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Makulov J.T.

Lecturer at the Department of Geography and Environmental Protection

Namangan State University

Namangan. Uzbekistan

IMPROVING THE FLOOD MONITORING SYSTEM: SCIENTIFIC FOUNDATIONS AND PRACTICAL APPROACHES

Abstract: *The article presents the views and observations of scientists on improving the flood monitoring system, monitoring water resources and identifying flooded areas, placing water level and precipitation sensors at key points of water catchments, collecting real-time data.*

Keywords: *Floods and floods, modern technologies, rapid reporting, hydrometeorological stations, agrometeorological posts, hydrological posts, modeling, Global Runoff Data Center.*

Макулов Ж.Т.

Преподаватель кафедры «Географии и охраны окружающей среды»

Наманганский государственный университет

Наманган. Узбекистан

СОВЕРШЕНСТВОВАНИЕ СИСТЕМЫ МОНИТОРИНГА НАВОДНЕНИЙ: НАУЧНЫЕ ОСНОВЫ И ПРАКТИЧЕСКИЕ ПОДХОДЫ

Аннотация: *В статье рассматриваются идеи ученых по совершенствованию системы мониторинга наводнений, мониторингу водных ресурсов и выявлению затопленных территорий, размещению датчиков уровня воды и осадков в ключевых точках водосборных площадей для сбора данных в режиме реального времени. Соображения по совершенствованию системы мониторинга наводнений были сделаны.*

Ключевые слова: *Наводнения и сели, современные технологии, оперативное оповещение, гидрометеорологические станции,*

агрометеорологические посты, гидрологические посты, моделирование, Глобальный центр данных по стоку.

Introduction: Floods and mudslides are among the most devastating natural phenomena that have a significant impact on ecosystems, economies, and societies. An effective flood monitoring system plays a key role in minimizing damage and preventing human loss. This text reviews the scientific basis of flood monitoring, modern technologies, and prospects for their improvement.

Floods are complex hydrological processes that occur as a result of heavy rainfall, snowmelt, dam failure, and other factors. According to the World Meteorological Organization (WMO), floods cause billions of dollars in damage and affect millions of people every year. Effective monitoring allows for:

- Timely identification of flood risks.
- Prompt notification of the population.
- Support decision-making to prevent and mitigate the impacts of flash floods.

Methods: The scientific basis of flood monitoring is based on hydrological, meteorological and geoinformation studies. The main scientific approaches include:

Hydrological modeling. Modern models such as HEC-RAS and SWAT allow for the prediction of river flow and water levels depending on meteorological conditions.

Meteorological data. The use of data on the amount, intensity and distribution of rainfall helps to assess the likelihood of flooding. In this regard, we can see that with an area of 7900 km2, Namangan region has 3 hydrometeorological stations, 3 agrometeorological posts, and 6 hydrological posts, which is very few for the region.[1] In this situation, we can see that it is not possible to obtain accurate data on the amount, intensity and distribution of rainfall in the territory of Namangan region.

Geographic information systems (GIS). GIS technologies allow combining spatial data on land, soil and aquifers to assess the vulnerability of areas. We see that it is appropriate to use geographic information systems to analyze spatial data and model flood zones.

It is necessary to develop algorithms for automatic analysis of big data and high-precision flood forecasting..

Results: One of the main issues today is the creation of applications for monitoring water resources and detecting flooded areas using satellite imagery and remote sensing data to provide rapid notification of hazards to the population.

Modern technologies significantly expand the capabilities of flood monitoring and forecasting:

Remote sensing. Satellite systems such as Sentinel and Landsat allow for regular monitoring of changes in water levels, vegetation conditions, and soil moisture.

Placing water level and precipitation sensors at key points in water catchment areas allows for real-time data collection. However, the fact that the catchment area of rivers and streams flowing through Namangan region overlaps with the territory of neighboring countries limits the possibility of placing water level and precipitation sensors.

From the above data, we can see that modern monitoring systems face a number of problems:

Lack of data. In some regions, the density of meteorological and hydrological stations is insufficient.

Forecast accuracy. Model complexity and input data uncertainty can reduce forecast accuracy.

Infrastructure constraints. Equipment obsolescence and lack of investment are slowing down the introduction of new technologies.

Ways to improve monitoring systems. To increase the effectiveness of flood monitoring, the following are necessary:

Expand the observation network. Increase the number of weather stations, hydroposts and sensors for data collection.

Data integration. Combine data from multiple sources, such as satellites, ground stations and crowdsourcing.

Development of digital platforms. Creation of cloud systems for data storage, processing and visualization.

Increasing the accuracy of models. Taking into account climate change and local characteristics in modeling.

Training of specialists. Training personnel capable of working with modern technologies and analyzing data.

European Flood Forecasting System (EFAS). EFAS combines data from various weather stations and satellites to produce regional forecasts.

FFGS (Flash Flood Guidance System) project. Implemented by WMO, FFGS provides rapid flood warnings in developing countries.

National Monitoring System of India. Uses radar, satellite and sensor data to manage flood risks.

Conclusions: The future of flood and mudflow monitoring systems lies in the development of data processing technologies, increasing the availability of satellite data and the use of artificial intelligence. Implementing an integrated approach that includes data integration, model accuracy and strong international cooperation will significantly reduce the impact of floods.

Improving flood monitoring systems requires an interdisciplinary approach that brings together scientists, engineers and policymakers. Investments in research, infrastructure and technology are key to achieving this goal.

Weather stations, hydrometric posts and sensors should be installed at key points in water catchment areas. Use mobile technologies. Develop and deploy mobile measuring stations or devices with alternative energy networks to provide remote data transmission for monitoring in remote and inaccessible areas.

To receive and transmit data, it is necessary to connect to international platforms such as the Global Runoff Data Center (GRDC).

Develop a digital platform for centralized collection, analysis and visualization of data from various sources.

Ensure data compatibility. Standardize data formats to simplify integration with other systems.

Improve existing models taking into account regional characteristics, climate change and high-resolution data.

Develop scenarios. Create scenarios to assess the impact of various factors (rainfall intensity, landscape changes, etc.) on the probability of flooding.

Training models. Regularly update data to increase forecast accuracy. Organize seminars, publish information materials and conduct training sessions to increase the preparedness of the local population for emergency situations.

Create early warning systems. Develop automatic notification systems via SMS, mobile applications and alarm sounds.

Improve cooperation with government agencies. Regular consultations with local authorities to exchange information and work together.

Establish bilateral and multilateral agreements to work together on flood and flood monitoring projects.

Organize conferences and symposia to share scientific achievements. Regularly analyze the performance of the system, assess its accuracy, response speed and user satisfaction. Test new technologies and approaches in selected areas before widespread implementation.

Continuously update the system to take into account new climatic, technological and social realities.

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