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Abstract

Chapter 7 presents the tools available to local communities to prepare for and manage the effects of drought, with a focus on the development of policies and procedures that will aide organizations and individuals during periods of scarce water supply. A brief introductory section divides drought management into drought mitigation and drought response, and outlines six key areas of drought management. Additional sections discuss each of the key areas, followed by a table presenting a list of drought management tools drawn from existing plans and planning guidelines available locally and nationally. The table indicates whether the tools are applicable to long-term mitigation or short-term drought response, and whether they help to increase supply, to reduce water use, or to provide other drought management benefits. Finally, a discussion on how local entities may best develop drought management plans is presented.

Introduction

Drought is a natural phenomenon that occurs over different time periods and at various scales. Similarly, drought management can also occur at various times and at various scales. Immediate and long-term impacts of drought are typically experienced most strongly at a local level, such as within a local water district, municipal jurisdiction, or ranch or farm. To this point, this chapter discusses and presents various *drought mitigation* and *response* tools that local entities may use to manage drought.

It is useful to distinguish two aspects of drought management that occur over time. *Drought mitigation* includes actions taken before a drought that reduce the occurrence and severity of water supply shortfalls. *Drought response* refers to actions taken during a drought to manage water supplies and water demand appropriately. Both *drought mitigation* and *response* require careful planning.

The six key areas of local drought management are shown at right.

These areas of drought management are discussed individually in the sections below. Table 7-1 then summarizes drought management tools related to the six key areas presented. The table identifies drought management tools, indicates whether the tools can be implemented for short-term *response* or long-term *mitigation*, and identifies whether the tools are used to reduce water demand, to increase water supply, or to manage responses to and impacts of drought.

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Key Areas of Drought Management

- Public policy evaluation, development and implementation, including emergency response plans
- Public education and relations
- Water rights management
- Water supply augmentation
- Monitoring and evaluation
- Water conservation and drought-time water use restrictions

The table contains tools that are useful to a variety of water user segments such as agricultural, municipal, and recreational entities. The needs and concerns surrounding drought management vary from one segment to another, though certain fundamental principals of planning and management outlined below will be pertinent to all entities. This list was compiled from several documents listed in the references section, including Denver Water 2002, Knutson et al. 1998, and Wilhite et al. 2003. Please also note that the category of “other” refers to the fact that in addition to reducing demand or increasing supply, some tools may help offset economic losses, provide information for improved management, or improve public understanding and compliance.

Drought Management Public Policy

Drought management will be most effective if it is set in the context of a full understanding of local water supply and demand, which will most likely be addressed in an entity’s master water management plan. Water rights management, supply development, and conservation, all discussed below, clearly have both drought and non-drought implications for local water management. In addition, understanding and managing the specific risks and impacts of drought requires integration of long-term and drought-specific planning and policy. Therefore, drought management policy can be effectively developed utilizing risk management analyses and techniques.

Under a risk management focus, drought planning entails impact assessments, economic analyses, and consideration of issues of vulnerability, equity, efficiency, cost and urgency. Understanding the economic, social and physical aspects and impacts of drought allows selection of *drought mitigation* policies, programs, and actions that fit with the overall water management plan and addresses the underlying causes of vulnerability to drought. This will reduce the chances of water supply and demand imbalances in times of drought. Further, the broad perspective afforded by risk management analyses allows entities to develop response plans that minimize economic, social, and other impacts when drought occurs. Development of *mitigation* and *response* plans and related policies should include substantial participation on the part of all affected stakeholders and the general public.

Developing appropriate drought management response plans require that entities have the authority and communication processes in place to take drought response actions, including how and when to declare a drought emergency and determination of when to declare it. The plan should also set out clear objectives and priorities for drought-

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related actions. Potentially conflicting objectives—which may include reducing economic impacts, minimizing inconvenience to users, avoiding rationing, saving trees and perennial plants, and more—should be addressed and prioritized in the plan, well before an actual drought. A plan should include carefully developed triggers for declaring drought of different levels of intensity (mild, moderate and severe) and the corresponding actions water managers and users should or must take. Specific issues addressed in a drought response plan often include provisions to supply critical uses of water, ways to adjust infrastructure operations to ensure maximum use of available water supplies, water quality monitoring under low flow conditions, water conservation and water use restrictions (and identification of goals for water savings at each level), and identification of state and federal sources of assistance to impacted water users.

Public Education and Relations

Attention to public relations is critical to the overall success of drought management tools. It is important that the local entity is prepared internally with consistent messages for the public and media. Strong media relationships established prior to a drought will help facilitate the exchange and broadcast of information during a drought. Various surveys and studies have investigated what attitudes are often found during drought and what issues should be highlighted to foster success in implementing drought measures. These include conveying the seriousness of drought, highlighting social and moral commitment, establishing perceived efficacy of water restrictions, and managing perceptions of inconvenience, cost, and equity among all members of the community (City of Phoenix 2003).

In addition, all members of the water community look for guidance and leadership during periods of drought. A strong public education program can help water users better understand issues and limitations that may affect them individually and collectively during a drought. To this point, cooperative agreements and operational flexibility related to water use are facilitated, in part, by good public education and relations programs.

Water Rights Management

Any tools selected to manage drought will need to work within the relevant water laws. In Colorado, the prior appropriation doctrine provides opportunities and limitations for managing water in a drought scenario. One legal tool employed by some municipalities in Colorado is dry-year leasing, a mechanism that allows for temporary water transfer, usually from agriculture to municipalities, during dry years when farming is less feasible or profitable. Local entities may also explore other forms of interruptible supply agreements and inter-



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system operational coordination that re-allocate water on a temporary basis during times of water need.

Additional mechanisms to obtain drought-time water supplies are under development in Colorado. These include water banking, where surplus water is pooled for rental to other water users, but available during times of drought or other need for increased water supply. Water banking is not yet a well-established concept in Colorado, but a pilot water banking project is being tested in the Arkansas River Basin and its use may be expanded.

Permanent water transfers are of course also possible—for instance, through acquisition of water rights—but often are typically irreversible and limit operational flexibility once water rights are sold

Supply Augmentation

In addition to water transfers, local entities can secure and augment water supplies through a variety of means. These can include repair and maintenance of existing storage facilities to assure their maximum utility, revision of reservoir operating procedures to increase storage and make more water available, weather modification, ground water use (though effects on surface flows must be considered), and when necessary, establishment of new water storage facilities. Operational and minor infrastructure changes can be very cost-effective, whereas new infrastructure can be costly. Any of these options may require substantial collaboration among several entities.

Monitoring and Evaluation

It is critical to good drought management that information be compiled and maintained on water supply use and infrastructure, and on drought indicators such as precipitation, temperature, evapotranspiration, meteorological forecasts, soil moisture, stream flow, ground water levels, reservoir and lake levels, and snow pack. Water providers and users can then monitor these data to identify if conditions for drought are developing or persisting. State and federal entities can also collect and monitor these data in support of local drought planning efforts.

In addition, the suite of selected *drought mitigation* and *response* tools should be reviewed periodically to see if they are achieving desired goals related typically to lessening the effects of drought and improving both preparedness and crisis response. Evaluation allows local entities to:



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- Assess the effectiveness of *mitigation* efforts in reducing the occurrence and impact of drought-related water supply shortfalls.
- Analyze their drought response needs and gauge the appropriateness of the thresholds they have set for varying degrees of drought severity;
- Generate metrics to determine and justify the level of drought response employed;
- Determine the effectiveness, equity and need for the response actions selected and employed.

Water Conservation and Drought-Time Water Use Restrictions

Water *conservation* is a broad term that can encompass water use efficiency (e.g., low-flush toilets), wise water use (e.g., Xeriscape™), system efficiency (e.g., distribution system leak repair), and supply substitution (e.g., wastewater reclamation). While many people refer to water use *restrictions* during a drought as “water conservation,” the objective of long-term water conservation is not to curtail water use. Rather it is to increase the productive use of the water supply in order to satisfy water needs without compromising desired water services. A drought management plan that includes curtailment of water services in response to drought may be appropriate, but curtailment is not a desired long-term result of a conservation program (Pinkham 2003).

Some people believe that conservation “hardens” demand, resulting in less flexibility to respond when drought occurs. On the contrary, water conservation is a highly appropriate *drought mitigation* strategy. Long-term water conservation reduces future demand, resulting in a larger supply margin than would otherwise be the case. Thus, previous water conservation efforts reduce both the likelihood and severity of water supply shortfalls during times of meteorological drought. Without conservation savings “in the bank,” a moderate drought event may become a severe one.

It is also important to realize that many water conservation actions require substantial time for implementation. If water conservation actions are not initiated until a “drought hits,” it is usually too late to achieve significant gains from toilet change-outs, landscape selection ordinances or incentives, distribution system repair, construction of water reuse infrastructure, and other “technological” measures and programs. On the other hand, “behavioral” *drought response* measures are still available. For instance, consumers can tighten up landscape irrigation schedules, practice extra diligence in fixing in-home leaks and turning off the tap when shaving, and make other choices to use less water. Publicity campaigns and drought surcharges can encourage users to make these short-term adjustments. Finally, if



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necessary, the same restrictions on lawn watering, car washing, and so on that have conventionally been used to respond to drought are available even if the community has previously achieved substantial long-term conservation savings.

There are numerous resources for communities interested in water conservation planning and implementation. Some municipalities have been involved in water conservation efforts for many years and have planning staff that may be available to answer questions and share knowledge and experience. Several organizations, both local and national, are active in Colorado and may be of assistance, including the America Water Works Association (www.awwa.org) and the Colorado WaterWise Council. The EPA Office of Water has a thorough document from 1998 on water conservation planning, *Water Conservation Plan Guidelines*, EPA-832-D-98-001. It can be accessed at <http://www.epa.gov/owm/water-efficiency/webguid.html>. Amy Vickers' book *Handbook of Water Use and Conservation* is a comprehensive resource. Some websites that could contain useful information are shown at right.

Useful Water Conservation Websites

Discussion

As Table 7-1 presents, a wide variety of drought management tools are available for consideration at the local level. These tools are applicable to many segments of water users and most levels of drought severity, noting that under water rights management dry year leasing, water banks and interruptible water supply agreements are most pertinent in moderate to severe droughts. Weather modification as part of water supply augmentation is most useful in moderate to severe droughts, as are all the emergency *response* tools listed. With water conservation measures, the last tools listed for soil, tillage, and crops are most relevant to agricultural lands.

- WaterWiser, <http://www.waterwiser.org>
- H2Ouse, <http://www.h2ouse.org>
- Natural Resources Conservation Service, <http://www.co.nrcs.usda.gov>
- Xeriscape™, <http://www.xeriscape.org>
- EPA Water Use Efficiency Program, <http://www.epa.gov/owm/water-efficiency/index.htm>

The table is not a complete list of all tools available. For example, additional legal tools may be available depending on potential water sources, and emergency responses may expand in especially severe droughts. Conversely, it would not be recommended that a local agency adopt all of the tools identified. The best suite of drought management tools can be selected through a local planning process that may include creating a team of qualified people, establishing mechanisms for public input, determining and ranking the severity of likely drought impacts, completing a vulnerability assessment, selecting tools to offset those vulnerabilities, integrating those tools into an action plan, implementing the plan, and periodically reviewing the effectiveness of local-level drought management.

Table 7-1 Local Scale Drought Management Tools

Tool	Planning Horizon		Management Impact		
	Short-Term Response	Long-Term Mitigation	Reduce Demand	Increase Supply	Other
Public Policy and Assessment					
Prepare and regularly update comprehensive water management plan with drought component		✓			✓
Establish drought response principles, objectives, and priorities		✓	✓	✓	✓
Establish authority for declaring a drought emergency		✓	✓	✓	✓
Develop triggers for drought-related actions (establishing thresholds for mild, medium & severe droughts)		✓	✓	✓	✓
Prepare ordinances on drought measures		✓	✓	✓	✓
Evaluate impacts of drought on different groups, economic segments, and environmental receptors		✓			✓
Emergency Response					
Declare a drought emergency	✓		✓	✓	✓
Establish water hauling programs	✓			✓	✓
Extend boat ramps and docks	✓	✓			✓
Restrict/prohibit new taps	✓		✓		
Identify state and federal assistance	✓	✓			✓
Public Education and Relations					
Prepare position papers for the public, media and elected officials describing public drought policies		✓			✓
Establish a public advisory committee		✓			✓
Organize drought information meetings and workshops for public and media	✓	✓			✓
Create informational materials and establish a drought information center		✓			✓
Water Rights Management					
Review water rights for modifications/flexibility during drought		✓		✓	
Dry year leasing of water rights	✓			✓	
Water banks established for the sale, transfer, and exchange of water	✓			✓	
Interruptible water supply agreements	✓			✓	
Water Supply Augmentation					
Rehabilitate reservoirs to operate at design capacity		✓		✓	
Inventory and review reservoir operation plans		✓		✓	✓
Aquifer storage and recovery; conjunctive use		✓		✓	
Weather modification (cloud seeding)	✓	✓		✓	
New water storage facilities		✓		✓	
Monitoring and Evaluation					
Monitor water supply components (e.g. snow pack, stream flow, etc.)	✓	✓			✓
Monitor water quality	✓	✓			✓
Track public perception and effectiveness of drought measures	✓	✓			✓
Improve accuracy of runoff and water supply forecasts		✓			✓
Water Conservation					
Develop, implement and monitor ongoing water conservation program		✓	✓		✓
Implement, upgrade water metering		✓	✓		
Implement, upgrade water loss control systems		✓	✓		
Water-efficient fixtures and appliances		✓	✓		
Low water use landscapes and efficient irrigation		✓	✓		
Improve commercial and industrial efficiencies		✓	✓		
Educational programs	✓	✓	✓		
Rate structures to influence water use	✓	✓	✓		
Water reuse		✓	✓		
Soil management such as soil-moisture monitoring		✓	✓		
Improved tillage practices		✓	✓		
Use drought or salinity tolerant crops		✓	✓		

It is also important to note that local communities in coordination with neighboring entities would best accomplish some measures, especially those related to increased storage and some areas of monitoring. In some cases significant economies of scale can be realized by coordinating efforts and the end water users will experience a coherent set of drought responses.

Useful Drought Management Sources

For more resources on drought management, several useful websites and documents are shown at right:

Conclusions

Drought management planning at a local level can be very beneficial in managing water supply during periods of drought. Planning helps determine communication and decision-making channels, technical responses, and public education and awareness needs. Key factors influencing the effectiveness of drought planning and *drought response* include:

- The National Drought Mitigation Center (<http://www.drought.unl.edu/index.htm>), especially “The Basics of Drought Planning: a 10-Step Process” (<http://www.drought.unl.edu/plan/handbook/process.htm>) and their “Mitigating Drought” page (<http://www.drought.unl.edu/mitigate/mitigate.htm>) with numerous links to other useful websites and documents.
- The Western Drought Coordination Council’s document, “How to Reduce Drought Risk” (<http://drought.unl.edu/wdcc/products/risk.pdf>).
- The American Water Works Association’s *Drought Management Handbook*.
- The National Oceanic and Atmospheric Administration’s (NOAA) drought website, <http://www.drought.noaa.gov/>
- Drought plans and experiences of other local entities in a region.

- Availability of local resources.
- Commitment of resources to evaluation, development and implementation of drought management plans and procedures.
- Adherence to developed procedures.
- Use of feedback mechanisms:
 - From the public (created through public education and stakeholder involvement processes)
 - From environmental factors and water systems (created through monitoring and evaluation processes)

References

1. American Water Works Association. “Drought Management Handbook.” 2002.
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5. Pinkham, R., "Technical Assistance to Covered Entities: Review of Conservation Planning Policies and Practices." Prepared for The Colorado Water Conservation Board. May 2003.
6. Wilhite, D.A., Hayes, M.J., Knutson, C, and Smith K.H., "The Basics of Drought Planning: A 10-Step Process." National Drought Mitigation Center. 2003.