SWIM and Horizon 2020 Support Mechanism

Working for a Sustainable Mediterranean, Caring for our Future.

Presentation of the findings of the Regional assessment of past drought episodes and their management in the SWIM countries

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Drought Risk Management (DRM) Mainstreaming" Regional Training

14-15 December 2016, Athens, Greece

This Project is funded by the European Union

1. Review & Inventory Of Past Drought Episodes In The PCs & Potential Linkage with Climate Change

Introduction

- The **precipitation regime** in the Project Countries (PCs) are characterized by:

- strong seasonal behaviour,
- rainy season mostly concentrated between November and March
- strong inter-annual and decadal variability.

- Major droughts are characterized by

- lack of rainfall during several months of winter
- during one year or consecutive years;

resulting in widespread devastating socio-economic and environmental impacts.

Source: (MATE, 2001)

1. Algeria - Drought occurrence & Trends

- Intense and persistent droughts during the past 25 years, with significant rainfall deficit:
  - ~ 30% across the country
  - > 50% in the central and western parts of the country
  - > 30% in the East
- Drought has significantly increased both in terms of frequency and duration (in 3 stations Oran, Algiers and Annaba) 1930-1995,

3 major trends in the western part of the country in the 1900s;

- Increase in rainfall since 1945 following a relatively dry phase,
- Decrease in rainfall from 1975
  - 20% in the plain of Mitidja (central north)
  - > 25 % in the plain of Ghriss West (100 Km SE of Oran located in the western part of the Northern coast).

Evolution of Climate between 1931-60 and 1961-90 for 3 regions (West, Central & East) shows:

- Increase in temperature of ~ 0.5°C,
- Increased potential evapotranspiration
- Decreased rainfall on average by 10%

1. Algeria – Affected/Vulnerable Areas

Acc. to a study **involving seven Algerian Planes** known for agriculture & economic contribution:

- Mitidja plane in the extreme west
- Maghnia plane in the extreme west
- the upper, mid, & lower Chelif planes ,
- Habra Sig plane ,
- Ghriss plane

- probability of occurrence of a non-dry year after a dry year, is more likely in the central than in the western plains,
- likelihood of occurrence of two successive dry years is higher in the western plains of the country than at the Centre.

2. Egypt - Drought occurrence & Trends

- Widespread droughts (Analysis 1901-2007): 7 droughts since the 1960s (1962, 1963, 1970, 1971, 1981, 1999, 2001)
- **Sections** of the **NW coast**: 1968, 1983, 1984, 1986, 2004, 2007
- 1999: The most severe drought between 1950& 2007

Based on the meteorological data (1973-2002) of 32 stations all over Egypt, extreme weather events in Egypt:

- Increased in severity
- Became more frequent.
- Successive increases in the amount of annual rainfall in the Med. coast

According to the 2nd national communication report (SNCR) to the UNFCCC, 2010:

- Increased severity and frequency of sand storms, dense haze and flooding

Countrywide: general decrease in annual SPI/decade & precipitation but the **absolute decrease has been v. small due to the v. low levels of precipitation in the desert areas.**

2. Egypt - Affected/Vulnerable Areas

- NW part of the country →here rain-fed agriculture is practiced
- In the past, Egypt's vulnerability to droughts was related to the Nile River flows providing > 95% of the country's water resources.
  - **Aswan High Dam** contributed to the reduction of Egypt's vulnerability to both drought and floods.

However the Nile flow: has high levels of inter-annual and inter-decadal variability; experienced locally and regionally (through its effects on downstream in Sudan and Egypt):

Between 1979 and 1987: Exposure to prolonged drought episodes.

- Diminishing headwater inflow.
- Reduced storage in the upstream buffer of the Lake Nasser Reservoir

→ cut down on Egypt's water use and consumption

2. Egypt - Affected/Vulnerable Areas

Based on Drought and Precipitation Trends (1901 to 2007):

Change of annual SPI per decade			change of annual precipitation per decade					
			Absolute change			Relative change		
Index points	% of total Area		mm / decade	% of total Area		% / decade	% of total Area	
	> 50 mm	< 50 mm		> 50 mm	< 50 mm		> 50 mm	< 50 mm
0.00 to -0.05	52%	2%	0 to -5	88%	92%	0 to -5	80%	5%
-0.05 to -0.10	35%	7%	-5 to -10	9%	[illegible]%	-5 to -10	15%	7%
-0.10 to -0.15	8%	34%	-10 to -15	3%		-10 to -15	4%	10%
-0.15 to -0.20	4%	49%	-15 to -20	0%		Over -15	1%	78%
-0.2 to -0.25	1%	8%	-20to -25	0%				

Source: Adapted from Göbel, and De Pauw (2010)

88% of the area which receives >50 mm rain and

92% of the area which receives <50 mm rain experienced 0 to -5 mm decrease in precipitation/decade

3. Israel - Drought occurrence & Trends

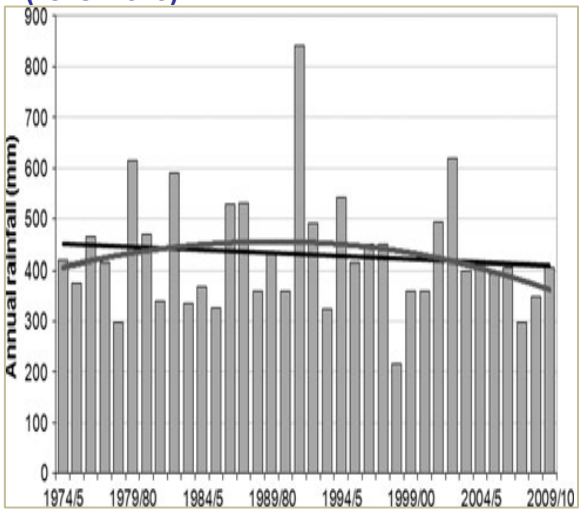
- 8 drought periods since 1915
- Several multi-year cycles of drought (mid-1990s) → severe crisis; jeopardizing domestic water supply.
- 1998/99: One of the worst drought in Israel; followed by < average rainfall until 2002 (→ Shortfall of 0.5 BCM in the annual water balance)
- Longest and most severe drought period: (2005-2011)
- 80-85% of the mean annual precipitation in 2009 in the Lake Tiberias in the North following reduction in annual precipitation recorded for the previous five years. → A state of drought in large parts of the arid South which receives Tiberia's water.

3. Israel - Drought occurrence & Trends

Results of the analysis of the trends in rainfall regime (1975–2010):

- -ve trend over most of Israel
- statistically significant reduction in the super-arid region,
- decrease in rainfall significant over most of Israel in spring (shorter rainy season, (3 days/decade)).
- longer dry spells.
- Increase in rainfall toward the 1990s, followed by higher rate decrease, towards the end of the study period.

Inter-annual variations of the annual rainfall averaged over Israel with rainfall >100 mm, together with the linear trend (black) and the polynomial curve (third-order, gray solid) for the study period (1975–2010).



4. Jordan - Drought occurrence & Trends

Frequency and severity of droughts in Jordan (50 years: 1961/62-2010/11)

	Mild Drought	Moderate Drought	Severe Drought	Extreme Drought
Probability	14%	8%	16%	14%
Ret (Ye		12	6	7
Yea	1989/90, 2000/01, 2001/02, 2006/07	1965/66 1984/85 2003/04 2010/11	1976/77-1978/79, 1985/86, 1992/93, 1995/96, 2005/06, 2008/09	1962/63, 1972/73, 1981/82, 1983/84, 1998/99, 1999/00, 2007/08

1. probability of occurrence of drought years in Jordan, regardless of its severity, is 52% (compared to 46.6% between 1937/38 and 2010/11.

2. Out of the 7 extr. droughts that occurred during the past 50 years, 5 of them occurred bet. 1980/81 & 2010/11: (probability ~ 16.7% during 30 years, compared with 14% during 50 years

Source: Based on analysis of rainfall data provided by MWI (2013).

4. Jordan - Drought occurrence & Trends

Analysis of meteorological data of 19 stations for the period 1961-2005 shows:

- decreasing trends in annual precipitation by 5-20% in majority of the stations
- very few stations in the extreme east and in the N.W. showed increased annual rainfall by 5-10% → may lead to an increase in the daily rainfall intensity and, thus, an increase in the chance of recording extreme precipitation.

4. Jordan - Affected/Vulnerable Areas

Based on Drought and Precipitation Trends (1901 to 2007):

Change of annual SPI per decade		change of annual precipitation per decade			
		Absolute change		Relative change	
Index points	% of total Area	(mm / decade)	% of total Area	% / decade	% of total Area
0.00 to -0.05	2%	0 to -5	1%	0 to -5	14%
-0.05 to -0.10	10%	-5 to -10	8%	-5 to -10	15%
-0.10 to -0.15	15%	-10 to -15	21%	-10 to -15	41%
-0.15 to -0.20	40%	-15 to -20	58%	Over -15	30%
-0.2 to -0.25	33%	-20to -25			

Source: Adapted from Göbel, and De Pauw (2010)

~ 58% of the area witnessed 15-20 mm drop in annual precipitation/decade

Decreased precipitation →less availability of water to recharge aquifers and feed surface runoff

5. Lebanon - Drought occurrence & Trends

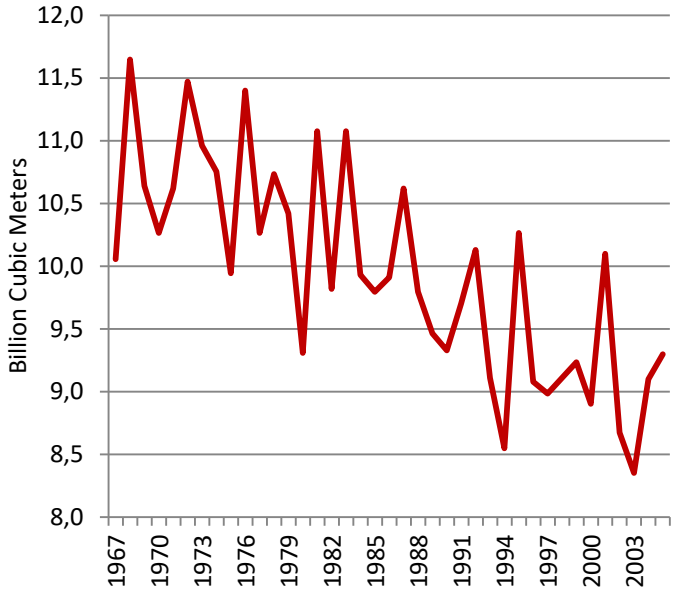
Between 1967 and 2005:

- Return period of Drought:
  - Mild drought: 1 in 3 years
  - Moderate drought: 1 in 8 years
  - Mild or moderate: ~ 1 in 2 years (46%): (1967-2005); compared to 70% between 1980 & 2005 (18 droughts during 26 years)

Göbel, and De Pauw (2010):

- The wettest years fall into the 1st half of last century
- Most of the droughts happened during the 2nd half (between 1957 & 2007)
- Unusual dry years: 1958, 59, 60, 72, 73, 89, 90, 95, 99.
- –Ve trends in annual precipitation

Annual Rainfall in Lebanon (1967-2005) in BCM



SNCR to the UNFCCC-2011: Based on daily met. records for Beirut (1980 to 2000)

- significant warming, (Increased no. of hot "summer days" & "tropical nights")
- Sharp increase in the absolute extreme of the maximum temperature within a year
- Overall decrease in total annual rainfall
- Decrease in the amount of rain falling in a 5-days period
- Large increase in the Consecutive Dry Days,

Shaban (2011): Increase in temperature→ snow-melting, reduction in its spatial cover

Rel. small decline in rainfall amount (1967 & 2009): 11mm/decade

5. Lebanon - Affected/Vulnerable Areas

Drought and Precipitation Trends 1901 to 2007 in Lebanon

Change of annual SPI per decade		change of annual precipitation per decade			
		Absolute change		Relative change	
Index points	% of total Area	(mm / decade)	% of total Area	% / decade	% of total Area
0.00 to -0.05	3%	0 to -5	0%	0 to -5	100%
-0.05 to -0.10	96%	-5 to -10	15%	-5 to -10	0%
-0.10 to -0.15	1%	-10 to -15	80%	-10 to -15	0%
-0.15 to -0.20	0%	-15 to -20		Over -15	0%
-0.2 to -0.25					

Göbel, and De Pauw (2010)

80% of the country is subject to an absolute change in annual precipitation trends per decade of -10 to -15 mm/decade

Source: Adapted from Göbel, and De Pauw (2010

6. Morocco - Drought occurrence & Trends

Chbouki (1992):

- Since 1896, **12 main generalized very dry periods with moderate to strong intensities, 7 of which starting from 60s** (1960-61; 1974-75; 1981-84; 1986-87; 1991-93; 1994-1995 & 1999-2003.
- Less generalized ones: 1965-67 and 1972-73.
- From agriculture point of view: 1982-83, 1994-95 & 1999-2000 were among the driest

Stour and Agoumi (2009): data for 7 stations (1961-2004)

- Increase in droughts' frequency, severity and spatial distribution
- Most persistent drought were during the last 20 years, consisting of 3-5 years of consecutive droughts, compared to isolated droughts between the 1960's and the 1970's.
- After 1972 droughts often affected the majorities of the region,
- During the last twelve years of the study period, there were 10 years of droughts of which two were general (affecting the seven regions).
- The most frequent droughts occur during fall and spring, followed by winter and spring droughts
  - Winter droughts affect > 40% of the regions.
  - Spring droughts ~ 29%
  - Droughts during fall and winter and that of fall to spring is less common and affect < 15% of the regions.
- Frequency of occurrence of the drought types decreases with the increase in its severity.

5. Morocco - Drought occurrence & Trends

Climate observations, over the last decades attest to:

- the growth of the semi-arid climate to the northern part of the country (MEMEE).

Examination of the period 1970-2000 show:

- increased **frequency and intensity of droughts** and unusually devastating floods (MEMEE, 2001).

The SNCR (2010) has also confirmed this.

All General circulation models predict

- global warming should continue in this area and even take another dimension in the coming decades (MEMEE).

6. Morocco - Affected/Vulnerable Areas

Frequency of dry, normal and humid years in seven cities; representing the main climatic zones in Morocco (1961-2004)

City	Location	Freq. Normal Years	Freq. Wet Years	Freq. moderate drought	Freq. severe drought
Agadir	South West	32%	25%	34%	9%
Casablanca	Central West	34%	27%	30%	9%
Ifrane	Western slope of Middle Atlas	30%	25%	34%	11%
Marrakech	Centre	14%	43%	20%	23%
Oujda	North East	18%	36%	30%	16%
Rabat	North West	23%	34%	30%	14%
Tanger	Extreme N. West	32%	27%	30%	11%

Source: Stour and Agoumi (2009).

- no extreme drought recorded.
- moderate drought likelihood:
  - Marrakesh: 1 in 5 yrs
  - Rest of the regions: 1 in 3 yrs
- severe drought likelihood:
  - Marrakesh: 1 in 4 yrs
  - Casablanca & Agadir: 1 in 11 yrs.

Cities mostly hit by drought of various severities: Oujda (freq. 46%), Rabat 44%, Agadir and Marrakesh at 43%

7. Palestine - Drought occurrence & Trends

Rabi et al. (2003): Analysis of 30 years of meteorological data

- No uniform return periods for the occurrence of drought
- 1998/99: Most extreme drought with AVG rainfall in 6 stations bet. 32 to 45 % of LTA
  - Rainfall during the critical months for agriculture:
    - October: < 16% of the normal average
    - November: 10 % of the normal averages;

Göbel and De Pauw (2010)

- Extreme variability in the spatial distribution of drought between the west bank and Gaza.
- widespread drought: 1962, 1978, 1995, 1999 (the most extreme drought)
- 1981, 1998 (except for the North),
- 1993 (except for the South),

7. Palestine - Affected/Vulnerable Areas

Drought and Precipitation Trends 1901 to 2007 in Palestine (Göbel, and De Pauw (2010): SPI analysis of meteorological records (1901 to 2007)

Change of annual SPI per decade			change of annual precipitation per decade					
			Absolute change			Relative change		
SPI	% of total Area		mm / decade	% of total Area		% / decade	% of total Area	
	West Bank	Gaza		West Bank	Gaza		West Bank	Gaza
0.00 to -0.05	61%	0%	0 to -5	32%	0%	0 to -5	100%	100%
-0.05 to -0.10	39%	100%	-5 to -10	65%	100%	-5 to -10	0%	0%
-0.10 to -0.15	0%	0%	-10 to -15	3%	0%	-10 to -15	0%	0%
-0.15 to -0.20	0%	0%	-15 to -20	0%	0%	Over -15	0%	0%
-0.2 to -0.25	0%	0%	-20to -25	0%	0%			

SPI decrease in the range of:

- 0 to -0.05 for 61 % of the West Bank area
- -.05 to -0.1 for 39% of the West bank area and 100% for the Gaza Strip

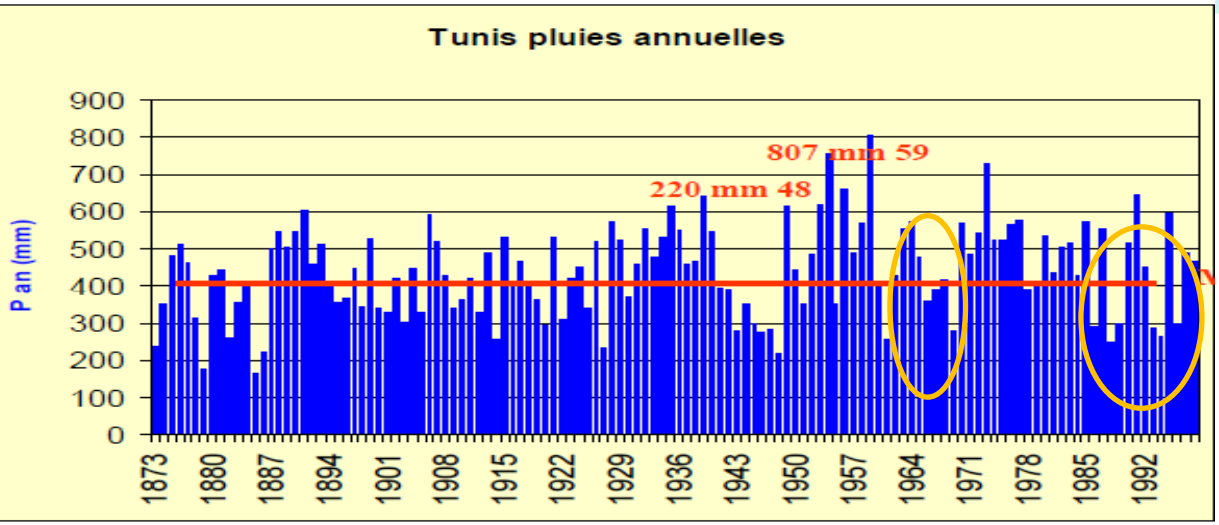
Decreasing trends also for the change in the absolute values of the annual precipitation

~46% of the country's area is "highly" and "moderately" affected by agr. droughts and around 15%is "slightly" affected

Source: Adapted from Göbel, and De Pauw (2010)

8. Tunisia - Drought occurrence & Trends

Annual Rainfall in Tunisia



Source: Med. Drought Preparedness & Mitigation Planning (MEDROPLAN) EU initiative

4 drought events in the 60s of which 2 are consecutive after 1965

Drought events reported for the periods: 1987-89, 1993-95 and 2000-02.

Study on rainfall data between 1931 & 2000:

- **One to two generalised drought episodes/decade,**
- **Given a dry autumn, the probability that the whole year is dry is high…between 67% & 90%**
- **The probability of drought to occur in three consecutive years** such as those witnessed between 1987 and 1989, 1993 and 1995 and 2000-2002 is **between 11 and 34**%.
- Frequency for a dry year to occur after a normal or wet autumn is between 9% & 22 %.

Bin Boubaker, 2007 - study of long rainfall series @ national & regional levels:

- No clear and statistically significant indications for upward or downward trend in precipitation indices.
- But the number of extreme droughts and floods has increased significantly over the last decade with a total of 11 events; constituting a period most loaded with events.

8. Tunisia - Affected/Vulnerable Areas

- Study on rainfall data between 1931 & 2000:
  - Frequencies between 26% and 33% for the northern parts of the country,
  - Highest numbers of dry years in central and south Tunisia, with frequencies between 36% and 41%.

2. SOCIO-ECONOMIC AND ENVIRONMENTAL IMPACTS OF DROUGHTS IN THE PCS

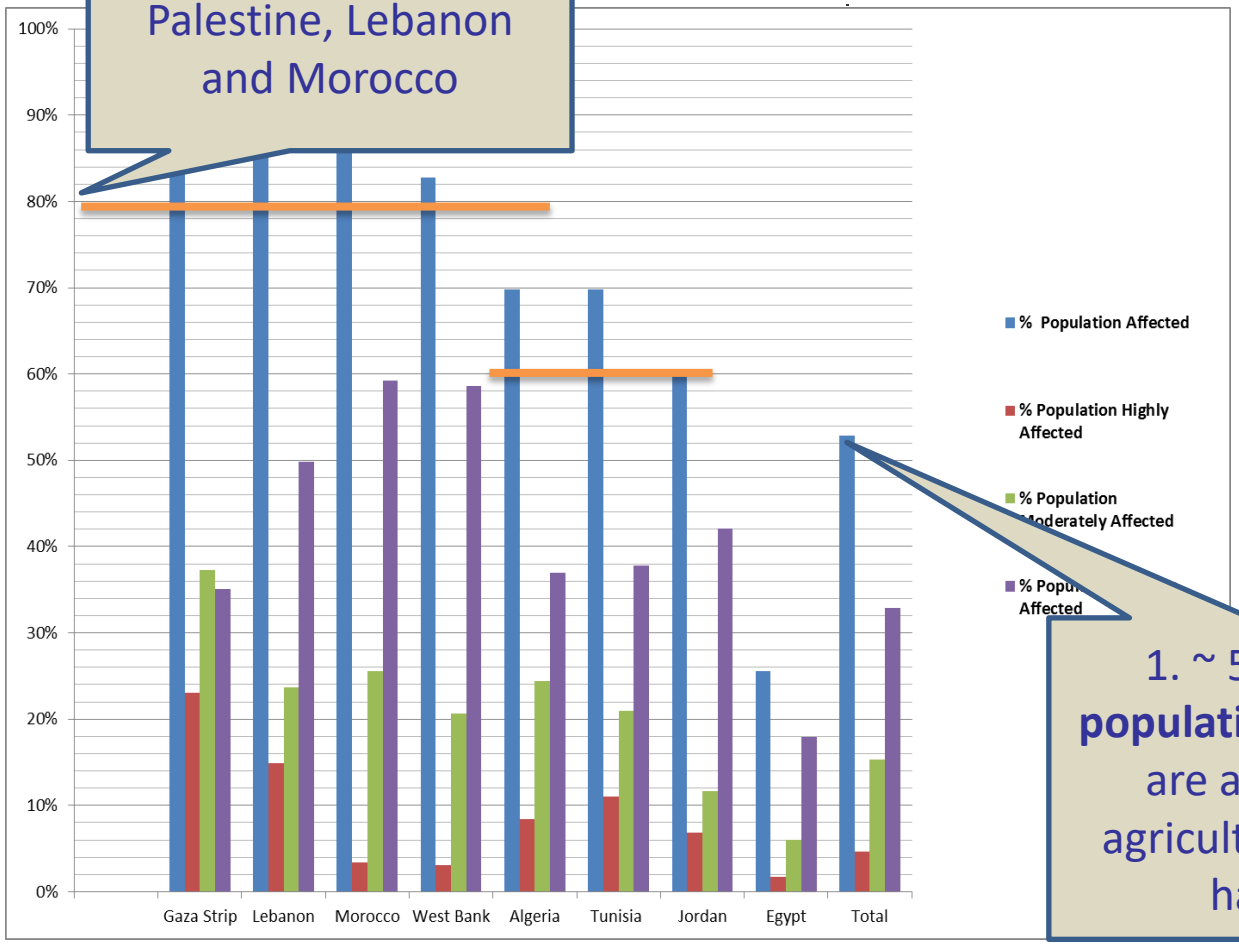
Main socio-economic and environmental impacts of droughts

Sector	Impact
Social	• Damage to public health & safety, by affecting air and water quality or increased fire • Increase in social inequality, • Tensions between public administrations and affected groups • Changes in political perspectives • Inconveniences due to water rationing • Impacts on way of life (unemployment, reduced saving capability, 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 distribution of mitigation measures • Abandoning of activities and migration (in extreme cases)
Economic	• Decreased production in agriculture, forestry, fisheries, hydroelectric energy, tourism, industry, and financial activities that depend on these sectors. • Loss of livestock's and herds. • Unemployment caused by decrease in production • Economic damage to reduced navigability of streams, rivers and canals • Damage to the tourism sector due to reduced water availability • Pressure on financial institutions (more risks in lending, capitals decrease etc.) • Income reduction for the water utilities due to reduced water delivery • Costs in emergency measures to improve resources and decrease demands (additional costs for water transport and removal, costs of advertising to reduce water use, etc.)

Source: Iglesias A. et al.(2007)

Population Affected by Agriculture drought Hazard in selected PCs

2. > 80%" of the population in Palestine, Lebanon and Morocco



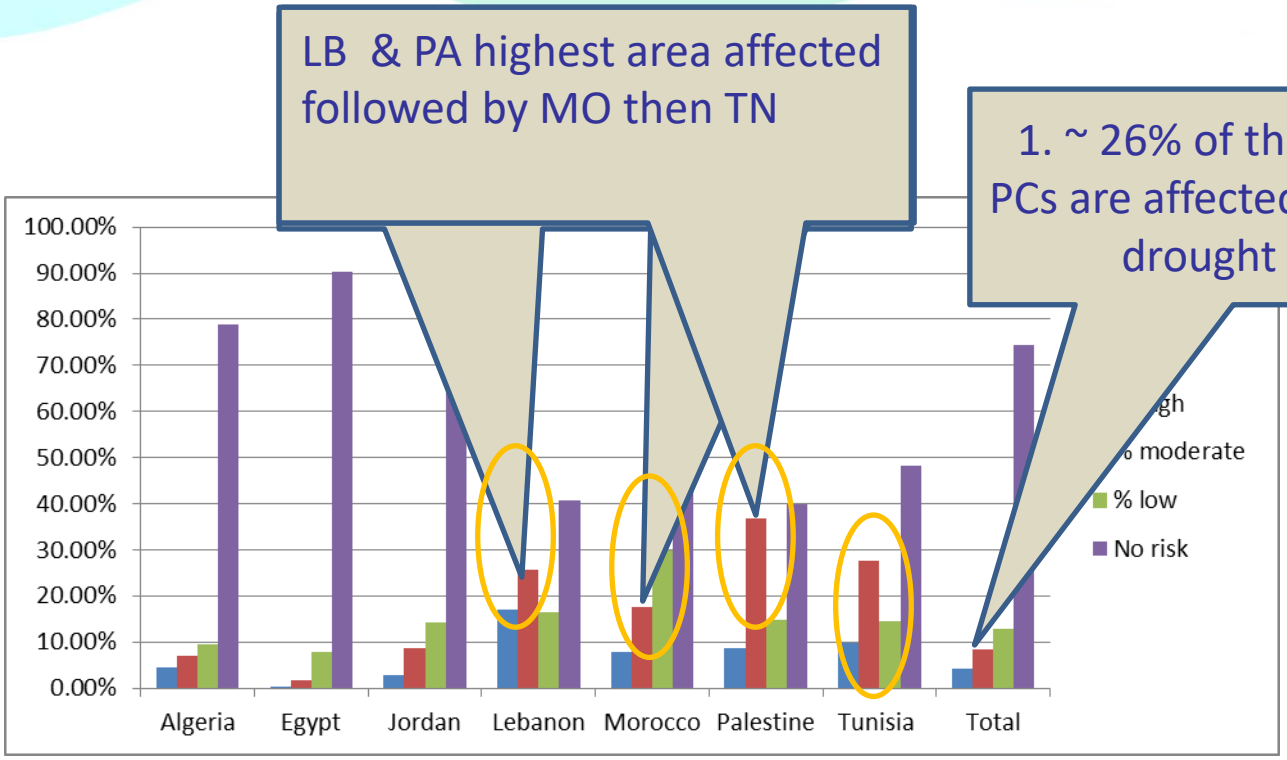
3. Algeria, Tunisia and Jordan (between 60% and 70% of the population), and finally Egypt at 25.6%

1. ~ 53% of the **population** of the PCs are affected by agriculture drought hazards;

Based on figures provided by Erian, 2013

Source: Adapted from Nasr (1999).

Agricultural Drought Hazard Areas in selected PCs (% of Total Areas)



Source: Based on figures provided by UNISDR, 2013 (a) (P45)

Lebanon: 17.13% of total area is subject to high agriculture drought risk,

- 25.67% subject to moderate risk
- 16.45% low risk

Palestine: ~ 46 % of the area is "highly" and "moderately" affected by droughts and around 15% is "slightly" affected

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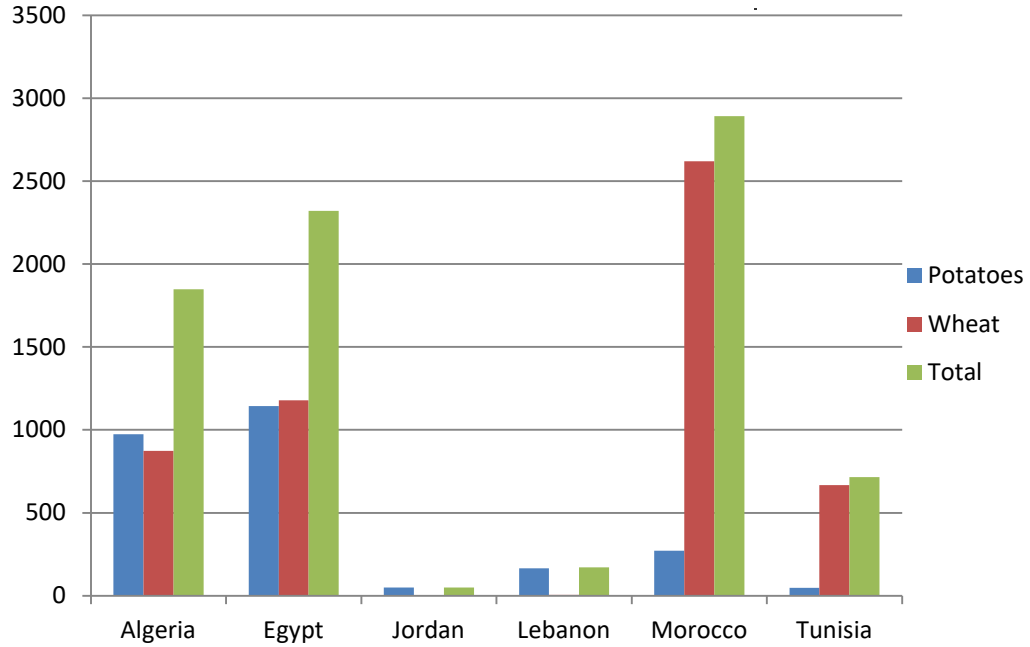
Total Economic Losses in selected PCs for selected crops (1999-2011) (Million US$)



Source: Based on figures provided in UNISDR (2013) (pages 285-293).

Farmers are usually the most affected.
FAO 2008: the 1998-2001 droughts which hit several countries of the PCs affected farmers and the economy:

Jordan:

- 180,000 farmers and herders were affected,
- food security for 4.75 million people was at stake.
- Only 1% of cereals and 40% of red meat and milk were harvested.

Morocco:

- 1 million ha of cropland were affected
- US$500 million in total cereal imports (2001)

Tunisia:

Cost of interventions : US$46 million

Other Main Impacts in the PCs

Impact of intense and persistent drought during the last decades in Algeria, (PNUD (2009)

- Reduction by 10.5% in the water resources potential → impacting the rivers' flow regimes.
- Steady decline in groundwater reserves of the major aquifers in the north.
- Alarming drop in groundwater level in many plains (> 20 m).
  - **Mineralization** of the unsaturated zones of the deep aquifers in the semi-arid regions (Oran Plateau and the high western plains).
  - **Lowered hydrostatic pressure** in the coastal areas → **sea water intrusion** (in the coastal aquifers of Mitidja, Oran, Terga and Annab).

Impact of the hydrological drought in the 1980s on Egypt's Nile River and Delta

- cut down on Egypt's water use and consumption & Loss of Agriculture & fisheries output
- Diminishing headwater inflow & drop in water level in Lake Nasser exacerbating the country's irrigation problems.
- Aggravation of the overgrazing effects (increased degradation of natural vegetation & soils)

Impact of 1999 drought on Israel

- Increased GW abstractions from 2 major GW basins by 20%,
- sharp drop in GW levels and significant cones of depression
  - Increased groundwater salinity & seawater intrusion and depletion of fresh water reserve
  - build-up of salinity and pollution.
- Dry-up of wadis & natural reservoir ponds, death of plants and animal species, & adverse effects on fish colonies and ancillary economic activity
- Desertification (esp. along the transition zones between the semi-arid regions & the desert).

Other Main Impacts in the PCs

The 1999 drought in Jordan :

- Serious economic impacts with the severe restrictions on agricultural water use,
- collapse of rain-fed farming
- Purchase of water in the black market.
- health implications from Water rationing.
- Environmental degradation included :
  - reduced environmental flows,
  - deterioration of water quality in the wadis (→ dominated by treated effluent in the case of the Zarqa River in Jordan),
  - increased soil salinity,
  - sharp water depletion
  - increased salinity of groundwater systems .
- Political consequences between Jordan and Israel

Lebanon: No information available on impact. However,

- Drought threatens 10% of the population to become under desertification risk (land degradation resulting **from climatic variation and human activities**).
- The rates of desertification (medium and more) is :
  - 60% for rain-fed lands
  - 90% for range lands (higher than the world percentage of 73%);
- The above poses serious threat to productive lands and agricultural production, in addition to loss of animal life and biodiversity.

Other Main Impacts in the PCs

Drought episodes in Morocco (1980/81-1985/86, 1991/92-1994/95 & 2000/01-2002/03):

- Decline in the dams' water reserves & GW levels -->
  - Limitations on drinking & irrigation water.
  - Impacts on hydro-power production
- Reductions of SW flows by 25.7% - 57%
- Water quality deterioration & water pollution;
- Dysfunction/interruption in the operations of drinking water treatment plants,
- Death of fish and increase in waterborne diseases.
- Impact on agriculture and livestock & their contribution to GDP

Palestine:

Drought impact is more devastating in Palestine: Very low per capita water availability (75 l/day) (Reduction in allocations greatly impact human health and agricultural production.

Drought in Tunisia

- Increased water salinity resulting in soil salinization → crop yield,
- clogging of pipes and supply channels (from high turbidity)
- increased production cost of drinking water.
- negative impact on the flow of hot springs and disrupted therapeutic hydrotherapy.
- overexploitation of GW resources
- Lowered water table (more pumping costs; 0.45 MTD in the watershed of Medjerda; in 2010)
- loss of hydropower production → production of electricity using fossil fuels & environmental degradation.

Other Main Impacts in the PCs

- Regionally: reduction of water flows into the Med Sea → severe changes in the coastal ecosystems,
  - saline intrusion in coastal areas,
  - regression of dunes and deltas
- Deteriorating water quality due to reduced discharge and thus insufficient mixing has triggered additional environmental stress for riverine ecosystems due to increased contaminant loads, and reduced self-regulative capacity.

3. WATER & ENVIRONMENT RESPONSE IN THE FOCUS COUNTRIES

Response in the Water Sector - Short term measures:

- Over-exploitation of groundwater resources and mobilization of additional resources (e.g. drilling of new wells).
- Strict application of water demand management measures including minimization of waste and fining practices that result in wasting water.
- Rationing in water distribution for drinking purposes.
- Reallocation of water between the sectors with water for municipal purposes given priority.
- Equipment of water points for domestic use and Distribution of water by tankers.
- Regular monitoring of water quality and quantity (both GW and SW)
- Increased public awareness campaigns involving all water users
  - to promote saving, and
  - alarm users of any degradation in water quality.

Response in the Water Sector – Long term measures:

Long term measures are undertaken as part of water resources management under water scarcity conditions that can also increase the countries' resilience to drought :

- Development of additional water resources,
- Construction of transfer systems between water surplus areas and deficit areas.
- Utilization of non-conventional water resources (Desalination of sea and brackish water and reuse of treated effluent)
- Groundwater recharge (and control of abstractions in the case of Jordan)
- Minimization of losses in the water supply systems and irrigation networks.
- Legal amendments and adoption of WDM measures including the progressive structuring of tariffs according to water consumption.
- Conservation of soil and water (Structures for spreading floodwaters, Benches, reforestation, etc.
- Promotion of new technologies, water saving irrigation techniques, crop selection and adoption of drought tolerant crops. etc.
- Changes in the education curricula in favour of increased water and environmental awareness and for the promotion of water conservation and saving.

Response in the Environment Sector

- Environmental institutions do not have a specific role in WRM or drought management.
- Monitoring water quantity and quality falls under the direct responsibility of the water departments.
- **Jordan:** the environmental law does not stipulate any provisions related to any type of environmental disasters; regardless of type or origin.
- **Palestine:** Preparing emergency plans to deal with environmental disasters is mandated to the Environment Quality Authority. Yet, the definition of environmental disasters as is broad and does not expressly mention droughts.
- Environmental institutions are **indirectly** involved as FPs for climate change (CC) adaptation projects; also setting CC policies & strategies & programs for the actions that address CC impacts and suggest adaptation capacities in the sectors affecting the environment.
  - The role of the environmental institutions can be prominent through planning and ensuring that:
    - protected areas are designed & managed in light of the increasing challenges of CC
    - That concerted actions are undertaken for the:
      - conservation & increasing the resilience of ecosystems & biodiversity to CC
      - restoration of rangelands,
      - conservation of soil,
      - curbing desertification, etc.,

4. TRADITIONAL COMMUNITIES' RESPONSE TO PAST DROUGHT EPISODES - INDIGENOUS BEST PRACTICES

Examples of traditional response measures to drought in the PCs

traditional response measures	Nature of Measure	Impact/Objective	Drought	Flood
Investment in digging of wells, cisterns and in rain and flood water harvesting systems	physical	Increase water availability for drinking and irrigation and/or protect land against floods (soil erosion control) - depending on the selected measure.	x	x
Earth-dams	physical	storage of irrigation water	x	
Dry-wall fencing and retention walls	physical		x	
Terracing	land management	erosion / top-soil conservation	x	x
Mixed and inter-cropping	land management	soil erosion	x	x
Diversified crop rotation	land management	soil erosion	x	
Low tillage of soils	land management	soil erosion	x	
Mobile or transhumant grazing practices that reduce risks of having insufficient forage in any location.	land management	erosion / top-soil conservation	x	

Examples of traditional response measures to drought in the PCs

traditional response measures	Nature of Measure	Impact/Objective	Droughts	Floods
Storage of surplus grains	management	food security	x	
Keeping contingency livestock to be liquidated during a drought	management	agro-economic risk buffer and food security	x	
Diversification among animal species and breeds within species.	management	agro-economic risk buffer and food security	x	
Flexible flock sizes and stocking rates	Land management and Management	optimization of adaptive capacity and reducing risk of land degradation	x	
Applying drought resistant seeds	management	food security / agro-economic response	x	
Reciprocal grazing with more distant communities for access to their resources in dry years	management	food security / agro-economic response	x	

Overview of the main water harvesting techniques used in the PCs.

Water Source	Objectives	Water Harvesting Techniques	Country
Rainfall	-Increase rainfall effectiveness - Conserve water (and soil)	Terraces	JO, TN
		Contour-ridge terracing	SY, TN, JO
		Dams	EG, TN, JO
Local runoff	- Collect water - Store harvested water (also used for domestic supply)	Micro-catchment	EG, Syria, JO, MO
		Cisterns	EG, JO, MO
Wadi flow (flood and base-flow)	- Divert water for irrigation - Protect land against floods (soil erosion control) - Extract from alluvial fill	Earth dykes / Kesaria (spate irrigation and small-head pumps & earth canals); Fogarras; Jessour	EG, TN, JO; DZ, MO
		Wadi-bank enforcement	JO (Aqaba)
Spring water	- Deliver water to users within water rights limits - Store limited quantities of water for short periods (also used for domestic supply)	Earth canals	EG
		Rock conduits	JO
		Cisterns	All PCs
Groundwater	- Abstract water from shallow aquifers (also used for domestic supply) - Exploit groundwater stored in the coastal sand dunes	Shallow dug wells and pits	EG, JO, MO
		Galleries	EG

Source: Adapted from Nasr (1999).

5. Key Findings on drought management in the focus countries (Jordan, Palestine and Tunisia)

Key Findings on drought management in the focus countries (Jordan, Palestine and Tunisia)

Area of Analysis	Jordan	Palestine	Tunisia
Legal / policy framework	- Multiple texts vaguely addressing weather induced calamities, - overlapping mandates between institutions - unclear responsibilities to ensure effective management of drought		Drought addressed in laws/decrees pertaining to the fight against natural calamities
	No drought strategies or policies		
Institutions & mechanisms	- Committees formed upon need & dissolved after event. - No permanent mechanisms in place to supervise and coordinate the development & implementation of drought mitigation plans. - Institutional fragmentation. - No unified vision or policies; resulting in segregated efforts and absence of integration of drought management planning with on-going development efforts.		- Clear mechanisms involving a permanent national committee mandated to supervise the execution of all operational actions before, during and after the event, - Committee work in coordination with regional and sectorial or specialized committees. - Complex institutional water management framework, with water competencies and responsibilities spread among several institutions may compromise coordination. - Consolidated responsibility for water, agriculture and environment within one ministry, minimises competing interests and provides better alignment of sectorial needs, especially during the times of drought.

Key Findings on drought management in the focus countries (Jordan, Palestine and Tunisia)

Area of Analysis	Jordan	Palestine	Tunisia
Institutions & mechanisms/Continued	- State funds are allocated only upon the evaluation of damages. - Due to financial constraints, they are allocated only when severe impacts are recorded.	Compensations provided by the state (Ministry of finance) based on reported damages	Mutual funds for the compensation of farmers against damages ensuing from natural disasters. However, the level of contribution by the private sector is limited.
Information Systems	- Although relevant drought management information sources exist, but they are scattered and diversified. - The above constrains information exchange and hampers efficient valorisation of information.		

Key Findings on drought management in the focus countries (Jordan, Palestine and Tunisia)

Area of Analysis	Jordan	Palestine	Tunisia
Drought preparedness, planning and management	- No drought management plans (No characterisation of droughts). - Drought thresholds or indices are not identified; neither at the national or local level. - No risk and vulnerability assessments are in place). - No alert mechanisms established. - Drought mitigation plans incl. reducing socio-economic vulnerability, are mostly developed reactively and implemented under emergency conditions. - Long term supply and demand management actions driven by severe water shortage also serve the country during periods of drought.		- Prediction of hydro-climatic situation - Practical guideline for drought management, consisting of methodological approaches; identifies the principal drought indices, describes the drought preparedness and management process, and maps the intervening parties. - Execution of the drought mitigation programmes depending on the type, intensity and duration of the drought event. - the drought mitigation plan needs regular evaluation and revision based on evolving technologies, emerging programmes and changing institutional responsibilities

6. Conclusions

- Lack of consistent data in terms of temporal and spatial resolution and extent.
- Most of the drought episodes occurred during the last 3 decades & are becoming more **persistent** involving multiple years of consecutive droughts.
- SPI Studies over the last century: the **E. Med** region**,** has **-VE trends of annual SPI & precip.**
- **Jordan, Lebanon and Palestine → most affected by SPI decrease**.
- The national communication reports to the UNFCC confirm that CC is one of the drivers for the extreme phenomena in the PCs (increased intensity and severity of droughts).
- High-resolution regional climate models for the E. Med give clear scientific backing to the IPCC projections for the region.
- IPCC 4th Assessment Report predicts that, for the southern and eastern Mediterranean, warming over the 21st century will be larger than global annual mean warming.
- Adopted approach is that of crisis management:
  - the provision of emergency relief to the affected areas or sectors.
  - decision makers, usually act when it reaches alarming levels in terms of intensity and areal extent and when water management options are quite limited.
  - Often, a national inter-government committee is formed to address the drought and its associated impacts; involving implicated line ministries (MoW, MoA, MoF, MoInt incl. civil defence departments, Trade and industry, etc.), NGOs & CBOs.

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6. Conclusions

- In most cases, once the drought cycle is over, the activity of the committee is abandoned, without due consideration to the lessons learnt from the previous drought episodes.

- Ineffective management approach, poorly coordinated and untimely
  - often leads to costly short term solutions under emergency situations;
  - involves high tensions between public administrations and affected groups, and competing sectorial interests
- Need effective response to the risks associated with the impacts of droughts →
  - proper management & promoting concepts & methodologies for drought risk management to replace the customarily crisis management of drought in the region.
- A well-established risk management system including contingency plans need to be developed and maintained by governments.
- The adoption of enabling **policies** and legal framework at the national level are crucial elements for the **reduction** of, and coping with drought hazards.

Thank you for your kind attention