Practical Optimization of SMS Push Timeliness in the Debris Flow Early Warning Information Release System

Weilin Yuan

Gansu Construction Supervision Co., Ltd., Lanzhou, Gansu 730070

Abstract: The timeliness of SMS push for debris flow early warning information is directly related to the effectiveness of early warning and protection. Optimizing push timeliness is a key direction to enhance the practical value of early warning systems. Focusing on this core demand, this paper conducts practical exploration on the timeliness optimization of SMS push, identifies the current timeliness bottlenecks in the push process, and constructs targeted optimization paths. Push efficiency is improved through measures such as optimizing the push process, improving technical support, and strengthening the coordination mechanism. Practice shows that scientific optimization strategies can effectively shorten the delay of information transmission, ensure that early warning information reaches the target audience in a timely manner, and provide strong support for debris flow disaster prevention and mitigation.

Keywords: Debris flow early warning; SMS push; Timeliness optimization; Information release system; Disaster prevention

DOI:10.12417/3029-2344.25.10.019

Introduction

Debris flow disasters are characterized by their sudden onset and high destructive power, making the timely dissemination of warning information a critical prerequisite for reducing casualties and property losses. As a key channel for releasing debris flow warnings, the timeliness of SMS push notifications directly determines the efficiency of initiating warning responses and the effectiveness of protective measures. Issues such as delays in information transmission and incomplete coverage during the SMS push process may prevent warning information from functioning promptly, thereby exacerbating disaster impacts. To optimize the timeliness of SMS push notifications, it is essential to integrate the practical scenarios of warning issuance, identify key nodes and constraints in the entire push workflow, and explore feasible optimization strategies. This effort will not only enhance the operational effectiveness of debris flow warning systems but also provide more reliable information support for disaster prevention and mitigation, establishing an efficient bridge from warning generation to information delivery.

1.Analysis of Existing Issues in Timeliness of Mudslide Early Warning SMS Notifications

1.1 Inconsistent push process integration leads to delayed timeliness

The SMS push process for debris flow warnings involves multiple stages, including warning information generation, review, distribution, and carrier transmission. The coordination between these stages directly impacts the overall timeliness of the push. After the warning information is generated, cumbersome review procedures and excessive approval hierarchies often lead to information stagnation, preventing it from swiftly entering the distribution phase. The lack of an efficient interface mechanism between the distribution stage and carriers results in issues such as inefficient format conversion and data transmission interruptions, further prolonging the information delivery time. Additionally, the absence of standardized push procedures across different regions—particularly in remote areas where process linkages are even weaker—leads to inconsistencies in the timing of warning information reaching audiences in different locations. This creates a time lag in information dissemination, hindering the coordinated advancement of disaster prevention efforts.

1.2 Insufficient Technical Support System Affecting Push Efficiency

The current technical architecture of debris flow warning information dissemination systems suffers from

multiple shortcomings, making it difficult to meet the timeliness requirements of SMS pushes. The limited computational capacity of the information processing module often causes delays when handling large-scale, multi-batch warning information pushes, impeding the rapid completion of tasks such as information classification, filtering, and target matching. Furthermore, the SMS push platform lacks stability, with issues such as system lag or crashes occurring under complex conditions like extreme weather, leading to interruptions in push operations [1]. Simultaneously, the absence of advanced positioning and precise push technologies prevents the implementation of differentiated pushes based on audience geographical location or risk levels. Instead, indiscriminate mass messaging is adopted, which not only reduces push efficiency but may also result in resource wastage.

1.3 Lack of Multi-Actor Coordination Mechanisms Causing Information Blockages

The SMS push process for debris flow warnings requires coordinated efforts among multiple stakeholders, including warning management departments, information dissemination agencies, communication carriers, and grassroots disaster prevention organizations. However, effective coordination mechanisms among these actors are currently lacking. Unclear delineation of responsibilities often leads to mutual blame-shifting when issues arise, thereby hampering the efficiency of push operations. Inadequate information-sharing channels hinder real-time communication between warning management departments and carriers, preventing carriers from preparing in advance for pushes and forcing them to respond passively after receiving information. Grassroots disaster prevention organizations are insufficiently engaged in the preparatory and feedback stages of push operations, failing to communicate local needs and emerging issues to upstream stakeholders in a timely manner. This disconnect results in a misalignment between push efforts and actual requirements.

2.Core Principles and Objectives for Optimizing the Timeliness of SMS Push Notifications for Debris Flow Warnings

2.1 Precision-Oriented Principle Guided by Disaster Prevention Needs

The primary purpose of SMS push notifications for debris flow warnings is to provide timely and effective information support for disaster prevention. Therefore, optimization efforts must be fundamentally guided by disaster prevention needs and adhere to the principle of precision. This entails accurately assessing the risk levels of debris flow hazards in different regions and understanding the varying information needs of different audiences. Tailored push strategies should be developed for high-risk areas and key demographic groups to ensure that warning information reaches those who need it most. Additionally, precise alignment with different stages of disaster occurrence—such as precursors, onset, and progression—allows for targeted warning messages and protective guidance to be disseminated. This approach avoids information redundancy or omissions, enhances the practical value of warnings, and provides clear directives for audiences to take prompt protective measures.

2.2 Efficiency Objective of Full-Process Closed-Loop Management

The core objective of optimization is to achieve efficiency under full-process closed-loop management, focusing on systematic control across the entire chain of SMS push notifications for warning information. Starting from the source of warning information generation, a thorough analysis of the operational logic of key stages—such as review, distribution, transmission, and delivery—is conducted. Standardized improvements are made to address gaps in coordination and redundancies in processes. Specific timeframes and quantitative performance standards are established for each stage, with detailed operational protocols and responsibility boundaries to ensure high-quality information delivery within prescribed deadlines[2]. Simultaneously, a dynamic tracking and precise control system for the entire process is established, leveraging technical tools to monitor the transmission status and progress of information at each stage in real time. This enables the precise identification of potential bottlenecks or delays during transmission and facilitates the immediate activation of countermeasures to prevent information stagnation or loss. Through such comprehensive and seamless efficient management, the overall time from warning information generation to final delivery is minimized, substantially improving the timeliness of SMS push notifications.

2.3 Holistic Principle of Multidimensional Coordination and Collaboration

Optimization efforts must adhere to the holistic principle of multidimensional coordination and collaboration, breaking down barriers among different stakeholders to achieve resource integration and complementary strengths. This involves coordinating the efforts of multiple actors, including warning management departments, information dissemination agencies, communication carriers, and grassroots disaster prevention organizations. Clear delineation of roles and responsibilities in the push process is essential, along with establishing efficient cooperation mechanisms. Promoting collaboration across technology, management, and institutional dimensions integrates advanced technical tools with scientific management methods, thereby refining collaborative work mechanisms to ensure seamless coordination and efficient cooperation among all stages and stakeholders. This approach enhances the collaborative effectiveness of SMS push operations at a holistic level, fostering a unified force to improve timeliness.

3.Key Pathways for Optimizing the Timeliness of SMS Push Notifications for Debris Flow Warnings

3.1 Restructuring the Push Process to Achieve Efficient Node Coordination

Restructuring the push process requires starting with an analysis of key nodes in the existing workflow, simplifying unnecessary approval steps, and consolidating redundant tasks to establish a streamlined and efficient push process system. A fast-track mechanism for generating and reviewing warning information should be established, with differentiated review standards tailored to varying levels of debris flow warnings. High-priority warnings may adopt a simplified review process to ensure they promptly enter the distribution phase. The interface between distribution and carrier transmission should be optimized by standardizing information formats and transmission protocols to enable rapid information transfer and reception. Additionally, push process standards should be unified across regions, with enhanced guidance and regulation for process coordination in remote areas. This will eliminate regional disparities in push timing and enable the simultaneous dissemination of warning information.

3.2 Upgrading the Technical Support System to Strengthen Efficiency Assurance

Enhancing the technical support system requires improvements in both hardware and software to boost computational capacity, stability, and precision. The information processing module should be optimized by integrating advanced big data processing technologies to accelerate the handling of large-scale warning information, enabling rapid classification, filtering, and target matching for pushes. The stability of the SMS push platform must be reinforced through redundant backup technologies to withstand system pressures under complex conditions such as extreme weather, thereby preventing system lag or crashes[3]. The adoption of precise positioning technologies and intelligent push algorithms should be prioritized to enable targeted warning notifications based on audience geographic location and risk levels. This approach will reduce the efficiency losses associated with indiscriminate mass messaging and enhance the relevance and effectiveness of pushes.

3.3 Establishing a Multi-Actor Coordination Mechanism to Streamline Information Flow

Creating a multi-actor coordination mechanism necessitates clearly defining the responsibilities and roles of all participating stakeholders, alongside establishing robust communication, coordination, and information-sharing platforms. Through measures such as signing cooperation agreements and implementing regular joint meetings, collaboration among warning management departments, information dissemination agencies, communication carriers, and grassroots disaster prevention organizations should be strengthened to promptly address issues arising during push operations. An integrated information-sharing platform should be developed to facilitate real-time information exchange among stakeholders. This will allow carriers to prepare in advance for scheduled warning pushes and enable grassroots disaster prevention organizations to provide timely feedback on push effectiveness and local needs, thereby informing ongoing optimization efforts. By fostering a vertically integrated and horizontally coordinated

operational framework, bottlenecks and obstacles in information transmission can be eliminated, ensuring the smooth flow of warning information.

4.Implementation of the Timeliness Optimization Practice Plan for SMS Push of Debris Flow Early Warning Information

4.1 Phased Implementation Strategy and Deployment of Key Tasks

The phased implementation strategy divides the optimization practice into three phases: initiation phase, advancement phase, and consolidation phase. During the initiation phase, the priority is to conduct a comprehensive review of the existing push processes, technical systems, and coordination mechanisms. It is necessary to identify problems and optimization directions in each link, and formulate detailed implementation plans and task lists. The advancement phase focuses on solving key problems. In the order of from easy to difficult, key tasks such as the reconstruction of push processes, the upgrading of technical support systems, and the establishment of multi-stakeholder coordination mechanisms will be carried out sequentially to ensure that all optimization measures are effectively implemented. The consolidation phase prioritizes refining and strengthening the implemented optimization measures, summarizing the experience and practices gained during the implementation process, addressing new problems that arise, and promoting the regularization and standardization of optimization work. Clear time nodes, responsible entities, and work requirements are specified for each phase to ensure the orderly progress of the implementation work.

4.2 Dynamic Control and Adjustment Measures During Implementation

Dynamic control in the implementation process requires the establishment of a real-time monitoring mechanism to continuously track the implementation progress and effectiveness of various optimization measures, as well as changes in push timeliness. By setting key performance indicators (KPIs), quantitative monitoring is conducted on the connection efficiency of the push process, the operation status of the technical system, and the operation effect of the coordination mechanism, so as to promptly identify deviations and problems arising during implementation[4]. Flexible adjustment measures are formulated for the problems identified through monitoring, and the implementation plan and optimization scheme are dynamically adjusted according to actual circumstances. Supervision and inspection over the implementation process should be strengthened to ensure that all tasks proceed as required and all adjustment measures are implemented in a timely manner, thus guaranteeing the smooth progress of the optimization practice.

4.3 Real-time Monitoring and Evaluation Methods for Implementation Effectiveness

Real-time monitoring of implementation effectiveness needs to build a multi-dimensional monitoring index system, which incorporates core indicators such as push delay time, information reach rate, and push coverage. Real-time collection and dynamic analysis of these indicators are completed by relying on technical means. The evaluation methods combine both qualitative and quantitative approaches: quantitative evaluation compares the push timeliness data before and after optimization to measure the actual effect of the measures; qualitative evaluation sorts out feedback from all participating entities and the practical application effect of early warning information to fully explore the value of the optimization practice. A feedback mechanism for evaluation results should be established to promptly notify responsible entities of existing problems, providing a basis for subsequent optimization and adjustment. The core objective of the optimization work is to achieve high efficiency under the whole-process closed-loop control, with systematic control carried out throughout the entire SMS push chain. Starting from the source of early warning information generation, the operational logic of key links such as review, distribution, transmission, and reach is sorted out. Standardized optimization is implemented to address connection loopholes and process redundancies. Clear time nodes and quantitative standards are defined for each link, and operational specifications and responsibility boundaries are refined to ensure that information transmission tasks in each link are completed on time and with guaranteed quality. Meanwhile, a full-process dynamic tracking and precise control

system is built. By virtue of technical means, the status and progress of information transmission are captured in real time, problems such as stagnation and delay are accurately located, and disposal measures are initiated immediately to avoid information retention and loss. Through all-round control over the entire chain, the time consumed for information transmission is minimized to effectively improve the timeliness of SMS push.

5.Establishing a Long-term Safeguard Mechanism for Optimizing the Timeliness of SMS Push Notifications in Debris Flow Warnings

5.1 Establishing a Technical Iteration and Upgrade Safeguard Mechanism

The establishment of a technical iteration and upgrade safeguard mechanism should be grounded in the development trends of industry technology. This involves regular evaluation of the technical architecture and core modules of the debris flow warning information dissemination system to identify technological shortcomings and upgrade requirements. A technical iteration and upgrade plan should be formulated, clearly defining iteration cycles, upgrade content, and implementation pathways to ensure the system continuously adapts to the needs of optimizing push timeliness. Investment in technological research and development should be increased, and collaboration with research institutions and enterprises should be encouraged to introduce advanced technological achievements, thereby enhancing the system's technological sophistication and competitiveness. A testing and verification mechanism for post-iteration technical updates should be established to ensure the stable operation of the upgraded system and effectively improve the efficiency of SMS push notifications.

5.2 Improving the Long-term Collaborative Working Mechanism

Improving the long-term collaborative working mechanism requires further detailing the responsibility lists of all stakeholders based on existing coordination frameworks. This includes clarifying collaboration processes and communication channels to avoid overlapping or gaps in responsibilities. A regularized communication and coordination mechanism should be established, with periodic collaborative meetings to report on push operations and address issues arising during collaboration[5]. A collaborative work assessment and evaluation mechanism should be implemented to evaluate the coordination and cooperation among stakeholders, linking assessment results to relevant rewards and penalties to stimulate collaborative enthusiasm. Continuous tracking and evaluation of the operation of the collaborative mechanism should be strengthened, with ongoing optimization based on actual outcomes to ensure the sustained and efficient functioning of collaborative efforts.

5.3 Constructing a Supervision, Assessment, and Feedback Improvement Mechanism

Constructing a supervision, assessment, and feedback improvement mechanism requires establishing a comprehensive supervision system. This involves integrating internal and external supervision resources to oversee the entire process of optimizing the timeliness of SMS push notifications. A scientific assessment indicator system should be developed, focusing on key areas such as push timeliness, process coordination, technical operation, and collaborative efficiency. Regular assessments should be conducted accordingly. Additionally, a feedback and application mechanism for assessment results should be established, promptly communicating identified issues to relevant units and individuals and urging timely rectification. At the same time, feedback channels should be streamlined to widely collect opinions and suggestions from all parties regarding push operations. This feedback should serve as an important basis for optimization efforts, forming a closed-loop management cycle of supervision, assessment, feedback, rectification, and continuous improvement.

6.Conclusion

This study has conducted a practical exploration into optimizing the timeliness of SMS push notifications within debris flow warning information dissemination systems. It has identified existing issues, established optimization principles and objectives, proposed key pathways and implementation plans, and constructed long-term safeguard mechanisms. Enhancing the timeliness of SMS pushes can effectively strengthen the practical efficacy of

debris flow disaster warnings and provide critical informational support for disaster prevention and risk avoidance. The experience and mechanisms derived from this practical exploration can serve as a reference for optimizing similar disaster warning information dissemination systems. Moving forward, continuous attention must be paid to technological developments and evolving practical needs. Ongoing refinement of optimization measures is essential to further enhance the service capacity of warning information dissemination systems, thereby better supporting disaster prevention and mitigation efforts.

References:

[1] XIAO Yang.Research on the Chain Monitoring and Warning Methods of Debris Flow Disasters in Southeastern Tibet[D].Tibet Agricultural and Animal Husbandry College,2025.

[2] ZHU Qingfang,WU Qi,HUA Jian,et al.Design and Practice of a Remote Online Monitoring System for Debris Flows[J].China Machinery,2025,(02):42–45.

[3] XIAO Yang,GUO Yonggang,WEI Luning.Design and Implementation of a Debris Flow Monitoring and Warning System in Southeastern Tibet[J].Acta Geologica Sichuan,2024,44(04):708–715.

[4] FENG Xinglong,FENG Ming,ZHU Sitao,et al.Construction and Application of an Integrated“Space-Ground-Well” Monitoring and Warning Platform for Debris Flows[J].Mining Research and Development,2024,44(08):190–196.

[5] ZHOU Kaizun.Research and Implementation of a Debris Flow Warning Platform Based on the SINMAP Model[D].North China University of Water Resources and Electric Power,2024.