National Drought Plan in Azerbaijan

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References

LIST OF ACRONYMS

AAWEOJSC	Azerbaijan Amelioration and Water Economy Open Joint Stock Company
AZERSU OJSC	Azersu Open Joint Stock Company (Azerbaijan Drinking Water company)
EU	European Union
CB	Cabinet of Ministers
DMP	Drought Management Plan
GEF	Global Environment Fund
GIS	Geographic Information Systems
GWP	Global Water Partnership
IWRM	Integrated Water Resources Management Plan
JSC	Joint Stock Company
MES	Ministry of Emergency Situations
MENR	Ministry of Ecology and Natural Resources
MOH	Ministry of Health
NAS	National Academy of Science
NHD	National Hydrometeorology Department (of MENR)
NWPD SC	National Water Policy Dialogue Steering Committee
OECD	Organisation for Economic Cooperation and Development
SPI	Standardized Precipitation Index
IRBMP	Integrated River Basin Management Planning
WRSA	Water Resources State Agency
UNEP	United Nations Environment Program
UNECE	United Nations Economic Commission for Europe
UNESCO	United Nations Education, Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change
WB	World Bank
WFD	Water Framework Directive
WUA	Water User Association

1. INTRODUCTİON

The Republic of Azerbaijan, with a territory of 86,600 km^2, is a coastal State bordering the Caspian Sea and sharing territorial borders with Russia in the north along the Samur River, Georgia in the northwest, Armenia in the west and southwest, and Iran and Turkey in the south. The Caspian coastline runs from the Astara River to the Samur River for 825 km.

There are 8,359 rivers in Azerbaijan. Most of these are small tributaries, although two (Kur and Araz Rivers) have a length of more than 500 km. There are 5,141 rivers in the Kur River basin, 1,177 in the Araz River basin, while the number of rivers that flow directly into the Caspian Sea is 3,218. Common river network density is about 0.36 km/km^2. In addition to rivers, surface waters comprise lakes, reservoirs and glaciers. About 67-70 per cent of water resources are part of transboundary networks.

The water resources of Azerbaijan are limited in comparison with other countries in the South Caucasus and is only 15 per cent of the all water resources in the region. From the water supply point, Azerbaijan is considered to be one of the driest regions of the world with approximately 100,000 m^3/year of water per km^2, and the annual amount of water per person is 950 to 1,000 m^3/year. Moreover, the water resources are shared unequally, with good water availability in some mountainous regions compared to significant shortages in some lowlands.

Agriculture. Agriculture is strategically important for the country’s social and economic development, as it provides income and employment for about 40% of the work force, while ensuring household and national food security. Azerbaijan is highly dependent on irrigation for most of its agricultural production. The total area of irrigated land exceeds 1.4 million hectares, about 30 per cent of the total utilized agricultural area of the country. Irrigation uses 70% of the water diverted from rivers, and there are significant opportunities to enhance productivity and efficiency of water use in irrigated agriculture[1].

Table 1.1 provides data related to annual water abstractions and use by sector. For year 2013, the total water abstraction is about 12.5 billion m^3, of which about 8.230 billion m^3 are usefully consumed and about 4.28 billion m^3 constitute losses.

Table 1.1 Water abstractions from the Kura River and sectoral use

Water abstraction (million m^3)	2000	2002	2004	2006	2008	2010	2012	2014	2016	2017
Total water abstraction	11110	10075	11440	12360	11735	11566	12484	12123	12504	12781
Total water consumption	6588	6754	8019	8865	7886	7715	8249	8115	8824	9154
Of which:										
Domestic purposes	449	503	498	523	348	405	279	313	308	291
Industrial needs	2316	1977	2264	2508	2042	1742	2098	2144	2108	2224
Drinking water	82	46	61	74	41	54	44	49	43	31
Irrigation supplies	3819	4248	5240	5817	5 474	5497	5772	5572	6342	6570
Volume of recycled and consequently	1875	704	2273	2198	2485	1787	2204	2469	2346	2398
Water losses in conveyance	3053	3321	3421	3495	3849	3851	4235	4008	3680	3628

[1] Most crop production takes place on irrigated lands in the plains area of the Kura-Aras River basin. Yields of most crops are low by international standards (World Bank, 2012).

Discharge sewage waters	4106	4596	4817	5164	5325	6005	5419	5358	5673	5453

Source: The State Statistical Commite of the Republic of Azerbaijan [17]

Irrigation supplies were about 5.75 billion m^3, which is about 70% compared to total amount consumed (8.23 billion m^3); and about 46% when compared to the total abstracted amount of 12.5 billion m^3. The losses, mostly in the conveyance of water supplies for irrigation, municipal and other uses and application to irrigated lands, are quite high – about 35%.

Irrigated agriculture: Irrigation is essential to both Azerbaijan's agriculture and economy as it supports water requirements of a large part of Azerbaijan's cropped land (World Bank, 2012). Current irrigated area is reported to be 1.45 million ha and the total cultivated land is about 2.1 million ha[2]. In 1913, only 582,000 ha were irrigated. The most intensive development of irrigation occurred after the Second World War and by 1975 the area equipped for irrigation was about 1.17 million ha. By 1995, 1.45 million ha were irrigated and the figure has remained largely constant since that time.

The total area sown to agricultural crops in 2013 (including rain-fed areas) was 1.68 million ha according to data from the State Statistical Committee. Of the 2013 sown area, about 690,000 ha were sown to winter wheat and 313,000 ha to winter barley, resulting in winter grown grains being by far the most popular crops to farmers. Corn, fodder and vegetables are also important crops in addition to the cereal grains.

The most dramatic change in cropping over the past 18 years has been the near disappearance of cotton from the crop mix. One reason for reduction in cotton production could be the low yields resulting from water shortage in summer. Irrigation deliveries are less than adequate to meet the crop's relatively high crop water requirements. For example, in the Kura-Aras lowlands, less than 10% of cotton's crop water requirement is met from the scant rainfall during the summer months (Table 3.3, Appendix A). In addition, cotton was considered a strategic crop during the Soviet era, and much of Azerbaijan's cotton was marketed to other republics in the Soviet Union. Many smallholder farmers chose not to produce cotton in the post-Soviet Union period, opting instead to produce grains and fodder that could be consumed at home and marketed within the country.

Water for domestic, municipal and industrial purposes: To supply water for drinking and other domestic purposes, the Azersu OJSC, has tapped diverse surface and subsurface water sources. Since the waters of Kura river are heavily polluted, the city of Baku is supplied with good quality water obtained from distant sources as follows:

- Khachmaz (1956; 2.65 m^3/s) and;
- Shollar lines (1917, 1937; 187 km from Baku, about 1.5 m^3/sec), and
- Djeiranbatan water intake (İs fed from Samur river by Samur-Absheron canal)
- Newly constructed Oguz Gabala Baku water pipeline project can deliver fresh drinking waters to Baku at capacity of 5 m^3/s.

1.1 Purpose and scope of the Plan

Currently different structures are involved to management of emergency situations, including droughts. They are Cabinet of Ministers, The Ministry of Ecology and Natural Resources (MENR) The Ministry of Emergency Situations (MES State Agency for Water Resources

[2] Annex D on Irrigation and Drainage provides detailed information about land use in Azerbaijan.

under MES (SAWR), “Azersu” OJSC, the Ministry of Health,Executive Powers of Administrative raions.

In order to make drought managemet effective it is important to develop Drought Management Plan (DMP) Drought Management Plan is planned to help reduce the time taken in mobilizing resources for an effective response and enable a harmonious relationship among stakeholders.

The goal of DMP is to facilitate overall management of the drought situation in a structured and planned manner with the most efficient and optimum utilisation of time, effort and resources so that adverse impact on the community is minimised.

DMP helps in delineating roles and responsibilities of Government and different Ministries/ of Azerbaijaninvolved in drought management for mitigation, preparedness and for relief measures in managing the drought.

DMP ensures better preparation and timely communication among stakeholders, which is critical in managing a drought.

This DMP would be applicable to the entire territory of Azerbaijan.

1.2 Plan Development: Introduction of main steps of Plan Development Process

The Sendai Framework for Disaster Risk Reduction 2015-2030 is a non-binding agreement, which the signatory nations, including India, will attempt to comply with on a voluntary basis. The four priorities for action under the Sendai Framework are:

1. Understanding disaster risk
2. Strengthening disaster risk governance to manage disaster risk
3. Investing in disaster risk reduction for resilience
4. Enhancing disaster preparedness for effective response and to “Build Back Better” in recovery, rehabilitation and reconstruction

The Sendai Framework aims to achieve substantial reduction of disaster risk and losses in lives, livelihoods, and health and in the economic, physical, social, cultural, and environmental assets of persons, businesses, communities, and countries. The Drought Management Plan (DMP) will be aligned broadly with the goals and priorities set out in the Sendai Framework for DRR. Based on global practices and national experiences, the plan will incorporate changes duringthe periodic reviews and updates.

A step-by-step approach is recommended for drought policy development and the production of the DMP in the WMO/GWP IDMP National Drought Management Policy Guidelines (described in chapter 2.2). The 10 steps suggested in these Guidelines were merged into seven steps in the context of the WFD, as listed below:

1. Develop a drought policy and establish a Drought Committee
2. Define objectives of drought risk-based management policy
3. Make inventory of data for Drought Management Plan development
4. Produce/update Drought Management Plan
5. Publicize Drought Management Plan for public involvement
6. Develop scientific and research programme
7. Develop educational programmes

According to GWP Guidelines for DMP development below three of the seven elements above are considered to be the key elements of the DMP framework (Report 2007):

- drought indicators and thresholds for drought classification and the drought early warning system
- measures to achieve specific objectives in each drought stage
- the organizational framework to manage drought

The entire planning process for the development of the DMP (Step 4) is divided into seven sub-steps:

4.a: Define the content of the DMP
4.b: Characterise and evaluate some historical drought events
4.c: Establish indicators and thresholds for drought classification
4.d: Establish a drought early warning system
4.e: Develop the programme of measures
4.f: Establish an organizational framework for the production, implementation, and updating of the DMP
4.g: Identify gaps and uncertainties

2. National environmental policy Policy and Legislative Context

2.1. National water laws, plans and strategies

Both water legislation and environment legislation in Azerbaijan are based on a complex series of legislative enactments and legal standards. The main laws include: the *Water Code of the Republic of Azerbaijan* (in effect since March 17, 1998), *Law on Melioration and Irrigation* (September 26, 1996), *Law on Water Supply and Sewage* (January 31, 2000), *Law on Hydro-meteorological Activity* (August 25, 1998) and the *Law on Environmental Protection* (August 10, 1999). In addition, the Government has approved a number of decisions, defining more detailed rules for water and environmental management, for example including decisions on environmental monitoring, exploitation and protection of water objects, pollution control, etc.

In addition to legislative provisions, the management of water and the environment is subject to a wide-range of national policy directions, programmes and action plans. The President has approved comprehensive state programs and national plans on socio-economic development in Azerbaijan, use of natural resources, including water resources and environmental protection. These programs and plans include the following:

- State Program on poverty reduction and sustainable development in the Republic of Azerbaijan in 2008-2015. September 15, 2008, No. 3043 (2nd Program);
- State Program on socio-economic development of the regions of the Republic of Azerbaijan in 2009-2013. April 14, 2009, No. 80 (2nd Program. 3nd Plan is about to be prepared);
- State Program on sustainable supply of the population with food products in the Republic of Azerbaijan in 2008-2015. August 25, 2008, No. 3004 (2nd Program);
- Integrated Action Plan on improvement of ecological situation in 2006-2010. September 28, 2006, No. 1697 (2nd Plan is about to be prepared);
- National Program on ecologically sustainable socio-economic development in the Republic of Azerbaijan. February 18, 2003. No. 1152 (former National Action Plan was adopted in 1998);
- National Program on restoration and enhancement of forests in the Republic of Azerbaijan. February 18, 2003, No. 1152;

- State Program on efficient use of summer-winter pastures, hayfields and prevention of desertification in the Republic of Azerbaijan. May 22, 2004, No. 222;
- Program for Hydrometeorology Development in the Republic of Azerbaijan. January 28, 2004, No. 62;
- State Program on use of alternative and renewable energy sources in the Republic of Azerbaijan. October 21, 2004, No. 462 (2nd State Program is under development);
- State Program on development of tourism in 2010-2014 in the Republic of Azerbaijan. April 6, 2010, No. 838 (2nd Program);
- National Strategy and Action Plan on protection and sustainable use of biological diversity in the Republic of Azerbaijan. March 24, 2006. No. 1368;
- State Program on development of resorts in the Republic of Azerbaijan in 2009-2018. February 6, 2009, No. 125

In addition to socio-economic development and environmental protection issues, all of these state programs and national plans cover issues related to efficient use and sustainable management of natural resources, including water resources, land and forest resources, combatting desertification and climate change, reduction of land and forest degradation, reduction of water pollution and measures to prevent flood and mudflows.

2.2. Importance of National Drought Plan

Importance of National Drought Management Plan

As mentioned Azerbaijan is located in arid zone and often is faced with water scarcity problems. Climat change leads significant reduction of water resources and deepening of existing related problems.

This requires to attach high priority to sustainable water management and take a step forward toward mitigating and addressing the issues of water insecurity and drought.

The ultimate goal of a National Drought Policy would be to create efficient drought-resilient societies, which that would make it mandatory   to provide safety nets, such as insurance, for the victims, financial assistance and provide lost items

It is important to initiate such policies as climate change is unfolding, resulting in drought becoming more intense and frequent   The concern regarding lack of preparedness, mitigation and inappropriate drought management policy around the world is now a serious issue.

In order to address the problems of national drought policy, the World Meteorological Organisation (WMO) and United Nations Convention to Combat Desertification (UNCCD) in collaboration with other UN agencies have planned a High Level Meeting on National Drought Policy (HMNDP) which took place in Geneva March 2013. The new paradigm for drought policies focuses on risk management, rather than as previous on the crisis which contributed to societal vulnerability (www.wmo.org).

An effective risk management strategy combines natural (hazard) and social (vulnerability) factors, which are considered during drought management. A risk management approach focuses on predisaster activities predicting hazard and vulnerability of drought for preparedness and mitigation measures. The approach is believed to increase resilience of drought in the society, if the strategies are followe.

It is also important to develop a drought management plan, specifying courses of action and concrete plan for responding to drought events. Risk management as a strategy helps to undertake actions by preparing for the disaster through prediction and early warnings. In addition, the risk management method is for protection, to mitigate future occurrence.

3. Overview on drought

3.1. General conditions

Drought takes place under the circumstances of of the absence of rainfall for a long time (in several weeks) in any region,due to low humidity, as the air temperature is above the normal range and and the water vapor is exhausted in the soil.

Drought is the most dangerous atmospheric event for agriculture. This atmosphere phenomenon often occurs in the formation of antisiklons in the region. It has been investigated by researchers over the past 100 years by using different approaches.

Meteorological droughts in Azerbaijan are studied by M. Shikhlinski.6 types of drought are identified within the territory of the Republic based on the results of studies. Here, the ratio of relative humidity value throughout the year to its summer value is used when providing the classification of drylands. Then, following criteria is used:

Type I (sharp dry areas) 15% / ≤5%;
Type II (strong droughts) 16-30% / ≤15%;
Type III (arid areas) 31-50% / ≤25%;
Type IV (mild droughts) 51-70% / ≤40%;
Type V (weak droughts) 71-99% / ≤50%;
Type VI (rarely observed droughts) 100-150% / ≤35%.

Most regions of Azerbaijan are characterized by varying degrees of dry climates. During the studies, the number of days without rainfall was determined for the areas of the afore-mentioned drought types and the humidity deficit was calculated for the entire territory of the Republic.

A.S.Mammadov has investigated drought phenomenon in the territory of Azerbaijan in more details [7,8] (Mammadov and others, 2000). He compiled a drought catalog for Azerbaijan for the temperature and rainfall data of 1891-1987, while using methodologies of D.A. Ped (Ped, 1973) and A.V. Meshcherskaya (Meshcherskaya, 1978). It was determined that drought was observed in all seasons of the following years: 1938 in Baku, 1961, 1966, 1971 in Ganja, 1971 in Guba, 1983, 1917 in Lankaran, and 1899 in Nakhchivan.

It is also mentioned that the recurrence of drought in the second half of the 1891-1987 period, i.e. from 1940, increased and amounted to 65-70% of total drought in 1940-1987.

In western countries, the standardized precipitation index (SPI) is preferably used to determine the dry season.

This index is calculated according to the following formula:

$$SPI = \frac{X_i - \overline{X}}{S_x}, \quad (1.1)$$

where: - X_i – the amount of atmospheric precipitation (annual or monthly) for each year;

$\overline{X}$ - average value of rainfall order;

S_x – medium squared deviation.

Drought severity rate is determined according to the following table (Table 3.1.1).

Table1 3.1.1 Drought severity rate

SY	Degree of droughts
0,0 - (- 0,99)	Poor
(-1,0) - (-1,49)	Medium
(-1,5) - (-1,99)	Strong
-2,0 and lower	Very strong

According to formula (3.1.1), drought has been determined forLankaran natural region, one of the largest economic regions of Azerbaijan [7, 9].

Table 3.1.2. Assessment of SPI for the summer season

Year	Lankaran	Astara	Yardimli	Goytapa	Kalvaz
1998	– 1,08	– 0,90	– 1,77	– 0,72	1,22
1999	– 0,11	0,02	0,86	0,79	– 0,68
2000	– 0,51	– 0,42	– 0,06	– 0,49	– 0,27
2001	– 1,59	– 1,90	– 1,42	– 1,28	– 1,90
2005	– 0,07	0,10	– 0,64	– 0,86	0,78
2006	– 0,84	– 0,75	– 0,46	– 0,73	– 1,49

Drought has changed dramatically due to the degree of severity, for example, severe droughts in Lankaran were observed in spring 2001 and in autumn 2005, in Astara in 2001 and in autumn 2007 and in Yardimli in the spring of 1998. In all parts of the province, the spring of 1998, 2000, 2001, 2006, and the autumn 2002, 2005, 2007 years have been devastating. In the remaining years, weak and moderate droughts have occurred unevenly in regions (Table 3.1.3).

Table 3.1.3 Assessment of the SPI for the autumn season

Year	Lankaran	Astara	Yardimli	Goytapa	Kalvaz
1998	0,47	1,05	0,12	– 0,36	– 0,62
2002	– 1,11	– 1,23	– 1,63	– 1,30	– 1,35
2003	– 0,09	– 0,11	– 0,28	0,03	– 0,83
2004	0,60	0,14	– 0,29	– 0,44	0,11
2005	– 1,57	– 1,22	– 0,81	– 0,23	– 0,57
2007	– 0,90	– 1,74	– 1,03	– 0,77	2,44

As can be seen from the picture, the drought recurrence increased by 9% in the second half of the past century in Lankaran (spring). Over the last 20 years, there have been 10 times different drought. This is 4.4% of the dry years in the area during 1891-2007. Drought repetition frequencies in the summer range coincide with the years 1891-1900, 1950-1960 and 1991-2000. The most severe droughts occurred in the area in 1917, 1938, 1952, 1954, 1964, 1971, 1978, 1981, 1992, and 2005.

Drought has a significant impact on the distribution of river flow quantities.

The influence of meteorological drought on river flow in Azerbaijan has been studied by M.A.Mammadov and F.A.Imanov [6,12]. At this time, 16 river basins with different natural conditions were selected and annual flows for these rivers, average monthly minimum summer water consumption, average monthly minimum water consumption were calculated.

Based on several-phased analyzes, it was identified that the cause of the water decrease of all rivers of Azerbaijan in 1971 was the drought in 1970:

1. Annual flows, average annual minimum summer water consumption, average annual minimum winter water consumption, and maximum water consumption for summer crops may be less than or equal to the norm;

2. There is no observation point, where these characteristics of the stream are less than normalin the dry years;

3. The drought poses strongest impact on minimal flow, and weakest impact on maximum flow among the reviewed flow characteristics;

4. The degree of effect of meteorological drought on river flow depends on the time when drought is observed within the year and its duration.

Table 3.1.4 Impact of Meteorological Drought on River Flow (1966)

№	River - station	Annual flow		Minimal spring flow		Minimal winter flow		Maximum flow	
		K	P,%	K	P,%	K	P,%	K	P,%
1	Gusarchay-Kuzun	1,10	30,3	0,78	81,3	0,81	76,2	1,14	29,7
2	Gudiyalchay-Kupchal	1,09	28,1	0,84	69,9	1,03	41,1	1,87	7,0
3	Valvalachay-Tangaaltı	1,85	2,2	1,37	17,0	0,80	59,6	3,05	4,3
4	Ayrichay-B. Dashagıl	0,71	78,7	0,74	73,5	0,61	81,6	0,62	53,3
5	Damarchık-Mansab	0,72	89,4	0,74	80,0	0,74	88,0	0,37	45,8
6	Damiraparanchay-Gabala	0,79	66,0	0,80	60,0	1,43	16,0	0,40	82,0
7	Shamkirchay-Yuxarı Chaykand	0,90	55,8	1,3	36,7	0,76	81,7	0,87	52,6
8	Ganjachy-Zurnabad	1,23	18,8	1,48	8,7	0,99	48,5	0,91	49,3
9	Kurakchay-Chaykand	1,26	14,3	1,30	18,2	1,20	14,5	0,91	51,9
10	Goranchay-Y.Agjakand	1,13	31,4	1,25	24,1	0,85	66,0	1,74	17,6
11	Gilanchay-Bilav	0,90	54,3	0,92	44,4	0,68	83,3	0,62	76,5
12	Nakhchivanchay-Garababa	0,72	70,2	1,11	32,7	0,95	33,3	0,77	38,3
13	Lankaranchay-Sifidor	1,50	4,7	1,13	30,0	0,97	43,3	2,53	1,9
14	Basharu-Dashtatuk	1,60	10,2	0,58	83,6	0,49	71,4	1,67	20,4
15	İstisuchay-Alasha	0,88	59,3	0,54	83,6	0,49	71,4	1,67	20,4
16	Tangarud-Vago	0,94	54,4	0,11	98,3	0,54	78,0	1,78	15.8
	K	1,08		0,92		0,89		1,34	

Note: K –is the module coefficient, P - empirical guarantee.

As can be seen from this table, the module coefficient of maximum water consumption for half of the rivers in 1966 was larger than the unit and the average value of the module coefficient was equal to 1.34. The average module coefficient for the annual flow is also greater than the unit. Modular coefficients for minimum summer and winter water consumption are smaller than one unit. Thus, in 1966, the rivers' minimum water consumption was only 8-11% less than the minimum flow rate. The year of 1966 can be estimated as a mid-watered year. In the same year, the annual rainfall amount on the territory of the republic was 6% above the norm.

3.2. Historical facts

Drought has been increasingly observed in Azerbaijan in recent years. This is mainly due to increased air temperature, particularly over recent years. The fall of precipitation in this region, especially in the Lesser Caucasus region, has further aggravated this process. According to the UN World Water Report, the number of people affected by natural disasters during the 1991-2000 period has increased from 147 million to 211 million. About 90% of 2557 natural disasters occurring during this period are related to water, 11% of which fall into drought (United Nations, 2003).

Currently, the problem of humidity deficiency in the arid zones of the Earth is exacerbated and dry periods are more frequent. Drought has a strong impact on the growing areas of dry-farming agriculture.

Since the drought is gradually occurring, it is believed that the chance to implement an action plan for minimizing the damage caused by the drought is enough big. Change in the land use pattern; use of water reservoirs and wells for irrigation; plant products insurance; protection of interests of priority water users and so on are among those measures. For long-term measures, replacement of plant varieties with other varieties and construction of reservoirs can be an example.

Generally, to reduce the risk of potential drought, this natural phenomenon should be investigated, its prediction must be drawn, the damage to be assessed depending on the severity, the complex of measures to be developed and the amount of funds required for it should be determined.

Drought is the most dangerous hydrometeorological event for agriculture, and the moisture content of the soil is exhausted because evaporation is more than rainfall during drought.

During drought, evaporation does not exceed the annual rainfall norm, and the average temperature drops to over 10˚C. As a result, the water in the soil is exhausted and there is a danger for the development of plants.

Various methods are used to identify areas where drought has occurred. The most widespread of these methods is a complex method of research. Here, the temperature is primarily based on the temperature-humidity complex (Tmax-Tmin-e). In this case, the role of atmospheric circulation is further illustrated by the formation of temperature fields. This meteorological complex has a great effect for the warm season of the year.

The second meteorological complex in the drought studies (q-s-p) is defined between precipitation, barrier and cloudiness [14]. This complex basically reflects the transition from winter to summer.

According to the universal complex for July, the maximum temperature in subtropical latitudes is typically r = 0.4, 0.6 (together with cloudiness-radiation complex) in weaker relationships. If the correlation coefficient (r> 0.8) between Tmax, Tmin and E in the winter and transition period is sufficiently large, then these relationships suffer considerably in the summer (especially when relationships between Tmax and e are practically zero).

According to the calculations for 8 regions of the Republic, the correlation coefficient of Tmax-e and Tmin-e complexes is given in Table 3.2.1

Table 3.2.1 Correlation coefficient for Tmax-Tmin-e complex for flat regions of the Republic

Quantities	May	Jun	July
T_{max}–e	0,1	- 0,2	- 0,12
T_{min}–e	0,41	0,35	0,32

Quantities	December	January	February

T_{max}–e	0,76	0,85	0,86
T_{min}- e	0,91	0,89	0,95

As can be seen in Table 1.5, the natural meteorological complex connection is great for the winter months. In this case, the correlation coefficient for the first type complexes (0.76, 0.85, 0.86) for the second type complexes is 0.91, 0.89, and 0.95 for winter months.

3.3 Types of drought

Two directions are widely highlighted in drought studies:

1. Drought is considered as the main indicator of anomalies of meteorological quantities.
2. Drought is considered as agrometeorological concept, and it is determined by estimating the damage to the vegetation and plants.

A.M. Alpatyev and V.N. Ivanova studied drought on a meteorological basis and propose to evaluate it based on (1.2) formula of hydrotermic coefficient

$$K_C = \frac{\Sigma R}{0{,}1\Sigma t} \qquad (1.2)$$

Where, $\sum R$ is the amount of precipitation during the vegetation (April-July); $\sum t$ -is the aggregate of average daily temperatures over 10^0C.

G.T. Selyaninov acknowledged that Kc – hydrotermic coefficient was Kc≤0.6 for desert and Kc≤0.7 for forests-desert. In addition, G.T. Selyaninov determined the following types of climate depending on the Kc coefficient:

a) Kc <0.5 –too low rainfall and very dry;
b) 0.5 <Kc <1.0 - low damp and dry;
c) Kc> 1.0 - diffuse wet.

N.N. Ivanova calculates the degree of humidification as the ratio of precipitation to possible evaporation:

$$K_n = \frac{R}{E} \qquad (1.3)$$

Where,
E = 0.0018(t+25)2(100 – α).
E – expresses the possible evaporation.
D. A. Ped proposes the following expression for determining the drought range:

$$S_i(\tau) = \frac{\Delta T}{\sigma_T} - \frac{\Delta R}{\sigma_R}, \qquad (1.4)$$

Where ΔT and ΔR determines respectively temperature and precipitation anomalies, and σT and σR define normal quadratic deviations of temperature and precipitation.

Later, D.A. Ped proposed the following (1.5) expression by adding deviations for ΔE – soil moisture:

$$S_i(\tau) = \frac{\Delta T}{\sigma_T} - \frac{\Delta R}{\sigma_R} - \frac{\Delta E}{\sigma_E} \;. \qquad (1.5)$$

Acrometeorological investigation of the drought is a form of study of the complex effects of the environment on plant biology. Among the studies in this direction, P.I. Brounov offers to learn drought as the lack of water in the atmosphere, soil and plant.

Several researchers sometimes use the price indexes of productivity and products found in different literatureto identify the drought.

S.I. Kostin has suggested that every information showing drought should be reflected in at least two sources of research.

It should be mentioned that hydrothermal and pylvimetric coefficients are widely usedin the vast majority of agrometeorological studies.

Drought determination in many studies is based on a 10% or more decrease in productivity. Such studies are applied to the grain cultivation areas of the European Territory.

Drought is always one of the most dangerous natural phenomena that causes unhappiness in people. Destruction of productivity leads to mass destruction of living things. Such a large-scalestarvation (causing the danger to Europe and Asia) was in 1946, 1963, 1967, 1972 and 1975. Drought also leads to various diseases and the population leaving their residential settlements.

3.4. Impact of drought: By sectors

The drought study in the territory of Azerbaijan, as we mentioned earlier, was based on Pediatric and Standardized Precipitation Index (SPI) methods, then the results of both methods were compared. The drought index has been somewhat intensified by adding the condition that the rainfall is lower than 80% when applying the method proposed by Ped.

Thus, the following conditions are taken for the S_i - drought indicator during calculations:

a) $1 \leq S_i(\tau) < 2$ - weak drought, as indicated in the tables;
b) $2 \leq S_i(\tau) \leq 3$- indicates mild drought;
c) $S_i(\tau) > 3$ - shows the sharp drought, as indicated in the tables.

One common aspect characteristic to the catalogs developed bu us should be mentioned thatthe weaker drought with longer duration of life is much more dangerous than other types of drought. Similar cases and circumstances were observed in 1901, 1902, 1938, 1940, 1961, 1971, in Baku;1938, 1953, 1961, 1962, 1966, 1971, 1987 in Ganja; 1901, 1902, 1938, 1940, 1961, 1971 in Shusha; and 1899, 1930, 1938, 1961, 1962, 1970, 1971in Nakhchivan.

Considering the latest 100-year observation data on the regions of Azerbaijan, a catalog of dry years has been prepared for the segments where drought is considered to be the most dangerous (Table 3.4.1).

Table 3.4.1 Replication of droughts with different intensity in spring season and years of observation in Azerbaijan

Region	Drought replication, %	Periods		
		1891-1940	1941-1970	1971-2008
Weak drought				
Absheron	16,1	1899,1903,1916, 1921,1926,1930, 1938,	1941,1947,1950, 1953,1957,1958,	1971,1977,1999, 2005,2006

			1970	
Greater Caucasus North - east slope	16,1	1892, 1901, 1903, 1906, 1909,1935, 1939	1951, 1953, 1958, 1964, 1968,	1977, 1979, 1983,1997,1998, 2001,2005
Greater Caucasus Southern slope	11,0	1891, 1892, 1923,1924, 1925,1930,1934,1935	1941, 1957, 1958,1968	1977, 1979, 1992,2001,
Lesser Caucasus	13,6	1901, 1909, 19014, 1917, 1926, 1930, 1935, 1939	1944, 950,1953, 1958,1961, 1962,	1977, 2006,
Upper Garabagh	14,3	1901, 1902, 1907,1909, 1912, 1918,1924, 1926, 1930, 1935,1938,1940	1944, 1946, 1962,1968	1971, 1987
Nakhchivan	15,1	1901, 1916, 1922,1930, 1932, 1935,1937, 1940,	1944, 1952,1957, 1959, 1961, 1965	1971, 1989, 2001
Jafarkhan	11,1	–	1958, 1970	1971,1977, 2005, 2006
Lankaran	15,9	1899, 1906,1910, 1916, 1922,1930, 1935	1941,1944,1947, 1961, 1962	1971,1975, 1977, 1983,2001,2006
Mild Drought				
Absheron	14,4	1906, 1910, 1914, 1917,1925	1944, 1951, 1961, 1962, 1968	1975,1983,1989, 1995,1998,2001, 2008
Greater Caucasus North - east slope	6,8	–	1947, 1950, 1961, 1962, 1970	1975,1989,2000
Greater Caucasus Southern slope	9,6	1901,	1950,1962,1970	1975,1995,2000, 2008
Lesser Caucasus	8,5	1906, 1932	1957, 1970	1995, 1997,1998 1999,2000, 2007
Upper Garabagh	10,7	1914, 1932,	1941,1947,1951, 1958, 1961,	1977
Nakhchivan	12,3	1917, 1925	1941, 1947, 1950, 1951, 1955, 1958 1962,1970	2008
Jafarkhan	13,0	-	1962	1975,1983,1989, 1995,2000, 2001
Lankaran	6,2	-	1950,1958, 1970	1989, 1995, 1998,2000
Strong drought				
Absheron	0,8	1901	-	-
Greater Caucasus North - east	1,7	–	-	1995, 2008

slope				
Greater Caucasus Southern slope	4,1	-	1951,1961	1989
Lesser Caucasus	2,5	–	1951	1989,2008
Upper Garabagh	3,6	1917	1970	1989
Nakhchivan	0,0	1899	–	–
Jafarkhan	3,7	-	1961	1998
Lankaran	4,4	1901, 1917, 1919, 1925	1951	-

Table 3.4.1 summarizes the replication of droughts with different intensity in spring season and years of observation in Azerbaijan. As can be seen from the table, 57.2% of the drought in the spring was weak, 34% mild and 8.8% strong. Mild and severe droughts have been more frequent in the 1941-2008 periods. In 1891-1940s, 22.6% of the droughts were weak, 8% were mild and 1.3% strong. 33.6% of the drought in 1940-1970 was weak, 15% were mild, and 3.5% were strong. 17.7% of the droughts that took place in the 1971 -2008s were weak, 5.3% mild and 4% strong (Table 3.4.1).

Table 3.4.2 Replication of droughts with different intensity in autumn season and years of observation in Azerbaijan

Region	Drought replication, %	Periods		
		1891-1940	1941-1970	1971-2008
1	2	3	4	5
Weak drought				
Absheron	14,4	1896, 1899, 1904, 1912, 1925, 1926, 1929, 1936, 1938	1955, 1960, 1970	1971, 1974, 1979, 1981, 1985
Greater Caucasus North - east slope	11,9	1913, 1928, 1931	1950, 1954, 1964, 1966, 1969, 1970	1978, 1979, 1989, 1994, 2004
Greater Caucasus Southern slope	21,9	1899, 1909, 1912, 1917, 1925, 1929, 1932, 1938	1954, 1957, 1966, 1968	1971, 1974, 1985, 1986, 1989, 1990, 1995, 1996, 2005, 2007, 2008
Lesser Caucasus	15,3	1899, 1915, 1927, 1928, 1931	1955, 1957, 1960, 1966	1971, 1974, 1981, 1983, 1984, 1994, 1996, 1998, 2001

Upper Garabagh	25,0	1893, 1905, 1933, 1938, 1940	1950, 1954, 1960, 1964, 1968, 1970	1971, 1979, 1983, 1985, 1986, 1991
Nakhchivan	17,8	1898, 1915, 1924, 1925, 1926, 1927, 1936, 1940	1942, 1943, 1947, 1950, 1960, 1961, 1962, 1963, 1964, 1970	1971
Jafarkhan	16,7	–	1955, 1960, 1966	1968, 1974, 1983, 1986, 1992, 2006
Lankaran	21,2	1899,1912,1913, 1917, 1923,1928,1933, 1935, 1936,1938, 1940	1944	1971, 1972, 1974, 1979,1984,1989, 1990, 1991, 1995, 1996, 1999
Mild drought				
Absheron	9,3	1893, 1909, 1915, 1917, 1918,1923,1933	1952, 1954	1990, 2002
Greater Caucasus North - east slope	11,0	1933	1952, 1957, 1968	1971, 1974, 1990, 1991, 1998, 2002, 2006, 2007, 2008
Greater Caucasus Southern slope	8,2	1905, 1919, 1923, 1937	1952, 1964	1981, 1991, 2001
Lesser Caucasus	5,9	1925	1952, 1968	1985,1990,1991, 2008
Upper Garabagh	5,4	1912, 1937	–	1974, 1990
Nakhchivan	11,0	1893, 1899, 1918, 1919, 1929, 1937	1944, 1952, 1954, 1955, 1957, 1968	2002
Jafarkhan	9,3	–	–	1985, 1990, 1991, 1998, 2002
Lankaran	3,5	1893, 1937	1952	1981, 2007
Strong drought				
Absheron	1,7	1905, 1919	–	–
Greater Caucasus North - east slope	1,7	1937	–	2001
Greater Caucasus	1,4	1918	–	2002

Southern slope				
Lesser Caucasus	2,5	1937	1954	2002
Upper Garabagh	1,8	–	1952	–
Nakhchivan	0,0	1897, 1905	–	–
Jafarkhan	0,0	–	–	–
Lankaran	3,5	1905, 1909,	1954	2002

Table 3.4.2 shows the replication of droughts with different intensity in autumn season and years of observation in Azerbaijan. 62.9% of the droughts that occurred in the autumn season were weak, 29.9% were mild and 7.2% strong. Of all the droughts that took place, 43.3% were observed in 1891-1940, 27.2% in 1941-1970 and 42% in 1971-2008.

The drought in the country over the last 10 years is illustrated in Table 1.8. The calculations were made using the standard precipitation index (SPI) (Table 3.1.1). According to estimates, almost 86% of the regions in 2017 have been dried up. In regions was 1 severe, 9 strong, 5 weak, and 6 medium intensity drought.

Table 3.4.3 Dry years in Azerbaijan in 2008 -2017

№	Stations	SPI precipitation index (annual prices)									
		2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
1	Shaki	-0,35	0,47	0,00	0,83	0,35	-0,89	-1,89	-0,72	1,21	-1,58
2	Zagatala	-0,96	0,63	-0,42	1,37	-1,09	-0,77	-1,09	-0,36	1,01	-1,59
3	Gabala	-0,05	-2,75	0,32	1,29	-0,87	-0,98	-2,05	1,65	0,70	-0,67
4	Guba	-0,56	0,45	-0,53	0,15	-0,66	1,15	-0,94	-0,50	2,04	-1,46
5	Khachmaz	-0,98	-0,28	-0,14	-1,29	1,12	0,61	-1,90	-0,20	0,81	-1,17
6	Griz	-0,32	0,28	0,04	-0,64	-1,30	-0,40	-1,37	-1,39	-0,41	-1,88
7	Ganja	-1,14	-0,51	0,80	-0,44	-1,83	-1,73	0,20	0,16	0,83	-0,70
8	Agstafa	-1,80	0,23	0,60	-1,03	-1,04	-0,96	-0,69	0,49	-0,21	-1,60
9	Gadabay	0,42	1,26	1,63	1,84	0,76	0,31	0,39	-0,62	0,39	-0,91
10	Lankaran	-0,17	-0,82	-0,48	1,75	-0,43	0,17	0,03	1,92	1,44	-0,15
11	Astara	-0,67	-1,82	-0,12	0,61	-0,95	0,00	-0,35	1,73	0,68	-1,18
12	Yardimli	-1,64	-1,11	-0,86	1,38	0,21	-0,85	-0,76	0,82	0,57	-1,03
13	Lerik	-0,64	-1,62	-1,67	1,05	0,56	-1,01	0,04	0,24	1,28	-0,06
14	Kurdamir	0,38	0,43	-0,22	2,15	0,07	1,12	-1,22	-0,57	0,39	-1,34
15	Goychay	-0,47	-0,51	1,29	1,08	-1,71	-0,86	-1,62	-0,19	-0,62	0,08
16	Yevlakh	-1,41	0,25	-0,11	0,02	-1,08	-1,59	-1,67	0,21	-0,32	-1,14
17	Jafarkhan	0,37	0,95	0,77	0,40	-0,63	0,12	-1,28	0,24	1,40	-2,04
18	Nakhchıvan	-1,67	0,94	0,19	1,59	-0,98	1,04	-1,03	0,37	-0,42	-0,59
19	Ordubad	-1,77	-1,44	-0,40	-1,16	-1,09	-0,95	-0,77	0,75	0,09	0,15
20	Baku	0,55	0,05	1,08	1,92	0,74	0,90	0,32	0,67	1,53	0,75
21	Mashtaga	-0,25	-0,98	-0,28	1,53	0,75	-0,18	-1,07	0,48	2,13	-0,19

Thus, the intensity of droughts has increased up to 10% in Azerbaijan over the past 10 years, the water availability of the rivers has diminished, resulting in considerable damage to productivity. While grain production increased by about 1 million tons in 2013 the annual harvest of winter grain was ineffective in 2014 due to dry winter. This impact was especially strong in mountainous areas and arid zones. In some regions, damage to the farm is estimated at $ 1 million. Productivity dropped to 5.2 centner / ha, at best it was 12 centner / ha. In 2017, the situation was even worse. Regular droughts also affect some of the population's demand for water in some regions.

4. Organizations and assignment of responsibilities

4.1. Organizational overview

A number of State bodies, specialized institutions and organizations are engaged in the management of water and environmental resources.

The Ministry of Ecology and Natural Resources (MENR) has responsibiliites related to the management of water sector, flooding, mudflow, submergence, landslide and natural disasters,including droughts. Its main functions include: preparing State programmes on the use and protection of water bodies; organizing hydrometeorology services, follow the implementation of proposals etc.

In the composition of the Ministry, there are Ecology and Nature Use Policy Department, Environmental Protection Office, National Hydrometeorology Department (NHD), regional field departments and other institutions which control rational use and protection of water bodies and lands. Hydrometeorological service is main body to warn about situation that may lead to meteorological and hydrological drought. This information is spread by special information chanals to CabMin and other related organizations.

Ministry of Agriculture in drought situations informs different organizations onnecessity of taking of drought impact mitigation actions.

The Ministry of Emergency Situations (MES), in line with its Statue, has necessary authorities in the area of management of flood, mudflow, submergence, landslide and other similar natural disasters in the country and carries out relevant functions, which include the following.

Water Resources State Agency under MES (WRSA), in line with its Statue, ensures reliable protection of water reservoirs of national importance, oversee technical maintenance of water reservoirs in the country, conducts monitoring of water bodies, hydrotechnical structures, water supply systems, and undertakes measures to improve water resources management. The Agency participates in the protection of water bodies, hydrotechnical structures and water supply systems in emergency situations and takes part in the mitigation of the results of the emergency situations jointly with other structural units of the Ministry and relevant public institutions.

MES and WRSA prepare and implement drought emergency plans jointly with other mentionednational level organizations,their regionaloffices and local gorernment in raions.

Emergency sitiations are managed by relevant national bodies and regional centers of the ministry in cooperation with permanatly acting emergency commsissions of administrative raions within the executive powrs of each raion.

Azerbaijan Amelioration and Water Economy (AAWE) OJSC, in line with its Charter, implements functions related to supply water consumers with water (primarily irrigation water) within its authorities, organize use of surface water bodies, operation and protection of state-owned amelioration and irrigation systems, distribute water taken from water bodies in the established order and organize control over use thereof, provide relevant state bodies with proposals on use, protection of surface water bodies and prevention of harmful effects of water, and monitoring data on surface water bodies , develop and implement measures on prevention of harmful effect of waters and mitigation of its results, organize operation of coast protection facilities.

AAWE OJSC together with SEDA and Azenergy company jointly act for prioritized use of waters in reservoirs and other waterbodies for irrigation and power production purposes according to drought emergency management plan.

“Azersu” OJSC, a non-state institution, and its relevant agencies and subordinate institutions deal with public drinkable water supply and wastewater management. It also via raion offices acts jointl with above organization and local government of raions for water management for drinking water supply of population as high priority sphere.

The state control on quality of water, particularly drinkable water is exercised by the Ministry of Health, its central and local bodies.Ministryof Health also via raion offices acts jointl with above organization and local government of raions for water safe way=er and sanitation in emergency situation and takes relevant measures to protect hyman health from negative consequences of droughts,.

The coordination between the state and non-state bodies function in the water sector of Azerbaijan and the leadership over the whole sector is exercised by the Cabinet of Ministers and its relevant departments.

National and offices of above organizations together with executuve powers of raions and municipalities are involved in drought management work. Main function of these organization in different stages ofdrought management id descrived below.

4.2. Assignment of responsibilities in relation to concfete stages of drought management

Drought Response Policy to manage drafts includes the establishment of authority, policy and procedures that describe the proper actions necessary for the protection of customer health, safety and welfare under described operating and drought conditions. This can be done by decisions of Cabinet of Ministers of Azerbaijan Republic.

This functions at first stage can be coordinated by the National Water Policy Diolofue Steering Committee (NWPD SC). Steering Committee includes representatives of Ministry of Ecology and Natural Resources (MENR), Ministry of Emergency Situations (MES), Ministry of Health (MOH), Amelioration OJSC, Azersu OJSC, MFA, National Academy of Science (NAS), BSU, NGOs, other national agencies members.

But there is need to see possibility of organizing acting entity as the Drought Autority by active participation of national and regional offices of above organizations can then effectively manage water demand during a drought-related shortage. The goal is to achieve the greatest customer benefit from limited supplies of water needed for domestic water use, sanitation, and fire protection and of allocate water for other purposes in an equitable manner.

This outlines the actions to be taken for the conservation of water supplied by water companies. These actions are directed both towards an overall reduction in water usage and the optimal use of available supply. The Drought Policy should authorizes and enables the Drought Administrator to declare the Drought Emergency and to enact the Phases of the Plan based on the system operating conditions that have been identified.

Upon its adoption, the Drought Administrator can then effectively manage water demand during a drought-related shortage. The goal is to achieve the greatest customer benefit from limited supplies of water needed for domestic water use, sanitation, and fire protection and of allocate water for other purposes in an equitable manner. This drought Policy should outline the actions to be taken for the conservation of water supplied by water purveyor. These actions are directed both towards an overall reduction in water usage and the optimal use of available supply.

The Drought Administrator should be authorised to declare the Drought Emergency and to enact the Phases of the Plan based on the system operating conditions that have been identified..

According to the Guideline A possible content for the DMP should include (taken from Report 2007):

- general river basin characterisation (national part):
- basic elements relevant to drought occurrence taken from the RBMPs, such as climate conditions, quantitative and qualitative status of water bodies, water
- demand, water availability (current amount and trend scenarios), water infrastructure characterization,
- irrigation systems, protected areas (e.g. wetlands), and land use
- drought characterization based on an evaluation of historical drought events
- indicators and thresholds for the classification of drought stages
- drought early warning system implementation
- programme of measures for preventing and mitigating droughts
- organizational structure of the DMP – the identification of a competent entity, committee or working group which will identify drought impacts and propose management measures
- update and follow-up to the DMP
- water supply plan providing specific information on the existing water supply infrastructure and available groundwater resources usable for mitigating drought impacts
- assessment of prolonged droughts in line with Article 4.6 of WFD (i.e. temporary deterioration of water body status)

It is important to remember that drought management based on risk reduction has three DMP phases:

- production
- implementation
- review/update

A national drought administration can ensure the execution of all phases. Specific tasks needed for each phase should be included in the DMP.

5. Drought monitoring forecast and impact assessment

5.1 The main signs of drought

Drought- depletion of water in the soil due to the rainfall below the normal for a long time period and high temperatures (as a result of evaporation and transpiration) in any season of the year thus the drought that is dangerous for all living organisms occurs.

Drought, as the main climatic indication, can occur unexpectedly every year, without recognizing any economic or political boundaries. Drought reduces productivity of agricultural products (especially grain yield reduces by 3-4 centner/ha), famine occurs, epidemiological situation, pests increase rapidly, forest and peat fires occur. Unlike other extreme events, droughts are a very poorly developed process, sometimes involving small regions and sometimes even an entire country. The reason for this is probably the fact that the area of falling rainfall is very different. Increasing costs for drought-reduction efforts, especially serious social and economic problems caused by it, has reflected the community and the issues such as drought impact assessment and monitoring became one of the foregrounding issues.

The drought is a physically complicated process that is why a certain criterion for its evaluation has not been developed yet. Drought indicators are separated into physical and biophysical indicators. Physical indicators include: rainfall, river level, river flow, groundwater level, soil moisture. Biophysical indicators include: yellowing of plant umbrellas, the formation of diaphoretic microorganisms, replacement of places of plants and animals.

Droughts differ in their form: (a) Atmospheric droughts are characterized by high air temperatures and low relative humidity (10-12%). This kind of droughts occurs as a result of the transfer of dry hot air masses and is called black wind. Long-term atmospheric droughts increase the evaporation and transpiration from the soil by the effects of dry hot winds.

Water vapor exhausts in the soil and drought begins; b) soil drought - the high temperature of the air and the insulation of the sun affects the active soil layer that result in lack of moisture and drying of the soil. The feeding patterns of the plants by the roots are degraded and cause their destruction; c) hydrological droughts - lack of rainfall in long-term is expressed by low levels of water in rivers, lakes, water reservoirs and underground waters; h) agricultural droughts – are expressed as the effects of meteorological and hydrological droughts into agricultural productivity.

5.2 Current monitoring, forecasting and data collection

The statistical reliability of 30 year drought indicators is very high in Europe. Among the largest and lowest values of the drought indicator parameter the average square fluctuations are 3-5 [10, 11].

M. Bogolepov has determined that the duration of this period is 33.5-35.5 years and as in Brikner it has been shown here that this period is not stable, ranging from 25 to 50 years. The nature of this era cannot be associated with the 3 layer 11 years solar cycle as in Brikner.

The durability of the drought cycle has a great practical and theoretical importance. The observations on the fluctuations of the Caspian Sea level indicate that it is 30 ± 2 years. The drought indicator index for this period is relevant to J.

Drought forecasts are part of the long-term weather forecasts. As known the self-affirmation of these predictions is much lower than short and medium-term forecasts.
The vast majority of forecasting issues are based on solar cycles. In the United States (flat regions), the tendency of recurrence of droughts was 20-22 years during the last 150 years.

Drought prediction in large areas should primarily be based on the prediction of the meteorological regime of the vegetation period. One of these methods is based on their periodicity. It is known that the meteorological characteristics of different regions and seasons are expressed in periods of different duration. Meteorological time series data (for the summer) allow us to explore the drought cycle. The drought index (J) that indicates humidity and the vegetation period temperature allow to explore 30 years of change (with 6 years average time periods).

The averaged drought data and drought index for 4 different regions of the USSR are synchronized with 6 years interval.

For three six years (1890-1895, 1920-1925, 1950-1955), which differed from each other about 30 years, the productivity was extremely low and meteorological conditions were extremely dry in the summer. The 30-year dry period has also been determined in the change of the level of the Caspian Sea. This is mainly due to rainfalls in the Volga River basin in Europe.

The statistical reliability of 30 year drought indicators is very high in Europe. Among the largest and lowest values of the drought indicator parameter the average square fluctuations are 3-5.

Robertsin's research shows that there is a link between droughts and solar cycles. In Borcher, Marshall, and Thomson, Robertsin's research, it has been reported that there is a 20-22 year interval recurrence in the trend of drought over the last 150 years. The recurrence phase of the drought has 22 years of solar cycle phase (not 11 years).

A. Mammadov identified that there is a high correlation relation between the total number of spots entering the solar cycles and drought repetitions. These correlations are 0.84 in Guba, 0.91 in Ganja, 0.72 in Baku and 0.58 in Nakhchivan **(**Table 5.2.1**).** The **k** in Table 5.2.1 is the correlation coefficient.

Table 5.2.1 Relations between the total number of spots in solar cycles and the number of droughts

Periods	Total of volf numbers	Guba	Ganja	Zagatala	Baku	Nakhchivan
1902-1913	373	4	4	9	7	9
1914-1923	447	0	5	9	17	8
1924-1933	411	8	3	9	8	15
1934-1944	611	14	13	17	14	17
1945-1954	751	14	15	17	14	14
1955-1964	956	19	17	12	15	20
1965-1976	710	22	18	15	15	13
1977-1985	819	23	16	14	12	11
average	635	13	11.4	12.8	12.8	13.4
k		0.84	0.91	0.6	0.72	0.58

Changing the level observed in Lake Victoria in the 1880-1930s has a positive (11-year cycles) correlation with precipitation falling in tropical zones, correlation was not observed until 1950, and negative correlation was observed in the next years.

The fluctuations in the Caspian Sea level in 1930-1940 have a positive correlation with the drought in Central Europe.

The movement of Iceland's minimum over the widths had impact on the features of winter cyclones over Europe being more evident in 1888-1973 (except 1923-1943). Drought prediction can be prepared by predicting precipitation anomalies [14].

5.3 Severity of Drought in Different Sectors

The severity of drought in the regions has been estimated based on data of the last 10 years in Azerbaijan (Table 5.3.1). The calculations were performed according to the SPI method (Table 3.1.1).

Table 5.3.1 Evaluation of drought severity in 13 territories of Azerbaijan with different characteristics (for spring and autumn seasons)

№	Stations	Spring III-V									
		2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
1	Shaki	-0,40	-0,48	1,67	0,65	-0,88	-0,38	-1,77	-0,51	-0,67	-1,28
2	Gabala	-1,69	-0,97	0,55	0,53	-0,53	-0,13	-1,21	-0,31	-0,77	-1,38
3	Guba	-0,91	-1,88	0,76	-1,18	-0,44	0,12	-1,16	-0,32	1,31	-0,55
4	Grız	-0,85	-1,15	0,90	-1,14	-0,47	-1,30	-0,40	-0,49	-0,81	-1,69
5	Agstafa	-1,36	-1,01	1,33	-1,06	-1,40	0,19	-0,36	0,68	-1,07	-0,72
6	Gadabay	0,42	0,39	2,20	1,77	0,99	0,47	0,40	-0,05	0,26	-0,56
7	Lankaran	-1,88	-0,21	0,80	-0,84	-1,17	-0,37	-1,24	-0,33	-0,36	-1,35
8	Lerik	-1,65	-1,39	-0,64	-1,06	0,87	-0,87	-1,17	-0,71	-0,01	-0,68
9	Goychay	-1,05	-1,35	1,28	0,36	-1,36	0,76	-1,17	-0,49	-0,36	-1,06
10	Jafarxan	-0,48	-0,41	1,80	-0,64	-1,05	-0,93	-1,33	-0,14	-0,24	-1,46
11	Nakhchıvan	-1,09	-0,92	1,02	0,98	-1,26	0,37	-0,61	0,59	-1,72	0,74
12	Baku	-1,07	-1,12	2,09	0,72	0,47	0,21	-1,05	0,29	0,50	-0,99
13	Mashtaga	-1,55	-1,59	0,71	0,20	-0,09	0,23	-1,52	-0,08	-0,15	-1,47

№	Stations	Autumn IX-XI									
		2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
1	Shaki	-1,18	1,04	-1,18	-0,34	0,53	-1,08	0,50	1,25	1,63	0,28
2	Gabala	1,38	0,47	0,92	-0,01	-0,65	-0,53	1,28	1,81	1,19	-0,10
3	Guba	-1,40	1,25	-0,17	-0,90	-0,67	-0,02	1,36	0,10	1,49	-1,05
4	Grız	-0,82	1,43	-0,92	-0,05	-0,93	-0,82	-0,68	-0,92	-0,59	-1,80
5	Agstafa	-1,80	-0,17	0,76	-0,40	0,73	-0,74	0,19	1,45	1,55	-0,61
6	Gadabay	-0,15	1,54	1,45	1,12	1,07	0,22	1,43	0,37	0,80	0,49
7	Lankaran	0,31	-0,83	-0,29	1,28	-0,07	0,27	1,23	1,21	1,90	0,90
8	Lerik	0,11	-0,64	-1,07	1,97	-0,12	-0,12	1,09	0,80	1,42	0,81
9	Goychay	0,03	1,22	0,68	1,14	-1,44	-1,41	0,43	1,19	0,09	1,05
10	Jafarxan	0,18	1,78	-0,59	1,41	0,20	0,36	0,92	0,03	1,80	-0,48
11	Nakhchıvan	-0,53	2,11	-0,55	0,59	-0,24	-0,25	0,31	1,83	0,71	0,75
12	Baku	0,35	0,19	0,65	1,75	0,12	0,27	0,90	0,43	2,07	1,00
13	Mashtaga	0,05	-0,63	-0,02	1,21	-0,85	-0,51	-0,02	-0,41	2,59	0,50

Table 5.3.2. Evaluation of the droughts severity in Azerbaijan in 2008-2017 (in spring)

The severity of drought	Shaki	Gabala	Guba	Grız	Agstafa	Gadabay	Lankaran	Lerik	Goychay	Jafarkhan	Nakhchivan	Baku	Mashtaga
Weak	6	5	4	5	2	2	5	5	2	6	2	1	3
Medium	1	2	2	3	5	-	3	3	5	3	2	3	1
Severe	1	1	-	1	1		1	1	-	-	1	-	3
Very severe	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 5.3.3 Evaluation of the drought severity in Azerbaijan in 2008-2017 (in autumn)

The severity of drought	Shaki	Gabala	Guba	Grız	Agstafa	Gadabay	Lankaran	Lerik	Goychay	Jafarkhan	Nakhchivan	Baku	Mashtaga
Weak	1	4	4	8	4	1	3	3	-	2	4	-	6
Medium	3	-	2	-	-	-	-	1	2	-	-	-	-
Severe	-	-	1	1	1	-	-	-	-	-	-	-	-
Very severe	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 5.3.2. and Table 5.3.3 show that 80% of the droughts in Azerbaijan were weak, 16% was moderate and 6% was severe in the last 10 years (in autumn). In spring, 57% of the drought is estimated to be poor, 36% moderate and 10% severe. Thus the weakest droughts in the territory of the Republic are repeated mostly and their impact can be minimized.

6. Drought risk and vulnerability

Drought has a special place in the research carried out to implement the world food program. The reason for this is that this phenomenon is closely related to the economy and it is a more dangerous process. The data on damage of droughts on farming areas each year can be found in a wide range of studies in different regions of the globe [13, 16]. However, researches in the area of drought and fertility interactions are far less than modern requirements. The reason for this is probably the lack of evaluation criteria. Thus productivity depends on both the drought and the effects of other climatic anomalies (strong precipitations, hails, frosts, strong winds, floods, pests, diseases). Therefore, it is difficult to define drought - fertility relations. Lack of a clear criterion in drought research, does not allow taking out and evaluating consequences of drought from among many natural anomalies.

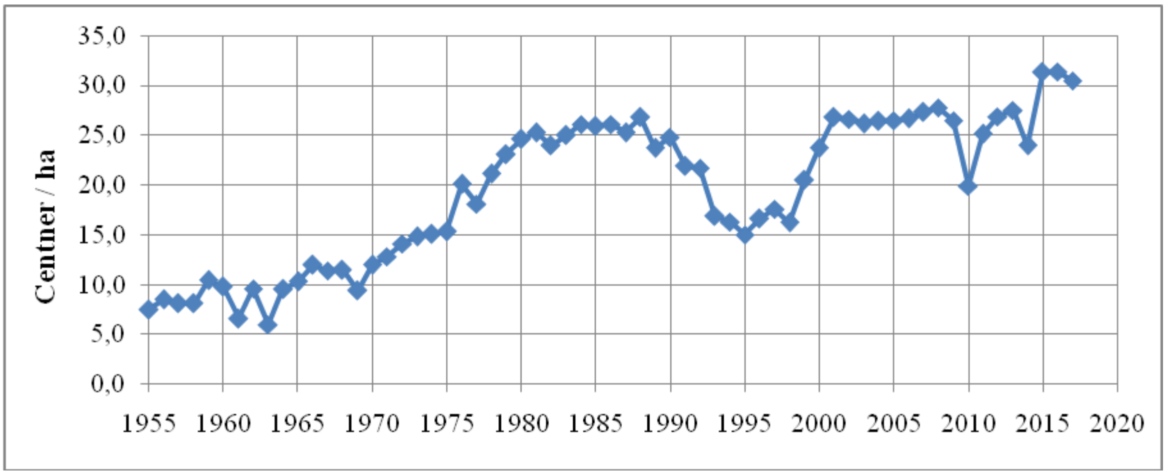

Figure 6.1 Autumn wheat yields over the Republic in 1955 - 2017, centner / ha

Figure 6.1 shows the autumn wheat yield in the Republic between 1995-2013. The maximum productivity in the graph appears to be 27.8 and 27.5 *centner* / ha in 2008 and 2013 respectively. By 2001, wheat yields continued to grow, followed by some stability until 2008 and a decline after 2009. Most declines were determined in 1995 and 2010. As seen, in 2010 the productivity dropped from 26.5 *centner* / ha to 19.9 *centner* / ha. This means a decline of about 25% of productivity.

Depending on the distribution areas, the droughts are divided into 5 categories: local areas covering less than 10%, 11 to 20% wide areas, 21 to 30% wider areas, 31 to 50% most wide areas, 50% large catastrophic area droughts. The drought that took place in Azerbaijan in 2010 belongs to large-scale category. During that time, about 30% of the territory of the Republic has been dried up.

Data from the State Statistical Committee of the Republic of Azerbaijan and the Department of Hydrometeorology were used to investigate droughts and fertility relations taking into account the various relief characteristics of Azerbaijan.

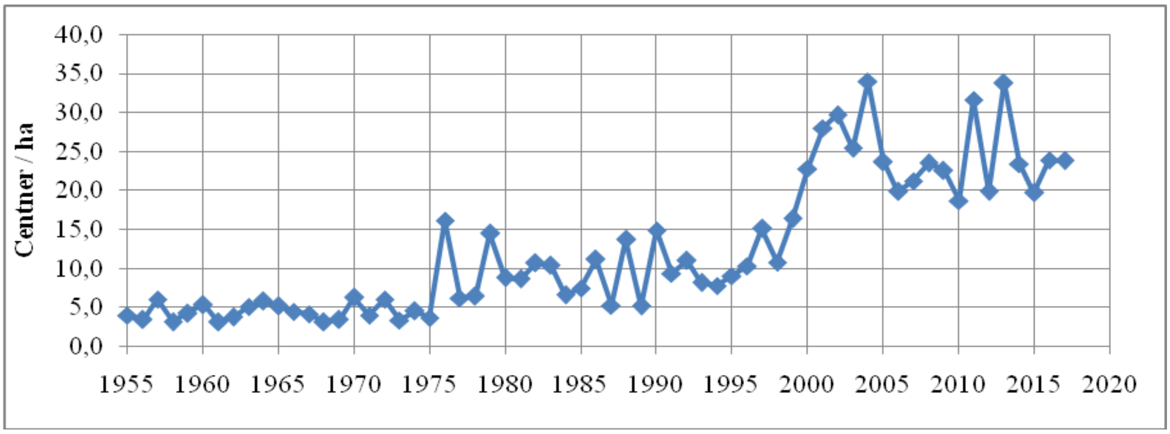

Figure 6.2. Spring wheat yields in Azerbaijan in 1955- 2017 (centner / ha).

Figure 6.2 show the yield of spring wheat in Azerbaijan has increased up to 30 centner per hectare from 1986 up to 2005 and decreased (10 centner / ha) in 2005 to 2008. In 1987- 1999, the increase in productivity was 5 to 15 centner / ha, whereas in 1999-2004 this increase reached to 18-32 centner / hectare and decreased up to 5-6 centner / ha in subsequent years. In the 1999-2008 time periods the productivity was relatively small.

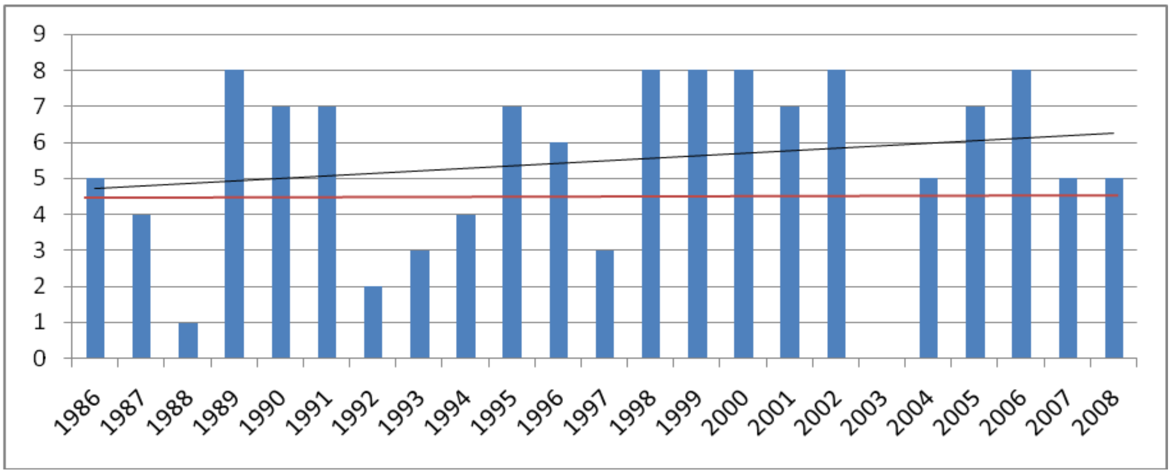

Figure 6.3. Droughts defined in 10 regions of Azerbaijan in 1986-2008.

As seen from Figure 6.3, the frequency of replication of droughts was higher between 1986 and 2008 than in the previous period and 21 drought cases in 23 years were recorded. Generally, the frequency of recurrence of droughts has increased up to 15% during the last warm-up period.

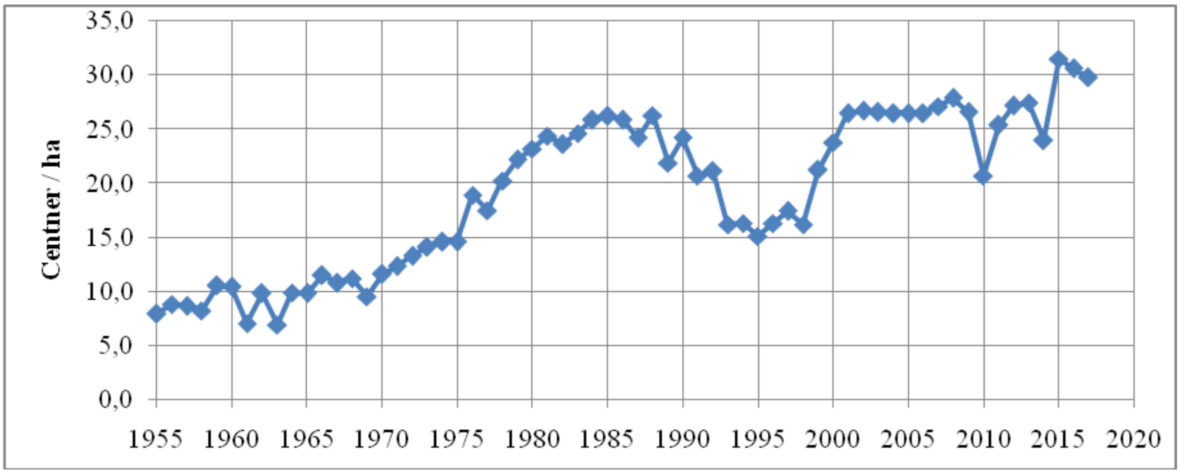

Figure 6.4.Total grain yield in Azerbaijan in 1955 - 2017 (cent. / ha).

Comparison of Figure 6.3 and Figure 6.4 shows that grain productivity in Azerbaijan decreased from 25 centner / ha to 15 centner / ha in 1986 - 1998. This certainly is due to the droughts in 8 out of 10 years in Azerbaijan during that time.

Certainly, the decline in productivity can be affected by some subjective factors, but the role of drought cannot be excluded as one of the main reasons.

Table 6.1 Droughts and productivity relations in regions of Azerbaijan.

Regions	Number of dry periods			Productivity Sent. / ha		
	2000	2005	2008	2000	2005	2008
Absheron	2	1	1	10,6	14,3	14,2
Ganja	3	1	2	14,5	24,2	16,6
Dashkasan	2	1	1	6,1	10,5	20,2
Zagatala	2	2	2	27,4	32,8	37,5
Lankaran	3	1	1	22,8	21,0	19,7
Guba	3	3	2	9,0	23,7	22,9
Jafarkhan	2	2	-	30,9	42,0	38,3
Shamakhı	3	2	1	0,0	23,5	20,6
Nakhchivan	1	-	1	5,6	38,7	21,5

As shown in Table 6.1 the productivity has declined in most regions due to dry periods. However, in some regions, this pattern is broken, which may have other reasons, as we mentioned before. Studies conducted for the Shamakhi show that despite the fact that three seasons was dry in the year 2000, the productivity situation was not so different from the productivity in 2008 (one season was dry). The drop in productivity in Shamakhi in 2008 is explained not by the fact of drought but by the fact that the rainfall was higher than normal. In the mentioned year in Shamakhi, rainfall was 15 mm above the normal in winter, 40 mm in spring, 110 mm in summer and 67 mm in autumn. In Dashkasan, the productivity has dropped dramatically (6.1 c / ha) as a result of the moderate and severe drought in the vegetation period of the plants in 2000. In subsequent years, the severity of the drought was moderate and weak that is why the productivity has been increased respectively. Notwithstanding the fact that in some year’s drought in the area was high but the productivity is not changed at all. Such areas are not sensitive to drought because of the long-term moisture content of the soil. These areas can be found on the north-east and south slopes of the Greater Caucasus, in the middle and highland regions of the Lesser Caucasus, in the Kura-Araz lowland. On the contrary, in the Lankaran natural area, the area is more vulnerable to drought.

It is known that many criteria are currently used in the researching of the droughts. When compare standardized precipitation anomalies (SPI) method and the methods suggested by Pétén, it was determined that, although some of the dry years are mentioned in the method proposed by Péten, the SPI method considered those years as a very weak category or is not considered as a dry year at all. This is due to the degree of sensitivity of the methodology. For example, the use of hydrothermal coefficients in drought researches of arid zones can lead to great controversy. The high temperatures in these areas (especially in the global warming period) and the lack of rainfall make it difficult to determine the probability of origin of drought. In general, the temperature, precipitation, and evaporation are accepted as the main indicator of drought. During the global warming period, the temperature can be fixed as a drought criterion. Hence, the probability of drought is determined by soil evaporation and precipitation. In arid zones, the amount of water in the soil is usually small. In these zones, the value of possible evaporation is great. Therefore, in these areas, droughts can only be determined by one parameter, only for the amount of rainfall. Generally, the possibility of recurrence of droughts in Azerbaijan is more than 50%. According to Table 6.1, drought was recorded 3 times in 4 years in Absheron, of which 2 times replicated in 2000, dropping productivity up to 4s / ha. In Ganja drought was registered 3 times in 2000, with productivity dropping to 10 s / ha and it was registered 2 times in 2008, with productivity dropping to 8 s / ha.

Thus, according to Table 6.1 drought-sensitive and areas not vulnerable to droughts can easily be selected in the territory of the Republic.

7. Drought early warning

According to the manual one of the main objectives of the NHD of MENR is to establish a reliable early warning system based on appropriate indicators and thresholds that classify drought stages according to drought intensity and impact severity.

The main objective of the early warning system is to provide timely warnings about:

- actual drought status in real time to enable decision-makers (Drought Committee) to take adequate measures (e.g. arrange a meeting of the Drought Committee)
- drought severity for stakeholders (e.g. farmers) that could be potentially affected by drought, currently or in the near future, enabling them to take appropriate measures (e.g. activation of irrigation systems)

Early warnings should be provided according to time period (adjusted according to stakeholder requirements):

- short-term warnings (1-7 days)
- medium-term warnings (10-15 days)
- seasonal forecasting (3-6 months)

To obtain timely information and a sufficient amount of spatial data about the actual drought situation, it is necessary to analyze the existing monitoring network for drought indicators that have been selected for the early warning system. The analysis should focus on examining the number of monitoring stations and frequency of measurements. An effective warning system should provide real-time information that is updated at least weekly. Usually, an upgrading of the existing monitoring system is needed, to increase the frequency of measuring the chosen indicators. A rational selection of representative monitoring stations is also needed to ensure comprehensive coverage.

In addition Ministry of Agriculture develop con consider necessity to develop agricultural drought monitoring methods by use of remote sensing data for the appropriate early warning of droughts before irreversible crop yield loss and/or quality degradation occur. (See description: www.gwp.org/GWP-CEE/IDMPCEE/)

To deliver early warnings to the general public, it is recommended to use existing technical means that are being applied to other types of warnings (e.g. floods). It is usually possible to transfer information to the publicthrough web and/or electronic communications, media (e.g. radio, TV), or special brochures.

As an example the early warning system used by different countries can be used for agricultural drought monitoring. For example in Table below is given example of Slovenia which is suitable tfor Azerbaijan as well.

Table 7.1: Early warning system in Slovenia: three-level concept of agricultural drought monitoring

Level	**Activity**	**Description**	**Indicators**
Level 1	Early drought warning	Precipitation deficit (meteorological drought)	SPI3 < –1, Share of cumulative precipitation in the vegetation period (% of long-term average)
Level 2	First signs of agricultural drought	Meteorological water balance (reference crop)	Meteorological water balance below statistical threshold (percentile analysis): - 75^{th} percentile – dry - 90^{th} percentile – very dry - 98^{th} percentile – extremely dry
Level 3	Agricultural drought	Agricultural crop drought stress (water balance for specific crop)	$DISS_k$ for selected crop: - 75^{th} percentile – dry - 90^{th} percentile – very dry - 98^{th} percentile – extremely dry

If the preliminary evaluation indicates the possible need for a drought response declaration the corresponding hydrologic region the drout administration should be onsulted to determine the potential severity of the drought condition (s), and the expected impacts. The authority can make a determination of the appropriate level of response, if any, to be made. All related national structures, their regional offices and local governments and water supply providers should be notisified to take needed actions. Press releases can be prepared explaining the situation and state response requirements.

In addition Ministry of Agriculture may consider necessary to develop agricultural drought monitoring and response methods by use of remote sensing data for the appropriate early warning of droughts before irreversible crop yield loss and/or quality degradation occur. (See description: www.gwp.org/GWP-CEE/IDMPCEE/)

Related sectors and water providers at nationaland local levels should develop their own water conservation plans.

8. Establishment of the national drought indicators system

8.1. Drought indicators

A national drought indicator system is one of the key elements of the DMP. It is an essential step in drought management which enables the identification and evaluation of drought conditions and the quantification of drought impacts. Due to the complexity of drought variability caused by climatic and geographic conditions, different parameters should be included in the national indicators system.

The national indicator system should be comprehensive, comprising of appropriate parameters and indicators needed for the characterization and evaluation of each type of drought, including the evaluation of different time categories of drought (e.g. historical drought event, ongoing drought episode, future drought).

The complete drought indicator system should include the described in previous chapters different sets of indicators grouped into the following sub-systems:

Sub-system 1: appropriate indicators for the evaluation of different drought types:
- meteorological drought based on climate parameters – e.g. precipitation, temperature, evapotranspiration
- hydrological drought based on hydrological parameters – e.g. river flow, groundwater level
- agricultural drought based on parameters characterising the water deficit in soil (i.e. soil moisture indexes)
- socio-economic drought based on a socio-economic impact assessment

Sub-system 2: sets of indicators appropriate for the:

- evaluation of historical or past drought events
- national drought early warning system
- Additional sets of indicators are needed for the identification of a `prolonged droughtr and the evaluation of impacts associated with the temporary deterioration of surface water quality (i.e. where the `goodecological statusr of water bodies, as required by the EU WFD, is not met).

8.2. Thresholds for different drought stages

Drought should be characterised according to different levels of drought intensity and impact severity. The recommendation is to follow the Report 2007 which provides drought classification definitions for four drought stages characterised as:

- Normal status – no significant deviation in relation to average values is observed
- Pre-alert status – declared when monitoring shows the initial stage of drought development
- Alert status – declared when monitoring shows that drought is occurring and will probably have impacts in the future if measures are not taken immediately
- Emergency status – declared when drought indicators show that impacts have occurred and water supply is not guaranteed

Pre-alert status: The objective here is to prevent the deterioration of water bodies while ensuring the activation of specific drought management measures and meeting water demands. These are mainly informative and control measures, as well as voluntary water-saving measures.
Alert status: This is an intensification of the pre-alert status, where drought, and measures to address it, increase. A priority is to prevent the deterioration of a water body’s status. Measures focus on saving water. Demand restrictions might be applied, depending on the prioritization of

the most vulnerable groups affected by drought. Areas with high ecological value should be monitored more intensively to prevent deterioration.

Emergency status: If all previous prevention measures have been applied, the drought situation becomes critical, and water resources are insufficient to meet essential water demands (affecting and restricting public supply), then additional measures may be used to minimize the impacts on water bodies and ecological systems.

The classification system must be based on threshold values that have been determined for the chosen drought indicators. Thresholds of droughts in Azerbaijan are assessed for different regions according to severity degrees of drought indicators in previous chapters (See Table 8.2.1).

Table1 8.2.1 Drought severity rate

SY	Degree of droughts
0,0 - (- 0,99)	Poor
(-1,0) - (-1,49)	Medium
(-1,5) - (-1,99)	Strong
-2,0 and lower	Very strong

According to this and Tables 3.1.2 and 3.1.3 can be assessed different drought emergency situations for different regions of Azerbaijan.

8.3. Predrought strategies and drought responses

Pre-drought strategies" are longer-term actions, implemented before a drought, for the purposes of preparedness, mitigation, monitoring, and conservation. "Drought responses" are shorter-term actions, implemented during a drought, according to the level of drought severity

Main strategies can cover importance of undertaking of below actions to be taken by future National Authority responcible fro drought management by involvement of oabove key related ministries (MoES, MENR, WRSA, MoA, MoH and others), water management organizations for irrigation and drinking water supply(Azersu OJSC, Amelioration OJSC), organizatiosn on Water use for isntustry and Hydropower generation (MoI, Renuable Enregy Agency, Azenergi OJSC), permanatly acting emergency commsissions of administrative raions within the executive powrs of each raion, municipalities and other organizatiosn:

- Establish a drought communications system between the state and local governments and water systems.
- Development and implementation of a statewide water conservation program to encourage local and regional conservation measures
- Provide guidance to the local governments and water supply providers on long-term water supply, conservation and drought contingency planning.
- Implementation of the local governments and water supply providers' conservation and drought contingency plans.
- Encourage water re-use as opposed to additional withdrawals of raw water.
- Work with local water systems to provide water efficiency education for industry & business.
- Conduct voluntary water audits for businesses that use water for production of a product or service.

- As a long-term strategy,develop programs to assist communities impacted by drought effects on vulnerable industries.
- Assess and classify drought vulnerability of individual water systems (e.g., # of days/weeks supply remaining under certain drought conditions, water source, and soil moisture).
- Define pre-determined drought responses, with outdoor watering restrictions being at least as restrictive as the state minimum requirements listed below.
- Establish a drought communications system from local governments and water supply systems to the public.
- Recommend that farmers attend classes in best management practices and conservation irrigation, prior to (i) receiving a permit, (ii) using a new irrigation system, or (iii) irrigating for a coming announced drought season.
- Encourage the development and distribution of information on water efficient irrigation techniques.
- Encourage the use of more drought resistant crops, subject to market conditions.
- Encourage the use of innovative cultivation techniques to reduce the amount of water needed or lost by a crop during summer.
- Provide farmers with normal year, real time irrigation, irrigation scheduling, and crop evaporation/transpiration information.
- Recommend regular irrigation system efficiency audits and for older systems, recommend retrofitting with newer and better irrigation technology.
- Support legislation and efforts (research, loan opportunities, and infrastructure improvements) to enhance the ability of farmers to secure adequate water supplies during drought conditions. For instance, establish low interest loan program for construction of on-farm off-stream storage facilities (ponds for surface water irrigation).
- Develop and execute an effort to identify pollutant load reduction opportunities by wastewater discharge permit holders (i.e., below levels in wastewater discharge permits).
- Develop and execute an effort to identify opportunities for industry to decrease water use during drought periods (i.e., use less water in producing products and services during drought, and thereby potentially reducing quantity of wastewater discharged).
- Evaluate the impact of water withdrawals on flow regimes and the impact of wastewater discharges on water quality during drought.
- Provide for protection of recharge areas through measures including land purchase or acquisition of easements.

Drought response actions may include below outdoor Watering Reduction Schedule:

- Outdoor watering other than those exempted activities is to occur only on scheduled days.
- Prior to onset of declared drought conditions, outdoor water use can occur during any hours on the scheduled days.
- During declared drought conditions, outdoor water use will only be allowed during scheduled hours on the scheduled days.

9. Drought mitigation programme of measures

9.1. Drought impact assessment

Impact assessment examines the consequences of a given drought event on human and economic activities as well as on the environment. Impact assessment should be part of the assessment of historical drought events (if data is available), and inevitably must be part of the risk assessment of future drought events. Drought is usually associated with a number of impacts that result from a reduction of water availability during a drought period or episode. Drought can affect a wide range of water-dependent users in different sectors. It is necessary to evaluate a potential impact for each user (or group of users) and subsequently make a comprehensive impact assessment for the whole area. It is appropriate to classify the types of impacts into three categories: economic, environmental, and social. A detailed checklist of impacts is provided in Table 9.1.1 (Source: Drought Management Guidelines: prepared by European Commission, MEDA Water, and MEDROPLAN).

Table 9.1.1: Overview of main drought impacts

Category of drought impact	Drought impact
ECONOMIC	Decreased production in agriculture, forestry, fisheries, hydroelectric energy, tourism, industry, or financial activities that depend on these sectors Unemployment caused by decreased production Economic damage due to reduced navigability of streams, rivers, and canals Damage to the tourism sector due to reduced water availability in water supply and/or water bodies Pressure on financial institutions (e.g. more risks in lending, capital decrease) Income reduction for water firms due to reduced water delivery Costs in emergency measures to improve resources and decrease demand (e.g. additional costs for water transport and removal, costs for advertising to reduce water use)
ENVIRONMENTAL	Decreases in water supply and the quality of surface water and groundwater Damage to ecosystems, wetlands, and biodiversity (e.g. soil erosion, dust, reduced vegetation coverage) and disease Land degradation and desertification More and larger fires Lack of feed and drinking water Increased salt concentrations (e.g. in streams, underground layers, irrigated areas) Loss in natural and artificial lakes (fish, landscapes, etc.) Damages to river and wetlands life (e.g. flora, fauna, habitats) Damage to air quality (e.g. polluting dust)
SOCIAL	Damage to public health and safety, by affecting air and water quality or increased fire risk Increase in social inequality, through larger impacts on specific socio-economic groups
Category of drought impact	**Drought impact**
SOCIAL	Tensions between public administrations and affected groups Changes in political perspectives Inconveniences due to water rationing Impacts on way of life (e.g. unemployment, reduced capacity to save funds, difficulty in personal care, reuse of water at home, street and car washing prohibition, doubt on future, decrease of celebrations and amusements, loss of property) Inequity in drought impacts and mitigation measures distribution Abandoning of activities and emigration (in extreme cases)

9.2. Program of measures

A programme of measures is a crucial element of a DMP. Its main objective is to minimize the risk of drought impacts on the economy, society, and environment. A programme of measures should be designated for each drought stage (i.e. normal, pre-alert, alert, and emergency).

The measures can be classified according to their purpose and grouped as follows (as stated in Report 2007):

- preventive or strategic
- operational
- organizational
- follow-up
- restoration

Preventive or strategic measures are developed and used under normal status. The aim is to increase resistance to drought and mitigate potential drought risk and impacts on the economy, society, and environment. The program of preventive measures should be interconnected with the program of measures included in RBMPs developed in line with WFD requirements. The direct links between drought issues covered by the DMP and integrated water management issues covered by RBMPs should be ensured through an assessment of groundwater quantitative status and of the ecological status of surface water bodies.

Preventive or strategic measures included in the DMP are only complimentary to those measures adopted in the RBMP that relate to quantitative groundwater status and ecological surface water status aimed at achieving good water body status. They can also contribute to the mitigation of drought risk. Clear links between both programmes of measures in the RBMP and DMP must be ensured.

In order to improve the resilience of aquatic ecosystems, it is necessary to follow the water efficiency options and suggestions provided in the Communication from Commission A Blueprint to Safeguard Europers Water Resources, adopted in 2012 (Blueprint). Green infrastructure, particularly natural water retention measures (NWRM), is among the measures that greatly contribute to limiting the negative effects of droughts. This includes restoring floodplains and wetlands which can hold water in periods of excessive precipitation. NWRM can provide multiple benefits for various sectors and policies and should be included in action plans (e.g. River Basin Management Plans, Flood Risk Management Plans, Rural Development Programmes, Adaptation Strategies, Natura 2000 management plans, and local development plans).

Operational measures are typically applied when droughts occur, during pre-alert and emergency status. Operational measures should be based on the management objectives specified for each drought stage

(1) Pre-alert

The management objective in the pre-alert phase is aimed at preparing for the possibility of drought impacts and preparing the Drought Committee and affected stakeholders for future actions. The main actions should be focused on: the activation of the Drought Committee; intensification of monitoring; and managing a drought early warning system that increases public awareness and evaluates future scenarios. The measures in the prealert situation are generally of an indirect nature (e.g. recommendations), implemented by stakeholders on a voluntary basis (e.g. through irrigation measures).

(2) Alert

The management objective here is to overcome the drought and avoid the emergency situation. The priority is to mitigate drought impacts that have already affected specific water use groups and prevent the deterioration of a water body’s status. Measures should preferably be focused on saving water. Demand management measures, including partial restrictions for water uses, may be applied, depending on their socio-economic impacts and the consensus of affected stakeholders. Areas with high ecological value should be monitored more intensively to prevent their deterioration.

(3) Emergency

The management objective is to mitigate impacts and minimize damages. The priority is to satisfy the minimum requirements for drinking water. Other water uses are second priority. Measures adopted under drought emergency conditions may be: non-structural, such as water restrictions for all users (including urban), or subsidies and low interest loans; or structural, such as new infrastructure, permission for new groundwater abstraction points, and water transfers.

The application of operational measures should be linked to specific advisory services. For example, advisory services for irrigation have been established in some countries to provide information to farmers about the recommended irrigation dose at a given stage of drought.

Organizational measures establish an appropriate organization to ensure the production and implementation of the DMP and the enforcement of programmes of measures. They can also create coordination protocols among administrations and public and private entities directly affected by the drought, especially those managing public water supply. Organizational measures should be specified for all drought stages.

Follow-up measures assess compliance with the DMP and the effects of its implementation.

Restoration or exit drought measures include the deactivation of measures adopted during the drought event (e.g. restrictions for water abstraction) and the activation of restoration measures aimed at the achievement of normal status for water resources and the aquatic ecosystem.

10. Water Conservation Practices/Public Education Awareness and Outreach

10.1 Water Conservation

Some conservation measures may include:

1. Eliminate the washing down of sidewalks, walkways, driveways, parking lots, tennis courts, streets and other hard surfaced areas;
2. Eliminate the washing down of buildings for purposes other than immediate fire protection
3. Eliminate the flushing of gutters
4. Eliminate the domestic washing of motorcycles, motorbikes, boats, cars, etc.;
5. Eliminate the use of water to maintain fountains, reflection ponds and decorative water bodies for aesthetic or scenic purposes, except where necessary to support aquatic life. Eliminate filling or maintaining customer or private swimming pools;
6. Reduce watering of lawns, plants, trees, gardens, shrubbery and flora on private or customer property to the minimum necessary. Encourage outdoor watering to be done during off-peak hours.
7. Reduce the amount of water obtained from fire hydrants for construction purposes,
8. Discontinue fire drills or for any purpose other than fire-fighting or flushing necessary to maintain water quality;
9. Limit normal water use by commercial and individual customers including, but not limited to, the following: Stop serving water in addition to another beverage routinely in restaurants; Stop maintaining water levels in scenic and recreational ponds and lakes, except for the minimum amount required to support aquatic life. Limit irrigating golf courses and any portion of their grounds that use finished water

10. Cease water service to customers who have been given a 10-day notice to repair one or more leaks and have failed to do so. Limit expanding commercial nursery facilities, placing new irrigated agricultural land in production, or planting or landscaping when required by site design review process.

11. Intensify maintenance efforts to identify and correct water leaks in the distribution system.

12. Cease to install new irrigation taps on the water system.

13. Control landscape irrigation by the utility's customers by staggering watering times

14. Continue to encourage and educate customers to comply with mandatory water conservation.

10.2. Publicize Drought Management Plan for public involvement

The aim of publicizing the DMP is to encourage public participation and the active involvement of interested parties in the production, implementation, and updating of the DMP. Public participation is an essential element of the drought management system and representing an opportunity to achieve consensus around the social, economic and environmental aspects of the plan. The process of public participation relates to:

- publishing the DMP (including provisional planning documents)
- making the DMP available for comments
- consultations aimed at active involvement of the interested parties

10.3. Research and science programme

The Drought Autority should identify the needs of a national scientific and research programme which can contribute to a better understanding of drought, its impacts, and mitigation alternatives. The development of the programme should be connected with the process which identified gaps and uncertainties during DMP production, taking into account relevant related issues (e.g. existing knowledge on climate change and its impacts on water resources, new effective monitoring methods based on remote sensing data, harmonisation of data inventory).

10.4. Educational programme

A broad educational programme should be developed by the Drought Autority the new drought risk management policy by providing information on the DMP and the prmeasures associated with the needs of specific groups affected by drought. Preferably oriented to interested groups at the local level (e.g. decision-maker). The development of education programmes includes:

- establishment of a task group responsible for training activities
- identification of vulnerable groups potentially affected by drought and g decision-makers
- scope, time frame, form (e. g. workshops, education trainings)
- development of training materials

11. Recomendation and implementation action

11.1. Action Plans

In future it is important to complement and enhance this national plan, in close collaboration with stakeholders to develop a series of action plans, where appropriate, to better manage water scarcity at a local level. As plan sets out the principles of water scarcity management, the action plans will identify local triggers that will initiate specific measures to be taken and include specific steps related to individual authorizations or groups of authorizations.

The action will be based on triggers initially at a catchment scale but could be refined where certain areas are particularly vulnerable.

An agricultural sector id important in Azerbaijan and requires large volumes of water to be abstracted from the water environment to irrigate crops during dry periods when the resource is already under stress and in future climate change may increase the water stress drier summers. Therefore it is important to liaise with the farming community and their representatives to develop a plan which will seek to implement appropriate measures to mitigate the impacts on the environment while endeavoring to achieve proportionate use of water.

It is important that as much work as possible is done in advance to enable the sector to manage prolonged dry periods in a more efficient manner.

It is necessary to work with the farmers to review catchments which are under pressure; that work and towards water scarcity planning. By making information available to those who irrigate it gives them a chance to take appropriate and timely action.

11.2. Future planning

The water scarcity plan may help to manage water resources in dry periods and will help to secure the sustainable use of the water environment, maximize the benefits of healthy water environment for people and businesses. It will also help for improved resilience to climate change, biodiversity, forestry, flood risk management, fisheries and sustainable land use.

Measures to address the impacts of diffuse pollution such as managing inputs to land through improved soil management will also slow rainwater run-off and reduce the impacts of water scarcity and flood risk.

It needs to be continued to raise awareness of the need to adapt to climate changes and adapt our approach accordingly whilst working with others. For example working with water users and environmental organizations to identify areas most at risk in dry periods now and in the future will show necessity to consider contingency planning.

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