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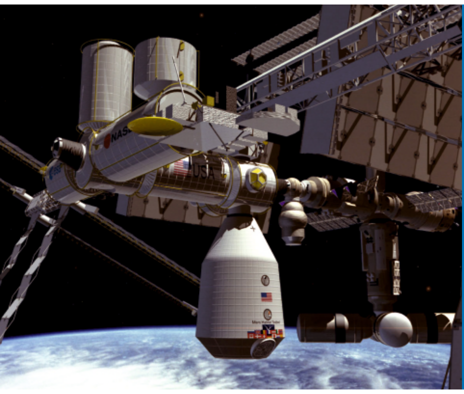

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Special Issue 2016

Almaty

“Disaster Management & Emergency Responses to Flooding”
Conference, 7-13 August 2016, Almaty, Kazakhstan

The event brought together scientists, engineers and practitioners from across academia, industry, and non-government organizations to discuss, share and promote current research and recent developments across all aspects of engineering in disciplines such as Civil, Environmental, Hydrological, Geological, Social, Political Sciences, Earth Observation Satellite or Remote Sensing Technologies. The workshop was focused on three specific themes related to forecasting, decision making and response to natural disasters:

I) natural hazards from floods and seismic activity to landslides

II) Remote Sensing (Satellite) for monitoring and prediction of natural disasters

III) Disaster Risk Reduction and Resilience (DRRR)

Theme I dealt with natural hazards with a particular focus on flooding from seasonal glacial ice melt and seismic distortions resulting in landslides, with field work tracking and sensors applications, data collection and modelling.

Theme II dealt with remote sensing for real-time monitoring and prediction analysis, applications of the different international satellite and local data, including Kazakhstan KazEOSat-1 and -2. Satellite data processing, data collection, modelling and visualization with web GIS tools application were also discussed.

Theme III dealt with Disaster Risk Reduction and Resilience (DRRR) and response. Cooperation strategies related to DRRR were discussed by public emergency preparedness researchers, emergency agencies, scientists, multidisciplinary social-political science and engineering science experts.

The papers presented in the conference are published in this special issue of VESTNICK of AUPET.

Acknowledgements:

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Special Issue

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MULTIDISCIPLINARY COLLABORATION FOR DISASTER RESILIENCE

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Abstract. Multidisciplinary cooperation and data sharing are very important when natural disasters occur. Until now most disaster support and training programs have been developed through narrow fields of specializations in Kazakhstan. However, in most aspects of life, the political, academic, research and social spheres, integration of expertise has proven to be more effective. Kazakhstan has weak multidisciplinary social and technical research cooperation since technical and social researchers usually do not have common projects. On the other hand, Western countries have strong support for multidisciplinary cooperation. In this paper, three examples of multidisciplinary cooperation in Canada, the Global Institute for Water Security (GIWS), the Red River Basin Commission (RRBC) and the Canadian Space Agency (CSA), are reviewed.

Key words: Disaster Resilience, multidisciplinary, Kazakhstan, integrated modelling.

Introduction

A multidisciplinary approach includes contributions from several disciplines to research problems to find solutions for complex situations. Identifying causes and determining potential disasters are an ideal context for an interconnected and multidisciplinary approach [1]. Earthquakes, bridge-dam-reservoir destruction, hurricanes, floods and fires could happen simultaneously. As well, during a flood, the management of all water (snow, melting snow, rain) should be measured and the movement, discharge to underground reservoirs, evaporation and other features of the water cycle need to be studied as a whole. As well as the purely technical factor, a multidisciplinary approach will highlight the social, economic and other contributory elements of flood disasters.

Kazakhstan situation

Multidisciplinary cooperation and data sharing are very important when natural disasters occur, but the infrastructure for this is very weak in Kazakhstan. Most organizations and agencies do not share data as they work on very narrow tasks. For example, Kazakhstan has recurring issues with large early spring floods in some regions (Almaty, Astana and Karaganda regions), and desertification in other regions (Central and Kyzul-Orda regions). Most of the water resource related organizations work on narrow issues, such as meteorology agencies that concentrate on precipitation tasks; hydrologists that focus only on the surface water tasks; hydro-geologists that specialise on the underground water investigation and all these bodies keep their data without sharing it. In this case, there is a lack of the multidisciplinary approach to work on modelling and prediction analysis of the entire water cycle, including the interconnected chain of processes: precipitation, surface and underground water. If there is a chain of disaster events, such as earthquake-flood-fire, experts from the different disciplines (meteorologists, hydrologists, hydro- geologists, and fire experts for example) work separately. However, unified databases and cooperative tools exist in many countries, including HAZUS in Canada [2]. Disaster and emergency activities in Kazakhstan, which rely on policing personnel, are for the most part reactive – after a disaster happens. They do not provide pro-active work based on analytical research. Essentially, they lack the expertise and skills to work on modelling and predictive analytical research. Cooperation among social and technical researchers is very limited, so people are not informed properly about potential disasters and the ensuing consequences. Kazakhstan does not have socio-hydrology cooperation programs because traditionally technical and social research experts have not conducted research together.

The Kazakhstan Space Agency Garysh Sapary has invested in very sophisticated technologies that require high expertise, knowledge and skills to develop applications. For example, Kazakhstan invested heavily in purchasing, launching and using two sophisticated Earth Observation Satellites (EOS): KazEOSat-1 (1 m panchromatic; 4 m four multispectral channels) developed by French Airbus Defence and the Space KazEOSat-2, which was developed by SSTL (Surrey Satellite Technology Ltd) of Guildford, UK. Many Kazakhstan organizations lack the expertise, knowledge and skills to process this high resolution raw data and apply it to their needs. Thus, training and promotion of the satellite data from the Kazakh Space Agency Garysh Sapary should be expanded. There are just a few consultant companies in the market, which do not share their knowledge and data. Kazakhstan is lacking applications of the satellite data for different engineering projects. These two KazEOSat-1 and -2 satellites can provide high-resolution data up to one meter, which is thirty times higher than the publicly available US Landsat with 30-meter resolution. The Kazakhstan Space Agency Garysh Sapary does not have a proper transparent user friendly science cooperation program with researchers and universities, but the Kazakhstan systems can find models in Canada to inform their innovation. Research projects involving SOAR, the Canadian data sharing – multidisciplinary research program Science and Operational Applications Research, are relevant to Kazakhstan's needs [3].

Examples of multidisciplinary cooperation

Governments and academic institutions in Canada strongly support multidisciplinary cooperation. This paper highlights three organizations as examples of practical and successful multidisciplinary cooperation in Canada: the

Global Institute for Water Security (GIWS), the Red River Basin Commission (RRBC), and the Canadian Space Agency (CSA).

Global Institute for Water Security (GIWS)

The Global Institute for Water Security (GIWS) is a multidisciplinary organization that focuses on the sustainable use of water resources around the world and on the protection against natural environmental hazards that concern water (especially droughts and floods). Their work in Saskatoon, Saskatchewan can inform Kazakhstan's practice since its base location is so similar. While the Saskatoon prairie is in the Western hemisphere, it has nearly the same climate, weather and precipitation patterns as Kazakhstan's steppe.

The GIWS has a unique multidisciplinary team of social and technical experts, which form the socio-hydrology research cooperation activities. At GIWS, the interdisciplinary teams include government scientists, university faculty and experts from different industrial companies who work with post-doctoral fellows and students. Their priority is to understand how land management practices, natural resource development and climate change affect the eco-system. Together, they develop and improve modelling tools which are necessary for managing water in a sustainable manner. GIWS combines expertise in engineering, the natural and the social sciences. Their research goes beyond traditional water resources management so that decisions about water "incorporate a range of values and perspectives about the meaning, value and use of water" [4].

The GIWS researchers conduct workshops and activities throughout the Saskatchewan River Basin to encourage dialogue between everyone involved with water resource management in order to understand concerns and determine the appropriate scientific tools which will enhance water security. The Slave Watershed Environmental Effects Program (SWEEP) is an example of a community based venture. The program empowers the residents to collect, interpret, and use a system of aquatic environmental indicators to address key issues and prioritize water management activities in the watershed. The local First Nations (Indian or Aboriginal) communities rely on the Slave River Delta culturally, socially and economically. Through one-to-one interviews and sharing circles, they have expressed that their main concerns include "water quality, hydrology, sediment load, wildlife, air, climate, vegetation, fish, and insects" [5]. Other information comes from traditional science which includes "measures of water quality, bottom-dwellers, hydrology, and fish health" [5].

Another more encompassing project is the Delta Dialogue Network (DDN), which coordinates the research activities from the Slave River, Peace Athabasca and Saskatchewan River Deltas. The DDN focuses on "knowledge mobilization", which is about making sure that knowledge serves society well by bridging any gaps between academic researchers, the general public and decision-makers [6].

Red River Basin Commission (RRBC)

The Red River Basin Commission (RRBC) is a Canada - USA trans-boundary cooperation, which was formed in 2002 to manage the common Red River Basin (RRB) water resources properly [7].

RRB is one of the Lake Winnipeg Watershed sub-basins (Figure 1). The Lake Winnipeg Watershed (LWW) is a very large watershed covering much of central Canada (four provinces) and four American states, which share the 49th parallel border. The LWW includes three major sub-watersheds: Red River (Assiniboine River); Winnipeg River; and the Saskatchewan River (GIWS focuses on and coordinates research on this third basin).

Figure 1 - Lake Winnipeg watershed, including Red River Basin shared by Canada and the USA. Source: [8]

The RRBC is a chartered not-for-profit corporation under the provisions of Manitoba (Canada), North Dakota, Minnesota and South Dakota (USA) bodies. The RRBC is made up of representatives of local governments (of the cities, counties, rural municipalities, provinces/states), watershed boards, water resource districts joint powers boards, as well as First Nations (Indian, Aboriginal) representation, a water supply cooperative, a lake improvement association, and numerous environmental groups.

One of RRBC's projects is the development of a Basin Wide Flood Flow Reduction strategy. "This strategy reduces flows on the mainstream by altering the hydrology of the contributing watersheds as a basin wide effort" [7]. The key advantage of this is that the flooding could be channelled along the entire length of the river, not just in communities that have a dam or other economic resources to prevent flood damage. It is significant that the tributary watersheds that are upstream will also benefit. Coordination is necessary in order to manage the flow from each of the contributing watersheds. The RRBC also developed a Drought Preparedness Strategy since droughts; either month long or longer, can potentially be more economically devastating. Their Scoping Document outlines the resources and timelines the USA-Canada stakeholders require [7].

After a major Red River flood in 1997, many of the concerned jurisdictions created an International Joint Red River Basin Task Force. Their major accomplishment was the development of an open source transparent database, where all data from all the regions were collected, including research projects, engineering consultant company jobs, geo-portal with downloadable files in different formats (to use with different software tools such as AutoCAD, GIS), and high resolution Light Detection and Ranging (LIDAR) data [9]. See Figure 2. This data was used to create a Decision Support System (DDS). The DSS provides the capacity to examine the costs and benefits associated with natural capital (or natural environments) restoration investments at the basin scale and within municipalities and counties.

This system allows the local, provincial/state and federal stakeholders to work on the entire ecosystem and to effectively manage it through dozens of multidisciplinary cooperation projects.

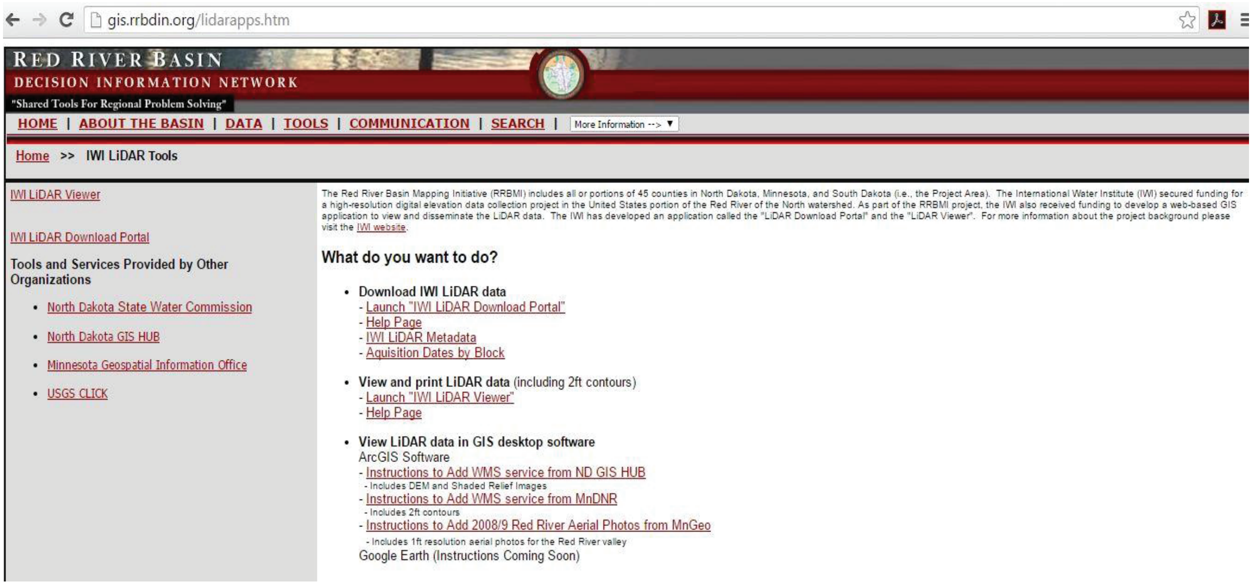

Figure 2 - Red River Basin Decision Information Network: Data available freely to the public. It includes high resolution LIDAR data at cm level resolution. Source: [9]

Canadian Space Agency (CSA) SOAR program

In 1989, the Canadian Space Agency (CSA) was created and has since reported to the Canadian federal Ministry of Industry. It endeavors to focus on the needs of a wide range of end-users through the integration of space science and technology research and its application to everyday public life. The applications include "television broadcasting, weather forecasting, mobile communications, water purification, heart monitors, ultrasound scanners, laser surgery, resource mapping, navigation, protective clothing, advanced structural design, robotics, solar power, sewage treatment, even shock-absorbing athletic shoes" [10]. An important example of CSA's innovative approach is Canadian Science and Operational Applications Research (SOAR), a multidisciplinary research program. SOAR is a joint partnership program between MacDonald Dettwiler and Associates Ltd, Geospatial Services Inc. (MDA GSI) and the Canadian government through the Canadian Space Agency (CSA) and the Natural Resources Canada's Centre for Remote Sensing (CCRS). The program provides free access to RADARSAT-2 data for research and testing purposes [3].

Conclusion

Kazakhstan endeavors to support more innovation. The essential driver for innovation is multidisciplinary cooperation, but that is still undeveloped in Kazakhstan. It is reasonable to introduce more multidisciplinary cooperation in Kazakhstan similar to the three examples of Canadian models that have been reviewed: the Global Institute for Water Security (GIWS), the Red River Basin Commission (RRBC), and the Canadian Space Agency (CSA) SOAR program.

Using these models, Kazakhstan could expand cooperation between social and technical researchers to develop similar multidisciplinary socio-hydrology teamwork programs. The best practices from the multidisciplinary approaches, cooperation, data sharing, similar to current practice in the three Canadian organizations GIWS, RRBC, and CSA - SOAR would be significantly helpful for Kazakhstan:

- Data sharing could be expanded and different data sharing platforms could be applied similarly to what exists in Canada. This free data for Earth Sciences Tools and Applications is available through National Resources Canada [11].
- Cooperation among researchers should be expanded. Meteorology experts and agencies could have more open course data related to precipitation with the hydrologists, who work on the surface water tasks, and the hydro-geologists, who work on underground water investigations. All these organizations and experts should cooperate more in data sharing with each other; and apply a more multidisciplinary approach to work on modeling and prediction analysis on the whole water cycle, including the connected chain of processes: precipitation, surface and underground water movement, as experts from Canada in GIWS and RRBC do.

- Social-hydrology types of cooperation among social and technical researchers should be expanded. Everyone, including the general public, should be more involved through training and proper information about many environmental complexities, including potential disaster issues. Curriculum for the public schools could also be developed for disaster preparation, so that the next generation is more aware and “ready.”
- Experts from the lines, such as earthquakes, meteorologists, hydrologists, hydro- geologists, fire experts, should have more cooperation and data sharing platforms, and have a unified database and should apply cooperative tools such as HAZUS.
- Currently, Kazakhstan acts mostly in a reactive capacity, dealing with the disaster after it occurred. It is possible to have more pro-active actions, analytical research work, prediction analysis and modeling research work.
- Specialized multidisciplinary institutes similar to Canadian GIWS and RRBC would be helpful if implemented in Kazakhstan for the Irtysh River Basin, Balkhash Lake Basin and SyrDarya River Basin. Specifically, the GIWS and RRBC models can inform joint cooperation institutes with the People’s Republic of China for the Irtysh River Basin and Balkhash River Basin. To date, trans-boundary water sharing has been very complicated in Kazakhstan. Canadian expertise of working on these issues through organizations can be very helpful for Kazakhstan.
- A multidisciplinary research program, similar to Canadian Space Agency (CSA) and Canadian Science and Operational Applications Research (SOAR) could be adapted for Kazakhstan. Establishing a transparent user-friendly platform could facilitate cooperation between the Kazakhstan Space Agency and Kazakh post-secondary institutions. Sharing this data could greatly impact educational, economic and environmental progress in Kazakhstan.
- All stakeholders concerned with water management in Kazakhstan, the governmental organizations, agencies, companies, and post-secondary institutions should share data and work on the next level of creative cooperation without repetition and duplication.

At Nazarbayev University, we are striving towards multidisciplinary cooperation related to disaster resilience through the development of the Disaster Resilience Institute, www.drinu.org [12] and the Laboratory to Monitor Engineering Constructions, www.lamec.org [13].

Acknowledgements

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МЕЖДИСЦИПЛИНАРНОЕ СОТРУДНИЧЕСТВО ПО УМЕНЬШЕНИЮ ВЛИЯНИЯ ЧРЕЗВЫЧАЙНЫХ СИТУАЦИЙ

Аннотация. Междисциплинарное сотрудничество и совместное использование баз данных очень важны для координации действий по стихийным бедствиям. В Казахстане до настоящего времени большинство программ поддержки стихийных бедствий и обучения были разработаны на основе узких областей специализации. Тем не менее, в большинстве аспектов жизни, политической, научных исследований и социальной сферах, интеграция знаний становится более эффективной для использования. Казахстан имеет слабое междисциплинарное сотрудничество в социально-технических исследованиях, так как технические и социальные исследователи, как правило, не имеют общих проектов. С другой стороны, западные страны оказывают сильную поддержку междисциплинарному сотрудничеству. В этой статье рассматриваются три примера междисциплинарного сотрудничества в Канаде между Глобальным институтом по безопасности водных ресурсов (GIWS), Трансграничным комитетом по водном ресурсам реки (RRBC) и Канадским Космическим Агентством (CSA).

Ключевые слова: устойчивость к бедствиям, междисциплинарное сотрудничество, Казахстан, интегрированное моделирование.

ТӨТЕНШЕ ЖАҒДАЙЛАРДЫҢ ӘСЕРІН ТӨМЕНДЕТУ ҮШІН ПӘНАРАЛЫҚ ЫНТЫМАҚТАСТЫҚ

Аңдатпа. Пәнаралық ынтымақтастық және деректер базасын бірлесіп пайдалану төтенше жағдайлар бойынша іс әрекетті бағыттауда өте маңызды болып табылады. Қазақстанда бүгінгі күнге дейін төтенше жағдайларды қолдаудағы және оқытудағы бағдарламалардың көпшілігі мамандандырудың өте тар ауқымы негізінде дайындалған. Алайда, өмірдің көптеген аспектілерінде, саяси, ғылыми-зерттеу және әлеуметтік салаларда білім интеграциясы қолданыста тиімдірек болып келе жатыр. Қазақстан әлеуметтік және техникалық зерттеулерде әлсіз пәнаралық ынтымақтастыққа ие, өйткені техникалық және әлеуметтік ғалымдардың әдетте ортақ жобалары жоқ. Екінші жағынан, батыс елдері пәнаралық ынтымақтастықтың мықты қолдауына ие. Бұл мақалада Су ресурстары қауіпсіздігі жөніндегі ғаламдық институтындағы (GIWS), Өзен су ресурстары бойынша трансшекаралық комитетіндегі (RRBC) және Канада ғарыш агенттігіндегі (CSA) пәнаралық ынтымақтастықтың үш мысалы келтірілген.

Кілттік сөздер: төтенше жағдайларға төзімділік, пәнаралық ынтымақтастық, Қазақстан, интеграцияланған моделдеу.

AVOIDING REDUCTIONISM IN DISASTER PREVENTION AND THE ROLE OF COMPLEXITY

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Abstract. Floods are catastrophic events caused by water, but not limited to its presence in places other than rivers, lakes or seas. The catastrophic characteristics arise when water interacts with other systems be it the cause or the effect of reciprocal failures. In this brief paper, we highlight the need for a more holistic approach to understand and prevent disasters, hence to engineer systems to this scope. We consider examples from recent flood events in Cumbria (UK) and Brisbane (Queensland, Australia) to show that simple cause-effect relation analysis fails to capture the dynamics of large system failure, and in particular, of water management systems at the origin of floods.

Key words: complexity, engineering, resilience, flood, holistic approach.

Introduction

A water drainage system does not work in isolation. It is subject to the weather variability and to the user pressure, besides being dependent on and working along other infrastructures. It is, in this respect, part of a larger and more complex system that comprises pipes and channels, the weather, the users and the environment, each of them with its own dynamics. These add on to any other infrastructure or engineering systems operating with the draining system, such as the electric power network to operate pumps or the transportation networks that intersect the drainage channels. Similarly, a dam is not just a system in isolation. It becomes an element in a larger system, even larger than the catchment. This complex system includes, amongst other elements, the dam, the catchment, the environment, the weather, the people (both users and operators), energy, and the communication and transportation systems. Looking at the 2011 Brisbane flood, the investigation carried out after the event highlighted how the Wivenhoe Dam was correctly operated according to the procedure, which prescribed the spillage of some excess water. However this was later found to be the cause of the escalation of the flood to a catastrophic level [1].

The flood problem has so far been tackled mainly looking at higher resolution precipitation forecasts [2,3]; however, beside the technological limits, there seem to be other factors limiting the effectiveness of this approach.

Water management and the disasters originating from the poor handling of it offer valuable examples of the problem arising from considering systems in isolation, without looking at the complexity of their operations and operating scenario. The interdependency of electric and communication networks taken as examples in [4] is another less dramatic example of this risk. The list extends to include the unforeseen effects across domains as in the case of the impact of bio-fuels on food farming and the economies of developing countries [5].

Our continuously more connected world risks becoming an even more fragile world as well if the engineering keeps on following an isolated design approach. Although a single definition of resilience is still to be agreed upon [6], it appears that the resilience of future engineering systems will rely more and more on the design and the characteristics of often apparently unrelated systems. These reasons call for a shift in the design and analysis of systems towards the domain of complexity science, with the expansion of the common understanding of complex engineering systems (CES). Complexity here is intended to be interdependency, multi-scale characteristics and emergence rather than a measure of how "far from simplicity" systems are. CES include those systems that, although conceived as single entities, end up to be part of larger (complex) systems and are interdependent within these.

In this short paper we present the case for a broadening of the engineering vision and to do so we take as examples water systems and their failure resulting in flood events. These are extremely good candidates by which to advocate the need for complex thinking as they normally operate in response to weather, a system universally recognised as complex. We consider the flood events in Cumbria in the last 10 years to show how the number and level of flood warnings are correlated to the amount of precipitations. In contrast, we refer to Brisbane river catchment data showing how the amount of precipitation is uncorrelated with the actual entity of the flooding event and the measures taken to mitigate them. We use these examples to stress the need for a more holistic approach when addressing complex systems and their resilience and the risk of relying on simple, sometimes reductionist, causal relations.

Methodology

We considered two data sets. The first refers to precipitation in Cumbria, UK, measured at Newton Rigg weather station in Penrith from March 2006 to March 2016 [7]. In conjunction with these, we considered the flood warnings issued by the Environment Agency [8] concerning the River Eamont, a tributary of the River Eden flowing out of the Ullswater Lake for approximately 12 miles, passing less than one mile South of Penrith. To consider the severity of the flood warnings, we associated a score system as follows:

- Flood watch/alert = 1
- Flood warning = 2
- Severe flood warning = 3

The data and the scoring system made it possible to plot and correlate precipitations and flood warnings.

The second set of data are the precipitations in the Brisbane river catchment (Queensland, Austalia) recorded at Alderly weather station during the major flood events of 1974, 1996 and 2011. We considered the filling level and the operations of the Wivenhoe Dam and the effect of similar amount of rain observed in the same region. These data were recorded and are freely available from the Australian Bureau of Metereology [9].

Results

The monthly precipitation amount recorded at Newton Rigg weather station is reported in Figure 1 and the number of weather warnings in Figure 2. A regression line is obtained from the scatter plot of these two sets, after having weighted the warnings according to the scores explained in the Methods. This is plotted in Figure 3. The two sets correlate with a R^2 of 0.440, and correlation coefficient of 0.663. However, when only data above 100 mm rain are selected, the correlation improves with a R^2 of 0.570 and a correlation coefficient of 0.751. Bootstrapping the data over 10000 repetitions reveals a statistically significant (below a 0.01 threshold, 2-sided) Pearson correlation coefficient between 0.471 and 0.787 in the upper 95% CI. This supports the cut-off above 100 mm since the correlation coefficient in this case is in the upper confidence interval. The data hence suggest that flood alerts are triggered by the amount of rain above some threshold as confirmed in the observations of the 2003 Wallingford report [2].

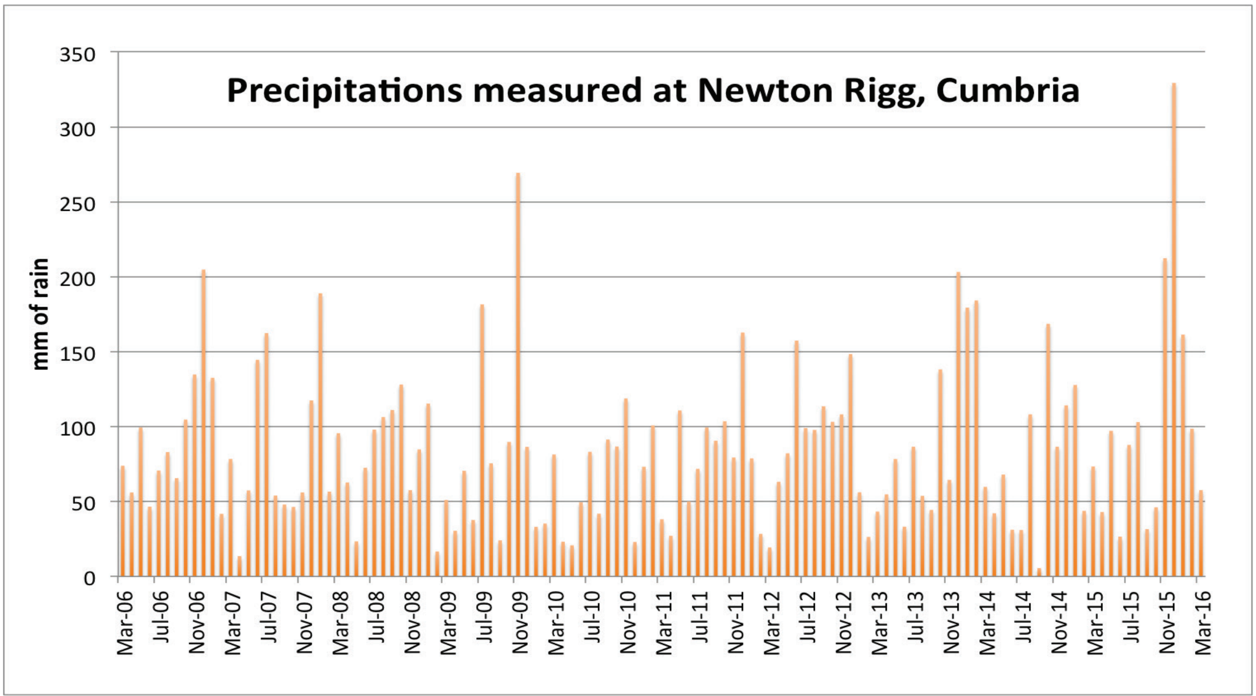

Figure 1 – mm of rain recorded each month from March 2006 to March 2016 at the Newton Rigg weather station, near Penrith, Cubria, UK

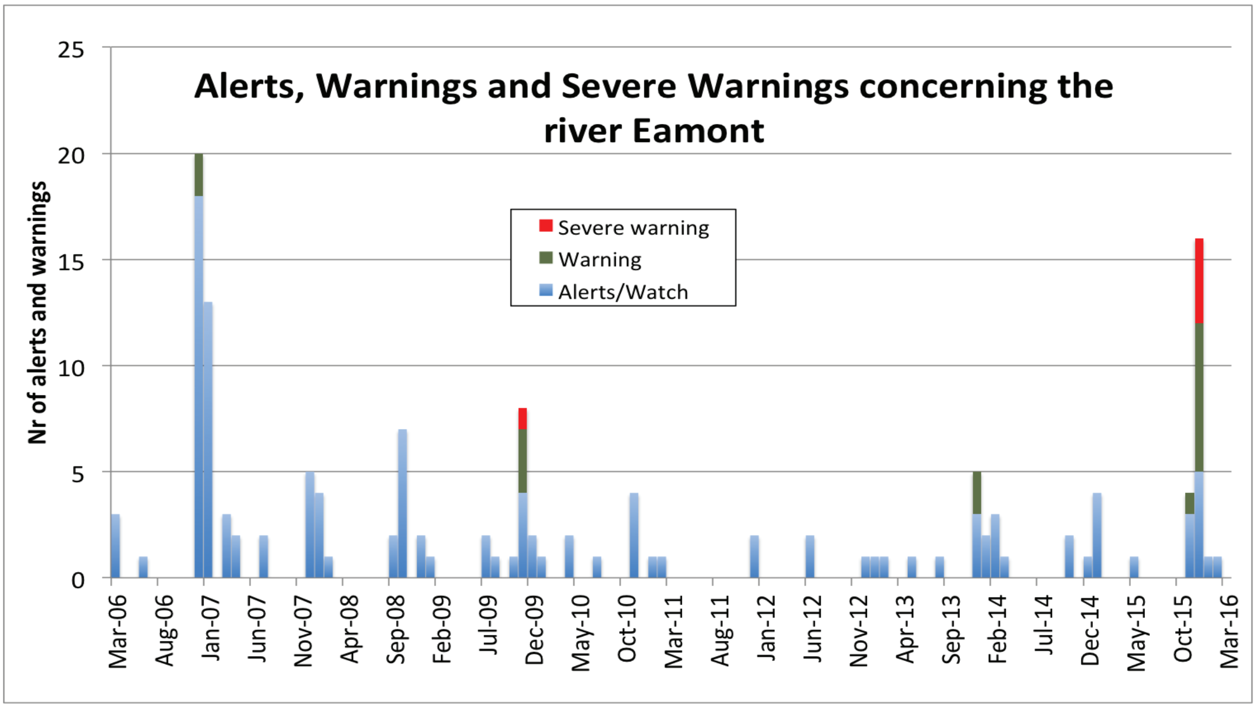

Figure 2 – Flood alerts and warning issued by the Environment Agency concerning the River Eamont from March 2006 to March 2016

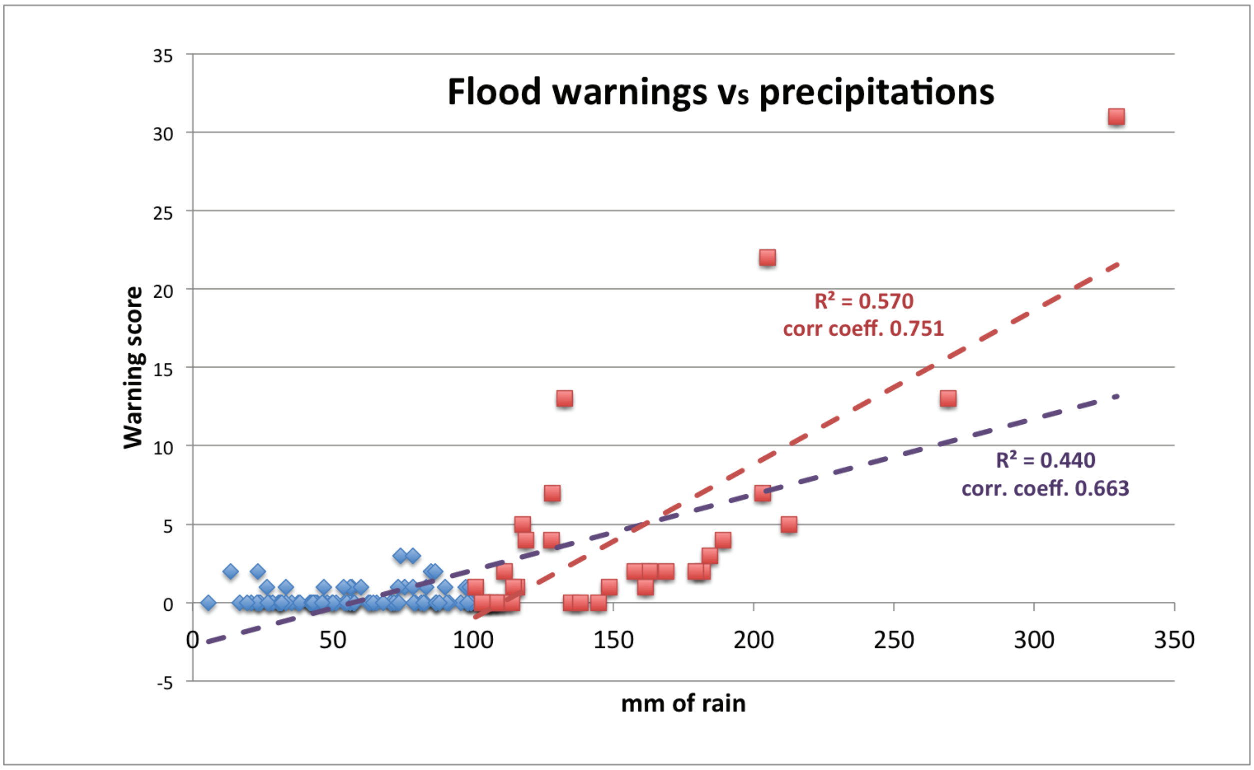

Figure 3 – Scatter plot supporting the correlation between the amount of precipitation and the flood warnings

However, when looking at the flooding events in Brisbane, Australia, the direct relation between precipitations and floods becomes more subtle. Figure 4 refers to the monthly precipitations during the winters of 1973-1974, 1995-1996, 2010-2011.

First, consider the events of January 1974 compared to those of December 1995 and January 1996. In both cases, floods occurred with exceptional strength despite the difference in concentration of the precipitations. Moreover, the 1996 flood occurred despite the presence of the newly built Wivenhoe Dam that did not even fill completely. In May 1996, major floods happened again in the Brisbane area, and again the Wivenhoe Dam filled to 90% of its nominal capacity (1.165 million megalitres), with no spillage operated.

The 2011 flood was caused by sustained precipitations during December 2010 and January 2011. In this case, the total amount of rain in the two months was comparable to May 1996, but Wivenhoe Dam filled above nominal capacity and spillage was necessary. Several reports confirmed that this was the main cause of the escalation of the floods in the Brisbane river valley, causing a number of casualties and long lasting disruptions [1].

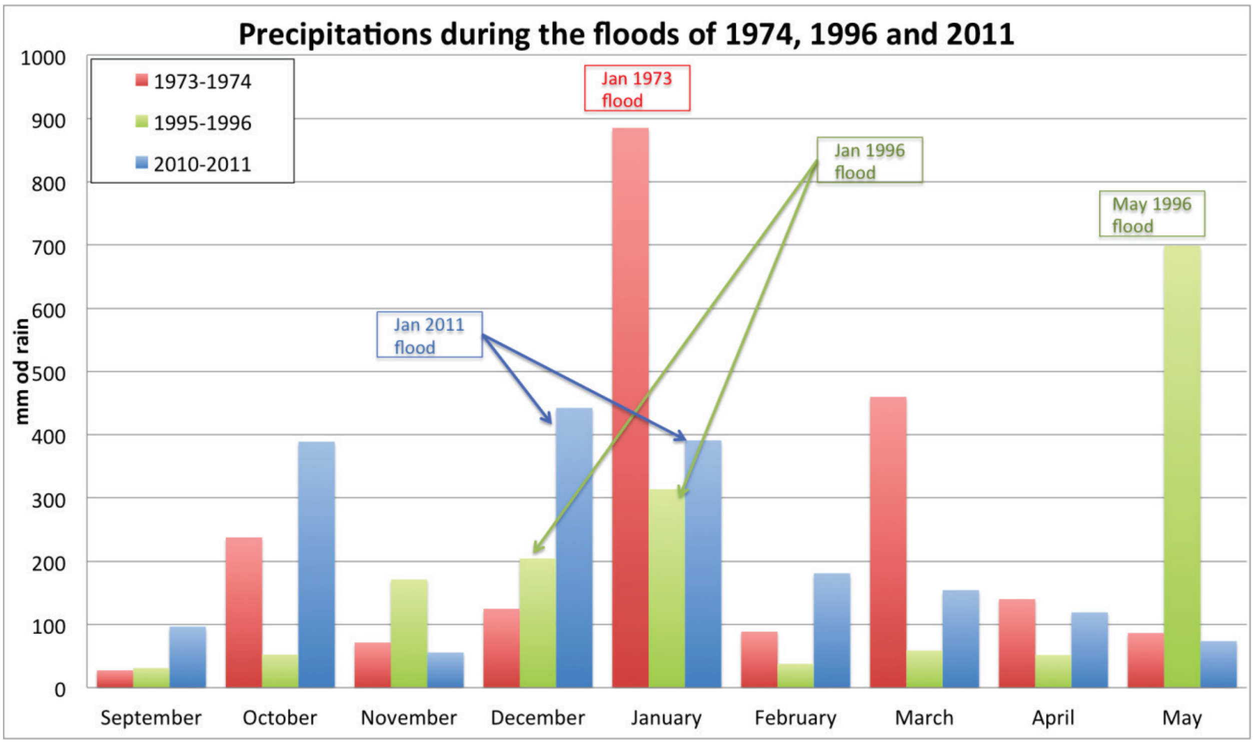

Figure 4 – Precipitations recorded monthly from September to May in years of severe floods

Discussion

The data highlight the inaccuracy of the causal perception that “more rain leads to more floods” which was used to raise flood warnings. However, since data reported here refer to single weather stations, and for exposition purposes, monthly sampling was necessary, and more in depth analysis are needed in order to fully prove the assertion in a positive sense. Presently, this work challenges a common belief rather than proving a thesis. A possible solution to improve our capabilities of preventing catastrophic floods can be pursued by both obtaining higher resolution data to improve the weather forecasts and by considering the whole complexity of the systems (natural and engineering) whose failures become evident as floods. However, while higher resolution requires some sort of technological progress, blurring the neat cause-and-effect relation to the advantage of a more holistic approach is a change of perspective that can be taken immediately.

Results indicate that basing flood predictions on a causal relation with precipitations is far from being as accurate as would be needed. The comparison between the different events in Brisbane shows on one side that neither the amount, nor the concentration of rain in time, are consistent with the floods, their severity, and the filling and spillage of Wivenhoe Dam. The presence of the dam in 1995-1996 did not prevent effects similar to the 1974 flood, despite the smaller amount of precipitations. The flood of 2011 was caused by a total amount of rain comparable with the one of May 1996, but more spread in time. Yet the 2011 flood made the dam gate opening necessary with dramatic consequences while during the 1996 flood, the basin did not even fill. In the particular case of the Wivenhoe Dam, this has the dual function of water reservoir and flood alleviation. Hence, it faces contrasting instances about the desired filling level. This, together with the tidal characteristics of the Brisbane River, highlights even more the importance of considering the whole environmental system, its peculiarities and the relations between them, rather than single elements.

Floods should be considered as the final outcome of the complex interactions of several factors, with weather and precipitations being just two of them. Higher resolution, both spatial and temporal, for weather forecasts is likely to produce more accurate precipitation forecasts. Presently, this is the main method through which weather-related disasters are being tackled although it will take time before the available resolution will allow for better long-term forecasts [10]. Even if such resolution was available, in the authors' opinion, this would solve just one part of the problem. This finds confirmation in the conclusion of the Smith and McAlpine work [11] indicating the presence of a number of possible future scenarios for flood risks, and in fact, the lack of reliable forecasting means.

Weather is a complex system 'per se' and floods are the outcome of the weather interacting with the environment, the engineering and the people. The latter in particular play a key role in the management of the events before and after a catastrophe, with the so-called community resilience being of fundamental importance [12]. The social, political and economic fabric of communities belongs to the category of complex systems as well as the infrastructures and the environment: it is well known that the combined interaction of all these actors is likely to be far different than the sum of the parts. It is striking to note here how the word "floods" at the beginning of this paragraph could be replaced by "power" or "communication outages", or even "earthquakes." This is because in all these events, what counts more is the fallback of one action onto another and of the failure of one system onto the others. This captures the complex nature of this kind of events well.

We are in the presence of the need for a shift in the way we approach floods and disasters in general. A requirement emerges for capturing the interactions rather than concentrating on the single events or systems. Complexity science is, in the authors' opinion, the way forward in this sense.

Conclusions

We compared flood events in Cumbria and Brisbane as a way of showing the poor understanding of the complex systems outcomes through weather-triggered natural disasters. The comparison between flood events distant in time and space reveals that the search for direct causal relations can be shortsighted if not inserted in a framework of complexity. This applies to flood prediction as well as to any event linked to other systems, either complex by nature or becoming complex through operations, such as the elements of electric power networks or transportation.

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МЕРЫ ПО ИЗБЕЖАНИЮ РЕДУКЦИОНИЗМА В БОРЬБЕ СО СТИХИЙНЫМИ БЕДСТВИЯМИ И РОЛЬ КОМПЛЕКСНОГО ПОДХОДА

Аннотация. Наводнения являются катастрофическими бедствиями, вызванными водой, но они не ограничены местами своего присутствия такими как реки, озера или моря. Катастрофические характеристики возникают тогда, когда вода взаимодействует с другими системами, являясь при этом либо причиной либо результатом взаимных неудач. В этом кратком документе мы подчеркиваем необходимость более целостного подхода к пониманию и предотвращению стихийных бедствий и соответственно проектировать системы в этой области. В данной статье рассматриваются примеры из недавних наводнений в Камбрии (Великобритания) и Брисбене (Квинсленд, Австралия), чтобы показать, что простая причинно-следственная связь не в состоянии охватить динамику сбоев крупных систем, и в частности, системы управления водными ресурсами в местах возникновения наводнений.

Ключевые слова: комплексный подход, инженерия, устойчивость, наводнения, целостный подход.

АПАТТАРДЫҢ АЛДЫН АЛУДАҒЫ РЕДУКЦИОНИЗМДІ ЖОЮ ЖӘНЕ КҮРДЕЛІЛІГІНІҢ РӨЛІ

Аңдатпа. Су тасқыны су әсерінен туындаған апатты оқиға болып табылады, алайда оның кездесу орындары өзен, көл немесе теңізбен шектелмейді. Апатты сипаттар су басқа өзара сәтсіздіктердің себебі немесе нәтижесі болып табылатын жүйелермен қарым-қатынасқа түскен кезден бастап туындай бастайды. Осы қысқа мақалада біз апатты жағдайларды түсіну мен алдын алуда біртұтас тәсілдемелердің қажеттілігіне назар аударамыз, яғни осы салада жүйені жобалау. Біз қарапайым

себеп-салдарлық байланыс, сондай-ақ су тасқыны болған кезде су ресурстарын басқару жүйелерінің үлкен динамикалы жүйенің істен шығуын қамтуға мүмкіншілігі жетпейтіндігін көрсету мақсатында жақын арада Камбрия (Ұлыбритания) және Брисбенде (Квинслендштаты, Австралия) болған су басу апатын мысал ретінде қарастырдық.

Кілттік сөздер: күрделілік, инженерия, тұрақтылық, су тасқыны, біртұтас тәсілдеме.

THE APPLICATION OF REAL-TIME MONITORING TECHNIQUES TO ENSURE THE SAFE COMPLETION OF COASTAL PROTECTION WORKS WITHIN AN ACTIVE LANDSLIDE ZONE

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Abstract. This paper describes the measures taken to ensure the stability and safety of works to construct new coastal protection and slope stabilisation measures in Lyme Regis, Dorset, England. The works were undertaken within an active landslide zone during a period of prolonged unusually wet and stormy weather. The paper describes the installation and implementation of a remote ground monitoring system utilising GPRS telemetry together with GPS / GNSS surveying. The system provided partially automated early warning of potentially dangerous ground movements via SMS text alerts and allowed the works to progress efficiently and safely. Severe weather in the winter of 2013-2014 mobilised landslides at the eastern end of the works. Additional GPS based surveying monitored the movements and allowed informed decision making on the re-commencement of works that had been halted for safety reasons. The decision making of the site team was supported by off-site experts who were able to advise on the significance of monitoring results, based on long term knowledge of the local movements and detailed knowledge of the geology of the works area. The works were successfully completed under budget and ahead of programme, with no injuries and limited equipment damage due to landslides and ground movements.

Key words: automated ground monitoring, GPS surveying, coastal slope stability, safety.

Introduction

The historic English coastal town of Lyme Regis is situated in one of the most unstable geological settings in the United Kingdom and has suffered severely from the effects of coastal erosion and landsliding. A combination of landslide activity and cliff retreat has damaged or destroyed many properties throughout the town together with roads, farmland and infrastructure.

Since the late 1980s, a long-term programme of engineering schemes has been promoted by West Dorset District Council to protect and stabilize the coastal frontage of the town [1]. The Lyme Regis Environmental Improvements Phase Four (LREIPIV) was the latest phase in the programme with construction works commencing in April 2013 and completed in March 2015. The works protect the eastern flank of the town and required extensive ground engineering and coastal protection works to be constructed within and below an area of active landsliding.

This paper describes the various techniques used by the construction project team to monitor the ground movements and the management procedures applied to ensure the safety of the workforce and stability of the works during the construction phase.

Description of main contract work

The main objective of the works is to protect and secure the long term future of the eastern part of Lyme Regis, while protecting the heritage, landscape and nature conservation value of the area. A selection of civil and geotechnical methods were used to achieve differing levels of protection to the land and property.

- Soil nails between 6 and 22m long, with associated plates and facing mesh 34km of soil nail bar were installed in total
- An anchored pile wall comprised of 900mm diameter piles up to 27m long, tied back with ground anchors between 35m and 46m in length.
- Dowel piling 300mm in diameter and between 8 and 12m long
- Drainage works including sub-horizontal drilled drains and cut-off trench drains
- A 400m long, 3.5 to 5.0m high wave return wall and associated walkway

The most environmentally sensitive areas of the active landslides were left unaffected, thereby allowing erosion to continue with the associated benefits including biodiversity and fossil exposure.

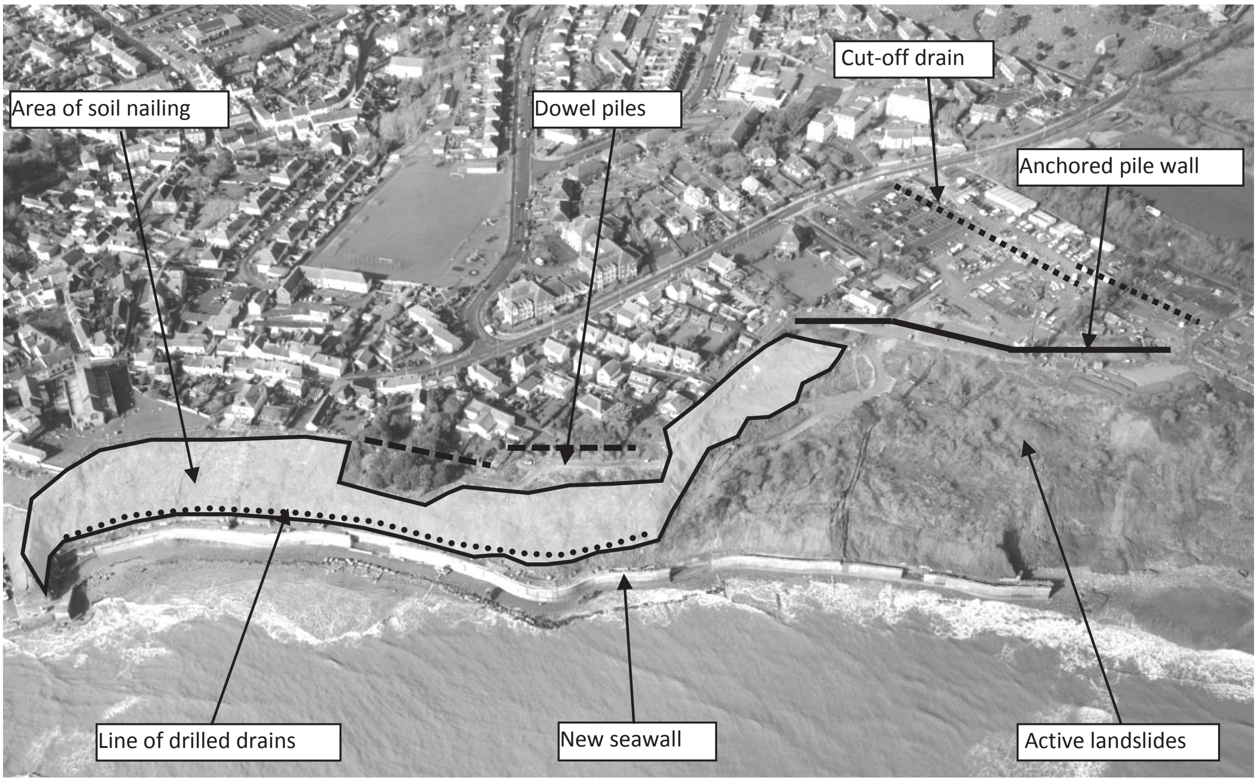

Figure 1 - Aerial view of works in progress, with locations of the main elements

Establishment of the monitoring regime

The client, West Dorset District Council, has maintained a system of ground monitoring for a number of years. This acts as an early warning of severe ground movements in unprotected areas, with additional monitoring installed into the new works to allow monitoring of the in-service performance of the structures [2,3]. The project team inherited responsibility for monitoring the eastern part of this system during the construction works and supplemented the existing system with new monitoring points. The system consisted of three types of monitoring:

- Permanent ground markers (PGMs): 38 total of which 15 were installed as part of the project, coincident with the new inclinometers
- Inclinometers: 26 total of which 15 were installed as part of the project
- Piezometers: 30 total of which 10 were installed as part of the project.

The inclinometers and piezometers were installed to typical depths of 25-30m. Installation took place as part of the detailed site investigation phase of the project (Figure 2).

Figure 2 - SI drilling rig. Note landslide scars behind rig. The green tubes are grooved inclinometer tubes to be inserted and grouted into the bore hole

All of the permanent ground markers were surveyed manually on a monthly reporting cycle. A surveyor was employed for the duration of the site works and spent approximately half of his time on surveying and processing data. Standard Leica GPS base station and receivers were used, with the aerials mounted on tripods to ensure accuracy. A typical visit to each ground marker would take 15-30 minutes, achieving accuracies of +/- 7.5mm in plan.

Eight of the new inclinometers and 6 of the new piezometers were automated. The automated inclinometer system comprised of MEMs biaxial sensors at 2.0m intervals. The automated piezometers were vibrating wire piezometers. Each automated instrument was connected wirelessly to one of 3 data logging stations. The solar powered stations included a data logger and GPRS modem. Data was transmitted via the domestic GPRS network for off-site collation and processing. A website based reporting system was established, which enabled the site team to check real-time reporting of the inclinometers. An automated weather station was installed on site providing readings of rainfall, wind-speed and temperature. The weather readings were processed through the same website system.

A full time specialist technician was employed to maintain the system and to carry out regular manual readings of the inclinometers and piezometers. Monthly reports of PGMS, inclinometers and piezometers were collated and sent for expert review by the design and supervision team.

An automated alarm system was also set up using SMS texts to notify 10 key members of the project team of any significant inclinometer movements. The alarm level was set to trigger an alarm if:

- Inclinometer downhill displacement > 2mm a day for 3 consecutive days
- Inclinometer downhill displacement > 5mm on a single (24 hour) day
- Rainfall in preceding month > 100mm
- Rainfall in preceding 3 days > 20mm

At the start of the project, minimum action responses to these trigger levels were established as follows:

- All construction in the affected would cease
- Site inspection within 24 hours by geotechnical personnel to assess the site conditions and to look for surface indicators of movement
- Monitoring frequency of PGMS, inclinometers and piezometers increased
- Approval by Client project manager prior to re-starting works

All of these measures were specified in the works order for the contract and were installed and commissioned prior to the commencement of main construction works in May 2013.

In-service monitoring system performance

During the construction phase, the majority of PGMS and inclinometers showed only minor movements (Figure 3).

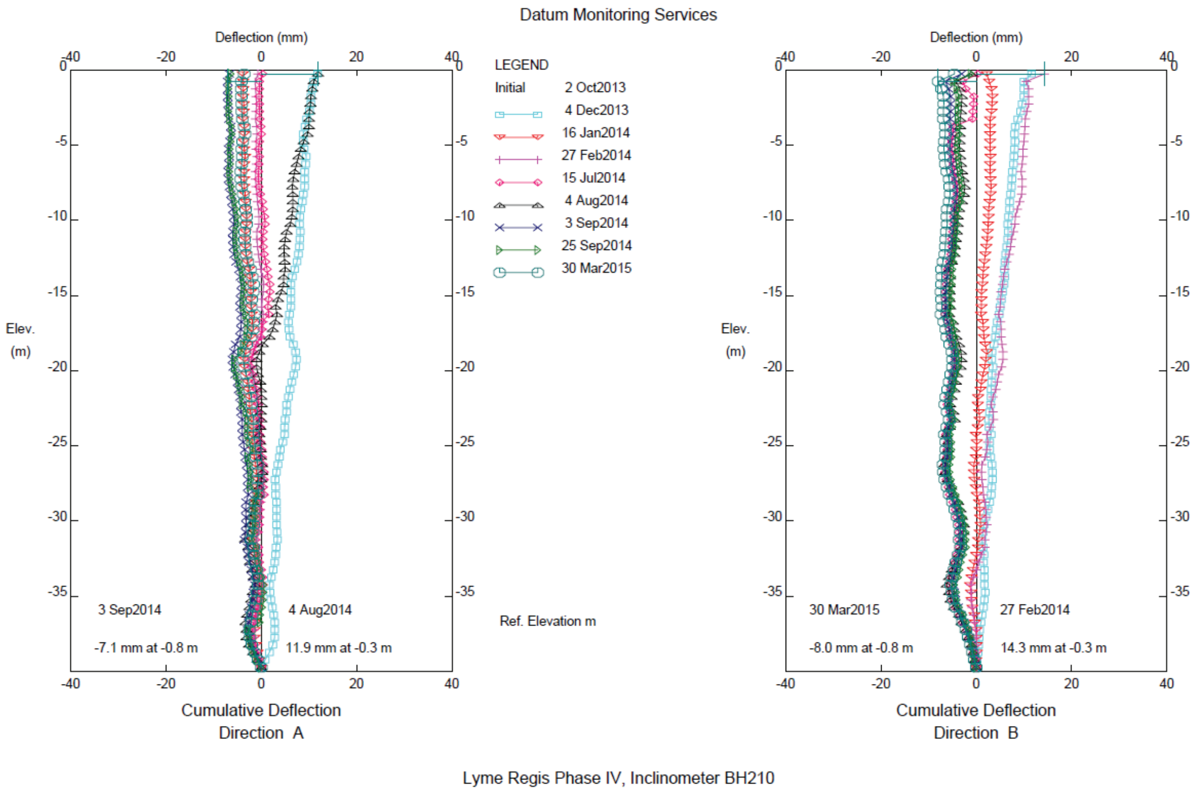

Figure 3 - Graphical report for inclinometer

A number of automated alarm events occurred, which on investigation were caused by one of the following:

- Data processing error where comparison was made to an older reading
- Shallow slip event with no direct impact on construction safety
- Construction plant coming into contact with top of borehole
- Soil nail drilling close to borehole moving the inclinometer tube.

The evidence of overall ground stability gathered by the monitoring regime allowed the site team to challenge the minimum plant weights specified in order to use larger, more efficient plants and provided reassurance during construction.

Additions and enhancements to the planned monitoring system

The main landslide events were on the section of active landslides directly above the eastern part of the new sea wall works. Shallow slips occurred from the start of the contract, particularly during the winter months with associated wet weather. This area was too inaccessible and unstable to install inclinometers. The design of the scheme allowed for landslides to continue in this area, with protection to the car park and local roads provided by the upper piled wall structure. Steps were taken to monitor the movement on the slopes in order to provide early warning of more serious landslides that may have endangered the workforce working below. These measures included:

- Positioning of ‘tell-tale’ marker posts allowing a quick pre-shift check for ground movements (Figure 4)
- Photographic recording of shallow slips to monitor propagation of failure scars
- Establishment of temporary ground markers along crest of failing slope.

Figure 4 - Marker posts aligned on slope crest

During the late autumn and winter of 2013 - 2014, a prolonged series of Atlantic storms impacted the south coast of England. Although each storm event was not of a high intensity, events occurred repeatedly over a number of weeks (Figure 5). The rainfall acted to mobilise the landslip and a significant slip occurred during the Christmas break.

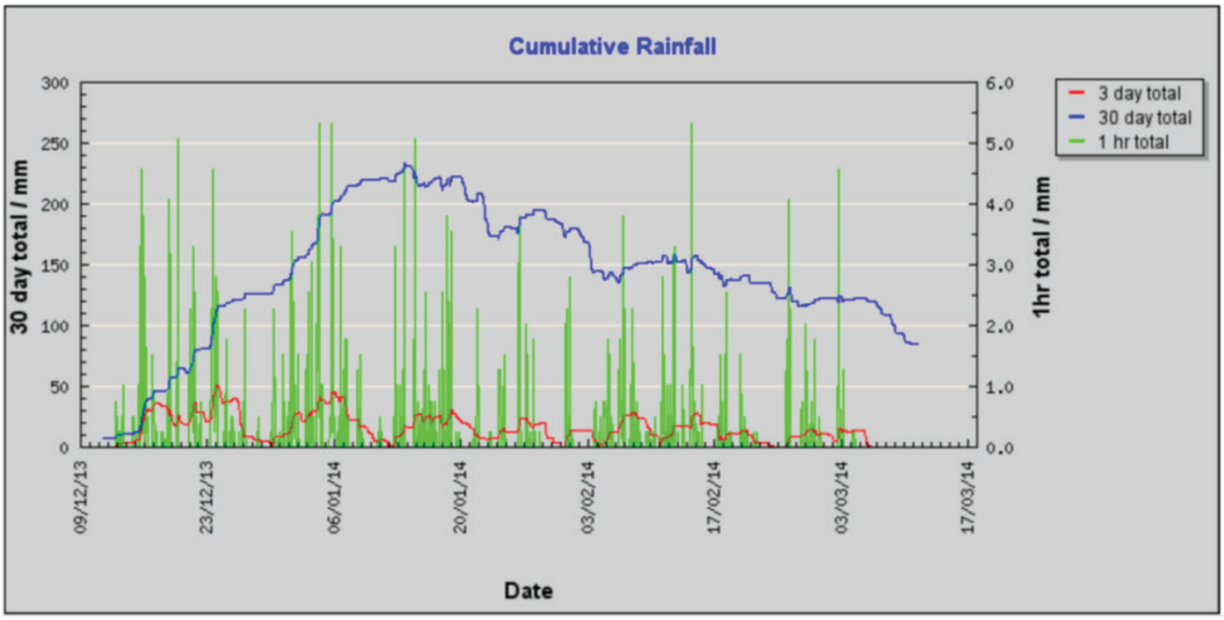

Figure 5 - Rainfall record for 09/12/16 – 17/03/16

Approximately 400T of material slid from the crest and into the work area directly behind the new wall. The material movement was caused by a ‘conveyor’ effect, with the top surface (0.5-1.0 deep) sliding over more stable layers of limestone. The top layer was fed from surface failures inland and mobilised by the prolonged rainfall (Figure 6).

Figure 6 - Landslide area: Stable limestone marker beds visible

Work on the new wall was suspended and the movement of the upper moving layer was daily monitored using GPS surveying. The ground markers used for the surveying were regularly re-positioned to landward as the layer moved over the crest. Cumulative movements of up to 12.0m occurred over 20 weeks. The GPS monitoring showed continued significant movements which subsided as the amount of rainfall reduced. The results of the movement were plotted as inverse velocity against time (Figure 7).

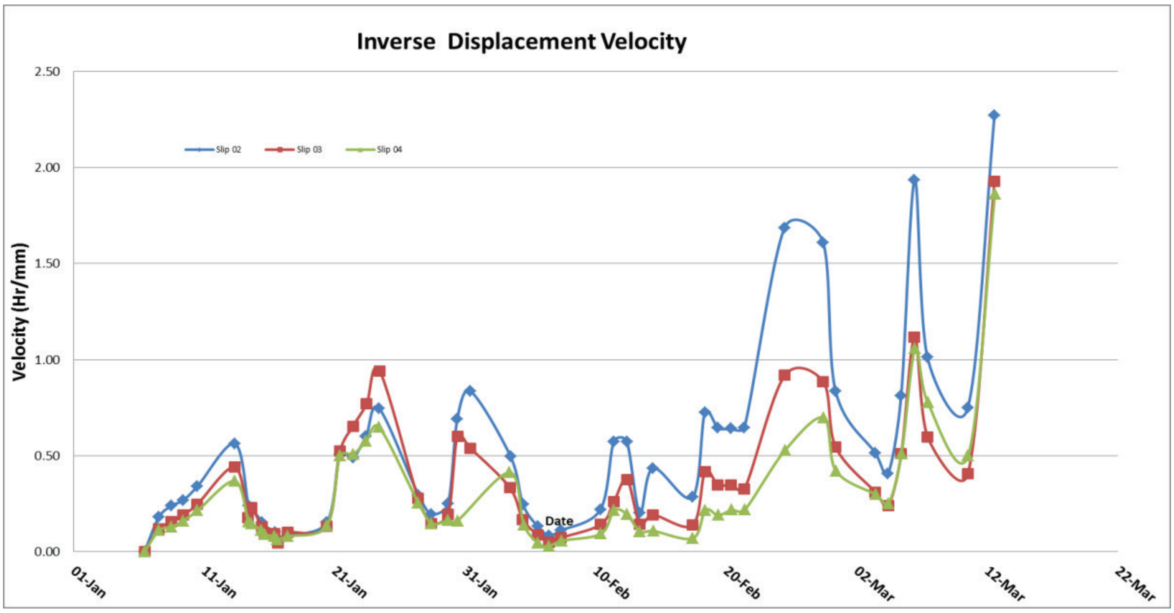

Figure 7 – Inverse displacement velocity of temporary ground markers on failing slope

The decision to re-commence works was based on the best-fit line trending to infinity (i.e. 0mm/hr movement) for at least 1 week continuously. This coincided with a period of prolonged dry weather in mid-March. Works were allowed to recommence on March 23, 2014.

The civil engineering elements of the project were successfully completed in December 2014 with the final landscape works completed in March 2015. No personal injuries were suffered by any of the workforce. Material losses were limited to damage of minor equipment that occurred during the initial landslide event in December 2013.

Conclusions

The project works were carried out during one of the wettest and stormiest periods in southern England in recent memory. Careful planning by the client, based on long term investigations and monitoring, ensured a robust and comprehensive monitoring system was specified as part of the works contract. The technologies applied are readily available in the UK allowing efficient and relatively inexpensive deployment and operation. Use of the planned system was enhanced by additional measures that responded to the weather events of winter 2013-2014.

The contractor's site management team was supported by a number of experts who had detailed knowledge of the area's geology and geomorphology. This allowed informed decision making on working methods, suspension of works and the timing of re-starting works in areas endangered by ground movements. The works were completed safely, on schedule and below budget and have been recognised with awards from a number of industry, professional and client organisations.

Acknowledgements

West Dorset District Council was the client for the project and the scheme promoter. CH2M HILL was the client's consulting engineer. Balfour Beatty Regional Civil Engineering was the design and build contractor. AECOM was Balfour Beatty's principal designer. Datum Monitoring Services supplied, installed and operated the ground monitoring system. The author is grateful for the support of key members of staff from each of these organisations whose dedicated and knowledgeable support allowed prompt, informed and ultimately successful decision making against the background of commercial and safety pressures for the companies and organisations involved.

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ПРИМЕНЕНИЕ МЕТОДОВ МОНИТОРИНГА В РЕЖИМЕ РЕАЛЬНОГО ВРЕМЕНИ ДЛЯ ОБЕСПЕЧЕНИЯ БЕЗОПАСНОГО ЗАВЕРШЕНИЯ ПРИБРЕЖНЫХ ЗАЩИТНЫХ РАБОТ В АКТИВНОЙ ОПОЛЗНЕВОЙ ЗОНЕ

Аннотация. В данной статье описаны меры, принятые для обеспечения стабильности и безопасности строительных работ новой береговой защиты и измерения стабилизации наклона в Лайм-Реджис, Дорсет, Англия. Работы проводились в активной оползневой зоне в течение длительного периода необычайно влажной и ветреной погоды. В статье описывается установка и внедрение системы дистанционного мониторинга с использованием наземной GPRS телеметрии совместно с GPS / GNSS разведкой. Система, посредством SMS-сообщений обеспечивает частично автоматизированное раннее предупреждение о потенциально опасных движениях земли и позволяет эффективно и безопасно проводить работы. Суровые погодные условия в зимний период 2013-2014 годов мобилизовали оползни в восточных областях проводимых работ. Дополнительная GPS-разведка контролировала перемещения и на основе полученной информации позволила принять взвешенное решение о возобновлении работ, прекращенных по соображениям безопасности. Принятие решений «местной» командой было поддержано удаленными экспертами, которые были в состоянии сообщить о важности результатов мониторинга, основанных на знании местных перемещений в течение длительного срока, и подробного знания геологии района работ. Работы были успешно завершены в рамках бюджета и с опережением программы, без травм и с незначительным повреждением оборудования из-за оползней и наземных движений.

Ключевые слова: автоматический мониторинг заземления, GPS съёмка, прибрежная устойчивость склона, безопасность.

БЕЛСЕНДІ КӨШКІН АЙМАҒЫНДА ЖАҒАДАҒЫ ҚОРҒАНЫС ЖҰМЫСТАРДЫ ҚАУІПСІЗ АЯҚТАУДЫ ҚАМТАМАСЫЗ ЕТУ ҮШІН НАҚТЫ УАҚЫТ ТӘРТІПТЕМЕСІ КЕЗІНДЕ МОНИТОРИНГ ӘДІСТЕРІН ҚОЛДАНУ

Аңдатпа. Бұл мақалада жағалаудағы жаңа қорғанысты салу кезіндегі құрылыс жұмыстарының қауіпсіздігін және тұрақталығын қамтамасыз ету үшін қолданған шаралар, сондай-ақ Лайм-Реджис, Дорсет, Англия аумақтарындағы көлбеулердің тұрақтылығын өлшеу баяндалады. Жұмыстар ұзақ уақыт аралығында белсенді көшкін аймағында, ерекше дымқыл және желді ауа райы кезінде жүргізілді. Бұл мақалада GPS / GNSS барлауы мен бірге жер үстіндегі GPRS телеметриясын пайдалана отырып қашықтық мониторинг жүйесінің орнатылуы және енгізілуі баяндалады. Жүйе, жердің әлеуетті қауіпті қозғалысы туралы SMS-хаттама арқылы ішінара автоматтандырылған ерте ескертуді қамсыздандырады және жұмыстарды тиімді және қауіпсіз өткізуге мүмкіндік береді. 2013-2014 жылдардың кысқы кезеңіндегі қатаң ауа райы өткізіліп жатқан жұмыстардың шығыс аймақтарындағы көшкіндерді жұмылдырды. Қосымша GPS барлауы қозғалыстарды бақылады және алынған ақпараттың негізінде қауіпсіздікті қамтамасыз ету үшін тоқтатылған жұмыстарды қайта бастау үшін шешім қабылдауға мүмкіндік берді. Мониторинг нәтижелерінің маңыздылығы туралы айтуға мүмкіншіліктері болған алыстағы сарапшылар, «жергілікті» команданың қабылдаған шешімін қолдады. Олар осы аймақтағы геология жұмыстарын және ұзақ уақыт бойы жергілікті қозғалыстарын толық білуіне негізделіп отыр.

Жұмыстар бюджет аясында және бағдарламадан алға кетіп, жабдықтардың көшкін және жер үстіндегі қозғалыстары әсерінен шамалы зақымдауына қарамастан, жарақатсыз сәтті аяқталды.

Кілттік сөздер: жерлендірудің автоматты мониторингі, GPS түсірме, жағалау бөктерінің тұрақтылығы, қауіпсіздік.

GEODESY TECHNOLOGIES FOR DISASTER RESILENCE

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Abstract. Geodesy technologies are widely used for many engineering applications, including objects under disaster events. Geodesy technologies are very helpful for monitoring and tracking changes with the related identification, determination and prediction of potential disasters. For Geodesy technology research applications, it will be reasonable to expand more training methodology strategies. In this paper we apply geodesy equipment to two projects: 1) Aral Sea Region Desertification Study and 2) Flood area identification and level categorization on a parking area at Nazarbayev University campus. The first project was field work conducted in the Aral Sea region with application of Global Navigation Satellite System (GNSS) equipment (Leica Zeno 20) to collect the ground control points (GCP) for further calibration and verification with processed satellite data. This methodology and field work data are available to download on the web link (http://www.drinu.org/?p=454). This data and methodologies are freely available for training and research purposes. The second project gives an example of how Nazarbayev University students applied the geodesy equipment for flood zone identification and level categorization in a parking area.

Key words: disaster Resilience, Aral Sea, Geodesy, GNSS, GCP, Kazakhstan, Nazarbayev University.

Introduction

Kazakhstan aims to develop more innovative technological applications and to have tighter connections and cooperation among researchers and practitioners. This task is very complex and requires much effort because sometimes researchers, practitioners, and academics have different views about how to better develop these connections, and there are various views about the character of this linkage. Some people believe that “university research often detracts from the quality of teaching” [1], while others argue that “courses taught by those at the cutting edge of research will necessarily be of higher quality than those taught by those merely using the research results of others – whatever the apparent quality of their style of delivery” [2]. Our study supports the latter point presented by Lee. Specifically, our research work and teaching methodology provides an example of the case study of knowledge and skills transmission through the research project “Aral Sea Region Desertification” for the Geomatics course at Nazarbayev University (NU).

Aral Sea region desertification study

The Aral Sea is world famous as it is used in the field for warnings about what should not be done. Inefficient engineering projects with irresponsible water resource use have resulted in dramatic Aral Sea shrinkage and desertification expansion in the region. We are working on tracking the desertification rate of this region. Our research methodology consists of these procedures: a) field data collection in the region, including GCP, b) remote sensing (satellite) data processing, interpretation of satellite images, c) processed satellite data calibration and verification by using GCP, d) expansion of satellite data processing by using corrections from calibrated and verified satellite data, and e) modeling and desertification prediction analyses by using processed and verified satellite data.

We finished the field work with GCP data collection (http://www.drinu.org/?p=454) for our project “Investigation process of desertification in the Kyzylorda region" in cooperation with the "Ulytau-Aral" expedition team from Kazakhstan National Geographic Society (http://kazgeography.org/en/node/932). The main task of our research group was to collect the GCP (reference) data. We used GNSS Leica Zeno 20 equipment for GCP measurements. We have collected 30 GCP widely spread throughout the research area (Figure 1). The GCP data collected during this field work will be used for further referencing, calibration and verification of the processed satellite data.

Figure 1 - Field trip map and location of Ground Control Points (GCP)

We finished the first project procedure - field data collection in the region, including GCP. We are working on the next project procedures: b) remote sensing (satellite) data processing, interpretation of satellite images; c) processed satellite data calibration and verifications by using GCP; d) expansion of satellite data processing by using corrections from calibrated and verified satellite data; e) modeling and desertification prediction analyses by using processed and verified satellite data. We are preparing training materials for laboratory sessions. Particularly, we will coordinate measuring equipment such as dual-frequency GNSS from Hexagon Leica Geosystems Zeno 20 GPS-GLONASS which was used during the implementation of the field work as well as training of geodesy equipment for leveling (Leica Level NA720 and Total Station TS06).

Flood zone identification and level categorization of a parking area

Flood zone identifiers are critical in many regions including Astana city and NU campus. Parking lots, pedestrian areas and roads are frequently flooded on NU campus. This project was part of the student training program to apply Geodesy technologies. Students worked with the leveling equipment Leica Level NA720 and Total Station TS06. The problematic zones at NU campus parking areas, which are exposed to flooding, were identified. For this purpose, high precision surface leveling mapping preparation was necessary. The surface levelling measurements were conducted at the NU campus car parking lot. The Digital Surface Model (DSM) was prepared by collecting 81 vertical point measurements. The initial locations, Bench marking (referencing) points, were used for the consistency of the measurements. The leveling methodology involved these stages: (1) data collection with the surface levelling measurements, (2) data processing and contour map preparation, and (3) map analysis and the determination of recommendations.

The first standard procedure for most engineering field projects is to measure the area and to prepare a proper surface leveling map. Surface elevation is important data for the identification of the different vertical points and leveling map preparation. Vertical distances are measured from the reference point above mean sea level (AMSL) [3]. One of the most popular methodologies to find vertical distance is levelling. Levelling equipment is known as a fundamental tool for surveying [4]. Contour maps are known as topography of the ground surface provided with level information. In particular, contour maps are represented by the combination of lines and points at the same vertical level or height [5]. The method of squares, which represents same-levelled squares at the same height level, was applied [6]. After that, the interpolation method was applied to draw a leveling map. For the identification of the specific areas that are subjected to flooding, the indirect method of levelling was applied. In the preliminary stage, a square grid of 45×45 meters dimension was superimposed on the parking slots. Next, each square grid was subdivided into small squares of 5×5 meters. All the point locations were determined by using the tape and were indicated by white paint (Figure 2). The 81 measured height points were indicated by using levelling equipment Leica Levels NA720.

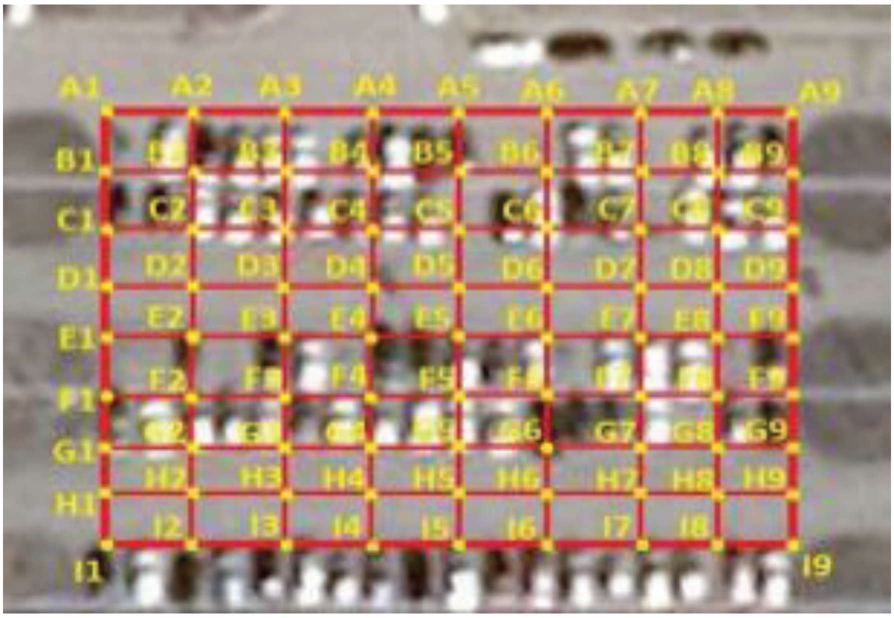

Figure 2 - The square grid of research area at Nazarbayev University Campus

For the construction of the parking area model, the measurements were recorded by applying the rise and fall method [7]. The heights of each point were calculated and tabulated. As a result, with the aid of AutoCAD software, the model of the parking area was constructed. The contour map represents the DSM of the site (Figure3).

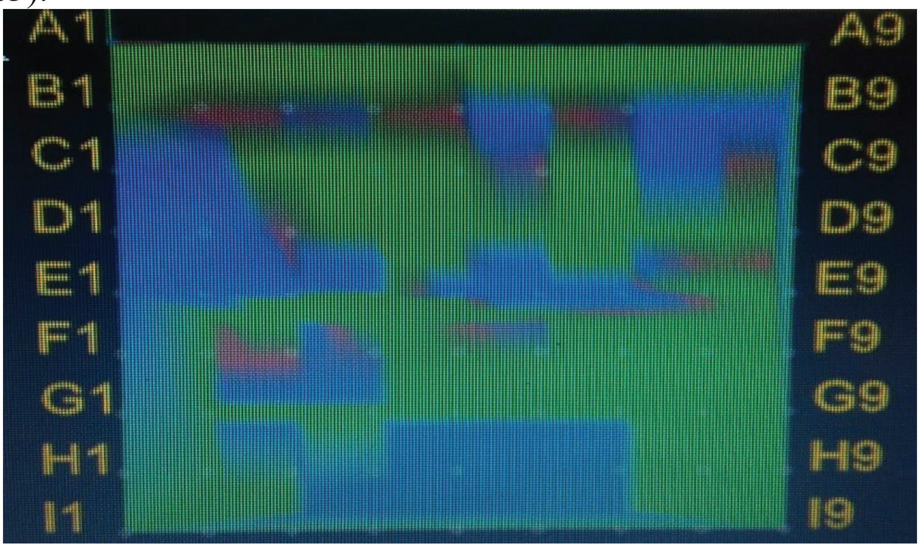

Figure 3 - DSM map of parking zone. Green color shows the highest parts, while red represents intermediate and blue indicates low spots

As shown in Figure 3, the car park area does not have a proper drainage system since it does not have the proper surface run-off structure. Water cannot drain in a consistent direction. The blue color, low level does not have the proper output or water exit areas. The parking area may go through deformation that could come from weather conditions, or overloading of the parking platform by vehicles [8]. The surface water runoff therefore loses its efficiency.

Figure 4 shows potential areas for drainage constructions (canalizations). It can be clearly seen that there are 4 main flooding areas. Next, the probable flooding sections were indicated with a star and water running construction was shown with a circle.

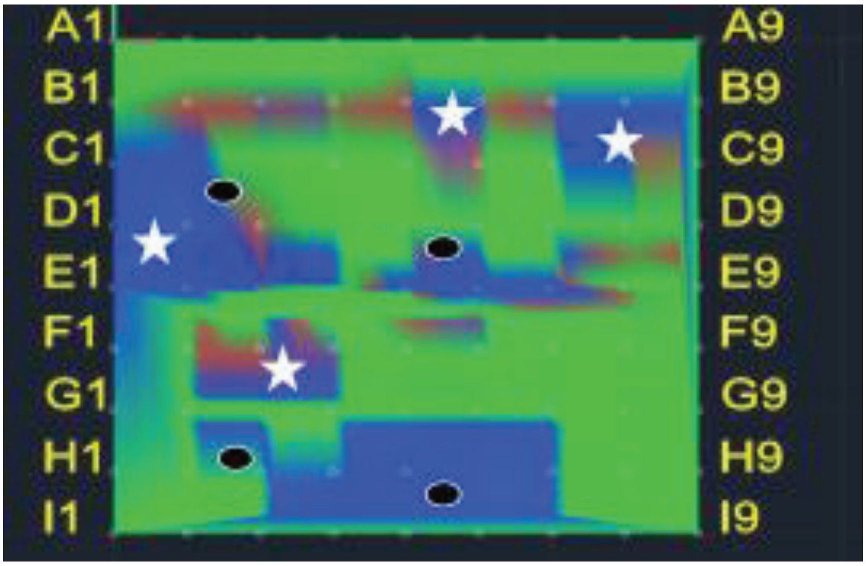

Figure 4 - Contour map with canalization and problematic zones

Figure 5 is a photo of the problematic zone after a light rainfall. It is the square A7xA8xD8xD7 (Figure 2). The proper leveling and drainage system will be necessary for the parking area.

Figure 5 - Parking zone after a light rainfall

Conclusion

Geodesy technologies are very helpful for many engineering applications. Current methodologies to increase students' interests to learn and apply the geodesy equipment such as Leica Zeno 20, Leica Level NA720 and Leica Total Station TS06 were presented. Practical examples of the two projects include: 1) Aral Sea Region Desertification Study and 2) Flood area identification and level categorization on a parking area at Nazarbayev University campus. Currently, we are working on the next stages of the research and expanding the training program with remote sensing (satellite) data processing, interpretation of satellite images, processed satellite data calibration and verifications by using GCP, modeling and prediction analyses.

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ГЕОДЕЗИЧЕСКИЕ ТЕХНОЛОГИИ ДЛЯ ПРОТИВОДЕЙСТВИЯ СТИХИЙНЫМ БЕДСТВИЯМ

Аннотация. Геодезические технологии широко используются для многих инженерных приложений, в том числе объектов в рамках стихийных бедствий. Геодезические технологии очень полезны для мониторинга изменений и отслеживания с помощью подключенной идентификации, определения и прогнозирования возможных бедствий. Для научных геодезических задач , будет разумно расширить больше стратегий методологии обучения. В данной работе мы применяем геодезическое оборудование в двух проектах: 1) Изучение процесса опустынивания на Приаралье и 2) Определение зоны затопления и категоризации уровня на парковке в университетском городке Назарбаев Университета. В первом проекте провелась полевая работа в регионе Аральского моря с применением глобальной навигационной спутниковой системы оборудования (Leica Zeno 20) для сбора опорных точек для дальнейшей калибровки и проверки использования обработанных спутниковых данных. Эта методология и полевые данные работы можно найти на веб-ссылке с возможностью загрузки (http://www.drinu.org/?p=454). Эти данные и методологии свободно доступны для учебных и исследовательских целей. Второй проект дает пример того, как студенты Назарбаев Университета применили геодезическое оборудование для определения зоны затопления и категоризации уровня в зоне парковки.

Ключевые слова: противодействие стихийным бедствиям, Аральское море, геодезия, Казахстан, Назарбаев Университет.

ТАБИҒИ АПАТТАРДЫ АЛДЫН АЛУДАҒЫ ГЕОДЕЗИЯЛЫҚ ТЕХНОЛОГИЯЛАР

Аңдатпа. Инженерлік жұмыстарда және табиғи апаттырды алдын алу бағытында геодезиялық технологиялар кеңінен қолданылады. Негізінен геодезиялық технологиялар табиғи апаттарды болжауда, қадағалауда, өзгерістерді маниторинг жүйесіне енгізуде өте пайдалы болып табылады. Ғылыми геодезиялық тапсырмаларды орындау барысында, білім беруде стратегиялық әдістемені ұғынықты кеңейту алға қойылған мақсаттардың бірі. Бұл мақалада, біз екі жоба бойынша геодезиялық құралдарды пайдаландық: 1) Арал маңы шөлейттену процесін зерттеу және 2) Назарбаев Университетінің кампусының аумағында маркшейдерлік жабдықтарды пайдалана отырып су басу зонасын анықтау және категориялау.

Бірінші жоба бойынша Арал маңы аумағында жаһандық позициялау жүйесі (GNSS) Leica Zeno 20 құрылғысы көмегімен далалық жұмыстар жүргізіліп, бақылау нүктелерінің координаталары анықталып, келешекте космостық суреттерді калибрлеу және тексеру мақсатында пайдаланылады. Бұл жүргізілген далалық жұмыстардың қорытынды деректерін (http://www.drinu.org/?p=454) веб-сілтемесінен жүктей аласыз. Бұл деректер білім беру және ғылыми-зерттеу мақсатында еркін қолжетімді әдістеме бола алады. Екінші жоба бойынша Назарбаев Университетінің студенттері автокөлікті қоятын орында су басу аймағын санауда және оның деңгейін анықтауда геодезиялық жабдықтарды пайдаланды.

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THE RESEARCH OF AUTOMATED RADIO SYSTEMS FOR TRANSMITTING NOTIFICATION INFORMATION ON SEISMIC HAZARD AND SEISMIC MONITORING DATA

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Abstract. Results of preliminary research of automated radio systems for transmitting notification information on seismic hazards and seismic monitoring data are presented. The aim of this paper is research and development of the optimal structure of automated radio systems for rapid transmission notification information on seismic hazards and seismic monitoring data as well as the development of an algorithm of automatic adaptation of radio systems to changes of interference environment of radio channels. The radio channel that belongs to such a system, must work reliably both before and after the seismic waves occur, must exclude the possibility of transmitting a false signal of the seismic hazard, must have a high probability of correct message reception in conditions of changing interference environment in time, and the various tracks should include closed ones.

Reliable performance before and after the arrival of seismic waves assumes an availability of sustainable electric power supply, including the availability of an emergency independent power supply, the mechanical strength of the hardware components and units during vibration and shock, and the keeping of necessary directional diagrams of the transmitting antenna with its possible slopes. High probability of correctly receiving a message for such systems is the most important criterion.

Key words: seismic hazard, seismic monitoring, radio system, transmission, information.

Introduction

According to experts, who are engaged in forecasting the economic development of South Kazakhstan, the possibilities in this region are enormous. On the other hand, the high seismic activity in the region prevents a more complete implementation of these features and significantly increases the risks for economic investment and tourism. Therefore, the solution for organizing the protection from possible damage during strong and catastrophic earthquakes, and from a variety of secondary disasters after the earthquakes, becomes more realistic. These include fires, explosions, floods, mudslides, rail disasters, and chemical and radioactive environmental contamination which would be a result of the destruction of chemical and nuclear power plants. Also, electrical shocks of the population during the destruction of electric networks is very dangerous. Victims and losses sometimes exceed the numbers from the initial damage. For example, the Tokyo earthquake ruined 128 thousand houses, and fires destroyed 448,000 buildings in 1923.

Almaty is considered to be one of the most earthquake-prone regions of the Republic of Kazakhstan. Therefore, decreasing the secondary injuries during the earthquake by increasing the reliability and efficiency of emergency rescue operations and victim assistance is a priority.

The radio system for information transmission on seismic hazards [1], which is part of research and development, uses the fact that the speed of seismic wave propagation is much lower than the speed of electromagnetic wave propagation. Thus, notification information on seismic hazards transmitted by radio from the area of the earthquake's epicenter may be highly reliable. Thus, it can be used for the automatic launch of safeguard measures at dangerous sites before the arrival of the destructive seismic wave.

The goal of this work is the research and development of an optimal structured automated radio system for rapid transmission of notification information about seismic hazards, seismic data monitoring, and the development of an algorithm of automatic adaptation of the radio system to changes of interference with the radio channel.

The goal is achieved by:

1. The research, specification and drawing up a mathematical model of signals and noise to transmit information on seismic hazards
2. The research of radio interference level in different frequency ranges
3. The analysis and evaluation of the various structural schemes of data transmission radio systems, which allow assessment for the advisability of their use for radio systems of transmission of information of seismic hazards
4. The development of the optimal structure of the radio system of transmission of notifications on seismic hazard
5. The development of software for PCs and algorithms of automated adaptation of radio systems to environmental changes
6. The experimental research of the structure of the radio system of transmission of notifications on seismic hazards

The practical significance of this work lies in the fact that these results allow us:

1. To analyze and calculate the interference environment for decameter and meter bands when transmitting digital information signal for any settlement.
2. To substantiate the criteria for selecting the structure of the radio system of transmission of notifications on seismic hazards.
3. To optimize the structure of the automated radio system of transmission of notifications on seismic hazards for two frequency bands.
4. To implement via a radio system, the necessary protective measures for dangerous objects in Almaty before the arrival of destructive seismic wave and notify the service of the State Committee for Emergency Situations. This would reduce the undesirable effects of secondary injury factors during strong earthquakes.
5. To use the developed software for automatic adaptation of the radio system of decameter band to environmental changes

Methodology

We conducted research of informational possibilities, advantages and disadvantages of various radio systems of information transmission, including seismic ones. We selected frequency ranges for the primary and backup radio channels of system of information transmission on seismic hazards.

Based on the analysis of the current studies in scientific publications, we researched mathematical models of interference impact on the radio system of transmission of notifications on seismic hazards. We analyzed data which allowed us to produce a qualitative assessment of the interference situation in the zone of action of radio system of transmission of notifications on seismic hazards. We clarified mathematical models of natural and artificial interference. Based on these, we created a total mathematical model of aggregate interference, which allows us to make a quantitative estimate of the interference environment. Next, the mathematical model of the interference effect on the radio system of transmission of notifications on seismic hazards is determined by studying the interference environment through quantifying the total interference for the two frequency bands for Almaty and South Kazakhstan. The calculations indicate that in the city of Almaty (decameter range at 5 MHz), the industrial noise has a predominant effect on receiving devices; that the actual sensitivity of the receiver is 10 - 20 times lower than the nominal sensitivity; that in the absence of industrial noise, the real sensitivity is determined by atmospheric disturbances and cosmic noise, and is decreased by a few times. In addition, in the meter range at a frequency of 150 MHz, industrial noise also has a dominant effect on the receiver, but its level is lower than at 5 MHz. The cosmic noise becomes more pronounced and inherent noise already amounts to more than 10% of the total level of interference. Experimental research in South Kazakhstan confirmed the theoretical studies [2]. The actual sensitivity of the receiver in the absence of industrial noise is determined by the cosmic and the inherent noise.

On the basis of the calculated and experimental data, the assessment of interference environment of radio channels of system of transmission of notifications on seismic hazards must be made by calculating the required field strength of the radio signal for its stable reception in conditions of action of interference.

In research by Konchin [1], the development of radio system blocks of transmission of notifications on seismic hazards was carried out in accordance to this system and with interference environment which existed in the area of action of the system. As well, questions concerning the experimental analysis of the radio system structure were considered.

The description of the algorithm of work of radio system of transmission of notifications on seismic hazards for two radio channels of meter and decameter ranges is given. The program, which implements an algorithm of adaptive restructuring of radio channels of the system from one operating frequency to another under changing external conditions and the level of atmospheric interference according to the model of the ionosphere and under the influence of any other factors that not accounted for in the model, is presented. In order to test the main provisions of the dissertation, we carried out an experimental analysis of the structure of the radio system, including laboratory tests of its blocks. The results of the laboratory tests have helped to establish the validity of the main conclusions of the work and the efficiency of applying the designed structure of radio system for proactive information transmission on seismic hazards in order to reduce the consequences of the secondary destruction during an earthquake.

However, the radio channel that belongs to such a system must work reliably both before and after the arrival of the seismic waves, must exclude the possibility of transmitting a false signal of the seismic hazard, must have a high probability of correct message reception in conditions of changing interference environment in time and the various tracks must include closed ones.

Reliable performance before and after the arrival of seismic waves assumes an availability of sustainable electric power supply, including the availability of an emergency independent power supply, the mechanical strength of the hardware components and units during vibration and shock, and the maintenance of necessary directional diagrams of the transmitting antenna with its possible slopes. A false signal of a seismic hazard may be transmitted either when it is formed through an intentional or random shock impact in the area of one of the radio seismic threshold sensors, or when the configuration of interference coincides with the specific structure of the emergency signal (signal on seismic hazard).

Results

To reduce the possibility of formation of a false message in the radio system, we propose the use of the major principle of the reception and processing of useful messages, and the application of noiseless coding.

Achieving a high probability of receiving a correct message for such systems is the most important criterion.

Conclusions

In the ranges of meter and centimeter length of waves, the implementation of a radio channel with the direct wave (digital radio relay line of sight), ensures high veracity of data transmission [2]. Even in the absence of noise immunity coding and other measures, improvement of the noise immunity of signal reception is possible.

In further studies we consider methods to improve the noise immunity of radio system of information transmission of seismic hazards, taking into account the possibility of using methods, studied in previous work, in modern communication systems.

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ИССЛЕДОВАНИЕ АВТОМАТИЗИРОВАННОЙ РАДИОСИСТЕМЫ ДЛЯ ПЕРЕДАЧИ ИНФОРМАЦИИ ОПОВЕЩЕНИЯ О СЕЙСМИЧЕСКОЙ ОПАСНОСТИ И ДАННЫХ СЕЙСМОКОНТРОЛЯ

Аннотация. Приводятся результаты предварительных исследований автоматизированной радиосистемы для передачи информации оповещения о сейсмической опасности и данных сейсмоконтроля. Целью работы является исследование и разработка оптимальной структуры автоматизированной радиосистемы для оперативной передачи информации оповещения о сейсмической опасности и контроля сейсмической обстановки, а также разработка алгоритма автоматической адаптации радиосистемы к условиям изменения помеховой обстановки радиоканала. Радиоканал, входящий в такую систему, должен надежно работать как до, так и после прихода сейсмической волны, должен исключать возможность передачи ложного сигнала сейсмической опасности, иметь высокую вероятность правильного приема сообщения в условиях меняющейся во времени помеховой обстановки и различных трасс, вплоть до закрытых.

Надежная работа до и после прихода сейсмической волны предполагает наличие устойчивого энергоснабжения, включая наличие аварийного автономного питания, механическую прочность аппаратных узлов и блоков при вибрациях и ударах, сохранение необходимой диаграммы направленности передающей антенны при возможных ее наклонах. Ложный сигнал сейсмической опасности может быть передан либо в том случае, когда он формируется случайным или умышленным ударным воздействием в зоне одного из радиосейсмических пороговых датчиков, либо, когда конфигурация помехи совпадает с принятой структурой аварийного сигнала.

Высокая вероятность правильного приема сообщения для систем подобного назначения является важнейшим критерием. Существенное значение при анализе этого вопроса имеет используемый диапазон частот.

В дальнейших исследованиях предлагается рассмотреть методы повышения помехоустойчивости радиосистемы передачи информации о сейсмической опасности с учетом возможности использования исследованных в предыдущей работе методов в современных системах связи.

Ключевые слова: сейсмическая опасность, сейсмоконтороль, радиосистема, передача, информация.

СЕЙСМОБАҚЫЛАУ МӘЛІМЕТТЕРІН ЖӘНЕ СЕЙСМИКАЛЫҚ ҚАУІПТІ ХАБАРЛАУ АҚПАРАТТАРЫН БЕРУ ҮШІН АВТОМАТТАНДЫРЫЛҒАН РАДИОЖҮЙЕНІ ЗЕРТТЕУ

Аңдатпа. Сейсмобақылау мәліметтерін және сейсмикалық қауіпті хабарлау ақпараттарын беру үшін автоматтандырылған радиожүйені зерттеудің алдын ала нәтижелері келтіріледі. Жұмыстың мақсаты сейсмикалық жағдайды бақылау және сейсмикалық қауіпті хабарлау ақпараттарын жедел беру үшін автоматтандырылған радиожүйенің оңтайлы құрылымын зерттеу және әзірлеу, сондай-ақ радиожүйенің радиоканалдың кедергі жағдайында өзгеру шарттарына автоматты бейімделу алгоритмін әзірлеу. Мұндай жүйеге кіретін радиоканал сейсмикалық толқын келгенге дейін де, кейін де сенімді жұмыс істеу керек, сейсмикалық қауіптің жалған сигналының берілу мүмкіндігін жою керек, түрлі, тіпті жабық жолдарда және кедергі жағдайында уақыт бойынша өзгеріп тұратын жағдайларда хабарламаны дұрыс қабылдау ықтималдығының жоғары болуы керек.

Сенімді жұмыс – сейсмикалық толқын келгенге дейін және кейін де апаттық автономиялық қорек көзі бар энергиямен тұрақты қамтамасыз етудің болуы, вибрация және соққы кезінде аппараттық түйіндер мен блоктардың механикалық беріктігі, тарататын антенна бағытының оның мүмкін болған еңкеюлері кезінде қажетті диаграмманың сақталуы. Сейсмикалық қауіптің жалған сигналы радиосейсмикалық межелік датчиктердің бірінің аймағында кездейсоқ немесе әдейі ұру әсерінен құрылған кезде немесе кедергі конфигурациясы қабылданған апаттық сигнал құрылымымен сәйкес келгенде берілуі мүмкін.

Осындай мақсатты жүйе үшін хабарламаны дұрыс қабылдау ықтималдығының жоғары болуы маңызды критерий болып табылады. Бұл сұрақты талдау кезінде қолданылатын жиілік диапазоны айтарлықтай маңызды.

Алдағы зерттеулерде алдыңғы жұмыста зерттелген қазіргі байланыс жүйесіндегі әдістерді қолдану мүмкіндігін есептегенде сейсмикалық қауіптілік туралы радиожүйенің ақпаратты таратуында кедергіге тұрақтылығын көтеру әдістерін қарастыру ұсынылады.

Кілттік сөздер: сейсмикалық қауіп, сейсмобақылау, радиожүйе, беру, ақпарат.

GIS & RSD FOR ANALYSIS OF DISASTERS AND EMERGENCY SITUATIONS

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Abstract. Geographical Information Systems (GIS) and Remote Sensing Data (RSD) became very important tools in different types of human activity – science, ecology, oil and gas, forestry management, land and water management, tourism, trade, defense and security and so on. Modern methods should help us face emergency situations and act in order to save lives. They are the tools that play important roles in all stages of disaster management, and can indicate guidance for various key activities. Geospatial solutions help us decrease the impact of natural and technogenic disasters and emergency situations. Geographic information can help us to be prepared for a disaster very precisely because it has relationships to realistic contexts.

This article includes information on GIS and RSD roles in Disaster Management as well as a description of Natural and Technogenic Disasters in which the authors were involved as Action Team members. Some examples and applications of Geospatial data use for Disaster Management and action during Emergency situation are shown. Also provided is a list of several existing Disaster Management Information systems and a description of technical information and communication tools of the Kazakh Emergency Situations Agency.

Key words: GIS, Remote Sensing, Geospatial, Disaster management, Methods.

Introduction

One of the pressing problems of geomorphology of arid regions of Kazakhstan is the study and evaluation of the eolian relief formation process. Since the independence of the Republic, the amount of extracted mineral resources has increased considerably. There have been intensive development of anthropogenic impact including the processes of relief formation in the Caspian region. Irrational use of the natural resources (overgrazing, use of trees and shrubs for fuel, man-induced effects on soil and vegetation cover, etc.) has led to an increase in issues of mobile sands, sand-drift of residential and engineering structures, wells and highways. A striking example of this consequence is the sandy massif called Tuyesu near Senek village in Karakiya region, Mangystau oblast (referred to as "Tuyesu" from now on). See Figure 1. For many years this village has experienced environmental pressure associated with drifting sand and changes in relief formation.

Figure 1 – Senek village, Mangistau oblast, Western Kazakhstan

The main purpose of this research is to study the current natural-anthropogenic conditions of formation and development of mobile sands in order to consolidate them.

Currently, Kazakh optical Satellites KazEOSat-1 and 2 can be the informational source for Disaster Management in our country. The data can be integrated into existing Emergency Information systems of our national services.

Methodology

Steps that have been completed:

- analysis of theoretical approaches and methods for assessing the formation and development of eolian relief
- application of modern GIS studying methods and mapping of eolian relief formation
- exploration of the natural-anthropogenic conditions for the formation of mobile sands, specifically Tuyesu
- exploration of current landscape and identification regularity of formation of Tuyesu
- completion of geomorphological zoning of mobile sands near Senek village in order to consolidate data
- consolidation of Tuyesu research in the framework of scientific and applied projects for the protection of natural resources, residential and engineering structures.

Provisions for protection:

- Assessment of natural-anthropogenic conditions of formation and development of Tuyesu and identification of key anthropogenic factors
- Detailed analysis of Tuyesu terrain using GIS technology allowed us to estimate the spatial and temporal patterns of their development.
- The dynamics of shifting sands, along with the climatic characteristics of the region, depend on the morphometric and morphological characteristics of Aeolian landforms, and the characteristics of the underlying surface
- Geomorphological zoning of shifting sands, based on an assessment of differentiation of mobile forms of Aeolian relief on indicators of their dynamics will develop the implementation of an effective restoration method.

Traditional geographical methods such as comparative, and cartographic, statistical analysis of indicators relief-mobile forms of Aeolian relief were utilized.

Baselines were established from findings of cameral and field studies conducted between 2003 and 2007, statistical and meteorological data, topographic and thematic maps, and remote sensing data [1].

Scientific novelty:

- conduct local research on relief-moving sands using instrumental observations and office processed data
- apply GIS technology to quantify the performance relief-moving sand with the creation of GIS maps of the local area
- presentation of the practical application of integrated protection of residential and engineering facilities from moving sands.

Practical significance and realization of this work is the author's participation in the improvement and implementation of an integrated method for protecting objects from sand drifts in the Senek Karakiya district from 2003 to 2007. Implementation of research results exist in the Mangistau region.

Kazakh satellite data were used to analyze the Karaghandy region in 2015 and the data were given to the Emergency Committee, published in newspapers and shown as a potential and authentic tool to monitor flood situations. Figure 2 is an example of the data gathered from a flood in central Kazakhstan".

All these data can be and should be integrated in "Corporate information and communication system of the State System of Civil Protection" and "Uniform System of Crisis Management Center of the Republic of Kazakhstan" as geospatial tools.

Results

So far, the main results of the studies were published in nine scientific works.

GIS mapping and Remote Sensing analysis methods were used in order to protect the village from moving sands (2003-2007):

1. Main moving sands area was also calculated through space images
2. Protection and fencing areas were defined

3. Objects requiring protection were defined
4. Primary and secondary phytomelioration areas were defined (360 Ha);
5. Quantity of materials necessary for this job (plants' quantity, water volume, pumps, workhours, etc.) were calculated (approximately $550,000 USD)
6. Work plan was created and considered.

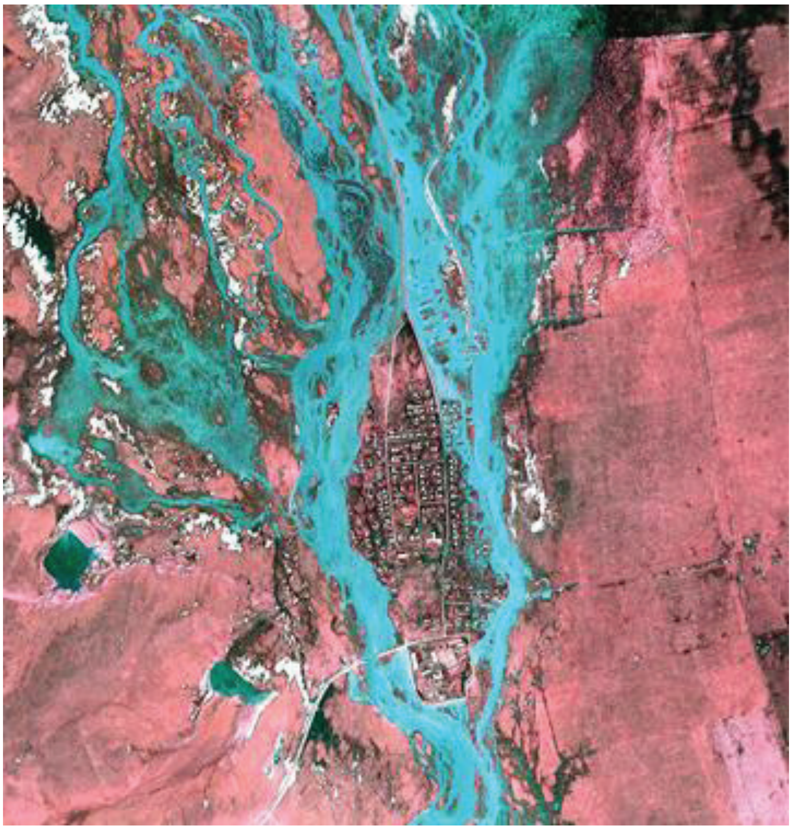

Figure 2 – Flood in Central Kazakhstan

Discussion

The main results of the research were presented at international conferences, including the international environmental conference "Ecological problems of the region of Turkestan" (in Turkestan, 2002), an international scientific-practical conference "Ecology and Oil and Gas Industry" (in Atyrau, 2003), an international conference "4th International Conference of UNESCO programme 481 Dating Caspian Sea Level Change" (in Aktau, 2006), and the "International Scientific and Practical Conference" Other presentations were done for "The geographical challenge of sustainable development of the Republic of Kazakhstan: Theory and Practice" (in Almaty, 2008), and an international scientific-practical conference on "Problems control environment of the area of the Caspian basin" (in Aktau, 2009).

Conclusions

a) RSD & GIS data are very useful for Disaster Management & Emergency Response

b) Kazakhstan has good potential to increase operational possibilities regarding Disaster Management

c) RSD & GIS data with other types of information should be integrated in a National Disaster Management & Emergency Response System – Kazakhstan has this potential.

d) The GIS communication system for disaster management is being developed. In the near future, the development of mobile applications for the Kazakhstan population is essential.

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ИСПОЛЬЗОВАНИЕ ГИС И ДЗЗ ДЛЯ АНАЛИЗА ЧРЕЗВЫЧАЙНЫХ СИТУАЦИЙ

Аннотация. Географические информационные системы и данные дистанционного зондирования Земли стали очень важными инструментами в различных видах человеческой деятельности - науке, экологии, добыче нефти и газа, управлении лесным хозяйством, управлении земельными и водными ресурсами, туризме, торговле, обороне и безопасности и т.д.

Современные методы должны помочь нам быть готовыми к чрезвычайным ситуациям и действовать для того, чтобы спасти жизни. Это инструмент, который играет важную роль на всех этапах ликвидации последствий стихийных бедствий, и может показать правильный путь для многих ключевых направлений деятельности. Геопространственные решения помогают нам уменьшить влияние природных и техногенных катастроф и чрезвычайных ситуаций. Географическая

информация может помочь нам подготовиться к катастрофе и является очень точной, поскольку она имеет отношения к реальным местам вокруг нас.

Эта статья включает в себя информацию о роли ГИС и ДЗЗ в ликвидации последствий стихийных бедствий, а также описание реальных природных и техногенных катастроф, где авторы, были участниками проектов, некоторые примеры и способы использования геопространственных данных для ликвидации последствий стихийных бедствий и во время чрезвычайной ситуации. В статье даны сведения о существующих в Казахстане информационных системах и описания технических, информационных и коммуникационных инструментов Комитета по чрезвычайным ситуациям МВД Республики Казахстан дается и представлены выводы.

Ключевые слова: ГИС, дистанционное зондирование, геопространственный анализ, борьба со стихийными бедствиями, методы.

ТӨТЕНШЕ ЖАҒДАЙЛАРДЫ ТАЛДАУ КЕЗІНДЕГІ ГАЖ ЖӘНЕ ҚАШЫҚТЫҚТАН ЗОНДТАУ

Аңдатпа. Геоақпараттық жүйелер мен қашықтықтан зондтау деректерін адамзат қызметінің әр түрлі түрлерін өте маңызды құралдарына айналды - ғылым, қоршаған ортаны қорғау, мұнай және газ, орман шаруашылығы, жер және су ресурстарын басқару, туризм, сауда, қорғаныс, қауіпсіздік және т.б. Қазіргі әдістер төтенше жағдайларды реттеу және адам өмірін сақтау үшін әрекет етуге көмектеседі, апатты жағдайларды басқарудың барлық кезеңдерінде маңызды рөл атқаратын заманауи құрал түрі. Қазіргі әдістері төтенше жағдайларға дайын болуға және халық өмірін сақтау үшін әрекет жасауға көмектеседі. Апат басқарудың барлық кезеңдерінде маңызды рөл атқарады және қызметінің басты бағыттары дұрыс жолды көрсете алады.

Геокеңістіктік шешімдер бізге табиғи және техногендік апаттар мен төтенше жағдайлар әсерін азайтуға мүмкіндік береді және олар бізді қоршаған нақты орындарыға қатысы болғандықтан өте дәл болып табылады.

Бұл мақалада төтенше жағдай кезінде шешім қабылдаудағы ГАЖ және қашықтықтан зондтаудың маңызды рөлі туралы ақпаратты, сондай-ақ авторлар қатысқан табиғи және техногендік сипаттағы төтенше жағдайлардың салдарын әлсіретуге бағытталған нақты жоба, апаттық жағдайды басқару кезіндегі геокеңістіктік мәліметтерді қолданудың мысалдары мен әдістері қамтылды.

Қазақстан Республикасы Ішкі істер министрлігі Төтенше жағдайлар комитетінің ақпараттық жүйелері мен олардың қолданыстағы техникалық, ақпараттық-коммуникациялық құралдарының сипаттамасы туралы ақпарат беріліп, қорытындылар ұсынылған.

Кілттік сөздер: ГАЖ, қашықтықтан зондтау, геокеңістіктік талдау, төтенше жағдайларды басқару, әдістер.

ARAL SEA REGION DESERTIFICATION STUDY

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Abstract. The region of Kyzylorda was selected for a study of the desertification process. This world renowned inefficient water resource usage problem has resulted in the manifestation of desertification in the Aral Sea region. To explore the process of desertification in this region, our research methodology consists of two parts: 1) field data collection in the region and 2) analysis of remote sensing (satellite) data. The first part of the research work was carried out in the Aral Sea region with Global Navigation Satellite System (GNSS) equipment (Leica Zeno 20) to collect the field measurements of ground control points (GCP). The GCP will be used for the calibration and verification of the processed satellite data. The second part of our methodology is based on the interpretation of satellite images. The GCP data collected during this field work will be used for further referencing with processed satellite images. We finished the first part; the field work related to collection of the GCP and the coordinates of 30 points were measured. We will use satellite data from ASTER, Landsat, KazEOSat to track the desertification process in the study area. The results of the field work can be used by other researchers. Data are available for free downloading from our website http://www.drinu.org/wp-content/uploads/2016/07/GCPs_Aral.pdf.

Key words: desertification, Aral Sea, Kazakhstan, Kyzylorga, GCP.

Introduction

The Aral Sea Basin ceased to exist in 1986 when the Small Sea completely separated from the Large Sea. This large scale event resulted in a number of disconnected bodies of water, most of which have since dried up. It has resulted in new deserts around the Aral Sea, further shrinking the Aral Sea Basin's region. The current ecological situation of the Aral Sea region is mostly the result of an intensified desertification process [1]. The desertification process of the Aral Sea can be tracked through using remote sensing and GIS technologies.

In order to investigate the implementation of integrating and monitoring remote sensing data, we choose the Aral Sea region, predominantly the territory of Aral district in Kyzylorda region as a project reference site for a study of desertification processes. From June 16 to 20, 2016, a Nazarbayev University research team conducted the “Investigation process of desertification in the Kyzylorda region" field work in cooperation with "Ulytau-Aral" expedition team from the Kazakhstan National Geographic Society.

The main task of the research group was to measure the coordinates of ground control (reference) points (GCP). The GCP will be used for further use to calibrate and verify the processed satellite data from ASTER, Landsat and KAzEOSAt. Simultaneously, the observational work focusing on desertification and land degradation processes was conducted. Water and soil samples were collected and analyzed. Heavy soil saline levels were tracked in many areas.

June 16. The research team arrived in Aralsk town. A number of GCPs within the town were measured (Figure 1).

Figure 1 - Control points taken next to the “Aralsk” hotel

June 17. The group met with the director of Barsa-Kelmes Reserve and with the 25 members of the "Ulytau-Aral" expedition. The expedition team members included experts in geography, geology, hydrology, biology, and journalism. The expedition continued their field work trip and travelled 165 km from Aralsk to Akespe village.

June 18. Next, the expedition drove about 4 hours from Akespe to Akbasty village. The causes of desertification, such as grazing and road digression, was observed in the Akespe village. *Peganum harmala* or adyraspan plants, one indicator of desertification, were found (Figure 2). GCPs were collected.

Figure 2 - One indicator of desertification - Peganum harmala or adyraspan

Many houses were covered by sand in this Aral Sea region. As well, sand drifts were noticed in Eski Akespe village (Figure 3).

Figure 3 - Sand drifts in Eski Akespe village

The high degree of digression due to overgrazing was evident in Akbasty village since there are around 35-1500 camels per yard (managed by about 500 people). Unsustainable land use, in particular, uncontrolled grazing, resulted in a desert. Moreover, poor vegetation is a direct result of the desertification. Houses and streets were covered with the Aral Basin sand. Sand dunes and drifts had begun formation in conjunction with the drying of the Aral Sea.

We also visited the so-called "Ship graveyards" in the northern part of the Large Aral Sea. The coordinates of these “ship graveyards” were taken (Figure 4).

Figure 4 - Measuring coordinates at “Ship graveyards”

June 19. The expedition team went on a 3 hour drive to the Kokaral Dam. GCPs at the dam were measured.

Then, the main national geographic expedition team “Ulytau-Aral” decided to stay for a longer time near the Kakaral Dam. The group of desertification process researchers separated from the main expedition with the assistance of Barsa-Kelmes Reserve workers and Deputy Director G. Satykeeva. Driving into the territory Barsa-kelmes Reserve territory required permission, which had to be managed and supported by a Reserve member.

June 20. The Barsa-Kelmes Reserve territory was toured and the coordinates of control points were obtained. Sites such as the cordon of the Reserve, former Hydrometeo post, mausoleum Kerderi and former Kerderi settlement were visited (Figure 5 a,b,c,d). In the evening, the group departed for Kyzylorda.

June 21. The field work group returned to Astana city [2].

Figure 5 - Measured coordinates: a) cordon of the Reserve Barsakelmes, b) former Hydrometeo station, c) ancient Kerderi mausoleum territory and d) debris (dishes) at the ancient Kerderi settlement

Methodology

Our methodology consists of two parts, which were implemented for the research work: 1) field work method using high-precision equipment with GNSS GPS-GLONASS, and 2) using satellite images for processing remote sensing data in offices away from the research site.

The coordinate measuring equipment was dual-frequency GNSS from Hexagon Leica Geosystems Zeno 20 GPS-GLONASS, which has provided by Hexagon Leica Geosystems Kazakhstan. According to the manufacturer, the specified device has some advantages:

- the possibility of upgrading the optional precision GNSS-positioning (meter, sub-meter, centimeter), which allows the user to select the accuracy in accordance with the requirements of the project or budget
- the equipment is convenient and data collection for GIS is simple and easy. The lightweight and compact device is equipped with a display size of 4.7 inches for operation under street lighting
- Zeno Connect for Android - will provide any application on Android access to high-precision RTK positioning
- Provides access to the data of Open Street Map [3].

Figure 6 - Measurement of GCP with Leica Zeno 20 in the Aral Sea region

The tracking process was performed with a wearable Garmin GPS 64s device, and Nikon SLR Cameras 3200 were used. The tracking is indicated by the yellow lines on the layout (Figure 7).

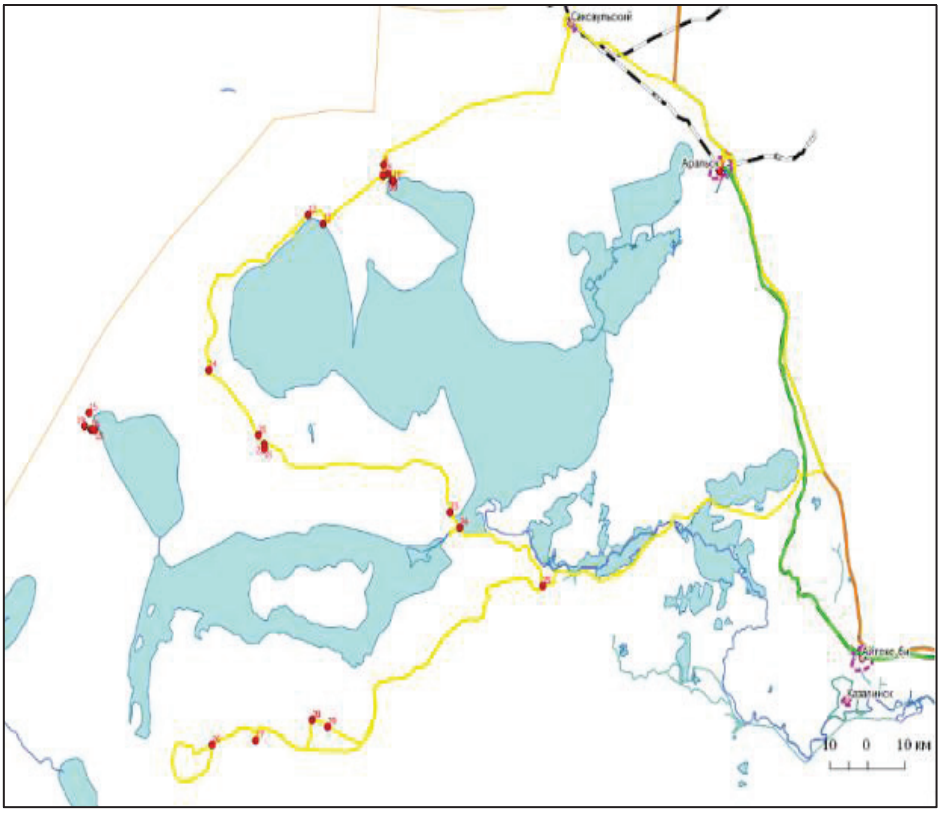

Figure 7 - A schematic arrangement of GCP and tracking

The next research stage involved the processing of the satellite image data. The essence of the soil (and vegetation) required the interpretation (recognition) of photos using photogrammetry and the visual method. The collection of satellite data (ASTER, Landsat, KAzEOSat) allowed us to further monitor the desertification process in the study area. Satellite images were obtained from the Internet portal USGS - http://earthexplorer.usgs.gov/ [4]. We have received mosaic from the Landsat-8 collected data. PCI Geomatics [5] software was used for the creation of the mosaic (Figure 8).

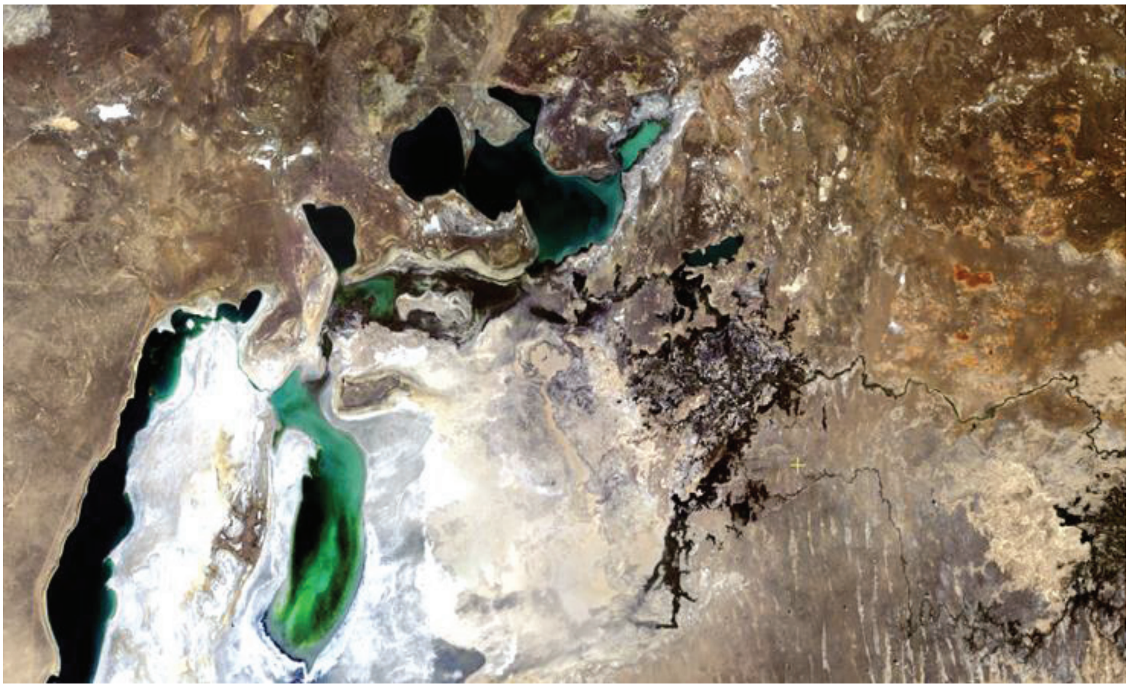

Figure 8 - Mosaic of Landsat – 8 imagery, 2016

Most GIS projects require some geo-referencing raster data. Geo-referencing is the process of assigning coordinates in the real world for every point raster. We obtained these coordinates using field measurements and collecting the coordinates using the GNSS-receiver in a few easily identifiable points of the picture. Through using these sample coordinates or control points (GCP), the image is distorted to fit the selected coordinate system. Points can be reservoirs, intersections, the confluence of one river to another, buildings, and so on (Figure 9).

Figure 9 - The types of sites used in the study of the accuracy sightings: a) corner of a building; b) Kokaral Resrvoir, c) & d) corners of houses; e) &, f) corners of abandoned ships

Discussion

The field work was initiated as part of the June 2016 "Ulytau-Aral" expedition, organized by the “Kazakh National Geographic Society” (QazaqGeo) public association. A significant change of the wind regime of the Aral Sea region has been accompanied with the removal of a huge amount of sand and salt from the dried bottom of the Aral Sea. These sand storms are one of the causes of desertification. To study the process, a group of researchers went to the Aral Sea region to measure the coordinates of the control points and to align them with satellite images. By comparing this data to images from the past, we revealed the dynamics of landscape change. During the field work, the coordinates of 30 points with approximately 2.5 m planning precision were measured (for comparison, a simple GPS provides about 6 - 7 m of precision on plains).

In addition, the results of the field work can also be used for the preparation of tour itineraries. Despite persistent environmental degradation, there are some sites that could be interesting for local, national and international tourism.

Table 1 - The list of potential tour excursion sites

No	Numbers of measured GCP	Place	Tourism Category
1	5	Geothermal (radon) source	Spa tourism
2	15	Ship graveyards	Cultural and educational tourism
3	20	Sahu mausoleum	Cultural and educational tourism
4	21	Geothermal (radon) source in Akbasty village	Spa tourism
5	24	Kokaral dam	Cultural and educational tourism
6	26	Barsakelmes Reserve	Ecological tourism, Cultural and educational tourism
7	27	Gidrometeopost	Cultural and educational tourism
8	28	Kerderi mausoleum	Cultural and educational tourism
9	29	Kerderi settlement	Cultural and educational tourism

Results

1) The main task of the geodesic survey of ground control points was fulfilled with 29 points documented in the research territory. These are available through: https://cloud.mail.ru/public/5kQB/3nvrqd49g

2) The indirect signs of desertification and land degradation were observed which in turn demonstrates the presence and progression of desertification.

3) Mosaics of the satellite images were created.

Future Requirements

1) Cartography of the whole infrastructure of the research territory is required.

2) The construction of land cover maps (LandCover) is needed.

3) The construction of land use maps (LandUse) is needed.

4) As one of the sideline tasks, a map of tour itineraries in the research area can be designed or transferred. Data about tour excursion sites and itineraries can also be combined with the information of the KNGS "Ulytau-Aral" expedition.

5) Desertification process will be monitored on the basis of satellite images.

Acknowledgments

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ИЗУЧЕНИЕ ПРОЦЕССА ОПУСТЫНИВАНИЯ НА ПРИАРАЛЬЕ

Аннотация. Территория Кызылординской области была выбрана для изучения процесса опустынивания. Неэффективное использование водных ресурсов является всемирно известной проблемой. В результате этого процесса происходит опустынивание в регионе Аральского моря. Наша методология изучения процесса опустынивания в регионе Аральского моря, состоит из двух частей научно-исследовательской работы: 1) сбор полевых данных региона и 2) исследования на основе данных дистанционного зондирования (Спутниковые снимки). Первая часть научно-исследовательской работы была проведена на Приаралье с помощью глобальной навигационной спутниковой системы (GNSS) Leica Zeno 20, с целью сбора полевых измерений опорных точек (GCP). GCP будет использоваться для калибровки и проверки обрабатываемых спутниковых данных. Вторая часть нашей методологии основывается на интерпретации спутниковых изображений. Собранные контрольные точки (GCP) во время полевых работ будут использоваться для дальнейшей привязки к данным с обрабатываемых спутниковых снимков. Мы закончили первую часть − полевые работы, связанные с коллекцией GCPs. Были измерены координаты 30-ти точек.

Мы будем использовать спутниковые данные из ASTER, Landsat, KazEOSat отслеживать процесс опустынивания в исследуемой области. Результаты полевых работ могут быть использованы другими исследователями. Данные доступны для бесплатной загрузки с нашего сайта http://www.drinu.org/wp-content/uploads/2016/07/GCPs_Aral.pdf.

Ключевые слова: опустынивание, Аральское море, Казахстан, Кызылорда, GCP.

АРАЛ МАҢЫ ШӨЛДЕНУ ПРОЦЕСІН ЗЕРТТЕУ

Аңдатпа. Шөлдену процесін зерттеу аймағы ретінде – Қызылорда облысы таңдалды. Дүние жүзіне әйгілі су ресурстарын тиімсіз пайдалану негізінен пайда болған мәселелердің бірі – Арал маңы шөлдену процесі. Арал маңы шөлдену процесін зерттеу әдісі екі ғылыми – зерттеу бөлімінен тұрады: зерттеу аймағынан далалық деректерді жинақтау және Жерді қашықтықтан зондтау деректері негізінде зерттеу. Алғашқы бөлім бойынша зерттеу әдісі Арал маңы аумағында жаһандық позициялау жүйесі (GNSS) Leica Zeno 20 құрылғысы көмегімен далалық жұмыстар жүргізіліп, бақылау нүктелерінің координаталары анықталды. Бақылау нүктелері (GCP) өңделетін космостық суреттерді калибрлеу және тексеру мақсатында пайдаланылады. Екінші бөлім бойынша зерттеу әдісі ғарыштық суреттерді дешифрлеу негізінде жүргізіледі. Далалық жұмыстар кезінде жинаған бақылау нүктелері (GCP) космостық суреттерді өңдеу кезінде пайдаланылады. Бірінші бөлім бойынша жұмыстанып, далалық жұмыс жүргізілді. Арал маңы далалық зерттеулер кезінде 30 нүктенің координаталары анықталды.

Қарастырылып отырған аймақты Жерді қашықтықтан зондылау деректері ASTER, Landsat, KazEOSat түсірілімдері негізінде зерттеу жұмыстары жүргізіледі. Жүргізілген далалық жұмыстың деректерін басқа да зерттеушілер пайдалана алады. Деректерге тегін қол жеткізу үшін осы сайттан жүктей аласыздар

http://www.drinu.org/wp-content/uploads/2016/07/GCPs_Aral.pdf.

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ISSUES OF PREDICTION AND PREVENTION EMERGENCIES IN CASE OF FLOODING AND UNDERFLOODING

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Abstract. This paper describes the possibility of increasing confidence in the projected emergency situations due to the increase in the number of autonomous stations and the creation of the national network of automatic exchange of reliable information.

Key words: forecasting, disasters, protection, forecast, meteorological, hydrological, terminals.

Introduction

Due to the diversity of natural and geological conditions, close to the entire territory of Kazakhstan (about 75%) is not protected against the natural disasters known to man, such as earthquakes, floods, droughts, mudslides, and so on. As a consequence, the well-being of humans isdeclining, negative impact on the environmental and social spheres are negatively impacted, fresh water is increasingly difficult to access and sustaining a balanced diet is becoming more difficult [1].

One of the most important and effective tools for protection of the population from impending natural disasters is a system of forecasting, monitoring and timely warnings.

In order to realize the state's civil, business and environmental protection policies and interests, planning for the monitoring and forecasting of natural disasters has been carried out by ministries and agencies of the Republic of Kazakhstan and by scientific and manufacturing organizations.

The principle of this work is a system ofmonitoring the conditions and the origin of natural disaster and noting the processes in the atmosphere, hydrosphere, lithosphere, and biosphere. A number of state and non-state institutions andorganizationsfor the monitoring of natural phenomenon and processes have been established.

In all regions of the republic, territorial units of a subsystem of the State System of Civil Protection (SSCP) have been created in order to forecast, prevent and respond to emergency situations.

Each territorial subsystem SSCP includes: commission on prevention and response to emergency situation in regions and districts (cities), territorial subdivisions of the authorized organization in the sphere of civil protection, a daily management body (a single duty-dispatching service "112", duty-dispatching services), service of civil protection in regions and districts (cities), the forces and facilities of territorial units, including financial, food, medical and logistical resources, communication, warning, and information support.

Over the past decade, changes in climate which are connected to the increase in temperature and evaporation rate, have limited agriculture development, and have had a negative impact on the nation's limited natural resources.

The most frequent causes of natural disasters are: spring floods and rain floods, constituting about 30% of the total number of disasters. There are also high risks associated with flooding and mudslides. Catastrophic flooding occurs about once every 50-100 years in Kazakhstan [1].

According to the Ministry of Emergency Situations,the estimated direct losses from emergencies in the country is from 3.5 to 4.5 billiontenge annually (without the cost of global natural disasters). Experts estimate the collateral damage in this case to be about 15-20 billion tenge and the damage from the loss of life and the treatment of victims is about 3 billion tenge. In total, the costs can be up to 25 billion tenge annually.

In this regard, one of the major priorities is the development a long term strategyfor the protection of Kazakhstan's national interests from the negative effects of natural hazards.

At the same time, we must underline that the current national natural disaster preparedness programis poor and does not cover the whole country.

In this sense, pre-preparedness, awareness and mobilization of all stakeholders, including competent authorities, academic institutions, international and non-governmental organizations and local communities are necessary to significantly improve the safety and security of the population.

Meteorological monitoring

The Republic State-owned Enterprise (RSE) "Kazhydromet" of the Ministry of Energy provides an environmental monitoring network of hydrological and meteorological stations and posts, and monitors environmental pollution.

The most important operational links and production activities of RSE "Kazhydromet" act as a service for the study of the natural environment through the stations and posts: meteorological, hydrological, agrometeorological and so on. This forms a single national grid and conducts surveillance on a common program and common terms.

Currently RSE "Kazhydromet" has 298 hydrological posts and 260 meteorological stations, of which 30 operate in automatic mode, and there are 2 avalanche stations [2].

The Ministry of Energy in cooperation with the Ministry of Internal Affairs developed an interaction algorithm between the Crisis Management Centre of the Committee of Emergency Situations and RSE "Kazgidromet" (Ministry of Energy). Reports are generated about the operational transmission of information about hydro meteorological phenomenon and regular storm warnings. As well, a consistent procedure for information exchange about meteorological and hydrological phenomenon under danger of an emergency situation occurrence has been adopted.

Similar algorithms were developed for the territorial bodies of the Committee of Emergency Situation and the subdivisions of RSE “Kazgidromet.”

The Ministry of Energy has developed a cooperation model with the interested state bodies, regional akimats, and the cities of Astana and Almaty. The scheme includes storm warnings via the RSE “Kazhydromet” about impending dangerous and hazardous hydrometeorological phenomena for the adoption of measures to reduce the risk of occurrence of emergency situations. At the local level, similar schemes have been developed and agreed upon with local authorities, regional Emergency Situations departments and RSE “Kazhydromet” branches.

Issue: Weather Stations

The RSE “Kazhydromet” includes 260 weather stations; however, this number of observation points is extremely insufficient. Thus, in accordance with regulations of the world meteorological organization, there should be 5 times more meteorological stations in Kazakhstan.

Suggested Solutions

It is necessary to increase the number of meteorological stations in accordance with the standards of the World Meteorological Organization [3] as well as re-equipping the existing stations with up-to-date technologies.

Issue: Flood Monitoring

The Minister of Energy of the Republic of Kazakhstan annually reports RSE “Kazhydromet” forecast data to relevant authorities on possible flood situation as of 1 February and 1 March. The forecast is based on data regarding the presence of snow cover, autumn moistening and forecasts for the spring.

An agreement was made in order to streamline the data exchange process, and to take timely preventive measures. It was developed by the Ministry of Internal Affairs and approved by the joint order of the Ministries of Internal Affairs (From September 16, 2015 №773) and Energy. It is titled, "By mutual exchange of hydrometeorological information security."

In 2015, the RSE“Kazhydromet” predicted and alerted state authorities that 4 regions of the country may experience a difficult flood situation. Forecast data was given in the extensive grounds, have insufficient accuracy for determining the time, place and situation possible [2].

The possible floodszones and melted waterinpacted 860 settlements, which are home to 1.9 million residents.

Based on the forecast data about water flow in the rivers, the presence of snow cover, and weather forecast presented by RSE “Kazhydromet,” the local executive bodies cooperated with the territorial bodies of the Committee for

Emergency Situations (Ministry of Internal Affairs) to develop and implement a set of preventive anti-flood measures.

Regions have developed annual monitoring data systems and have corrected plans to respond to flood situations and established procedures for the cooperation of concerned agencies and organizations for the flood period.

Issue: Hydrological Stations

RSE "Kazhydromet" has an only 298 hydrological stations, an insufficient number. In accordance with the standards of the World Meteorological Organization (WMO), Kazakhstan should have 3 times more hydrological stations.

Suggested Solutions

In order to solve the existing problems it is necessary:

- toincrease the number of hydrological stations in accordance with the standards of the WMO.
- to create a single automated system for hydrological stations and to integrate the existing stations and posts, government offices 'Kazselezashita."

The increase in the number of hydrometeorological posts can be met through the creation of automated terminals, which will be installed at the control points of the environment condition and be shared with the centeral receiving telemetry through data transmission systems. The transmission medium can be wired, wireless and optical communication systems. The autonomous automatic stations must have alternative sources of energysupply (solar panels, wind and hydro/hydrogenerators)which will recharge the batteries. The terminal exchange protocol and the Centre will monitor the conditions of all power supply system elements. If necessary, a specialist of the district or of the regional monitoring center will arrive and address the problem. The terminals should be appropriately built to ensure protection from vandals.

The terminals should register the temperature of the air, water, earth, humidity, speed and wind direction, rainfall, soil freezing depth, snow depth, some status parameters moraine lakes, information about seismic activity of the earth, the water level in rivers and reservoirs, the appearance of water in dangerous places, the ability to transmit photos, video and audio information where it is required.

The terminals may have remote sensors of various physical parameters. Technically, all the system components of a terminal have been developed and are widely used in practice. It is still necessary to compose a modular design and test it in practice. During trials various technical and organizational issues will invariably arise and must be addressed. After successful completion of the test, the construction into a series must begin. Serial production of the components of the system can even be commissioned to be carried out by students of the corresponding specialties. A structure that will service, repair and prevention of all equipment must also be created. It is possible to organize all of this on the basis of local area government offices. Also, a service which will deal with the preparation and training of specialists in the service terminal is required. Another task is to create an enterprise engaged in the production of model components and assemblies included in the system.

The connections system which can be used for radio communication systems include medium wave, short wave, very high frequency (VHF), microwave, WI-Fi, GSM and optical communication systems for different environmental conditions. Each terminal must link exactly for this point of the area. Accordingly, each terminal as well as some units and assembly will be different.

For example, a terminal installed in a flat area will have wind turbines and solar panels, whereas a terminal on the mountain stream will have a hydroelectric generator. One terminal will transmit information at Very high frequency (VHF), and the other for GSM or even WI-Fi. A terminal which is installed on a snow slope will have a height sensor snow cover, and a terminal on the glacier will have some glaciologically measuring instruments.

To save energy, information can be sent in compressed form in a short package. For transmitter operation, by reducing the duration of a transmitted packet, it is possible to strengthen the power of the transmitted signal. Accordingly, the transmission distance is decreased the load on the batteries is reduced.

The creation of a unified transmission system of hydro-meteorological information will improve the accuracy of forecasts of emergencies for the two or three orders of magnitude. Additionally, the centralization of the system will save the Republic of Kazakhstan since material and financial resources significantly exceed the costs of creation and maintenance of the system.

The use of unmanned aerial vehicles for the monitoring status of avalanche dangerous areas and the condition of the glaciers will be more effective and less costly than the use of manned flight vehicles.

Currently, space monitoring policies of the Republic of Kazakhstan does not allow the use of information for the operational monitoring of emergent and developing emergency situations. Software which allows the combination of photos and topography of the territory is missing. Forecasting the disaster situation with more certainty is possible with the availability of 3D maps of the area.

Finally, 3D maps of Kazakhstan could be created because the technical capabilities are there, but it has not been considered to be necessary. It is possible to use the data obtained from the terminals for an interactive map of the Republic of Kazakhstan which would allow for direct observation of the status of hazardous areas and for predictions of dangerous and impending changes in real time.

These timely measures can prevent the occurrence of emergency situations, and ultimately save the lives of many people. As well, there is an opportunity to save many billions of KZT which are now spent on the primary and secondary consequences of emergency situations.

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НЕКОТОРЫЕ ВОПРОСЫ ПРОГНОЗИРОВАНИЯ И ПРЕДУПРЕЖДЕНИЯ ЧС ПРИ ЗАТОПЛЕНИИ И ПОДТОПЛЕНИЯХ

Аннотация. В этой статье описана возможность повышения достоверности прогнозируемых чрезвычайных ситуации из-за увеличения числа автономных станций и создание национальной сети автоматического обмена достоверной информации.

Ключевые слова: прогнозирование стихийных бедствий, защита, прогноз, метеорология, гидрология, терминал.

СУ БАСУ ЖӘНЕ СУ АСТЫНДА ҚАЛУ БОЛҒАН ТӨТЕНШЕ ЖАҒДАЙЛАРДЫ ТАЛДАУ ЖӘНЕ ЕСКЕРТУ КЕЗІНДЕГІ СҰРАҚТАР

Аңдатпа. Бұл мақалада автономды станциялар санының көбеюіне байланысты болжанатын төтенше жағдайлардың сенімділігін ұлғайту мүмкіндігін сипаттау және сенімді ақпаратты автоматты түрде алмастыратын ұлттық желі құру мәселелері қарастырылған.

Кілттік сөздер: табиғи апаттарды болжау, қорғау, метеорология, гидрологиялық, терминал.

RISK MANAGEMENT PROCESS FOR EXTREME WEATHER EVENT IMPACTS

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Abstract. The paper describes a risk management structure that allows decision-makers to define and improve their attitude to risks of extreme weather event impacts on critical infrastructure as well as derive and test alternative measures and their costs and benefits. The structure has been developed under the context of the European INTACT project.

The risk management structure identifies six steps comprising 'good practice' in decision-making. It recognizes the circular nature of risk management, which may require the review of the risk analysis and assessment after implementation of risk reduction control measures.

Key words: risk, extreme events, critical infrastructure.

Introduction

Resilience of Critical Infrastructure to Extreme Weather Events, such as heavy rainfall, drought or icing, is one of the most demanding challenges for both government and society. Critical infrastructure (CI) is an asset, system or part thereof which is essential for the maintenance of vital societal functions, health, safety, security, economic or social well-being of people, and the disruption or destruction of which would have a significant impact as a result of the failure to maintain those functions. Extreme Weather (EW) is a phenomenon that causes severe threats to the well-functioning of CI.

The effects of various levels of EW on CI are witnessed through changes in seasons and extreme temperatures (high and low), humidity (high and low), extreme or prolonged precipitation (for example rain, fog, snow, and ice) or prolonged lack thereof (drought), extreme wind or lack of wind, and thunderstorms. The increased frequency and intensity of EW can cause events such as flooding, drought, ice formation and wild fires, which present a range of complex challenges to the operational resilience of CI.

The economic and societal relevance of the dependability and resilience of CI is obvious: infrastructure malfunctioning and outages can have far reaching consequences and impact on economy and society. The cost of developing and maintaining CI is high if they are expected to have a realistic functional and economic life (50+ years). Hence, future EW events have to be taken into account when considering protection measures, mitigation measures and adaption measures to reflect actual and predicted instances of CI failures.

The aim of this paper is to describe a risk management structure that allows decision-makers to define and improve their attitude to risks of Extreme Weather Event (EWE) impacts on Critical Infrastructure (CI) as well as deriving and testing alternative measures and their costs and benefits. The structure has been developed under the context of the European INTACT project.

The INTACT project brings together innovative and cutting edge knowledge and experience in Europe in order to develop and demonstrate best practices in crisis response and recovery capabilities. The objectives of the INTACT project are to:

- Assess regionally differentiated risk throughout Europe associated with extreme weather
- Identify and classify, on a Europe wide basis, CI and to assess the resilience of such CI to the impact of EWE
- Raise awareness of decision-makers and CI operators about the challenges (current and future) that EW conditions may pose to their CI, and
- Indicate a set of potential measures and technologies to consider and implement, be it for planning, designing and protecting CI or for effectively preparing for crisis response and recovery.

More explanations about the project and provisional results can be found at <<www.intact-project.eu>>. The project will finalize in 2017.

Risk management process

The structure of the risk management process is based on the developments presented in the European Commission's Framework Programme [1]. The overall purpose of the structure is to assist CI stakeholders in the improved assessment of EWE impacts on their infrastructures, and to provide support on how mitigation measures could lead to improved CI resilience in the face of increasing EWEs due to climate change.

The risk management process is based on that promoted by the International Electrotechnical Commission [2]. It identifies the main steps comprising 'good practice' in decision-making. It recognizes the circular nature of risk management, which may require the review of the risk analysis and assessment after implementation of risk reduction control measures. The steps of the process are:

- Scope definition: determines the scope of the risk assessment in terms of the CI, the information needed and the type of approach, timeframes and scales to be considered
- Risk identification: explores and classifies the main hazards and vulnerabilities taking into account cascading effects
- Risk estimation: assesses the risk magnitude using available models and taking into account uncertainties

• Risk evaluation: assesses the magnitude of risk considering the particular context of the CI
• Proposals for action: provides guidance on the possible mitigation measures to reduce the estimated risk
• Risk reduction control.

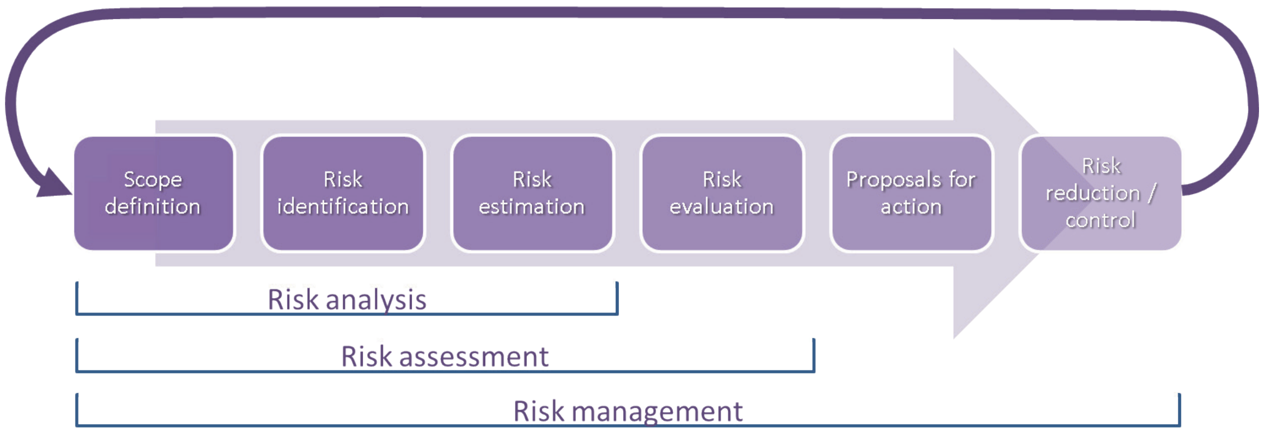

Figure 1 - INTACT risk management process

The INTACT Risk Assessment Process provides guidance on methods and available tools; however, it does not cover all possible methods available and does not intend to be prescriptive in which methods to use. These tools and methods are presented in [3].

Scope definition

The starting point of a risk assessment is the definition of the scope: the objectives and purpose of the risk assessment considering the context (e.g. stakeholders' needs and perceptions, legislation and regulations, etc.), the available information and the scales and timeframes of the assessment.

The scope should define the CI's core functions, characteristics and processes and take into account the type of dependencies. Goris and Rilling [4] provide a good overview on the increasing interconnectedness of infrastructure systems with physical, cyber, geographical and other types of dependencies [5].

Relevant EWE and EWE situations need to be identified and described including the context in which they should be considered such as scale and timeframe (e.g. their nature, intensity and duration).

In order to correctly set up the context of the assessment, current legislation and procedures should be taken into account.

When considering the scope definition, end-users and CI operators should consider both quantitative and qualitative information sources (datasets) to inform and then decide upon effective risk estimation. Quantitative and qualitative risk analyses are both possible to assess risks. The former assigns fixed numerical values to risk while the latter uses intervals or scales represented by non-numerical labels such as High, Medium and Low.

Risk identification

The objective of this step is to identify the main hazards likely to occur given a particular EWE and its impacts and consequences on a CI depending on its vulnerability.

The process to follow to identify risks has three main steps:

1. Identify extreme weather events
2. Identify vulnerabilities
3. Identify impacts.

Identify extreme weather events. In order to identify risks, it is important to understand EWE temporal distribution (frequency, seasonality, diurnal patterns), spatial distribution and magnitude. This requires more detailed descriptions of EWE than the ones contained in the Scope Definition Phase. Two concepts need to be considered when exploring EWE:

- Hazard, defined as the potential occurrence of an EWE
- Exposure, which refers to the critical infrastructure being located in the geographic range of hazardous extreme weather events.

The goal of hazard identification is to establish an exhaustive list of hazards, regardless of how small the likelihood of their occurrence. This will constitute the base for a comparison and prioritization of the most devastating hazards that will be taken forward in the analysis.

Identify vulnerability. The objective is to establish a list of factors contributing to CI vulnerability. In the context of the INTACT project, vulnerability is mainly structural vulnerability, defined as the capacity of CI to cope with extreme conditions although other types of vulnerabilities such as social or human could also be addressed.

Identify impacts. In order to identify the impacts, it is important to have an understanding of the available response time related to the time between warning and occurrence of the hazard. The duration of the impact is also important when assessing risks and considering the best recovery type of measures. Relevant impacts may include scale of damage, number of CI and services impacted (e.g. outages), fatalities, number of persons, properties or business affected, and so on.

The impact of disrupted CI can be assessed from a qualitative point of view (e.g. acceptable risk, inconvenience, moderate, disaster) or quantitatively, estimating a cost associated to the damages, or number of fatalities/injuries. The impacts of hazards on CI can be direct, when they occur at the area where EWE occurs, or indirect, when they occur outside the original location of the EWE or occur over time after an EWE.

Cascading effects occur when the functioning of one infrastructure is required for the functioning of another one, i.e. there are dependencies within the infrastructure system. In this case, a problem (disruption, failure) in the first infrastructure will cause problems in the second one. For example, loss of electric power might lead to disruption in water transportation (pumps) and health care systems (among others). Getting a good understanding of the likelihood of cascading effects and thus, of the interdependencies between infrastructures, is essential for the identification of risks.

Risk estimation

This step involves the calculation of risk based on the selected hazard and CI vulnerability, taking account of both impact and loss assessment. Risk is generally considered to be related to the probability of consequences or outcomes occurring. There are a large number of tools, models and approaches used to assess or calculate the risk, which generate a set of outputs and indicators. Indicators are an attribute of the risk being measured and they can be used to detect or predict opportunities or threats, estimate the probability of those happening and to control the impacts. When deriving indicators, it is necessary to take into account the following:

- Does the indicator help to understand the current risk?
- Does the indicator cover a key component of the risk process?
- Is it possible to detect trends in the indicator and compare them with suitable thresholds?
- Does the indicator deal with probability of occurrence or exposure?
- Is it cost-effective to measure the indicator?

The calculated risk (indicator) is used for comparison with any set or agreed thresholds in the next ‘evaluation’ step.

Uncertainty should form part of the user’s assessment of the level of risk that is acceptable. Uncertainties can be categorized into aleatory (random), representing the "true" temporal and/or spatial variability in the likelihood of EWE’s, and epistemic (knowledge), representing, among other things: the imperfections in measurements and estimates of the parameters; the imperfections in the models; the uncertainty in statistical estimates of model parameters resulting from the limited size of data sets. Aleatory uncertainty can typically not be reduced and is sometimes referred to irreducible uncertainty analysis. Epistemic uncertainty can be reduced, but never completely eliminated, by increasing the size and quality of data sets and by improving models.

Neglecting uncertainty leads to the simplification of the systems under investigation and hinders a comprehensive understanding of the sensitivity of a system to the (effectively existing) indetermination in its parameters and models. Exclusion of uncertainty can also hinder decision-making since the decision-maker does not know the weight to put on any risk metric. Uncertainty-based approaches to risk estimation include – but are not limited to – probabilistic risk estimation, relying on statistical and probabilistic modelling.

To estimate the risk, the probability of occurrence of the EWE source needs to be assessed for each CI asset. It may also be necessary to calculate the probability associated with the hazard pathway, and to combine this with the source probability. Thus for example, the coastal inundation of CI assets near the shoreline should consider both the probability of occurrence of extreme sea levels (source) and the probability of failure of the sea defenses (pathway) to such extreme levels.

Some risk estimation methods focus on general mapping of the hazard sources, so they enhance understanding of the potential consequences and impacts. Other methods involve very detailed analysis in the form of indexing and strict quantitative modelling, for example.

The selection of the most appropriate risk estimation method depends on how much effort can and should be expended, what data are available to support such analysis, the most suitable indicators to characterise the impacts, and the overall uncertainty inherent in the estimation process for the given CI and EWE. All of these factors need to be considered when choosing a method, and in certain situations, it may be prudent to use more than one method to ensure that robust decisions are subsequently made.

Generally, three types of risk calculation are available:

- Qualitative assessment defines consequence, probability and level of risk by significance levels such as “high”, “medium” and “low”, may combine consequence and probability, and evaluates the resultant level of risk against qualitative criteria.
- Semi-quantitative methods use numerical rating scales for consequence and probability and combine them to produce a level of risk using a formula. Scales may be linear or logarithmic, or have some other relationship. The formulae used can also vary.
- Quantitative analysis estimates practical values for consequences and their probabilities, and produces values of the level of risk in specific units defined when developing the context. Full quantitative analysis may not always be possible or desirable due to insufficient information about the system or activity being analysed, lack of data, influence of human factors, and so on, or because the effort of quantitative analysis is not warranted or required. In such circumstances, a comparative semi-quantitative or qualitative ranking of risks by specialists, knowledgeable in their respective field, may still be effective.

Risk evaluation

Having estimated the risk for the particular combination(s) of CI and EWE, the next stage in the process is to examine and judge the significance of the risk. This evaluation of the risk is normally against some specified criteria.

A key aspect of the evaluation phase therefore, is the setting of appropriate thresholds or values for what is considered to be an acceptable level of risk. Different organisations or countries could set varying levels of acceptability, and this would depend on whether they were ‘risk averse’ or ‘risk taking’ in their approach to the management of CI systems. While such thresholds provide a quantitative measure to assess the risk, their derivation may well involve values and value judgements, and therefore sit outside a purely objective approach. This is to be expected given that the societal framework in any country sets the views on what are deemed to be acceptable levels of risk. It is worth noting two limits of risk that are often used in practice:

- Acceptable Risk: “a risk, which for the purposes of life or work, everyone who might be impacted is prepared to accept assuming no changes in risk control mechanisms” [6]
- Tolerable Risk: “a risk within a range that society can live with (1) so as to secure certain net benefits. It is (2) a range of risk that we do not regard as negligible or as something we might ignore, but rather as something we need to (3) keep under review and (4) reduce it still further if and as we can (ALARP, As Low As Reasonable Practicable)” [7] adapted from [8].

Proposal for action

This step in the risk management process is concerned with deriving potentially suitable mitigation measures, and assessing whether they can contribute to reducing the risk to Critical Infrastructure, either for current weather conditions or to alleviate future predicted impacts.

Details and outputs from the Risk Estimation and Risk Evaluation stages form a key requirement for implementing this step. The different types of measures can be classified depending on whether they are applicable before or after the event, whether they are for preparedness, mitigation, response or recovery of/from an event and considering which vulnerability dimension they are addressing.

The assessment of a range of measures or actions can be undertaken by the operator of the particular CI using any appropriate assessment method. However, there could be important benefits in undertaking this comparison using the same stakeholder group or methods involved in the risk assessment, so a valid comparison of the effectiveness of measures or actions can be assessed. This is particularly the case for methods that require prioritisation or trade-offs to be determined, which needs group discussion of the weights or values to be applied to a range of 'success' factors.

The outcome of this step is a list of potential measures, covering both operational and capital options, with the assessed scores according to different metrics (e.g. cost, reduction in risk, effectiveness). On the basis of these scores, the preferred option(s) will be selected.

Risk reduction control

This forms the final step in the risk process, which in the current IEC 31010 [2] formulation corresponds to the ‘Monitoring and Review’ step which circles back to the start of the process. Therefore in reality, 'risk reduction control' is what the whole process is trying to achieve and represents the need to continually re-assess the risk at appropriate intervals, which is achieved by monitoring and review protocols. This is necessary as the external environment is ever-changing, such as extreme weather and population demographics, so the requirements and impacts for a CI system are always in flux. The review period will be set to an appropriate interval, although in reality, quality controls will be continuous for most CI systems. Separate to the risk process, CI systems require a monitoring and control protocol, which will be used on a regular basis to check that:

- Previous assumptions about risk are still valid (as determined in the scope definition and risk identification steps).
- Assumptions used in the risk assessment remain valid, including the external context (assumed weather hazards, CI demands etc.).
- Outputs from the CI system(s) are as required.
- Risk assessment methods are being correctly applied.
- Risk mitigation measures are achieving their required outcomes.

Alongside the monitoring and review process, it is important that effective communication and consultation is used throughout all stages of the risk assessment process. This ensures that everyone is informed of the risks and the measures taken to reduce them, and that expert and other views are utilised in the most effective ways in the management of the CI system.

Conclusions

This paper proposes a logical and practical risk management structure to assess the impacts of extreme weather on critical infrastructure and the resilience of CI against extreme weather. Furthermore, it contributes to the more comprehensive use of available information affecting the risk assessment, the analysis of the effectiveness of mitigation investments and the resilience of critical infrastructure.

During the development of the structure, we faced the challenge that the methods and tools of assessment are typically very CI- and EWE-specific. Consequently, the choice of the tool and method depends on how much resource (time, money) can be used, and on the availability and accessibility of data. As such, the common understanding of available and realisable methods is important for further research and development.

In the context of the INTACT project, the structure described in this paper is being evaluated and tested in a series of case studies in 5 different countries in Europe.

The risk management process is being developed into a tool to guide a user through a workflow-like sequence of options, guidance and recommendations. The process will be built in a wiki environment, which would provide a seamless user interface.

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ПРОЦЕСС УПРАВЛЕНИЯ РИСКАМИ ПОСЛЕДСТВИЙ ЭКСТРЕМАЛЬНОЙ ПОГОДЫ

Аннотация. В статье описана структура управления рисками, которая позволяет лицам, принимающим решения, определить и улучшить свое отношение к рискам воздействия экстремальных погодных явлений на критическую инфраструктуру, а также выводить и тестировать альтернативные меры и рассчитывать их рентабельность. Структура была разработана в рамках Европейского проекта INTACT.

Структура управления рисками определяет шесть этапов, содержащих «хорошие практики» в процессе принятия решений. Она признает циркулирующий характер процесса управления рисками, который может потребовать пересмотра анализа и оценки рисков после осуществления мер контроля по снижению риска.

Ключевые слова: риск, экстремальные явления, критическая инфраструктура.

ЭКСТРЕМАЛДЫ АУА-РАЙЫ САЛДАРЫНЫҢ ТӘУЕКЕЛІН БАСҚАРУ ПРОЦЕССІ

Аңдатпа. Бұл мақалада тәуекелдерді басқару құрылымы баяндалған. Ол шешім қабылдаушы адамдардың сыни инфрақұрылымға ауа райы құбылысы экстремалды ықпалының тәуекеліне өзінің қатынасын жақсартуға және анықтауға, сондай-ақ балама шаралардың шығындарын және пайдасын шығару және тестілеуге мүмкіндік береді. Бұл құрылым INTACT Европалық жобасы аясында дайындалған.

Тәуекелдерді басқару құрылымы шешім қабылдау процесі кезінде «жақсы тәжірибесі» бар алты кезеңді анықтайды. Ол тәуекелдерді басқарудың айналым сипатын мойындайды, яғни ол тәуекелді төмендетуді бақылау шараларын жүзеге асырғаннан кейін тәуекелдердің анализін және бағалауын қайта карауды қажет етуі мүмкін.

Кілттік сөздер: тәуекел, экстремалды оқиғалар, сыни инфрақұрылым.

CAUSES AND CONSEQUENCES OF THE FLOODS IN KAZAKHSTAN AND AROUND THE GLOBE

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Abstract. The most common aspects of research are explained and data on scales of floods are analyzed. The author's concept of protection against floods is briefly described.
Key words*:* safety, emergencies, flood, protection, water, risk.

Kazakhstan, which has signed a number of international treaties in the field of emergency situations, is actively integrated with the structures of the UN, CIS, MOGO and other international organizations. It also takes part in humanitarian activities.

Floods are considered as an extreme or rare situation. The adverse effects on life, property and activities of mankind can lead to catastrophic consequences. It is shown that the frequency of floods has increased from century to century. Most attention is paid to geographical and social and economic problems. Floods, which occurred on various continents between 1998 and 2015 will be discussed. Data on the scale of the flood from each continent is analyzed: number, the duration, number of victims and temporarily evacuated people, and the damage in US dollars. The authors' concept of protection against floods will be explored.

Kazakhstan is located in Eurasia between 40056I and 55026I of north latitude and 45027I and 87018I of east longitude and extends from the north to the south for 1600 km, and from the west to the east for 2900 km. It occupies about 2725 thousand. sq.km or 2,7% of the Earth's landmass. It shares borders with the Russian Federation, People's Republic of China, the Kyrgyz Republic, the Republic of Uzbekistan and Turkmenistan. Kazakhstan is comprised of a wide variety of natural landscape features: high mountains, lowlands and plains, steppes, deserts, oases, forests, and large and small reservoirs which include the Caspian and Aral seas. The climate is sharply continental, droughty with poor, uneven distribution of water resources and the prevalence of arid forms of landscapes [1].

Because of its geographical location, Kazakhstan is susceptible to various natural disasters such as earthquakes, floods, mud streams, avalanches, collapses, landslides, and flooding of the Caspian Sea coastal zone. Other dangers include meteorological phenomena, forest and steppe fires, epidemic diseases of humans, epizootic diseases of animals, diseases and susceptibility of plants to wreckers, and so on. The risk of natural catastrophes could affect about 75% of the territory.

There are approx. 85,000 rivers and temporary streams, including rivers more than 10 km long – 8386, and their total length is close to 223,000 km within Kazakhstan. The river network is better developed in the more humid mountainous areas of Altai, Dzhungarsky and Zailiysky Alatau, which are located in the east and south-east regions of the republic.

The largest waterway of Kazakhstan is the Irtysh River. Its upper part is in the People's Republic of China and it also crosses Russia. The length of the river is 4248 km, with 1677 km of it flowing through Kazakhstan. The drain of Irtysh is regulated by the cascade of water storage basins. For example, at the village of Shulba, the average long-term consumption of water prior to the regulation of a drain was equal to 895 m^3/s, and the maximum reached 8330 m^3/s.

Other large rivers partially flow across the territory of Kazakhstan: The Ural, Syr Darya, Ili, Ishim, Tobol, and Shu. The rivers which are completely within the borders of Kazakhstan and are different in length include Nura, Turgai, Uil, Sarysu, Emba, Irgiz, and Sagiz. Rivers such as Bukhtarma, Uba, and Ulba, which flow down from the ridges of Altai. The Karatal River in the Dzungarian Alatau is characterized by increasing water content [1].

The characteristics of flat rivers and temporary streams change sharply for a month in spring mainly due to the thawing of seasonal snow cover. Mountain rivers have high water levels for 3 to 6 months because the snow melts at different rates. The maximum water consumption, in the case of high thawing water, exceeds the low flow by tens, hundreds and even thousands of times. The fluctuation of water level constitutes several meters. Sometimes the water level rises by 2,5 m to 3,5 m per day. For the rivers of West Kazakhstan, it may increase up to 4 to 5 m. This naturally leads to considerable floods of the rivers and other water sources. On the contrary, in dry years, the small and average flat rivers with no drainage, especially those in Central and North Kazakhstan, the high water can be poorly expressed or be absent.

In Kazakhstan, there are over 57,000 lakes, not less than 4,000 artificial reservoirs, natural reservoirs, ponds, excavated tanks and excavated ponds. The lakes more often meet in North Kazakhstan, in floodplains and river deltas. The total surface area of lake water is approximately 45,000 sq.km. The number of lakes with an area of more than 1 sq.km is 2999, and their total area is about 40,5 thousand sq.km. The largest reservoirs are the Caspian and Aral seas (located in Kazakhstan partially), Balkhash, Alakol, Tengiz, Seletytengiz, and Kushmurun lakes, and the laragest water reservoirs are Bukhtarminskoye, Kapchagaiskoye, Shulbinskoye, and Shardarinskoye.

Many lakes of Kazakhstan have no drainage, are salty, are up to 1 m deep and they dry up or freeze. Flowing freshwater lakes are mainly found in floodplains, deltas and mountain lakes. Water level fluctuations are mainly determined by the seasonal dynamics of surface water flow and evaporation from the surface of the water. The maximum seasonal height of lakes reaches 1,5 to 3,3 m. The summer-autumn water decreases an average of 0.3 to 0.7 m.

Throughout millennia, people have fought against floods with no success. Damage from floods, especially in the last decades, has increased sharply. The area of the world's flood-prone territories is close to 3 million sq.km. That is comparable to the total area of all the Western European states. Approximately 1 billion people live in the areas subject to flooding. Annual losses from floods constitute tens of billions of US dollars, and in some years, the damage exceeds 200 billion dollars. For example, 240 million people have suffered from floods in 1998 alone.

To date, there are no commonly accepted concepts for the calculation of the damage caused by floods nor concepts of protection against them [2, 3].

Currently, historians, archeologists and other experts have done considerable research on great floods in different countries. It is safe to conclude that the large floods have occurred in all areas of the globe. Legends of great floods exist for Babylon, Jewish, Ancient Greek, Old Indian, in East Asia, on islands of the Malay Archipelago, in Australia, in New Guinea and Melanesia, in Polynesia and Micronesia, in South America, in Central America, Mexico, in North America, and on continental Africa [4-9]. Table 1 describes eight major floods.

Table 1 - Largest floods on the globe

№	Date	Place	Number of the victims	Material damage
1	June 1972	Rapid City, South Dakota	215	$ 100 M USD
2	May 11-23, 1970	Oradea, Romania	200	225 settlements were damaged
3	August8-14, 1968	Gujarat, India	1000	
4	October 9, 1963	Belluno, Italy	>2000	Water overflow through the Vajont dam
5	October 4, 1955	Pakistan and India	1700	Losses of $63M USD from flooding of 5,6 million acres of agricultural land
6	August 14, 1950	Province of Anhui, People's Republic of China	500	10 million people were homeless; 5 million acres were flooded
7	December 31, 1962	Northern Europe	> 309	
8	1887	Henan, China	> 900000	Yellow River flooding destroyed numerous human settlements

Floods caused by spring, or spring-summer high waters exist for rivers in most regions of Kazakhstan. The emergence of floods of this type of rivers in southern Kazakhstan is probable in February – June. In southeast and east Kazakhstan, they occur between March and July. The flat rivers experience flooding between March and June. The greatest damage is caused by floods of the Irtysh, Ural, Tobol, Ishim, Nura, Emba, Turgai, Sary-su, and from their numerous inflows as well.

The catastrophic floods associated with wind setups in Kazakhstan are observed in the delta of the Ural River and along the northeast coast of the Caspian Sea. The periods from October to December and in May are when the water level reaches 2.0 to 2.5 m. It is very dangerous when the sea water spreads tens of kilometers over the land.

In recent years, the number of the floods caused by anthropogenous factors has sharply increased. For example, the Syrdarya River flood occurs because of increased disposal of water from the Shardarinsky reservoir (due to non-compliance with the release schedule) during the winter period. Another danger involves problems with sewage ponds/ devices of a number of the large cities (Almaty, Aktobe, Taraz, etc.). In some cases, dams of large water-engineering systems are in critical condition (e.g., Tasotkelsky, Ters-Ashchibulaksky, Shardarinsky, Sergeyevsky), so this can result in catastrophic floods.

We conducted research on the monitoring of natural processes in Kazakhstan, including Almaty. We also used data received by the natural phenomena observation network. The relevant calculations were used to assess how much territory was exposed to natural disasters. A risk assessment of their impact was carried out. Also, central and local executive authorities coordinated and methodically managed the work with the Agency of the Republic of Kazakhstan on Emergency Situations.

On the basis of the analysis of natural dangers and vulnerability of the environment, the risk was estimated. Results of calculations are given in the form of risk maps where the territories of various risk degree are specified. These maps help to resolve issues of risk management and planning of social and economic development of the region.

We believe that implementation of the actions we propose can play a significant role in the reduction of disasters and damage caused by floods. The complex and modern strategies of protection of the population against natural disasters in flood-prone areas include forecasting, planning and performance of work. Timely warning of people of the impending disaster should be carried out before a flood, during it and after the termination of the natural disaster. Specific activities include systems of supervision over conditions and occurrence of natural hazards in the atmosphere, the hydrosphere, the lithosphere and the biosphere.

In Kazakhstan, floods can be caused by a spring and spring-summer high water, wind setups in the coastal zone of the Caspian Sea, mash phenomena on the rivers, release of water from large reservoirs, breaks of ponds, settlers and poor sewage ponds. Except for the latter, all types of floods can be predicted beforehand from several hours to one month and more (the first type). Therefore, as a rule, the population is usually evacuated in good time. Nevertheless, the loss of human life is connected to this type of natural disaster. Quite often, it is necessary to carry our search and rescue operations of people, who for one reason or another, hadn’t been notified of the possible flood. As well, in the settled territories, transport networks can be damaged or temporary disabled. Therefore, daily attention has to be paid to fight against floods and to their prevention.

The sad irony of fate is that the vital water brings the misfortune to the humans. For all time, people have settled on the coasts of bodies of water.

However, if the water level suddenly and sharply increases because of heavy rains, strong winds, or inflows, for example, it can turn into the dangerous enemy.

The current state of forecasting, measuring and calculating floods, the economic use of the flood-prone territories, the assessment of consequences for the economy, society and environment reveal the immediate requirement for a reliable accounting of flood damage and the development of effective measures for fighting against them.

Conclusion

Floods have accompanied human society since ancient times. Due to various reasons, floods occur from rivers, oceans and sea coasts across the globe. Based on the number of the victims and damage caused to society, floods are the most serious natural disaster. There are still no reliable long-term methods to forecast their occurrence, no standard concept for protection, nor reliable and standard techniques to calculate the damages. Taking into account the global scale of a problem, the appropriate governmental bodies of all countries and international organizations have to pay attention to its study and practical resolution.

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ПРИЧИНЫ И ПОСЛЕДСТВИЯ ГЛОБАЛЬНЫХ ПРОБЛЕМ НАВОДНЕНИЯ

Аннотация. Наводнения рассматриваются как экстремальная ситуация или редкая, складывающаяся в природной среде, неблагоприятное воздействие которой на жизнь, имущество и деятельность человека столь велико, что может привести к катастрофическим последствиям. Показано, что частота наводнений усиливается от столетия к столетию. В статье дано представление о наводнении – как явлении глобального масштаба, сопутствующего человечеству с древнейших времен и до наших дней. Основное внимание в статье уделяется географическим и социально-экономическим проблемам, характеризуются наводнения. Показаны масштабы наводнений, характеризуется авторские предложения защиты от наводнений.

Ключевые слова: безопасность, чрезвычайные ситуации, наводнение, защита, вода, риск.

СУ ТАСҚЫНЫ БОЙЫНША АУҚЫМДЫ МӘСЕЛЕЛЕРДІҢ СЕБЕПТЕРІ МЕН САЛДАРЫ

Аңдатпа. Су тасқыны экстремалды жағдай немесе табиғи ортада сирек кездесетін, апаттық салдарға әкеліп соқтыратын адамның өміріне, мүлігіне, іс-әрекетіне тигізетін қолайсыз әсер ретінде қарастырылған. Су тасқынының жиілігі ғасырдан ғасырға күшейгенін байқап жүрміз. Мақалада су тасқыны туралы адамзатта көне заманнан бүгінгі күнге дейін жалғасып келетін ауқымды көлемдегі мәселенің түсінігі берілген. Су тасқынының аумағы туралы деректер келтірілген, су тасқынынан қорғанудың авторлық тұжырымдамасы қысқаша сипатталынған.

Кілттік сөздер: қауіпсіздік, төтенше жағдайлар, су тасқыны, қорғау, су, тәуекел.

ISSUES OF LANDSLIDE RISK REDUCTION IN ALMATY REGION

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Abstract. This article discusses the current issues of landslide risk in Almaty and the surrounding area because the potential risks have increased due to climate change and atmospheric global warming. The impact of human activities is also considered. A cyclonic nature of these changes is suggested. They are believed to be global mechanisms of landslide activity. The increase of landslide activity may cause mudflow activity. The impact of climate change on the seismicity of the region is assumed. The spatial-temporal and instrumental methods of landslide risk are assessed. The development of instrumental methods and accelerometers are suggested for the prevention of landslide and debris flow.

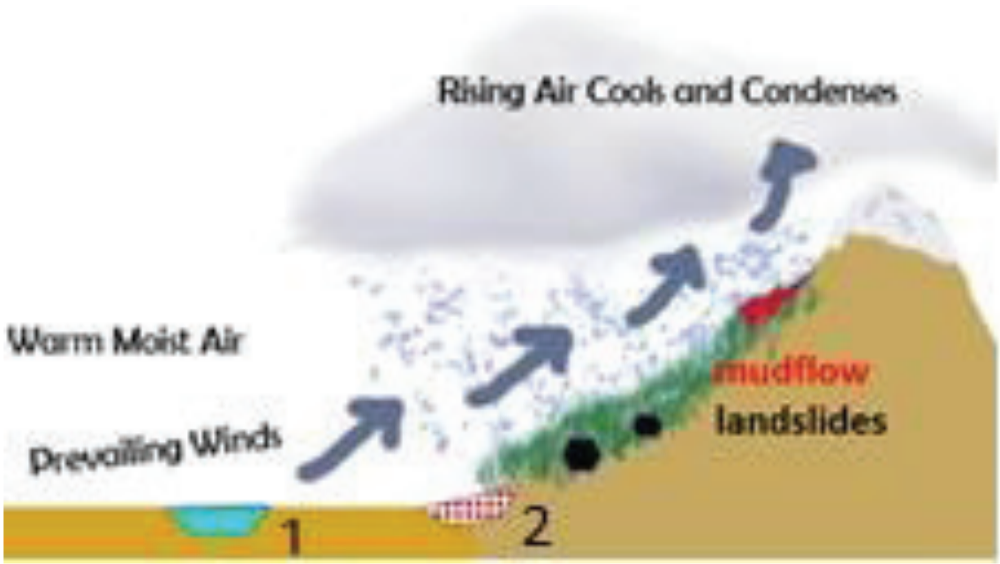
Key words: landslides, climate change, accelerometer, cyclone, risk, seismicity.

Introduction

The scientific society has voiced their concern in light of recent climate changes in mountain areas. The city of Almaty is located in an alluvial cone of foothills of Zailiyskiy Alatau, a highly seismic zone of the Eurasian continent. The evaluation of consequences of changes in global warming of the atmosphere is necessary. One of the consequences we have observed is increased landslide activity caused by growing precipitation. This work offers strategies for landslide risk mitigation.

Climate conditions of Almaty

In the 1960s, this was the classic situation: The western and northwest air masses bearing moisture, rose above mountainous areas and cooled down. Water vapor reached saturation points, and all that moisture was carried over the plains. The average annual precipitation amount of rainfall of 400 mm increased from the foothills to the middle of the mountains by 1.5 to 2 times, and in high mountains it was even more. Near permanent snow cover precipitation exceeded 1000 mm, and in other years 1500 mm [1]. The climate was mild, yet extremely continental with dry, hot summers, and winters with snow and light freezing weather.



Left to right: 1-Kapchagai reservoir, 2 - alluvial cone (Almaty), black spots - landslides, red – mudflow.

Figure 1 - Almaty atmospheric and geophysical situation: mountain and valley winds, erosion processes

However, real shifts in the climate system can occur due to an accumulation of seemingly insignificant atmospheric changes. For example, we consider the Kapchagai reservoir. More than one cubic kilometer of water evaporates annually [2]. Part of it rains down on Almaty. Waters of Kapchagai above the low left bank became a type of support for ground water running down from Zailiyskiy Alatau. Due to the increased ground water level, marshes were formed. Marsh and salt accumulation caused additional evaporation and an increase of salt into the west and north with western winds carrying precipitation [2]. As a result, in the 1970s, the climate of Almaty began to change (we'll call it "A") resulting in an increase of rainfall. We might say that the climate is now C+K where C - classic, K – evaporation from warm Kapchagai reservoir with winds from the steppe. We have more rain now than in the 1960s. In addition to more rain, frost comes early, and as a consequence we lost Oporto apples, a unique kind of apple of this area.

Today 30 years later, we can add to this formula two more effects: global warming "G" and urbanization "U". A two fold increase of the population occurred in one generation, multiple new buildings were built, and the number of cars grew perhaps ten times. Thus, every day almost a million cars move in the city, with half of this number commuting to and from the city daily. Urbanization generates a lot of heat, water and pollution into the atmosphere. It is also important to note that 90% of the water used by the city is provided by drill holes and some of this water also gets into the atmosphere.

So, A = C+G+K+U. Please note that every component in this equation contains water and warmth. Evidently, the last three components significantly change the situation. In the classical situation, condensation grew gradually with less amount of rain, and was balanced with change in the spring time. When the vapor particles are saturated, they form into droplets and fall as rain and the humidity increases significantly.

Local warming up from Kapchagai and urbanization of the city has led to the enlargement of the foot hill area, the city atmosphere and a drop in its pressure. This has caused a cyclonic effect and air is sucked. If it gets in from below, it carries the polluted and warm air from the steppe, which causes condensation. If the air comes from the top, it is cold and causes precipitation. It is called the piedmont – city cyclone. As evidence of this phenomenon, there is rain but on the 17th of May 2011, we experienced a unique hurricane at the Medeo and Chymbulak sites. Several thousand trees were destroyed. They were not carried by the force or broken with some exceptions, so the author believes that heavy air came down as a force and knocked the trees down. It happened unevenly due to relief or air currency. Therefore, the increase of precipitation and the massive loss of hilly forests could be an argument for the beginning of an Almaty cyclone. Perhaps the cyclone may influence the glacier processes.

A good cyclone provides solid precipitation. Consequences of this cyclone are evident. Rains are going to fill our hills causing hazardous conditions. Many people have noticed fresh landslides around the city. The risk of mudflow is real but to a lesser degree because of prevention steps that have been taken. Rain causes ground water to rise and has a negative effect on the environment.

Climate change impact on region seismicity

Seismicity situation deteriorates during major precipitation increase. The probability and scale of secondary consequences of earthquakes, such as landslides and mudflow, are growing. Massive and numerous landslides during an earthquake can lead to casualties and disrupt rescue operations. As well, the level of groundwater can reach the surface causing an increase in the force of the earthquake by 1 or 2 units. The Almaty area is already mapped as 8-9 points by the MSK. We might reconsider a seismic risk evaluation for Almaty. For example, this year a certain building in Almaty tilted by32 sm. Some assume it was due to an increase of water caused by frequent rains.

Earthquakes cause landslides. After the seismic impact, soil and rocks slide due to the shaking [3]. For instance, even a small local earthquake with a magnitude of 2 will cause landslides.

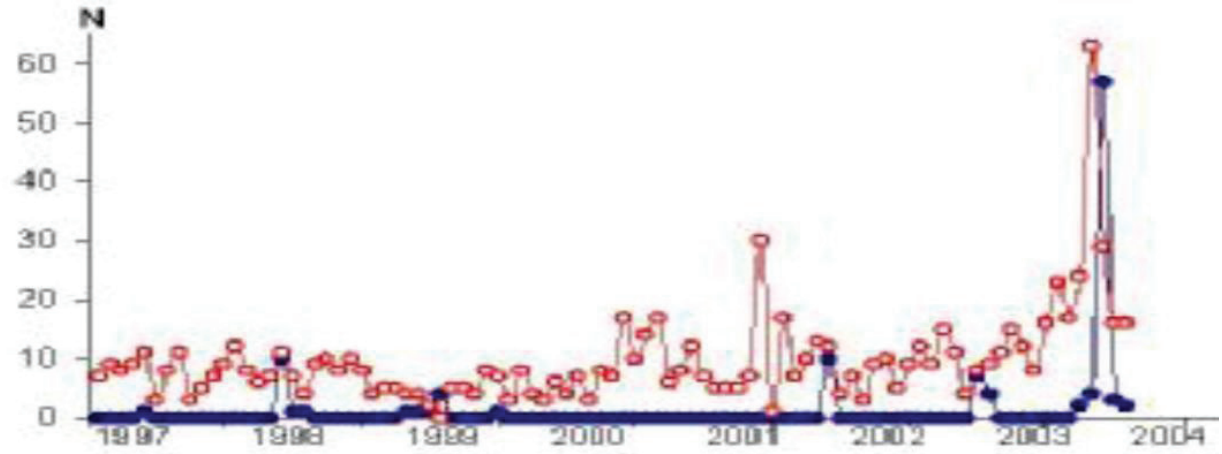


Figure 2 - The number of weak earthquakes and landslides in the period from 1997 to 2004 in Almaty region. Red - the earthquakes, the blue - landslides [3]

When strong earthquakes occur, landslides are a secondary result because of liquefaction.

Research studies and specialists note that sometimes massive landslides occur across vast areas. The author witnessed this in 2004 while working for Kazselezashita (State Mudflow Defense Organization). The author connected these events with the Indonesian earthquake on December 26, 2004, which was rated as the deadliest disaster in modern history. It had a magnitude of 9.1 to 9.5 on the Richter scale. Before such strong earthquakes, we have observed the mitigation of seismic activity on the Earth. Several days before an earthquake, the world seismicity falls almost to zero.

To confirm this, let's consider hydrogeological data from neighboring Kyrgyzstan which is located behind the mountain range of Zailiyskiy Alatau. "Clear synchronizing of ground water level of drill holes was noted for the period of 2001-2007 with a climax in 2003-2004. In those years, the maximum high level of ground waters and maximum enlargement of subsoil waterlogging of Chuyskaya basin" [4].

Calm zones of strong and medium earthquakes can reach massive areas, including several countries. Therefore, we can assume that global stress fields affect vast areas of the earth crust and can influence the levels of ground water in vast areas. The last situation leads to landslides. For seismologists, the variation of ground water level is not unusual because the hydrodynamic way of forecasting earthquakes is to check for the variation of ground water in drill holes across large distances - up to 1000 km from the epicenter.

Also, the correlation between current seismicity and irregularities of the Earth's rotation is interesting because it is occurring simultaneously with the rise the Earth's atmospheric temperature. It may be related to reasons of global warming and climate change. For instance, the 17 strongest earthquakes of $M \geq 8.5$ have occurred since 1900, and 6 of them happened in this century [5]. Over a period of 12 years, 35% of them occurred and the last powerful earthquake was in 2012. It seems our planet is shifting.

If this is so, our evaluation of risks has merit. Real cyclonic weather for Almaty, which was explained above, will continue in the future, and if certain steps are not be made, risks will increase.

Methodology

Space methods of risks evaluation. We know of few methods of landslide evaluation. The most popular is the mapping of possible landslides areas, and areas where landslides had taken place. Figure 3 is an example of a map for Central Asia and Caucasus completed by CFDRR in 2008 [6].

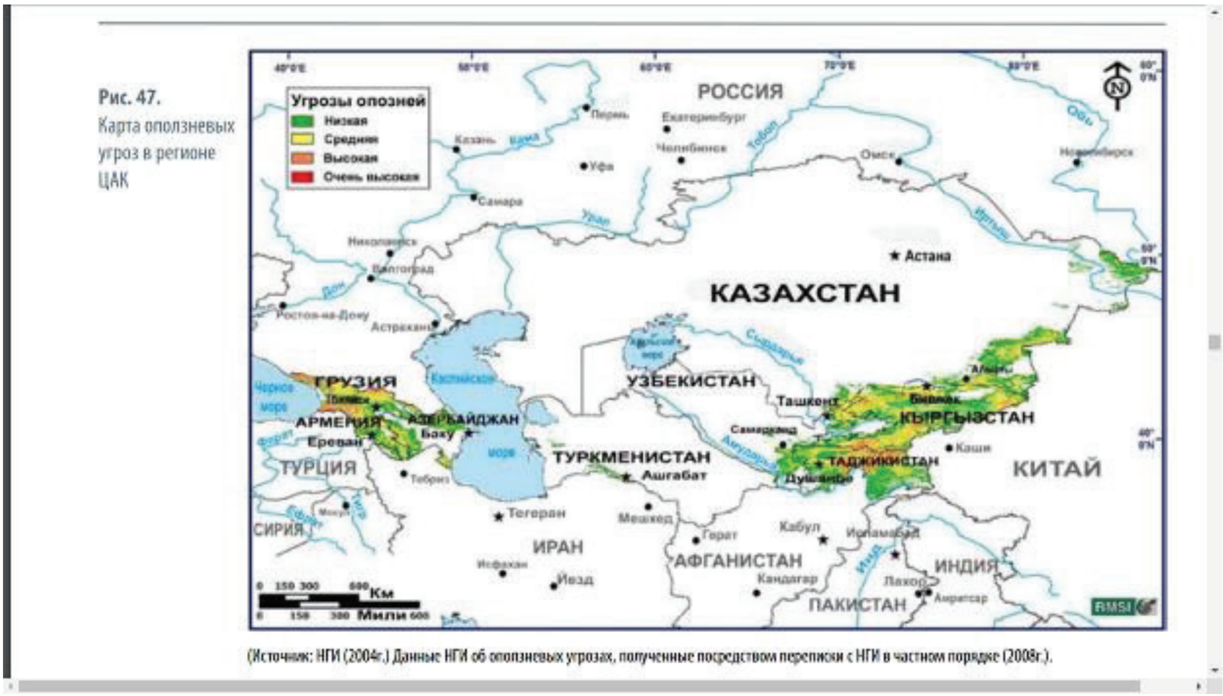


Figure 3 - Map of landslide threats Central Asia and Caucasus region

Figure 4 is a more detailed “Map of landslide capacity of northern slope of Zailiyskiy Alatau” which was published by the Geography Institute in Almaty in 2004.

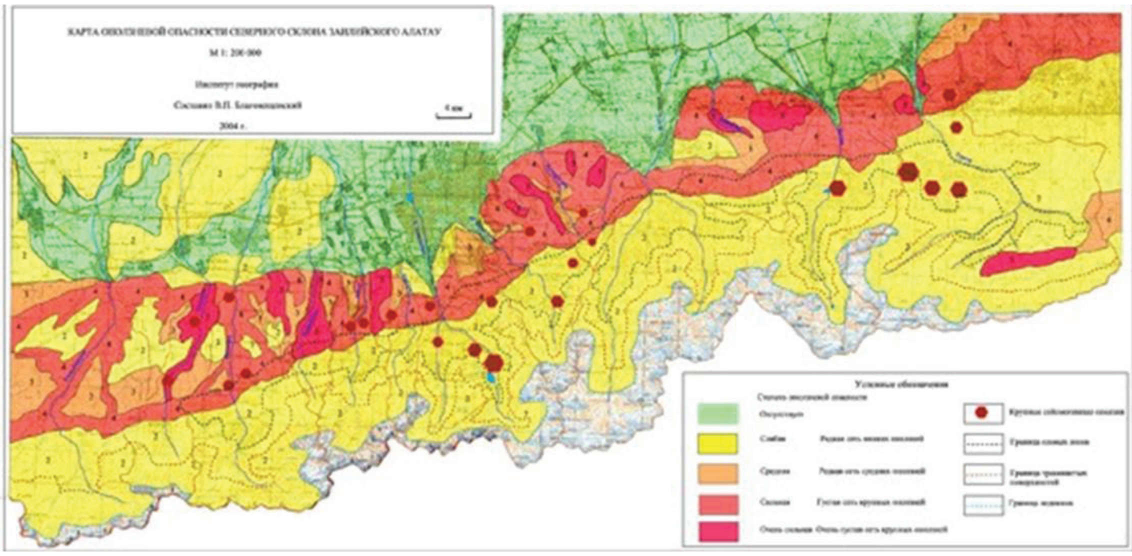


Figure 4 - Landslide hazard map of the northern slope of the Zailiyskiy Alatau

Maps are in real time. More information can be drawn from maps of real time from the Japan Meteorological Agency, for instance.

Maps in real time are everywhere**.** NASA freely offers a DRIP-SLIP program that allows landslides around the world to be tracked live.

New field methods and results

Results of monitoring of field methods. Russian specialists use field tools of monitoring and forecast as shown in Figure 5.

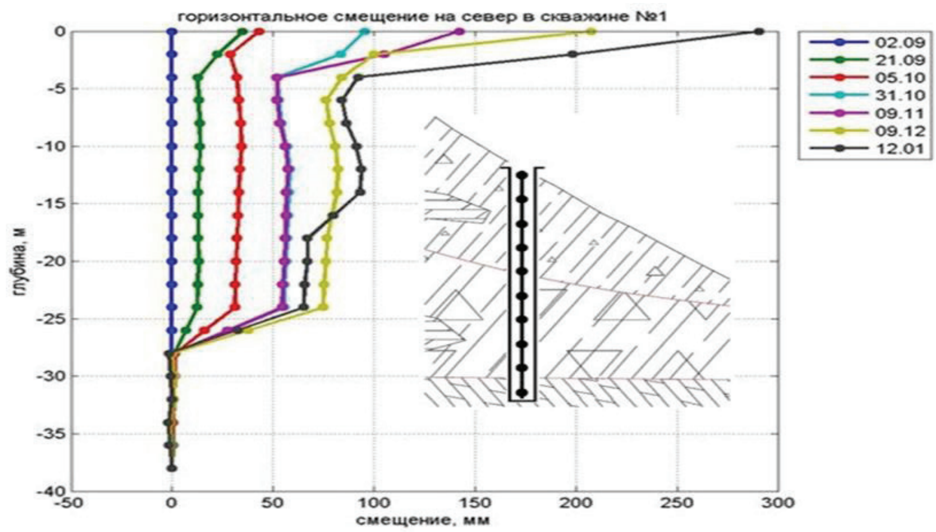


Figure 5 - Horizontal displacement of landslides at different depths. Field scheme of mini sensors – inclinometers is displayed as vertical drill hole like sensors garlands. Seven diagrams created due to seven times fixation of inclination – dates of fixation are in right corner above. We can observe that in a period of 4.5 months, the upper layer of the landslide moved 30 sm

Use of accelerogram for monitoring of the process of erosion. It would be more interesting to apply inclinometers but not accelerographs as sensors. Accelerographs contain more information about the tilt and acceleration. Tilt data allows us to track landslides and accelerograms track the mudflows. The use of inclination signals is shown in Figure 5. The use of accelerogram signals is shown in Figure 6.

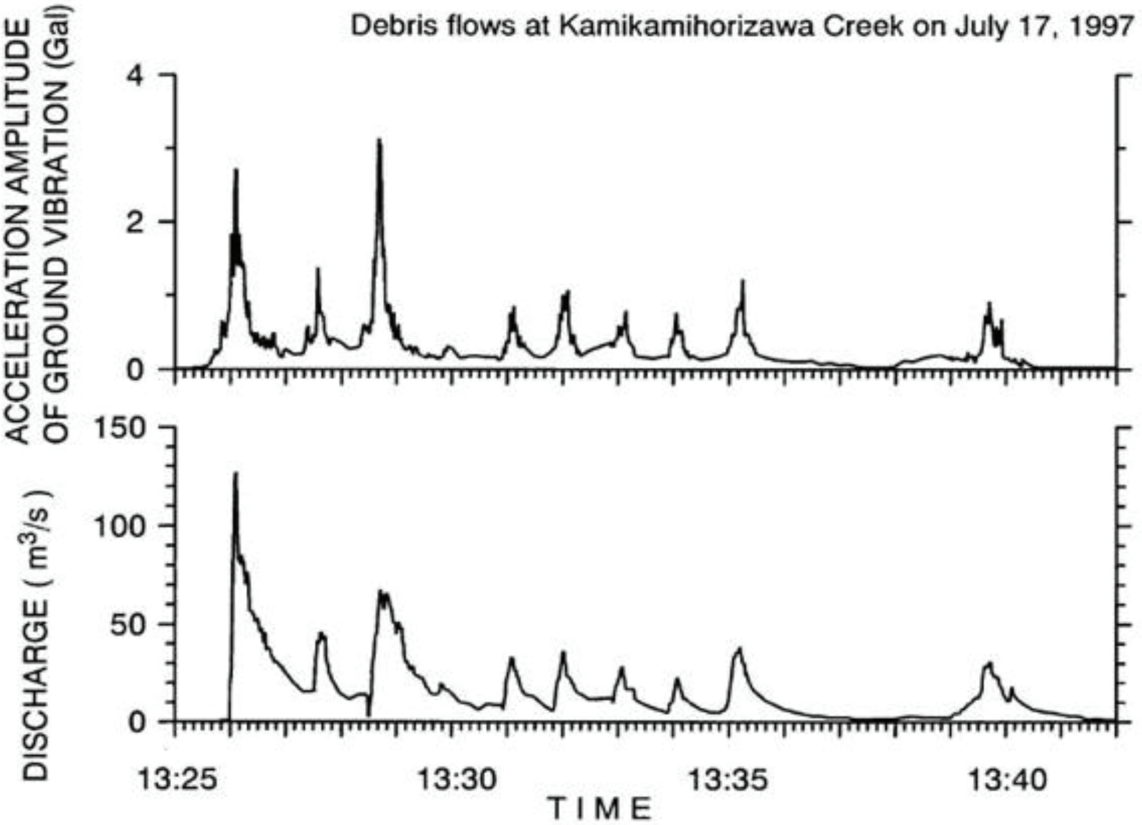


Figure 6 - Record accelerations and hydrograph made by Japanese specialists

As we can see in Figure 6, the value of acceleration and hydrograph match [3]. The record of mudflow acceleration is easily identified with records of close and distant earthquakes. Therefore, we see that implementing accelerographs is more useful because it allows to fixate both the landslides and mudflows in the seismic field. This is useful as we can observe landslides and mudflows occurring in one space temporal area. At the same time, it allows us to see the erosion processes, landfall, rock fall, as well as the earthquake seismic activity.

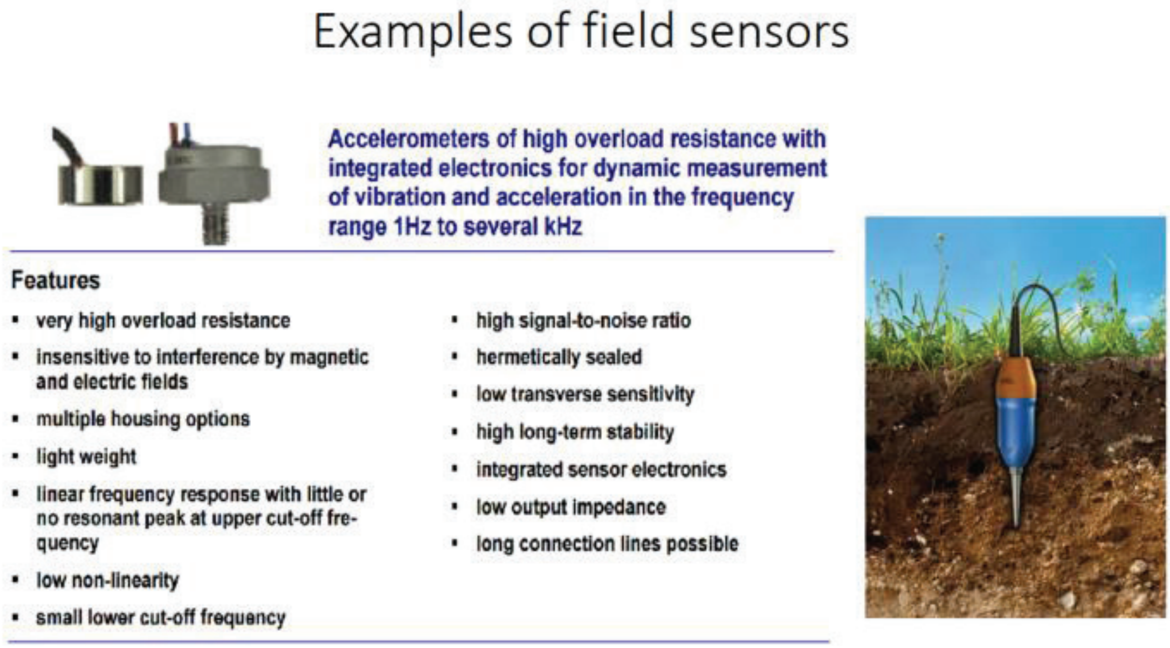


Figure 7 - Example of compact accelerometer (left) and its installation into the soil (right). Modern microelectronic systems allow for the small size and low power consumption. On the right, we see its field use in a rugged case, inside of which is a battery, two axis accelerometers and a GSM transmitter

Also, the accelerograph is a popular and cheap sensor. Once it is in the soil, it doesn't require maintenance. It can also be useful for detecting earthquakes.

Record of Almaty landslide process

It is very important to know which records to analyze. We were able to get records of landslides near the Talgar seismic station near Almaty [3]. This is a record of velocity of displacement, and it is not too different from the acceleration in Figure 7.

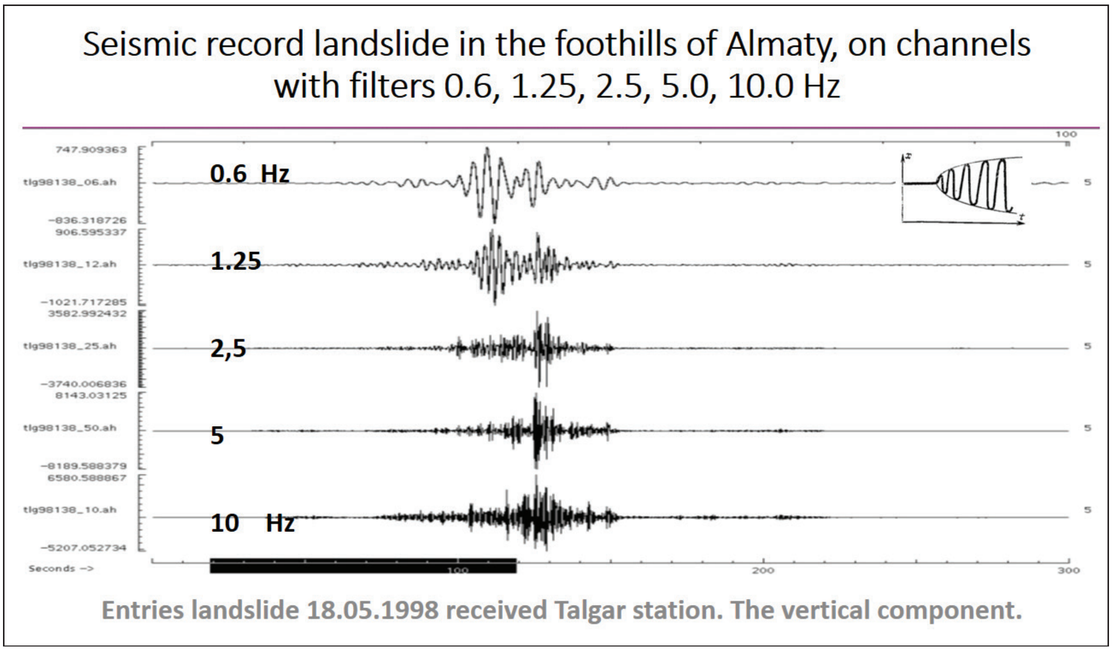


Figure 8 - Seismic record landslide near Almaty [3]

It is important to note the Main low frequency channels - 0.6 and 1.25 Hz. We can interpret the first group of waves as mild loss of stability – the analog of such instability is shown in the right upper corner. The second lower amplitude group of waves can be interpreted as an impact of a main landslide mass onto the surface. The impact is seen on high frequency channels. The author participated in research of this medium sized landslide. It was a vertical landslide of some tens of meters.

Knowledge of such signals can help identify landslide fulfillment especially after preliminary monitoring of tilt signals. It will help the emergency services process.

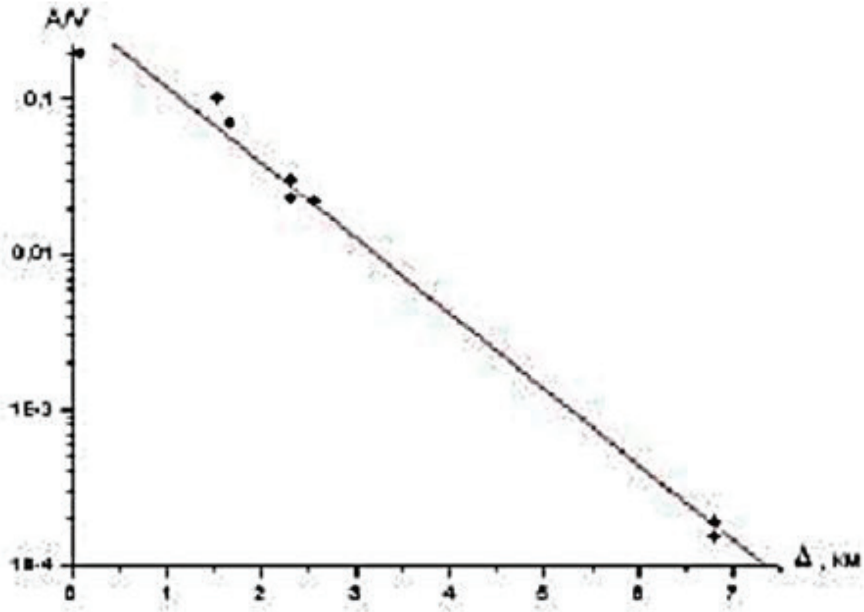


Figure 9 - Attenuation landslide amplitude seismic records (normalized to the volume of the landslide) with distance [3]

The amplitude of landslides records quickly attenuate with distance as shown in Figure 9.

For monitoring mudflows which also quickly attenuate, it would be appropriate to install sensors along mudflow prone river banks several meters away from the river. Of course, installation issues are resolved on the spot and based on the task.

Therefore, to successfully monitor hundreds of hazardous mudflow or landslide spots and activity, it is best to use accelerometers [7]. They allow us to receive two signals simultaneously: tilts of upper layer of ground where the sensor is installed and acceleration that shows us of more energetic mudflows.

Discussion

Discussions in this work is necessary with meteorologists. We offer our geophysical approach. Discussion could be voiced over the development of Almaty cyclone formation. We can only refer to the facts such as increased rain fall, strong winds and the loss of mountain forests.

Regarding landslide mitigation steps, there are two large if not grandiose measures that could be taken. Firstly, there has to be scientific grounds for emptying the Kapchagai water reservoir. It is clear that the reason for the increase in rainfall is global warming, but the water reservoir also has a huge impact. The water reservoir is under our control, but global warming is not.

Secondly, there has to be grounded reasons for curbing the urbanization of Almaty. Clearly there will be social implications, but the climate of the foothills is sensitive to water flow, increased temperatures and pollution. Interested stakeholders in Almaty have held talks on this matter, but not much progress was made. However, we could at least start with banning older vehicles which discharge a high concentration of pollution because of worn out engines.

Field methods can have other characteristics. By suggesting the use of accelerographs, we can gather a lot of information at a low price. That will allow us to quickly create a local monitoring network. We can use GSM and each spot as a WAP. The type of communication could be different, but what is essential is that the sensor data should be available on the Internet. One weak aspect could be GSM, but when using several sensors, the connection can be clearer. Clearly, the use of sensors is not scientifically accurate, but for the sake of safety, it is quite acceptable.

Conclusion

1. The climate of Almaty has changed with the formation of a cyclone.

Change has happened and increased rainfall and strong winds are evident especially in Almaty where in early years (the 1960s and 1970s) still days were the norm. We interpreted that these changes, the Almaty cyclone, are due to global warming, manmade influence of the Kapchagai water reservoir and rapid urbanization.

2. Number of landslides and mudflow have increased.

If we are right about Almaty mountainous cyclone, we are faced with an increased risk of landslide and their hazards. The level of mudflow will lift as well because landslides and mudflows boost each other and often share one origin.

3. Seismic hazards will increase, expressed in seismo-landslides and seismo-mudflows, and the level of earthquake intensity will increase due to the higher level of ground water. All this will lead to increased vulnerability of Almaty city and its suburbs

4. There may be wider ranging environmental impacts.

Recommendations

1. Create an international pool of scientific hydrogeologists, geophysicists, ecologists, economists, and others to support the shutdown of the Kapchagai reservoir.

2. Develop a set of measures to limit urbanization.

3. Carry out work on the draining of dangerous sites and important facilities.

4. Develop and implement a monitoring and warning system for dangerous landslides and mudflows in an electronic online mode.

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ВОПРОСЫ СНИЖЕНИЯ ОПОЛЗНЕВОГО РИСКА АЛМАТЫ

Аннотация. В работе рассмотрены актуальные вопросы оползневой опасности г.Алматы и окрестностей. Причиной повышения этой опасности являются изменения климата Алматы на фоне глобального потепления атмосферы. Также рассмотрено влияние антропогенной деятельности. Показан циклонический характер этих изменений. Предполагаются также глобальные механизмы развития оползневой деятельности. Рост оползневой активности может вызвать параллельную селевую активность. Отмечено также влияние изменений климата на сейсмичность региона. Рассмотрены пространственно-временные и инструментальные методы оценки оползневого риска. В развитие инструментальных методов предупреждения оползневой и селевой опасности предлагается использовать акселерометры.

Ключевые слова: оползни, изменения климата, акселерометры.

АЛМАТЫДАҒЫ ЖЕР КӨШКІНІ ҚАУПІН АЗАЙТУ МӘСЕЛЕЛЕРІ

Аңдатпа. Мақалада Алматы қаласы мен оның айналысындағы жер көшкіні қаупі мәселелерін шешу қарастырылған. Ол қауіптің дамуының себебі ретінде жаһандағы болып жатқан ауаның жылу салдарынан Алматы қаласындағы климаттық өзгерістерге әсері бар туралы баяндалған. Сонымен қатар антропогендік адами әрекеттердің әсері де анық көрсетілген. Бұл өзгерістердің циклдық қасиеттері бар екендігі де мәлімделген. Осы орайда жер көшкініне қарсы атқарылатын іс-шаралардың ауқымды механизмдері ұсынылған. Жер көшкіні қаупінің артуы сол кезеңде сел жүру мәселерімен қатар дамуы мүмкін екендігі мәлімделген. Климаттың өзгерудің сейсмикалық аумақтарда әсері болуы туралы айқын көрсетілген. Мақалада жер көшкіні қаупін анықтау шаралары кеңістік-уақыттық және құралдық әдістемелер арқылы қарастырылған. Құралдық әдістемелерді дамыту мен жер көшкінінің және сел жүру мәселелерінің алдын алу кезінде акселерометрді қолдану ұсынылған.

Кілттік сөздер: жер көшкін, климаттық өзгерістер, акселерометр.

ISSUES FACING ASSESSMENT AND EMERGENCY MANAGEMENT IN KAZAKHSTAN

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Abstract. Each year, natural disasters bring enormous damage (50 billion USD and more) in the world. The territory of Kazakhstan also is subject to a wide range of natural disasters, among which the greatest dangers are earthquakes and their secondary factors (mudflows, landslides, breakthroughs mountain lakes, etc.). The annual property damage caused by emergencies and accidents exceeds 11 bln KZT (60- 70 mln USD) in Kazakhstan. In this regard, the Republic of Kazakhstan should design plans on the basis of the best international experience and programs in the field of sustainable development at all levels, emphasizing disaster prevention, consequences mitigation, provision of preparedness and reduction of vulnerability. Also, special attention should be paid to the solution of the problem of engaging local communities in the prevention of natural disasters. The first step is to focus on solving the existing problems in the Civil Protection System.

Key words: natural disasters, earthquakes, man-made disasters, sustainable development, civil protection.

This article is based on the materials and knowledge gleaned from the Joint Project of the Republic of Kazakhstan and UNDP "*Enhancing National Potential for Risk Assessment, Prevention and Response to Natural Disasters" (2013-2015)* [1, 2]. The author of this article was the project manager.

Since 1900, over 18 thousand emergency situations have been registered in the world, according to the Research Center on Disasters Epidemiology based in Belgium. During this period, the annual number of victims ranged from 20,000 to 50,000 people; the number of injured ranged from 200 to 250 million people; and the number of economic losses exceeded 50 billion USD. In 2011, the greatest economic damage to the global world economy from a variety of natural and man-made disasters was recorded as 350 billion USD [3].

The territory of Kazakhstan is also subject to a wide spectrum of natural disasters. The damages could be as high 150 billion tenge (1 USD=340 KZT) in the republic. Kazakhstan is located in the temperate continental zone in the central part of the Eurasian continent between 40°56'-55°26'N and 45°27'-87°18'E. The geographical scope of the republic is very wide: the maximal length of the country is about 1,600 km from north to south, and it exceeds 2,900 km from west to east. The total area of the republic is about 2,725 sq.km or 2.7% of the Earth's land mass. The Republic of Kazakhstan borders with five countries as follows: the Russian Federation, the People's Republic of China, the Kyrgyz Republic, the Republic of Uzbekistan and Turkmenistan.

Kazakhstan is characterized by a wide variety of landscapes: from high mountain glaciations, lowlands and plains, steppes, deserts, oases, forests and large and small water reservoirs, including the Caspian and Aral Seas. The climate is sharply continental, arid with poor uneven distribution of water resources and the predominance of arid landscapes forms [4].

Large portions of the country are deserts and semi-deserts: 36% and 18% respectively. Steppes occupy 35%, forests 5.9%, mountain landscapes account for about 30%, including 5% covered by alpines.

According to the Committee of Emergency Situations under the Ministry of Interior Affairs of Kazakhstan, emergency situations of natural character can be caused by the following natural phenomena: earthquakes, spring floods and rain floods, mudslides, avalanches, rock falls and landslides, wind-induced surges in the Caspian Sea and other large bodies of water, hazardous weather events (droughts, prolonged precipitation, strong winds and blowing snow, the sharp decrease in air temperature, frost in the ground layer of the atmosphere and in the soil during the growing season, severe and prolonged frost glaze phenomena and sticking of wet snow, fog, dust storms), forest and steppe fires, and epidemic diseases.

Every year Kazakhstan faces over 21,000 emergency situations and accidents, including about 4,000 natural disasters and over 17,000 man-made ones (the ratio is 1 to 4).The annual number of emergencies and accident victims is about 7,000 people, including more than 1,500 deaths. With natural disasters, the number of sufferers is double the number of those from man-made disasters, but the number of deaths is about half than ones resulting from man-made disasters. The annual economic losses from emergencies and accidents in the Republic of Kazakhstan exceed 11 bln KZT (60-70 mln USD). The contribution of natural and industrial emergencies and incidents is roughly the same, but the damage from the disasters and natural accidents vary greatly from year to year [5].

For these reasons, the governmental policy on the reduction of disaster impact shall be an essential part of sustainable development in all countries. It was confirmed by international studies which determined that 1 USD contributed in prevention of natural disasters saves up to 7 USD [3].

All states are responsible for the protection of people and property from consequences of natural disasters on their territories. In this regard, it is vitally important to give priority to activities on the reduction of disasters risks in the national policy, taking into account possibilities and necessary resources. In this regard, Kazsakhstan faces the following ***strategic tasks.***

1) more effective integration of efforts connected with disasters' risks in the policy, planning and development of sustainable development programs at all levels, paying special attention to disasters prevention, softening their consequences, providing the readiness for them and the reduction of vulnerability;

2) establishment of and strengthening of institutes, mechanisms and potentials, in particular at the local level, which can constantly and systematically promote the growth of potential danger prevention [3].

Nowadays, there are serious problems in the Civil Protection (CP) system in the Republic of Kazakhstan.

1. Archived information of emergency situation reports collected for 20 years has not been processed statistically. Therefore, the harm and risks of Emergency Situations (ES), as well as vulnerability of the population, objects and territories both at the national and local levels are still not evaluated. Only background small-scale maps of ES dangers exist in a 2010 publication of *The Atlas of Natural and Industrial Dangers and Risks of Emergency Situations in the Republic of Kazakhstan* [6].

2. The dictionary of terms in the ES field is not approved.

3. The approved ES classification should be revised for forming an objective ES data base and ES statistic processing.

4. Systematic statistical analysis of the susceptibility of territories to ES doesn't reflect the real situation as the carried-out analysis is based on imperfect classification of ES. Also, there is an absence of assessment methods for damage caused by different types of emergencies.

5. Seismological monitoring in the republic is mostly focused on the Almaty seismically dangerous region. All other seismically dangerous regions of the republic, including territories where intensive production of hydrocarbon raw materials is carried out, do not meet even the most elementary requirements of an organized network of seismological supervision.

6. Kazgidromet's hydro meteorological monitoring network (national network of meteorological stations, hydrological posts, avalanche stations, snow-measuring routes, etc.) which was significantly reduced in the 1990s still isn't restored. Their technical devices and equipment are outdated and do not meet current standards. Remote desert and mountain territories remain almost without supervision.

7. In republican and the territorial crisis centers, there are no specialists in the field of natural and man-made emergencies capable to carry out quick and analytical processing of the incoming information. Thus, professional and competent decisions and responses to emergencies are lacking.

8. The Committee of Emergency Situations of the Ministry of Interior Affairs carries out no studies or calculations for an assessment of economic efficiency of precautionary actions. Therefore, the Emergency Situation control branch is traditionally considered to be highly expensive.

9. There are no reports published in Kazakhstan similar to the Russia Estimated Report on climate changes and their consequences. This could be catastrophic for Kazakhstan in 20 or 30 years. Examples include the Caspian Sea background level rise, growth of number and a catastrophic nature of spring floods on the flat rivers, full degradation of mountain glaciers, repeated activation of torrential activity, strengthening and increase of soil and atmospheric droughts, and so on. The lack of this research on climate change consequences does not allow for planning and implementation of preventative and adaptive measures for the mitigation of the danger.

10. Professional training of regular personnel of the Committee of Emergency Situations of the Ministry of Internal Affairs of the RK is required, especially at regional and local levels.

11. Skills' training for the population about action before and during a natural or man-made emergency is important. To complete this task, working out of new methods for training the population for action in ES before the arrival of rescue teams is necessary.

12. Kazakhstan's Interior Ministry Committee of Emergency Situation does not have its own research institute on the common and private problems of emergency management. It is also not authorized as a body in the field of research on emergency situations.

13. The status of Kazakhstan's Interior Ministry Committee of Emergency Situation doesn't conform to the international requirements about priority of the emergencies in public policy. Activity in the field of an emergency in the republic is just regulated by ordinary law, but not the Code, for example, The Environmental Code or The Water Code of the Republic of Kazakhstan.

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О ПРОБЛЕМАХ ОЦЕНКИ РИСКОВ И УПРАВЛЕНИЯ ЧРЕЗВЫЧАЙНЫМИ СИТУАЦИЯМИ В КАЗАХСТАНЕ

Аннотация. Ежегодно в мире от стихийных бедствий гибнет от 20 до 50 тыс. чел., число пострадавших – от 200 до 250 млн чел., а экономические ущербы – от 50 и более млрд долларов США.

Территория Казахстана также подвержена широкому спектру стихийных бедствий, размеры возможного единовременного суммарного ущерба от них в республике могут составить до 150 млрд тенге. Разнообразные природные условия Казахстана предопределяют различную подверженность республики многим стихийным явлениям, наибольшую опасность среди которых представляют землетрясения и их вторичные факторы (сели, оползни, прорывы горных озер и др.). Ежегодное количество пострадавших от ЧС и происшествий составляет около 7 тысяч человек, в том числе погибших - более 1,5 тысяч человек.

Ежегодный материальный ущерб от ЧС и происшествий в РК составляет более 11 млрд тенге ($60-70 млн). В связи с этим Республика Казахстан в целях решения задач по уменьшению опасности бедствий на основе наилучших международных практик должна разрабатывать и планировать программы в области устойчивого развития на всех уровнях с концентрацией особого внимания на предотвращении бедствий, смягчении их последствий, обеспечении готовности к ним и снижении уязвимости. При этом особое внимание уделить решению задачи по приобщению местных сообществ к деятельности по предотвращению стихийных бедствий. В первую очередь необходимо сосредоточить усилия на решении существующих проблем в системе Гражданской защиты.

Ключевые слова: стихийные бедствия, землетрясения, техногенные катастрофы, устойчивое развитие, гражданская защита.

ҚАЗАҚСТАНДАҒЫ ТӘУЕКЕЛДЕРДІ БАҒАЛАУ ЖӘНЕ ТӨТЕНШЕ ЖАҒДАЙЛАРЫ БАСҚАРУ КЕЗІНДЕГІ МӘСЕЛЕЛЕРІ БОЙЫНША

Аңдатпа. Жыл сайын әлемде дүлей апаттардан мерт боғандар саны 20 мыңнан 50 мыңға дейін барады, зардап шеккендер саны 250 млн астам адам, ал экономикалық залалдар 50 млрд АҚШ долларды құрап отыр.

Қазақстан Республикасы да дүлей зілзалаларға душар болуы мүмкін, одан шеккен зардаптың жиынтық мөлшері 150 млрд теңге құрауы мүмкін. Қазақстан Республикасының табиғи құбылыстарға ұшырауы, олардың арасында көптеген табиғат жағдайлары әр түрлі ұшырағыштықты айқындайды және олардың қайталама факторлары ең үлкен қауіп төндіреді, олардың ішіндегі ең қауіптісі жер сілкінісі және оның салдары (тасқын, көшкін, таулы өзендердің жарылуы және т.б.). Төтенше жағдайлар мен оқиғалардан зардап шеккендердің жыл сайынғы саны шамамен 7 мың адам, оның ішінде қаза тапқандар саны 1,5 мың астам адам санын құрайды.

Қазақстанда төтенше жағдайлар мен оқиғалардан жыл сайынғы материалдық залал 11 млрд теңгеден астам ($60-70 млн) болып тұр. Осыған байланысты Қазақстан Республикасы қауіп-қатерді азайту мақсатында, озық халықаралық тәжірибені пайдалана отырып, орнықты даму саласындағы бағдарламаларды әзірлеу және жоспарлау тиіс. Оған қоса, жергілікті қоғамдастықтың зілзаланың салдарын болдырмау мақсатта әр түрлі шаралар мен тапсырмаларға ерекше назар аудару қажет. Бірінші кезекте, қолданыстағы азаматтық қорғау жүйесіндегі шешілмеген проблемаларды шешу үшін бар күш-жігерді жұмсау қажет.

Кілттік сөздер: дүлей зілзала, жер сілкіну, техногендік апат, тұрақты даму, азаматтық қорғанысы.

SAR INTERFEROMETRIC ANALYSIS OF GROUND DEFORMATION MONITORING IN KAZAKHSTAN

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Abstract. This paper briefly presents results of SAR (Synthetic Aperture Radar) interferometry for displacement monitoring by using StaMPS/MTI software over urban areas and areas of intensive hydrocarbon extraction. Almaty city presents a great potential for SAR interferometry technology use since the city is located in the seismic zone. Astana is not in a seismic area, but it is one of the fastest-growing regions in the country. Datasets used for these case studies, include the archive of ENVISAT ASAR data (2003-2010) for Almaty and COSMO-SkyMed data (2011-2014) for Astana. Also, the subsidence over Karazhanbas field was measured by using interferometric analysis of SAR archive data from ENVISAT ASAR (2004-2009). Deformation maps of the study areas were produced by using Persistent Scatterers (PS) and Small Baseline Subset (SBAS) methods.

Key words*:* SAR interferometry, StaMPS/MTI, PSP-IFSAR.

INTRODUCTION

Satellite-based remote sensing data became a commonly used technology for mapping deformation in Kazakhstan in the last ten years [1,2].

Interferometric application extends to economic activity realized on wide areas and extended linear objects, for instance, building sites, mine production units, energy facilities, and transport infrastructure items. Interferometric processing technology can be applied for monitoring sudden and quick catastrophic natural processes, for example, mud flows and landslides due to heavy rain and thunder storms.

This paper presents two applications of SAR interferometry for the monitoring of urban areas and oilfields.

The basic scheme of research will include several methods: using Persistent Scatterers (PS), Small Baseline Subset (SBAS) methods and PSP-IFSAR (E-Geos technology). First, these techniques were applied to ENVISAT and COSMO-SkyMed images in Almaty (one of the most seismically active areas of the country) and Astana (the capital of country) respectively. The second application was related to monitoring of Karazhanbas field also using the two methods previously mentioned.

Methodology

Satellite radar data was processed using StaMPS/MTI (Stanford Method for Persistent Scatterers/ Multi-temporal InSAR). StaMPS/MTI is an improved and expanded version of the software package STAMPS, that implements an InSAR persistent scatterer (PS), a small baseline method (SBAS) and a combined multi-temporal InSAR method.

The satellite radar interferometry method uses the effect of the interference of electromagnetic waves and is based on mathematical processing of several coherent amplitude-and-phase measurements at the same site of ground surface with shift in space of the receiving antenna of radar. Two or more images received by the sensor during repeated space vehicle flights over the same territory are used for this purpose. As a result of manipulating the phase components of radio signals, it is possible to obtain the elevation of one resolution element relative to another, to construct a digital elevation model with reference to reflective surface, and to estimate the changes of the elevation which have occurred in the time between data acquisition.

The interferometric processing method is a powerful tool which is described well in scientific literature. This literature provided the basis for the brief description of the widely known principles of radar interferometry below:

The interferogram is generated by the multiplication of two radar images presented in complex values:

$$I = S_1 \cdot S_2^* = A_1 e^{j\phi_1} \cdot A_2 e^{-j\phi_2} = A_1 A_2 \cdot e^{j(\phi_1 - \phi_2)} = A_1 A_2 \cdot e^{j\Phi}$$

where I is the complex interferogram,

S_1 is the radio signal in complex values received during the first (master) acquisition,

S_2^* is the complex-conjugate signal received during the second (slave) acquisition,

A_1, A_2 are amplitudes of the signals,

ϕ_1, ϕ_2 are phase values of the signals,

Φ is the resultant interferometric phase.

The interferogram phase consists of several components:

$$\Phi = \Phi_{topo} + \Phi_{def} + \Phi_{atm} + \Phi_n$$

where Φ_{topo} is the phase contribution due to topography observation under two different angles,

Φ_{def} is the phase contribution due to surface displacement in time between acquisitions,

Φ_{atm} is the phase contribution due to difference of optical wave lengths because of refraction in the environment of signal propagation,

Φ_{n} is phase variations as a result of the speckle-noise caused by incomplete compensation of a phase of multiple reflections due to reorientation of elementary objects and their movements inside of a resolution element.

Results

Figure 1 shows the outcomes of the PS and SBAS processing, where the indicated subsidence can be potentially associated with oil field development. The results over the field show slow displacement trends of ± 20 mm/yr and show good agreement with each other.

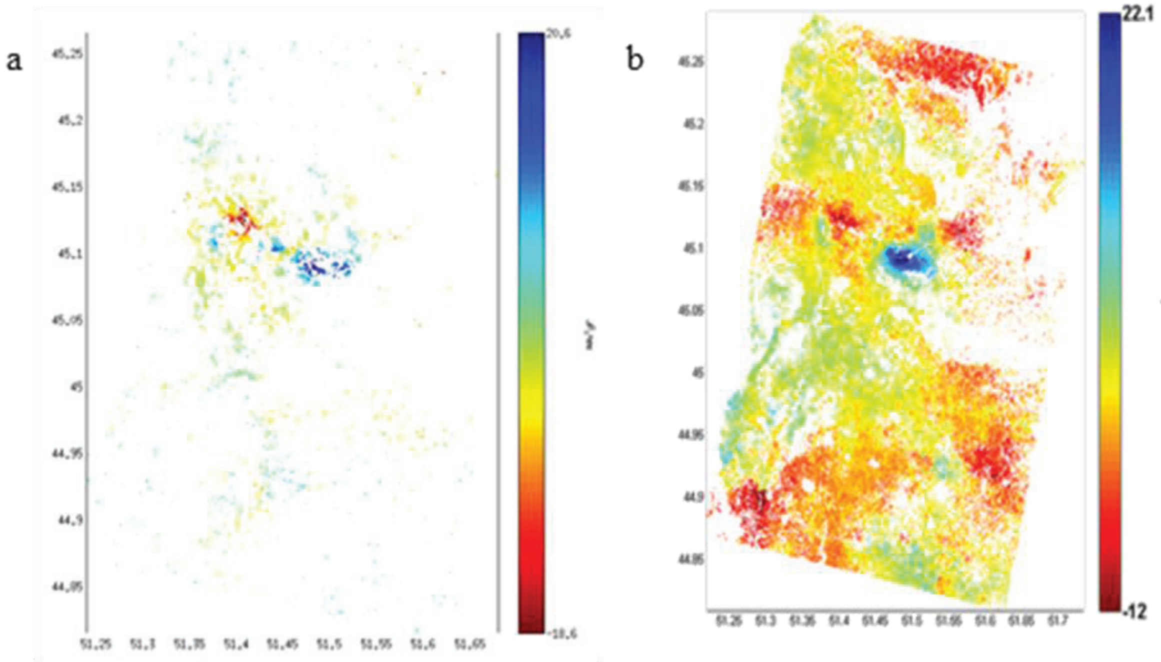

Figure 1 - a) Persistent Scatterers (PS) result; b) Small Baseline Subset (SBAS) results

According to the PS results, as shown in Figure 1a, the 6130 PS points with high coherence signal have been identified, while 72 488 PS points have been selected by SBAS method. Further analysis detected that SBAS points were interpolated by IDW (Inverse Distance Weighted) method in the ArcGIS software (Figure 2).

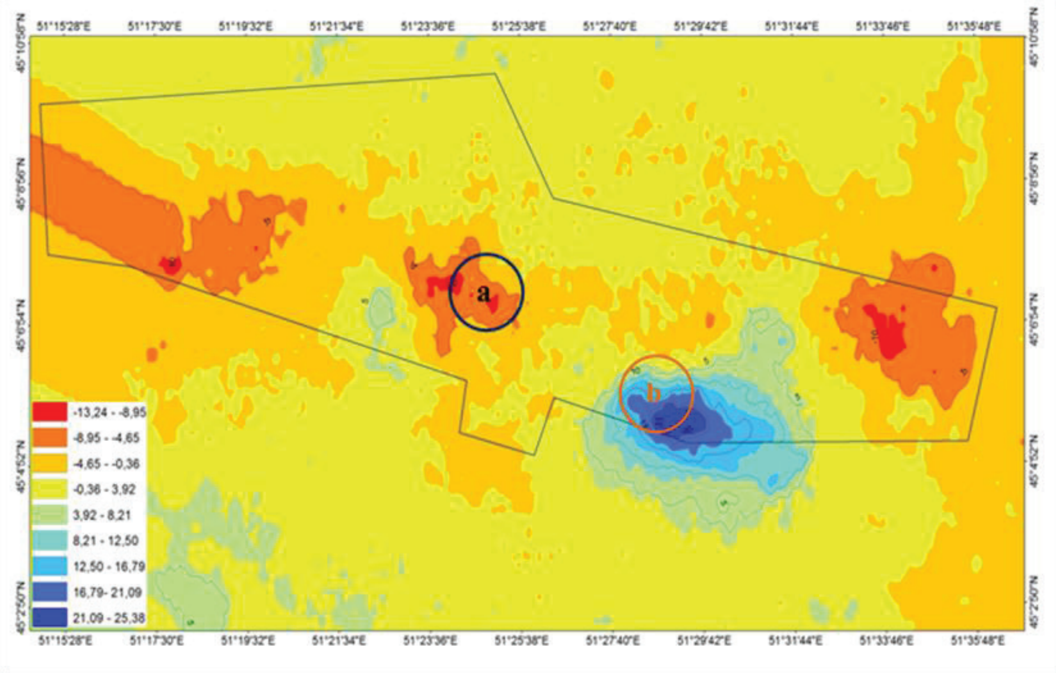

Figure 2 - Interpolated vertical displacement map of Karazhanbas field, velocity in mm/year. For deformations in circled areas (a,b) shown graphs in Figures 3 and 4.

The processing of archived data using StaMPS methods detected few unstable zones at the licence block of the field. There is high-amplitude subsidence of the earth's surface in the south-eastern and central parts. As can be seen from Figure 3, the graph for the circled zone in Figure 3 PS points into the 100 meters radius characterized by subsidence with an amplitude of -40 mm.

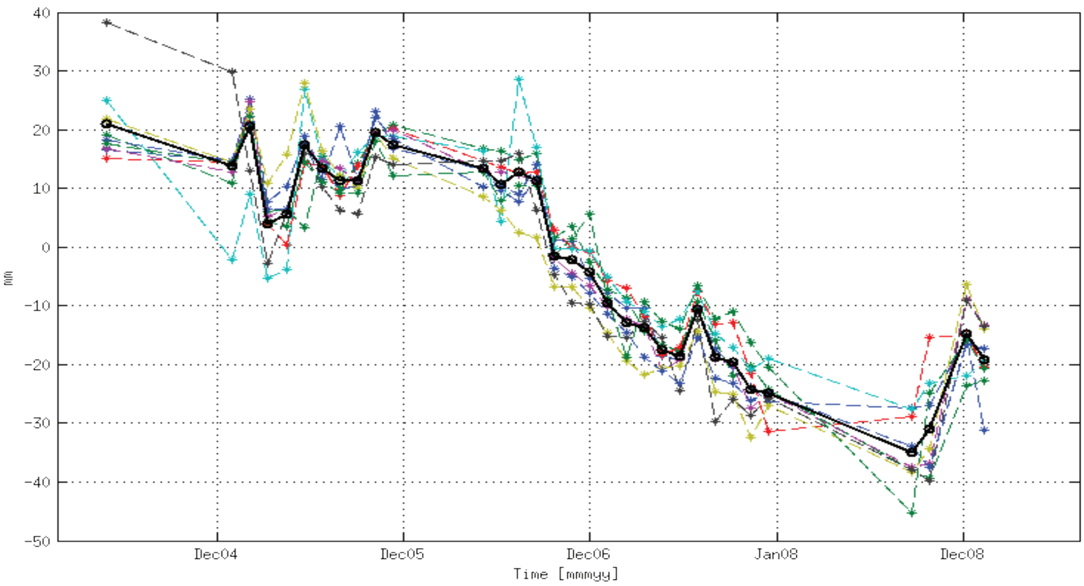

Figure 3 - The subsidence rate of PS (circle a)

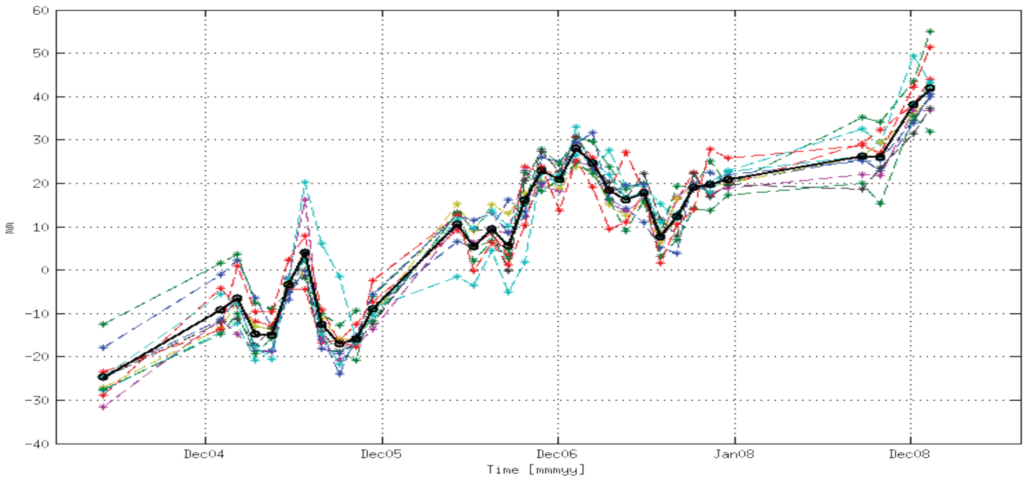

Figure 4 - The subsidence rate of PS (circle b)

There is uplift zone at a rate of 20 mm per year for the observation period. Researchers [3,4] assumed that the detected uplift zone was associated with the activity of the mud volcano- see Figure 4. However, this assumption has not been confirmed.

The resulting map of mean vertical displacements over Almaty city from 2003 to 2010 from ENVISAT ASAR satellite is shown in Figure 5.

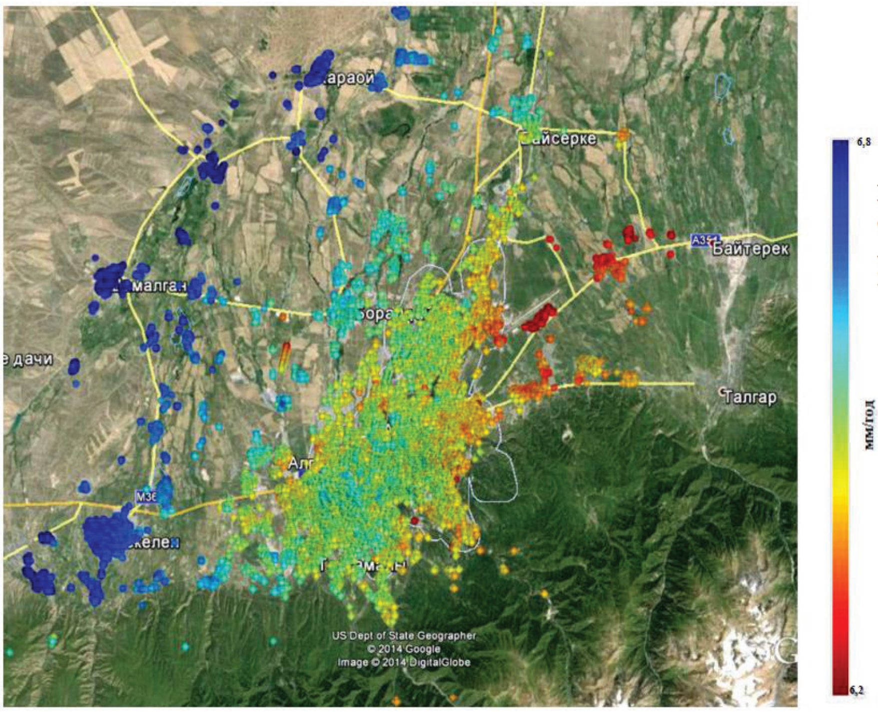

Figure 5 - Average displacement rates as obtained through PS processing over Almaty city area

According to the results of the ENVISAT ASAR over Almaty and the surrounding area, the vertical velocity rates were between 6.2 mm/yr and 6.8 mm/yr for the 7 year period of time.

The technology which enabled and guaranteed the high accuracy and high measurement density is an e-GEOS patented processing technology named PSP-IFSAR [5].

Some results of COSMO-SkyMed data (2011-2014) processing for building stability analysis and managed through Google Earth platform for Astana city are explained below.

Figure 6 - 3D view of the PS mean velocity measurements obtained by PSP-IFSAR processing of COSMO-SkyMed images acquired from 2011 to 2014 over Astana

Figures 6, 7 and 8 represent the overall view of urbanized area stability showing highly detailed (millimetre accuracy) information on buildings and structures (Bayterek monument and House of Ministries) and PS mean velocities of highways and roads in Astana.

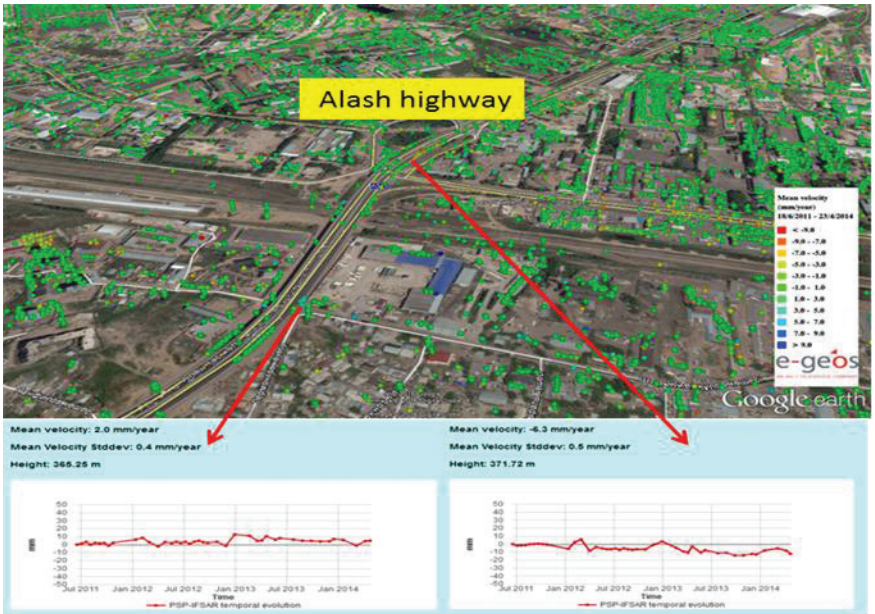

Figure 7 - PS mean velocities of Alash highway area

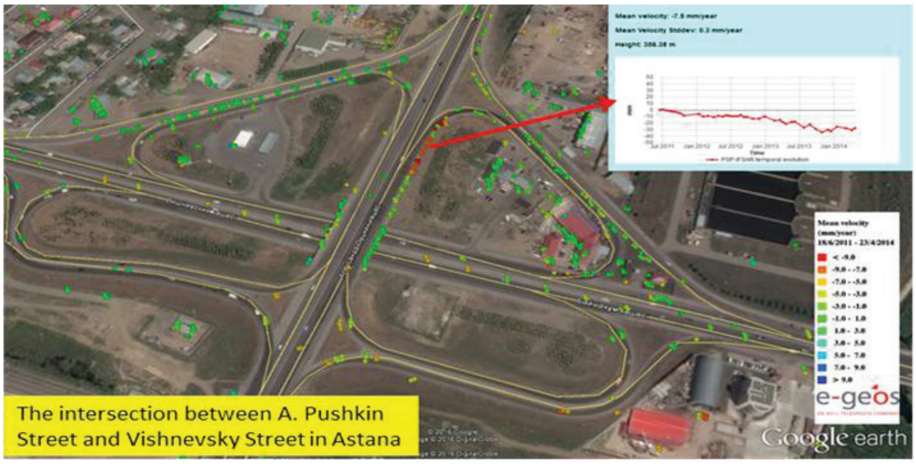

Figure 8 - Subsidence along the A. Puskin street in Astana

Conclusion and discussion

In this work, several examples of SAR interferometry applications demonstrate that the measurements obtained from radar images have millimetric precision for different surface models.

For the Karazhanbas field area, where the majority of subsidence on field is affected by oil and gas activities, the results show slow displacement trends of ± 20 mm/yr. The verification of the SAR - interferometry results with ground-based observations showed an accurate correlation.

The PSP-IFSAR is an advanced processing technology, which provides very high density of persistent scatterers with high sensitivity to displacements. The results obtained for Astana prove this. However, it is necessary to mention that this technology is very expensive.

Finally, the vertical movements of the earth surface in the region of Almaty were studied based on radar images from satellite ENVISAT ASAR. Based on these maps (by satellite radar interferometry) of vertical displacements of the Earth's surface, intensive vertical movements in the fault zones of the southern part of Almaty region were noted.

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РСА ИНТЕРФЕРОМЕТРИЯ ДЛЯ АНАЛИЗА ДЕФОРМАЦИЙ ЗЕМНОЙ ПОВЕРХНОСТИ В КАЗАХСТАНЕ

Аннотация. В данной статье кратко рассмотрены возможности обнаружения смещений земной поверхности по данным обработки радарной спутниковой съемки. Для анализа были выбраны области с различными типами поверхностей – городские агломерации и районы месторождений нефти и газа. Результаты обработки данных РСА интерферометрии, которые широко используются для мониторинга смещений земной поверхности, были проанализированы с использованием открытого программного обеспечения StaMPS/MTI для городских территорий и районов интенсивной добычи углеводородов. В качестве городских территорий было выбрано два крупнейших города страны – город Алматы, который расположен в зоне высокого сейсмического риска и столица Астана, являющийся одним из наиболее быстро развивающихся городских центров в республике. Набор используемых снимков для исследования городских территорий включает в себя архив данных ENVISAT ASAR (2003-2010) для города Алматы и данные COSMO-SkyMed (2011-2014) для города Астана. В качестве территорий добычи углеводородов было выбрано месторождение Каражанбас – радарные данные со спутника ENVISAT ASAR (период 2004-2009 гг.).

Ключевые слова: РСА интерферометрия, StaMPS/MTI, PSP-IFSAR.

ҚАЗАҚСТАНДА ЖЕР ҚЫРТЫСЫНЫҢ ДЕФОРМАЦИЯЛАНУЫН ТАЛДАУ ҮШІН РСА ИНТЕРФЕРОМЕТРИЯСЫН ҚОЛДАНУ

Аңдатпа. Осы мақалада ғарыштық радарлы түсірілімдерінің мәліметтерін қолданып өңдеу арқылы жер қыртысының ығысуын анықтау мүмкіндіктері қысқаша қарастырылған. Талдау үшін әртүрлі аймақтар, қалалық агломерациялар мен мұнай және газ кен орындары іріктелді. Жер қырытысынң ығысуын бақылауда кеңінен қолданылатын интерферометриялық мәліметтерді өңдеу нәтижелері, көмірсутек белсенді өндіріліп жатқан кала және ауыл аймақтары үшін ашық қолданыстағы StaMPS/MTI программасын қолдану арқылы жүзеге асты. Қалалық аймақ ретінде еліміздің ең улкен екі қаласы таңдалды- жоғары сейсмикалық қуіпті белдемде орналасқан Алматы және республикамыздың ең қарқынды дамып жатқан қалаларының бірі Астана. Қалалық аймақтарды зерттеу үшін ғарыштық түсірілімдердің жиынтығы Алматы қаласы үшін ENVISAT ASAR (2003-2010) қамтиды, ал Астана қаласы үшін COSMO-SkyMed (2011-2014) мәліметтері қолданылды. Көмірсутек өндірүші аймақ ретінде Қаражанбас кен орны таңдап алынды, оған ENVISAT ASAR (2004-2009 жылдар) мәліметтері қолданылды.

Кілттік сөздер: РСА интерферометрия, StaMPS/MTI, PSP-IFSAR.

HIGH ALTITUDE PLATFORM STATIONS IN DESIGN SOLUTIONS FOR MONITORING AND PREDICTION OF NATURAL DISASTERS

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Abstract. In this article, the main trends of the modern world industry for creation of high altitude platform stations are considered. Along with satellites, high altitude platforms (HAPS) will be completely isolated from the effects of disasters on the ground. Also, they can be used to monitor the state of the environment, to forecast and to prevent natural disasters. This paper discusses the calculated service area, influence of different factors on attenuation, propagation attenuation due to atmospheric gases, and the attenuation between a HAPS and ground terminal. Recommendations for the use of HAPS in highlands area are made.

Key words: remote sensing, high altitude platform stations, HAPS, telecommunications, geo stationary, stratospheric platform, attenuation, global positioning, elevation angle.

Introduction

In the last decade, the world has faced a variety of natural and technogenic disasters which are connected with anthropogenic and climate change. Mountainous areas in Kazakhstan, located in the territory of Central Asia, and part of the so-called Alpine-Himalayan seismic belt, have a high probability of earthquakes. Near the Alatau and TienSchan mountains, there is a high probability of flooding caused by melting glaciers. It is considered that the high temperatures and heavy rainfall this year are a result of global climate change. Thus, the threat of natural disasters has increased. Therefore, constant and continuous monitoring of the state of the environment is helpful in predicting such disasters. These problems are quite relevant and current for the Almaty region.

This paper is a detailed analysis of various tracking technologies (monitoring) of the environment, identification of their strengths and weaknesses, and the determining factors considered for selecting the monitoring method.

Communications platforms situated at high altitudes can be dated back to the last century. In 1960, a giant balloon was launched in the USA. It reflected broadcasts from the Bell laboratories facility (Crawford Hill, New Jersey) and bounced the signals to long distance telephone call users. This balloon can be regarded as a forerunner of High Altitude Platform Stations (HAPS).

With today’s space technology, airships will become one of the safest methods of transportation. By solving economic and environmental issues, airship-based solutions are generally fuel efficient and quiet, and they cause little air pollution and have low transportation costs.

Methodology

The proposed structures of terrestrial wireless, satellite communications systems and stratospheric telecommunications platform occupy an intermediate position between the previous methods.

Satellite communication systems have proven to be sufficiently accurate highly reliable systems with global positioning and navigation. They are widely used all over the world, including in matters of territory sensing and monitoring of the environment. Their use is not in doubt. However, in our view, the use of satellites for such monitoring has a number of problems:

- Construction and output on the satellite orbit are quite expensive (especially for high altitude geostationary systems)
- Impossibility of replacing, upgrading and repairing the satellite
- Limited life span
- Removal of satellite from orbit after the expiration of the service
- The creation of "space debris".

Therefore, it was of interest to consider the stratospheric telecommunications platform. Depending on their configuration, they allow high efficiency to conduct the following tasks:

- Mine detection and mapping of minefields
- Mapping and 3D-modeling areas
- Precision shooting topography of vast territories
- Monitoring and control of large areas and length in the sparsely populated and remote areas
- Monitoring and diagnostics of electrical lines, gas pipelines, roads, railways, waterways and water areas
- Mineral exploration
- Security for major public and sporting events
- Multiple military purposes [1, 2, 3, 4].

The economic feasibility of the use of stratospheric airships is evident from a comparison of the costs of operation of various types of aircrafts. According to [2], the hourly cost of operation are: for satellites - $1000-4000, for unmanned aircrafts (HAWK type) - $300-1000, and for stratospheric airships (high altitude platform stations (HAPS) - $2-5.

However, the creation and operation of HAPS presents a number of difficulties. Such HAPS need to operate for a lengthy time (from several months to a year) at high altitudes, in a rarefied atmosphere, at sufficiently low temperatures, and with intense sunlight exposure. Undoubtedly, one of the greatest challenges in the construction of HAPS is the creation of the balloon envelope, which must be capable of functioning for long periods of time in extremely harsh conditions.

Another important issue is the creation of a HAPS power system based on thin solar cell layers, promising electrochemical batteries and combining them with a hybrid power facility, similar to those for high-performance electric motors.

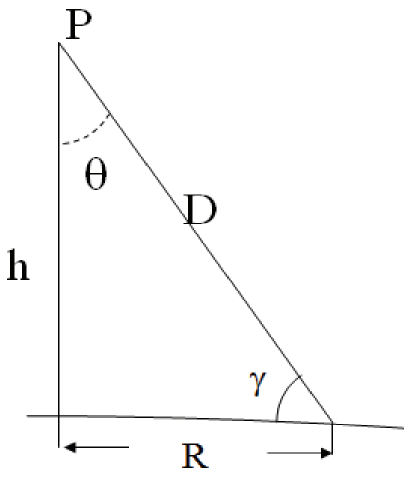
Modern materials, technology and engineering solutions make it possible to create such HAPS. Currently, the following companies are engaged in the design of hybrid aircrafts: Augur Aeronautical Centre (Russia), Worldwide Aeros (US), Lockheed Martin (US), and Luftschifftechnik Zeppelin Gmbh (Germany). Usually these research and development projects are conducted to meet military needs.

Table 1 - The main technical characteristics of modern airships [1]

Name	The main technical characteristics			
	Volume, m^3	Carrying, kg	Altitude, m	Duration, day
Blue Devil 2 TCOM (US)	42 000	2 000	6 000	5
LEMV Northrop Grumman (US)	38 000	1 200	6 000	21
Unmanned platform «Sokol» (Russia)	10 400	500	5 000-6 000	10
Zeppelin NT-07 Luftschifftechnik Zeppelin (Germany)	8 825	350	3 000	8
Integrated Sensor Is Structure (ISIS) –(US)	120 000	-	21 000	30
Stratospheric airship «Bercut» (Russia)	200 000	1 000	20 000	180

The calculation of HAPS and combining them with telecommunication systems is the purpose of further study. One of the main requirements for the satisfactory operation of HAPS is obtaining reliable data, geostationary - the possibility of finding data lasting over one point of the earth's surface. This limits the wide use such technology [5].

The scheme of telecommunication systems on the base of stratospheric platform is shown in Figure1.



R - radius of the HAPS service area; h – Altitude HAPS; D - The distance from the HAPS to the border of service area; ϴ- the width of the NAM in the organization of narrow beams; γ - Elevation angle on the border of the system.

Figure 1 - To calculate the technical characteristic of telecommunication system based on a stratospheric platform

The coverage area of one of the aircrafts depends on the altitude of the radio antenna, and its radius of action from 50 to 600 km. The use of multibeam antenna systems on such platforms allows for the possibility of different sized monitoring zones on the Earth’s surface [2]. All this will increase the service area, which depends on the antenna used by the HAPS systems. Flight control and operation of the aircraft systems is assumed to mainly be conducted in an automated mode.

Referring to Figure 1, the zone range may be calculated from the formula:

$$R = h/tg(\gamma),\ \kappa m$$

Results

1. The calculation of the radius and area of coverage area high altitude platforms for two heights:

h_1= 3km and h_2= 21 km (above sea level).

For a comparative analysis of the size of the coverage area at various altitudes, we consider the dependence of the coverage area (r) from the elevation angle (α) on the border zone.

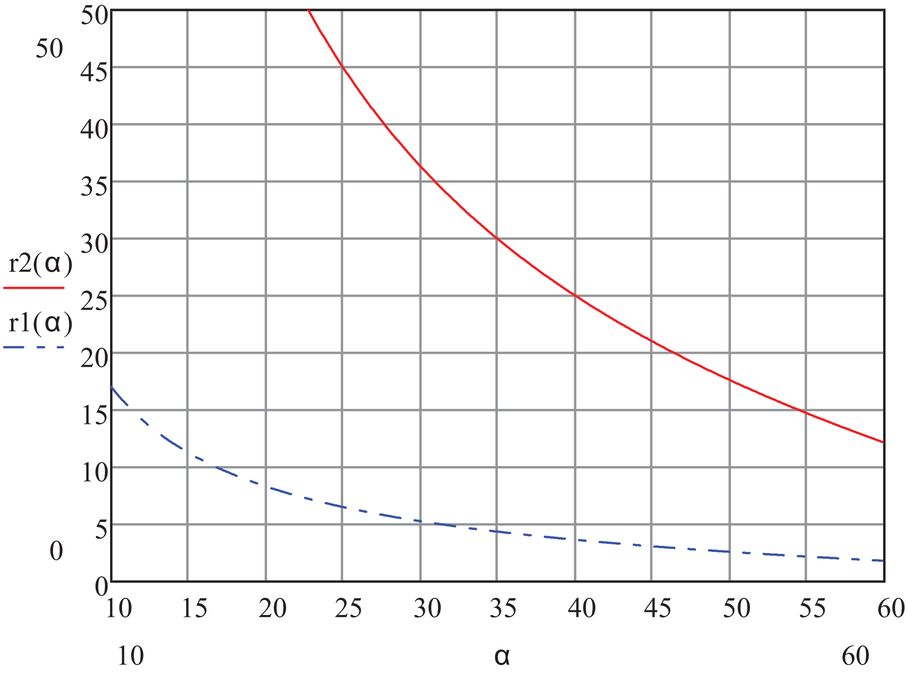


Figure 2 - The dependence of the coverage area from the elevation angle on the border zone

2. Figure 3 gives the symbols used in the calculation of the attenuation in the rain.

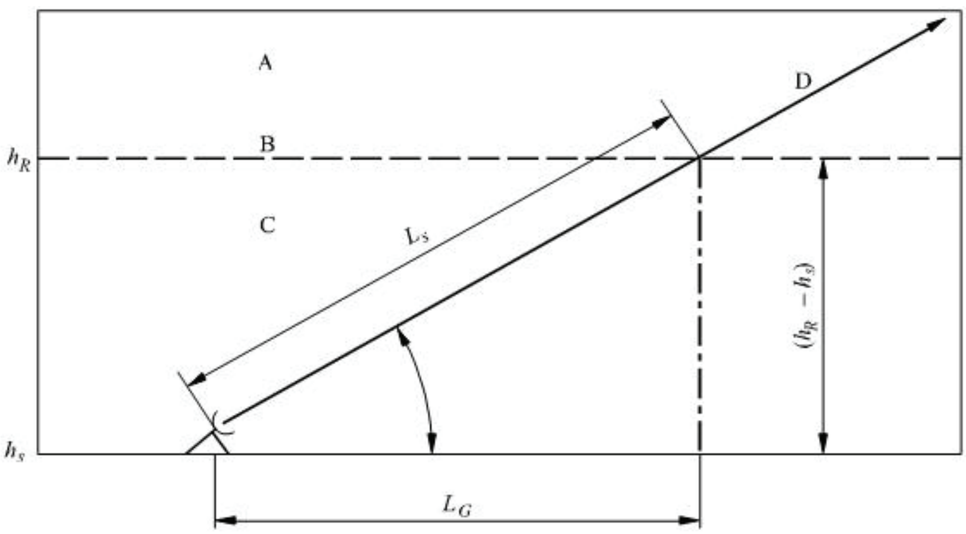


Figure 3 - Schematic representation of the track land-HAPs, indicating the initial parameters for the attenuation forecasting

The results of calculation of the attenuation in the rain based on the ITU recommendations, depending on the elevation angle are shown in Figure 3. The rain intensity is $R_{0.01} = 22$ mm/h for Kazakhstan.

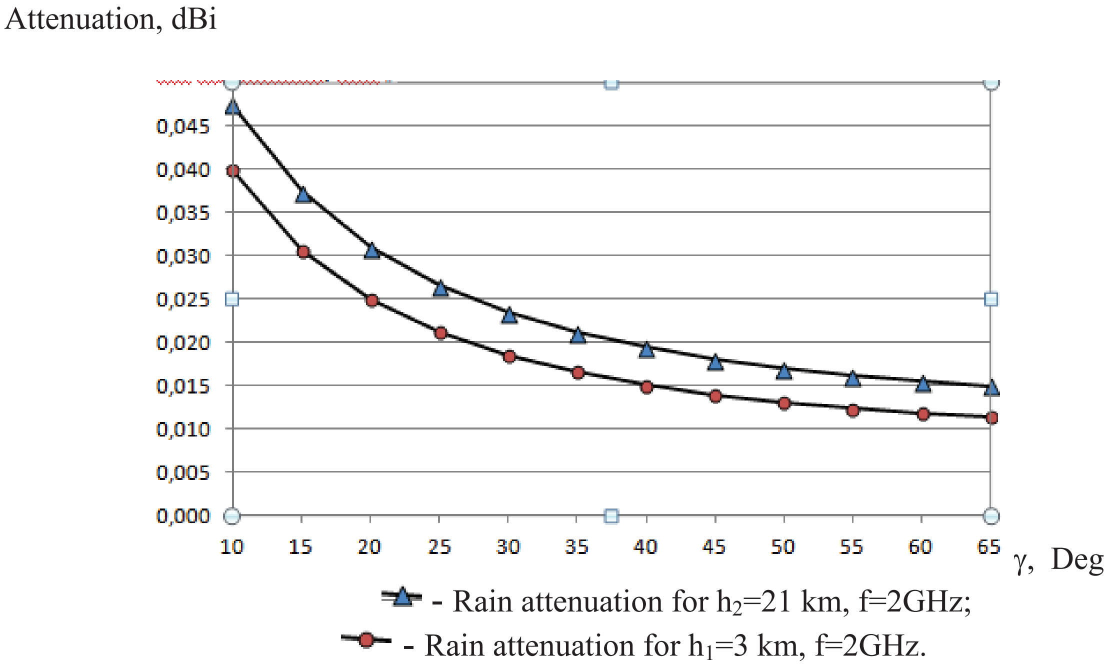


Figure 4 - Rain attenuation at deferent HAPS altitude

3. Calculation of propagation attenuation due to atmospheric gases.

As recommended by ITU-R P.676-6 make up for the 2.0 GHz frequency 0,07dB/km, for the frequency of 29.0 GHz - 0.5 dB/km, for the frequency of 48.0 GHz - 3 dB/km.

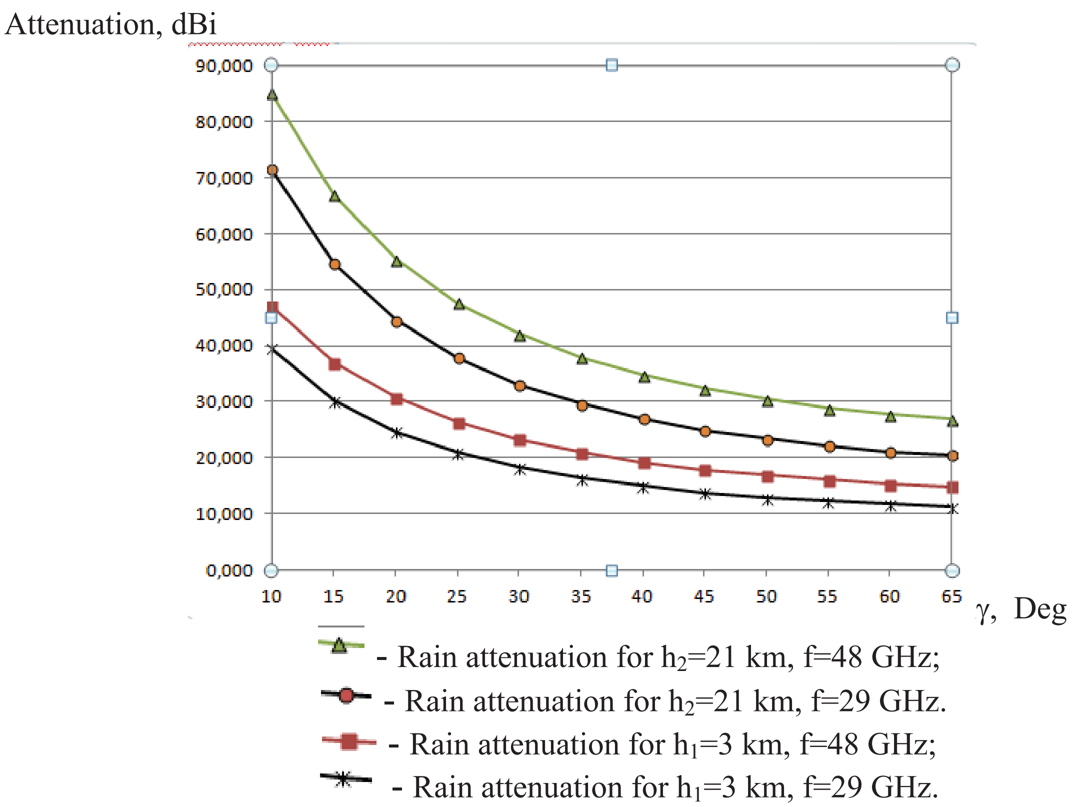


Figure 5 - Rain attenuation at deferent HAPS altitude

4. Taking into account the attenuation of the gases of the atmosphere, calculations for the attenuation of the radio line between a HAPS and ground terminals for different frequencies based on the slant range.

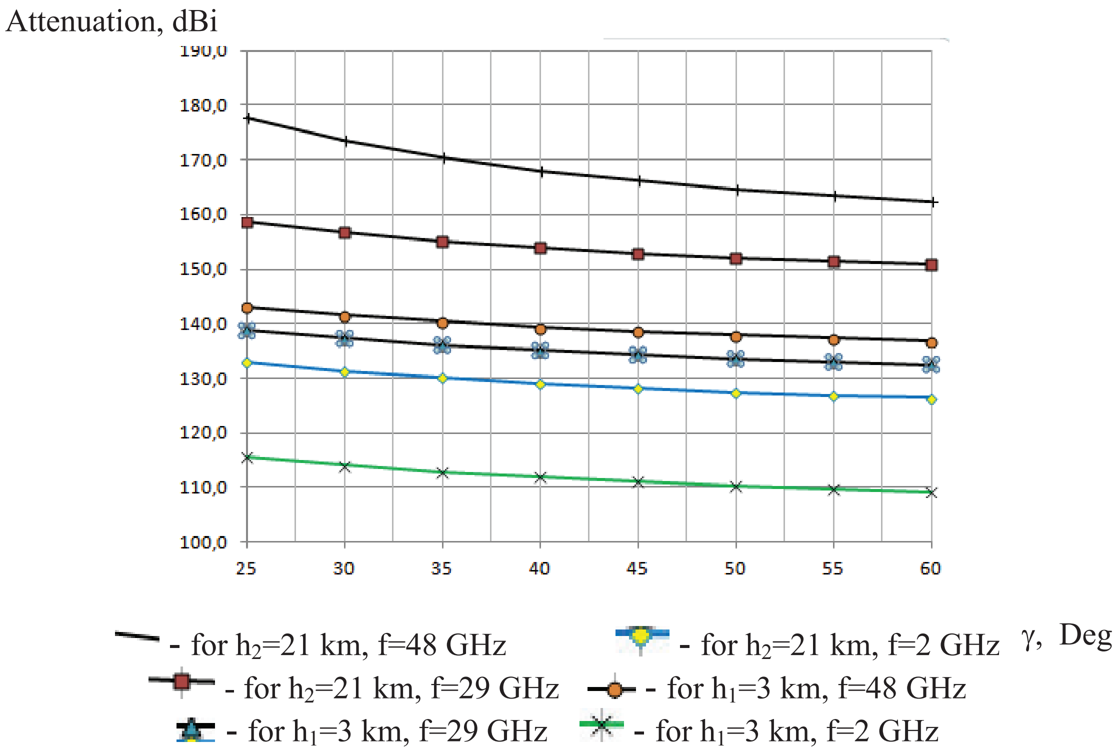


Figure 6 - Attenuation between a HAPS and ground terminals
at different altitudes and frequencies

Discussion

1 The influence of altitude of HAPS on research

HAPs are located at 20–25 km above the Earth's surface because these altitudes are well above the space used by airlines. The wind conditions in the stratosphere are normally predictable. See Figure 7 for the average wind velocities with season and location variations. Further, the zone of 20 to 22 km suffers from a relatively mild turbulence. The most preferable altitudes fall between 20 and 22 km. Generally, wind velocities increase over the altitude of 25 km. Besides, as the altitude increases, the air density is reduced, making the placement of the vehicle very difficult. For example, at 12 km (the maximum altitude of airplane lanes) the density is about 25 percent compared to that at sea level, while at 24 km it is only about 3.6 percent. The possible monitoring of the territory should also take into account the height of the Alatau Mountains and the foothills of the Tian Shan Mountains. It is also important that the stratospheric airships will not interfere with air traffic since planes fly at altitudes up to 12 km.

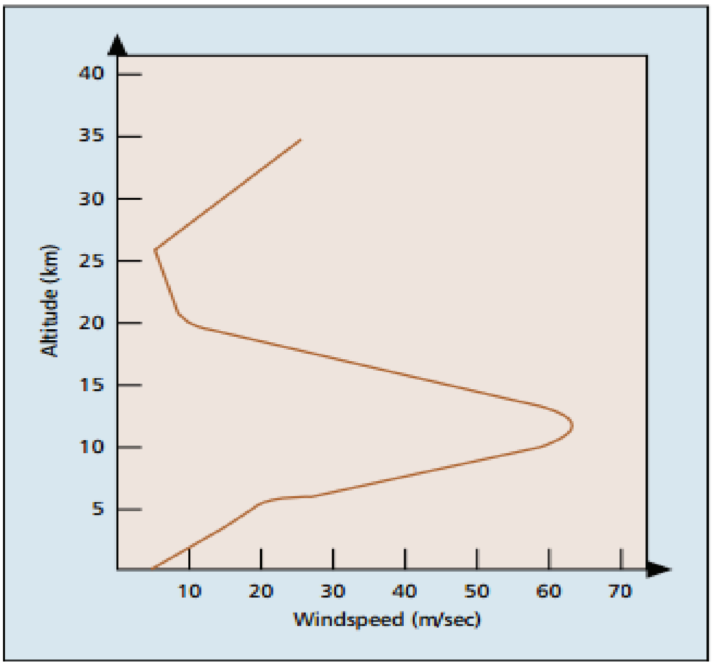


Figure 7 - Dependence of the altitude from wind speed [5]

2 The influence of elevation angle on research

Elevation angles less than 25 degrees in the mountainous area are not desirable as this may impair the free space line because of the mountain peaks. In this situation, the radius of the coverage area for altitude of 3,000 m is 6 km away, which is insufficient for solving the problems.

An altitude of 21km will allow for observation of an area of approximately 6.5 km^2, the radius will be 45 km. This is sufficient for the observation of local phenomena. The altitude of 23km will allow observation of an area of approximately 7 648 km^2, of which the radius will be 49 km.

3 The influence of atmospheric gases and rain on research

Atmospheric gases including water vapor cause attenuation, which depends on the distribution of meteorological parameters such as temperature, pressure and humidity. Thus, variations will occur because of the geographic location of the site, the month of the year, the height of a ground terminal above sea level, the elevation angle of the slant path and the operating frequency.

For communication between the surface devices and the radio transmitter on HAPs, the waves pass through two zones of atmosphere: unstable climatic zone and a relatively stable composition and position zone.

The first zone (ground) is characterized by the presence of large amounts of water vapor, and various types of rain. There are many clouds which are located at a height of not more than 2 km. This has a strong influence on the propagation of radio waves at the millimeter range.

The second section, which is located above the first, is characterized by low amounts of water vapor and the attenuation of the signal in this layer is insignificant. The upper border of this section is the stratosphere. Since

Kazakhstan is situated between the North 40° and 53° latitudes, the altitude of the lower stratosphere border is about 12 km.

4 The influence of propagation frequency on research

Since 2000, according to ITU-R F.1500 and F.1501, frequency bands for HAPS were determined: 7.2 ... 47.5 GHz and 47.9 ... 48 2 GHz respectively. In 2002, the F.1569 Recommendation determined two frequency ranges for HAPS: 27.5 ... 28.35 and 31 ... 31.3 GHz.

In 2000, Recommendation ITU-R M.1456 for high altitude platform stations provided technology IMT-2000 in the bands 1 885 - 1 980 MHz, 2 010 - 2 025 MHz and 2 110 - 2 170 MHz in regions 1 and 3 and 1885 - 1980 MHz and 2 110 - 2 160 MHz in region 2. Kazakhstan is considered a region 3.

Thus, the main working ranges of frequencies for HAPS are millimeter and centimeter ranges. These conditions are heavily dependent on the attenuation of radio waves in the atmosphere by the presence of hydrometeors, as well as the need for a free space line between the HAPS and terrestrial objects.

Conclusions

A network that is based on High Altitude Platform Stations has great importance in the unfolding operational radio network over large areas in the aftermath of earthquakes, flooding and other emergencies in an unstable operation of terrestrial communication networks. It has significant advantages both in cost and capability of solving problems.

Accordingly, this study offers some of the data for designing HAPS with a telecommunication system for the monitoring of mountain areas.

Date: the elevation angle on the border zone – 25 degree

Altitude of HAPS above the sea level - 21 km

Frequency of transmitter - 2 GHz.

In other conditions, energy characteristics of the transmitting equipment must be very large, due to the signal attenuation. It is difficult to implement as on HAPS, there is limited power consumption.

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ВЫСОТНЫЕ АЭРОСТАТНЫЕ ПЛАТФОРМЫ КАК РЕШЕНИЕ ДЛЯ МОНИТОРИНГА И ПРОГНОЗИРОВАНИЯ СТИХИЙНЫХ БЕДСТВИЙ

Аннотация. В этой статье рассматриваются основные направления современной мировой индустрии для создания высотных аэростатных платформ (ВАП). Наряду со спутниками, такие высотные аэростатные платформы являются полностью изолированными от последствий стихийных бедствий в местах природных катастроф. Также ВАПы могут быть использованы для контроля за состоянием окружающей среды, с целью прогнозирования и предотвращения стихийных бедствий. В данной работе рассчитывается зона обслуживания, влияние различных факторов на затухание, затухание при распространении сигнала различной частоты из-за атмосферных газов, затухание между ВАП и наземной поверхностью. Результаты этих расчетов могут использоваться как рекомендации для построения телекоммуникационных систем на базе ВАП в горной местности.

Ключевые слова: дистанционное зондирование, высотная аэростатная платформа, ВАПы, телекоммуникационные сети, геостационарность стратосферные платформы, затухание, глобальное позиционирование, угол возвышения.

БИІКТІК ӘУЕШАР ПЛАТФОРМАЛАРЫ ТАБИҒИ АПАТТАР МОНИТОРИНГІ МЕН БОЛЖАУДАҒЫ ШЕШІМ РЕТІНДЕ

Аңдатпа. Бұл мақалада биіктік әуешар платформаларын жасау үшін қазіргі заманғы әлемдік өнеркәсіптің негізгі бағыттары қарастырылады. Спутниктермен салыстырғанда, мұндай биіктік әуешар платформалары (БӘП) қауіпті аудандардағы табиғи апаттар әсерінен толық оқшауланған. Сондай-ақ олар табиғи апаттарды болжау және алдын алу мақсатында, қоршаған ортаның жай-күйін бақылау үшін пайдаланылуы мүмкін. Бұл мақалада сөнуге әсер ететін факторлар, атмосфералық газдар салдарынан әр түрлі жиілік сигналдарының таралу кезіндегі сөну, БӘП және жер беті арасында сөну және қызмет көрсету аймағы есептелген. Осы есептеулер нәтижелері таулы аймақта БӘП негізінде телекоммуникациялық жүйелер құру үшін ұсыныс ретінде пайдаланылуы мүмкін.

Кілттік сөздер: қашықтықтан зондтау, биіктік әуешар платформа, БӘП, телекоммуникациялық желі, геостационарлық стратосфералық алаң, сөну, жаһандық позициялау, биіктеу бұрышы.

SEISMOGENIC LANDSLIDE RISK ZONING IN THE SURROUNDING AREAS OF ALMATY CITY, KAZAKHSTAN

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Abstract. The article deals with the experience of the zoning of Almaty city and its surroundings for the risk level of a landslide caused by earthquakes. Zoning is done by combining maps of landslide hazards and the development of the territory. The landslide hazard areas with a strong, medium and weak risk level are shown on the map of the landslide hazard. Seven degrees of development of the territory are marked on the map from the dense urban areas with a population density of more than 10 000 people per km^2 to the uninhabited areas with a population density of less than 1 person per km^2. The territory surrounding Almaty city is divided into three zones: high, moderate and low seismogenic landslide risk according to the ratio of the degree of landslide hazard and the degree of development.

Key words: seismogenic landslides, risk, zoning.

Introduction

Strong earthquakes with a magnitude of more than 6.0 in mountainous areas usually cause devastating rock and soil landslides. The damage caused by them can even exceed the damage caused directly by the earthquake. With an earthquake with a magnitude of 6 (M 6), landslides descend at a distance of 20 km from the epicenter. With earthquakes of M 7, this distance is increased to 50 km, and earthquakes of M 8 cause landslides of rock and soil in a radius of 200 km from the epicenter [1].

The most devastating earthquake that has been recorded is a 7.8 M quake in Gansu Province in China in 1920. Those landslides killed about 100,000 people [2]. The landslide at Hait earthquake in Tajikistan in 1949 impacted several villages and killed 26,000 people [3]. In Peru in 1970, an earthquake of 7.7 M caused a gigantic landslide from Mount Huascaran which destroyed the Yungay city and several villages. At least 18,000 people were killed [4]. The 2005 Kashmiri earthquake in Pakistan caused a combination of 25,500 landslides and 87,500 people were killed [5]. The 7.9 M earthquake in Sichuan, China in 2008 created nearly 200,000 landslides in an area of 110,000 km^2. The volume of the largest landslide amounted to 750 million m^3. The death toll was almost 70,000 people [6, 7].

The catastrophic "Verny Earthquake" of M 7.3 happened in the Ile Alatau in 1887 [8]. Faithful Verniy city (now Almaty city) was razed to the ground. There were many landslides and falling rocks in the mountains. The total volume of landslides and rocks was 440 million m^3. The volume of the largest rockfall was 54 million m^3. A few hours after the earthquake, mudflows occurred in the valleys of the major rivers. The number of earthquake victims was 332 people of which 154 people were killed by landslides.

Another catastrophic earthquake was “Kemin”, with a magnitude 8.2 it occurred in 1911 [9, 10]. This earthquake is the strongest one recorded in Central Asia. Collapses in the Chon Kemin and Chilik valleys reached colossal proportions.

Almaty’s current border far exceeds the boundaries that existed for the city of Verny in 1887. Urban areas have expanded towards and into the mountains. Many of the buildings and infrastructure features are located in potential landslide areas. The danger of landslides is amplified by human activity. There is a clipping and overloading of slopes, and additional moisture from damaged pipelines. Every year several damaging landslides are recorded in the city. These even occur in the "dry season” in October and in December.

Therefore, the development of a seismic safety system for Almaty must take into account the risks from the seismogenic landslides - the seismogenic landslide risk.

Methodology

The risk is the average losses from natural hazards for a certain period of time [11]. When we consider the seismogenic landslide risk, we are measuring the loss associated with landslides caused by earthquakes. The value of the seismogenic landslide risk is determined by several factors: the frequency of earthquakes of varying intensity, the probability of landslides during earthquakes, the probability of the landslide’s impact on people and structures, and the probability of damage and its impact. All of these factors, especially the first two, are subject to substantial uncertainty. Therefore, determining an accurate quantification of seismogenic landslide risk is virtually impossible. In this study, we carried out a qualitative assessment of three categories of risk: high, moderate and low. High risk implies the real possibility of severe consequences combining seismogenic landslides with extensive material damage and numerous casualties. A moderate level of risk can be compared with acceptable risk (as defined by UNISDR [11]). At this level of risk, little material damage is possible, and deaths are improbable. With a low level of risk, the possibility of damage from the seismogenic landslides cannot be taken into account.

Results

A landslide hazard map was compiled from a survey of traces of landslides, the majority of which originated with the Verny earthquake in 1887 [6]. The landslide hazard map is drawn in a scale of 1:25 000 for the territory of Ile Alatau low mountain zone, which surrounds Almaty city. The map shows landslide-prone slopes of three categories: slopes composed of loess loam; slopes covered with powerful deluvial deposits; and slopes with a thin cover of deluvial deposits.

In areas composed of loess-like loam, landslides can capture large blocks up to ten meters thick. Loess deposits are prevalent in the low area with a height of 1500 m a.s.l. These areas have a strong landslide hazard risk.

Above the loess zone, slopes are composed of rock, covered with a surface layer of deluvial deposits submitted by detritus loams. On the northern slopes, the thickness of the deluvial cover reaches up to several meters. The earthquake landslide spans a large area, but the penetration depth is limited. Displaced masses very quickly turn into a stream consisting of dirt, gravel, turf and trees. The landslide hazard risk in this area is also strong.

On the southern slopes, the deluvial cover does not exceed 1 m. On such slopes, only small shallow landslides descend less than 1000 m^3. The landslide hazard risk is considered weak.

To assess the seismogenic landslide risk, a map of the territory's development was also drawn. The map shows the location of 1) dense urban residential areas, 2) dense country houses, 3) sparse urban development, 4) sparse country houses, 5) undeveloped areas adjacent to housing estates, 6) territory which has no permanent population, but which is often visited by tourists, and 7) uninhabited areas rarely visited by tourists. The main objective of this zoning is the ranking of the probability that people could be impacted by a landslide.

The combination of the landslide hazard and development maps has allowed for a qualitative assessment of seismogenic landslide risks (see Table 1 and Figure 1). The studied area has been divided into three zones: low, moderate and high risk.

The high-risk zone is the area with a strong hazard of landslides, in which people are constantly present. It includes the residential buildings and adjacent areas. There is a very high probability of human victims in this area during strong earthquakes. This zone is located in south-western part Almaty city and in the holiday villages and cottages area on the Kamenskoe Plateau. Because of continual development of cottages in landslide-prone regions, the size of high-risk zones is constantly expanding.

An area with moderate risk includes territories with a strong potential of landslides, where there is no permanent presence of people. Areas with low risk are areas with weak hazard landslides and are rarely visited by people.

Conclusions

The level of the seismogenic landslide risk is determined by the seismicity, the landslide-prone spread, the landslide's volume, as well as the degree of development.

The three categories of Zoning Risk (high, moderate, low) may be accomplished by combining the data from the landslide hazard and the territory development maps.

In areas with a high level of risk, there is a real possibility of large material damage and numerous human victims. These territories include landslide-prone slopes in the southern part of Almaty city, where private cottages have been constructed. It is necessary to carry out a complex set of the prevention measures.

Table 1 - Level of seismogenic landslide risk, depending on the degree of landslide hazard and the development of the territory

Territory development		Degree of landslide hazard		
Type of development	Population density, people/km^2	Strong: volumes of landslides more 1000 m^3, landslides spreading more 10%	Medium: volumes of landslides more 1000 m^3, landslides spreading less 10%	Weak: volumes of landslides less 1000 m^3, landslides spreading less 10%
Dense urban development	More 10000	high	high	high
Dense summer residence houses	1000 - 10000	high	high	high
Rare urban development	500 - 1000	high	high	high
Rare summer residence houses	100 - 500	high	high	moderate
Areas adjacent to the built-up areas	10 - 100	high	moderate	moderate
Unpopulated areas used for recreation	1-10	moderate	moderate	low
Unpopulated areas	less 1	low	low	low

Moderate risk is observed in areas where there may be little material damage and a few human casualties. It includes areas with no permanent population, but which are frequented by people, especially for recreational purposes. They are located in the bottom of the river valleys in the middle mountain zone of the Ile Alatau. In these areas, it is sufficient to identify the landslide-prone zones and to create a system of warning about the landslide threats.

Low risk is inherent in the mountainous areas of Ile Alatau, where there are no conditions for the development of landslides, no permanent population, and rare presence of visitors. In such areas, the seismogenic landslide risk can be ignored.

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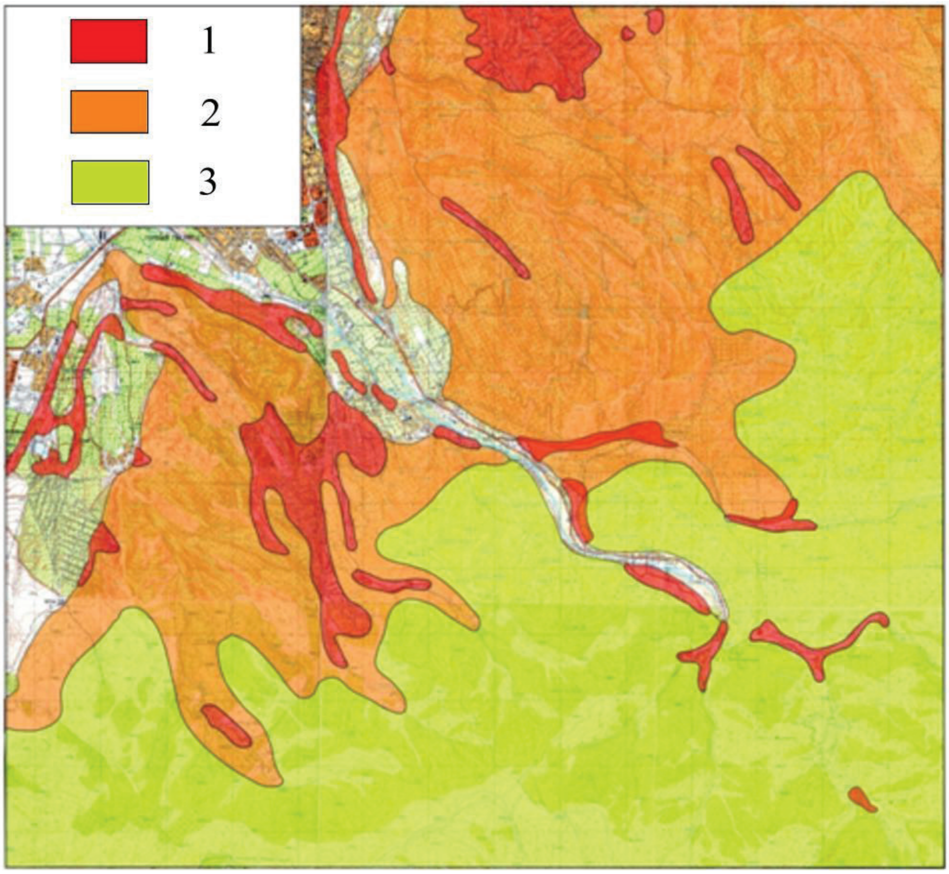

Risk level: 1 - high, 2 moderate, 3 – Low.

Figure 1 - Map of Seismogenic Landslide Risk

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ЗОНИРОВАНИЕ СЕЙСМОГЕННОГО ОПОЛЗНЕВОГО РИСКА В ОКРЕСТОСТЯХ ГОРОДА АЛМАТЫ

Аннотация. В статье рассматривается опыт зонирования территории города Алматы и его окрестностей по уровню оползневого риска, вызываемого землетрясениями. Зонирование проводится путем совмещения карт оползневой опасности и освоенности территории. На картах оползневой опасности показаны участки с сильной, средней и слабой оползневой опасностью. На картах освоенности выделены 7 степеней освоенности территории от плотной городской застройки с плотностью населения более 10 000 человек на км^2 до ненаселенных мало посещаемых людьми территорий с плотностью населения менее 1 человека на км^2. По соотношению степени оползневой опасности и степени освоенности территории выделены три зоны: с высоким, умеренным и низким уровнем сейсмогенного оползневого риска.

Ключевые слова: сейсмогенные оползни, риск, зонирование.

АЛМАТЫ ҚАЛАСЫНЫҢ МАҢЫНДАҒЫ СЕЙСМОГЕНДІК КӨШКІНДЕР ҚАУІП-ҚАТЕРІН ЗОНАЛАУ

Аңдатпа. Мақалада Алматы қаласы мен оның маңы аумағын жер сілкіну салдарынан болатын көшкіндер қауіп-қатерінің деңгейіне байланысты зоналау тәжірибесі қарастырылған. Зоналау көшкіндер қауіп-қатері және аумақтың игерілуі карталарын қиыстыру арқылы жасалады. Көшкіндер қауіп-қатері картасында көшкіндер қауіп-қатерінің күшті, орташа және әлсіз бөлімшелері көрсетілген. Аумақтың игерілу картасында аумақтың игерілуінің халық тығыздығы км^2-ге 10 000 адам болатын қалалық тығыз құрылыстан халық тығыздығы км^2-ге 1 адамды құрайтын адам сирек баратын аумақтарға дейінгі 7 дәрежесі ажыратылған. Көшкіндер қауіп-қатерінің дәрежесі мен аумақтың игерілу дәрежесінің қатынасына байланысты үш зона анықталды: сейсмогендік көшкіндер қауіп-қатерінің жоғары, бірқалыпты және төменгі деңгейлі зоналары.

Кілттік сөздер*:* сейсмогендік көшкіндер, қауіп-қатер, зоналау.

USE OF PARKED VEHICLE LIGHTING FOR MULTI-STORY BUILDING EVACUATION

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Abstract. When emergency evacuation is required at night for a residential multi-story building which has a disabled power supply, the researcher recommends the use of parked car headlights. The author uses data of participant's walking speeds as they experience emergency evacuation routes with different lighting.

Key words*:* night-time, evacuation, cars, vehicles, lighting.

A number of Republic of Kazakhstan large cities (including Almaty) are located in areas prone to strong and devastating earthquakes, the consequences of which are unpredictable and can lead to, or cause, extensive material damage, massive losses and deaths [1].

Experience has shown that the most reliable way to ensure the safety of people in such cases is their timely evacuation from the building to a safe place. Evacuation is a process organized by the movement of people through the escape routes (staircases between floors) towards an open area.

During the evacuation of people from residential multi-storey buildings (RMB), additional difficulties may arise because of the failure of the power supply system since the power system's elements are susceptible to mechanical damage or outages from short circuits. In [2], it is recommended even in such situations to cut the supply of electricity in the RMB in order to avoid fires, gas explosions or other consequential accidents.

The use of mobile power stations for evacuation of people is problematic since their number is very limited in urban areas, and delivery of energy from other regions will take a long time.

In this article, the use of headlights of parked cars in parking lots to illuminate the emergency evacuation route from RMBs is recommended.

Existing published research [3, 4] lacks information on the use of vehicles for evacuation and rescue operations in emergency situations. Umbetkulov and Askar [5] identified the need for research on the use of vehicles for general or local lighting during evacuation at night.

Method & Results

Currently, the city of Almaty is experiencing serious problems with the organization and availability of parking spaces. Many vehicles are parked near RMB entrances and the adjacent territory.

An estimated number cars parked near the RMB during the day was carried out for common types of apartment buildings in different densely populated areas of Almaty. Figures 1, 2 and 3 show the distribution of the number of parked cars during the day near 3 different residential complexes: a 4-stair large-panel system RMB , a 9-stair large-panel system RMB and a 16-stair RMB. Observations were made and data was collected in four time periods: 20.08.2015, 12.11.2015, 10.01.2016 and 15.03.2016.

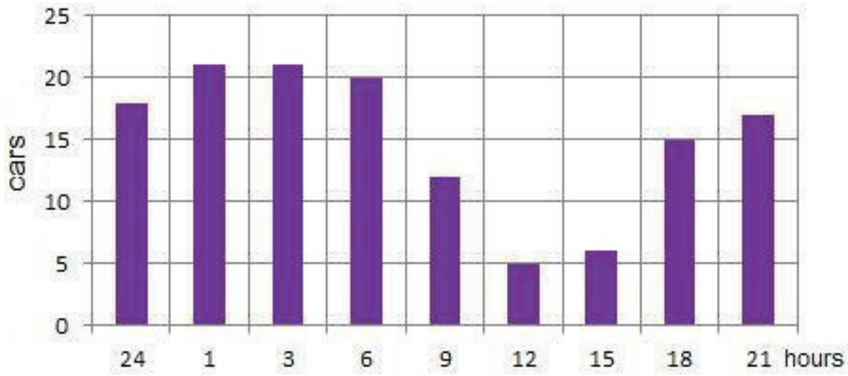

Figure 1 - Distribution of parked cars/ hour at a 4-stair large-panel system RMB 1

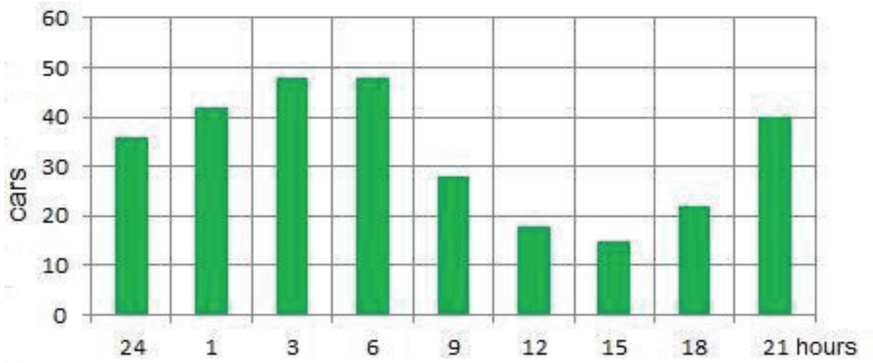

Figure 2 - Distribution of parked cars/ hour at a 9-stairs large-panel system RMB 2

Figure 3 - Distribution of parked cars/hour at a 16-stair RMB 3

This data indicates the maximum number of parked cars accounted for during the night (from 00:00 to 06:00). During the observation periods, the maximum number of parked cars rarely changed. Thus, the average number was calculated to be: for RMB1 -- 21 cars, for RMB 2 -- 48 cars and for RMB 3 -- 85 cars. The last figure includes 60 vehicles that are regularly parked in an underground garage in the yard of the 16-storey residential complex. The number of cars remained stable, and was not impacted by the season.

A further examination of the possibility of using parked cars for illumination of escape route sections was conducted in a 9-storey RMB in Almaty.

The estimated time for complete evacuation is determined by the sum of movement time on separate areas of the path/route [4]:

$$t_p = t_1 + t_2 + t_3 + ... + t_i, \quad (1)$$

where t_1 – time of motion of people on the first (initial) area, min;

t_2, t_3,...t_i – time of motion of people on each of the following after the first area of path, min.

The walking speed at every area, m/min:

$$V_i = l_i / t_i, \quad (2)$$

where l_i – length of path, m

t_i – time of movement on an area, min.

The sample of participants acting as evacuees was composed of:

- 4 males (aged 35-40 years) and 3 females (aged 25-30 years)
- 2 cars: Toyota Camry (2003) and Toyota Yaris (2007)

The males went down the stairs from the 9^{th} floor

The females went down the stairs from the 5^{th} floor.

The illumination was measured by a digital light meter Mastech MS6610. The start time and duration of the participants' movement on the escape routes were recorded on stopwatches.

The experiments were performed on 22.02.2016 from 21:00 to 22:00. Figure 4 exhibits the location of the 2 cars in relation to the RMB building.

The average walking speed of all participants was pre- measured and the benchmark during a lighted escape route was about 20 lx.

Further, all electric lighting of the story landings, flights of stairs and staircases of the 9-storey RMB was completely shut off. Figure 4 shows how the evacuation route (storey landings and staircases) of the building were illuminated in two ways:

1. Lighting the porch of the 1st floor of the RMB by headlights of Toyota Yaris, which was 2.5 meters away from the front door entrance

2. Lighting window hole of staircase between floors 3 and 5 by the headlamp (Beam) of Toyota Camry, which was 21 meters away from the entrance. The front wheels of this vehicle were slightly elevated on an artificial hill to simulate a curb.

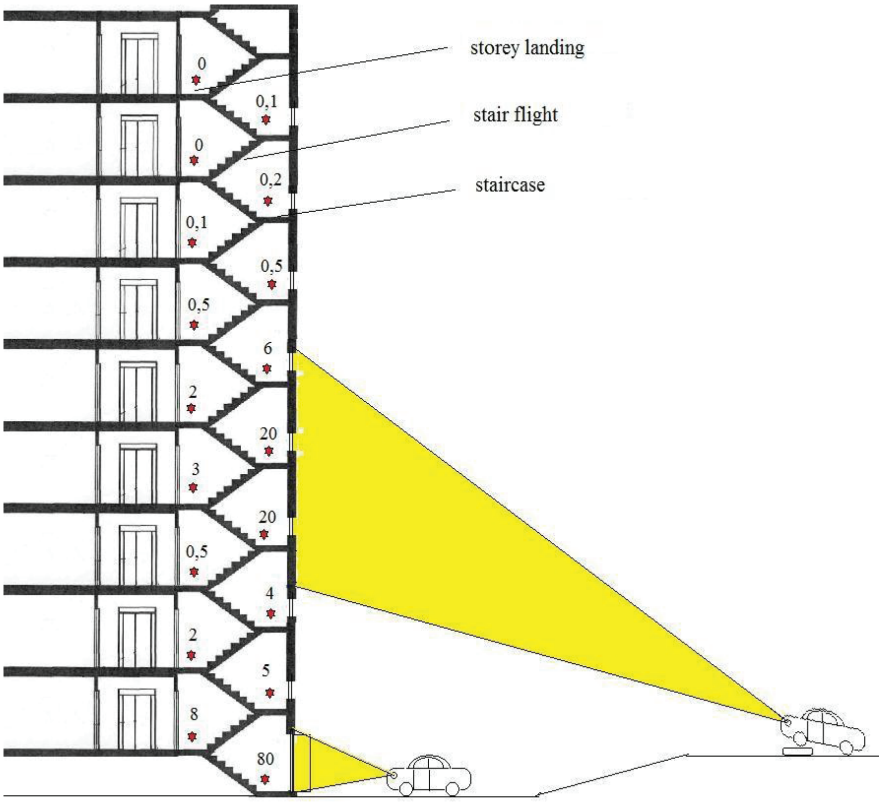

Figure 4 - Car headlight lighting of emergency escape route in a 9-storey RMB

During the observed time period, the illumination in all areas of the escape route (staircases and flights) was measured and recorded by light meter.

Figure 5 indicates the data of average walking speeds in different parts of the escape route (1 - story space, 2 - a flight of stairs and the 3 - staircase), depending on the degree of illumination.

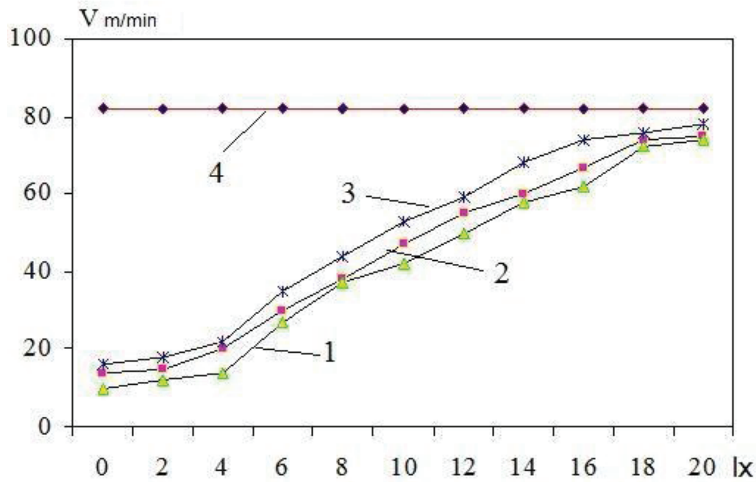

Figure 5 - Dependencies of average walking speed on emergency exit route in terms of different lighting: 1 – storey landing; 2 – stair flight; 3 - staircase; 4 – average speed at lighting of 20 lx

Figure 5 suggests that the maximum walking speed occurred on the stair flight, since in this area of the escape route, the lighting from the car headlights reaches its highest level.

Conclusions

An analysis of the average walking speed of the participants at night with the escape routes illuminated by the car headlight, was reduced by approximately 5-6 times, compared to the evacuation walking time without lighting.

The measurement of male and female movement in the study revealed differences in speed. The walking speed of the females on all sections of the escape route was somewhat lower than the males' (approximately on 20-30%).

It appears males have considerable physical advantages over females as they move at a higher speed. In the absence of illumination, the males maneuvered more actively by overtaking people walking in front of them. By increasing the illumination of the escape route, the walking speed of men and women did not differ significantly.

A significant reduction of average speed (about 2 times) can be expected during the evacuation of elderly people and small children. It should be noted that the walking speed of all evacuee categories will also depend on their psychophysiological and emotional state.

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ЭВАКУАЦИЯ ЛЮДЕЙ ИЗ МНОГОЭТАЖНЫХ ЖИЛЫХ ДОМОВ В НОЧНОЕ ВРЕМЯ С ИСПОЛЬЗОВАНИЕМ ПРИПАРКОВАННЫХ АВТОМОБИЛЕЙ

Аннотация. Для эвакуации людей из жилых многоэтажных домов, при отключенной системе электроснабжения в ночное время, предлагается использовать освещение от фар припаркованных автомобилей. На основе экспериментальных исследований определены скорости передвижения людей по участкам эвакуационного пути при ее различной освещенности.

Ключевые слова: ночное время, эвакуация, автомобили, освещение.

ТҰРАҚТЫЛАНҒАН КӨЛІКТЕРДІ ПАЙДАЛАНУ АРҚАСЫНДА ТҮН МЕЗГІЛІНДЕ КӨПҚАБАТТЫ ТҰРҒЫН ҮЙЛЕРДЕН АДАМДАРДЫ ЭВАКУАЦИЯЛАУ

Аңдатпа. Мақалада, түн мезгілінде электрмен жабдықтау жүйесі істен шыққан жағдайда, көпқабатты тұрғын үйлерден адамдарды эвакуациялау үшін жақын жерде тұрақтыланған көлікттер арқылы жарықтандыру ұсынылып отыр. Эксперименттік зерттеу негізінде эвакуация жолдарындағы түрлі жарықтандырылған учаскелердегі адамдардың қозғалыс жылдамдықтары анықталған.

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IMPROVING AIR QUALITY IN ALMATY USING BEST PRACTICES FROM CALGARY

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Abstract. The current emission inventories of Almaty city in Kazakhstan and Calgary city in Alberta, Canada are presented in this paper. We compared the factors affecting air quality in both cities. Five criteria contributing to air pollution were analyzed: transportation, industry, green areas, wind patterns and waste management. We analyzed these factors and identified the underlying problems associated with them. Finally, recommendations to improve the environmental situation in Almaty are provided based on existing and successfully implemented practices and initiatives from the city of Calgary, showing how Canadian models can be implemented for Kazakhstan.

Key words: Almaty, Calgary, air pollution, transportation, industry, green area, waste, wind, Canadian Model.

1. Introduction

People have distorted nature for many years. Our actions affect the environment drastically. The race for energy has resulted in the massive production of greenhouse gases, which have caused global warming and climate change. Urbanization and industrialization have increased air pollution and the consequences have affected us.

The current generation lives in a century of fast growing change. A large portion of our lives depends on technologies which were fantasies years ago. This growth has made a variety of challenges to our environment. Today, these effects are becoming apparent in the air we breathe. Most of us support the idea of environmental sustainability, and thus, the need to control air pollution. If immediate steps will not be taken in Almaty, the city will not be a particularly friendly place for future generations.

Emissions of solid particles and gases due to industry development have created health problems and environmental risks in Almaty (UNDP, 2015). People suffer from a variety of diseases. The consequences of it may lead to the case when locals will have to wear masks due to the dramatic degradation of air quality and decreasing visibility level in polluted areas. Even though the Kazakhstani government seems to be aware of the problem and is attempting to find a reasonable solution, the air quality is still very poor. There could be environmental justice movements involved in order to diminish the effect of air pollution.

While identifying a good example of a country or district that was able to overcome air pollution problems, the city of Calgary, Alberta immediately came to our minds. Indeed, both cities have similar geographical and demographic characteristics as shown in Figure 1. Also, both cities have large emissions due to the high number of vehicles and industries. However, the Canadian government, with the help of its citizens, managed to improve pollution control and reduce emissions of hazardous gases into the atmosphere. In our perspective, that is a great demonstration of human – environment interaction even though there are many reasons and issues underlying this achievement.

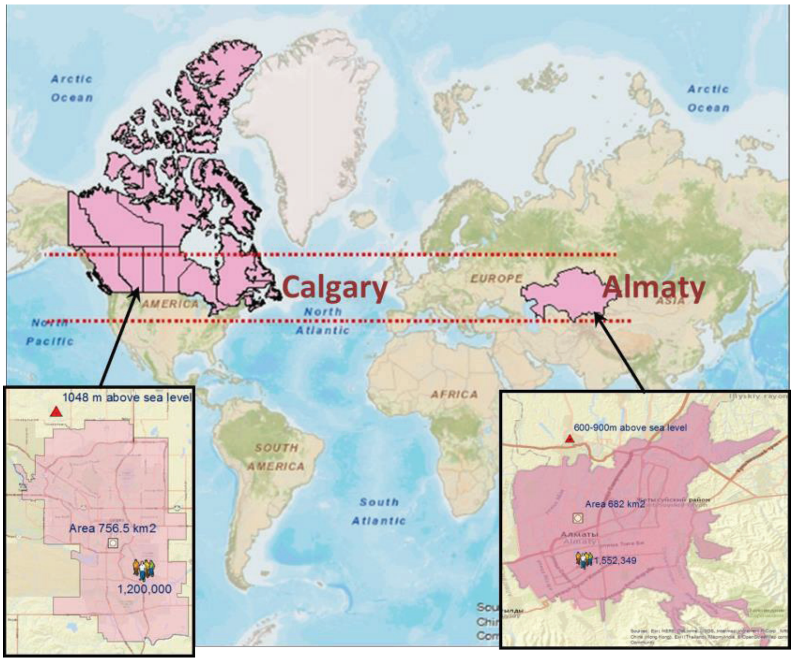


Figure1 - Geographical and Demographic characteristics of Almaty and Calgary

2. Air Pollution

Air pollution is a mixture of gases and solid particles that cause pollution in the atmosphere. These substances are mostly produced by our human needs. According to the EPA, there are five common pollutants: carbon monoxide, nitrogen dioxide, ozone, sulfur dioxide and PM2.5-10. The table below shows their source (WHO 2008).

Table 1 - Air pollutants and their sources

Pollutants	Sources
Particulate Matter	construction sites
Sulfur dioxide	power plants, industries
Carbon Monoxide	burning fossil fuels
Nitrogen dioxide	power plants
Volatile Organic Compound	chemicals used for household products

In order to increase air quality and maintain a cleaner, healtier environment in Almaty, all the gases mentioned above have to be reduced.

2.1. Air quality in Almaty

Almaty is characterized by a fairly complicated ecological condition. There is constant gray smog hanging above the town as shown in Figure 2. More than 80% of air pollution in the city is accounted for by road transport whereas 20 % are by industries. According to recent data, the number of cars is growing every day. Every year, these vehicles emit around 250-260 thousand tons of hazardous pollutants (UNDP, 2015). According to Numbeo (2015a), air quality in Almaty is rated as very low.

Figure 2 - Smog over Almaty city

2.2. Air Quality in Calgary

When it comes to the most environmentally friendly cities in the world, we imagine a sparsely populated place. However, this is not always true. As it was mentioned above, Calgary like Almaty used to have an air pollution problem. Calgary with a relatively large population (more than 1 million) and developed industries (oil and gas fields) is one of the most environmentally friendly places in the world (Hutchin, 2013). Numbeo (2015b) rates air quality in Calgary as high. It becomes clear that sustainability for the residents of Calgary - is not a gift of nature, but the result of their own deliberate actions (Figure 3).

Figure 3 - Calgary landscape

3. Comparison analysis

Considering the current situations in both Almaty and Calgary city, determined 5 main factors that affected air quality were determined. They are transportation, industry, parks and green areas, wind pattern and waste management. In the following sections, both cities will be compared in terms of these factors using ArcGIS software and related findings will be revealed.

3.1. Transportation

In Almaty the biggest portion of air pollution comes from transportation. According to recent data, the number of registered vehicles in Almaty is approximately 800 000 and corresponding emission of air pollutants is 260 000 tons per year (Rysbay, 2007). This gives the ratio of 325 kg per vehicle. In Calgary this number is significantly different. Nowadays, in Calgary the number of vehicles reached 1 000 000 units and their total emission is approximately 215 000 tons per year, which means that emission per vehicle is 215 kg (Dhaliwal, 2013).

Based on these numbers, it is possible to say that Almaty produces higher amounts of air pollutants compared to the city of Calgary, despite the fact that the number of vehicles in Almaty is relatively less than in Calgary. This statement points to the fact that transport quality in Almaty is not high. Most of the vehicles are very old and the quality of the gasoline in the city is getting worse (Nurkz, 2014). These problems increase the amount of air pollutants every day. The other factor affecting the high emission from transport could be the quality of the roads within the city. Most of the roads are not even and this leads to the consistent stopping of the vehicles. Consequently, vehicles emit higher air pollutants. In Calgary the quality of transportation is not bad due to the use of more electric vehicles and the management of gasoline use.

3.2. Industry

Industry and residential heating also contribute to air pollution in Almaty. They account for about 20% of emissions, totaling 65000 tons per year (Rysbay 2007). Whereas in Calgary, stationary pollution sources account for nearly 50% of emissions, which totals up to 167 000 tons of air pollutants per year (Dhaliwal, 2013). The number of industry facilities in Almaty and Calgary are 199 and 4116 respectively (The city of Calgary 2006). The areas of industries and residential heating facilities were highlighted with blue using the ArcGIS software in order to show their approximate locations with respect to the industrial and residential areas (Figure 4 and 5).

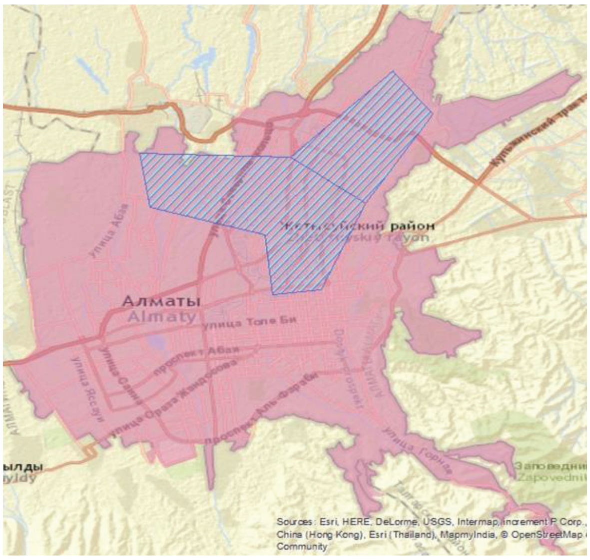


Figure 4 - Industry area in Almaty

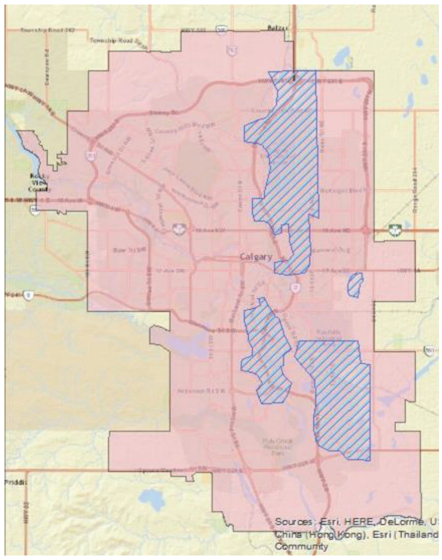
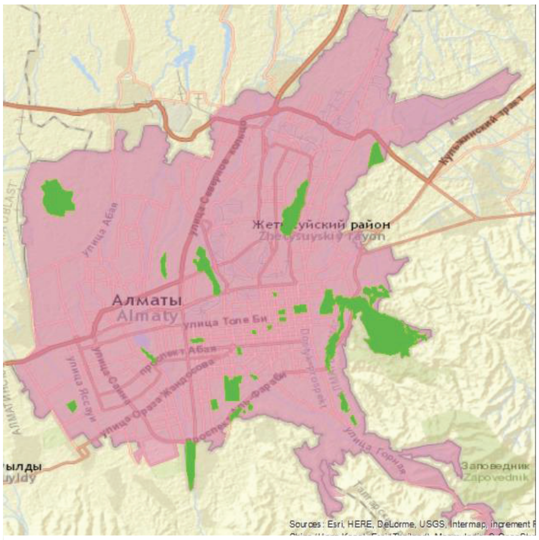


Figure 5 - Industry area in Calgary

Based on the data, it is possible to see that Calgary city, with more than 20 times more industries, produces only 2.5 times more emissions per year compared to Almaty. This demonstrates the fact that the industries in Almaty do not control their emissions well. From Figure 5, it can be seen that, in Calgary, most of the industries are located in the middle of the city; however, the city is not damaged by the emissions from industries. This is because the Calgarian industries manage and control their emissions better and use alternative sources of energy.

3.3. Parks and green areas

Green area is another factor that affects air quality. Vegetation can help to clean air by absorbing different air pollutants. It is a fact that the biggest cities in the world, such as New York, are improving their air quality by increasing the amount of vegetation and number of parks (Chen and Ye, 2015). Almaty, once called a green oasis, has long lost this name. With about 7 square meters of green space per citizen, parkland and green spaces cover an area of slightly more than 1000 hectares, less than 5% of the city's total area. According to the international standards average green space per person should be 10 square meters, which shows that there is lack of green area in Almaty (Tengrinews, 2014). On the other hand, the city of Calgary has around 8000 hectares of parks and green areas, which is about 66 square meters of green space for every citizen. With over 30 parks, Calgary is considered one of the greenest cities not only in Canada, but worldwide (Calgary city news blog, 2015a). The difference in green area distribution can be seen in the maps that were developed by using ArcGIS software (Figure 6 and 7).



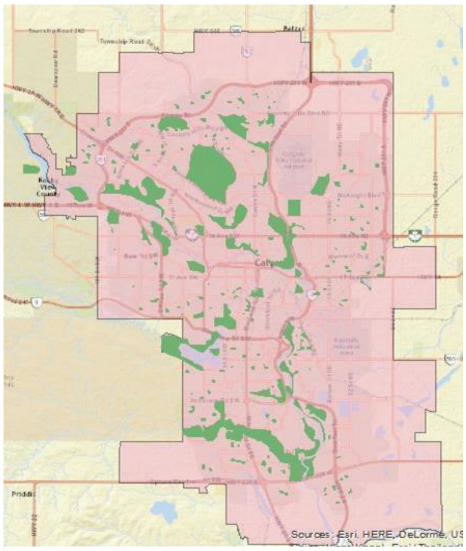


Figure 6 – Green area in Almaty   Figure 7 - Green area in Calgary

In Almaty, green spaces are located at certain areas within the city and mostly at the areas close to the border of the city where not many people live. Alternatively, in Calgary, green spaces and parks are located throughout the city by making green spaces accessible for every resident. Additionally, Calgary government always promotes different environmental programs to maintain and extend the green areas. Reduction of green spaces and parks in Almaty could be due to constant cutting down of trees and using parkland territories for commercial or residential purposes.

3.4. Wind patterns

Wind pattern has a significant effect on air quality. Frequent and strong wind can decrease the amount of air pollutants by dispersing them. In order to analyze wind patterns in both cities 'wind rose diagrams' were developed using recent wind information. Figure 8 and 9 demonstrate wind rose diagrams for Almaty and Calgary respectively. In Almaty, the most frequent wind comes from the north with a frequency of 7 days per month and wind speed varies between 1-

4 m/s. In addition, most of the days in Almaty are windless (Gismeteo, 2015). On the other hand, in Calgary the highest frequency of the wind is 3-4 days per month from the north-west and south directions and the average speed of the wind is 15 m/s (Windfinder, 2015)

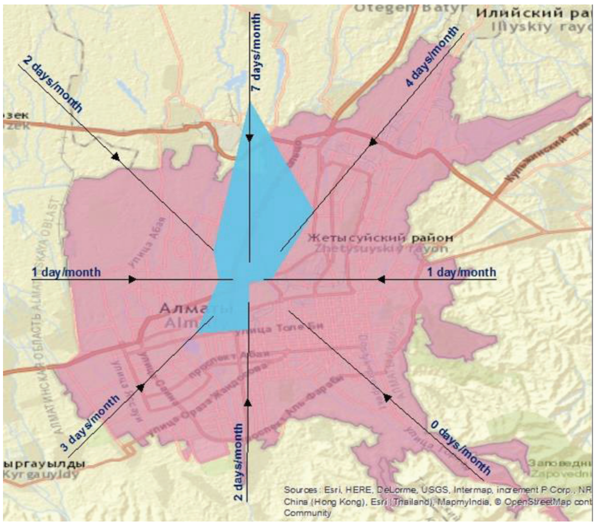


Figure 8 - Wind rose diagram for Almaty

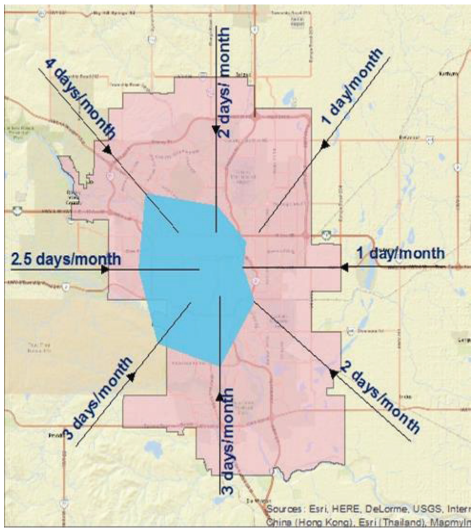


Figure 9 - Wind rose diagram for Calgary

After an analysis of wind frequency and speed in both cities, it was decided to combine the wind rose diagrams, industry facilities and mountain layers in the ArcGIS software in order to find some pattern related to air pollution (Figure 10 and 11).

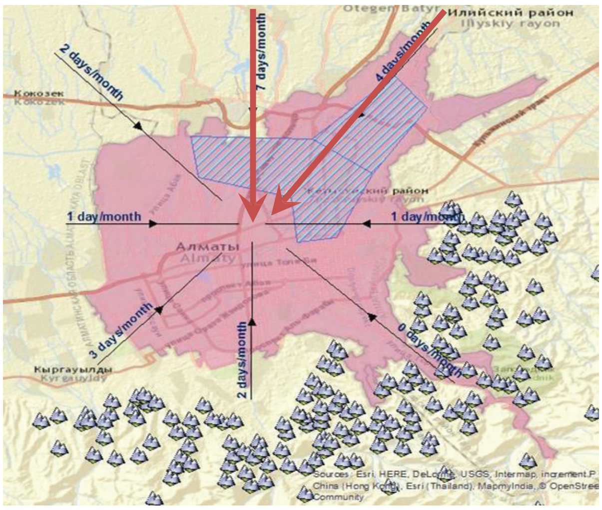


Figure 10 - Wind rose, industry and mountain layers in Almaty

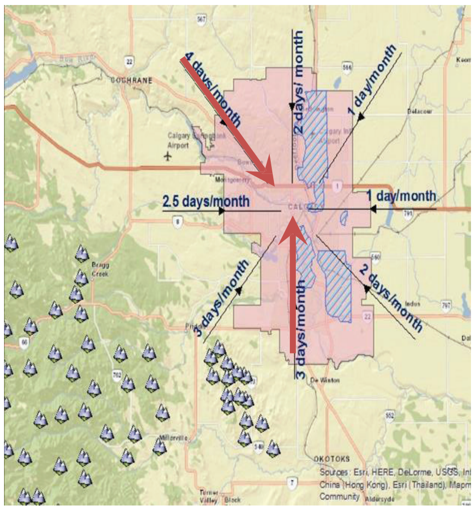


Figure 11 - Wind rose, industry and mountain layers in Calgary

In Figure 10 and 11, industry facilities are highlighted with blue and the most frequent wind directions are shown with red arrows. The most interesting fact that was discovered from the map of Almaty is that most frequent wind directions pass through the industrial facilities first and then transfer air pollutants from the industrial area towards the city. Afterwards, this polluted wind is trapped by mountains. The other significant issue is that most of the buildings in Almaty are located perpendicularly to the wind direction, and thereby making wind movement difficult.

In Calgary, the wind pattern is not as big of an issue as in Almaty. The most frequent wind comes from opposite directions (south and north) and the mountains do not interfere. Additionally, in order to make free wind movements within the city, some of the buildings in Calgary were built strategically by considering the direction of the wind. It is also important to consider that the wind speed in Calgary is significantly stronger than in Almaty. This can be due to the location of the mountains. As it is shown in the figures, in Almaty the mountains surround the south part of the city, whereas in Calgary the mountains are located only to the south-west side and are slightly farther away from the city.

3.5. Waste Management

The more waste that is generated, the more of it has to be disposed eventually. Most of the ways of waste disposal result in air pollution due to the greenhouse gases coming from them into the atmosphere. The amount of waste that is produced in a given city is an important factor that impacts the overall amount of emissions. Having studied various sources of information and making an analysis of the data, we have found that for the city of Almaty, the total amount of waste is about 649,900 tons per year and the total number of factories involved in their recycling is only about 25 with a rate of 5-7% of total waste recycled (Mitsubishi Heavy Industries Environmental & Chemical Engineering Co., 2014). On the other hand, the city of Calgary produces 630,000 tons of waste per year with 95 factories involved in recycling 20 percent of total waste (Calgary city news blog, 2015b). Both cities use landfills for the rest of the waste just like many other parts of the world since it seems to be the most cost-effective way of dealing with waste. Figures 12 and 13 demonstrate the locations of main recycling waste plants and landfills in the two cities.

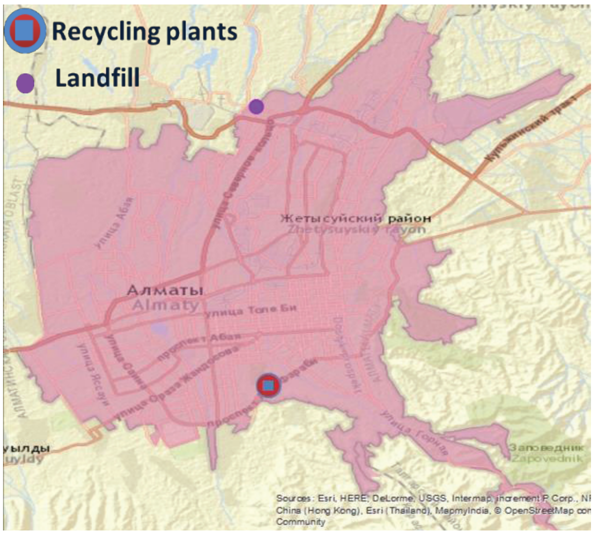


Figure 12 - Recycling plants and landfills in Almaty

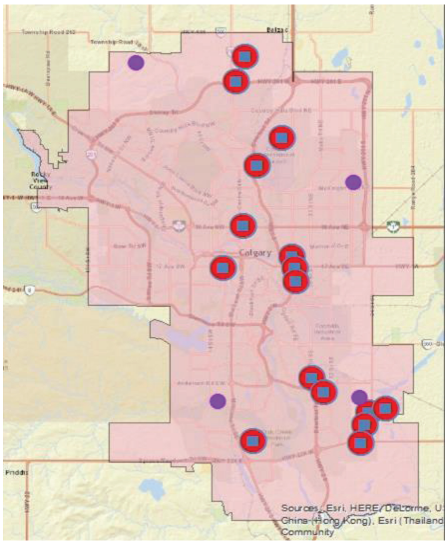


Figure 13 - Recycling plants and landfills in Calgary

It can be seen that waste in Almaty is not well managed compared to Calgary. People continue to dispose the waste into the landfills and increase emissions of harmful gases such as methane. Alternatively, Calgary succeeds in solving this problem by increasing the number of recycling facilities and it continues to improve its waste management situation.

4. Recommendations

This comparative analysis identified a number of air pollution issues in Almaty that need to be addressed in order to improve the quality of the city's atmosphere. The research showed that similar problems have been successfully targeted in the city of Calgary through various federal and municipal plans, programs and initiatives (The City of Calgary, 2011). These best practices are applicable to Almaty in order to decrease the current emission numbers and contribute to overall improvement of the environmental situation. The recommendations cover all the factors that affect air pollution in the most populated city in Kazakhstan.

4.1. Transportation

Varying vehicle registration fees as well as tax schemes will increase the demand for fuel efficient vehicles, i.e. cars with small engine capacity which will eventually result in a decrease of total emissions.

Electrification of cars will have its own impact on decreasing air pollutants. Nowadays, their use is a common practice in most parts of the world, but they are not widespread in Almaty or in Kazakhstan in general. However, increasing the number of electrified cars is not as great a solution as it may seem at first glance. This is due to the fact that in some countries, electricity production is heavily coal based, so the increase in demand for electricity will result in an increase of emissions from the energy production facilities making electricity for electrified vehicles. This actually has been a main issue in Calgary for many years and still has a significant negative impact on the city's air pollution.

Improving traffic management is a key activity to reduce the emissions. Building roads or planning traffic flows avoiding stop-go intervals could have a significant impact as well as implementing more speed limit signs. The less time the vehicles spend on the road travelling the less they tend to emit unwanted gases and thus reduce the total amount of emissions. Banning the use of old cars, (i.e. cars that were manufactured some 10 years ago or more) as well as increasing the standards for manufacturing new vehicles, especially a high control of the emissions they make at a factory level test, can also be an environmentally beneficial solution.

There is a lack of data to find out the exact level of pollution in Almaty. Government and local authorities should allocate more funds to carry out related research activities in order to identify the exact amount of pollution and its sources.

4.2. Industrial and residential buildings

The most significant impact on the decrease of harmful pollutants in the air will come from reducing the use of traditional energy sources, such as coal and oil, and switching to alternative sources. In fact, the city of Calgary only uses wind energy for its operations (Dodge and Kinney, 2015). Moreover, factories and plants should be encouraged to use renewable sources by getting tax credits and other financial support from the government. The use of green energy should be economically attractive for business operations.

The construction of residential and industrial buildings should be done with a sustainable approach, allowing for efficient heating and electricity use. 'Energy efficiency labeling' should be introduced, and existing buildings should be evaluated according to recommended world standards.

Modern technology and tools must be used to control factory emissions and capture hazardous pollutants on site. The installment of such equipment should be incentivized with the creation of stricter emission standards and regulations. Those exceeding the recommended amount of emissions must be punished with fines.

4.3. Parks and green areas

The improvement of parks and green areas is primarily achieved with the help of governmental funding. However, existing initiatives for the enhancement of green space in Almaty are usually of non-recurrent nature and do not involve huge financial investments. What Almaty needs is a well-designed program to upgrade its parkland. In 2012, the city of Calgary received 75 million dollars in funding for its park system (Stephenson, 2014). A similar program in

Almaty would greatly benefit the city. The money could be used to renovate current parks and add new green areas.

A widespread practice of cutting down trees to use the land for commercial purposes must be more thoroughly controlled. Unauthorized cutting of trees must be punishable by large fines. Trees should be dug up and replanted or new trees should be planted elsewhere. People need to be encouraged through social responsibility programs to plant trees and take care of them. Almaty citizens have to understand that by increasing the number of green plants they contribute to the environmental wellbeing of the city.

4.4. Wind patterns

One of the major problems regarding wind patterns in Almaty is the construction of the buildings. In order to solve this problem, buildings should be constructed in a way that does not block the free movement of the wind. This will create wind corridors within the city to allow for better ventilation of the streets. Moreover, future industries should not be built along the most frequent wind directions. This will decrease the amount of air pollutants moving towards the city.

Another ambitious project would be to create a wind corridor through the Almaty-Medeu canon as shown in Figure 14. The feasibility of such project is yet to be assessed.

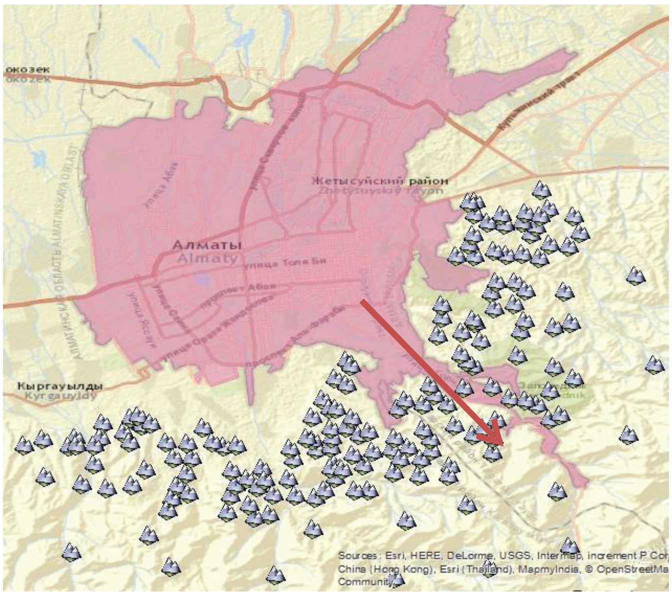


Figure 14 - Wind corridor through Almaty-Medeo canon

4.5. Waste management

Emissions from inefficient waste handling are not a big concern for Almaty. However, some best practices from Calgary can be used to improve the situation. Despite producing nearly an identical amount of waste, Calgary has 5 times more recycling facilities. Almaty needs to increase the number of recycling plants. Moreover, recycling rates should be also increased. In order to achieve high recycling rates, people have to be educated about sustainable use and disposal of products. As well, financial incentives, such as deposits and refunds on beverage containers could be implemented. The attitude of Almaty's citizens towards recycling must be changed.

5. Conclusion

In this research paper, we compared air quality in Almaty and Calgary, two cities with similar geographic and demographic characteristics. It was revealed that both cities exhibit a large amount of air pollutants. However, the findings showed that Calgary manages their air pollution problems through a number of governmental and municipal programs. Those include reducing current emissions by using alternative sources of energy, introducing varying vehicle registration fees, energy efficiency labeling, increasing the number of parks and green space, sustainable construction of buildings, and changing people's attitudes towards waste recycling. Our suggestions include gradually applying similar approaches to those that Calgary uses to overcome the problem of air pollution in Almaty. We recommend an improvement in the environmental situation in Almaty and the implementation of practices and initiatives from the city of Calgary. Almaty and Calgary cities could become twin or sister cities, and that would help with cooperation and implementation.

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УЛУЧШЕНИЕ КАЧЕСТВА ВОЗДУХА В АЛМАТЫ С ИСПОЛЬЗОВАНИЕМ ПЕРЕДОВОГО ОПЫТА ИЗ КАЛГАРИ

Аннотация. В данной статье представлены существующие кадастры выбросов города Алматы в Казахстане и города Калгари в Канаде. Мы сравнили факторы, влияющие на качество воздуха в обоих городах. Мы проанализировали пять критериев, способствующих загрязнению воздуха: транспорт, промышленность, зеленые зоны, ветровые режимы и управление отходами. Мы проанализировали эти факторы и определили основные проблемы, связанные с ними. Рекомендации по улучшению экологической ситуации в Алматы основаны на существующих и успешно внедренных практиках и инициативах из города Калгари, и показывают как канадская модель может быть реализована для Казахстана.

Ключевые слова: Алматы, Калгари, загрязнение воздуха, транспорт, промышленность, зеленые зоны, отходы, ветер, Канадская модель.

АЛМАТЫ ҚАЛАСЫНЫҢ АУА САПАСЫН ЖАҚСАРТУДА КАЛГАРИДАҒЫ АЛДЫҢҒЫ ҚАТАРЛЫ ТӘЖІРИБЕЛЕРДІ ПАЙДАЛАНУ

Аңдатпа. Бұл мақалада Қазақстандағы Алматы және Канададағы Калгари қалаларындағы қазіргі қалдықтар кадастры көрсетілген. Біз екі қаладағы ауа сапасына әсер ететін факторларды салыстырдық. Ауаның ластануына себепші болатын бес критерийді талдадық: транспорт, өндіріс, жасыл аймақтар, жел режимдері және қалдықтарды басқару. Біз осы факторларды талдай отыра, осыларға қатысты негізгі проблемаларды аныктадық. Соңында, Канадалық моделдерді Қазақстанда жүзеге асыру үшін Калгари қаласындағы сәтті жүзеге асқан тәжірибелер мен бастамалар негізінде Алматыдағы экологиялық ахуалды жақсарту бойынша ұсыныстар берілді.

Кілттік сөздер: Алматы, Калгари, ауа ластануы, тасымалдау, өндіріс, жасыл аймақтар, қалдықтар, жел, Канадалық модель.

EXPERIMENTAL PLATFORM FOR THE DEVELOPMENT SYSTEM OF MEASURING TECHNOLOGICAL PARAMETERS

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Abstract. The article proposes the use of an AUPET experimental platform for research on the collection, processing and data management technology options to address disaster prevention in industrial environments and socio-adapted facilities.
Key words: database, wireless communication, industrial controller, microcontroller, software.

Introduction

An educational and research platform for multilevel system automation of industrial processes was created at AUPET based in the laboratories of the Electronics department. This area, which was built in a hierarchical manner, has three levels: an intellectual system of central control station, intelligent network management system of industrial controllers, and intellectual system of data measuring channels [1].

Simply put, the experimental area of the department is a network of virtual laboratory work bench (VLWB), which includes two components: virtual - the program, and physical – the real hardware. Educators using VLWB integrate diverse interdisciplinary knowledge and many types of academic work of students.

The physical structure for collecting data from laboratory stands is shown in Figure 1. Each laboratory stand is connected to a PC or laptop for controlling the laboratory setting and collecting data about parameters. The PC or laptop plays the role of a network client. The client sends all data about the laboratory benches to the server, which works as a control station. The server provides all the information about the parameters of the laboratory facilities to the personal computers for further processing.

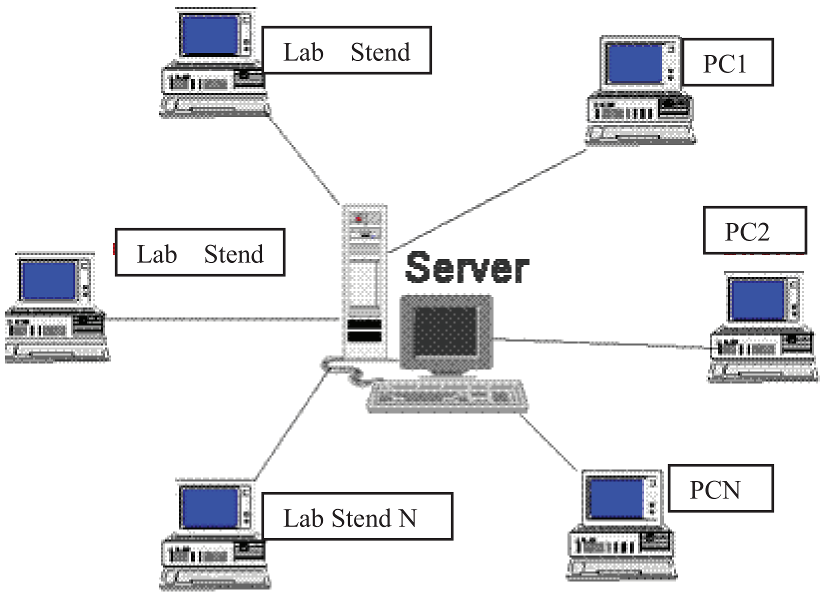


Figure 1 – Structure of the VLWB network

The Department of Electronics uses the different laboratory facilities with the various measurement technics and a wide variety of methods of controlling and automation starting from microcontrollers up to industrial controllers. It is very important to gather all the information and provide easy access to learners and teachers for processing. In order to do this, the Department of Electronics decided to find solutions in related branches of science: communication, information technology, microprocessor machinery, and so on.

The following objectives were set for designing the experimental platform:

– organization of communication between the lab benches, computers-clients, servers, and other members of the VLWB network

– programming microcontrollers [5], and industrial controllers [6]

– schedule organization [7]

– the development of communication interfaces [8]

– the application of information technology for data collection.

Communication between the laboratory bench and the computer, which acts as a point of controlling a bench and a receiver of information about laboratory parameters, can be realized through either wireless [8], or wired network communications. The connection to the server requires wireless communication, as the server is in a different room and there is only one for a number of network clients. For organization, a wireless network is supposed to use the following wireless technologies: Wi-Fi, Bluetooth, ZigBee, Z-Wave. The advantage of using wireless technology is the ability to expand the system, which is important for the construction of an experimental platform which includes new educational stands in the current VLWB network. Currently, two types of wireless communication: Wi-Fi on most customer points and a radio signal on the basis of an experimental set of MSP-EXPC430RF4 software CC430 Wireless Network Monitor v1.0 with SimpliciTI wireless data transfer protocol [5,8] are implemented and work well.

The remaining tasks are dedicated to developing software. The software required to build an experimental platform can be divided into three types:

1) software for controlling a laboratory bench

2) software for data collection

3) software for data processing.

In the department, laboratory benches are connected to microcontrollers of various companies, such as AVR, PIC and Texas Instruments, as well as different classes of SIEMENS industrial controllers (Simatic S7-314C, S7-1212, S7-1515). Therefore, the software for managing and controlling the laboratory bench is individual for each bench and the choice depends on the type of controller used.

Totally Integrated Automation (TIA) Portal software environment is used to manage and control the laboratory bench with SIEMENS controllers [6,7].

TIA Portal is an intuitive, efficient and reliable development framework that allows you to optimally design all automation processes using a single operating screen. TIA Portal creates a unified framework for the development of complex projects based on a variety of hardware and software components of the LA & DT department. This framework provides support for navigation features projects, the concept of using a single library, centralized data management and ensures their coherence, actuation of the necessary editors, saving projects, diagnostics and many other functions. TIA Portal integrates software STEP 7 V13 and WinCC V13.

Software WinCC V13 contains a complete set of tools to solve all the problems of human-machine interface based on software and SIMATIC HMI hardware. Projects may be developed as separate operator panels and multi-user SCADA systems with the help of software WINCC.

Additional software WinCC Runtime is utilized to collect data in real time. To ensure communication between the client and the server, we used WinCC Server program and WinCC Client [2].

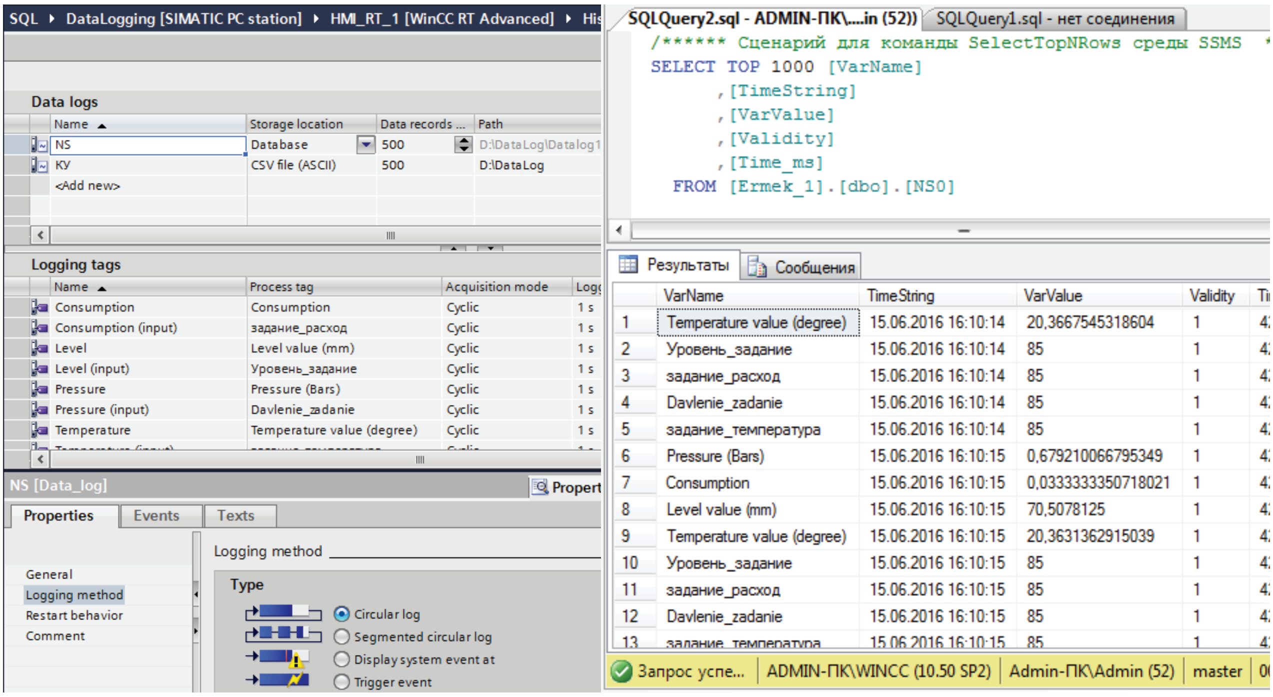
In order to develop software communication interfaces to other laboratory benches, LABVIEW graphical programming tools were chosen. Laboratory Virtual Instrument Engineering Workbench (LabVIEW) allows you to develop application software for interaction with measuring and control equipment, the collection, processing and display of information and the results of calculations and modeling of individual objects, and automatic systems in general [3].

The chosen software for data acquisition was MS SQL Server, which is a system with relational database designed to gather information about the parameters of laboratory facilities in real time. TIA Portal and LabVIEW are able to communicate directly with SQL Server databases. Figure 2 shows the connection between the TIA Portal and SQL Server programs based on the example of a "pumping station" laboratory bench. The process of collecting and storing data is automated with the ability to automatically save any amount of data.

The advantages of using the MS SQL Server is the ability to combine multiple instances of SQL Server on the same network. In this case, the database is physically located on the server. The remaining databases are located on the client

PC, and they simply display all of the information stored on the server. User identification data such as, server login and password are required to gain access to the database server [4].

SQL Server has essential capabilities to process information and provide the data in the form of various reports, graphs, charts, etc. At the same time, to use these functions you need knowledge of the SQL query language, which is not always known to students at the beginning level. Therefore, to access the database and process data, the graphical tool LabVIEW is also used.



a) Historical Data window in the TIA   b) SQL Server query window

Figure 2 - The relationship between the TIA Portal and SQL Server

Discussion

Thus, the experimental platform for the developing a measurement system of technological parameters allows you to:

– ensure the collection of information from the equipment

– archive data as new information becomes available

– solve design challenges, in terms of inflow new data and the user's request

– provide information to the users in the form of mimic diagrams, graphs, and tables with values of parameters of the equipment

– realize tasks display, processing and transmitting process parameters - temperature, humidity, flow rate, air pressure and liquid; electric quantities - current, power, voltage, circuit resistance, digital codes of different signals.

Conclusion

Combining different layout settings to the network with a common database will allow:

- an increase in the number of ongoing laboratory work on the stands
- develop new labs using several stands
- optimal use of the available stands for education and scientific research
- conduct laboratory work remotely, without being tied to an audience
- handle obtained VLWB data as they become available on-line or off-line, after a sufficient amount of the saved parameters;
- send data coming from VLWB to a few PCs for individual work of students with a stand.

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ЭКСПЕРИМЕНТАЛЬНАЯ ПЛОЩАДКА ДЛЯ РАЗРАБОТКИ СИСТЕМЫ ИЗМЕРЕНИЯ ТЕХНОЛОГИЧЕСКИХ ПАРАМЕТРОВ

Аннотация. В статье предлагается использовать экспериментальную площадку АУЭС для проведения исследований по сбору, обработке и управлению данными технологических параметров для решения вопросов предотвращения чрезвычайных ситуаций в промышленной среде и социально-адаптированных объектах.

Ключевые слова: база данных, беспроводная связь, промышленный контроллер, микроконтроллер, программное обеспечение.

ТЕХНОЛОГИЯЛЫҚ КӨРСЕТКІШТЕРДІ ӨЛШЕУ ЖҮЙЕСІН ҚҰРАСТЫРУҒА АРНАЛҒАН ТӘЖІРИБЕЛІК АЛАҢЫ

Аңдатпа. Бұл мақалада әлеуметтік дағдыланған нысандар мен өндірістік ортада төтенше жағдайларды болдырмау сұрақтарын шешу үшін мәліметтерді жинастыру, өңдеу және технологиялық көрсеткіштер мәліметтерін басқару сияқты зерттеулерді жүргізу үшін АЭжБ университетіндегі тәжірибелік аланды қолдану ұсынылады.

Кілттік сөздер: мәліметтер қоры, сымсыз байланыс, өндірістік бақылаушы, микробақылаушы, бағдарламалық жасақтама.

CLIMATE CHANGE IMPACTS ON GLACIER AND RIVER RUNOFF IN WESTERN PART OF ZHETYSU (DZHUNGAR) ALATAU

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Abstract. Our glaciological studies were conducted for the periods of 1956-1989, 1989-2001 and 2001-2012 and are based on Landsat TM/ETM+ data analysis. A well-established semi-automated band ratio technique was applied for glacier mapping. The result showed a comparatively higher shrinkage rate (-1.02%) than rates in other glacierized areas of Central Asian mountains, including Altai, Tien Shan and Pamir. We also analyzed long-term climatic and runoff fluctuations for the different sub-basins of the Karatal River. A positive trend in annual discharge was detected in almost all the glacierized tributaries of the Karatal River during the last half of the century.

Key words: glacier shrinkage, glacier mapping, river runoff, Karatal river basin.

Introduction

Global climate has changed on both regional and global scales, with a mean increase in annual temperature of 0.74 from 1906 to 2005 and a predicted increase of 1.1 °C−6.4°C by 2100 [1]. This increase in surface temperature has important consequences for the hydrological cycle, particularly in regions where the water supply is provided mostly by melting ice or snow. Even a low fraction of change in glacial cover within a basin has tremendous impact on hydrology. Various research studies based on remote sensing methods found that the shrinkage of Central Asian glaciers has accelerated in the last several decades [2, 3,4]. Especially, glaciers that are located on the peripheral regions of the Tien Shan [5, 6] have changed.

In spite of the glaciers' importance to the economy, after the collapse of the USSR in the 1990s, regular glacier mass balance and other ground-based glaciological measurements were discontinued in the Karatal River basin, as well as in the entire Zhetysu Alatau mountain range.

In this study, the glacier area shrinkage and the effects of dramatically decreased glacier runoff for the sub-basins of Karatal river with different glaciation area are assessed. The three main parts of this study include detection of long-term trends of runoff, precipitation, and air temperature; estimation of glacier change; and the assessment of the effects of glacier and climate changes on runoff.

Study area

We focused on the Karatal River Basin, which is the largest basin in Zhetysu Alatau. It covers an area of 19,100 km2; and the total area of the four sub-basins studied here is 4370 km^2 (Figure 1).

The Karatal river basin is located on the outer ranges of Zhetysu Alatau, where the elevations of the highest mountain ridges range between 3800 and 3850 m above sea level [7]. Most glaciers found here are small in size (less than 1 km^2). In addition, the Karatal basin is close to urban areas, which are located approximately 60 km from the lowest glaciers [8].

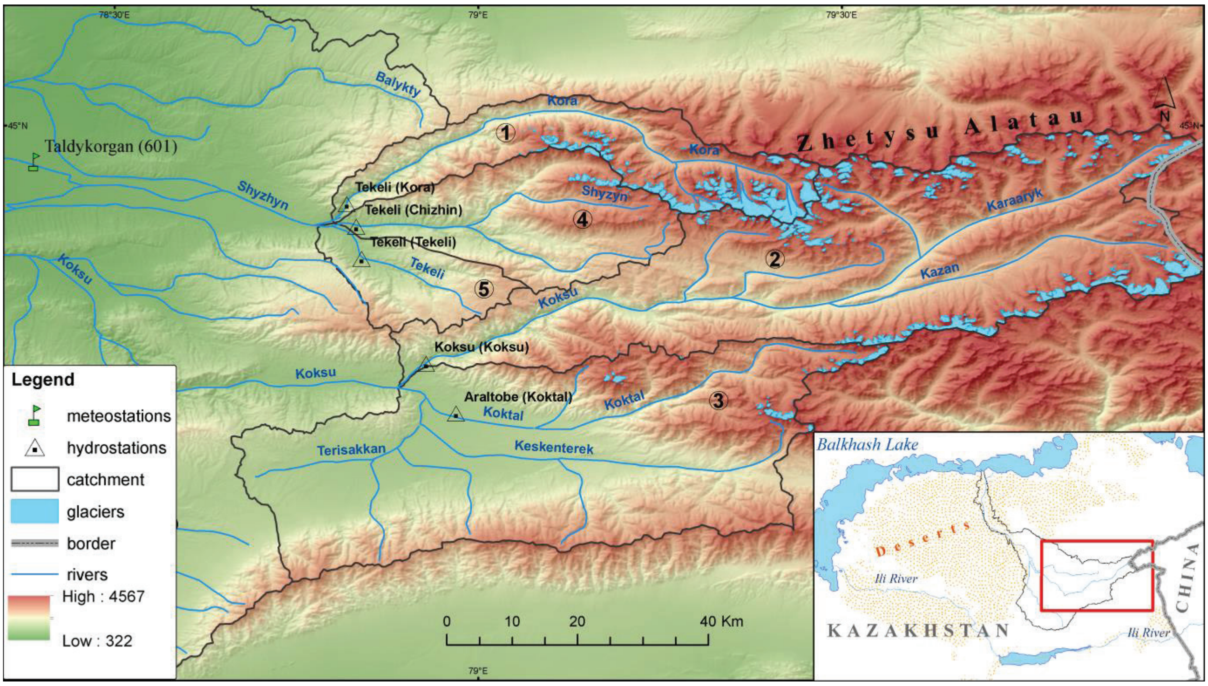

Figure 1 - Location of the study area; map based on SRTM3-DEM; sub-basins with glacier: 1 – Kora; 2 – Koksu; 3 – Koktal; 4 – Chizhin; 5 – Tekeli; Weather station – Taldykorgan (air temperature, precipitation)

Data and methods

Remotely sensed data and glacier mapping technique

Landsat TM and ETM+ images were used to measure glacier delineation. We applied a well-established semi-automated approach using the TM3/TM5 band ratio to produce glacier outlines. Misclassified areas, such as snow patches, cast shadows and lakes, were corrected manually using false-colour composite (TM bands 5, 4, and 3) on the Landsat imagery. All of the images were obtained during cloud-free conditions and for the ablation period when the extent of snow cover was minimal in order to reduce potential uncertainly in glacier boundary delineation because of seasonal snow cover. Changes in the extent of glaciers were assessed with regard to images from 1989, 2001 and 2012, and analysed according to the surface area. Landsat TM and ETM+ scenes were co-registered to the 2001 Landsat ETM+ scene, and root-mean-square error (RMSE) was within 0.5 pixels.

Hydro-meteorological data and trend analysis

In order to determine and analyse the potential drivers of glacier changes and investigate the changes in river runoff over the past decades, a trend analysis using the Mann-Kendall test [9] was carried out for the time series of runoff at selected hydrological stations.

An accumulative deviation test was applied to detect trends in air temperature at the Taldykorgan weather station. Test results showed that the temperature had a step change point occurrence in 1977. Therefore, the data series was divided into two periods before and after 1977.

The rank-based nonparametric Mann-Kendall test is commonly used to assess the significance of monotonic trends in a hydro-meteorological time series. In this test, the standard normal statistic Z is estimated and compared with the standard normal deviate $Z_{\alpha/2}$. The test statistic Z is not statistically significant if $-Z_{\alpha/2} < Z < Z_{\alpha/2}$. Correspondingly, this test shows a statistically significant trend if $Z < -Z_{\alpha/2}$ or $Z_{\alpha/2} < Z$. The confidence level fixed at $\alpha = 0.95$ and critical z values for two-sided test are −1.96 and +1.96.

Results

Glacier shrinkage

Our glaciological studies were conducted for the periods of 1956-1989, 1989-2001 and 2001-2012 based on Landsat TM/ETM+ data analysis.

In 1989, we found 243 glaciers with a total area of 142.8 km^2 that by 2012 had shrunk to 214 glaciers with a total area of 109.3 km^2. This indicates a decrease of 33.5 km^2 over 23 years or -1.02% per year. We also analyzed the shrinkage rate of glaciers based on their differences in size, altitude and aspect of slopes, as well as other topographic parameters in four sub-basins, where glacier shrinkage varied from 18% to 39% (Table 1).

Table 1 - Changes in Glacier area

Region	Area change (%) /annual rate (%)					Mean size (km^2) in
	1956-89	1989-01	2001-12	1956-12	1989-12	
Terisakkan	-40/-1.22	-23/-1.96	-20/-1.8	-63/-1.13	-39/-1.68	0.403
Koksu	-31/-0.93	-15/-1.24	-13/-1.14	-48/-0.86	-26/-1.11	0.506
Chizhin	-44/-1.32	-15/-1.24	-9/-0.79	-56/-1.0	-22/-0.97	0.445
Kora	-28/-0.61	-14/-1.03	-7/-0.63	-35/-0.62	-18/-0.80	0.873
Total	-28/-0.86	-14/-1.20	-11/-0.96	-45/-0.81	-23/-1.02	0.588
Glaciers <0.1 km^2 in 1956	-34/-1.04	-68/-5.63	-22/-1.99	-83/-1.49	-75/-3.25	0.031

Runoff Trends

Trends in monthly and annual runoff for the sub-basins of Karatal river were analysed. Discharge trend analysis was calculated for three periods: full-observed time and for periods before and after 1977 (step change year) for each hydrological station. Annual runoff of almost all of the sub-basins showed an increasing trend for annual, melting and frozen seasons for the entire observed time (Figure 2 A). An increasing discharge trend was statistically significant in more glacierized catchments (Kora, Koksu and Koktal). Runoff trends for the melting season were similar to those in the annual cycle. Less glacierized (Chizhin) and non-glacierized sub-basins (Tekeli) show a lower increasing trend in the melting season and annual time frame.

The discharge trend for the first period, before step change year (1977), showed a slightly negative trend in the annual and melting cycle. A positive trend was found for only two stations, Chizhin and Tekeli. However, the trends for cold months and the frozen season were different. The discharge trend was increased in Koktal and decreased in Chizhin and both trends were statistically significant (Figure 2 B).

Runoff data for the second period (after 1977) indicated trends that are more positive. In the Koksu sub-basin, where most of the glaciers were located (108.6 km^2 in 1956), trend analysis exhibited a statistically significant increase for melting, frozen and annual cycles. Three sub-basins, which were more glacierized, showed a slight increasing trend, while less glacierized sub-basins had small decreasing trend during the melting season (Table 4 C).

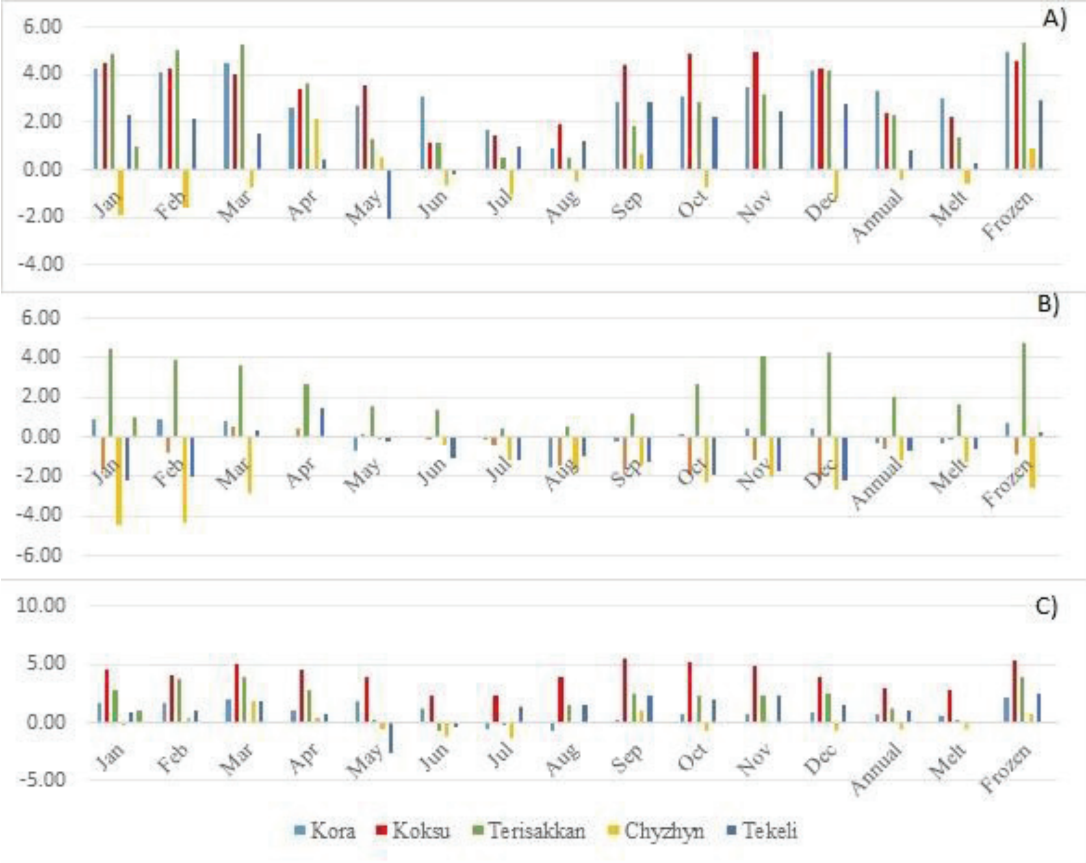

Figure 2 - Kendall test Z statistics for trends of monthly, annual and seasonal runoff for the Karatal river sub-basins: (A) for entire period, (B) and (C) for the periods before and after the 1977 (step change) year, respectively. Critical value of $Z < -1.96$ and $>+1.96$ (two-sided)

Discussion

The linear trend analysis of mean temperature indicated that the average rate of temperature increase was 0.43 °C $(10a)^{-1}$, while the summer (JJA) temperature rose 0.28 °C $(10a)^{-1}$ (see Figure 3). From 1960 to 2007, records at the same station displayed a slight decrease in annual precipitation. Increasing temperature leads to: (1) increased energy available for ice and snow-melt, (2) decreased snow accumulation, and (3) lower albedo of the glacier surface [10, 11]. The temperature increase caused the rainfall rate to increase, rather than snowfall in the high altitude glacierized areas, leading to a reduction of accumulation and the acceleration of ablation, especially during the summer. Due to a significant increase in annual temperatures between 1960 and 2007, and a stable annual precipitation trend, which did not compensate for the rising temperature, intensive glacier melting occurred.

The area changes of the glaciers investigated in the Karatal river basin confirmed an expected and widely published trend of glacier retreat [11, 12]. However, our results for this region indicated the highest shrinkage rate for the period of 1989-2012 compared to other glacierized areas of Central Asia, including all parts of Tien Shan and Pamir. The effect on runoff changes was different in glacierized sub-basins of Karatal river. The relatively high glacierized Kora area (14% glaciation) showed the highest positive trend, while the smaller glacierized Koktal area (5%) demonstrated a smaller trend, with the statistically significant magnitude of 3.32 and 2.31, respectively (Table 2). In the catchment with only 2% glaciation (Chizhin), the trend was even negative with a magnitude of -0.43. Apparently, the tipping point (peak water) for this catchment might be already passed [12, 13].

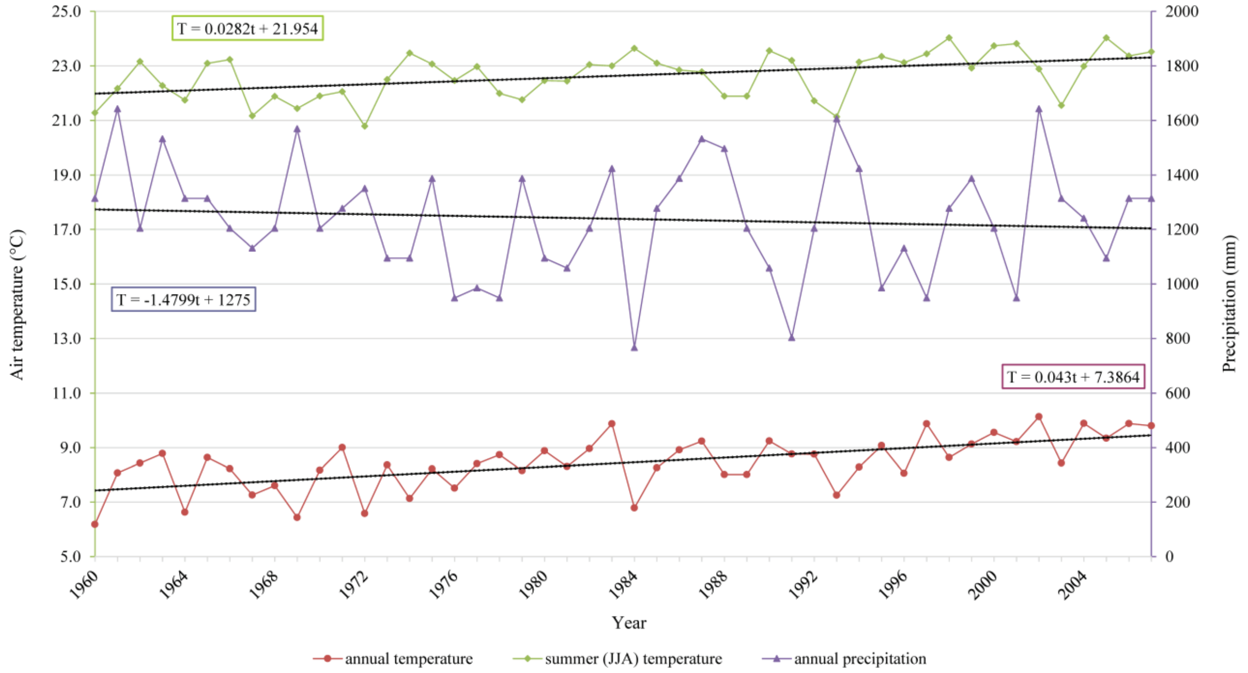

Figure 3 - Annual and summer (JJA) temperature and annual precipitation of Taldykorgan station [4]

Table 2 - Characteristics of sub-basins and changes in annual runoff

	Glaciation, %	Z of trend in annual runoff	Mean runoff (m3/s)	Basin area(km^2)
Kora	14	3.32	14.1	484
Koksu	7	2.38	39.2	1590
Terisakkan	5	2.31	9.3	293
Chyzhyn	2	-0.43	11.6	479
Tekeli	0	0.86	2.2	193

*Critical value of Z < −1.96 and >+1.96 (two-sided)

The tipping point is a phenomenon when runoff during warm temperatures will at first increase due to the higher temperatures and result in more meltwater.

This effect is gradually reduced when the glacier area begins to decline as a result of continued glacier mass loss. Tekeli sub-basin, which has no glacier, showed a slight increasing trend, but the absolute water volume of the rising trend was very small. Based on runoff trend analysis, the runoff in the sub-catchments was controlled by temperature provoking the melting of glaciers which had existed for decades and centuries.

Conclusions

Our results, with the shrinkage rate of about -0.8% to -1% per year for the periods of 1956-1989 and 1989-2012 for this study area, showed the highest decreasing rate compared to other glacierized areas of Central Asian mountains, including Altai, Tien Shan and Pamir. Climatic conditions play a primary role on glacier status. Two main climatic factors, statistically significant temperature increases and slight precipitation decreases, were the main cause in the glacierized area loss in the Karatal river basin.

River runoff demonstrated a significant increasing trend during the last half of the century at the expense of glaciers' melting intensification against a background of slight decreasing precipitation at the same time.

The increase of global temperature had a significant impact on the river runoff fluctuations for even small glacierized areas (5% - 14% of the total basin).

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ВЛИЯНИЕ ИЗМЕНЕНИЯ КЛИМАТА НА ЛЕДНИКИ И РЕЧНОЙ СТОК В ЗАПАДНОЙ ЧАСТИ ЖЕТЫСУСКОГО (ДЖУНГАРСКОГО) АЛАТАУ

Аннотация. Наши гляциологические исследования проводились на периоды 1956-1989, 1989-2001 и 2001-2012 на основе анализа данных Landsat TM/ETM+. Для картирования ледников использован налаженный полуавтоматический метод Band ratio technique. Результаты показали, что скорость сокращения ледников (-1.02%), сравнительно быстрее чем в других оледенённых горных территориях Центральной Азии, включая Алтая, Тянь-Шаня и Памира. Мы также проанализировали долгосрочную колебанию климата и речных сток для различных под-бассейнов реки Каратал. Была обнаружена положительная тенденция почти во всех оледенённых притоках реки Каратал за последние полвека.

Ключевые слова: сокращение ледников, картографирование ледников, речной сток, Каратальский речной бассейн.

ЖЕТІСУ (ЖОҢҒАР) АЛАТАУЫ БАТЫС БӨЛІГІНДЕГІ МҰЗДЫҚТАРДЫҢ ЖӘНЕ ӨЗЕН СУЫНЫҢ ӨЗГЕРІУІНЕ КЛИМАТТЫҢ ӘСЕРІ

Аңдатпа. Біздің гляциологиялық зерттеулер 1956-1989, 1989-2001 және 2001-2012 жылдар аралығына Landsat TM/ETM+ мәліметтерін талдау негізінде жасалды. Мұздықтарды картографиялауда кең таралған жартылай автоматты Band ratio technique әдісі қолданылды. Алынған нәтижелер мұздықтардың - 1,02%

жылдамдықта қысқарғандығын және бұл көрсеткіш салыстырмалы түрде Орталық Азия таулы аймақтарындағы (Алтай, Тянь-Шань және Памир тауларын қоса есептегенде) мұздықтардан жылдам қыскарып жатқандығын қөрсетті. Сонымен қатар, Қаратал өзеніндегі әртүрлі салалардағы өзен суы мен климаттың ауытқулары талданды. Соңғы жарты ғасырда Қаратал өзенінің салаларында судың көбейгендігі байқалды.

Кілттік сөздер: мұздықтардың қысқаруы, мұздықтарды картографиялау, өзен ағысы, Қаратал өзені бассейні.

PREVENTIVE MEASURES TO REDUCE THE DAMAGE FROM SOME SECONDARY EARTHQUAKE DAMAGE

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Abstract. This article deals with questions about the consequences of earthquakes in the earthquake zones of Kazakhstan and explains measures to reduce casualties, in particular, the use of shatterproof bulletproof glass and other mechanical protective equipment.

Key words: earthquakes, natural disasters, disasters, protective film, glass, seismic resistance.

Of all natural disasters known on earth, earthquakes, more than other natural disasters (ND), often occur quite suddenly. Examples of devastating EQs in our area include: Ashkhabad in 1948, Tashkent in 1966 and Spitak in 1988 [3].

Economic losses from EQ, as well as their social, natural, and environmental impacts are significant. Total losses in the world from emergency situations (ES), including technogenic ones, steadily increase every year and reach hundreds of billions of dollars, and claim hundreds of thousands of human (and animal) lives. At the same time, the destructive EQ is accompanied by a change in the environment, landscape, deterioration of air quality and destruction of man-made objects and infrastructure.

Because a third of Kazakhstan's territory is seismically active, EQs especially represent a serious threat. For example, in the late XIX and early XX centuries in the Tien Shan region, in only a 26 year time period, there was a series of devastating EQs, of which Belovodskoe, Chilik, Kemin had serious consequences for Almaty city [3].

Hence, the problems associated with the EQ, are relevant for the southern capital and the rest of the country. The vulnerability of people in relation to the ND has been steadily growing due to increasing population density, and infrastructure complexity. Almaty has about 1.4 million residents. The number significantly increases if all the outlaying settlements in Almaty region are included in the count. The large settlements and towns have a high concentration of industrial enterprises, a large number of gas pipelines, flammable agent storage facilities, and transport systems. Thus, an EQ may cause various technical accidents - fires, explosions, and emissions of hazardous substances into the atmosphere.

As a result, the significant expansion of the zone of emergency situation (ES) has dramatically increased the economic loss, environmental damage, and the irrecoverable loss of life and health. For example, during the EQ in Japan on 17 January 1995, more than 350 fires destroyed the buildings in the densely populated area of the city [3].

In addition, there are social costs associated with the breach of supplies; the deterioration of sanitary conditions, leading eventually (with high probability) to the development of communicable diseases, which will necessitate quarantine conditions. EQ may cause the activation of other manifestations of the phenomena of natural character such as mudslides, floods, tsunamis, landslides, and avalanches.

President Nazarbayev in his message to the Nation "Kazakhstan – 2050," identified "... Our main goal - by 2050 is to become one of the 30 most developed countries of the world. Our achievements and our Kazakh model of development should be the basis of a new political course" [2]. For the execution of this goal of stable development of our country and economic growth, it is necessary, along with other important issues, to ensure seismic safety in Kazakhstan. It is necessary to ensure that the security of the vital interests of the country and the people in the seismic areas are protected from the EQ and the secondary consequences. Numerous measures must be implemented. The awareness of the tragic consequences of a catastrophic EQ has led to the fact that the task of ensuring the seismic safety of all the stakeholders has become connected to national security issues.

Many newly constructed buildings in Almaty are designed with a lot of glass. The impression is that the buildings are made entirely of glass. These buildings, with significant outer glazing, are very dangerous - not only for those who are inside the building, but also those outside. It is difficult to present a picture of what will happen to people who are in such buildings, when a 5 to 7 point earthquake occurs (on the MSK-64 scale), let alone a more destructive EQ. Statistics say that modern humans spend more than 70% of their time in different locations. At the same time, the share of destruction due to shards of broken glass during possible accidents accounts for about 30%. With explosions, the figure rises to 60 to 70%. In reality, the number of attacks involving explosives has not tended to decrease, while more and more glass is being used in construction of all sizes of buildings [4].

The main causes of the destruction of glass used in construction are thermal stresses resulting from the heating of glass, mechanical forces, due to its own weight, wind, hits from flying objects, and vibration loads. Due to the design, location and construction of buildings and the nature of ND, winds now frequently accompany EQ [6].

A destructive EQ can lead to massive destruction of glass and the number of casualties caused by the natural EQ factors increases significantly due to the distribution of glass fragments.

With a significantly strong EQ, it is the destruction of the frames and transoms, which leads to the destruction and distribution of glass. The damage is comparable to the effects of an explosion. The number of injuries caused by glass fragments from an EQ is greater than injuries caused by shards of glass during an explosion. From a security standpoint perspective, the more vulnerable sections of the buildings are glazed openings: windows, stained glass windows, glass doors, and partitions. That material which is designed for protecting lives and property, is referred to as "protective glazing." This is shatterproof and bulletproof glass, and laminated glass or glass covered with a protective film (PF). Such film is generally used where there is no need to use expensive armored glass shatterproof and mechanical or other protective equipment [6].

The main function of the PF is to preserve the integrity of the system: Film + glass even if the glass is destroyed. In high-rise buildings, glass film prevents the glass from falling to the street**.** PO is an alternative replacement of existing glass with laminated floors**.** It is important not to confuse the PF, with all the necessary safety qualities - strength, protection against ultraviolet and infrared radiation from the conventional tinting film. PF are the products of nanotechnology and manufactured only in countries that own these technologies. According to international experts, the best PF is currently produced in the United States, France and Japan [5].

These countries have adopted measures to improve the safety of the glass fragments. Installing the PF has shown that 80% fewer injuries occur from glass fragments.

Earthquakes are geodynamic processes that occur in a short moment originating in the depths of the earth. EQ is one of the most formidable ND, leading to disasters with serious economic, environmental and social consequences.

For Kazakhstan, where more than 30% of the territory belongs to the seismically active zone, ensuring seismic safety and protecting Kazakhstan's population from the effects of these geological disasters requires urgent attention.

In the Republic of Kazakhstan "On civil protection" Law, the idea of the importance of early preventive measures is evident. For example, in Section 1, Chapter 1, Article 1, claim 72 clearly indicates the direction of events at the maximum possible reduction of the risk of emergencies, as well as the preservation of human life and health [1].

On this basis, realizing the tragic consequences of the secondary factors of EQ, relating to glass lesions, it is necessary in the planning of activities of civil protection, to fully assess the risks and comply with the requirements of the Republic of Kazakhstan Law "On Civil Protection."

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ПРЕВЕНТИВНЫЕ МЕРОПРИЯТИЯ ПО СНИЖЕНИЮ УЩЕРБА ОТ НЕКОТОРЫХ ВТОРИЧНЫХ ФАКТОРОВ ЗЕМЛЕТРЯСЕНИЙ

Аннотация. В статье рассматривается вопросы о последствиях землетрясений в сейсмоопасных зонах РК и меры уменьшения жертв, в частности, применение безосколочного бронестекла и иных механических защитных средств.
Ключевые слова*:* землетрясение, стихийные бедствия, бедствия, защитная пленка, стекло, сейсмоустойчивость.

ЖЕР СІЛКІНІСІНІҢ КЕЙБІР ҚАЙТАЛАМА ФАКТОРЛАРЫНЫҢ БОЛАТЫН ШЫҒЫНДАРДЫ АЗАЙТУ БОЙЫНША АЛДЫН АЛУ ШАРАЛАРЫ

Аңдатпа. Мақалада Қазақстан Республикасының сейсмикалық қауіпті аймақтарында жер сілкінісінің зардаптары және адам шығынын азайту шараларын, яғни бронды шиша қолданылуы мен басқа да механикалық қорғау құралдарын қолдануын қарастырады.
Кілттік сөздер: жер сілкінісі, табиғи апаттар, апаттар, қорғаныш пленкасы, шыны, сейсмикалық төзімділігі.

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