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Management of Drought

N. O. Baykan[1], C. Özçelik[2]
[1] *Department of Civil Engineering, Pamukkale University, Kınıklı Campus, Denizli/Turkey, 20017, obaykan@pamukkale.edu.tr*
[2] *Department of Civil Engineering, Dokuz Eylül University, Tınaztepe Campus, İzmir/Turkey, 35160, ceyhun.ozcelik@deu.edu.tr*

Abstract: The studies within the last ten years showed that the doubling of CO_2 in the atmosphere caused by extreme usage of hydro-chlorofluorocarbons shall arise the earth temperature between 1.5 and 4°C in the coming 40-60 years. As a result of this event, certain territories of the earth shall suffer under flood while some others from drought. Management of drought may mitigate the effects of drought. By viewing through this angle, the idea of an integrated sustainable management by taking into consideration of some measures may guarantee service of water resources systems for a long period of time. So, providing of the following activities shall be very useful in advance: 1. Establishment of an Integrated Climate Monitoring System; 2. Establishment of a Regional/National Drought Mitigation Center; 3. Rediscovery of resources; 4. Forecasting of drought: status and future prospects; 5. State efforts to monitor and coordinate responses to drought; 6. Training of the target audiences; 7. Exchanges of experiences. In this study, after giving brief information about drought, some management strategies are given to mitigate its effects. Additionally, the situation in Turkey has been discussed shortly and, necessary precautions in general for the drought management have been summarized.

Key words: drought, management, global warming, forecasting

1. INTRODUCTION

Drought is a complex hydrologic phenomenon related to climate, water and land use (Grigg, 1996). So, management of it necessitates a collaboration to provide, to share and to conserve secure water, food and medicine. Drought can cause disasters unpreventable and generally, it is not easy to predict until it reaches in its middle. Effects of this phenomenon can be on some agricultural or industrial districts, cities, villages or on the entire country based on water usage such as for irrigation, drinking water, hydropower, industrial usage, recreation, wildlife etc.

Drought, a serious and continuing problem all round the word, is ordinary hydrologic phenomenon and generally caused by the lack of planning and management. There is no region immunized to drought, as well as to flooding. Dealing with drought must be a process not a project that starts and finishes with drought (Grigg, 1996).

Each drought produces a certain set of impacts, depending not only on its severity, duration, and spatial extent but also on changing of social conditions. Drought is determined by a wide range of physical and social factors such as demographic trends and geographic characteristics. One of the challenges of drought-planning is to understand its direct and indirect impacts.

Predictions of global climate change induced by increasing concentration of greenhouse gases are based on general circulation models (GCM). These models can reproduce the large scale patterns of the atmospheric circulation, and need to downscaling (Matyasovszky, 1993).

2. REASONS AND DEFINITIONS OF DROUGHT

2.1. Reasons of Drought

The continents come together and separate themselves in every 500 million years (Panagulia, 1993). When they transform to a single mass, the temperature arises around 8°C compared to values of our time. When they move far from themselves, this temperature decreases. We are now in the beginning of this closing period (Yaşar, 2002).

The basic factors that affect the climates can be summarized as follows:

1. movements of plates (they are effective for long-run);
2. parameters of rotation of the earth around itself and around the sun;
3. sunspots (Fig. 1);
4. volcanoes;
5. stream systems, such as el nino, la nina;
6. meteoroids.

The rotation parameters of the world either around itself or around the sun are changing regularly within the period of 100 000, 40 000, 20 000 years or shorter periods. Changing of these parameters causes to increase or decrease on solar energy absorbed by the globe, therefore, the world lives the periods of glaciers and inter-glaciers alternatively (Fig. 2).

Recently, although some scientists argue that increment in the temperatures is in its normal cycle, great amount of them claim that this increment is one of the results of global warming

The studies within the last ten years showed that the doubling of CO_2 in the atmosphere caused by extreme usage of hydro-chlorofluorocarbons shall arise the earth temperature between 1,5°C and 4°C in the coming 40-60 years (Plate, 1993). As a result of this event, certain territorial of the earth shall suffer under flood while some others under drought (Panagulia, 1993). To study the impact of an augmentation of CO_2 in the atmosphere, hydrologists and meteorologists use "general circulation models (GCM)". These mesoscale models have coarse resolutions that are sometimes not compatible with regional hydrologic models, used in general smaller scales (Rasmussen & Bobeé, 1993).

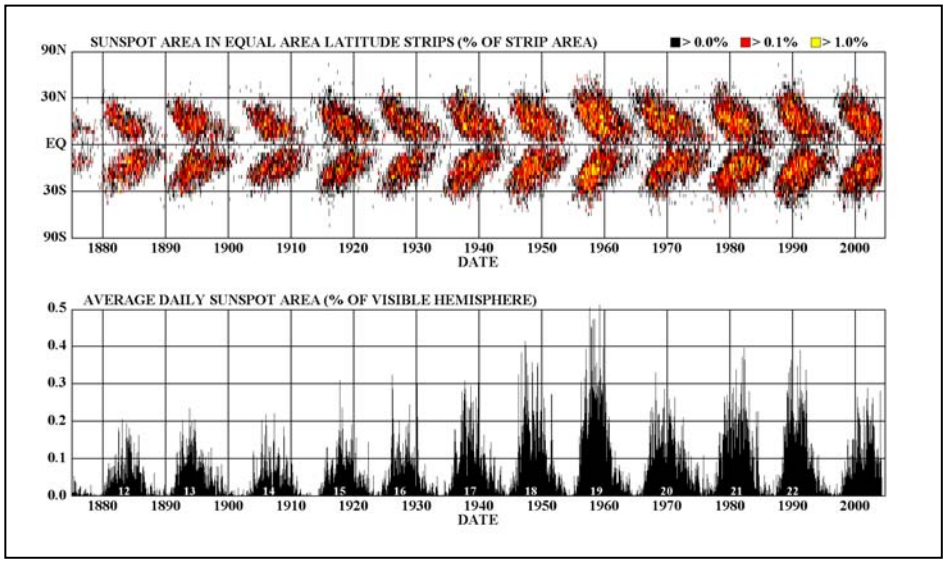

Figure 1. Daily sunspot area averaged over individual solar rotation (Yaşar, 2002).

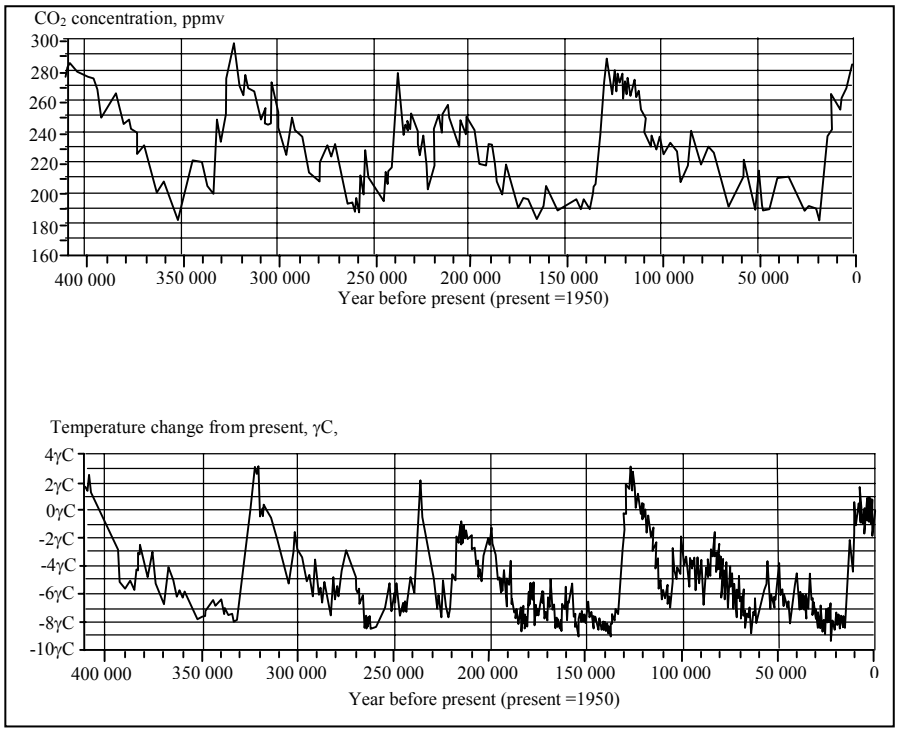

Figure 2. Temperature and CO2 concentration in the atmosphere over the past 400000 years from the Vostok ice core (Yaşar, 2002).

2.2. Definitions of Drought

Drought can be defined as a natural hydrologic phenomenon caused by serious hydrologic defects effecting natural sources negatively, when precipitation goes down under normal limits. It can be said that there is Meteorological Drought when there is a rainfall under a certain limit in particular period in an area; there is a Climatologic Drought when a rainfall falls in particular period, in an area, is under some amount of the mean rainfall in same period; there is a Atmospheric Drought when water amount in atmosphere is under some amount of the mean, and there is a Agricultural Drought when yield of product is under a certain limit by the effect of lack of the rainfall, soil structure, plant pattern etc. (Su Vakfı, 2001).

However, drought may be defined practically as a period rainless or without sufficient rain (meteorological drought) or as a period of shortage for water (the agricultural, hydrological or economical drought).

Drought can be determined based on the elements in hydrologic cycle, namely precipitation, runoff, soil moisture, stream flow, groundwater etc. Definition of drought may be also based on the agricultural, meteorological, hydrological, economical, and social phenomena.

These complex classifications as well as drought timing, intensity and geographic variation create difficulties on the management and coordination, in general. Furthermore, economical results of drought are not predictable, so it can not be managed optimally. Flexibility in water use may be a partial solution but this may encounter some political obstacles.

3. DROUGHT INDICES

Drought indices content thousands of data on rainfall, streamflow, snow, and other indicators that transform these huge data sets into a comprehensible big picture. A drought index value is typically a single number, more useful than raw data-set for decision making. Many drought indices are presently being used for the identification of drought which are: “Percent of Normal”;

"Standardized Precipitation Index"; "Palmer Drought Severity Index"; "Crop Moisture Index"; "Surface Water Supply Index"; "Reclamation Drought Index"; "Deciles"(*NDMC, 2004*).

The percent of normal is a simple calculation well fitted to the requirements of TV weathercasters and watchers; it is quite effective for comparing a single season or region. Standardized Precipitation Index (SPI) is an index based on the probability of precipitation for any time scale. Many drought planners appreciate the SPI's versatility.

The SPI can be computed for different time scales, can provide early warning for drought and help assess drought severity, and is less complex than the Palmer, index values of which are based on preliminary data that may change. These time scales reflect the impact of drought on the availability of the different water resources.

The PDSI is a meteorological drought index, and it responds to weather conditions which are abnormally dry or abnormally wet. When conditions change from dry to normal or wet, for example, the drought measured by the PDSI ends without taking into account streamflow, lake and reservoir levels, and other longer-term hydrologic impacts (Palmer, 1965; Karl & Knight, 1985). The PDSI is calculated based on precipitation and temperature data, as well as the local Available Water Content (AWC) of the soil (Soil moisture conditions respond to precipitation anomalies on a relatively short scale.)

Crop Moisture Index (CMI), a Palmer derivative, reflects moisture supply in a short term through major crop-producing regions and is not intended to assess long-term droughts; it identifies potential agricultural droughts (Palmer, 1968). The (CMI) uses a meteorological approach to monitor week-to-week crop conditions.

Surface Water Supply Index (SWSI) developed by Shafer & Dezman (1982) is designed to complement the Palmer in the state of Colorado, where mountain snowpack is a key element of water supply. The objective of the SWSI, resembling the Palmer Index, was to incorporate both hydrological and climatological features into a single index value for each major river basin in the state of Colorado (Shafer & Dezman 1982).

Reclamation Drought Index (RDI), incorporating temperature as well as precipitation, snowpack, streamflow, and reservoir levels as input , like the SWSI, is calculated at the river basin level,. It is developed by the Bureau of Reclamation.

Deciles (D), provides an accurate statistical measurement for precipitation. Accurate calculations require long climatic record, it is developed by Gibbs & Maher (1967).

4. IMPACTS OF DROUGHT ONTO WATER

One of most important measurements to mitigate the effect of drought is to use the available water efficiently. In order to increase the efficiency of water use, the following approaches may be used by considering the usage areas (Fig. 3).

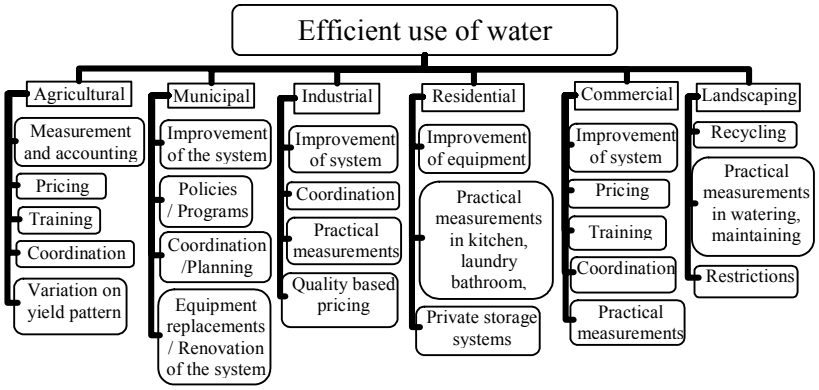

Figure 3. Efficient use of water.

5. MANAGEMENT OF DROUGHT

5.1. Steps for Drought Planning

Management of drought may be classified into several groups:

1. Risk management (determination of danger, probability of occurrence, prediction of the effect of drought on society, determination of measurements to decrease the risk and application of these measurements)
2. Management of loss (life, structural, economical)
3. Taking under control the disaster
4. Distribution of aid (timing, equity)
5. Management of source.
6. Reduce the effects of disaster.

Management strategies of a drought process can be summarized as Fig. 4 below.

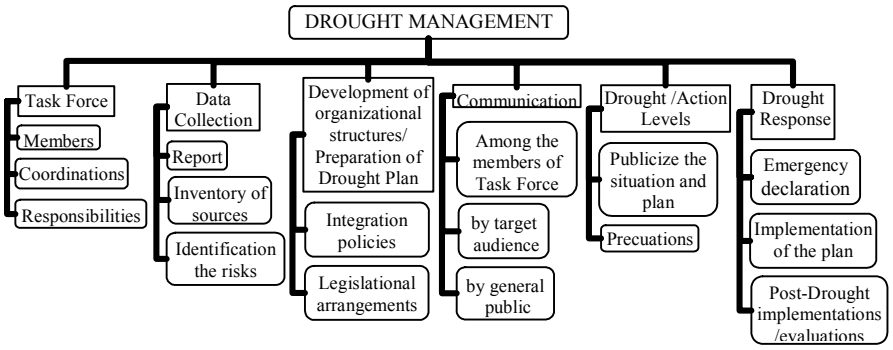

Figure 4. Drought management strategies.

Drought response is closely related to determination of the degree of the disaster. Once we determine the importance of the situation by tracing it, we can consciously respond to disaster. Phases in a drought phenomenon may be listed as below.

1. Normal situation (data collection, monitoring, prediction)
2. Predetermination, prediction (determination of indices and severity, advises to drought authorities)
3. Watching the process
4. Drought warning (coordination of drought plan, recommendation to governor, publization of the importance of the event)
5. Emergency (declaration and implication of plan)

Additionally, response to the disaster may be thought in 5 steps:

1. Preparation phase
   - Being preparedness
   - Observation and early warning
   - Planning forward
2. Warning phase
3. Emergency phase
   - Emergency Aids
4. Rehabilitation phase
   - Sustaining of life
5. Reconstruction phase

5.2. Measures

Although a great amount of studies are continuing about drought, there are no coordination among them and they are coming into agenda generally in the middle of the disasters.

Actually, in general, it is always crisis management in agenda, but the responses have to be continuous and organized. Drought mitigation plans must be put on desk.

Moreover, electricity production will be affected from drought especially in the countries of which ratio of electricity production provided from hydropower is high, and the priority in water usage that was in irrigational purposes formerly, tends to domestic and industrial usages.

So, to able to mitigate the effect of drought and to take measurements, long and short term plans must be prepared by observing drought trend continuously.

States, cities, districts, farmers, ranchers should develop a contingency plan including short and long term mitigation strategy.

In order to satisfy water savings, institutional structure supporting measurement of water savings have to be arranged.

Technique and social measurements encouraging water savings have to be taken.

Additionally, knowing devastating effects of drought sensed mostly when demand for water is high, we can decrease harms of drought by balancing water demand/supply relationship and can ensure diminishment in loss of life and property, economic damaging by early warning systems, planning and training.

5.3. Drought Mitigation System

Although some scientists have the opinion that "you can not manage drought" (Higginson, 1994), since, drought mitigation is often really just survival strategy and surviving is depending on grazing management, stock reduction strategy, financial plans, as well as vegetation recovery plans when droughts end, we can constitute an effective organized management strategy .

Drought management includes not only organizing all water control facilities but also planning, designing, application, and organizing.

Fighting with drought is such not easy generally that politicians and society may not understand importance of the event, there may not be a drought management plan, there may be a financial insufficiency, there may be subject to many kind of drought types together and responsibilities may be divided among many governmental jurisdiction (NDMC, 2004).

Drought managers can reduce damage and cost of drought by applying effective drought management approaches. For this propose, Managers generally use following devices

- risk based planning, and examining
- to get acquired social conscious,
- source management
- to take legal measurements (may be to diversify prices)
- to train society (may be in water usage, irrigation or planting techniques or in disaster management)
- economic regulations for water usages

6. SITUATION IN TURKEY

Turkey has presently no provincial plan to mitigate the effect of drought. Related centers and necessitated plans may be performed with associations of some international institutions such as UNDRO (United Nations Disaster Relief Office), UNHCR (United Nations High Commissioner Refugees), UNRNA (United Nations Relief and Work Agency), Special Office for Drought Mitigation in UNICEF, (USDA, 2004; WRCC, 2004; NOAA, 2004).

As an instance of harmful effects of drought in Turkey, the consequence of the drought realized after 1990's may be summarized as follows: 1. Decreasing precipitation (rain-prayers, rain-bombs); 2. Decreasing dam water levels (crisis on energy and problems on irrigation); 3. Boring of extra wells (problems of energy and natural source consumption), (Fig. 5); 4. Water conflicts with southern neighbours of Turkey; 5. Decreasing marine and continental productions. Some information is also obtainable from web-site of State Meteorological Works (DMI, 2004).

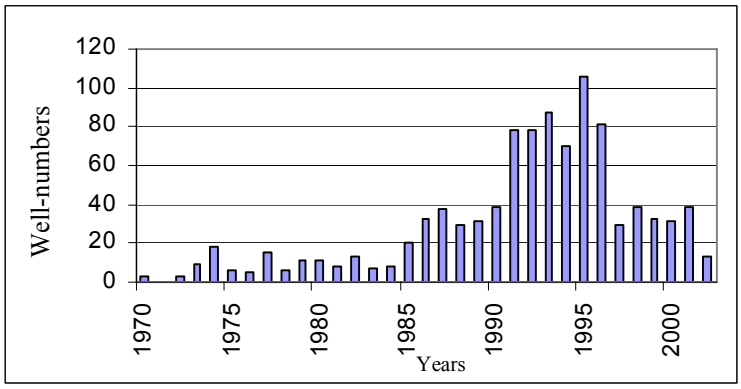

Figure 5. Well-numbers during drought period in 1990's (Yaşar, 2002).

7. CONCLUSIONS

Management of drought can mitigate harms of drought by effective organized collaborative plan and application. By viewing through this angle, the idea of an integrated sustainable management by taking into consideration of some measures may guarantee to service of water resources systems for a long period of time.

Listed below some concrete strategies against drought (IPCC, 1992): 1. Determining the flexibility and vulnerability of current hydrologic systems and water management systems; 2. Enhancing system-wide operation; 3. Enhancing scientific measurement, monitoring, knowledge and forecasting; 4. Implementing water conservation measures; 5. Addressing escalating demand for water through proper prizing mechanisms; 6. Establishing institutional mechanisms to assure that water is directed to where is most productive; 7. Modification of agricultural modification practices; 8. Design modification and changes in operation; 9. Improving flood plain management, warning and evacuation systems; 10. Protecting estuarine and adjacent groundwater quality susceptible to saltwater intrusion due to potential sea level rise.

To provide the following activities shall be very useful in advance: 1. Establishment of an Integrated Climate Monitoring System; 2. Establishment of a Regional/National Drought Mitigation Center; 3. Rediscovery of resources; 4. Forecasting of drought: status and future prospects; 5. State efforts to monitor and coordinate responses to drought; 6. Training of the target audiences; 7. Exchanges of experiences.

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