Drought Conditions and Management Strategies in Jordan

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Background:

Drought is a normal component of the climate and agriculture in most countries of the Middle East. During the past decades, Jordan has suffered from recurrent drought episodes, which have seriously affected economic growth and social development of the country. The drought has occurred more frequently during the 1970s, 1980s and 1990s, the worst recorded in the last 32 years was in 1999-2000. The drought has already severely affected agriculture and livestock with dramatic social, economic and environmental impact.
Government of Jordan effort is not sufficient to address the serious consequence of the drought. Government of Jordan recognizes the urgent need to develop appropriate strategy and action plan for drought preparedness and mitigation particularly for the agricultural sector. Experience elsewhere has shown that countries with long term drought management policies, like Australia, South Africa and some States of the USA are generally better prepared to deal with drought than those just managing the crisis.

Rainfall in Jordan

The following main points may be concluded from the spatial analysis of rainfall in Jordan.

- The northern parts of Jordan receive the highest amount of rainfall, in comparison to the northern and the southern stations of the same region as shown Table 1. This may be attributed to the high frequency of winter storms in the northern parts.
- The eastern side stations have lower amounts of rainfall due to their locations in the lee side of the mountains. Even among the stations of one region the eastern stations, such as Amman in the east of mountainous region has annual rainfall of about 264mm, where Madaba station in the west within the same region has annual rainfall of about 354 mm.
- The rate of decrease in rainfall along in the southeast direction is more than the rate of decrease in the south or east directions alone. This is because the southeast direction join two factors that causing decrease in rainfall. These are the east direction in the lee mountain side with the southward direction, which lies way from the tracks of winter storms. Each eastward and southward direction has decreasing factors mentioned above.
- Table 2 shows Land Distribution According to Climatic Zones and the amount of rainfall fall on each climate zone area

Table 1 Rainfall behavior across Jordan

Area		Station	Annual average precipitation (mm)
Jordan valley	North ↓ South	Baqura	397
		Deir Alla	293
		Ghor Safi	77
		Aqaba	30
Mountainous region	North ↓ South	Irbed	472
		Ras Munif	584
		Amman	264
		Madaba	354
		Errabah	348
		Tafileh	240
		Shoubak	279
		Ma'an	42
North desert region	West ↓ East	Mafraq	160
		Azraq	60
		Safawi	74
		Ruwashed	84
Eastern desert region	West ↓ East	Maa'n	42
		Jafor	32

Table 2 Land Distribution According to Climatic Zones

Climatic Zone	Average Annual Rainfall (mm)	Area (Million dunums)	% Of the Total Area
Badia(Semi-desert)	< 200	80.4	90.2
Dry	200-350	5.7	6.4
Semi-dry	350-500	2.0	3.2
Semi-humid	>500	1.0	1.1
Total		**89.3**	**100.0**

Drought monitoring and early warning systems:

Drought from Meteorological perspective is a period (months or years) when precipitation levels drop below the long-term average. Drought has been studied by several methods and techniques.

The drought intensity is defined by McKee et.al (1993) by using standardized precipitation index (SPI) is shown in Table 2. The SPI is not a drought prediction tool but it can also be used to determine periods of anomalously wet events, high SPI value (closer to 3) indicate heavy precipitation event over time period specified, Medium SPI value (approximately = 0) normal precipitation event over time period specified**.**

Table 2

Rainfall Season	Jordan Valley														
	Baqura			Wadi El-Rayyan			Deir Alla			Ghor Safi			Aqaba		
	Rainfall	Performance %	SPI	Rainfall	Performance %	SPI	Rainfall	Performance %	SPI	Rainfall	Performance %	SPI	Rainfall	Performance %	SPI
1975/1976	323.4	81%	-0.5	240	78%	-0.6	202	69%	-0.8	68.7	94%	-0.2	27	90%	-0.1
1976/1977	377.1	95%	-0.1	369	120%	0.5	262	89%	-0.3	60.7	83%	-0.6	14	48%	-0.7
1977/1978	383.5	97%	-0.1	245	79%	-0.5	212	72%	-0.8	38.3	52%	-1.5	37	122%	0.3
1978/1979	279.7	70%	-0.9	270	88%	-0.3	172	58%	-1.1	49.9	68%	-1.0	37	122%	0.3
1979/1980	632.1	159%	1.7	515	167%	1.7	457	155%	1.5	72.1	98%	-0.1	10	35%	-0.9
1980/1981	431.9	109%	0.3	216	70%	-0.8	267	91%	-0.2	101.0	138%	1.2	49	164%	0.9
1981/1982	222.1	56%	-1.3	347	113%	0.3	256	87%	-0.3	46.5	63%	-1.2	48	160%	0.8
1982/1983	496.7	125%	0.7	226	73%	-0.7	374	127%	0.8	88.6	121%	0.7	16	53%	-0.6
1983/1984	305.1	77%	-0.7	285	93%	-0.2	230	78%	-0.6	31.7	43%	-1.8	9	30%	-1.0
1984/1985	359.0	90%	-0.3	320	104%	0.1	210	71%	-0.8	71.2	97%	-0.1	15	51%	-0.7
1985/1986	354.2	89%	-0.3	487	158%	1.5	240	81%	-0.5	96.5	131%	1.0	53	177%	1.0
1986/1987	430.1	108%	0.2	415	135%	0.9	297	101%	0.0	79.7	109%	0.3	30	101%	0.0
1987/1988	441.2	111%	0.3	333	108%	0.2	347	118%	0.5	95.1	130%	0.9	69	230%	1.8
1988/1989	284.8	72%	-0.8	234	76%	-0.6	248	84%	-0.4	98.2	134%	1.1	21	69%	-0.4
1989/1990	518.3	130%	0.9	388	126%	0.7	300	102%	0.1	91.0	124%	0.8	37	122%	0.3
1990/1991	365.3	92%	-0.2	357	116%	0.4	253	86%	-0.4	106.6	145%	1.4	62	207%	1.5
1991/1992	918.3	229%	3.9	505	164%	1.6	598	203%	2.8	83.1	113%	0.4	12	39%	-0.8
1992/1993	449.2	113%	0.4	311	101%	0.0	286	97%	-0.1	70.6	96%	-0.1	10	32%	-0.9
1993/1994	311.8	78%	-0.6	257	84%	-0.4	184	62%	-1.0	88.1	120%	0.6	85	284%	2.5
1994/1995	438.8	110%	0.3	396	129%	0.7	382	130%	0.8	106.8	146%	1.5	23	77%	-0.3
1995/1996	365.7	92%	-0.2	252	82%	-0.5	241	82%	-0.5	56.9	78%	-0.7	2	5%	-1.3
1996/1997	390.0	98%	-0.1	507	165%	1.6	380	129%	0.8	60.7	83%	-0.6	13	45%	-0.8
1997/1998	459.1	116%	0.5	300	97%	-0.1	360	122%	0.6	101.2	138%	1.2	37	122%	0.3
1998/1999	174.3	44%	-1.6	120	39%	-1.5	118	40%	-1.6	60.1	82%	-0.6	31	104%	0.1
1999/2000	352.8	89%	-0.3	658	214%	2.9	261	89%	-0.3	18.3	25%	-2.4	4	13%	-1.2
2000/2001	327.8	82%	-0.5	376	122%	0.6	245	83%	-0.4	69.5	95%	-0.2	27	88%	-0.2
2001/2002	401.2	101%	0.0	224	73%	-0.7	347	118%	0.5	55.7	76%	-0.8	9	31%	-0.9
2002/2003	656.4	165%	1.9	326	106%	0.2	476	162%	1.7	74.0	101%	0.0	11	37%	-0.9
2003/2004	289.6	73%	-0.8	128	42%	-1.5	181	61%	-1.0	87.2	119%	0.6	15	48%	-0.7

Drought Duration

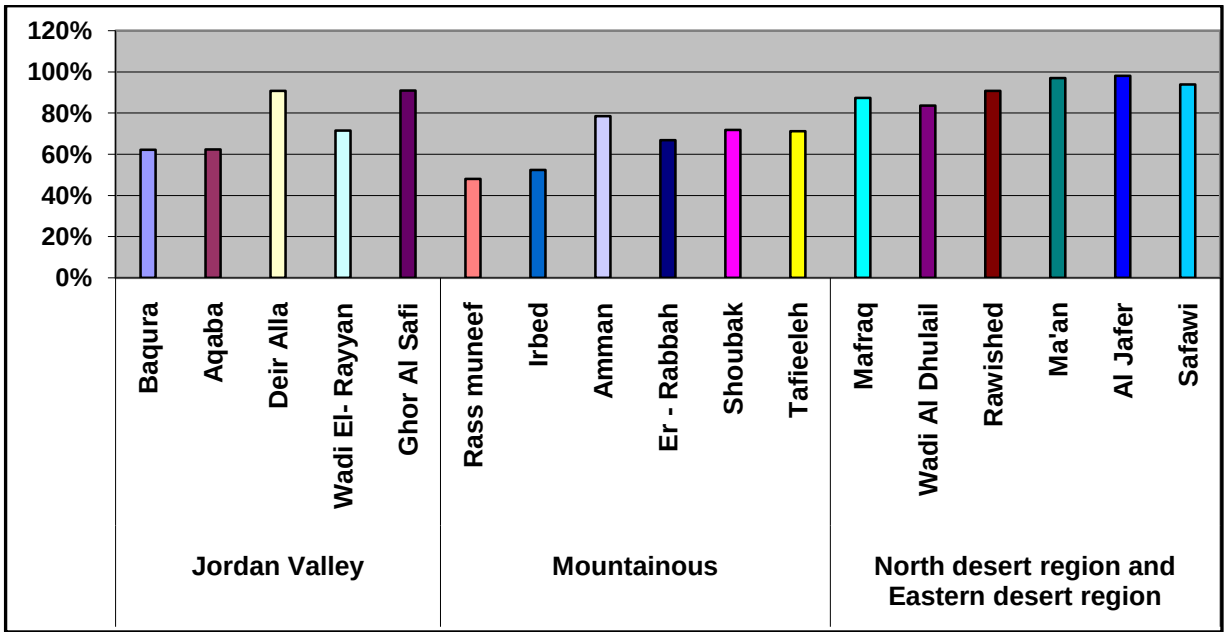
The longest dry spell duration is 9 seasons in Shoubak, RasMuneef and Amman (1995-2004) Mountainous region, while it is 5 seasons in Baqura (1974-1979) , Deir all (1974-1979) and Ghoar Safi (1975-1980) Jordan valley region . The longest dry spell is 7 seasons in Mafraq (1995-2002) and in Safawi (1989-1996) in the north desert region and eastern desert region Table 22.
Figure 29 shows the longest dry spell duration for different locations in Jordan. This figure shows homogeneity of the longest dry spell in the northern, central and southern mountains. This is clearly shown in the figure where RasMuneef in the northern mountains, shoubak station in the southern mountains and Amman station in the central mountains.

From Table 2 we can conclude, that drought has been analyzed in 16 meteorological weather stations that represent the different climatic and topographic regions in the country during the period 1975-2004; consequently the following main results were concluded:

- Almost all regions suffer from drought to some degrees but not all the regions experience droughts during the same periods.
- Temporal distribution and frequency of the dry periods varies markedly along the regions.
- Longest dry spell duration is 9 seasons in Shoubak, RasMuneef and Amman (1995-2004) Mountainous region.
- Maximum average dry spell duration in Er-Rabbah station in the southern mountainous area, where the average dry spell duration is 4.2 seasons.
- Maximum average wet spell duration in Er-Rabbah station in the southern mountainous area, where the average dry spell duration is 2.8 seasons
- On the average (average of dry seasons during the dry seasons of 1975-2004) severe to extreme drought hit most parts of the country.
- The maximum frequency of dry seasons found in the north desert region, 21 dry season. The mountainous region is the second region vulnerable to drought (19 dry season). Aqaba, Jordan valley and Eastern desert regions shows 18, 16 and 15 dry season respectively.
- Drought persists in the Mountainous Jordan valley and Desert region during 1998-2002 seasons
- Drought occurred more frequently in 1970s, 1980s and 1990s, the worst recorded rainfall in 32 years was in 1999-2000

It’s clear from Figure 1 that percentage reduction in rainfall in the desert region was more than the other regions and thus the average monthly performance of rainfall in the dry seasons was less than mountainous and Jordan valley regions. On the average one can conclude that severe to extreme drought hit most parts of the country during the dry seasons of 1975-2004

Figure 1 Average Percentage reduction in rainfall during the dry seasons of the period 1972-2004 compared to the long-term average



It is concluded that Jordan would benefit greatly from the development of a national drought strategy directed at building institutional capacity to cope with recurring drought episodes. The country is currently facing significant pressure on water supply because of the general aridity of their climate, recent drought events, and changes in societal vulnerability resulting largely from a rapidly expanding population.

Development of a national drought strategy is of paramount importance to the future sustainability of the economy and the environment.

Procedures for implementation national drought strategy should take into account:

1. Jordan is an arid country that is ranked as one of the world's ten most water-stressed nations.
2. Jordan experiences recurring periods of drought. The most recent drought period, 1998-2000, resulted in serious economic, environmental, and social losses. Drought impact information is a critical requirement for the conduct of vulnerability assessments for various sectors.
3. The relevant ministries, departments, and NGOs recognize the importance of developing a national drought policy and strategy and are willing to collaborate on the development and implementation of this strategy.
4. Data on meteorological and hydrological indicators, soils, agricultural statistics, and plant/animal species are available. Ministries and others are willing to share this information as cooperating partners on a national drought strategy.

5. No drought early warning system is currently in operation in Jordan, although is it one of the principal components of a national drought policy and strategy. The U.N.'s World Food Program is funding the establishment of a drought early warning unit at **National Center for Agricultural Research and Extension** and Jordan Meteorological Department which should be an integral component of a national drought strategy.
6. There is considerable GIS capability at the Royal Jordanian Geographic Center and **National Center for Agricultural Research and Extension.** Expertise in remote sensing is also available at both institutions. There exists some GIS and remote sensing capability at other ministries and departments as well. There is little coordination of these activities.
7. Progress has been made on networking and telemetric weather station at Jordan Meteorological department, Ministry of Water and Irrigation There are currently a reasonable number of automated weather stations operating in Jordan these stations since 2005. Currently, nine stations operated Jordan Meteorological department are networked, nine stations operated by **National Center for Agricultural Research and Extension** are networked. The Ministry of Water and Irrigation operate 70 automatic stations but no specific information on the network was made available. These stations, once identified need to be networked and become part of the drought monitoring and early system that will be developed as part of the national drought strategy and the drought early warning unit at **National Center for Agricultural Research and Extension** and Jordan Meteorological department. The timely retrieval of data from these stations is critical for the delivery of information to decision makers at all levels.
8. No soil moisture monitoring network exists in Jordan. The establishment of a network, at least in the primary agricultural regions, would be extremely beneficial in support of a national drought mitigation strategy and vulnerability assessments.
9. Jordan remains ill-prepared to deal proactively and effectively with recurring drought episodes. Response to the drought of 1998-2000 was largely in a crisis management mode. Jordan would benefit substantially from development of a national drought preparedness policy and strategy and an action plan for implementation.

It is concluded that Jordan would benefit greatly from the development of a national drought strategy directed at building institutional capacity to cope with recurring drought episodes. The country is currently facing significant pressure on water supply because of the general aridity of their climate, recent drought events, and changes in societal vulnerability resulting largely from a rapidly expanding population. Development of a national drought strategy is of paramount importance to the future sustainability of the economy and the environment. The discussion which follows outlines the key ingredients of a national drought strategy, including identification of the main principles of a

national drought policy, the proposed objectives of a drought mitigation plan, and the procedures that should be followed in the development and implementation of this strategy.

Vulnerability assessment:

The main cause of drought is low level of water source in the reservoirs which will effect to agricultural sector and water for consumption such water supply in household and industry sector. Rain fed agriculture in Jordan is one of the most vulnerable sectors to drought, as the available water and land resources are limited and most of the country' s land is arid . Desertification is the loss of complexity of biological and/or economic productivity of crop, range or wood-lands. Reasons of such a loss are mainly due to climatic change and unsustainable human activities. The arid and semi-arid lands of Jordan are sensitive to human interference that resulted in a severe depletion of its natural resources and in different forms of land degradation due to multiple interactions of socio-economic factors.

Further, degradation will continue if human activities are not carefully controlled and managed. Almost 90% of the land area of Jordan receives less than 200 mm of rainfall annually. This is reflected in poor structural stability of soils and the subsequent vulnerability to excessive erosion following shallow rainstorm events. Such a fragile ecosystem has also been manifested by non sustainable land use patterns and poor vegetative cover of the range land and the remaining forest batches. Therefore, most of the economic activities take place on the remaining 10% of the land area and the competition between different user groups for these lands is, therefore, intense.

The guidelines for the implementation of groundwater protection areas for all public water supplies are being prepared in Jordan. Implementation of these guidelines requires not only legal, but also technical and institutional support. Technical support includes carrying out relevant hydro geological studies, inventorying possible sources of contamination for a groundwater.

Reference

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