Photo: Aftermath of a landslide after an earthquake in Central Asia. © Temir Shintemirov | istock.com

Earthquake and Flood Risk Assessment in Central Asia

Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan, and Uzbekistan, all situated within Central Asia, are known to be highly exposed to natural hazards, especially floods, earthquakes, and landslides.

The annual average population affected by floods in these countries reaches almost one million, while the annual average population affected by earthquakes is almost two million.[1] In the last 20 years, these disasters have caused losses in excess of US$ 1.5bn.[2]

The loss of life, disruption to livelihoods, and damage to housing and infrastructure already poses a significant challenge to the development of these emerging economies. Climate change, uncoordinated urbanization, aging infrastructure, and population growth are expected to exacerbate these risks going forwards.

Natural hazards are not contained by national boundaries and so national Disaster Risk Management (DRM) and Disaster Risk Financing and Insurance (DRFI) strategies benefit from a regional and shared approach. But as a first step, such efforts require a firm basis of regionally consistent and coherent risk information.

The SFRARR Program and its objectives, funders, and partners

In July 2019, to confront these challenges, the European Union, in collaboration with the World Bank and the GFDRR, started the “Strengthening Financial Resilience and Accelerating Risk Reduction in Central Asia” (SFRARR) Program. Set to run until October 2024, the overarching objective of the Program is to improve financial resilience and risk-informed policymaking, thus advancing disaster and climate resilience in Central Asia.

Key to the Program was the delivery of a probabilistic risk assessment of floods and earthquakes, as well as assessment of landslide susceptibility and selected land-

[1] GFDRR, 2017. Disaster Risk Profiles. https://www.gfdrr.org/en/disaster-risk-country-profiles

[2] Centre for Research on the Epidemiology of Disasters (CRED), 2023. EMDAT. https://emdat.be/

Flooding in Tajikistan. © Ahliddin Salimov | shutterstock.com

slide scenarios, and their impact on multiple asset types. These analyses have recently been concluded and provide a firm foundation for devising coherent and consistent solutions across geographies and economic sectors.

For this work, the Program engaged a consortium of international experts led by RED (Risk, Engineering and Development) of Italy. The consortium comprised the Italian Institute of Oceanography and Experimental Geophysics, Evaluación de Riesgos Naturales of Mexico, the UNESCO Chair on Prevention and Sustainable Management of Geo-Hydrological Hazards of the University of Florence, AKUA Capital, who partnered with locally based subject experts in research and engineering institutions.

The involvement of the local teams and their governments was critical to SFRARR's goal of strengthening capacity within Central Asia's administrative and scientific communities.

Assessment methodology

The regional approach to the probabilistic disaster risk assessment significantly benefits each country by providing common analytics and metrics and facilitating training, sharing of knowledge and technology, and co-development of solutions for national and transboundary risks.

Concerning earthquakes, a Probabilistic Seismic Hazard Assessment (PSHA) was carried out at regional level. The developed earthquake source models and ground motion prediction models were then used for the calculation of specific earthquake scenarios at five target sites (one per country) deemed representative of key urban areas.

For flooding, the modelling relied on a hybrid stochastic and physical approach, to simulate flooding at high resolution and across large scales for the current climate and under future climate conditions.

Regionally consistent exposure datasets were developed by the consortium for the analysis, building on previous studies. This included the distribution, value and structural information on buildings and infrastructure, and population demographics and distribution.

Final risk assessments used this information to run state of the art analyses to estimate the geographic distribution and probability of damage and loss for the building stock, roads, railways, crops and population over a given period of time. The risk was characterized in terms of number of fatalities, number of damaged assets, and estimated economic loss. These were given for the long-term annual average, and the potential loss from extreme events, across the five countries and for specific urban areas.

Results

Following such a comprehensive regional process the study produced a wealth of crucial information that offers useful insights for policymakers. Headline figures capture the scale of the threat that flooding and earthquakes pose. Estimated loss and damage are not only dependent on the potential intensity of the hazard. They are also highly influenced by whether the large numbers of people and their assets are in high-hazard areas such as on a floodplain or near an active fault, and how vulnerable those communities and buildings are to damage and disruption.

In terms of potential losses to flooding, it was estimated that Kazakhstan had the most assets at risk, with a once-in-a-century event causing $1.8bn to $2.4bn in losses, considering the effects of a flood with and without flood protection, respectively. At the other end of the scale, the Kyrgyz Republic would manage a potential range of $215.7-224mn in losses.

Given that Uzbekistan is more populated in the east, in regions that also have the highest earthquake hazard the country is estimated to experience a seismic event that could cause $10bn in damages at least once in any 100-year period, dwarfing Turkmenistan's equivalent losses of $362mn, the lowest in the region.

Such a disparity is also reflected in the estimated economic cost, in terms of GDP, following an extreme event. For Uzbekistan a worst-case scenario could see damage reach 41% of GDP, while for Turkmenistan the figure is only 1%. During an average year, however, it is Tajikistan that must face the highest estimated economic costs from flooding and earthquakes at 4.7% of its GDP.

Recommendations

When it comes to **earthquake mitigation**, first, it is crucial to update seismic risk studies. By doing so, we can better understand the areas and sectors most at risk and prioritize the implementation of risk reduction actions at national, subnational and sector levels.

A key aspect of earthquake mitigation is retrofitting critical infrastructure, such as hospitals, bridges, public buildings, and schools, as well as residential blocks. Campaigns should be carried out to strengthen assets in sectors that are more prone to earthquake risk, and fiscal incentives could be provided to encourage the retrofitting of residential and commercial properties.

Turning to **flood risk mitigation**, identifying flood hazard zones is a fundamental step. The maps generated by the study provide valuable information regarding the main flood hazard areas. Similar to earthquake mitigation, high-risk zones should be identified to prioritize the implementation of risk reduction actions.

To effectively manage flood risk, a combination of measures can be implemented, including both grey infrastructure (e.g., dams, levees) and nature-based solutions (e.g., wetland restoration, riverbank stabilization). These flood control measures help to reduce the overall risk and protect vulnerable areas from the destructive impact of floods.

A detailed evaluation of key lifelines should be conducted, such as power generation and transmission in areas prone to high earthquake and flood hazards. This evaluation will provide essential insights for improving the performance and resilience of these critical systems during crises.

Early warning systems including detection systems and training on evacuation actions should be established to ensure that the population knows how to respond effectively during a seismic or flooding event. These measures collectively contribute to minimizing loss of life and improving overall preparedness.

Next steps

By implementing these recommendations for earthquake and flood mitigation, countries in Central Asia can take significant steps toward reducing the vulnerability of their communities, safeguarding critical infrastructure, and improving disaster preparedness.

One crucial aspect of developing an effective strategy lies in identifying the components that contribute to its success. Policymakers can use the risk information now available to determine strategies to manage residual risk (that which remains after DRR investments have reduced overall risk) that can be transferred via a risk-layering approach to insurance and capital markets or retained as self-insurance or reserve funds. This assessment provides a clear understanding of the financial implications and potential returns on investment, enabling policymakers to make informed choices and allocate resources effectively.

The completed assessments are already informing national government and World Bank activities on emergency planning and DRM enabling a productive dialogue between the Bank, local governments, and regionalCenter for Emergency Situations and Disaster Risk Reduction (CESDRR)[3]. This dialogue is set to strengthen financial resilience in Central Asia over the long term. The results of the study are now publicly available on the World Bank Data Catalogue.[4]

[3] https://cesdrr.org/

[4] Search for "SFRARR."

Central Asia Hazard Risk Fact Sheets

Central Asia is an area characterized by complex tectonic activity and effected by recurrent fluvial and pluvial flooding. For the Strengthening Financial Resilience and Accelerating Risk Reduction in Central Asia (SFRARR) Program, a probabilistic risk assessment has informed the strategic dialogue between stakeholders on reducing this risk. This data supports discussion on potential parametric and indemnity risk financing solutions.

In some countries, earthquake risk is greater than flood risk. For example, in Uzbekistan there is a 1% chance in any given year of an earthquake causing over $10bn loss, whereas a flood with the same likelihood is estimated to cause around $1.5bn. The annual average earthquake loss in Uzbekistan and Kyrgyz Republic is around twice the estimated annual average loss from flood. In Tajikistan, AAL from earthquakes exceeds that due to floods but they are more similar. However, in Turkmenistan and Kazakhstan flood AAL is much greater than AAL due to earthquakes. Such disparities can exist at subnational level and sector level, so having this type of evidence to show which risk or risks are present and which have most impact is necessary for making effective risk-informed investment decisions.

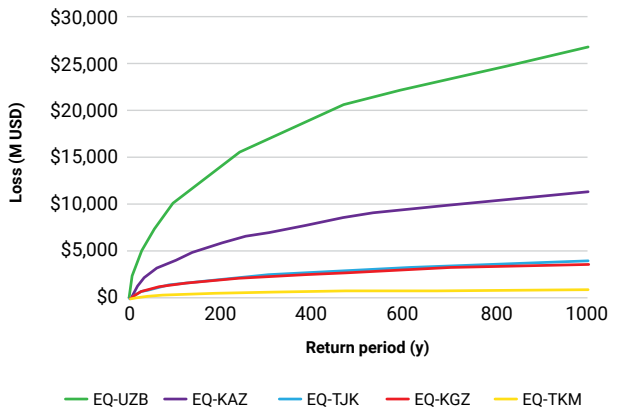
Region at a Glance

- Population: 78.4 million
- GDP: US$368 bn

Earthquakes

What is at Risk?

Return period losses from earthquakes per country using current exposure



Residential buildings make up 66% of the total exposed assets. More than 2,000 industrial sites, 15,000 energy infrastructure sites, 170 km of water and communication infrastructure, approximately 30.5 million people and more than 45,000 km of transport infrastructure are located in areas that could experience, at least once every 250 years, very strong shaking causing moderate damage.

The long-term average number of fatalities due to earthquakes (based on 2020 population figures) are estimated to be around 850 per year.

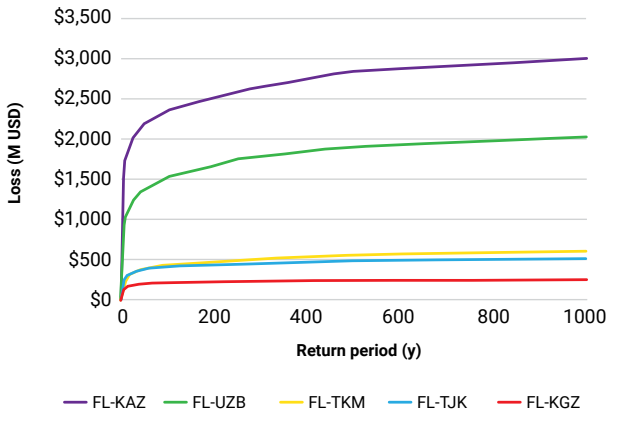
Country Snapshot – Earthquakes

- Average annual loss (total exposure, regional): $2bn
  - Kyrgyz Republic: $192mn
  - Kazakhstan: $351mn
  - Tajikistan: $238mn
  - Turkmenistan: $34.4mn
  - Uzbekistan: $1.1bn

Flooding

What is at Risk?

Return period losses for fluvial flood risk per country using current exposure in an undefended case



Residential exposure makes up 61% of the total of exposed assets. Concerning critical infrastructure, when accounting for the impact of climate change, there are more than 40 industrial sites, 1,200 km of water and

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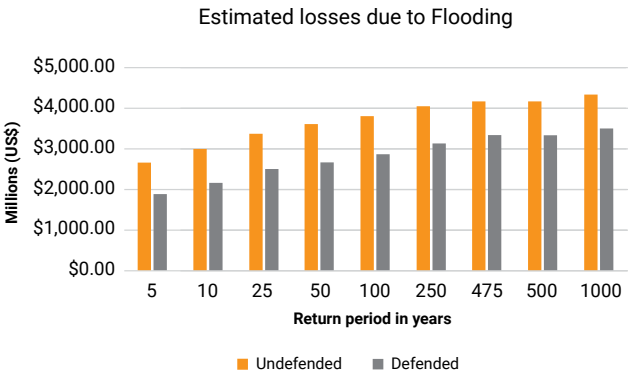
communication infrastructure, approximately 700,000 people and more than 2,100 km of transport infrastructure that could be exposed to 2–4 m of flooding at least once every 200 years.

The long-term average number of fatalities due to flooding (based on 2020 population figures) are estimated at over 300 each year, and over 230 if considering the effect of flood protection.

Reducing Risk

Losses for different return periods for fluvial flood risk undefended and undefended scenarios



Disaster risk assessments can be used to estimate the impact of DRM investments made in the past or of potential future investments. For example, the effect of flood protection on flood losses (the undefended and defended scenario above) or the effect of seismic retrofit of building, on seismic losses and fatalities due to building collapse. In the fluvial flood hazard modelling conducted in this project, the presence of flood protection is shown to reduce the estimated 1-in-10-year regional loss by around a third. Particularly significant reductions in flood risk are found in Kazakhstan, Turkmenistan, and Uzbekistan due to the presence of flood protection.

Country Snapshot – Flooding

- Average annual loss (total exposure, regional): $2.2bn (undefended); $1.5bn (defended)
  - Kyrgyz Republic: $95mn; $91mn
  - Kazakhstan: $1.2bn; $727mn
  - Tajikistan: $177mn; $174mn
  - Turkmenistan: $123mn; $89mn
  - Uzbekistan: $630mn; $433mn