Seismic hazard and building vulnerability in post-Sovietic Central Asian republics

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PREFACE

The dissolution of the Soviet Union in 1991 triggered a renaissance bordering on chaos in the five Central Asian republics of Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan. After 70 years of technical, political, and economic dependence on Moscow, these republics were, instantaneously and (to a certain extent) against their wishes, on their own. Each had to form a new system of government. None could guarantee its territorial security, even though one, Kazakhstan, found itself the world's fourth-largest nuclear power. A bloody civil war broke out in Tajikistan that threatened to spread to its neighbors. Each republic established its own official state language, replacing Russian. The region's ruble-based economy was abandoned in favor of five new and noninterchangeable currencies. Inflation soared. Millions of people of non-Central Asian heritage emigrated. Religion burst onto the scene: In 1989, each capital city averaged 10 mosques; two years later, this number had grown to several hundred. In place of security and stability came vulnerability and volatility, and most importantly, opportunity.

Given the enormity of the challenges they faced, these republics have made and continue to make remarkable progress. They have held elections and developed foreign policies. The civil war in Tajikistan has not spread and shows signs of ending. Inflation has abated. Investors have been attracted to the region's natural resources, which include some of the largest deposits of minerals, oil, and natural gas in the world. Billions of dollars in foreign currency are being spent on oil and gas exploration, automobile factories, telecommunication networks, international airports, and hotels. Pipelines are planned to stretch to the China Sea, the Indian Ocean, and the Mediterranean. A trans-Asian railroad and highway are under construction, and will connect the republics to each other and their immediate neighbors. These enterprises are forging new commercial and cultural links between Central Asia and the rest of the world, accelerating the region's political, social, and economic development. If Central Asia can survive these transitional years, its future is bright indeed.

One of the threats to Central Asia's future development is the region's large and growing urban earthquake risk.

Central Asia's earthquake activity has long been recognized as one of the highest in the world, but the extreme vulnerability of its Soviet-era residential

buildings was realized only after two recent earthquakes outside the region. In 1988, an earthquake in Annenia caused the collapse of more than 95% of one type of residential building and 75% of another type in the city of Leninakan; other types of buildings in that city remained standing but were damaged. In 1995, another earthquake near Sakhalin, an island in the northwest Pacific Ocean, caused all of yet another type of residential building to collapse in the city of Neftegorsk; again, other building types survived. These experiences in Armenia and Sakhalin suggest that the thousands of residential buildings with similar design and construction found throughout Central Asia are highly vulnerable to earthquakes.

Just as Central Asia's large urban earthquake risk was being recognized, the ability to manage it was drastically decreasing. Since the Soviet Union's disintegration, responsibility for earthquake preparedness and response has been turned over to local officials, who are often inexperienced and usually more than occupied with present day emergencies. None of the five republics has a standing army capable of managing the consequences of a natural catastrophe. Among the millions of people who recently emigrated were about half of Central Asia's most experienced civil engineers and earth scientists. Those who remain are isolated from their colleagues in other republics and have difficulty attracting students to their professions. Funding for research and development has virtually ceased. For all of these reasons, it is understandable that the lessons of Armenia and Sakhalin have gone unheeded. But continuing to ignore them is unacceptable for both Central Asians, who live there, and the world community, which is poised to pour additional investments into the region.

Recognizing the urgency of addressing Central Asia's urban earthquake risk, GeoHazards International organized a NATO Advanced Research Workshop to assess the vulnerability of the region's Soviet-era residential buildings and develop a strategy for reducing it. The government of Kazakhstan agreed to act as host.

Support for organizing this workshop came from a wide variety of organizations. The initial seed funding came from NATO's Scientific and Environmental Affairs Division. Additional, essential financial support came from (listed in alphabetical order): the Foreign Office of the Federal Republic of Germany, GeoHazards International, the Kazakh State Committee for Emergencies, the United Nations University and the US Geological Survey. Other important support was provided by the Applied Technology Council (USA); the Cecil and Ida Green Foundation (USA); the German Association of Earthquake Engineering and Structural Dynamics; the International Association of Earthquake Engineering's World Seismic Safety Initiative; the International Association of Seismology and Physics of the Earth's Interior; the IRIS Consortium (USA); the Joint Seismic Program of Lamont-Doherty Geological Observatory of Columbia University (USA); the Kazakh Research and Experimental Design Institute on Earthquake Engineering and Architecture; OYO Corporation (Japan); the United Nations Educational, Scientific, and Cultural Organization (UNESCO); and the US National Center for Earthquake Engineering. The editors wish to express their gratitude to all these organizations, whose contributions made the workshop a success.

The resulting workshop was held in Almaty, Kazakhstan, from October 22-25, 1996, and involved more than 50 experts from the fields of seismology, earthquakeresistant design, and emergency response from across Central Asia and around the world.

This volume contains papers that were prepared for presentation and discussion at the Almaty workshop. Following the Executive Summary, which summarizes the outcome of the workshop, the next two papers provide an overview of the seismic hazard and building vulnerability, respectively, in the Central Asian republics. The next five papers are reports on seismic hazard and building vulnerability in each of the five Central Asian republics prepared by the workshop participants from each republic prior to the meeting in Almaty. These papers are based on responses to a series of questions pertaining to seismic hazard and building vulnerability that were formulated by the conference organizers. The questions, included in this volume in the Appendix, were designed to help the experts in each republic prepare comparable reports that were made available at the time of the Almaty workshop.

The next three papers describe observations and analysis of building damage in the 1988 Spitak, Armenia earthquake, the 1994 Kuril Islands earthquake, and the 1995 Sakhalin earthquake. Many of the buildings destroyed in these earthquakes are of similar design and construction to buildings located in the Central Asian republics. The final paper is a study of the seismic resistance of mass-constructed Soviet-era buildings that are located throughout Central Asia, using the city of Almaty as an example.

The editors wish to express, on behalf of all the participants of the Almaty workshop, their deep appreciation to several individuals whose personal efforts made this workshop and, therefore, this book possible. The Honorable Nikolay Makievsky, Deputy Prime Minister of Kazakhstan, provided the local overall support and hospitality that allowed the workshop to take place. The keynote speeches by him and by the Honorable Elizabeth Jones, Ambassador of the US to Kazakhstan, and by the Honorable Henning von Wistinghausen, Ambassador of the Federal Republic of Germany, underlined the need for the workshop and motivated the participants in their work. Academician Toeleby Zhunusov, Director of the Kazakh Research and Experimental Design Institute of Aseismic Engineering and Architecture, made available the resources of his institute. This workshop was triggered by a paper of William Leith, in June 1995, in which he pointed out that the consequences of the Sakhalin Earthquake should renew concerns about seismic safety in the former Soviet Union; he provided encouragement and resources throughout the organization of the workshop. Giinter Klein and Christopher Rojahn provided almost daily support and advice while the workshop was organized and conducted. The concern for Central Asia and the technical expertise of all the workshop participants - largely unnamed in this book - shaped in very real ways the eleven papers presented here; many of these participants carefully prepared for the workshop and traveled long distances to attend. Dr. Luis Veiga Da Cunha and Alison Trapp of the Scientific and Environmental Affairs Division of NATO patiently guided us throughout the entire process of applying for support up to and including conducting the workshop itself. Wil Bruins and Annelies Kersbergen of Kluwer Academic Publishers assisted us in the publication of the manuscript. Finally, the person most responsible for the multitude of logistical arrangements of the workshop and without whose help the workshop would not have been a success, is Cheryl Eichorn, of the U.S. Geological Survey.

In closing we would like to urge readers to consider how best to help the peoples of Central Asia. As mentioned already, Central Asia has experienced for centuries the severest social, political, religious, and economic changes. These changes continue to this day. While the opportunity now exists for social stability, political freedom and economic development, these have not yet been completely achieved. At such a time, it may seem ill-considered to draw attention to yet another problem- urban earthquake risk, especially one that will occur at some unknown time in the future, with some unknown consequences. Why not let the Central Asians alone to deal with today's challenges?

For us, the question is not "either- or". The answer is that the Central Asians and international developers should face today's challenges with the inevitable large, future earthquakes in mind. When investing in infrastructure, developers should insist on employing seismically-resistant design and construction methods. When devising legal and political reforms, public officials should consider the need to create, maintain and enforce modem building codes. When expanding the freedom of the press and other media, leaders should be aware of the need to inform honestly the public of the risk involved in living and working in the many seismically-vulnerable structures built during the Soviet era. Failing to take into account Central Asia's earthquake risk puts all the current and future development and social progress in jeopardy. We hope that this book contributes in a small way to the rapid development of Central Asia and to the safety of its people.

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