Nat Hazards (2012) 64:839–851
DOI 10.1007/s11069-012-0274-6

ORIGINAL PAPER

Social perception and response to the drought process: a case study of the drought during 2009–2010 in the Qianxi'nan Prefecture of Guizhou Province

Su Yun · Yin Jun · Shen Hong

Received: 7 December 2011 / Accepted: 28 June 2012 / Published online: 14 July 2012

Abstract Studies carried out on the drought process, which can be classed as a gradual disaster, can help us to understand the disaster mechanism and offer strategies for disaster prevention. This paper uses the example of the drought in the Qianxi'nan Prefecture of Guizhou Province from July 2009 to May 2010. Data have been collected from government gazetteers, meteorological monitoring data, and field surveys to build up a sequence of meteorological drought indices. The categorization of the victims' perception of drought impact, and the stages of drought responses of different subjects (government, social organizations, and the public), has also been examined by the same way. By contrasting the differences between the metrological drought indices, and victims' perception of drought impact, researchers explored the drought cognition features of victims, social response features, and dynamic relationships between drought development and social responses. The results were as follows: The drought evolution process could be divided into 6 phases, and victims' perception of drought impact could be divided into 7 phases. They were consistent in time period, and the victims' perception of drought was subjective and based on their direct experiences. Their response has the characteristics of long term and concentration on a time. The responses of government and social organizations obviously fell behind those of victims, but they were effective and intensive in both timescale and effort. As the drought developed, responses shifted from individual to social responses and from practical to economic, political, and technological responses. On the basis of the results, the author has suggested methods of preparing stakeholders against possible drought risks.

Keywords Drought · Social response · Perception · Time series comparison · Interaction process

S. Yun (✉) · Y. Jun · S. Hong
School of Geography, Beijing Normal University, Beijing 100875, China
e-mail: suyun@bnu.edu.cn

S. Yun · Y. Jun · S. Hong
Key Laboratory of Regional Geography, Beijing Normal University, Beijing 100875, China

1 Introduction

The formation of a drought event is a result of the interaction between natural processes and the social response to those processes. The social response to the disaster will directly affect it, enhancing or alleviating the intensity of the disaster.

Drought is classed as a gradual disaster, which develops over a period of time and has a prolonged effect. It can be difficult to notice the onset, but once it develops into a disaster, it brings about serious consequences. In the formation process of a drought, natural hazards and the social response interact, greatly affecting the distribution and impact on the use of regional water, soil resources, ecology, and environment. Studies carried out on the process of drought perception and response can help to reduce drought risks and enhance strategies to allow human adaptation to drought events.

From September 2009 to May 2010, a once-in-a-century extreme drought hit Yunnan and Guizhou in southwest China, lasting from autumn to spring (Fu 2010). A strong subtropical high-pressure system moved westward for a prolonged period of time, blocking up the warm and wet air from the southern ocean. Although cold air was concentrated in the north, it seldom went south. Therefore, cold air and warm air seldom met in west Guizhou Province. The combination of these phenomena led to the severe drought conditions in Qianxi'nan Prefecture, Liupanshui City, and Bijie areas (Jiang et al. 2011). Precipitation in Qianxi'nan Prefecture from September 2009 to March 2010 amounted to 115.6 mm, much lower than previous years over the same period. Temperatures were consistently higher than average, which led to prolonged (as long as 100 days) drinking water difficulties for 1,997.4 thousand people (62 % of population in the whole prefecture), a substantial reduction in summer-harvested crops (80 % had no yield) and affected spring plowing. During this time, 219 forest fires hit the area, burning an area of 2,273 hectares. Some industries such as the hydroelectric industry were severely hit (Zhou et al. 2010). By the end of March, direct economic losses from drought totaled over 2,600 million CNY. It seriously harmed local production rates and people's livelihoods and restricted the development of society, as well as having ecological and environmental impacts.

When faced with such a severe drought, how do local residents, community organizations, and the government perceive the situation? And how does this perception influence the decisions and actions taken to mitigate the effects of the drought?

This article takes the drought that occurred in Qianxi'nan Prefecture during 2009 and 2010 as an example. It explores the changes in drought responses of different subjects (government, social organizations, and public) as the drought developed. This article aims to explore appropriate methods to quantify social responses to drought and details the changing perception of different subjects as the drought evolved.

2 Study area

Qianxi'nan Prefecture is located in southwest Guizhou province (104°31′–106°32′E and 24°37′–26°11′N) and includes Xingyi, Pu'an, Qinglong, Xingren, Zhenfeng, Anlong, Ceheng, and Wangmo. Its population has reached 321.5 million, in which 73.9 % are based in agriculture since 2009. Its gross domestic product (GDP) has reached 232 billion CNY in 2009, equivalent to 7216 CNY per capita, while in the same year, the national average is 26600 CNY per capita (Statistics Bureau of Guizhou Province 2010). Qianxi'nan Prefecture is also an undeveloped area (Fig. 1).

Fig. 1 The map of Qianxi'nan Prefecture

Qianxi'nan Prefecture has an annual average temperature of between 13.6 and 19.1 °C, an average accumulated temperature above 10 °C between 4,000 and 6,250 °C, and an average annual precipitation between 1,200 and 1,500 mm, 80 % of which occurs from May to September (Zhao and Chen 1999). Qianxi'nan Prefecture is suitable for planting a number of crops including rice, corn, tobacco, winter wheat, and Canna edulis Ker, to name some.

Qianxi'nan Prefecture covers an area of 16,804 square kilometers, 92 % of which are mountains and hills. It consists of a typically tropical karstic geology with Karst landform areas accounting for 72 % of the total area. Rocky desertification of land areas accounts for 28 % of the total area; hence, there is significant fragmentation of arable land with shallow soils and considerable erosion. In areas of arable land, 27 % are paddy fields and 73 % are dry fields (Zhao and Chen 1999).

Due to the imbalance between annual precipitation over time and the mountainous karstic environment, it is common to see high farm land or high dwellings with minimal sources of surface and groundwater, making the use of natural water sources difficult. Therefore, the main usage pattern of mountain water is to collect rainfall and save irrigation water. Rainfall-collecting infrastructures include pools, cisterns, and embankments. The main water usage is by supplemental and sprinkling irrigation. However, the effectiveness of the irrigation systems is restricted by the isolation and backwardness of the areas, the age and disrepair of the systems, all of which lead to insufficient water supply. The total effective irrigation area supplied by water conservancy projects in the prefecture only amounts to 79.45 thousand hm^2 (accounting for 47.7 % of arable area) (Statistics Bureau of Guizhou Province 2010). In addition, agricultural production is labor intensive with little scientific support. For example, rice seedlings and seeding all depend on precipitation, without mulching films. Thus, it can be seen that agricultural production here is inefficient, dependant on nature, and poor in adapting to climate change.

3 Materials and methods

In this research, three sequence categories have been set up to clearly show the drought processes from different perspectives. The first sequence category is based on the meteorological monitoring instrument data concerning meteorological drought trend; the second is based on social survey and reflects the process of local inhabitants' perception and response to the drought; and the third is based on the media reports and drought response level of the government and the meteorological department, concerning the social response to the droughts. In the research, stakeholders are those who have been affected by the drought and those who take action to mitigate it, including the government; professional organizations (those who provide support to help mitigate the effects of the drought, such as the meteorological department whose main jobs include weather forecast, climate prediction, drought monitoring and forecasting, agricultural meteorological and so on; science and water conservancy department whose main jobs include prevention and control of flood and drought, water resources management and utilization; anti-epidemic department whose main jobs include medical treatment, public health, and disease prevention); other social organizations (mainly enterprises); the general public (those who are not affected by the drought); and drought victims (those who are affected by the drought). The above three categories, respectively, show how the drought occurs and develops, how victims' perception of the drought changes over time, and how different social mitigation participants' responses to the drought change as the drought develops.

3.1 Construction of meteorological drought evolution sequence

In this step, the natural evolution of the drought is clearly described based on the meteorological monitoring instrument data.

The research took meteorological data (from July 2009 to May 2010) from 8 county meteorological stations in Qianxi'nan Prefecture (including Qinglong, Pu'an, Xingren, Xingyi, Anlong, Ceheng, Zhenfeng, and Wangmo). On the basis of the meteorological magnitude of drought reflected from these data day by day, the research built up a meteorological drought index for the whole prefecture (see Eq. 1).

$$\mathrm{MD}_i = \left(\sum_{j=1}^{5} M_{ij} \times N_{ij} \right) / 8 \tag{1}$$

MD is the meteorological drought index, i refers to the time (date), M_j is the value of jth meteorological drought degree (dryness is divided into 5 degrees: no drought, mild drought, medium drought, severe drought, and extreme drought, whose corresponding scores are 0, 0.25, 0.5, 0.75, and 1, respectively), and N_j is the number of meteorological stations of jth meteorological drought degree, amounting to eight. Meteorological drought degree is determined according to national standards—Classification of meteorological drought category (GB/T 20481-2006).

3.2 Construction of drought perception and responses category of drought victims

In this step, the process of local inhabitants' perception and response to the drought is investigated by Social Survey. Field investigations are the main source of information.

In August 2010, researchers carried out interviews of 56 households. These respondents were hit by the drought in Yuzhang Town, Jiaole Village, Qijiadadi Village, and other towns and villages in Qianxi'nan Prefecture. The interviews focused on obtaining information from respondents since July 2009 on climatic anomalies noted, drought evolution trends, and time intervals for various phases of the drought. The interviewers also recorded the respondents' criteria and different features used to measure drought, actions taken to alleviate its impact in different phases, and the influence of those actions on the drought.

On the basis of the information collected, researchers recorded victims' perception of drought trends, their corresponding responses at each stage of the drought, and the effects of their responses.

The majority principle was adopted to determine the sequence of drought evolution. Months with a greater number of samples (months with the largest percentages) were used to define the boundaries of each stage of drought evolution. In this way, a graphical plot of victims' understanding of drought evolution was drawn.

3.3 Construction of responses sequence of government and social organizations

Researchers determined that the best way to obtain information on responses of government and social organizations to the drought was by using data from the official Gazetteer and local mainstream media.

Firstly, based on the drought response level of the government and the meteorological department recorded in the gazetteers (Zhang 2010), researchers built up a graphical plot of the response sequence.

Secondly, researchers built up a graphical plot of social responses sequence based on media reports. The News media source of data is publicly available, easily obtained, quickly reported, and responded to and reflects the general views of society, given that they have drawn society-wide attention (Sobh 2007). As the drought impacted, the whole of society, from government, social organizations to the general public, had gradually attached more importance to it. The media, serving as a watchtower for society, provided a record of the disaster trend and the social response to it. To a great extent, it provided a relatively accurate record of the attention and responsiveness afforded to the event by the whole of society (Chen 2010). There is only one newspaper in Qianxi'nan Prefecture actually. Meanwhile, its responses are more rapid and comprehensive than other higher levels of newspapers. Hence, this research took drought reports from local mainstream media *Qianxi'nan Daily* (Qianxi'nan Daily 2009–2010) (from July 1, 2009, to May 31, 2010) as a main way to obtain information of different stakeholders' responses to the development of the drought. On the basis of the number of drought reports and the occupied pages every day, the research built up another index named social response index (see Eqs. 2, 3).

$$\mathrm{SR}_{i'} = \mathrm{RN}_i/\mathrm{RN}_{\max} + \mathrm{RP}_i/\mathrm{RP}_{\max} \tag{2}$$

$$\mathrm{SR}_i = \mathrm{SR}_{i'}/\mathrm{SR}_{\max'} \tag{3}$$

SR is the social response index, which is a normalized difference index and lies between 0 and 1; *i* refers to the time (date); RN is the number of drought reports in *Qianxi'nan Daily*; and RP is the occupied pages of drought reports in the *Qianxi'nan Daily*.

4 Results and discussion

4.1 Victims' cognitive processes and characteristics of the drought

4.1.1 Phasing of the drought evolution

The sequence of the meteorological drought index of Qianxi'nan Prefecture was built up according to Eq. 1 and relative meteorological data. Conversely, the sequence of victims' perception of drought level was built up according to the social survey data.

According to the instrument data, the meteorological drought evolution process can be divided into 6 phases, divided by boundaries set by the values of meteorological drought degrees (0.25, 0.5, 0.75, and 1) (see Fig. 2). As Fig. 2 shows, the meteorological drought developed as follows: From July 2009 to mid-October 2009, it was classed as mild drought; from late August to late September, it developed into a medium drought; from late September 2009 to late January 2010, it became a severe drought; from late January to mid-April, it was classed as extreme drought (according to the meteorological data, the rainfall from January 2010 to March 2010 was between 4.0 and 19.4 mm for the whole prefecture. This was much lower than historical minimum levels with a decrease of 77.1 % in Ceheng and 95.5 % in Xingren. The air temperature rose by 2.7 to 3.7 °C.); from mid-April to early May, it diminished to a medium drought; and in mid-to-late May, it further alleviated to mild drought. The meteorological drought in the Qianxi'nan Prefecture went through the whole process, from appearance, aggravation, maintenance, to elimination from 2009 to 2010. Prominent features of this drought were the following: prolonged (continuous drought from autumn, winter, to spring), severe, and extreme drought

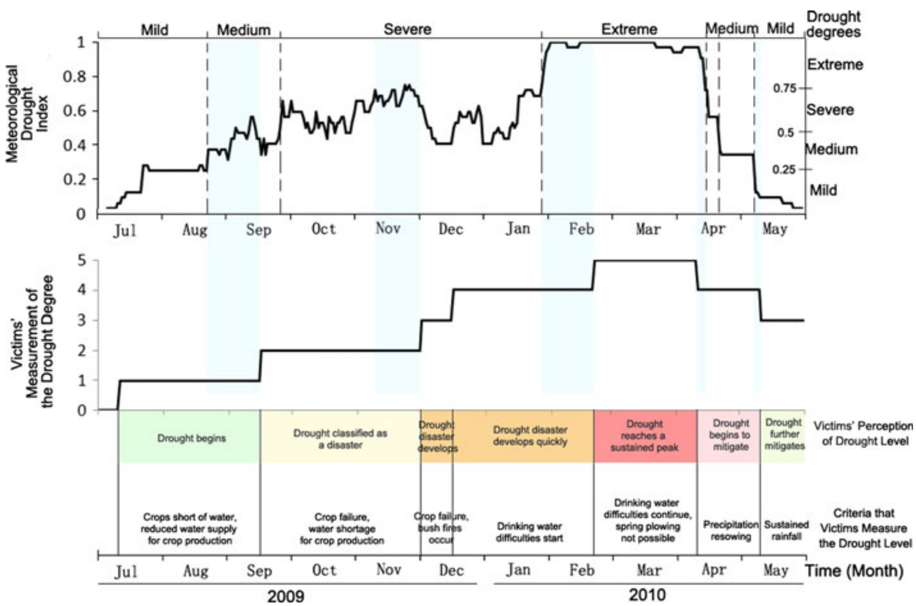

Fig. 2 The contrast between meteorological drought index and victims' perception of drought level (the *color* in the *vertical marks* out time difference. *Horizontal colorized ribbons* show victims' perception of drought level)

dominant (they last for about 200 days, occupying about two-thirds of the whole process) and fast to alleviate during late drought.

According to victims' measurement of the drought evolution, their perception of the drought level could be divided into 7 phases as follows: From early July 2009 to mid-September, drought appeared; from mid-September to late November, the drought turned into disaster; in early and middle December, drought disaster continued to develop; from late December 2009 to late February, drought disaster developed quickly; from late February to early April, drought developed to peak; from mid-April to early May, drought began to mitigate; and in mid-to-late May, drought further mitigated.

4.1.2 Subjectivity of victims' perception of the drought

By contrast, it could be shown that the victims' perception of the drought level is generally in accord with the meteorological drought evolution process. However, since their criteria to measure the drought level varied, the results of measuring the degree of drought at the same time may differ. Meteorological drought relied on instrument data, while victims relied on signs of drought in farmland, decreased production, changes in standard of living, and natural phenomena.

Field investigation results showed that victims respond to the drought principally based on physical signs of drought (decreased production) and secondarily based on natural phenomena and changes in the standard of living. Signs of drought were noted when anomalies appeared in crop growth and surface soil water, based on farming experience. They could help to evaluate whether drought conditions existed and how severe it was. They could also serve to guide farmers on how to irrigate properly. Drought for farmers meant, crop failure, water shortages, decreased standard of living, and economic loss. They measured drought by intuition and common sense which was to some extent a subjective measurement.

Local inhabitants recorded that the drought first appeared in July 2009, mainly because at that time both the output and quality of tobacco leaves declined (the surface of leaves has some spots). At the same time, drinking water supply was still normal, but the farming water supply was insufficient. In September, the drought continued from summer into autumn, seriously affecting late corn and late rice production which went without irrigation cover. It also made it hard to cultivate in autumn. Rice filling is also difficult in fields without irrigation, leading to reduced output of autumn grain.

Up until winter in 2009, drought had affected the seeding, emergence, and growth of winter-sowed crops, such as cole, winter wheat, and horsebean, even leading to crop death. However, it was at the same time as harvesting of root crops like Canna edulis Ker and sweet potato. Therefore, it also led to a severe reduction of productive fields. Lots of trees also perished from drought, and local inhabitants had heard of or seen several forest fires. At this time, drinking water and farming water supplies were also in short supply.

The disaster developed fastest and became worst in spring of 2010. It became extremely difficult to find drinking water and farming water, which threatened the basic livelihoods of local people. Moreover, it affected the rice seeding, and farmers were unable to cultivate in time for spring.

4.1.3 The empiricism and limitation of victims' perception of the drought

As for the victims, their understanding of the drought and response to it was based on their previous experiences instead of surface phenomena. They explained the new phenomena brought by this drought in the context of previously experienced conditions. Their perception of the current drought level was formed by contrasting with the previous droughts. Therefore, their perception of the drought was very empirical.

Drought is one of the most severe natural disasters in the Qianxi'nan Prefecture (Sun et al. 2006). Researchers thoroughly examined the historical precipitation data from 1951 to 2005 in Xingyi City of Qianxi'nan Prefecture, worked out the precipitation anomalies month by month, and explored the historical drought patterns in Qianxi'nan Prefecture according to the National Drought Level Standard (see Fig. 3). As Fig. 3 shows, Qianxi'nan Prefecture is an area with a high drought probability, as high as 83 %, with medium droughts dominating. Droughts in this area mainly hit in winter and spring. In February, March, November and December, drought probabilities are all over 20 %. Generally, spring drought is the main reason for reduced grain production in this area. Crops sowed in autumn and winter do not have a large water demand. In winter, natural soil water is used to ensure the water supply of the coming year's spring sowing and the sprouting of winter crops. Therefore, winter drought does not have a severe influence on this area. Only when winter drought meets spring droughts, or if it is preceded by autumn drought will it become serious.

As is shown from above, local inhabitants have some experience in responding to droughts, especially to spring drought, autumn and winter drought, and winter and spring drought. However, such severe and long-lasting drought conditions have surpassed their current experiences. When the results of the events are unpredictable or beyond current experience, the confidence of people's prediction of occurrence will decline.

4.1.4 The delay of victims' cognition of the drought

By contrasting meteorological drought and the victims' cognition of the drought level, we can see that there is a delay in their recognition of drought. In the evolution of drought from medium drought, severe drought, extreme drought, to drought alleviation, victims' cognition is 15–20 days later than meteorological drought.

Local inhabitants measure drought mainly by signs of drought in their fields and decreased production. There is a lag between the appearance of meteorological drought and the appearance of signs of drought in fields, so victims' recognition of the drought will be delayed. As a result, local inhabitants cannot take mitigation actions to resist drought as soon as it appears.

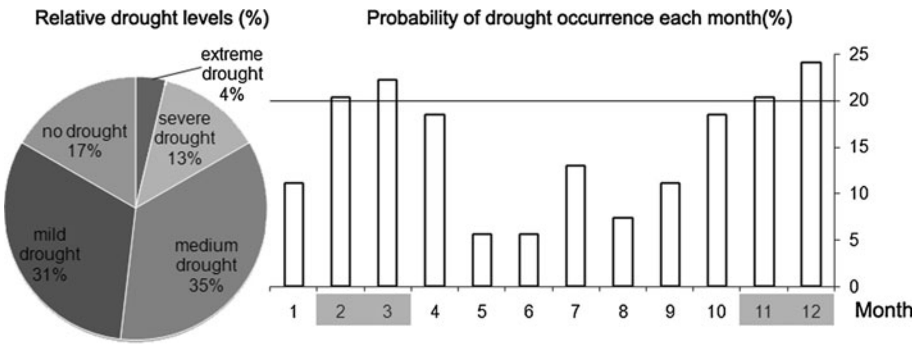

Fig. 3 The drought frequency in Qianxi'nan Prefecture

4.2 Social cognition and responses to the drought

4.2.1 Timelines of drought responses of different subjects

With the data collected from government gazetteers and media, using Eqs. 2 and 3, researchers drew the timeline of government and weather department emergency response history and social response index curves. The drought response sequence of varied subjects is shown in Figs. 4 and 5.

Except for the victims of drought, other subjects responded to the drought from early January 2010 to early May 2010, with a concentration between March and April, when the drought was most severe. From July 2009 to early January 2010, when drought developed

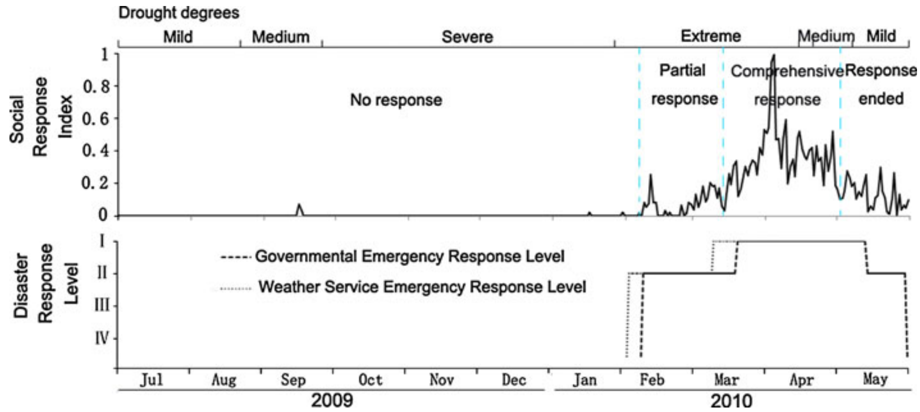

Fig. 4 The contrast between social response index and disaster response level

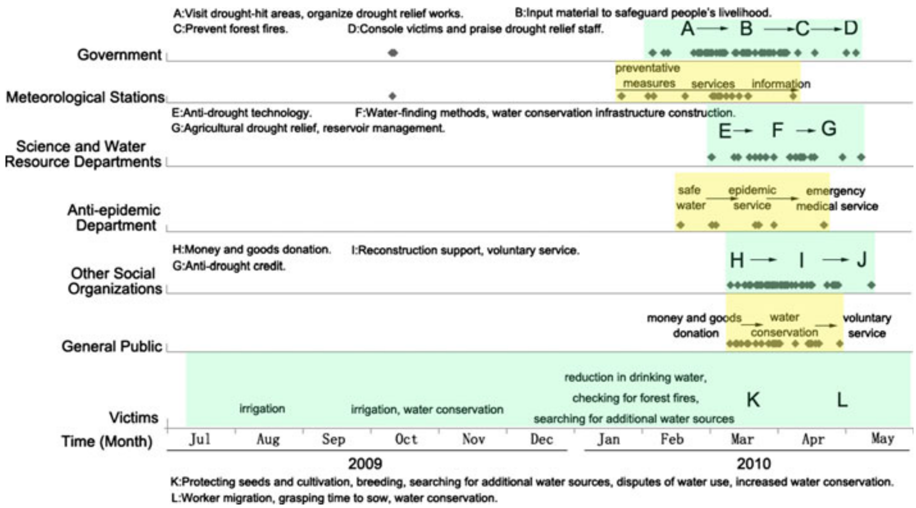

Fig. 5 Timelines of drought responses by different organizations (*colorized ribbons* show the different responses' starting and ending times)

from a mild to a severe impact, the social responses were limited as the drought had not raised sufficient subject-wide attention yet. From late January to early February, during which time the severity of the drought was sustained, the meteorological department and government successively released a Level II Emergency Response. In early March, it turned into an extreme drought, and the meteorological department and government successively released a Level I Emergency Response. From March to early April, the anti-epidemic department and science and water conservancy department also began professional anti-drought responses as well. At the same time, other social organizations and the general public also began to take drought relief action. Comprehensive social responses peaked during this period.

From mid-April to May, the drought quickly turned from extreme to medium. The Meteorological department and government both downgraded their emergency response levels. As rainfall started and levels increased, the government shifted their response into expressing sympathy to the victims and praising individuals and organizations who instigated drought relief measures. The meteorological departments continued to provide weather services, while the science and water conservancy department, anti-epidemic department, other social organizations, and general public successively ended their drought responses. The social response index plot had a sharp decrease at this period of time.

Examining the timeline, it was victims who responded to the drought first, followed subsequently by the meteorological department, government and other professional organizations (science and water conservancy department, anti-epidemic department), with other social organizations and the general public last. The main reason for this time difference was that the subjects' decision-making bias differed. For the victims, they took action dependent on their current level of damage and previous experiences. For government and other professional organizations, they responded to the drought mainly according to monitoring data and the emergency response level released by the meteorological department. For other social organizations and general public, especially those beyond the drought hit area, they adjusted their drought responses mainly in accord with media reports.

4.2.2 Response features of different subjects

The response of victims lasted for the whole drought process, starting early and ending late. Their anti-drought goals shifted as the drought developed and were targeted depending on the drought period, from production guarantee in mild drought period to basic livelihood guarantee in severe and extreme drought periods. With strong subjectivity and restricted by their limited experience, local inhabitants concentrated on irrigation and water conservation methods to mitigate the effects of the drought. From previous experience, rice could be extensively cultivated. For example, the fields used for raising seedlings could be open to the air without any water cover. Seed emergence did rely on precipitation; however, this practice was unavailable under such extremely dry conditions. As the drought developed, their anti-drought measures and strategies also changed, from individual responses at early times, no responses when it turned severe (very little could be done), to group responses (searching for help) when it turned to extreme.

The responses of government and social organizations were obviously later than victims. There were three time lags in government response: perception lag, decision-making lag, and implementation and mobilization lag. Inevitably, some inefficiency lays in their responses; however, since government and social organizations were professional and with a clear assignment of responsibilities, their drought responses were effective, especially in distributing relief materials, finding additional water sources, sourcing drought seedlings, and providing financial support. Their responses were concentrated in both time and intensity. When the drought developed to the extreme, which was beyond the ability of local action to deal with, aid from other areas contributed a great deal to help the anti-drought effort. This aid included military support, money and goods donations, voluntary service, reconstruction support, and many other types of support.

Overall, as the drought developed, drought responses shifted from individual to social responses, from productive, economic responses to political and technological responses. From July 2009 to September 2009, the dominant responses to the drought were local inhabitants' individual productive responses (irrigation and water use management). From October 2009 to January 2010, it shifted to individual economic responses (cutting revenue, using stored grains, and reducing consumption). From February 2010 to April 2010, the government produced drought relief policies; professional departments provided scientific and technological services; media increased anti-drought reports, and the whole of society donated and provided voluntary support. It turned into a social response.

4.2.3 Revelation to prevention of drought risks

Each drought response subject helped in the drought relief, but their effectiveness was limited. Therefore, apart from the active responses to the drought when it happens, local adaptability to drought should be strengthened. Compared with the emergency response capacity, the ability to quickly adapt and prevent is more important.

On the basis of the geomorphic and meteorological features of this area, the first step to relieve drought conditions is to strengthen infrastructure construction. Karst is the dominant landform in this area, with coverage of 71.5 %. Surface water is in shortage, while ground water is in abundance. There is a high seasonal variation in rainfall. Though average rainfall in this area in previous years lies between 1,200 and 1,500 mm, it is not well distributed in time and space. High fields and low surface water, high areas of residence, and low water are the most common scenes in this area, which makes it hard to utilize water. Most of the irrigation systems and water conservancy measures (IWC) are outdated and incomplete. This extreme drought has taught us that there is a severe engineering water shortage in Qianxi'nan Prefecture. Effective irrigation areas in the whole prefecture amount to only 79.45 thousand hm^2 (Statistics Bureau of Guizhou Province 2010). Water supplied by water projects amounts to only 46.5 million m^3, taking up 4.38 % of average annual flow (1,060.6 million m^3) (Statistics Bureau of Guizhou Province 2010). Irrigation and water conservancy is severely deficient for the demands of food production and maintaining livelihood. In short, there is a huge shortfall in water supply.

Hence, in the process of constructing the adaptation prevention, the capability, construction, and management of IWC should be strengthened. Not only should medium-sized reservoirs be constructed but also small size or microwater conservancies should be built to retain precipitation efficiently. Water storage should be increased to take advantage of precipitation and floods, and groundwater resources should be reasonably developed. Construction of small projects for rainfall collecting, streamflow collecting, and water raising, such as raising water from cellars, water tanks, pools, and underground water, should follow the principle of suiting water use management systems to differing conditions in terms of location, timescale, issue, and people involved. Farmers should be guided to select drought-resistant crops scientifically, distribute crops, and irrigate reasonably and raise overall drought-resisting capability.

In addition, the adaptation prevention capability of stakeholders should be strengthened. Victims that are directly affected by drought have responses that are faster and more prolonged. Therefore, guidance for raising their risk identification and drought-resisting capability can help them to put preventative measures in place before drought impacts, respond in time during drought conditions, and restore after drought more efficiently. The government plays a leading role in organizing drought-resisting works and is supposed to strengthen cooperation and coordination with drought victims and other social organizations. It has a responsibility to make drought-resisting plans and to respond in a timely and appropriate way. The meteorological department, the direct source of drought information, needs to strengthen its monitoring network, forecast promptly and reliably, provide meteorological service, and offer early warning information to the government. The media, which disseminates firsthand information from government and the meteorological department, is supposed to improve publicity to raise public awareness to help drought prevention and to report drought information on time.

5 Conclusions

This article took the drought in Qianxi'nan Prefecture during 2009 to 2010 as an example, collecting information from government gazetteers, meteorological monitoring data, and field survey to build up the sequence of meteorological drought index, sequence of victims' perception of drought level, and the timeline of drought responses of different subjects. Researchers also collected the drought responses of different subjects, contrasted the differences between metrological drought and the victims' perception of drought level, and summarized and distinguished the response features of the varied subjects. By quantifying the drought, researchers explored the drought perception features of victims, social response features, and dynamic relationships between drought development and the social responses. Results of this research can help to prepare stakeholders against possible drought risks.

Conclusions of the research are as follows:

1. According to the meteorological drought index, the drought evolution process could be divided into 6 phases. It was prolonged, severe, and extreme drought dominant and fast alleviating during late drought.
2. According to the victims' measures of the drought evolution, their perception of drought level could be divided into 7 phases, generally in accordance with the meteorological drought evolution process. However, the victims' assessments were subjective, based on their own assessments and with a time lag. As a result, victims' drought response was prolonged (for the whole process), significant, and limited by the victims experience.
3. Responses of the government and social organizations were obviously later than the victims. But their drought responses were effective and concentrated in both timescale and effort. The government took action based on drought reports and monitoring data released by the meteorological department. Professional organizations responded to the drought according to the government emergency responses, and other social organizations and general public respond to the drought according to the media reports.

4. On the whole, as the drought developed, drought responses shifted from individual responses to social responses and from production and economic responses to political and technological responses.

Acknowledgments This study was supported by the National Nature Science Foundation of China (No.41171402) and Major State Basic Research Development Program of China (973 Program) (No.2010CB950103). The author wishes to thank Nong Haiyan, Ma Yining, Zhang Qiansheng, Pei Xia and Qin Longyang from School of Geography in Beijing Normal University for their help with field survey and constructive suggestions of the paper.

References

Chen Z (2010) A special method and grading index on the quantitative assessment about the social emergent response to extreme low temperature, raining and snowing, icing disasters. J Huazhong Agric Univ 3:119–122 (Social Sciences Edition)
Fu Q (2010) The problems existing in the construction of irrigation and water conservancy basing on southwest drought. J Anhui Agric Sci 16(11):27–28
Jiang B et al (2011) Analysis on climatic characteristics of drought and seasonal water shortages in 2010 in Southwest Guizhou. J Anhui Agric Sci 9(4):2045–2047
Qianxi'nan Daily (2009–2010) Drought report in Guizhou Province. http://qxnrb.com/epaper/html/2010-07/01/node_2.htm, 20 June 2012
Sobh T (2007) Innovations and advanced techniques in computer and information sciences and engineering. Springer, Berlin
Statistics Bureau of Guizhou Province (2010) Guizhou statistical yearbook 2010. China Statistics Press, Beijing
Sun W et al (2006) The disaster analysis and countermeasure research of the drought in the Southeast of Guizhou. J Guizhou Meteorol 30(2):27–29
Zhang Z (2010) 2010 flood control and drought fighting work report. Beijing
Zhao J, Chen C (1999) Geography of China. Higher Education Press, Beijing
Zhou S et al (2010) Cause analysis of the drought during 2009–2010 in the Qianxi'nan Prefecture. J Guizhou Meteorol 34:25–26