Addressing Drought: A Survey of Canadian and International Experiences

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Water
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Group

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Water Policy and Governance Group: About Us

The Water Policy and Governance Group is a multi-university, collaborative research team based at the University of Waterloo. Our focus is water governance and water policy, emphasizing Canadian experiences. Major themes in our research program include collaborative water governance, water security, source water protection, water allocation, and adaptation to climate change. We carry out practical, policy-relevant research that contributes solutions to these problems.

Our success is grounded in our network of researchers and partners across Canada and around the world. Graduate training is a central part of our mission. We accomplish our goals in large part because of our excellent graduate students, post-doctoral fellows and research associates.

We are grateful to the Faculty of Environment, University of Waterloo, for providing the WPGG with dedicated research space and administrative support.

Preface

This report summarizes findings from a study of drought management in countries around the world. It was developed as a partnership among the Water Policy and Governance Group, the Ontario Ministry of Agriculture, Food and Rural Affairs, Conservation Ontario, and the Ontario Ministry of Natural Resources and Forestry.

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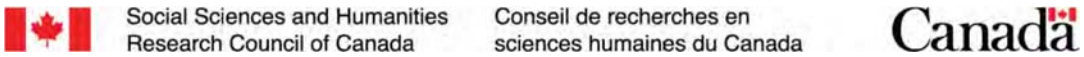

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Abstract

Approaches to measuring and understanding local drought conditions have progressed a great deal over the last twenty years. However, less well understood are the strengths and weaknesses of alternative approaches to organizing drought management at the local and regional scales. In particular, the appropriate role of collaborative approaches to drought planning and management relative to conventional top-down, government-led approaches remains unclear. This report addresses this gap by evaluating a selection of drought management processes around the world that include collaborative decision-making processes. We compared eleven drought management processes from Canada, the United States, Europe and Australia using a conceptual framework that investigated how decisions are made and by whom, the role of state actors, manifestations of authority and program evaluation practices. Data were collected from documents and key informant interviews. We found that collaboration played multiple roles in drought management and planning, including addressing impacts of drought and determining drought conditions. Plans addressed response efforts for drought and longer-term mitigation efforts to ameliorate future drought impacts. Impact assessment was rarely formally measured in program evaluation processes, except for in the Murray Darling Basin, where a framework existed to measure environmental, governance, and social and economic outcomes. Drawing on insights from the research, the report synthesizes implications for Ontario's approach to drought management.

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1. Introduction

Drought is a challenging natural hazard. Droughts can occur over vast regions, but their specific impacts can vary widely from one local area to another [54]. It can be difficult to pinpoint the onset and end of a drought episode, and the extent and severity of drought typically varies depending on the types of economic activities that rely on water in affected areas [30]. Physical indicators based on historic records of average precipitation and stream flow are often used to identify the onset and period of drought. As such, they are critical to the development of early warning systems, which are essential to effective drought management. However, physical indicators on their own can provide an incomplete picture of the nature and severity of the hazard. In the minds of many policy makers and members of the public, drought becomes an issue only when, for example, community water supplies are affected, or when economic activities are harmed. This accounts for the emphasis in recent literature on defining droughts from both socio-economic as well as biophysical perspectives [27], preparing local communities for the social and economic impacts of drought, and for building adaptation into water sector and community practices [28][34][44].

Approaches that coordinate drought management using monitoring standards, early warning mechanisms, and planned management stages are essential [4][53]. However, vulnerability can also be reduced by building social capital and strengthening relationships among key actors, which addresses vulnerability through reducing exposure and sensitivity, and building adaptive capacity [34]. This approach can facilitate collective responses to drought that avoid costly and unequal legal solutions that may leave some water users with no water [34]. Governments often seek to package these kinds of measures into consistent responses to drought that can be implemented through legal or policy frameworks. However, the complexity of the drought hazard usually means that one-size-fits-all solutions developed at the national or state/provincial scale will be challenging to implement locally. Multi-level approaches to drought management have therefore become common in many jurisdictions [53].

In multi-level governance situations, responsibility for planning, mitigation and response is shared among various levels of government, and between governments and non-government actors, including resource users, community members, private firms and others. Collaboration is a common governance strategy in this setting [22]. In collaborative approaches to environmental governance, actors with diverse backgrounds come together voluntarily to address shared problems; decision-making often takes place under consensus rules; and relationships tend to be long-term [1][14][25]. Collaboration often is seen as a way to encourage local buy-in and compliance with voluntary measures [33]. At the same time, governments may create and rely on collaborative processes to implement programs through voluntary support from multiple actors outside of government [21].

Collaborative approaches to drought management are becoming increasingly important in countries around the world. For example, securing agreement on drought response measures prior to a crisis is essential for immediate, organized and accepted response. Collaboration among key actors (government

officials, water users, and the public) – in advance of a drought incident – is one way to achieve this aim [27]. A key challenge for those involved in planning for and responding to drought is determining how to use collaborative approaches effectively and appropriately in settings where governments are primarily responsible, but impacts are experienced differently at local scales, and successful responses require local participation and buy-in.

In this report, we compare approaches to drought management from around the world in an attempt to understand how collaborative approaches are used, and to determine how resulting social, economic and environmental impacts are measured on-the-ground. We begin with a review of decision-making informed by collaboration, and drought impact evaluation approaches. The evaluation framework used to compare example drought management processes is then outlined. The results of the comparative analysis are presented and discussed. The discussion and conclusions synthesize insights relating to the role of collaborative approaches in drought policy and programs, efforts at mitigation and response to drought, and emergency management and impact monitoring. Implications of the research for Ontario's approach to drought management are identified.

2. Comparing Collaborative Approaches to Drought Management

Collaboration has become an important mechanism for addressing environmental challenges and opportunities in a host of settings [32]. In the context of drought, collaboration is being used to ensure decisions are integrated and coordinated across relevant scales [4], to capture the multi-dimensional aspects of drought [23], and to support drought early warning mechanisms [44]. The success of collaboration in reducing conflicts, improving relationships between actors, and building social capital has been mixed in the natural resource management literature [3]. Collaboration has been linked to improving implementation efforts [31], empowering communities [29][48], and improving relations among concerned actors. However, the conditions to generate these types of outcomes are context-dependent and often rely on the interpersonal and interorganizational dynamics that exist among participants [45].

An important factor that influences the success or failure of collaboration is the relationship of collaborative processes to other decision-making processes. For example, responding effectively to drought may require situating local context and water needs, vulnerability and hazards within a legislative framework that determines how actions are taken in an accountable manner [47]. The effects of drought and policies aimed at mitigating drought impacts are most strongly experienced in communities. Thus, local engagement is needed at planning and implementation stages. However, in many jurisdictions accountability for drought management ultimately resides at higher levels (for example, in state or provincial governments in federations such as Canada, the United States and Australia). In decision-making situations such as these, relatively complex, formal structures are common; these typically dictate who participates and how, and what types of outcomes can be produced by collaborative processes [46]. Under these circumstances, governments tend to maintain authority and have final decision-making powers that function through conventional accountability channels. For example, once emergency conditions are reached it is common for governments to take back decision-making power that was assigned to other actors [27]. This may be entirely appropriate from the viewpoint of accountability, but an unintended consequence can be a reduced desire among non-government actors to collaborate or work together in future [42].

Our goal in this report is to evaluate approaches to drought management from around the world in an attempt to understand how collaborative approaches are used and how resulting social, economic and environmental impacts are measured on-the-ground. This required the use of a consistent set of comparison themes. Table 1 presents the categories and questions that were used in this report.

Table 1: Comparative Framework

Category	Evaluative Questions
Purpose and Scope	• What is the objective of the plan? • What types of drought are considered? • What is the scale of decision-making? • Is the focus mitigation of, or response to, drought?
Membership	• Who is included in decision-making? • How are members determined? • Is government part of local or regional decision-making?
Decision-Making	• How are drought conditions determined? • Who makes decisions for determining drought severity? • What happens during an emergency? • Who is responsible for implementation?
Role of Governments	• What is the role of governments in drought management? • Are they conveners, leaders, funders, or participants?
Authority and Accountability	• Who is in charge of the drought management system? • How are actions for drought management enforced?
Evaluation	• How often are drought plans reviewed? • What outcomes are measured on-the-ground to reflect the progress or success of the plan?

3. Research Approach

An international comparison of drought management processes provided the foundation for this research. The themes presented in Table 1 guided the analysis. The drought management processes included in the research were limited to those created by government in western democracies. Government processes reflect a conventional form of authority with resulting standards of accountability based on accepted democratic conventions. Other "grassroots" collaborative arrangements may not have defined accountability checks and balances.

In addition to the above selection criteria, cases were chosen based on the following criteria: (1) there was an official plan or act that outlined drought management activities; (2) the impacts of drought were considered broadly instead of focusing on one sector (for example, agricultural management of drought); (3) there was a collaborative element in planning for drought or drought management that included water users, public or business interests; and (4) material was accessible. Thirty drought management systems were initially considered based on these criteria, and eleven were selected as best fitting them. Drought processes were reviewed from Canada (British Columbia and Ontario), the United States (California, Indiana, Georgia and Texas), Europe (England and Wales, and Spain), and Australia (Murray Darling Basin, South Australia, and Victoria).

Document analysis and key informant interviews were used to gather data. The first step of gathering data was to review the drought management plan and supporting documentation, such as annual reports, government websites and academic journals. These resources were used to populate the framework categories. Required information that was not available from document analysis was noted and then collected through targeted key informant interviews with knowledgeable officials. Interviews or email correspondence responding to question took place in nine case studies with 13 individuals; interviews in the Texas and Spain case studies could not be completed during the timeline of this study. Most interviews took place over 20 minutes to one hour. Most key informants were involved in delivering the drought management mechanisms were interviewed on the phone; some preferred to respond to written questions in emails. Interviews and requests for information over email focused on filling gaps in the evaluation, and cross-checking and verifying information gathered from documents. A consistent gap in the document analysis was information about outcomes from drought and program implementation and how they are measured. Hence, this was a common theme across interviews. Importantly, because the focus of the interviews was on filling gaps in data collected through documents and in verifying existing information, rather than on personal perspectives it was not necessary to return interview transcripts to interview subjects for approval, but findings were shared with interviewees. Findings that are based on interviews are identified as "Personal Communications" in the text; findings are not attributed to specific people.

4. Results

Findings from the comparison of the 11 drought management systems are summarized in this section, using sub-sections organized around the themes in Table 1. The Appendix contains detailed findings for each theme, organized around jurisdictions.

4.1. Purpose and Scope

All cases used local scales for implementing drought management measures (Table 2). England and Wales, and Victoria focused on coverage of water utilities and their customer bases. In England regional government boundaries were also used for planning and monitoring drought. The other cases used climatic or hydrological scales for drought planning and management; these were based on watersheds (catchments), basins, or climatic regions. Texas and Indiana both included different types of drought in planning and management, e.g., insufficient supply to meet demand, or agricultural drought largely based on soil water deficits; other cases focused on meteorological drought.

Drought management programs often attempt to include actions to mitigate the potential for drought and to ameliorate drought impacts. Drought management processes were, in general, created to assess and respond to drought conditions. Other purposes for drought management processes were to coordinate response to drought (Ontario, British Columbia, California), to promote conservation activities (Indiana, Georgia), and to ensure that water needs are met (Texas). In Australia, the purpose for the plans was not specifically for managing and responding to drought, but instead focused on water allocation (South Australia), fairly sharing and trading water (Victoria), and sustainably taking water from the system (Murray Darling Basin). These purposes would help to manage water at all times, which is necessary given the current drought experience in Australia.

Table 2: Purpose and Scope of Drought Management Processes

Jurisdiction	Findings
Indiana	• During water shortages the plan manages water resources through stages that implement conservation. • There are nine regional climate divisions.
Texas	• The Drought Preparedness Plan outlines drought assessment procedures and advises on implementing measures to address drought in 10 regions. • The State Water Plan tasks regional groups to create plans that outline how water needs are met during drought in 16 regional water planning areas.
California	• The plan coordinates drought response, improves monitoring and plans for preparedness and response. However, the plan is a supplemental document to the California Water Plan and has not been implemented. • There are 10 hydrological regions where drought actions may take place.

Jurisdiction	Findings
Georgia	• The plan focuses on mitigating drought through conservation and strategic actions planned at various stages of drought. • Georgia has 9 climate divisions.
Ontario	• The plan coordinates a provincial response to drought and suggests local actions for organizing and responding to low water. • Decisions are made on a watershed scale based on the 36 conservation authority boundaries where they exist, or where they do not exist by the Ministry of Natural Resources district offices.
British Columbia	• The plan recommends actions for provincial government, which can also apply to local government, First Nations, and Water licensees to reduce impacts from drought and ensure access to water.
Spain	• Drought Management Plans aim to guarantee access to water and minimize environmental impacts from drought. • Spain has 25 river basin authorities.
England and Wales	• The plan outlines drought planning and measures to be implemented during drought conditions. • There is a national drought plan, a regional plan for Wales and six regional plans based on Environment Agency regions.
South Australia	• The Act promotes integrated management and protection of natural resources through plans, including a water allocation plan. • There are 8 regions under the plan.
Victoria	• Victoria's Catchment Management Framework works to develop and coordinate actions to protect natural resources. • There are 10 catchment based areas for integrated management.
Murray-Darling Basin	• The Commonwealth Water Act (2007) incorporates the Murray-Darling Basin Agreement that states the rules for water sharing between jurisdictions. • There is a water market in the lower Murray that includes (South Australia, Victoria, and New South Wales). The water market allows for water transfers between jurisdictions. • There are 36 areas with a Water Resource Plan.

4.2. Membership

Collaboration takes place at a regional level (Murray Darling Basin), state or provincial level (Indiana, California, Georgia), locally (Ontario, British Columbia, Texas) and both at a provincial level and a local level (South Australia, Victoria) (Table 3). Collaborative group members were either appointed by government (Indiana, South Australia, Victoria) or members volunteered for a place on collaborative groups (Ontario, British Columbia).

Table 3: Comparison of membership in drought management processes

Jurisdiction	Findings
Indiana	• The task force consists of ten members each from a sector defined in the plan, including academics, industry, municipalities, environmentalists, etc. • State actors advise the task force in their duties, which primarily involve creating the plan.
Texas	• The Drought Preparedness Council includes relevant state agencies. • The Water Plan forms regional groups that have 20 members including representatives from government, 11 required sectors, and local concerns.
California	• The task force includes government managers who coordinate response. • The Impact Assessment Work Groups includes groups at risk of drought impacts, including health, biodiversity, agriculture, recreation, economics, tribal, etc.
Georgia	• The Drought Response Committee includes the water conservation coordinator, state and federal agencies, and one representative from each of a Regional Development Centre, NGO, business and agriculture.
Ontario	• Local Water Response Teams include provincial staff, municipalities, conservation authorities, First Nations, water users, and other interests at the local level.
British Columbia	• The drought working group includes relevant provincial and federal staff. • Technical drought teams include regional cross-government representatives. • Local multi-actor drought teams may be established, but few have been. • Local teams should include: water users, government, First Nations, NGOs, etc.
Spain	• River Authorities include environmentalists, urban and rural dwellers, urban water supply companies, and farmers.
England and Wales	• Regional drought planning is led by environment and performance teams. • Members on regional teams are nominated from Environment Agency staff. • Water companies manage supply to provide for customers, protect the environment and balance water needs.
South Australia	• The Management Council includes views of community, conservation, agriculture and aboriginal people. • Regional Boards should reflect resource interests and be locally relevant.
Victoria	• The Water Act gives government the right to control and allocate water. • Corporations develop drought management plans for urban areas under the Water Industry Act.
Murray-Darling Basin	• The Ministerial Council and Officials Committee include members from each state and territory in the Murray Darling Basin. • The community committee includes a chair and 16 members that represent, water users, indigenous peoples, farming, and environmental water management sectors.

The diversity and breadth of actors varied by case. For example, in Georgia, a place was reserved for a few specific interests to be involved with decision-making, whereas in Indiana, ten different interests were represented. However, it is important to note that in the case of Georgia collaboration is used for decision-making, whereas in Indiana collaboration was used to create the water shortage plan.

Government is included in collaborative groups in Ontario and Texas in a non-voting role and in Georgia at the state level in a directing role. In some jurisdictions collaborative groups did not have government members, but were advised by governments (Indiana and British Columbia). In all cases governments maintained a dominant and steering role in responding to drought. For example, in the case of Ontario local collaborative groups make the decision to declare a level 1 or 2 low water condition and spread word of suggested voluntary water reductions. However, decision-making power for regulatory restrictions on access to water reverts to the provincial government during extreme or persistent drought conditions.

4.3. Decision-Making

Drought decision-making was based on a consistent formula in the 11 cases (Table 4). Decisions were made based on drought stages with corresponding actions to encourage conservation, or to initiate regulations or restrictions. Stages were delineated by indicators that measured conditions on-the-ground and signified increasing severity of conditions as indicators varied from a norm. However, the number of levels and the types of indicators that were used varied by case and depended on context. Australia uses integrated management in basins using regional management boards to plan and manage natural resources. South Australia has the Natural Resource Management Act, which protects local natural resources through creating plans, including a water allocation plan. Spain also uses existing River Basin Authorities developed under the Water Framework Directive, which are given the mandate to address drought under the National Hydrological Plan Act.

Table 4: Comparison of decision-making in drought management processes

Jurisdiction	Findings
Indiana	• The task force created the Indiana Water Shortage Plan. • The Department of Natural Resources determines drought stages. • In an emergency regional input is sought for priority uses in addition to nine water use priority recommendations set in the plan.
Texas	• The Preparedness Council and the Drought Manager use levels of concern to determine if action is necessary. • The Governor's Division of Emergency Management coordinates immediate response. • Regional groups formed under the State Water Plan identify groups that will have access to required water during drought and recommend coping strategies.

Jurisdiction	Findings
California	• The taskforce recommends drought stages based on recommendations from a monitoring committee, impact assessment work groups and stakeholders. • The Water Resources, and Emergency Management departments work with local agencies to identify and assess local impacts and response. • The governor declares emergency and funds state and local government for damages.
Georgia	• The Director consults with the drought response committee to determine drought levels and response. • Local drought management and conservation plans outline appropriate actions. • In emergency Georgia Emergency Management Agency is contacted for assistance.
Ontario	• Water Response Teams respond to local and current conditions to determine when to change drought levels. • The Ontario Water Directors Committee is responsible for calling for emergency response, based on the recommendation of the Water Response Team.
British Columbia	• The Technical Drought Working Group in collaboration with regional cross-government drought teams determines drought severity. • Water prioritization is first in time, first in right.
Spain	• River Basin Authorities develop Drought Management Plans and measure conditions to provide warning of potential drought. • Emergency measures for drought are passed as a general interest action.
England and Wales	• The regional drought team makes decision on whether action is needed based on present and forecast conditions and perceived effectiveness of action. • Water companies create plans that outline how water supplies are protected and ensure access to water.
South Australia	• Water allocation plans must be prepared by regional boards for prescribed water resources [19]. • Plans include environmental water requirements, water access entitlement, conservation methods, actions to mitigate negative impacts from water taking, etc.
Victoria	• A water market allows entitlement holders to manage water and reallocates water during drought. • The water entitlement and planning framework defines how water is shared and ensures environmental water needs.
Murray-Darling Basin	• Water Resource Plans assist in planning sustainable diversion limits. • Sustainable diversion limits dictate the amount of water that can be removed from the system.

Water utility companies are important actors in decision-making in England and Wales, and in the Australian state of Victoria. Water companies in England and Wales develop plans that characterize how supply will be protected during low water situations and ensure that customers will be able to access water. These measures are in addition to regionally-based government drought plans. Water utilities in Victoria respond to short-term drought in urban areas, while a water market can reallocate water during

prolonged droughts. In Spain, the management plan also includes a clause where water supply systems that support more than 20, 000 people must have an emergency plan in place in case of severe drought. Including water utilities in drought management and planning underscores the importance of protecting domestic access to water. In comparison, water users with a license to withdraw water are often limited in their ability to access water during low water through set priorities, which vary by context and depend on existing water laws and regulation, such as first in time first in right.

Prioritizing water uses during low water remains largely a government-based task and takes place in the context of existing water right laws. For instance in British Columbia and California rights to access surface water are based on the principle of first-in-time, first-in-right. A role for local input in determining what priorities local stakeholders and communities value was evident in several cases. Indiana, Ontario and Spain all provide a more integrated role for local voices to inform what uses of water should be prioritized during low water decision-making. In Ontario, collaborative local groups determine drought levels and advise the government on what should be prioritized during drought. However, in practice it has been difficult for teams to prioritize uses in ways considered equitable by all types of users.

4.4. Role of Governments

Governments play a core role in drought planning, management and implementation, as should be expected given their responsibilities and the need to be accountable. This is evident in Table 5, which outlines the main roles of state (government) actors in the drought management processes examined. A lead agency that coordinates government action among a number of agencies that have a stake in drought planning and management existed in most of the cases. Organizations that are responsible for drought often include departments or ministries with a mandate for environmental management, emergency services, or environmental protection. A government agency is normally responsible for measuring hydro-meteorological indicators to determine the onset of drought and to monitor conditions during low water or drought events. In England and Wales, Ontario, and British Columbia existing regional government offices play key roles in coordinating a more local response to drought. Government agencies are responsible in each jurisdiction for determining when regulatory action is required and for implementing water restrictions. These decisions were made with consideration for local conditions. They often included avenues for local stakeholders to give input into what water uses should be prioritized in an emergency (Indiana, Ontario), and into the definition of local impacts (California, Texas).

Table 5: Comparison of the role of government actors in drought management processes

Jurisdiction	Findings
Indiana	• Department of Natural Resources monitors conditions and a member of the department is appointed the Water Shortage Coordinator.
Texas	• The Drought Preparedness Council is the lead for a coordinated response to drought and is responsible for collecting, analyzing and providing information for drought. • The Texas Water Development Board approves regional water plans created under the State Water Plan.
California	• The taskforce gives direction on policy areas of interest and makes recommendations for management plans and emergency response efforts.
Georgia	• The Environmental Protection Division coordinates information sharing and water conservation and the State Climatologist and Environmental Protection Division monitors drought.
Ontario	• Provincial coordination for drought response is through the Ontario Water Directors Committee. • The Ministry of Natural Resources analyzes data and distributes condition reports and maps.
British Columbia	• The Inter-Agency Drought Working Group based on information from the technical drought group, ensures effective plan delivery and decides when to take regulatory action. • The Technical Drought Working Group coordinates provincial response.
Spain	• The Ministry of Environment developed a national hydrological indicator system that is used for River Basin Authorities to declare drought stages. • Drought measures are implemented through royal decrees.
England and Wales	• Drought planning is nationally coordinated by water resource teams. • Government oversees the activities of the water companies and grants permits, but the companies limit water taking by customers if needed.
South Australia	• Regional boards are under the direction and control of the Minister and s/he must approve plans before they are implemented. • In low water the Minister can restrict or prohibit water taking, manage dams, determine priorities for water, etc.
Victoria	• The government manages water allocations for cities, towns, irrigation and industry while ensuring healthy water systems.
Murray-Darling Basin	• States that are part of the Basin develop Water Resource Plans in cooperation with the Basin Authority. • Water Resource Plans outline the management of water resources.

4.5. Authority and Accountability

Governments had clear authority for drought management processes in all the cases examined (Table 6). However, other actors are often required to take on a degree of authority for which they must be accountable. Water suppliers have a degree of authority in some drought processes. In British Columbia, England and Wales, and Texas water utilities were responsible for imposing restrictions on their customers during drought. In other cases, organizations created by government had a role in drought management. In Spain and the Murray Darling Basin, semi-autonomous organizations existed that were responsible for organizing drought management. In the case of Spain, these were the national government and River Basin Authorities created under the Water Framework Directive; drought measures are still implemented through royal decree, meaning that a degree of oversight remains. In Australia the Murray Darling Basin Authority coordinates state action across a vast basin shared by four states (New South Wales, Victoria, Queensland and South Australia) and the Australian Capital Territory. However, organizationally each Water Resource Plan is developed for an area completely within one state or territory; this design is meant to ensure accountability, and to produce plans that reinforce existing water resource studies and management processes. In situations where other actors play key roles in drought management there are requirements for reporting activities, changes in conditions, and other factors depending on the mandate of the organization to the government.

Table 6: Comparison of Authority Aspects in Drought Processes

Jurisdiction	Findings
Indiana	• The Ministry of Natural Resources leads and implements the plan in partnership with Homeland Security and Environmental Management. • The Governor can restrict non-essential water use in an emergency.
Texas	• The Drought Technical Assistance and Technology committee coordinates with regional water planning groups on drought issues for their water plans. • Public water suppliers are required to notify the government when they implement mandatory restrictions.
California	• Department of Water Resources is the lead and responds to drought through existing functions. • Drought disaster funds are provided through the Disaster Assistance Act.
Georgia	• The Department of Natural Resources is responsible for implementing the plan. • Funding requests are developed by applicable agencies and are supported by the Drought Response Committee.
Ontario	• The Ministry of Natural Resources leads drought management under existing legal authority. • Local teams do not have legislative authority, but provides advice on using tools and policies and report their decisions to the Ministry of Natural Resources.

Jurisdiction	Findings
British Columbia	• The Environment Minister leads drought management through existing legislation. • Water suppliers with support of local governments maintain water supply and enforce compliance with restrictions.
Spain	• The Act requires basin authorities to develop Drought Management Plans, which supplement River Basin Management Plans. • Plans were approved by Ministerial Order and drought measures are approved by royal decree.
England and Wales	• The Environment Agency is the lead for water resources, including drought management. • Under the Water Industry Act water companies implement temporary water restrictions.
South Australia	• The Department of Environment, Water and Natural Resources is the lead. • The Natural Resource Management Council annually reports to the Minister on council activities and expenditures and Regional Boards report to the Minster on their performance.
Victoria	• A water market has existed since 1991. • Water corporations and catchment authorities prepare annual reports to the Minister of Environment and Primary Industries.
Murray-Darling Basin	• The Authority is an independent government agency with enforcement powers and reports to the Parliamentary Secretary to the Minister for Water. • Water Resource Plans are managed by States. • The Minister is responsible for accrediting plans with Authority recommendations.

4.6. Evaluation

In five of the eleven cases a process of reviewing or updating existing plans was underway during the study period (Ontario, Indiana, California, England and Wales, and Georgia). Reviews were triggered by a schedule defined in legislation or policy, or on an a*d hoc* (as needed) basis (Table 7). Promoting education and awareness of drought was common among the cases. In Indiana, water utilities can provide water bills more frequently to raise awareness of the costs of water during drought, and they can provide retrofit kits and home audits for the public. Conservation authorities are semi-autonomous agencies in Ontario that are responsible for managing and protecting certain natural resources. They are involved in educating the public on topics that are relevant to environmental protection including how to conserve water during drought.

Programs evaluate effectiveness of their communication plans (Ontario, British Columbia, England and Wales), compared plans to stated objectives (Murray Darling Basin), and evaluated measures taken (South Australia). British Columbia focused on evaluating the hydrometric measures of streams to support fish health and habitat because protecting flow for spawning salmon is an objective in this jurisdiction's plan. Implementation efforts were also evaluated during program evaluation. Recording

experiences to inform future drought events and debriefing with those involved in drought planning and management is a common practice in reviewed cases. The Murray Darling Basin was the only case with a published evaluation framework for measuring progress made using water reforms [37]. The report identified methods and indicators for evaluating environmental, governance, and social and economic outcomes.

Table 7: Comparison of Program Evaluation Components of Drought Processes

Jurisdiction	Findings
Indiana	• The plan should be reviewed and updated every 2 to 5 years. • Ground water level monitoring evaluates impacts and recovery while utilities report on their ability to provide water.
Texas	• The Drought Preparedness Council changes the plan as needed. • The council prepares an end of year report for the legislature on education activities, prevention, response, accomplishments and setbacks. • A Texas State Water Plan is created every 5 years.
California	• The Plan is reviewed as needed and to match the California Water Plan. • After a drought the taskforce debriefs on successes, lessons and possible improvements.
Georgia	• The plan is reviewed every 5 years or after a drought. • Drought impacts (largely economic) are reported to the government by sectors of the economy that are affected by drought.
Ontario	• Plan review is as needed and is usually prompted by stakeholder feedback. • Pilot projects capture lessons from areas with frequent or severe drought. • Impacts are recorded by local teams, but there are challenges to capturing local impacts.
British Columbia	• The plan is reviewed as needed. • Regional staff can debrief local drought events with a focus on regulatory action, communications, monitoring, etc. • Protecting fish health and habitat particularly for salmon is an important goal, which requires measuring environmental stream conditions.
Spain	• Plans include a post-drought process to report on the drought and implementation efforts including evaluating local and regional knowledge and expertise.
England and Wales	• The plan is reviewed every year and every three years includes public consultation. • Post drought reports include a summary of impacts and mitigation actions, lessons learnt, and recommendations for future events.

Jurisdiction	Findings
South Australia	• The management council reviews the Natural Resource Management Plan at least every five years. • Regional plans include methods to determine successful implementation and effectiveness of measures. • The Monitoring, Evaluation, Reporting and Improvement (MERI) Framework is used to help set realistic, measurable outcomes so that effectiveness and investment can be measured.
Victoria	• Water Corporations review plans at least every 5 years and must monitor their compliance to their obligations under the Water Industry Act. • The Environmental Water Holder leads the effort to ensure environmental water entitlements create beneficial outcomes from available water.
Murray-Darling Basin	• The ministerial council can ask the Authority to revise the Basin Plan. • The Authority leads monitoring of the plan, including effectiveness of the Basin Plan compared to objectives. • The Basin Plan Evaluation Framework details how the Authority evaluates the implementation of the plan and the effectiveness of significant water reform packages.

5. Discussion

Comparison across the eleven drought plans revealed several cross-cutting themes. By including drought plans that use collaborative approaches a number of different roles for collaboration in drought planning were identified. Findings point to voluntary response efforts through plans can be difficult to achieve and that targeted programs or incentives can more effectively change water use practices during a drought. Emergency response to drought is better specified in areas that suffer frequent or prolonged drought as is to be expected. Finally, the inclusion of impacts caused from drought in decision-making processes and evaluation of program success is increasingly being discussed in recent literature. However, as is discussed below, there are information gaps and resource deficiencies that make it difficult to include impact assessment in drought processes.

This section summarizes insights relating to four cross-cutting themes that emerged from the research (Section 5.1) and then focuses on implications for Ontario (Section 5.2).

5.1. Cross-Cutting Themes

The role of collaboration

Collaboration played four key roles in the eleven drought management processes included in this study.

- *To develop a drought management plan:* British Columbia, Georgia and Indiana used a collaborative process to develop a plan for addressing drought. In the case of Indiana the multi-actor taskforce was meant to play a role in determining drought conditions, but in practice the state was responsible for determining drought conditions and response. Indiana's Water Shortage Plan is in transition to reflect how drought management works on-the-ground.
- *To determine drought conditions:* In the cases of Ontario and Georgia, collaborative groups are used to assess drought conditions and determine drought levels. In Ontario, the government plays an advisory role on Water Response Teams and is responsible for declaring Level 3 (the highest level). In Georgia, key sectors are selected to sit on a government committee to assist in informing decisions.
- A*s a method for long-term or mitigation-based efforts in drought management:* Three cases used collaboration to address drought in the long-term through mitigation (Texas, Victoria, and the Murray Darling Basin). In Texas the Drought Preparedness Plan is overseen and implemented by government through conventional channels. The main purpose of the plan is to respond to short-term challenges arising from drought conditions. In contrast, the State Water Plan uses collaborative regional groups to prepare for local experiences of drought over a longer time frame. Victoria's approach to differentiating between responding to drought and mitigating the potential for drought is similar to the case of Texas, except water corporations are responsible for the short-term immediate response to drought and ensuring that customers can access supply. Furthermore, the Catchment

Management Authority in Victoria has a mandate that is much broader and includes protecting natural resources in general.

- *To address impacts of drought:* Texas, Ontario, South Australia and California use collaborative groups to address local impacts. These cases all have experience with longer term or ongoing drought events. In Texas, the State Water Plan uses regional groups to identify water users or vulnerable peoples who will not be able to access required water during drought and to estimate environmental impacts. Projects to alleviate stress on communities and the environment are then prioritized for state funding. California's unimplemented plan has a relatively top-down approach to drought management, but includes affected actors in the Impact Assessment Work Group. The work group creates impact assessment reports for the Interagency Drought Task Force. In South Australia, Water Allocation Plans are developed by regional management boards and must include methods of conserving water and mitigating negative impacts from low water.

A number of challenges were identified by interviewees in using collaborative approaches for drought management. Identifying the interest of local actors and securing required resources to encourage the formation and continuation of local collaborative drought management teams was a key challenge. For example, in British Columbia while the Drought Management Plan was being developed, it was envisioned that local multi-actor groups should have the ability to mobilize and develop local actions to ameliorate low water impacts given the local context, but only three groups were formed. One was in a particularly dry region of British Columbia that had some capacity and existing connections and built a drought communication plan, but did not mobilize as expected for drought response. The other two were existing watershed-based groups that have been able, or have the potential to build drought response into their activities.

Response vs. Mitigation

Response plans outline short-term, immediate actions that should be taken in response to an emerging drought. Drought mitigation plans provide actions that should be taken in advance of a drought that will reduce the severity of anticipated drought related impacts. Drought mitigation planning involves mapping drought vulnerable regions, identifying the types and scope of potential drought related impacts to sectors and communities, identifying projected frequency of future droughts, and public benefits/costs to minimize negative impacts on the regional and local natural resources and economy. There is an overlap in mitigation and response actions (i.e., monitoring drought indicators serve long-term and short-term response needs) and there is an overlap in the roles of the state/province and local governments to participate in drought mitigation and response planning and efforts. Where there is insufficient local capacity to meet either a drought response or drought mitigation planning effort, the province or state needs to be clear on what is their role and what role will they play in transitioning from response to mitigation drought planning and management.

Measures for both responding to drought and mitigating the potential for impacts are often included in drought management processes. For example, in British Columbia drought response occurs through

four levels with increased water conservation corresponding to escalating drought conditions and mitigation is addressed through encouraging local drought management plans that outline potential best management practices. However, it can be easier to use regulation to create a response to drought and more difficult to encourage the public and water users to adopt adaptive management plans that prepare them for future events, as evidenced in the cases of Georgia and British Columbia. In Georgia one interviewee who had participated in the collaborative workshop to create the initial state drought management plan reflected that the hope at the time was that if there was a state-based framework for drought management local people would contribute to complete the spectrum of required management. This person reported that during a subsequent drought event there was little evidence that water users were taking into consideration local conditions in their actions in drawing water or implementing stringent voluntary conservation.

In Indiana, it was recognized that information, incentives and technical support were better able to achieve objectives than mandating changes to water use and were therefore more effective at encouraging conservation than enforcing water reductions. A number of programs already exist for educating water users and the public on the importance of conservation and programs to encourage desired behaviours. For example, in the city of Santa Cruz, California, mandatory water rationing was used, but if people exceed their allocation they can attend an educational workshop to have the penalty dropped [2]. In Spain, public awareness campaigns encourage water saving and conservation [26]. Conservation Authorities, a semi-autonomous organization based on watersheds in Ontario, are responsible for promoting local long-term water conservation through strategies that advocate learning and public education to support drought management objectives (Personal Communication).

Emergency Response

The trigger for the formation and review of drought processes is often drought events that drive a required response or efforts at managing drought that did not meet needs. For example, in 2009, British Columbia endured drought conditions that reflected a 1 in 50 year drought. At the time the only tool to restrict water taking to ensure adequate flow was through first in time, first in right water rights and voluntary measures. The older licenses that this tool prioritizes did not include a clause to protect flows for fish. One of the goals of drought management in British Columbia is to protect stream flow for spawning Kokanee Salmon, which are publically valued and important to British Columbia's economy. In reflecting on this emergency one interviewee noted that "when the conditions started to badly deteriorate in August and September when it was getting really bad and there were fish mortalities, the biologists were getting frustrated with us, asking why we weren't cutting off these water withdraws. It was equally frustrating to respond that we didn't have the legal means to do so." Given this situation, legislation was passed that allowed licenses to be suspended to protect fish, which happened very quickly and allowed regulations to be imposed. Regulations were considered necessary because voluntary measures were not enough. The review of this 2009 drought event led to the realization that a more organized response to drought was required.

In Canada drought management processes did not outline emergency response activities, such as compensation for losses or financial disaster relief. In other countries, once an emergency was declared, a higher level of government stepped in, in the form of the governor (Indiana, California, and Texas) or the state legislature (Spain). Financial contributions to ease the effect of drought were more common in places that more often face severe and long-lasting events. In Texas, the Legislature provided $1.47 billion over five years to fund projects created by the 2007 State Water Plan [49]. The Water Plan uses local collaborative groups to identify water use groups that will not have access to water during drought and to recommend strategies to address shortages and associated costs through tangible projects. In California, the legislature passed an emergency drought relief package of $687 million [2]. Finally, accredited Murray Darling Basin plans are funded for 10 years [40].

Drought Impact Assessment

Program evaluation depended on the goals of the drought management process. Environmental indicators usually determine the onset and severity of low water or drought conditions. Most cases informally included impacts in post-drought reviews to improve planning for future drought. There was little evidence in the eleven processes studied that drought management processes collected data on the social and economic impacts of drought to inform decision-making processes. However, an exception was the Murray Darling Basin where a Basin Plan Evaluation Framework was created to detail how the Authority evaluates the implementation of the Plan, including the effectiveness of plan implementation and how it is working. It also measures the effectiveness of the significant water reform package in terms of whether social, economic and environmental objectives and outcomes are being achieved. In order to develop the indicators that are used in the Basin Plan Evaluation Framework a number of actors were consulted, including farmers, irrigation operators, local business owners, local councils, local community groups, tourism operators, universities, consultants, scientists and Basin States (Personal Communication). In other cases environmental water flows were the most commonly measured environmental impact and the data was used in making drought response decisions.

The challenges of including impact assessment in drought planning and monitoring became evident during interviews. Often priority is given to monitoring water bodies and determining the onset of drought, which is necessary for appropriately responding to drought. Trade-offs for what is funded often occur and resources are often not available for determining impacts. For example one interviewee noted, "I think it would … be a good idea [to calculate economic, social and environmental impacts], but you would need some dedicated thought and effort to document and analyze it. We currently don't have the capacity to do that level of analysis within my ministry, or elsewhere in government to my knowledge. Our focus is primarily on planning and response."

In the case of Ontario, local and collaborative Water Response Teams are responsible for gathering social, economic and environmental impacts. This is considered an essential step in the decision-making process that can lead to declaration of Level 3 and enforcement of restrictions. However, there are

uncertainties as to the type of information that should be collected and what evidence demonstrates a severe impact that is caused by drought.

Australia's drought experience in the Murray Darling Basin prompted the creation of a water market. In South Australia, water use decisions encourage water availability for environmental needs during drought. The water market assists in buying back water in an over allocated system and encourages infrastructure improvement to provide more water for the environment. The water market responds to environmental impacts of drought by attempting to leave more water in the system and allows water users to sell their allocations to alleviate social impacts on an individual level.

5.2. Implications for Ontario

Ensuring successful collaboration

Compared to the other cases examined in this report Ontario displays a strong case of local collaboration. Other cases either had difficulty in promoting local collaborative groups, such as British Columbia and Georgia or focused on consulting with water users, such as England and Wales, and Indiana. In the case of Australia and Spain collaboration was successful, but the focus was on issues larger than low water or drought management and responses; as a result, groups were able to meet more frequently and to form stronger relationships among actors. British Columbia formed its drought program in 2010, which may be too recent to assess whether collaboration has been successful because collaboration requires time and resources to flourish.

Other jurisdictions that have promoted the use of local groups to make drought management decisions have had less success in having collaborative groups form and regroup as low water conditions appear and to mobilize around a shared issue. Locally one of the strengths of the Ontario approach that addresses this issue is the inclusion of provincial government and conservation authority representatives on Water Response Teams. A permanent, legitimate body contributes to a strong institutional structure with institutional memory. It also provides the resources and scientific information needed by local groups. Findings from this research suggested including provincial government representatives on Water Response Teams built a bridge to government decision-making processes. At the same time, this bridge helped to ensure that Water Response Teams were more aware of tools and programs for reducing water use. This type of relationship can be difficult to form because of concerns water users can have about working with government. However, if collaborative relationships involving government officials and water users can be formed, our evaluation suggests that they can improve the process of implementing voluntary water reductions and education on best management practices.

Strengthening the role of Water Response Teams

Collaboration can achieve a number of outcomes, such as improved communication and better working relationships, but these benefits can disappear if conflict arises or tough decisions, such as whose water use will be restricted during low water, must be made. One challenge in Ontario Low Water Response is the difficulty of declaring a Level 3. In order for the Ontario Water Director's Committee, Low Water Committee, to decide if a Level 3 is justified the Water Response Teams must provide evidence that water users voluntarily reduced water

taking, that social, economic and environmental impacts are present, and that a prioritization of use has been developed. These may be difficult tasks for Water Response Teams to accomplish. Opportunities exist to better collect date on social, economic and environmental impacts from low water at the local scale. Members of Water Response Teams, especially water users, experience the impacts of drought first hand. Data on experiences over time with low water, such as stress, financial strain, and observed environmental impacts, could be compared between years to understand if response efforts are improving conditions for water users and prioritize types of responses.

In most of the cases examined in this report, social and economic impacts were not measured. However, recent literature and some interviewees pointed to the importance of understanding impacts in order to deliver effective and targeted response efforts. Understanding local impacts from drought and identifying measures to ameliorate these impacts could be a way to increase provincial preparedness.

Strengthening emergency management ties

Ontario Low Water Response is focused on ensuring provincial preparedness in the face of low water, but it is not a disaster relief or emergency response plan. Ontario Low Water Response is considered a mitigation strategy relative to the five pillars of emergency management in the Ontario *Emergency Management and Civil Protection Act* (prevention, preparedness, response, mitigation, and recovery). This means that municipal or provincial compensation for losses is not part of a response effort.

In cases from the United States discussed in this report, once an emergency was declared the governor could take over planning and often make resources available to ease the effects of drought. In the Murray Darling Basin and California, where extreme cases of drought have been experienced, more drastic measures to mitigate the impacts of drought are available. Strengthening ties between Low Water Response and Emergency Management could improve the ability to provide a timely effective response to drought in Ontario. This could be achieved by including a representative of Emergency Management Ontario on the Ontario Water Directors Committee – Low Water Committee.

Maintaining provincial oversight:

All cases had a strong role for national or provincial/state oversight, which is necessary to retain the legitimacy of drought planning and management. A balance between regulatory and incentive-based programs to elicit an appropriate response to drought that ameliorates impacts on the environment and water users is an effective approach to mitigate drought impacts. Water users may be more likely to adhere to voluntary conservation if the consequence of not reducing water use will result in regulatory action.

6. Conclusions

Drought management literature points to the need to shift from a reactive to a proactive approach to be able to better weather the crisis. This includes the recommendation for multiple stakeholders to take part in decision-making for drought management. Many different forms of collaboration are being used in drought management processes at different levels of decision-making. However, there are challenges to including actors in decision-making that are involved in drought, such as water users, municipalities, Indigenous Peoples, recreationalists, etc. One challenge is mobilizing collaborative groups once drought is declared and maintaining engagement through non-drought periods. Responding to drought often requires decisive and immediate decisions that government makes to protect water resources, but water users often spurn these actions, particularly if voluntary pre-emptive measures are possible.

A number of cases created a plan that followed a standard drought management procedure, but do not use the plan as described in actual drought planning and response. Plans should reflect what happens on the ground during drought response and actions are being taken to revise plans to reflect this. The nature of drought makes it a challenging policy problem to prepare and respond to especially in times of prolonged or severe drought. These events can catalyze plan development and innovative approaches to drought management, such as the creation of a water market.

Drought impact measures were largely not included in drought program evaluation. In most cases, interviewees believed that including impact measures in program evaluation would be too costly to monitor. However, the literature encourages incorporating local impacts into drought planning and management to improve the targeting of an appropriate response. Evaluation processes largely reviewed the drought event and recorded lessons learned to incorporate into future drought planning. A water market was established in Australia to respond to the environmental impacts of prolonged drought. However, the expensive and required stakeholder support for a water market makes it implausible for cases that do not experience prolonged or severe drought. The Murray Darling Basin was the only case with an evaluation framework for measuring decision-making progress on their water reform package. The framework included indicators for environmental, governance, and social and economic outcomes.

In subsequent research it may be worthwhile to compare more local regions with similar characteristics. Reviews have been happening at the state level, but it may be more helpful to compare the drought management at more local scales that have similar contexts. State drought plans can be difficult to implement during a severe drought given the need for different actions at local levels. Furthermore, in research that recommends collaborative approaches for drought management and planning more detail needs to be provided for the types of roles non-government actors can play in a predominantly government process and strategies to overcome hurtles that are specific to drought for effective collaboration.

7. Appendix

Detailed findings for each jurisdiction are presented in this appendix. For each jurisdiction, the corresponding table uses the categories described in Table 1. Note that in several jurisdictions drought management takes place under two or more laws, policies or other institutional arrangements; this is noted where it is the case.

7.1. Indiana's Water Shortage Plan (1994, 2009)

Category	Findings
Purpose and Scope	• During water shortages the plan manages water resources through stages that implement conservation[24]. • The plan addresses regional meteorological drought, but can also be used locally for other types of drought[24]. • There are nine regional climate divisions[24].
Membership	• The Water Shortage Task Force consists of ten members, one member for each area with a stake in drought as defined by the plan, including academic experts, industry, municipalities, environmentalist, etc.[24]. • State departments advise the multi-actor task force, but are not included as members[24]. • In regional drought situations members that reflect local input from water uses should be included in the task force[24]. • The Director of the Department of Natural Resources appointed the task force in 2006 to update the existing drought management plan (Personal Communication). • The task force was dissolved in 2012 (Personal Communication).
Decision-Making	• The plan gives criteria that outlines three stages of water shortage with corresponding actions for state and local government, the public and water users[24]. • The plan outlines that the task force elevates and decreases drought stages based on conditions[24]. However, in practice the task force is not involved in drought management, but is informed of conditions by the Department of Natural Resources (Personal Communication). The plan is in the progress of being updated to reflect this (Personal Communication). • Shortage stages can be declared locally, regionally or state-wide[24]. • In an emergency the task force seeks regional input for priority uses before mandatory restrictions are implemented[24]. • Local and regional decision-makers use nine water use priority recommendations outlined in the plan to evaluate local water use and to determine priority use during water shortages[24]. • Wise water use is promoted through the Suggested Model Ordinance, which is a template that communities can choose to implement (Personal Communication).
Role of Governments	• The Department of Homeland Security and Department of Natural Resources convene the task force once Phase 1 Water Shortage Watch has been indicated[24]. • Department of Natural Resources monitors conditions and a member of the department is appointed the Water Shortage Coordinator[24].

Category	Findings
	• State level of government retains authority and plays a high level advisory role with special attention to emergency, but there is an emphasis on local governments creating priorities and implementing water management strategies.
Authority and Accountability	• Department of Natural Resources is the lead under the plan[24] and is responsible for implementing the plan in partnership with the Department of Homeland Security and Department of Environmental Management (Personal Communication). • The Governor under the Emergency Management and Disaster Law has emergency powers and through emergency regulations can restrict non-essential water use[24]. • Reducing water taking is voluntary, but conservation is promoted and a prioritization principle is to demonstrate conservation and water efficiency[24]. • The task force recognized that information, incentives and technical support is more effective than mandates for changing water use practices (Personal Communication). • Water rights issues routinely occur throughout the state, but are addressed through emergency regulation of ground water rights, which protect small capacity wells against the impacts of high capacity pumping (Personal Communication).
Evaluation	• Promoting water conservation, education and awareness is the responsibility of state, local governments and the water utility[24]. • The water utility can provide bills more frequently to raise awareness and can provide retrofit kits and home audits[24]. • The task force should review and update the plan every 2 to 5 years[24]. • The Governor or affiliated state departments can modify the plan to respond to conditions or achieve water reductions[24] • Ground water levels are monitored by the USGS and Department of Natural Resources and allows for the evaluation of impacts and recovery (Personal Communication). • Public water supply utilities provide data to the Department of Environmental Management regarding their ability to supply water during a shortage (Personal Communication). • The plan was evaluated by the Department of Homeland Security in an 'After Action Report and Improvement Plan'. Suggestions are being evaluated for future implementation (Personal Communication).

7.2. Ontario Low Water Response (2003, 2010)

Category	Findings
Purpose and Scope	• The plan coordinates a provincial response to drought and outlines local actions for responding to low water[43]. • Decisions are made on a watershed scale based on the 36 conservation authority boundaries where they exist, or where they do not exist by Ministry of Natural Resources district offices[43]
Membership	• Water Response Teams include provincial agencies, municipalities, conservation authority staff, First Nations, water users, and other interests as applicable for local decision-making[43]. • Water Response Teams attempt to be inclusive, but membership is voluntary[43].
Decision-Making	• There are three levels that indicate worsening low water conditions that are based on comparing stream flow and precipitation to local norms[43]. • Water Response Teams respond to local and current conditions to determine when to change a low water level. • The Ontario Water Directors Committee is responsible for calling for emergency response, based on the recommendation of the Water Response Team[43]. • The plan does not act as an 'emergency' plan. The declaration of any level does not result in compensation for losses[43]. • At Level 3 the Ministry of Environment can restrict water use based on the Permit to Take Water program [43]. • At all levels priorities are developed by Water Response Teams (Personal Communication).
Role of Governments	• Provincial coordination for drought response is through the Ontario Water Directors Committee[43]. • A sub-committee responsible for low water includes Directors from: Ministry of Environment; Agriculture, Food and Rural Affairs; Municipal Affairs and Housing; and Natural Resources[43] • Ministry of Natural Resources analyzes precipitation and stream flow data and distributes low water condition reports and maps depicting current data as a percentage of historic data[43]. • Relevant provincial government representatives participate on Water Response Teams to inform and advise the process, but are non-voting[43]. • Provincial government maintains central authority and final decision-making power, but is advised by local collaborative Water Response Teams on local conditions and needs.
Authority and Accountability	• The Ministry of Natural Resources is the lead agency for drought management under the Emergency Management and Civil Protection Act and associated Order In Council 1157/2009 [43]. • The plan is based on legislation and regulations and is implemented under existing legal authorities[43]. • The Water Response Team does not have legislative authority, but advises on using

Category	Findings
	tools and policies and reports their decisions to the Ministry of Natural Resources[43]. • Water Response Teams advocate voluntary conservation at Level 1 and 2[43]. • Municipal bylaws can be used to implement restrictions on non-essential, non-permitted water use[43].
Evaluation	• Long-term strategies of the plan include public education to encourage success of the program and conservation[43], specific programs to advocate learning are largely supported through Conservation Authorities (Personal Communication). • Water Response Teams self-evaluate for equity, efficiency and effectiveness of communications, information, actions and monitoring after drought events[43]. • Plan review is as needed and is usually prompted by stakeholder feedback (Personal Communication). • Pilot projects are created in areas that face frequent and severe drought to learn lessons about local response (Personal Communication). • Social, economic and environmental impacts are recorded by Water Response Teams, but there are many challenges to effectively capture local impacts.

7.3. British Columbia Drought Response Plan (2010)

Category	Findings
Purpose and Scope	• This plan recommends actions for provincial government, which can also apply to local government, First Nations, and Water licensees to reduce impacts from drought and ensure access to water[13]. • The basin scale is the level of decision-making[13].
Membership	• The Inter-Agency Drought Working group is chaired by the Ministry of Environment and includes relevant provincial and federal staff[13]. • The Technical Drought Working Group includes members from regional cross-government drought teams and reports to the inter-agency working group[13]. • Regional Cross-Government Drought Teams provide advice on regional and watershed based drought response levels, issues advisories or notifications on drought, and supports pre-drought preparedness in vulnerable regions[13] • Local Drought Management teams may be established by local authorities or stewardship groups, but few have been established (Personal Communication). Local teams should include water users, government, First Nations, water suppliers, non-government organizations, business and recreation, and federal and provincial government staff[13].
Decision-Making	• Representatives from local government, First Nations, water licensees and users, among other organizations attended a series of 5 workshops to assist in preparing this plan[13].There are four levels of drought (normal, dry conditions, very dry, and extremely dry), which are determined by a number of seasonal indicators[13]. • The Technical Drought Working Group in collaboration with the regional cross-

Category	Findings
	government drought team considers current and forecasted status of core indicators to determine the severity of drought[13]. • Local Drought Management Plans are created by local authorities and/or local drought management teams[13]. • Water prioritization is first in time, first in right (Personal Communication). • The plan does not address emergency response as outlined in the Emergency Program Act. Drought declarations do not imply compensation from municipal or provincial government[13].
Role of Governments	• The working group ensures effective plan delivery and determines when to take regulatory action under the Fish Protection Act[13]. • The technical drought working group (through the regional water manager) determines when to take regulatory action under the Water Act[13]. • Ministry of Agriculture and Lands assess impacts of drought in agriculture and provides information on drought programs and initiatives to producers[13]. • At level 4 the Inter-Agency Drought Working Group based on information from the Technical Drought Working Group, decides when to take regulatory action[13]. • The Technical Drought Working Group coordinates provincial response[13]. • The provincial government maintains central control, but encourages local governments and other water-based organizations to create local adaptation plans. The plan was also created through input from collaborative workshops.
Authority and Accountability	• The Minister of Environment is the lead in managing drought[13]. • Drought response is based on existing legislation and regulation[13]. • Local drought management teams do not have regulatory authority, but advise government on timing and use of regulatory tools[13]. • Water suppliers with the support of local governments are responsible for maintaining water supplies and monitoring and enforcing compliance with restrictions[13].
Evaluation	• Local drought management plans provide information to the public about water supplies, encourage conservation and establish a local drought communication plan[13]. • Inter-Agency Drought Working group ensures that lessons from drought events are documented and available internally and externally[13]. • The Inter-Agency Drought Working group, the Technical Drought Working group or other involved parties should hold a post-drought workshop to assess equity, efficiency, and effectiveness of communication, information actions and monitoring that were undertaken. Lessons should be documented and used for recommendations[13]. • The province monitors hydrometric data on streams (Personal Communication). Protecting fish health and habitat particularly for Kokanee salmon is an important goal of drought management so stream measures are essential (Personal Communication). • The plan is reviewed as needed. Regional staff can debrief local drought events that

Category	Findings
	focus on regulatory action, communications, monitoring, etc. (Personal Communication).

7.4. Texas Drought Preparedness Plan (2005) / Texas State Water Plan (2012)

Category	Findings
Purpose and Scope	• The Drought Preparedness Plan outlines drought assessment procedures and advises on implementing measures to address drought[12]. • There are 10 drought regions in Texas[12]. • Climatological, agricultural, and availability drought are considered in the plan and each has a separate assessment index[12]. • State Water Plan tasks regional groups to create plans that outline how water needs are met during drought[49]. • There are 16 regional groups based in water planning areas[50].
Membership	• Drought Preparedness Council includes 16 representatives from designated state agencies that have a stake in drought response[12] • The Drought Preparedness Council consists of the: Drought Planning and Coordinating Committee, Drought Monitoring and Water Supply Committee, Drought Technical Assistance and Technology Committee, Drought Impact Assessment Committee, and Drinking Water Task Force[12]. • Regional groups have about 20 members. There are 11 stated interests that must have a representative in the group and other local concerns can be represented as needed[49]. • Federal, state and local government agencies are non-voting members in regional groups[49].
Decision-Making	• Drought is assessed through the three types of drought on 5 levels of concern[12]. • The Drought Preparedness council and the State Drought Manager use the levels of concern to determine if action is necessary[12]. • The State Drought Manger is the State coordinator of Emergency Management[12]. • The Governor's Division of Emergency Management is responsible for coordinating short-term immediate response[12]. • Regional groups identify water use groups that will not have access to required water during drought and recommend strategies to address shortages and associated costs[49]. • Regional group meetings are open and participatory[49]. Consensus building is encouraged in regional groups[50]. Plans are voted in and take into consideration representatives organizational bylaws[50]. • Water plans include how long-term water protection will be ensured by estimating

Category	Findings
	environmental impact of the management strategies and specifying locally important water resources in the and how they will be protected[49].
Role of Governments	• The Drought Preparedness Council is the lead for a coordinated state response to drought. It collects, analyzes and provides information for drought. • The Texas Water Development Board approves regional water plans and using plans from across the state develops the state water plan every 5 years[49].
Authority and Accountability	• The Drought Preparedness Council has support from the Governor's Division of Emergency Management[12]. • The Drought Technical Assistance and Technology committee coordinates with regional water planning groups on drought issues in their regional water plans[12]. • Public water suppliers are required to notify the Texas Commission of Environmental Quality when they implement mandatory water restrictions[12]. • Regional water planning groups were created by the legislature in 1997[50]. • The Texas Legislature provided 1.47 billion to implement state water plan projects through three Texas Water Development Board financial assistance programs[49]. • The Texas Water Development Board surveyed projects from the 2007 state plan by surveying project sponsors to see if projects had made progress, been completed or started[49]. • Projects must be consistent with regional and state water plans to qualify for financial assistance from the Texas Water Development Board
Evaluation	• The Drought Preparedness Council develops and changes the plan when necessary[12]. • The Drought Impact Assessment Committee is responsible for reporting drought monitoring and water supply information to the public[12]. • The Drought Technical Assistance and Technology Committee maintains the database of water suppliers and communicates with suppliers during an emergency[12]. • All Drought preparedness council meetings are posted on their website and the council prepares an end of year report for the legislature, including information on education, prevention, response, accomplishments and setbacks[12]. • A Texas State Water Plan is created every 5 years[49]. • "This process has resulted in greater public participation, public education, and public awareness, underscoring the benefits of directly involving local and regional decision makers and the public in water planning"[50]. • Public meeting are held to inform the scope of regional groups and before plans are adopted[50].

7.5. California Drought Contingency Plan (2010) *

Category	Findings
Purpose and Scope	• The 2010 DCP was prepared as an appendix or supplemental document to the California Water Plan (Personal Communication). • The DCP is not an implementation document (Personal Communication). • The 2010 DCP has not been implemented (Personal Communication). • The plan coordinates drought response, improves monitoring and plans for preparedness and response[5]. • There are 10 hydrological regions where drought actions may take place[5].
Membership	• The Interagency Drought Task Force includes managers from executive and policy government branches. The taskforce coordinates between federal, state, local and tribal agencies for drought response[5]. • The Drought Monitoring Committee, includes applicable government agencies and measures indicators for drought[5]. • The Impact Assessment Work Groups members' include groups that are at risk of drought impacts. Group members include representatives from: health, biodiversity, agriculture, recreation, forestry, energy, economics, and tribal governments[5]. The Groups are created by the taskforce[5].
Decision-Making	• The taskforce recommends drought stages based on information from the monitoring committee, impact assessment work groups and other stakeholders[5]. • Regional offices for the Department of Water Resources and California Emergency Management Agency work with local agencies to identify and assess local impacts and a response[5]. • A state of emergency is declared by the governor when local resources no longer are adequate to meet challenges from drought. Funds for State and local government are made available and for landowners with damages[5].
Role of Governments	• The California Emergency Management Agency plays a supportive role, but primarily for emergency response and recovery[5]. • The taskforce gives the Drought monitoring committee and the impact assessment work groups direction on policy areas of interest and makes recommendations for management plans and emergency response efforts[5]. • Drought response is largely directed by the state, but the Impact Assessment Work Groups provide input from at risk populations.
Authority and Accountability	• Department of Water Resources is lead for the plan[5]. • Existing function and authority of state agencies is used to respond to drought[5]. • The California Emergency Management Agency provides funds through the California Disaster Assistance Act in an emergency[5]. • In 2014 Legislature passed an emergency drought relief package of $687 million[2]. • Local drought response is voluntary or mandatory conservation through local ordinances[5].

Category	Findings
Evaluation	• The taskforce provides drought indicator information to water managers and the public[5]. • The plan is updated and reviewed to correspond to California Water Plan[5]. • After a drought the taskforce debriefs on successes, lessons and possible improvements[5].

* California has many different types of drought plans, including 2014 and 2015 Drought Contingency Plans for the State Water Project and federal Central Valley Project. These plans are implementation documents.

7.6. Spain's National Hydrological Plan Act (2001)

Category	Findings
Purpose and Scope	• Drought Management Plans aim to guarantee access to water and minimize environmental impacts from drought[17]. • Spain has 25 river basin authorities.
Membership	• River Basin Authorities include farmers, environmentalists, urban and rural dwellers, urban water supply companies and the River Basin Authority[18]. • The president of the Basin Authority can create committees or task forces to address challenges in the basin[18].
Decision-Making	• River Basin Authorities develop Drought Management Plans[17]. • Drought statuses, include normal, pre-alert, alert and emergency[17]. • Plans identify adequate mitigation actions for each drought status, which include conservation, restrictions and prioritizing water use during a higher status[17]. • Emergency measures for drought are approved as general interest actions[18]. • Emergency plans must be developed for public water systems that provide for 20,000 people or more[18].
Role of Governments	• The Ministry of Environment developed a national hydrological indicator system that measures conditions and provides warning of potential drought and is a reference for River Basin Authorities to declare emergency[17]. • Drought measures are implemented through royal decrees[18]. • Drought planning and response is coordinated by pre-existing basin authorities that are accountable to government, but are multi-actor groups, which varies from convention government roles in decision-making.
Authority and Accountability	• The Water Framework Directive (EU) provides Spain the opportunity to create integrative management plans on a basin scale that incorporate national experience[18] • River Basin Authorities are an independent public organization under the authority of the Ministry of the Environment[18]. • The Act requires basin authorities to develop drought management plans[18]. • Drought Management Plans supplement River Basin Management Plans[17]. • Drought Management Plans were approved by Ministerial Order[17].
Evaluation	• The Act encourages water saving and conservation through public awareness

Category	Findings
	campaigns[26]. • Plans include a post-drought process to analyze implementation measures and a methodology for reporting on the drought[17]. • The plan outlines drought diagnosis, program of measures and management, and follow-up systems[17]. • Drought diagnosis includes considering lessons from past droughts and evaluating local and regional knowledge and expertise[17].

7.7. England and Wales Head Office Drought Plan (2012)

Category	Findings
Purpose and Scope	• This plan outlines drought planning and measures to be implemented during drought conditions[15]. • There is a national drought plan, a regional plan for Wales and six regional plans based on Environment Agency regions[15].
Membership	• Regional drought planning is led by Environment and Performance teams and the Environment Agency nominates drought roles for staff [15]. • Regions can be subdivided into smaller areas each with a drought team[16]. • Water companies must manage water supplies to provide for customers, while protecting the environment and balancing the needs of water users and create drought management plans for their operation[15]
Decision-Making	• There are four drought stages (normal, potential drought, drought, post-drought). A range of drought triggers are used to identify whether to take drought action and when, but crossing a drought trigger does not require action. • The regional drought team makes decision on whether action is needed based on a range of factors, including present and forecast conditions and perceived effectiveness of action[15]. • Water companies create drought plans that outline how water supplies are protected and ensure that customers can access water[15]. • The operational environmental monitoring teams collect and analyze data in regions[15].
Role of Governments	• Government oversees the activities of the water companies and grants permits, but the water companies limit water taking by customers if needed[15]. • Drought planning is nationally coordinated by water resource teams in Environment & Business and Operations Technical Services and the National Incidents and Contingency Planning[15]. • The Head Office Drought team informs and communicates with applicable government agencies national organizations, NGOs, and the media[15]. • When all regions are no longer experiencing drought conditions the Head of Water Resources will remove the government drought team[15].

Category	Findings
	• The direction and oversight for drought planning comes from the government, but the responsibility for implementation is on water companies, which represent a type of decentralized governance.
Authority and Accountability	• The Environment Agency is the lead for water resources, including drought management [15]. • Drought plans are voluntary and not necessary under statutory legislation, therefore strategic environmental assessment is not required for drought plans[15]. • Drought plans outline how drought impacts are monitored and managed[15]. • Under the Water Industry Act water companies implement temporary water restrictions during water shortages[15].
Evaluation	• Drought plans are reviewed every year and every three years there is public consultation for updating the drought plan[15]. • The Head Office Drought team informs the public and water users on reporting environmental problems and saving water[15]. • Lessons learned from drought will be captured to inform future staff in managing drought and report on environmental response from the drought[15]. • Post drought reports are mainly a snapshot of what happened during the drought event and how we can improve next time (Personal Communication). • Post-drought reports are created before 6 months after the drought has ended and include a summary of impacts and mitigation actions, lessons learnt and recommendations[15]. • Drought plan exercises are used to test plans based on drought simulations using past data and experiences[15].

7.8. Georgia Drought Management Plan (2003)

Category	Findings
Purpose and Scope	• The plan focuses on mitigating drought through conservation and strategic actions planned at various stages of drought[9]. • Georgia has 9 climate divisions[9]. • Regional water planning is directed by the State Water Plan, which develop detailed regional water plans, but focus on averages and not extreme conditions (Personal Communication).
Membership	• The plan was created by a 85 actor collaborative effort that included a diverse geographic, political and sector involvement[9]. • The Environmental Protection Division Director convenes and chairs the Drought Response Committee[9]. • The Drought Response Committee includes the water conservation coordinator, applicable state and federal agencies, one Regional Development Centre representative, one NGO, and one representative from each business and agriculture[9].

Category	Findings
	• Water conservation plans are created by the Department of Natural Resources water conservation coordinator, applicable state departments, Regional Development Centres, local governments, and water supply providers[9].
Decision-Making	• The Director, in consultation with the Drought Response Committee, determines the drought level (1-4)and necessary response given the conditions[9]. • A member of the Drought Response Committee, usually the chair, will inform Regional Development Centres, local governments and water supply providers of actions to take during drought level[9]. • Local and regional drought management and conservation plans outline appropriate actions given the local context[9]. • In an emergency local water suppliers or government contact the Georgia Emergency Management Agency for assistance[9].
Role of Governments	• Water conservation plans are provided to the Environmental Protection Division[9] • The Environmental Protection Division coordinates with applicable agencies to share information about drought and water conservation concerns and solutions[9]. • The State Climatologist and Environmental Protection Division monitors drought indicators[9]. • The State maintains a conventional governing role, but consults with key water users through a more permanent body that is part of government. The plan was also created through a collaborative process.
Authority and Accountability	• The Department of Natural Resources is responsible for implementing the plan[9]. • Local and regional authorities may decide to surpass the requirements and create additional prevention or response strategies[9]. • Funding requests to support actions under the plan are developed by an applicable agencies and are supported by the Drought Response Committee[9]. • Press releases outline the state of drought and how the government is responding[9].
Evaluation	• Local government and water suppliers determine a drought communication process[9]. • The plan is reviewed every 5 years or after a drought response to "evaluate the performance and suitability of the drought indicators, the effect of the pre-drought and drought responses, and to what extent the plan is followed". The Drought Response Committee alters the plan based on reviews[9]. • In the 2007-2008 drought event water limits were imposed on an area with around 50 counties without considering local variations and prompting possible new drought rules, which are presently under review (Personal Communication). • In response outdoor watering hours and water audits were put into state law in 2010 (Personal Communication). • Drought impacts (largely reflecting economic impacts) are reported to the government by sectors of the economy that are affected by drought, such as landscaping (Personal Communication).

7.9. South Australia Natural Resources Management Act (2004) *

Category	Findings
Purpose and Scope	• This Act (2004) promotes integrated management and protection of natural resources through plans, including a water allocation plan[19]. • There are actions for inadequate supply or overuse of water[19]. • The River Murray Prescribed Watercourse, in the Murray Darling River Basin, is the only water resource that has been prioritized during drought (Personal Communication). • There are 8 regions under the plan. • There is a water market in the lower Murray that includes (South Australia, Victoria, and New South Wales). The water market allows for water transfers between jurisdictions (Personal Communication).
Membership	• The Natural Resource Management Council has 9 members who are recommended by the Minister to the governor who appoints members to the council[19]. One member on the council represents someone actively involved in community affairs, one member is put forward by conservation/agricultural interests and one member is supported by aboriginal people. The public are invited to propose people for the council[19]. • The management council should work with national and state and local government, industry, and environment and community groups[19]. • Natural Resource Management Boards are created in regions. • Management Boards have up to nine members who are appointed by the governor on recommendations of the minister and management council. Nominations should consider a variety of natural management actors and be locally relevant[19].
Decision-Making	• The Natural Resource Management Council advises the Minister on administering, and auditing the Act (2004), and monitoring and evaluating resources on-the-ground[19]. • Regional Natural Resource Management Boards create and implement a plan to protect regional resources[19]. • A water allocation plan must be prepared by the regional management board for each prescribed water resource[19]. • Water allocation plans, include environmental water requirements, water access entitlement, methods of conservation for water, mitigating negative impacts from water taking, etc.[19]. • In times of low water the Minister can restrict or prohibit water taking or manage dams, reservoirs, etc.[19]. • The water market assists in buying back water in an over allocated system and encourages infrastructure improvement programs to provide more water for the environment (Personal Communication).
Role of Governments	• The Governor can remove people from the management council[19]. • Regional management boards are under the direction and control of the Minister[19]. • A regional management plan cannot be implemented unless it has been approved by

Category	Findings
	the Minister[19]. • Australia has embraced integrated resource management and South Australia includes drought response and water allocation in that approach. • The water market has a Commonwealth Environmental Water Holder and water use decisions are informed by legislation to encourage water availability for environmental needs during future droughts (Personal Communication).
Authority and Accountability	• The Department of Environment, Water and Natural Resources is the lead under this Act (2004). • The Natural Resource Management Act guides the creation of water allocation plans. • The Natural Resource Management Council annually reports to the Minister on council activities and expenditures[19]. • Regional Natural Resource Management Boards also report to the Minster on their performance[19]. • If a person does not comply with restrictions on water use a fine may be handed down[19]. • Under the Natural Resource Management Act the Minister can determine priorities for water by allocating different water use percentages to consumptive pools (Personal Communication). • Under the Water Act water for "critical human water needs" is given priority (Personal Communication).
Evaluation	• This Act (2004) aims to provide educational initiatives and increase individual capacity to take part in managing natural resources[19]. • The Management council reviews the State Natural Resource Management Plan at least every 5 years[19]. • Regional natural resource management plans, include methods for determining the degree of successful implementation of the plan and effectiveness of measures. • In South Australia critical human water needs include human consumption in urban and rural areas and non-human consumption "that a failure to meet would cause prohibitively high social, economic or national security costs" • During the past drought 2002-2010 in some instances water priorities were developed on an as needed basis, which were primarily ecological needs for water (Personal Communication). • An allocation framework was developed each year during the drought to determine the likely scenarios for allocating water the next year based on conditions and predicted storage (Personal Communication). • The Monitoring, Evaluation, Reporting and Improvement (MERI) Framework is used to help set realistic, measurable outcomes so that effectiveness and investment can be measured (Personal Communication).

* Drought management in the State of South Australia takes place under the South Australia Natural Resources Management Act and the broader framework of the Commonwealth Water Act (2007).

7.10. Victoria, Australia *

Category	Findings
Purpose and Scope	• The Water Industry Act prompts water suppliers to develop drought response plans for urban systems and allocate water for rural reserves[8]. Plans should respond to immediate or short-term water shortages[10]. Victoria has 19 water corporations[8]. • Victoria's Catchment Management Framework works to develop and coordinate actions to protect natural resources[51]. There are 10 catchment based areas for integrated management[51].
Membership	• The Victoria Catchment Management Council includes up to 10 members who are appointed by the Governor through recommendations from the Minister[20]. Council members include representatives that support the opinion of land and water users[20]. • Each Catchment Management Authority has a board of 5-8 members (a majority of members must be employed in primary production)[20]. Board members are appointed by the Minister[20].
Decision-Making	• In the Water Act the "water entitlement and planning framework defines how water is shared, held used and traded. It allocates water and ensures environmental water needs"[7]. • In the Water Industry Act a response is outlined for each water system held by the company[52]. There are four stages (Alert, save, just enough and critical) with corresponding actions related to a number of water uses. Emergency measures require ministerial approval and limit water taking to 60 L/p/d for residential consumers[52]. • Catchment management authorities preparing and implementing regional strategies for managing resources and make special area plans[20]. However, authorities play a limited role in drought management, which mainly consists of supporting the Victorian Environmental Water Holder (Personal Communication). • Quorum for authorities is the majority of members attending a meeting[20].
Role of Governments	• The Water Act gives the government the right to use, flow and control water and manage water allocation[7]. • Catchment authorities advise the Minister[20]. • Victoria's approach to drought management involves the use of a water market with government oversight. Public short-term droughts are the responsibility of water corporations and environmental water needs are supported by catchment management authorities.
Authority and Accountability	• A water market has existed in Victoria since 1991. Water trading allows entitlement holders to manage water and reallocates water during prolonged drought and times of scarcity[7]. • Department of Environment and Primary Industries is the lead under the listed acts. • Under the Statement of Obligation the Board of Water Corporations is accountable to the Minister for ensuring good governance of the corporation and they prepare an annual report for the Minister[8].

Category	Findings
	• The Catchment Management council provides an annual report to the Minister and every 5 years reports on the assessment of the conditions and management of state resources[20]. • The Catchment management authority prepares annual reports for the council and the minister[20].
Evaluation	• Catchment Authorities are responsible for building community awareness and conservation[20]. • Water Corporations must review and amend drought plans every five years or after restrictions are imposed or after a change to a water supply system[8]. • Water corporations must monitor their compliance with its obligations[8]. • "The Victorian Environmental Water Holder works with catchment management authorities and Melbourne water to ensure environmental water entitlements are used to achieve the best environmental outcome with the water that is available"[6]. "The Victorian Water Holder was established in 2011 and is the independent statutory body responsible for holding and managing Victoria's environmental water entitlements"[6].

* Drought management in the State of Victoria takes place under the Victoria's Water Act (1989), the Water Industry Act (1994), the Catchment and Land Protection Act (1994) and the Commonwealth Water Act (2007)

7.11. Australia's Murray-Darling Basin (Murray-Darling Basin Plan)

Category	Findings
Purpose and Scope	• The plan outlines planning and management of water resources in the Murray Darling Basin[36]. • There are 36 areas with a Water Resource Plan[41]. • The Commonwealth Water Act (2007) incorporates the Murray-Darling Basin Agreement that states the rules for water sharing between jurisdictions (Personal Communication).
Membership	• The Murray Darling Basin Authority (MDBA) includes a chair, chief executive and four part-time members[36]. • The Murray-Darling Basin Ministerial Council includes the Commonwealth Minister for Water as Chair and one minister from each state or territory in the basin (Queensland, New South Wales, Victoria, South Australia and Australian Capital Territory) and the MDBA Chair who is a non-voting member[36]. • The Basin Officials Committee is made up of Basin government officials and advises the MDBA. It is chaired by the Commonwealth and representatives are from the state and territory governments in the basin, the MDBA Chair is a non-voting member[36]. • The Basin Community committee includes a chair and 16 members that represent: water users, indigenous peoples, farming, environmental water management sectors and one MDBA member[36].

Category	Findings
	• To assist in its advisory role the Basin Community Committee is required to form irrigation, environmental water and Indigenous water subcommittees (Personal Communication).
Decision-Making	• Drought is addressed through several requirements of Water Resource Plans. One risk to the availability of water resources is drought, so this could be identified in the risk assessment, and where appropriate strategies to address the risk can be identified. Plans also include how water resources will be managed during extreme events, including drought (notes). • Water Resource Plans assist in planning the sustainable diversion limits operation from 2019 and into the future[40]. Sustainable diversion limits dictate the amount of water that can be removed from the system[40]. Specifically Water Resource Plans specify water sharing arrangements, environmental water needs, and risks to water resources[40]. • The Basin Community Committee provides advice to the MDBA and the Ministerial Council[36].
Role of Governments	• States that are part of the Basin develop Water Resource Plan outlining the management of water resources[38]. • The States already undertake water resource planning for most parts of the Basin and the Authority will cooperate with States to develop Water Resource Plans which include Basin Plan requirements[40]. • The state largely is working through conventional tools, but with legislated state collaboration overseen by an independent body.
Authority and Accountability	• The Commonwealth Minister for Water is the lead for the Basin Plan[36]. • The MDBA develops, implements, and monitors the Basin Plan[36]. • MDBA is an independent government agency [36] created by the Water Act 2007[11]. • MDBA reports to the Parliamentary Secretary to the Minister for the Environment, who also chairs the Murray-Darling Basin Ministerial Council[36]. • The areas under Water Resource Plans are managed by States therefore each area is entirely within one state[41]. • MDBA has enforcement powers[11]. • The Minister is responsible for accrediting Water Resource Plans with recommendations from MDBA[40]. • Once the Minister accredits Water Resource Plans investment is ensured for water users for 10 years[40].

Category	Findings
Evaluation	• The Basin Ministerial Council can ask the MDBA to revise the Basin Plan[36]. • Annual reports are created on progress of Basin Plans[35]. • Water Resource Plans are set for 10 year periods[38] • Water Resource Plans drive the implementation of outcomes from the Basin Plan locally and throughout the basin[40]. • MDBA leads monitoring of the plan at the basin level, including evaluating the effectiveness of Basin Plan compared to objectives and outcomes outlined in the plan[35]. • MDBA educates the community on basin water resources[39]. • The Basin Plan Evaluation Framework details how the Authority evaluates the implementation of the plan (how well it has been put in place and how it is working) and the effectiveness of the significant water reform package (whether social, economic and environmental objectives and outcomes are being achieved (Personal Communication). • The MDBA spent a lot of time talking with farmers, irrigation operators, local business owners, local councils, local community groups, tourism operators, universities, consultants, scientists and Basin states to develop a range of suitable indicators that can be used in our evaluation (Personal Communication).

8. References Cited

Reference List

1 Ansell, C. and Gash, A. 2007. Collaborative governance in theory and practice. *Journal of Public Administration Research and Theory,* 18 (4), 543-571.

2 Association of California Water Agencies. 2014. *2014 Drought* Sacramento, CA: Association of California Water Agencies.

3 Benson, D., Fritsch, O., Cook, H., and Marylise, S. 2014. Evaluating participation in WFD river basin management in England and Wales: process, communities, outputs and outcomes. *Land Use Policy,* 38, 213-222.

4 Bokal, S., Grobicki, A., Kindler, J., and Thalmeinerova, D. 2014. From national to regional plans - the Integrated Drought Management Programme of the Global Water Partnership for Central and Eastern Europe. *Weather and Climate Extremes,* 3, 37-46.

5 California Department of Water Resources. 2010. *California Drought Contingency Plan* Sacramento, CA: State of California.

6 Department of Environment and Primary Industries. Victorian Environmental Water Holder. 2015.

7 Department of Environment and Primary Industries. Water Entitlements and Trade. 2015.

8 Department of Environment and Primary Industries. 2015. *Water Industry Act 1994 Statement of Obligations* Melbourne, Vic: The State of Victoria.

9 Department of Natural Resources. 2003. *Georgia Drought Management Plan* Atlanta, GA: State of Georgia.

10 Department of Sustainability and Environment. 2011. *Guidelines for the Development of a Water Supply Demand Stategy: Overview* Melbourne, Vic: State Government of Victoria.

11 Department of the Environment. Water Legislation. 2013.

12 Drought Preparedness Council. 2005. *State Drought Preparedness Plan* Austin, TX: State of Texas.

13 Econnics. 2010. *British Columbia Drought Response Plan* Victoria, BC: Econnics.

14 Emerson, K., Nabatchi, T., and Balogh, S. 2012. An integrative framework for collaborative governance. *Journal of Public Administration Research and Theory,* 22 (1), 1-29.

15 Environment Agency. 2012. *Head Office Drought Plan* Bristol, UK: Environment Agency.

16 Environment Agency. 2012. *South West Drought Plan*. Bristol, UK series: Environment Agency.

17 Estrela, T. and Vargas, E. 2012. Drought Management Plans in the European Union. The Case of Spain. *Water Resources Management*.

18 Garrote, L., Iglesias, A., and Flores, F. 2009. Development of Drought Management Plans in Spain. In *Coping With Drought Risk in Agriculture and Water Supply Systems, Advances in Natural and Technological Hazards Research,* ed. A. Inglesias. Dordrecht: Springer.

19 Government of South Australia. 2004. *Natural Resources Managemetn Act* Adelaide, SA: Government of South Australia.

20 Government of Victoria. 1994. *Catchment and Land Protection Act*

21 Hermans, L. M., Naber, A. C., and Enserink, B. 2012. An approach to design long-term monitoring and evaluation frameworks in multi-actor systems - a case in water management. *Evaluation and Program Planning,* 35, 427-438.

22 Holley, C., Gunningham, N., and Shearing, C. 2012. *The New Environmental Governance* London, UK: Routledge.

23 Iglesias, A., Garrote, L., and Martín-Carrasco, F. 2009. Drought risk management in Mediterranean River Basins. *Integrated Environmental Assessment and Management,* 5 (1), 11-16.

24 Indiana Department of Natural Resources. 2009. *Indiana's Water Shortage Plan* Indianapolis, IN: State of Indiana.

25 Innes, J. E. and Booher, D. E. 2010. *Planning With Complexity: An Introduction to Collaborative Rationality for Public Policy* New York: Routledge.

26 Juan Carlos I. 2003. Act 10/2001, of 5 July, concerning the national hydrological plan. *Journal of Water Resources Development,* 19 (3), 353-376.

27 Kallis, G. 2008. Droughts. *Annual Review of Environment and Resources,* 33, 85-118.

28 Lackstrom, K., Brennan, A., Ferguson, D., Crimmins, M., Darby, L., Dow, K., Ingram, K., Meadow, A., Reges, H., Shafer, M., and Smith, K. 2013. *The Missing Piece: Drought Impacts Monitoring*: Workshop report produced by the Carolinas Integrated Sciences & Assessments program and the Climate Assessment for the Southwest.

29 Laurian, L. and Shaw, M. M. 2009. Evaluation of public participation the practices of certified planners. *Journal of Planning Education and Research,* 28 (3), 293-309.

30 Logar, I. and van den Bergh, J. C. J. M. 2013. Methods to assess costs of drought damages and policies for drought mitigation and adapation: review and recommendations. *Water Resources Management,* 27 (6), 1707-1720.

31 Margerum, R. D. 2008. A typology of collaboration efforts in environmental management. *Environmental Management,* 41, 487-500.

32 Margerum, R. D. 2011. *Beyond Consensus: Improving Collaborative Planning and Management* Cambridge, MA: MIT Press.

33 Marshall, G. R. 2009. Polycentricity, reciprocity, and farmer adoption of conservation practices under community-based governance. *Ecological Economics,* 68 (5), 1507-1520.

34 McNeeley, S. M. 2014. A "toad's eye" view of drought: regional socio-natural vulnerability and responses in 2002 in Northwest Colorado. *Regional Environmental Change,* 14, 1451-1461.

35 Murray-Darling Basin Authority. 2012. *Basin Plan* Canberra, AU: Commonwealth of Australia.

36 Murray-Darling Basin Authority. 2014. Governance of the Murray-Darling Basin Authority. http://www.mdba.gov.au/about-mdba/governance. Accessed November 26, 2014.

37 Murray-Darling Basin Authority. 2014. *Murray-Darling Basin Water Reforms: Framework for Evaluating Progress* Canberra, ACT: Murray-Darling Basin Authority.

38 Murray-Darling Basin Authority. 2014. Preparing Water Resource Plans. http://www.mdba.gov.au/what-we-do/water-planning/water-resource-plans/preparing-water-resource-plans. Accessed November 27, 2014.

39 Murray-Darling Basin Authority. 2014. The Authority. http://www.mdba.gov.au/about-mdba/governance/the-authority. Accessed November 26, 2014.

40 Murray-Darling Basin Authority. 2014. Water Resource Plans. http://www.mdba.gov.au/what-we-do/water-planning/water-resource-plans. Accessed November 27, 2014.

41 Murray-Darling Basin Authority. 2014. Water Resources Plan Areas. http://www.mdba.gov.au/what-we-do/water-planning/water-resource-plans/water-resource-plan-areas. Accessed November 27, 2014.

42 Niles, M. T. and Lubell, M. 2012. Integrative frontiers in environmental policy theory and research. *Policy Studies Journal,* 40 (S1), 41-64.

43 Ontario Ministry of Natural Resources, Ontario Ministry of the Environment, Ontario Ministry of Agriculture and Food, Ontario Ministry of Municipal Affairs and Housing, Ontario Ministry of Enterprise, Opportunity and Innovation, Association of Municipalities of Ontario, and Conservation Ontario. 2010. *Ontario Low Water Response* Toronto, ON: Queen's Printer for Ontario.

44 Pulwarty, R. S. and Sivakumar, M. V. K. 2014. Information systems in a changing climate: early warning and drought risk management. *Weather and Climate Extremes,* 3, 14-21.

45 Reed, M. G., Henderson, A., and Mendis-Millard, S. 2013. Shaping local context and outcomes: the role of governing agencies in collaborative natural resource management. *Human Dimensions of Wildlife,* 18 (4), 292-306.

46 Robinson, C. J., Margerum, R. D., Koontz, T. M., Moseley, C., and Lurie, S. 2011. Policy-level collaboratives for environmental management at the regional scale: lessons and challenges from Australia and the United States. *Society and Natural Resources,* 24 (8), 849-859.

47 Rossi, G. and Cancelliere, A. 2013. Managing drought risk in water supply systems in Europe: a review. *International Journal of Water Resources Development,* 29 (2), 272-289.

48 Taylor, B. and de Loë, R. 2012. Conceptualizations of local knowledge in collaborative environmental governance. *Geoforum,* 43, 1207-1217.

49 Texas Water Development Board. 2012. *2012 Water for Texas* Austin, TX: State of Texas.

50 Texas Water Development Board. 2013. *Water for Texas: Regional Water Planning in Texas* Austin, TX: State of Texas.

51 Victoria Catchment Managemetn Council. 2007. *Celebrating 10 Years Linking Communities and Catchments* Melbourne, Vic: State of Victoria.

52 Western Water. 2012. *Drought Response Plan* Sunbury, VIC: Western Water.

53 Wilhite, D. A., Sivakumar, M. V. K., and Pulwarty, R. 2014. Managing drought risk in a changing climate: the role of national drought policy. *Weather and Climate Extremes,* 3, 4-13.

54 Wilhite, D. A., Svoboda, M. D., and Hayes, M. J. 2007. Understanding the complex impacts of drought: a key to enhancing drought mitigation and preparedness. *Water Resources Management,* 21 (5), 763-774.