

APPENDIX **K**

Drought Planning

Water Resource Protection Plan 2019 Update

K Drought Planning

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Droughts have affected the islands throughout Hawai'i's recorded history, with the most severe events occurring in the past 15 years associated with the El Niño phenomenon. Drought is a persistent and extended period of below normal precipitation where abnormal moisture deficiencies induce a variety of adverse effects. Impacts due to drought, both direct and indirect, manifest as changes in the environment, economy, public health, and long-term water supply. The impacts of climate change may exacerbate drought and its impacts in Hawai'i. There is some uncertainty about how drought may be affected, however recent research has shown that there may be a continuing trend towards declining annual rainfall in Hawai'i. This chapter reviews drought mitigation planning efforts undertaken in the State of Hawai'i.

K.1 Goals and Objectives

The State Water Code recognizes the need for comprehensive water resource planning to address water supply and conservation. Drought planning activities are integral to water conservation and resource protection. The State Water Code identifies the *Water Resource Protection Plan* as the document in which to include programs to conserve, augment, and protect the resource, as well as other elements necessary or desirable for inclusion. Although HRS §174C does not require drought planning, the *Statewide Framework for Updating the Hawai'i Water Plan* (2000) specifically recommends drought planning to be included in the Hawai'i Water Plan update, and reinforces the need for drought planning in support of water conservation and water shortage planning.

The drought from 1998 to 2003 had devastating impacts throughout the islands, including numerous wildland fires, record-low rainfall, cattle losses, and major crop damage. In mid-2000, a statewide drought declaration was issued by the Governor, and the State, together with federal and county agencies, private organizations, and affected stakeholders, identified and executed various drought response projects. Initiatives were also undertaken towards the development of a drought plan for the State to mitigate and plan for the long-term effects of drought. The Commission on Water Resource Management assumed the role of lead agency in the development of the State's emerging drought program.

The Hawai'i Drought Council and its subcommittees were established in 2000 to oversee drought response and mitigation efforts. The chairperson of the Hawai'i Department of Land and Natural Resources and the chairperson of the Hawai'i Department of Agriculture (HDOA) serve as co-chairs of the Hawai'i Drought Council. CWRM provides administrative support to the Hawai'i Drought Council and its committees, and provides coordination support to the county-level drought committees through the State Drought Coordinator, who is a CWRM staff member. The Hawai'i drought program has grown considerably since its inception in 2000, resulting in the

solidification of agency coordination, communication, and involvement at both the State and county levels. CWRM remains committed to drought mitigation, and has set forth the following goals for the drought program:

- Fulfill the State’s responsibility, as trustee of water resources, to protect and ensure the long-term viability of resources through implementation of the drought program and regular updates of the Hawai’i Drought Plan (HDP).
- Support legislative budget appropriations that strengthen the drought program and achieve the HDP priority implementation actions, provided that this does not affect the State’s executive budget priorities.
- Expand and improve outreach and public education programs, including the Hawai’i Drought Monitor website and the production and distribution of drought awareness public service announcements in multiple media formats.
- Support and encourage the efforts of the Hawai’i Drought Council through the efforts of the State Drought Coordinator.
- Continue to provide advisory and liaison support to county drought committees in communications with State and federal agencies, and encourage implementation of county drought mitigation strategies.
- Seek to improve drought risk assessment methods, drought impact assessment methodologies, and apply new information in developing and updating drought mitigation strategies.
- Maintain and foster positive relationships with federal agencies involved with drought hazard mitigation, response, and relief including the National Drought Mitigation Center, National Integrated Drought Information System, Federal Emergency Management Agency (FEMA), the U.S. Bureau of Reclamation (Reclamation), and the USDA.
- Cultivate partnerships with business, agriculture, and environmental organizations and professional associations to expand participation in drought planning and mitigation activities and increase public awareness and support of drought issues.

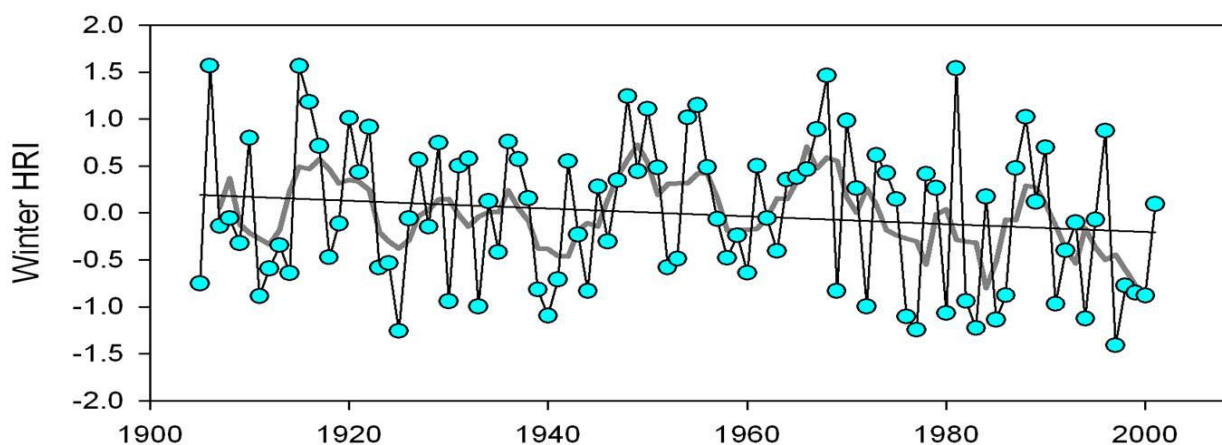
K.2 Overview of Drought

Drought is a normal and temporary climate abnormality, but it can have profound effects on the environment and the lifestyles of affected communities. Drought diminishes natural stream flow, depletes soil and subsoil moisture, and the resultant variety of social, environmental, and economic impacts can be numerous and widespread.

K.2.1 Climate Change and Drought

According to the U.S. Drought Monitor, Hawai'i has experienced D2 (severe) drought conditions somewhere in the state since June 2008.¹ The report for the Pacific Islands Regional Climate Assessment (PIRCA) shows that there has been an increase in average air temperature in the Hawaiian Islands from 1916-2006. The report also shows that there has been a downward trend in rainfall across the state since the beginning of the 20th century and an even steeper negative trend since 1980. The main Hawaiian Islands have seen an increase in the number annual consecutive dry days from the period 1950-1970 compared to 1980-2011, indicating a tendency for more prolonged dry periods.²

Figure K-1 Interannual and Interdecadal Rainfall Variations in the Hawaiian Islands³



The data also shows a decrease in stream base-flow across the state since the early 1900s, which indicate a decrease in ground water recharge and storage, which coincide with the trend of decreasing rainfall. The PIRCA report also includes research projections of future rainfall in the Hawaiian islands. One statistical downscaling model predicts decreasing wet-season rainfall and increasing dry-season rainfall. As with any projection, there is uncertainty with this model prediction, but results seem to line up with a trend in increasing winter drought in Hawai'i since the 1950s. Data and research suggest that Hawai'i should be prepared for a future with a warmer climate, diminishing rainfall and declining stream base flows.

¹ National Drought Mitigation Center, U.S. Drought Monitor, accessed February 28, 2014, <http://droughtmonitor.unl.edu/MapsAndData/DataTables.aspx>

² Keener, V. W., Marra, J. J., Finucane, M. L., Spooner, D., & Smith, M. H. (Eds.). (2012). *Climate Change and Pacific Islands: Indicators and Impacts. Report for The 2012 Pacific Islands Regional Climate Assessment*. Washington, DC: Island Press.

³ Chu, P.-S., and Chen, H. 2005. Interannual and interdecadal rainfall variations in the Hawaiian Islands. *Journal of Climate* 18: 4796-4813

K.2.2 Understanding Drought

The National Drought Mitigation Center (NDMC) uses two main types of drought definitions: conceptual and operational. Conceptual definitions of drought are general and help people understand the concept of drought. Operational definitions help to define the onset, severity, and end of a drought. Operational definitions of drought include the following:

- **Meteorological Drought:** Meteorological drought is usually an expression of the precipitation level's departure from normal over some period of time. Meteorological measurements are the first indicators of drought.
- **Agricultural Drought:** Agricultural drought occurs when there is inadequate soil moisture to meet the needs of a particular crop at a particular time. Agriculture is usually the first economic sector to be affected by drought.
- **Hydrological Drought:** Hydrological drought refers to deficiencies in surface and subsurface water supplies, reflected in declining surface and ground water levels. There is lag time between a lack of rainfall and the observed decrease of water levels in streams, rivers, lakes, reservoirs, and aquifers; therefore, hydrological drought will not be reflected until precipitation is deficient over an extended period of time.
- **Socioeconomic Drought:** Socioeconomic drought occurs when a physical water shortage affects people such that the demand has exceeded supply, as a result of a water deficit. This can affect human and animal population and growth rates, water and fodder requirements, agricultural drought impacts, and various industries.

K.2.3 Drought Impacts

The direct impacts of drought include: reduced cropland, rangeland, and forest productivity; increased fire hazard; reduced water levels; increased livestock and wildlife mortality rates; and damage to wildlife and fish habitat. Indirect drought impacts are the consequences of direct impacts.

Drought impacts can also be categorized by the sector that experiences the impacts. These types of impacts are economic, environmental, or social. Many of the economic impacts occur in agriculture and related sectors, due to their reliance on rainfall and on surface and ground water supplies. In addition to losses in yields to both crop and livestock production, impacts can be indicated by income loss to farmers, which has a ripple effect, impacting income to retailers and others who supply goods and services to farmers.

Environmental impacts refer to the losses incurred as direct or indirect results of drought, such as wildfire damage to plant and animal species. Direct and indirect negative impacts can include: degradation of wildlife habitat; degradation of air, water, and landscape quality; loss of biodiversity; and soil erosion. Social impacts involve public safety, health, water use conflicts, quality-of-life issues, and socio-spatial inequities in the distribution of impacts and disaster relief. Many impacts that have economic and environmental effects have social components as well.

The Eastern portion of the Hawaiian Islands seem to have been most severely impacted by drought events since around the year 1999. This includes the Hawai'i Island and the County of Maui, comprised of Moloka'i, Lāna'i, Kaho'olawe, and Maui Islands. While drought has continued to affect Kaua'i and O'ahu, the severity and duration of drought there has not been as bad as in Maui and Hawai'i Counties.

Much of the impacts of drought during the past 15 years or so have been to the cattle industry. Drought withers pastures and makes it difficult to provide drinking water for livestock. Without healthy and sufficient pasture, livestock cannot obtain adequate nutrition through grazing. Supplemental cattle feed such as hay is extremely expensive in Hawai'i and is usually financially unsustainable for ranchers. The result is ranchers destocking and selling off portions of their herd in order to reduce expenses. Once the drought is over, it can take several years for the operation to grow their herd back to its size before the drought, causing hardships for the ranching operation.

Other significant drought impacts are to unirrigated agriculture, such as the Kona Coffee industry, where the timing and amount of rainfall is crucial for a successful crop. Irrigated agriculture can also be impacted by drought. Reduced surface water inflows to irrigation systems during drought can cause system operators to reduce the amount of water available to its customers through voluntary reductions or mandatory restrictions.

K.2.4 Drought Response versus Mitigation

The term “drought response” refers to emergency actions that are implemented directly in response to drought conditions. In contrast, “drought mitigation” is defined as short- and long-term actions and/or programs that may be implemented prior to, during, and after drought events to reduce the degree of risk to human life, property, and the economy. Examples of response actions and corresponding examples of mitigation actions are listed in **Table K-1 Associated Drought Response and Mitigation Actions**, below. Effective drought planning and mitigation programs can reduce the need for extensive federal, state, and county emergency response and relief expenditures to rebuild local economies and reduce competition for water during drought.

Table K-1 Associated Drought Response and Mitigation Actions

Drought Response	Drought Mitigation
Alert appropriate agencies of emerging rainfall deficits.	Expand current network of rain gages to improve rainfall monitoring.
Implement agency-coordination actions enumerated in an existing drought plan.	Develop a drought plan to coordinate drought response between agencies.
Alert appropriate agencies of declining ground and surface water storage.	Establish alert procedures for declining water level conditions.
Implement voluntary and/or mandatory water use restrictions.	Establish conservation programs to reduce water consumption.
Mobilize contractors to truck water to ranches without sources.	Establish contingency water-hauling programs for livestock.
Modify and utilize monitor wells to provide emergency sources of water.	Seek authorization and funding for development of additional storage, alternative water sources and new water supply sources.
Utilize models and monitoring data to assess drought recovery or escalation of drought conditions.	Identify areas at risk to drought and plan for regional response actions and strategies.
Release regular and timely media advisories.	Develop and implement drought-related public awareness programs.

K.2.5 Hawai'i's Need for Drought Mitigation

Drought can lead to difficult decisions regarding the allocation of water, as well as stringent water use limitations, water quality problems, and inadequate water supplies for fire suppression. In Hawai'i, droughts and wildland fires threaten all islands in any given year. Also, there are additional issues such as growing conflicts between agricultural uses of surface water and instream uses, "surface and ground water" interrelationships, and the effects of growing water demands on traditional and cultural uses of water.

In the past, drought was addressed as a temporary emergency. Actions were taken in response to impacts, in a reactionary fashion. The most important lesson learned in recent years is that the best time to reduce the impacts of drought is before they occur. Therefore, it is important to develop drought planning programs that advocate a proactive management approach.

Droughts have been prevalent in the past and will continue to adversely affect the environment, economy, and the citizens of the State, due to Hawai'i's strong dependency on rainfall and the lack of adequate water supply and/or infrastructure in certain areas of the State. Historical patterns indicate that Hawai'i will continue to suffer damaging droughts, and the loss potential will only increase as the need for economic growth and revitalization amplify pressures upon the State's limited water supply. Aggressive planning and the utilization of alternative resources are necessary to avoid a situation where future population and economic growth cannot be sustained, due to insufficient quantity and quality of water resources. Since water is limited and precise rainfall predictions are not possible, effective water resource planning and management is critical to the long-term sustainability of our island communities.

K.3 Existing Drought Planning Context

State efforts to establish a drought plan were undertaken in recognition of and in coordination with the various federal agencies that administer drought assistance programs, including FEMA, Reclamation, the USDA Farm Service Agency, the Natural Resources Conservation Service, the U.S. Forest Service, and the Small Business Administration. The following sections provide background information on federal legislation and the resultant State and county actions that have contributed to the development of Hawai'i's drought program.

K.3.1 Federal Disaster Management Act

Hazard mitigation is an action or number of actions taken to reduce or eliminate long-term risk to people and their property from the effects of natural hazards. The purpose of hazard mitigation is two-fold: 1) to protect people and structures from harm and destruction; and 2) to minimize the costs of disaster response and recovery. Hazard-mitigation planning is the process that analyzes a community's risk from natural hazards, coordinates available resources, and implements actions to reduce risks.

In the past, funding for hazard mitigation was typically available only following a disaster declaration, based on a percentage of the estimated damages. Since the early 1990s, FEMA and Congress have witnessed large increases in disaster response and recovery costs and have provided funds to communities, counties, and states to reduce impacts from natural hazards through hazard mitigation. The Federal Disaster Management Act of 2000 requires each state and territory to conduct hazard mitigation planning and to implement projects to reduce hazard impacts prior to a disaster occurrence. This Act marked a fundamental shift in policy. Rather than placing primary emphasis on response and recovery, FEMA's focus broadened to incorporate mitigation as the foundation of emergency management.

K.3.2 State Hazard Mitigation Planning

Changes in federal laws have resulted in pre-disaster mitigation project funding and mitigation planning requirements. However, future funding for public assistance subsequent to disasters will be largely contingent upon mitigation plan completion. Additionally, states are required to have an approved Standard State Mitigation Plan in order to receive additional pre-disaster mitigation funds for state or local mitigation projects after November 1, 2004. Planning efforts are independent of any specific hazard event.

The Standard State Mitigation Plan will also be required for non-emergency assistance provided under the Stafford Act, including Public Assistance restoration of damaged facilities and Hazard Mitigation Grant Program funding. A state with a FEMA-approved Enhanced State Mitigation Plan at the time of a disaster declaration is eligible to receive increased funds under the Hazard Mitigation Grant Program, based on 20 percent of the total estimated eligible Stafford Act assistance. Therefore, the development of State and local hazard mitigation plans is key to maintaining eligibility for future FEMA mitigation and disaster-recovery funding.

K.3.3 Hawai'i State Hazard Mitigation Plan

In order for the State of Hawai'i to be eligible for certain types of FEMA funding (Hazard Mitigation Grant Program and Public Assistance), it must have an approved Multi-Hazard Mitigation Plan.

The Hawai'i State Hazard Mitigation Forum, which is composed of county, State, and federal agency representatives, as well as private individuals with interest in hazard mitigation planning, agreed that the Hawai'i State Hazard Mitigation Plan should be a multi-hazard plan. For the purpose of the plan, the term "multi-hazard" shall not be limited to discrete natural hazards, and will include anthropogenic activities that could exacerbate hazard event impacts and potentially threaten the life and safety of the citizens of Hawai'i. The goal of the plan is to mitigate the impact of such potential disasters.

The Hawai'i State Hazard Mitigation Plan encompassed the broadest possible scope of disaster occurrences, focusing on nine natural hazards: hurricanes, tsunamis, earthquakes, floods, volcanic eruptions and lava flow, coastal erosion, landslides, wildfire, and drought. For each of these specific categories of disasters, additional mitigation plans or strategies targeted at these disasters will be appended to the Hawai'i State Hazard Mitigation Plan. Several of these hazard categories have current advisory boards or task forces that have developed recommendations and strategies.

In September 2003, CWRM completed a statewide Drought Risk and Vulnerability Assessment. This document is referenced in the Hawai'i State Hazard Mitigation Plan. The Drought Risk and Vulnerability Assessment illustrates the extent and severity of drought risk for different impact sectors throughout the islands, and will facilitate the development of drought response and mitigation strategies.

The State Hazard Mitigation Plan must highlight any gaps in data collection and analysis, as well as propose or recommend specific projects to address such gaps as well as short- and long-term drought risk reduction. Therefore, the Drought Risk and Vulnerability Assessment is an important tool for future drought hazard mitigation planning. The Hazard Mitigation Plan incorporates the results of the risk and vulnerability assessment. These results provide input and context for drought response actions and drought mitigation strategies. FEMA requires that State Multi-Hazard Mitigation Plans be updated and reapproved every three years.

Hawai'i Emergency Management Agency (HI-EMA) has taken the lead for the State of Hawai'i Multi-Hazard Mitigation Plan. The Plan covers different hazards including hurricanes and strong winds, flood, drought, wildfire, climate change, earthquakes, tsunamis, volcanoes, coastal erosion, landslides, dam failure, hazardous materials, homeland security and terrorism, and health-related. The Plan assesses risk and vulnerability to each hazard, reviews current mitigation actions and capabilities, and develops a mitigation strategy for each hazard including mitigation projects and actions.

HI-EMA completed its most recent update of the State of Hawai'i Multi-Hazard Mitigation Plan which was submitted to FEMA and approved in October 2013. This update includes additional analysis on Threat Hazard Identification and Risk Assessment (THIRA). The THIRA process is:

1. Identify Threats and Hazards of Concern: Based on a combination of experience, forecasting, subject matter expertise, and other available resources, identify a list of the threats and hazards of primary concern to the community.
2. Give the Threats and Hazards Context: Describe the threats and hazards of concern, showing how they may affect the community.
3. Establish Capability Targets: Assess each threat and hazard in context to develop a specific capability target for each core capability identified in the National Preparedness Goal. The capability target defines success for the capability.
4. Apply the Results: For each core capability, estimate the resources required to achieve the capability targets through the use of community assets and mutual aid, while also considering preparedness activities, including mitigation opportunities.

K.3.4 County Multi-Hazard Mitigation Plans

As noted above, the Disaster Mitigation Act of 2000 requires that each state develop a hazard mitigation plan in order to receive future funding following a disaster. This requirement provides some funding for each state to engage in planning activities and plan preparation. Federal law also requires the development of local or county plans for that particular county to be eligible for post-disaster funding. The purpose of these requirements is to ensure that there are local programs and projects in place that will help minimize the loss of life, property, and total cost of disasters.

As is the case with the State-level plan, the county Multi-Hazard Mitigation Plans are multi-hazard plans. These county plans follow steps similar to the State Multi-Hazard Mitigation Plans during their development and have a five-year update cycle. All four county Plans are current and are required to be updated every five years:

- Kaua'i- August 2015
- Honolulu- September 2017
- Hawai'i- October 2015
- Maui-October 2015

K.3.5 Hawai'i Drought Plan, Phase I

As drought conditions emerged and continued through the late 1990s, CWRM and the USDA, with assistance from Reclamation and cooperation from affected agencies, organizations, and stakeholders, undertook efforts to develop a statewide drought planning document.

One of the major objectives of the HDP, Phase I was to develop a planning framework in which to address a multitude of drought-related issues. The plan, completed in 2000, was structured to be dynamic in nature, utilizing a “living document” approach to address more than just response-oriented actions. Under this approach, provisions were established to accommodate changes in the drought leadership structure established by the plan, as well as to allow for periodic evaluation and revision to the plan itself.

K.3.5.1 Drought Risk and Vulnerability Assessment and GIS Mapping Project

In 2003, CWRM, on behalf of the Hawai'i Drought Council and as part of the priority implementation actions recommended in Phase I of the HDP, completed a geographic and sector-based risk assessment and vulnerability analysis with applications toward statewide drought planning.

The Drought Risk and Vulnerability Assessment and Geographic Information System (GIS) Mapping Project was designed to focus drought mitigation planning by delineating risk areas through the analysis of interrelated parameters. Follow-up mitigation planning would provide for protection of resources, public safety, property, and the economy by allowing for the implementing specific projects in identified risk areas.

The Drought Risk and Vulnerability Assessment and GIS Mapping Project utilizes mapping techniques to incorporate geographic, environmental, and social data to determine areas at risk to meteorological, hydrologic, and agricultural drought, as well as environmental and socioeconomic impacts that may occur due to drought conditions.

The report results include maps of drought frequency, vulnerability, and at-risk areas for each county, as well as recommendations for both mitigation actions and future studies. The maps are intended for public dissemination and use by the counties and local stakeholders in the development of mitigation strategies and projects. Recommendations for future studies and actions include:

- Develop new and improved methods for drought forecasting, tailored to Hawai'i. More accurate forecasts will facilitate early identification of impending drought conditions and reduce the vulnerability of climate-sensitive activities like agriculture, water resource management, public health, and forestry.

- Conduct advanced drought frequency analysis and GIS mapping. Compile data from State and federal rain gage networks to improve accuracy and reliability of drought frequency analyses and to resolve microclimate variations.
- Conduct multi-year drought frequency and recurrence interval analyses. Study the frequency, as well as the spatial and temporal variations associated with longer-duration drought events (on the order of several years).
- Analyze drought patterns and severity during El Niño and La Niña years. Conducting such studies would help in anticipating drought patterns and severity as El Niño and La Niña events are developing. It would also be of interest to investigate the changes in drought frequency and patterns during different phases of the Pacific Decadal Oscillation, as a guide for future long-term, drought risk management.
- Conduct drought impact studies to understand how people are impacted and how best to reduce these impacts. An accurate accounting system of economic data on drought loss, including qualitative information and anecdotal reports, would be useful in quantifying, or even qualifying, the degree of drought severity from event to event.

K.3.6 Hawai'i Drought Plan Update

The *Hawai'i Drought Plan, Phase I* was completed in August 2000 and submitted to the U.S. Bureau of Reclamation for review. Reclamation subsequently provided comments and recommendations for refinements that would facilitate the plan's eventual submission to and acceptance by the United States Congress. CWRM, on behalf of the Hawai'i Drought Council and with additional technical and financial assistance from Reclamation, revised the plan to address Reclamation's comments and well as to include additional information on drought related projects and programs that developed between 2000 and 2005.

The updated document is entitled the *Hawai'i Drought Plan, 2005 Update*. It provides the most up-to-date, statewide drought response and mitigation plan for Hawai'i as of its publication date. This plan strives to retain the dynamic structure and flexibility of the previous drought planning effort, while delineating program-specific actions and recommendations for planning future activities, within a document that is user-friendly and that facilitates action implementation.

Since the development of the *Hawai'i Drought Plan, Phase I* in 2000, the State has completed several actions toward the implementation of the plan and further development of the drought program:

- Requested and received Emergency Drought Assistance from Reclamation under Title I of the Reclamation States Emergency Drought Relief Act of 1991, in addition to technical/planning assistance under Title II of the same Act;

- Participated as a member of the Western Governors Association’s Drought Working Group, to help draft the proposed National Drought Preparedness Act of 2003 for submission to Congress;
- Established in 2002, through successful legislative authorization, a permanent State Drought Coordinator position within the Commission on Water Resource Management;
- Applied for and received a FEMA Pre-Disaster Mitigation grant to develop a Statewide Drought Risk and Vulnerability Assessment and GIS Mapping Analysis in support of the Hawai‘i Drought Plan and the State/County Hazard Mitigation Plans;
- Developed public outreach and education tools, including the completion of the Hawai‘i Drought Monitor Website and the production and distribution of drought awareness public service announcements in both radio and television;
- Established County/Local Drought Committees (CLDCs);
- Developed a DLNR prototype State Agency Water Conservation Plan with assistance from Reclamation for application across State government agencies.
- Developed the Hawai‘i Water Conservation Plan in 2013

CWRM continues to serve as the lead agency for the State’s overall drought program and the update/implementation of the HDP. The drought program has grown since 2000, resulting in the solidification of agency coordination, communication, and involvement at both the State and county levels. The HDP describes: the drought program leadership structure for the State of Hawai‘i; the purpose, responsibilities, and involvement of agency and stakeholder representatives on various drought committees; and the communication protocol for effective drought response, monitoring, recovery, and post-drought evaluations.

K.3.7 Hawai‘i Drought Plan, 2017 Update

The HDP has been updated for use by the Hawai‘i Drought Council to improve coordination and implementation of drought management strategies for the State of Hawai‘i. The revised plan is intended to serve as a “framework” through which State and local entities can work together to proactively implement mitigation measures and appropriate response actions during periods of drought. Effective coordination of these activities can help reduce and minimize the effects upon the people and natural resources of Hawai‘i.

The HDP was designed as an informative guide to help reduce the negative impacts that drought conditions cause for the State of Hawai‘i. It addresses an overview of drought in Hawai‘i along with the threat of future droughts, the coordination of Hawai‘i’s Drought Program, methods for drought monitoring, forecasting, and impact assessment, and strategies for drought planning

and mitigation. Drought mitigation has been emphasized in this plan as a proactive approach to lessen the intensity of dry periods.

Since the initial HDP in 2000 and its 2005 Update, much progress has been made with drought planning, particularly with regard to implementation of specific recommended actions. In the future, continued implementation of recommended plan provisions will remain a key challenge to the Hawai'i Drought Council and its member agencies and stakeholder representatives. Appropriate government and private sector resources will need to be identified to address the recommended priority mitigation actions identified in the plan. The success of the plan will ultimately be measured by the ability of government agencies, stakeholders, and the general public to function as a team in achieving the necessary goals and objectives for successful mitigation of drought impacts for the state.

CWRM sought out and received valuable input from members of the respective County Drought Committees and members of the Hawai'i Drought Council during this revision of the Plan. Some key changes in the 2017 update include:

- Revised and simplified provisional impact sector drought risk maps
- Revised recommended drought response actions from Governmental agencies
- Revised drought communication structure, abdicating the Water Resources Committee
- Summary of drought mitigation projects completed
- Inclusion of climate change as a factor in drought mitigation planning
- Revised recommendations

This plan has been designed as a dynamic “living” document, which should be utilized and updated to reflect changing conditions, new information, and an evolving leadership structure encompassing the Hawai'i Drought Council, U.S. Drought Monitor, Hawai'i Author, and the County/Local Drought Committees. The plan is available on the Hawai'i Drought Website⁴ to facilitate public access and the review of future plan updates.

K.3.8 County Drought Mitigation Strategies

In 2004 and 2005, a series of county meetings were held involving agencies and stakeholders who agreed to participate in the CLDCs. Through these meetings, county drought mitigation strategies were developed to coordinate government agency and stakeholder actions, and projects were identified for integration within the *County Hazard Mitigation Plans*. Implementation of these projects would be championed by the CLDCs. The HDP emphasizes

⁴ <http://dlnr.hawaii.gov/drought/>

local drought response, mitigation, and organizational efforts at the county level. While the Hawai'i Drought Council and the State Drought Coordinator seek to assist local government agencies and stakeholders in coordinating drought response and mitigation, project implementation is dependent upon input and action by the CLDCs, who provide local and regional knowledge, information, and resources. In 2011, CWRM completed an update of the drought mitigation project listings for each of the County Drought Mitigation Strategies.

K.4 Other Drought Resources

K.4.1 U.S. Drought Monitor and Designation of Drought

The U.S. Drought Monitor (USDM) is a map-based drought assessment displaying levels of drought intensity across the contiguous United States, Alaska, Hawai'i and Puerto Rico. Updated weekly, the USDM is a collaborative effort between the National Oceanic and Atmospheric Association, USDA, and the National Drought Mitigation Center. Each state has an expert author(s) who is responsible for weekly updates of the USDM using a combination of hydrologic and on-the-ground drought impact data in various sectors to formulate the weekly assessment of drought. The USDM is used as an index to make policy decisions related to drought. The USDA uses the USDM to make secretarial drought disaster designations and to distribute disaster program assistance.

In Hawai'i, the USDM is used to monitor the intensity and duration of drought events and cycles and has become the de facto drought indicator for the State of Hawai'i.

K.4.2 Drought Impact Reporter, Hawai'i

The [Drought Impact Reporter](#) (DIR) is an online geospatial drought database where the public can report drought impacts in their location and impact sector. The DIR, developed by the National Drought Mitigation Center, compiles drought impact data from news outlets, government reports, and individual observers into a comprehensive database of drought impacts across the United States. Users can search the DIR database by location, time period, categories and report types.

A DIR, Hawai'i version was later developed by the NDMC to facilitate the reporting of drought impacts from Hawai'i.

K.4.3 National Integrated Drought Information System

The National Integrated Drought Information System (NIDIS) was established by Congress in 2006 to provide an effective drought early-warning system, coordinate and integrate federal drought research, and to build upon existing drought forecasting and assessment programs and partnerships. According to the NIDIS website⁵:

⁵ National Integrated Drought Information System, U.S. Drought Portal Overview, accessed March 3, 2014, <http://www.drought.gov/drought/content/what-nidis>

The [NIDIS Implementation Plan](#) outlines how to:

- Develop the leadership and networks to implement an integrated drought monitoring and forecasting system at federal, state, and local levels
- Foster and support a research environment focusing on risk assessment, forecasting, and management
- Create an "early warning system" for drought to provide accurate, timely, and integrated information
- Develop interactive systems, such as the Web Portal, as part of the early warning system
- Provide a framework for public awareness and education about droughts

The Road Ahead

As we embark on implementing NIDIS, the initial focus will be on:

- Developing the U.S. Drought Portal
- Integrating and fostering coping strategies through research, preparedness, education and public awareness
- Integrating data and predictions
- Developing pilot programs for design and implementation of early warning systems in selected locations

The U.S. Drought Portal

The U.S. Drought Portal is part of the interactive system to:

- Provide early warning about emerging and anticipated droughts
- Assimilate and quality control data about droughts and models
- Provide information about risk and impact of droughts to different agencies and stakeholders
- Provide information about past droughts for comparison and to understand current conditions
- Explain how to plan for and manage the impacts of droughts
- Provide a forum for different stakeholders to discuss drought-related issues

K.4.4 Hawai'i Rainfall Atlas

The Rainfall Atlas of Hawai'i⁶ website was developed by the University of Hawai'i Geography Department in 2013 to provide a comprehensive estimate of monthly and annual mean (average) rainfall in the State of Hawaii. The Rainfall Atlas of Hawai'i is an online tool with an interactive rainfall map and links to downloadable rainfall data and maps from across the State of Hawai'i. Data from over 1,000 rainfall stations for the base period 1978-2007 were used along with advanced analytical methods to estimate rainfall at discrete grid units measuring 234 meters x 250 meters. Other features of this website include the history of rainfall collection in Hawai'i as well as the project methodology and final report. The Rainfall Atlas of Hawai'i project has initiated other important rainfall research including month-year rainfall maps, which are available on the Rainfall Atlas of Hawai'i website.

K.5 Recommendations for Drought Planning

The drought program in Hawai'i has been successful in raising public awareness of drought hazard and in creating an effective planning framework. The HDP establishes a leadership structure to coordinate drought monitoring, mitigation, and response activities, and formalizes a protocol for communication among agencies and stakeholders. The HDP also serves as a guide for government agencies to develop mitigation and response strategies within their areas of jurisdiction and serves as a resource document for private stakeholders to develop appropriate strategies to prepare for and respond to drought.

The HDP delineates several State- and county-level priority implementation actions, which are included below with general drought program recommendations and are incorporated herein as recommendations for statewide drought planning:

- The Hawai'i Drought Council should continue to refine drought indices for each impact sector by correlating historical drought impact data with past drought events and developing a drought climatology for Hawai'i.
- Additional monitoring of surface water sources, including stream diversions, ditch systems, and reservoirs should be undertaken. The drought leadership structure should discuss ways in which agencies can achieve better coordination of program activities to facilitate monitoring of these surface water resources.
- The State Drought Coordinator should work with the National Weather Service Climate Prediction Center to determine if additional drought-forecasting products can be developed for Hawai'i. Similarly, the State Drought Coordinator should continue to correspond and work together with other drought-related agencies such as the National Drought Mitigation Center, National Integrated Drought Information System, Western Regional Climate Center, Western Governors' Association, University of Hawai'i,

⁶ <http://rainfall.geography.hawaii.edu/>

National Weather Service–Honolulu Office, State and County Emergency Management Agencies, etc. to coordinate data collection and access to such data in a reasonable time frame and to provide real-time data where possible through the sharing of electronic databases.

- A methodology to conduct statewide drought impact assessments should be developed. The HDC, through its Water Resources Committee, the State Drought Coordinator and CLDCs should work together to develop a uniform system for the assessment of drought impacts. CLDCs should establish and implement a mechanism for conducting impact assessments on a regular basis after each drought event and report such information to the HDC.
- CLDCs should continue their work towards developing county-level drought mitigation and response strategies. CLDCs should also continue to work with State and county emergency management agencies to incorporate additional drought mitigation projects into the County Hazard Mitigation Plans.
- CWRM should continue to implement its Hawai'i Water Conservation Plan and to develop partnerships with government and private organizations to further water conservation and efficiency throughout the State.
- Further refinement of the Drought Risk and Vulnerability Assessment and GIS Mapping Project (2003), should be conducted. The assessment should be updated to include data from State rain gages and analyses of multi-year drought events, recurrence intervals, drought patterns, and drought severity during El Niño and La Niña years.
- The University of Hawai'i, Pacific Regional Integrated Sciences and Applications, and Pacific Islands Climate Change Cooperative should continue research on climate change impacts to drought in Hawai'i and to develop climate change adaptation policies for drought.
- The Hawai'i Drought Monitor website should be maintained and utilized to promote public education and awareness of drought-related program activities and initiatives.
- The County Drought Committees should maintain and update their respective list of drought mitigation projects and initiatives and continually seek out funding for implementation.
- The State Drought Coordinator with the County Drought Committees should promote individual drought and water conservation plans for agricultural operations, water utilities, and other businesses or organizations impacted by drought.

K.5.1 Recommendations for Future HDP Updates and Revisions

The HDP should undergo timely updates and revisions at least every five years. Plan recommendations and the drought communication protocol should likewise be reevaluated and revised as appropriate.

The plan has been designed as a dynamic “living” document, which should be utilized and updated to reflect changing conditions, new information, and an evolving leadership structure. Additional public and private sector resources should be continually sought, and the participation of all appropriate agencies and stakeholder representatives should be expanded and fortified. The net effect of the HDP implementation will be the effective coordination of people and resources to reduce and minimize drought impacts to the State of Hawai‘i.