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GIS-technology in the management of mudflow risk

This article considers the possibility of using GIS technology in the management of mudflow risks. It is proposed to creating a single electronic database with spatial referenced in real terrain. Among the dangerous exogenous processes occurring in the mountain and foothill regions of Kazakhstan, mudflows are among the most catastrophic on the territorial distribution, the formation frequency, the scale of the caused damage. Threatened of mudflows are plenty of settlements and cities, as well as significant areas of valuable lands and economic facilities of south-eastern and eastern Kazakhstan. The effectiveness of management measures to reducing and preventing the devastating effects of mudflows on social, techno and ecosphere of the region is highly dependent on decision making on time. To make justified and effective decisions in managing mudflows risks, modern specialist should be able to receive, collect, preserve and process data, presenting the results in the form of visual documents by via computers and communications equipment. The main objective of the creation of such databases to help less experienced users to finding existing description solutions of any problems in a subject fields.

Key words: GIS, dangerous phenomenon, mudflows, mudflow risks, risk managements, decision-making.

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Сел қаупін ауыздықтауда ГАЖ-технологияларын қолдану

Аталған мақалада сел қаупін ауыздықтауда ГАЖ-технологияларын қолдану мүмкіндігі қарастырылған. Шынайы аумақта кеңістікті байлам анықталған мәліметтердің бірыңғай электрондық базасын құру ұсынылады. Қазақстанның таулы және тауалды аудандарында көрініс беретін апатты экзогенді процестер арасында сел тасқындары таралуы, қайталанғыштығы және оның көрініс беру нәтижесінде туындайтын зиянды салдары жөнінен айтарлықтай апатты құбылыстар санатына жатады. Қазақстанның шығыс, оңтүстік-шығысындағы елді-мекендер мен қалаларға, сондай-ақ егістік алқаптар мен шаруашылық нысандарға төніп тұр. Сел тасқындары арқылы келтірілетін шығын көлемі әдеуір болғандықтан, олардан қорғануды талап етеді. Сел тасқындарының аумаққа тигізетін апатты әсерін төмендету және алдын алу жөніндегі ауыздықтау шараларының тиімділігі шешімдердің уақытылы қабылдануына тікелей тәуелді. Сел қаупін ауыздықтаудағы негізделген және тиімді шешімдерді қабылдау үшін қазіргі заманғы мамандар компьютер және байланыс құралдарының көмегімен ақпараттарды қабылдап, жинақтап, сақтап және өңдеп және нәтижелерді көрнекі құжаттар ретінде көрсете алуы керек. Мұндай мәліметтер базасын құрудың басты мақсаты – тәжірибесі аз мамандарға төтенше жағдайлардың алдын алуды, уақытылы әрі жылдам шешім қабылдауға мүмкіндік береді.

Түйін сөздер: ГАЖ, қауіпті құбылыстар, сел тасқыны, сел қаупі, сел қаупін ауыздықтау, шешімдер қабылдау.

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ГИС-технологии в управлении селевыми рисками

В данной статье рассматривается возможность применения ГИС-технологий в управлении селевыми рисками. Предлагается создание единого электронного банка данных с пространственной привязкой в реальной местности. Среди опасных экзогенных процессов, происходящих в горных и предгорных районах Казахстана, селевые потоки относятся к наиболее катастрофическим по территориальному распространению, частоте формирования, масштабам наносимых ущербов. Под угрозой селевых потоков находится большое количество населенных пунктов и городов, а также значительные площади ценных земельных угодий и хозяйственные объекты Юго-Восточного и Восточного Казахстана. Ущерб, наносимый селями, требует защиты от них. Эффективность управленческих мероприятий по снижению и предотвращению разрушительных воздействий селей в большой степени зависит от своевременного принятия решений. Для принятия обоснованных и эффективных решений в управлении селевыми рисками современный специалист должен уметь с помощью компьютеров и средств связи получать, накапливать, хранить и обрабатывать данные, представляя результат в виде наглядных документов. Главная цель создания таких баз – помочь менее опытным людям найти существующее описание способа решения какой-либо проблемы предметной области.

Ключевые слова: ГИС, опасные явления, селевые потоки, селевой риск, управление рисками, принятие решений.

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GIS-TECHNOLOGY IN THE MANAGEMENT OF MUDFLOW RISK

1. Introduction

Geographic information systems and technologies are increasing application in human life. Range of solvable tasks by using GIS tools is extremely wide. Scientists estimate that 85 % of information facing by human in their lives has a territorial binding. Therefore, to enumerate all the GIS application areas are simply impossible. These systems can be applied virtually in any field of labor activities of human. GIS are effective in all areas, which are carried out accounting and control of the territory and objects on it. GIS is more actively included of our lives, scope of activities and business.

What is happening in the world large-scale build-up and diversified the introduction of geographic information resources is largely due to the need to improve information systems for decision-making at the state level.

Large-scale build-up and multi-pronged implementation of geoinformation resources are happening in the worldwide is largely associated with the need to improving information systems to providing decision-making at the state level. Interdepartmental information interaction and analytical support decision-making can be ensured by using such systems based on modern methods of spatial analysis, simulation of emergency situations and predict their consequences.

2. Discussion

Among the dangerous exogenous processes occurring in the mountain and foothill regions of Kazakhstan, mudflows are among the most catastrophic on the territorial distribution, the formation frequency, the scale of the caused damage. Threatened of mudflows are plenty of settlements and cities, as well as significant areas of valuable lands and economic facilities of south-eastern and eastern Kazakhstan.

The damage caused by mudflows, requires protection from them. The growth of the negative effects of mudflows caused by the mudflows phenomena activation and strengthening the economic development of the territories, among the priority tasks put forward is the creation and implementation of management systems of mudflow risk. The developments effectiveness of management measures

to reducing and preventing the devastating effects of mudflows on social, techno and ecosphere of the region is highly dependent on the degree of it scientific validity. The quality of the latter is determined by the knowledge levels about the formation conditions, mechanisms appearance of mudflows and their parameters, composition of recipient and characteristics of the mudflows impact. The knowledge required for managing mudflow risk, based on collected, analyzed and systematized data of information. From the completeness, accuracy and detail of background information in a heavily depends on the correctness of determining of the spheres and activity directions on protection from mudflows.

One of the common forms of data systematization for mudflows risk management system is the "Passport of mudflow basins". The Geography Institute of the MES by the order of SI "KazSeleZashshita" was developed the structure of the "Passport of mudflow basins" and was compiled the "Passport of Kishi Almaty River's mudflow basin" [1, 2].

The creation purpose of the Passport was information provision of management mudflow risks; data systematization, it was carried out in accordance with the main directions of risks management.

Designed passport in that time has satisfied all the demands that were delivered by it. But they were not perfect. The main disadvantage of this Passport can be assumed, that the Passports structure and composition while working with it does not allow fast access to the information, and use it as a visual material, to add, to re-saving and to processing data [3].

3. Methods

The authors of this article in aim to eliminate these disadvantages and drawing on the experiences of foreign countries, had attempted to describe the methodologically efficient and correct actions that need to be carried out in the emergency organizations.

Risk management – a multi-stage process, which aims to reduce or compensate damage for the facility upon the occurrence of adverse events. It is important to understand that minimize the damage and risk reduction – are not adequate concepts [4]. Reducing the risk that is to say the mudflow risk means either a reduction of possible damage during the passage of mudflows or a decline in the probability of genesis of mudflows.

Mudflows risk – is the danger of negative effects of mudflow phenomenon. Mudflows risk is determined by the product of the probability of occurrence of mudflow phenomena and the damage caused by them. Determination of the mudflows' negative impact is an integral and essential part of mudflows risk management [5].

The main stages process of mudflows risk management includes the following steps (1 Figure) [6].

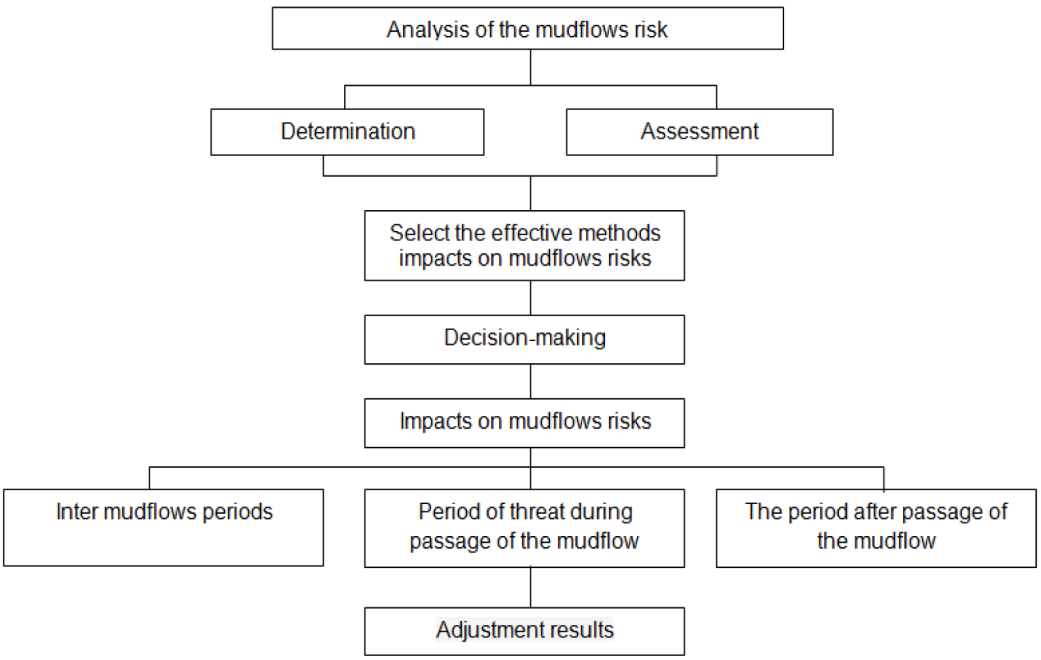

Figure 1 – The general scheme of the process of mudflows risk management

Analysis of the mudflows risk – the first stage, purpose to obtaining the necessary information about the structure, properties of mudflows. To make adequate decisions on the subsequent stages, the collected information should be sufficient. Analysis of the mudflows risk consists of identifying the of mudflows risks and to assess degree of the mudflows risks.

In identifying risks (qualitative component) are determined all the risks, inherent to the mudflows. To identifying the centers of origin of mudflow phenomenon, monitoring of their condition and the extent of mudflow risk in real time, must be consistent implementation of the following activities: interpretation of aerial photos and satellite images controlled territory with a view to select mudflows objects; aero visual surveillance of mudflows objects and their dynamics; ground surveys of the most dangerous objects in the case of aggravation of the situation; cartography mudflow hearths; drafting the passport of mudflows objects; observation of mudflow forming factors and the passage of mud floods.

To identify zones of the negative impact of mudflows are necessary to consistently carry out the following works: identify mudflows risk areas; construct maps of zones of negative impact of mudflows; create Passports of sites the devastating effects of mudflows based on analysis of retrospective data and the calculation of the maximum possible characteristics of mudflows. The degree of mudflows risk is considered as a combination of frequency and probability and consequences of mudflows. In other words, the concept of risk always consists of two elements: the frequency of mudflows formation (repeatability) and the effects of mudflows that is the application concepts risk allows to transfer the danger into the category of measured values. Using the available information, science-based forecasts of assessment of mudflows risk is help to reliably assess the risk. The effectiveness of mudflows risk assessment depends on many factors. In the first place the correctness of the chosen method, the accuracy of its calculations, as well as the level of technological equipment in the practical application of methods, it means: the presence of the database, the duration and spatial and temporal coverage of observations of mudflows, implementation means of environment monitoring.

Databases for managing mudflow risk must be contain accordingly interpreted and structured, meaningful and sufficient information to develop management solutions: information passed mudflows, conditions of their formation and flow characteristics, and the recipients in the impact areas of mudflows and inflicted damage. In addition, important to solve organizational issues: the involvement of qualified and competent specialists involved in risk assessment, selection of an analysis object, financing, concerted action by all stakeholders. Forecasts based on the analysis of environmental factors with the modeling prospects of development situations can have a high efficiency.

Evaluation – this is a quantitative description of the identified mudflows risks. In assessing the mudflows risks are carried out directed and systematic works on the determining of recipients and origin of the mudflow risk, as a result is it determines the degree of debris flow risk areas. The risk degree depends on the economic criteria for assessing the direct and indirect losses [7]. Identification and assessment of mudflows risk are closely linked between themselves, and it is not always possible to divide them into independent parts of the general process. Furthermore, the analysis is often in two opposite directions – on the evaluation to the identification and vice versa. At the first case, there are already (fixed) losses and need to identify the causes. At the second case identified risks and the possible consequences based on the of system analysis. Evaluation of mudflows risk is carried out in order to select the best optimal method of controlling them [8].

Then, occurs the step of selecting the method of exposure to the risk in order to minimize the possible damage in the future. Each type of risk allows several traditional methods to reducing them. Therefore there is the problem of assessing the comparative effectiveness of methods to influence the risk of selecting the best of them. The comparison may be based on various criteria, including economic. After selecting the optimal methods to influence to the mudflows risk it is possible to form an overall strategy of management of the entire risk complex. This is the stage of decision-making. Decision-making should be done with the applying of evidence-based methods. There are a lot of decision-making techniques. The most commonly used mathematical procedures for decision-making are linear programming, simulation models, network models, queuing theory, decision tree, game theory, and others.

The effectiveness and implementation of developed solutions depends on the amount and quality of information resources. Scenario analysis is widely advertised as the methodology of construction systems of security management. Scenario analysis includes the steps of determining the objectives

of formation scenarios, the determination of the scenario characteristics, scenario analysis, scenario optimization, transformation of the scenario in the program and plans.

Mudflows phenomenon characterized by a discrete appearance and short duration of passage, risk management is carried out in the periods between mudflows phenomenon, the threat of their occurrence and transmission, post mudflows.

Managing mudflows risks, carried out during the period of the threat and passing the mudflows, and post mudflows and inter mudflows periods are significantly different. Managing mudflows risk in the inter mudflows period includes preventive measures, which should be aimed at reducing the probability of appearance mudflows, impacts of mudflows, damage caused by mudflows.

Accordingly, specified areas there are various control actions.

Reducing the probability of appearance mudflows is possible due to the control action on mudflow formation factors – to avoid exceeding their critical values for the occurrence of mudflows.

Because the mudflows occur resulted from imbalance of the system "water – loosely detrital material at a certain slope", control actions should be directed at the reduction or stabilization of a particular component of the system.

The final stages of the mudflow risk management are the control and correction of the implementation results of the chosen strategy, with considering new information. Control is to provide information about the nature of mudflows, as well as the loss occurred and the measures taken to minimize them. It can be expressed in the new circumstances changing the level of risk, monitoring the efficiency of work systems ensuring security, etc.

Analysis of the occurred mudflow phenomena should be conducted in order to obtain new knowledge about the nature of the phenomenon and characteristics, draw the moral from actions of the existing mudflow risk management system to identify the necessity and ways to improving it.

The mudflows causes, mudflows characteristics, works of mudflows protection facilities, works of warning systems, systems of emergency response and disaster, the characteristics of the negative effects of the mudflows and their current and long-term consequences should be analyzed. In accordance with the above, correction mudflow risk management systems should be implemented.

Once every few years should be a revision of data about the effectiveness of risk management measures taking into account the information about occurred of loss during this period.

The described algorithm of actions requires highly qualified experienced specialists who understand the nature of mudflows. The Emergency Situations sphere should not depend on the separate personalities in this field should work coordinated system. The economic crisis, which began with the middle of 80's twentieth century and lasted until the late 90's as well as the collapse of the USSR led to the cessation of work aimed at studying of the mudflows phenomenon [9]. The sharply reduction in appropriations for study was an additional blow to the development of mudflows science. The collapse of the Soviet Union mudflow community was divided by national borders. The mudflow committee stops working. Training specialists and transfer the experiences are overlooked. On present day, we have experienced highly qualified staff, but there is no the younger generation, who could continue to work at the same level.

If taken account the suddenness of the appearance of this phenomenon, the immediate response in decision-making is required. To solve these problems is proposed the creation of an electronic database, which has a spatial reference to the real surface. With this data bank be possible to make up for the lost generations of continuity in emergency situations.

It is possible to piece out of the subtlety continuity generations in the Emergency Situations field.

Conclusion

At the present stage the fundamental and applied researches are not conducted without the computerization and automation of information-reference systems.

Information about emergency situations, in particular the mudflow phenomenon has an important role in various sectors of the economy of the dangerous of mudflow areas. Economic efficiency correctly and timely use the information about mudflow phenomenon will be in demand with the development of the national economy.

Creation and development of computer and information technologies in the mudflows field researches is difficult and requires a plenty of time and money. Despite of all these difficulties in the neighboring and foreign countries is held a series of fundamental researches.

Many organizations and institutions of these countries in their daily activities apply GIS-technology to solve security problems. Through the GIS-technologies are predicted particularly

hazardous phenomenon such as forest fires, floods, earthquakes, storms and mudflows. As well as are identifying potential the degree of hazards and on this basis are accepting decisions on the provision of assistance to victims. It is also possible to estimate the volume of forces and means for the prevention of emergency situations, to plan the most optimal route to the disaster site, calculate the possible damages to the environment and human, and losses in different sectors of the economy.

Geoinformation system about mudflows should include the following: firstly need to create a large-scale base map of mudflow hazardous areas of the country, on this map should draw a boundaries of hazardous mudflow basins and mudflow hearths in each of them. Each designation mudflow hearth should give the user information not only on spatial data, as well as information on morphometric (the absolute height of the mudflow hearth, square, length, width, bias) parameters, information about mudflows were generated at this hearth or else crossed the mudflow hearth, information on the economic, social objects near the mudflow hearth, and possible critical and mudflows forming parameters in the hearth. In the case of equipping it by GIS sensors or hydrometeorological data the importance and usefulness will only increase. To enlarge informativeness of the GIS data in the additional layers should be displaying a degree of mudflow risks and the level of mudflow hazard.

To make justified and effective decisions in managing mudflows risks, modern specialist should be able to receive, collect, preserve and process data, presenting the results in the form of visual documents by via computers and communications equipment. The main objective of the creation of such databases to help less experienced users to finding existing description solutions of any problems in a subject fields.

It should be noted that information about the mudflows phenomenon integrated into a single electronic database using GIS technology should be accessible, simple and understandable for the user. This electronic database with geo-spatial referenced in real terrain will be in demand in the departmental emergency organizations of various ranks.

References

1 Report: Develop the structure and composition passport mudflow basin. Kishi Almaty as a model for the certification of mudfow basins mountainous areas of Kazakhstan (Contract №188). 2008.

2 Medeu A.R., Kirenskaya T.L. Certification mudflows as an information basis of risk management mudflows in Kazakhstan, 2011. Questions of Geography and Geoecology. – №2. – P. 31-36.

3 Moldakhmetov M.M. Makhmudova L.K. Mussina A.K. (2013). The importance of the development of the geoinformation system of mudflow problems / Materials of IV international scientific-practical conference «Actual problems of fire safety, prevention and liquidation of emergency situations». Kokshetau. – P. 75-78

4 Khokhlov N.V. Risk Management: Textbook. Manual for schools. – M.: UNITY-DANA, 2001.

5 Report: Safety Assessment of RK mudflow hazard territories. Section «Develop a methodical risk assessment based on the effects of debris phenomena (for example, the Trans-Ili Alatau)». – Almaty, 2002. – 239 P.

6 Moldakhmetov M.M., Mussina A.K. Organization process of the mudflows risk management // KazNU Bulletin, 2010. Geography Series. №.1 – P. 90-95.

7 Medeuov A.R., Nurlanov M.T. Mudflow's seismically active areas of Kazakhstan (Management Issues). – Almaty, 1996. Kazhy-kaganat. 204 P.

8 Medeu A.R., Kirenskaya T.L. Debris risks and their evaluation methods. / Proceedings of the International Symposium "Geological risk: assessment and reduction". Tashkent, 2003. – P. 14-17.

9 Chernomorets S.S. International Conference "Mudslides: disasters Risk, Forecast, Protection" // Bulletin of MGU. – 2009. Geography Series. – №4. – P. 72-73.

Литературы

1 Отчет о научно-исследовательской работе по теме: Разработать структуру и составить Паспорт селеопасного бассейна р. Киши Алматы как модельного объекта для паспортизации селевых бассейнов горных районов Казахстана (Договор №188 от 18.07.2008 г.)

2 Медеу А.Р., Киренская Т.Л. Паспортизация селевых бассейнов как информационная основа управления селевыми рисками // Вопросы географии и геоэкологии, 2011, № 2, с. 31-36.

3 Молдахметов М.М., Махмудова Л.К., Мусина А.К. Сел мәселелеріне қатысты геоақпараттық жүйе құрудың маңызы жайында // Материалы IV международной научно-практической конференции «Актуальные проблемы пожарной безопасности, предупреждения и ликвидации чрезвычайных ситуаций». 17 октября 2013 г. Кокшетау.

4 Хохлов Н.В. Управление риском: учеб. пособие для вузов. – М.: ЮНИТИ-ДАНА, 2001. – 239 с.

5 Отчет по теме: Оценка безопасности селеугражаемых территорий РК. Раздел «Разработать методические основы оценки риска воздействия селевых явлений (на примере Заилийского Алатау)». – Алматы, 2002.

6 Молдахметов М.М., Мусина А.К. Сел қаупін ауыздықтау мәселесі жайында // Вестник КазНУ. Серия географическая. Алматы. 2010, №.1 – б. 90-95.

7 Медеуов А.Р., Нурланов М.Т. Селевые явления сейсмоактивных территорий Казахстана (Проблемы управления). – Алматы: Қаржы-қаражат, 1996. -204 с.

8 Медеу А.Р., Киренская Т.Л. Селевые риски и методы их оценки. // Материалы Международного симпозиума «Геологический риск: оценка и уменьшение». – Ташкент, 2003. – С. 14-17.

9 Черноморец С.С. Международная конференция «Селевые потоки: катастрофы, риск, прогноз, защита» // Вестник МГУ. Сер.5. География. – 2009. – №4. – С. 72-73.