DROUGHT CHAPTER

The State of Oregon is confronted with continuing challenges associated with drought and water scarcity. The challenges are "exacerbated" because of a rapidly growing population and the demands placed on a renewable, yet finite resource - water. The two terms, drought and water scarcity, are not necessarily synonymous; distinctly water scarcity implies that demand is exceeding the supply. The combined effects of drought and water scarcity are far-reaching and merit special consideration. A full list of acronyms used in this chapter is provided in Appendix 8-B.

Hazard Analysis/Characterization

TYPES OF DROUGHTS

Drought can be defined in several ways, depending on who is doing the defining and for what reason. The American Heritage Dictionary defines drought as "a long period with no rain, especially during a planting season." While straight forward, this definition falls far short of the benchmark needed to assess the extent or severity of the hazard and how it might be mitigated.

In the early 1980's, researchers with the National Drought Mitigation Center and the National Center for Atmospheric Research located more than 150 published definitions of drought. There clearly was a need to categorize the hazard as to "type of drought." The following definitions are a response to that need:

Meteorological or climatological droughts usually are defined in terms of the departure from a normal precipitation pattern (Figure D-1) and the duration of the event. Drought is a slow-

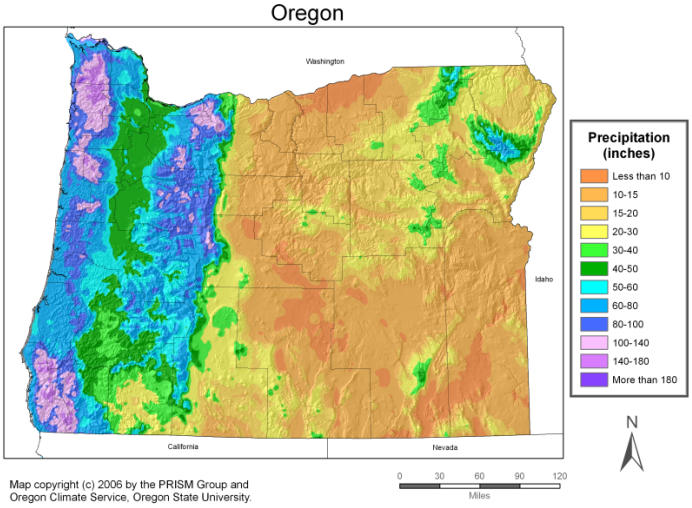

Figure D-1: The map above was provided courtesy of the PRISM Group, Oregon State University, copyright © 2006;

see http://www.prismoregonstate.edu and http://prism.oregonstate.edu/state_products/index.phtml

Drought is typically measured in terms of water availability in a defined geographical area. It is common to express drought with a numerical index that ranks severity. Most federal agencies use the Palmer Method which incorporates precipitation, runoff, evaporation and soil moisture. However, the Palmer Method does not incorporate snowpack as a variable. Therefore it is not believed to provide a very accurate indication of drought conditions in Oregon and the Pacific Northwest.

The Oregon Drought Severity Index is the most commonly used drought measurement in the state. It is considered to be a better indicator of drought severity because it incorporates both local conditions and mountain snowpack. The Oregon Drought Severity Index categorizes droughts as mild, moderate, severe, and extreme. The index is available from the Oregon Drought Council.

Figure D-2: Methods of Measuring Droughts

onset phenomenon that usually takes at least three months to develop and may last for several seasons or years.

Agricultural droughts link the various characteristics of meteorological drought to agricultural impacts. The focus is on precipitation shortages and soil-water deficits. Agricultural drought is largely the result of a deficit of soil moisture. A plant's demand for water is dependent on prevailing weather conditions, biological characteristics of the specific plant, its stage of growth, and the physical and biological properties of the soil.

Hydrological droughts refer to deficiencies in surface water and sub-surface water supplies. It is measured as stream flow, and as lake, reservoir, and ground water levels. Hydrological measurements are not the earliest indicators of drought. When precipitation is reduced or deficient over an extended period of time, the shortage will be reflected in declining surface and sub-surface water levels.

Socioeconomic droughts occur when physical water shortage begins to affect people, individually and collectively. Most socioeconomic definitions of drought associate it with supply, demand, and economic good. One could argue that a physical water shortage with no socio-economic impacts is a policy success.

Once drought conditions have been established, requests for assistance may follow. The mechanism to trigger federal or state assistance is contained in the following definition as presented in the state *Drought Annex*:

"The Legislative Assembly finds that an emergency may exist when a severe, continuing drought results in a lack of water resources, thereby threatening the availability of essential services and jeopardizing the peace, health, safety, and welfare of the people of Oregon." [ORS 536.710]

Figure D-3: Utilizing Regulatory Definitions

History of Droughts in Oregon

Oregon records, dating back to the late 1800s, clearly associate drought with a departure from expected rainfall. Concern for mountain snowpack, which feeds the streams and rivers, came later. Droughts were particularly noteworthy during the following years:[1]

1904-05: drought period of about 18 months

1917-31: very dry period punctuated by brief wet spells (1920, 1927)

1939-41: three-year intense drought

1965-68: three-year drought following the big regional floods of 1964-65

1976-77: brief, but very intense statewide drought

1985-94: generally dry period, capped by statewide droughts in 1992 and 1994

[1] Excepting 2001-02, this is excerpted from *The Oregon Weather Book, a State of Extremes* (Corvallis, Oregon: Taylor, George H., and Hatton, Raymond R., 1999), p. 201.

2001-02: the second most intense drought in Oregon's history

2005: this drought affected at least eleven of Oregon's thirty-six counties

Some Oregon droughts were especially significant during the period of 1928-1994.[2] The period from1928 to 1941 was a prolonged drought that caused major problems for agriculture. The only area spared was the northern coast, which received abundant rains in 1930-33. The three Tillamook burns (1933, 1939, and 1945) were the most significant results of this very dry period.

During 1959-1962 stream flows were low throughout Eastern Oregon, but areas west of the Cascades had few problems. Ironically, the driest period in Western Oregon was the summer following the benchmark 1964 flood.

Low stream flows prevailed in Western Oregon during the period from 1976-81, but the worst year, by far, was 1976-77, the single driest year of the century. The Portland airport received only 7.19 inches of precipitation between Oct. 1976 and Feb. 1977, only 31% of the average 23.16 inches for that period.

The 1985-94 drought was not as severe as the 1976-77 drought in any single year, but the cumulative effect of ten consecutive years with mostly dry conditions caused statewide problems. The peak year of the drought was 1992, when a drought emergency was declared for all of Oregon. Forests throughout the state suffered from a lack of moisture. Fires were common and insect pests, which attacked the trees, flourished.

In 2001 and 2002 Oregon experienced drought conditions. These conditions were compounded by actions taken by the federal government in the Klamath Basin. State declaration of drought conditions were made in various counties throughout Oregon during 2001, 2002, 2003, 2004 and 2005. During the 2005 drought the Governor issued declarations for eight counties, all east of the Cascades, and the USDA issued three drought declarations, overlapping two of the Governor's. State declarations were made for Baker, Crook, Gilliam, Hood River, Klamath, Morrow, Sherman, and Umatilla counties. Federal declarations were made in Coos, Klamath, and Umatilla counties. Wheeler County made a county declaration. The USDA declarations provided accessibility to emergency loans for crop losses.

Frequency and Probability

Drought is a normal, recurrent feature of climate, although many erroneously consider it a rare and random event. It is a temporary condition and differs from aridity because the latter is restricted to low rainfall regions and is a permanent feature of climate. It is rare for drought not to occur somewhere in North America each year. Despite impressive achievements in the science of climatology, estimating drought probability and frequency continues to be difficult. This is

[2] The source for the information on this page is also *The Oregon Weather Book, a State of Extremes* (Corvallis, Oregon: Taylor, George H., and Hatton, Raymond R., 1999), p. 204.

because of the many variables that contribute to weather behavior, climate change and the absence of long historic databases. Nevertheless, progress is being made, particularly in the area of cyclic climatic variations.

Cyclical Climatic Variations

There is a great deal of debate about cyclic climatic changes in Oregon and the Pacific Northwest. The dialogue seems to center on two Pacific weather systems, El Niño and La Niña, but there also is considerable interest in two much larger systems: the El Niño Southern Oscillation (ENSO) and its counterpart, the Pacific Decadal Oscillation (PDO). Simply stated, all of these systems involve the movement of abnormally warm or cool water into the eastern Pacific, dramatically affecting the weather in the Pacific Northwest.

An El Niño system moves heat, both in terms of water temperature and in atmospheric convection. The heat is transported toward North America, producing mild temperatures and dry conditions in Oregon. Its effects are most pronounced from December through March. It appears to occur in cycles of two to seven years and its effects have become fairly predictable.

- Drought is often associated with water scarcity, which usually is perceived as a "human-caused" hazard, rather than a "natural" hazard.
- Drought is frequently an "incremental" hazard, the onset and end are often difficult to determine. Also, its effects may accumulate slowly over a considerable period of time and may linger for years after the termination of the event.
- Quantifying impacts and provisions for disaster relief is a less clear task than it is for other natural hazards.
- The lack of a precise and universally accepted definition adds to the confusion about whether or not a drought actually exists.
- Droughts are often defined by growing seasons, the water year, and livestock impacts.

Figure D-4: drought – the nebulous natural hazard

La Niña conditions are more or less opposite those created by El Niño. It involves the movement of abnormally cool water into the eastern Pacific. This event produces cooler than normal temperatures in Oregon and increased precipitation. It also is most pronounced from December to March. Typically, El Niño events occur more frequently than La Niña events.

Predicting Droughts in Oregon

Predicting weather patterns is difficult at best, however the 1997-98 El Niño event marked the first time in history that climate scientists were able to predict abnormal flooding and droughts months in advance for various locations around the United States.[3] The methodology consists of monitoring water temperatures, air temperatures, and relative humidity plus measuring sea-surface elevations. Once an El Niño or La Niña pattern is established, climatologists can project regional climatic behavior. Although the scientific community is enthusiastic about its recent successes, all droughts are not associated with El Niño / La Niña events. Weather prediction is, in a word, promising.

[3] nationalgeographic.com, 1999

TERRITORY AT RISK

Hazard analyses, prepared by local emergency program managers, provide an indication of how drought is perceived in their communities. Six counties, Harney, Jefferson, Klamath, Sherman, Wallowa, and Wheeler ranked drought as their "number one" natural hazard concern. Gilliam County also ranked it highly. [4] All of these counties are located on the arid east side of the Cascade Mountains.

Hence, there is a tendency to associate drought conditions with the arid sections of the state, principally east of the Cascade Mountains. However, this perception is not totally accurate. Every county in Oregon is subject to drought, even the notoriously wet coastal counties. For example, during the winter of 2002-03, Coos and Curry counties on the South Coast experienced drought conditions for a time.

IMPACTS

Droughts are not just a summer-time phenomenon; winter droughts can have a profound impact on the state's agricultural sector, particularly east of the Cascade Mountains. Also, below average snowfall in Oregon's higher elevations has a far-reaching effect on the entire state, especially in terms of hydroelectric power, irrigation, recreational opportunities and a variety of industrial uses.

There also are environmental consequences. A prolonged drought in Oregon's forests promotes an increase of insect pests, which in turn, damage trees already weakened by a lack of water. A moisture-deficient forest constitutes a significant fire hazard (see the Wildland-Urban Interface Fire Chapter of this plan). In addition, drought and water scarcity add another dimension of stress to species listed pursuant to the Endangered Species Act (ESA) of 1973.

The following information addresses the impact of a severe or prolonged drought on the population, infrastructure, facilities, economy, and environment of Oregon:

Population: Drought can affect all segments of Oregon's population, particularly those employed in water-dependent activities (e.g., agriculture, hydroelectric generation, recreation, etc.). Also, domestic water-users may be subject to stringent conservation measures (e.g., rationing) and could be faced with significant increases in electricity rates.

Infrastructure: In general, infrastructure such as highways, bridges, energy conveyance systems, etc., are unaffected by drought, which can, but seldom does, produce structural damage. [5] An exception would include areas of severe

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[4] Statewide Hazard Analysis, 2002

[5] Some clay soils (e.g., containing bentonite) have significant shrink-swell properties. Prolonged drought can shrink these soils resulting in structural damage. Although these soils occur in Oregon, their geographical extent is

soil shrinkage. In these uncommon situations, soil shrinkage would affect the foundation upon which the infrastructure was built. In addition, water-borne transportation systems (e.g., ferries, barges, etc.) could be impacted by periods of low water.

Critical/Essential Facilities: Facilities affected by drought conditions include communications facilities, hospitals, and correctional facilities that are subject to power failures. Storage systems for potable water, sewage treatment facilities, water storage for firefighting, and hydroelectric generating plants also are vulnerable. Low water also means reduced hydroelectric production especially as the habitat benefits of water compete with other beneficial uses.

State Owned or Operated Facilities: There are a variety of state owned or operated facilities that could be affected by a prolonged drought. The most obvious include schools, universities, office buildings, health-care facilities, etc. Power outages always are a concern. Maintenance activities (e.g., grounds, parks, etc.) may be curtailed during periods of drought.

Economy: Drought has an impact on a variety of economic sectors. These include water-dependent activities and economic activities requiring significant amounts of hydroelectric power. The agricultural sector is especially vulnerable as are some recreation-based economies (e.g., boating, fishing, water or snow skiing). Whole communities can be affected. This was particularly evident during 2000-2001 when one-half (18) of Oregon's counties sought relief through state and federal drought assistance programs.

The years 2000 and 2001 were the second driest years in Oregon's climate history. Marion County's recreation community of Detroit suffered economic hardships when adjacent reservoir levels became too low to support normal summer activities. In addition, the drought directly affected over 200,000 irrigated acres in the Klamath River Basin. Farmers were among the first to be affected, followed by local agricultural support industries (e.g., pesticides, fertilizer, farm equipment, etc.), as well as Native American Tribes which partly depend on local fish resources. There were also endangered species considerations. In short, there was an over-commitment of water resources, something that will recur.

Environment: Oregon has several fish species listed as threatened or endangered pursuant to the Endangered Species Act (ESA) of 1973. Some of these species have habitat requirements that often conflict with the needs or desires of the human environment. For example, in times of scarcity, the amount of water necessary to maintain certain fish species may conflict with the needs of the local agricultural community. The State of Oregon is committed to the implementation of the ESA and the viability of its agricultural economic base. There are no easy solutions, only continuous work to resolve difficult drought situations.

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limited.

Existing Strategies and Programs

Oregon has established a hierarchy of committees consisting of representatives from various state and federal agencies to evaluate drought conditions, formulate action plans and policy, and advise the Governor. The Drought Council and the Water Availability Committee perform these duties.

DROUGHT COUNCIL

Drought Council is responsible for assessing the impact of drought conditions and making recommendations to the Governor's senior advisors. The Drought Council is, in turn, advised by a subcommittee of technical people who monitor conditions throughout the state and report these conditions monthly. It is known as the Water Availability Committee. In this manner the Drought Council keeps up-to-date on water conditions. Members combine this knowledge with information they bring from their organizations and differing geographic areas of the state in order to make recommendations for policy, response, and mitigation.

Drought Council is chaired and facilitated by Oregon Emergency Management. Members of the Council include state and federal agencies, and private organizations involved in drought forecasting, assessment, response, or recovery. The goal of the Drought Council is to "strive to reduce the effects of an impending drought through a coordinated federal, state, local, and voluntary effort, consisting of the development of drought plans, policies, and procedures, and through coordinated state response." [6]

"The heart of the matter is the process of determining a menu of mitigation options that is fair, equitable, economically realistic, and environmentally responsible. As an example, when surface water is in short supply, irrigators turn to groundwater. The added stress to groundwater aquifers may be environmentally feasible in some instances, and not in others. The argument can be made that even in groundwater aquifers that are already stressed, short-term use is feasible. However, groundwater pumping installations are expensive to develop and, once installed, they are not easily abandoned. Short-term use easily becomes long-term use, considering it is more reliable, and environmental problems grow.

Recommendations by the Drought Council include public information and proposals for reallocation of existing resources to be considered by the Governor. When a statewide emergency is declared by the Governor, existing resources are not normally reallocated for mitigation purposes. The Governor simply stresses the need for state agencies to perform as best they can in mitigation activities already included in existing programs." [7]

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[6] Drought Annex to the State Emergency Operations Plan, September 2002

[7] Barry Norris, Administrator, Technical Services Division, Water Resources Department, *Planning for Drought*, 2001

Specific tasks of the Drought Council include:

- Monitoring meteorologic and hydrologic conditions to determine the current and future severity of a drought;
- Estimating the severity of a drought and its impact on electric power consumption and generation, agricultural production, essential human needs, industrial output, fish and wildlife, state forests, and other areas as appropriate;
- Developing an inventory of physical, economic, or other resources available for responding to anticipated drought impacts;
- Determining potential conflicts between water users and electric power users, and initiating actions to minimize these conflicts;
- Coordinating drought response and recovery efforts;
- Acting as a clearinghouse for questions and requests for state and federal drought declarations;
- Assisting the Governor and Oregon Emergency Management in determining the need for various federal disaster declarations and other federal assistance; and
- Reporting to the Governor's Natural Resource Advisor.

Facilitating and coordinating development of water and power conservation plans.

Facilitating and coordinating public information processes that encourage voluntary conservation measures.

"Experience in Oregon tells us that the most effective measures for mitigation and response include a good program for monitoring statewide conditions, close coordination among state 'experts' who are involved in reporting statewide conditions, and a good public information program. While these activities do not actually provide direct mitigation, they promote public awareness and allow individuals and organizations to make preparations.

A second important factor in drought response and mitigation is to approach special water management practices with caution. It is easy for regulation activities to fall into a trap of invoking special use permits in a manner that will actually encourage more than normal use in some areas.

From the beginning of our effort in developing a state drought plan it was evident that we needed to concentrate on three things:

Close coordination among state and federal agencies

Procedures for obtaining the best data available on statewide conditions

Establish a strong network and public information program to make data on existing conditions available"

Source: Barry Norris, Administrator, Technical Services Division, Oregon Water Resources

Figure D-5: Planning for Drought

Water Availability Committee

The Water Availability Committee is a subcommittee of the Drought Council. The committee is chaired by the Oregon Water Resources Department. Committee members include representatives from the National Weather Service, NW River Forecast Center, Natural Resources Conservation Service, U.S. Geological Survey, Oregon Climate Service,[1] and Oregon Department of Forestry. The primary responsibility of the Water Availability Committee is to determine the appropriate

[1] The Oregon Climate Service and Oregon Climate Change Research Institute are based at Oregon State University.

Oregon Drought Severity Index for locations throughout the state.

Drought Annex to the State Emergency Operations Plan

Droughts occur within drainage basins (watersheds) that usually involve more than one city or county. Some cities and counties benefit by planning on a regional level. The state *Drought Annex* provides information to facilitate regional planning efforts, model water curtailment measures for water utilities, and other strategies. It describes the state system for addressing drought emergencies, but it does not carry the force of law. Its purpose is to coordinate local, state, and federal agency response to drought emergencies and to provide water supplies for human consumption and use under conditions of inadequate supply.

"A major component in the success of a state drought program is an emphasis on coordination, communication, and accuracy. The Drought Council subcommittee responsible for water condition assessments includes people in the state that the media look to for water condition assessments. Through monthly meetings and other frequent contacts these individuals are able to tell the same story. In response to the need for an objective index for measuring drought severity, the subcommittee developed an objective index called the Surface Water Supply Index (SWSI). This index is very helpful in describing conditions to the media, and relating them to past drought events.

The SWSI is an index of current water conditions throughout the state. This index utilizes parameters derived from snow, precipitation, reservoir, and streamflow data. The data is gathered each month from key stations in each basin. The lowest SWSI value, -4.1, indicates extreme drought conditions. The highest SWSI value,+4.1, indicates extreme wet conditions. The mid-point is 0.0. This indicates a normal water supply."

Source: Also, *Planning for Drought*, 2001

Figure D-6: Surface Water Supply Index

Emergency Water Shortage Powers

Although there are no easy solutions to Oregon's drought challenges, there are opportunities to lessen the impacts.

STATEWIDE

Towards State NHMP Goals: #2, #3, and #4

Pre-2012 State NHMP Action Met: D-ST-1

Lead Agency: WRD

Support Agencies: ODFW, ODA

Project Type: land use

Project Start Date: These powers were authorized by the 1989 Oregon Legislature, and amended by the 1993 Oregon Legislature

Project End Date: ongoing

Years Project Tested: 1992, 2001

Funding Source: n/a

Project Cost: unknown

Project Benefits: These rules provide for action available to the Governor and the Water Resources Commission during extraordinary drought situations. Action within these rules is intended to mitigate problems which may develop during years when water supplies are inadequate.

ORS 536.700 to .780 provide extraordinary measures that can only be enacted in an area where the Governor has declared a drought emergency. Residents of these areas are then eligible for emergency water use permits to supplement existing uses. However, the emergency permits are subjected to a limited public interest review, and they can only be used on areas that have an existing water right that cannot be used because of drought conditions. Use from the new source cannot harm an existing use, and it must be determined that no harm to the public interest will occur. Additionally provisions allow jurisdictions to enter into options/agreements for moving water from one location to another, and placing numerous individual water rights under one jurisdiction for control and allocation. Use can be intended for various things including irrigation and instream water. These provisions were used extensively during the summers of 1992 and 2001 with considerable success.