International Journal of Innovation and Applied Studies
ISSN 2028-9324 Vol. 4 No. 2 Oct. 2013, pp. 298-310

http://www.issr-journals.org/ijias/

Applied analysis and construction of Prevention, Monitoring and Early Warning System of Mountain Torrent Disaster

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ABSTRACT: To prevent from the hazards of mountain torrent disasters, today's monitoring and early warning system is widely used in mountain areas to keep alert from the rainstorm. Mountain torrent disaster caused by the rainstorm and is one of the most important reasons, resulting in transportation blocks and mass casualties. Mountain torrent disaster occurs frequently depends on the weather of mountain's country. It can be distinguished and predicted by monitoring and early warning system to provide the safety reference in disaster presentation and reduction. This paper presents the analysis and key management of monitoring and early warning system of mountain torrent which mainly includes monitoring system and early warning system of water and rain information. In order to achieve better effect of disaster prevention and reduction, establish an organization system of mass observation and mass prevention and enhance training propaganda. The monitoring system of water and rain information mainly includes network layout of water and rain monitoring station, information acquisition, information transmission and communication networking and configuration of devices. Early warning system of mountain torrent is composed of platform-based early warning system of torrent defense and early warning system of torrent mass observation and mass prevention. And also appended short description of publicity and training includes popularization of knowledge about disaster prevention; preparations of disaster prevention, maintenance and operation of monitoring and warning facilities, publicity and rehearsal of proposal.

KEYWORDS: Mountain torrent disaster, Monitoring system, Early warning system, prevention, reduction, training, rehearsal.

1 INTRODUCTION

The mountain torrent disaster burst out frequently and one of the most important reasons is rainstorm. And the solution is monitoring and early warning system of mountain torrent. The mountain torrent disaster early warning system chiefly focuses on three aspects: monitoring, early warning and response [1]. The monitoring and early warning system mainly include in monitoring system and early warning system of water and rain information. In monitoring system of water and rain information have a network layout of water and rain monitoring station, information acquisition, information transmission and communication networking and configuration of devices and as well as facilities [1]. Therefor to achieve better efficiency in disaster prevention and reduction, the organization system of mass observation, mass prevention and enhance training propaganda is also established in this paper.

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In most townships and villages, the simple and easy facilities are usually used for early warning and monitoring; while in areas above country level, it is possible to arrange some practical and advanced facilities with some technical content and high automation level according to financial situation and torrent features. The water and rain monitoring information converging into torrent prevention and early warning platform mainly refers to the automatic remote-metering information of areas above county level; while the water and rain monitoring information of mass observation and mass prevention focuses on information from simple observation in townships and villages. Based on wide range and complex formation causes of mountain torrent in our country, it is necessary to make existing monitoring stations of hydrological and meteorological department more intensive, so as to control water and rainfall information and release early warning information timely. Early warning system of mountain torrent is composed of platform-based early warning system of torrent defense and early warning system of torrent mass observation and mass prevention.

The information collection and early warning platform of torrent prevention in platform-based early warning system of torrent defense is core of data information processing and service of the system, which is mainly composed of information convergence subsystem, information query subsystem, computer network subsystem and database subsystem.

The platform-based early warning system of torrent defense mainly consists of information convergence subsystem, information query subsystem, forecast decision subsystem and early warning subsystem, which shall be erected in flood control headquarters of areas above county level and areas with serious torrent disaster, so as to obtain real-time water and rain information and timely prepare and release early warning of torrent disaster. Usually, the system is required to have functions as reporting of water and rain information, query of weather, water and rain, forecast decision, early warning, preparation and issuance of government files, generation of comprehensive materials and duty management and reserved with interfaces for prevention information of mud-rock flow and landslide. The whole process of Monitoring and early-warning system of torrent disaster is discussed and develops the task based on the analysis [2].

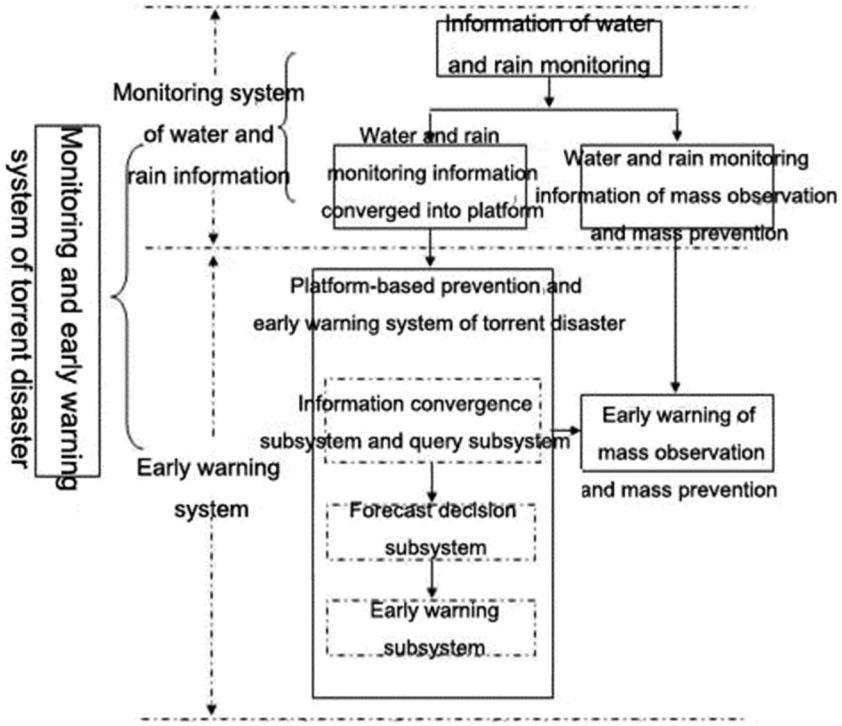


Fig. 1. Structure diagram of monitoring and early warning system of mountain torrent disaster

The early warning system of mass observation and mass prevention includes early warning release and procedures, early warning mode, communication network of warning transmission and information feedback and setting of alarm device, etc. The information, mode and signal of early warning shall be determined according to the concrete conditions of local area. Furthermore, the mode and signal of early warning shall be simple and be easily accepted by ordinary people.

The organization system of mass observation and mass prevention mainly refers to establishment of 5-level (county, township, village, and group, household) responsibility system of mountain torrent prevention and definition of organization, personnel arrangement and responsibilities of each level in prevention of torrent disaster. It is necessary to ensure the smooth transmission of information related to disaster prevention and implementation of measures for monitoring, early warning and disaster avoiding.

The content of publicity and training includes popularization of knowledge about disaster prevention, preparations of disaster prevention, maintenance and operation of monitoring and warning facilities, publicity and rehearsal of proposal, etc. This article looks at issue of mountain torrent disaster mechanism and pattern of early-warning and monitoring system for the majority of mountain torrent disaster users [3].

2 PURPOSE AND SIGNIFICANCE OF SYSTEM CONSTRUCTION

In recent years, based on the analysis of statistics and field survey the sudden and local torrent disaster caused by extremely strong rainfall has resulted to mass casualties [4]. The population of total death toll caused by mountain torrent is increasing and mass death or injury happens frequently. Since the torrent disaster has seriously hindered the economic development in hills and mountains, masses from casting off poverty to get rich and construction of harmonious socialist society and new socialist countryside, it has been a problem that needs to be solved in current flood control and disaster reduction of our country.

Make scientific development as guidelines; insist on people first and the scientific concept “harmony between man and nature”; focus on ensuring life and property safety of the masses; aim for furthest reducing disaster loss; base on special climate, landform, geology and other features of mountain torrent in various regions of our country, actual development situations of economy and society and document “Planning Report for Nationwide Prevention of Torrent Disaster ” approved by the state council; Combine torrent disaster prevention with geological disaster prevention and engineering measures with non-engineering measures; coordinate with economic and social development of local area. Then, carry out comprehensive prevention and treatment for mountain torrent based on all above measures to comprehensively improve local capacity and level for dealing with torrent disaster, providing important support and guarantee for flood control and sustainable development of economy and society in hills and mountains. The Basis of system compilation is following as

- Planning for Nationwide Prevention of Torrent Disaster
- Outline for Compilation of Torrent Prevention Plan
- Outline for Compilation of Implementation Plan about County-level Non-engineering Measures Construction of Torrent Disaster Prevention
- Technical Requirement for Construction of County-level Monitoring and Early Warning System of Torrent Disaster Prevention
- Other related standards, specifications, regulations and management methods

2.1 CONSTRUCTION OF GOAL AND TASK

In goal structure, Construct monitoring and early warning system, strength system of mass observation and mass prevention, perfect prevention plan, propagandize prevention knowledge and improve awareness of all people to disaster prevention and avoidance in townships and villages with task of torrent prevention and treatment, so as to effectively prevent disaster, change the situation of increasingly serious torrent disaster, reduce casualties and property loss and especially avoid mass death and mass injury.

In task structure, the construction of non-engineering measures for torrent prevention mainly includes general investigation of torrent disaster, demarcation of dangerous area, definition of early warning index of critical rainfall and water level, construction of monitoring and early warning system, establishment of responsibility system, compilation and perfection of prevention plan and rehearsal of publicity and training, etc.

2.2 INVESTIGATION AND EVALUATION OF CURRENT SITUATION

Generally investigate the basic information of nature, economy and society, population distribution, torrent type, information of historical torrent disaster, populations threatened by torrent disaster and distribution of main economic facilities in all small watersheds. The local government or flood-control headquarters organizes the investigation of torrent disaster and investigates the influence of torrent on affected areas based on existing documents of meteorological and territorial departments and according to planning of torrent prevention and related regulations and specifications, so as to

define threatened range and degree. Divide areas reasonably according to formation features of torrent disaster, investigation of historical torrent, conditions of climate, terrain and geology and analysis of possible type, degree and influence range of torrent. The dangerous area usually refers to area in river valley, channel, river beach, under steep slope, low-lying place and under unstable massif; the safe area often refers to flat area with high terrain or gentle slop which is shelter for people in dangerous.

2.3 DETERMINATION OF EARLY WARNING INDEX

The early warning index of torrent disaster is established with following purpose: assist to judge the possible risk and occurrence time with torrent forecast model before torrent arrives, so as to inform persons in protected areas to transfer timely, furthest protecting their life security. Two factors have to be considered for the index: 1. how much rainfall will cause torrent, i.e. critical rainfall; 2. whether the time from sending out early warning to torrent happening is enough for transfer of persons in protected areas, i.e. response time of early warning. The early warning index of torrent includes warning rainfall (water level) and dangerous rainfall (water level). The former one refers to the case, in which, it is very possible to have torrent and need to prepare for rain transfer in advance; the latter one refers to the case, in which, it is extremely possible to have torrent and need to transfer rainfall immediately.

2.4 CONSTRUCTION OF MONITORING AND EARLY WARNING SYSTEM

1.1.1 MONITORING WATER AND RAIN INFORMATION

Simple monitoring station: In monitoring mood and flood forecasting system, configure simple facilities for rainfall and water level monitoring according to actual conditions. The township, village and group monitor water and rain information with direct and feasible monitoring method and release information by means of early warning mode suitable for local area, so as to achieve the goal of mass observation and mass prevention. The simple rainfall and water-level station adopts rainy regular monitoring and intensive monitoring of rainstorm or water-level rising to timely report related information and inform related villages and groups at downstream.

Automatic monitoring station: In monitoring mood and flood forecasting system, adopt the management mode of manned watch and unattended operation to realize the automatic acquisition and transmission of water and rain information. The automatic monitoring station adopts combined remote-metering of automatic reporting and query – reply mode, regularly automatic reporting, and addition of event reporting and compatibility of measure calling.

1.1.2 ARRANGEMENT OF STATION NETWORK

The network of monitoring station is mainly arranged in small watershed easily suffered from torrent disaster with valley area less than 200km2. It is necessary to lay out the station network according to investigation of torrent probability zone, regional historical flood and social economy and with full consideration of existing monitoring stations. In layout of rainfall station when establishing rainfall station, it is necessary to fully consider zoning control (20～100km2/station), valley control, terrain control, communication, traffic and other conditions for management and maintenance of operation. In Principle, the simple rainfall station is arranged one in each natural village, but can be properly increased in quantity for villages with people scattered and with large possibility of torrent. Make full use of existing resources. All existing rainfall monitoring information of hydrological and meteorological departments shall be included into county-level monitoring and early warning platform. In the arrangement of water-level station, the automatic water-level monitoring station shall be erected in basin of area more than 100km2 with serious torrent disaster and county or township government or dense population, important industrial and mining enterprises and facilities along its banks. The simple water-level monitoring station shall be erected in small basin of area less than 100km2 with serious torrent disaster and residential area of concentrated population or important industrial and mining enterprises and facilities along its banks. Other small basins shall be also established with simple water-level monitoring station according to actual conditions. The Selection of information transmission communication network includes

- The communication mode commonly used for data transmission of water and rain information includes GPRS/GSM, ultra-short wave (UHF/VHF) and satellite, etc.
- Investigation of communication resources
- Principle for selection of transmission mode
- For areas covered by public network, usually select public network for networking (GPRS/GSM);

- For areas uncovered by public network, usually select satellite or ultra-short wave for communication;
- For important monitoring station and conditional areas, it is possible to select two different communication modes for mutual standby and automatic switching, so as to ensure smooth channel of information transmission.

1.1.3 MONITORING FACILITIES & EQUIPMENT OF SIMPLE MONITORING SYSTEM

Rainfall monitoring: The technical requirements for information acquisition device of simple rainfall monitoring station are as follows:

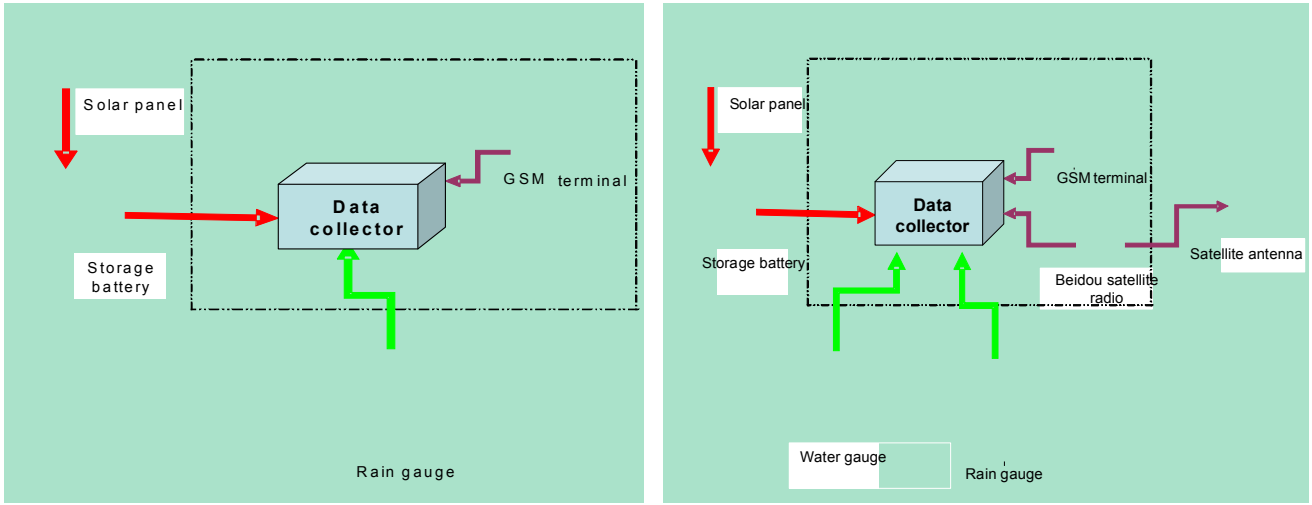
- Configure simple rainfall monitor; the diameter of water receiving mouth, which can be made of iron sheet and plastics, is Φ200+0.6mm.
- The simple rainfall monitor has to be fixed with bracket at the time of installation. After installation, the horizontal distance between the monitor and barriers (e.g.: building, trees) shall be twice of barrier height. It indicates the early warning value of rainfall in labeled area outside water receiving container.

Water-level monitoring: Monitor water level manually with simple and reliable method. The related technical requirements are as follows:

- Erect simple water-gauge pile on bank, which can be wooden pile or stone pile.
- For monitoring station which is impossible to be erected with piles, mark water-level scale on the fixed building or rock near river bank.
- Set the scale on water-level monitoring ruler for the purpose of convenient and direct reading by workers and mark the water level of early warning according to the actual conditions of each monitoring point.

1.1.4 MONITORING FACILITIES & EQUIPMENT OF SIMPLE MONITORING SYSTEM OF AUTOMATIC MONITORING SYSTEM

Rainfall monitoring: The design of rain information acquisition mainly includes the selection of rain monitoring place and rainfall sensor. The rainfall monitoring shall meet related requirements of Specifications for Rainfall Monitoring. In principle, no rainfall monitoring field is newly erected. For station which has been established with rainfall monitoring field, install automatic rainfall station into the monitoring field. For station which cannot be erected with rainfall monitoring field, it is recommend to use integration equipment, which can be installed on pole, roof and platform, etc. Water-level monitoring: The design of water-level information acquisition mainly includes the selection of water-level monitoring facilities and water-level sensor. Each county can select float, pressure, ultrasonic or radar water gauge for monitoring according to actual conditions. Besides, every area can also carry out supporting civil works or installation construction as per selected water-level sensor.



(1) Rainfall Automatic Monitoring Station *(2) Water-level Automatic Monitoring Station*

Fig. 2. (1),(2) Devices Layout in GPRS/GSM/Beidou Satellite Automatic Monitoring Stations

3 MONITORING AND EARLY WARNING PLATFORM

As center of data information processing and service of torrent monitoring and early warning system, the monitoring and early warning platform is mainly composed of computer network, database and application system with main functions as information convergence, information service and module of warning information issue. It explains the working principle of the real-time monitoring and early-warning system [5].

3.1 DATABASE MANAGEMENT SUBSYSTEM

The database system of torrent early warning system stores and manages lots of historical data and real-time data and provides information convergence, information service, consultation, query and forecasting by means of application software. It is required that the system must be able to not only effectively manage lots of long-term historical data for convenience of analysis, calculation and query, but also give rapid response to above applications, so as to ensure the real-time performance of system. In order to ensure the safety and reliability of database, the database management subsystem shall have following functions:

- database generation
- Online modification of database
- Backup and recovery of database
- Monitoring and management of database

Structure classification of database subsystem:

- Basic information management database
- Real-time rain information database
- Thematic database of torrent early warning
- Forecast information database
- Temporary database

Information service subsystem:

- Real-time monitoring (selected sensors) [6]
- Data query, display and printing
- WEB browser service
- 2-dimensional GIS monitoring
- Man-machine interface maintenance
- Access control
- Information exchange

The information received and processed by information convergence subsystem mainly can be classified into following several types. Monitoring management information: including observation and reporting parameters of each monitoring station, station position, station files, station identification and features and station watch, etc. Information about monitoring of water and rain: the monitoring station network established through system automatically acquires water level and rainfall information of monitoring station and collects actually observed information through other means.

Meteorological information: real-time meteorological information, result of meteorological analysis, numerical forecast output and rainfall forecasting result from automatic meteorological station and meteorological and territorial service system. Information related to forecast and system operation management generated from processing and calculation also has to be stored in system. Information service subsystem is supported by GIS monitoring and network techniques, the system is capable to providing the information exchange [7]. The module of warning information issue online monitors all real-time status, water and rain information, each node and network, carries out related analysis, determines the limit and level of early warning as per index of early warning model and automatically alarms once any abnormality is detected.

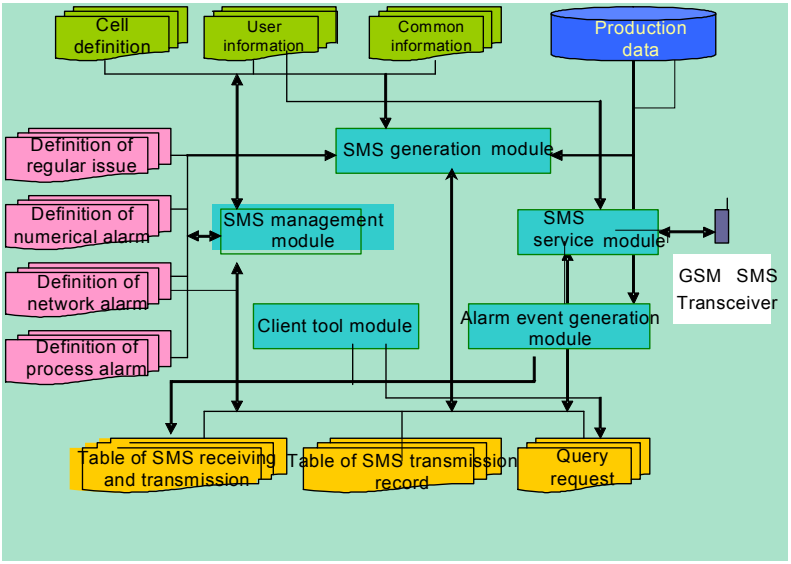


Fig. 3. Module of warning information issue online monitors all real-time status

4 SOFTWARE AND HARDWARE CONFIGURATIONS OF MONITORING AND EARLY WARNING PLATFORM

- In order to ensure the reliable operation of torrent early warning system, the corresponding requirement is also proposed for the response index and reliability of computer, so as to fully play the role of computer in torrent early warning system. The computer of central station is configured with switching fast Ethernet and dual redundancy and structured of C/S and B/S with flexible and variable scale.
- Based on meeting above configuration requirements, the model selection of devices still has to comply with following principles:
- Ensure the reliability and advancement of system;
- Full consider the safety and reasonability of system;
- Adopt technologies which conform to international tendency;
- Support network function;
- Have good expansion capacity;
- Ensure convenient maintenance and management of hardware devices;
- Comprehensively consider cost performance.

5 EARLY WARNING SYSTEM

The early warning information can be obtained from two channels, i.e., from county-level monitoring and early warning platform or from mass observation and mass prevention. The early warning information is mainly issued by torrent prevention command department at each level or monitoring persons on monitoring point of mass observation and mass prevention through transmission network of early warning information and other means.

5.1 EARLY WARNING PROCESS

The early warning information can be prepared and issued through monitoring and early warning platform. The county-level flood-control headquarters issues early warning information to county, township, village, group and principals of related departments and units through monitoring and early warning platform. Then, each township, village, group and related unit organizes to take measures according to prevention planning. The early warning process based on platform is as shown below in fig.4.

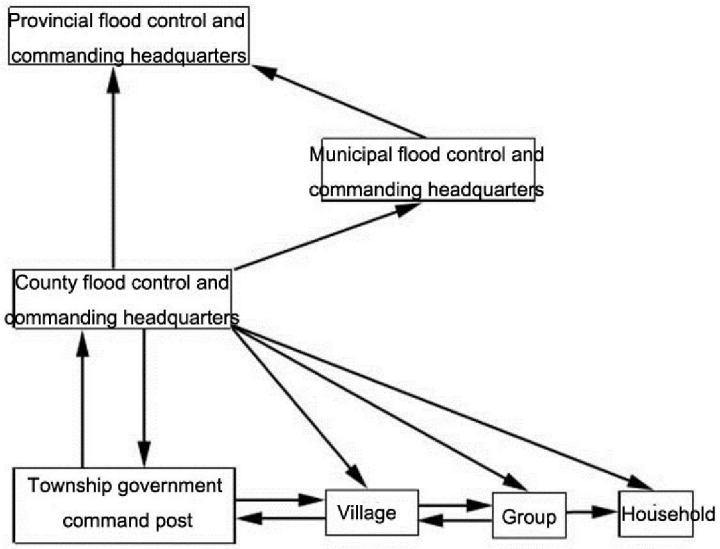


Fig. 4. Early warning process based on platform

The early warning information of mass observation and mass prevention is obtained from county, townships, villages or monitoring points. Observers issue early warning information according to experience, technologies and monitoring information of monitoring facilities mastered from publicity and training related to torrent prevention. In addition to warning information issued or released by county-level flood control department, each township also receives the information from monitoring points of mass observation and mass prevention, villages, reservoirs and hilly ponds. The early warning information of townships, villages and groups at upstream shall be timely transmitted to the corresponding ones at downstream. The warning process of mass observation and mass prevention is as shown in fig.5.

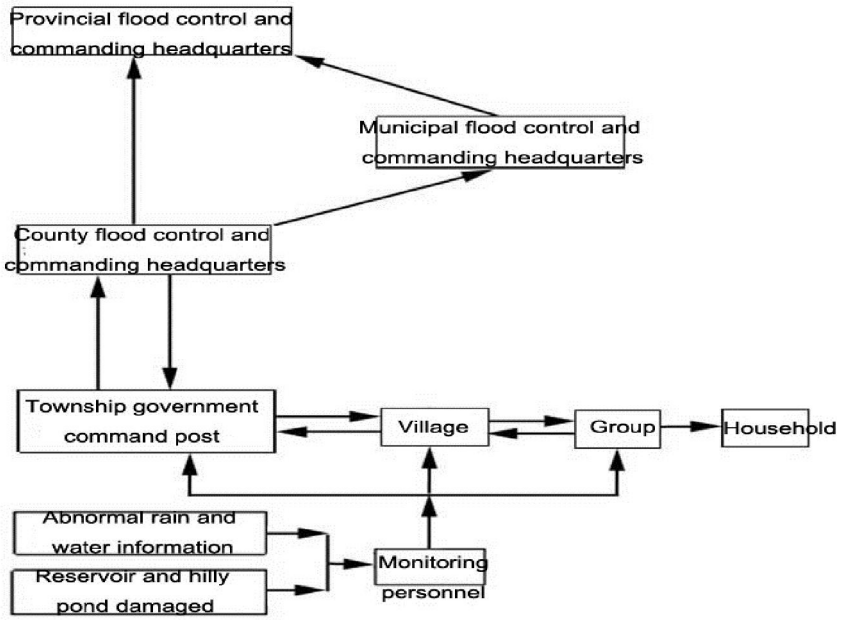


Fig. 5. Warning process of mass observation and mass prevention platform

5.2 ISSUE OF EARLY WARNING INFORMATION

- Authority of early warning issue: The authority of early warning issue belongs to different persons in charge of flood control according to different obtaining channels of early warning information.
- Content of early warning issue: Mainly include flood forecast, rainfall, water-level information of rill, river, reservoir and hilly pond, warning level, notice for transfer preparation and command of emergency transfer, etc.
- Object of early warning issue: The object may refer to cities, towns, villages, residential areas, schools, industrial and mining enterprises and scenic spots and so on which may be threatened by mountain torrents.
- Mode of early warning issue: The early warning can be divided into two stages: internal early warning (to flood-control persons and related principals) and external early warning (to publics).

5.3 COMMUNICATION DEVICE FOR EARLY WARNING

- The county-level torrent prevention headquarters has to transmit the warning information to townships and villages through following means and communication modes;
- The county monitoring and early warning platform automatically transmits warning information to townships and villages threatened by torrent disaster through SMS and fax;
- Issue warning information through radio and TV;
- Transmit warning information to townships through PSTN and mobile phone.
- Early warning communication between townships and villages
- The warning information between towns and villages is transmitted mainly through following method:
- Transmit warning information by means of PSTN, mobile phone and wireless warning broadcast.
- When all communication facilities are damaged by torrents, resulting to be unable to contact with outside, townships and villages can make use of existing vehicles and equipped wireless warning broadcast to inform residents threatened by torrents to evacuate and transfer.
- For villages and groups with scattered populations, the traditional warning means as wireless warning broadcast, interphone, loudspeaker, manual alarm, gong, drum, trumpet, torch, signal flare and manual transfer can be used to issue warning.

6 RESPONSIBILITY SYSTEM

In order to ensure the smooth and orderly prevention of torrents disaster, it is necessary to establish organization and commanding headquarters of torrent prevention, build necessary systems and regulations to define responsibilities and arrange tasks and carry out 5-level (county, township, village, group and household) responsibility system of torrent prevention. The organization and commanding headquarters is usually established in county, town and village.

6.1 ORGANIZATION AND COMMANDING HEADQUARTERS

Composition of county-level organization and commanding headquarters: Set up headquarters in county, which handles official affairs jointly with county headquarters of flood control and drought relief. Both of departments are uniformly commanded by county headquarters of flood control and drought relief. Set offices and 5 working teams (monitoring team, information team, transfer team, dispatching team and safeguard team) under the headquarters. Besides, it is necessary to establish emergency rescue team (more than 10 people) in each county, town, Sumu and office and arrange 1 or 2 information messengers and senders for each Gacha and village.

Composition of township organization and commanding headquarters: Set up torrent prevention headquarters in township, which is arranged with commander and vice-commander and is composed of principals of related functional departments, such as water sources, territory, civil affairs, meteorology, construction, transport, public security and sanitation and so on. Set 5 working teams (monitoring, information, transfer, dispatching and safeguard) and emergency rescue team under the headquarters.

Composition of village organization and commanding headquarters: Set torrent prevention headquarters in each administrative village, which is taken charge by village director; establish emergency rescue team composed by primary militia for each village; define persons in charge of monitoring and early warning; prepare registration book and submit it to township and county headquarters for future reference.

6.2 WORK DIVISION AND RESPONSIBILITIES

1. Work division

The county headquarters of torrent prevention uniformly leads and organizes the work related to torrent prevention. Each related department is respectively responsible for own task. The office of county headquarters is responsible for daily work of headquarters. The township headquarters of torrent prevention carries out torrent prevention work under the unified leadership of county headquarters, reports to related department if any abnormality is detected and takes corresponding emergency measures. The village headquarters of torrent prevention is responsible for water and rain monitoring, early warning, person transfer and rescue work of its own administrative village and assists neighboring villages to carry out torrent prevention work if necessary.

2. Responsibilities

- Responsibilities of monitoring team
- Responsibilities of information team
- Responsibilities of transfer team
- Responsibilities of dispatching team
- Responsibilities of safeguard team
- Responsibilities of emergency rescue team
- Responsibilities of information messenger and sender

6.3 COMPILATION OF PLAN

The content compiled into plan of county torrent prevention includes:

- Investigate basic conditions of nature, economy and society, torrent type and loss caused by historical torrents in the county and analyze the formation causes and features of torrents;
- Define responsibilities and principal of county headquarters of torrent prevention;
- Define townships with task of torrent prevention and measures for torrent prevention;
- Establish monitoring communication and early warning system; define process and mode of early warning; timely issue warning information of torrent disaster according to forecasting;
- Formulate requirements for transfer and relocation; make various measures related to rescue relief work and post-disaster reconstruction; arrange daily publicity and rehearsal, etc.

7 PUBLICITY, TRAINING AND REHEARSAL

7.1 PUBLICITY

Propagandize knowledge related to torrent prevention in village, household and even to individual by means of meeting, radio, TV, newspaper, bulletin board, pamphlet, wall map, compact disk and card issue, so as to continuously improve the consciousness of active prevention and legal defense and enhance the self-rescue awareness and ability.

Organize residents to be familiar with transfer route and relocation place, erect clear warning board in striking place of dangerous area and indicate transfer object, transfer route and relocation place to make all people in dangerous area know related measures.

The publicity materials are uniformly compiled by torrent prevention headquarters at or above county level with concrete requirements as follows: Print Pamphlet of Knowledge about Torrent Prevention, Fabricate compact disk and audio tape to propagandize knowledge of torrent prevention, Prepare Understanding Card of Torrent Prevention, Prepare bulletin board and propaganda column; fabricate warning board.

7.2 TRAINING

Train commanders, principals, monitoring persons, warning persons and regional responsible persons of county and township torrent prevention headquarters in aspect of professional knowledge to define respective responsibilities, so as to ensure the normal and effective operation of commanding system.

Train them in aspect of technologies and operation maintenance of torrent monitoring and early warning system, so as to ensure the effective operation of system.

Train related person to make them understand composition and technology of torrent monitoring and early warning system in current county, use and maintenance of monitoring and early warning platform or information terminal, diagnosis and processing method of computer network fault, operation, maintenance and management of automatic monitoring station, simple monitoring station, flood information and other technologies, so as to ensure the normal operation of monitoring and early warning system.

Train workers of simple monitoring station to make them understand monitoring method of rainfall and water level and transmission method of torrent early warning information, so as to improve the reliability and correctness of torrent monitoring. For information messengers and senders of village and groups, it is necessary to train them in aspect of method for information collection and sorting and mode of warning signal issue, for the purpose of ensuring the orderly and effective development of mass observation and mass prevention

7.3 REHEARSAL

The torrent prevention area carries out once or twice rehearsal of disaster avoidance to make all people clearly know transfer route and relocation place, ensuring calm and safe transfer even in case of power off and communication outage. The content of rehearsal includes emergency response, emergency rescue, disaster relief, transfer, logistics support, personnel transfer and relocation, etc. Describe object, range and content of rehearsal in brief.

8 INVESTMENT EVALUATION

Give brief introduction of principle and basis for compilation of investment evaluation and referred expense standard and related specifications. The price level adopted is price level of that very year. Costs for equipment installation facilities and civil work (labor cost and material cost); the equipment cost mainly refers to expense for purchase of hardware equipment. For main allocated equipment and some damageable accessories, prepare spare parts of them according to 10 ～15% of quantity allocated; the cost of software development mainly refers to expenses for development of monitoring and early warning platform software and purchase operating system, GIS and database related to the platform, etc. Freight and miscellaneous expense, communication expense, installation and debugging expense and taxes are all charged independently according to corresponding standard of fee collection. Evaluate the cost for plan compilation, publicity and training according to actual work amount. Construction management fees, survey and design fees, supervision fees and other fees are controlled as per 6%～8% of total investment for project construction.

8.1 UNIT PRICE AND INVESTMENT REFERENCE SCALE

All regions shall reasonably determine the unit price of all equipment according to actual situation of local pilot. The investment reference scale for each part of torrent prevention non-engineering measures are as shown in table below. The scale can have proper fluctuation when each region compiles estimate cost. The costs of installation and maintenance, and improve the system reliability and expansibility is involved [8].

No.	Item	Construction Content	Proportion in Total Investment
1	Monitoring system	Construction of automatic/simple rainfall/water level station, including monitoring information receiving part in platform	27% around
2	Early warning system	Configuration of equipment for implementation of early warning in county, township, village and groups	35% around
3	County monitoring and early warning platform	Hardware purchase, software development construction and transform of computer room and conference environment, etc.	18% around
4	Mass observation and mass prevention system	General survey of torrent disaster, designation of dangerous area, determination of early warning index, plan compilation, publicity, training and rehearsal of torrent disaster, etc.	20% around

Fig. 6. Table of Unit price and investment reference scale

9 CONSTRUCTION AND OPERATION MANAGEMENT

The water administration department of county where project is shall establish specialized agency, appoint specially-arranged person and carry out project implementation work according to arrangement or requirements of superior department. After project completed, the provincial water administration department shall organize to formulate operation management system. The outlay for operation management is included into provincial, municipal and county financial budget. The operation management is taken charge by county and township. Management of automatic monitoring station and business guidance shall be entrusted to corresponding hydrographic office (sub-office). Related information is included into flood-control and command system to realize information sharing define management system, outlay and personnel to ensure normal operation of system and produce the best possible result

10 CONCLUSION

In this paper, we analysis current condition of key research and establish the requirements for monitoring and early warning system to improve the reliability and expansibility of the system [9]. Since many years, Monitoring and Early Warning System of Mountain were studied with good rick management performance by monitoring research institution bodies and keeps numerous achievements from the research scholars over the world. In conclusion, what article is illustrated that the monitoring system and early warning system is a very effective research measure for mountain torrent disaster reduction and mountainous flood disaster reduction, only after full-filled following these several points [10]:

- Reasonable observation points distribution of disaster warning
- Management risk & analysis system which can get a relatively accurate observations result
- Being accuracy and timely warning signal dissemination mechanism process
- Reasonable research institutional structure, based on the administrative structure plan
- Awareness and perfect emergency response system and planning
- Training, Practices, rehearsal evacuation system based on Public community
- Planned construction and operation management projects

ACKNOWLEDGMENT

The authors would like to acknowledgement technical support from China State Grid Electric Power Research Institute, Nanjing (SGEPRI) and Nanjing Automation Research Institute (NARI) and financial support from the Hohai University, Nanjing China.

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