Gorgan University of Agricultural Sciences and Natural Resources

Environmental Resources Research (ERR)

Print ISSN: 2345 - 430X
Online ISSN: 2345 - 4318

Assessing the quality of drought adaptation in regional plans – Case study of Chaharmahal and Bakhtiari Province

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Article Info

Article type:
Research Article

Article history:
Received: December 2020
Accepted: September 2021

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Keywords:
Adaptation
Assessment
Drought
Regional Plan

Abstract

The impact of regional plans on water resources and has always been a concern for researchers. In the meantime, one of the issues which is being raised by drought is how to assess the quality of regional plans considering the drought. In this research, Fu and Tang plan assessment method called "Awareness-Analysis-Action" is used to assess the quality of six regional plans of Chaharmahal and Bakhtiari Province in Iran. Findings show that the awareness component in all plans is at an average level. Regarding the analysis component, comprehensive regional plans are in a good level, and other plans were at an average level. The action component was rated moderate in all plans and the scores related to the component of action in the plans were not different significantly. In terms of the overall plan score, only one plan received a score above average. Results of ANOVA test showed that the mean of the "Analysis component" in the plans is more than the two other components and there is no significant difference between the score of the three components of the plans. In other words, regional development plans have failed to succeed in three components of awareness, analysis, and action regarding drought adaptation.

Cite this article: Vahid Yeganegi, Mohammad Hossein Sharifzadegan & Naghmeh Mobarghei. 2021. Assessing the quality of drought adaptation in regional plans – Case study of Chaharmahal and Bakhtiari Province. *Environmental Resources Research*, 9 (2), 133-142. DOI: 10.22069/IJERR.2021.16440.1269

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DOI: 10.22069/IJERR.2021.16440.1269
Publisher: Gorgan University of Agricultural Sciences and Natural Resources

Introduction

Before establishing regional planning and management institutions in Iran, it was individuals who planned and managed activities as a self-organized behavior. Such behaviors have lasted for centuries in areas such as Chaharmahal and Bakhtiari a province in southwest of Iran whose economy is heavily dependent on agriculture. For example, behavior of farmers regarding the selection of suitable land for agricultural activities and water consumption were influenced by individual and collective assessment of environmental conditions and annual precipitation. In fact, farmers' activities were largely in line with the concept of sustainability. After establishment of the governmental institutions and the presentation of regional plans, the role of individuals in the management and planning of activities at the

local level was reduced and a new attitude emerged upon which only government was regarded as responsible for planning and managing and protecting vital resources such as soil and water. At the same time, during the last four decades, numerous water transfer projects from this province to other provinces were implemented, and numerous licenses for drilling wells were granted to applicants. The increase in droughts caused by climate change was also added to the dimensions of these problems and provided a new atmosphere for the presence of state institutions. However, it is surprising after decades of institutional activities in agricultural management, planning, and policy-making, farmers are still not able to adapt to drought conditions and use the non-renewable water resources more efficiently. It seems that governmental plans prepared by local institutions have not been successful enough. As drought intensified, the use of groundwater resources increased and a large part of the preserved lands was also used by farmers for rain-fed farming (Chaharmahal & Bakhtiari Regional Water Company, 2018). Since the pattern of development in this province closely follows agriculture and tourism (Chaharmahal and Bakhtiari Management and Planning Organization, 2018), continuation of this process will threaten sustainable development of the region and may lead to a massive change in land use, displacement of the population and the creation of economic and social problems. Therefore, assessing the quality of drought adaptation in regional plans is essential as a first step in identifying the status quo.

What justifies the need for regional planners to study more the spatial effect of drought is that it can affect the various economic sectors, including agriculture which can then lead to problems such as exacerbation of regional inequalities, decreasing life quality, widespread unemployment, and conflict over water resources and widespread migrations. Researches in this field focus on four subject areas including spatial assessment of vulnerability to drought, identifying factors affecting vulnerability to drought, interventions for adaptation and minimizing damage caused and evaluation of the success of interventions (Anđić and Vorkapić, 2014).

Also, a review of the relevant research shows that there are two main approaches of dealing with drought in regional planning including mitigation and adaptation (Bajracharya, 2011). In the mitigation approach, planners focus mainly on the physical aspects of the environment and in the adaptation approach the focus is on the institutional and behavioral and planning aspects (Schwab, 2010). Therefore, policy making and planning to deal with droughts without evaluating the quality of previous plans may lack important information for actions.

This has been confirmed in several studies. In their study on vulnerability to drought in Middle East, Brown and Crewford concluded that the potential impact of droughts is not solely a result of drought itself, but it is influenced by the strategies and options that a planning system is designed to respond to (Brown and Crewford, 2009).

Dulal and his colleagues also showed that factors such as the quality of planning in dealing with drought are important for biophysical hazards in detection of possible damages (Dulal et al., 2010). In his studies, Fussel concluded that, in order to reach drought-ready communities, spatial planning should provide comprehensive knowledge of drought and systematically analyze the dangers of droughts and turn knowledge and concerns into proper actions (Fussel, 2007).

So far, many studies have been carried out on the assessment of the quality of drought adaptation in regional plans each focusing on a range of factors that affect the quality of the plan (Balling Jr. et al. 2007; Hayes et al. 2004; Ivey et al. 2004; Tang et al 2011; Wilhite, 2011; Wilhite et al., 2007).

There are also two approaches in drought adaptation planning. The first approach focuses on provision of independent drought adaptation plans and the second focuses on integrating the drought adaptation into the plans (Tang et al., 2011). Consequently, Fu and Tong have introduced a protocol called "AAA" for assessing the quality of drought adaptation in spatial plans, which had a strong correspondence with the five tasks

that Svoboda et al. (2010) outlined to achieve drought-ready communities (see Figure 1). The five tasks are (1) getting started, (2) information gathering, (3) monitoring, (4) awareness and education, and (5) action plan (Svoboda et al., 2010).

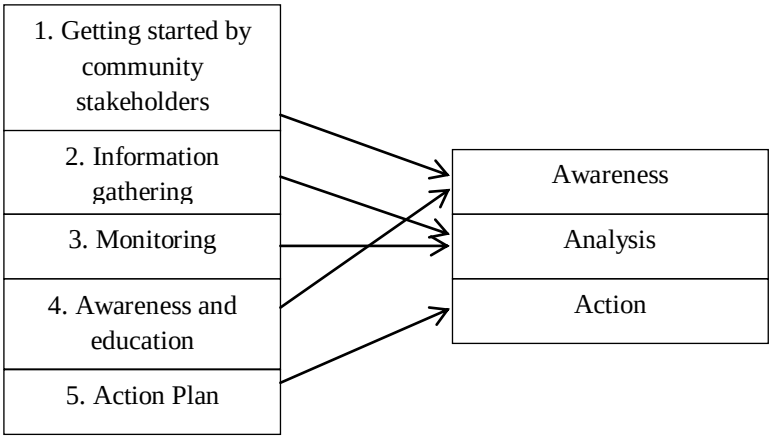

Figure 1. Plan components' relationships

Table 1. Indicators of plan quality assessment for drought adaptation (Fu and Tang, 2013)

Plan component	indicator	
Awareness	Local perception of drought and water shortage	
	Historical records of drought	
	Population growth and impacts	
	Recognition of state drought plan	
	Existing water-related regulations/codes/plans	
	Water conservation/efficiency goals	
	Public awareness and education campaign	
Analysis	Water supply sources inventory	
	Identify water uses	
	Identify water supply status	
	Identify how previous droughts affect local community	
	Identify drought prone areas and vulnerable sectors	
	Identify local climate	
	Identify local drought triggers and indicators	
	Current water usage and future demand projection	
Action	Coordination	Coordination within jurisdiction
		Coordination beyond jurisdiction
	Land Use Policies	Land use restrictions from watersheds
		Land acquisitions to preserve integration of watersheds
		Green infrastructures
		Mixed-used and compact development
	Water Conservation Regulations	Water-saving building codes
		Water-efficient irrigation
		Drought-resilient landscaping
		Restrictions in some urban water uses
		Improve water system efficiency
		Wastewater recycle and reuse
	Financial Tools	Water pricing
		Establishment of water conservation
	Implementation	Establish drought leadership team
		Prioritize water related plans
		Identify feasibility of actions
		Continuously monitor, assess, and update

Fu and Tong have developed 33 indicators to measure the quality of components and the entire plan to drought adaptation. Within the three core components (awareness, analysis, and actions), each indicator is scored on a 0-2 scale. Such ordinal coding scheme was originally developed by Berke and French (1994). Any indicator that is not mentioned in the plan receives a score of "0." An indicator that is considered, but not thoroughly, is scored as "1". A score of "2" means the indicator is fully considered.

Wilhite indicates that the awareness component should include studying water supply, water use, local weather conditions, past droughts, drought-prone areas and economic, environmental and social vulnerabilities (Wilhite, 2011). According to Brody's findings local institutions should carry out an analysis to determine how communities recognize the drought (Brody, 2003)

Brody also showed that the action component forms the heart of the plan which is a means to ensure that goals are achieved. The actions include strategies (Ivey et al. 2004), land use policies (Burby et al. 2000), water conservation rules (APA, 2002; Wilhite, 2011), financial tools and enforcement strategies (Svoboda et al., 2010). The aim of this study is to evaluate the quality of drought exposure in the regional plans of Chaharmahal and Bakhtiari Province using Tong and Fu methods.

Materials and methods

Research area

Chaharmahal and Bakhtiari Province lies in the southwest of Iran. It has an area of 16,332 square kilometers with a population of 895,263 in 2018 (Chaharmahal and Bakhtiari Management and Planning Organization, 2018). It is a mountainous region and has nine counties including Shahrekord, Boroujen, Saman, Ben, Kouhrang, Farsan, Kiar, Ardal and Lordegan (Figure 2). The average annual precipitation in the province is about 700 mm, but the spatial distribution of water resources is extremely non-uniform, so that its annual rainfall varies from less than 300 mm in the eastern regions (Boroujen county) to over 1400 mm in the western regions (Kouhrang county). If we accept the threshold of start of the drought is 75% of the average precipitation of thirty years period, then in the province for the last thirty years up to 2017 there were a total of nine years of drought, of which three droughts occurred in the last 10 years (Chaharmahal and Bakhtiari Regional Water Company, 2018).

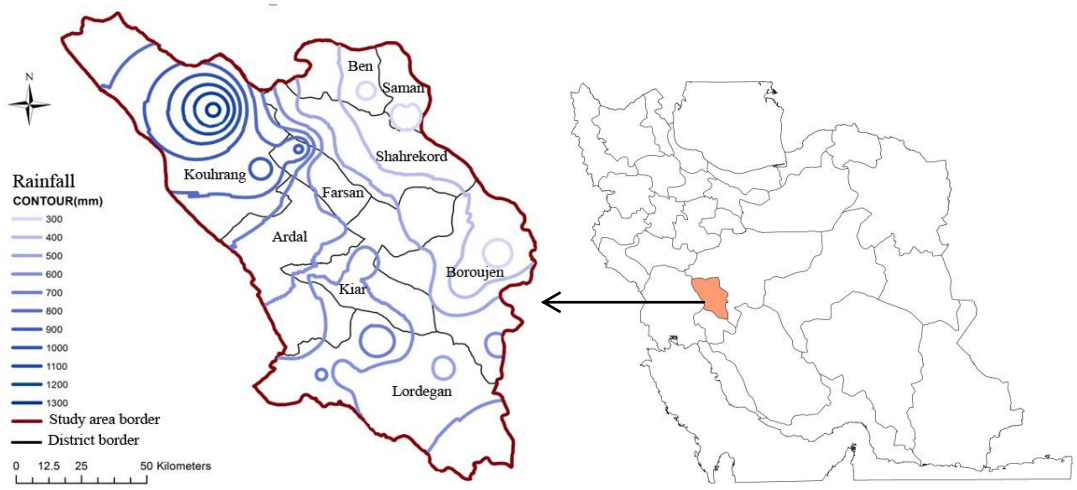

Figure 2. Study area

Research method

Data were collected through the review of regional plans. The reviewed plans included the following: Province Master Plan (PMP), Karun River Aquifer Management Plan (KAMP), Province Water Management Plan (PWMP), Provincial Tourism Master Plan (PTMP), Shahrekord Regional Master Plan (SRMP) and Boroujen Regional Master Plan (BRMP). Fu and Tong methods were used to assess the quality of the components and the entire plans regarding the method, taking into account the relationship of each indicator with the plan components (Awareness, Analysis, Action). In the process, a score of 0 to 2 is given to each indicator. Any indicator not considered in a plan will receive a score of 0. If the indicator is poorly considered it will receive a score of 1 and if the indicator is fully considered in the plan, it will receive a score of 2.

Assessment was carried out by eight experts from the fields of agricultural management, watershed management and regional planning based on Tang and Fu coding method (values 0, 1, 2). The calculation of the score for the three components of the plan and the whole plan was also carried out according to the proposed method of Fu and Tang (Equation 1 for plan components and Equation 2 for the whole plan).

Equation 1. $$PC_j = \frac{10}{2m_j}\sum_{i=1}^{m_j} I_i$$

Equation 2. $$TPQ = \sum_{i=1}^{3} PC_j$$

where PC_j indicates the quality of the jth plan component (ranging 0-10); m_j represents the number of indicators within the jth plan component; I_i represents the ith indicator's score (ranging 0-2); and TPQ means the total score of a whole plan (ranging 0-30). To assess the quality of the plan components, a breakdown of the range of scores was used as described by below classification.

A= poor $0 \leq A \leq 2.5$
B=average $2.5< B \leq 5$
C=good $5 < C \leq 7.5$
D=excellent $7.5< D \leq 10$

To assess the quality of the whole plan, a breakdown of the range of scores was used as described by below classification.

A= poor $0 \leq A \leq 7.5$
B=average $7.5< B \leq 15$
C=good $15 < C \leq 22.5$
D=excellent $22.5< D \leq 30$

Results

Tables 2 - 23 show the results of calculation based on the AAA scoring method.

Table 2. Scores obtained for awareness component (PC1)

Plan	Expert1	Expert2	Expert3	Expert4	Expert5	Expert6	Expert7	Expert8	Mean	Std.Dev
PMP	4.29	5.71	4.29	1.43	3.57	2.86	1.43	3.57	3.39	1.47
KAMP	3.57	2.86	3.57	4.29	5.71	3.57	4.47	5	4.13	0.92
PWMP	6.43	7.14	4.29	4.29	3.57	4.29	5.71	4.29	5	1.26
PTMP	2.86	1.43	3.57	3.57	1.43	3.57	1.43	2.86	2.59	1
SRMP	4.29	3.57	3.57	2.86	5.71	2.14	2.86	3.57	3.57	1.08
BRMP	4.29	4.29	2.86	3.57	5	3.57	4.29	2.14	3.73	0.94

Table 3. Scores obtained for analysis component (PC2)

Plan	Expert1	Expert2	Expert3	Expert4	Expert5	Expert6	Expert7	Expert8	Mean	Std.Dev
PMP	5.63	5	3.75	3.13	4.38	5.63	3.75	5.63	4.61	1
KAMP	6.25	3.13	7.5	1.88	2.5	3.13	2.5	5	3.99	2.03
PWMP	1.88	4.38	3.13	5.63	2.5	5	5.63	4.38	4.07	1.42
PTMP	2.5	3.13	3.75	2.5	4.38	6.25	3.75	5.63	3.99	1.38
SRMP	3.13	7.5	5	4.38	5.63	7.5	5.63	4.38	5.39	1.53
BRMP	7.5	2.5	5.63	6.25	5.63	3.75	6.88	4.38	5.31	1.67

Table 4. Scores obtained for action component (PC3)

Plan	Expert1	Expert2	Expert3	Expert4	Expert5	Expert6	Expert7	Expert8	Mean	Std.Dev
PMP	2.22	5	3.89	3.33	4.44	5.56	3.89	3.33	3.96	1.05
KAMP	6.11	3.33	7.22	2.87	3.33	3.89	5	5.56	4.65	1.57
PWMP	7.22	4.44	6.67	8.33	5	6.11	4.44	5.56	5.97	1.39
PTMP	2.22	1.67	2.22	1.11	2.78	3.33	3.89	3.33	2.57	0.93
SRMP	3.33	4.44	3.89	2.78	2.22	3.89	2.78	4.44	3.47	1.83
BRMP	5	4.44	3.33	2.78	3.89	5	2.78	3.33	3.82	0.91

Table 5. Quality of awareness in the PMP

level	respondents	Frequency (%)	Cumulative frequency (%)
poor	2	25	25
average	5	62.5	۸۲/۵
good	1	12.5	100
excellent	0	0	100

Table 6. Quality of awareness in the KAMP

level	respondents	Frequency (%)	Cumulative frequency (%)
poor	0	0	0
average	7	87.5	87.5
good	1	12.5	100
excellent	0	0	100

Table 7. Quality of awareness in the PWMP

level	respondents	Frequency (%)	Cumulative frequency (%)
poor	0	0	0
average	5	62.5	62.5
good	3	37.5	100
excellent	0	0	100

Table 8. Quality of awareness in the PTMP

level	respondents	Frequency (%)	Cumulative frequency (%)
poor	3	37.5	37.5
average	5	62.5	100
good	0	0	100
excellent	0	0	100

Table 9. Quality of awareness in the SRMP

level	respondents	Frequency (%)	Cumulative frequency (%)
poor	1	12.5	12.5
average	6	75	87.5
good	1	12.5	100
excellent	0	0	100

Table 10. Quality of awareness in the BRMP

level	respondents	Frequency (%)	Cumulative frequency (%)
poor	1	12.5	12.5
average	7	87.5	100
good	0	0	100
excellent	0	0	100

Table 11. Quality of analysis in the PMP

level	respondents	Frequency (%)	Cumulative frequency (%)
poor	0	0	0
average	5	62.5	62.5
good	5	37.5	100
excellent	0	0	100

Table 12. Quality of analysis in the KAMP

level	respondents	Frequency (%)	Cumulative frequency (%)
poor	3	37.5	37.5
average	3	37.5	75
good	2	25	100
excellent	0	0	100

PTMP Table 13. Quality of analysis in the PWMP

level	respondents	Frequency (%)	Cumulative frequency (%)
poor	2	25	25
average	4	50	75
good	2	25	100
excellent	0	0	100

Table 14. Quality of analysis in the PTMP

level	respondents	Frequency (%)	Cumulative frequency (%)
poor	2	25	25
average	4	50	75
good	2	25	100
excellent	0	0	100

Table 16. Quality of analysis in the SRMP

level	respondents	Frequency (%)	Cumulative frequency (%)
poor	0	0	0
average	4	50	50
good	4	50	100
excellent	0	0	100

Table 15. Quality of analysis in the BRMP

level	respondents	Frequency (%)	Cumulative frequency (%)
poor	1	12.5	12.5
average	2	25	37.5
good	5	62.5	100
excellent	0	0	100

Table 17. Quality of action in the PMP

level	respondents	Frequency (%)	Cumulative frequency (%)
poor	1	12.5	12.5
average	6	75	87.5
good	1	12.5	100
excellent	0	0	100

Table 18. Quality of action in the KAMP

level	respondents	Frequency (%)	Cumulative frequency (%)
poor	0	0	0
average	5	62.5	62.5
good	3	12.5	100
excellent	0	0	100

PTMP Table 19. Quality of action in the PWMP

level	respondents	Frequency (%)	Cumulative frequency (%)
poor	0	0	0
average	2	25	25
good	5	62.5	87.5
excellent	1	12.5	100

Table 20. Quality of action in the PTMP

level	respondents	Frequency (%)	Cumulative frequency (%)
poor	5	62.5	62.5
average	3	12.5	100
good	0	0	100
excellent	0	0	100

Table 22. Quality of action in the SRMP

level	respondents	Frequency (%)	Cumulative frequency (%)
poor	1	12.5	12.5
average	7	87.5	100
good	0	0	100
excellent	0	0	100

Table 21. Quality of action in the BRMP

level	respondents	Frequency (%)	Cumulative frequency (%)
poor	0	0	0
average	8	100	100
good	0	0	100
excellent	0	0	100

Table 23. Average score of components and total score of plans

Plan	awareness	analysis	action	total
PMP	3.39	4.61	3.96	11.96
KAMP	4.13	3.99	4.65	12.77
PWMP	5	4.07	5.97	15.04
PTMP	2.59	3.99	2.22	8.8
SRMP	3.57	5.39	3.47	12.43
BRMP	3.73	5.31	3.82	12.86

The significance level in the Shapiro-Wilk test was 0.841. So the distribution of mean of components can be assumed normal. The ANOVA test and Scheffe test were also used to examine the difference between the scores of components. Tables 24 and 25 show the results of the tests.

Table 24. The ANOVA test results

component	Mean	Std. Error	F	P
awareness	3.73	0.8		
Analysis	4.56	65.0	1.205	0.327
action	4.01	1.24		

Table 25. The Scheffe test results

component	groups	Mean difference	P
awareness	analysis	-0.82	0.339
	action	-0.28	0.875
analysis	action	0.54	0.611

The significance level in ANOVA test results is more than 0.05 (Table 24). It means that there is no significant difference between the scores of triple components. Results of Scheffe's follow-up test show that the scores related to the component of awareness are 82% lower than the scores related to the component of analysis, but this difference is not significant. Also, scores related to the component of awareness is 0.28 less than the scores related to the component of action, and this difference is not significant. The scores of analysis are also 0.54 higher than the scores of action, and this difference is not significant. Tables 26 to 28 show the total scores of the components and Table 29 shows the total score of plans.

Table 26. level of awareness component

Plan	Mean of scores	Level of score
PMP	3.39	average
KAMP	4.13	average
PWMP	5	average
PTMP	2.59	average
SRMP	3.57	average
BRMP	3.73	average

Table 27. level of analysis component

Plan	Mean of scores	Level of score
PMP	4.61	average
KAMP	3.99	average
PWMP	4.07	average
PTMP	3.99	average
SRMP	5.39	good
BRMP	5.31	good

Table 28. level of awareness component

Plan	Mean of scores	Level of score
PMP	3.39	average
KAMP	4.13	average
PWMP	5	average
PTMP	2.59	average
SRMP	3.57	average
BRMP	3.73	average

Table 29. level of whole plan

Plan	Total score	Level of score
PMP	11.96	average
KAMP	12.77	average
PWMP	15.04	good
PTMP	8.8	average
SRMP	12.43	average
BRMP	12.86	average

Pearson correlation test was also used to measure the relationship between the scores of plan components. Table 30 shows the results of the test.

Table 30. Pearson correlation test results between plans' components

components	Pearson Correlation	Sig. (2-tailed)
Awareness-analysis	-0.133	0.801
Awareness -action	0.997	0.001
Analysis-action	-0.220	0.676

Discussion

According to the research findings, none of the plans has earned more than 5 score regarding the awareness component. Therefore, the component of awareness is moderately considered in all plans. The scores related to the awareness component did not also differ significantly. The minimum score of awareness was 2.9 in the PTMP and the highest attention was paid to the issue of drought in the PWMP.

Regarding the analysis component, comprehensive regional plans are in a good level and received scores more than 5 points, however other plans are in an average level. The lowest score for the analysis component (3.99 out of 10) was observed in the KAMP and PTMP. The highest scores related to the analysis component were observed in SRMP (score 4.9 out of 10).

Table 29 shows the total score of the plans (range from 0 to 30). As can be seen, only one of the plans (Water Resources Management Comprehensive Plan) received more than 15 points and was ranked at a good level and other schemes received less than 15 points (out of 30) and their quality was found to be moderate. The results of ANOVA test show that there is no significant difference between the score of plans' components. It also indicates that the average scores of the analysis is greater than the two other components, although the component of the action did not get a high score (average score 4.54 out of 10). In other words, regional plans have failed to succeed in the three components of awareness, analysis and action regarding drought adaptation. Also, the results of the correlation test showed that there is no specific pattern about the relationships between the components of the plans.

Conclusion

The Chaharmahal and Bakhtiari Province enjoys an agricultural-based spatial development and needs to adapt to drought. However, findings show that the spatial development plans have not enough capacity regarding drought adaptation and most of the reviewed plans in all counties have not been able to provide enough information about the drought and water shortage issues and consequently these plans have not succeeded in analyzing and

action stages. Therefore, assessing vulnerability to drought and integrating drought vulnerability information into spatial development plans seems essential. For conclusion, according to the AAA method, the following suggestions can improve the province's plans regarding drought adaptation:

- Although regional plans may or may not necessarily include water and drought, because of the spatial dimension of the regional plans and their relevance to the distribution of population and activities, drought adaptation in such plans should be regarded as an important component.
- To improve the awareness component in the reviewed regional plans, issues related to local understanding of droughts, historical records of drought, impacts of population growth on water resources and water usage, existing water-related regulations/codes/plans, other government programs and water use rules, water conservation goals, and public awareness and education campaigns should be reviewed.
- To improve the level of analysis in the regional plans, issues related to the study of water resources, water use, water supply status, the effects of past droughts on the community, identification of vulnerable and drought-prone areas, identification of local climate, identification of local drought triggers and future demand projection should be analyzed or considered in the program.

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