Managing risks of extreme events: drought in the Arab Region

Drought Monitoring and Assessment in Arab Region

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Droughts have been a part of our environment since the beginning of recorded history, and humanity's survival may be testimony only to its capacity to endure this climatic phenomenon.

**Drought**

is considered by many to be the most complex but least understood of all natural hazards, affecting more people than any other hazard.
Increase in Forest Fires

Hot Waves

Increase in Surface Temperature

Drought

Decrease soil moisture

Sand Storms

Sand Encroachments

Decrease Renewable Water

Desertification

Loss in Vegetation Cover

Reduction on Land Productivity

Decline on Natural Vegetation

Increase Food Insecurity

Increase Migration

Reduce Bio-diversity

Increase Water Scarcity
“there is medium confidence that droughts in Mediterranean will intensify in the 21st century, the 20th century simulations indicate that the ‘transition’ toward drier conditions has already started to occur and has accelerated around the turn of the century towards the larger rates projected for the 21st century, there is also low confidence in projected future changes in dust activity.,”

(Mariotti et al., 2008; Giorgi, 2006; Beniston et al., 2007; Planton et al., 2008).
Mariotti (2008) ENVIRONMENTAL RESEARCH LETTERS

Mediterranean water cycle anomalies over the period 1900–2100 relative to 1950–2000. Area-averaged evaporation (brown), precipitation (blue) and precipitation minus evaporation (black; \( P - E \)) are based on an average of CMIP3 model runs. For \( P - E \), the envelope of individual model anomalies and the 1 standard deviation interval around the ensemble mean are also shown (light gray and dark gray shading respectively). Data are six years running means of annual mean area-averages over the box of figure 3 broadly defining the Mediterranean region. Panel a: land-only. Panel b: sea-only. Focus periods are highlighted (yellow).
Projected Aridity Changes in the 21st Century.

Mediterranean water cycle changes by 2070–2099 compared to 1950–2000 for the ‘wet’ and ‘dry’ seasons. Precipitation (a) and (b), evaporation (c) and (d), and precipitation minus evaporation (e) and (f).

Anomalies are based on an average of CMIP3 model runs. For all, units are m/d. *The box broadly depicts the Mediterranean region.*
Giannakopoulos et al., 2009, determined climatic changes through comparison between control (1961–1990) and future (2031–2060) years. He used means and extremes to describe future changes in both considering seasonal and yearly parameters. He added that climatic changes over the Mediterranean basin in 2031–2060, when a 2 °C global warming is most likely to occur, as investigated with the HadCM3 global circulation model, he concluded that the rate of warming is found to be around 2 °C in spring and winter, while it reaches 4 °C in summer. An additional month of summer days is expected, along with 2–4 weeks of tropical nights. Increase in heat wave days and decrease in frost nights are expected to be a month inland. The impacts of these climatic changes on human activities such as agriculture, energy, tourism and natural ecosystems forest fires are also assessed.

Left column: difference in the average annual (a) maximum, (b) mean, and (c) minimum temperature (°C) between 2031–2060 and 1961–1990. Right column: the corresponding 95% confidence range.

Left column: differences in annual (a) number of dry days and (b) length of longest dry spell averaged over 2031–2060 and over 1961–1990, in weeks. Right column: the corresponding 95% confidence range in weeks.

Spatial distribution of the likelihood of increase or decrease of moderate drought for MPE and MME. Locations where more than 70% of the ensemble members show a decrease (increase) in moderate drought are in blue (red). Places where less than 70% of the ensemble members agree on either an increase or a decrease are in gray. The percentage of the total area where more than 70% of the models agree is given.
Giorgi 2006[1], calculated the Regional Climate Change Index RCCI using wet season (WS) and dry season (DS) as defined by Giorgi and Bi, 2005[2], temperature and precipitation over 26 land regions of the world, as shown in figure, from 20 global model simulations (some including multiple realizations) of 20th and 21st climate under forcing from 3 IPCC emission scenarios, A1B, B1 and A2 (IPCC, 2000). He added, that the RCCI for the different regions showed that the most prominent Hot-Spots emerging from the RCCI analysis are the Mediterranean and North Eastern Europe (NEE) regions.


Drought Indices
The need for proper quantification of drought impacts and monitoring and reporting of drought development is of critical importance.
During the first decade of the twentieth century, the U.S. Weather Bureau identified drought as occurring during any period of 21 or more days with rainfall 30% or more below normal for the period.

A drought measure frequently used at that time was the accumulated precipitation deficit, or the accumulated departure from normal. Other examples of early criteria include the following:

1) 15 consecutive days with no rain,
2) 21 days or more with precipitation less than one third of normal,
3) annual precipitation that is less than 75% of normal,
4) monthly precipitation that is less than 60% of normal, and
5) any amount of rainfall less than 85% of normal.

As late as 1957, Friedman used annual rainfall as his drought index in a study of drought in Texas. Similar criteria have been employed in other countries:

1) Britain: 15 consecutive days with less than 0.25 mm (0.01 in.) [or 1.0 mm (0.04 in.)];
2) India: rainfall half of normal or less for a week, or actual seasonal rainfall deficient by more than twice the mean deviation;
3) Russia: 10 days with total rainfall not exceeding 5 mm (0.20 in.);
4) Bali: a period of 6 days without rain; and
5) Libya: annual rainfall that is less than 180 mm (7 in.).

The weather station data,
- is very accurate at recording what is happening at ground level
- weather stations are expensive and require constant recording of measurements and periodic maintenance.
- weather stations are consequently sparsely distributed, especially in developing countries.
- Rural areas are poorly covered and require interpolation between stations.

The satellites,
- satellites see entire landscapes and
- they are able to provide precise measurements at every location.
- However, satellites cannot make precipitation ground measurements as accurately as weather stations. But measure surface wetness, temperature, temperature condition index, and vegetation condition index.
At the meantime:

- Traditional methods of drought assessment and monitoring rely on rainfall data, which are limited in the region, often inaccurate and, most importantly, difficult to obtain in near-real time.
- Satellite-sensor data are consistently available and can be used to detect drought, duration and magnitude; Thiruvengadachari and Gopalkrishna 1993.
- Crop yields can be predicted 5 to 13 weeks prior to harvests using remote-sensing techniques; Ungani and Kogan 1998.
- Vegetative conditions over the world are reported occasionally by NOAA National Environmental Satellite Data and Information System (NESDIS) using the Advanced Very High Resolution Radiometer (AVHRR) data (Kogan 2000).


Types of Drought
A period of abnormally dry weather long enough to cause a serious hydrological imbalance.

Drought is a relative term — shortage of precipitation related to particular activity.

Storage changes in soil moisture and groundwater are also affected by increases in actual evapotranspiration in addition to reductions in precipitation.

A MEGADROUGHT is drought, lasting much longer than normal, usually a decade or more.

A period with an abnormal precipitation deficit is defined as a METEOROLOGICAL DROUGHT.

during the growing season affects yield – SOIL MOISTURE DROUGHT, or AGRICULTURAL DROUGHT,

during the runoff season affects water supplies – HYDROLOGICAL DROUGHT.
Drought Monitoring

Vegetation Index Map
Difference from Normal

April 30, 2009

Irrigated

Rainfed Grain Crops

NDVI:
Better
No Data
No Change
Worse
# METEOROLOGICAL DROUGHT

<table>
<thead>
<tr>
<th>Index Name</th>
<th>Calculation</th>
<th>Drought Classification</th>
<th>Strength</th>
<th>Weakness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Palmer Drought Severity Index (PDSI)</td>
<td>Based on a 2-layer bucket-type water balance model, the PDSI measures the departure of moisture balance from a normal condition</td>
<td>−4.0 or less: extreme drought; −3.0 to −3.99: severe drought; −2.0 to −2.99: moderate drought; −1.0 to −1.99: mild drought; −0.5 to −0.99: incipient dry spell; 0.49 to −0.49: near normal</td>
<td>Considers both water supply (precipitation) and demand (potential Evapo-transpiration)</td>
<td>Does not work well over mountainous and snow covered areas; may require re-normalization</td>
</tr>
<tr>
<td>Standardized Precipitation Index (SPI)</td>
<td>Fitting and transforming a long-term precipitation record into a normal distribution with respect to the SPI, which has zero mean and unit SD.</td>
<td>−2 or less: extremely dry; −1.5 to −1.99: severely dry; −1.0 to −1.49: moderately dry; −0.99 to 0.99: near normal</td>
<td>Can be computed for different time scales; symmetric for both dry and wet spells; relates to probability</td>
<td>Requires long-term precipitation data; no consideration of evaporation Refs 25, 26; any area by drought planners</td>
</tr>
<tr>
<td>Rainfall Deciles (RD)</td>
<td>Ranking rainfall in the past 3 months against the climatological record of 3-month rainfall, which is divided into 10 quintiles or deciles</td>
<td>deciles 1–2 (lowest 20%): much below normal; deciles 3–4: below normal; deciles 5–6: near normal</td>
<td>Provides a statistical measure of precipitation; performed well in limited tests</td>
<td>Requires atmospheric forcing data and a land surface model</td>
</tr>
</tbody>
</table>

Deciles: Any one of nine numbers in series dividing the distribution of the individuals in the series into 10 groups of equal frequency.
## AGRICULTURAL DROUGHT

<table>
<thead>
<tr>
<th>Index Name</th>
<th>Calculation</th>
<th>Drought Classification</th>
<th>Strength</th>
<th>Weakness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computed Soil Moisture (CSM)</td>
<td>Soil moisture content is computed by a land surface model forced with observed precipitation, temperature and other atmospheric forcing</td>
<td>Drought may be defined based on the percentiles of the CSM, e.g., ≤20th percentile: very dry; 20–40%: dry; 40–60%: near normal</td>
<td>Considers antecedent conditions</td>
<td>Requires atmospheric forcing data and a land surface model</td>
</tr>
<tr>
<td>Palmer Moisture Anomaly Index (Z-index)</td>
<td>The Z-index is the moisture anomaly for the current month in the Palmer model</td>
<td>Percentiles of the Z-index may be used to define drought</td>
<td>Rapid response to current precipitation deficit</td>
<td>Does not consider antecedent conditions</td>
</tr>
</tbody>
</table>
# HYDROLOGICAL DROUGHT

<table>
<thead>
<tr>
<th>Index Name</th>
<th>Calculation</th>
<th>Drought Classification</th>
<th>Strength</th>
<th>Weakness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total water deficit (S)</td>
<td>( S = D \times M ), where D is the duration during which the stream flow is below the normal level and M is the average departure of stream flow from the long-term mean during period D</td>
<td>S may need normalization in defining drought</td>
<td>Simple calculation</td>
<td>No sub-basin information, no standard drought classification</td>
</tr>
<tr>
<td>Palmer Hydrological Drought Index (PHDI)</td>
<td>Computed using the same Palmer model as for the PDSI, but with a more stringent criterion for the termination of the drought or wet spell</td>
<td>Values similar to PDSI, but with smoother variations</td>
<td>Use of a water balance model to account for the effect of both precipitation and temperature</td>
<td>Does not work well over mountainous and snow covered areas; may require re-normalization</td>
</tr>
<tr>
<td>Surface Water Supply Index (SWSI)</td>
<td>Calculated by river basin based on snowpack, stream flow, precipitation, and reservoir storage</td>
<td>Normalized values similar to PDSI</td>
<td>Considers snowpack and water storage</td>
<td>Basin-dependent formulations</td>
</tr>
</tbody>
</table>
## Regional Drought

<table>
<thead>
<tr>
<th>Index Name</th>
<th>Calculation</th>
<th>Drought Classification</th>
<th>Strength</th>
<th>Weakness</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Drought Area Index (DAI)</strong></td>
<td>Percentage of a given region under drought condition based on a drought intensity index</td>
<td>Drought is defined based on a separate index</td>
<td>Quantifies drought areal extent</td>
<td>Does not provide the mean intensity of drought over the region</td>
</tr>
<tr>
<td><strong>Drought Severity Index (DSI)</strong></td>
<td>Area-weighted mean of a drought intensity index over the drought area in a given region</td>
<td>Drought is defined based on a separate index</td>
<td>Quantifies drought severity over a region</td>
<td>Does not provide drought areal extent</td>
</tr>
</tbody>
</table>
a. Standardized precipitation index (SPI)
The SPI is a meteorological drought index that provides a comparison of the precipitation over the preceding 12-month period with the corresponding climatology. It is estimated by transforming the long-term precipitation distribution for each location to a normal distribution (Guttman 1999). Because the SPI is based solely on precipitation it is readily available and useful for planners and policy makers.

b. Palmer drought severity index (PDSI)
The PDSI was created by Palmer (1965) to provide the “cumulative departure of moisture supply” from the normal. Full details of the PDSI calculation can be found at the National Agricultural Decision Support System Web site (http://nadss.unl.edu). As suggested by Burke et al. (2006), the potential evaporation required as input to the PDSI was calculated using the Penman–Monteith equation (Shuttleworth 1993) instead of the Thornthwaite (1948) equation. Analysis shows that the PDSI has a memory of the order of 12 months, resulting in the use of this time scale for the other indices. Despite being developed to provide an estimate of meteorological drought, published comparisons between the PDSI and soil moisture (e.g., Sheffield et al. 2004) suggest that the PDSI might also give some indication of agricultural drought.
Rainfall received in various governorates in 2008/09 as compared with the 2007/08 season and the long-term average

During the 2007/2008 and 2008/2009 seasons, Al Hassakeh, Deir Ezzor and Ar Raqq;a received much-reduced rainfall, especially in 2007/2008, with shortfalls of 66%, 60% and 45%, respectively. What are known as Zones 4 and 5 of these governorates were seriously affected, in particular because of the practice of rain-fed cropping in these governorates. The most affected were Al Hassakeh, Deir Ezzor and Ar Raqq;a. Only about 50% of the long-term average was received in these areas. Rural Damascus received 69% of the long-term average. The least-affected areas were Hama and Homs, which received 80% and 84% of the long-term average respectively.
The study of the standardized precipitation index SPI, for the east MED shows that, over the last century the SPI has dropped by around 0.5 to 1 points with the exception of a part of Iraq, the entire region has negative trends of annual SPI and annual precipitation, and countries most affected by the decrease are Jordan, Syria, Lebanon and Palestine; Göbel and De Pauw, 2010.
Standard Deviation of Annual Precipitation
Mediterranean water cycle changes observed during the 20th century relative to the period 1950–2000. Area-averaged annual mean precipitation anomalies (six years running means) from various datasets (panel a; mm/d) and PDSI (panel b; au); discharge anomalies (units are % of climatology) for various Mediterranean rivers (panel c). Due to data availability, discharge anomalies are relative to the 1960–1980 period.
**Satalite Drought-Monitoring Indices**

Drought-monitoring indices are derived from AVHRR and MODIS data (table 1). They are normally radiometric measures of vegetation condition and dynamics, exploiting the unique spectral signatures of canopy elements, particularly in the red and near-infrared (NIR) portions of the spectrum (e.g., Huete et al. 1997, 2002) and are sensitive to vegetation type, growth stage, canopy cover and structure (Clevers and Verhoef 1993; Thenkabail 2003).

<table>
<thead>
<tr>
<th>Drought index</th>
<th>Band or index used to compute the index</th>
<th>Range</th>
<th>Normal condition</th>
<th>Severe drought</th>
<th>Healthy vegetation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AVHRR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Normalized</td>
<td>Band 1 (0.58-0.68µm)</td>
<td>-1 to +1</td>
<td>Depends on the location</td>
<td>-1</td>
<td>+1</td>
</tr>
<tr>
<td>difference</td>
<td>Band 2 (0.73-1.10µm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>vegetation</td>
<td>Band 1 (0.62-0.67µm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>index (NDVI)</td>
<td>Band 2 (0.84-0.87µm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Drought</td>
<td>NDVI</td>
<td>-1 to +1</td>
<td>0</td>
<td>-1</td>
<td>+1</td>
</tr>
<tr>
<td>severity</td>
<td>NDVI long-term mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>index (DEVNDVI)</td>
<td>NDVI long-term mean</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Vegetation</td>
<td>NDVI</td>
<td>0 to 100 %</td>
<td>50 %</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>condition</td>
<td>NDVI long-term minimum</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>index (VCI)</td>
<td>NDVI long-term maximum</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Temperature</td>
<td>Band 4 (10.3-11.30µm)</td>
<td>0 to 100 %</td>
<td>50 %</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>condition</td>
<td>Band 4 temp long-term minimum</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>index (TCI)</td>
<td>Band 4 temp long-term maximum</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
They utilize reflectance data in two or more spectral bands, thus enhancing the vegetation signal and canceling out the effects of topography, sun angle and atmosphere.

Normalized Difference Vegetation Index (NDVI).

NDVI was first suggested by Tucker (1979) as an index of vegetation health and density.

\[
\text{NDVI} = \frac{\lambda_{\text{NIR}} - \lambda_{\text{red}}}{\lambda_{\text{NIR}} + \lambda_{\text{red}}}
\]

Where, \( \lambda_{\text{NIR}} \) and \( \lambda_{\text{red}} \) are the reflectance in the NIR and red bands, respectively.
Vegetation Condition Index

\[ VCI = \frac{(NDVI - NDVI_{\text{min}})}{(NDVI_{\text{max}} - NDVI_{\text{min}})} \times 100 \]

Temperature Condition Index

\[ TCI = \frac{(BT_{\text{max}} - BT_{\text{min}})}{(BT_{\text{max}} - BT_{\text{min}})} \times 100 \]

Where, \( BT \) is the brightness temperature (MODIS LST)

Vegetation Healthy Index

\[ VHI = VCI \times 0.5 + TCI \times 0.5 \]
ARIDITY CHANGES

Drought Severity Index Penman–Monteith method (sc-PDSI pm)

Drought-affected areas in Syria, indicating areas where rains have failed for one, two or three consecutive years, and indicating the importance of assistance Al-Shaddadi district (Hassake Governorate) as one of the most vulnerable areas, affected by two years of failed rainfall.
The distribution for three different seasons 03/04, 07/08 and 09/10 have been shown in for illustration.

• **Vegetation Healthy Index**

\[ VHI = (VCI \times 0.5) + (TCI \times 0.5) \]
DROUGHT FREQUENCY
<table>
<thead>
<tr>
<th>No. of Drought Years</th>
<th>Area Million Ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–2</td>
<td>1.54</td>
</tr>
<tr>
<td>2–4</td>
<td>6.67</td>
</tr>
<tr>
<td>4–6</td>
<td>7.56</td>
</tr>
<tr>
<td>6–8</td>
<td>2.49</td>
</tr>
<tr>
<td>8–10</td>
<td>0.23</td>
</tr>
<tr>
<td></td>
<td>1.25</td>
</tr>
</tbody>
</table>
Length of Drought Periods
<table>
<thead>
<tr>
<th>Drought Length</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>In Years</td>
<td>Million Ha</td>
</tr>
<tr>
<td>&lt; 3</td>
<td>11.29</td>
</tr>
<tr>
<td>3</td>
<td>4.03</td>
</tr>
<tr>
<td>4</td>
<td>9.80</td>
</tr>
<tr>
<td>5</td>
<td>1.35</td>
</tr>
<tr>
<td>6</td>
<td>0.64</td>
</tr>
<tr>
<td>7</td>
<td>430.0</td>
</tr>
<tr>
<td>&gt; 7</td>
<td>0.15</td>
</tr>
</tbody>
</table>
Vulnerable Areas
<table>
<thead>
<tr>
<th>Vulnerability Classes</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Million Ha</td>
</tr>
<tr>
<td>Not Vulnerable</td>
<td>12.19</td>
</tr>
<tr>
<td>Slight</td>
<td>3.59</td>
</tr>
<tr>
<td>Moderate</td>
<td>1.92</td>
</tr>
<tr>
<td>High</td>
<td>0.78</td>
</tr>
</tbody>
</table>
Drought Vulnerability and Land Use
خريطة استعمالات الأراضي في محافظة الحسكة
خارطة المناطق الأكثر تعرض للجفاف في محافظة الحسكة
مناطق زراعات بعلية وري آبار

شديد
متوسط
منخفض
لا يوجد

رأس العين
الحسكة
القائملي
المعطية
خريطة المناطق الأكثر تعرض للجفاف في محافظة الحسكة
مناطق زراعات بعلية

الدميكية
المالكية
القامشلي
رأس العين
الحسكة
خارطة المناطق الأكثر تعرض للجفاف في محافظة الحسكة
مناطق زراعات بعلية ومراعي
خارطة المناطق الأكثر تعرض للجفاف في محافظة الحسكة مناطق زراعات مروية
خريطة المناطق الأكثر تعرض للجفاف في محافظة الحسكة

مناطق مراعي 4 - 15 %
خريطة المناطق الأكثر تعرض للجفاف في محافظة الحسكة
مناطق مراعية أقل من 4%
II. PREPAREDNESS
Disaster = Drought + Vulnerable Area

Increase the chances for Socio-economical disaster

Water Scarce Pressure

(Unstable to low stability)
Community not Prepared Site 1

(Medium to high stability)
Community Socio-economically Preparedness Site 2

Reduce the chances for Socio-economical disaster

Assets Governance Technology
خريطة امكانيات الخدمات التعليمية مرحلة ابتدائي

الخدمات الصحية
- أقل من 500 م
- من 500 إلى 1000 م
- من 1000 إلى 2000 م
- من 2000 إلى 5000 م
- أكثر من 5000 م
نسبية الأمية 15 سنة فأكثر إجمالي على مستوى النواحي

نسبية الأمية

%
منخفض > 30
متوسط 30 - 50
عالي 50
العلاقة بين التسرب من التعليم و الخدمة التعليمية اعدادي
خريطة إمكانية تقديم الخدمات الصحية للمشافي

الخدمات الصحية
- أقل من 10 كم
- من 10 إلى 20 كم
- من 20 إلى 30 كم
- من 30 إلى 50 كم
- أكثر من 50 كم
ACSAD Tool Box
Climate Change
Estimation of crops Areas and Productivity
Rehabilitating Degraded Areas
Flood Risk Control
Introducing new stress resistant Varieties
Improve Animal Productivity via Breeding
Monitoring and assessing Environmental Hazards
Agriculture Conservation
Integrate Water Source Management
Harmonization and Standardization efforts within Arab Countries Through Capacity Building and Networking
ACSAD Tool Box
Draw Vulnerability Maps
Land use Maps & Land Cover Maps preparation
Base Maps :
Soil Maps–Maps of Water Sources

“Arab Framework Action Plan on Climate Change” (AFAPCC) 2010-2020 under preparation
Water Harvesting, Supplementary Irrigation, Rehabilitating Depredated Areas
Integrated Water Management System

(1500 km²) Berrechid Basin -1

MOROCC

(140 km²) Zabadani Basin -2

SYRIA
Use of non-traditional Water and Increase Irrigation Efficiency
Sustainable Land Management

• Land Use Mapping
• Conservation Agriculture
• Manure and organic solid waste recycling
• Crop Rotation.
Introduce new Variety of Seeds Tolerant to Drought, Heat, Salinity and Diseases
Improve Small Cartel Productivity
Training
ACSAD Tool Box

- Reducing Drought Risk
- Climate Change
- Combating Desertification
- Estimation of crops Areas and Productivity

- Harmonization and Standardization efforts within Arab Countries
  Through Capacity Building and Networking

- Agriculture Conservation
- Integrated Water Source Management
- Introducing new stress resistant Varieties
- Flood Risk Control
- Improve Animal Productivity via Breeding
- Rehabilitating Degraded Areas
- Monitoring and assessing Environmental Hazards

Base Maps :
- Soil Maps–Maps of Water Sources

Land use Maps & Land Cover Maps preparation

Draw Vulnerability Maps

Thank you

Acknowledgment to ACSAD RS/GIS unit, NRSC Lebanon, GTZ