Abstract

China is a country prone to natural disasters. To deal with natural disasters, a large number of relevant departments in China fight separately, so that the resources which include information, services, materials, human and finances cannot be shared and used effectively. This paper will present a vision of Chinese Natural Disaster Reduction System of Systems (CNDRSS). The CNDRSS aims to link together existing and planned systems which have the ability to reduce the hazards of natural disasters and support the development of new systems where gaps currently exist. The CNDRSS will provide decision-support tools to the decision makers to fight against natural disasters. In this paper, a framework of CNDRSS will be proposed and discussed first, and then some challenges and the corresponding advices will be given for the building of CNDRSS.

Key words: CNDRSS; natural disasters; CCI; framework; system

1. INTRODUCTION

In recent years, Major natural disasters around the world occurred frequently. Because of China’s unique geological conditions and the Natural Environment, China is one of the Countries most seriously affected by major natural disasters[6]. Natural disasters such as earthquakes, typhoons, floods, drought, snow, landslides, sandstorm, ice flood, forest and grassland fires bring great loss of life and property to China. Major natural disasters will lead to a wide range of information on blind spots and traffic gridlock, which will make a serious impediment to the disaster assessment, decision support, emergency response, disaster relief, and other aspects of the work. China takes several actions to enhance the capacity of disaster reduction which include putting in a lot of human and material resources to implement disaster projects, building three-dimensional monitoring systems, establishing disaster relief emergency response systems, establishing disaster reduction technology support system, building disaster reduction personnel training system and developing community disaster reduction systems. There are two core issues still in the work of China’s disaster emergency rescue. The one is lack of real-time data in disaster area and the other one is lack of rapid, effective, accurate, reliable information sharing mechanism among various departments which lead to serious lag, contradiction and repetition in delivery of information. The lack of information sharing mechanism has become a bottleneck which has serious impact on natural disaster prevention, disaster relief. According to China’s current meteorological,
oceanographic, resource and environmental mitigation series of satellite-based information, basic geographic information, airborne remote sensing information, ground-sensing information and other thematic information, as well as information acquisition and processing facilities and management status of relevant departments, it is necessary to establish the CNDRSS which will rapidly integrate the existing spatial information from different departments, realize the collection, compilation, evaluation and reporting of disaster information. So the CNDRSS can provide reliable, timely and accurate disaster information, ensure that the disaster relief headquarters is able to make accurate decisions which allocate the limited resources to the most suitable locations quickly. A framework of CNDRSS will be proposed and discussed in Section 2, and then some challenges and the corresponding advices will be given for the building of CNDRSS in Section 3.

2. THE FRAMEWORK OF CNDRSS

The goal of CNDRSS is to provide stakeholders with disaster reduction services in several natural disaster areas via the internet. CNDRSS will link all the existing systems and develop common technology standards to integrate thousand of types of data, component, products and services. According to the current situation, systems in CNDRSS should be linked together in federal structure. As showed in Figure 1, CNDRSS is composed by Observation Systems, CCI (CNDRSS Common Infrastructure), Disaster Survey Systems, Disaster Reduction Application Systems, Disaster Reduction Components Providers, Disaster Resources Support Systems and Stakeholders. The Observation Systems will provide spatial data such as remote sensing data and in-situ data which meet the standards of CNDSS. The Disaster Survey Systems will provide socio-economic data and disaster information related to disaster reduction. The Disaster Reduction Component Providers which maybe companies, universities and research institutes will provide functional components related to disaster reduction. The Disaster Resources Support Systems will provide CCI with information of disaster reduction resources which include human resources, financial resources and material resources. The CCI will set standards for data, components, products, services and provides registration services which contain User Registration, Data Registration, Components Registration and Disaster Reduction Services Registration. The CCI will first get data, components and then provide them for Disaster Reduction Application Systems which will feedback Disaster Reduction Products, finally provide Disaster Reduction Services to Stakeholders according to their needs.

Most systems in CNDRSS are operated by 34 departments which are relevant ministries, military, scientific research institutes and non-governmental organizations. National Commission Disaster Reduction (NCDR) coordinates all the 34 departments to achieve the goal of CNDRSS and operates the CCI. All the departments behind the CNDRSS will be further introduced in Section 2.1.
2.1. National Commission for Disaster Reduction

National Commission for Disaster Reduction (NCDR) is an inter-ministerial coordination body of procedure under the leadership of the State Council. The main task of NCDR is to study the development of national disaster reduction principles, policies and plans, coordinate the launch of major disaster reduction activities, guide the work of the local disaster reduction and promote international exchanges and cooperation in disaster reduction\[10\]. The members of NCDR include 34 units which are the relevant ministries, military, scientific research departments and non-governmental organizations as shown in Figure 2. The executive departments of NCDR are General Office, Board of Experts and National Disaster Reduction Center (NDRCC). The function of NCDR decides that it is fit for the construction of NCDRSS.
2.2. Stakeholders

There is a very wide range of actors who deal with natural disasters. The actors are comprised of stakeholders defined as “any person or group of persons who may be impacted by a given natural disaster”. Stakeholders include governmental organizations, non-governmental organizations and individuals.
2.3. CCI

The vision for CNDRSS is to realize a future wherein decisions and actions for the benefit of disaster reduction are informed by coordinated, comprehensive and sustained disaster observations and information. To achieve this vision and stimulate broad use of CNDRSS, the system of systems must provide ready access and improved interoperability for existing and future systems. The tools for access and interoperability are core elements of the “Common Infrastructure” of CNDRSS (CCI).

The CCI consists of web-based portals, a clearinghouse for searching data, components, products and services, and registries containing information about CNDRSS data, components, products, services, standards and best practices. (1) Registration of offered CNDRSS resources (components, services, products and data), standards and best practices. The registries should allow easy submission and offer data, components, products and services and support standard search protocols and metadata formats to promote interoperability and integration. (2) Standardized search (CNDRSS Clearinghouse) across registered items and metadata catalogues to promote rapid access to inventory-level information about offered components, products, services, and data. (3) Primary user interface (CNDRSS Web portal) to discover and access registered disaster reduction services of interest, interaction goals for the portals include the ability to allow to search, discover and access to all CNDRSS services through a single user interface with minimal user interaction (“fewest clicks to content”) to connect to services and information through well-documented interfaces.

The CCI operates in the context of external users and providing access to their offered resources, as shown in Figure 4. The figure which is referenced by GEOSS CCI[11] identifies the interactions between the CCI and external resources. The arrows in the diagram do not represent information flow, but rather are intended to describe the relationships between each of the two linked objects. The primary resources ‘outside’ of the common infrastructure are the data, components, products, and portals operated by CNDRSS Members and Participating Organizations. And the registered products will be packaged into services which will be provided to users.
Figure 4. An object-interaction diagram depicting the major relationships between the CCI component services and selected external resources

The CNDRSS Registries expose standardized registration and query interfaces and perform a “yellow pages” role in managing high-level access to CNDRSS resources. All the registries are used as a place to store and publicize items which should be visible in CNDRSS. If an item is in a Registry, it is recognized as a part of CNDRSS. CNDRSS Standards and Interoperability Registry are used to register and share standards nominated by CNDRSS Members and Participating Organizations. Each standard is given a name, a unique identifier, a description, and is classified by type of standard. The Data, Components, Products and Services Registry provides the key “yellow pages” feature of CNDRSS which allows CNDRSS members and Participating Organizations to identify and describe CNDRSS data, components, products and services associated with them. The Best Practices Wiki is a less-structured form of registry that allows CNDRSS Members and Participating Organizations to share common techniques. The User Requirements Registry consolidates requirements for disaster reduction services based on series of user types.

2.4. Observing Systems

The Observing Systems of CNDRSS should contain Satellite remote sensing observing system, UAV observing system, land mobile measurement systems and in-situ systems which can build a disaster-oriented integrated ground-space monitoring network. Currently, there are 12 operational observing systems in China: (1) Comprehensive Information on Disasters & Observing System; (2) Integrated Agricultural Observing System; (3) Integrated Hydrological Monitoring System; (4) Integrated Land Observing System; (5) Integrated Observing System in Cities/Townships & Landscapes; (6) Integrated Meteorological Monitoring System; (7) Seismological & Geophysical Monitoring System; (8) Integrated Environment Monitoring System; (9) Integrated Forest & Ecological Monitoring; (10) Basic Ocean Monitoring System; (11) Integrated Surveying and Mapping Information Platform; (12) Scientific Research-oriented Monitoring System. Each system above is operated by corresponding department, for example, the Comprehensive Information on Disasters & Observing System is operated by NCDR which mentioned in Section 2.1 and the Integrated Meteorological Monitoring System is operated by China Meteorological Administration (CMA). The CNDRSS also should try to get observation data from international
cooperation mechanisms, such as GEOSS, CHARTER and SPIDER.

2.5. Disaster Surveying Systems

Disaster Surveying Systems operated by NCDR and National Bureau of Statistics will provide socio-economic data and disaster information to Disaster Reduction Application Systems. National Bureau of Statistics will collect socio-economic information of disaster areas and analyze the information, and then provides the socio-economic data which should meet the standards of CCI. NCDR operates a surveying network which contains half a million nodes and each administrative village has a node which can report the disaster information through 3G Network. The surveying network will provide disaster information which also should meet the standards of CCI.

2.6. Disaster Reduction Application Systems

The Disaster Reduction Application Systems will contain three parts which are data integration, components and disaster reduction applications. The relationship between the 3 parts can be seen in figure 5. As showed in Figure 5, the data integration will build a Disaster Reduction Application Database which will integrate and store the disaster-oriented data from other systems. The components include basic functional components and disaster-oriented functional components. The Basic Functional Components will provide several basic functions for Disaster Reduction Applications such as Remote Sensing Data Processing, Two-dimensional Data Visualization, Three-dimensional Data Visualization, etc. The Disaster-oriented Functional Components will provide large number of disaster-oriented functional components for Disaster Reduction Applications which select the appropriate components. As showed in Figure 5, the Disaster Reduction Applications get components and data from outside, and then produce disaster reduction products throughout the disaster continuum which contains Emergency Response, Rehabilitation, Reconstruction, Disaster Prevention, Disaster Mitigation and Disaster Preparedness[9].

![Figure 5. The procedure of Disaster Reduction Application Systems](image-url)
3. THE CHALLENGE AND ADVICE OF CNDRSS BUILDING

The process of CNDRSS building will face many challenges, such as funds, experts, department cooperation, technology, etc. This section will discuss the challenges and advices of CNDRSS building in technology level which contains disaster reduction tasks, data acquisition and processing, data transmission, disaster-oriented model and method, disaster application environment.

3.1. Disaster Reduction Tasks

The CNDRSS should be driven by tasks. Disaster reduction is a complex process, so the disaster reduction tasks are dynamic especially in the stage of emergency response. The resources which include data, communication, computation, supplies, funds and human for the dynamic tasks are hard to prepare in a short time. And sometimes, there are maybe a lot of resources, but the resources which meet the task requirements are few. To solve the problems above, the disaster reduction continuum and disaster types should be investigated first, disaster reduction tasks should be defined then, at last do the needs analysis for the tasks and establish task templates.

3.2. Data Acquisition and Transmission

When major disaster happened, the real-time data in disaster area is difficult to obtain because the infrastructure in disaster area may has been destroyed. Data acquisition methods which include satellite remote sensing, aerial remote sensing and UAV will be put into use. Because of the weather, satellite remote sensing and aerial remote sensing may be limited to get real-time data in disaster area. So the disaster-oriented UAV data acquisition method should be improved in the future. The conventional communication facilities are very likely to be destroyed in major disasters, so the best way to transmit data is through the satellite communication network. But there are several technical difficulties in the satellite communication network transmission: (1) Large amount data and limited bandwidth; (2) Selection of transmission path; (3) The security of transmission information. These problems can be improved by research support in those problems. In the stage of emergency response, efficient data processing will save a lot of valuable time. Currently, there are a lot of new technologies such as grid computing and cloud computing, which should be used in disaster-oriented data processing to reduce the processing time.

3.3. Disaster-oriented Model and Method

The extraction, analysis, deduction of disaster information needs accurate and efficient models and methods. Currently, the accuracy and efficiency of those models and methods cannot meet the requirements of disaster reduction. For example, the monitoring model of landslide and flood still needs improve to support the disaster reduction tasks. So some related research institutes should get support to do further research on those models and method.

3.4. Decision Support Environment

In order to accomplish the disaster reduction tasks well, the decision support environment is essential. When major disaster happened, experts in related fields and leaders of relevant departments will form a decision-making team. Usually the members of the decision-making team are not in the same place, effective communication will be a problem. And the disaster information may be not easy to understand. So that it is need to set up a remote consultation platform which supplies a free “face to face” communication environment. In the platform, disaster information which the decision-making team mostly wanted to see will be visually displayed in an orderly, lively, and easy to understand way.
4. CONCLUSION

According to China’s current situation of natural disasters and technology, the building of CNDRSS is a trend and will be a long-term process. This paper promotes a framework of CNDRSS from macro level. As stated in Section 3, the building of CNDRSS will face a lot of technical difficulties which may be gradually resolved in the next few years. Further detailed research work should put on the construction of CCI, it is soul of CNDSS which will linked all the systems together. And the difficulties of CCI construction are not technology, but rather standard-setting and coordination.

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