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Power to the People: Disaster Resilience support with advance energy storage systems

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Abstract

The occurrence of both natural and man-made disasters is inescapable, but the consequences for the lives of vulnerable communities can be mitigated. United Nation (UN) and organizations such as the Federal Emergency Management Agency (FEMA) recommend investing proactive rather than re-active actions in dealing with disasters. It is commonly understood that "$1 spent on risk reduction saves between $5 and $10 in economic losses from disasters." Currently Central Asian countries including Kazakhstan have weak proactive support programs and disaster mitigation plans. Most of the support activities are post disaster. Proactive actions, monitoring and prediction analysis of the potential disasters in Kazakhstan and other Central Asian countries require a multidisciplinary cooperative approach with applications of remote sensing sensor monitoring technologies. These require a permanent energy supply in various harsh environmental conditions. What advance energy storage systems are available and can be used for a Disaster Resilience programs? How can these energy storage systems be integrated into remote sensing sensor monitoring technologies? Our group of researchers is developing the multidisciplinary Disaster Resilience Institute (www.drinu.org) and Laboratory to Monitor Engineering Constructions (LaMEC, www.lamec.org) to work on proactive monitoring actions related to engineering facilities that are interconnected to surface and underground water resources such as bridges, dams, and reservoirs. We are looking for the cooperation in these areas and are convinced that success is presaged on a multidisciplinary approach.

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Keywords: Disaster Resilence, DRINU, Kazakhstan, Central Asia, Monitor Engineering Constructions, LaMEC, Kazakhstan Committee for Emergency Situations

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1. Kazakhstan's current situation related to Disaster Resilience

Kazakhstan has recurring issues related to disaster (emergency) events, including landslides, mudslides, debris flows, avalanches large earlier spring floods in some regions (Almaty, Astana and Karaganda regions), desertification in other regions (Central and Kyzul-Orda regions), south region of Kazakhstan is under risk of earthquake events.

Kazakhstan is located in a seismic hazard region [1]. South Mountainous area is in a very high seismic hazard region. About 30% of Kazakhstan's total area of 650 000 km^2, with a population of over 6 million people and 40% of the industrial potential of the country, is located in the high seismic risk zone. This Kazakhstan's zone is in the most dangerous Mediterranean-Asian seismic belt. Over the past couple of hundred years, there were catastrophic earthquakes, such as the Verny earthquake of 1887 (M = 7.3), the Chilik Earthquake in 1889 (M = 8.3) and the Kemin earthquake of 1911 (M = 8.2). The Almaty region was almost flattened during these earthquakes [2]. There have also been earthquakes in neighbouring countries with magnitudes of between 9 and 10 on a 12-point scale. Highly damaging earthquakes occur about every 100 years. [2] Strong earthquakes can happen at any time in Almaty [3].

The most frequent causes of natural disasters are spring floods and rain floods, which constitute about 30% of the total number of disasters. Kazakhstan is in the high-risk category for flooding and mudslides. Once every 50 years, it has catastrophic flooding. Several regions of Kazakhstan struggled with disaster flooding in 2015. According to the most conservative estimates, the damage totaled several billion tenge. The Government of the Republic of Kazakhstan has allocated from the emergency reserve more than 1 billion tenge to provide priority assistance to the population of the Karaganda region. The East Kazakhstan is also a priority area. Water has destroyed roads in Kostanai and Pavlodar regions. Several villages of Akmola region as well as suburban areas of Astana are in danger of flooding. In the Karaganda region, the affected residential properties damage is estimated more than one billion tenge in 2015. In addition, flooding in the region damaged infrastructure: roads and bridges were destroyed.

Landslides are also a significant hazard in Kazakhstan. The March 2004 landslide in Talgar district killed 48 people [2]. The flood hazard in combination with earthquakes is significant in Kazakhstan. The largest flood mudflows are those activated by earthquakes [4]. According to the Kazakhstan Committee for Emergency Situations, the annual direct losses from emergencies are estimated as 5 billion tenge. Experts estimate the cost of collateral damage at 20 billion tenge with the loss of life and the treatment of victims at more than 3 billion tenge. In total, it can be more than 25 billion tenge annually [5].

Kazakh Space Agency, Garysh Sapary, has analyzed the engineering accidents for the period 2006-2013 in Kazakhstan [6, 7]. From the 71 cases of major engineering constructions accidents, 68 accidents were related to the failures of bridges. According to this analysis, there are 1500 different type of bridges in Kazakhstan, 290 of the bridges were built before 1970. The bridges' health has not been monitored properly and their condition is unpredictable. Of this total, 42 accidents had grave consequences to the partial destruction of the structure and the loss of human life, which is considered an abnormally high rate (an average of 7 serious accidents per year). One of the most severe cases happened in Atyrau city, West Kazakhstan, where a bridge collapsed in 2009 killing 8 people with loss of dozens of million dollars. In 2015, in Almaty, a bridge collapsed at the intersection of avenues Ryskulov and Saina and 19 people were seriously injured and one person killed [8].

Events of the kind described above, usually occur with little warning. Nevertheless, it is possible to recognize some factors that indicate serious risk even before the disaster itself. The monitoring, detection and analysis of such risk factors could help significantly in meeting the danger. So, for example, an analysis of the devastating floods in Kyzylagash, probably the most serious the nation's history, pointed to serious failings on the part of public sector employees. Hundreds of civil servants and related personnel were convicted of significant neglect of duty by the investigation into the flooding [9].

Disaster (emergency) events can happened as a chain of the connected cataclysm actions, such as earthquakes-flood-fire. Multidisciplinary cooperation and data sharing are very critical for proper Disaster Resilience preparedness. Unfortunately, multidisciplinary cooperation and data sharing are very weak in Kazakhstan. Most organizations and agencies do not share data as they work on very narrow tasks. Most of the water resource related organizations, for example, work on tightly-defined issues, such as meteorology agencies that focus on precipitation tasks; hydrologists monitor only on the surface water tasks; or, hydro-geologists specialize on the underground water investigation. All these bodies keep their data without sharing data with each other. In this case, there is lack of the multidisciplinary approach to work on modeling and prediction analysis of the entire water cycle, including the