Journal of Applied Science and Engineering Innovation, Vol.3 No.1 2016, pp. 34-38
ISSN (Print): 2331-9062
ISSN (Online): 2331-9070

Analysis and Design of Drought Monitoring and Assessment System in Northwestern Liaoning, China

WANG Xiaoge[1], ZHANG Yulong[1], WANG Zhenying[2]

[1]*Shenyang Agricultural University, Shenyang 110866, China*

[2]*Research Institute of Water Resources and Hydropower, Liaoning Province, Shenyang 110003, China*

Abstract: Drought phenomenon frequently occured in northwestern areas of Liaoning, China. With the increasing of country's drought occurrence, an increased number of exhibits, intensifies, spread expanded platform was needed. Drought inhibits occur frequently disrupt the normal life of people and undermine the sustainable development of the ecological environment. Therefore, the construction of drought monitoring and warning assessment system was significance. This paper fully consider the characteristics of drought in northwestern areas of Liaoning, RS, GIS, databases, networks, and computer technology was launched for drought monitoring and warning evaluation system, and achieve its regular operation, which provide scientific and drought relief strategy for the future development.

Keywords Drought monitoring; geographic information system; decision trees, classification rules.

INTRODUCTION

China is a vast country and have a relatively poor use of water resources, because of the climate differences, soil properties. The utilization of water resources is extremely uneven and the phenomenon is more prominent in the Liaoning province, China, so establish of drought monitoring system is extremely necessary. Analysis of soil moisture conditions in various regions, distribution and causes of drought, forecast the development trend, farmers timely and appropriate irrigation. The government departments timely development drought reliefIt which has great practical significance (Wan Z. et al, 2004).

Drought monitoring and assessment system is an important part of the state flood control and drought relief work (Man Cheol Kim. et al, 2010; Morid S, Smakhtin V. et al, 2006). The national and provincial flood control center attached great importance of the water sector in the drought monitoring and assessment system construction, in order to achieve the regimen, real-time monitoring and effective management of rainfall, soil moisture information (Mozny M. et al, 2012). Construction contents of the system focused on the following: soil moisture monitoring; drought information management; data sources drought information management system. The system is mainly used in the statistical data of three soil moisture stations, weather stations monitoring data and related departments to get the topic the main means of figure geographic information, data released manifestations mainly consist with various thematic maps and statistical tables (Du L. et al, 2013; Chia-HungLien. et al, 2008).

Drought in northwestern Liaoning lasted long, heavy damage, spread a wide range of other new features, the traditional method of meteorological and hydrological exposing their fast implementation on a large regional scale drought monitoring and evaluation deficiencies. However, the advent of remote sensing (RS), geographic information systems (GIS) and other advanced technology carried out drought relief work. New ideas, theories and methods to solve the existing drought monitoring and warning methods in time and space poor sensitivity on the scale, while the accuracy and reaction is low, application of scale narrow range of issues. This design of drought monitoring system achieve the following functions: achieve the pre-disaster risk map warning function; achieve a drought disaster monitoring from many angles; achieve a comprehensive post-disaster drought assessment capabilities; multi-scale early warning function achieve a drought forecast; implement drought management network and automation capabilities.

RELATED CONTENTS OF OBJECT AREA

Overview of research area

In northwestern areas, Liaoning province in the northwest located between the geographical coordinates of longitude 118 °52 ' to 124 °26', latitude 39 °59 'to 43 °28'. South of the yellow sea, the southwest border with Hebei Province, adjacent to the northwest and Inner mongolia autonomous region, Jilin Province, adjacent to the northeast and east near the central city of Liaoning group.

The total land area of research area is 59,600 square kilometers, accounting for 14.8 percent of the province's total land area. Total land area in the northwest mountain is 7,900 square kilometers, accounting for 13.31%; hills of 19,800 square kilometers, accounting for 33.16%; plain is 31,900 square kilometers, accounting for 53.53%. Mountainous terrain and hilly areas dominated terrain from the northwest to the southeast reduced stepwise to form the narrow coastal Bohai Sea coastal plains, mountains and sea, which was known as the "western corridor." Nevada is the Inner Mongolia Plateau to the transition constituted Liaohe Plain, at an elevation of 300-1000 meters (Majid Khodier. et al, 2010).

Water resource distributed.

Water resource distributed. Northwestern Liaoning province is the most impoverished areas of water resources. Annual average amount of 6.95 billion cubic meters of water resources in northwestern areas, accounting for 20% of the province's total water resources; annual average surface water resources 5.197 billion cubic meters, accounting for 17% of the province's surface water resources; groundwater resources 3.867 billion cubic meters, accounting for 31% of the province's groundwater resources (Table 1). Therefore, northwest Liaoning province is mainly arid region.

Table 1. Water resources distributed in northwestern areas

Area	average amount water resources	average surface water quality	average groundwater quality
Liaoning Northwest	69.50	51.97	38.67
Province	341.79	302.49	124.68
Percentage	20%	17%	31%

Precipitation anomaly percentage refers to the difference between precipitation and normal over a period of climate average compared with the percentage of units (%). In the ordinary course of business used for meteorological drought events evaluate monthly, quarterly. Specific formula is as follow (Aleksandar Radonjie. *et al,* 2010; Seungh wan Kim. *et al,* 2010):

$$D_p = \frac{P-\overline{P}}{\overline{P}} * 100\% \qquad (1)$$

In the formula, D_p - precipitation anomaly percentage, %;

P - Calculate the hours of precipitation, mm;

$\overline{P}$ - For many years the same period the average annual precipitation, mm; should adopt the average for nearly 30 years.

Hydrological drought refers to abnormal water shortages by the precipitation and surface water or groundwater imbalance caused by surface runoff, which can be used in combination with other factors to multi-factor analysis of hydrological drought indicators (Son N T. *et al,* 2012; Hao Z. *et al,* 2014).

Reservoir storage capacity anomaly percentage:

$$I_k = {(S - S_0)}/{S_0} \times 100\% \qquad (2)$$

In the formula, S - the current reservoir storage capacity (ten thousand cubic meters);

S_0 - Over the same period the average years of storage capacity (ten thousand cubic meters)

River inflow anomaly percentage:

$$I_r = {(R_w - R_0)}/{R_0} \times 100\% \qquad (3)$$

In the formula, R_w - current river flow (cubic meters per second);

R_0 - The same period with average flow rate (cubic meters per second)

MONITORING AND EVALUATION INFORMATION SYSTEM

Architecture of monitoring and evaluation information system.

Microsoft Visual studio 2008 was used as development platform, using C/S and B/ S two architectures, develop convenient and practical drought monitoring and evaluation systems, and business-oriented operation drought monitoring and and assessment. Where C/S-based systems for all types of data for various indicators related to the process of generating and drought, B/S mechanism for C/S processing result of the query and display (Pozzi W. et al, 2013; Katiraie-Boroujerdy P S. et al, 2015).

The system has four categories of functionality that is predicted drought early warning, monitoring, evaluation and drought management. Where drought monitoring meteorological, hydrological and remote sensing three ways to achieve, drought assessment capabilities through agriculture, population affected; short-term and long-term drought forecast by achieving. Drought management briefing by drought plan regulations into drought experience It can be achieved after the system running drought monitoring, assessment and forecasting capabilities, a complete change of the consequences of the development of drought and the resulting track. Functional structure of the system construction is shown in Figure 1.

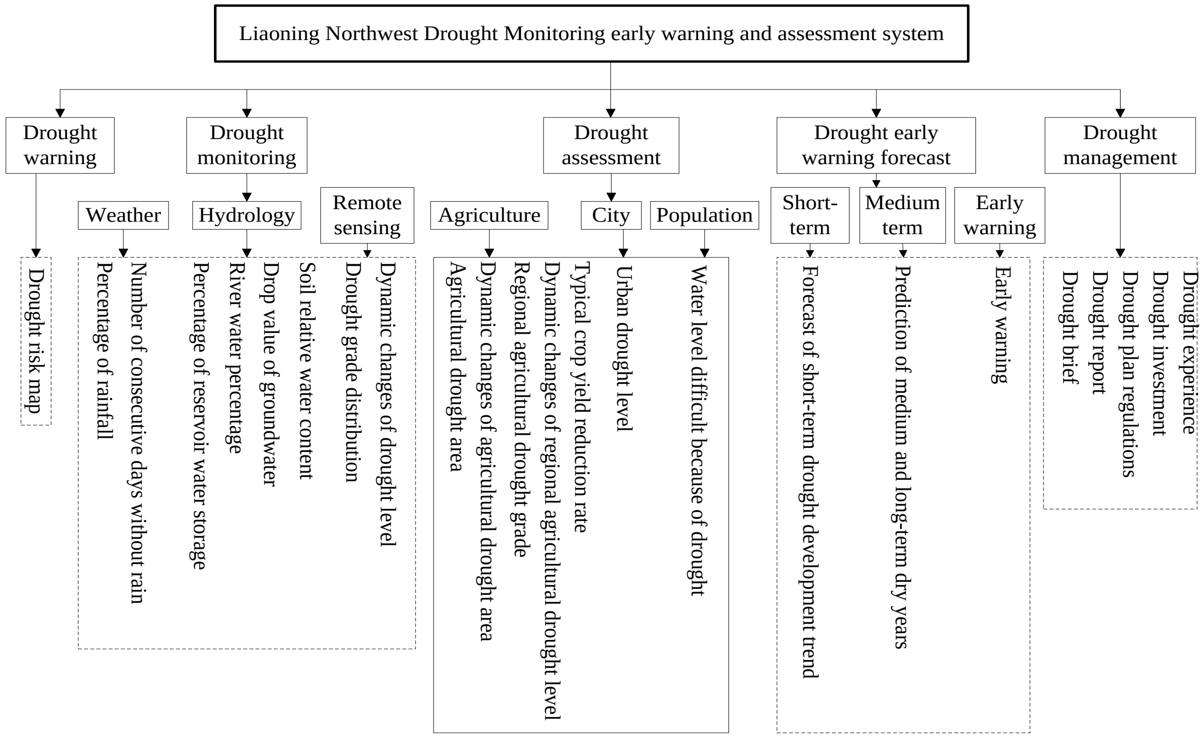

Figure 1. Functional structure of the system construction

B. Database construction. Hydrological data is basis for hydrological drought monitoring. Stations in the study area for daily news are mainly have five types of hydrological stations: water stations, rainfall stations, reservoirs station, moisture and evaporation station. In fact, the vast majority of moisture station and hydrologic station overlap coincide with few rainfall stations or reservoir station. Currently, the provincial hydrological bureau has this part of data collated and construction of the Liaoning provincial flood control and drought hydrological database, therefore, the construction of this system understand the basis of an existing database, according to the actual need of customize the database content and structure (Senay G B. et al, 2015).

According to hydrological drought monitoring needs, the northwestern areas can provide rainfall, soil moisture, reservoir, river monitoring station data. The situation and need run the group of stations, select the desired station, which was shown in Table 2.

Hydrological drought monitoring rainfall anomaly percentage for consecutive rainless days, reservoir storage capacity anomaly percentage, river inflow anomaly percent, groundwater depth and soil moisture content decreased value calculation requires six indicators. Meanwhile, in order to facilitate the operation, the site corresponding to each index is stored separately in a table 3.

Table 2. The distribution of selected stations

City	Number of Stations	Counties (cities, districts)	Number
Shenyang	16	Kangping	7
		Faku	9
Jingzhou	13	Yi	5
		Linghai	3
		Heishan	3
		Beizheng	2
Fuxin	18	Zhangwu	8
		Fumeng	10
Tieling	8	Changtu	8
Chaoyang	26	Lingyuan	2
		Gezuo	3
		Jianping	5
		Chaoyang	7
		Beipiao	9
Huludao	18	Xingcheng	5
		Suizhong	4
		Jianchang	9
Total	99	17	99

Table 3. The basic situation of each indicator selected sites

Number	Index	Number of situation
1	Rainfall anomaly percentage	58
2	Consecutive rainless days	58
3	Reservoir storage capacity anomaly percentage	35
4	River inflow anomaly percentage	23
5	Groundwater table drop value	6
6	Relatively moisture of soil	41

EXPERIMENTAL RESULTS

Moderate-resolution imaging spectroradiometer data.

Source remote sensing data released by nasa modis data products. Full name of modis id moderate-resolution imaging spectroradiometer. Modis onboard the 1998 model is mounted to morning orbit and afternoon orbit series of satellites, formally transmit data to the ground from December 1999. Planet Earth is nasa modis mission plans with a total of 15.

Modis is the current generation of the world's optical remote sensing instruments, with high spectral resolution, temporal resolution and multi-spatial resolution. 36 spectral channels, distributed within the range of the electromagnetic spectrum 0.4-1.4um. Multi-band data may reflect the land while providing cloud boundary, cloud properties, ocean color, phytoplankton, biological geography, chemistry, atmospheric moisture, surface temperature, cloud top temperature, air temperature, ozone and cloud top height feature information with the land surface, biosphere, solid earth, atmosphere and oceans for long-term global observations. Modis spatial resolution are 250m, 500m and 1000m, scanning width of 2330 km, in earth observation process, which can get 6.1 per megabit from the atmosphere, oceans and land surface information, can be a daily or every two days being a global observation data, these data for natural disaster monitoring, global environmental and climate change research. Global ecological changes and comprehensive research has important significance.

HDF data format is a hierarchical data management structure, which was shown in Figure 2, it was a self-described, more objective, scientific data for storage and distribution of data formats. For a variety of storage and distribution of scientific data requirements provide solutions. HDF data format design features are: self-description, diversity, flexibility, scalability and independence.

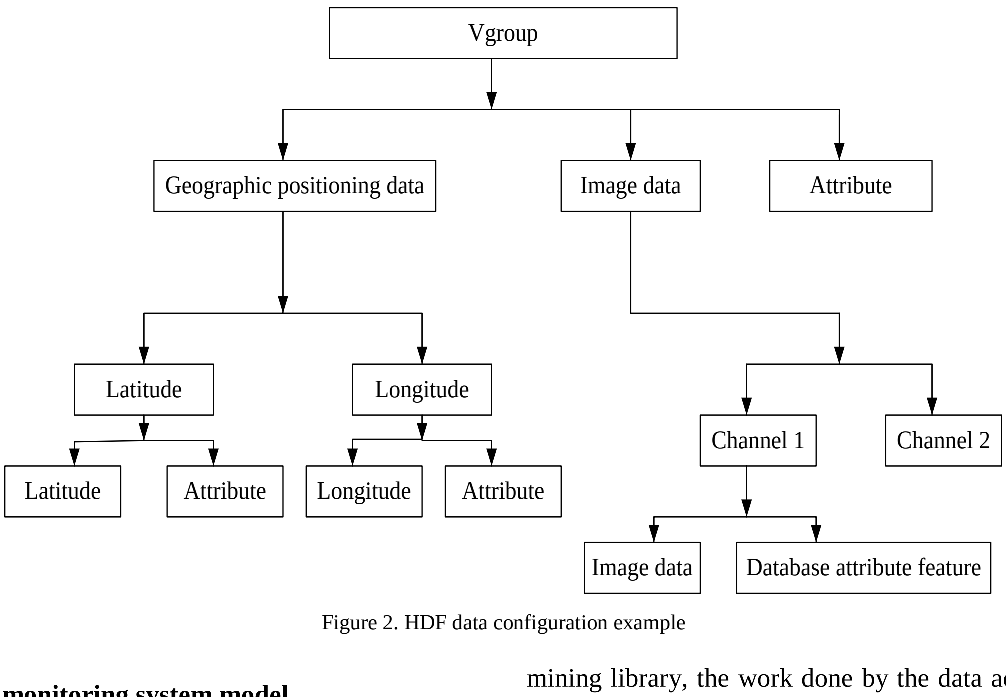

Figure 2. HDF data configuration example

Drought monitoring system model.

Early surveillance mining library decision analysis requires a lot of well-organized and comprehensive data. In particular, data mining depend on the drought after a certain pre-plot data, which comes from a variety of external data, need to go through a complex cleansing and integration, integration to drought data mining library, the work done by the data acquisition layer. So, early data acquisition layer plays a very important role in the whole system. In this article, we have obtained pretreatment and correlation analysis layer for data in the drought data.

Data mining layer of drought situation monitoring system model is early in the highest level, also they tend to be most concerned about the user level. Data mining library drought significant integration of data be used for the user, based on data mining data warehouse used in this layer through a variety of mining techniques and tools. Establish drought monitoring side data mining models in this layer, also known as the mining model drought data mining algorithms, algorithms decide how to analyze examples of early surveillance data mining library. In this article, we use decision tree algorithm to achieve early data mining work.

CONCLUSION

Meteorological drought refers to a certain period of time due to the evaporation and precipitation imbalance. Water indicated shortages caused by income greater than water itself, the system selects the rainfall anomaly percentage and consecutive rainless days two indicators to achieve a meteorological drought monitoring. Hydrological drought refers to abnormal water shortages by the precipitation and surface water or groundwater imbalance caused by surface runoff which can be used in combination with other factors to multi-factor indicators to analyze hydrological drought, reservoir storage system selected anomaly percentage, river inflow anomaly percent, groundwater depth and soil relative humidity values fall four indicators to achieve a hydrological drought monitoring. Remote sensing drought monitoring can be implemented by the regional drought monitoring grades relative humidity of soil inversion, the system selects drought grade distribution and dynamic changes level drought indicators realized remote sensing drought monitoring.

REFERENCES

Chia-HungLien, Hsien-Chung Chen,Ying-Wen Bai, Ming-Bo Lin, 2008, “ Power Monitoring and Control for Electric Home Appliances Based on Power Line Communication”. Instrumentation and Measurement Technology Conference proccedings, vol.1. pp. 62-79

Du L, Tian Q, Yu T, et al. , 2013, “ A comprehensive drought monitoring method integrating MODIS and TRMM data”. International Journal of Applied Earth Observation and Geoinformation, vol.23. pp. 245-253.

Man Cheol Kim, Jinkyun Park, Wondea Jung, Hanjeom Kim, Yoon Joong Kim, 2010, “ Development of a standard communication protocol for an emergency situation management in nuclear power plants ”. Annals of Nuclear Energy, vol.37, no 6, pp. 888-893.

Majid Khodier, Gamcel Saleh, 2010, “ Beamforming and Power control for interference reduction in wireless communications using particle swarm optimization ”. International Journal of Electronics and Communications, vol.64 .no. 6, pp. 489-502.

Morid S, Smakhtin V, Moghaddasi M., 2006, “ Comparison of seven meteorological indices for drought monitoring in Iran”. International journal of climatology, vol.26.no 7, pp. 971-985.

Mozny M, Trnka M, Zalud Z, et al., 2012, “ Use of a soil moisture network for drought monitoring in the Czech Republic[J]. Theoretical and Applied Climatology, , vol.107 .no 1-2, pp. 99-111.

Wan Z, Wang P, Li X., 2004, “ Using MODIS land surface temperature and normalized difference vegetation index products for monitoring drought in the southern Great Plains, USA”. International Journal of Remote Sensing, vol.25, no 1, pp. 61-72.