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MODELS AND FRAMEWORKS FOR ASSESSING THE VALUE OF DISASTER RESEARCH: A FOCUS ON CENTRAL ASIA AND THE REPUBLIC OF UZBEKISTAN

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Abstract. *Funders, governments, and multilateral stakeholders globally require demonstrable evidence that investment in disaster risk reduction (DRR) research yields tangible impact beyond the academic domain, contributing effectively to policy formulation, improved practice, and societal resilience. This paper reviews and adapts existing research impact assessment frameworks for conceptualising and measuring the value of DRR research within the distinctive, high-risk context of Central Asia (CA), with a dedicated emphasis on the Republic of Uzbekistan. The CA region is uniquely characterised by complex, transboundary hazards, notably high seismic activity, recurrent fluvial and urban floods, and pervasive climate-induced droughts. We argue that assessing research value in this setting necessitates a shift from purely economic quantification to a multi-dimensional framework encompassing policy alignment, capacity development, and the robust quantification of systemic and transboundary risk. Case evidence from Uzbekistan demonstrates that the value of DRR research is primarily realised through the development and institutionalisation of region-specific technical tools – such as Probabilistic Seismic Hazard Analysis (PSHA) models, harmonised exposure databases, and the systematic institutionalisation of disaster loss tracking systems like DesInventar Sendai. This analysis concludes that an effective value assessment framework for Central Asia must prioritise demonstrable contributions to strengthening risk governance and accelerating the implementation of the Sendai Framework for Disaster Risk Reduction (SFDRR) targets, particularly by enhancing the use of scientific knowledge in decision-making.*

Key words: *Disaster Risk Reduction (DRR); Research Impact Assessment (RIA); Central Asia (CA); Uzbekistan; Seismic Hazard Modeling; Risk Governance; Sendai Framework; Capacity Building; Transboundary Risk.*

1. INTRODUCTION

The growing number and severity of natural and human-caused disasters around the world have made it clear that we need to use evidence-based methods to lower the risk of disasters (DRR). After the Sendai Framework for Disaster Risk Reduction (2015–2030) was put into place, the focus changed from dealing with crises after disasters to proactive, science-based risk governance. For this paradigm shift to happen, both the public and private sectors need to

put a lot of money into research to learn more about risks so that they can be reduced and resilience can be built.

But there is also a strong need for accountability: funders, governments, and civil society are all demanding more and more proof that research investment is a good use of resources and has a clear effect on society. In the realm of disaster risk reduction (DRR), quantifying this impact is intricate, as it necessitates the measurement of averted losses, the valuation of non-market benefits (such as improved community safety), and the correlation of policy alterations to scientific contributions.

This paper examines the conceptual and practical difficulties of research impact assessment (RIA) by utilizing established frameworks within the context of Central Asia. Kazakhstan, the Kyrgyz Republic, Tajikistan, Turkmenistan, and Uzbekistan make up the region, which is a unique place to study because it is very exposed to multiple hazards, has a lot of financial problems, and is in the process of changing to more modern, risk-informed governance structures. We suggest a multi-faceted framework for evaluating the significance of DRR research specific to the region, offering a comprehensive case study of Uzbekistan's advancements and the influence of research on its institutional reforms.

2. LITERATURE REVIEW

The systematic assessment of research impact, characterized as the evident contribution of research to the economy, society, culture, public policy, health, or environment beyond the academic realm, has become increasingly significant over the past twenty years. There are several well-known frameworks for thinking about and measuring this value, but they all have pros and cons when used in the disaster field.

2.1. Attribution and Quantification Models

Traditional RIA models often rely on a clear **attribution chain** to link research input to a policy or practice outcome.

- **The Payback Framework:** This model divides impact into five areas: creating new knowledge (academic), setting research goals (like new methods), changing policies and practices, helping society, and making money. Attributing disaster avoidance (the core of DRR value) to a specific piece of research is methodologically difficult, even though it is thorough.
- **Logic Models and Theory of Change (ToC):** These frameworks show how research inputs, activities, outputs (like publications and models), and expected outcomes (like policy change and capacity increase) are all connected. ToC is very useful for DRR because it makes researchers spell out the path they want to take from a scientific output (like a PSHA map) to a social outcome (like safer building codes).

2.2. The Public Value Framework

The Public Value approach, which started in public sector management, is very useful for research on disasters. It looks at value not only in terms of how much money it saves, but also in terms of how much research helps public goals and democratic accountability. In DRR, public value comes from:

1. **Legitimacy and Support:** Research that is seen as credible and authoritative by stakeholders (e.g., government, emergency services).
2. **Operational Capacity:** Research that enhances the tools and skills of risk managers (e.g., new early warning systems).

3. **Substantive Outcomes:** Research that directly reduces mortality, morbidity, and economic losses.

Using this framework in Central Asia lets us include things that aren't economic, like better regional cooperation and sharing of risk information across borders (a key public good for the region) that come from joint research projects.

2.3. Suitability for the DRR and Central Asian Context

Disaster research poses a distinct challenge: its significance frequently resides in the prevention of adverse outcomes, which is intrinsically challenging to measure. The Central Asian context also makes things more complicated because:

- **Data Scarcity and Fragmentation:** Historical loss data, especially from the early post-Soviet period, is frequently incomplete, contradictory, or non-standardized, complicating baseline assessment.
- **Capacity Gaps:** There is a lot of good hazard analysis capacity from the Soviet era, but vulnerability analysis and the use of research in financial mechanisms (like insurance) are still weak.

Therefore, any RIA framework that works for the region must put a lot of emphasis on the process-oriented effects of capacity building, data harmonization, and policy integration, as well as the final results.

3. DISASTER RISK PROFILE OF CENTRAL ASIA

Central Asia is one of the world's most disaster-prone areas because of a mix of natural, technological, and geophysical threats. Natural disasters have harmed more than 10 million people and cost more than $3.7 billion in damages over the past 30 years.

3.1. Geophysical Risks: The Dominant Seismic Threat

Earthquakes are the biggest danger in Central Asia, and they have historically killed the most people. The Indian and Eurasian plates crashing into each other makes the tectonic system active, which causes a lot of earthquakes in the area.

- **The Uzbek Seismic Reality:** The country is in an area with a low to very high risk of earthquakes. The capital city of Tashkent and other major cities are very vulnerable. Less than 15% of Uzbekistan's land is at very high risk of earthquakes, but more than half of the country's population and about 65.5% of its GDP come from these areas (for example, the Tashkent and Bukhara regions). An earthquake with a low frequency and a big effect could cost the country almost 6% of its nominal GDP. Because of this risk profile, high-resolution seismic research is important for the country's financial security.

3.2. Hydro-Meteorological Risks and Climate Change

The region is highly vulnerable to floods (fluvial and urban), mudslides, landslides, and drought. Seasonal floods often ruin farmland and hurt the agricultural sector, which many people in rural areas depend on.

- **The Flood and Drought Dualism:** Floods cost Uzbekistan's economy an average of more than $395 million a year, mostly in the Karakalpakstan, Khorezm, and Andijan regions. On the other hand, climate change forecasts show that the risk of droughts and water shortages will rise, which is a long-term, systemic threat to agriculture and water management, especially in the Aral Sea basin area.

3.3. Systemic and Transboundary Risks

Research in Central Asia must confront hazards that transcend national borders.

- **Transboundary Water Management:** Hydrological risks frequently transcend borders, necessitating regional collaboration in early warning systems and collective modeling.
- **Interlinked Vulnerabilities:** An earthquake in a major city or industrial area (like Tashkent) is likely to have a long-term effect on the economy, affecting supply chains, international trade, and national recovery efforts. This shows that we need research that looks at both the physical threat and the economic weakness of the system.

4. ASSESSING RESEARCH VALUE IN CENTRAL ASIA: A MULTI-DIMENSIONAL FRAMEWORK

Given the unique context of Central Asia, a multi-dimensional framework is necessary to assess the value of DRR research, moving beyond purely academic output. We propose three primary dimensions for value quantification: Policy and Governance, Scientific and Technical, and Socio-Economic.

4.1. The Policy and Governance Dimension (Value as Institutional Change)

Research impact is valued by its ability to influence and reform state structures. Metrics include:

- **Policy Adoption Index (PAI):** This index shows how well research recommendations (like specific risk thresholds and zoning maps) have been put into national laws, strategies, and regulatory codes. Case Metric (Uzbekistan): How much the new PSHA model affected the Law on Seismic Safety and the rules for building.
- **Risk Governance Score (RGS):** This score shows how the shift from managing disasters on the fly to a more organized, ongoing approach to risk governance is happening. This is often shown by the institutional mandate and funding for research-informed activities.
- **SFDRR Alignment Metric** shows how well the reporting on SFDRR targets A-D is going. This depends directly on research tools like DesInventar Sendai.

4.2. The Scientific and Technical Dimension

This dimension values the creation of high-quality, practical risk knowledge and the associated local capacity to use it.

- **Knowledge Utility Score (KUS):** Measures how useful research outputs are to people who aren't academics, like city planners and emergency services. This includes making high-resolution models and databases that work together. Case Metric (Central Asia): The creation of a single database of structures, infrastructure, and crop assets for the SFRARR program. This is necessary for consistent risk analysis across the five countries.
- **Capacity Development Index (CDI):** This shows how much local technical knowledge has grown. Case Metric (Uzbekistan): The number of local experts who have learned how to use the new PSHA model and Exposure Mapping, as well as their ability to keep these tools up to date and use them on their own.

4.3. The Socio-Economic Dimension

It is hard to put a number on avoided loss and improved financial resilience, but this is a key part of DRR value.

- **Avoided Loss Ratio (ALR):** A probabilistic estimate of the economic value saved by putting research-based mitigation measures into place (for example, moving or retrofitting based on a PSHA map). A lot of the time, this number comes from the new risk models.

- **Financial Resilience Score (FRS):** This score shows how much research helps with ways to protect your money. Case Metric (Central Asia): Investigate the viability of creating national catastrophe insurance pools, akin to the Turkish model, for nations such as Uzbekistan and Kazakhstan to financially prepare for significant events.

5. CASE STUDY: THE VALUE OF DRR RESEARCH IN THE REPUBLIC OF UZBEKISTAN

Uzbekistan’s recent efforts provide a clear illustration of how research impact is being generated and measured across the multi-dimensional framework. The country's high exposure to seismic and hydro-meteorological risks has led to strong institutional reforms supported by targeted research.

5.1. Seismic Risk and the Value of PSHA Modeling

The 1966 Tashkent earthquake remains a landmark event, underscoring the necessity of seismic preparedness. The value of recent research in this domain is profound:

- **Advancing the Scientific Baseline:** Research efforts from around the world and in the US have led to the creation of a modern, regionally consistent Probabilistic Seismic Hazard Analysis (PSHA) model. This model uses the latest methods, an updated earthquake catalog, and active fault databases. This model is an unprecedented technical achievement, receiving high marks on the Scientific and Technical Dimension (KUS).
- **Direct Policy Codification:** The Policy and Governance Dimension shows the most important value. The new PSHA model is now the basis for putting the national Law on Seismic Safety into action. This means that building codes, land-use planning, and investments in infrastructure must all be based on risk. This direct link to the law is the most powerful way for policy to have an effect.
- **Economic Risk Quantification:** Research gives us real numbers on possible losses. Modeling shows that an earthquake with a return period of 100 years could cost Uzbekistan $3.6 billion. This number forces governments and financial institutions to recognize and prepare for this risk.

5.2. Hydrological Risk and Flood Resilience

While seismic risk is high-impact, low-frequency, hydrological hazards (floods, mudslides) are higher-frequency and disproportionately affect the agricultural sector and regional populations.

- **Agricultural Adaptation Research:** Research on agricultural adaptation has looked at in-depth diagnostic assessments in places like Samarkand and Surkhandarya to find and test climate-resilient farming methods. The analytical reports that come from this give a full picture of climate risks and how ready farmers are to take steps to adapt. This is a clear example of how protecting livelihoods can create Socio-Economic Value.
- **Spatial Risk Analysis:** It's been very important to focus on mass movements (landslides, mudflows) in mountainous areas like Tashkent Province. Researchers are using Remote Sensing technology to keep an eye on high-risk areas (like the Mingchukur landslide) and stop bad things from happening to important infrastructure, like water reservoirs. This improves Operational Capacity in the Public Value framework.

5.3. Institutionalization of Risk Knowledge: DesInventar Sendai

The core challenge of data fragmentation and inconsistent standards in loss reporting has been directly addressed by research-led institutionalisation.

- **The Power of Standardisation:** The UN Office for Disaster Risk Reduction (UNDRR) coordinated the use of DesInventar Sendai in Central Asia, which is a direct result of research. This tool is very important because it makes it easier to collect data on damage and loss and is fully compliant with the Sendai Framework Monitor.
- **Value Proposition:** The value here comes from the improved Accountability and Policy Efficacy Feedback. Research-based policy changes can be looked at in the past and the future by providing a structured, verifiable record of disaster impacts. This will improve the country's Policy and Governance Dimension (SFDRR Alignment).

5.4. Financial Resilience and Risk Transfer

Research value encompasses the financial domain, investigating the methods by which nations fund disaster response and recovery efforts. Because governments usually have to pay for most of the costs, which takes money away from other important investments, the research focus has shifted to ex-ante financial planning.

- **Fiscal Preparedness:** Research indicates that nations with more substantial economies, like Uzbekistan, ought to contemplate the creation of national Catastrophe Insurance Pools. This research is valuable as it offers the technical analysis and economic rationale required to transition government policy from ad hoc budgeting to structured, pre-arranged financial mechanisms, thereby creating significant Socio-Economic Value (FRS).

6. CHALLENGES, GAPS, AND FUTURE RESEARCH AGENDAS

While significant progress has been made, particularly in Uzbekistan, several challenges remain in maximising the value of DRR research across Central Asia. Addressing these gaps forms the basis of the future research agenda.

6.1. Data Scarcity and Vulnerability Analysis

Even though projects like SFRARR are trying to make data more consistent, vulnerability analysis is still the weakest part of the risk equation in Central Asia. After the fall of the Soviet Union, analysts put a lot of effort into hazard modeling, but they often ignored how vulnerable assets were in terms of their social, economic, and physical conditions.

- **Future Agenda:** Research should concentrate on disaggregated data collection (age, gender, disability) to comprehend the impact of hazards on various groups. This necessitates grassroots, community-oriented disaster risk reduction research, leveraging current initiatives such as the MCR2030 (Making Cities Resilient) program, which includes cities like Namangan in Uzbekistan.

6.2. Translating Regional Knowledge to Local Action

While regional projects have made high-level models, they often lose their value when they are used at the local level. Mayors and other local leaders need easy-to-use, low-cost tools to help them include risk information in their planning and budgeting for cities.

- **Future Agenda:** There is a need for research that makes useful, smaller city risk profiles and training modules for local officials that focus on how to use them in real life instead of complicated modeling theory. The regional conversation about how cities can be more resilient, which includes Namangan, is a good step forward.

6.3. Integrating Climate Change and Systemic Risk

The full value of DRR research will only be attained when the examination transcends individual, discrete hazards. It is necessary to model how different hazards interact with each

other. For example, the risk of earthquakes goes up because of the size of man-made water reservoirs, and landslides caused by climate change happen at the same time.

- **Future Agenda:** Research needs to include high-resolution climate change projections in order to model how future hazards will build on and affect each other. This means getting to know systemic risk, which is when one system fails (like when a drought causes the water supply to fail) and that failure leads to another system failing (like when agriculture fails, people move, and food becomes scarce).

6.4. Sustainable Regional Cooperation

Research is an important factor in keeping regions stable and working together, especially when it comes to risks that cross borders. The benefits of working together on projects go beyond the scientific results. They also include creating long-lasting places for conversation and sharing skills.

- **Future Agenda:** Regional organizations like the Center of Emergency Situations and Disaster Risk Reduction (CESDRR) need ongoing support to become a real "center of excellence" for disaster risk reduction (DRR). The quality and frequency of knowledge sharing and the commitment of governments to the Regional DRR Strategy 2022–2030 should be used to judge the research value.

7. CONCLUSION

The demand for research accountability calls for a strong method for figuring out how valuable and useful investing in disaster risk reduction is. In the case of Central Asia, and especially the Republic of Uzbekistan, a model that only looks at economics is not enough. We need a multi-dimensional framework that can capture value in the areas of Policy and Governance, Science and Technology, and Socio-Economic.

Uzbekistan's experience shows that the most valuable research is that which leads to institutional reform, such as the legislative codification of modern PSHA models for seismic safety and the creation of reliable loss reporting systems like DesInventar Sendai. So, research is valuable not just because it creates new knowledge, but also because it builds capacity and strengthens governance systems so that knowledge can be used and kept. Future research must rectify significant deficiencies in vulnerability data, enhance regional models for local applicability, and incorporate systemic climate risks to guarantee that Central Asia maintains its progress towards increased resilience and sustainable development in accordance with global directives.

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