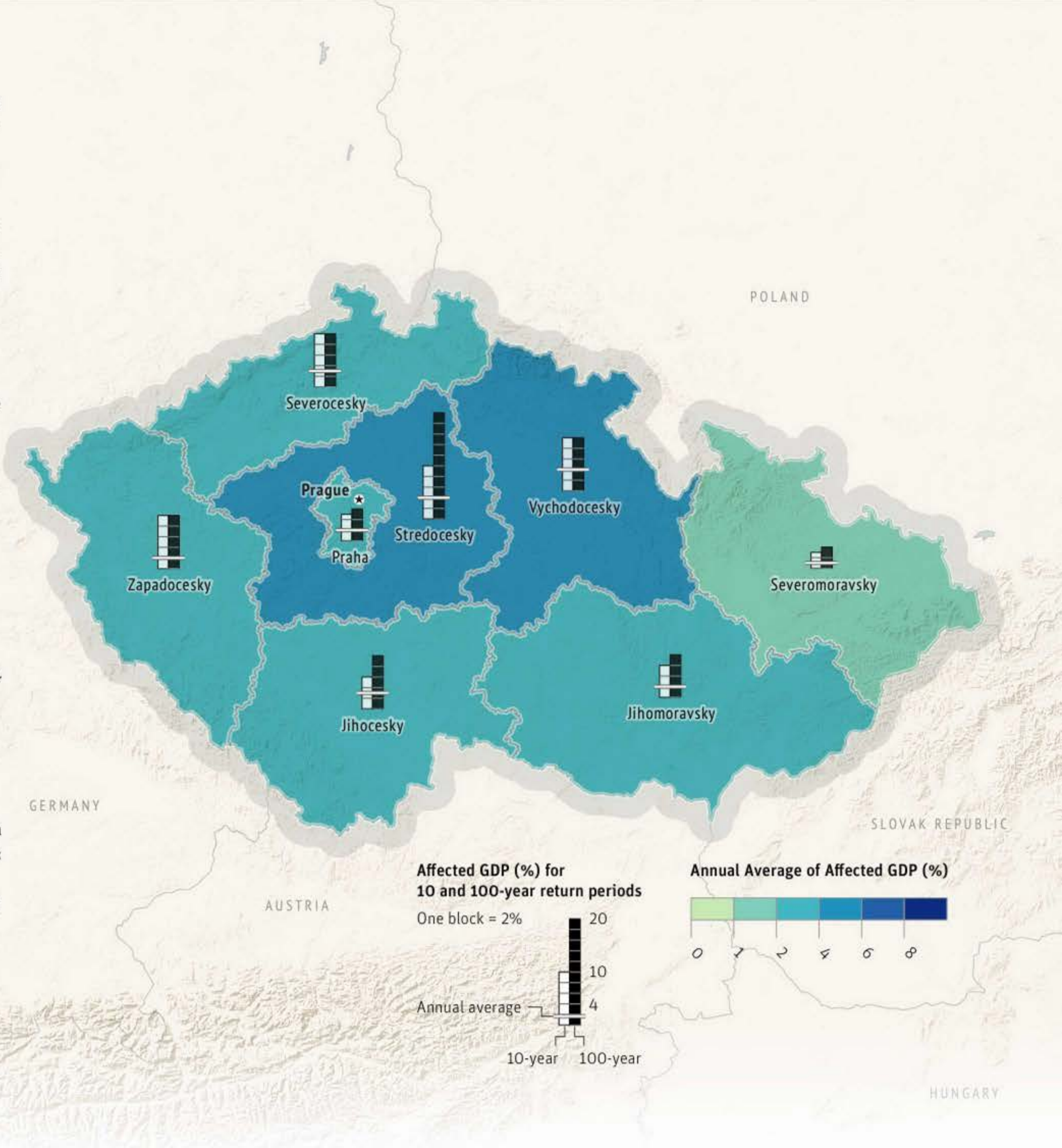
The most devastating flood in the Czech Republic since it gained its independence in 1993 occurred in 2002. It killed 18 people and caused over $3 billion in damage. A 1997 flood caused 29 fatalities and almost $3 billion in damage. More recently, flooding in 2013 affected over 1 million people and caused close to $850 million in damage. Further floods in 2009 and 2010 caused over $150 million in damage per event.

This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population exposed to flooding in the Czech Republic is about 200,000 and the annual average affected GDP about $4 billion. For most provinces, in which the impacts from 10- and 100-year floods do not differ much, relatively frequent floods have large impacts on these averages. For the few in which the 100-year impacts are much greater than the 10-year impacts, less frequent events make a significant contribution to the annual average of affected GDP.



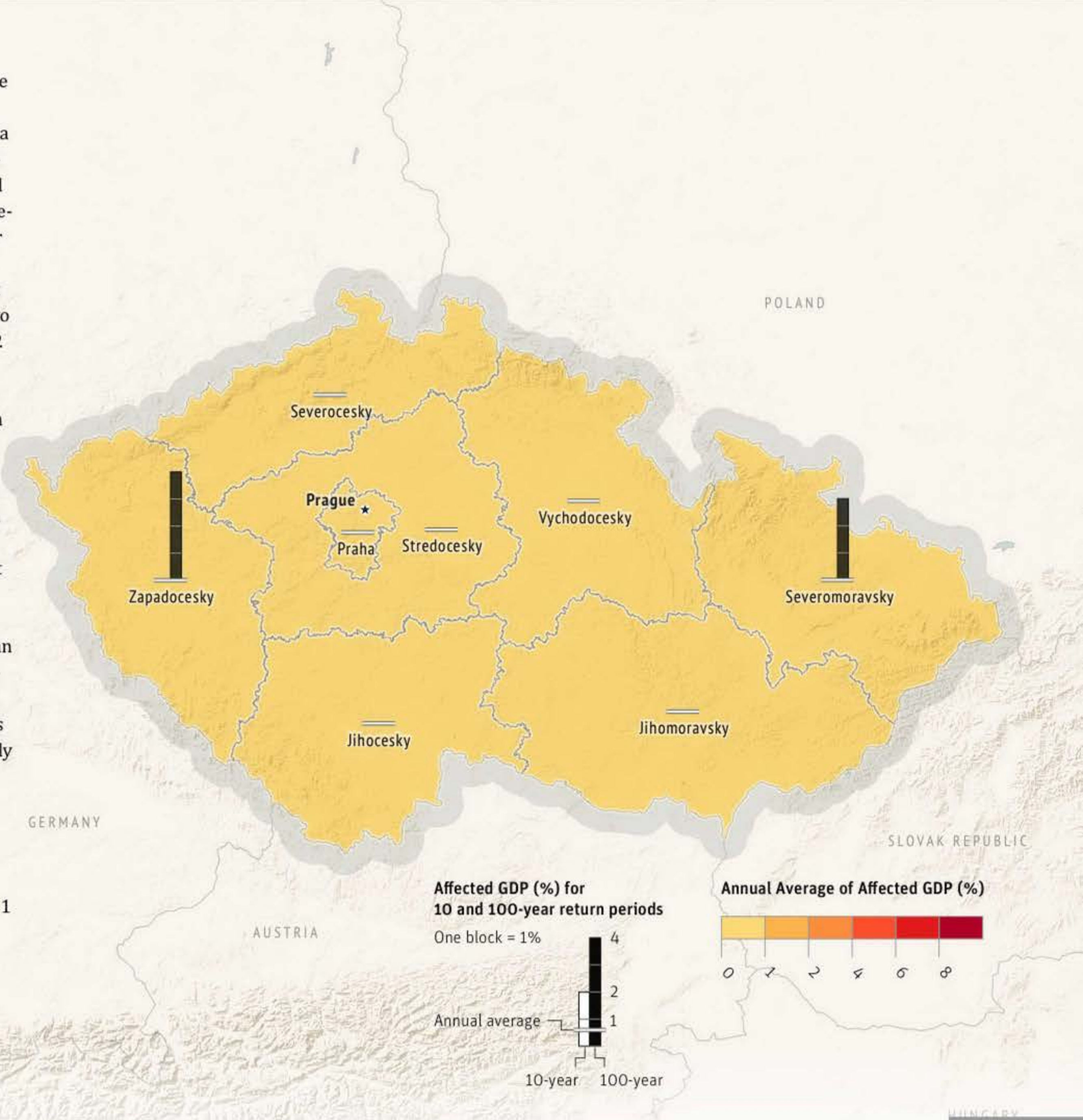
The Czech Republic has experienced several earthquakes of magnitude 7 in its history, including one in 1786 in Tesin, one in 1872 in Gera, and one in 1901 in Trutnov.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

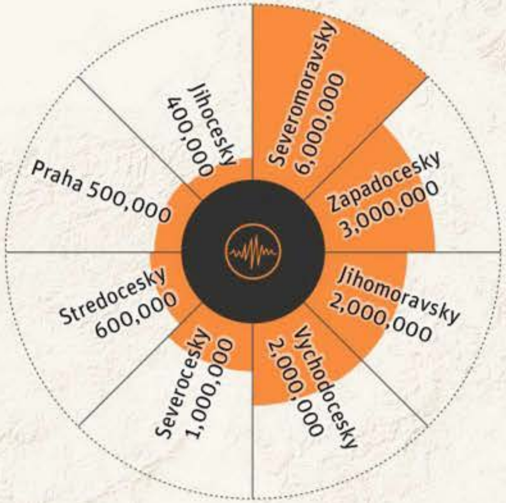
When an earthquake has a 10-year return period, it means the probability of occurrence of an earthquake of that magnitude or greater is 10 percent per year. A 100-year earthquake has a probability of occurrence of 1 percent per year. This means that over a long period of time, an earthquake of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year earthquake will occur exactly once every 100 years. In fact, it is possible for an earthquake of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make larger contributions to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by earthquakes in the Czech Republic is about 6,000 and the annual average affected GDP about \$100 million. The annual averages of fatalities and capital losses caused by earthquakes are less than one and about \$20 million, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause nearly \$800 million in capital loss (about 1 percent of GDP).



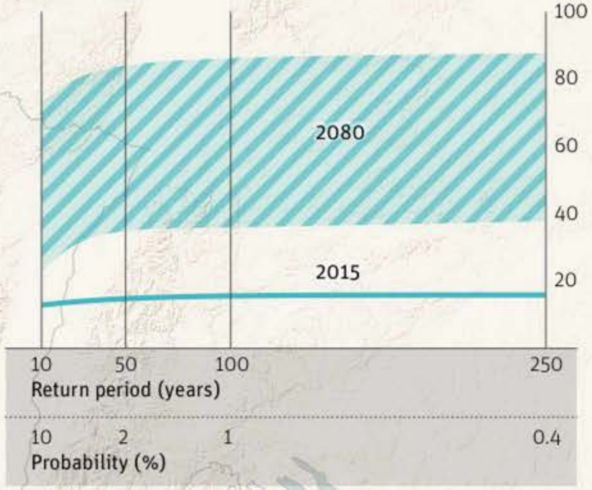
EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS ($)



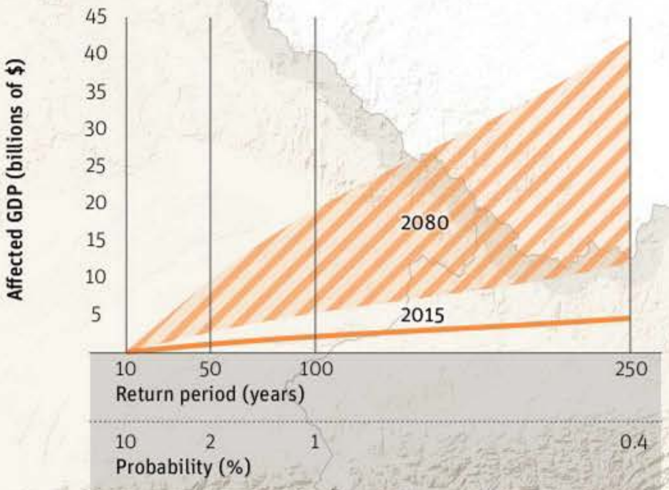
EARTHQUAKE
ANNUAL AVERAGE FATALITIES

The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Severomoravsky, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if the Czech Republic had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $20 billion. In 2080, however, the affected GDP from the same type of event would range from about $40 billion to about $90 billion. If the Czech Republic had experienced a 250-year earthquake event in 2015, the affected GDP would have been about $5 billion. In 2080, the estimated affected GDP from the same type of event would range from about $10 billion to about $40 billion, due to population growth, urbanization, and the increase in exposed assets.

All historical data on floods and earthquakes are from, respectively, D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be, and J. Daniell and A. Schaefer, "Eastern Europe and Central Asia Region Earthquake Risk Assessment Country and Province Profiling," final report to GFDRR, 2014. Damage estimates for all historical events have been inflated to 2015 US$.

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EUROPE AND CENTRAL ASIA (ECA)
RISK PROFILES

Estonia

	AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
GDP $23.6 billion*	$600 million (2%)	$80 million (<1%)	$30 million (<1%)
Population 1.3 million*	40,000 (3%)	6,000 (<1%)	0 (<1%)

*2015 estimates

Estonia's population and economy are exposed to earthquakes and floods, with floods posing the greater risk. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

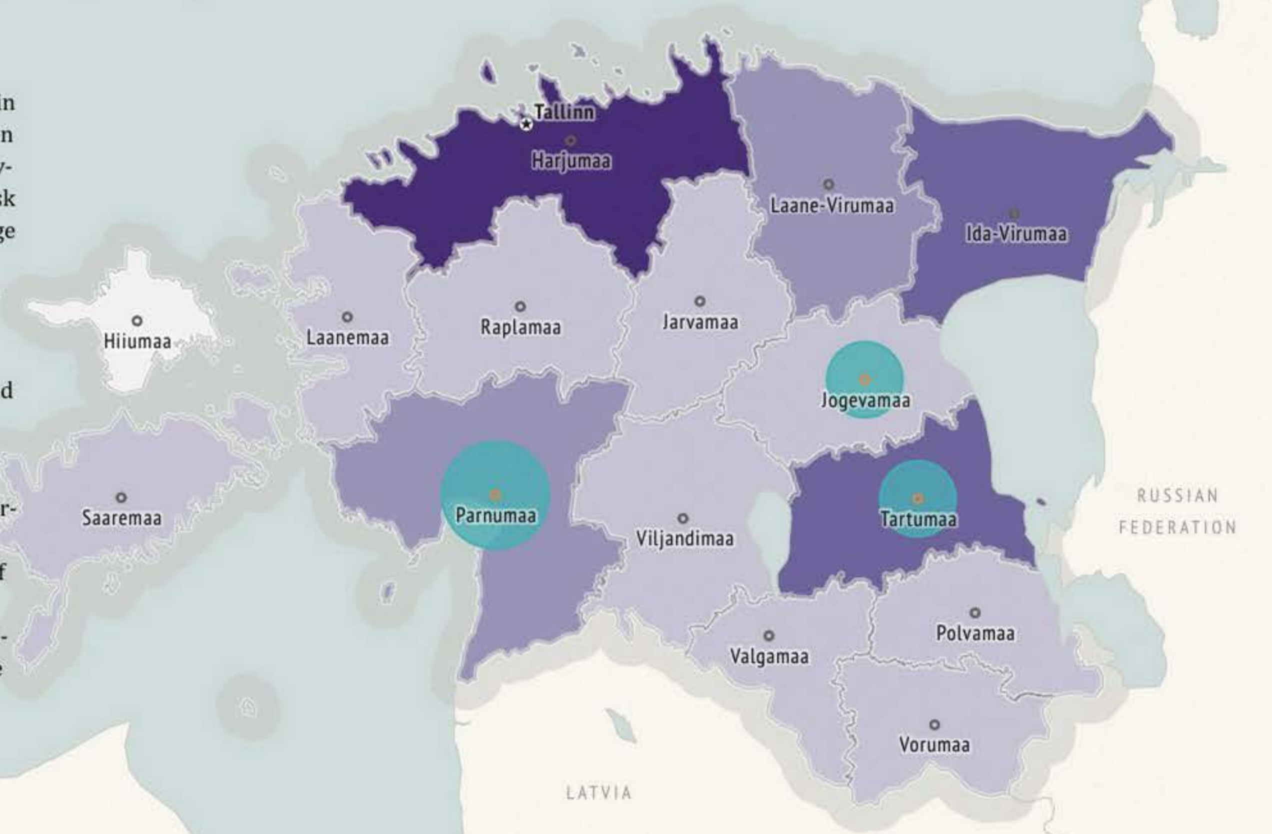
Close to 70 percent of Estonia's population lives in urban environments. The country's GDP was approximately US$23.6 billion in 2015, with nearly 70 percent derived from services, most of the remainder generated by industry, and agriculture making a small contribution. Estonia's per capita GDP was $17,900.

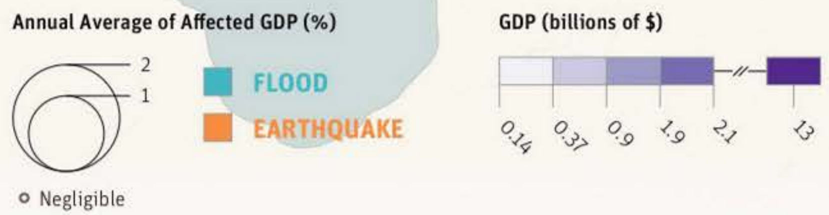
This map displays GDP by province in Estonia, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of floods is Parnumaa, and the one at greatest risk of earthquakes is Tartumaa. In absolute terms, the province at greatest risk of both floods and earthquakes is Harjumaa.

TOP AFFECTED PROVINCES

FLOOD ANNUAL AVERAGE OF AFFECTED GDP (%)		EARTHQUAKE ANNUAL AVERAGE OF AFFECTED GDP (%)	
Parnumaa	2	Tartumaa	0
Jogevamaa	1	Raplamaa	0
Tartumaa	1	Parnumaa	0
Ida-Virumaa	0	Polvamaa	0
Harjumaa	0	Hiiumaa	0
Raplamaa	0	Jarvamaa	0
Valgamaa	0	Ida-Virumaa	0
Laanemaa	0	Laane-Virumaa	0
Polvamaa	0	Laanemaa	0
Viljandimaa	0	Saaremaa	0





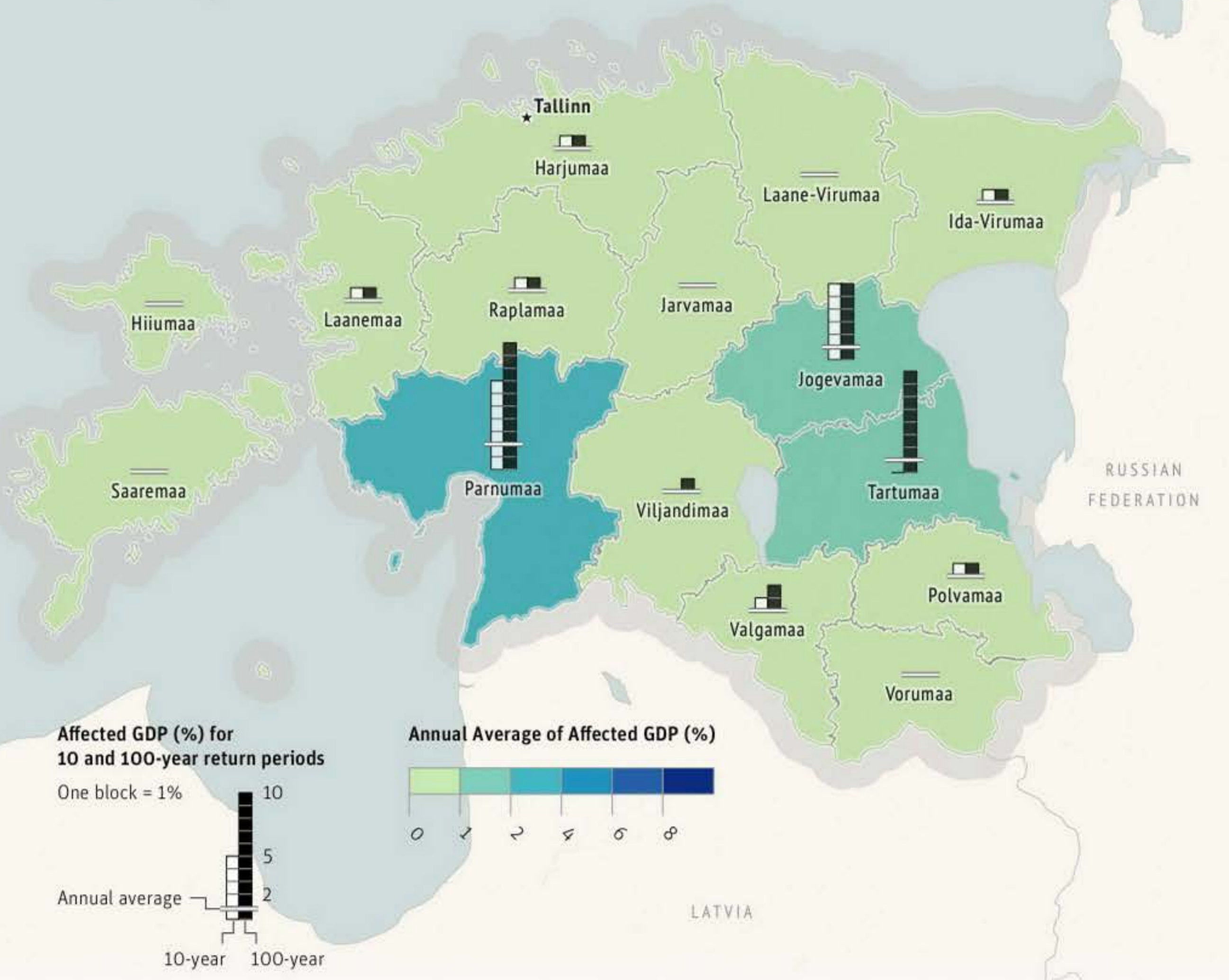
There is a high correlation (r=0.95) between the population and GDP of a province.

This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in Estonia is about 6,000 and the annual average affected GDP about $100 million. Within the various provinces, the 10- and 100-year impacts do not differ much, so relatively frequent floods have large impacts on these averages.



Estonia EARTHQUAKE

Estonia has experienced several modest earthquakes. Its worst since 1900 took place in 1976 in Osmussaar. Earlier earthquakes happened in 1602, 1670, and 1881, all in Narva.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

When an earthquake has a 10-year return period, it means the probability of occurrence of an earthquake of that magnitude or greater is 10 percent per year. A 100-year earthquake has a probability of occurrence of 1 percent per year. This means that over a long period of time, an earthquake of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year earthquake will occur exactly once every 100 years. In fact, it is possible for an earthquake of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

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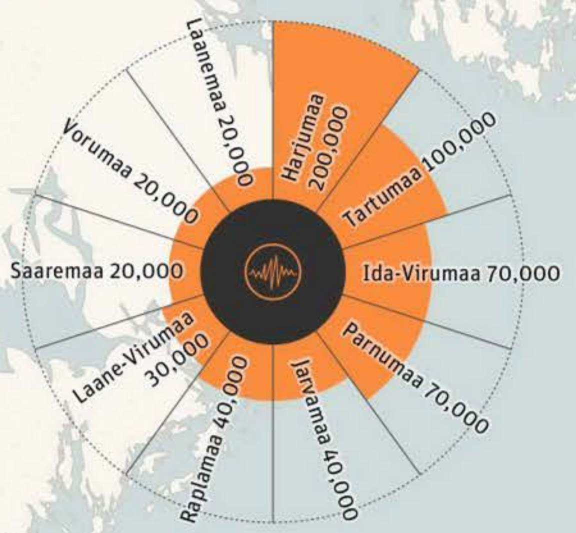
The annual average population affected by earthquakes in Estonia is about 200 and the annual average affected GDP about $3 million. The annual averages of fatalities and capital losses caused by earthquakes are less than one and about $700,000, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause about $30 million in capital loss (less than 1 percent of GDP).

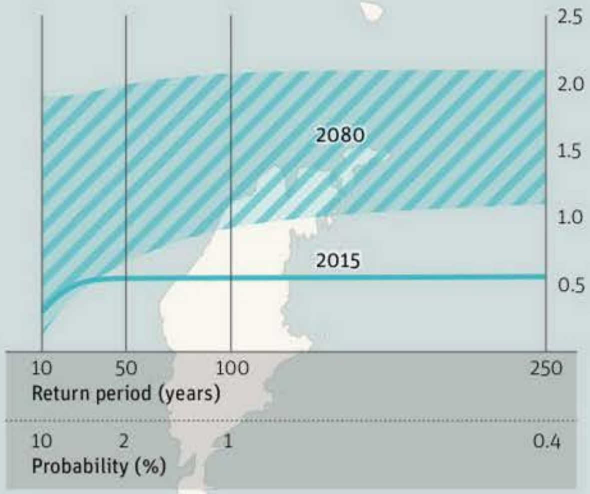
EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS ($)



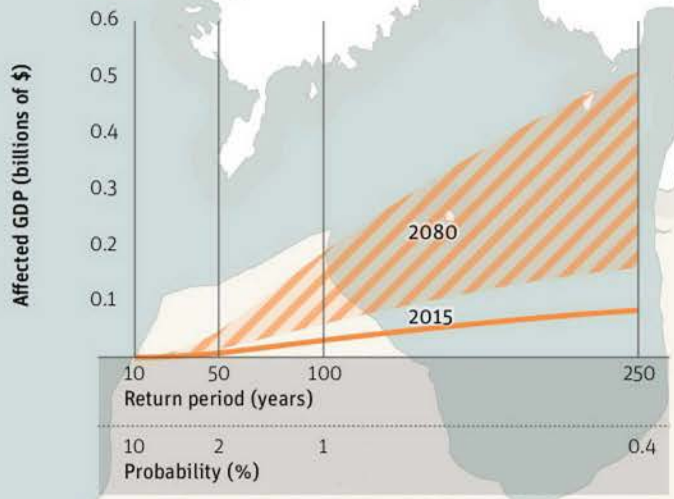
EARTHQUAKE
ANNUAL AVERAGE FATALITIES

The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Harjumaa, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if Estonia had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $600 million. In 2080, however, the affected GDP from the same type of event would range from about $1 billion to about $2 billion. If Estonia had experienced a 250-year earthquake event in 2015, the affected GDP would have been about $80 million. In 2080, the affected GDP from the same type of event would range from about $200 million to about $500 billion, due to population growth, urbanization, and the increase in exposed assets.

All historical data on earthquakes are from J. Daniell and A. Schaefer, "Eastern Europe and Central Asia Region Earthquake Risk Assessment Country and Province Profiling," final report to GFDRR, 2014. Damage estimates for all historical events have been inflated to 2015 US$.

Georgia

	AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
GDP $13.7 billion*	$1 billion (10%)	$10 billion (82%)	$7 billion (53%)
Population 3.9 million*	400,000 (10%)	3 million (82%)	20,000 (1%)

*2015 estimates

Georgia's population and economy are exposed to earthquakes and floods, with earthquakes posing the greater risk of a high impact, lower probability event. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

Just over half of Georgia's population lives in urban environments. The country's GDP was approximately US$13.7 billion in 2015, with close to 70 percent derived from services, most of the remainder generated by industry, and agriculture making a small contribution. Georgia's per capita GDP was $3,500.

This map displays GDP by province in Georgia, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of flood is Tbilisi, and the one at greatest risk of earthquakes is Kvemo Kartly. In absolute terms, the province at greatest risk of both floods and earthquakes is Tbilisi.

TOP AFFECTED PROVINCES

FLOOD

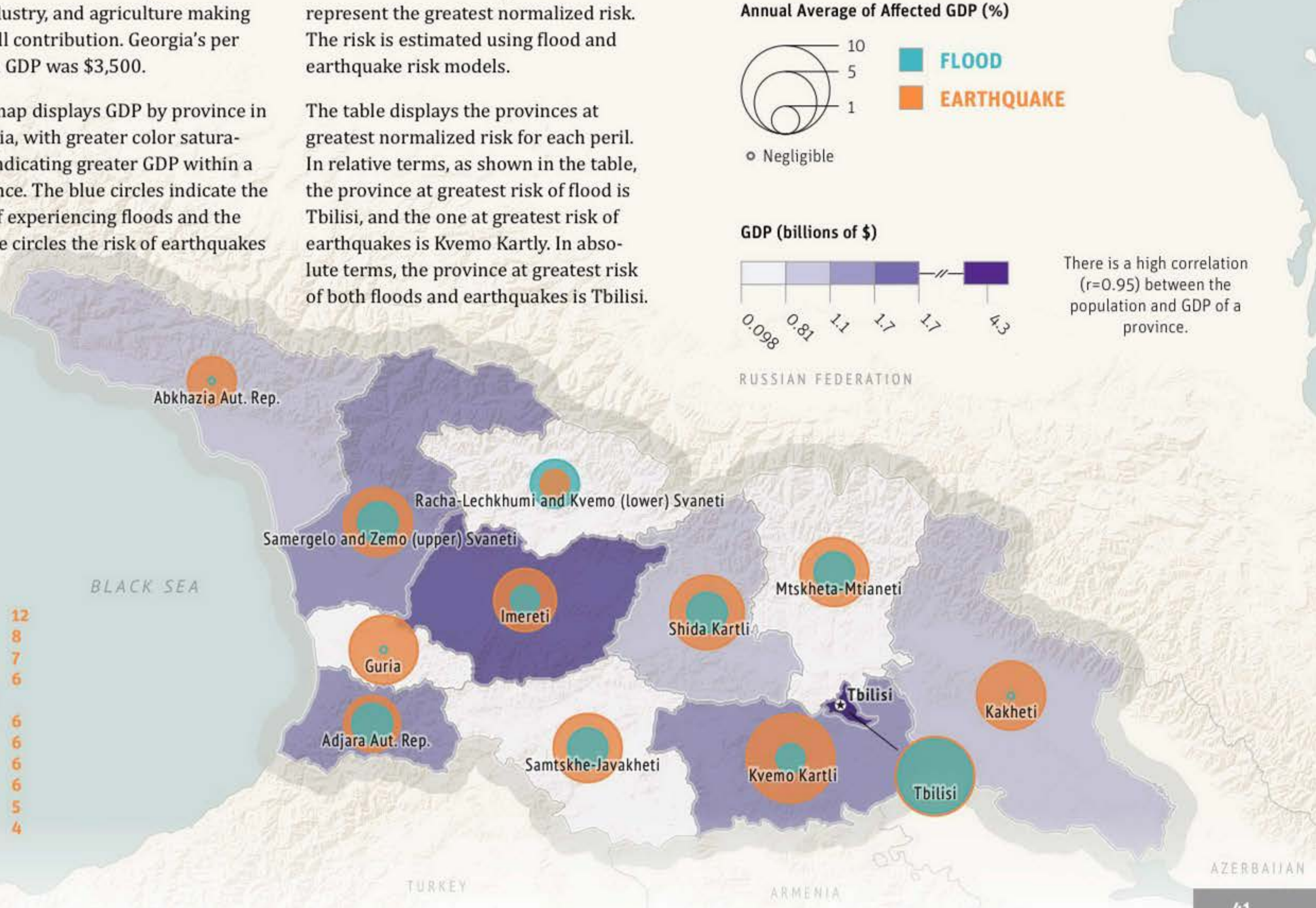
ANNUAL AVERAGE OF AFFECTED GDP (%)

Tbilisi	6
Racha-Lechkhumi and Kvemo (lower) Svaneti	3
Shida Kartli	2
Mtskheta-Mtianeti	2
Adjara Aut. Rep.	2
Samtskhe-Javakheti	2
Samergelo and Zemo (upper) Svaneti	2
Imereti	1
Kvemo Kartli	1
Kakheti	1

EARTHQUAKE

ANNUAL AVERAGE OF AFFECTED GDP (%)

Kvemo Kartli	12
Tbilisi	8
Shida Kartli	7
Samergelo and Zemo (upper) Svaneti	6
Guria	6
Samtskhe-Javakheti	6
Kakheti	6
Mtskheta-Mtianeti	6
Imereti	5
Adjara Aut. Rep.	4



There is a high correlation (r=0.95) between the population and GDP of a province.

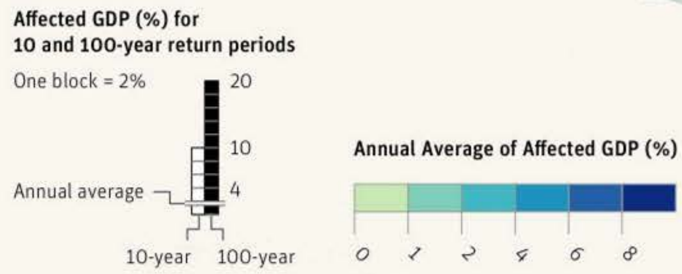
The most devastating floods in Georgia since it gained its independence in 1991 occurred in 1997. In that year, Georgia was hit by two floods, which together caused 7 fatalities and over $40 million in damage. Flooding in 2012 caused less damage ($3 million), but it affected over 100,000 people. Flooding in 2013 affected close to 25,000 people but also caused limited damage. Other floods occurred in 1995, 2004, 2005, and 2011, with fewer than 2,500 people affected and less than $4 million in damage per event. According to a 2015 World Bank Post Disaster Needs Assessment (in press), the June 2015 flooding in Tbilisi caused 19 fatalities (in addition, three people are still missing), affected over 700 people, and caused over $20 million in damages. All these events highlight Georgia's vulnerability to floods. They are not always devastating, but they follow each other quickly and have a large cumulative effect on the country.

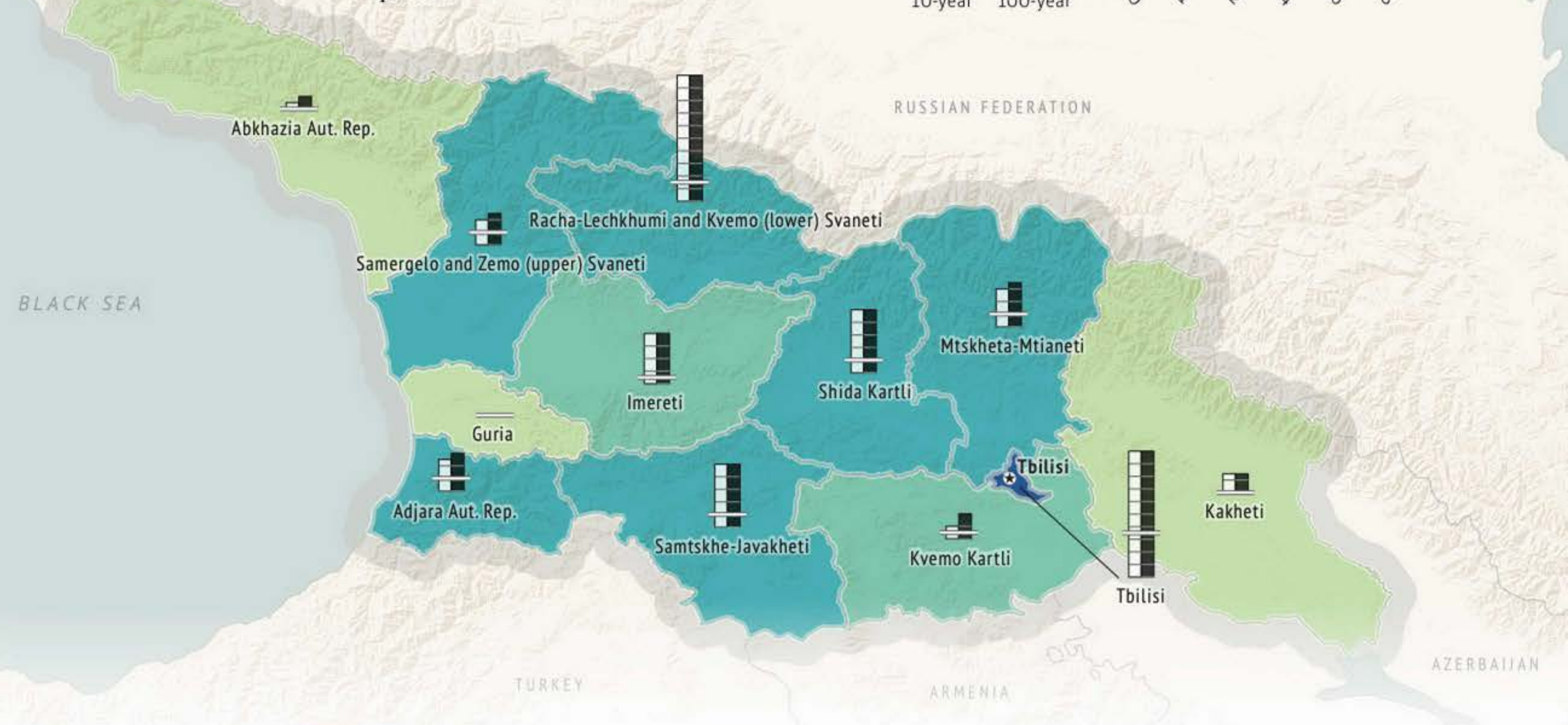
This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in Georgia is about 100,000 and the annual average affected GDP about $400 million. Within the various provinces, the 10- and 100-year impacts do not differ much, so relatively frequent floods have large impacts on these averages.





Georgia's worst earthquake since 1900 occurred in 1991, with a magnitude of 7. It caused over 250 fatalities and close to $3 billion in damage. An earthquake in 2002 affected nearly 20,000 people and caused about $500 million in damage. The impact of earthquakes in 1992 and 2009 was less extensive.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

When an earthquake has a 10-year return period, it means the probability of occurrence of an earthquake of that magnitude or greater is 10 percent per year. A 100-year earthquake has a probability of occurrence of 1 percent per year. This means that over a long period of time, an earthquake of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year earthquake will occur exactly once every 100 years. In fact, it is possible for an earthquake of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

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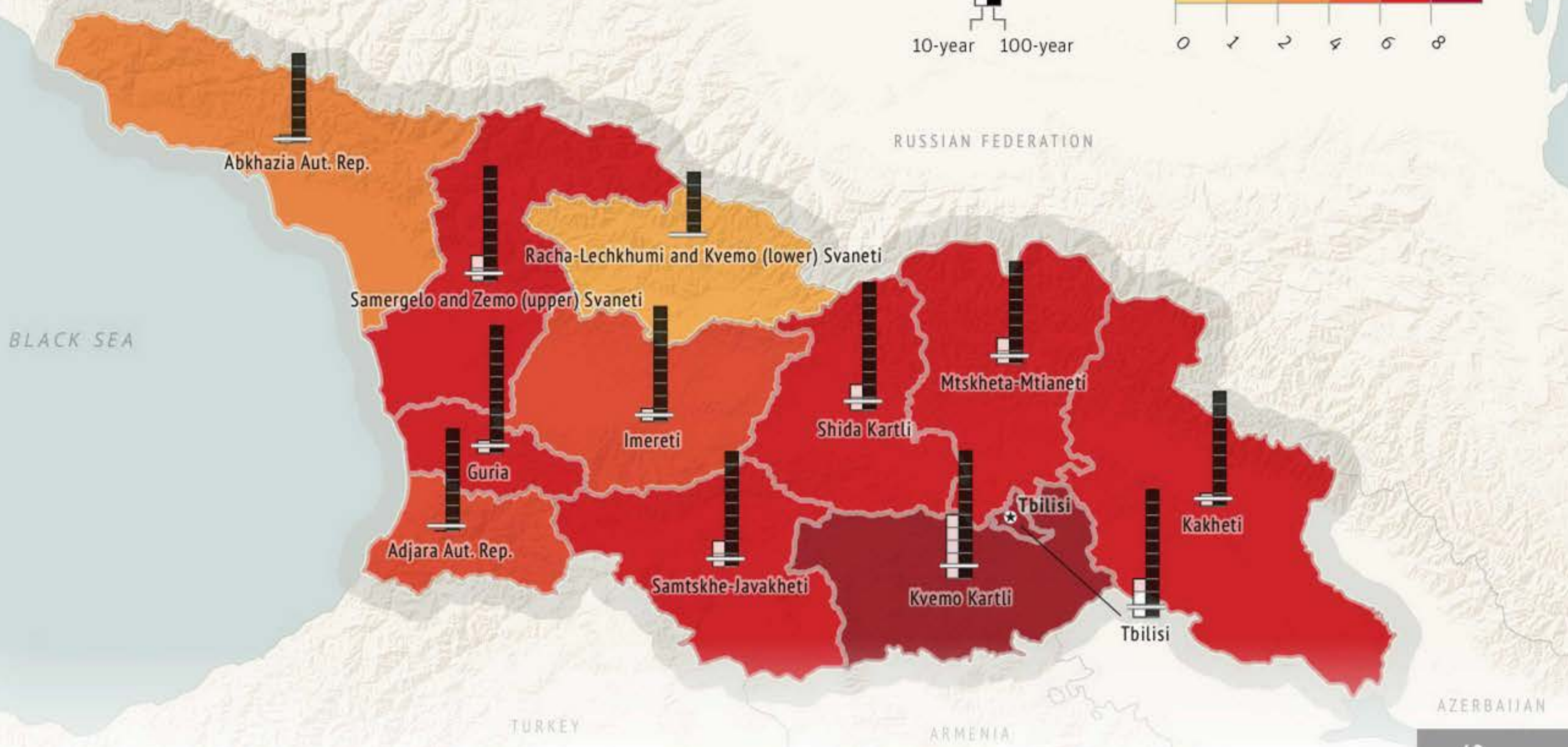
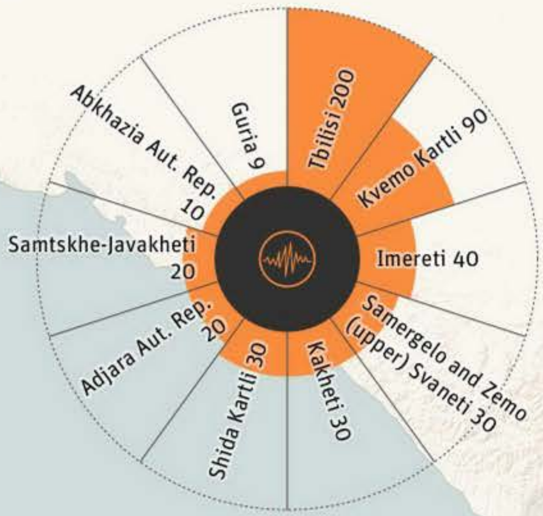
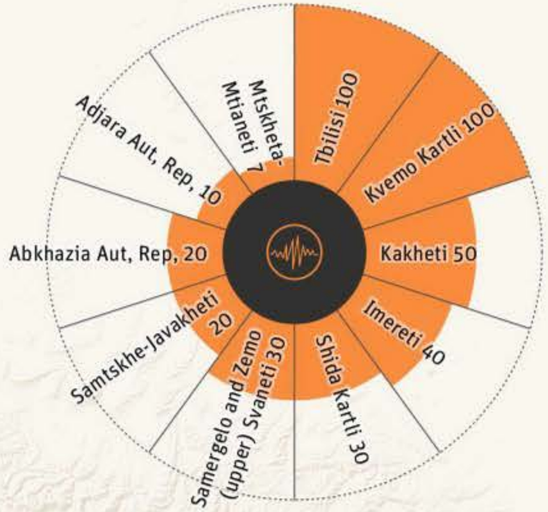
The annual average population affected by earthquakes in Georgia is about 300,000 and the annual average affected GDP about $900 million. The annual averages of fatalities and capital losses caused by earthquakes are about 500 and about $500 million, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause about 20,000 fatalities and $7 billion in capital loss (about 50 percent of GDP).



EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS (MILLIONS $)

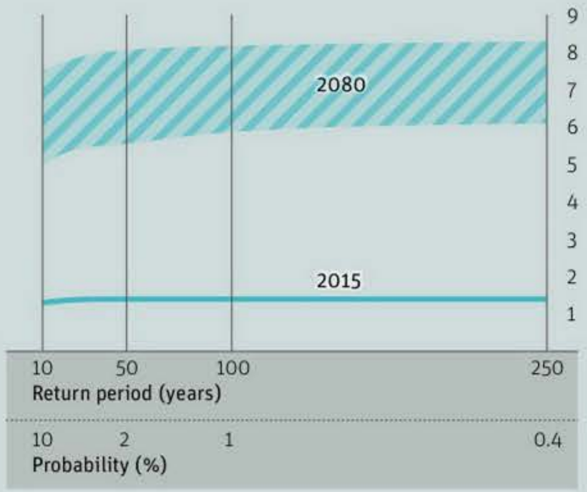


EARTHQUAKE
ANNUAL AVERAGE FATALITIES

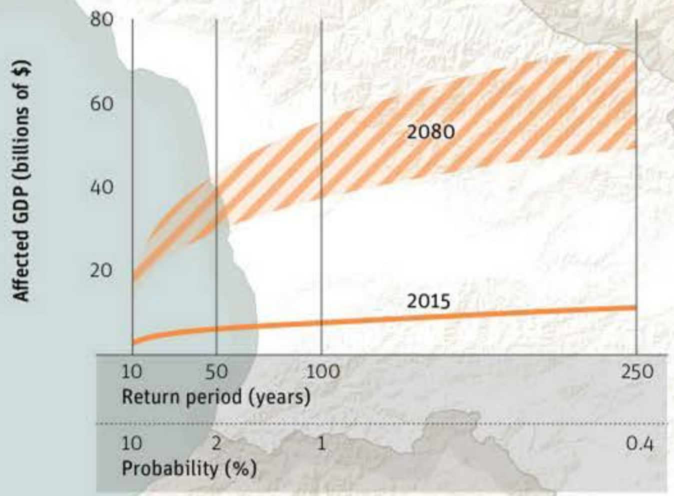


The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Tbilisi, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if Georgia had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $1 billion. In 2080, however, affected GDP from the same type of event would range from about $6 billion to about $8 billion. If Georgia experienced a 250-year earthquake event in 2015, the affected GDP would have been about $10 billion. In 2080, the affected GDP from the same type of event would range from about $50 billion to about $70 billion, due to population growth, urbanization, and the increase in exposed assets.

All historical data on floods, unless otherwise noted, and earthquakes are from, respectively, D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be, and the National Geophysical Data Center/World Data Service (NGDC/WDS), Significant Earthquake Database (National Geophysical Data Center, NOAA) doi:10.7289/V5TD9V7K. Damage estimates for all historical events have been inflated to 2015 US$.

WORLD BANK GROUP GFDRR

EUROPE AND CENTRAL ASIA (ECA) RISK PROFILES

Greece

	AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
GDP $192 billion*	$3 billion (1%)	$90 billion (47%)	$20 billion (8%)
Population 10.8 million*	200,000 (2%)	4 million (36%)	2,000 (<1%)

*2015 estimates

Greece's population and economy are exposed to earthquakes and floods, with earthquakes posing the greater risk of a high impact, lower probability event. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

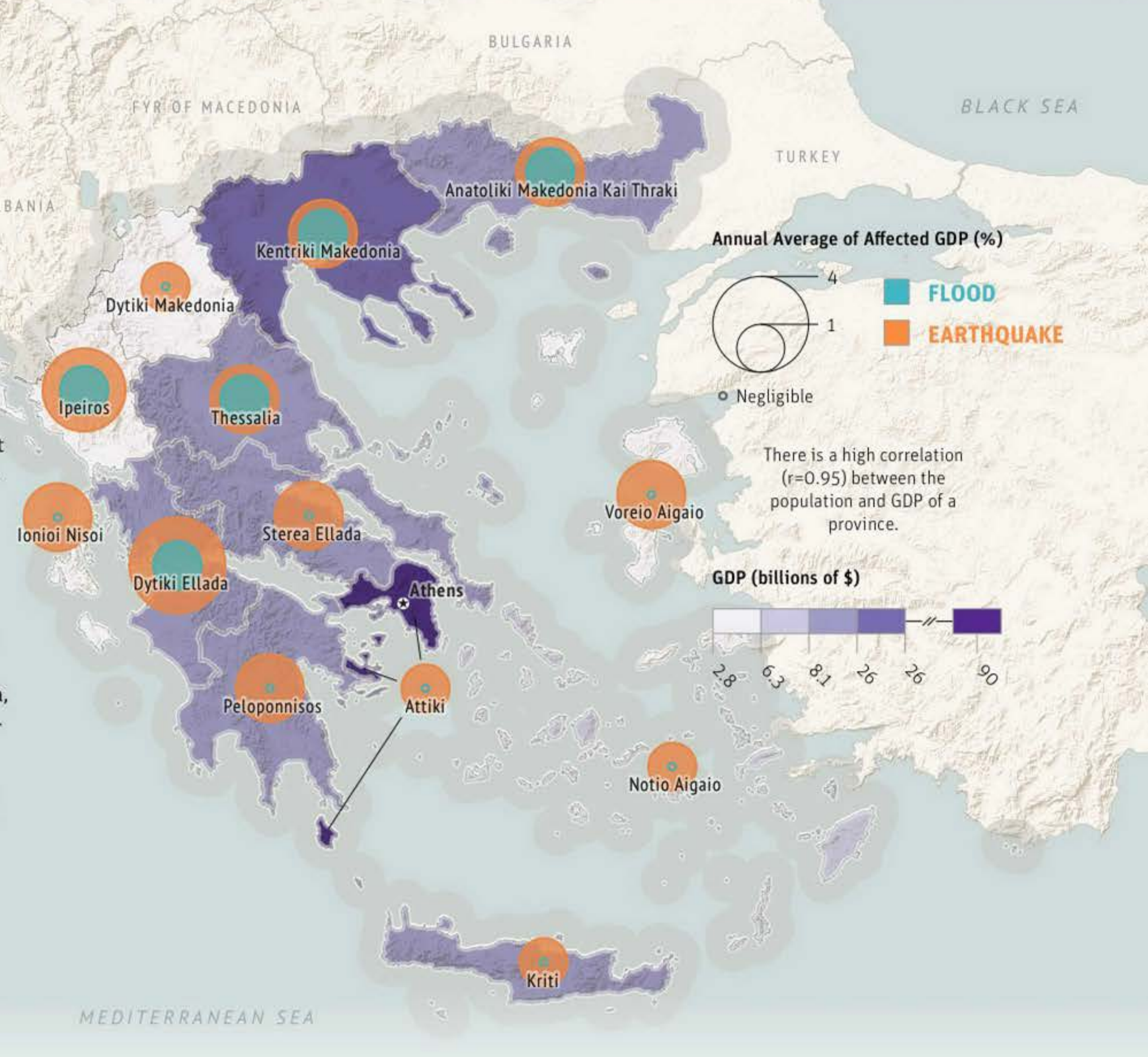
Just over 60 percent of Greece's population lives in urban environments. The country's GDP was approximately US$192 billion in 2015, with close to 80 percent derived from services, most of the remainder generated by industry, and agriculture making a small contribution. Greece's per capita GDP was $17,800.

This map displays GDP by province in Greece, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of floods is Anatoliki Makedonia, and the one at greatest risk of earthquake is Dytiki Ellada. In absolute terms, the province at greatest risk of floods is Kentriki Makedonia, and the one at greatest risk of earthquake is Attiki.

TOP AFFECTED PROVINCES

FLOOD ANNUAL AVERAGE OF AFFECTED GDP (%)		EARTHQUAKE ANNUAL AVERAGE OF AFFECTED GDP (%)	
Anatoliki Makedonia Kai Thraki	1	Dytiki Ellada	4
Thessalia	1	Ipeiros	3
Ipeiros	1	Voreio Aigaio	2
Kentriki Makedonia	1	Ionioi Nisoi	2
Dytiki Ellada	1	Kentriki Makedonia	2
Peloponnisos	0	Anatoliki Makedonia Kai Thraki	2
Dytiki Makedonia	0	Sterea Ellada	2
Sterea Ellada	0	Thessalia	2
Attiki	0	Peloponnisos	2
Ionioi Nisoi	0	Attiki	1



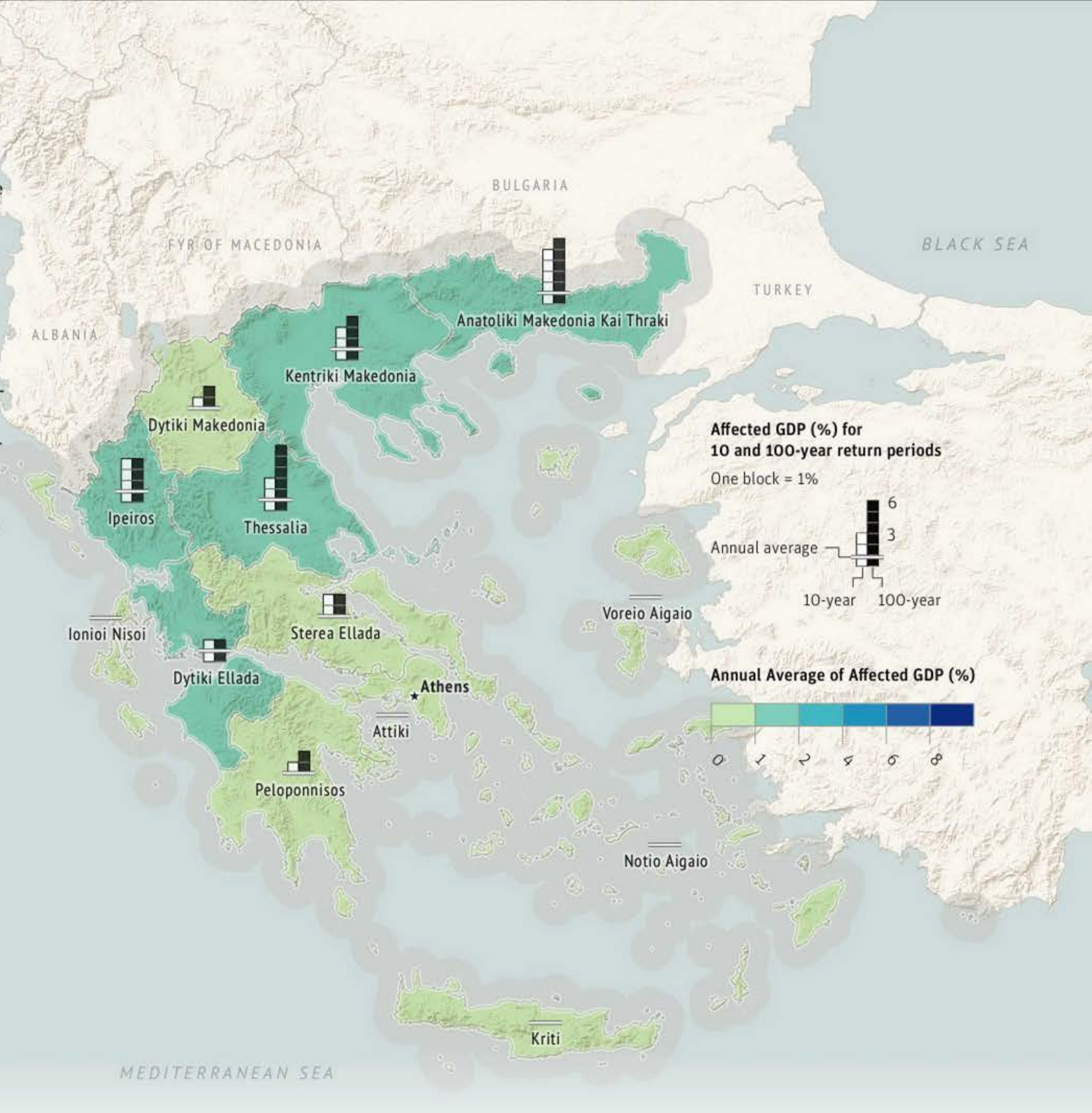
The most damaging floods in Greece since 1900 occurred in 1994 and 2003, causing over $700 million and $800 million in damage, respectively.

This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in Greece is about 50,000 and the annual average affected GDP about $600 million. Within the various provinces, the 10- and 100-year impacts do not differ much, so relatively frequent floods have large impacts on these averages.



Greece's worst earthquake since 1900, with a magnitude of 7.2, took place in 1953 in Kefalonia and caused over 450 fatalities. Many people left the island after the event, reducing its population to a mere 20 percent of its size before the disaster. The same region was also hit by earthquakes in 1867 and 2011. A 1999 earthquake in Athens caused close to 150 deaths and over $6 billion in damage. More recently, in 2014, an earthquake in southern Greece caused three fatalities and almost $500 million in damage.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

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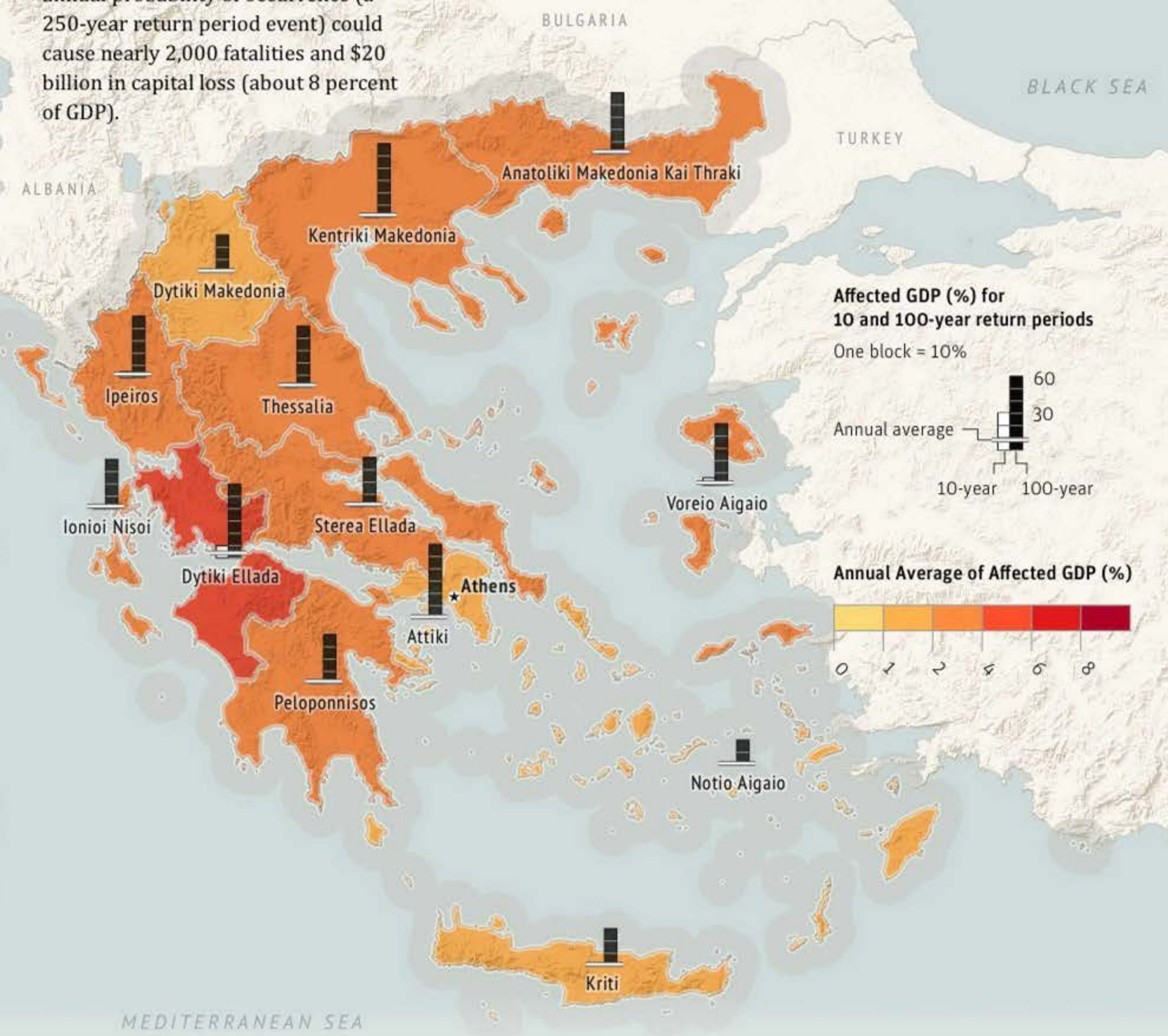
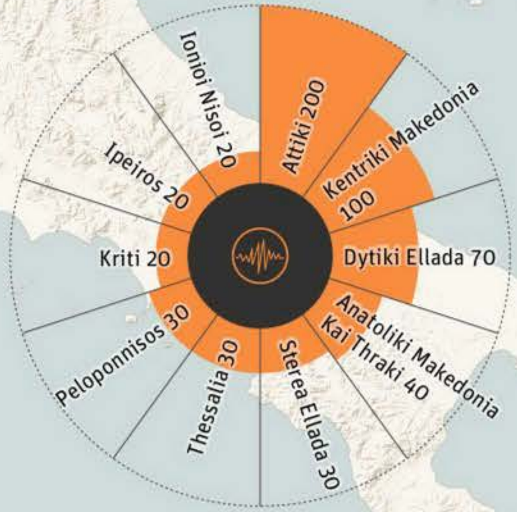
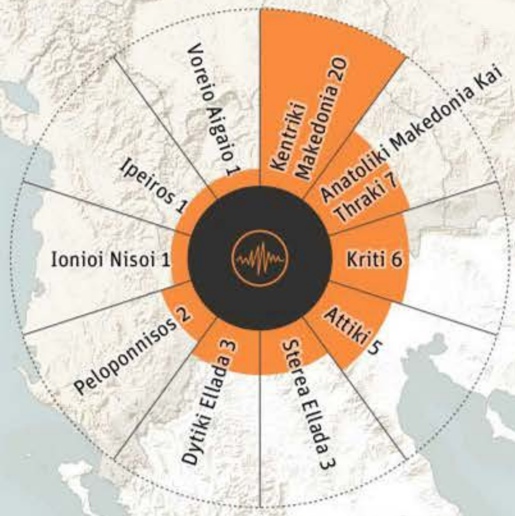
The annual average population affected by earthquakes in Greece is about 200,000 and the annual average affected GDP about $3 billion. The annual averages of fatalities and capital losses caused by earthquakes are about 50 and about $700 million, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause nearly 2,000 fatalities and $20 billion in capital loss (about 8 percent of GDP).



EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS (MILLIONS $)

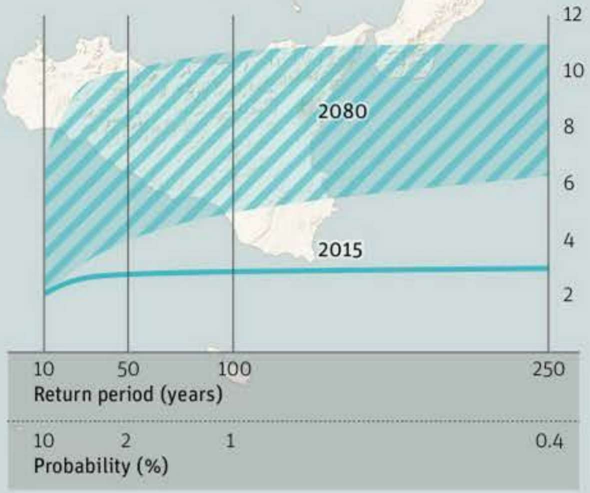


EARTHQUAKE
ANNUAL AVERAGE FATALITIES

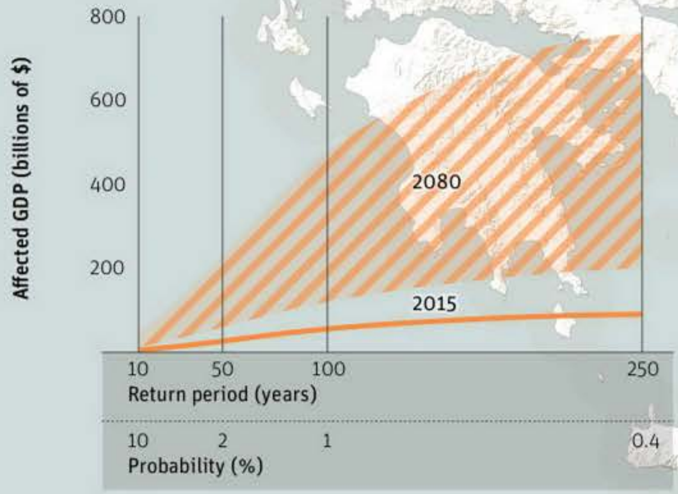


The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Attiki, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



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All historical data on floods and earthquakes are from D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be; the National Geophysical Data Center/World Data Service (NGDC/WDS), Significant Earthquake Database (National Geophysical Data Center, NOAA), doi:10.7289/V5TD9V7K; and J. Daniell and A. Schaefer, "Eastern Europe and Central Asia Region Earthquake Risk Assessment Country and Province Profiling," final report to GFDRR, 2014. Damage estimates for all historical events have been inflated to 2015 US$.

WORLD BANK GROUP GFDRR

EUROPE AND CENTRAL ASIA (ECA) RISK PROFILES

Hungary

	AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
GDP $126 billion*	$9 billion (7%)	$50 billion (41%)	$6 billion (5%)
Population 9.8 million*	900,000 (9%)	2 million (23%)	20 (<1%)

*2015 estimates

Hungary's population and economy are exposed to earthquakes and floods, with floods posing the greater risk. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

About 70 percent of Hungary's population lives in urban environments. The country's GDP was approximately US$126 billion in 2015, with close to 70 percent derived from services, most of the remainder generated by industry, and agriculture making a small contribution. Hungary's per capita GDP was $12,800.

This map displays GDP by province in Hungary, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of floods is Csongrad, and the one at greatest risk of earthquakes is Komarom-esztergom. In absolute terms, the province at greatest risk of floods is Csongrad, and the one at greatest risk of earthquakes is Budapest.

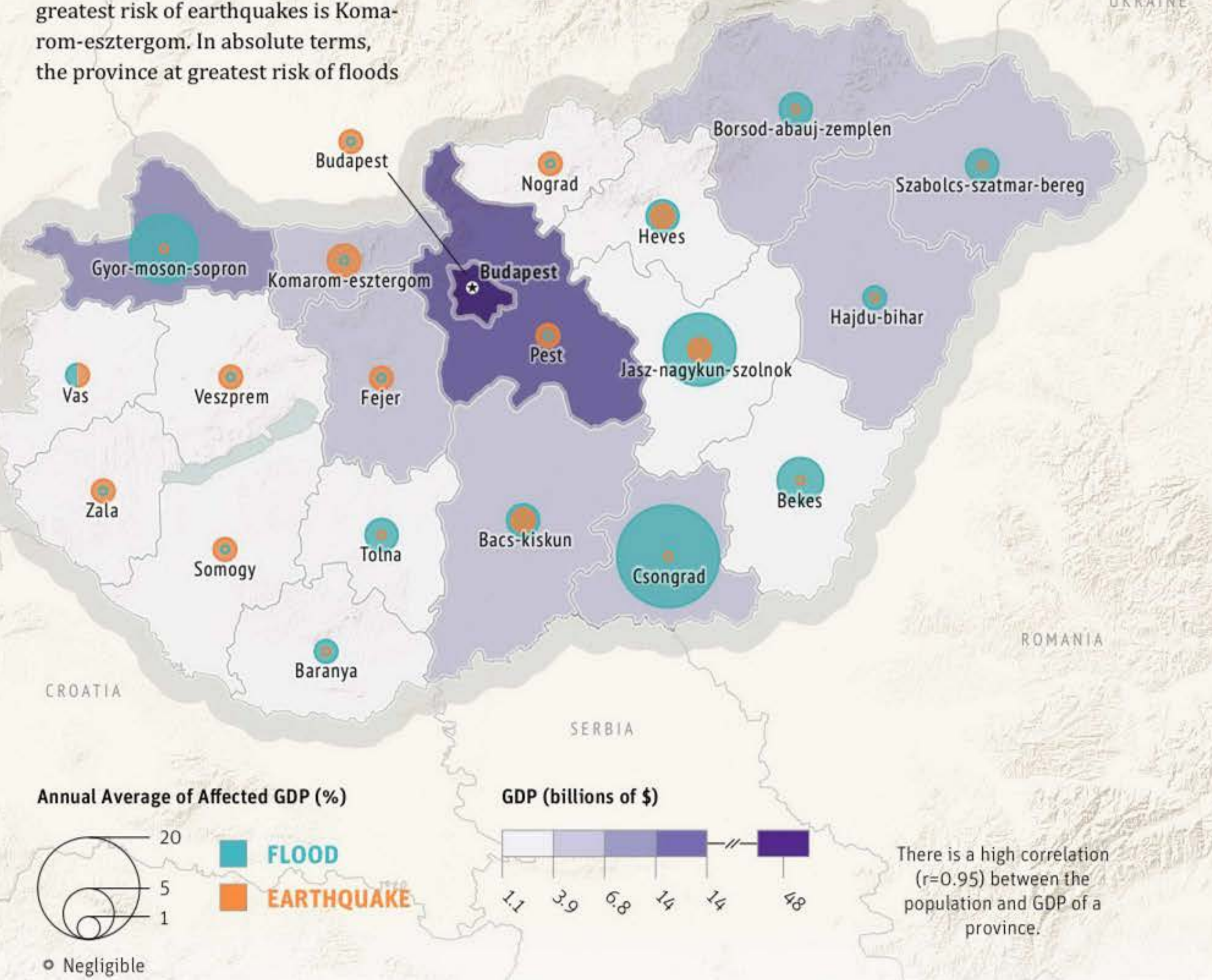
TOP AFFECTED PROVINCES

FLOOD
ANNUAL AVERAGE OF AFFECTED GDP (%)

Csongrad	16
Jasz-nagykun-szolnok	13
Gyor-moson-sopron	9
Bekes	4
Szabolcs-szatmar-bereg	2
Tolna	2
Heves	2
Borsod-abauj-zemplen	2
Bacs-kiskun	2
Hajdu-bihar	1

EARTHQUAKE
ANNUAL AVERAGE OF AFFECTED GDP (%)

Komarom-esztergom	2
Budapest	1
Pest	1
Zala	1
Veszprem	1
Heves	1
Somogy	1
Nograd	1
Jasz-nagykun-szolnok	1
Vas	1



There is a high correlation (r=0.95) between the population and GDP of a province.

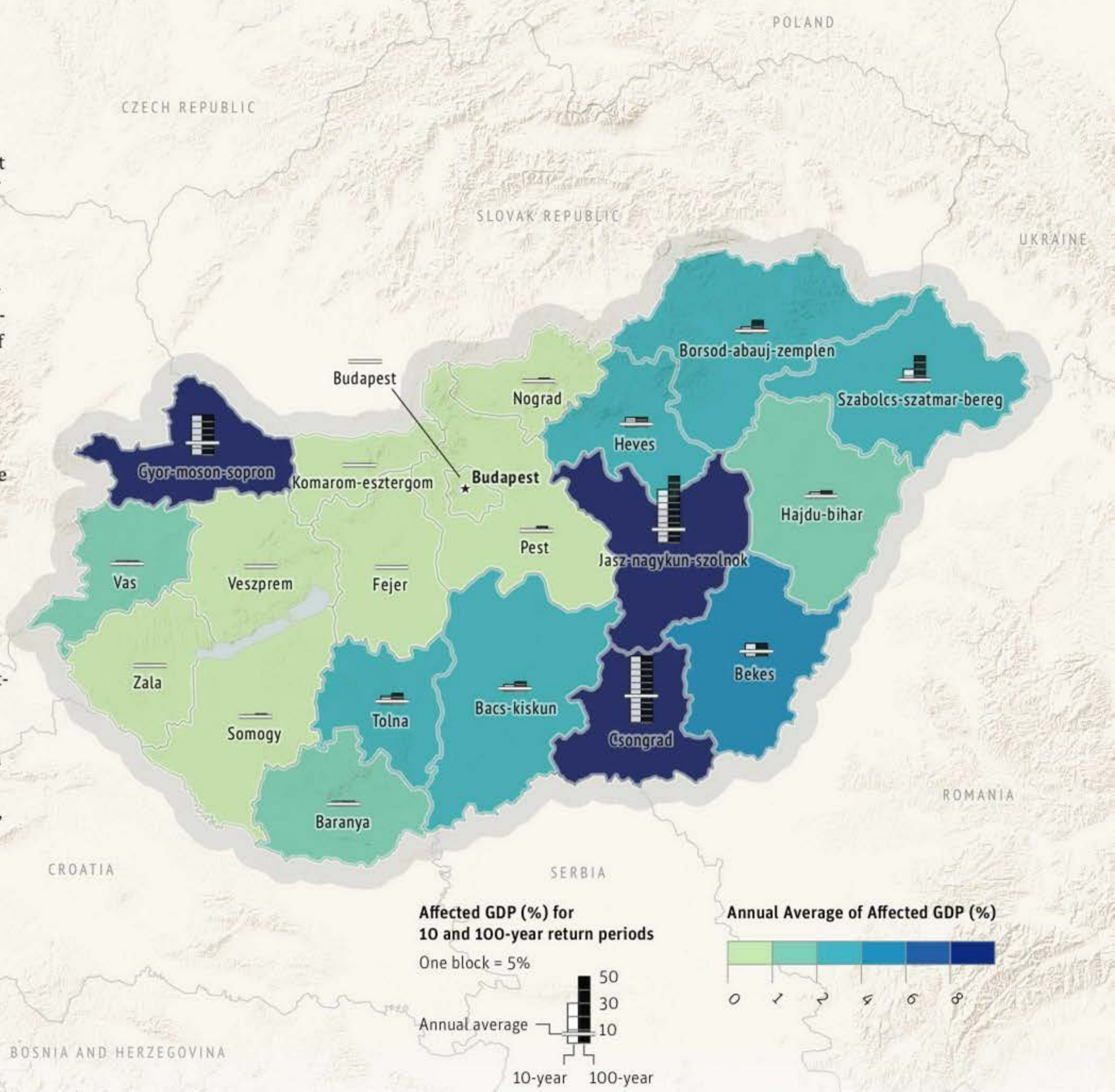
The most deadly flood in Hungary since 1900 took place in 1970 and caused about 300 fatalities and over $500 million in damage. More recently, in 1999, two floods occurred that together caused at least eight fatalities, affected over 100,000 people, and brought over $400 million in damage. A single flood in 2010 caused no fatalities but almost $500 million in damage. These statistics highlight the lives being saved by disaster risk management efforts but also the possibility that the damage associated with flooding will rise.

This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in Hungary is about 200,000 and the annual average affected GDP about $2 billion. Within the various provinces, the 10- and 100-year impacts do not differ much, so relatively frequent floods have large impacts on these averages.



Hungary's worst earthquake since 1900 took place in 1911 in Kecskemet, causing 10 fatalities. Others occurred in 1599, 1763, 1783, and 1879, and, most recently, in 2011.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

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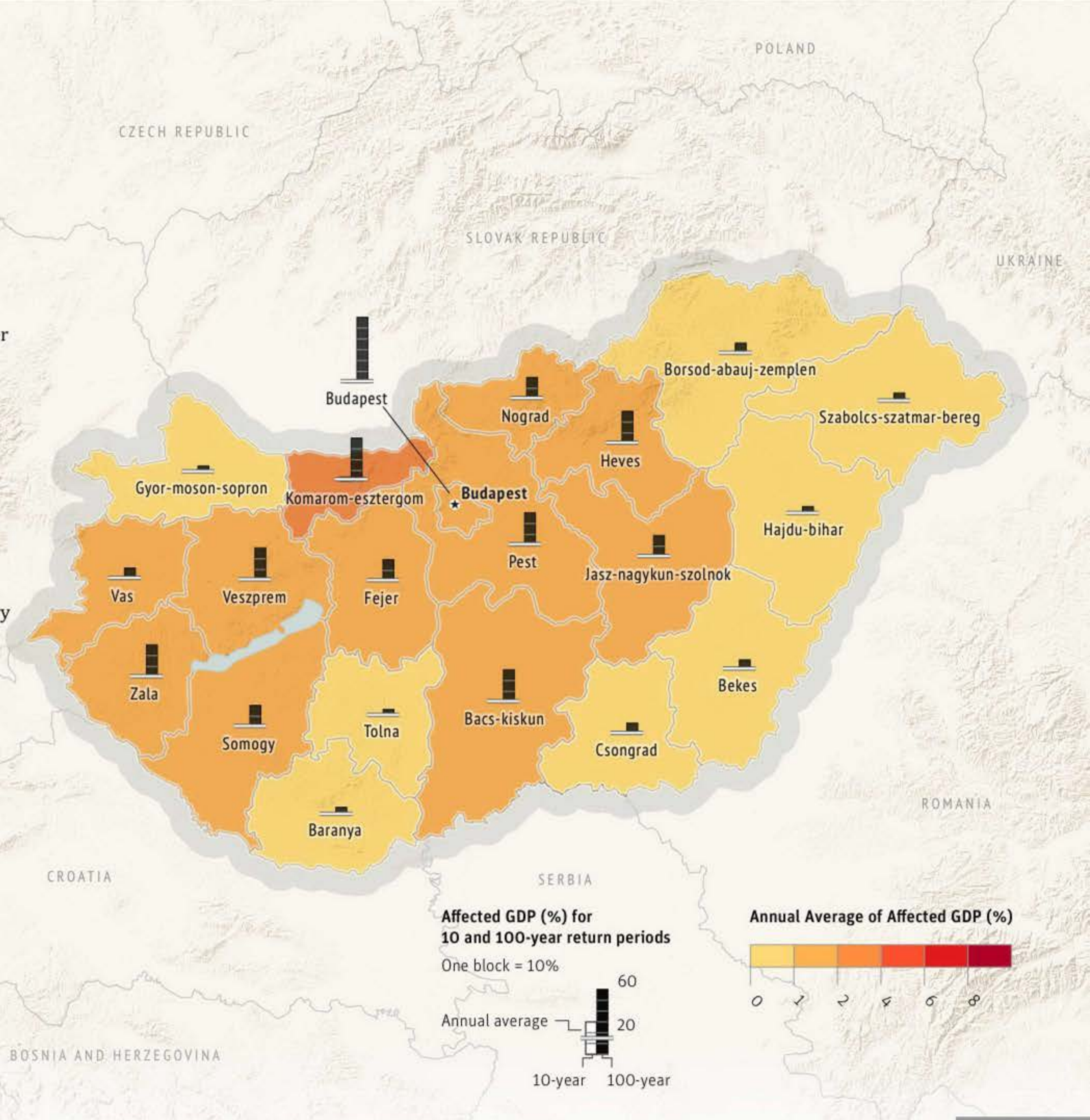
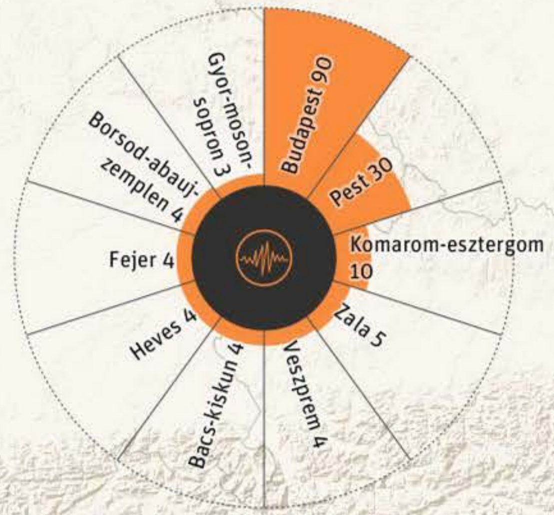
If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make larger contributions to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by earthquakes in Hungary is about 80,000 and the annual average affected GDP about $1 billion. The annual averages of fatalities and capital losses caused by earthquakes are about one and about $200 million, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause about $6 billion in capital loss (about 5 percent of GDP).



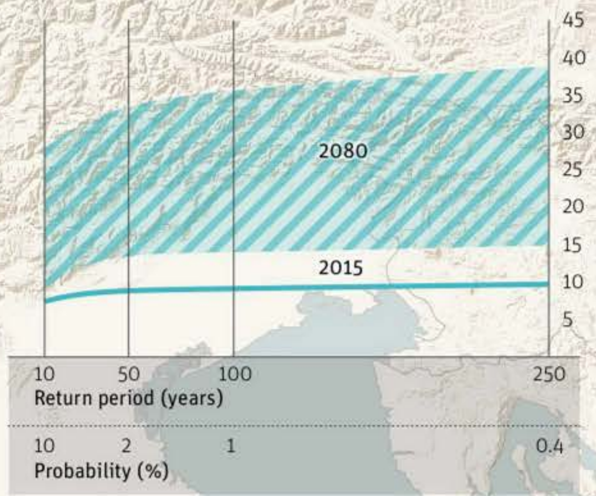
EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS (MILLIONS $)



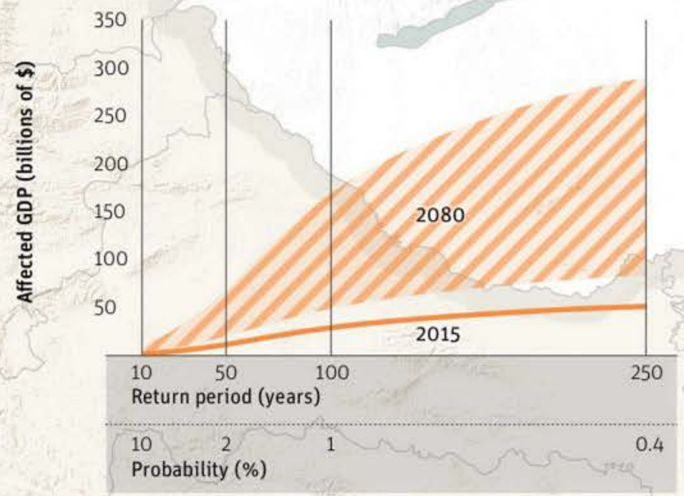
EARTHQUAKE
ANNUAL AVERAGE FATALITIES

The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Budapest, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if Hungary had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $9 billion. In 2080, however, the affected GDP from the same type of event would range from about $10 billion to about $40 billion. If Hungary had experienced a 250-year earthquake event in 2015, the affected GDP would have been about $50 billion. In 2080, the affected GDP from the same type of event would range from about $80 billion to about $300 billion, due to population growth, urbanization, and the increase in exposed assets.

All historical data on floods and earthquakes are from, respectively, D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be, and J. Daniell and A. Schaefer, "Eastern Europe and Central Asia Region Earthquake Risk Assessment Country and Province Profiling," final report to GFDRR, 2014. Damage estimates for all historical events have been inflated to 2015 US$.

Kazakhstan

GDP $120 billion*

Population 17.7 million*

	AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
GDP	$10 billion (11%)	$30 billion (22%)	$20 billion (14%)
Population	1 million (8%)	3 million (17%)	20,000 (<1%)

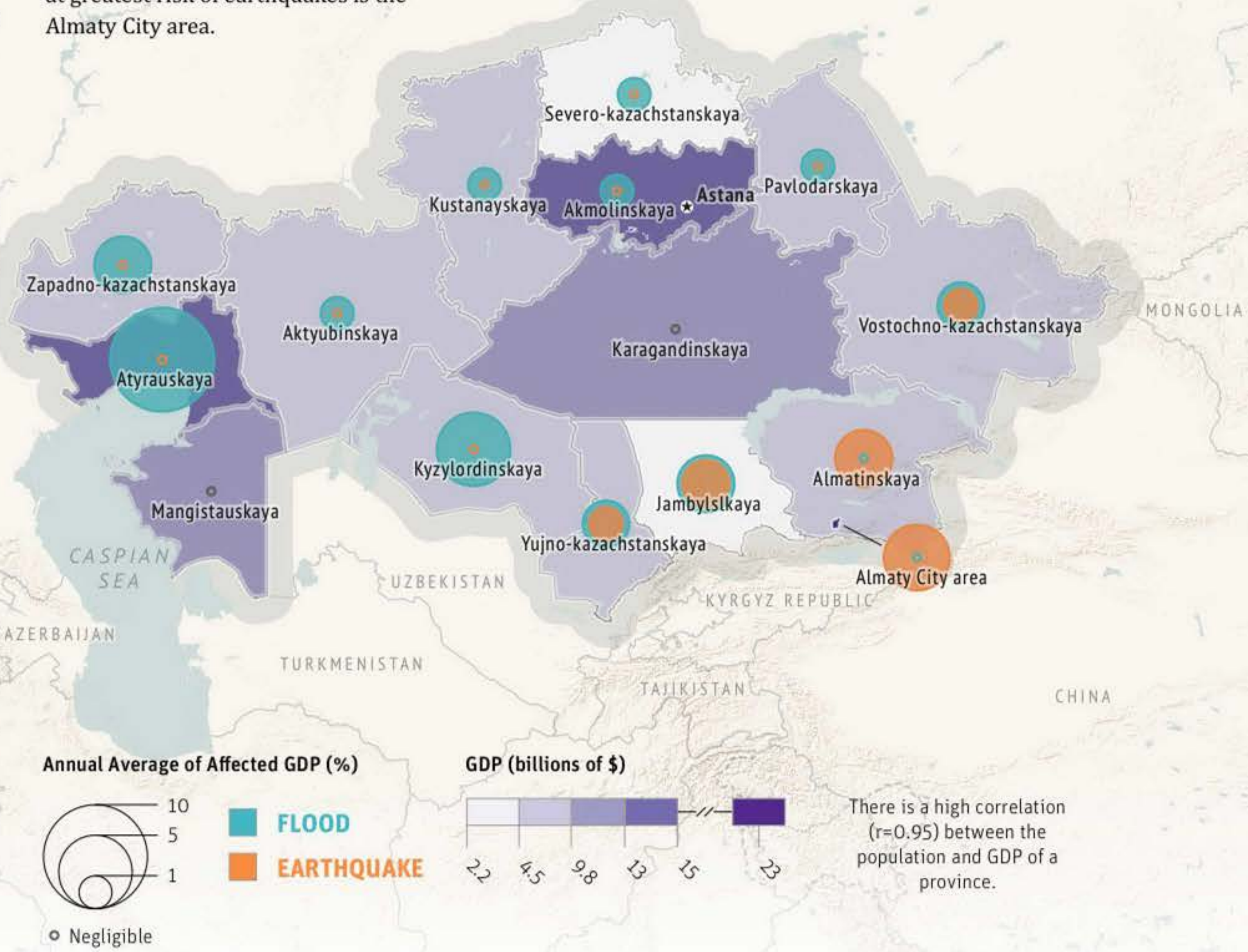
*2015 estimates

Kazakhstan's population and economy are exposed to earthquakes and floods, with floods posing the greater risk. The model results for present-day risk presented in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 dollars.

Just over half of Kazakhstan's population lives in urban environments. The country's GDP was approximately US$120 billion in 2015, with close to 70 percent derived from services, most of the remainder generated by industry, and agriculture making a small contribution. Kazakhstan's per capita GDP was $6,770.

This map displays GDP by province in Kazakhstan, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In both relative and absolute terms, the province at greatest risk of floods is Atyrauskaya, and the one at greatest risk of earthquakes is the Almaty City area.



There is a high correlation (r=0.95) between the population and GDP of a province.

TOP AFFECTED PROVINCES

FLOOD

ANNUAL AVERAGE OF AFFECTED GDP (%)

Atyrauskaya	11
Kyzylordinskaya	5
Zapadno-kazachstanskaya	3
Jambylslkaya	2
Yujno-kazachstanskaya	2
Vostochno-kazachstanskaya	2
Severo-kazachstanskaya	1
Akmolinskaya	1
Aktyubinskaya	1
Kustanayskaya	1

EARTHQUAKE

ANNUAL AVERAGE OF AFFECTED GDP (%)

Almaty City area	4
Almatinskaya	3
Jambylslkaya	2
Yujno-kazachstanskaya	1
Vostochno-kazachstanskaya	1
Mangistauskaya	0
Pavlodarskaya	0
Kyzylordinskaya	0
Severo-kazachstanskaya	0
Akmolinskaya	0

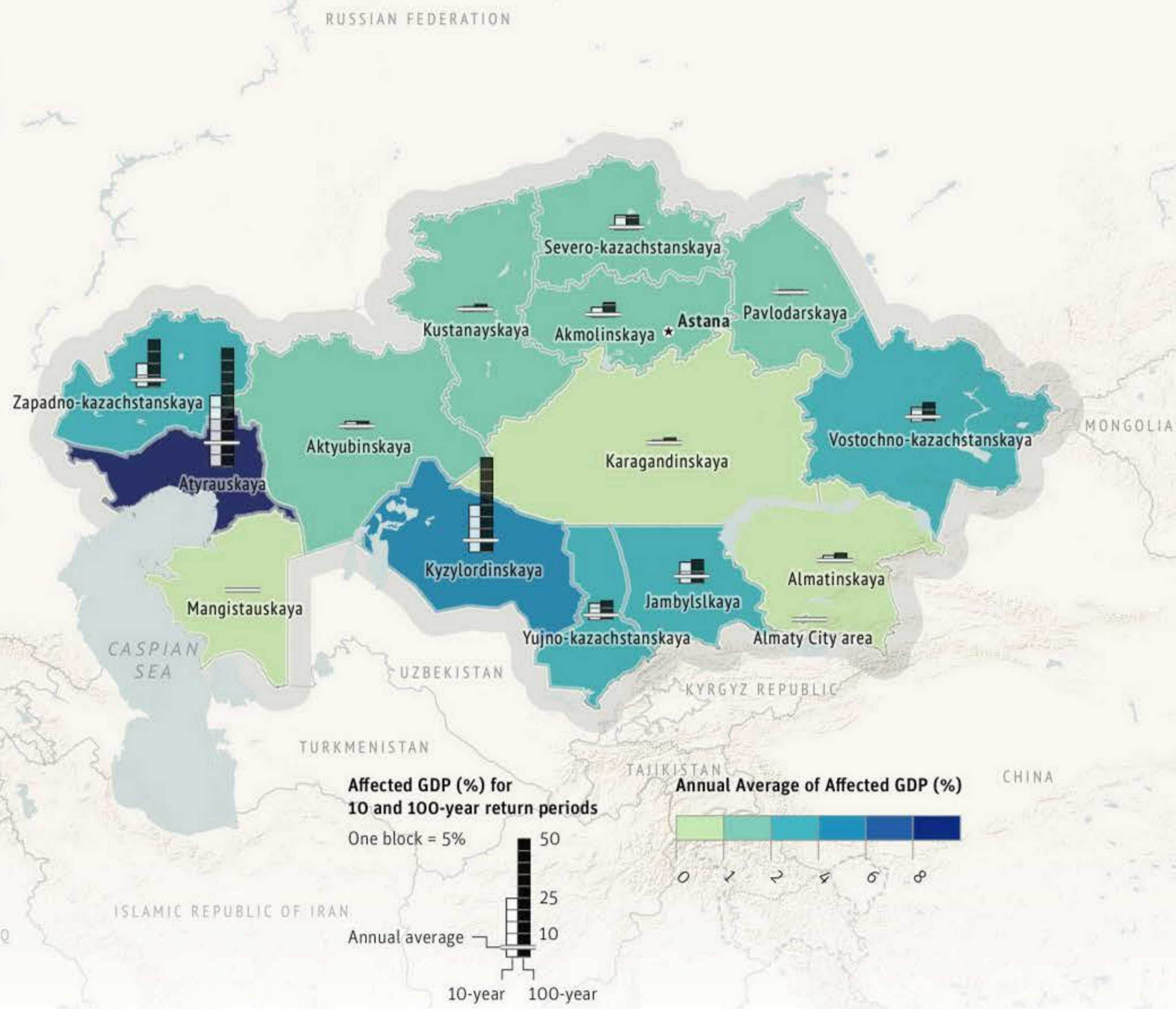
The most deadly flood since Kazakhstan gained its independence in 1991 occurred in 2010. It caused over 40 fatalities and close to $40 million in damage. The most damaging flood took place in 2008, causing one death and over $100 million in damage. A 1993 flood caused approximately 10 fatalities and close to $60 million in damage. Flooding in 2011 caused only two fatalities and damage close to $70 million.

This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in Kazakhstan is about 300,000 and the annual average affected GDP about $3 billion. For most provinces, the 10- and 100-year impacts do not differ much, so relatively frequent floods have large impacts on these averages. For the few in which the 100-year impacts are much greater than the 10-year impacts, less frequent events make a significant contribution to the annual averages of affected GDP.



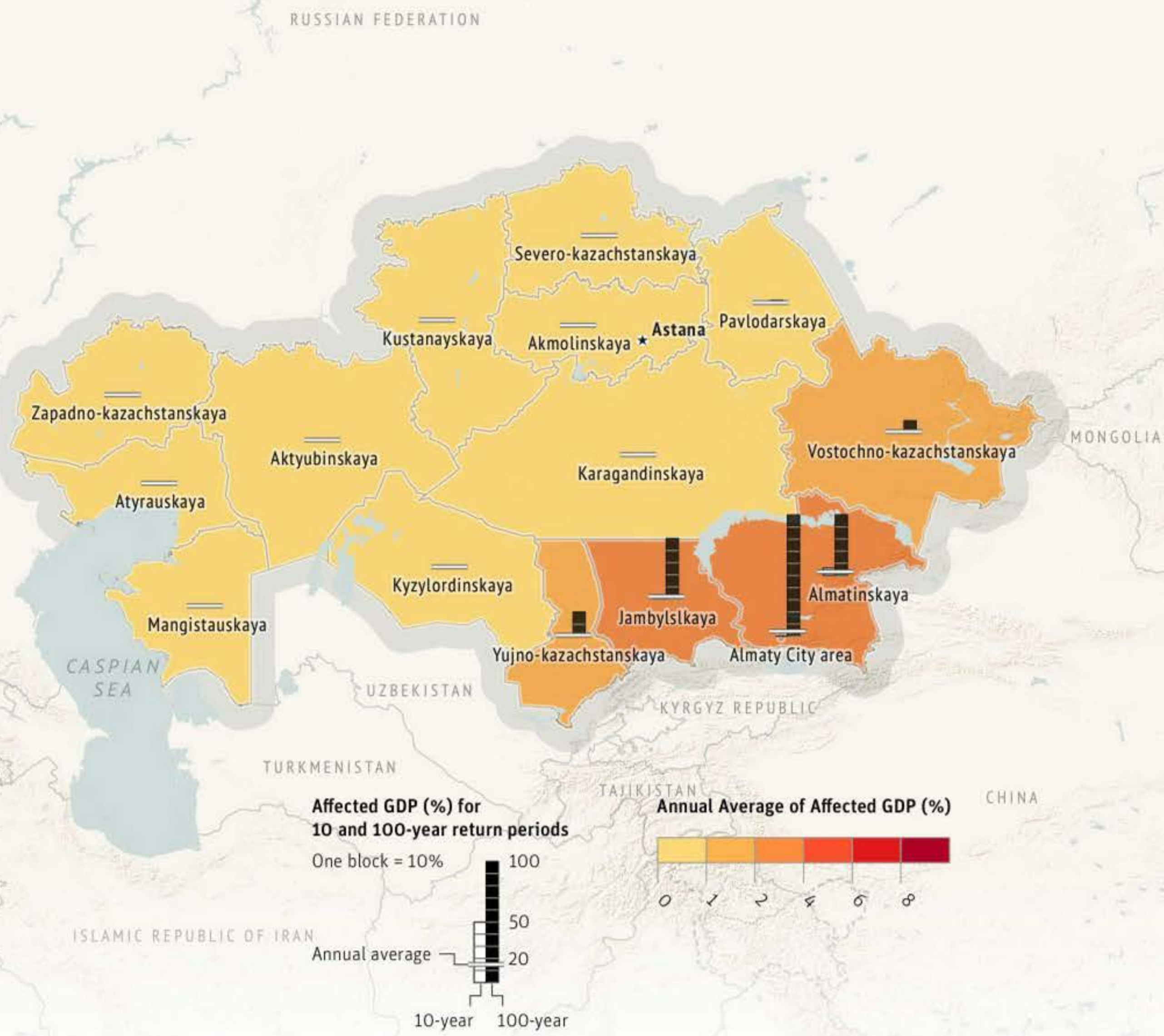
Kazakhstan's worst earthquake since 1900 took place in 1911 in Kemin, with a magnitude of 7.7. The earthquake caused over 450 fatalities and more than $20 million in damage. Other earthquakes occurred in Aksu in 1716 and Alma-Ata in 1889. More recently, in 2003, an earthquake caused three deaths and affected close to 40,000 people.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

When an earthquake has a 10-year return period, it means the probability of occurrence of an earthquake of that magnitude or greater is 10 percent per year. A 100-year earthquake has a probability of occurrence of 1 percent per year. This means that over a long period of time, an earthquake of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year earthquake will occur exactly once every 100 years. In fact, it is possible for an earthquake of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make larger contributions to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by earthquakes in Kazakhstan is about 200,000 and the annual average affected GDP about $1 billion. The annual averages of fatalities and capital losses caused by earthquakes are about 500 and about $400 million, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause nearly 20,000 fatalities and $20 billion in capital loss (about 10 percent of GDP).

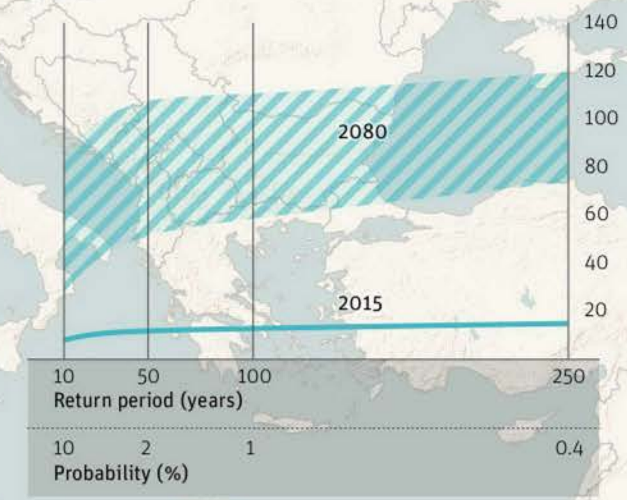


EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS (MILLIONS $)

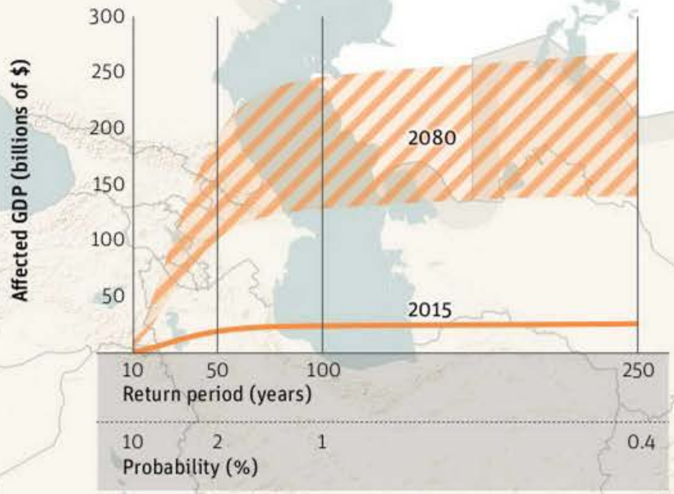
EARTHQUAKE
ANNUAL AVERAGE FATALITIES

The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in the Almaty City area, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if Kazakhstan had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $10 billion. In 2080, however, the affected GDP from the same type of event would range from about $60 billion to about $100 billion. If Kazakhstan had experienced a 250-year earthquake event in 2015, the affected GDP would have been about $20 billion. In 2080, the affected GDP from the same type of event would range from about $100 billion to $300 billion, due to population growth, urbanization, and the increase in exposed assets.

All historical data on floods and earthquakes are from D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be; the National Geophysical Data Center/World Data Service (NGDC/WDS), Significant Earthquake Database (National Geophysical Data Center, NOAA), doi:10.7289/V5TD9V7K; and J. Daniell and A. Schaefer, "Eastern Europe and Central Asia Region Earthquake Risk Assessment Country and Province Profiling," final report to GFDRR, 2014. Damage estimates for all historical events have been inflated to 2015 US$.

Kyrgyz Republic

GDP $5.5 billion*

Population 5.7 million*

AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
$400 million (7%)	$3 billion (61%)	$4 billion (64%)
500,000 (8%)	3 million (45%)	8,000 (<1%)

*2015 estimates

The Kyrgyz Republic's population and economy are exposed to earthquakes and floods, with earthquakes posing the greater risk of a high impact, lower probability event. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

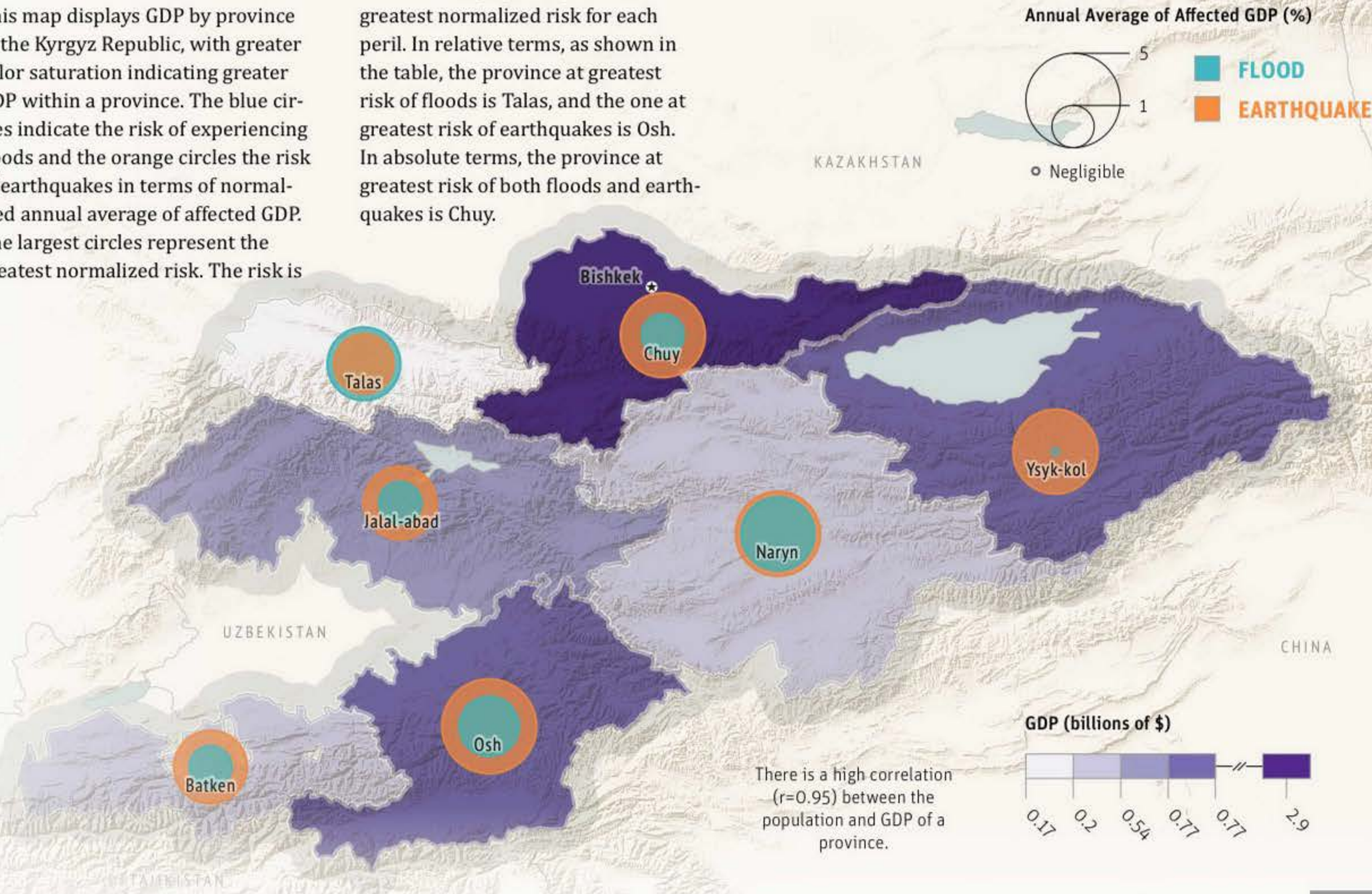
Over 60 percent of the Kyrgyz Republic's population lives in rural environments. The country's GDP was approximately US$5.5 billion in 2015, with nearly 50 percent derived from services, most of the remainder generated by industry, and agriculture contributing 20 percent. The Kyrgyz Republic's per capita GDP was $970.

This map displays GDP by province in the Kyrgyz Republic, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of floods is Talas, and the one at greatest risk of earthquakes is Osh. In absolute terms, the province at greatest risk of both floods and earthquakes is Chuy.

TOP AFFECTED PROVINCES

FLOOD ANNUAL AVERAGE OF AFFECTED GDP (%)		EARTHQUAKE ANNUAL AVERAGE OF AFFECTED GDP (%)	
Talas	3	Osh	5
Naryn	3	Chuy	4
Osh	2	Ysyk-kol	4
Jalal-abad	1	Naryn	4
Chuy	1	Batken	3
Batken	1	Jalal-abad	3
Ysyk-kol	0	Talas	2



There is a high correlation (r=0.95) between the population and GDP of a province.

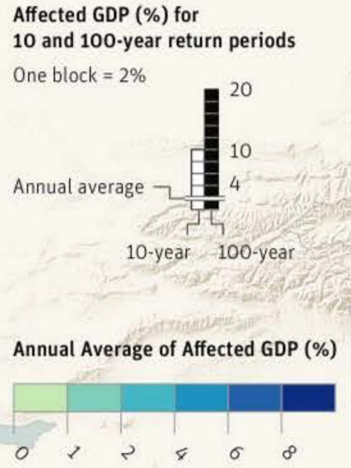
The Kyrgyz Republic has experienced some floods since gaining its independence in 1991. Floods in 1998 and 2005 each caused over $3 million in damage. More recently, in 2012, flooding in Osh, Batken and Jalalbad affected about 11,000 people.

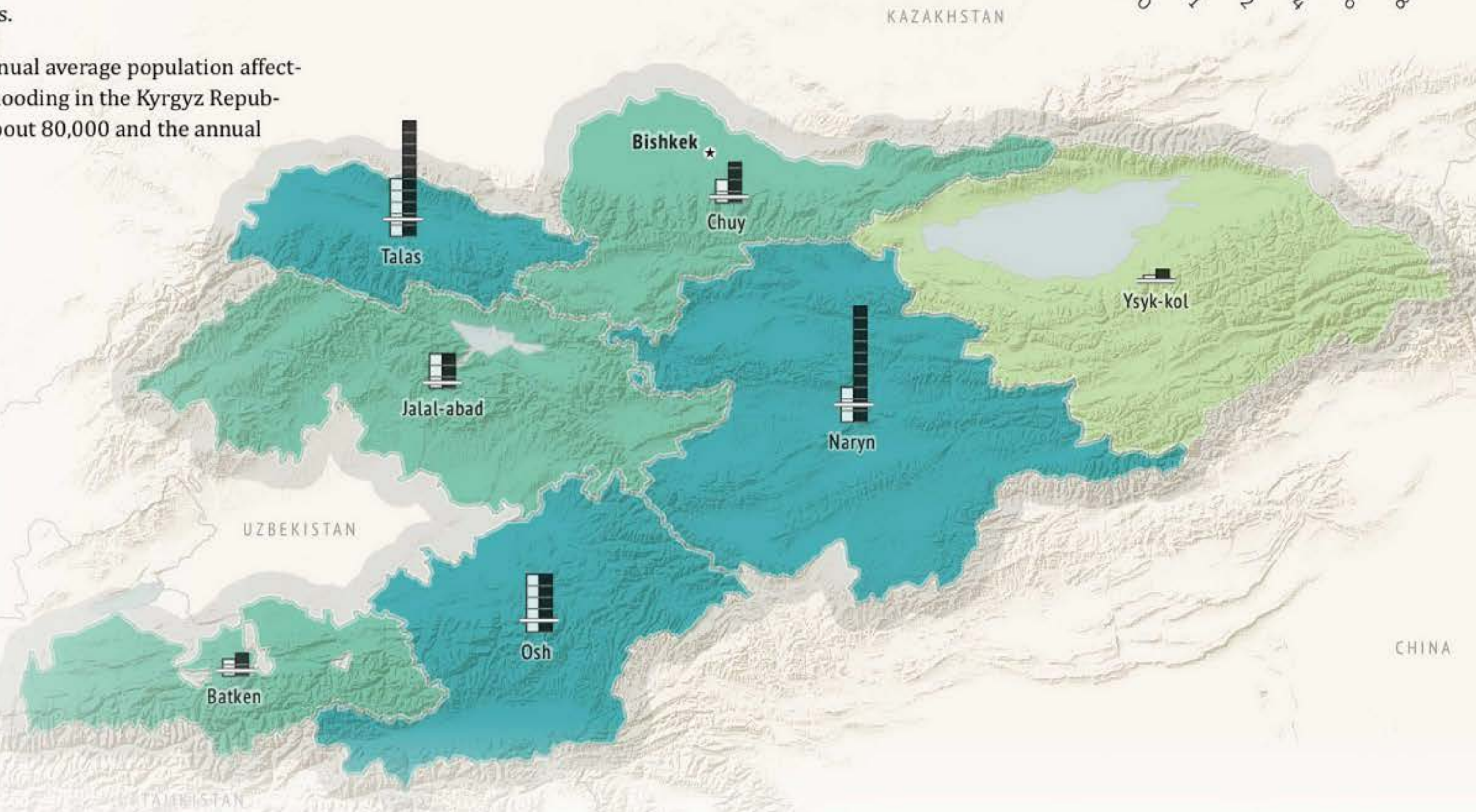
This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in the Kyrgyz Republic is about 80,000 and the annual average affected GDP about $70 million. For most provinces, the 10- and 100-year impacts do not differ much, so relatively frequent floods have large impacts on these averages. For the few in which the 100-year impacts are greater than the 10-year impacts, less frequent events make a significant contribution to the annual average of affected GDP.





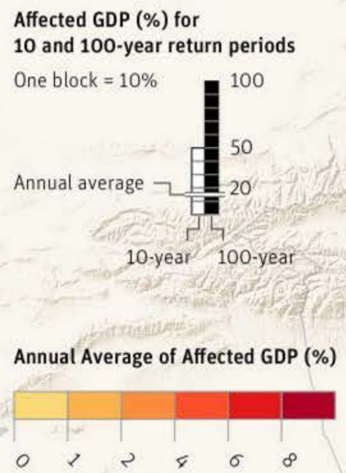
The Kyrgyz Republic's worst earthquake since 1900 occurred in 1911 in Pamir, causing over 90 fatalities. Earthquakes in 1992 caused over 50 fatalities and close to $300 million in damage. More recently, in 2008, an earthquake killed over 70 people.

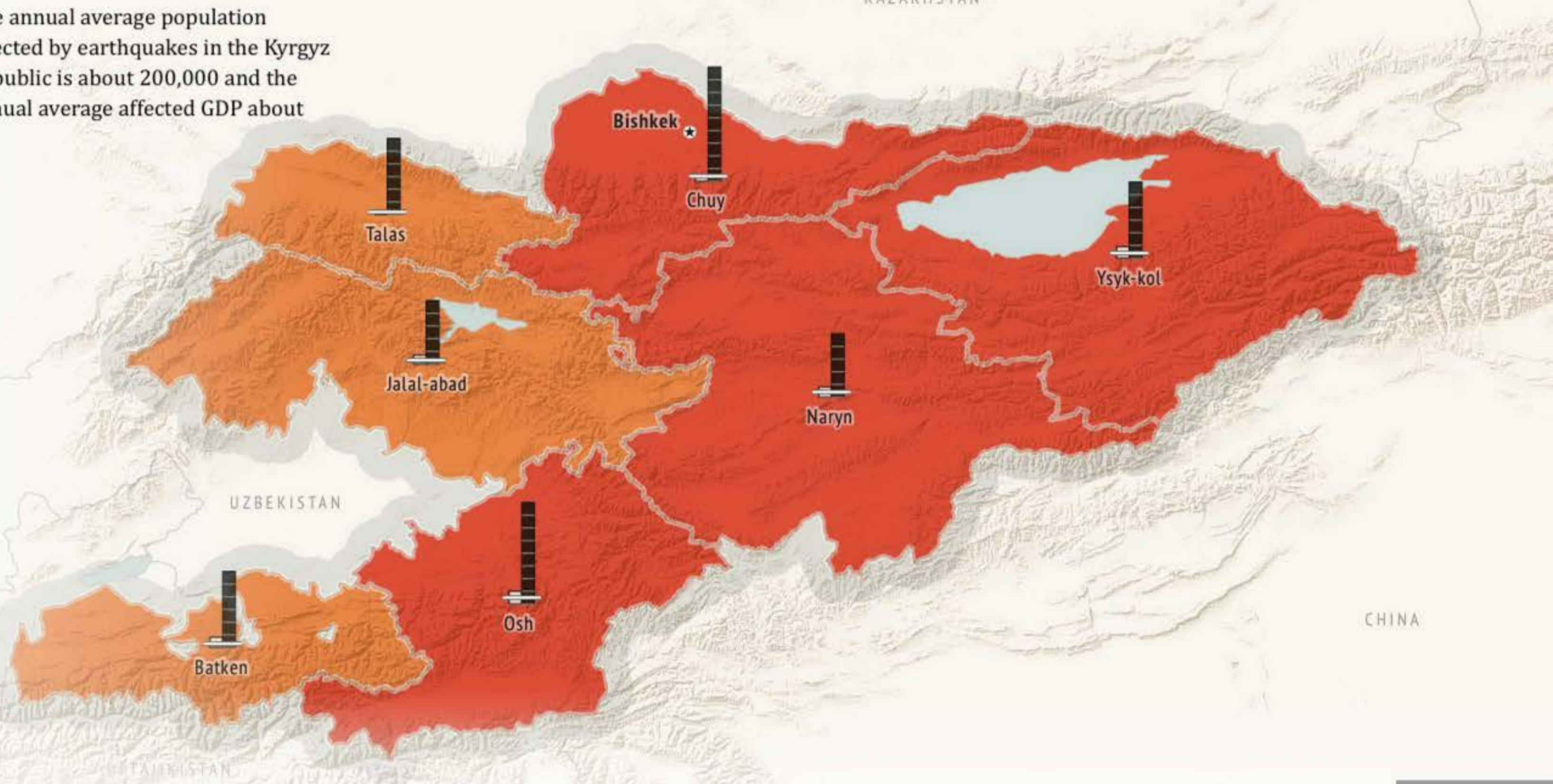
This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

When an earthquake has a 10-year return period, it means the probability of occurrence of an earthquake of that magnitude or greater is 10 percent per year. A 100-year earthquake has a probability of occurrence of 1 percent per year. This means that over a long period of time, an earthquake of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year earthquake will occur exactly once every 100 years. In fact, it is possible for an earthquake of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

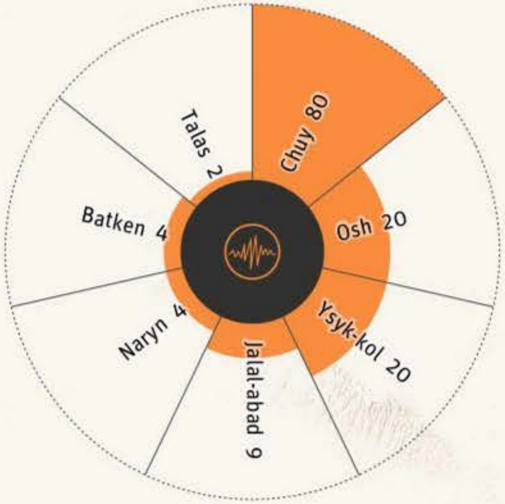
If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make larger contributions to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by earthquakes in the Kyrgyz Republic is about 200,000 and the annual average affected GDP about $200 million. The annual averages of fatalities and capital losses caused by earthquakes are about 200 and about $100 million, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause nearly 8,000 fatalities and $4 billion in capital loss (about 60 percent of GDP).

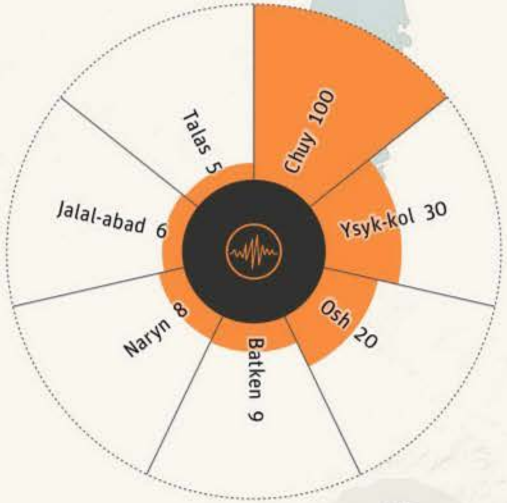




EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS (MILLIONS $)

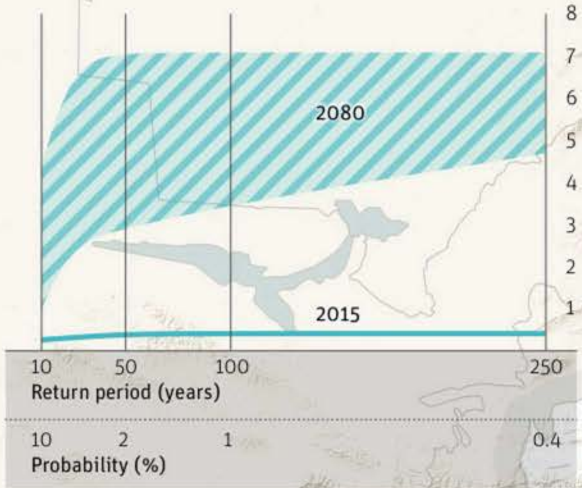


EARTHQUAKE
ANNUAL AVERAGE FATALITIES

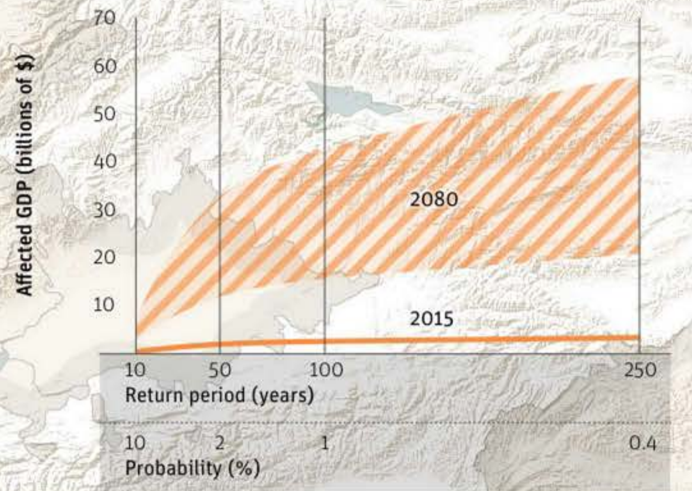


The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Chuy, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if the Kyrgyz Republic had experienced a 100-year return period flood event in 2015, affected GDP would have been an estimated $400 million. In 2080, however, the affected GDP from the same type of event would range from about $4 billion to about $7 billion. If the Kyrgyz Republic had experienced a 250-year earthquake event in 2015, the affected GDP would have been an estimated $4 billion. In 2080, the affected GDP from the same type of event would range from about $20 billion to about $60 billion, due to population growth, urbanization, and the increase in exposed assets.

All historical data on floods and earthquakes are from D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be; the National Geophysical Data Center/World Data Service (NGDC/WDS), Significant Earthquake Database (National Geophysical Data Center, NOAA), doi:10.7289/V5TD9V7K; and J. Daniell and A. Schaefer, "Eastern Europe and Central Asia Region Earthquake Risk Assessment Country and Province Profiling," final report to GFDRR, 2014. Damage estimates for all historical events have been inflated to 2015 US$.

Latvia

	AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
GDP $28.2 billion*	$3 billion (9%)	$70 million (<1%)	$20 million (<1%)
Population 2.0 million*	200,000 (8%)	8,000 (<1%)	0 (<1%)

*2015 estimates

Latvia's population and economy are exposed to earthquakes and floods, with floods posing the greater risk. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

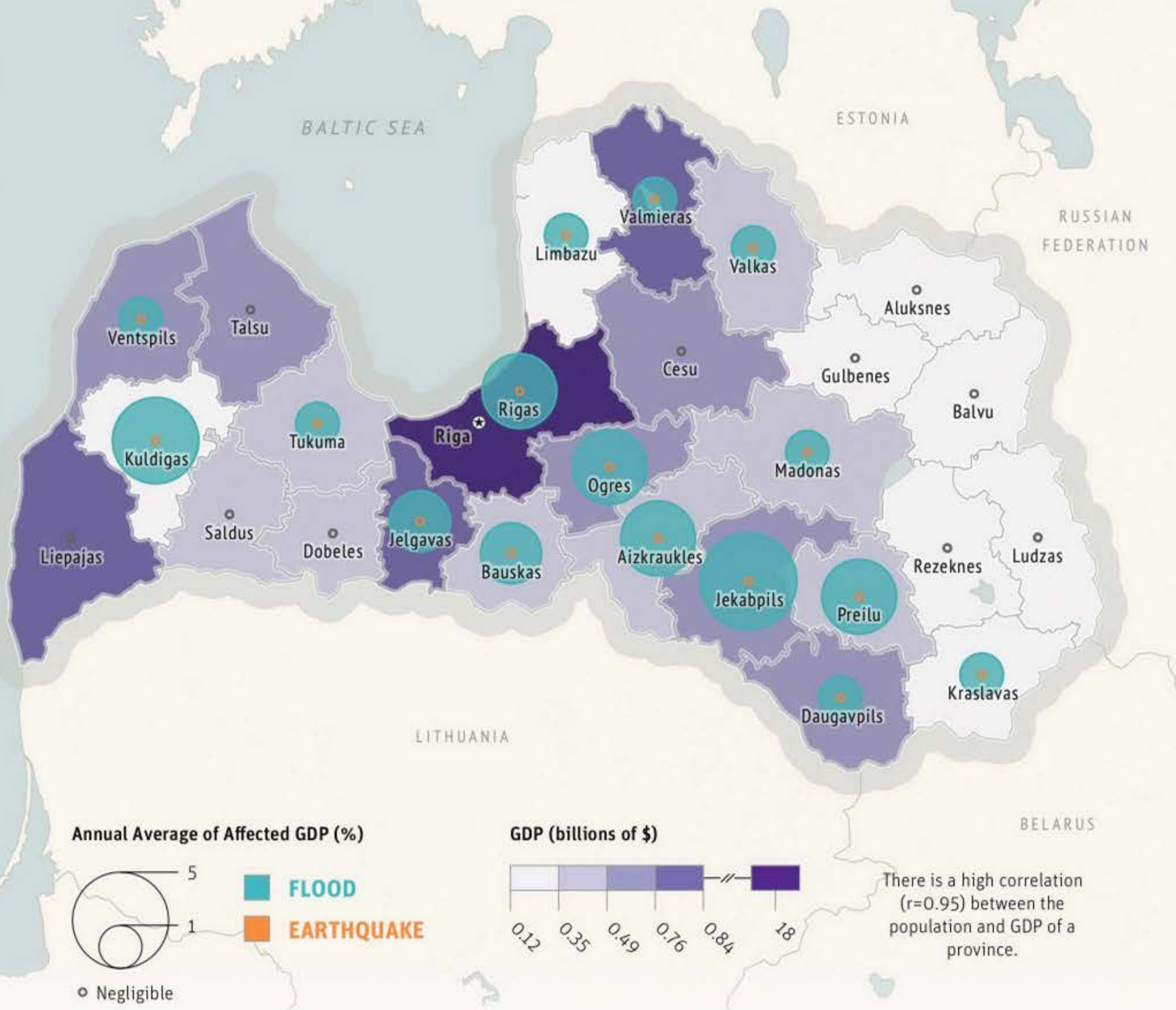
Close to 70 percent of Latvia's population lives in urban environments. The country's GDP was approximately US$28.2 billion in 2015, with nearly 70 percent derived from services, most of the remainder generated by industry, and agriculture making a small contribution. Latvia's per capita GDP was $22,000.

This map displays GDP by province in Latvia, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of floods is Jekabpils, and the one at greatest risk of earthquakes is Ogres. In absolute terms, it is Rigas.

TOP AFFECTED PROVINCES

FLOOD ANNUAL AVERAGE OF AFFECTED GDP (%)		EARTHQUAKE ANNUAL AVERAGE OF AFFECTED GDP (%)	
Jekabpils	5	Ogres	0
Kuldigas	4	Limbazu	0
Ogres	3	Rezeknes	0
Preilu	3	Saldus	0
Rigas	3	Talsu	0
Aizkraukles	2	Madonas	0
Jelgavas	2	Balvu	0
Bauskas	2	Valmieras	0
Valkas	1	Kuldigas	0
Valmieras	1	Aluksnes	0



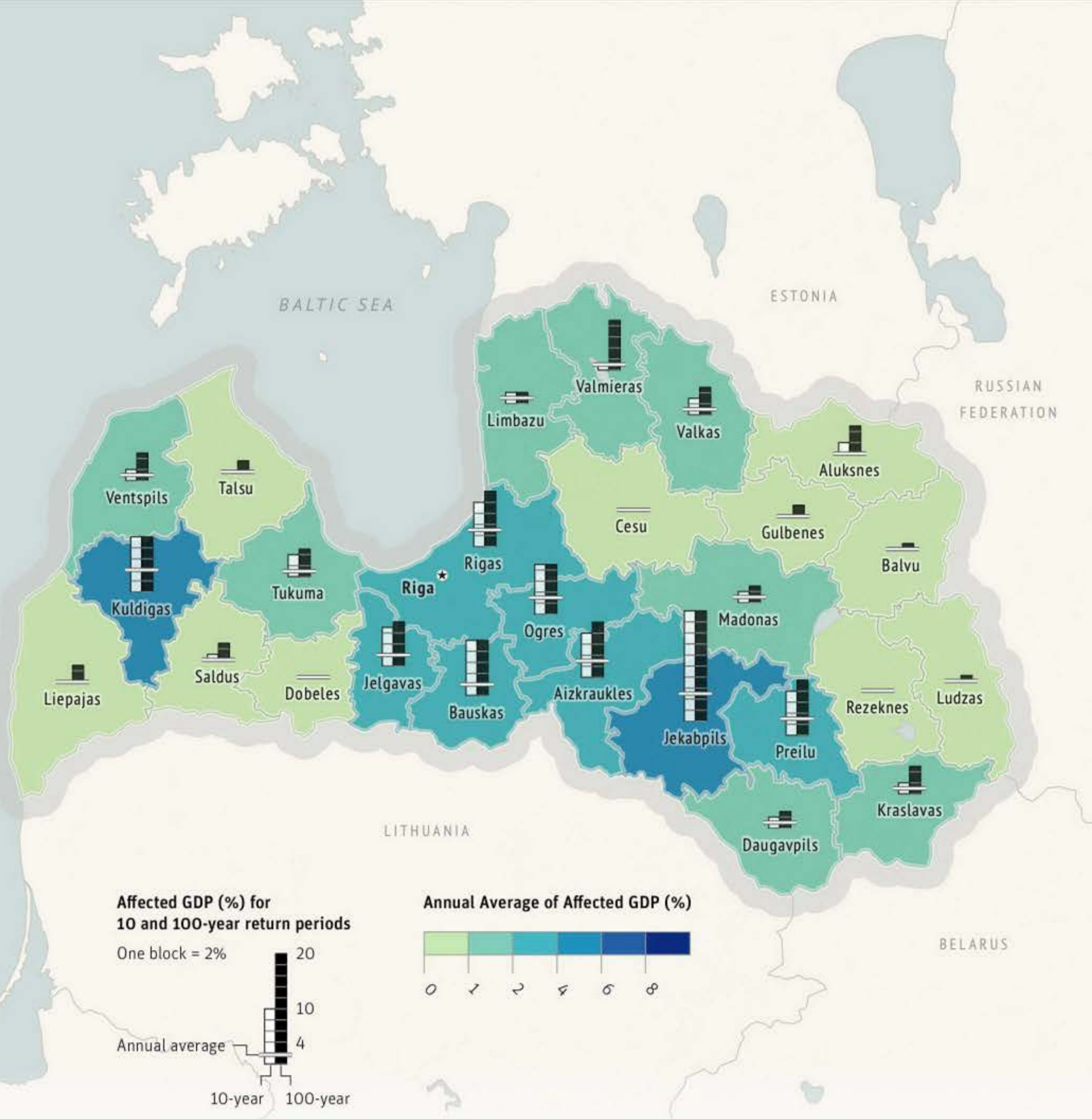
There is a high correlation (r=0.95) between the population and GDP of a province.

This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in Latvia is about 30,000 and the annual average affected GDP about $600 million. Within the various provinces, the 10- and 100-year impacts do not differ much, so relatively frequent floods have large impacts on these averages.



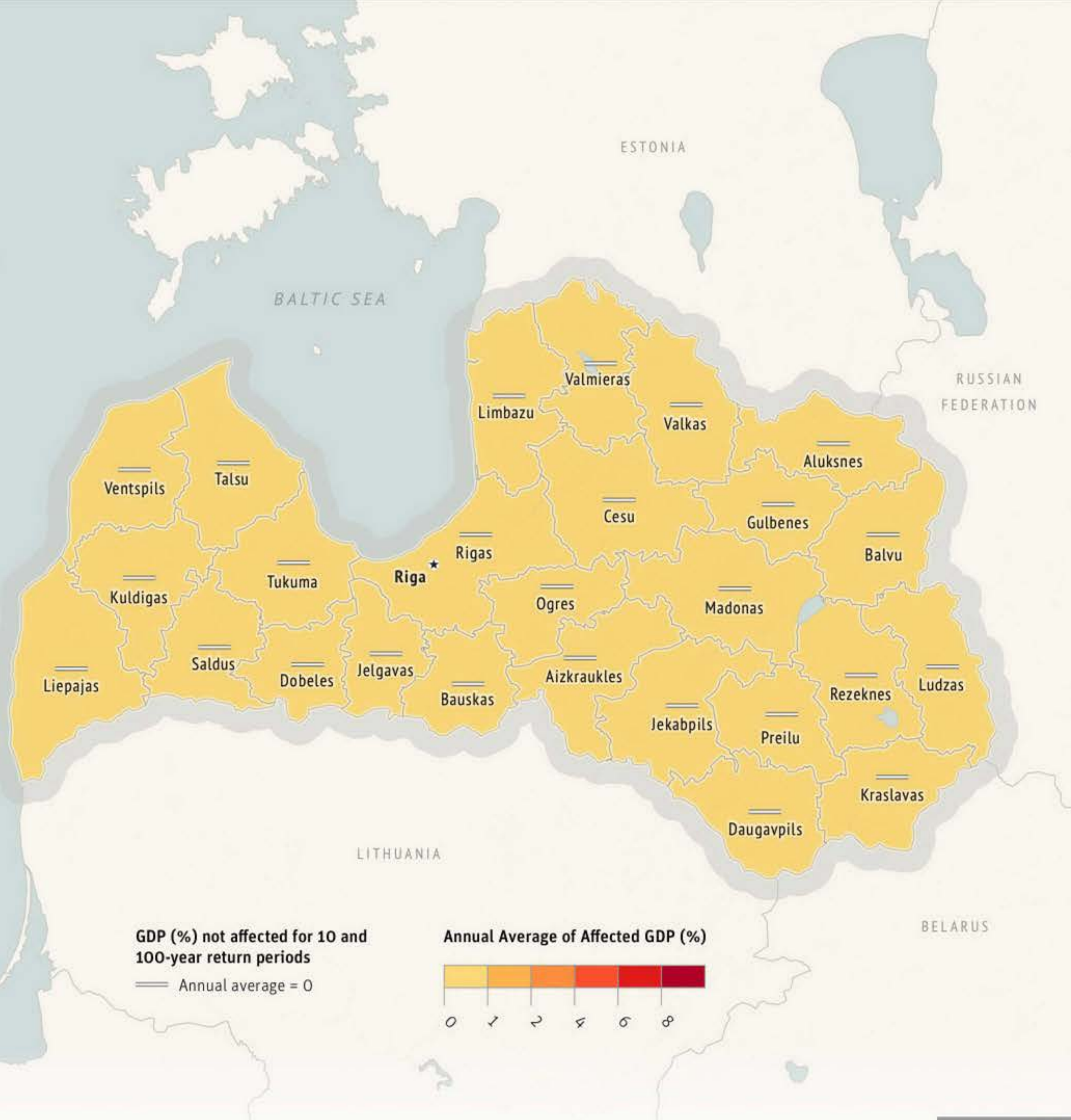
The worst earthquake to affect Latvia since 1900 occurred in 1908. Other major events have occurred in 1616 and 1821.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

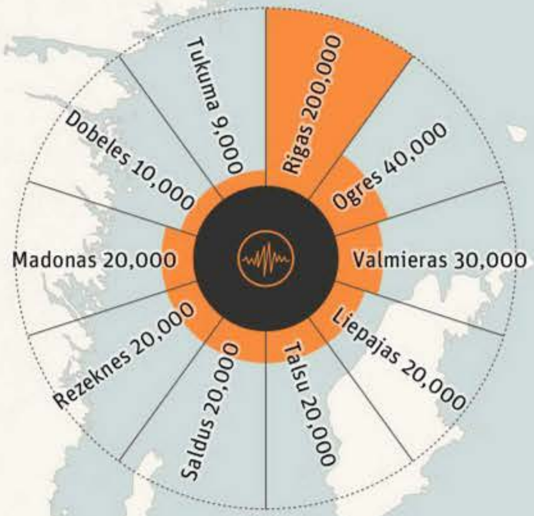
When an earthquake has a 10-year return period, it means the probability of occurrence of an earthquake of that magnitude or greater is 10 percent per year. A 100-year earthquake has a probability of occurrence of 1 percent per year. This means that over a long period of time, an earthquake of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year earthquake will occur exactly once every 100 years. In fact, it is possible for an earthquake of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make larger contributions to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by earthquakes in Latvia is about 100 and the annual average GDP about $2 million. The annual averages of fatalities and capital losses caused by earthquakes are less than one and about $500,000, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause nearly $20 million in capital loss (less than 1 percent of GDP).



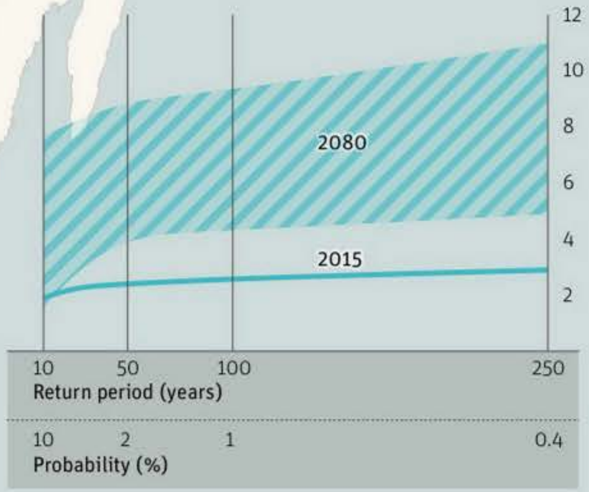
EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS ($)



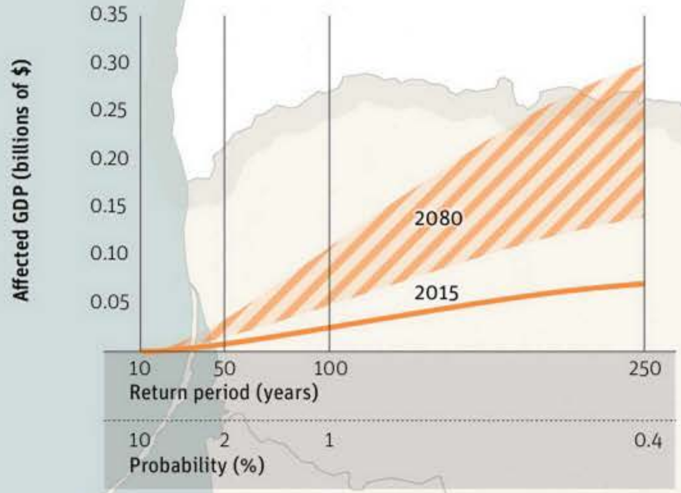
EARTHQUAKE
ANNUAL AVERAGE FATALITIES

The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Rigas.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if Latvia had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $3 billion. In 2080, however, the affected GDP from the same type of event would range from about $5 billion to about $9 billion. If Latvia had experienced a 250-year earthquake event in 2015, the affected GDP would have been about $70 million. In 2080, the affected GDP from the same type of event would range from about $100 million to about $300 million, due to population growth, urbanization, and the increase in exposed assets.

Damage estimates for all historical events have been inflated to 2015 US$.

Lithuania

		AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
GDP	$43.0 billion*	$4 billion (9%)	$60 million (<1%)	$20 million (<1%)
Population	2.9 million*	200,000 (8%)	5,000 (<1%)	0 (<1%)

*2015 estimates

Lithuania's population and economy are exposed to earthquakes and floods, with floods posing the greater risk. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

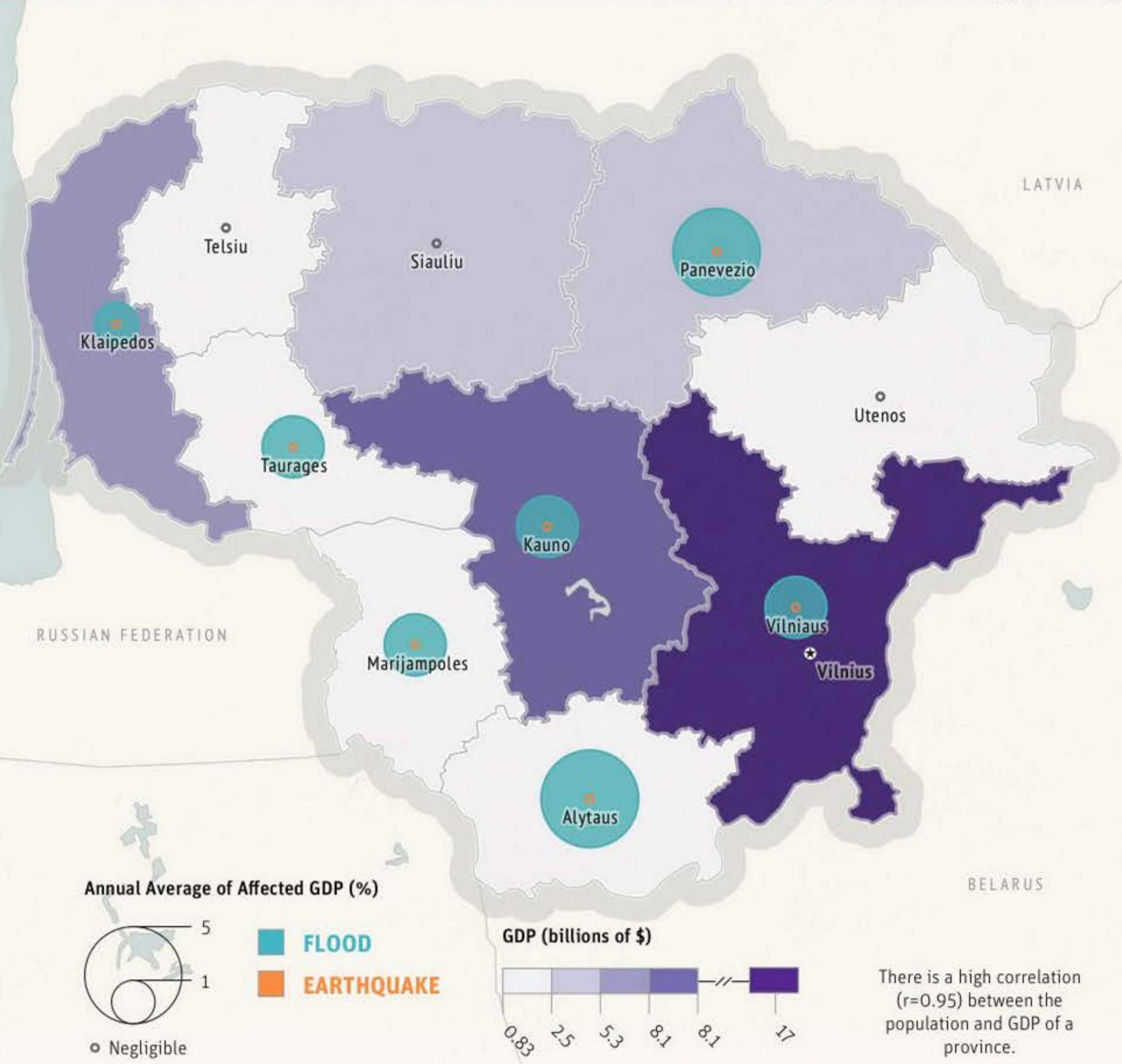
Close to 70 percent of Lithuania's population lives in urban environments. The country's GDP was approximately US$43.0 billion in 2015, with nearly 70 percent derived from services, most of the remainder generated by industry, and agriculture making a small contribution. Lithuania's per capita GDP was $15,100.

This map displays GDP by province in Lithuania, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of floods is Alythaus, and the one at greatest risk of earthquakes is Siauliu. In absolute terms, the province at greatest risk of floods is Vilniaus, and the one at greatest risk of earthquakes is Siauliu.

TOP AFFECTED PROVINCES

FLOOD: ANNUAL AVERAGE OF AFFECTED GDP (%)		EARTHQUAKE: ANNUAL AVERAGE OF AFFECTED GDP (%)	
Alytaus	5	Siauliu	0
Panevezio	4	Klaipedos	0
Kauno	2	Telsiu	0
Vilniaus	2	Panevezio	0
Taurages	2	Marijampoles	0
Marijampoles	2	Utenos	0
Klaipedos	1	Kauno	0
Utenos	0	Taurages	0
Siauliu	0	Alytaus	0
Telsiu	0	Vilniaus	0



There is a high correlation (r=0.95) between the population and GDP of a province.

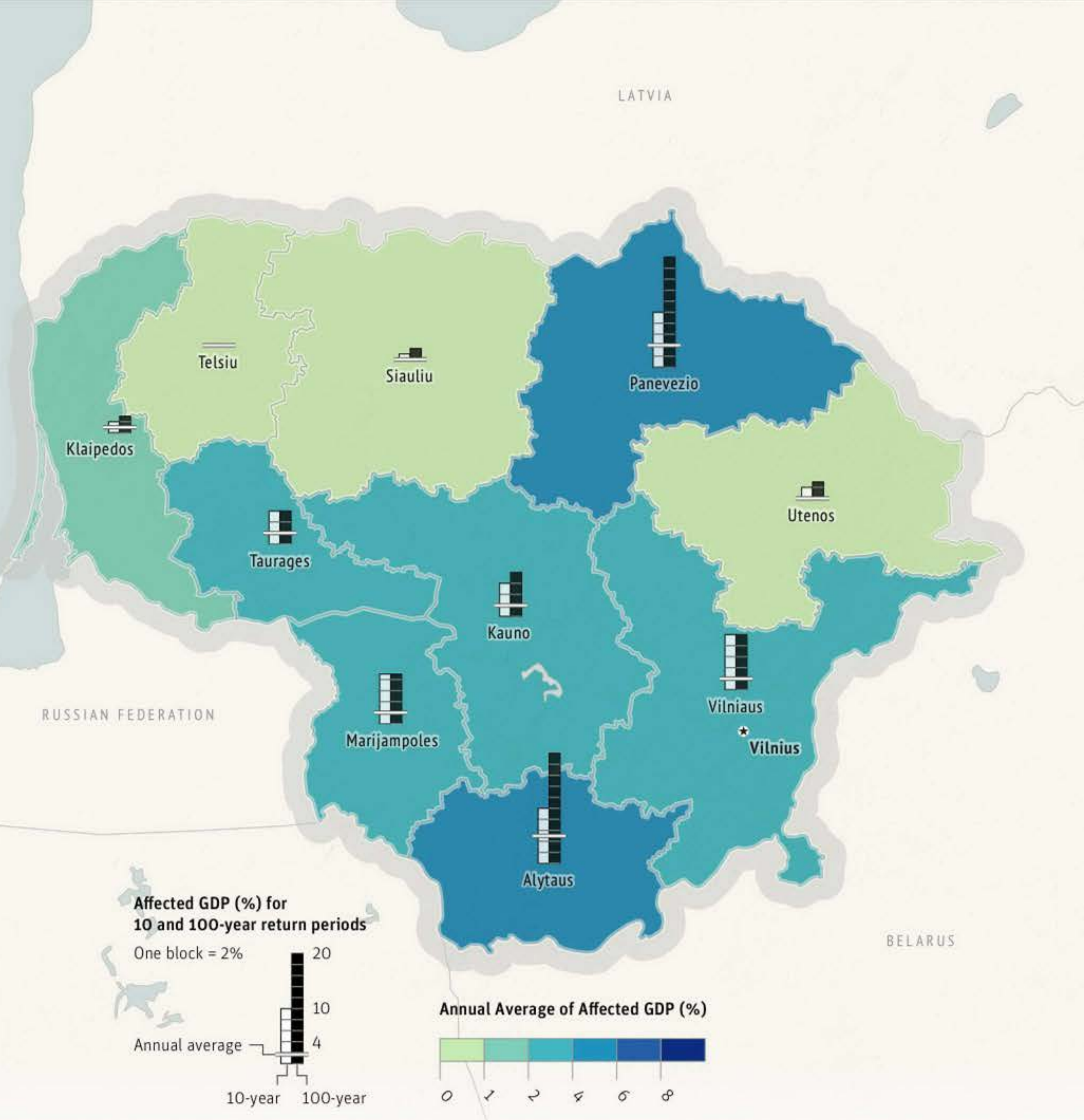
Flooding in 2010 caused four fatalities in Lithuania.

This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in Lithuania is about 60,000 and the annual average affected GDP about $800 million. For most provinces, in which the impacts from 10- and 100-year floods do not differ much, relatively frequent floods have large impacts on these averages. For the few in which the 100-year impacts are much greater than the 10-year impacts, less frequent events make a significant contribution to the annual average of affected GDP.



The worst earthquake to affect Lithuania since 1900 occurred in 1908 near the Belarus border. A more recent, widely felt earthquake occurred in 1988; damage was minimal, however.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

When an earthquake has a 10-year return period, it means the probability of occurrence of an earthquake of that magnitude or greater is 10 percent per year. A 100-year earthquake has a probability of occurrence of 1 percent per year. This means that over a long period of time, an earthquake of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year earthquake will occur exactly once every 100 years. In fact, it is possible for an earthquake of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

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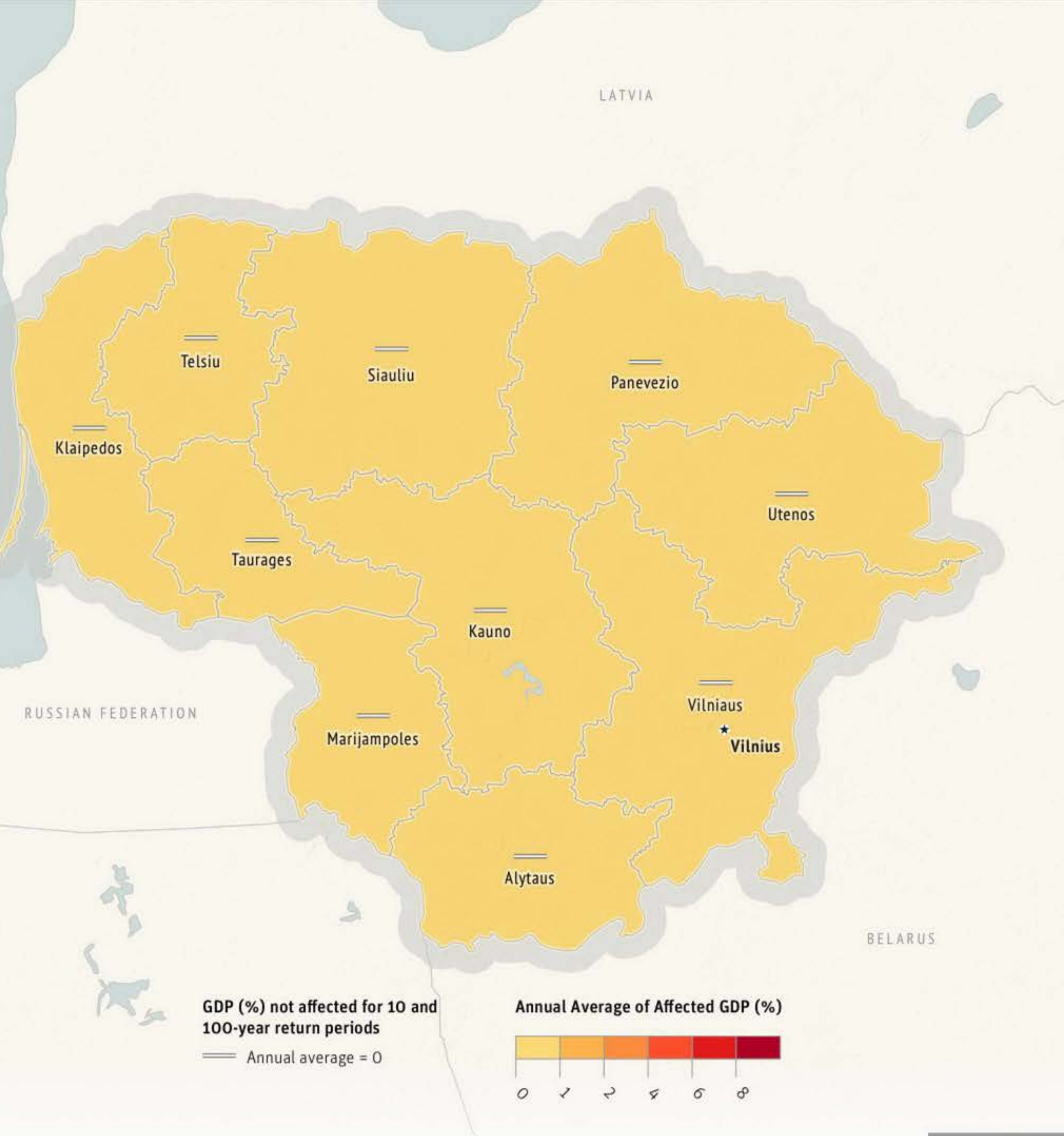
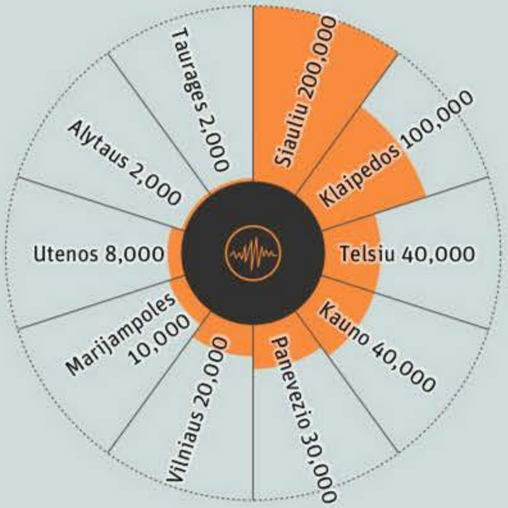
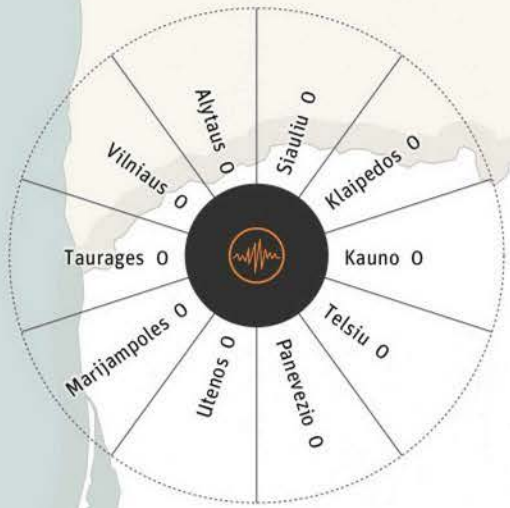
The annual average population affected by earthquakes in Lithuania is about 100 and the annual average affected GDP about $2 million. The annual averages of fatalities and capital losses caused by earthquakes are less than one and about $500,000, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause about $20 million in capital loss (less than 1 percent of GDP).



EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS ($)

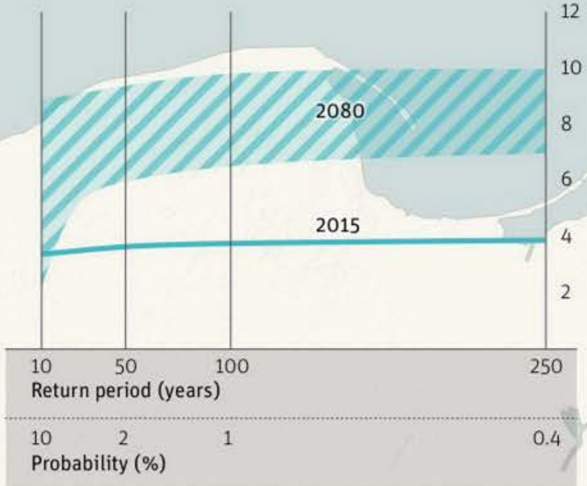


EARTHQUAKE
ANNUAL AVERAGE FATALITIES

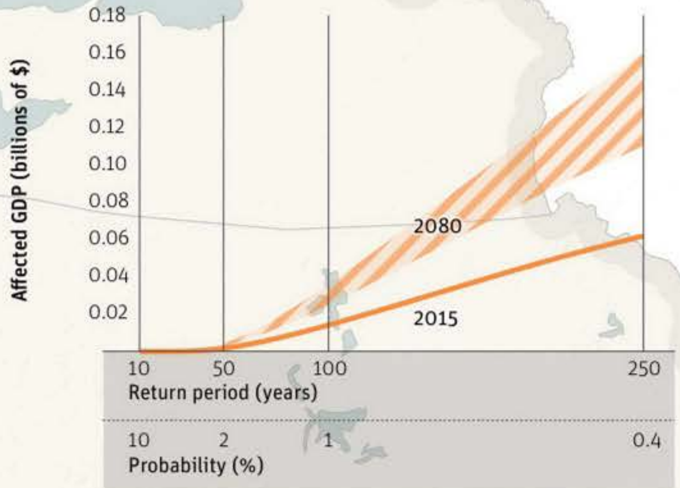


The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The province with the potential for greatest capital loss is Siauliu.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if Lithuania had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $4 billion. In 2080, however, the affected GDP from the same type of event would range from about $7 billion to about $10 billion. If Lithuania had experienced a 250-year earthquake event in 2015, the affected GDP would have been about $60 million. In 2080, the affected GDP from the same type of event would range from about $100 million to about $200 million, due to population growth, urbanization, and the increase in exposed assets.

All historical data on floods and earthquakes are from D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be, and J. Daniell and A. Schaefer, "Eastern Europe and Central Asia Region Earthquake Risk Assessment Country and Province Profiling," final report to GFDRR, 2014. Damage estimates for all historical events have been inflated to 2015 US$.

EUROPE AND CENTRAL ASIA (ECA) RISK PROFILES

Macedonia, FYR

GDP $10.5 billion*

Population 2.1 million*

	AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
GDP	$2 billion (18%)	$5 billion (50%)	$2 billion (23%)
Population	300,000 (13%)	900,000 (43%)	400 (<1%)

*2015 estimates

The population and economy of the former Yugoslav Republic of Macedonia are exposed to earthquakes and floods, with floods posing the greater risk. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

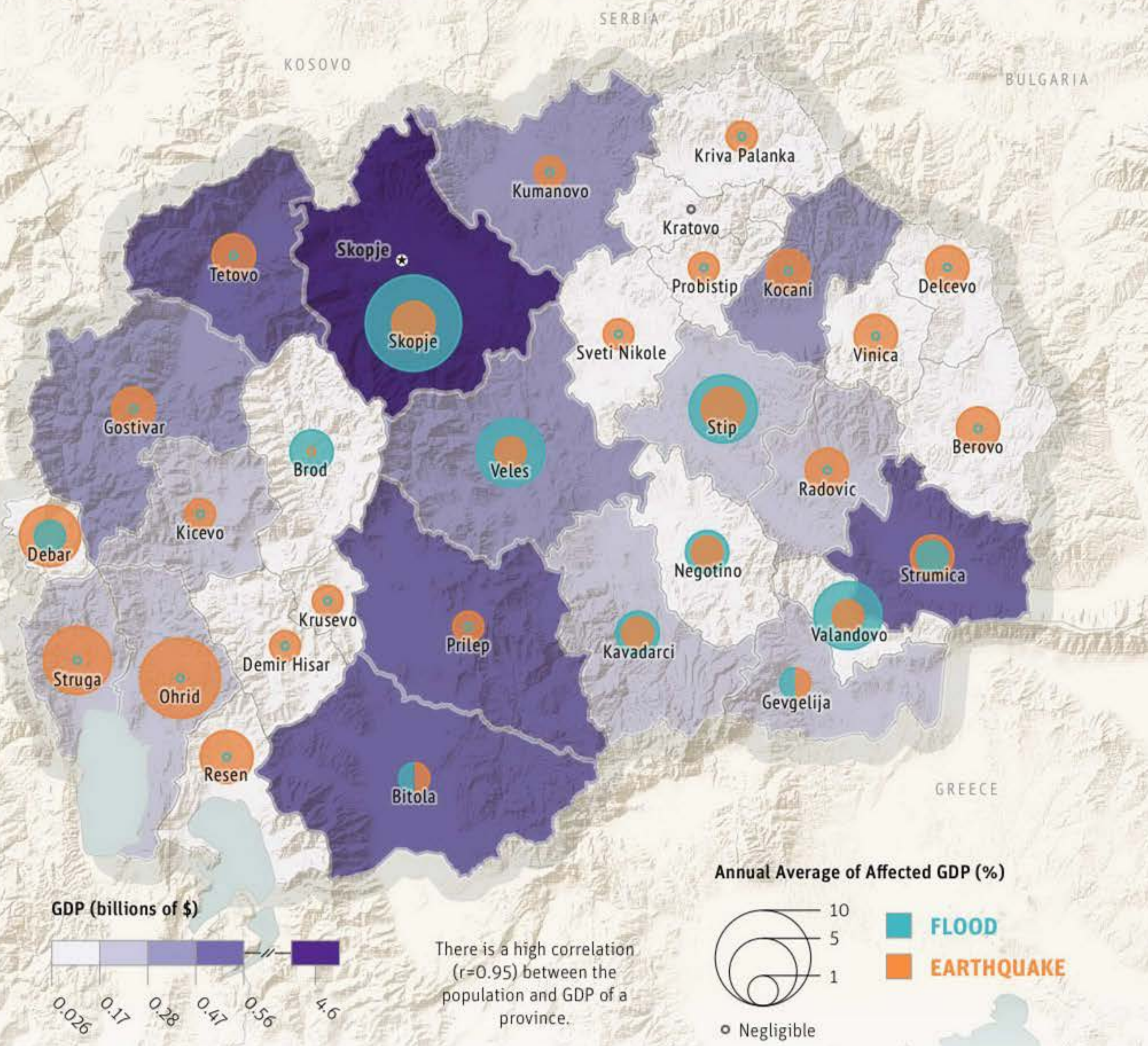
About 60 percent of FYR Macedonia's population lives in urban environments. The country's GDP was approximately US$10.5 billion in 2015, with over 60 percent derived from services, most of the remainder generated by industry, and agriculture making a smaller contribution. FYR of Macedonia's per capita GDP was $5,040.

This map displays GDP by province in the FYR Macedonia, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of floods is Skopje, and the one at greatest risk of earthquakes is Ohrid. In absolute terms, the province at greatest risk of both floods and earthquakes is Skopje.

TOP AFFECTED PROVINCES

FLOOD ANNUAL AVERAGE OF AFFECTED GDP (%)		EARTHQUAKE ANNUAL AVERAGE OF AFFECTED GDP (%)	
Skopje	10	Ohrid	6
Veles	5	Struga	5
Valandovo	5	Debar	4
Stip	5	Resen	3
Negotino	2	Skopje	2
Brod	2	Berovo	2
Kavadarci	2	Delcevo	2
Gevgelija	1	Strumica	2
Bitola	1	Gostivar	2
Debar	1	Vinica	2



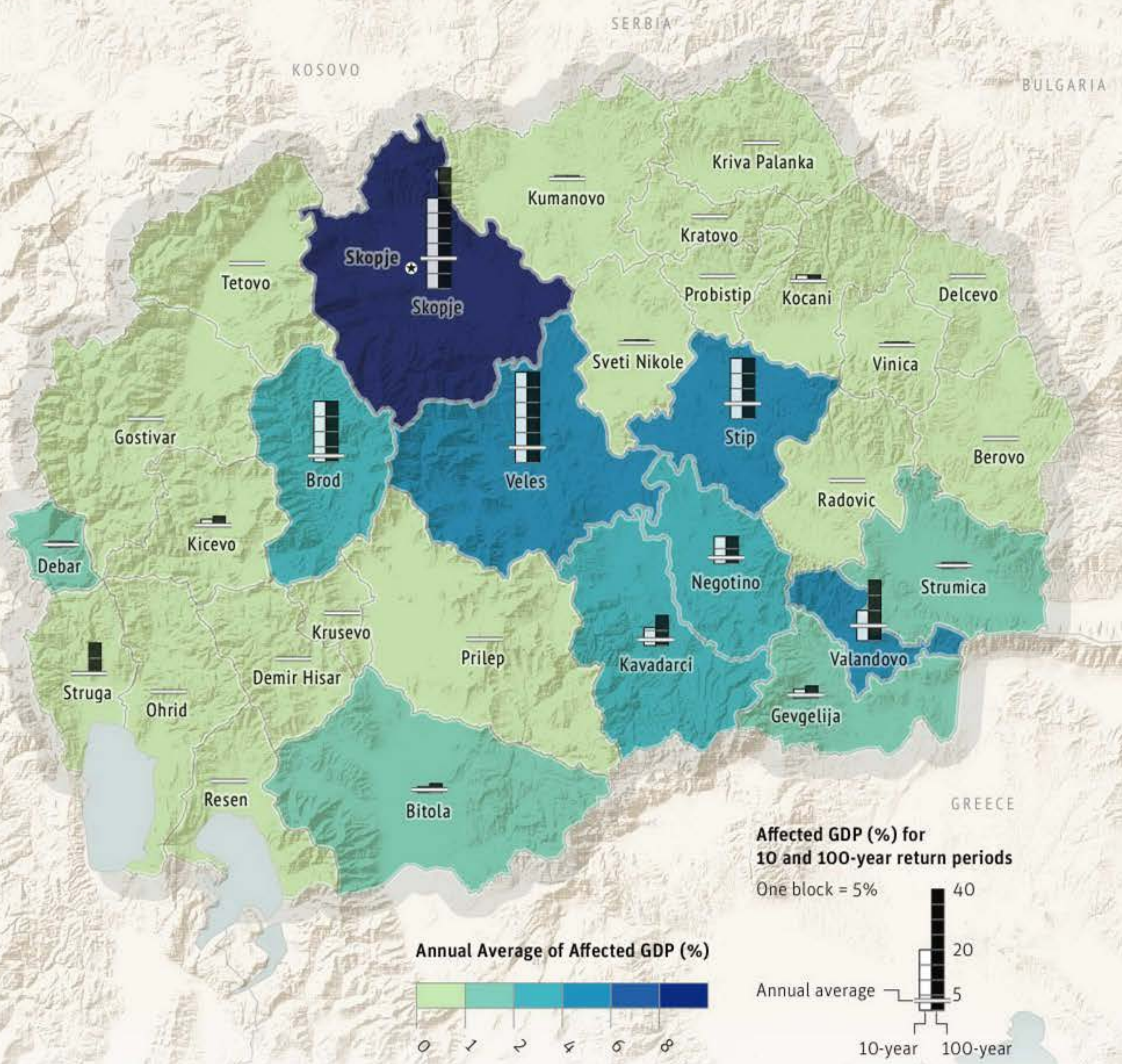
The most devastating flood in the former Yugoslav Republic of Macedonia since it gained its independence in 1991 occurred in 1995 and caused nearly $400 million in damage. More recently, flooding in 2004 affected over 100,000 people and caused almost $5 million in damage.

This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in FYR Macedonia is about 70,000 and the annual average affected GDP about $500 million. For most provinces, the 10- and 100-year impacts do not differ much, so relatively frequent floods have large impacts on these averages. For the few in which the 100-year impacts are much greater than the 10-year impacts, less frequent events make a significant contribution to the annual average of affected GDP.



The former Yugoslav Republic of Macedonia's worst earthquake since 1900 happened in 1963 in Skopje, with a magnitude of 6. It caused over 1,000 fatalities and close to $8 billion in damage, and Skopje was almost completely destroyed. A 1931 earthquake, also in Skopje, killed over 150 people.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

When an earthquake has a 10-year return period, it means the probability of occurrence of an earthquake of that magnitude or greater is 10 percent per year. A 100-year earthquake has a probability of occurrence of 1 percent per year. This means that over a long period of time, an earthquake of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year earthquake will occur exactly once every 100 years. In fact, it is possible for an earthquake of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

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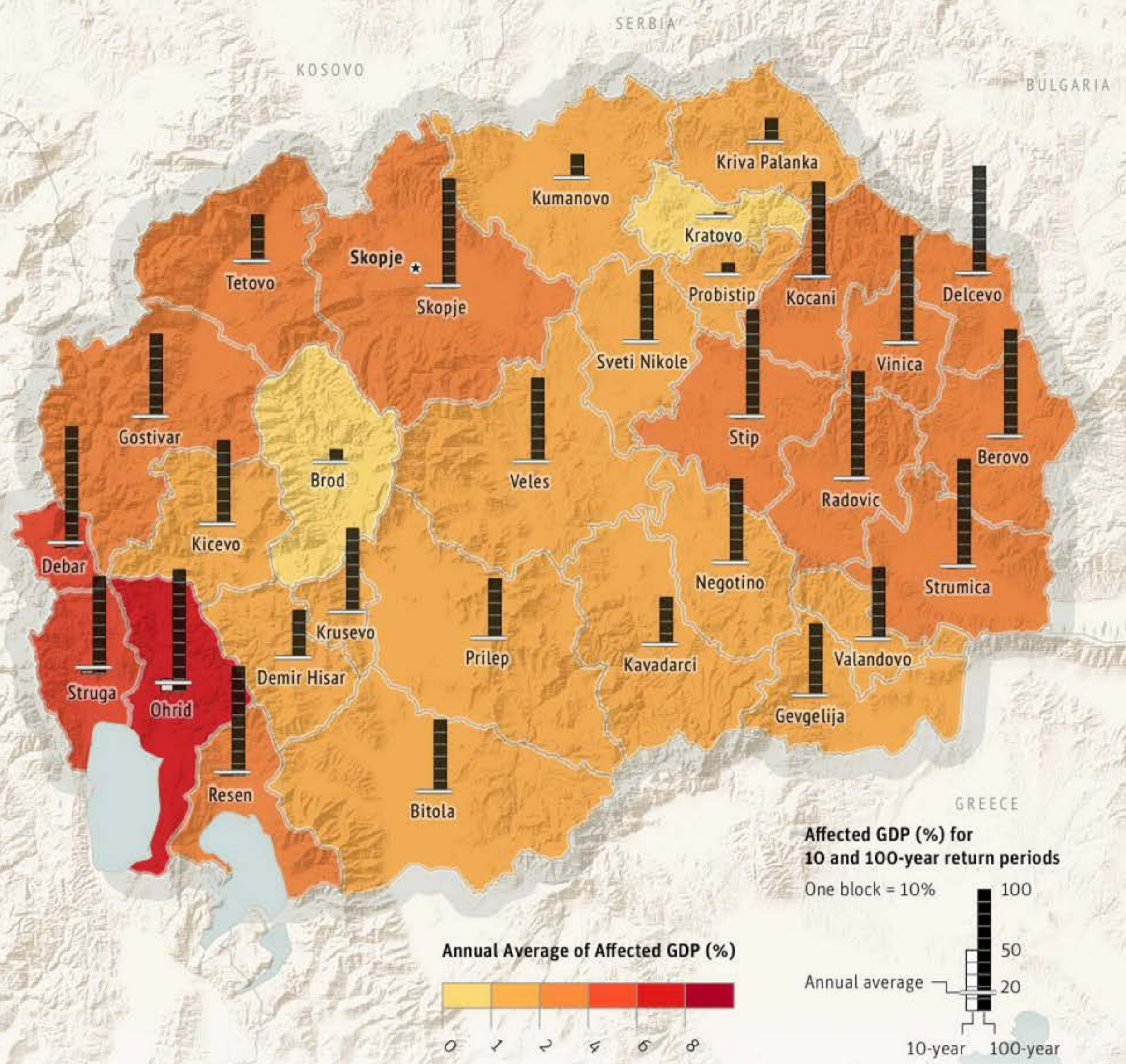
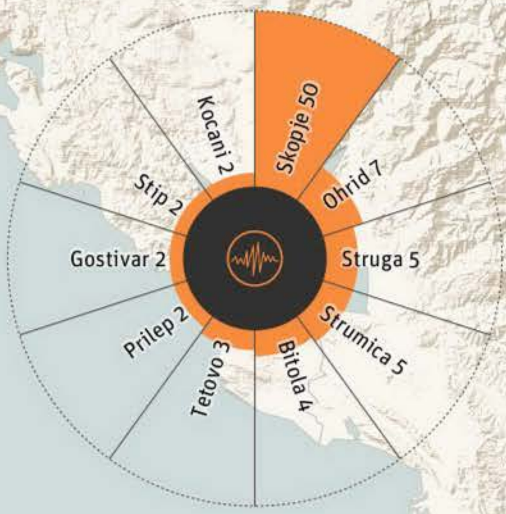
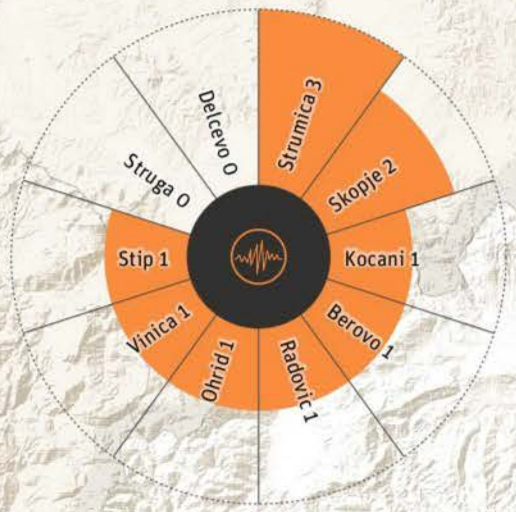
The annual average population affected by earthquakes in FYR of Macedonia is about 40,000 and the annual average affected GDP about $200 million. The annual averages of fatalities and capital losses caused by earthquakes are about 10 and about $100 million, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause about 400 fatalities and $2 billion in capital loss (about 20 percent of GDP).



EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS (MILLIONS $)

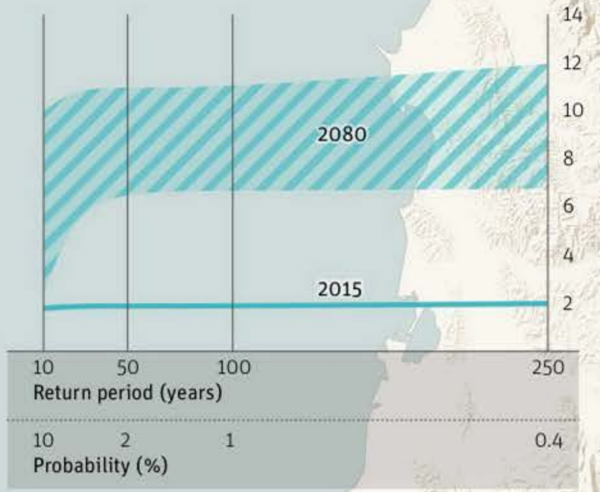


EARTHQUAKE
ANNUAL AVERAGE FATALITIES

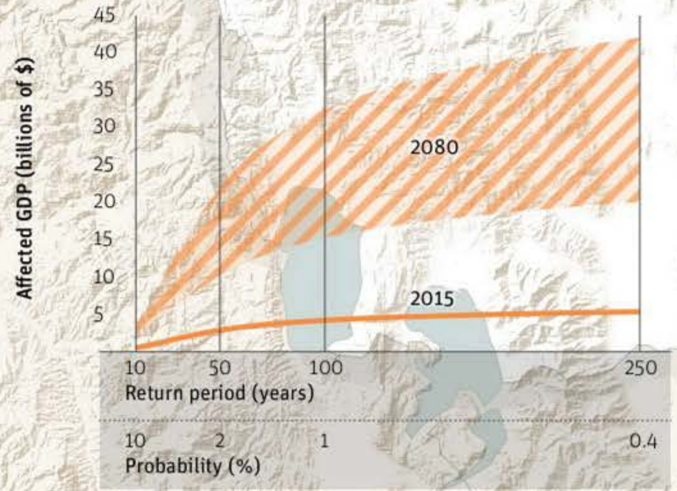


The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Skopje, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if FYR of Macedonia had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $2 billion. In 2080, however, the affected GDP from the same type of event would range from about $7 billion to about $11 billion. If FYR of Macedonia had experienced a 250-year earthquake event in 2015, the affected GDP would have been about $5 billion. In 2080, however, the affected GDP from the same type of event would range from about $20 billion to about $40 billion, due to population growth, urbanization, and the increase in exposed assets.

All historical data on floods and earthquakes are from D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be, and J. Daniell and A. Schaefer, "Eastern Europe and Central Asia Region Earthquake Risk Assessment Country and Province Profiling," final report to GFDRR, 2014. Damage estimates for all historical events have been inflated to 2015 US$.

Moldova

GDP $6.3 billion*

Population 3.6 million*

AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
$500 million (7%)	$4 billion (62%)	$4 billion (59%)
300,000 (7%)	2 million (59%)	200 (<1%)

*2015 estimates

Moldova's population and economy are exposed to earthquakes and floods, with floods posing the greater risk. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

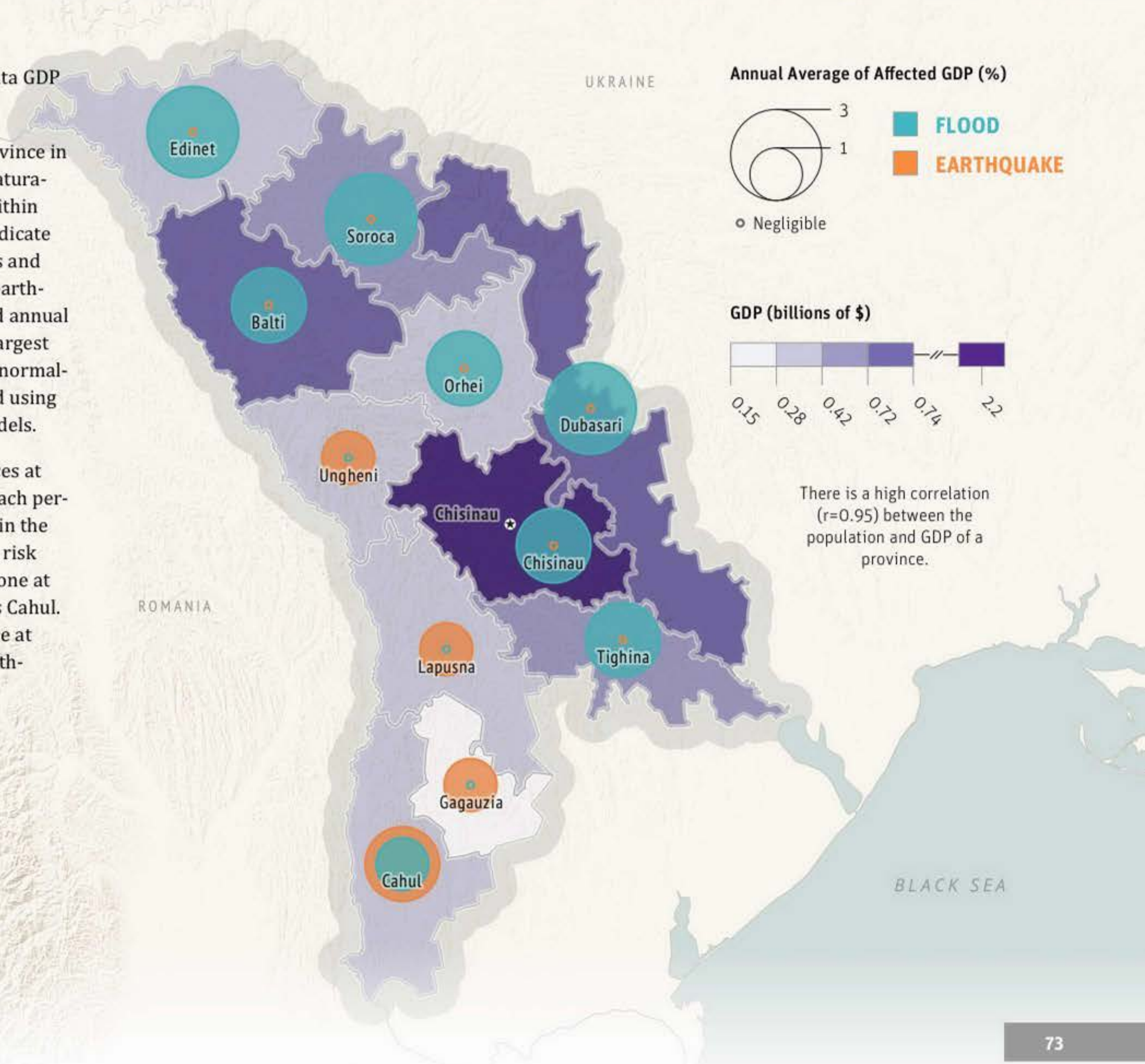
Just over half of Moldova's population lives in rural environments. The country's GDP was approximately US$6.3 billion in 2015, with over 60 percent derived from services, and with industry and agriculture generating the remainder. Moldova's per capita GDP was $1,760.

This map displays GDP by province in Moldova, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of floods is Dubasari, and the one at greatest risk of earthquakes is Cahul. In absolute terms, the province at greatest risk of floods and earthquakes is Chisinau.

TOP AFFECTED PROVINCES

FLOOD ANNUAL AVERAGE OF AFFECTED GDP (%)		EARTHQUAKE ANNUAL AVERAGE OF AFFECTED GDP (%)	
Dubasari	3	Cahul	2
Soroca	3	Gagauzia	1
Edinet	3	Lapusna	1
Tighina	2	Ungheni	1
Balti	2	Chisinau	0
Chisinau	2	Balti	0
Orhei	2	Tighina	0
Cahul	1	Dubasari	0
Ungheni	0	Orhei	0
Lapusna	0	Soroca	0



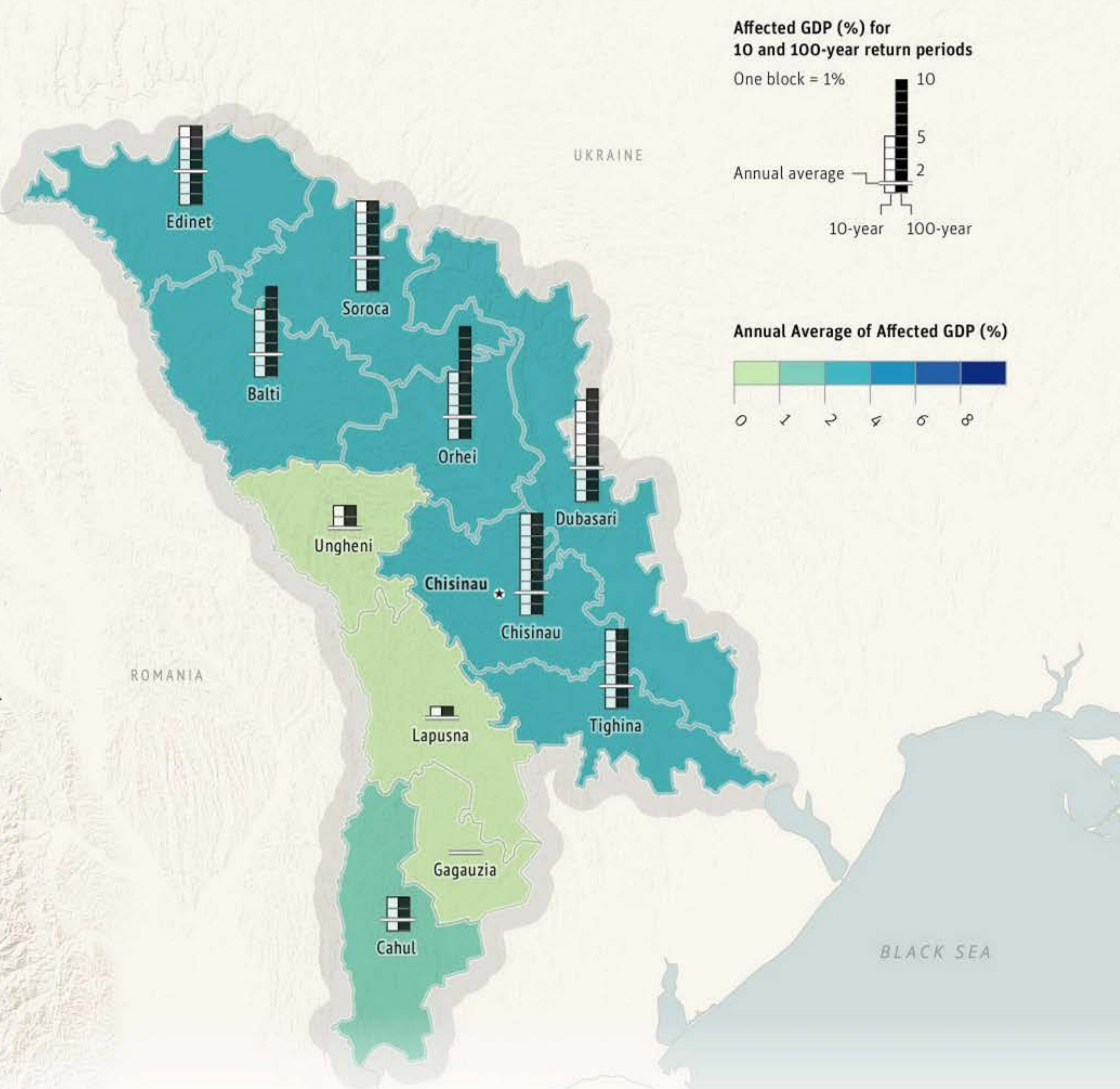
The worst flood in Moldova since the country gained its independence in 1991 occurred in 1994. It killed close to 50 people and caused almost $500 million in damage. In 1997, 28 of Moldova's 40 provinces experienced floods, causing nine deaths and about $70 million in damage. Further flooding occurred in 1999, 2002, and 2005 with smaller impacts, ranging from $1 million to nearly $10 million in damage. This record highlights Moldova's vulnerability to floods. While not always devastating, they have a relatively large cumulative effect on the country when they follow one another quickly.

This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in Moldova is about 70,000 and the annual average affected GDP about $100 million. Within the various provinces, the 10- and 100-year impacts do not differ much, so relatively frequent floods have large impacts on these averages.



Moldova EARTHQUAKE

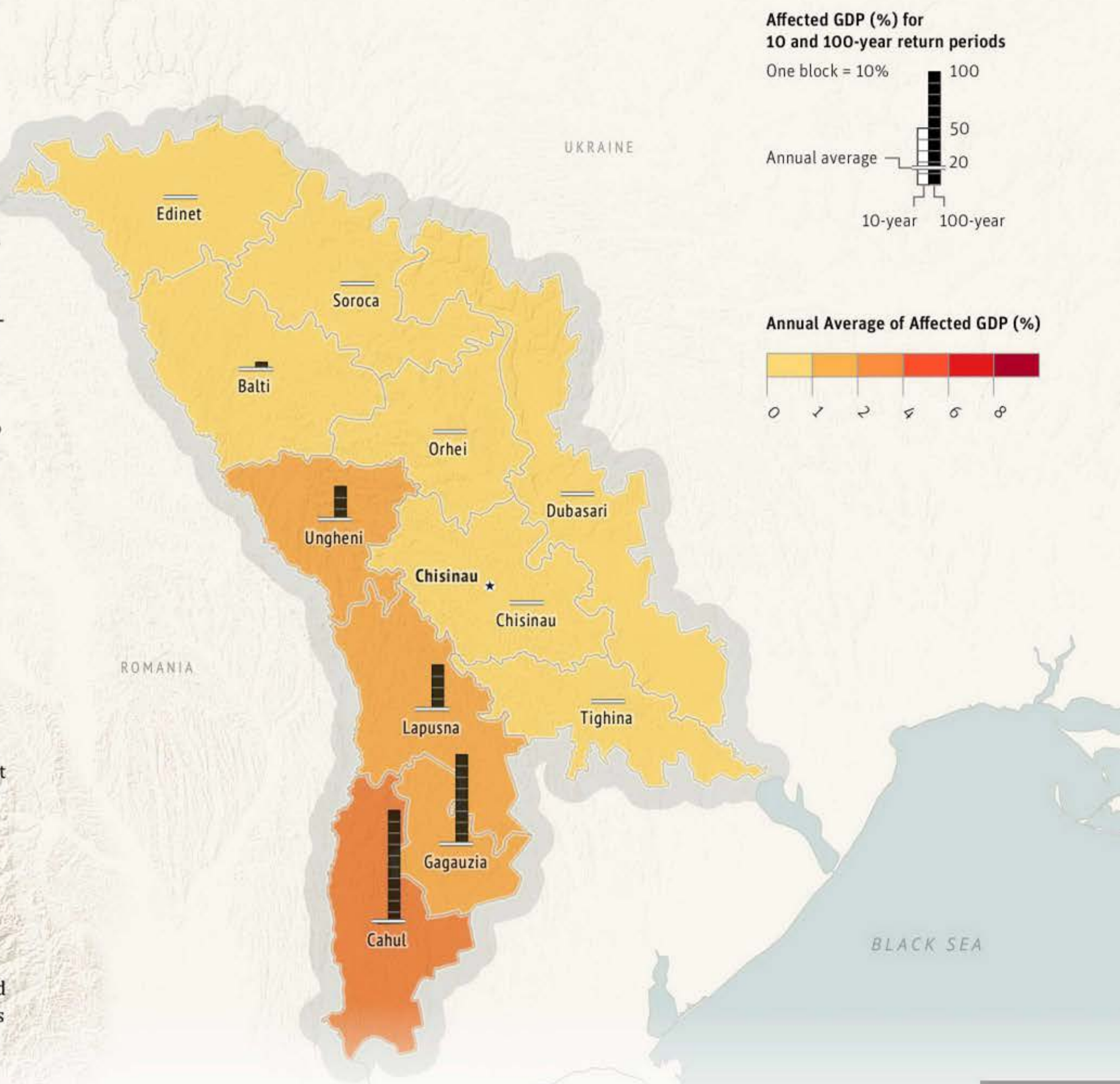
The worst earthquake affecting Moldova since 1900 occurred in 1986 in Vrancea, Romania, with a magnitude of 7.2. It killed at least four people in Moldova and caused over $200 million in damage. Other major earthquakes affecting Moldova occurred in 1802, 1838, 1940, 1977, and 1990, and all were centered in Vrancea. The 1802 event was one of the largest earthquakes on record to occur in Europe.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

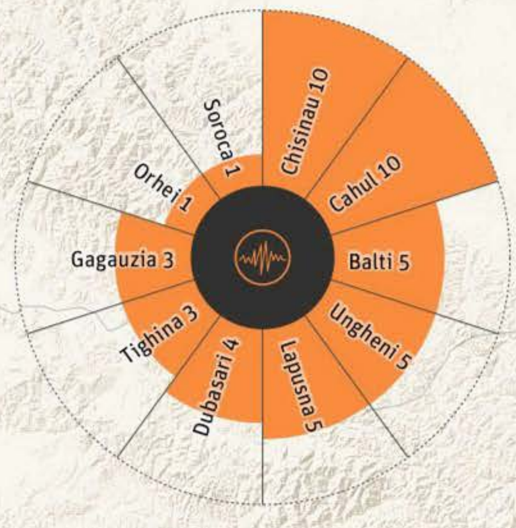
When an earthquake has a 10-year return period, it means the probability of occurrence of an earthquake of that magnitude or greater is 10 percent per year. A 100-year earthquake has a probability of occurrence of 1 percent per year. This means that over a long period of time, an earthquake of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year earthquake will occur exactly once every 100 years. In fact, it is possible for an earthquake of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make larger contributions to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

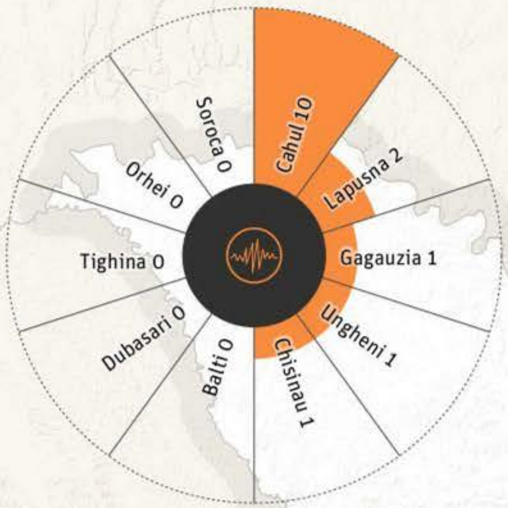
The annual average population affected by earthquakes in Moldova is about 20,000 and the annual average affected GDP about $40 million. The annual averages of fatalities and capital losses caused by earthquakes are about 20 and about $50 million, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause about $4 billion in capital loss (about 60 percent of GDP).



EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS (MILLIONS $)

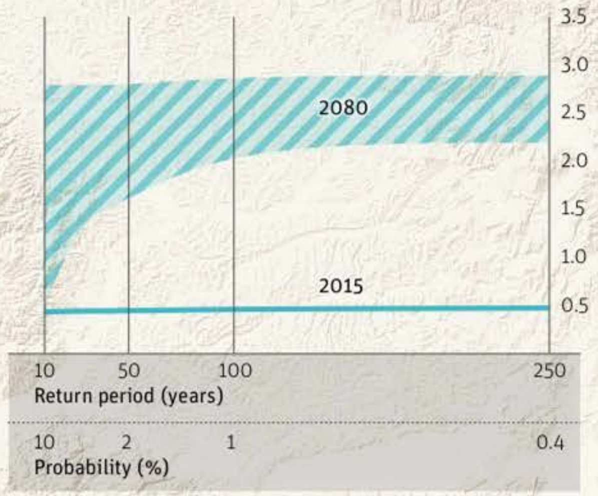


EARTHQUAKE
ANNUAL AVERAGE FATALITIES

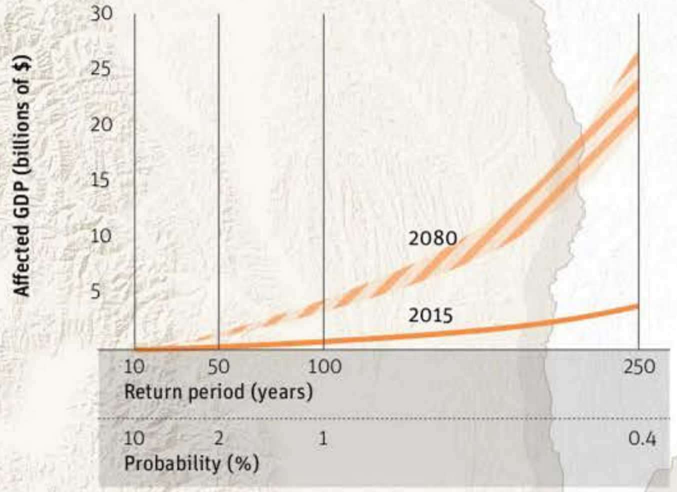


The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Chisinau, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if Moldova had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $500 million. In 2080, however, the affected GDP from the same type of event would range from about $2 billion to about $3 billion. If Moldova had experienced a 250-year earthquake event in 2015, the affected GDP would have been about $4 billion. In 2080, the affected GDP from the same type of event would range from about $20 billion to about $30 billion, due to population growth, urbanization, and the increase in exposed assets.

All historical data on floods and earthquakes are from D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be, and J. Daniell and A. Schaefer, "Eastern Europe and Central Asia Region Earthquake Risk Assessment Country and Province Profiling," final report to GFDRR, 2014. Damage estimates for all historical events have been inflated to 2015 US$.

Montenegro

GDP $4.0 billion*

Population 623,000*

AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
$400 million (10%)	$3 billion (64%)	$400 million (10%)
60,000 (10%)	300,000 (50%)	50 (<1%)

*2015 estimates

Montenegro's population and economy are exposed to earthquakes and floods, with floods posing the greater risk. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

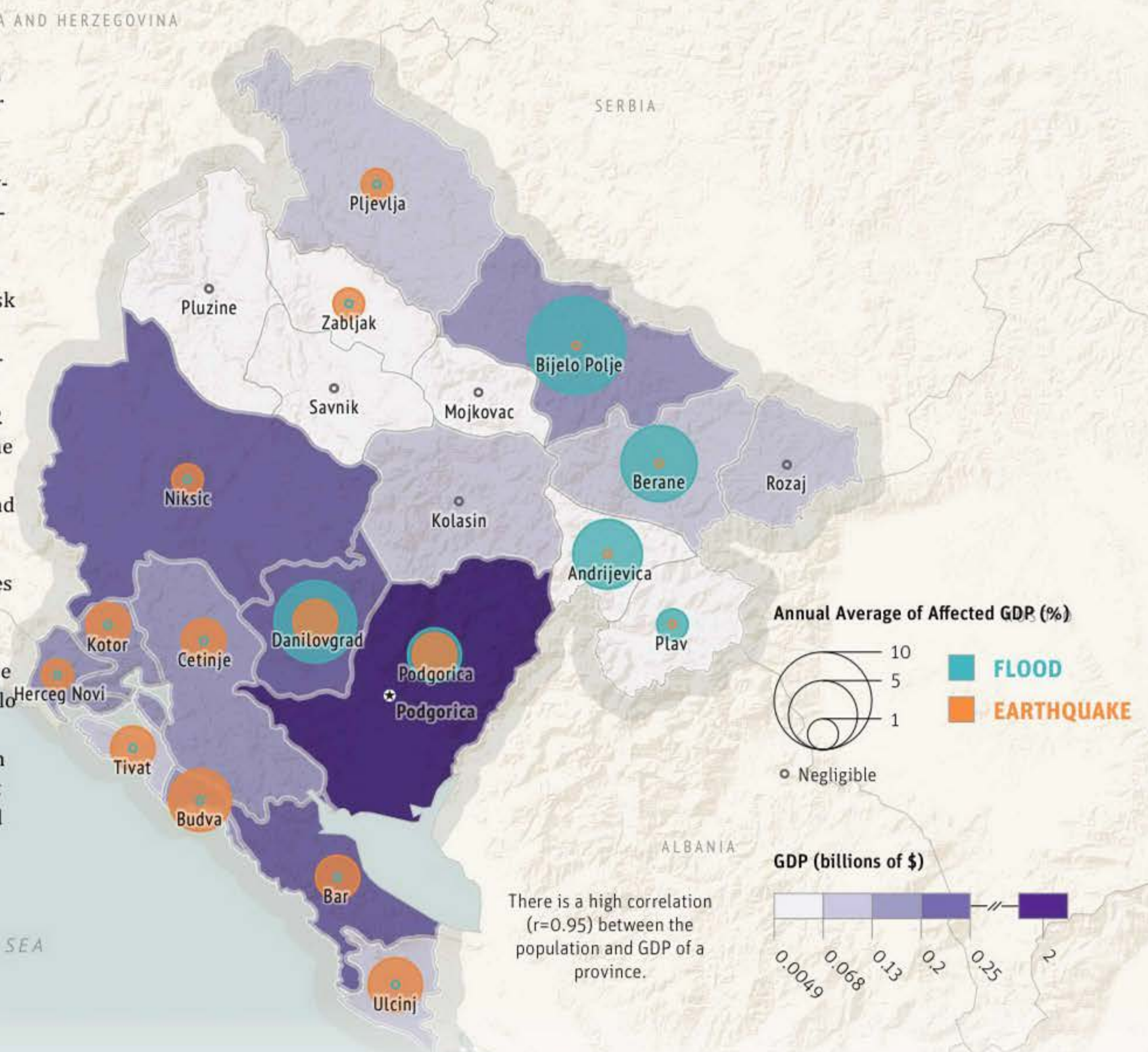
Just over 60 percent of Montenegro's population lives in urban environments. The country's GDP was approximately US$4.0 billion in 2015, with close to 90 percent derived from services, most of the remainder generated by industry, and agriculture making a small contribution. Montenegro's per capita GDP was $6,470.

This map displays GDP by province in Montenegro, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of floods is Bijelo Polje, and the one at greatest risk of earthquakes is Budva. In absolute terms, the province at greatest risk of both floods and earthquakes is Podgorica.

TOP AFFECTED PROVINCES

FLOOD ANNUAL AVERAGE OF AFFECTED GDP (%)		EARTHQUAKE ANNUAL AVERAGE OF AFFECTED GDP (%)	
Bijelo Polje	11	Budva	4
Danilovgrad	7	Ulcinj	3
Berane	6	Danilovgrad	2
Andrijevica	5	Kotor	2
Podgorica	3	Bar	2
Plav	1	Podgorica	2
Ulcinj	0	Tivat	2
Bar	0	Cetinje	2
Pluzine	0	Niksic	2
Cetinje	0	Herceg Novi	1



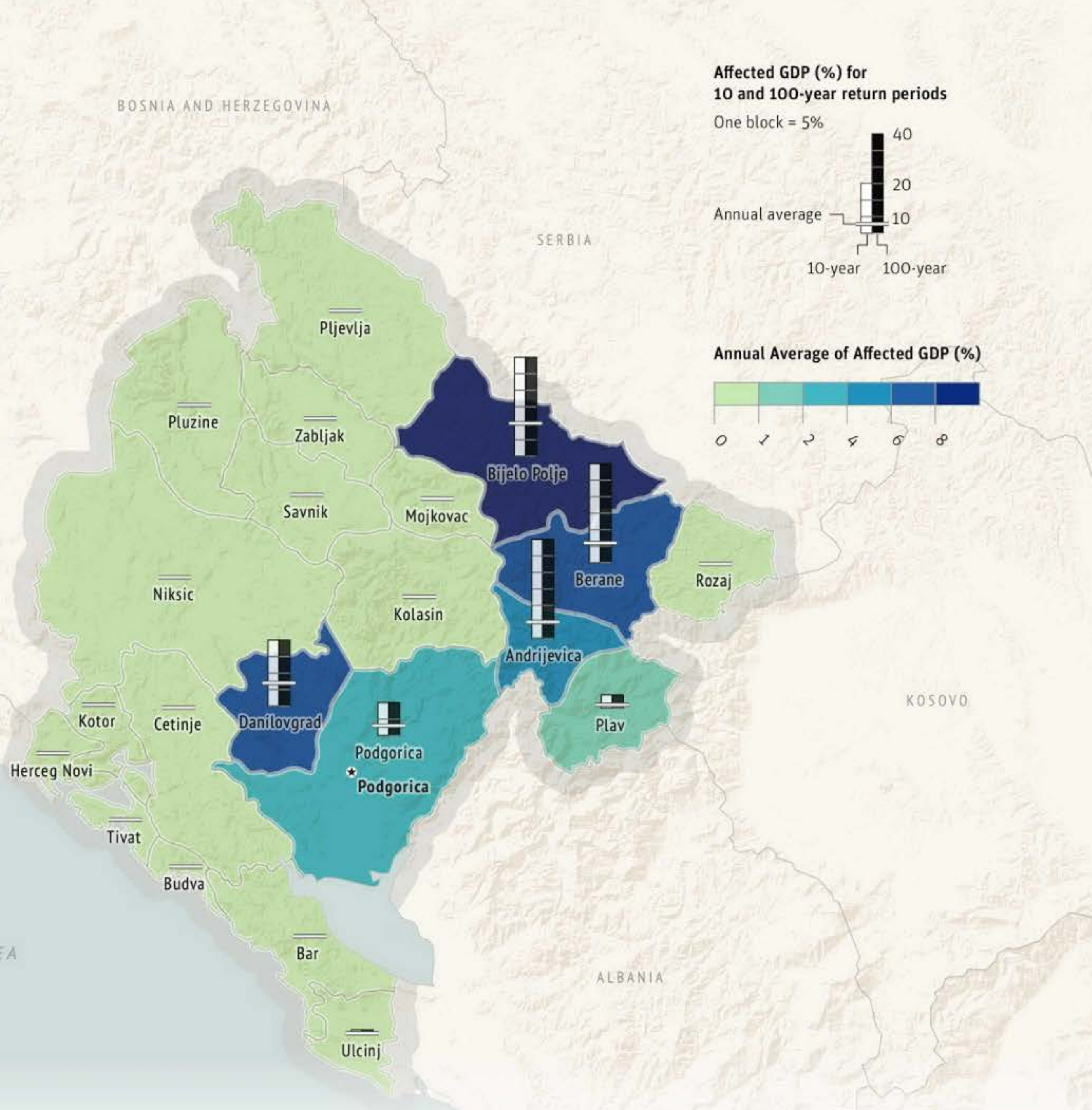
Floods in 2010, declared by the country's government as the "worst floods ever recorded,"1 affected over 5,000 people in Montenegro. In 2014, a devastating flood in the Balkans also affected Montenegro, although at the time of this publication its impact had not been quantified.

This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in Montenegro is about 10,000 and the annual average affected GDP about $90 million. Within the various provinces, the 10- and 100-year impacts do not differ much, so relatively frequent floods have large impacts on these averages.



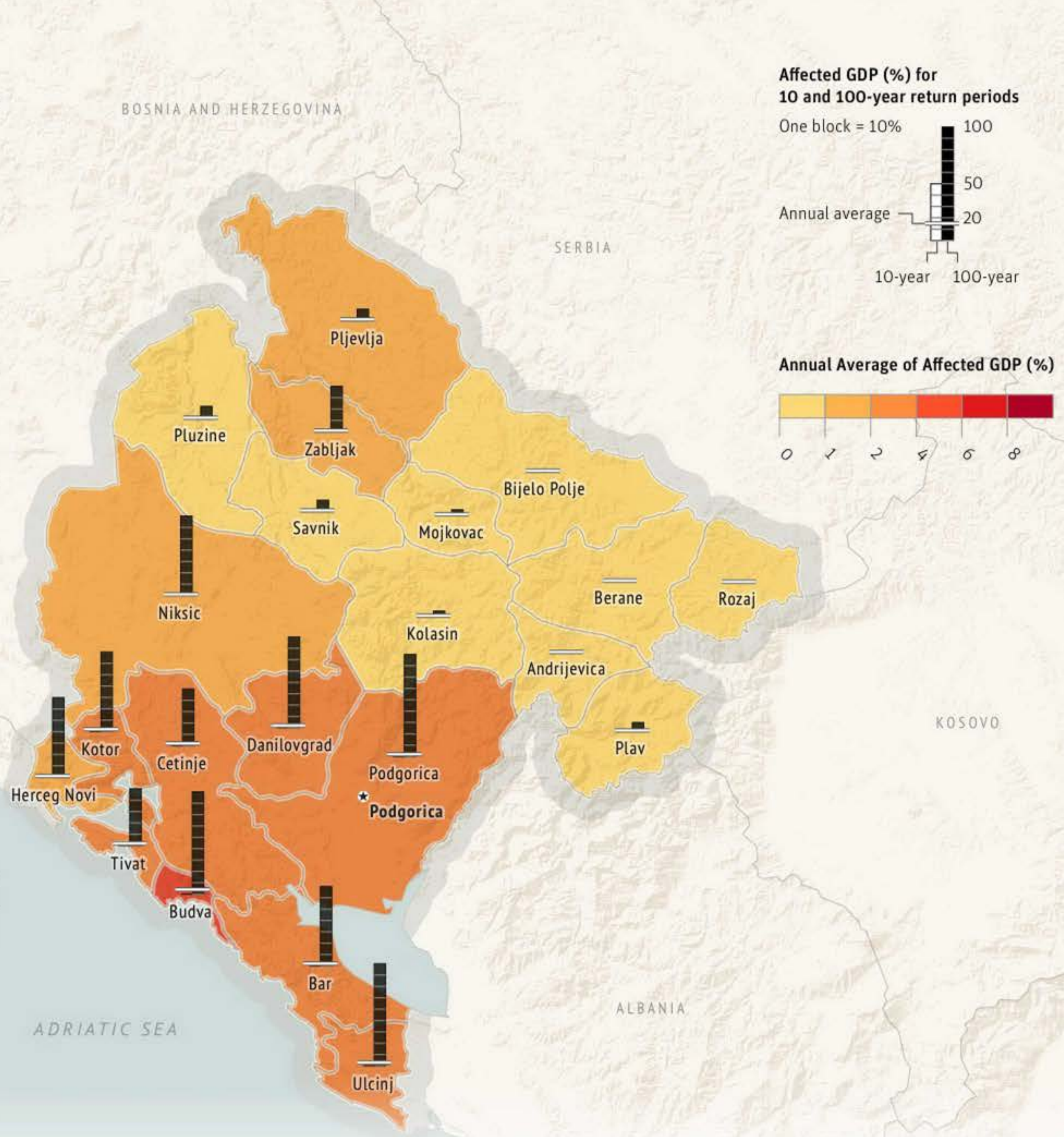
Montenegro's worst earthquake since 1900 took place in 1979. The earthquake caused over 120 fatalities and close to $13 billion in damage. Other earthquakes affecting Montenegro during the twentieth century occurred in 1905 and 1968.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

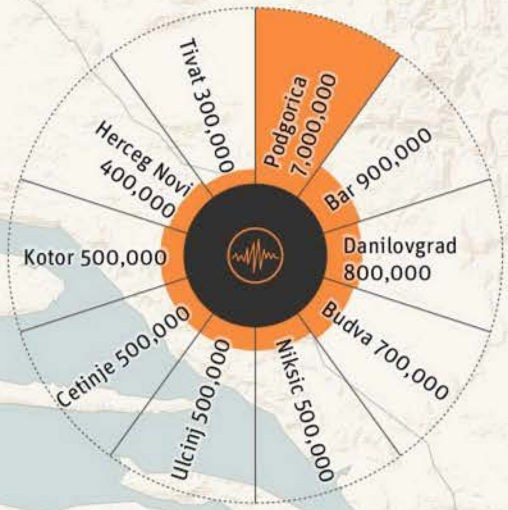
When an earthquake has a 10-year return period, it means the probability of occurrence of an earthquake of that magnitude or greater is 10 percent per year. A 100-year earthquake has a probability of occurrence of 1 percent per year. This means that over a long period of time, an earthquake of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year earthquake will occur exactly once every 100 years. In fact, it is possible for an earthquake of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make larger contributions to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

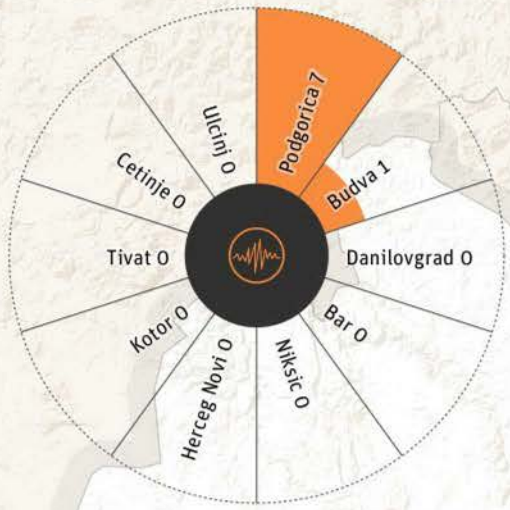
The annual average population affected by earthquakes in Montenegro is about 9,000 and the annual average affected GDP about $70 million. The annual averages of fatalities and capital losses caused by earthquakes are about eight and about $10 million, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause $400 million in capital loss (about 10 percent of GDP).



EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS ($)



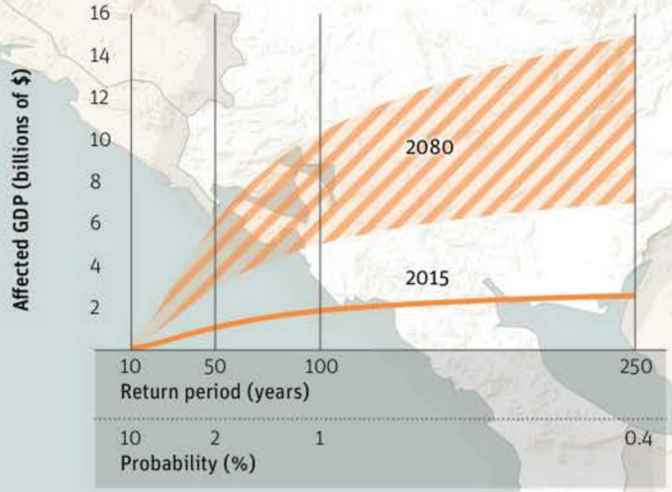
EARTHQUAKE
ANNUAL AVERAGE FATALITIES



The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Podgorica, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080

EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if Montenegro had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $400 million. In 2080, however, the affected GDP from the same type of event would range from about $1 billion to about $2 billion. If Montenegro had experienced a 250-year earthquake event in 2015, the affected GDP would have been about $3 billion. In 2080, the affected GDP from the same type of event would range from about $7 billion to about $15 billion, due to population growth, urbanization, and the increase in exposed assets.

All historical data on floods and earthquakes are from D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be, and J. Daniell and A. Schaefer, "Eastern Europe and Central Asia Region Earthquake Risk Assessment Country and Province Profiling," final report to GFDRR, 2014. Government quote on floods is from Government of Montenegro, "Montenegro Suffers Worst Floods Ever Recorded," press release, December 3, 2012, http://www.gov.me/en/News/101512/Montenegro-suffers-worst-floods-ever-recorded.html. Damage estimates for all historical events have been inflated to 2015 US$.

WORLD BANK GROUP GFDRR

EUROPE AND CENTRAL ASIA (ECA) RISK PROFILES

Poland

GDP $494 billion*

Population 39.0 million*

	AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
GDP $494 billion*	$30 billion (6%)	$10 billion (2%)	$700 million (<1%)
Population 39.0 million*	2 million (6%)	700,000 (2%)	100 (<1%)

*2015 estimates

Poland's population and economy are exposed to earthquakes and floods, with floods posing the greater risk. The model results for present-day risk v in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

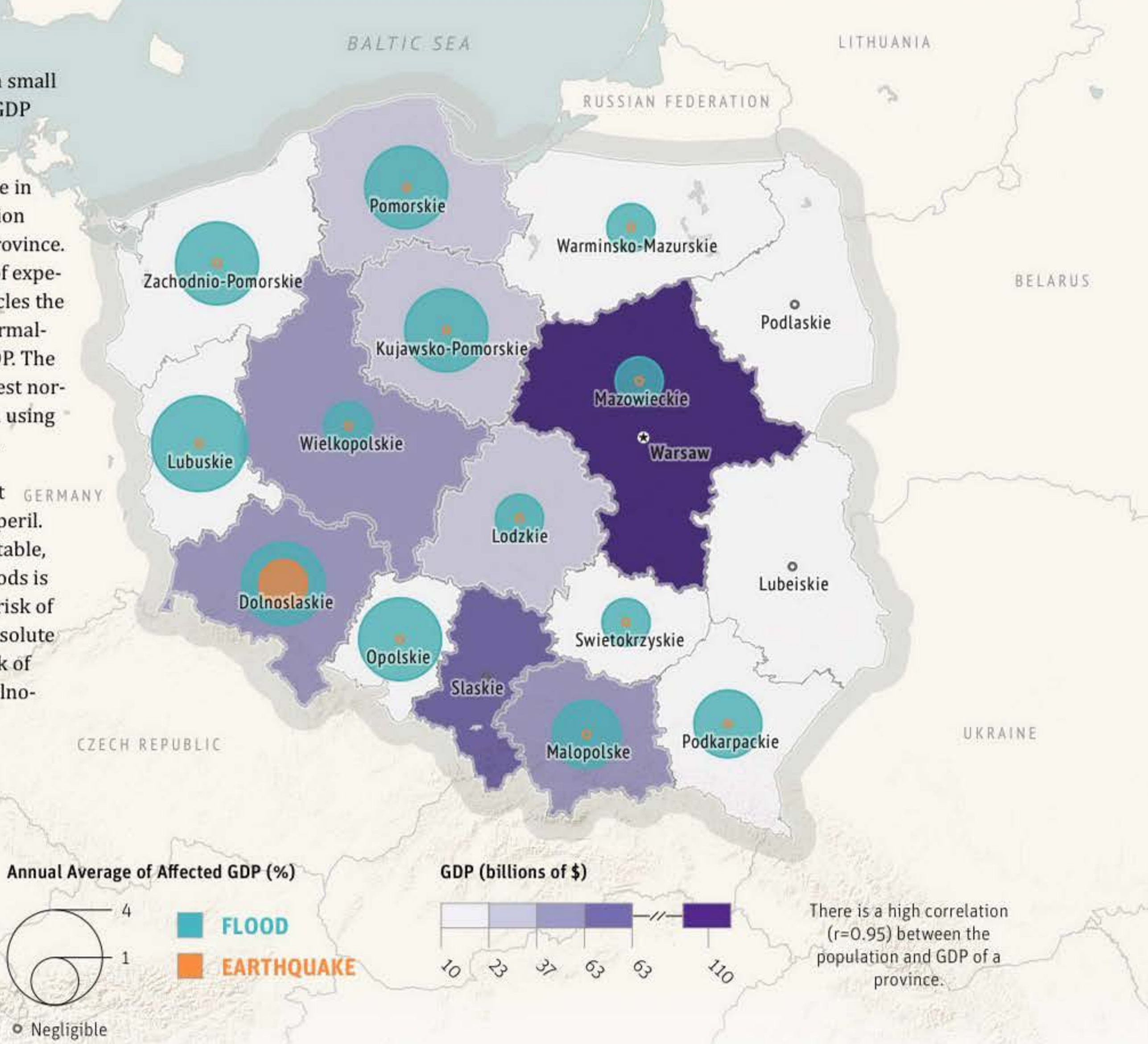
Just over 60 percent of Poland's population lives in urban environments. The country's GDP was approximately US$494 billion in 2015, with more than 60 percent derived from services, most of the remainder generated by industry, and agriculture making a small contribution. Poland's per capita GDP was $12,700.

This map displays GDP by province in Poland, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of floods is Lubuskie, and the one at greatest risk of earthquakes is Dolnoslaskie. In absolute terms, the province at greatest risk of both floods and earthquakes is Dolnoslaskie.

TOP AFFECTED PROVINCES

FLOOD ANNUAL AVERAGE OF AFFECTED GDP (%)		EARTHQUAKE ANNUAL AVERAGE OF AFFECTED GDP (%)	
Lubuskie	4	Dolnoslaskie	1
Opolskie	3	Lubuskie	0
Dolnoslaskie	3	Wielkopolskie	0
Kujawsko-Pomorskie	3	Slaskie	0
Zachodnio-Pomorskie	3	Opolskie	0
Pomorskie	2	Malopolske	0
Podkarpackie	2	Podkarpackie	0
Malopolske	2	Lodzkie	0
Wielkopolskie	1	Zachodnio-Pomorskie	0
Warminsko-Mazurskie	1	Kujawsko-Pomorskie	0



There is a high correlation (r=0.95) between the population and GDP of a province.

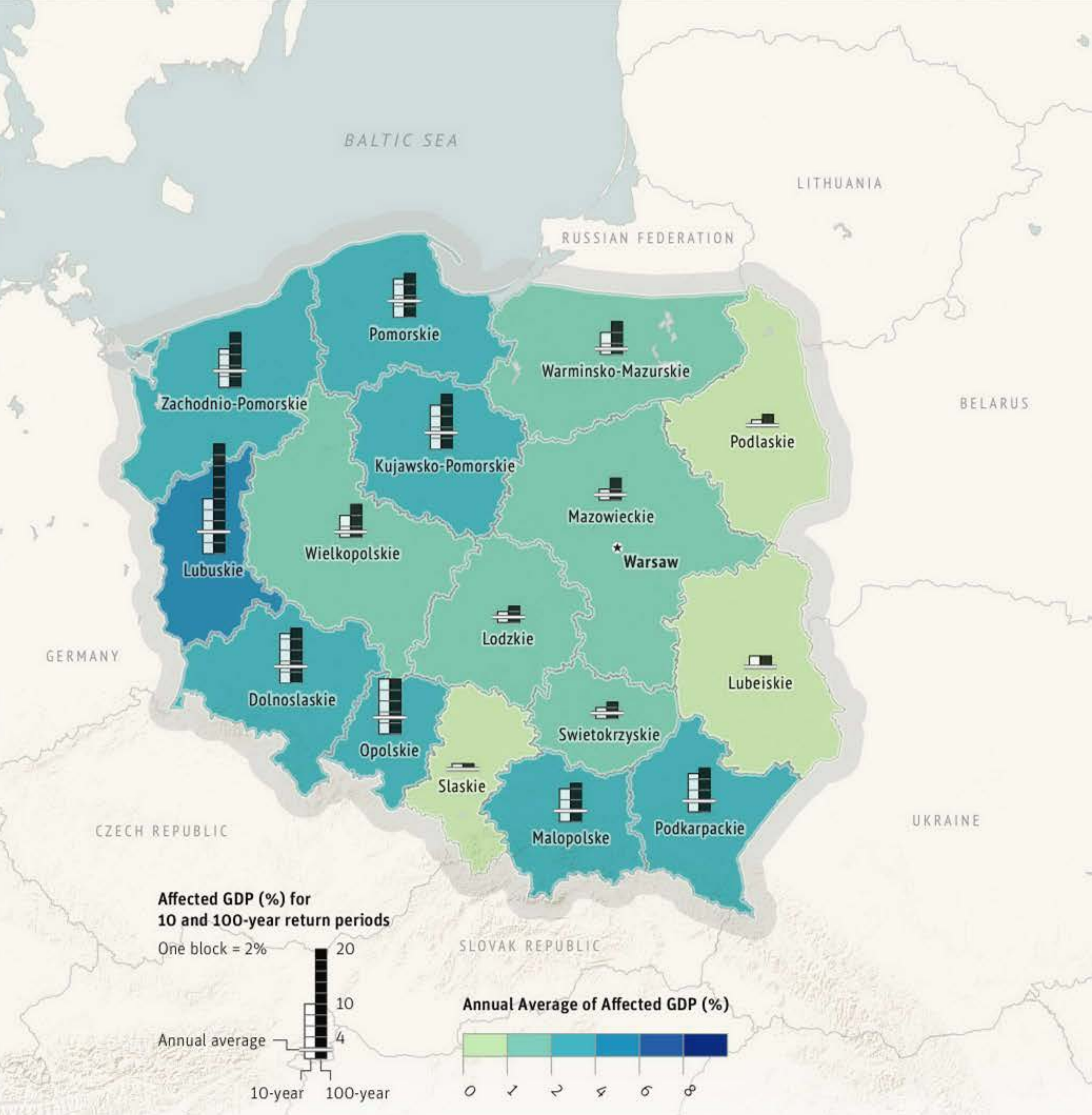
The most devastating flood in Poland since 1900 occurred in 1997. It affected over 200,000 people and caused about $5 billion in damage. Another major flood event took place in 2010, affecting about 100,000 people and causing over $3 billion in damage. Floods in 1987 and 2001 each caused close to $1 billion in damage.

This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in Poland is about 600,000 and the annual average GDP about $7 billion. Within the various provinces, the 10- and 100-year impacts do not differ much, so relatively frequent floods have large impacts on these averages.



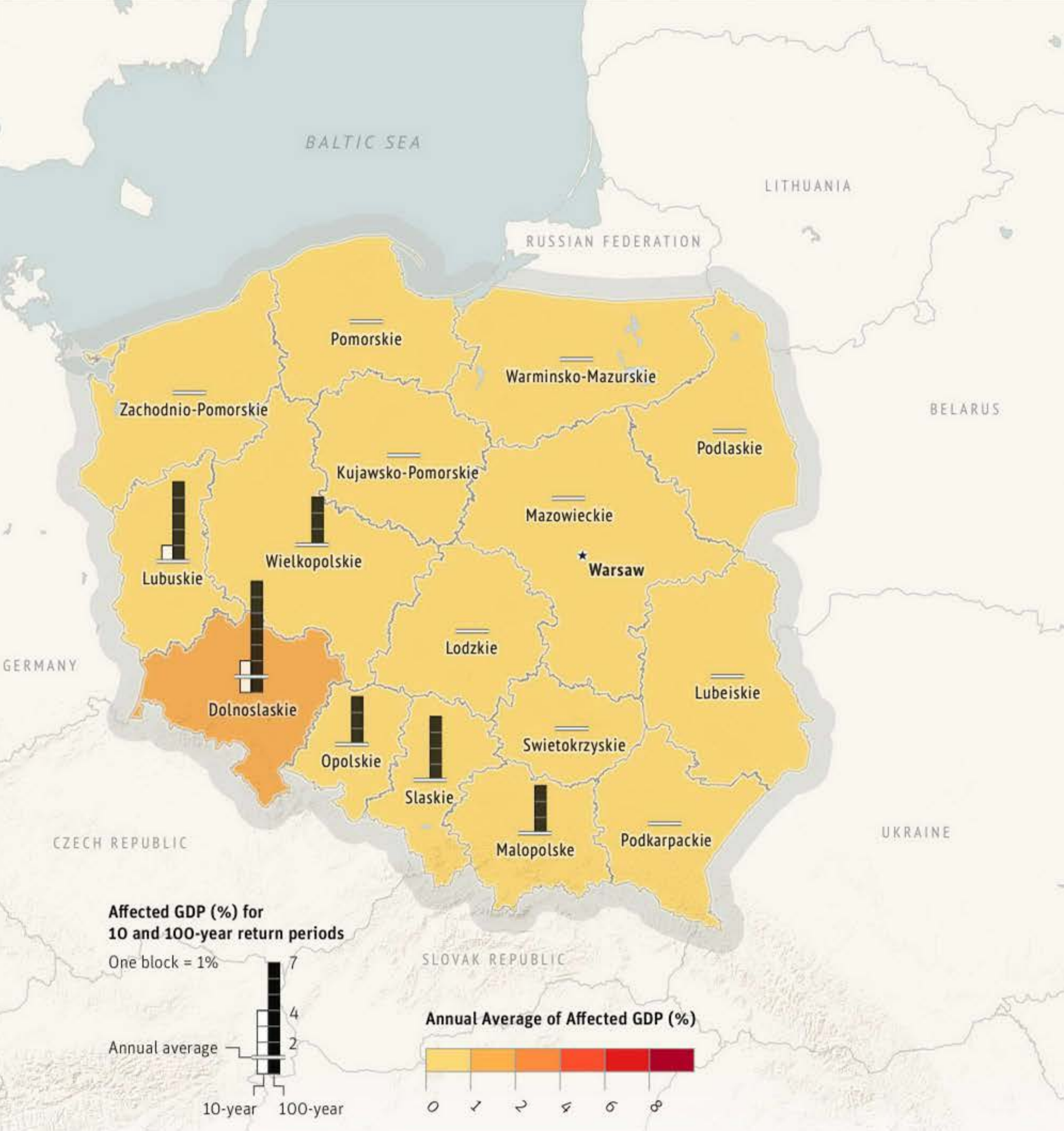
Poland experienced a minor earthquake in 1982, affecting over 1,000 people. The event indicates that, although no major earthquakes have been reported there, Poland has the potential to experience moderate ones.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

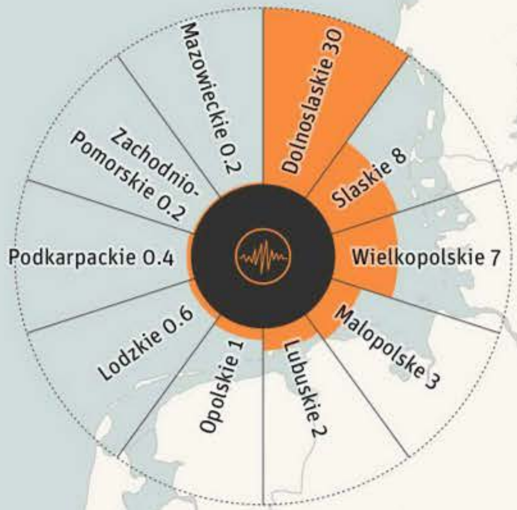
When an earthquake has a 10-year return period, it means the probability of occurrence of an earthquake of that magnitude or greater is 10 percent per year. A 100-year earthquake has a probability of occurrence of 1 percent per year. This means that over a long period of time, an earthquake of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year earthquake will occur exactly once every 100 years. In fact, it is possible for an earthquake of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make larger contributions to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

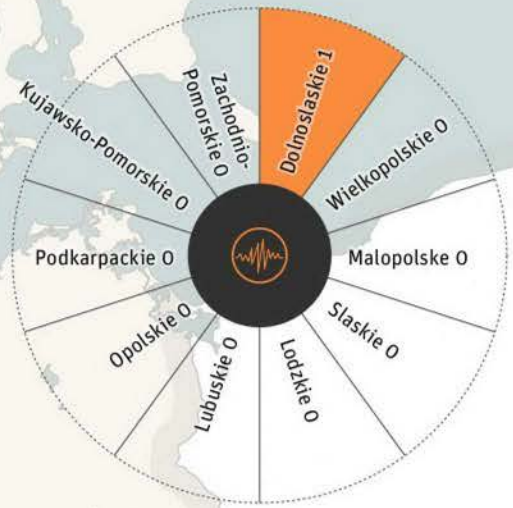
The annual average population affected by earthquakes in Poland is about 50,000 and the annual average affected GDP about $600 million. The annual averages of fatalities and capital losses caused by earthquakes are about three and about $50 million, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause about $700 million in capital loss (less than 1 percent of GDP).



EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS (MILLIONS $)

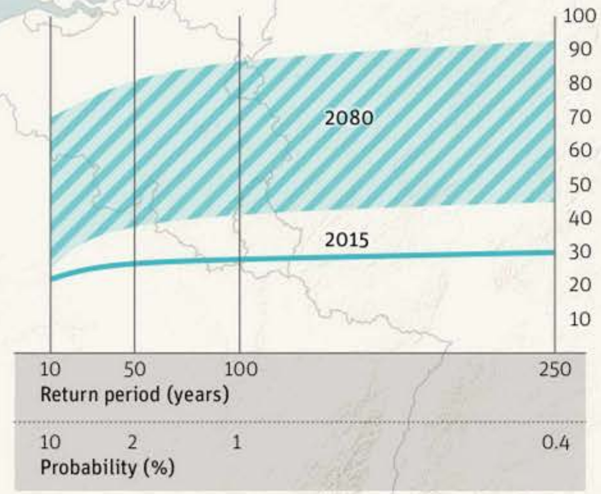


EARTHQUAKE
ANNUAL AVERAGE FATALITIES

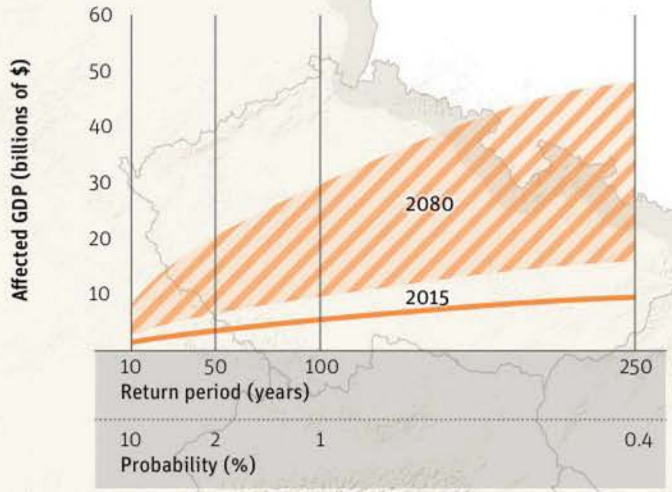


The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Dolnoslaskie, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if Poland had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $30 billion. In 2080, however, the affected GDP from the same type of event would range from about $40 billion to about $90 billion. If Poland had experienced a 250-year earthquake event in 2015, the affected GDP would have been about $10 billion. In 2080, the affected GDP from the same type of event would range from about $15 billion to about $50 billion, due to population growth, urbanization, and the increase in exposed assets.

All historical data on floods and earthquakes are from D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be. Damage estimates for all historical events have been inflated to 2015 US$.

Romania

		AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
GDP	$185 billion*	$10 billion (7%)	$100 billion (65%)	$20 billion (11%)
Population	19.5 million*	2 million (8%)	10 million (59%)	5,000 (<1%)

*2015 estimates

Romania's population and economy are exposed to earthquakes and floods, with earthquakes posing the greater risk of a high impact, lower probability event. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

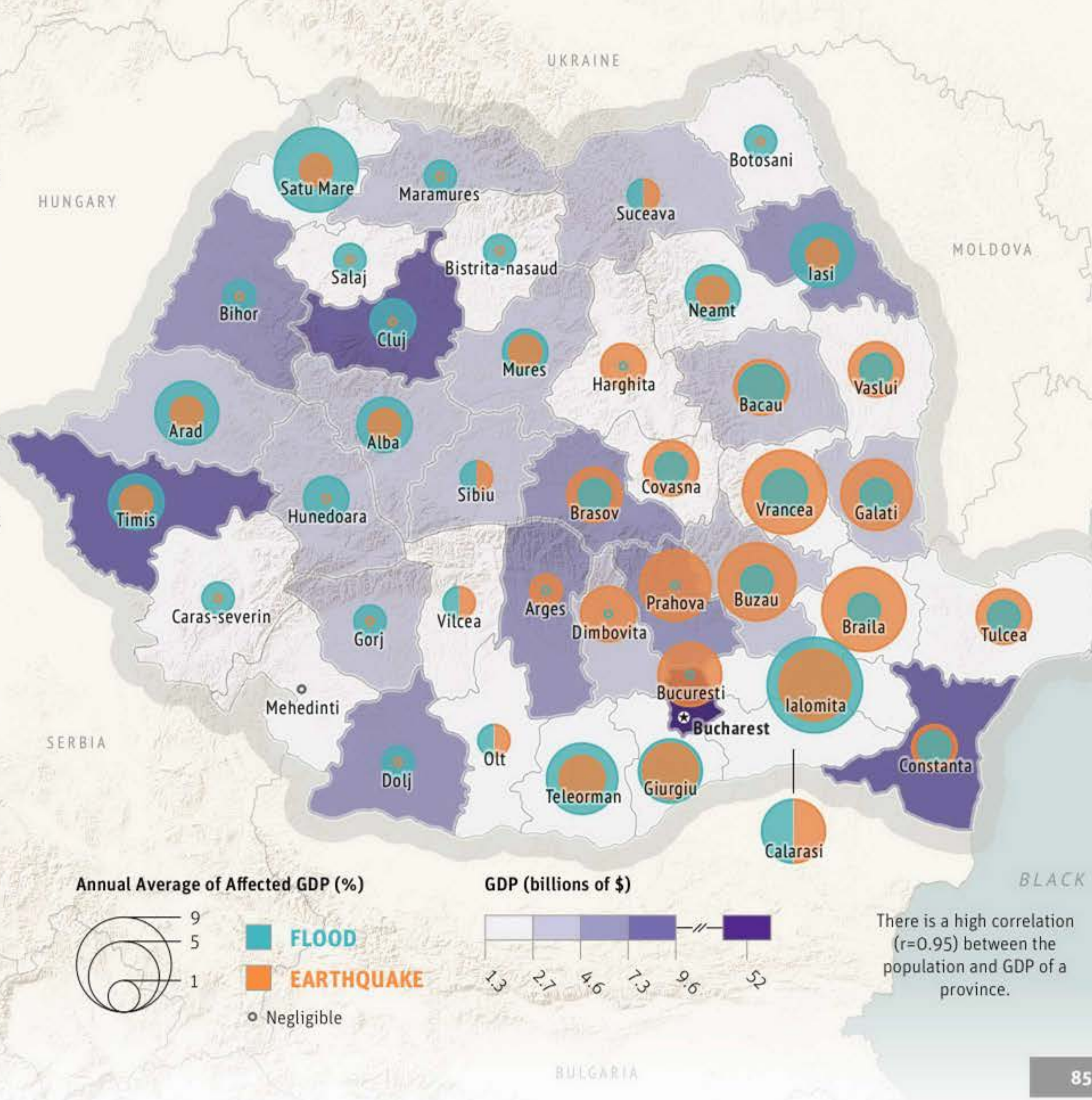
Just over half of Romania's population lives in urban environments. The country's GDP was approximately US$185 billion in 2015, with over 50 percent derived from services, most of the remainder generated by industry, and agriculture making a small contribution. Romania's per capita GDP was $9,490.

This map displays GDP by province in Romania, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of floods is Ialomita, and the one at greatest risk of earthquakes is Braila. In absolute terms, the province at greatest risk of floods is Timis, and the one at greatest risk of earthquakes is Bucuresti.

TOP AFFECTED PROVINCES

FLOOD ANNUAL AVERAGE OF AFFECTED GDP (%)		EARTHQUAKE ANNUAL AVERAGE OF AFFECTED GDP (%)	
Ialomita	9	Braila	7
Satu Mare	7	Vrancea	7
Teleorman	5	Buzau	6
Iasi	4	Galati	6
Arad	4	Prahova	5
Giurgiu	4	Ialomita	5
Calarasi	4	Calarasi	4
Alba	3	Bucuresti	4
Timis	3	Giurgiu	3
Neamt	3	Bacau	3



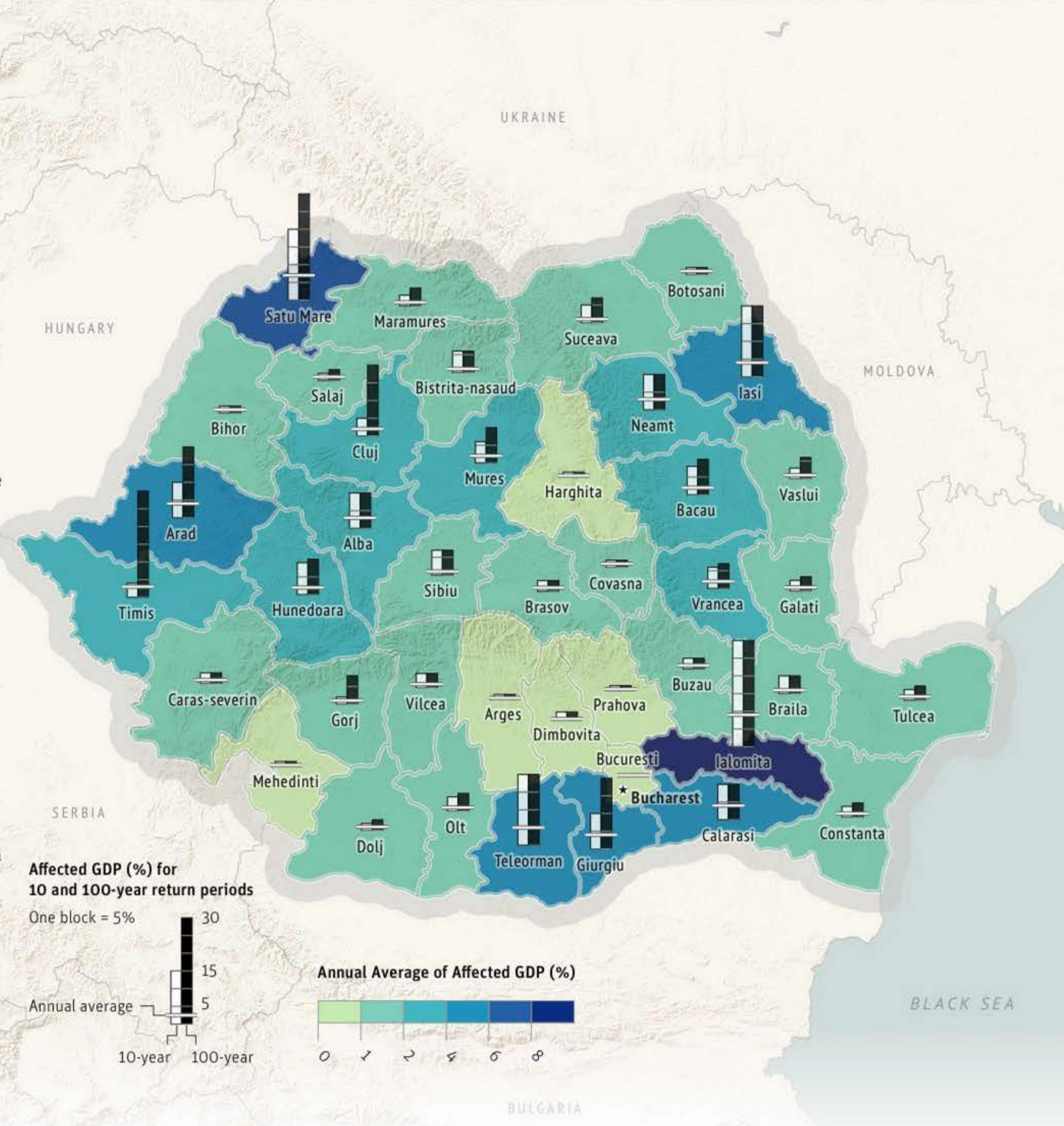
Romania's most deadly flood since 1900 occurred in 1926 and caused about 1,000 fatalities. More recently, flooding in 1970 caused over 200 fatalities and at least $3 billion in damage. Floods in 1975 caused approximately 60 fatalities. Three floods in 2005 caused close to 60 deaths and almost $2 billion in damage. Further flooding in 2010 caused no fatalities but over $1 billion in damage. These statistics highlight the lives saved by disaster risk management efforts, but also the possibility that the damage associated with flooding will rise.

This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in Romania is about 300,000 and the annual average affected GDP about $2 billion. Since within the various provinces the impacts from 10- and 100-year floods do not differ much, relatively frequent floods have large impacts on these averages.



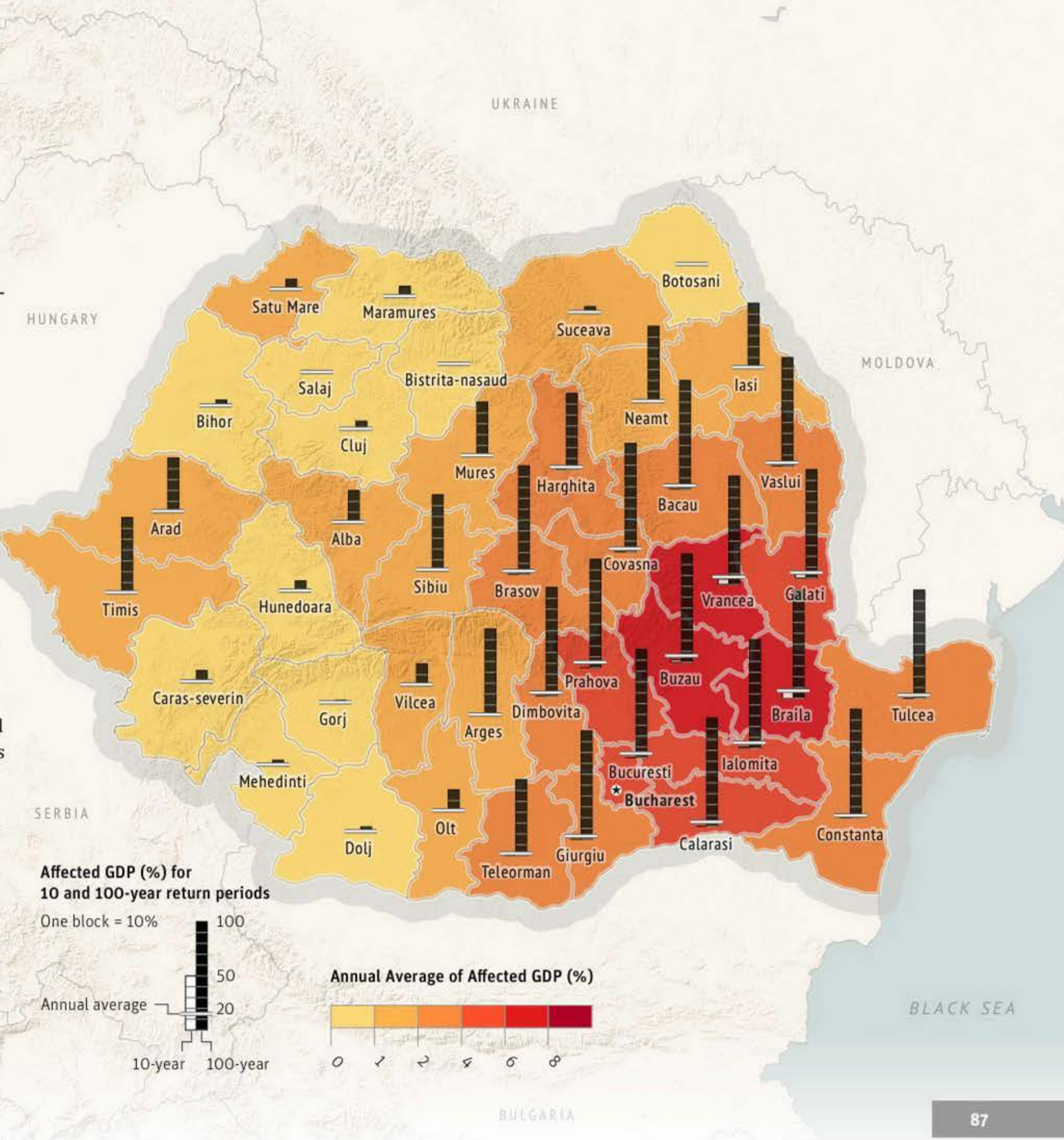
Romania's worst earthquake since 1900 took place in 1977 in Vrancea, with a magnitude of 7.2. It caused more than 1,500 fatalities and close to $8 billion in damage. Other major earthquakes affecting Romania occurred in 1802, 1838, 1940, 1986, and 1990. The 1802 event, also centered in Vrancea, was one of the largest earthquakes on record to occur in Europe, and the largest to strike Romania.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

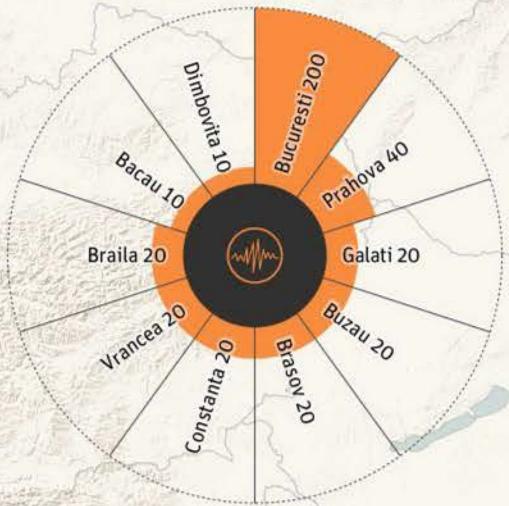
When an earthquake has a 10-year return period, it means the probability of occurrence of an earthquake of that magnitude or greater is 10 percent per year. A 100-year earthquake has a probability of occurrence of 1 percent per year. This means that over a long period of time, an earthquake of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year earthquake will occur exactly once every 100 years. In fact, it is possible for an earthquake of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make larger contributions to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

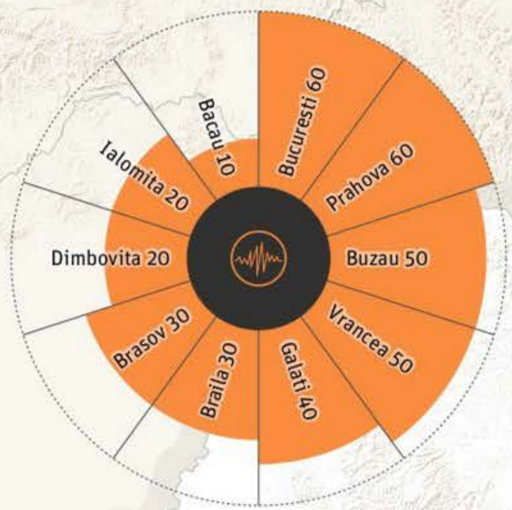
The annual average population affected by earthquakes in Romania is about 400,000 and the annual average affected GDP about $5 billion. The annual averages of fatalities and capital losses caused by earthquakes are about 400 and about $500 million, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause about 5,000 fatalities and $20 billion in capital loss (about 10 percent of GDP).



EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS (MILLIONS $)

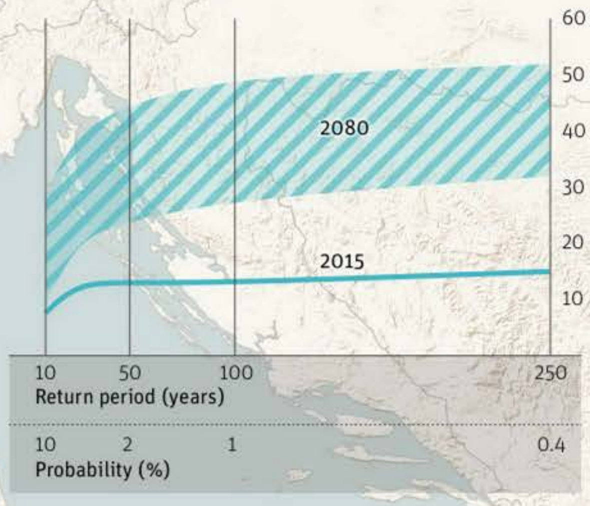


EARTHQUAKE
ANNUAL AVERAGE FATALITIES

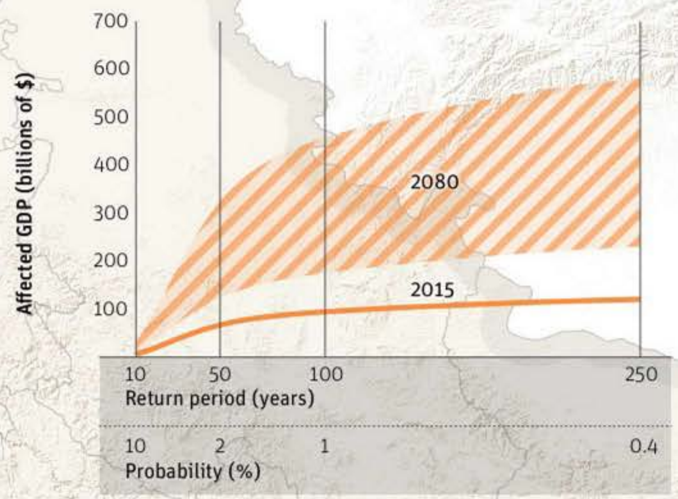


The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Bucuresti, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if Romania had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $10 billion. In 2080, however, the affected GDP from the same type of event would range from about $30 billion to about $50 billion. If Romania had experienced a 250-year earthquake event in 2015, the affected GDP would have been about $100 billion. In 2080, the affected GDP from the same type of event would range from about $200 billion to about $600 billion, due to population growth, urbanization, and the increase in exposed assets.

All historical data on floods and earthquakes are from, respectively, D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be, and J. Daniell and A. Schaefer, "Eastern Europe and Central Asia Region Earthquake Risk Assessment Country and Province Profiling," final report to GFDRR, 2014. Damage estimates for all historical events have been inflated to 2015 US$.

Russian Federation

GDP $1.2 trillion*
Population 144 million*

AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
$60 billion (6%)	$10 billion (1%)	$6 billion (1%)
8 million (6%)	2 million (2%)	10,000 (<1%)

*2015 estimates

The Russian Federation's population and economy are exposed to earthquakes and floods, with floods posing the greater risk. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

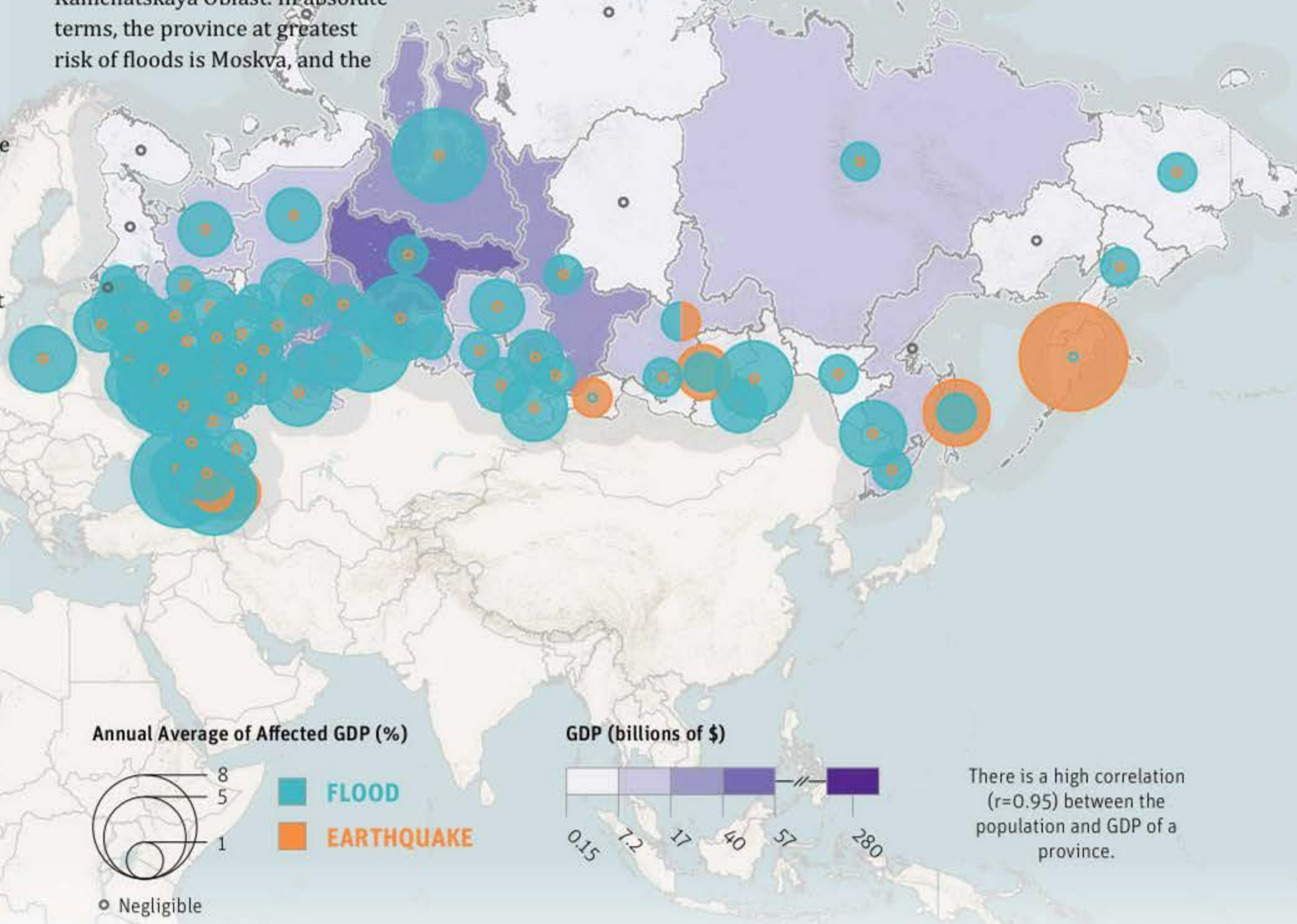
Close to 75 percent of the Russian Federation's population lives in urban environments. The country's GDP was approximately US$1.2 trillion in 2015, with nearly 60 percent derived from services, most of the remainder generated by industry, and agriculture making a small contribution. The Russian Federation's per capita GDP was $8,140.

This map displays GDP by province in the Russian Federation, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of floods is Adeygeya Republic, and the one at greatest risk of earthquakes is Kamchatskaya Oblast. In absolute terms, the province at greatest risk of floods is Moskva, and the one at greatest risk of earthquakes is Sakhalinskaya Oblast.

TOP AFFECTED PROVINCES

FLOOD ANNUAL AVERAGE OF AFFECTED GDP (%)		EARTHQUAKE ANNUAL AVERAGE OF AFFECTED GDP (%)	
Adygeya Rep.	7	Kamchatskaya Oblast	8
Yamalo-nenetskiy Okrug	6	Sakhalinskaya Oblast	3
Severnaya Osetiya-alaniya Rep.	5	Buryatiya Rep.	2
Kurganskaya Oblast	5	Dagestan Rep.	2
Tyumenskaya Oblast	5	Chechnya Rep.	1
Orlovskaya Oblast	4	Tyva Rep.	1
Karatchayevo-cherkesiya Rep.	4	Severnaya Osetiya-alaniya Rep.	1
Mariy-el Rep.	4	Karatchayevo-cherkesiya Rep.	1
Chitinskaya Oblast	4	Kabardino-balkariya Rep.	1
Tverskaya Oblast	4	Irkutskaya Oblast	1



There is a high correlation (r=0.95) between the population and GDP of a province.

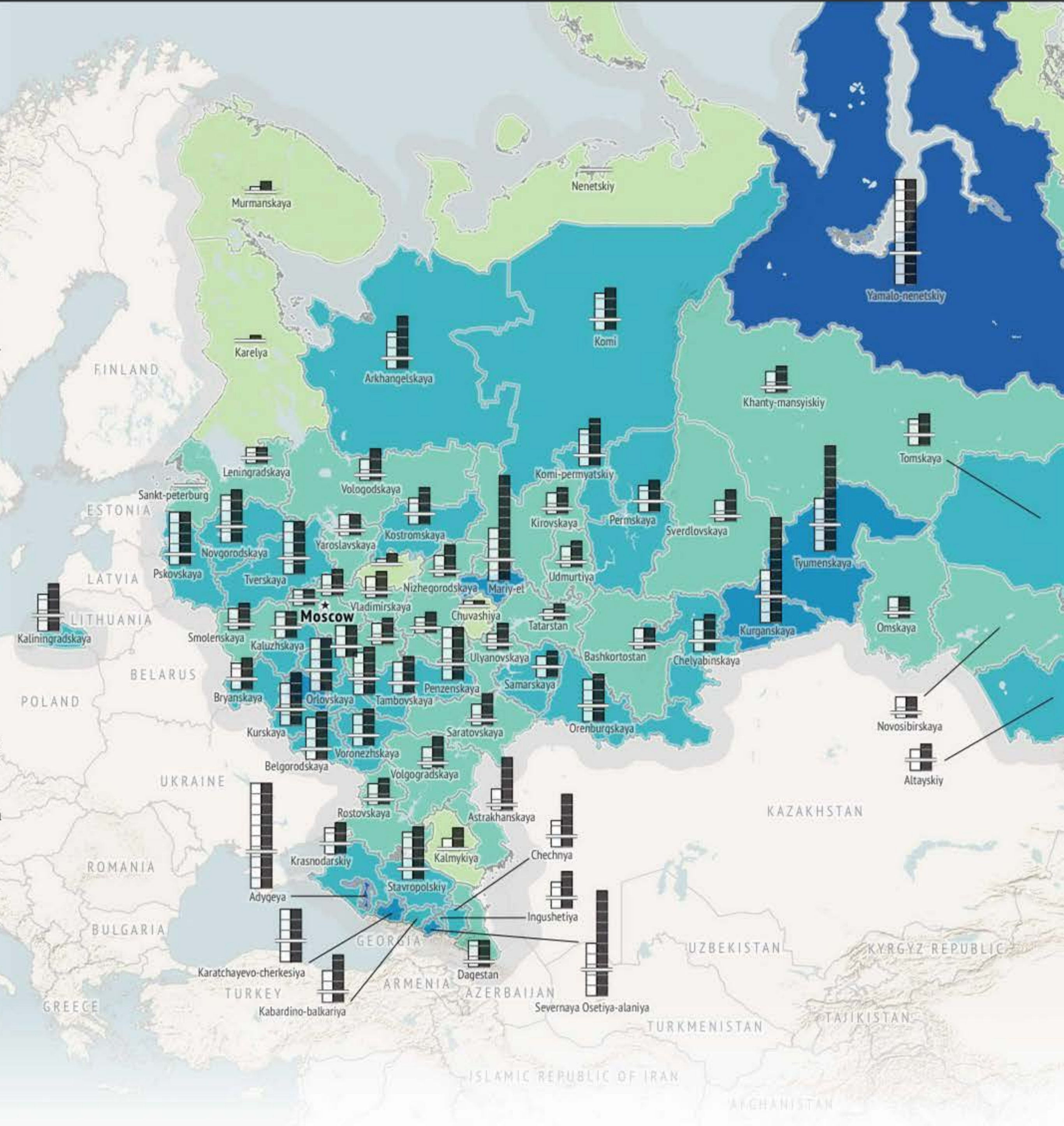
The most devastating flood in the Russian Federation since its reconstitution in 1991 occurred in 2013, causing about $1 billion in damage. A 2012 flood caused over 150 fatalities and over $600 million in damage. Fatalities and damage caused by flooding in August 2002 were on par with those of the 2012 flood. Flooding also occurred in 1994, 1996, and 1998, with the 1996 flood affecting close to 800,000 people.

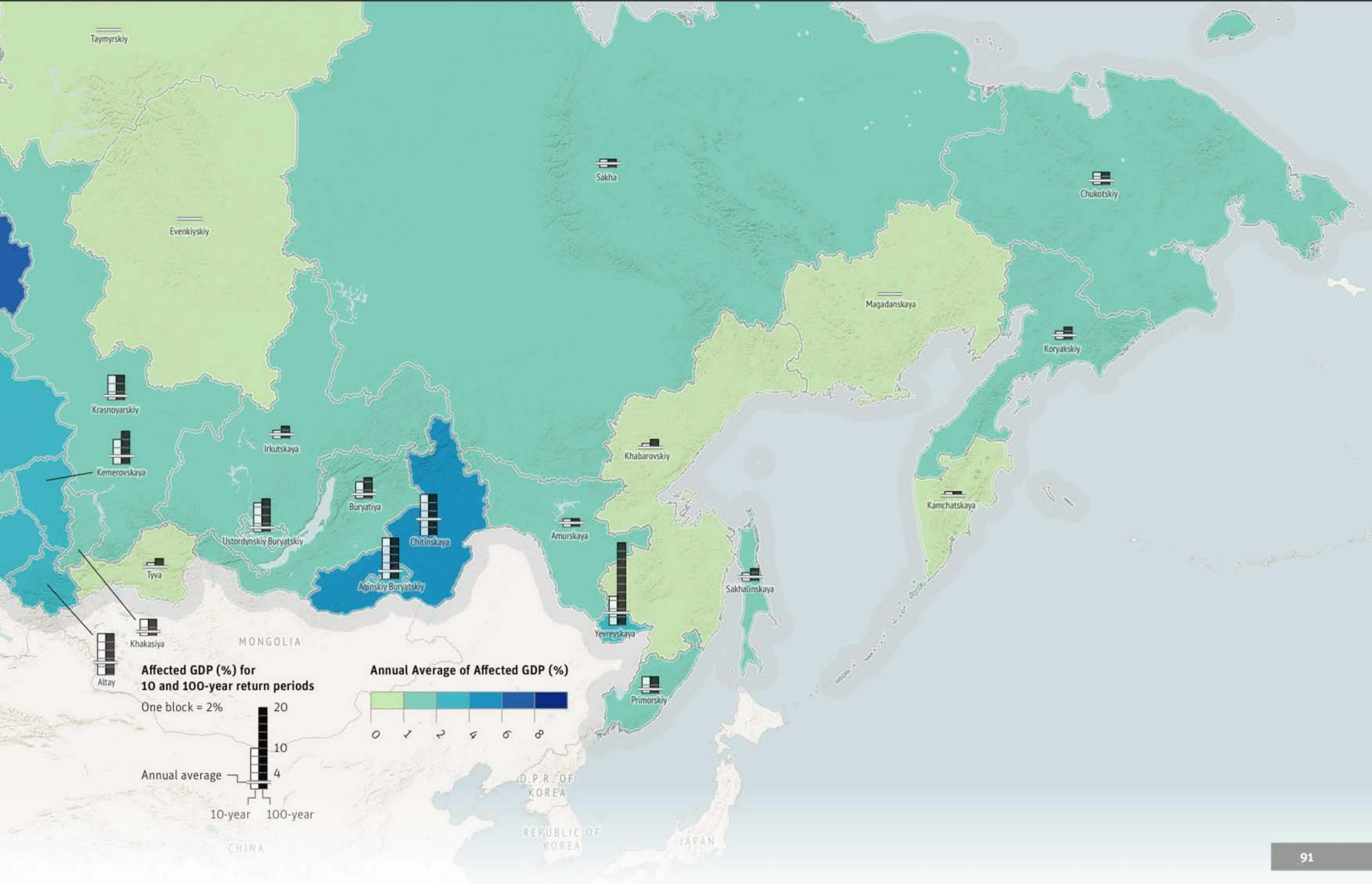
This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in the Russian Federation is about 2 million and the annual average affected GDP about $20 billion. For most provinces, the 10- and 100-year impacts do not differ much, so relatively frequent floods have large impacts on these averages. For the few in which the 100-year impacts are much greater than the 10-year impacts, the less frequent events make a significant contribution to the annual average of affected GDP.




Taymyrskiy
Evenkiyskiy
Sakha
Chukotskiy
Magadanskaya
Koryakskiy
Krasnoyarskiy
Irkutskaya
Kemerovskaya
Khabarovskiy
Kamchatskaya
Buryatiya
Chitinskaya
Amurskaya
Ustordynskiy Buryatskiy
Tyva
Aginskiy Buryatskiy
Sakhalinskaya
Yevreyskaya
Khakasiya
MONGOLIA
Altay
Primorskiy
Affected GDP (%) for
10 and 100-year return periods
One block = 2%
20
10
4
Annual average
10-year
100-year
Annual Average of Affected GDP (%)
0
1
2
4
6
8
D.P.R. OF
KOREA
REPUBLIC OF
KOREA
CHINA
JAPAN

Russian Federation EARTHQUAKE

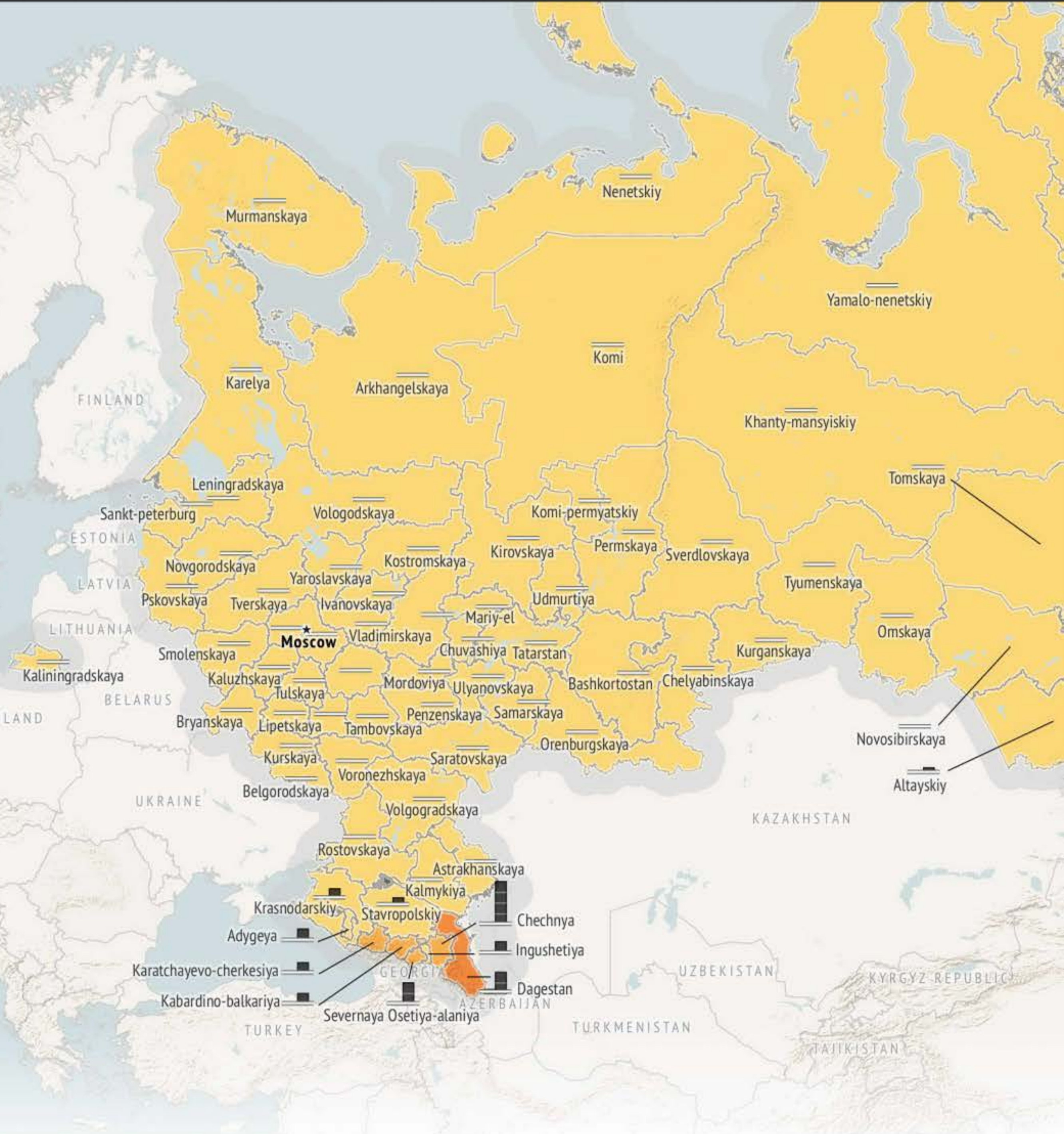
The Russian Federation's worst earthquake since 1900 took place in 1995 in Neftegorsk, with a magnitude of 7.1. It destroyed the settlement of Neftegorsk and caused nearly 2,000 fatalities and over $450 million in damage. Another major earthquake, which occurred in Kamchatka in 1952 and was followed by a tsunami, killed over 2,000 people. More recently, in 2007, an earthquake in the Russian Federation caused over $450 million in damage.

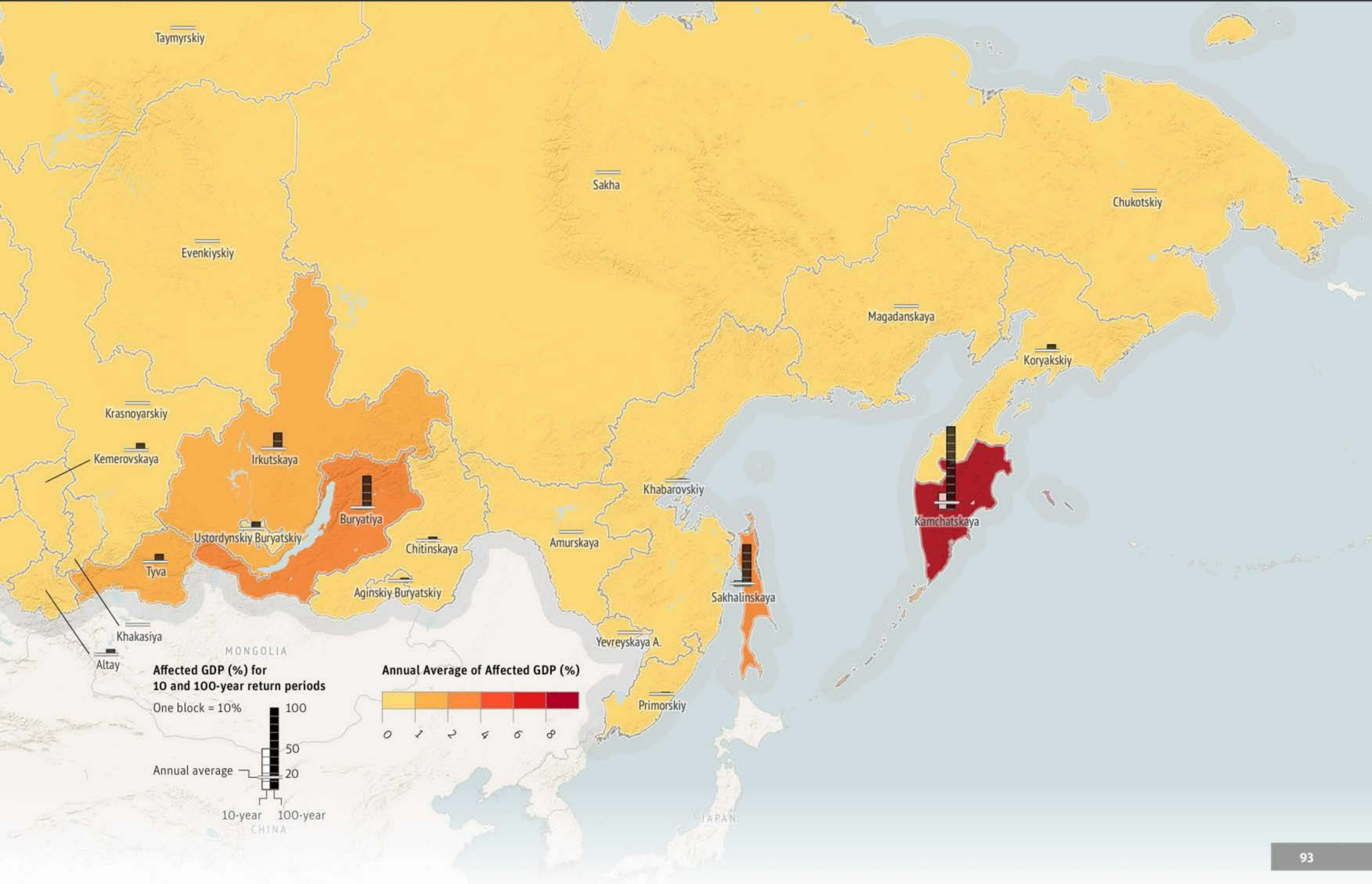
This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

When an earthquake has a 10-year return period, it means the probability of occurrence of an earthquake of that magnitude or greater is 10 percent per year. A 100-year earthquake has a probability of occurrence of 1 percent per year. This means that over a long period of time, an earthquake of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year earthquake will occur exactly once every 100 years. In fact, it is possible for an earthquake of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make larger contributions to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

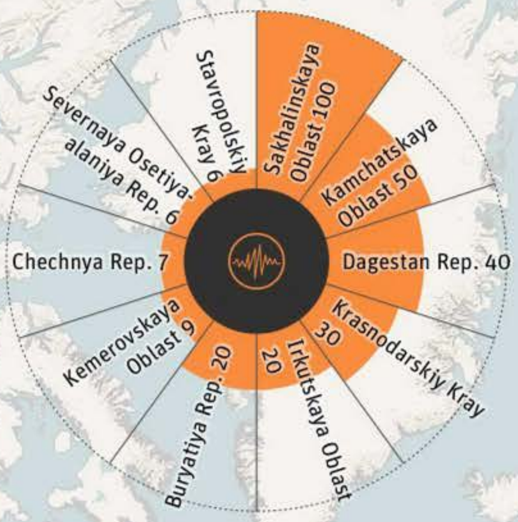
The annual average population affected by earthquakes in the Russian Federation is about 200,000 and the annual average affected GDP about $1 billion. The annual averages of fatalities and capital losses caused by earthquakes are about 200 and about $400 million, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause about 10,000 fatalities and $6 billion in capital loss (less than 1 percent of GDP).




Taymyrskiy
Sakha
Chukotskiy
Evenkiyskiy
Magadanskaya
Koryakskiy
Krasnoyarskiy
Kemerovskaya
Irkutskaya
Buryatiya
Khabarovskiy
Kamchatskaya
Ustordynskiy Buryatskiy
Chitinskaya
Amurskaya
Tyva
Aginskiy Buryatskiy
Sakhalinskaya
Khakasiya
Altay
MONGOLIA
Yevreyskaya A.
Primorskiy
CHINA
JAPAN
Affected GDP (%) for
10 and 100-year return periods
One block = 10%
100
50
20
Annual average
10-year
100-year
Annual Average of Affected GDP (%)
0
1
2
4
6
8

Russian Federation

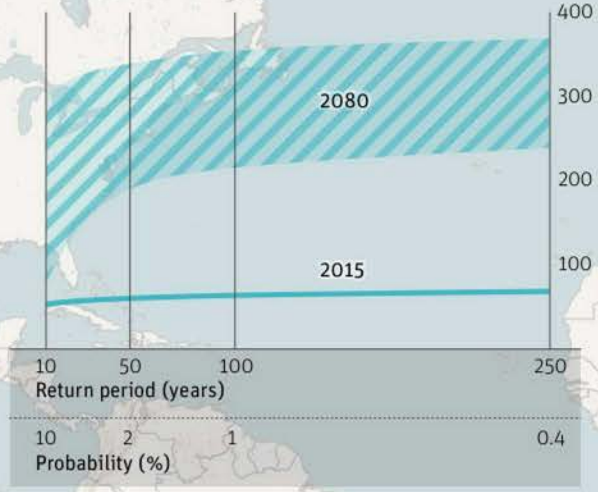
EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS (MILLIONS $)



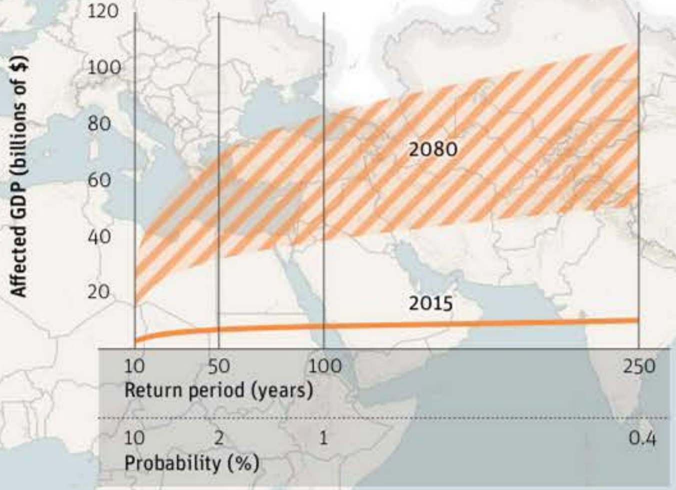
EARTHQUAKE
ANNUAL AVERAGE FATALITIES

The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Sakhalinskaya Oblast, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if the Russian Federation had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $60 billion. In 2080, however, the affected GDP from the same type of event would range from about $200 billion to about $400 billion. If the Russian Federation had experienced a 250-year earthquake event in 2015, the affected GDP would have been an estimated $20 billion. In 2080, however, the affected GDP from the same type of event would range from about $50 billion to about $100 billion, due to population growth, urbanization, and the increase in exposed assets.

All historical data on floods and earthquakes are from D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be, and J. Daniell and A. Schaefer, "Eastern Europe and Central Asia Region Earthquake Risk Assessment Country and Province Profiling," final report to GFDRR, 2014. Damage estimates for all historical events have been inflated to 2015 US$.

WORLD BANK GROUP GFDRR

EUROPE AND CENTRAL ASIA (ECA) RISK PROFILES

Serbia

GDP $36.4 billion*

Population 7.1 million*

	AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
GDP	$4 billion (12%)	$10 billion (29%)	$1 billion (3%)
Population	800,000 (11%)	2 million (23%)	500 (<1%)

*2015 estimates

Serbia's population and economy are exposed to earthquakes and floods, with floods posing the greater risk. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

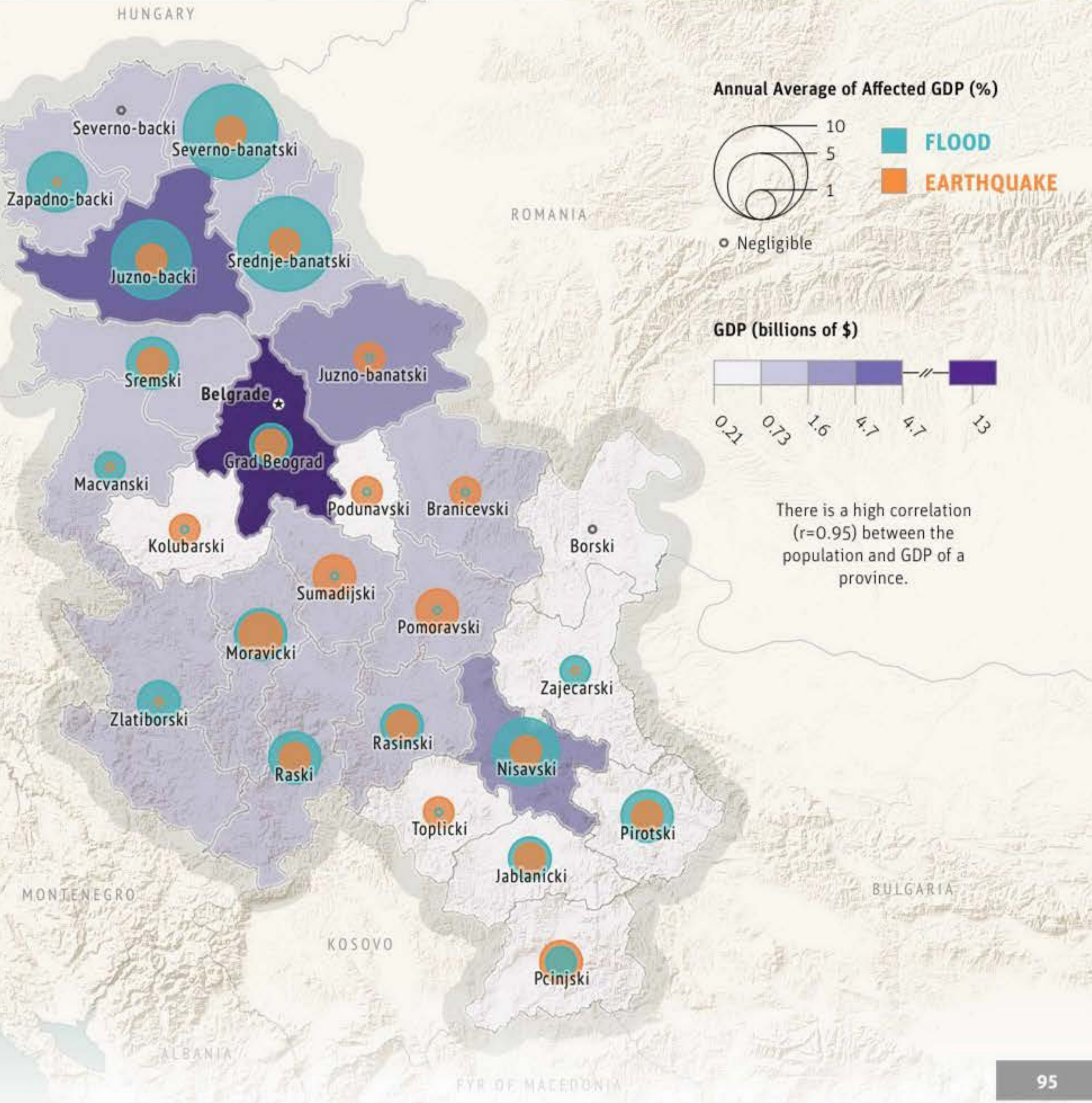
Just over 55 percent of Serbia's population lives in urban environments. The country's GDP was approximately US$36.4 billion in 2015, with about 60 percent derived from services, most of the rest generated by industry, and agriculture making a small contribution. Serbia's per capita GDP was $5,140.

This map displays GDP by province in Serbia, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of floods is Severno-banatski, and the one at greatest risk of earthquakes is Sumadijski. In absolute terms, the province at greatest risk of floods is Juzno-backi, and the one at greatest risk of earthquakes is Grad Beograd.

TOP AFFECTED PROVINCES

FLOOD ANNUAL AVERAGE OF AFFECTED GDP (%)		EARTHQUAKE ANNUAL AVERAGE OF AFFECTED GDP (%)	
Severno-banatski	14	Sumadijski	2
Srednje-banatski	11	Moravicki	2
Juzno-backi	7	Pcinjski	2
Nisavski	5	Pomoravski	2
Zapadno-backi	4	Kolubarski	1
Sremski	3	Pirotski	1
Raski	3	Rasinski	1
Pirotski	3	Jablanicki	1
Moravicki	3	Raski	1
Jablanicki	2	Podunavski	1



There is a high correlation (r=0.95) between the population and GDP of a province.

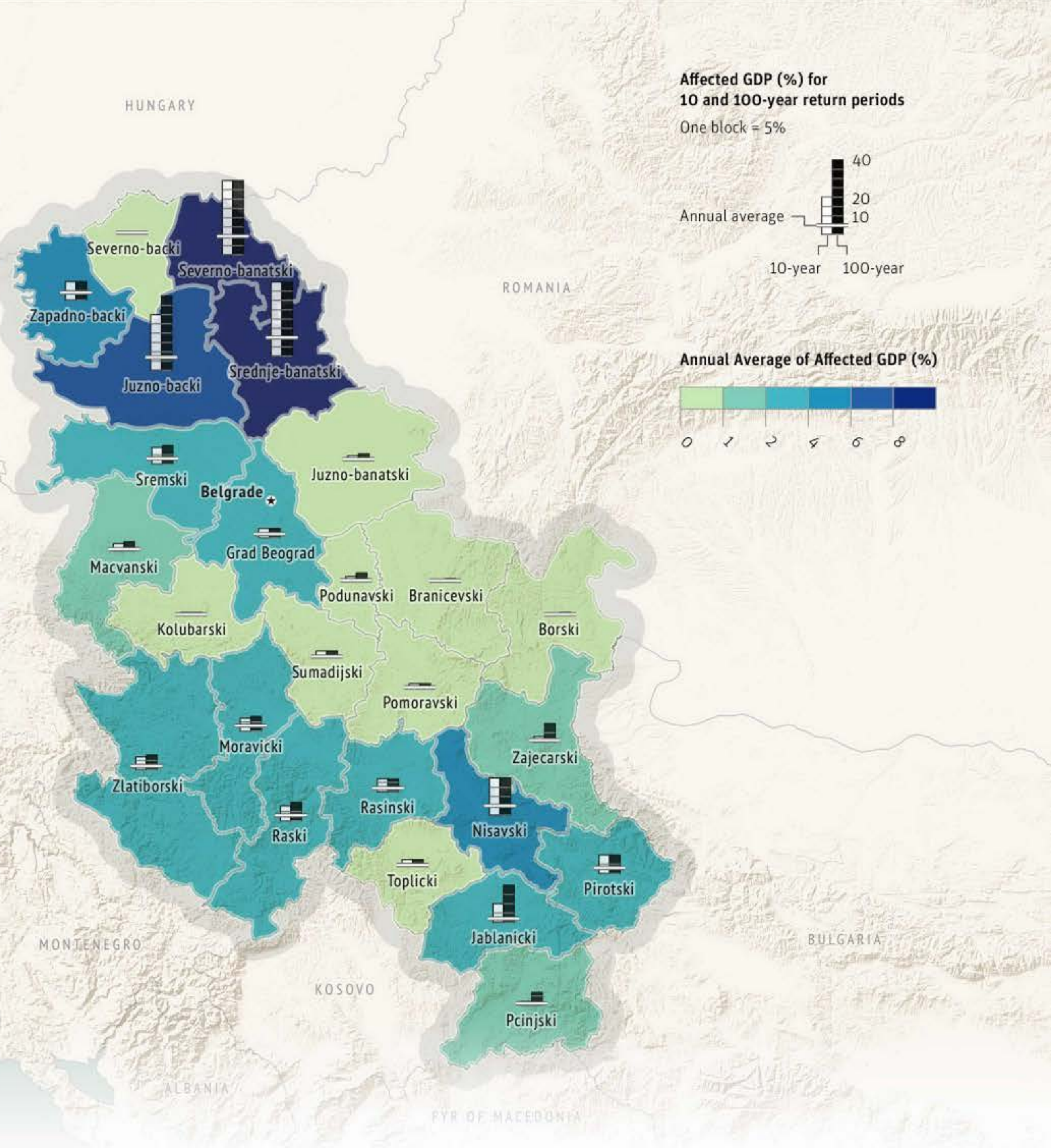
The most devastating flood in Serbia since it gained its independence in 2006 occurred in 2014. It affected over 1.6 million people in 38 municipalities in western and central Serbia, and it caused over 50 fatalities and more than $2 billion in damage. Other major floods took place in 1999, 2001, 2002, 2005, 2006, 2007, 2009, and 2010. All these events highlight Serbia's great vulnerability to floods, and their rapid succession produces a large cumulative effect on the country.

This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in Serbia is about 200,000 and the annual average affected GDP about $1 billion. Within the various provinces, the 10- and 100-year impacts do not differ much, so relatively frequent floods have large impacts on these averages.



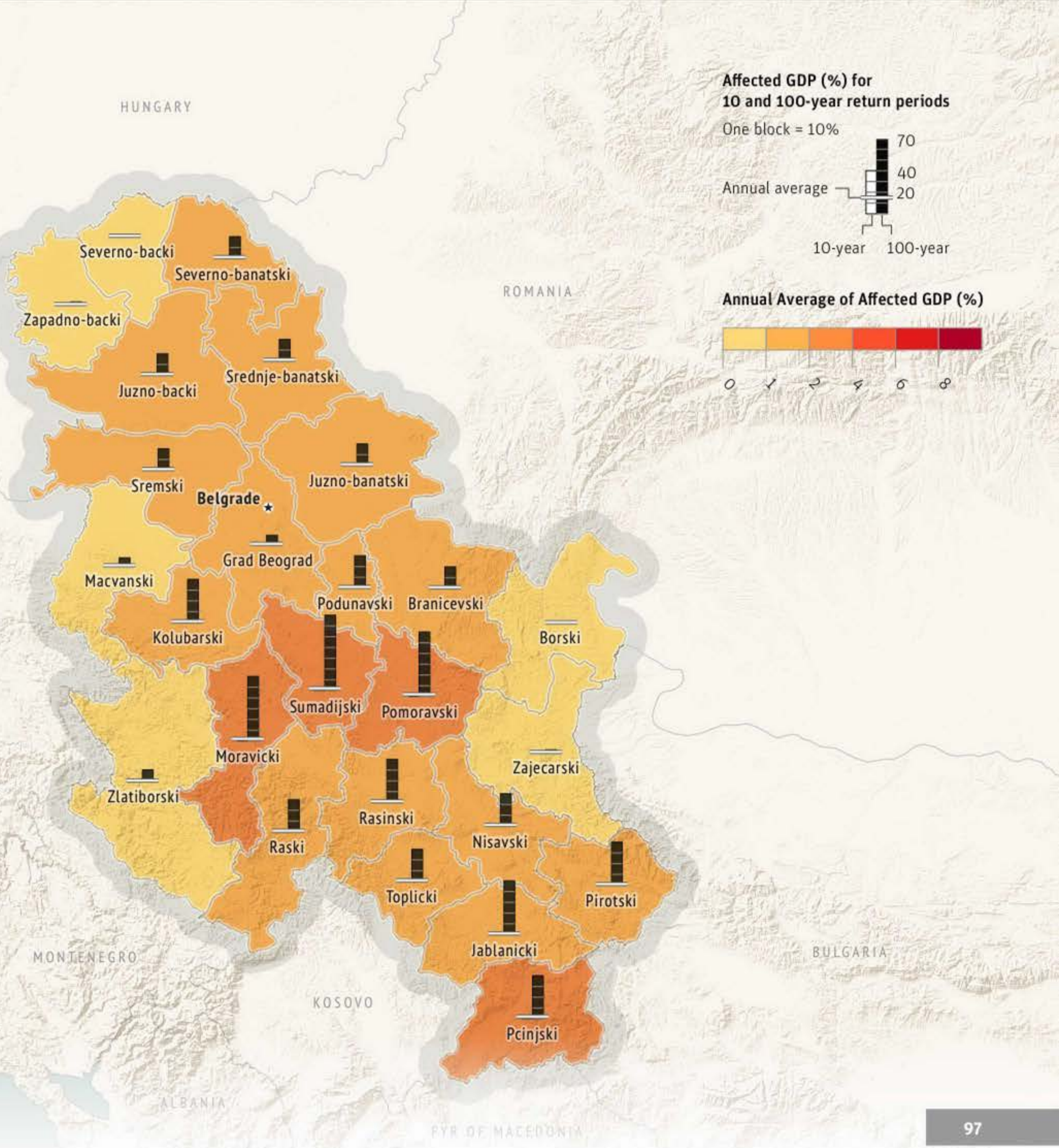
Serbia's worst earthquake since 1900 took place in 1922 in Belgrade, with a magnitude of 6. Another major earthquake occurred in 1740 and damaged Novi Sad. If the same earthquake were to occur today, it would have an estimated death toll of close to 200 and cause about $3 billion in damage. More recently, a 2010 earthquake caused two fatalities and more than $100 million in damage.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

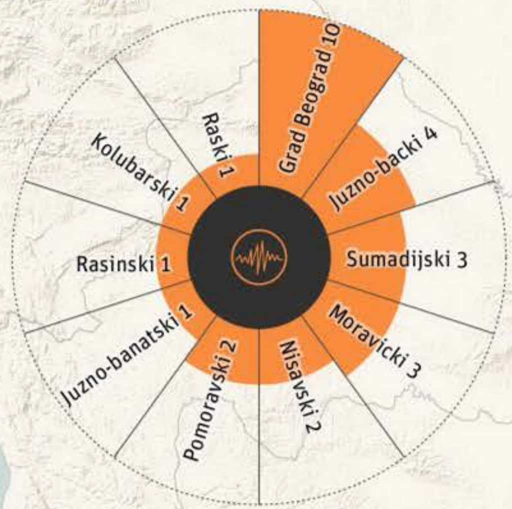
When an earthquake has a 10-year return period, it means the probability of occurrence of an earthquake of that magnitude or greater is 10 percent per year. A 100-year earthquake has a probability of occurrence of 1 percent per year. This means that over a long period of time, an earthquake of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year earthquake will occur exactly once every 100 years. In fact, it is possible for an earthquake of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make larger contributions to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

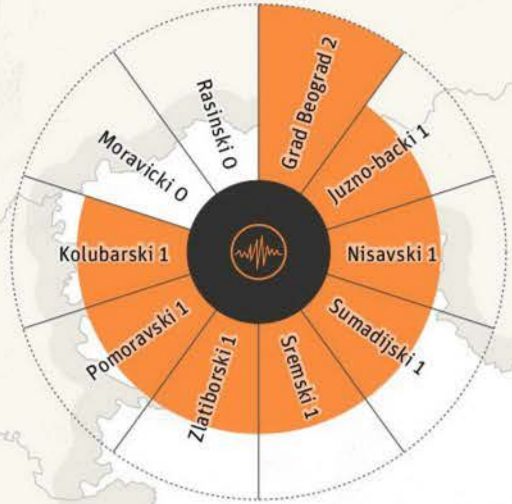
The annual average population affected by earthquakes in Serbia is about 60,000 and the annual average affected GDP about $300 million. The annual averages of fatalities and capital losses caused by earthquakes are about 10 and about $40 million, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause about 500 fatalities and $1 billion in capital loss (about 3 percent of GDP).



EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS (MILLIONS $)

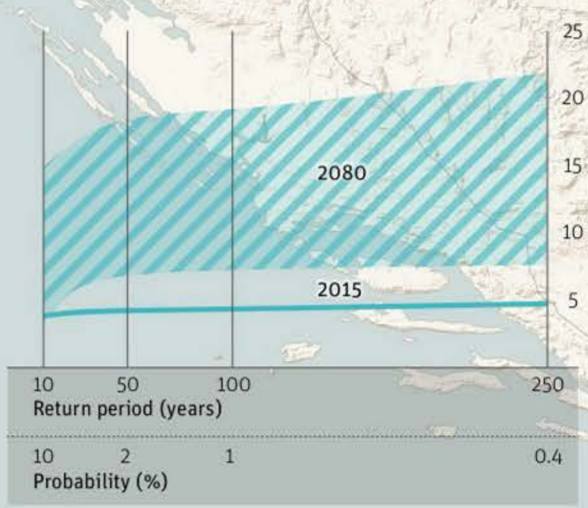


EARTHQUAKE
ANNUAL AVERAGE FATALITIES

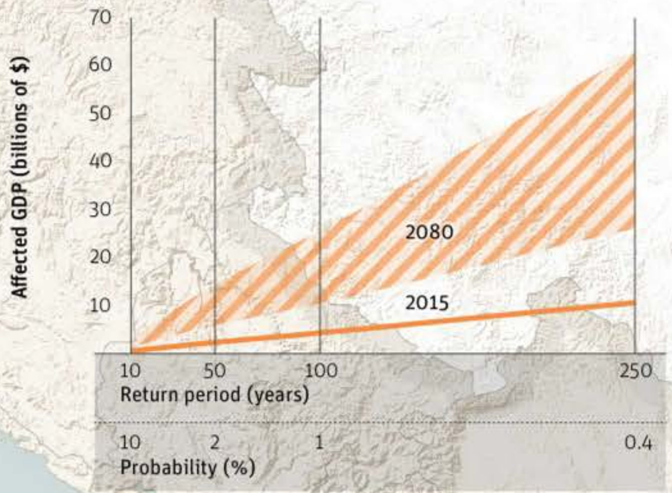


The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Grad Beograd, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if Serbia had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $4 billion. In 2080, however, the affected GDP from the same type of event would range from about $7 billion to about $20 billion. If Serbia had experienced a 250-year earthquake event in 2015, the estimated affected GDP would have been about $10 billion. In 2080, the affected GDP from the same type of event would range from about $25 billion to $60 billion, due to population growth, urbanization, and the increase in exposed assets.

All historical data on floods and earthquakes are from D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be; the National Geophysical Data Center/World Data Service (NGDC/WDS), Significant Earthquake Database (National Geophysical Data Center, NOAA), doi:10.7289/V5TD9V7K; and J. Daniell and A. Schaefer, "Eastern Europe and Central Asia Region Earthquake Risk Assessment Country and Province Profiling," final report to GFDRR, 2014. Damage estimates for all historical events have been inflated to 2015 US$.

Slovak Republic

GDP $86.4 billion*

Population 5.4 million*

AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
$10 billion (16%)	$20 billion (20%)	$2 billion (2%)
800,000 (15%)	700,000 (13%)	3 (<1%)

*2015 estimates

The Slovak Republic's population and economy are exposed to earthquakes and floods, with floods posing the greater risk. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

Just over half of the Slovak Republic's population lives in urban environments. The country's GDP was approximately US$86.4 billion in 2015, with more than 60 percent derived from services, most of the remainder generated by industry, and agriculture making a small contribution. The Slovak Republic's per capita GDP was $16,000.

This map displays GDP by province in the Slovak Republic, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of floods is Trnava, and the one at greatest risk of earthquakes is Bratislava. In absolute terms, the province at greatest risk of floods is Trnava, and the one at greatest risk of earthquakes is Bratislava.

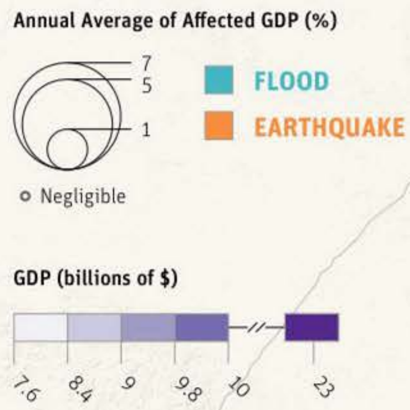
TOP AFFECTED PROVINCES

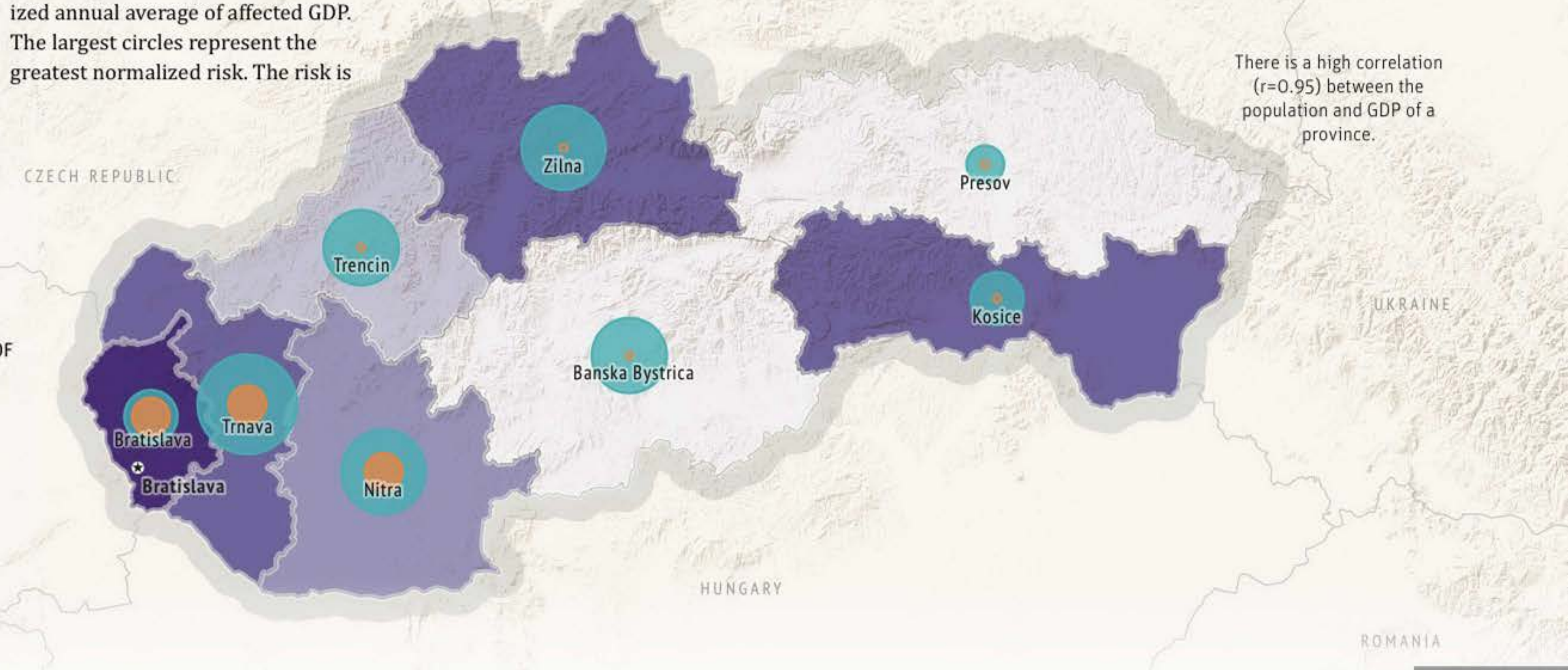
FLOOD
ANNUAL AVERAGE OF AFFECTED GDP (%)

Trnava	7
Zilna	5
Nitra	5
Banska Bystrica	4
Trencin	4
Kosice	2
Bratislava	2
Presov	1

EARTHQUAKE
ANNUAL AVERAGE OF AFFECTED GDP (%)

Bratislava	1
Nitra	1
Trnava	1
Kosice	0
Trencin	0
Presov	0
Banska Bystrica	0
Zilna	0





Slovak Republic FLOOD

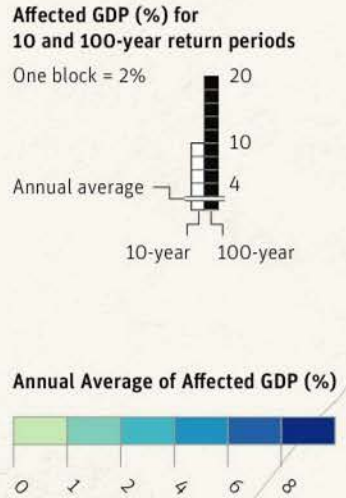
The most deadly flood in the Slovak Republic since it gained its independence in 1993 occurred in 1998 and caused more than 50 fatalities and over $60 million in damage. Flooding in 1999 caused just two fatalities but over $200 million in damage. Floods in 2001 and 2002 caused about $8 million and $4 million in damage, respectively. More recently, flooding in 2010 caused almost $30 million in damage. This record highlights the Slovak Republic's great vulnerability to floods, whose rapid succession has a large cumulative effect on the country.

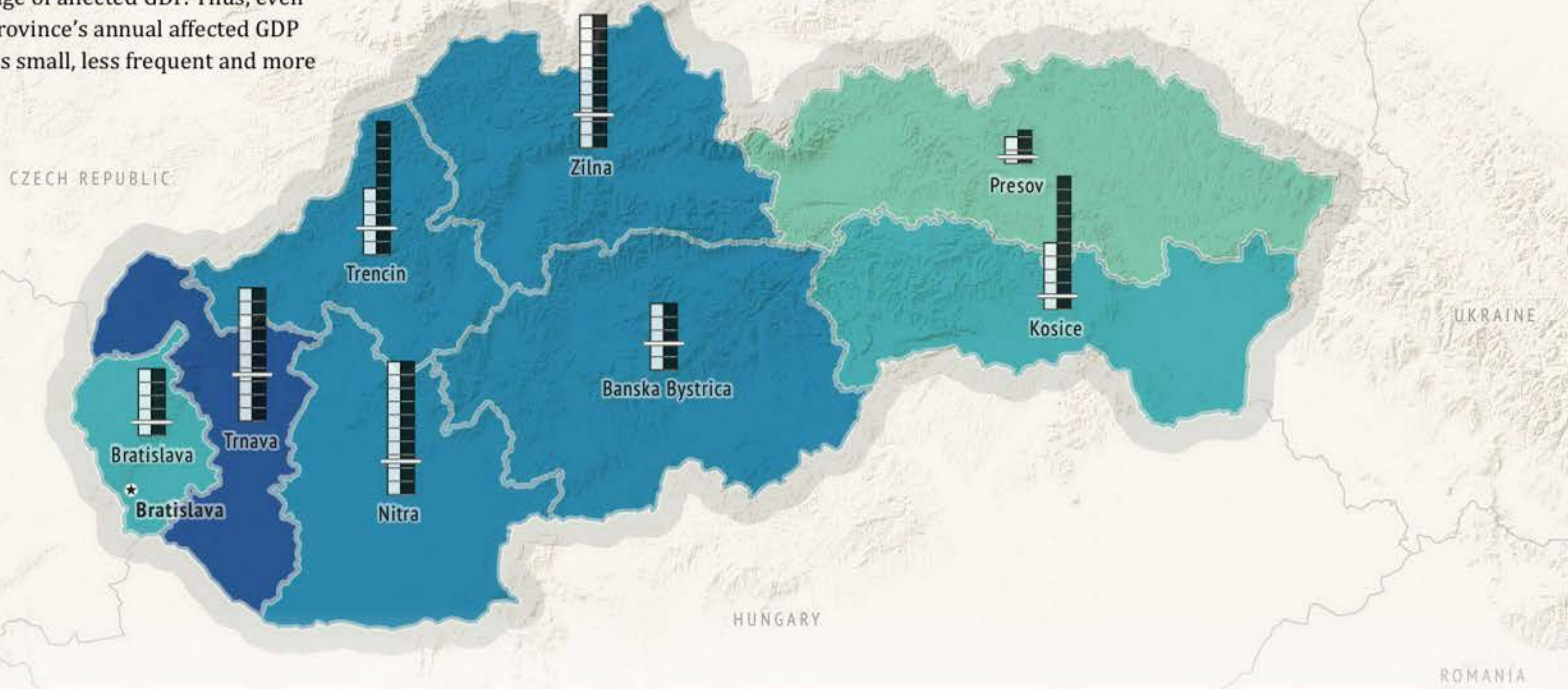
This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in the Slovak Republic is about 200,000 and the annual average affected GDP about $3 billion. Within the various provinces, the 10- and 100-year impacts do not differ much, so relatively frequent floods have large impacts on these averages.





The most significant earthquake since 1900 to affect the Slovak Republic occurred in 1906, while one of the earliest known occurred in 1443, near Banska Stiavnica.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

When an earthquake has a 10-year return period, it means the probability of occurrence of an earthquake of that magnitude or greater is 10 percent per year. A 100-year earthquake has a probability of occurrence of 1 percent per year. This means that over a long period of time, an earthquake of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year earthquake will occur exactly once every 100 years. In fact, it is possible for an earthquake of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

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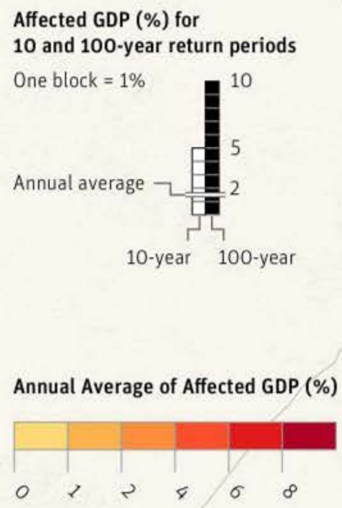
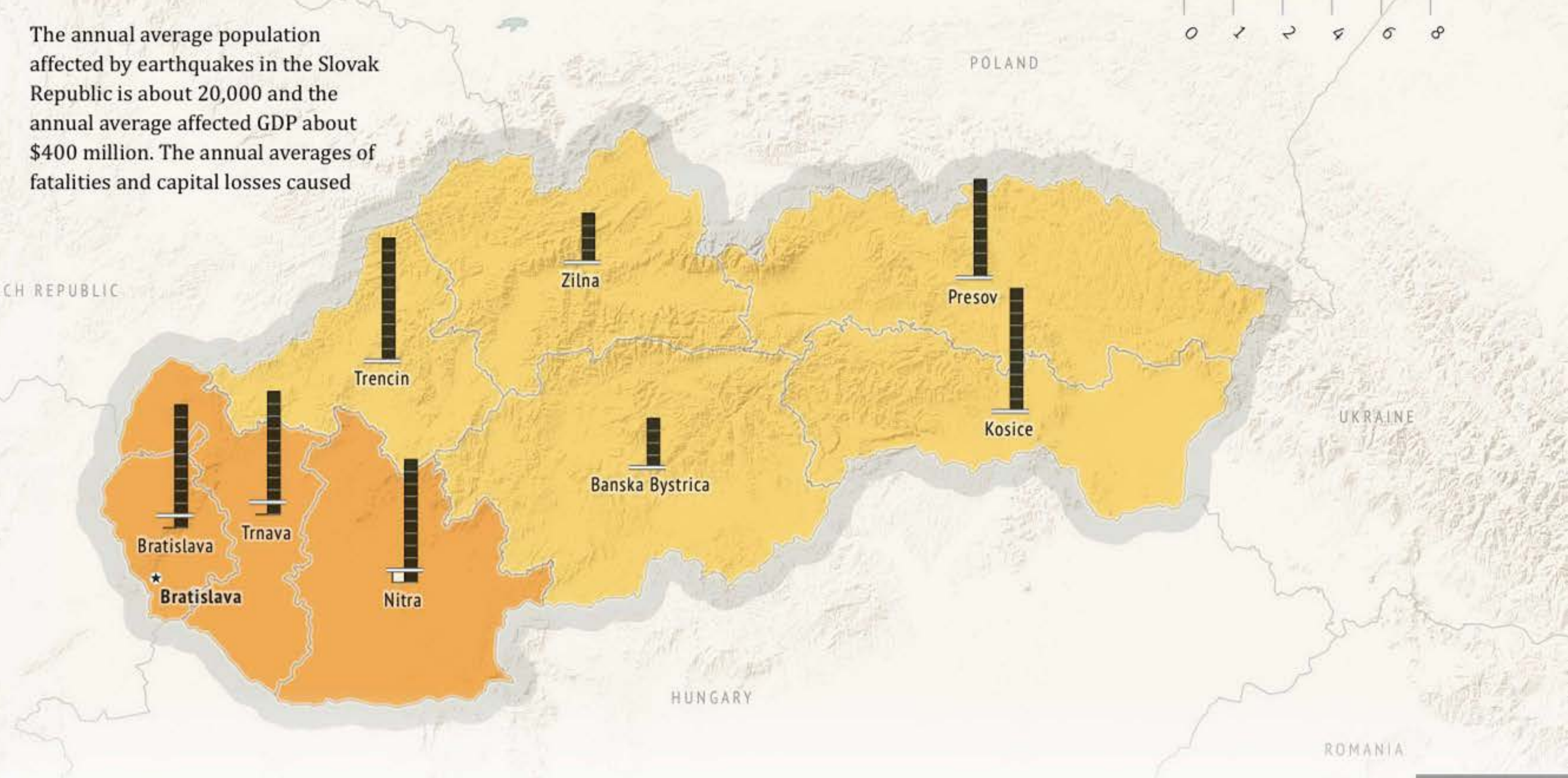
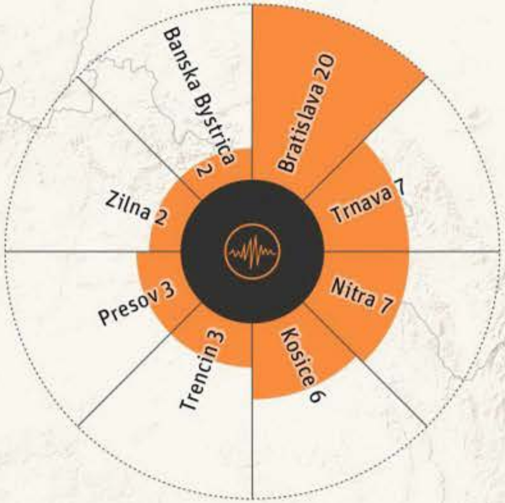
The annual average population affected by earthquakes in the Slovak Republic is about 20,000 and the annual average affected GDP about $400 million. The annual averages of fatalities and capital losses caused by earthquakes are about one and about $50 million, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause about $2 billion in capital loss (about 2 percent of GDP).





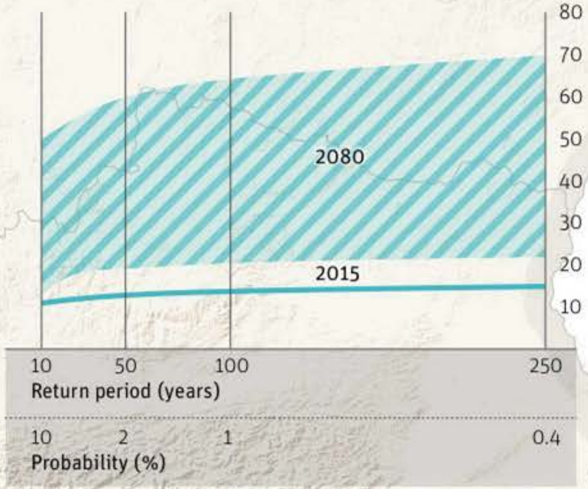
EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS (MILLIONS $)



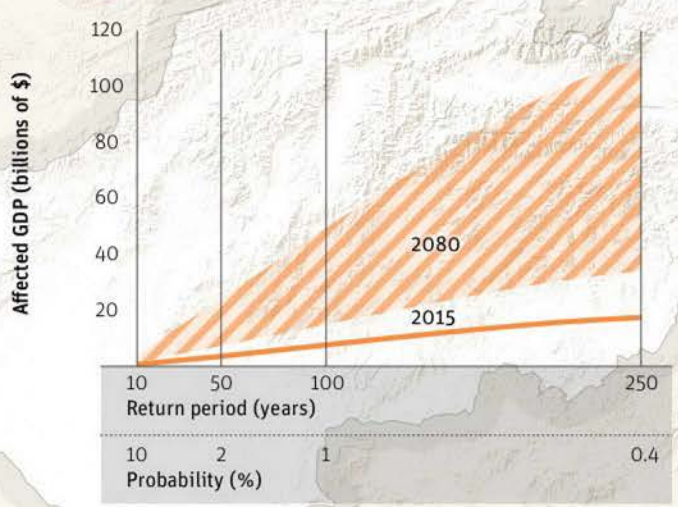
EARTHQUAKE
ANNUAL AVERAGE FATALITIES

The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Bratislava, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if the Slovak Republic had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $10 billion. In 2080, however, the affected GDP from the same type of event would range from about $20 billion to about $70 billion. If the Slovak Republic had experienced a 250-year earthquake event in 2015, the affected GDP would have been about $20 billion. In 2080, the affected GDP from the same type of event would range from about $30 billion to about $100 billion, due to population growth, urbanization, and the increase in exposed assets.

All historical data on floods and earthquakes are from, respectively, D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be, and J. Daniell and A. Schaefer, "Eastern Europe and Central Asia Region Earthquake Risk Assessment Country and Province Profiling," final report to GFDRR, 2014. Damage estimates for all historical events have been inflated to 2015 US$.

Slovenia

	AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
GDP $44.5 billion*	$5 billion (10%)	$20 billion (51%)	$4 billion (8%)
Population 2.1 million*	200,000 (11%)	900,000 (43%)	1,000 (<1%)

*2015 estimates

Slovenia's population and economy are exposed to earthquakes and floods, with earthquakes posing the greater risk of a high impact, lower probability event. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

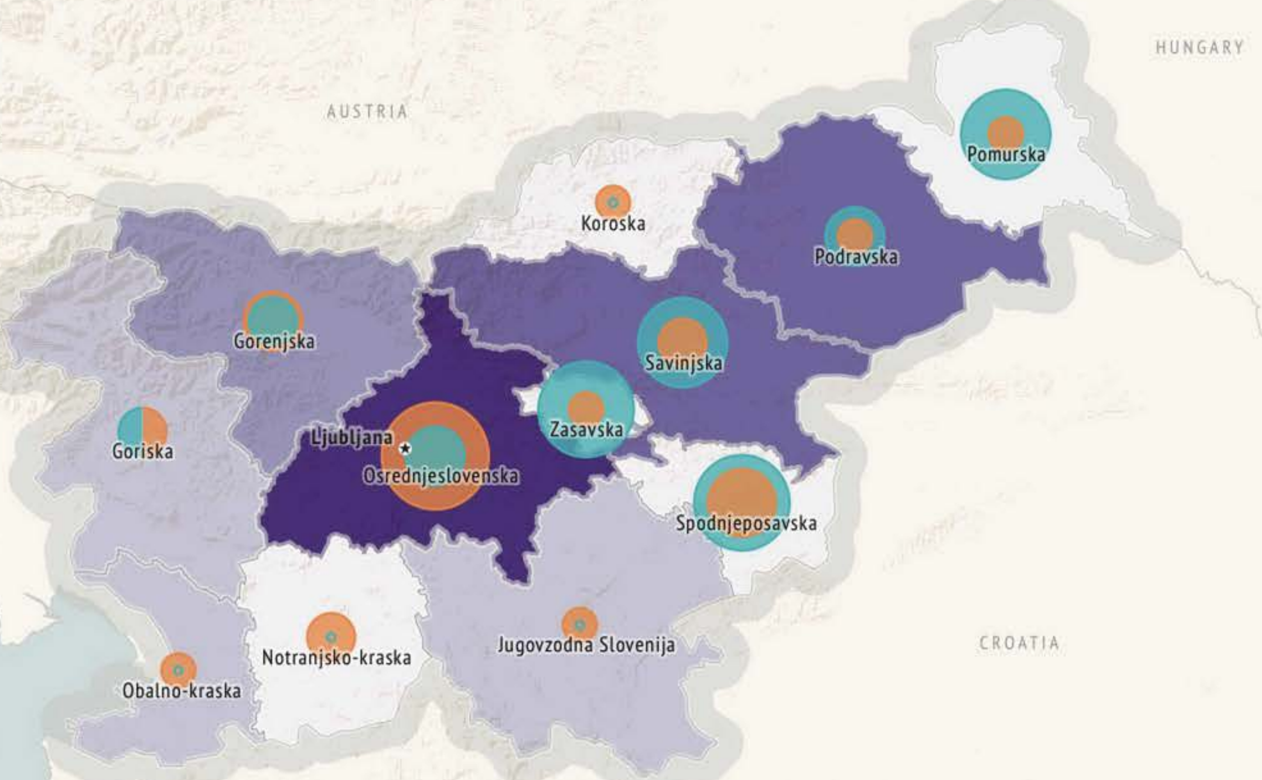
Just over half of Slovenia's population lives in rural environments. The country's GDP was approximately US$44.5 billion in 2015, with close to 70 percent derived from services, most of the remainder generated by industry, and agriculture making a small contribution. Slovenia's per capita GDP was $21,500.

This map displays GDP by province in Slovenia, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of floods is Spodnjeposavska, and the one at greatest risk of earthquakes is Osrednjeslovenska. In absolute terms, the province at greatest risk of both floods and earthquakes is Osrednjeslovenska.

TOP AFFECTED PROVINCES

FLOOD ANNUAL AVERAGE OF AFFECTED GDP (%)		EARTHQUAKE ANNUAL AVERAGE OF AFFECTED GDP (%)	
Spodnjeposavska	8	Osrednjeslovenska	10
Zasavska	8	Spodnjeposavska	4
Savinjska	7	Gorenjska	3
Pomurska	7	Notranjsko-kraska	2
Podravska	3	Goriska	2
Osrednjeslovenska	3	Savinjska	2
Goriska	2	Jugovzodna Slovenija	1
Gorenjska	2	Zasavska	1
Jugovzodna Slovenija	0	Obalno-kraska	1
Koroska	0	Podravska	1



There is a high correlation (r=0.95) between the population and GDP of a province.

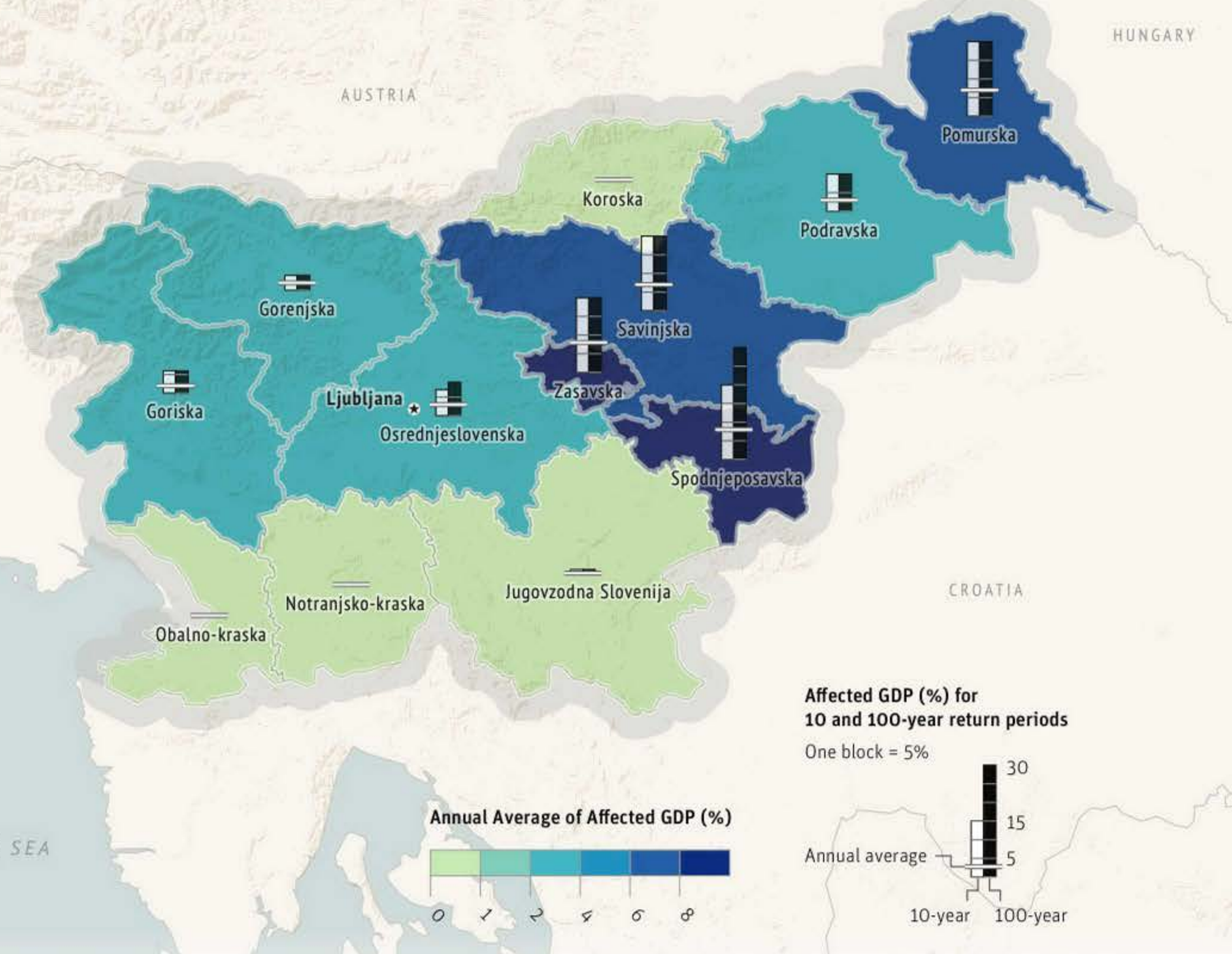
The worst flood in Slovenia since it gained its independence in 1991 occurred in 2012. It affected more than 10,000 people and caused almost $300 million in damage. Flooding in 2005 generated about $6 million in damage.

This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in Slovenia is about 70,000 and the annual average affected GDP about $1 billion. Within the various provinces, the 10- and 100-year impacts do not differ much, so relatively frequent floods have large impacts on these averages.



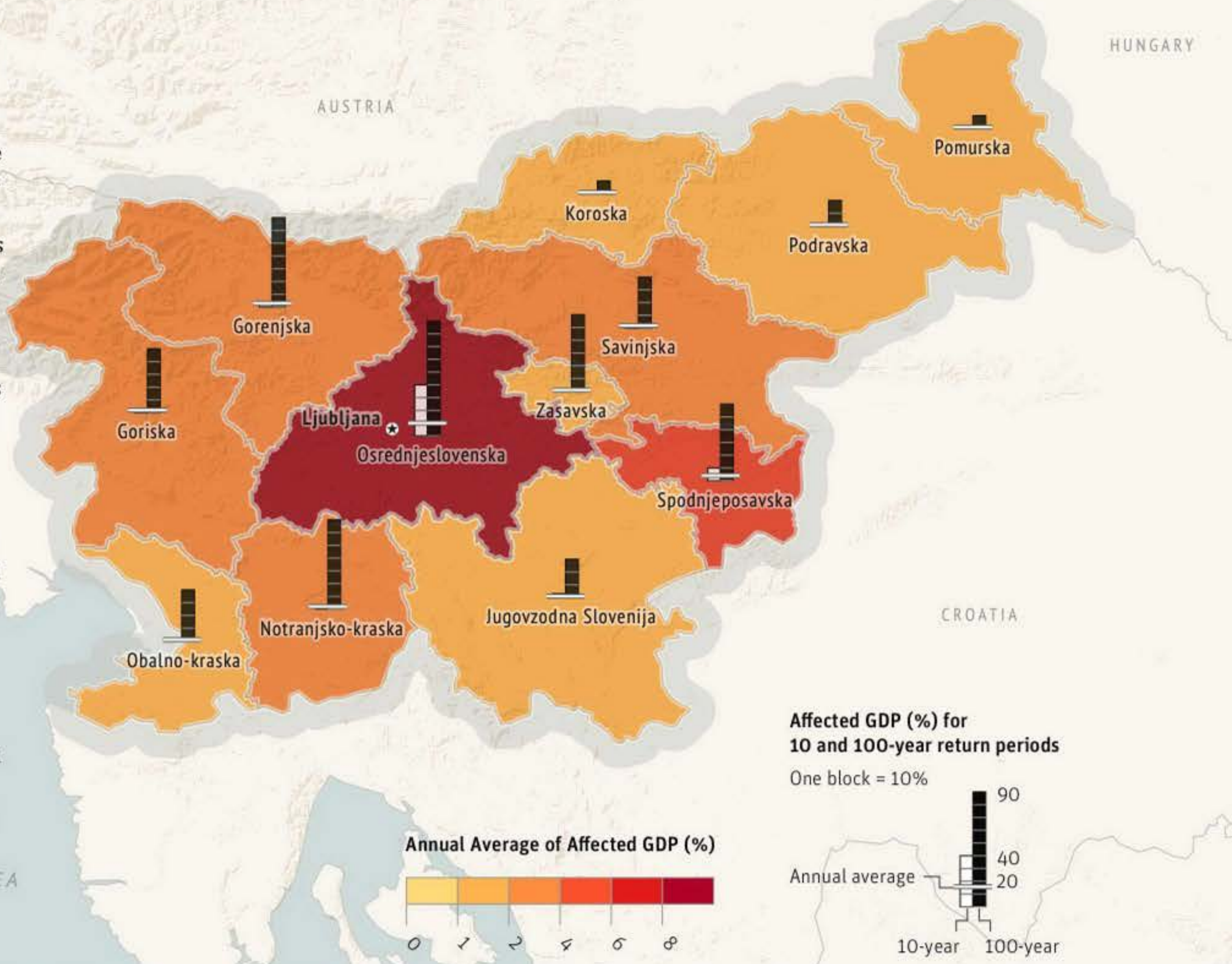
Slovenia's worst earthquake since it gained its independence in 1991 took place in 2004, with a magnitude of 5.2, and caused over $10 million in damage. Slovenia was also affected by a 1976 earthquake in Friuli, Italy, which left 13,000 people homeless in Slovenia's Soca Valley and caused much damage there.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

When an earthquake has a 10-year return period, it means the probability of occurrence of an earthquake of that magnitude or greater is 10 percent per year. A 100-year earthquake has a probability of occurrence of 1 percent per year. This means that over a long period of time, an earthquake of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year earthquake will occur exactly once every 100 years. In fact, it is possible for an earthquake of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make larger contributions to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by earthquakes in Slovenia is about 80,000 and the annual average affected GDP about $2 billion. The annual averages of fatalities and capital losses caused by earthquakes are about 50 and about $200 million, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause about 1,000 fatalities and $4 billion in capital loss (about 8 percent of GDP).

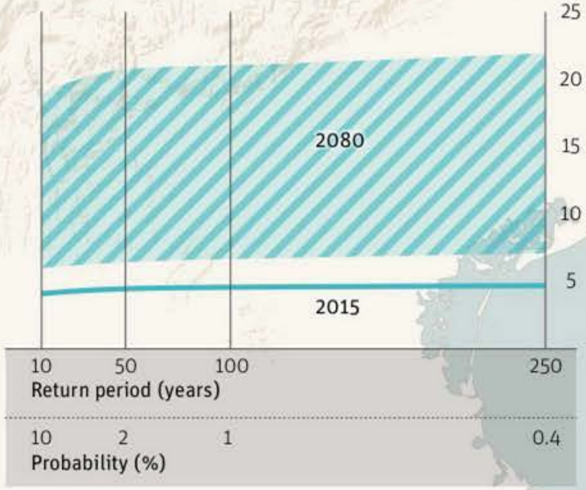


EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS (MILLIONS $)

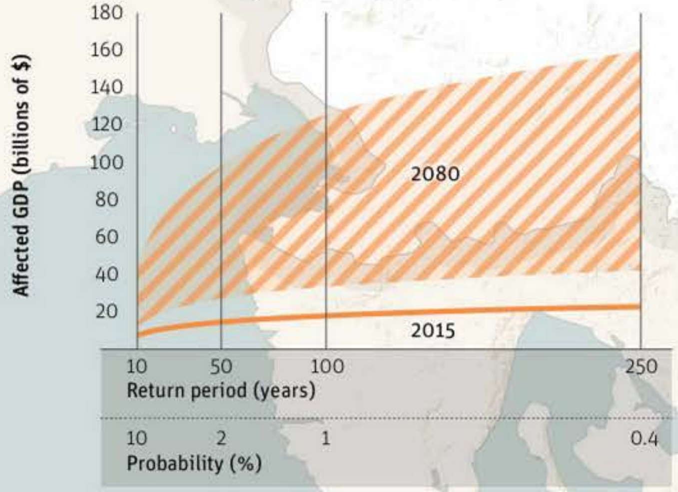
EARTHQUAKE
ANNUAL AVERAGE FATALITIES

The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Osrednjeslovenska, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if Slovenia had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $5 billion. In 2080, however, the affected GDP from the same type of event would range from about $7 billion to about $20 billion. If Slovenia had experienced a 250-year earthquake event in 2015, the affected GDP would have been about $20 billion. In 2080, the affected GDP from the same type of event would range from about $40 billion to about $150 billion, due to population growth, urbanization, and the increase in exposed assets.

All historical data on floods and earthquakes are from D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be, and J. Daniell and A. Schaefer, “Eastern Europe and Central Asia Region Earthquake Risk Assessment Country and Province Profiling,” final report to GFDRR, 2014. Damage estimates for all historical events have been inflated to 2015 US$.

Tajikistan

GDP $6.9 billion*

Population 8.5 million*

	AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
GDP	$500 million (8%)	$5 billion (70%)	$2 billion (34%)
Population	600,000 (8%)	6 million (69%)	10,000 (<1%)

*2015 estimates

Tajikistan's population and economy are exposed to earthquakes and floods, with earthquakes posing the greater risk of a high impact, lower probability event. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

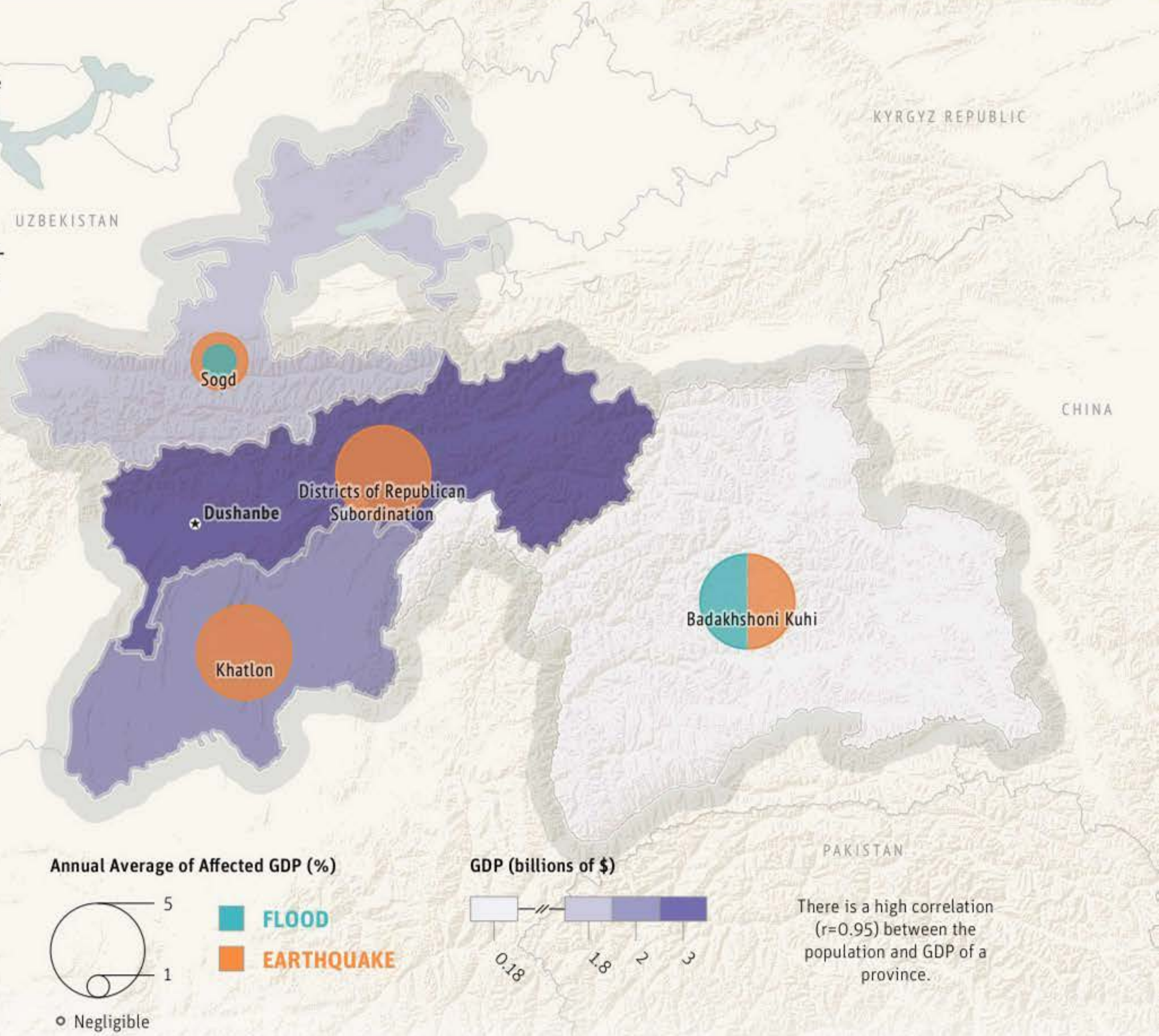
Almost 75 percent of Tajikistan's population lives in rural environments. The country's GDP was approximately US$6.9 billion in 2015, with just over half derived from services, and agriculture and industry generating the remainder. Tajikistan's per capita GDP was $810.

This map displays GDP by province in Tajikistan, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of floods is Badakhsoni Kuni, and the one at greatest risk of earthquakes is Districts of Republican Subordination. In absolute terms, it is Districts of Republican Subordination.

TOP AFFECTED PROVINCES

FLOOD ANNUAL AVERAGE OF AFFECTED GDP (%)		EARTHQUAKE ANNUAL AVERAGE OF AFFECTED GDP (%)	
Badakhshoni Kuni	5	Districts of Republican Subordination	5
Sogd	2	Khatlon	5
Tadzhikistan Territories	1	Badakhshoni Kuni	5
Khatlon	1	Sogd	3



There is a high correlation (r=0.95) between the population and GDP of a province.

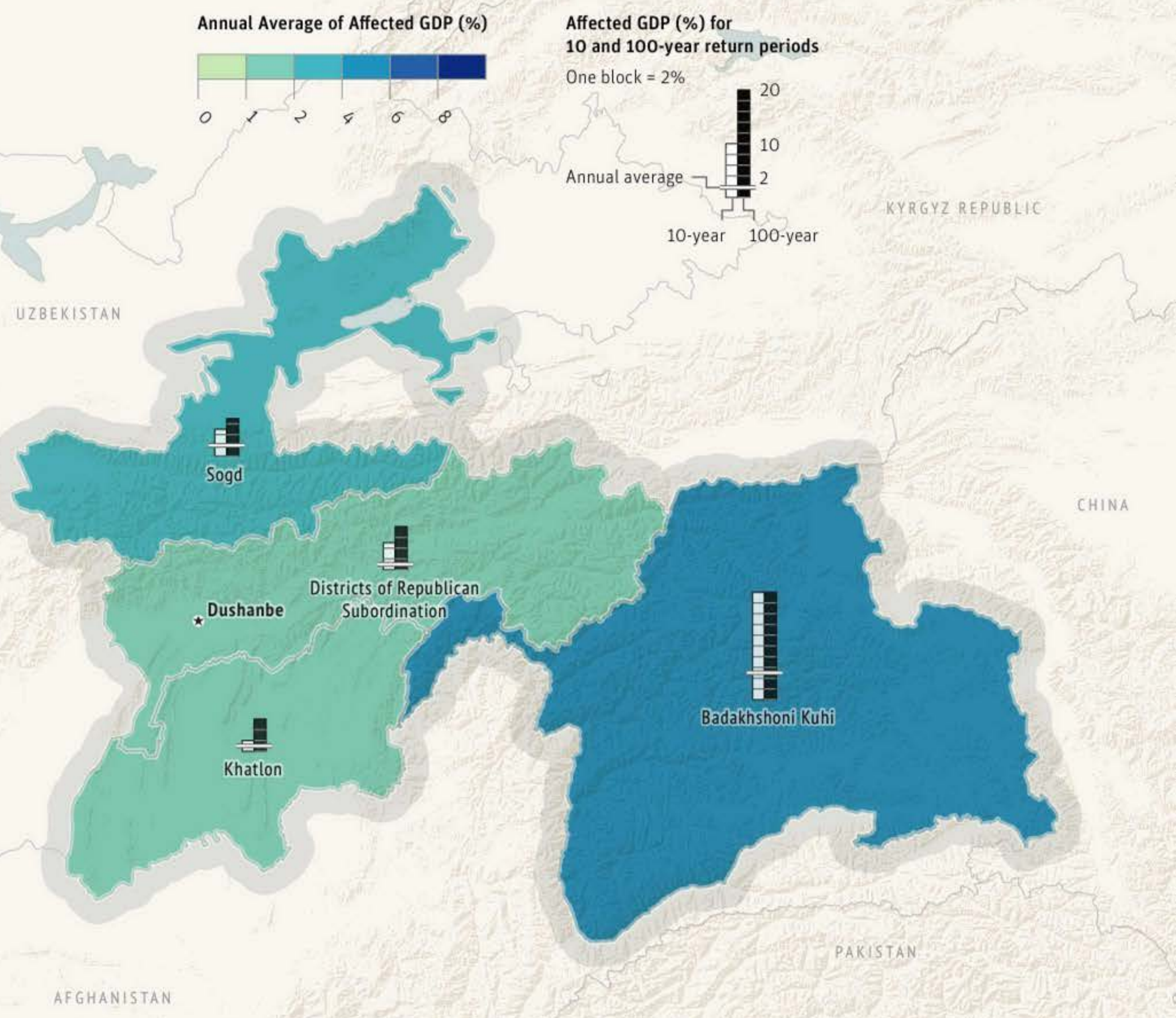
The most devastating flood in Tajikistan since it gained its independence in 1991 occurred in 1992. It caused over 1,300 fatalities and about $500 million in damage. Flooding in 1998 caused more than 50 deaths and close to $100 million in damage. A flood in 2005 caused no fatalities, but about $60 million in damage. In 2010, flooding caused over 70 fatalities and over $200 million in damage. Damage from further floods in 1999, 2002, and 2007 was significantly less, but each event caused over 20 deaths. This record highlights Tajikistan's great vulnerability to floods, the rapid succession of which has a large cumulative effect on the country.

This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in Tajikistan is about 100,000 and the annual average affected GDP about $100 million. Within the various provinces, the 10- and 100-year impacts do not differ much, so relatively frequent floods have large impacts on these averages.



Tajikistan's worst earthquake since 1900 took place in 1907 in Karatag (Qaratog), with a magnitude of 7.4. It caused about 14,000 fatalities and almost $200 million in damage. Another major earthquake occurred in 1949 in Khait. The landslide it triggered killed approximately 12,000 people. Other earthquakes that have affected Tajikistan occurred in 1815, 1895, 1924, 1930, 1985, and 1989.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

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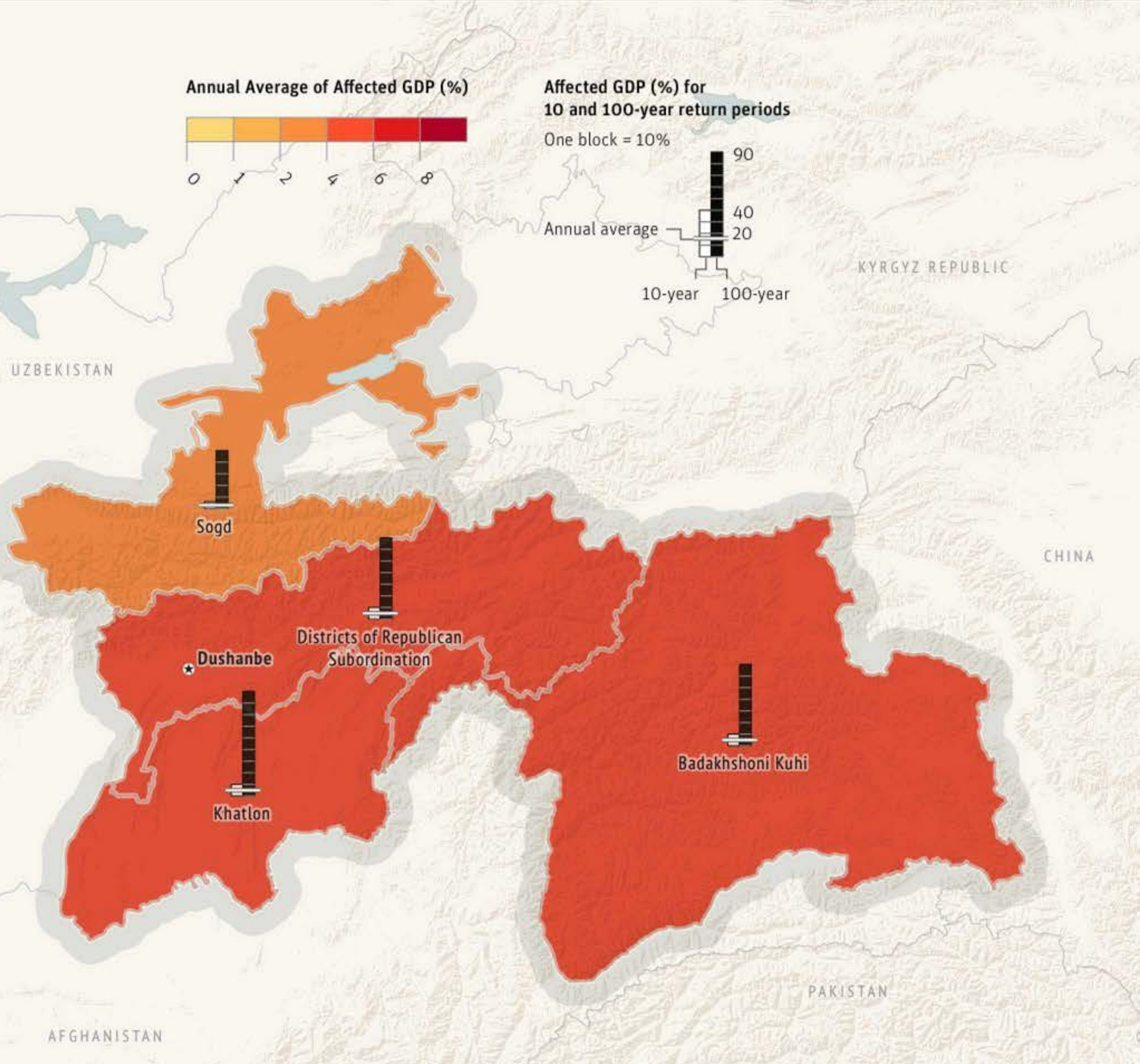
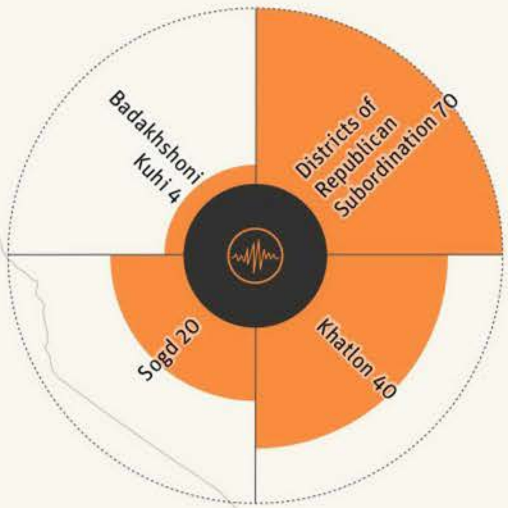
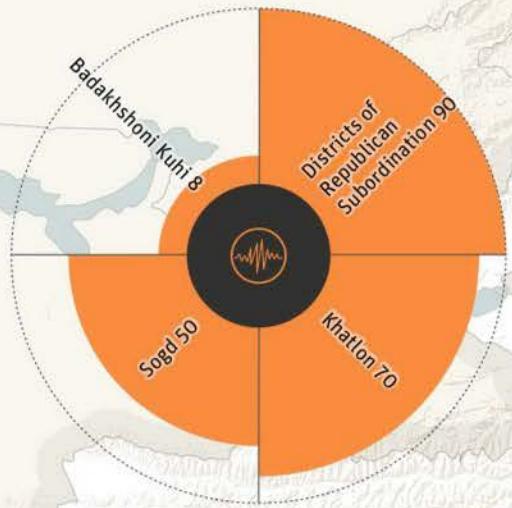
The annual average population affected by earthquakes in Tajikistan is about 400,000 and the annual average affected GDP about $300 million. The annual averages of fatalities and capital losses caused by earthquakes are about 200 and about $100 million, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause about 10,000 fatalities and $2 billion in capital loss (about 30 percent of GDP).



EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS (MILLIONS $)

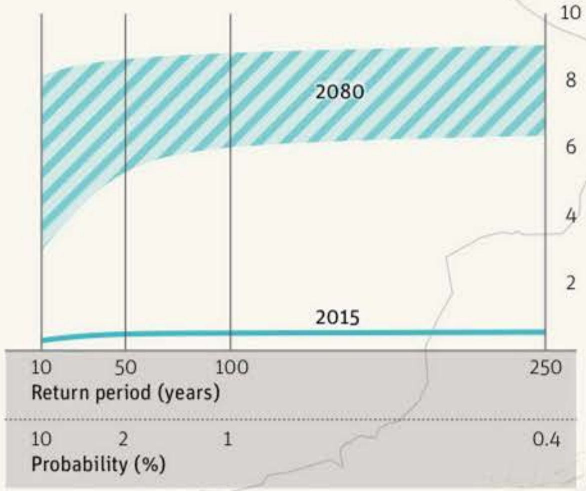


EARTHQUAKE
ANNUAL AVERAGE FATALITIES

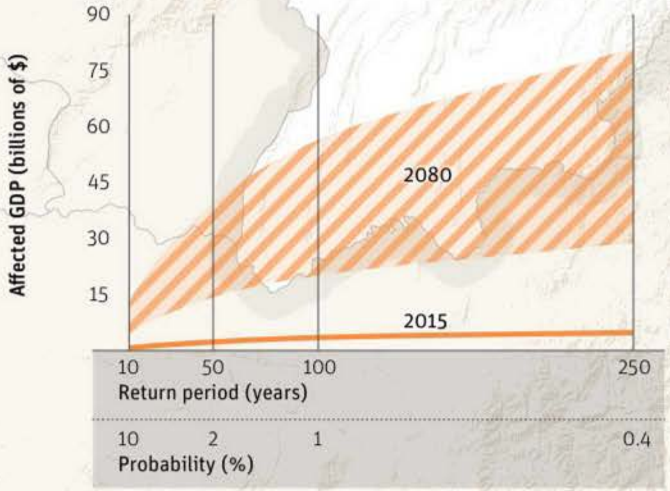


The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Districts of Republican Subordination, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if Tajikistan had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $500 million. In 2080, however, the affected GDP from the same type of event would range from about $6 billion to about $9 billion. If Tajikistan had experienced a 250-year earthquake event in 2015, the affected GDP would have been about $5 billion. In 2080, the affected GDP from the same type of event would range from about $30 billion to about $80 billion, due to population growth, urbanization, and the increase in exposed assets.

All historical data on floods and earthquakes are from, respectively, D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be, and J. Daniell and A. Schaefer, "Eastern Europe and Central Asia Region Earthquake Risk Assessment Country and Province Profiling," final report to GFDRR, 2014. Damage estimates for all historical events have been inflated to 2015 US$.

WORLD BANK GROUP | GFDRR

EUROPE AND CENTRAL ASIA (ECA)
RISK PROFILES

Turkey

GDP $699 billion*

Population 78.1 million*

	AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
GDP	$20 billion (3%)	$300 billion (38%)	$60 billion (8%)
Population	3 million (3%)	20 million (27%)	80,000 (<1%)

*2015 estimates

Turkey's population and economy are exposed to earthquakes and floods, with earthquakes posing the greater risk of a high impact, lower probability event. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

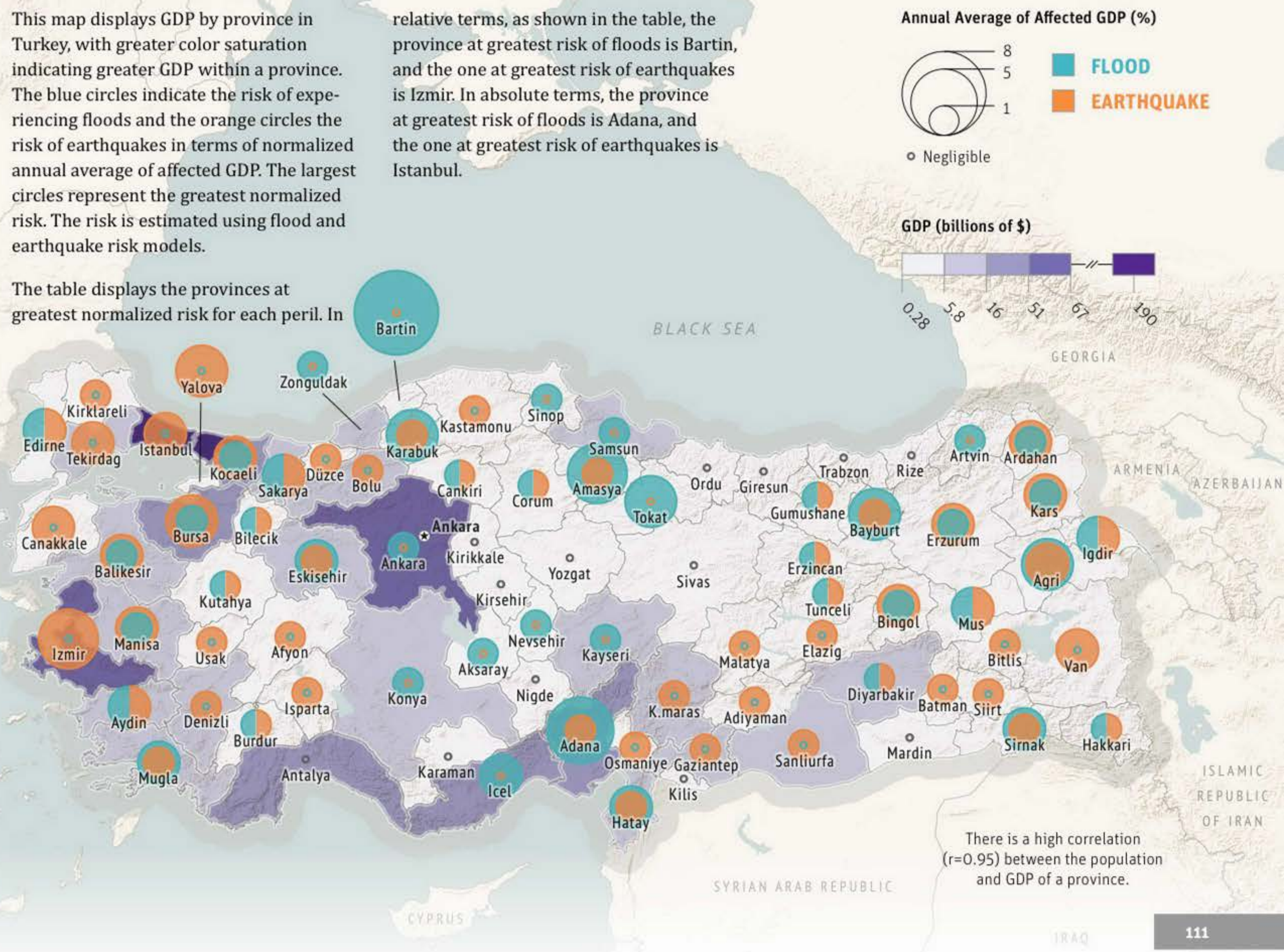
Almost 75 percent of Turkey's population lives in urban environments. The country's gross domestic product (GDP) was approximately US$699 billion in 2015, with more than 60 percent derived from services, most of the remainder generated by industry, and agriculture making a small contribution. Turkey's per capita GDP was $8,940.

TOP AFFECTED PROVINCES

FLOOD ANNUAL AVERAGE OF AFFECTED GDP (%)		EARTHQUAKE ANNUAL AVERAGE OF AFFECTED GDP (%)	
Bartin	8	Izmir	4
Adana	4	Bursa	3
Amasya	4	Yalova	3
Bayburt	3	Istanbul	2
Tokat	3	Canakkale	2
Agri	3	Manisa	2
Karabuk	3	Edirne	2
Igdir	2	Erzurum	2
Hatay	2	Van	2
Sakarya	2	Igdir	2

This map displays GDP by province in Turkey, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of floods is Bartin, and the one at greatest risk of earthquakes is Izmir. In absolute terms, the province at greatest risk of floods is Adana, and the one at greatest risk of earthquakes is Istanbul.



There is a high correlation (r=0.95) between the population and GDP of a province.

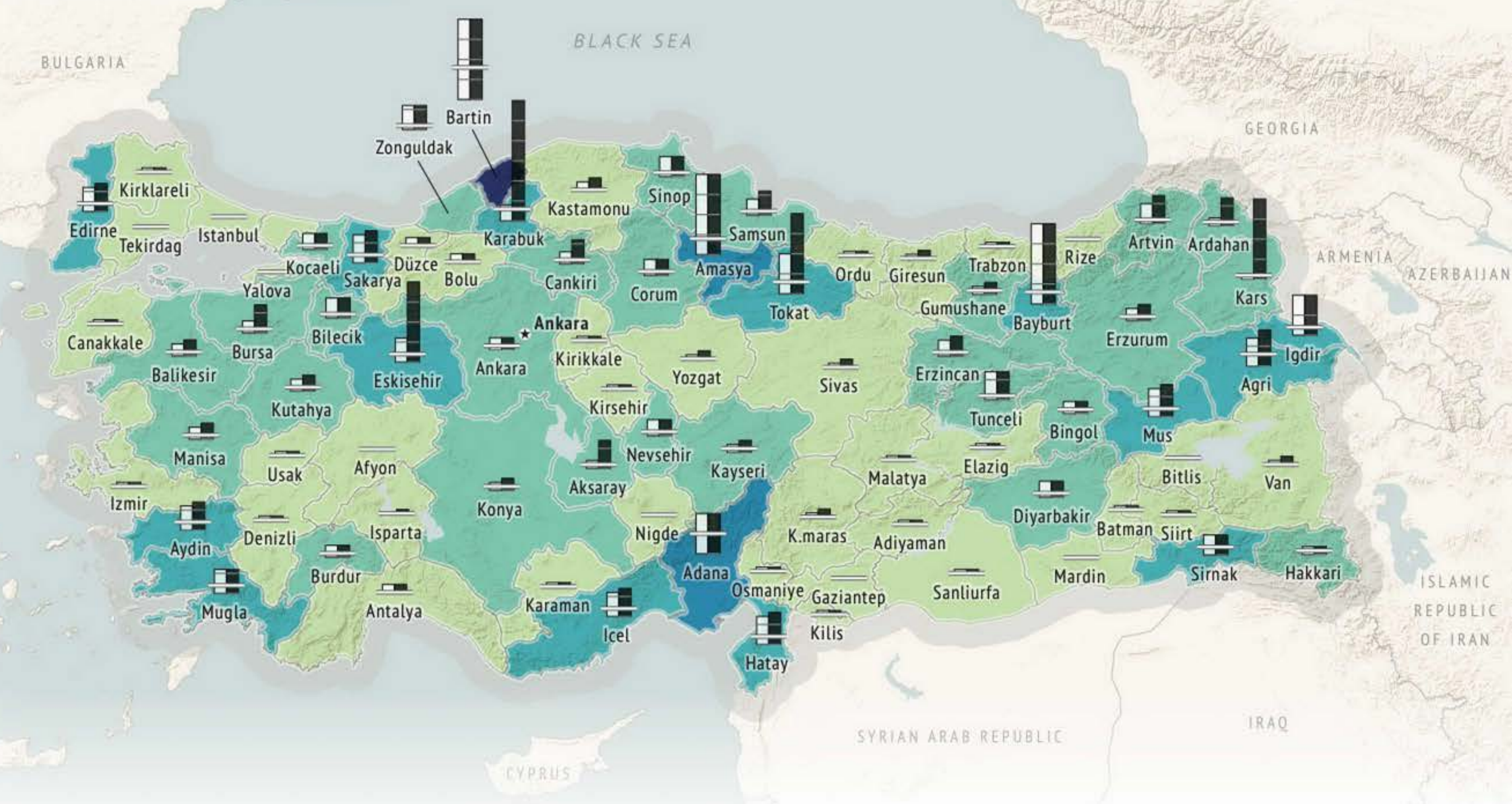
The most devastating flood in Turkey since 1900 occurred in 1998. It affected over 1 million people and caused over $1 billion in damage. Flooding in 2006 caused almost $400 million in damage, while further floods in 2009 caused about $600 million in damage.

This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in Turkey is about 600,000 and the annual average affected GDP about $5 billion. For most provinces, in which the impacts from 10- and 100-year floods do not differ much, relatively frequent floods have large impacts on these averages. For the few in which the 100-year impacts are much greater than the 10-year impacts, less frequent events make a significant contribution to the annual average of affected GDP.



Turkey's most deadly earthquake since 1900 took place in 1939 in Erzincan, with a magnitude of 7.7. It caused more than 30,000 fatalities and over $300 million in damage. A 1999 earthquake with a magnitude of 7.6 caused nearly 18,000 deaths, affected over 1 million people, and caused close to $30 billion in damage.

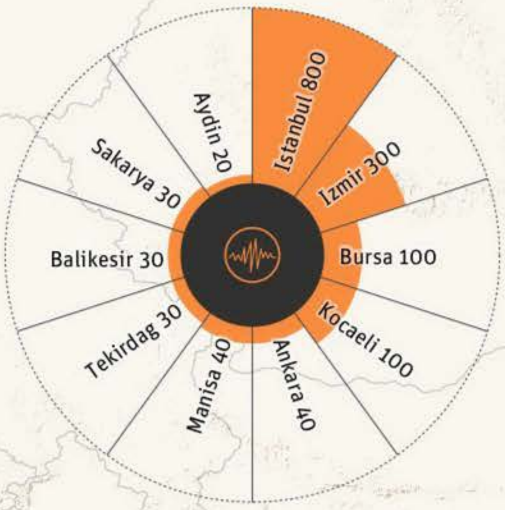
This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

When an earthquake has a 10-year return period, it means the probability of occurrence of an earthquake of that magnitude or greater is 10 percent per year. A 100-year earthquake has a probability of occurrence of 1 percent per year. This means that over a long period of time, an earthquake of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year earthquake will occur exactly once every 100 years. In fact, it is possible for an earthquake of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

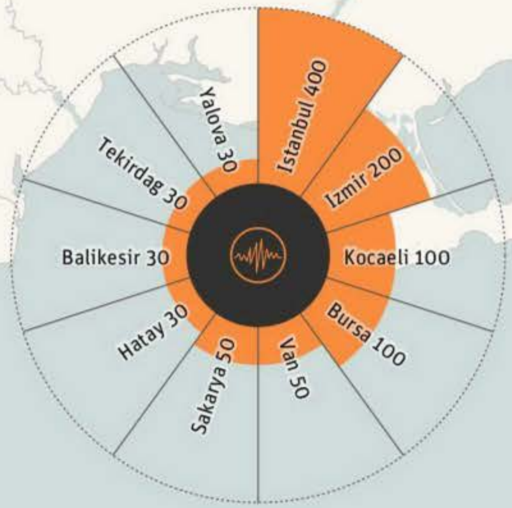
If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make larger contributions to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by earthquakes in Turkey is about 1 million and the annual average affected GDP $10 billion. The annual averages of fatalities and capital losses caused by earthquakes are about 1,000 and about $2 billion, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause about 80,000 fatalities and $60 billion in capital loss (about 8 percent of GDP).

EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS (MILLIONS $)

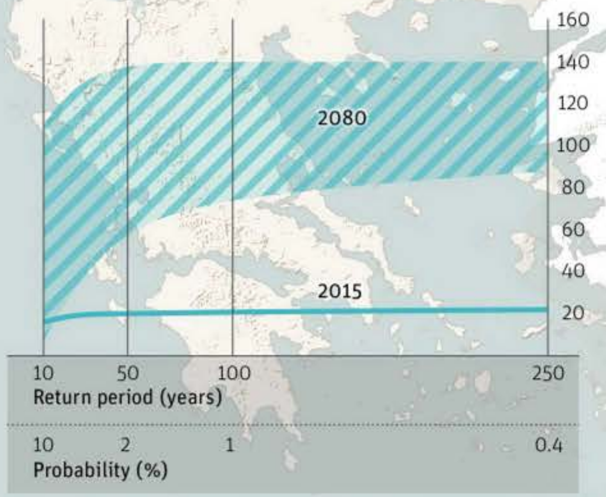


EARTHQUAKE
ANNUAL AVERAGE FATALITIES

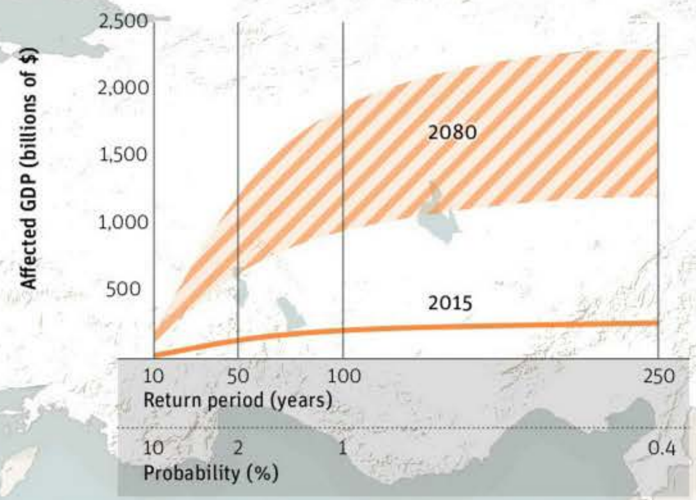


The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Istanbul, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if Turkey had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $20 billion. In 2080, however, the estimated affected GDP from the same type of event would range from about $80 billion to about $140 billion. If Turkey had experienced a 250-year earthquake event in 2015, the affected GDP would have been about $300 billion. In 2080, the affected GDP from the same type of event would range from about $1 trillion to about $2 trillion, due to population growth, urbanization, and the increase in exposed assets.

All historical data on floods and earthquakes are from, respectively, D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be, and the National Geophysical Data Center/World Data Service (NGDC/WDS), Significant Earthquake Database (National Geophysical Data Center, NOAA), doi:10.7289/V5TD9V7K. Damage estimates for all historical events have been inflated to 2015 US$.

WORLD BANK GROUP GFDRR

EUROPE AND CENTRAL ASIA (ECA) RISK PROFILES

Turkmenistan

GDP $50.0 billion*

Population 5.4 million*

	AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
GDP	$3 billion (7%)	$30 billion (52%)	$5 billion (10%)
Population	400,000 (7%)	3 million (50%)	10,000 (<1%)

*2015 estimates

Turkmenistan's population and economy are exposed to earthquakes and floods, with earthquakes posing the greater risk of a high impact, lower probability event. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

Just over half of Turkmenistan's population lives in rural environments. The country's GDP was approximately US$50.0 billion in 2015, with close to 50 percent derived from industry, most of the remainder generated by services, and agriculture making a small contribution. Turkmenistan's per capita GDP was $9,230.

This map displays GDP by province in Turkmenistan, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of floods is Chardzhou, and the one at greatest risk of earthquakes is Turkmenistan Territories. In absolute terms, it is Turkmenistan Territories.

TOP AFFECTED PROVINCES

FLOOD

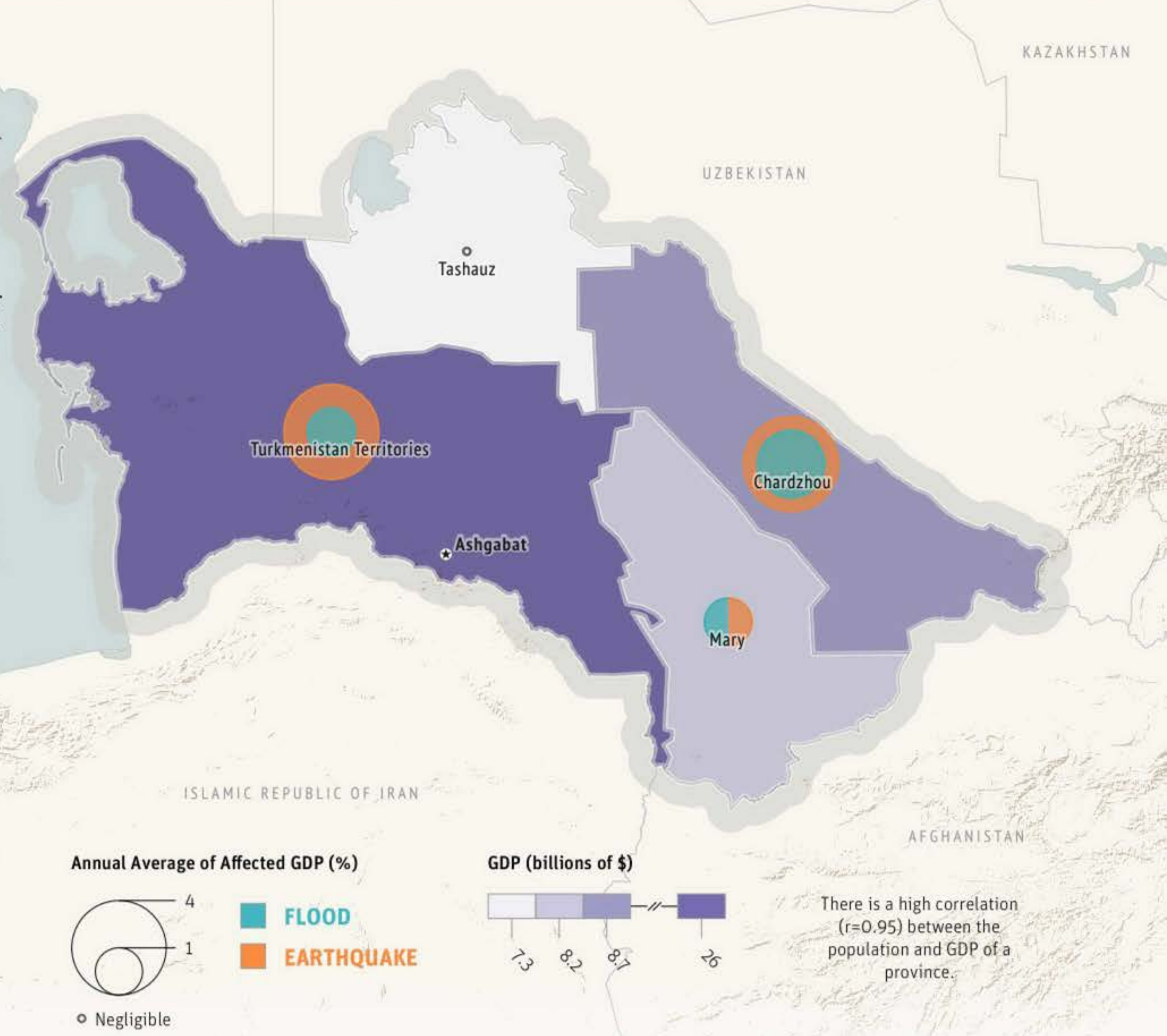
ANNUAL AVERAGE OF AFFECTED GDP (%)

Chardzhou	2
Turkmenistan Territories	1
Mary	1
Tashauz	0

EARTHQUAKE

ANNUAL AVERAGE OF AFFECTED GDP (%)

Turkmenistan Territories	4
Chardzhou	4
Mary	1
Tashauz	0



There is a high correlation (r=0.95) between the population and GDP of a province.

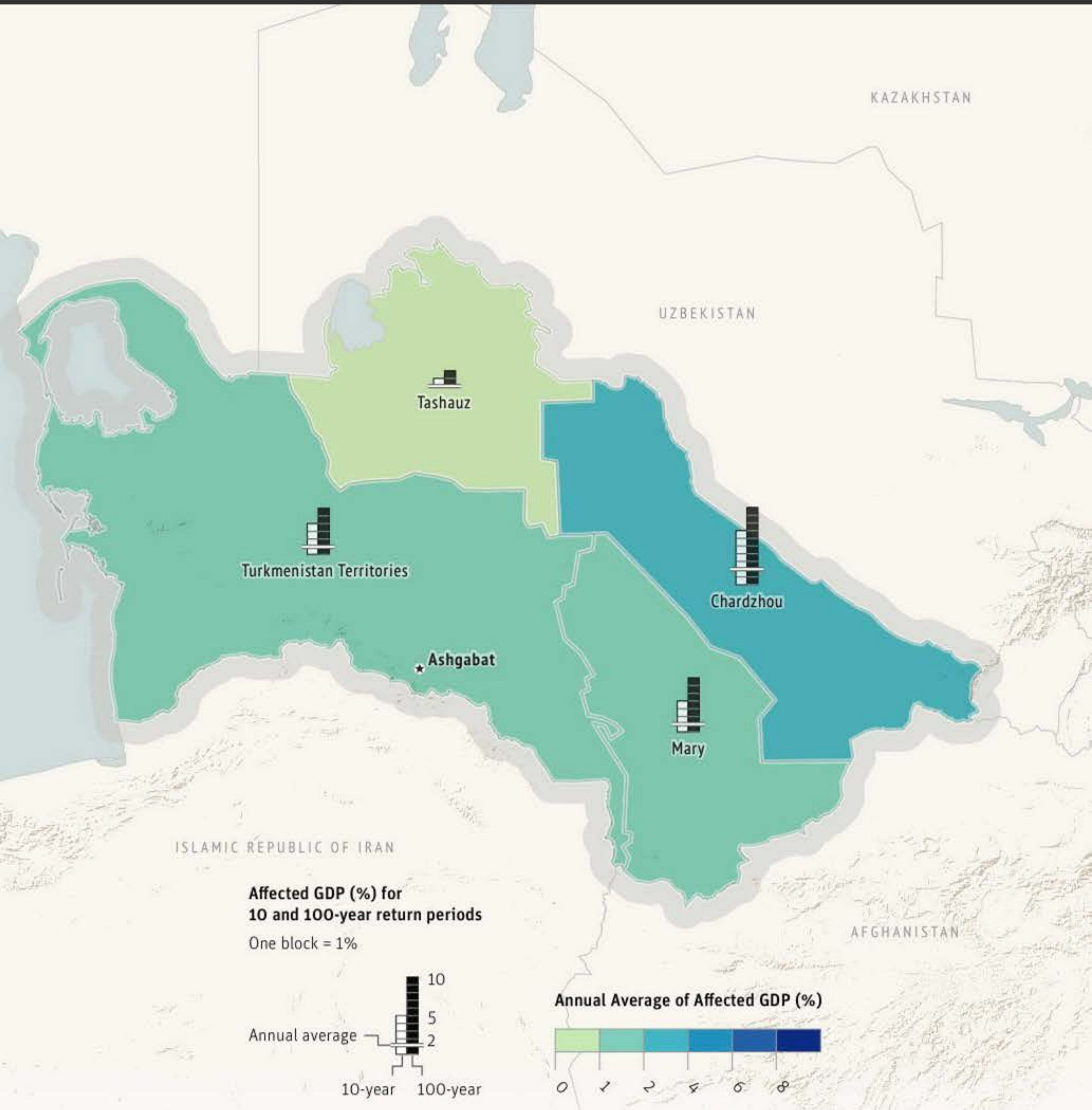
The worst flood in Turkmenistan since it gained its independence in 1991 occurred in 1993 and caused about $200 million in damage.

This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in Turkmenistan is about 70,000 and the annual average affected GDP about $700 million.



Turkmenistan's worst earthquake since 1900 took place in 1948 in Aschgabad, with a magnitude of 7.3. It caused anywhere from 50,000 to over 100,000 fatalities and almost $4 billion in damage. Other significant earthquakes affecting Turkmenistan occurred in 1895, 1929, and 1946.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

When an earthquake has a 10-year return period, it means the probability of occurrence of an earthquake of that magnitude or greater is 10 percent per year. A 100-year earthquake has a probability of occurrence of 1 percent per year. This means that over a long period of time, an earthquake of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year earthquake will occur exactly once every 100 years. In fact, it is possible for an earthquake of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

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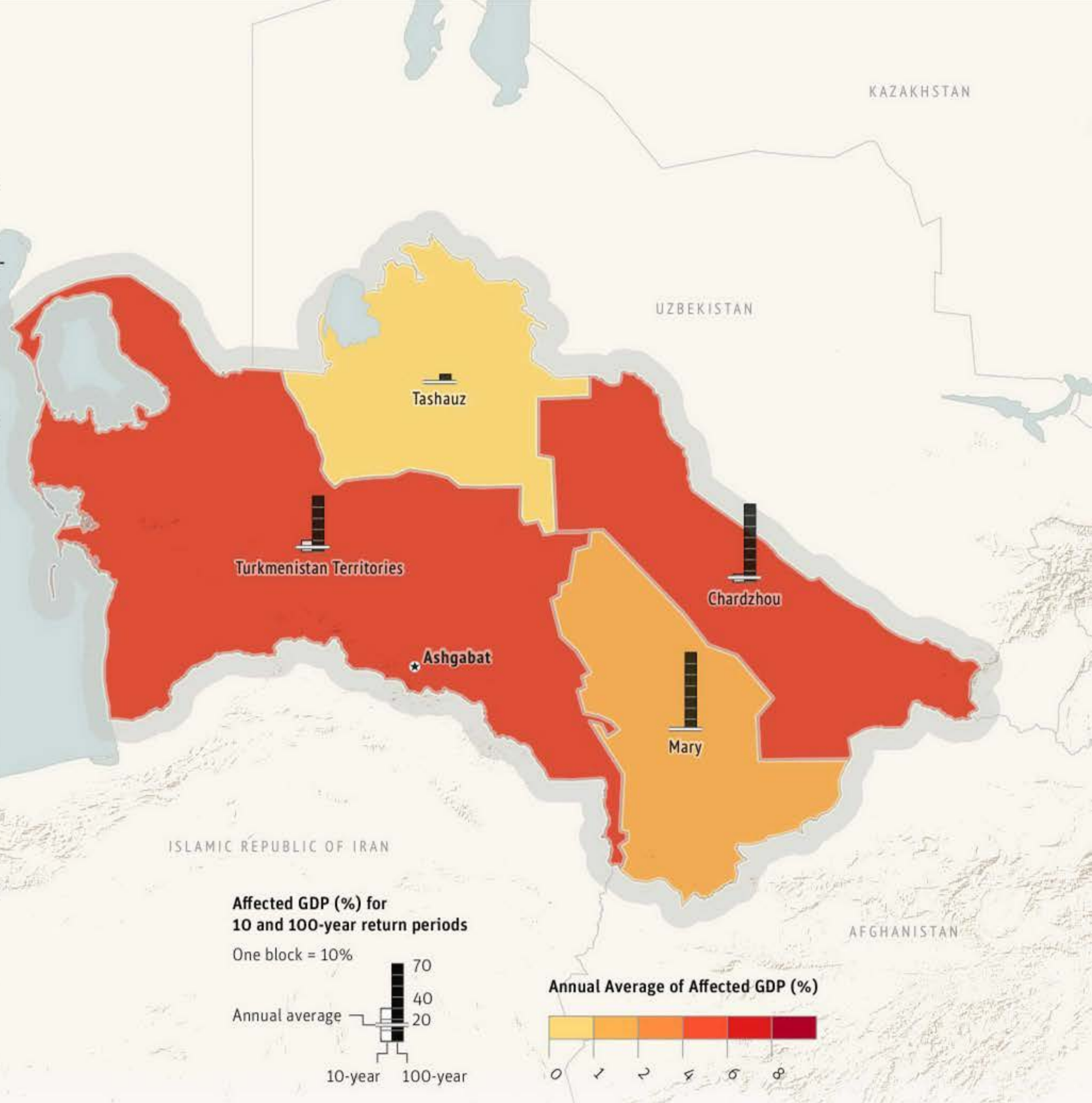
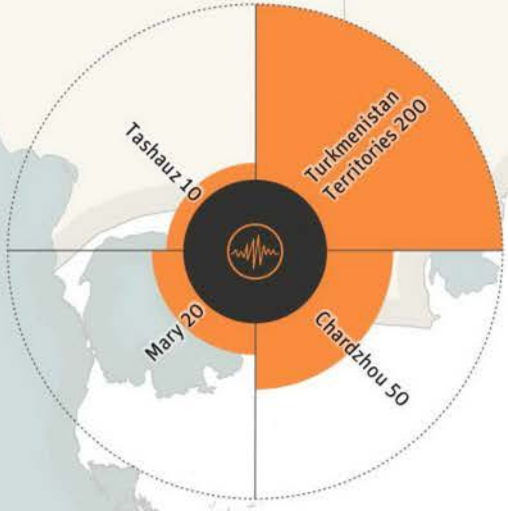
The annual average population affected by earthquakes in Turkmenistan is about 100,000 and the annual average affected GDP about $2 billion. The annual averages of fatalities and capital losses caused by earthquakes are about 300 and about $200 million, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause about 10,000 fatalities and $5 billion in capital loss (about 10 percent of GDP).



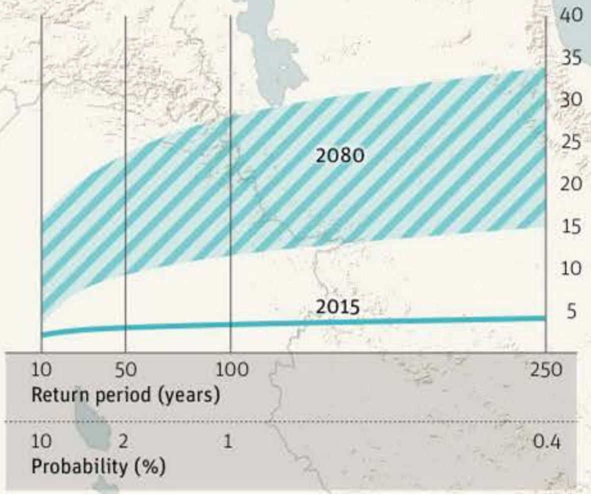
EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS (MILLIONS $)

EARTHQUAKE
ANNUAL AVERAGE FATALITIES

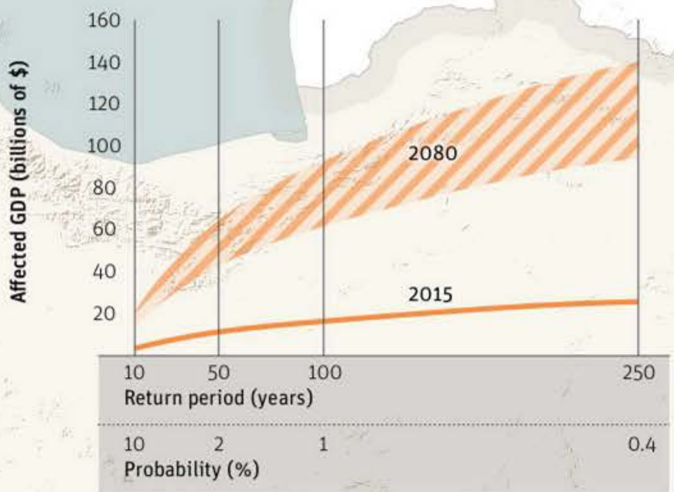


The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Turkmenistan Territories, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if Turkmenistan had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $3 billion. In 2080, however, the affected GDP from the same type of event would range from about $10 billion to about $30 billion. If Turkmenistan had experienced a 250-year earthquake event in 2015, the affected GDP would have been about $30 billion. In 2080, the affected GDP from the same type of event would range from about $90 billion to about $140 billion, due to population growth, urbanization, and the increase in exposed assets.

All historical data on floods and earthquakes are from, respectively, D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be, and J. Daniell and A. Schaefer, "Eastern Europe and Central Asia Region Earthquake Risk Assessment Country and Province Profiling," final report to GFDRR, 2014. Damage estimates for all historical events have been inflated to 2015 US$.

Ukraine

GDP $89.2 billion*
Population 44.9 million*

	AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
GDP	$4 billion (4%)	$6 billion (7%)	$2 billion (2%)
Population	2 million (5%)	4 million (9%)	700 (<1%)

*2015 estimates

Ukraine's population and economy are exposed to earthquakes and floods, with floods posing the greater risk. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

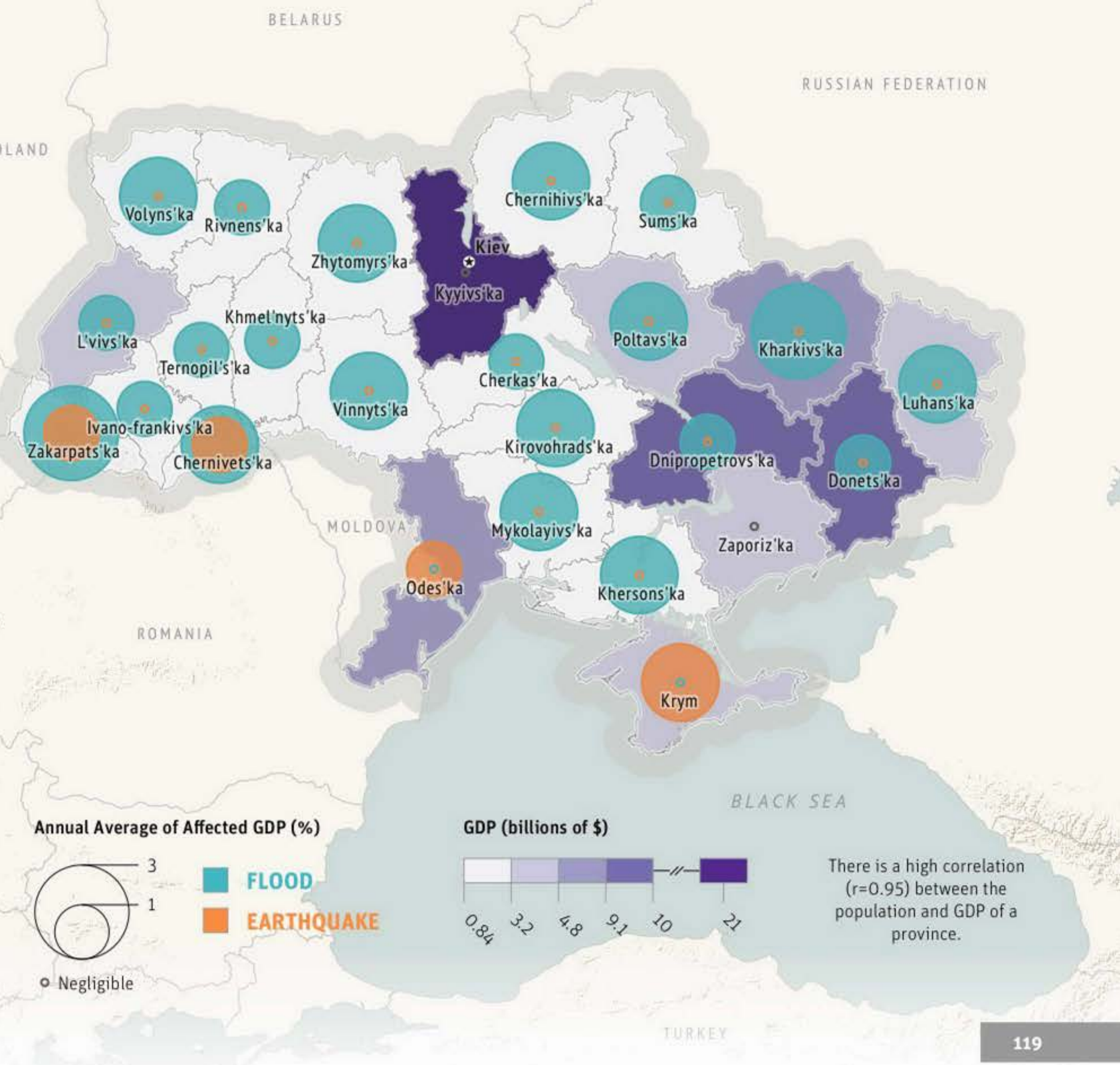
Close to 70 percent of Ukraine's population lives in urban environments. The country's GDP was approximately US$89.2 billion in 2015, with about 60 percent derived from services, most of the remainder generated by industry, and agriculture making a small contribution. Ukraine's per capita GDP was $1,990.

This map displays GDP by province in Ukraine, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of floods is Kharkivs'ka, and the one at greatest risk of earthquakes is Krym. In absolute terms, the province at greatest risk of floods is Kharkivs'ka, and the one at greatest risk of earthquakes is Odes'ka.

TOP AFFECTED PROVINCES

FLOOD ANNUAL AVERAGE OF AFFECTED GDP (%)		EARTHQUAKE ANNUAL AVERAGE OF AFFECTED GDP (%)	
Kharkivs'ka	3	Krym	2
Zakarpats'ka	3	Odes'ka	1
Kirovohrads'ka	2	Zakarpats'ka	1
Luhans'ka	2	Chernivets'ka	1
Chernihivs'ka	2	Ivano-frankivs'ka	1
Poltavs'ka	2	Vinnyts'ka	0
Vinnyts'ka	2	L'vivs'ka	0
Mykolayivs'ka	2	Ternopil's'ka	0
Khersons'ka	2	Khmel'nyts'ka	0
Zhytomyrs'ka	2	Khersons'ka	0



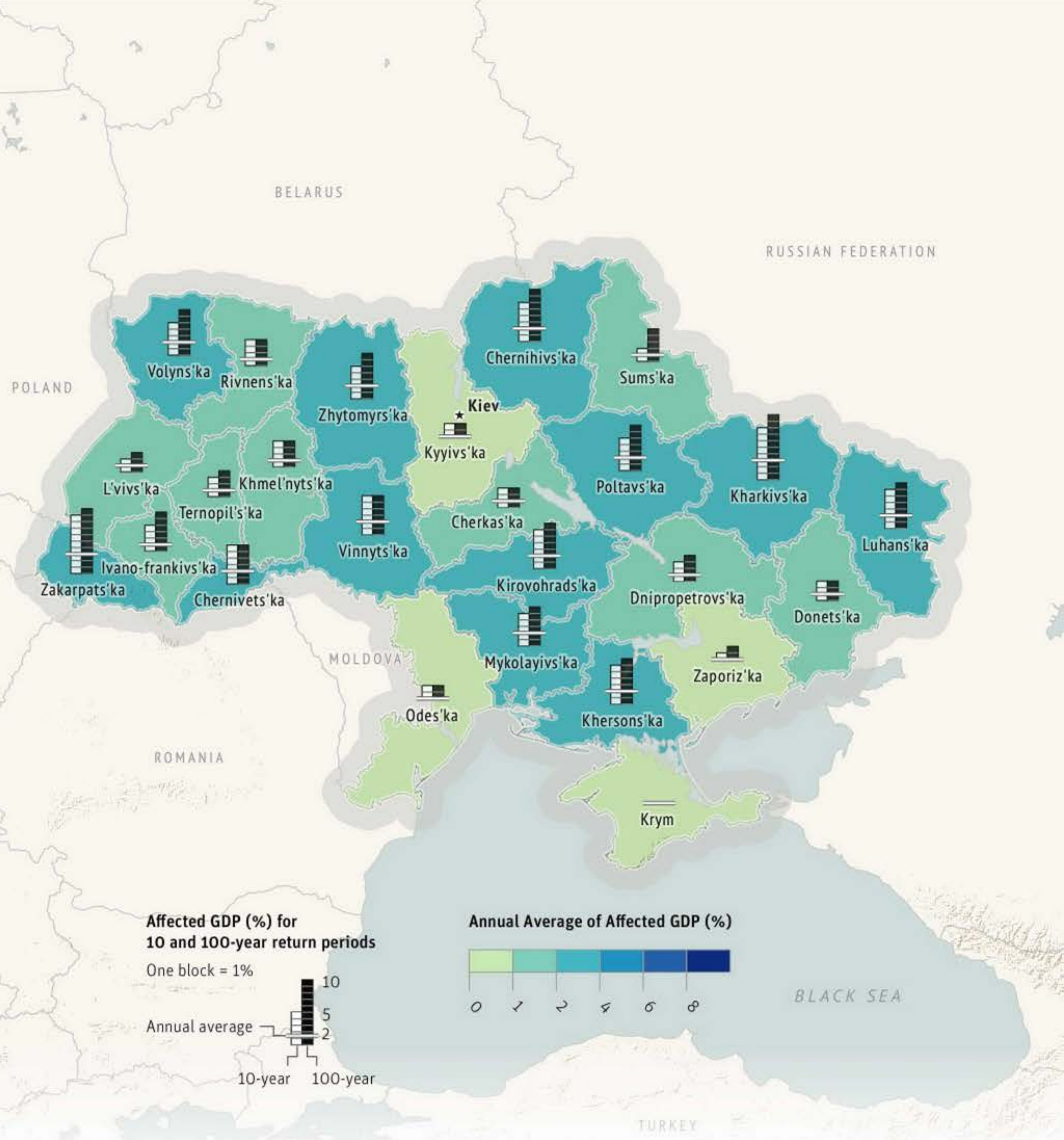
The most devastating flood in Ukraine since it gained its independence in 1991 occurred in 2008, causing nearly 40 fatalities and about $1 billion in damage. Flooding in 1993 caused about $300 million in damage, and a 1998 flood killed nearly 20 people. Further flooding in 2006 and 2013 caused no fatalities but over $20 million in damage in each year.

This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in Ukraine is about 600,000 and the annual average GDP about $1 billion. Within the various provinces, the 10- and 100-year impacts do not differ much, so relatively frequent floods have large impacts on these averages.



Ukraine's worst earthquake since 1900 took place in 1927 in Crimea, with a magnitude of 6.8. It caused about 15 fatalities and close to $200 million in damage. Other major earthquakes affecting Ukraine occurred in 1170 in Kiev and in 1751 and 1872 in Crimea.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

When an earthquake has a 10-year return period, it means the probability of occurrence of an earthquake of that magnitude or greater is 10 percent per year. A 100-year earthquake has a probability of occurrence of 1 percent per year. This means that over a long period of time, an earthquake of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year earthquake will occur exactly once every 100 years. In fact, it is possible for an earthquake of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

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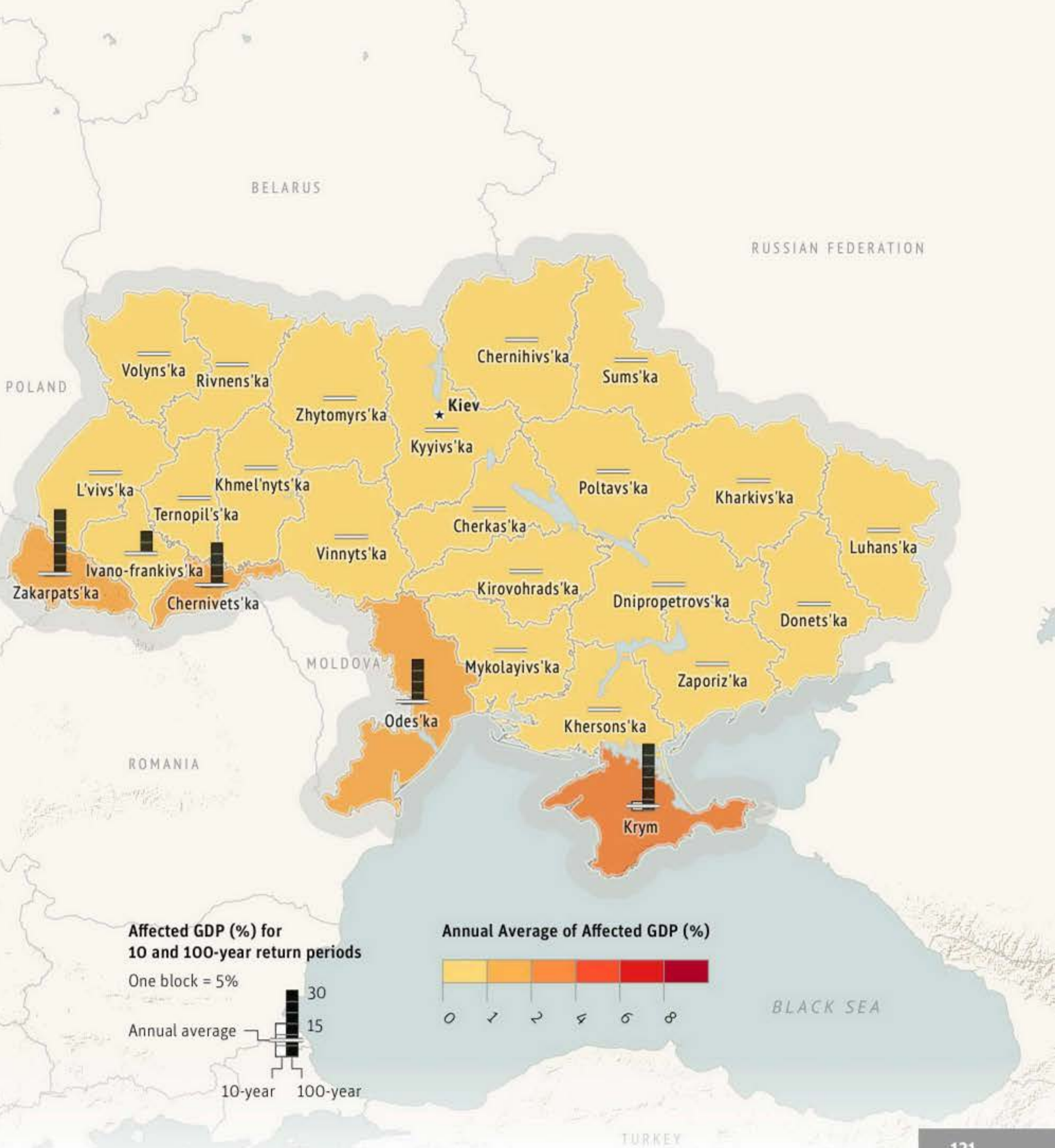
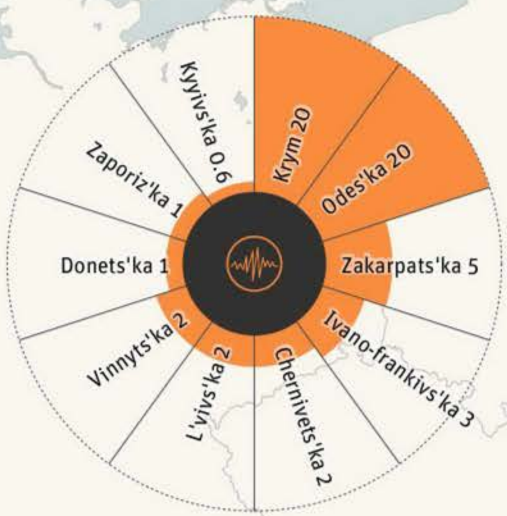
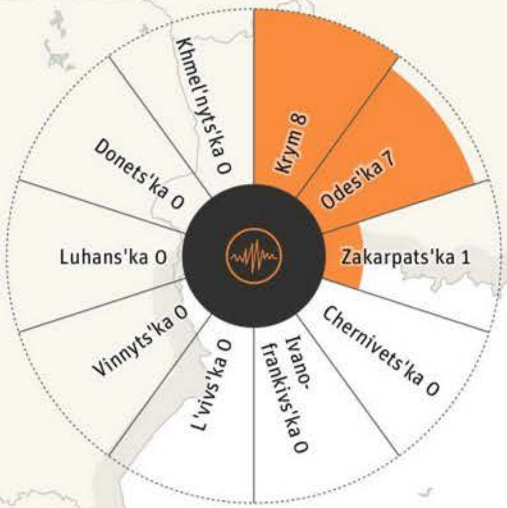
The annual average population affected by earthquakes in Ukraine is about 100,000 and the annual average affected GDP about $100 million. The annual averages of fatalities and capital losses caused by earthquakes are about 20 and about $60 million, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause about 700 fatalities and $2 billion in capital loss (about 2 percent of GDP).



EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS (MILLIONS $)

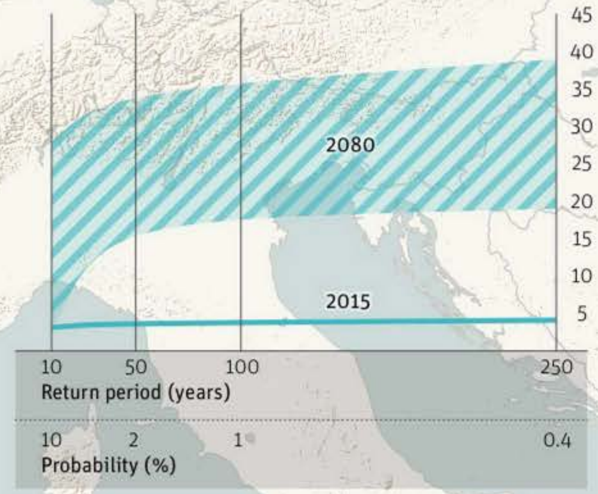


EARTHQUAKE
ANNUAL AVERAGE FATALITIES

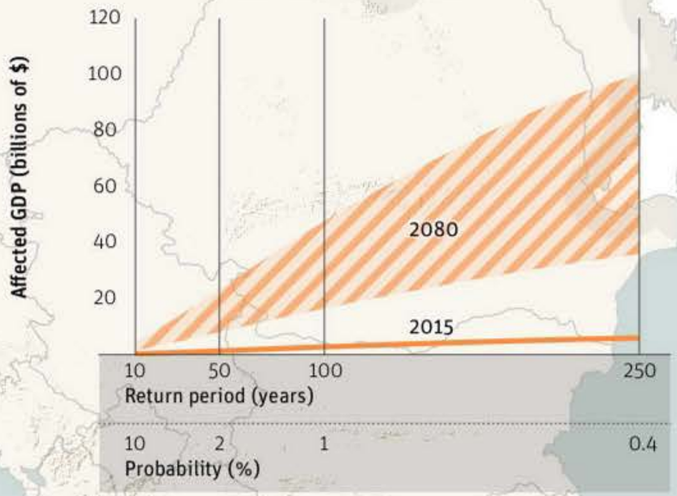


The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Krym, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if Ukraine had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated \$4 billion. In 2080, however, the affected GDP from the same type of event would range from about \$20 billion to about \$40 billion. If Ukraine had experienced a 250-year earthquake event in 2015, the affected GDP would have been about \$6 billion. In 2080, the affected GDP from the same type of event would range from about \$40 billion to about \$100 billion, due to population growth, urbanization, and the increase in exposed assets.

All historical data on floods and earthquakes are from, respectively, D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be, and J. Daniell and A. Schaefer, "Eastern Europe and Central Asia Region Earthquake Risk Assessment Country and Province Profiling," final report to GFDRR, 2014. Damage estimates for all historical events have been inflated to 2015 US\$.

Uzbekistan

GDP $66.0 billion*

Population 30.2 million*

	AFFECTED BY 100-YEAR FLOOD	AFFECTED BY 250-YEAR EARTHQUAKE	CAPITAL LOSS FROM 250-YEAR EARTHQUAKE
GDP	$4 billion (5%)	$20 billion (30%)	$10 billion (19%)
Population	2 million (6%)	10 million (32%)	10,000 (<1%)

*2015 estimates

Uzbekistan's population and economy are exposed to earthquakes and floods, with earthquakes posing the greater risk of a high impact, lower probability event. The model results for present-day risk shown in this risk profile are based on population and gross domestic product (GDP) estimates for 2015. The estimated damage caused by historical events is inflated to 2015 US dollars.

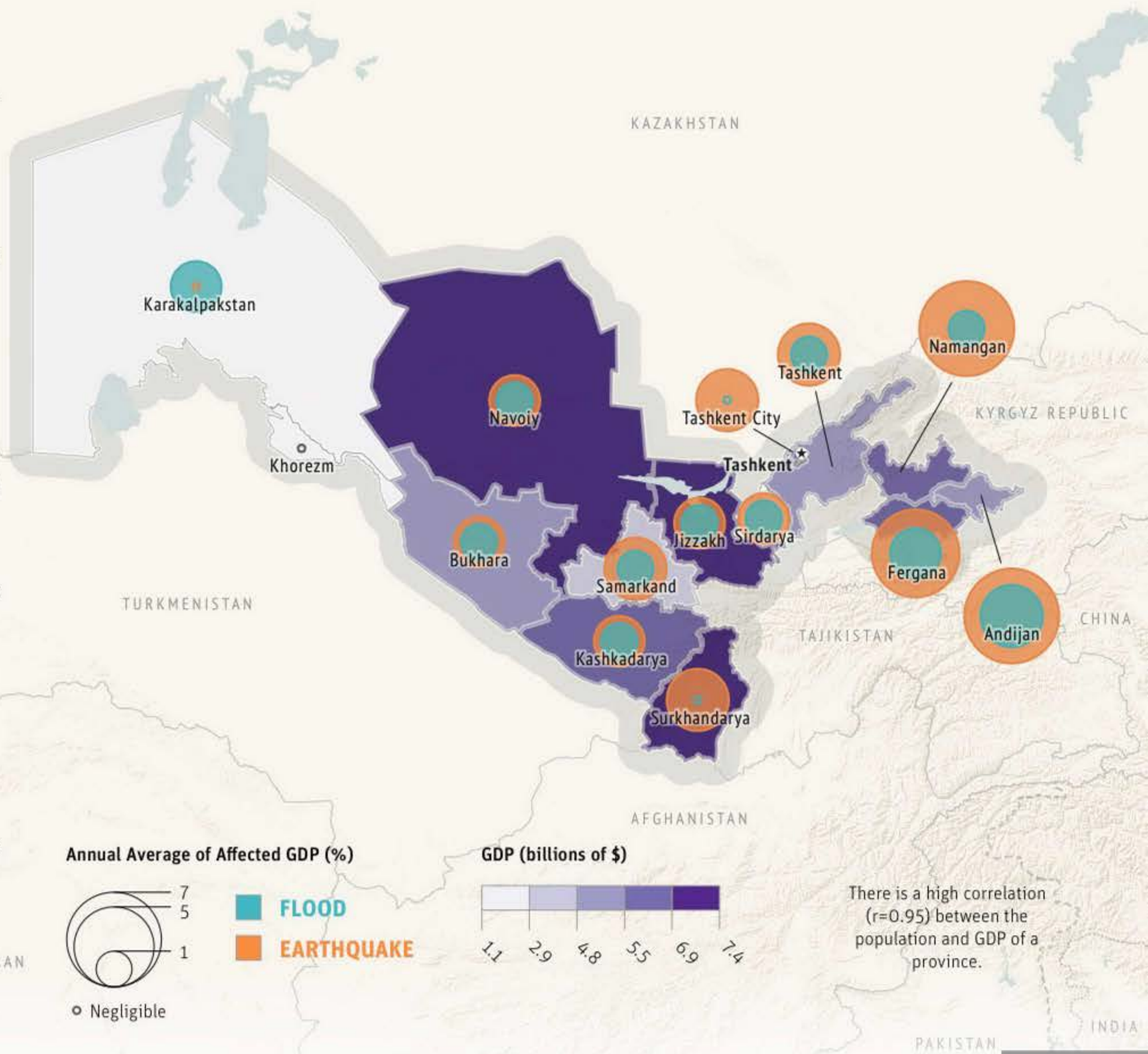
More than 60 percent of Uzbekistan's population lives in rural environments. The country's GDP was approximately US$66.0 billion in 2015, with most derived from services and industries (together about 80 percent) and agriculture generating the remainder. Uzbekistan's per capita GDP was $2,190.

This map displays GDP by province in Uzbekistan, with greater color saturation indicating greater GDP within a province. The blue circles indicate the risk of experiencing floods and the orange circles the risk of earthquakes in terms of normalized annual average of affected GDP. The largest circles represent the greatest normalized risk. The risk is estimated using flood and earthquake risk models.

The table displays the provinces at greatest normalized risk for each peril. In relative terms, as shown in the table, the province at greatest risk of floods is Andijan, and the one at greatest risk of earthquakes is Namangan. In absolute terms, the province at greatest risk of floods is Fergana, and the one at greatest risk of earthquakes is Namangan.

TOP AFFECTED PROVINCES

FLOOD ANNUAL AVERAGE OF AFFECTED GDP (%)		EARTHQUAKE ANNUAL AVERAGE OF AFFECTED GDP (%)	
Andijan	3	Namangan	7
Fergana	2	Andijan	7
Karakalpakstan	2	Fergana	6
Namangan	1	Tashkent city	3
Sirdarya	1	Samarkand	3
Bukhara	1	Tashkent	3
Tashkent	1	Surkhandarya	3
Jizzakh	1	Sirdarya	2
Samarkand	1	Jizzakh	2
Kashkadarya	1	Kashkadarya	2



There is a high correlation (r=0.95) between the population and GDP of a province.

A flood that occurred in Uzbekistan in 2005 affected around 1,500 people.

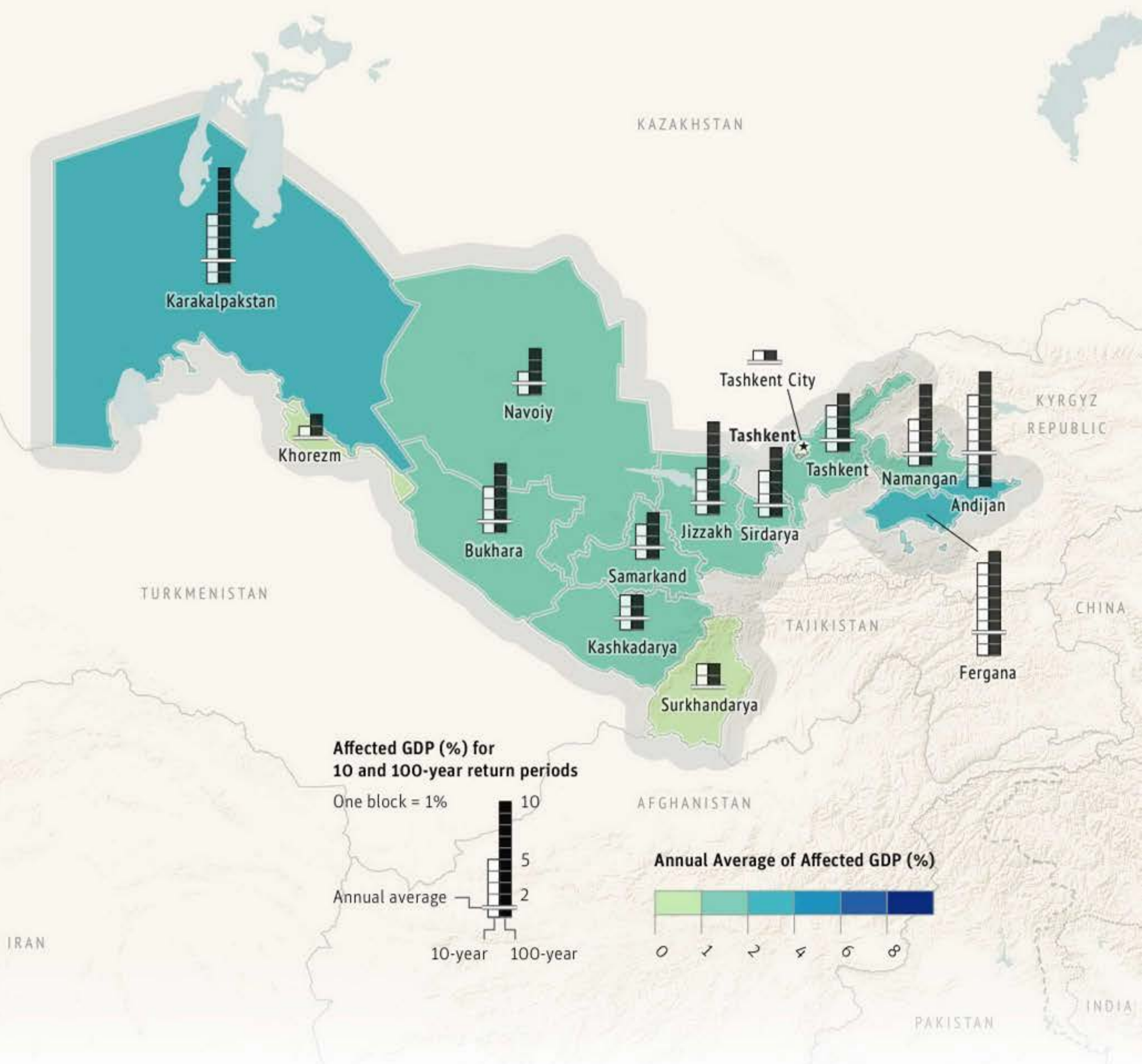
This map depicts the impact of flooding on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by floods with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by floods.

When a flood has a 10-year return period, it means the probability of occurrence of a flood of that magnitude or greater is 10 percent per year. A 100-year flood has a probability of occurrence of 1 percent per year. This means that over a long period of time, a flood of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year flood will occur exactly once every 100 years. In fact, it is possible for a flood of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently.

If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make a larger contribution to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by flooding in Uzbekistan is about 400,000 and the annual average affected GDP about $800 million. For most provinces, the 10- and 100-year impacts do not differ much, so relatively frequent floods have large impacts on these averages. For the few in which the 100-year impacts are much greater than the 10-year impacts, less frequent events make a significant contribution to the annual average of affected GDP.



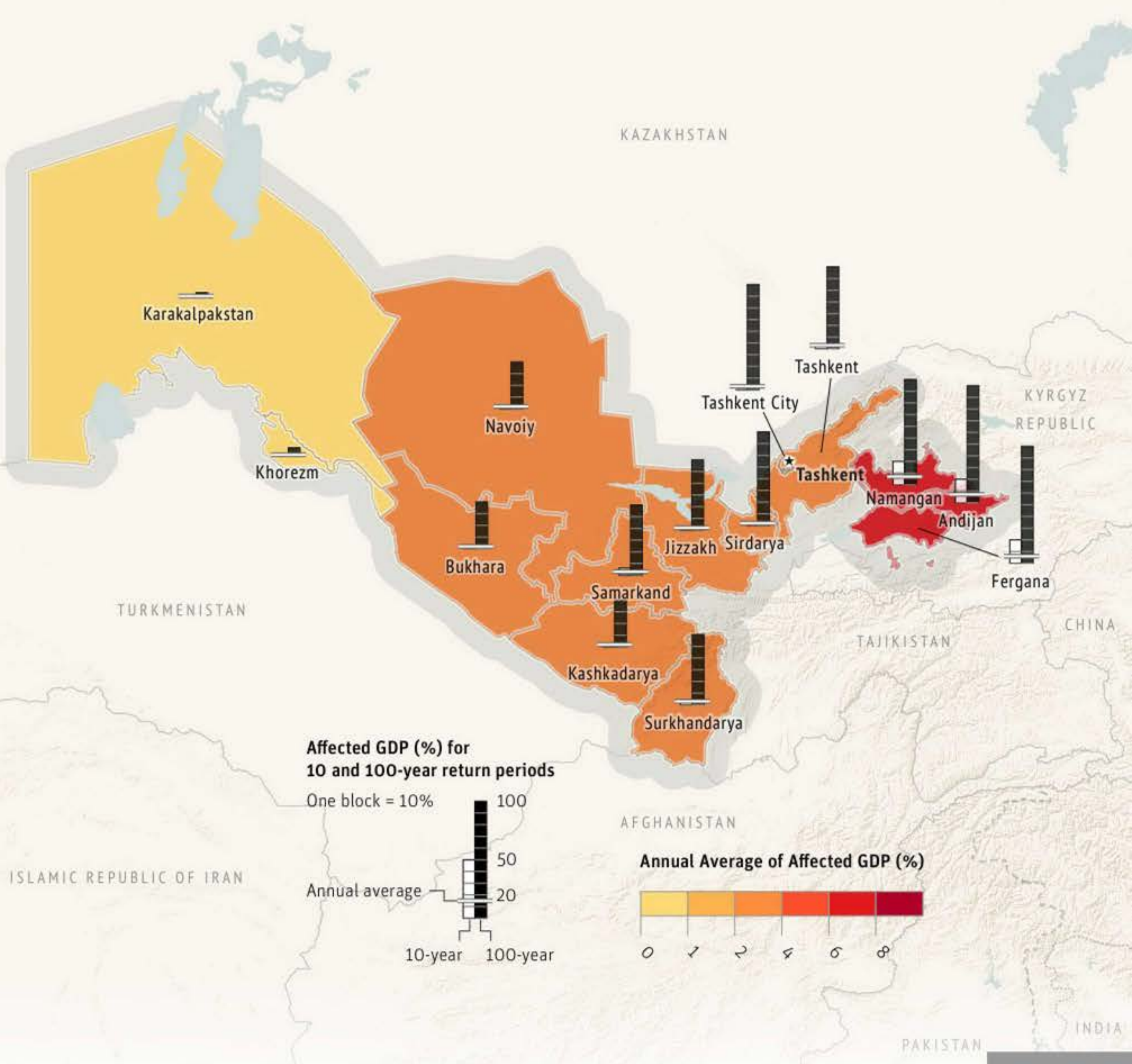
Uzbekistan's worst earthquake since 1900 took place in 1902 in Andizhan, with a magnitude of 6.4, and caused nearly 5,000 fatalities. More recently, earthquakes in 1992 and 2011 caused approximately 10 fatalities per event. Other major earthquakes affecting Uzbekistan occurred in circa 838, 1966, and 1984.

This map depicts the impact of earthquakes on provinces' GDPs, represented as percentages of their annual average GDPs affected, with greater color saturation indicating higher percentages. The bar graphs represent GDP affected by earthquakes with return periods of 10 years (white) and 100 years (black). The horizontal line across the bars also shows the annual average of GDP affected by earthquakes.

When an earthquake has a 10-year return period, it means the probability of occurrence of an earthquake of that magnitude or greater is 10 percent per year. A 100-year earthquake has a probability of occurrence of 1 percent per year. This means that over a long period of time, an earthquake of that magnitude will, on average, occur once every 100 years. It does not mean a 100-year earthquake will occur exactly once every 100 years. In fact, it is possible for an earthquake of any return period to occur more than once in the same year, or to appear in consecutive years, or not to happen at all over a long period of time.

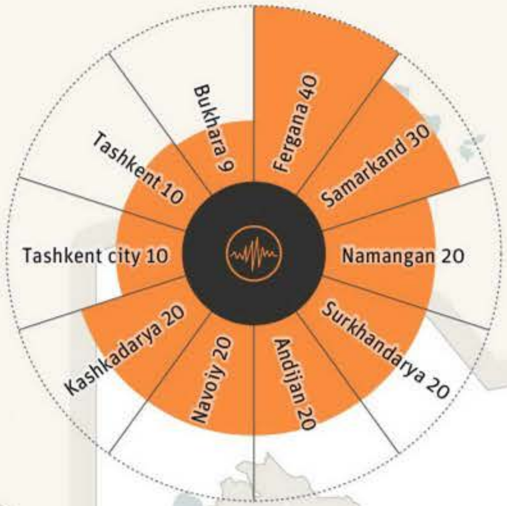
If the 10- and 100-year bars are the same height, then the impact of a 10-year event is as large as that of a 100-year event, and the annual average of affected GDP is dominated by events that happen relatively frequently. If the impact of a 100-year event is much greater than that of a 10-year event, then less frequent events make larger contributions to the annual average of affected GDP. Thus, even if a province's annual affected GDP seems small, less frequent and more intense events can still have large impacts.

The annual average population affected by earthquakes in Uzbekistan is about 1 million and the annual average affected GDP $2 billion. The annual averages of fatalities and capital losses caused by earthquakes are about 200 and about $900 million, respectively. The fatalities and capital losses caused by more intense, less frequent events can be substantially larger than the annual averages. For example, an earthquake with a 0.4 percent annual probability of occurrence (a 250-year return period event) could cause about 10,000 fatalities and $10 billion in capital loss (about 20 percent of GDP).



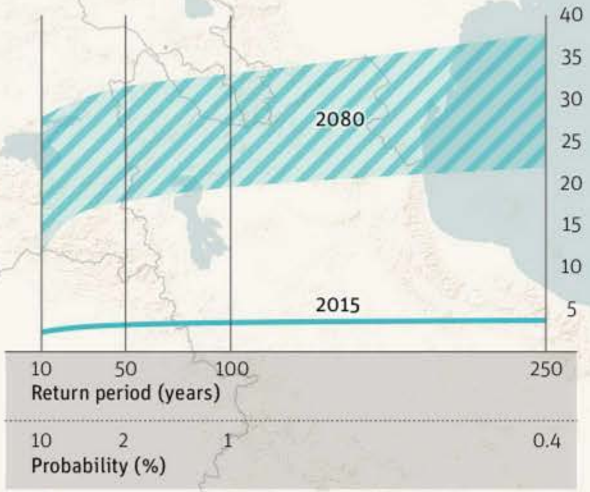
EARTHQUAKE
ANNUAL AVERAGE CAPITAL LOSS (MILLIONS $)

EARTHQUAKE
ANNUAL AVERAGE FATALITIES

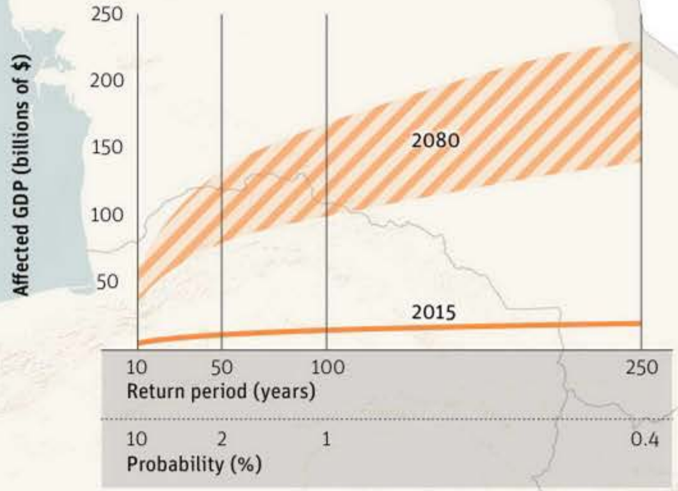


The rose diagrams show the provinces with the potential for greatest annual average capital losses and highest annual average numbers of fatalities, as determined using an earthquake risk model. The potential for greatest capital loss occurs in Namangan, which is not surprising, given the economic importance of the province.

FLOOD
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



EARTHQUAKE
EXCEEDANCE PROBABILITY CURVE, 2015 AND 2080



The exceedance probability curves display the GDP affected by, respectively, floods and earthquakes for varying probabilities of occurrence. Values for two different time periods are shown. A solid line depicts the affected GDP for 2015 conditions. A diagonally striped band depicts the range of affected GDP based on a selection of climate and socioeconomic scenarios for 2080. For example, if Uzbekistan had experienced a 100-year return period flood event in 2015, the affected GDP would have been an estimated $4 billion. In 2080, however, the affected GDP from the same type of event would range from about $20 billion to about $30 billion. If Uzbekistan had experienced a 250-year earthquake event in 2015, the affected GDP would have been about $20 billion. In 2080, the affected GDP from the same type of event would range from about $100 billion to about $200 billion, due to population growth, urbanization, and the increase in exposed assets.

All historical data on floods and earthquakes are from D. Guha-Sapir, R. Below, and Ph. Hoyois, EM-DAT: International Disaster Database (Université Catholique de Louvain, Brussels, Belgium), www.emdat.be; the National Geophysical Data Center/World Data Service (NGDC/WDS), Significant Earthquake Database (National Geophysical Data Center, NOAA), doi:10.7289/V5TD9V7K; and J. Daniell and A. Schaefer, "Eastern Europe and Central Asia Region Earthquake Risk Assessment Country and Province Profiling," final report to GFDRR, 2014. Damage estimates for all historical events have been inflated to 2015 US$.

Technical Annex

The country risk profiles presented in this document were derived from complex flood and earthquake models developed for assessments on a global scale. This annex provides an introduction to the technical details associated with the exposure data used for the modeling and to the models themselves. Readers interested in more complete documentation should refer to articles referenced in the text.

EXPOSURE DATA

Each model uses two major classes of exposure data: population and gross domestic product (GDP). Both were derived from global data sets and downscaled to a grid approximately 1 km by 1 km (30 x 30 arc seconds) in size, as described below.

The high-resolution population data were estimated by downscaling 2010 population data (Van Vuuren et al. 2007) and mapping them at 0.5° x 0.5° resolution, using population scenarios for 26 world regions from the Integrated Model to Assess the Global Environment, or IMAGE (Bouwman et al. 2006), and population maps for the year 2000 from LandScan 2010 (Bright et al. 2011). The 0.5° x 0.5° gridded population data were further downscaled to 30" x 30" using LandScan population maps and corrected for differences between census Level 2 totals and LandScan totals over the same census spatial units. For more information, see Ward et al. (2013).

Most existing studies use a national average GDP per capita to distribute GDP throughout a country. This study, however, followed the approach of Daniell (2014) and distributed GDP at 30" x 30" resolution, using estimates of Level 2 GDP within each country and the gridded population data. Nonetheless, a high correlation still exists between aggregated GDP and population at Level 1 within a country, typically $r \geq 0.95$.

The population and GDP exposed to earthquake and flood risk were modeled at 30" x 30" resolution and the exposure aggregated and presented at Level 1 and national levels. The administrative boundaries used to create the gridded data and for aggregating results were based on shape files obtained from the World Bank. While the Level 2 units in the shape files had very good correlation with ground features, such as rivers and border stations, these were adjusted, particularly within the Balkan region, to match census names and statistical data with units and borders. Specifically, the GADM database for Global Administrative Areas was used to define Level 3 units for Bosnia and Herzegovina. The adjustment resulted in the creation of 863 administrative units throughout the Europe and Central Asia (ECA) region. Subsequent changes aggregated the Bosnia and Herzegovina results data into three Level 1 regions and updated the provincial boundaries for Turkey to include Düzce.

The GDP and population exposure data have been updated to 2015 estimates using province- and country-specific correction factors. In most cases the changes were less than ±25%. However, corrections for a few provinces and countries were more significant. For example, the country level correction factor for Turkmenistan and Uzbekistan were 2.26 and 1.68, respectively.

EARTHQUAKE MODEL

The stochastic earthquake model follows a standard risk modeling approach that uses exposure (see above), a hazard component representing earthquake events, and vulnerability functions to estimate the affected GDP, affected population, capital losses, and fatalities caused by an earthquake. The impacts of all the stochastic events are used to estimate risk.

In addition to GDP and population, the earthquake exposure includes gross capital stock.

Hazard component

The hazard component of the earthquake model consists of a 10,000-year stochastic catalog of over 15.8 million earthquake events of at least magnitude 5 and a suite of ground motion prediction equations (GMPEs). The hazard component for the ECA region contains 1,437 source zones and 744 faults. A variety of publications was used to define source zones and faults, and inconsistencies among the different source zones were reconciled and data gaps filled based on expert opinion. For a given region, the maximum magnitude for earthquakes generated within a zone or by a fault was based on expert assessment of the historical record. For more details, see Daniell (2014).

The earthquake zones were used to account for seismicity on unknown faults and in regions with low seismicity. The frequency and magnitude of the earthquakes within each zone of the catalog were specified using historical data and a Gutenberg-Richter (G-R) relationship between magnitude and number of occurrences. Specific characteristics (for example, location or epicenter, fault motion, hypocentral depth, and fault length) of each earthquake were defined based on known faults and fault models, previously derived source regions, and geophysical knowledge.

For earthquakes on known faults, fault source characteristics (for example, the strike and dip of the fault and the type of fault—strike-slip, thrust, or normal) were based on a random sampling of seismicity from the period 1980–2010. Earthquakes with magnitudes less than 5.8 and earthquakes within a zone representing background seismicity were modeled as point sources. Earthquakes with magnitudes equal to or greater than 5.8 were modeled as finite faults. For a given earthquake magnitude, the rupture length can vary significantly as a function of fault characteristics. Rupture length along a fault for a larger-magnitude earthquake was determined based on published relationships (see Daniell 2014). Hypocentral depths were derived by randomly sampling the historical record of earthquakes within each zone. Finally, the source model also accounts for the observation that hypocentral depth tends to increase with magnitude.

Ground motion produced by an earthquake event is modeled in terms of peak ground acceleration (PGA) using GMPEs specific to active and stable tectonic regions and estimates of local soil conditions. To estimate PGA at a location, a subset of GMPEs was selected from more than 300 (Douglas 2011) and combined using a logic tree approach. Two logic trees were developed, one for tectonically active regions, the other for inactive regions. These tectonic regimes were also used to estimate local soil conditions from topographic slope, following Allen and Wald (2007). PGA-MMI relationships were used to convert PGA to Modified Mercalli Intensity (MMI).

Vulnerability component

The vulnerability component for the earthquake model is based on surface intensity specified as MMI, not on earthquake magnitude in terms of PGA. MMI 6 is typically defined as the intensity at which buildings start to experience damage. Vulnerability was quantified using relationships that estimate capital loss and fatalities as a function of MMI in regions experiencing MMI 6 and greater. The vulnerability functions used in this study relating intensity to capital loss account for changes through time in building typologies, seismic codes, and the Human Development Index (HDI), as well as climate and the age of buildings. The HDI was used as a proxy for the development of a nation and its expression through building quality, building practices, and materials use. The vulnerability function for fatalities varied by region, time of day, and HDI. For more information on the development of these functions, see Daniell (2014).

The model also estimates the GDP and population affected by an earthquake. For these estimates, a step function that switches from zero to one at MMI 6 was used as a vulnerability function. In other words, the model calculated impact in terms of GDP and population experiencing ground motion intensities equal to or greater than MMI 6.

Risk calculations

Once the impact for each event is determined, earthquake risk is calculated in terms of annual averages and return period impacts. Annual average is the sum of all the impacts divided by the length of time (10,000 years) represented by the catalog.

Return period impacts are determined by rank ordering. The top-ranked impact is the 10,000-year return period impact, as it occurs once in the 10,000-year catalog. The second- ranked impact is the 5,000-year return period impact, as two events of that impact or greater occur over the 10,000 years. Similarly, the tenth-ranked impact is the 1,000-year return period impact, as ten events of that impact or greater occur over the 10,000 years; and so on.

The GDP and population model results have been updated to 2015 estimates using province- and country-specific correction factors. In most cases the changes were less than ±25%. However, corrections for a few provinces and countries were more significant. For example, the country level correction factor for Turkmenistan and Uzbekistan were 2.26 and 1.68, respectively.

FLOOD MODEL

The method for calculating flood risk in this study was different from that chosen for the earthquake risk. Where earthquake risk was determined from 10,000 years of simulated events, flood risk was determined using 40 years of climate simulations and extreme value analysis.

Hazard component

Several modules of the GLOFRIS[1] global flood risk modeling cascade were used to derive the flood risk results in this study.

The first step in the flood hazard modeling is the simulation of daily discharges at a horizontal resolution of 0.5° x 0.5°, using the global hydrological model PCR-GLOBWB[2] (Van Beek and Bierkens 2009; Van Beek et al. 2011). For the present-day climate, this hydrological model was forced with daily meteorological data for the years 1960–99, provided by the EU-WATCH project (Weedon et al. 2010). The second step is to simulate daily time series of within-the-channel and overbank flood volumes at the 0.5° x 0.5° spatial resolution, using the DynRout extension (PCR-GLOBWB-DynRout), which simulates flood wave propagation within the channel and overbank. For more information, see Winsemius et al. (2013) and Ward et al. (2013), who describe this approach in more detail and discuss its applicability.

The last step in the flood hazard modeling is the inundation modeling. Annual time series of maximum flood volumes were extracted from the daily flood volume time series. Estimates of flood volumes per grid cell (0.5° x 0.5°) were derived for selected return periods (2, 5, 10, 25, 50, 100, 250, 500, and 1,000 years), using extreme value statistics based on the Gumbel distribution and the yearly non-zero flood volume time series. These flood volume estimates were used as input for the GLOFRIS downscaling module to calculate inundation depths at the 30" x 30" level for the chosen return periods (Winsemius et al. 2013). Under the assumption that flood volumes with two-year return periods would not lead to overbank flooding, the flood volumes for all return periods were corrected by subtracting the two-year return period flood volume before inundation downscaling was carried out. This meant that, in this approach, such flood protection measures as the use of dikes or retention areas were not taken into account, which may have led to an overestimation of the actual flood extent.

The quality of the modeled inundation depths depend on the quality of the elevation data used to project flooding on the terrain. This study used the Shuttle Radar Topography Mission (SRTM) elevation data, processed into a number of

1. Global Flood Risk with IMAGE Scenarios.

2. PCRaster Global Water Balance.

elevation-derived products available on the HydroSHEDS pages.[3]

Vulnerability and risk calculation

In this study, affected GDP and affected population were considered as metrics for flood risk. Given the uncertainties in estimated flood depths, the annual average and return period impacts were estimated in terms of GDP and population experiencing floodwater at any depth. The GDP and population affected by flood for each return period were represented by the counts of population or GDP in each grid cell that had non-zero flood depths at the selected return periods. The average annual values at each grid cell were derived by integrating over the nine return period impact estimates. The annual average and return period values for GDP and population affected by flood in the Level 1 administrative regions were determined by summing the impacts within each area.

Future Earthquake and Flood Risk

Estimates of the GDP and population affected by earthquakes in 2080 were based on the 2080 socioeconomic and climate conditions associated with the five Shared Socioeconomic Pathways (SSPs) created by the Intergovernmental Panel on Climate Change (IPCC) for the Fifth Assessment Report (AR5). Estimates of future exposure data (GDP and population in 2080) were developed using the IMAGE model of the PBL Netherlands Environmental Assessment Agency, forced by the five SSPs. The population numbers estimated with the IMAGE model were then further modified to be consistent on a Level 1 administrative (province) level using the 2010 round of census data. The earthquake model was then used to calculate the affected GDP and affected population for the five projections of the 2080 exposure.

Estimates of the GDP and population affected by flooding in 2080 were based on both the socioeconomic and climate conditions in 2080. The 2080 climate conditions

CLIMATE MODEL	DESCRIPTION
GFDL ESM2M	GFDL Earth System Model 2 with medium resolution
HadGEM2-ES	Hadley Global Environment Model 2–Earth System
MIROC-ESM-CHEM	MIROC (Model for Interdisciplinary Research on Climate) Earth System CHASER-coupled Model (Atmospheric Chemistry version)
IPSL-CM5A	IPSL Coupled Model 5
NorESM1-M	Norwegian Earth System Model with medium resolution

Table 2. *Climate Models Used for Flood Risk Estimates.*

RCP SCENARIO	SSP SCENARIO	SCENARIO CHARACTERIZATION
RCP4.5	SSP2	Cautiously optimistic
RCP8.5	SSP2	Present trends continue
RCP8.5	SSP3	Worst case

Table 3. *RCP and SSP Scenario Combinations Used to Estimate Future Flood Risk.*

3. http://hydrosheds.cr.usgs.gov.

used in this publication were based on the Representative Concentration Pathways (RCPs) created by the Intergovernmental Panel on Climate Change (IPCC) for the Fifth Assessment Report (AR5). The RCPs were used to force the five climate models, listed in table 2, to simulate daily future climate data. The future flood hazard estimates were subsequently calculated using the same GLOFRIS model cascade described above but forced with the daily future climate data from the five climate models. The precipitation estimates for the climate models were bias corrected using the 1960–99 EU-WATCH data and a methodology developed by the Inter-Sectoral Impact Model Intercomparison Project (ISI-MIP). For details on the bias correction, see Hempel et al. (2013).

Future flood risk for 2080 was then estimated for scenarios that combined the projections of the flood hazard and exposure data based on the RCPs and SSPs in table 3.

For more information on the RCPs, see Meinshausen et al. (2011). For information on the SSP scenarios, see the special issue of the journal, *Climate Change on Shared Socioeconomic Pathways* (Nakicenovic et al. 2013).

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The Europe and Central Asia (ECA) region experiences a variety of natural hazards, including floods, earthquakes, droughts, landslides, and wildfires. The frequency and impact of these events can be great. For example, close to 500 significant floods and earthquakes have occurred in the region over the past three decades, affecting nearly 25 million people and causing 50,000 fatalities and approximately US$80 billion in damage. Disaster risk management could reduce the impact of such events appreciably.

Maximizing development and minimizing the impact of disasters requires understanding, managing, and mitigating disaster risk. Investments supporting disaster risk management provide benefits beyond the mitigation of risk and the reduction of loss when disaster strikes. They also stimulate economic activity through the creation of an improved investing environment, provide additional benefits through social, environmental, and economic synergies, and enhance social progress, even in the absence of disaster.

Intended as a catalyst for discussions of disaster risk management for countries in the ECA region, this publication provides high-level assessments of risk to gross domestic product (GDP) and population from floods and earthquakes. From it, national decision makers can obtain an overview of the risk in each country, how the risk varies among a country's provinces, and how countries rank in regard to risk in the ECA region.

WORLD BANK GROUP

GFDRR
Global Facility for Disaster Reduction and Recovery