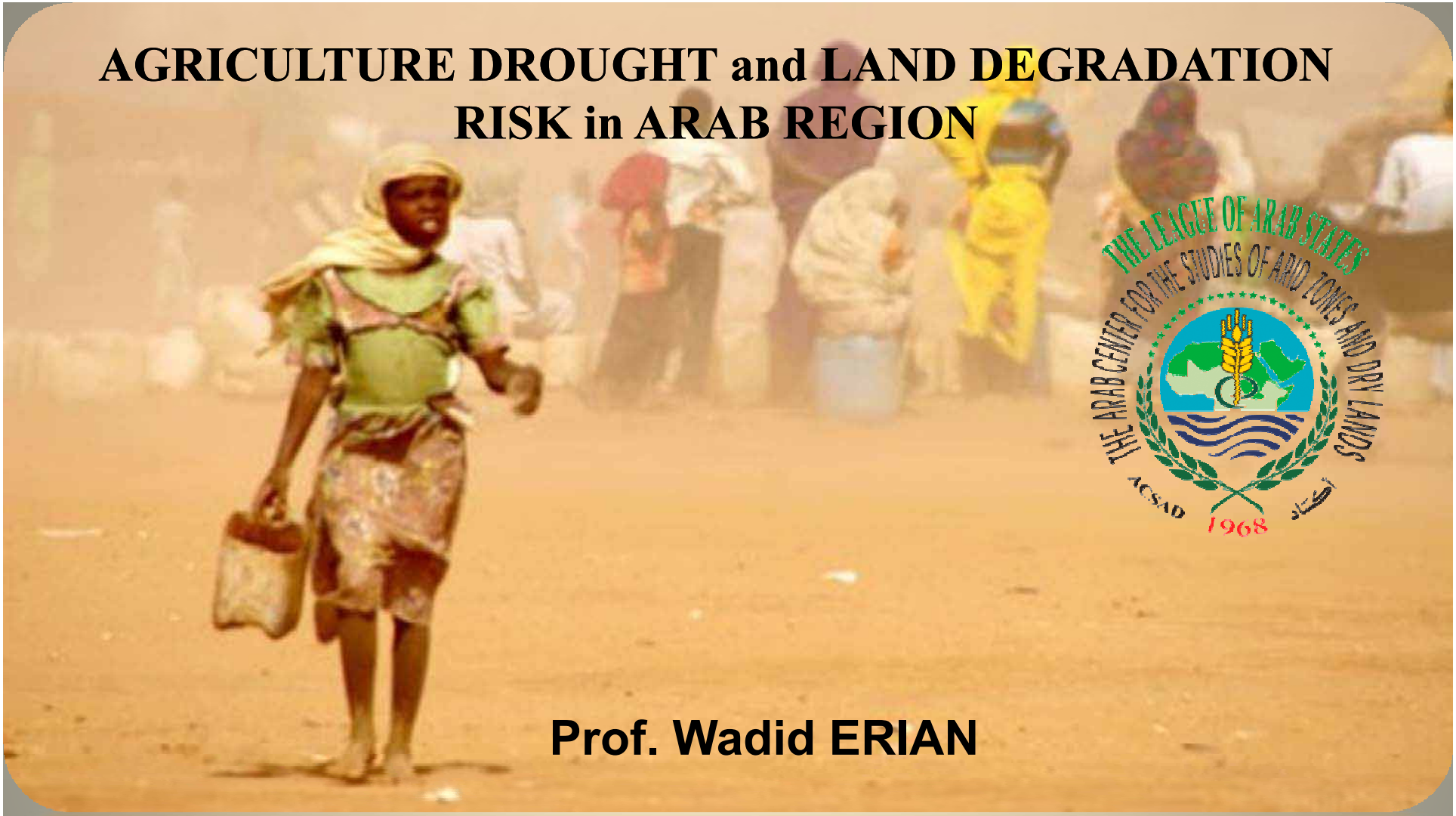
AGRICULTURE DROUGHT and LAND DEGRADATION RISK in ARAB REGION



Prof. Wadid ERIAN

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LAS ACSAD
Lead Author in IPCC - SREX , WGII
Member in UNISDR GAR Advisory Board
Advisor World Bank

A HARSH ENVIRONMENT HAS SHAPED THE CULTURES IN THE REGION

- Climate has shaped the cultures of Arab countries.
- The first:
  Settlements in the world,
  Farming communities, and
  Cities
  all began in this region, and all have changed in response to a variable climate.
- For thousands of years, people of the region have coped with the challenges of climate variability by adapting their survival strategies to changes in rainfall and temperature.

But the message is clear: over the next century this variability will increase and the climate of Arab countries will experience unprecedented extremes.

The Pyramids in Egypt

In about 2200 BC, a temporary climate shift created 300 years of reduced rainfall and colder temperatures, which forced people to abandon their rainfed fields in what is now northeast Syria.

As people migrated to the south or turned to pastoralism to survive, whole cities were deserted and covered in the dust of drought .

(Weiss and Bradley 2001).

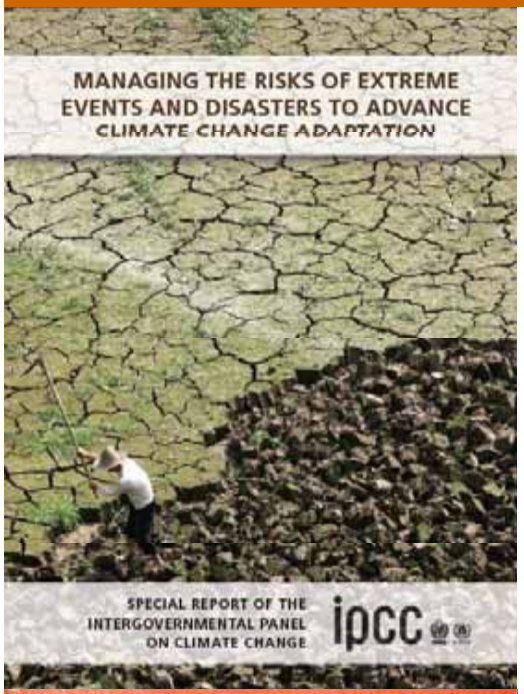
Climate change has already affected or will soon affect most of the 340 million people in the Arab region, but the roughly 100 million poor people are the least resilient to the negative impacts from these changes

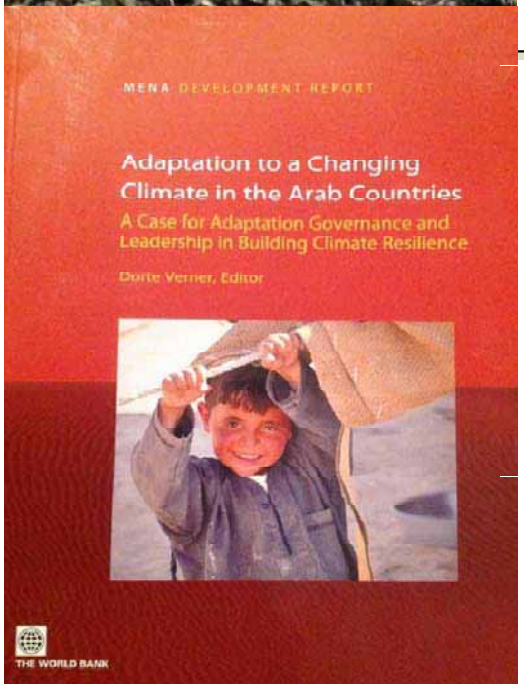
A Bedouin woman uses water from an ICRC/SARC water truck.
© ICRC / sy-e-00068

More Displacement and migration to Cities
70% will live in Cities by 2050
Reducing quality and urbanization culture

DROUGHT

الحد من مخاطر الج
– تقارير دولية شارك فيها






In Africa, the Arab states and the Mediterranean, agricultural drought is a major hazard. Without taking into account its potential impact on natural capital and on economies in the region, any estimation of disaster risk is fundamentally incomplete.

Box 6.3 presents two different but complementary approaches being pursued to improve the characterisation of agricultural drought risk (Erian et al., 2012; Jayanthi and Husak, 2012). The models include crop losses and economic environmental impacts. But the impacts on welfare and livelihoods have not been estimated at this time.

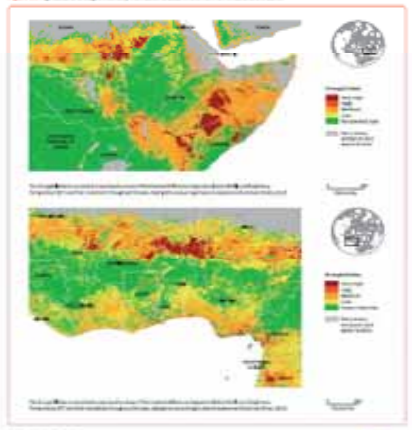
Analysis of changes in vegetation cover* between 2000 and 2010 highlights that a large area of Africa, the Arab states and the Mediterranean has experienced drought (Erian et al., 2012). Figure 6.6, for example, illustrates agricultural drought intensity in the Horn of Africa affected by severe drought; in Italy, Serbia and Macedonia, 20 percent of total rain-fed cropland has been affected. In Portugal, Spain and Greece, more than 25 percent of the rangeland is heavily affected by drought. This corresponds, respectively, to 15 percent, 10 percent, and 8 percent of total land in these countries (Erian et al., 2012).

Scientific literature (IPCC, 2007 and 2012) agrees that all categories of drought hazard in the Mediterranean region will get worse as the region gets drier and warmer. However, in Africa, there is only medium to low confidence owing to a lack of documented evidence and data (IPCC, 2012).

In Eastern Africa, other studies highlight long-term decline in rainfall and increasing temperature, such as in parts of Ethiopia, Kenya, Sudan and Uganda, which will increase agricultural drought hazard (Funk et al., 2010; 2012a; 2012b). Figure 6.7,

Box 6.3 Modelling agricultural drought risk

The Arab Centre for the Study of Arid Zones and Drylands (ACSAD) uses satellite data from the last 10 years to reconstruct past agricultural droughts. It measures month by month differences in vegetation. This allows characterisation of the intensity, variability frequency and persistence of agricultural drought in any given area. With this information, it is possible to identify the exposure of areas of rain-fed agriculture, rangeland, individuals and cattle to agricultural drought as well as the amount of drought-affected areas experiencing land degra

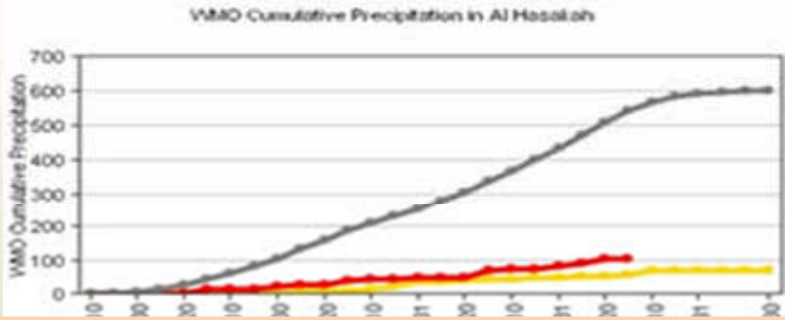


A period of abnormally dry weather long enough to cause a serious hydrological imbalance.

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.



Precipitation deficit is defined as a METEOROLOGICAL DROUGHT.

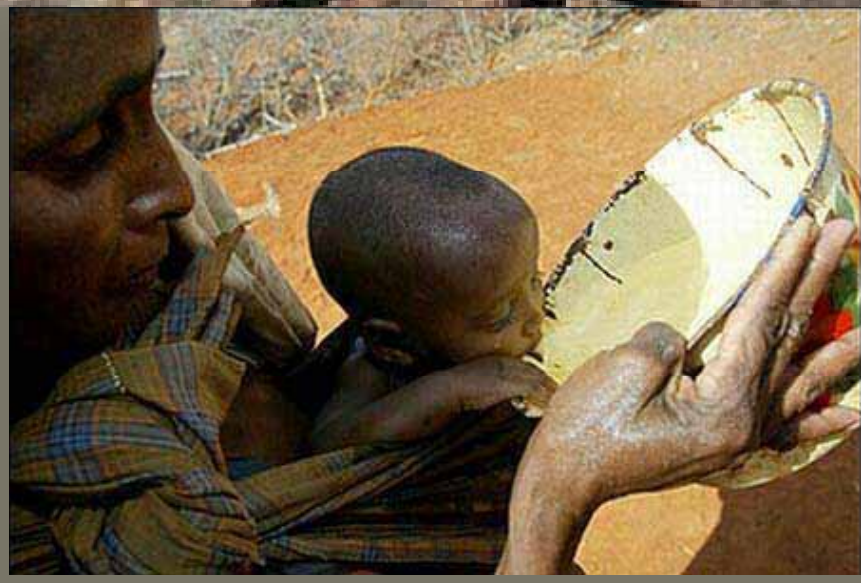
during the growing season affects yield - SOIL MOISTURE DROUGHT, or AGRICULTURAL DROUGHT,

during the runoff season affects water supplies – HYDROLOGICAL DROUGHT.

Major Key Massage Indicated in IPCC 2012

- *There is medium confidence that since the 1950s some regions of the world have experienced trends toward more intense and longer droughts, in particular in Southern Europe and West Africa, but in some regions droughts have become less frequent, less intense, or shorter, for example, central North America and northwestern Australia.*

- *There is medium confidence that anthropogenic influence has contributed to some changes in the drought patterns observed in the second half of the 20th century, based on its attributed impact on precipitation and temperature changes (though temperature can only be indirectly related to drought trends).*

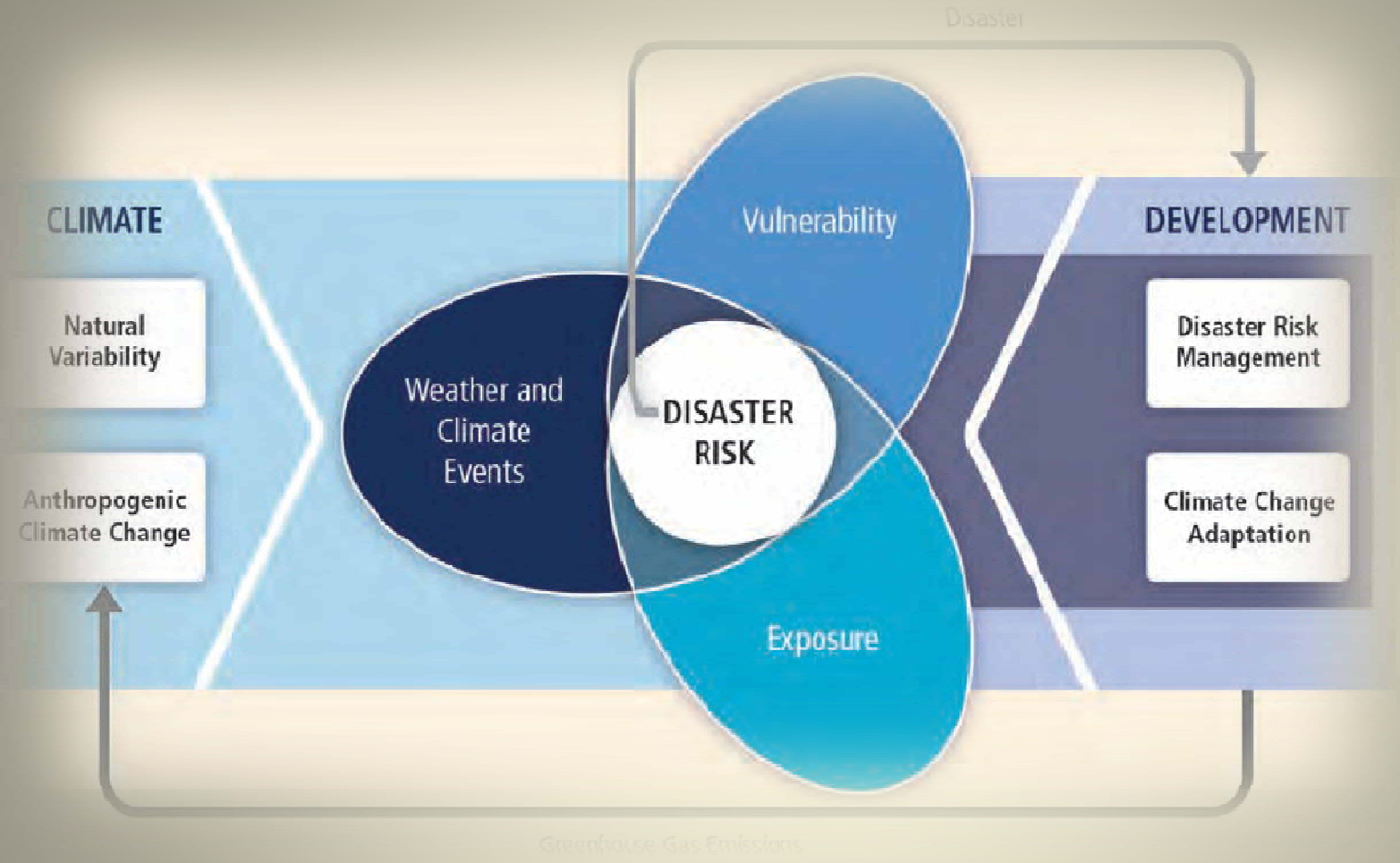


KEY MESSAGE

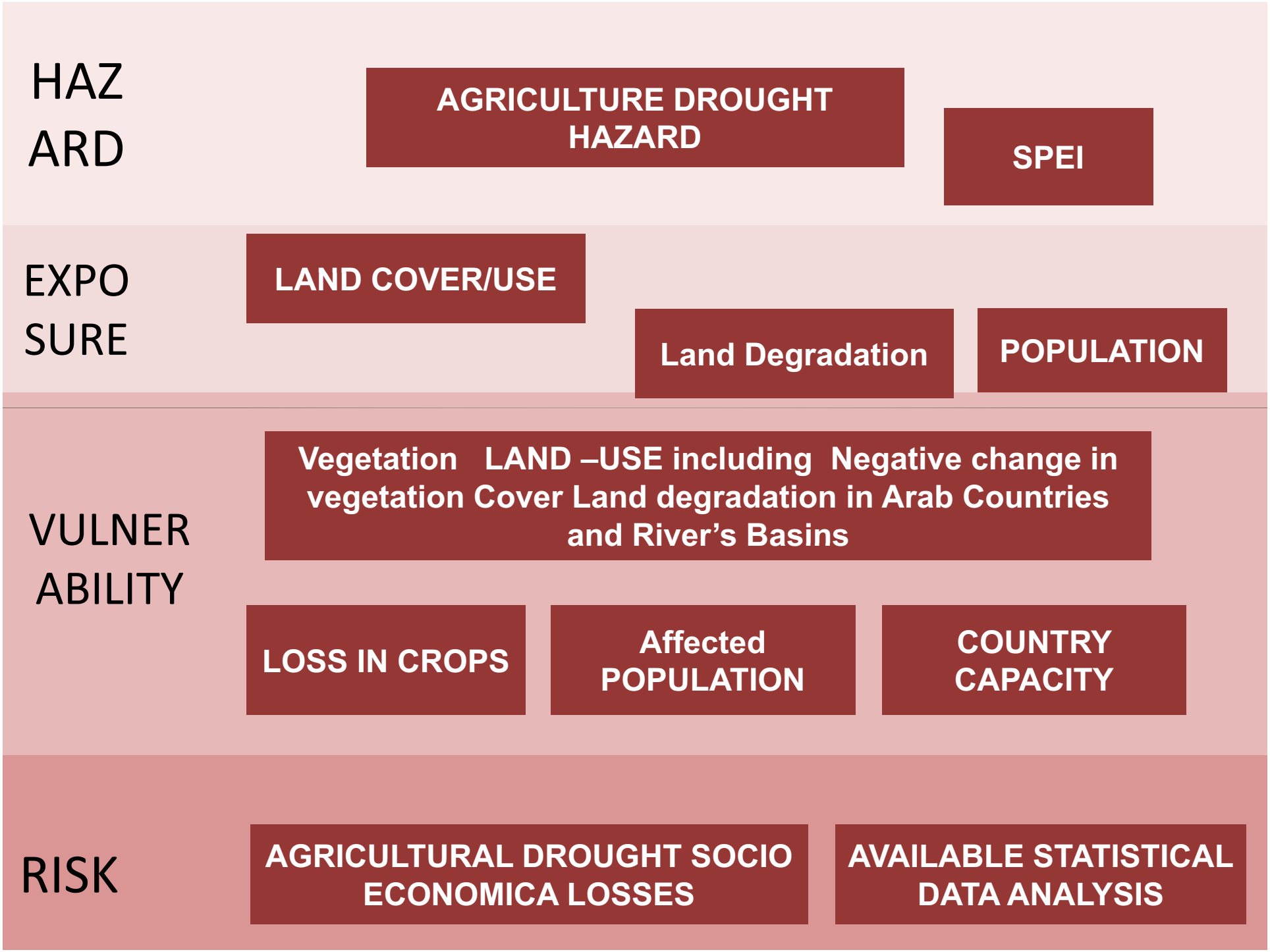
*" there is medium confidence that droughts in **Mediterranean** will intensify in the 21st century,*
the 20th century simulations indicate that the 'transition' toward drier conditions has already started to occur and has accelerated around the turn of the century towards the larger rates projected 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).

STUDING DROUGHT HAZARD



Exposure and vulnerability to weather and climate events (drought in our study) determine impacts and the likelihood of disasters (disaster risk).

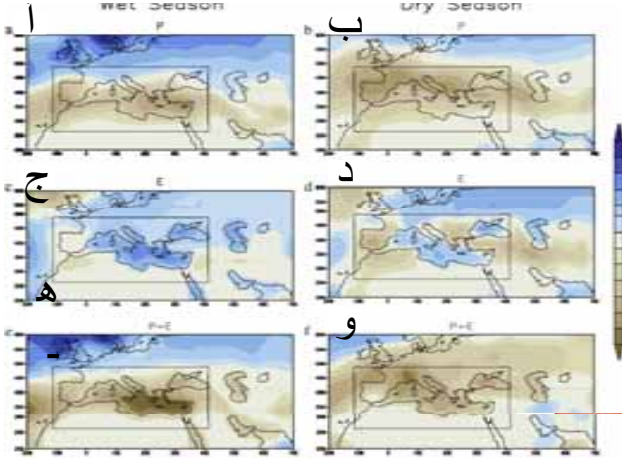

HAZ
ARD
AGRICULTURE DROUGHT HAZARD
SPEI
EXPO
SURE
LAND COVER/USE
Land Degradation
POPULATION
VULNER
ABILITY
Vegetation LAND –USE including Negative change in vegetation Cover Land degradation in Arab Countries and River's Basins
LOSS IN CROPS
Affected POPULATION
COUNTRY CAPACITY
RISK
AGRICULTURAL DROUGHT SOCIO ECONOMICA LOSSES
AVAILABLE STATISTICAL DATA ANALYSIS

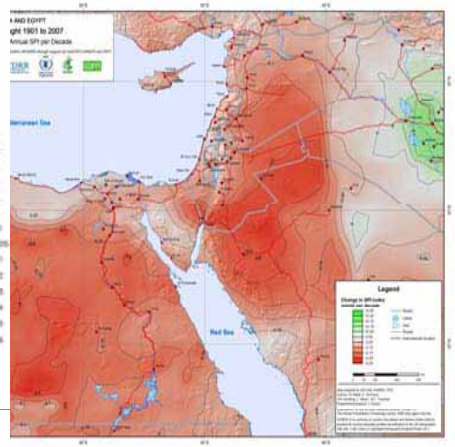
HAZ
ARD

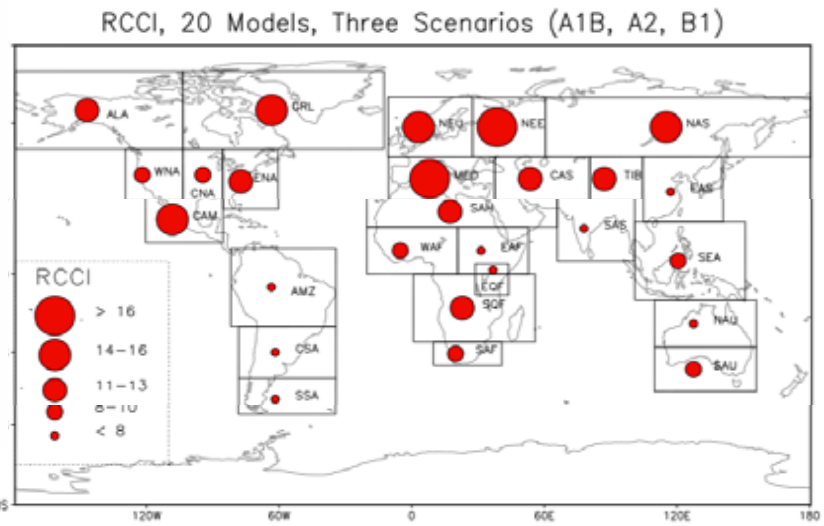
HAZ
ARD

AGRICULTURE DROUGHT HAZARD

SPEI

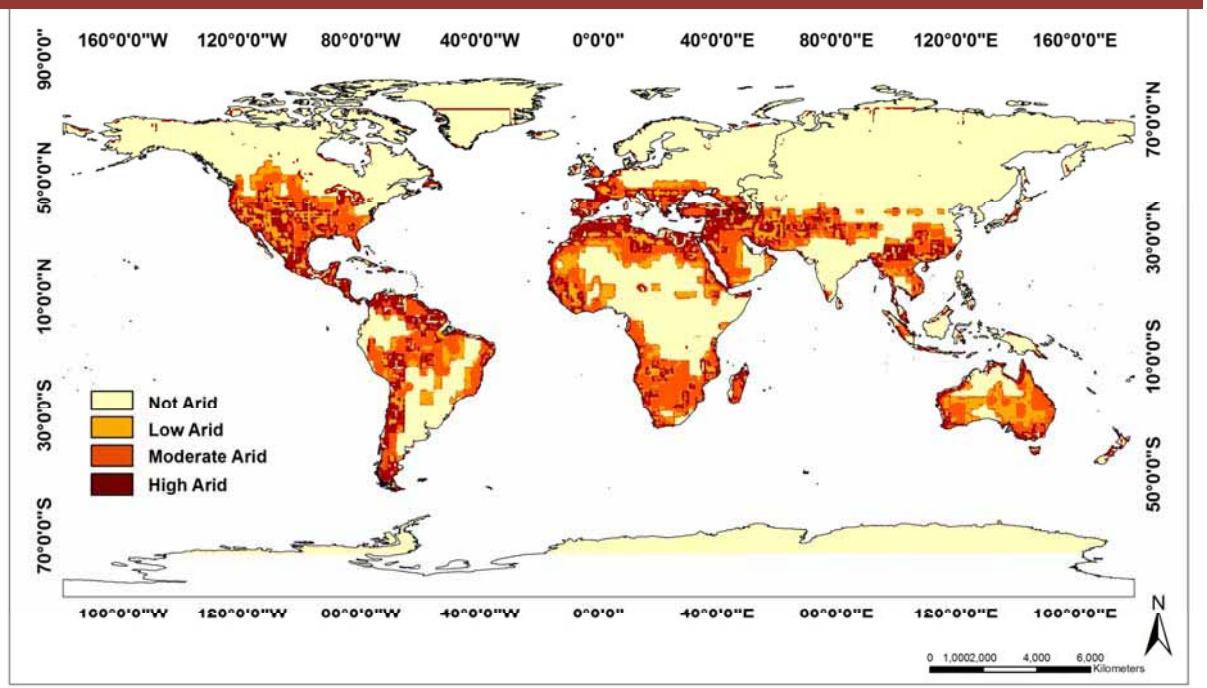


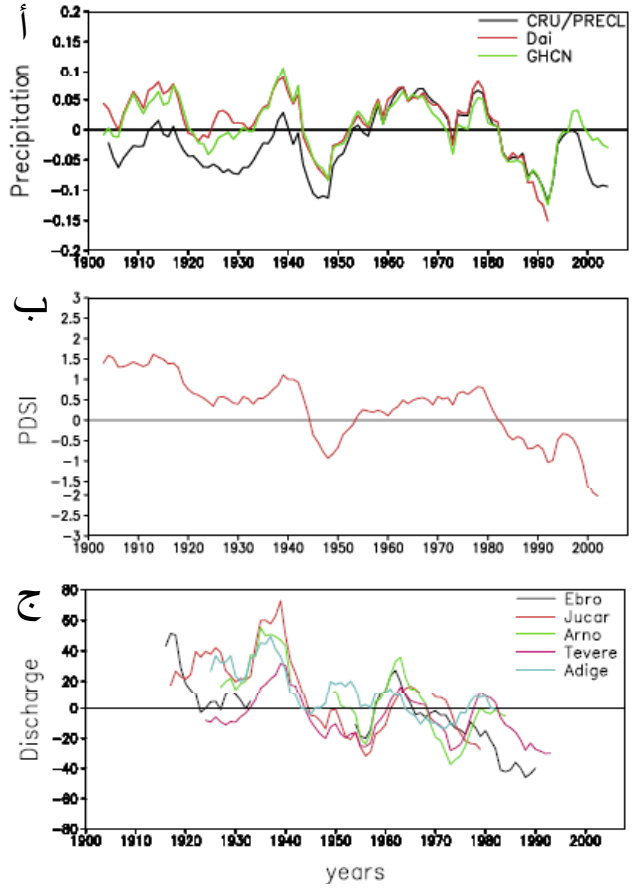




Aridity map for years 2030 – 2039

Projected Aridity Changes in the 21st Century.





Dai Aiguo 2010. "Drought under Global Warming " . National Center for Atmospheric Research, Boulder, Colorado , USA , John Wiley & Sons, Ltd. DOI: 10.1002/wcc.81

Producing ADH map

Using **MODIS** The Moderate Resolution Imaging Spectroradiometer 1999-2011

Monthly during 12 years But as Africa and Mediterranean countries have different climatic zones all agriculture seasons will be analyzed as follows
1. (12 months) for all Africa and mainly tropical region),
2. (Winter Months -8 from Oct-May),
3.(Summer Months -8 from March - Oct)
4. (Monsoon Months – 6 May – Oct)

Monthly VCI
Vegetation Condition Index

+

Monthly TCI
Temperature Condition Index

=

Monthly VHI
Vegetation Healthy Index

Drought Intensity Map

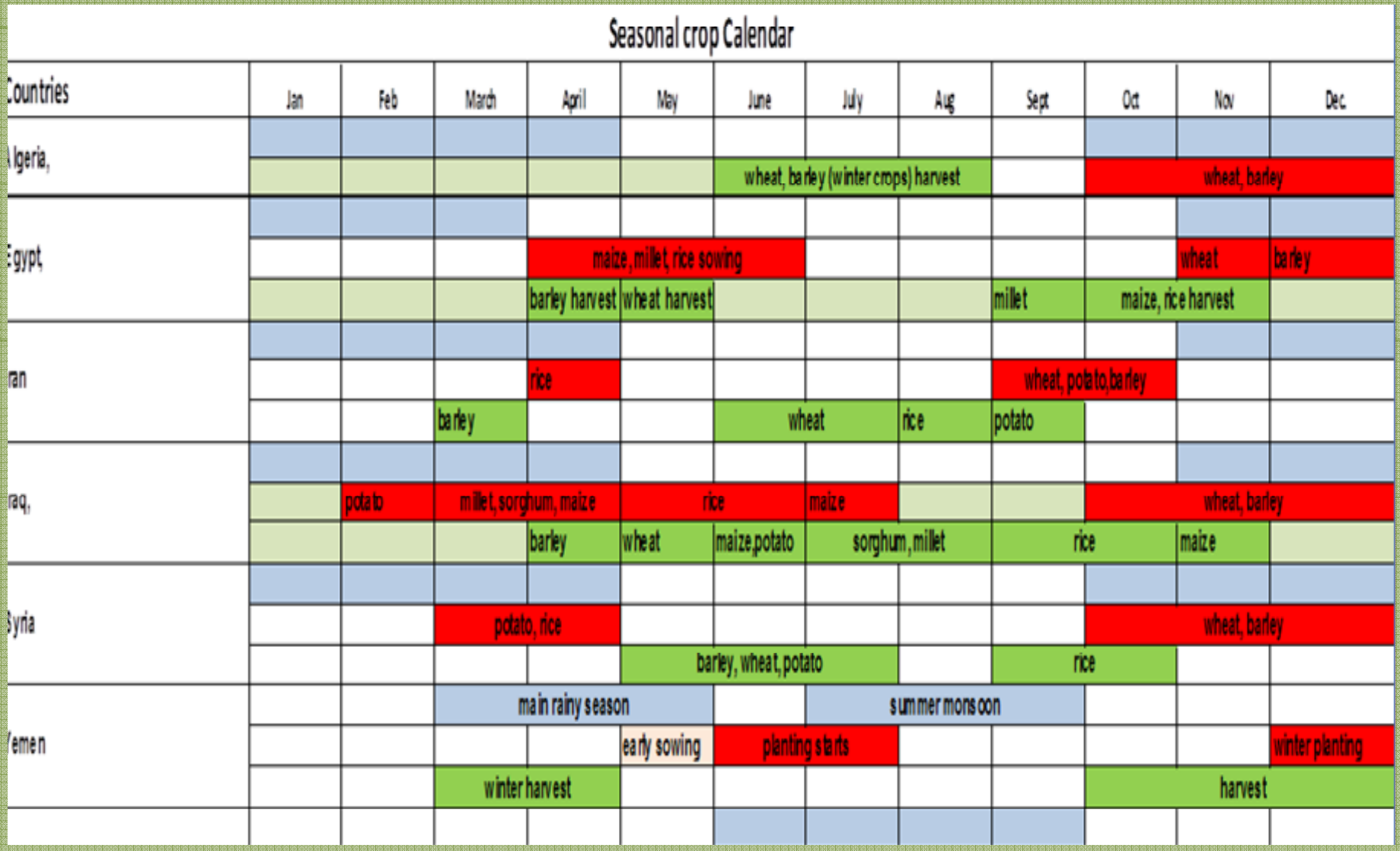
Drought Variability Map

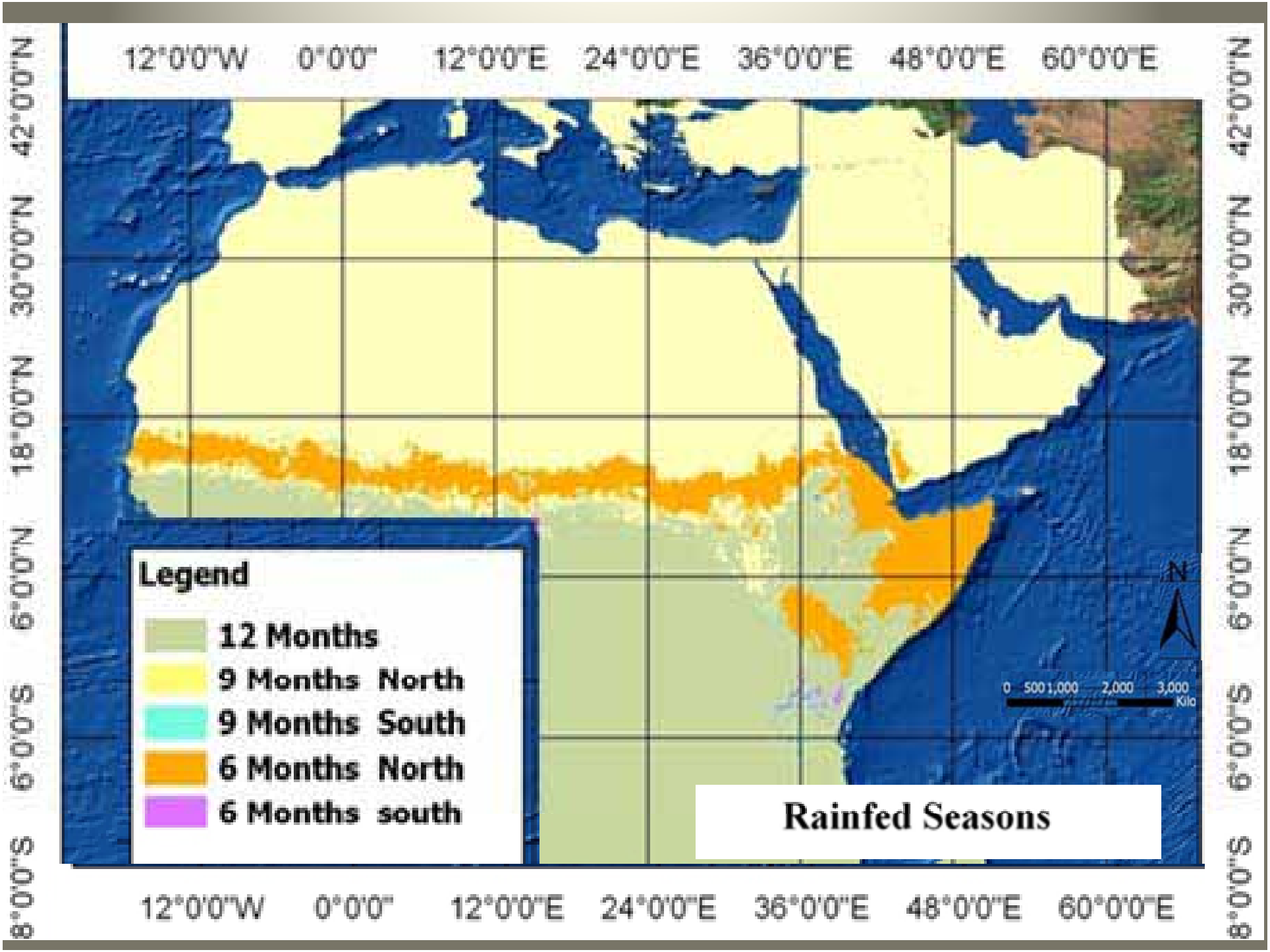
Drought Frequency Map

Drought Consecutive Map

Agriculture Drought Hazard Map

Examples of Crop Calendar For The Studied Countries, after WFP 2011

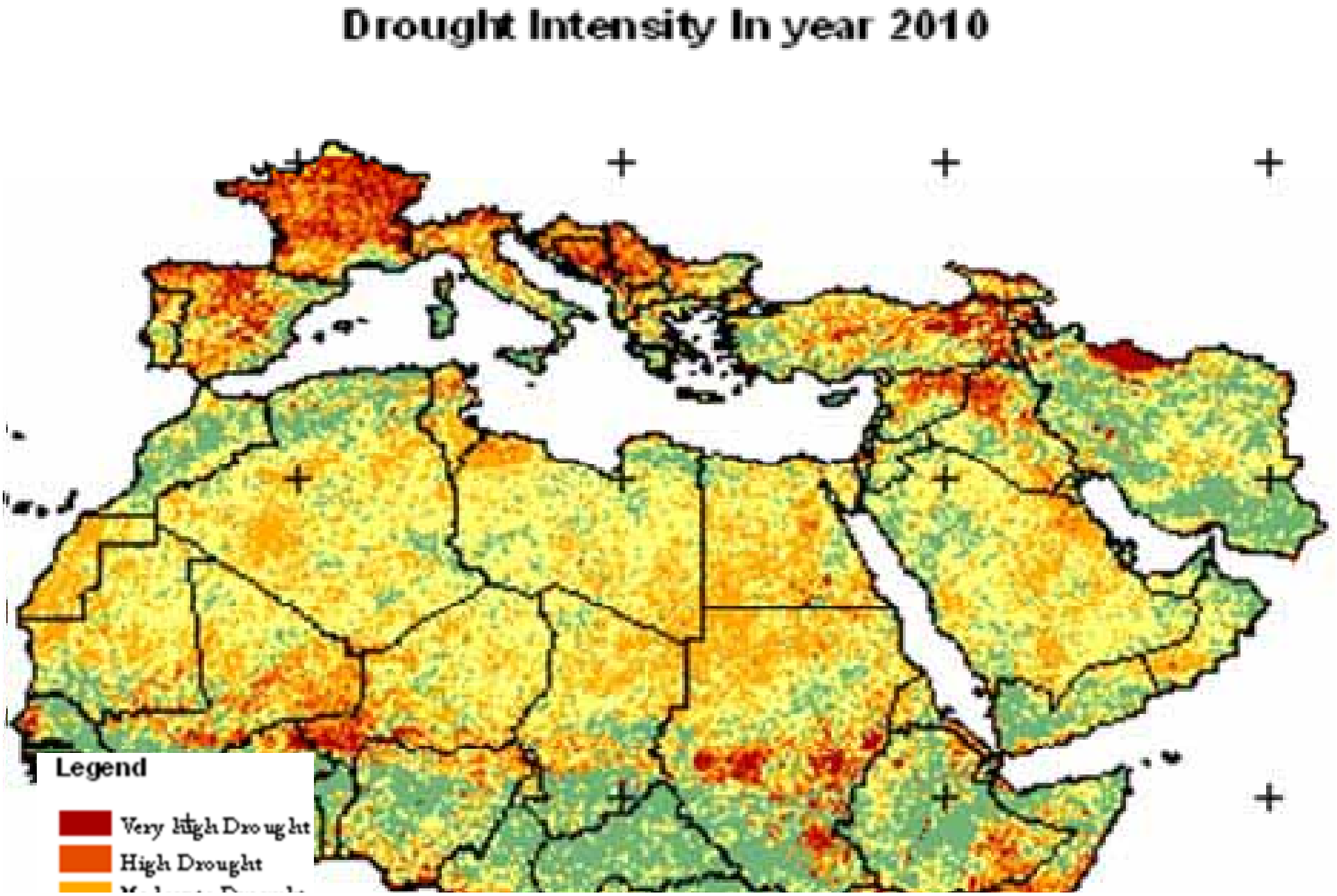



12°0'0"W
0°0'0"
12°0'0"E
24°0'0"E
36°0'0"E
48°0'0"E
60°0'0"E
42°0'0"N
30°0'0"N
18°0'0"N
6°0'0"N
6°0'0"S
8°0'0"S
Legend
12 Months
9 Months North
9 Months South
6 Months North
6 Months south
N
0 500 1,000 2,000 3,000
Kilo
Rainfed Seasons

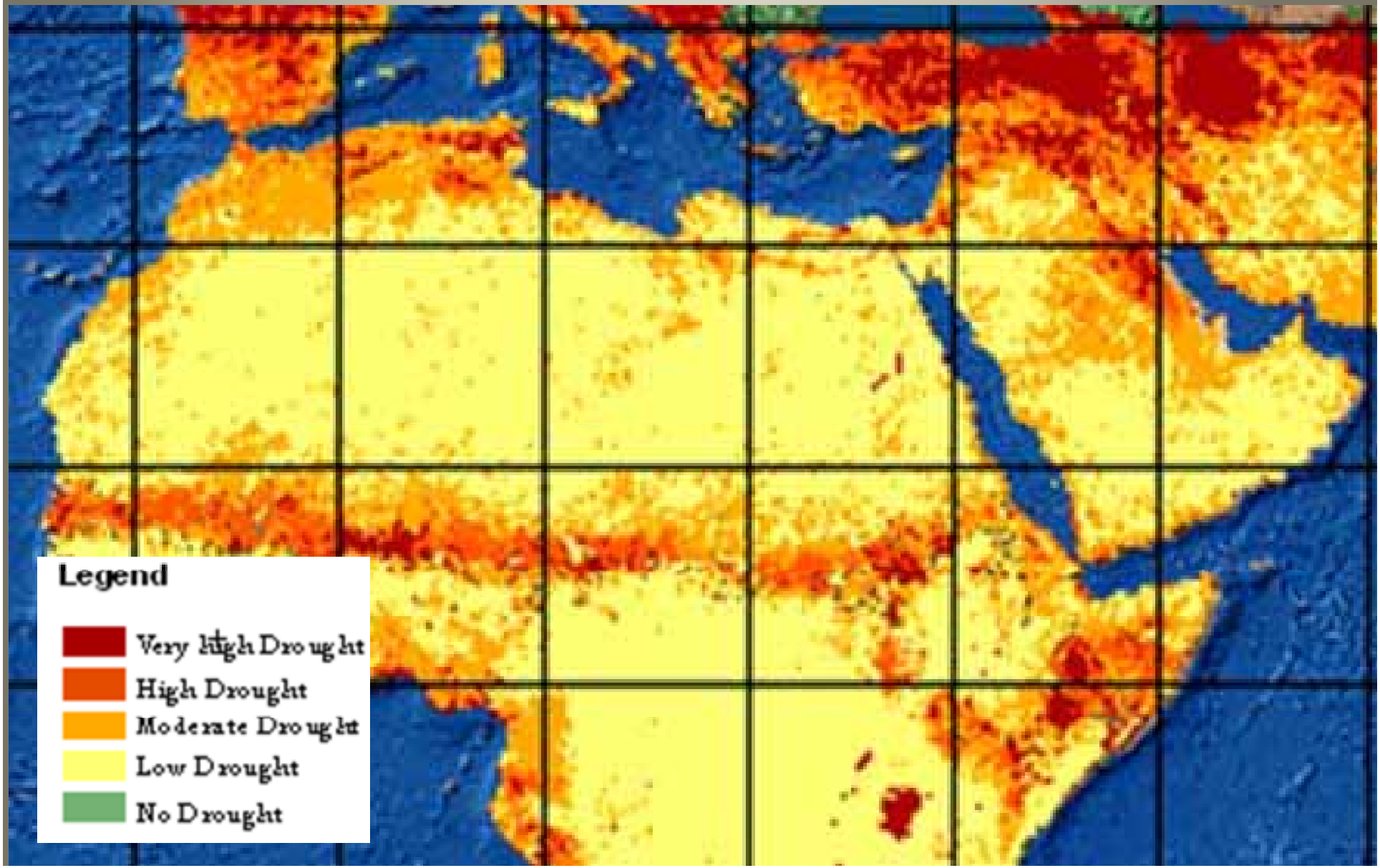
Historical Drought Data

Countries	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec.
Algeria,	2000	2008										
Egypt,												
Iran				1999	2008	2000	2001					
Iraq,												
Occupied Palestinian Territories												
Syria												
Yemen												
Djibouti,	2010			2015	2017	2017	2018	1999				
Somalia,	2010	2016	2014	2019	2018				2009			2001

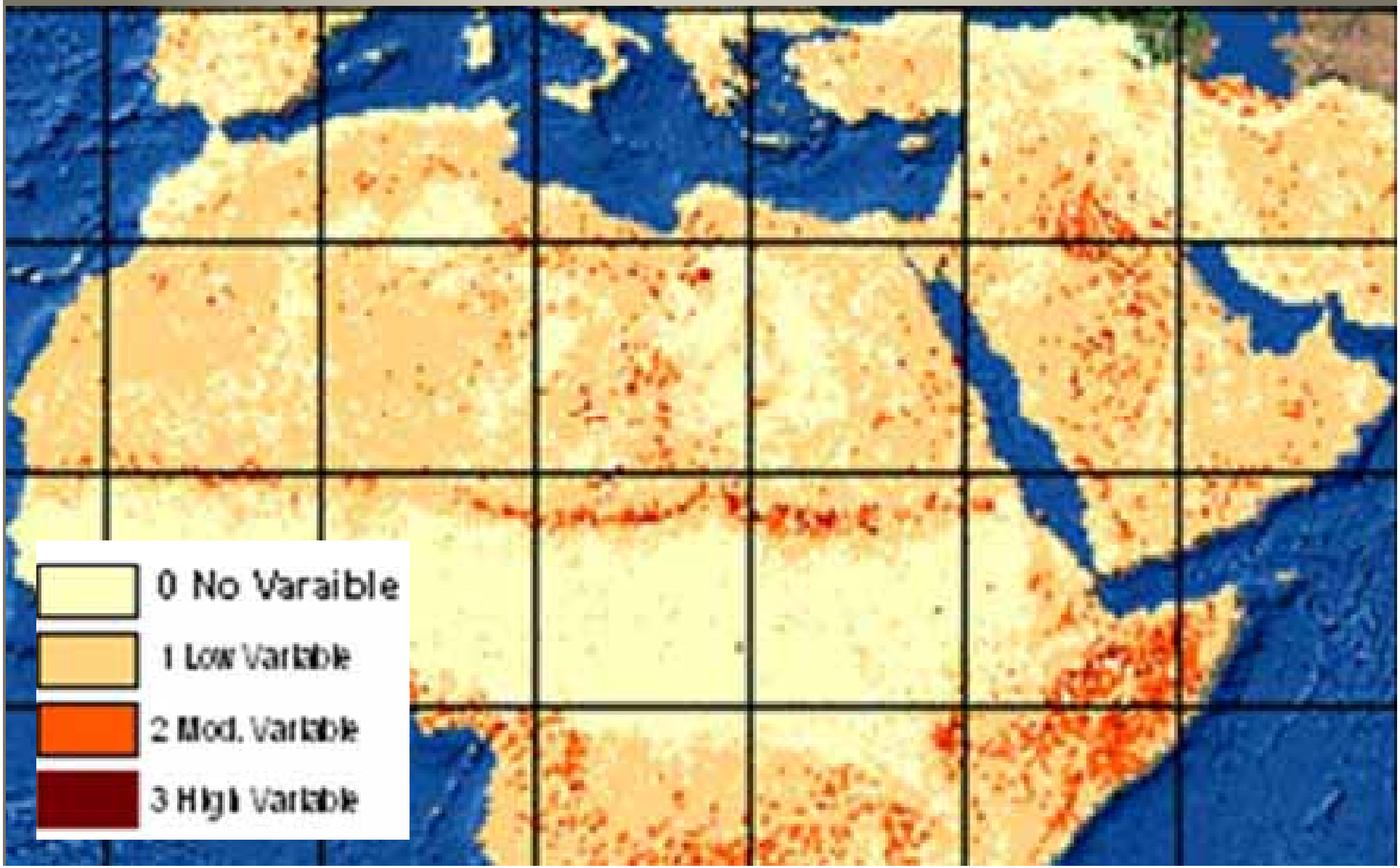
Drought intensity Map of Agriculture Season 2000/2010



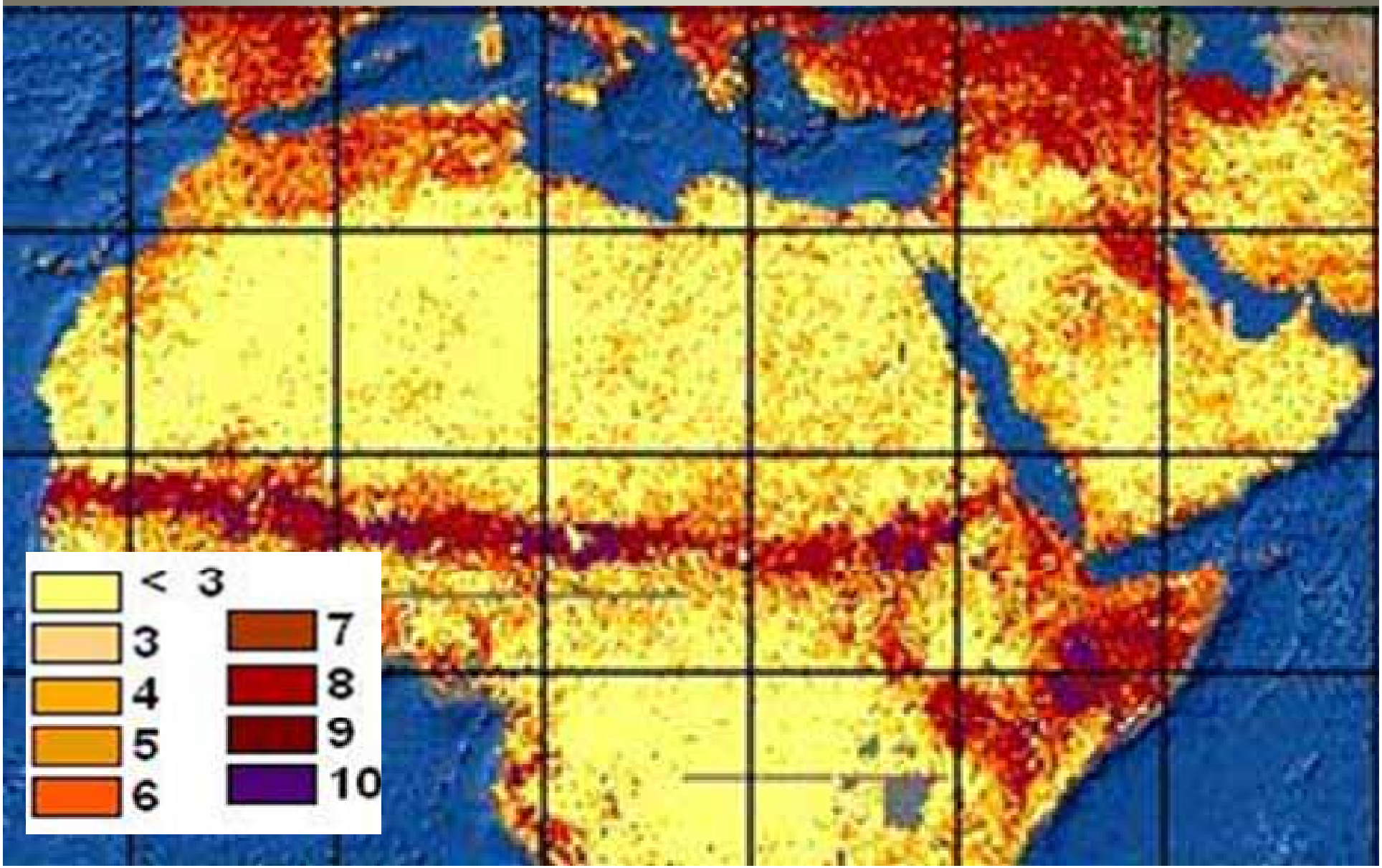
Agriculture Drought Intensity 2000 - 2011



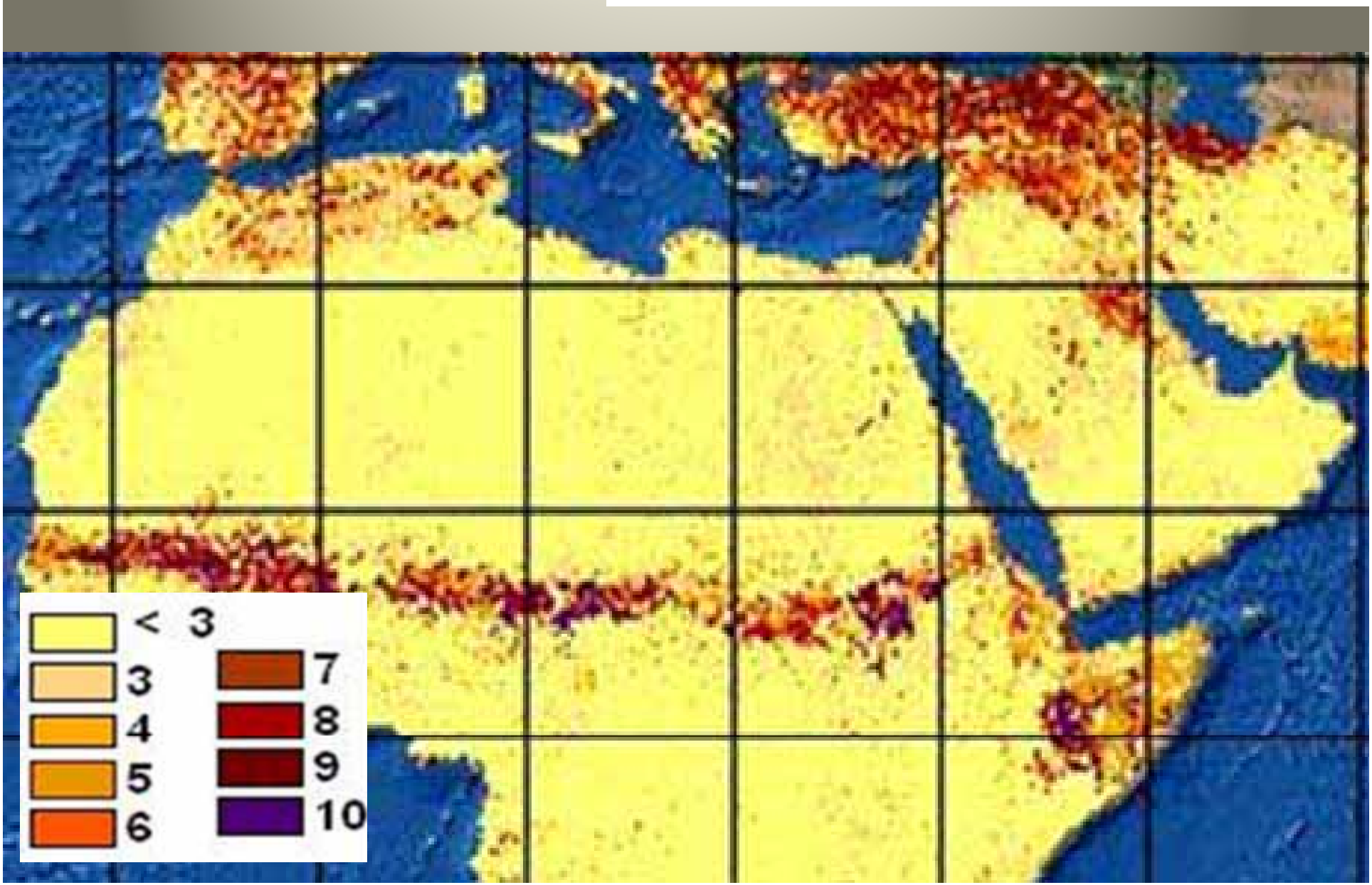
Agriculture Drought Variability 2000 - 2011



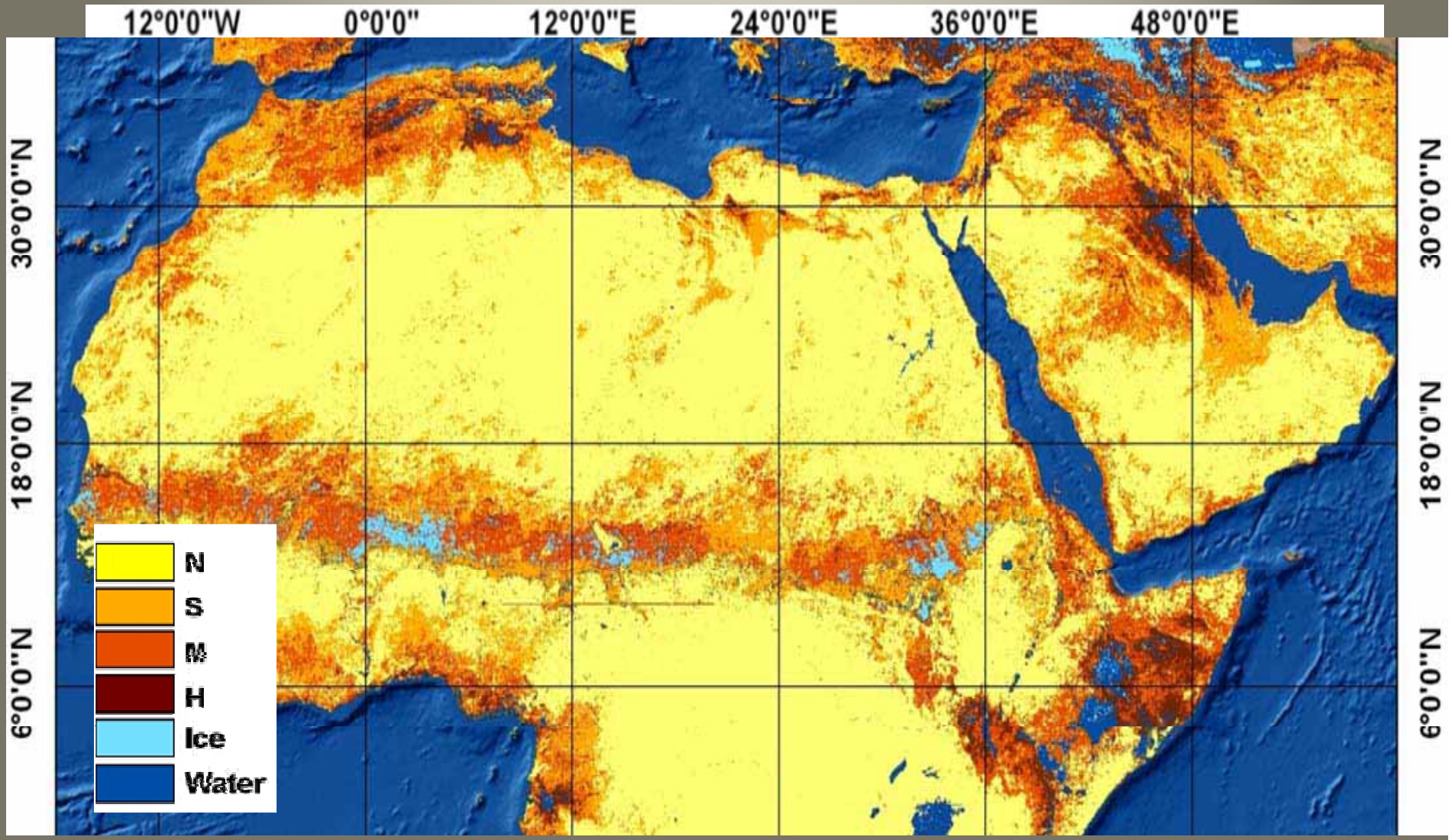
Agriculture Drought Frequency 2000 - 2011



Agriculture Drought Consecutive 2000 - 2011

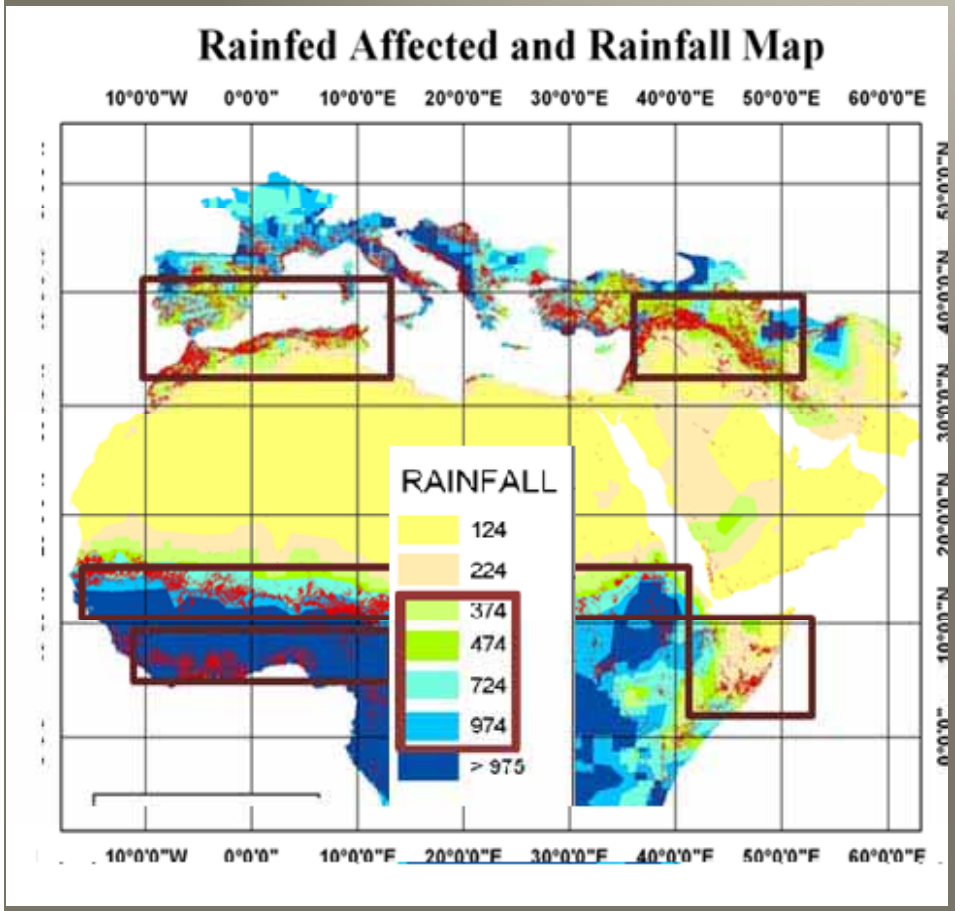


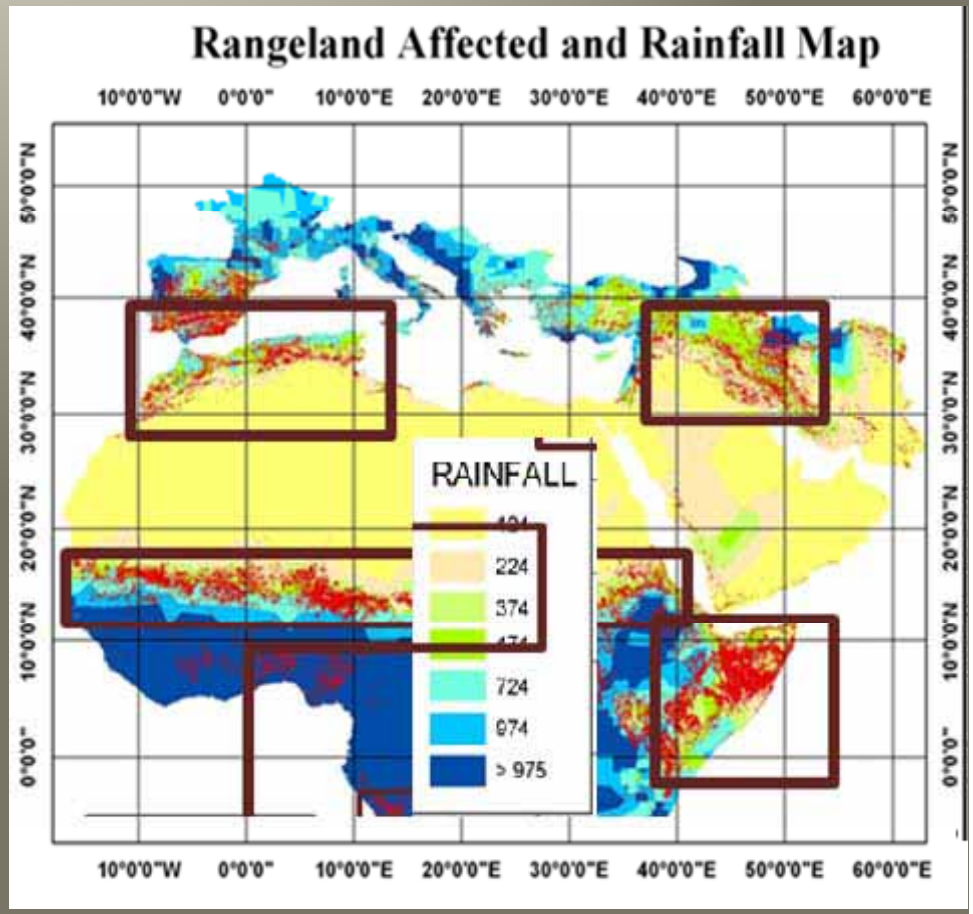
AGRICULTURE DROUGHT HAZARD



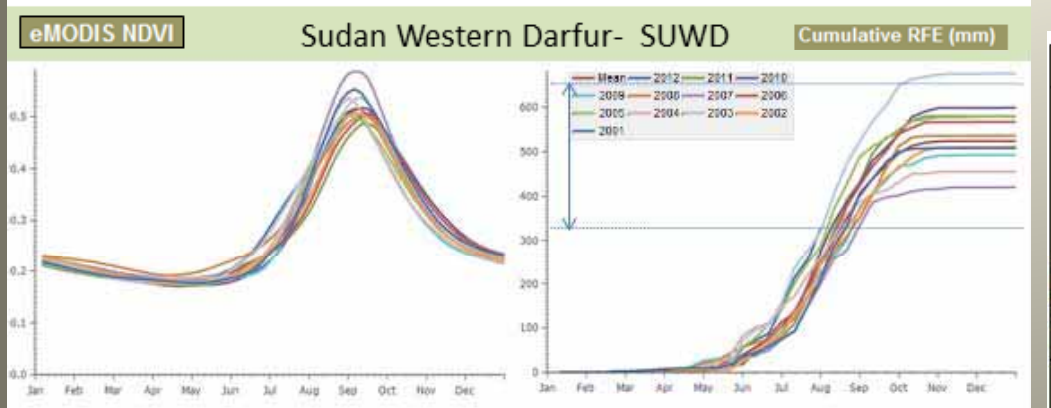
Country	High	Moderate	Slight	No Change	All Hazard	High/Moderate	Ranking
	3	2	1	0	(1+2+3)	(2+3)	(2+3)
	Class 7: very High coverage of ADH >85 %						
Lebanon	15.16	24.67	49.79	10.38	89.62	39.83	3
Gaza Strip	9.69	35.09	44.82	10.39	89.6	44.78	3
Qatar	18.15	33.34	34.88	13.62	86.37	51.49	4
	Class 6, High coverage of ADH 75 – 85%						
Morocco	2.9	31.14	50.18	15.77	84.22	34.04	3
Kuwait	47.12	26.71	9.29	16.88	83.12	73.83	6
West Bank	3.8	19.96	57.23	19.01	80.99	23.76	2
Syria	19.87	30.02	29.9	20.21	79.79	49.89	4
	Class 5, high to Moderate Coverage of ADH 60-75 %						
Tunisia	10.6	20.17	39.03	30.2	69.8	30.77	3
Iraq	21.95	27.31	19.61	31.12	68.87	49.26	4
Djibouti	9.08	38.74	20.51	31.67	68.33	47.82	4
	Class 4, Moderate Coverage of ADH 45-60 %						
Somalia	18.56	34.01	3.96	43.46	56.53	52.57	4
	Class 3, moderate to low Coverage ADH 30-45 %						
Saudi Arabia	4.09	11.5	24.12	60.29	39.71	15.59	2
U. A. Emirates	0.14	6.69	32.85	60.31	39.68	6.83	1
Sudan	1.74	13.21	18.35	66.7	33.3	14.95	1
	Class 2, low Coverage of ADH 15-30 %						
Yemen	1.87	11.8	15.79	70.54	29.46	13.67	1
Jordan	3.65	6.44	18.64	71.27	28.73	10.09	1
Algeria	3.34	9.41	12.77	74.49	25.52	12.75	1
Mauritania	1.03	9.61	14.13	75.23	24.77	10.64	1
Oman	0.18	3.4	15.85	80.58	19.43	3.58	1
Libya	0.6	2.86	13.34	83.2	16.8	3.46	1
Egypt	0.89	3.09	11.92	84.09	15.9	3.98	1

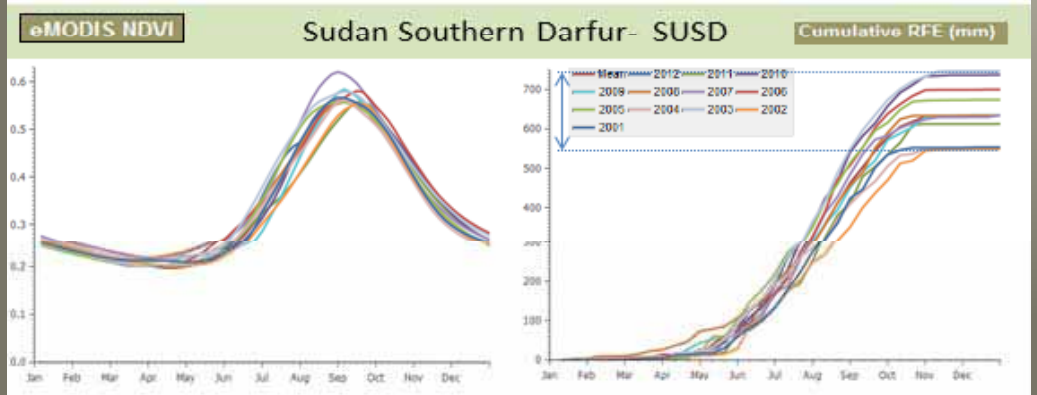
Affected land Use vs Rainfall.

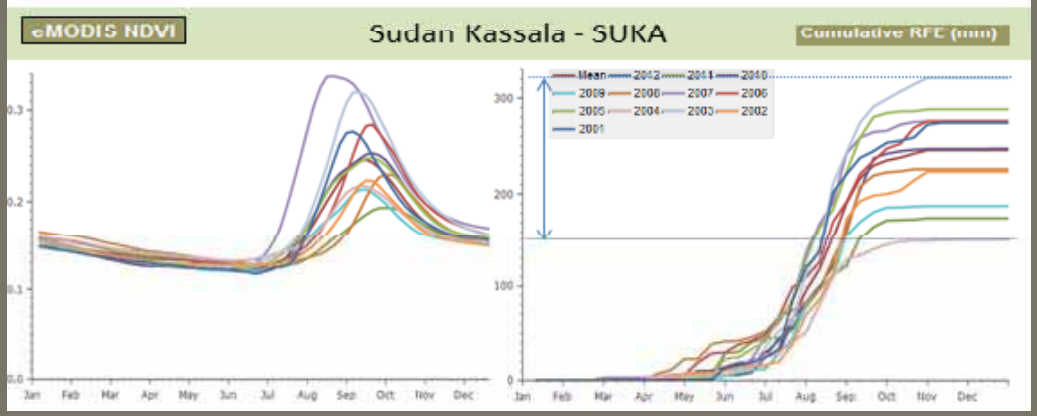


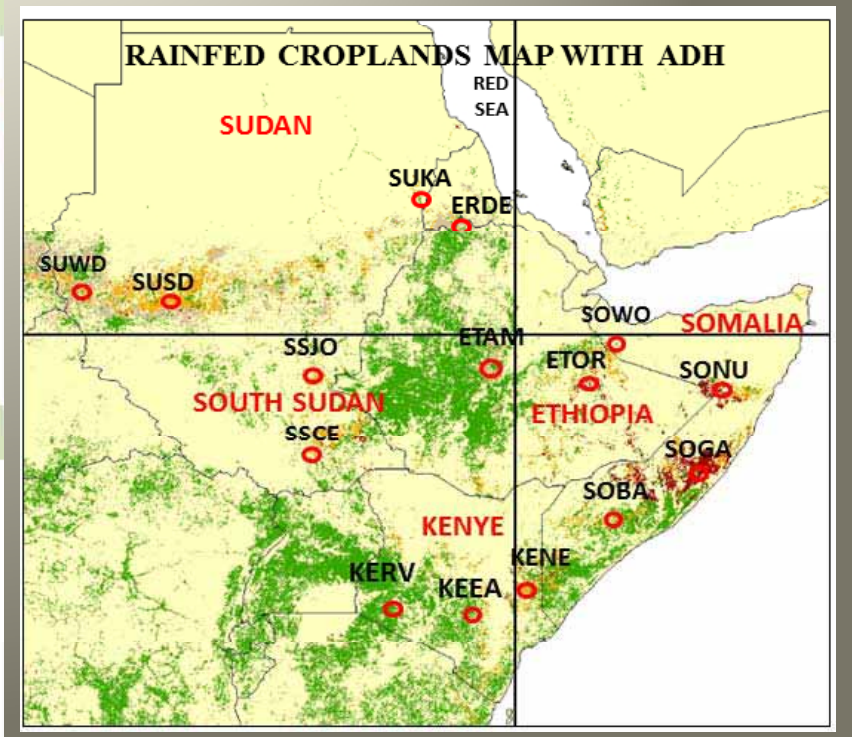


NDVI and Rainfall Variability over years







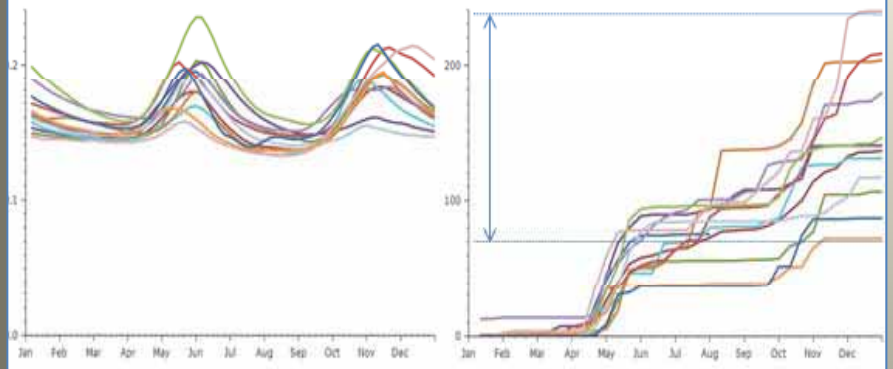


Points Selected to Study the Relation between NDVI and Rainfall in Areas Affected by ADH on Rainfed Cropland Areas in the **Horn Of Africa**.

eMODIS NDVI

Somalia Nugaal- SONU

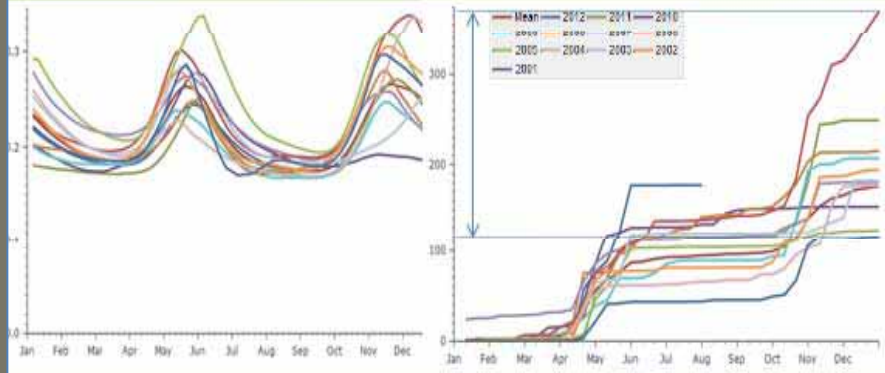
Cumulative RFE (mm)



eMODIS NDVI

Somalia Galgaduud - SOGA

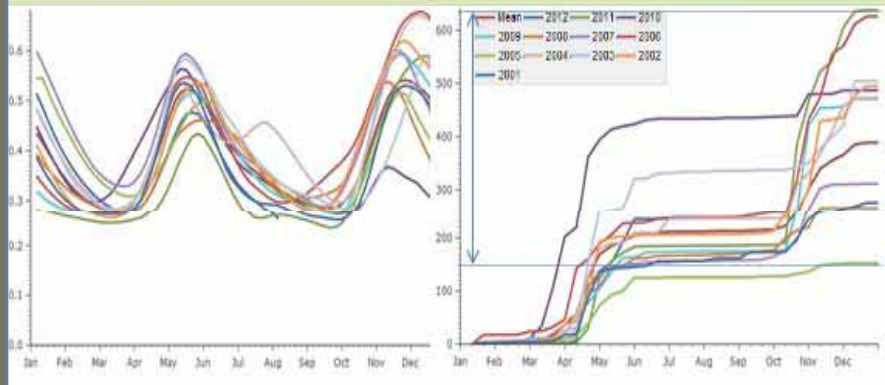
Cumulative RFE (mm)



eMODIS NDVI

Somalia Bay - SOBA

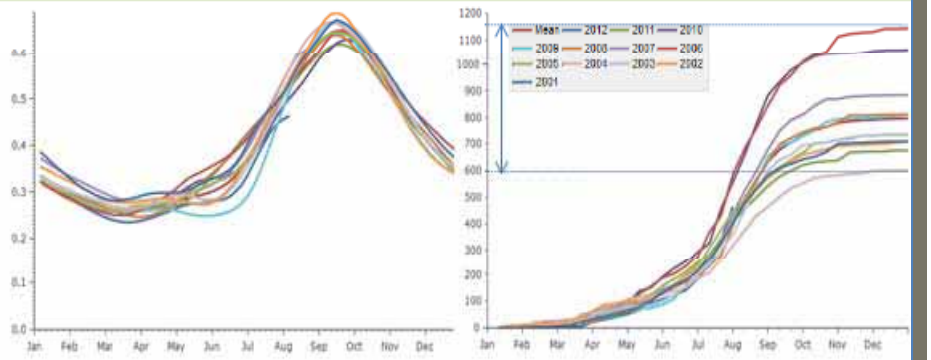
Cumulative RFE (mm)



eMODIS NDVI

Ethiopia Ambara - ETAM

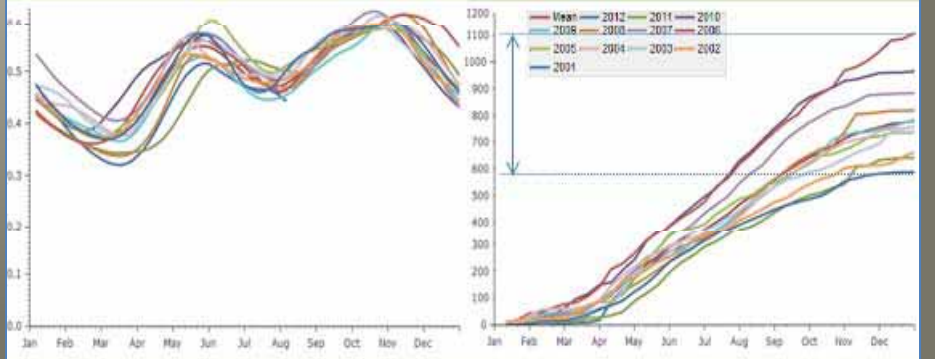
Cumulative RFE (mm)



eMODIS NDVI

Ethiopia Oromia - ETOR

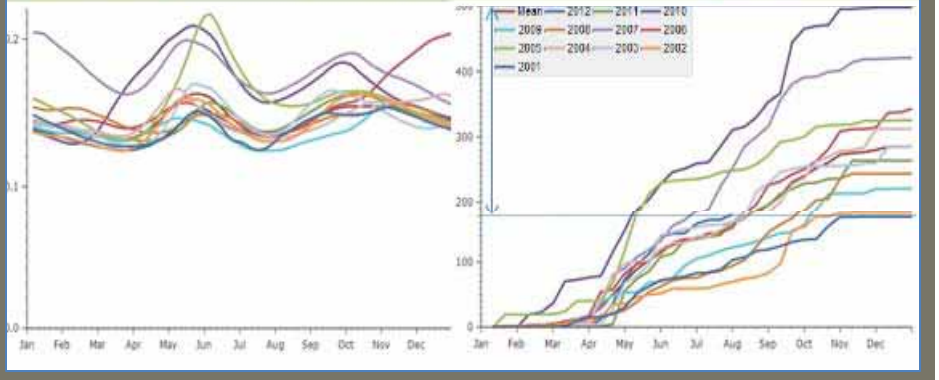
Cumulative RFE (mm)

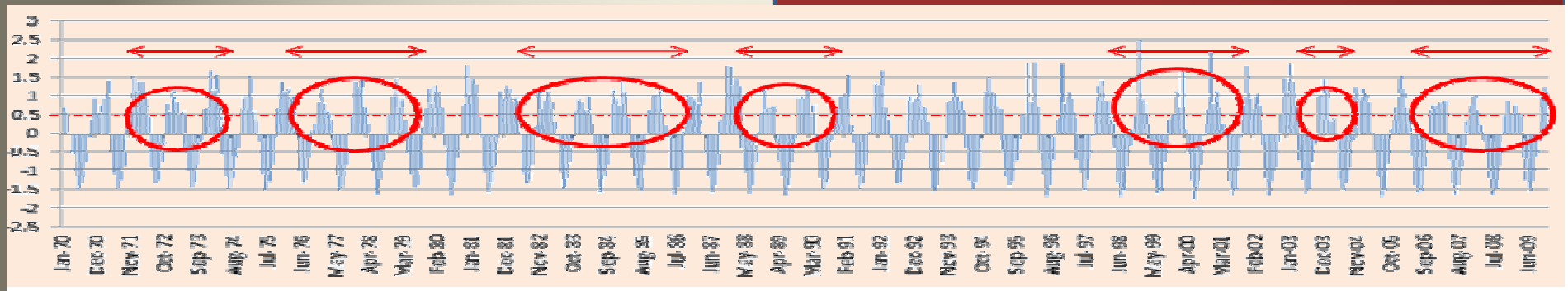


eMODIS NDVI

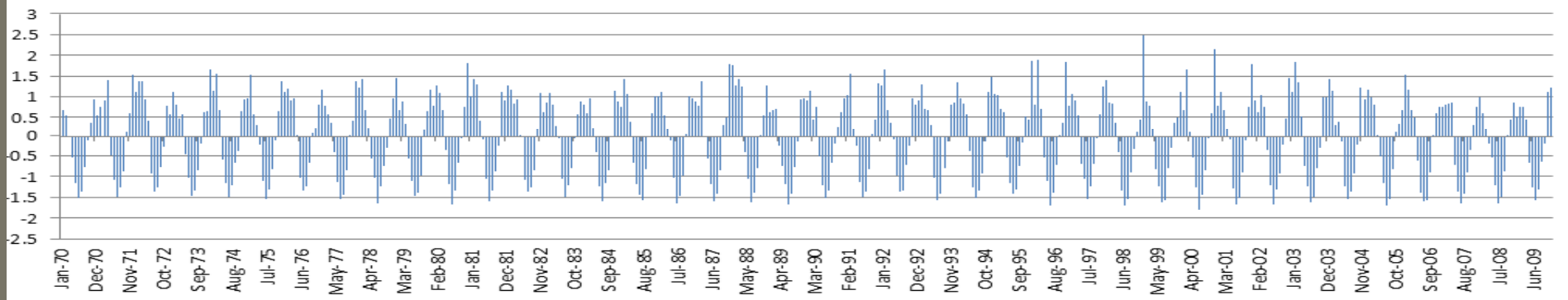
Somalia Woqooyi - SOWO

Cumulative RFE (mm)

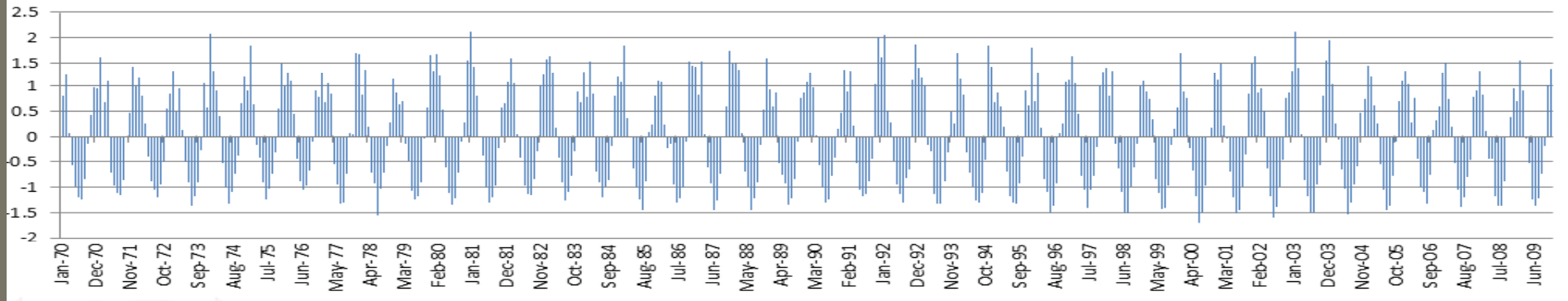


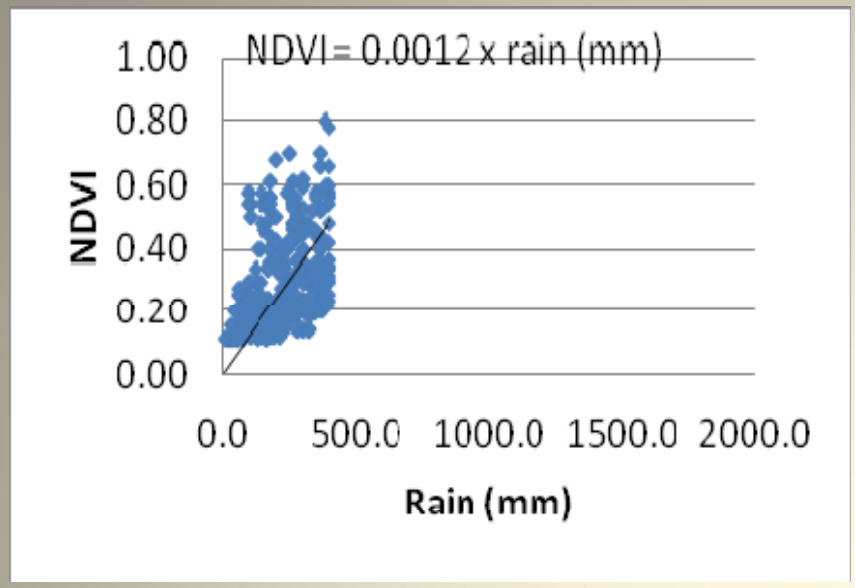


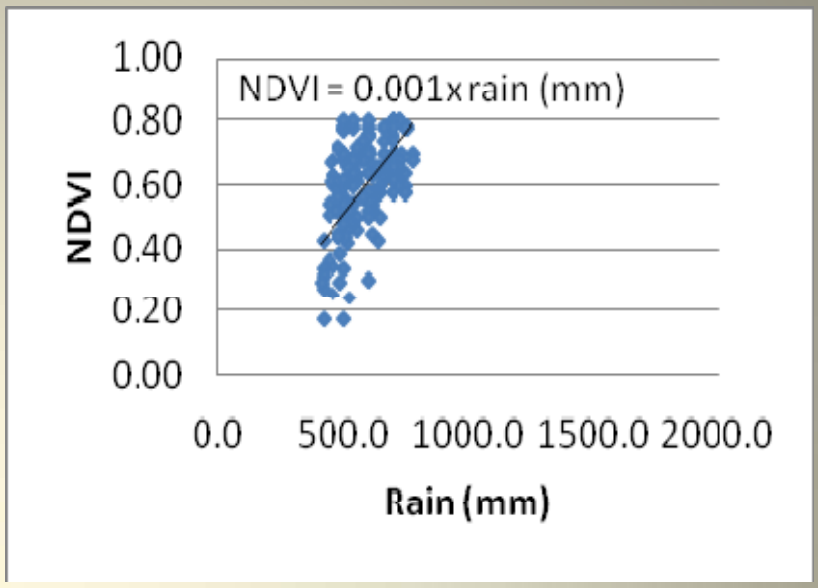
spei p253syria

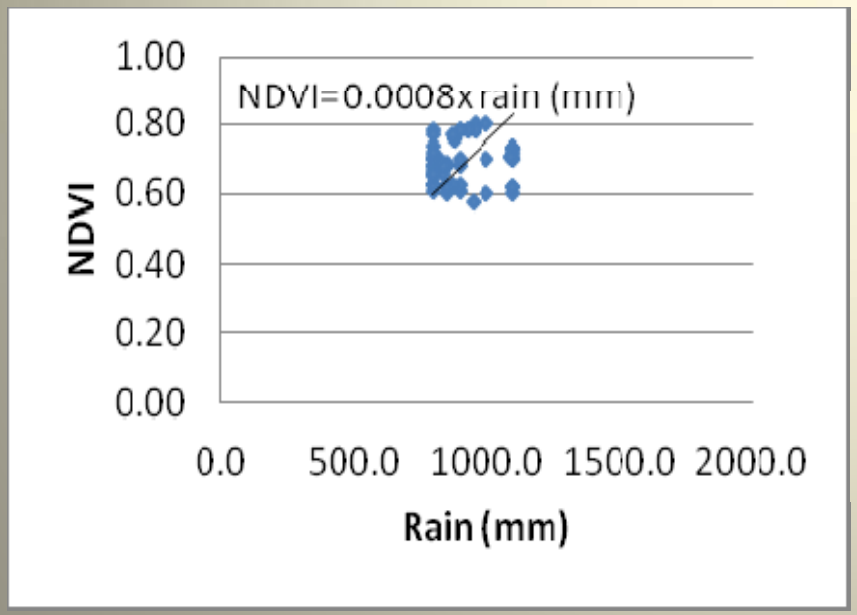


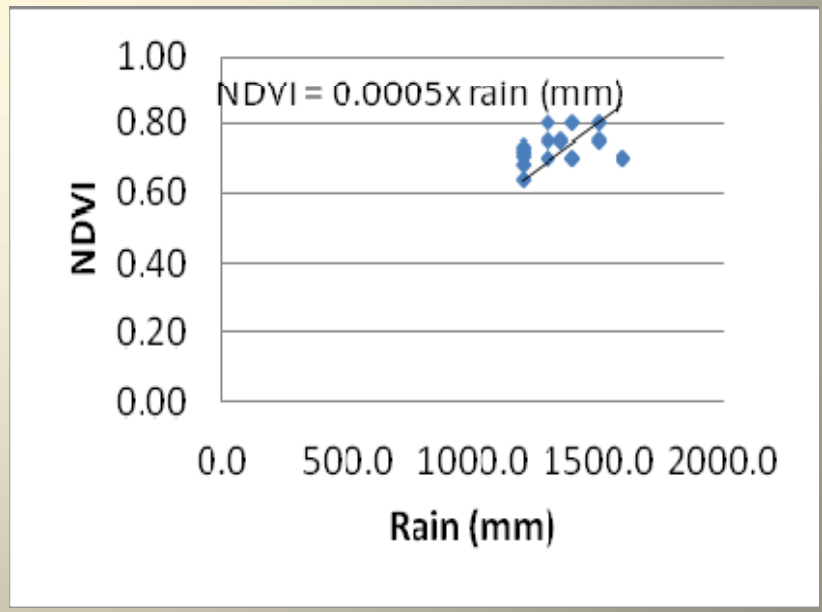
spei p254syria

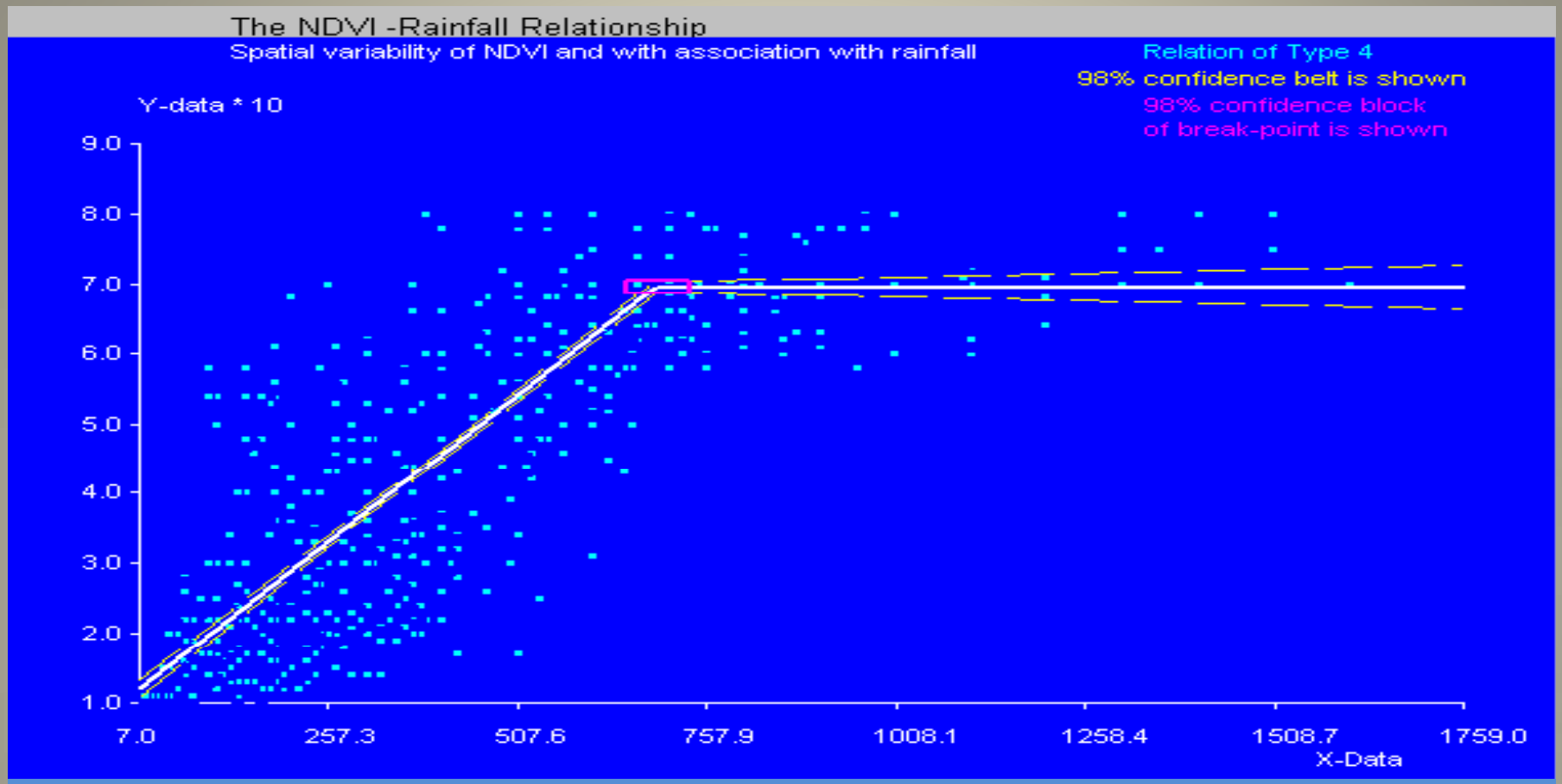



NDVI = 0.0012 x rain (mm)
NDVI
1.00
0.80
0.60
0.40
0.20
0.00
0.0
500.0
1000.0
1500.0
2000.0
Rain (mm)


NDVI = 0.001x rain (mm)
NDVI
1.00
0.80
0.60
0.40
0.20
0.00
0.0
500.0
1000.0
1500.0
2000.0
Rain (mm)


NDVI = 0.0008x rain (mm)
NDVI
1.00
0.80
0.60
0.40
0.20
0.00
0.0
500.0
1000.0
1500.0
2000.0
Rain (mm)


NDVI = 0.0005x rain (mm)
NDVI
1.00
0.80
0.60
0.40
0.20
0.00
0.0
500.0
1000.0
1500.0
2000.0
Rain (mm)



Slope threshold fitting of the NDVI vs. annual rainfall

Optimal breakpoint of X (BPx) : 692 mm

There are two regression equations:

When rainfall is smaller than 692 mm: NDVI = 0.000843 rainfall + 0.112

When rainfall is greater than 692 mm: NDVI = 0.695

The standard precipitation evapotranspiration index (SPEI)

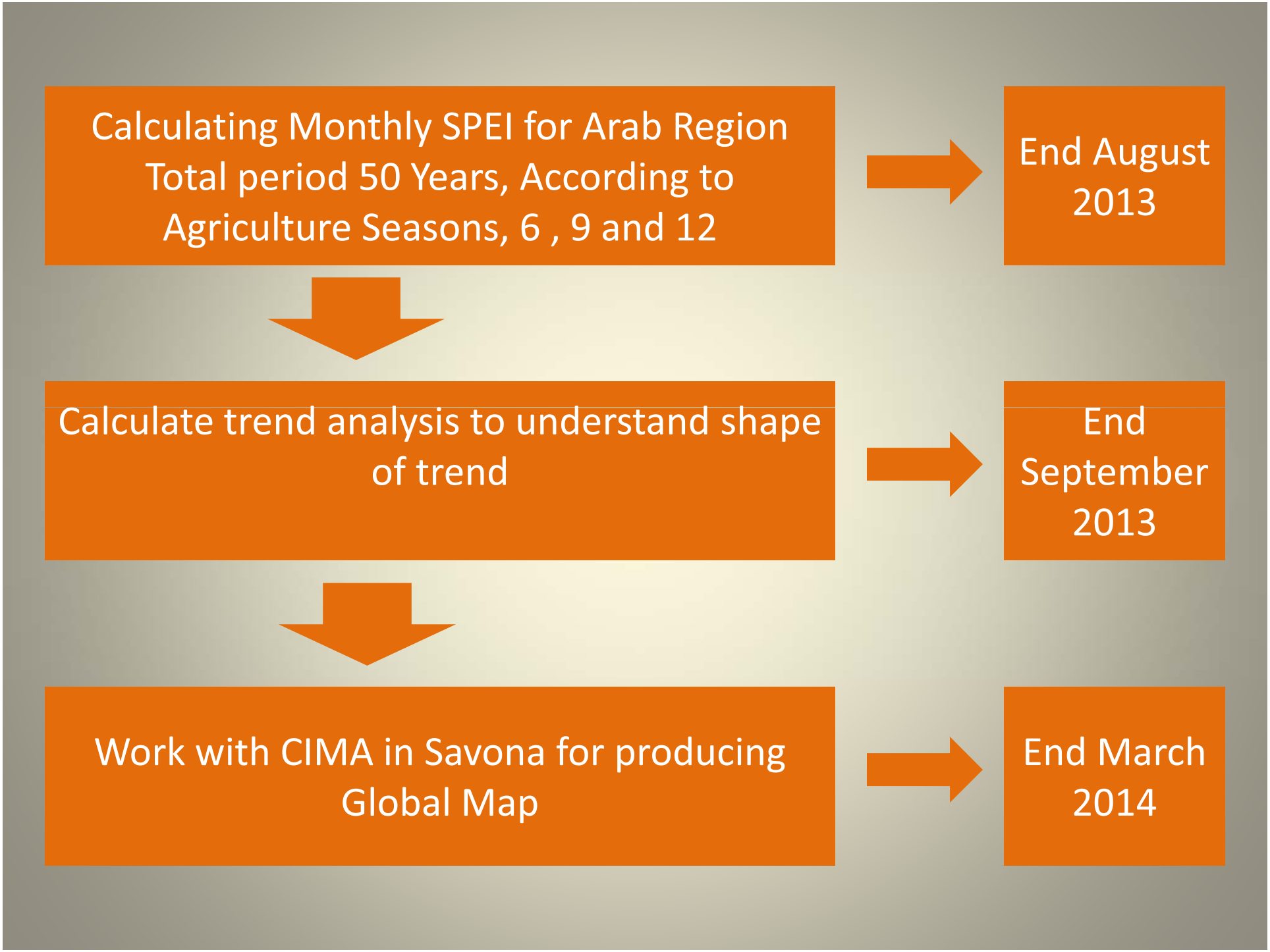
The Spanish Scientific Research Council (CSIC) developed C++ program used for calculate SPEI which is available to download from (http://digital.csic.es/handle/10261/10002).

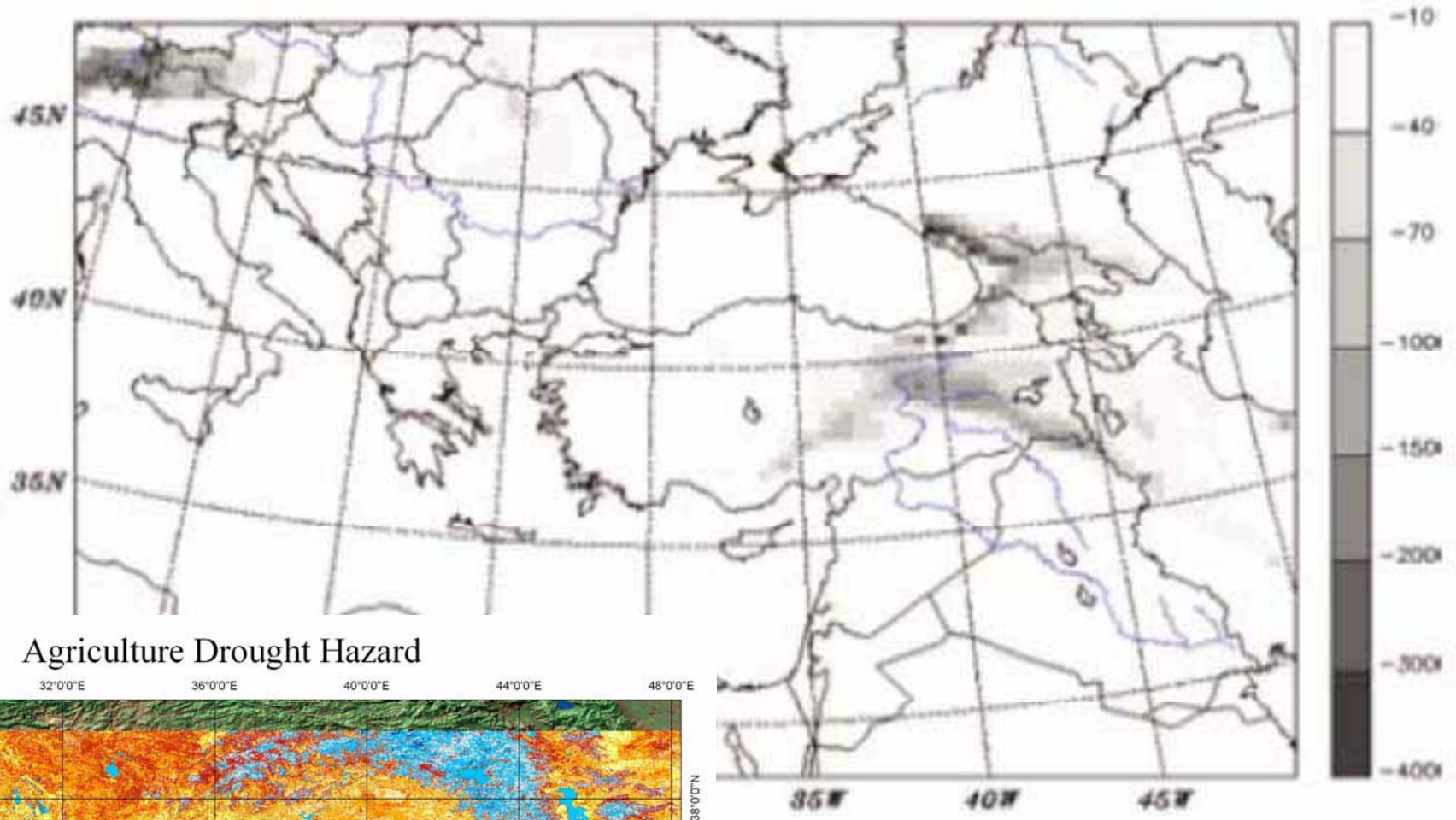
The climate data used as input to the program downloaded from climate research unit (CRU) with version TS3.1 dataset (available at http:// badc.nerc.ac.uk/data/cru/), with a spatial resolution of 0.5°. A C++

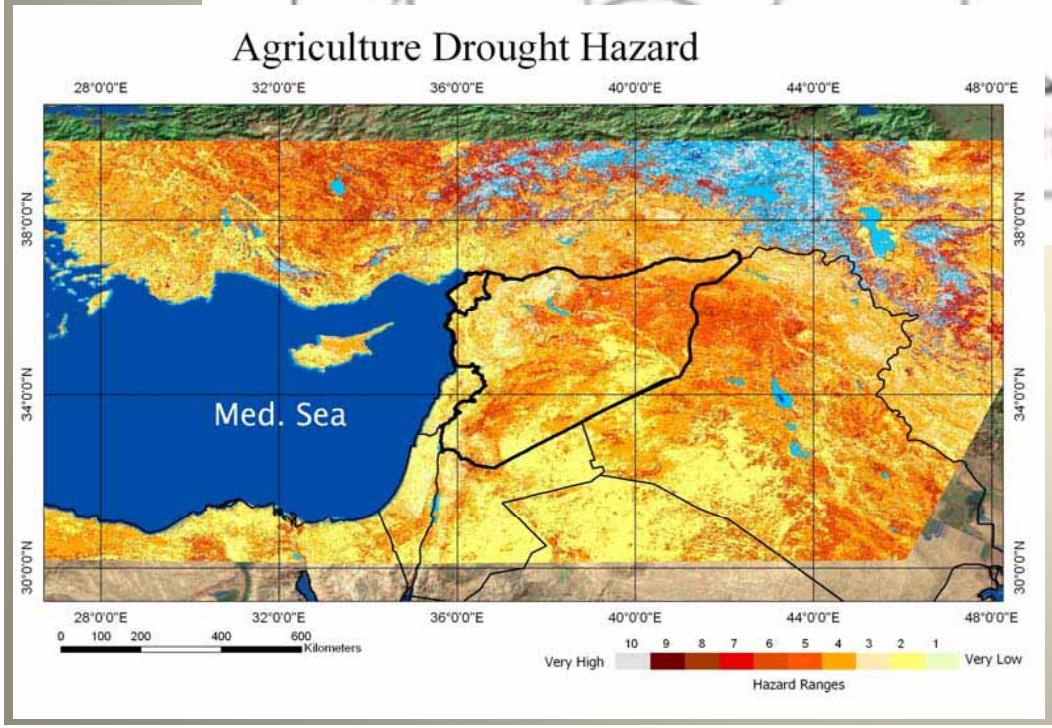
following the classical approximation of **Abramowitz and Stegun (1965):**

$$SPEI = W - \frac{C_0 + C_1 W + C_2 W^2}{1 + d_1 W + d_2 W^2 + d_3 W^3}$$

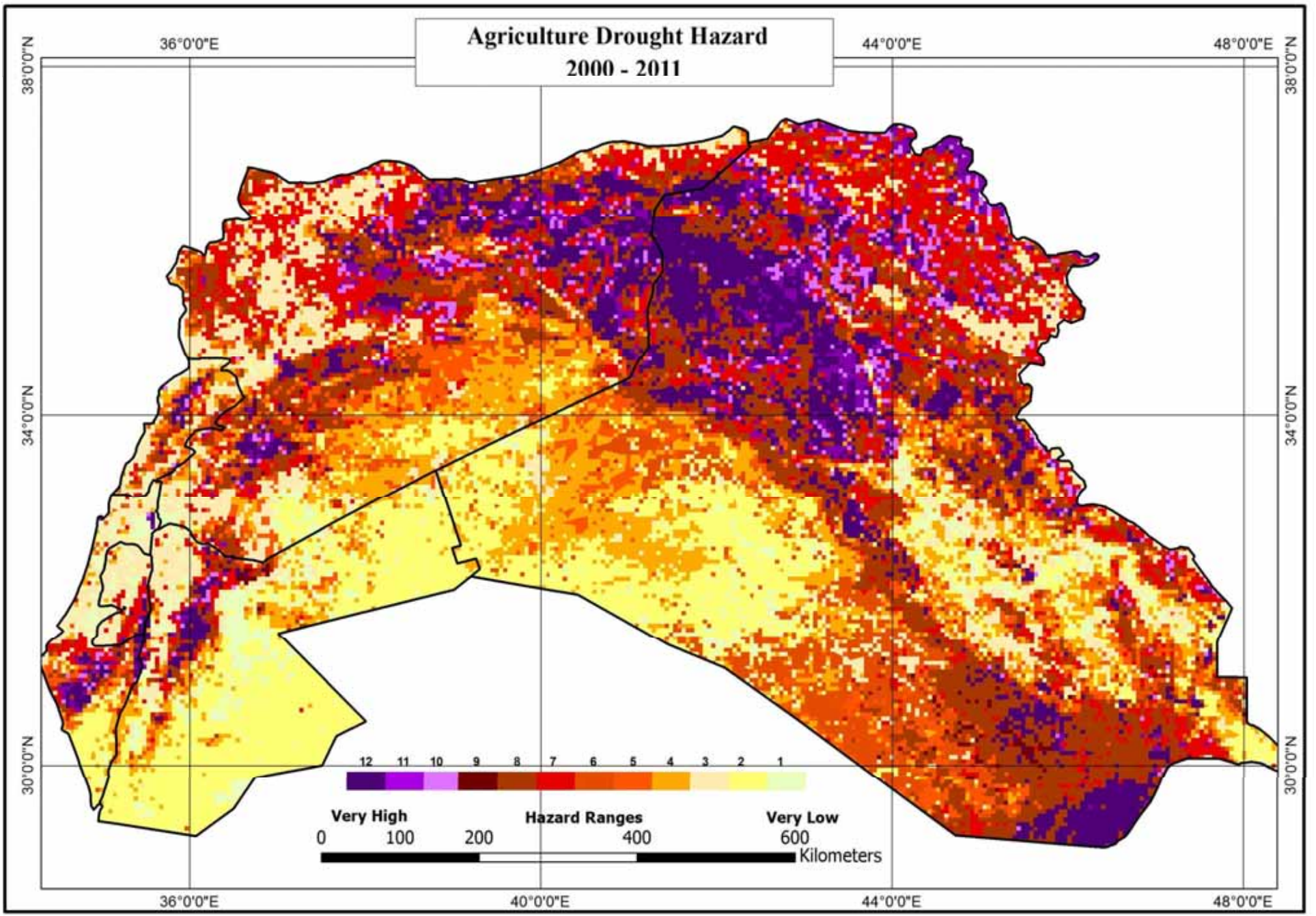
Where $W = \sqrt{-2 * \ln(P)}$ *for* $P \leq 0.5$, where P is the probability of exceeding a determined D value, $P = 1 - F(x)$. If $P > 0.5$, P is replaced by 1−P, and the sign of the resultant SPEI value is reversed. The constants are: $C_0 = 2.515517$, $C_1 = 0.802853$, $C_2 = 0.010328$, $d_1 = 1.432788$, $d_2 = 0.189269$, *and* $d_3 = 0.001308$. The average value is 0, and the standard deviation is 1.

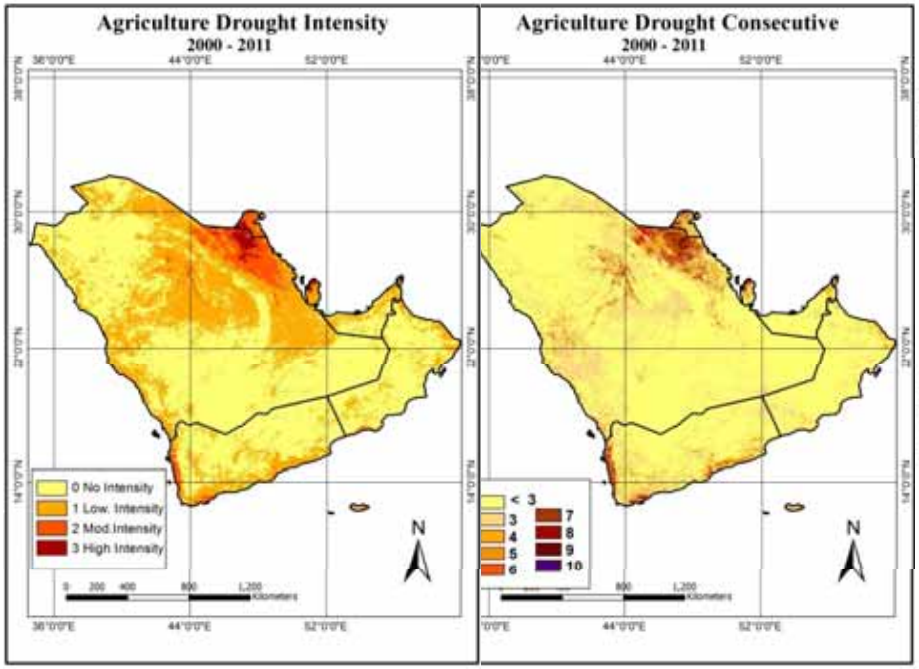

Calculating Monthly SPEI for Arab Region Total period 50 Years, According to Agriculture Seasons, 6 , 9 and 12
End August 2013
Calculate trend analysis to understand shape of trend
End September 2013
Work with CIMA in Savona for producing Global Map
End March 2014



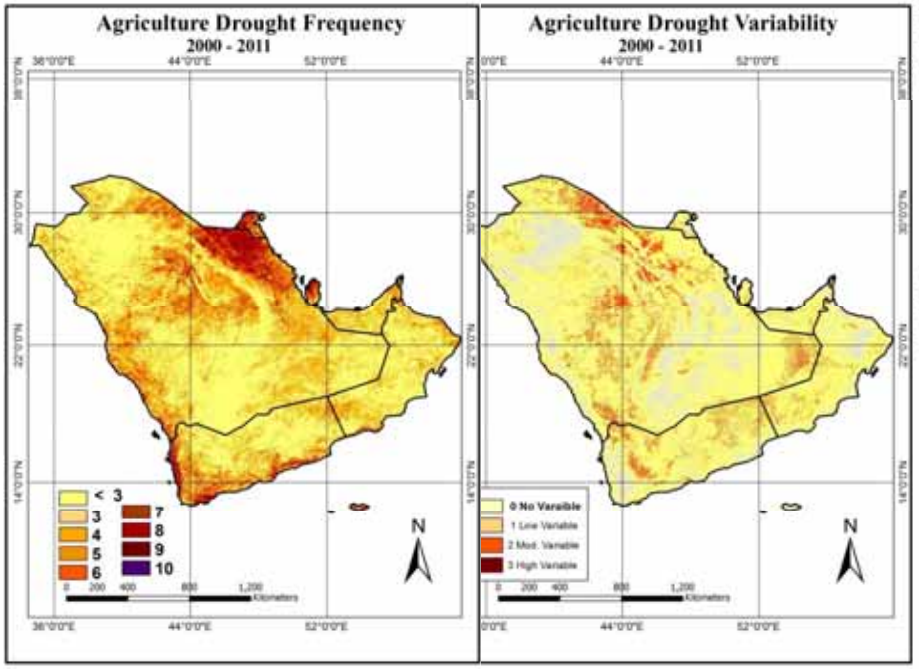


Climate change prediction for Turkey: Changes in snow water equivalent (in mm) affecting Euphrates and Tigris basins

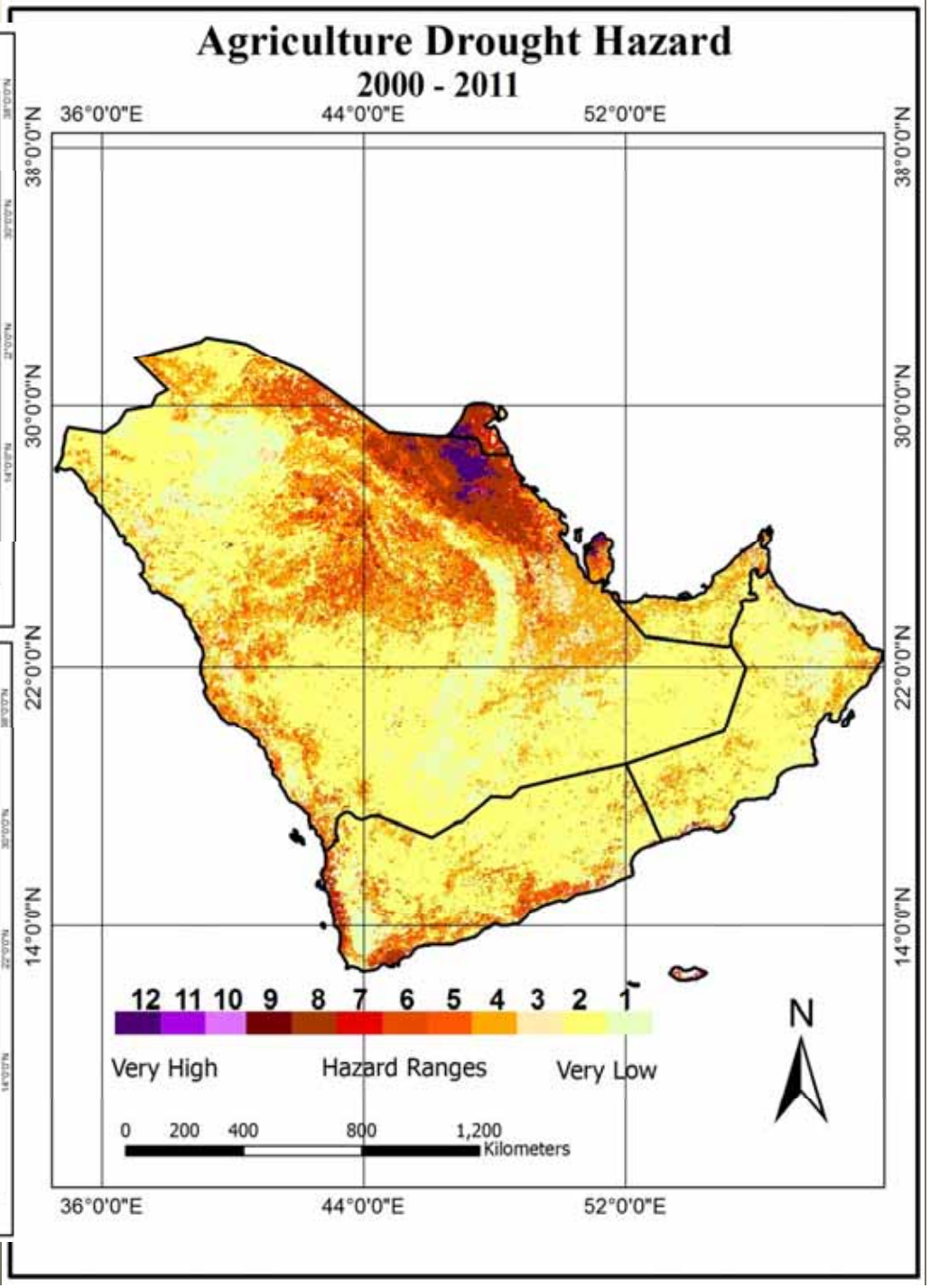

Agriculture Drought Hazard
2000 - 2011
36°0'0"E
44°0'0"E
48°0'0"E
38°0'0"N
34°0'0"N
30°0'0"N
40°0'0"E
12 11 10 9 8 7 6 5 4 3 2 1
Very High
Hazard Ranges
Very Low
0 100 200 400 600
Kilometers

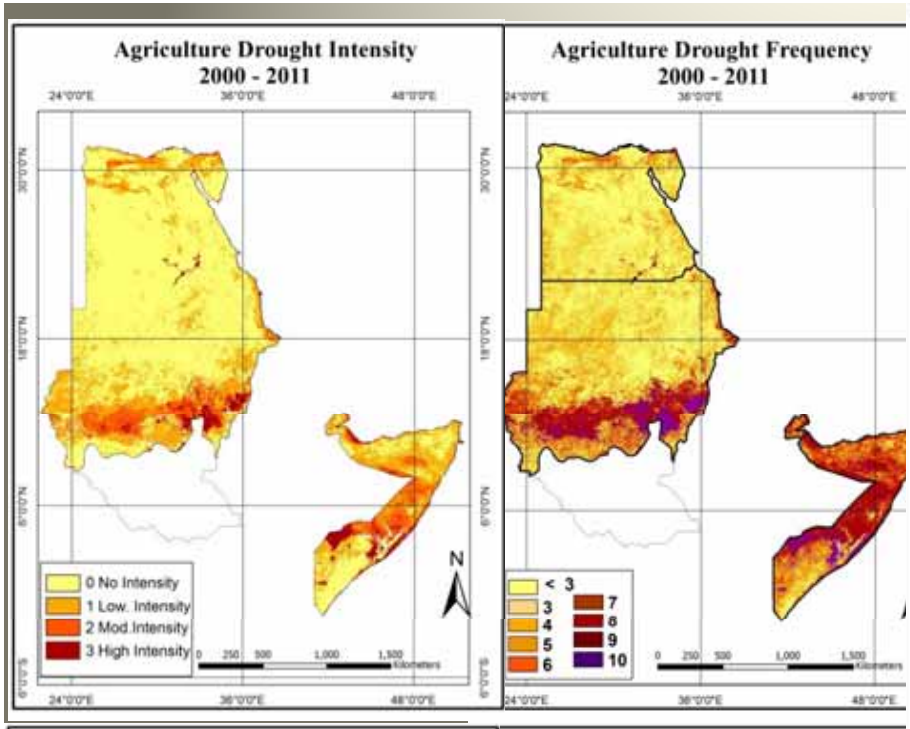

Agriculture Drought Intensity
2000 - 2011
0 No Intensity
1 Low. Intensity
2 Mod.Intensity
3 High Intensity
N

Agriculture Drought Consecutive
2000 - 2011
< 3
3
4
5
6
7
8
9
10
N

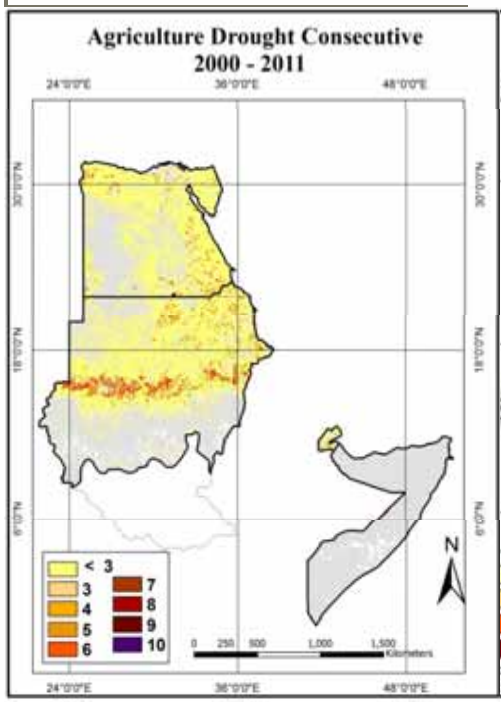

Agriculture Drought Frequency
2000 - 2011
< 3
3
4
5
6
7
8
9
10
N

Agriculture Drought Variability
2000 - 2011
0 No Varaible
1 Low Variable
2 Mod. Variable
3 High Variable
N

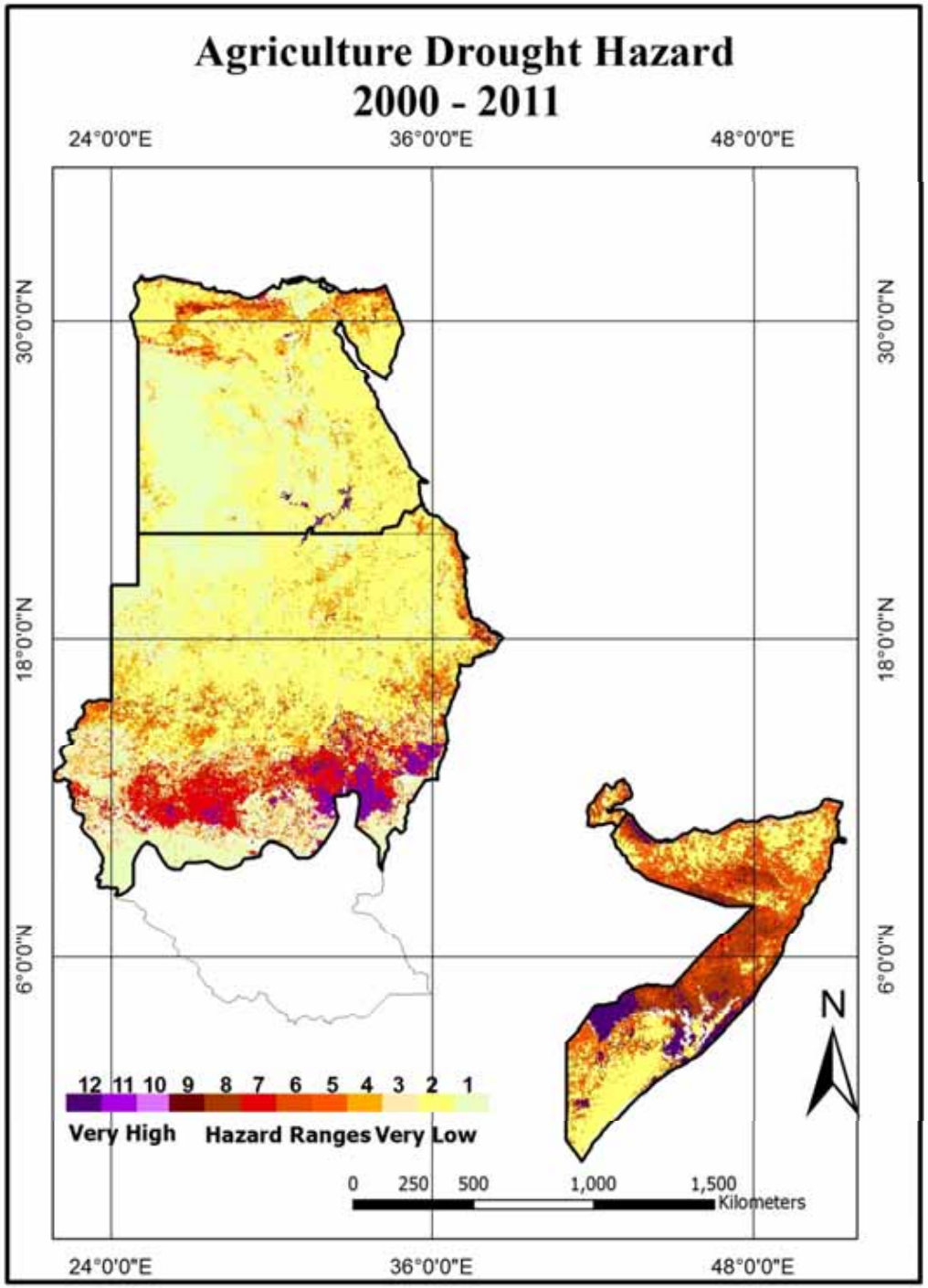

Agriculture Drought Hazard
2000 - 2011
36°0'0"E
44°0'0"E
52°0'0"E
38°0'0"N
30°0'0"N
22°0'0"N
14°0'0"N
12 11 10 9 8 7 6 5 4 3 2 1
Very High
Hazard Ranges
Very Low
N
0 200 400 800 1,200
Kilometers

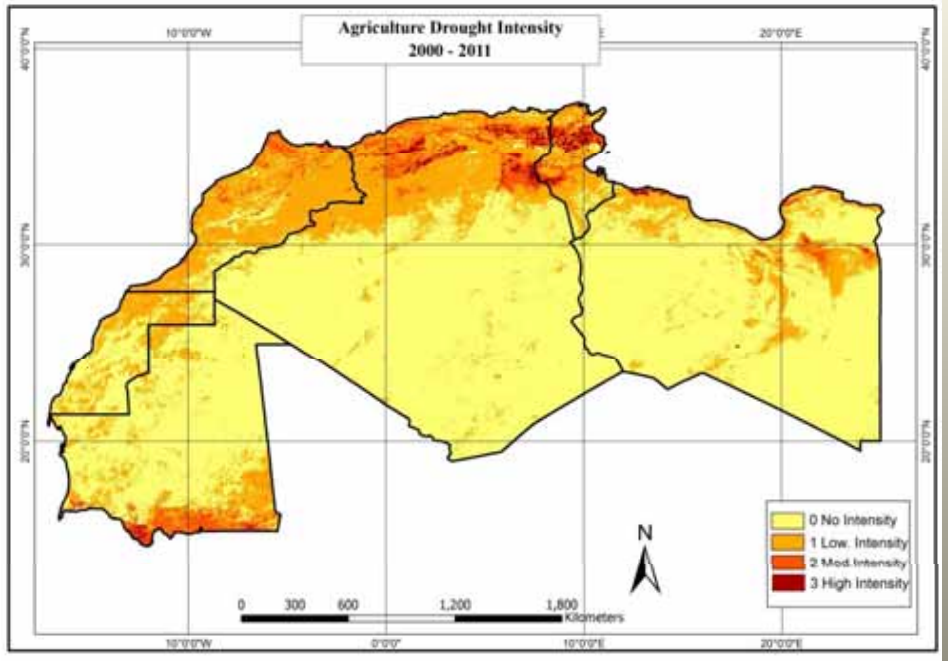

Agriculture Drought Intensity
2000 - 2011
24°0'0"E
36°0'0"E
48°0'0"E
0 No Intensity
1 Low. Intensity
2 Mod.Intensity
3 High Intensity
0 250 500 1,000 1,500
Kilometers
N

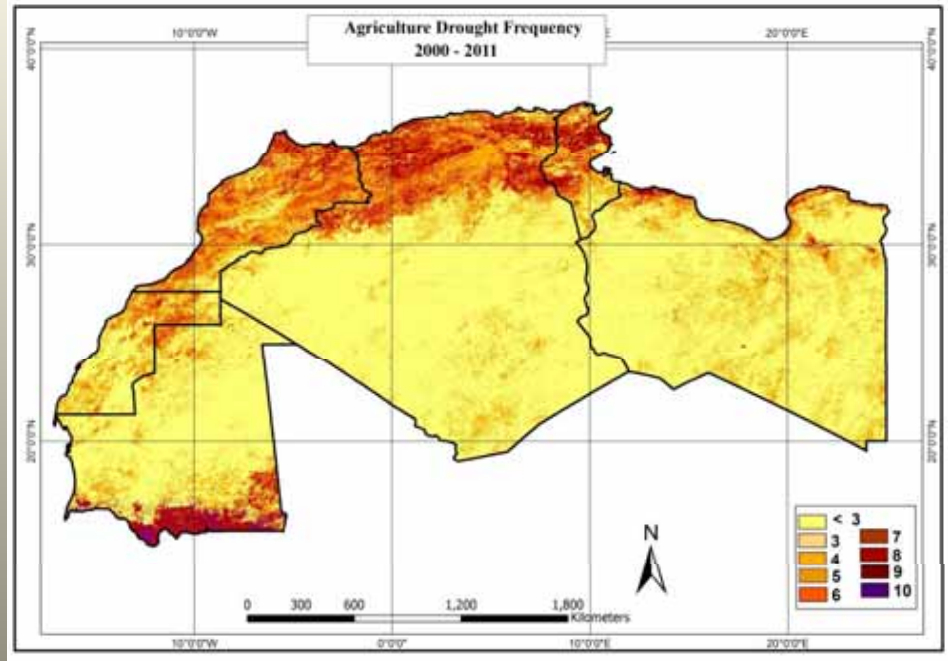
Agriculture Drought Frequency
2000 - 2011
24°0'0"E
36°0'0"E
48°0'0"E
< 3
3
4
5
6
7
8
9
10
0 250 500 1,000 1,500
Kilometers

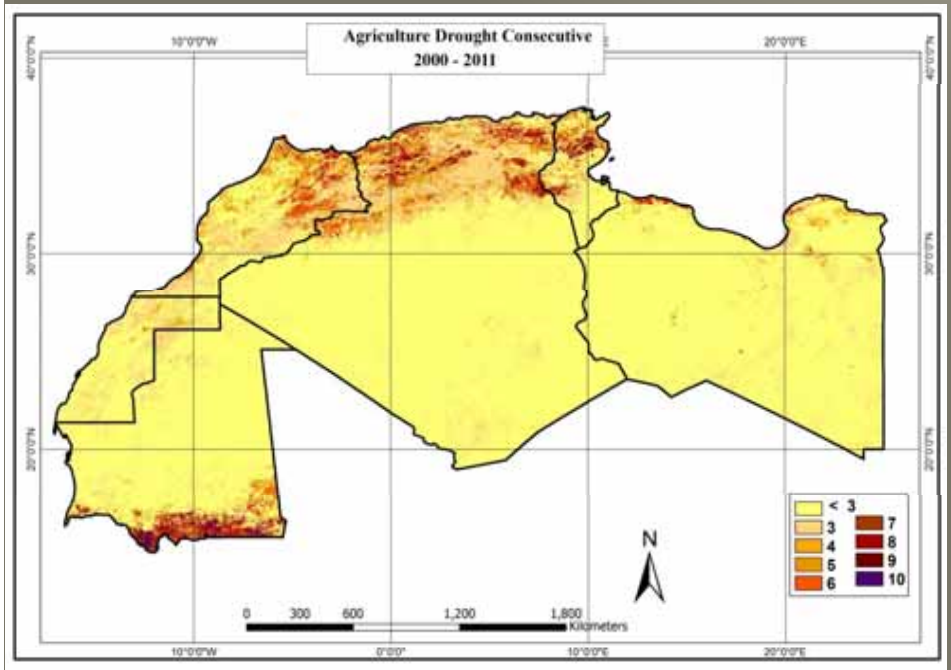

Agriculture Drought Consecutive
2000 - 2011
24°0'0"E
36°0'0"E
48°0'0"E
< 3
3
4
5
6
7
8
9
10
0 250 500 1,000 1,500
Kilometers
N

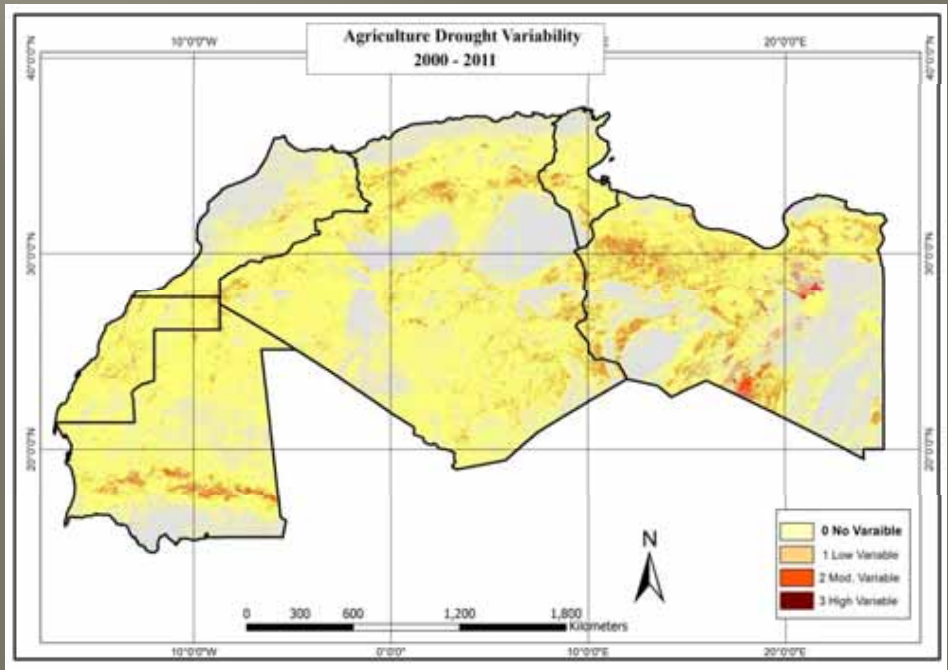

Agriculture Drought Variability
2000 - 2011
24°0'0"E
36°0'0"E
48°0'0"E
0 No Varaible
1 Low Variable
2 Mod. Variable
3 High Variable
0 250 500 1,000 1,500
Kilometers

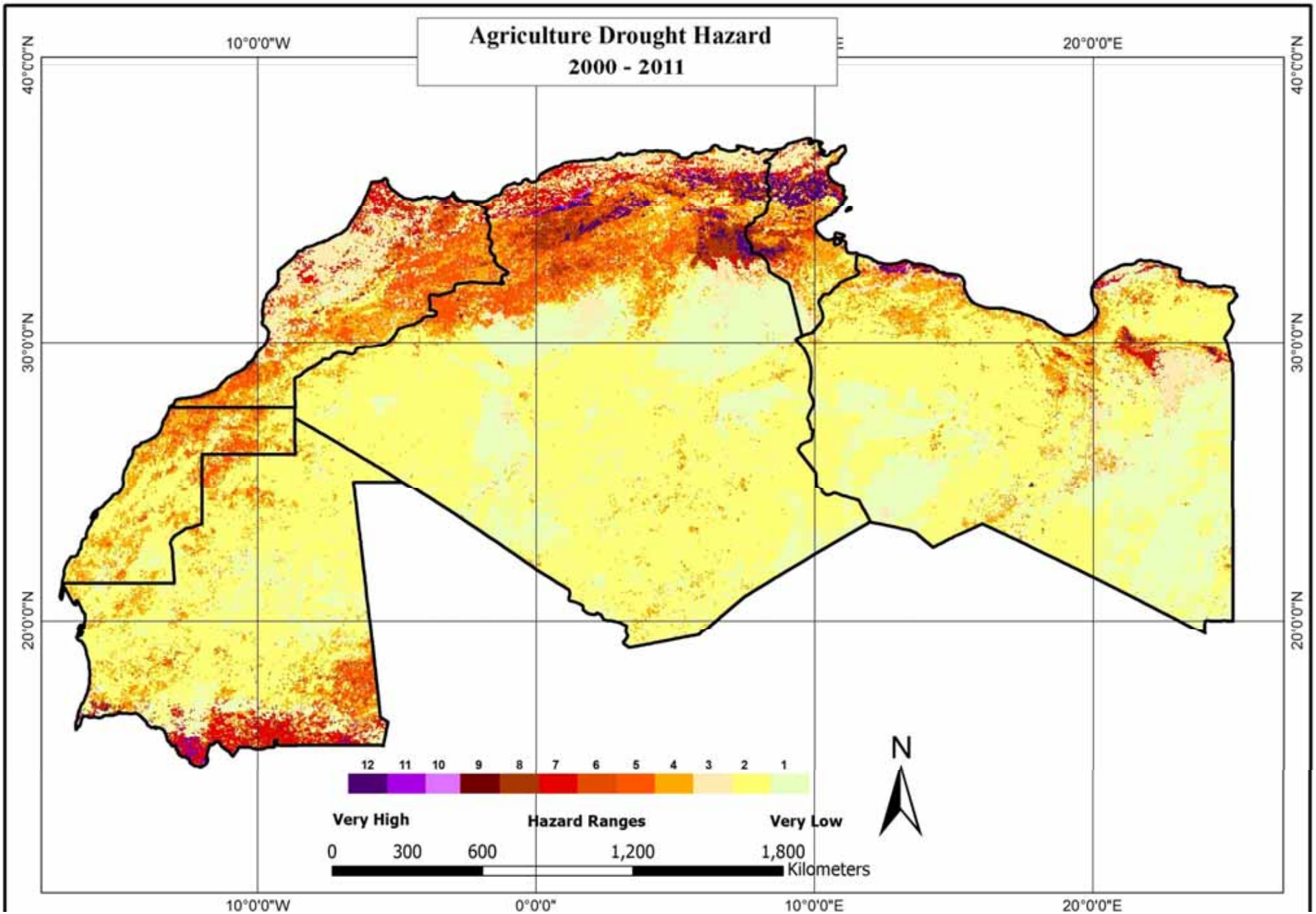

Agriculture Drought Hazard
2000 - 2011
24°0'0"E
36°0'0"E
48°0'0"E
30°0'0"N
18°0'0"N
6°0'0"N
12 11 10 9 8 7 6 5 4 3 2 1
Very High
Hazard Ranges
Very Low
0 250 500 1,000 1,500
Kilometers
N


Agriculture Drought Intensity
2000 - 2011
10°0'0"W
20°0'0"E
0 No Intensity
1 Low. Intensity
2 Mod. Intensity
3 High Intensity
N
0 300 600 1,200 1,800
Kilometers

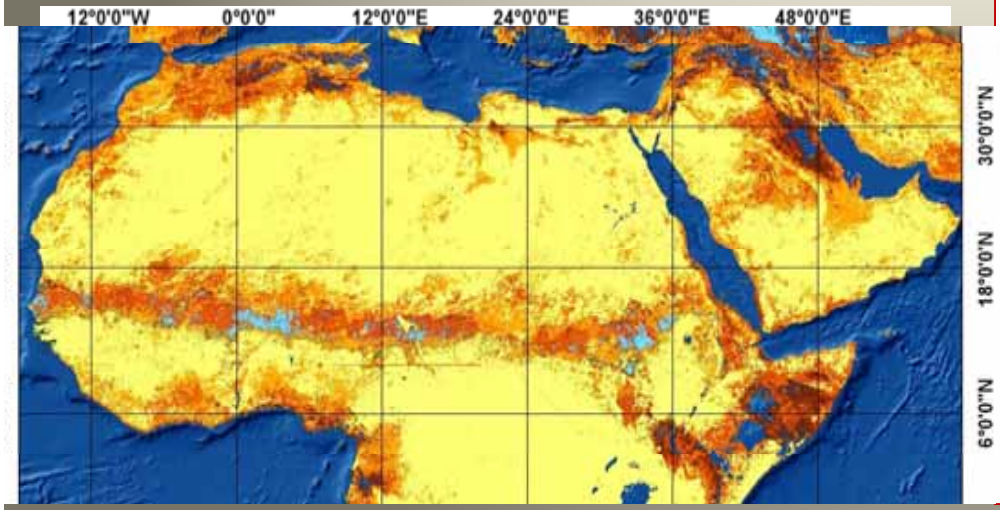

Agriculture Drought Frequency
2000 - 2011
10°0'0"W
20°0'0"E
< 3
3
4
5
6
7
8
9
10
N
0 300 600 1,200 1,800
Kilometers


Agriculture Drought Consecutive
2000 - 2011
10°0'0"W
20°0'0"E
< 3
3
4
5
6
7
8
9
10
N
0 300 600 1,200 1,800
Kilometers


Agriculture Drought Variability
2000 - 2011
10°0'0"W
20°0'0"E
0 No Varaible
1 Low Variable
2 Mod. Variable
3 High Variable
N
0 300 600 1,200 1,800
Kilometers

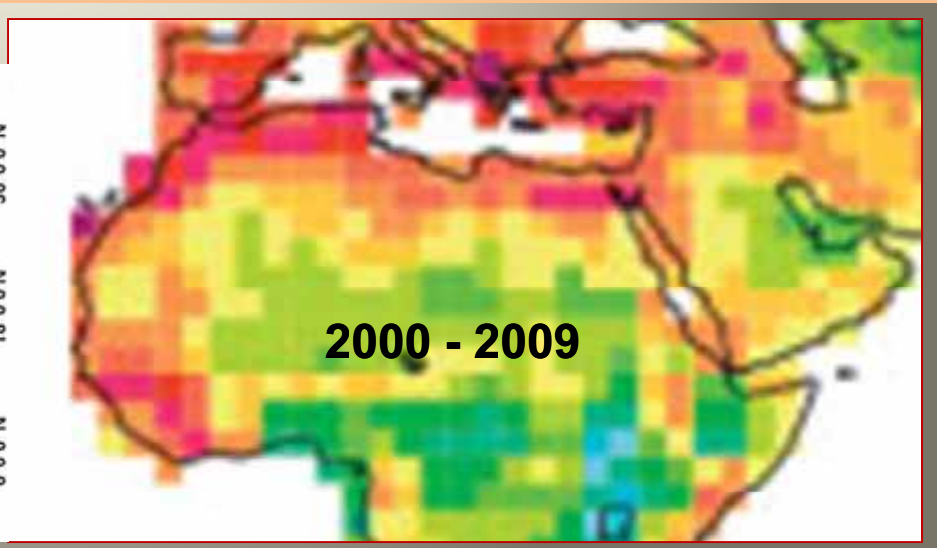

Agriculture Drought Hazard
2000 - 2011
10°0'0"W
20°0'0"E
40°0'0"N
30°0'0"N
20°0'0"N
12 11 10 9 8 7 6 5 4 3 2 1
Very High
Hazard Ranges
Very Low
0 300 600 1,200 1,800
Kilometers
N
10°0'0"W
0°0'0"
10°0'0"E
20°0'0"E

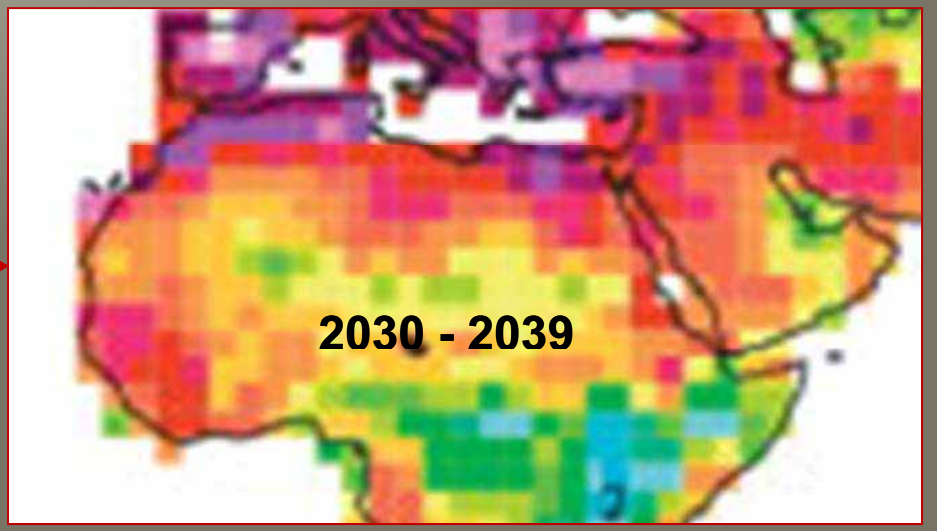
ARIDITY CHANGES

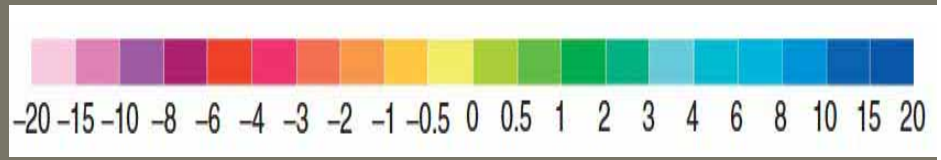


ACSAD result for Agriculture Drought

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







Dai Aiguo 2010. "Drought under Global Warming " . National Center for Atmospheric Research, Boulder, Colorado , USA , John Wiley & Sons, Ltd. DOI: 10.1002/wcc.81

EXPO
SURE

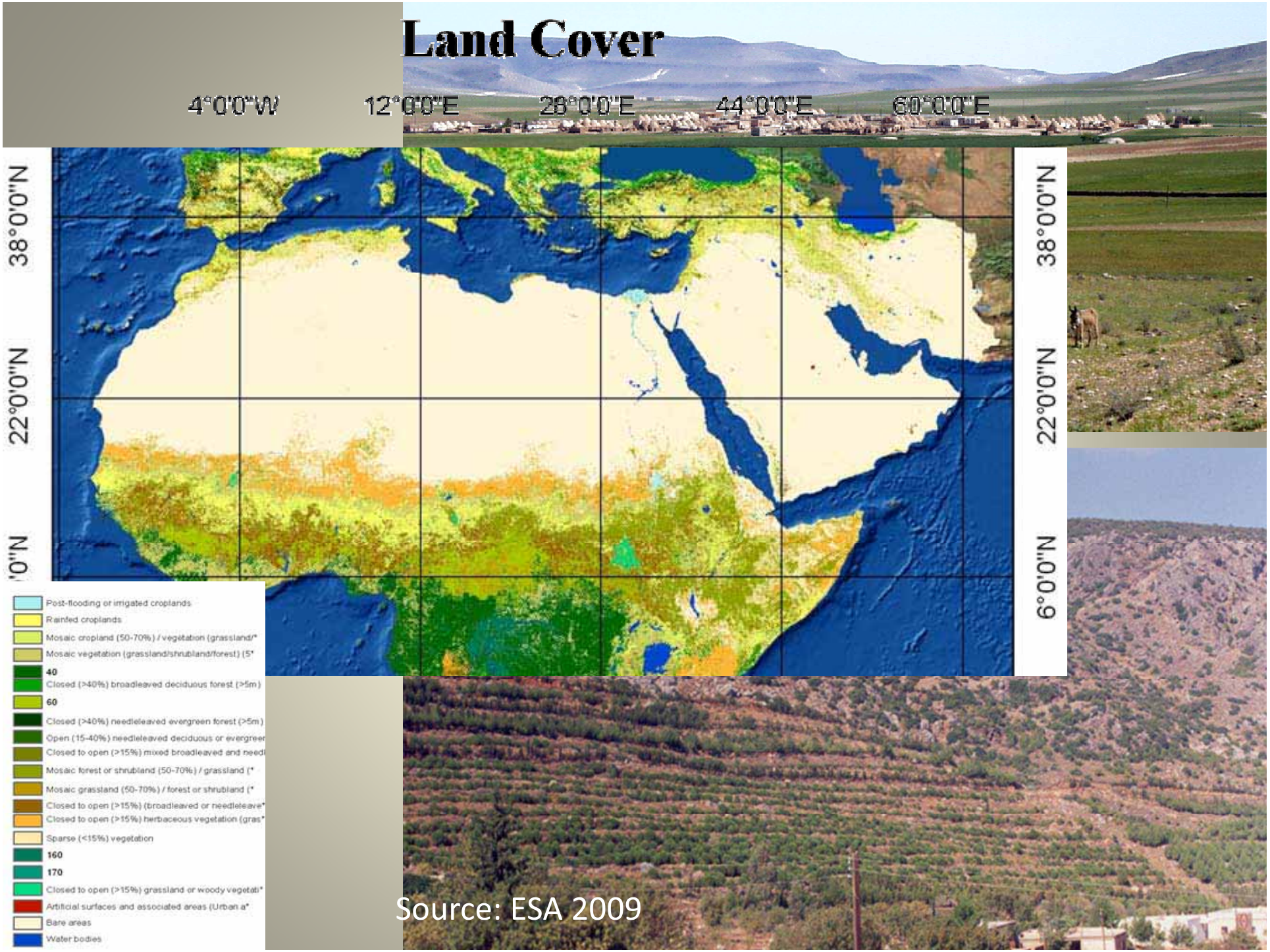
EXPO
SURE

LAND COVER/USE

Land Degradation

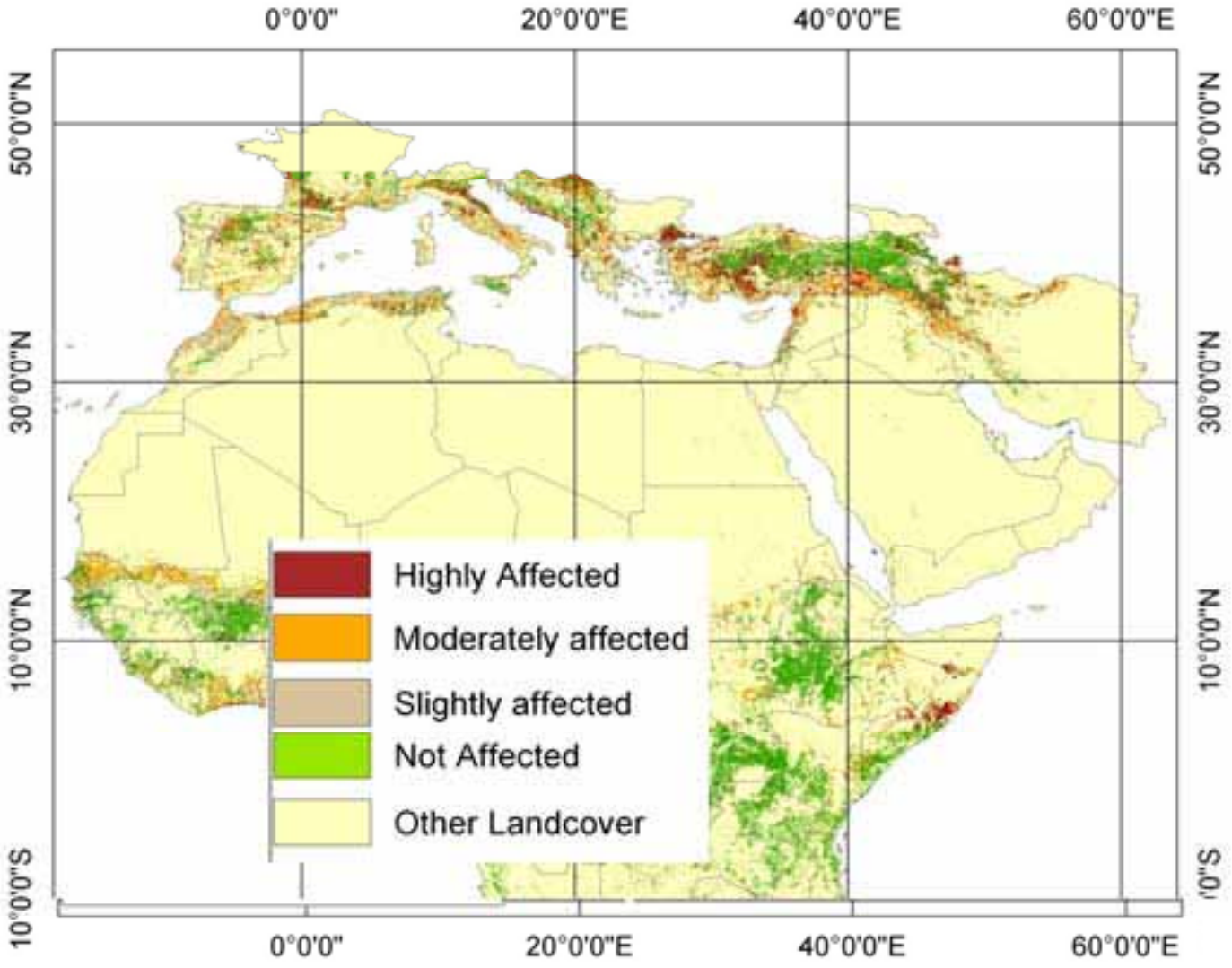
POPULATION

Land Cover

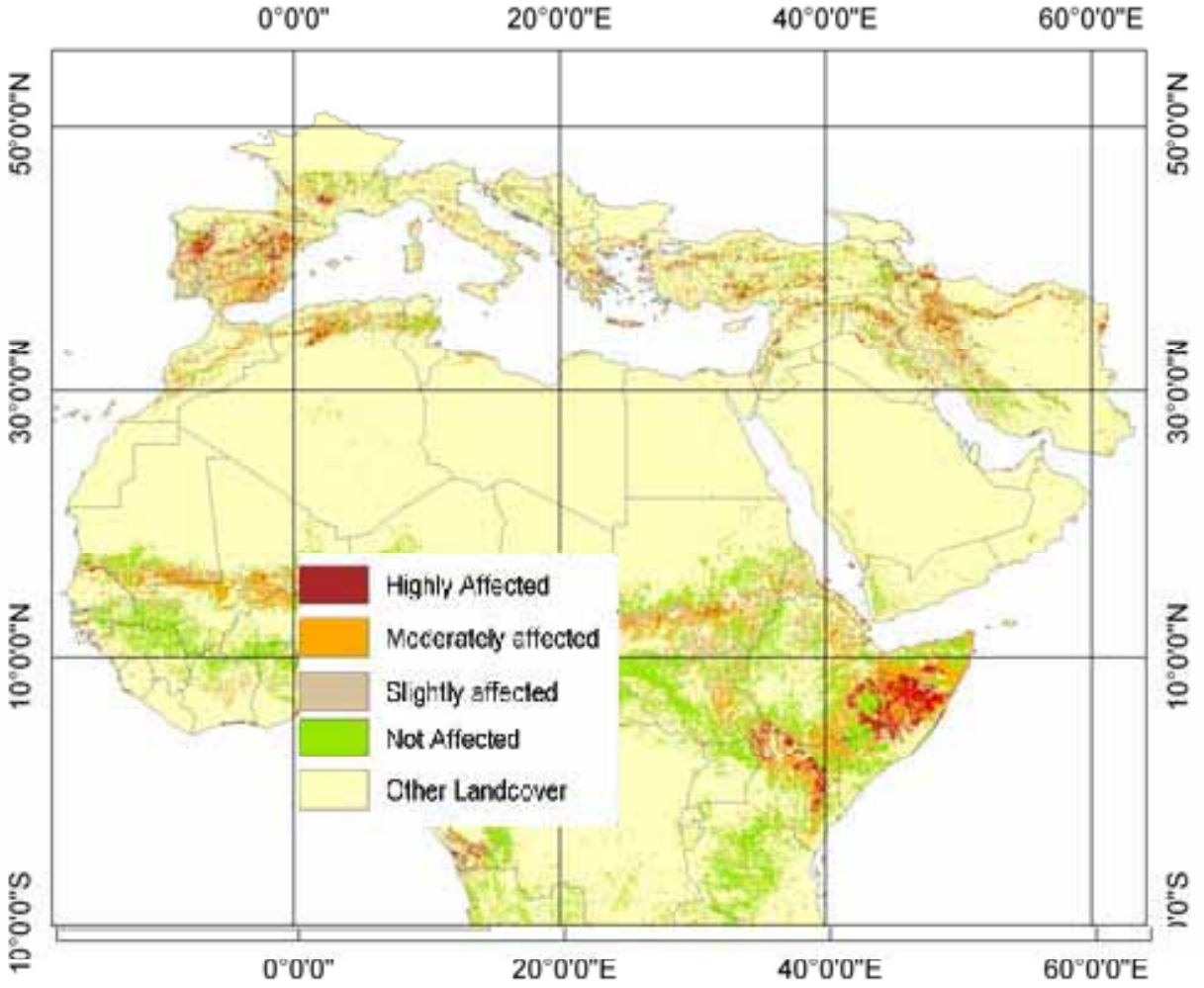


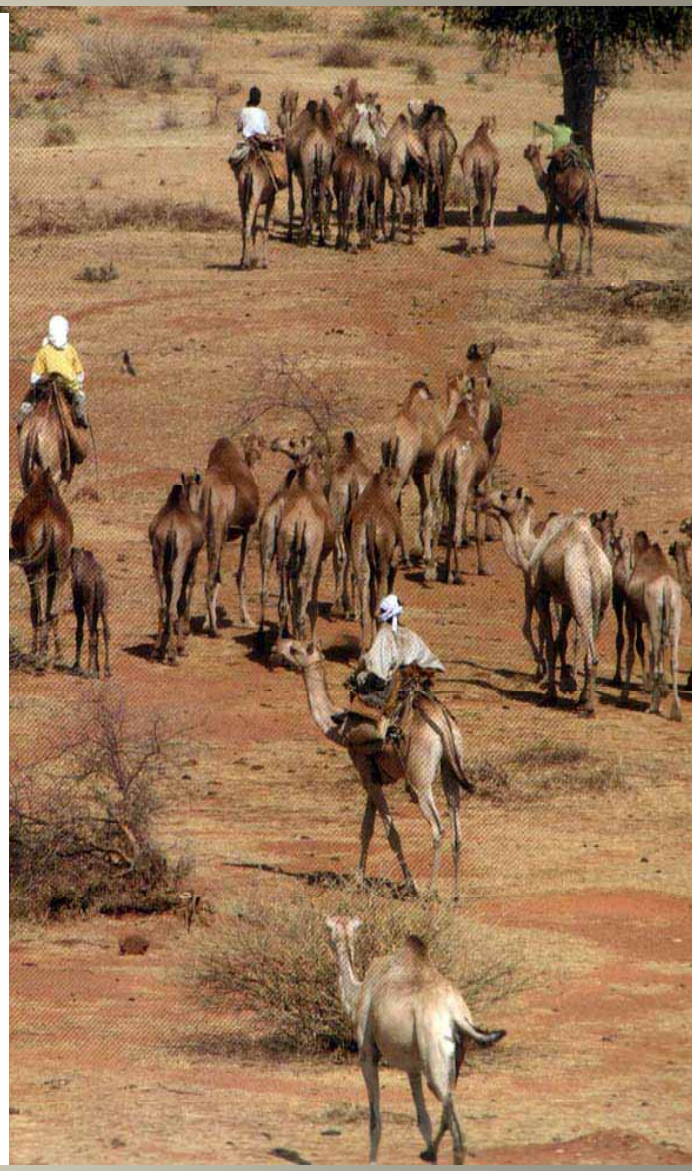
Source: ESA 2009

Land cover - Rainfed land affected by Drought Hazard

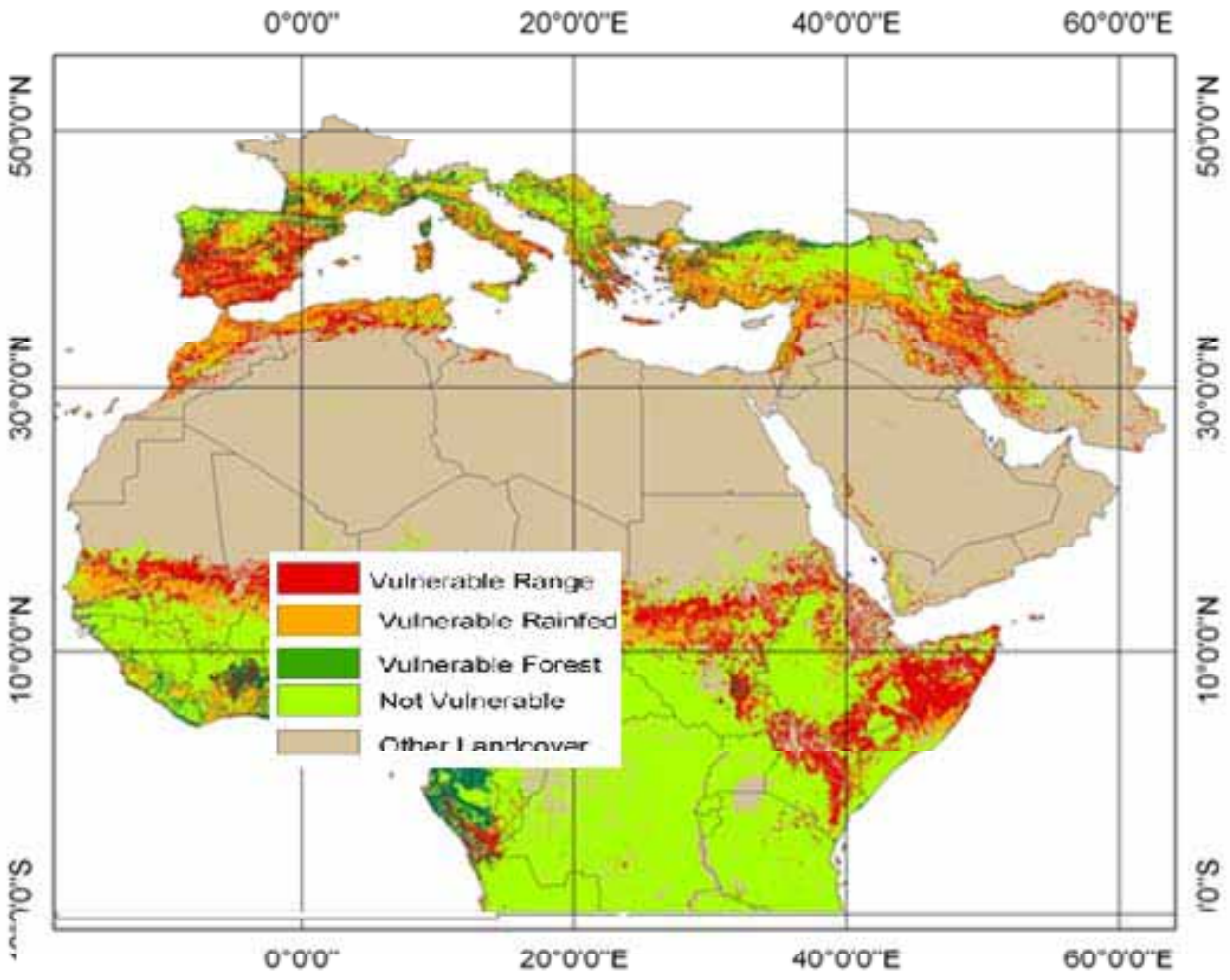


Land cover - Rangeland affected by Drought Hazard



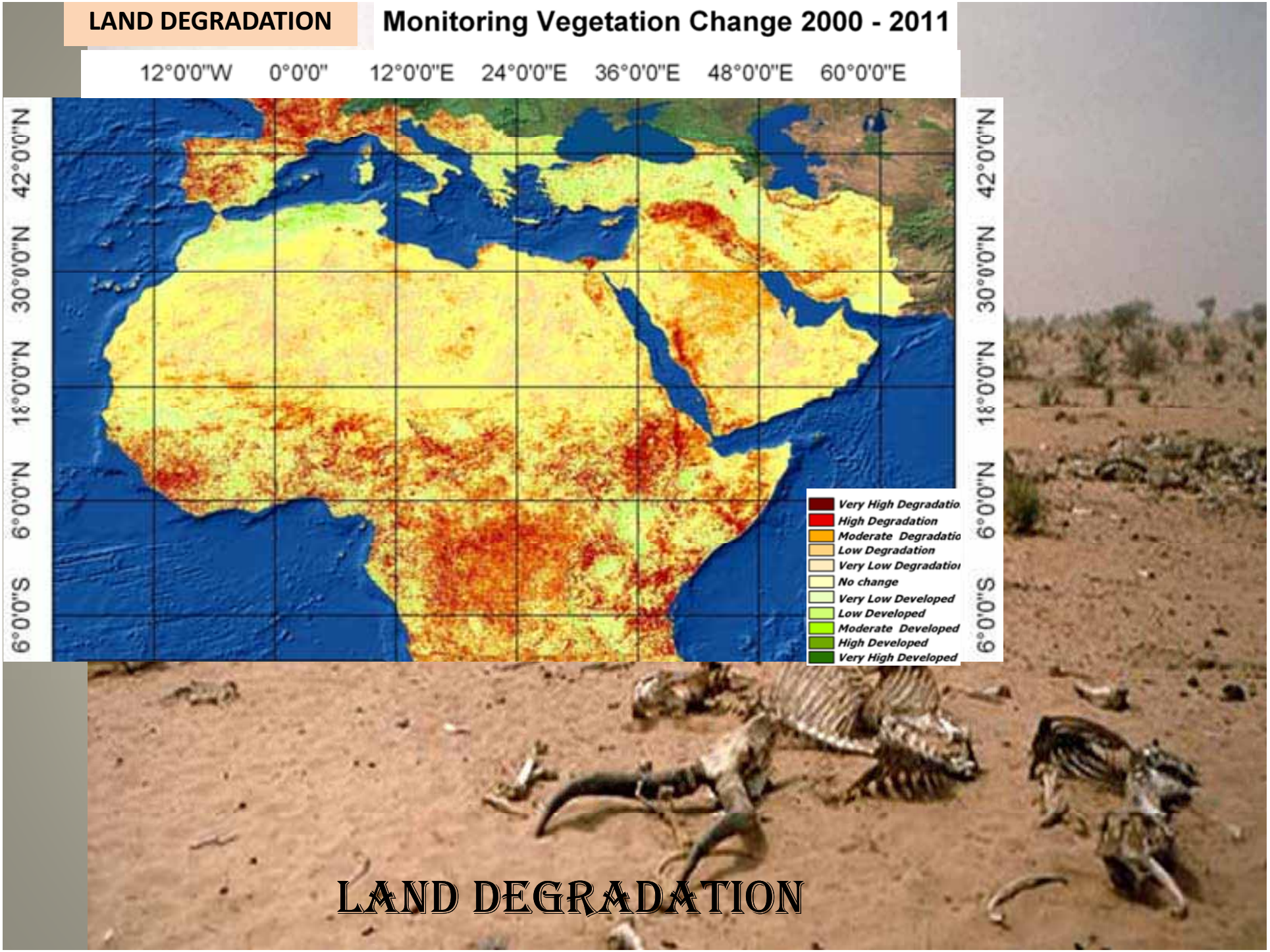


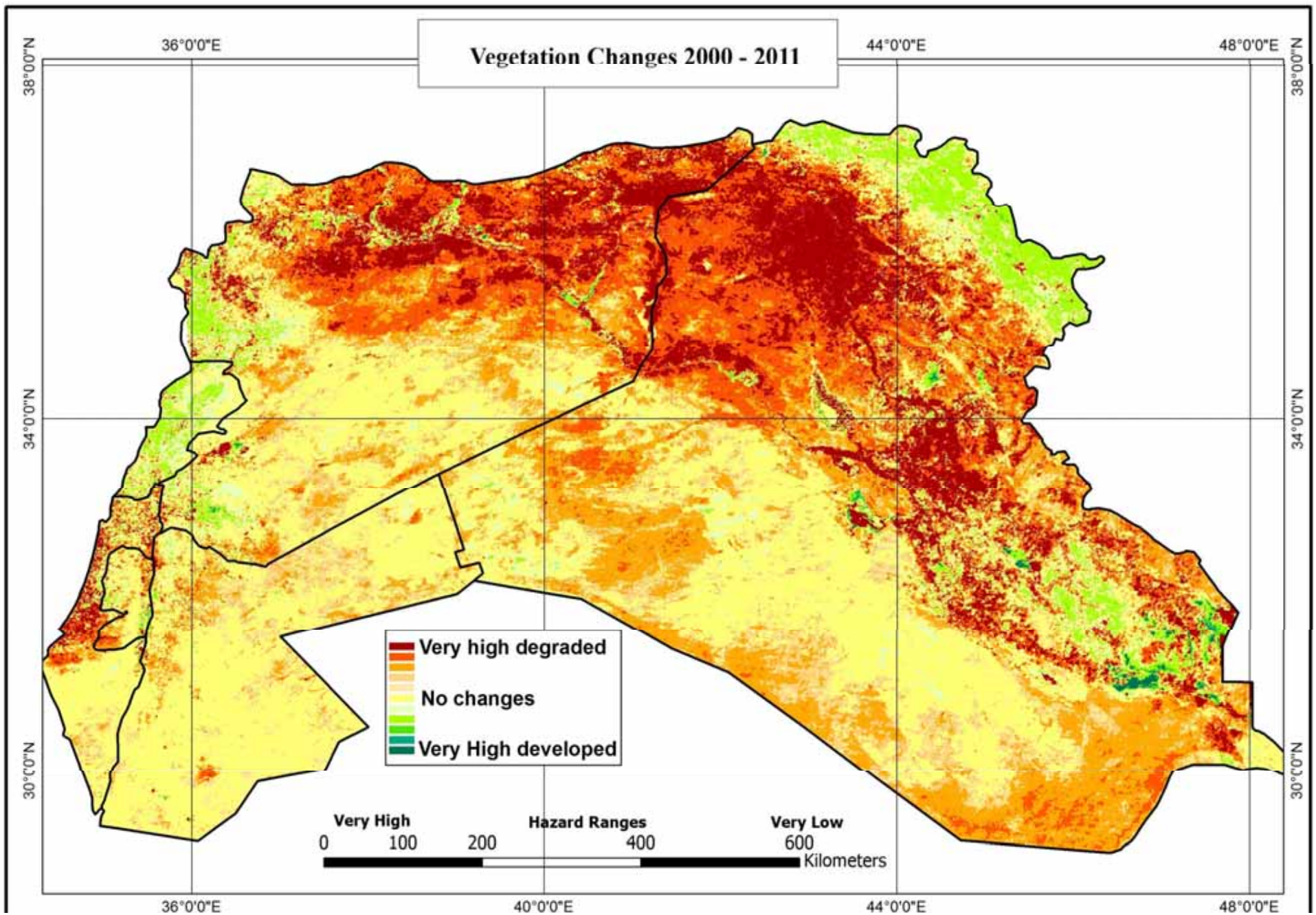
Affected Vegetation Cover BY ADH

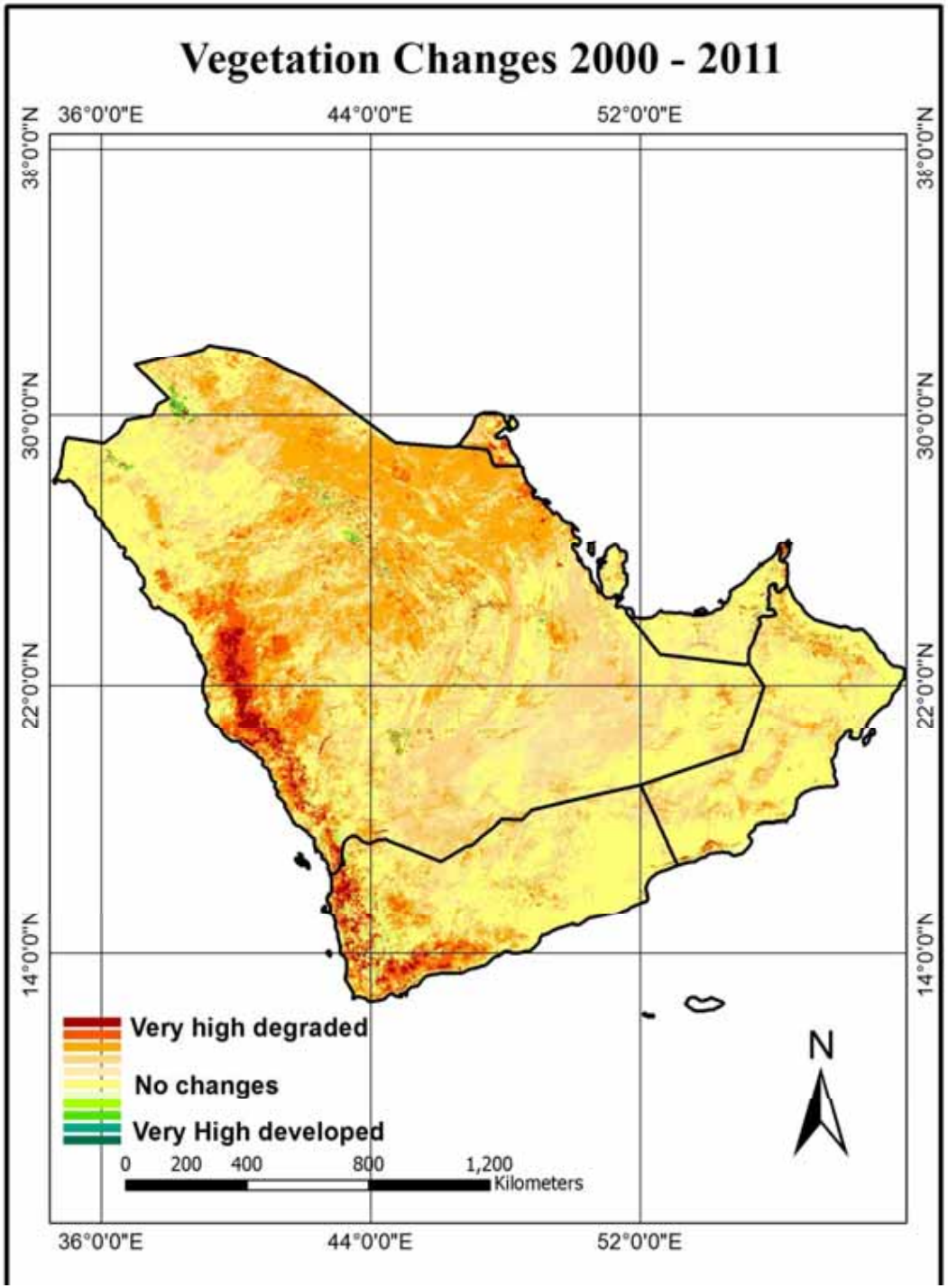


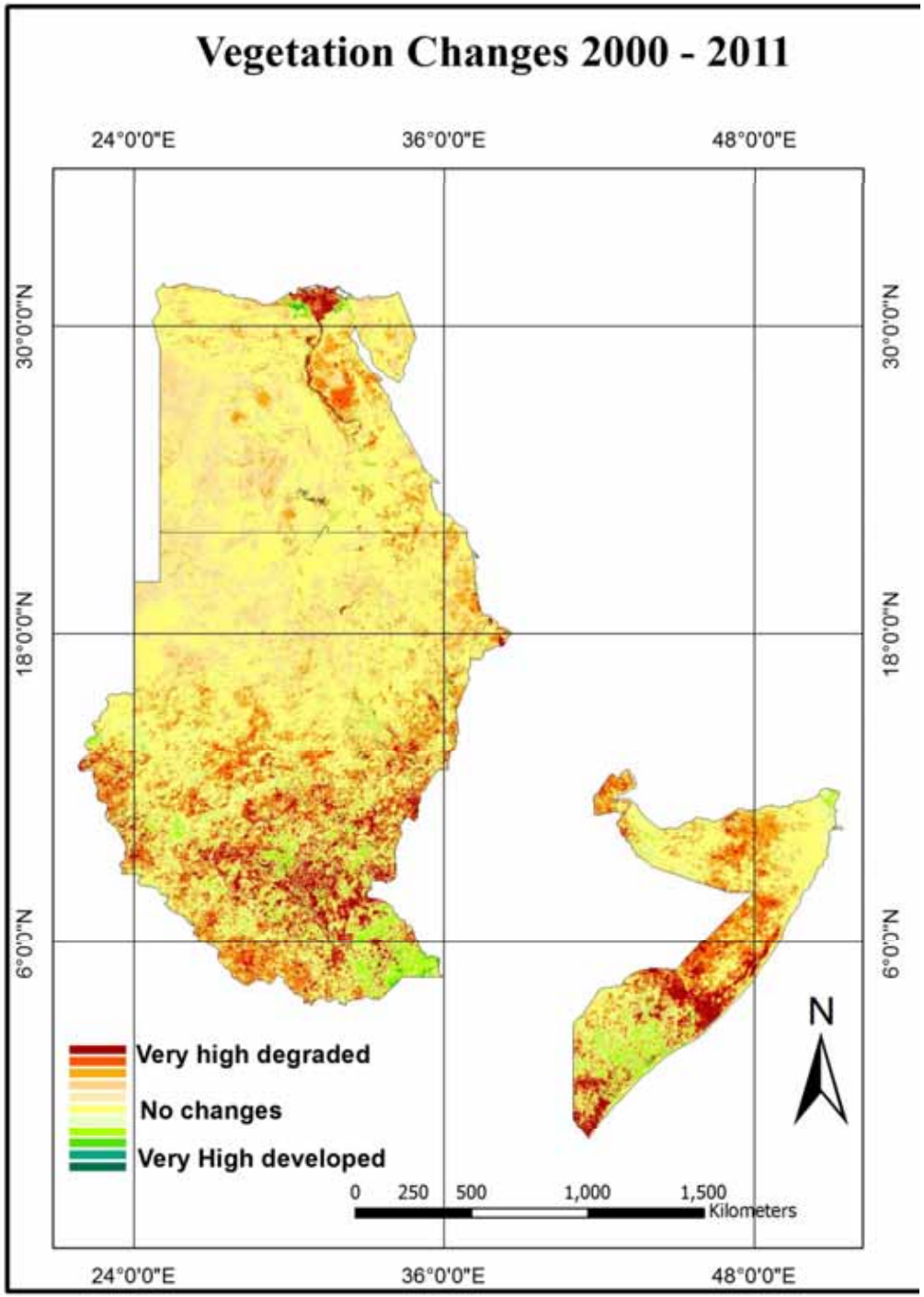
LAND DEGRADATION

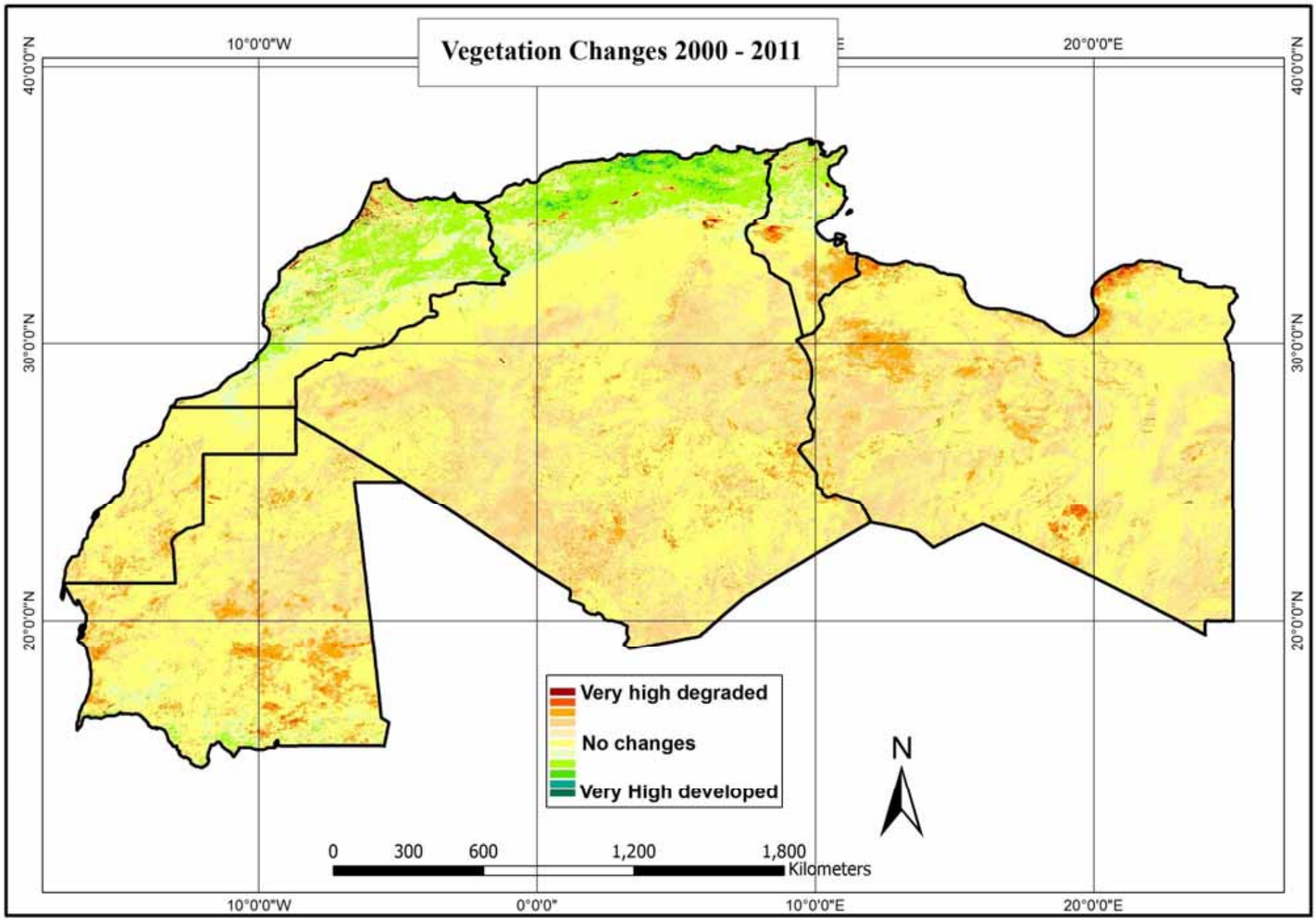
Monitoring Vegetation Change 2000 - 2011



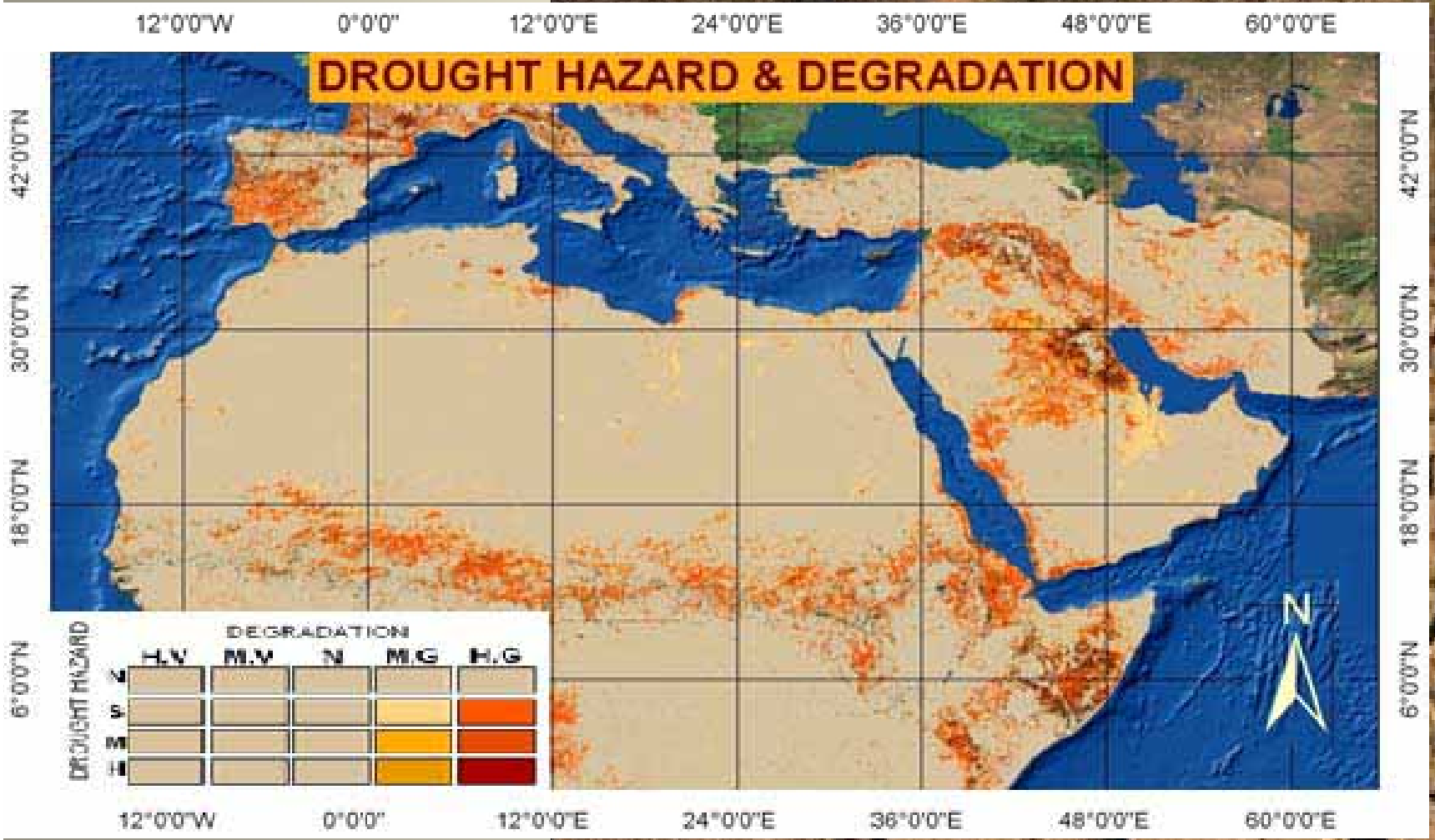

Vegetation Changes 2000 - 2011
36°0'0"E
44°0'0"E
48°0'0"E
38°0'0"N
34°0'0"N
30°0'0"N
40°0'0"E
Very high degraded
No changes
Very High developed
Very High
Hazard Ranges
Very Low
0
100
200
400
600
Kilometers


Vegetation Changes 2000 - 2011
36°0'0"E
44°0'0"E
52°0'0"E
38°0'0"N
30°0'0"N
22°0'0"N
14°0'0"N
Very high degraded
No changes
Very High developed
0 200 400 800 1,200
Kilometers
N

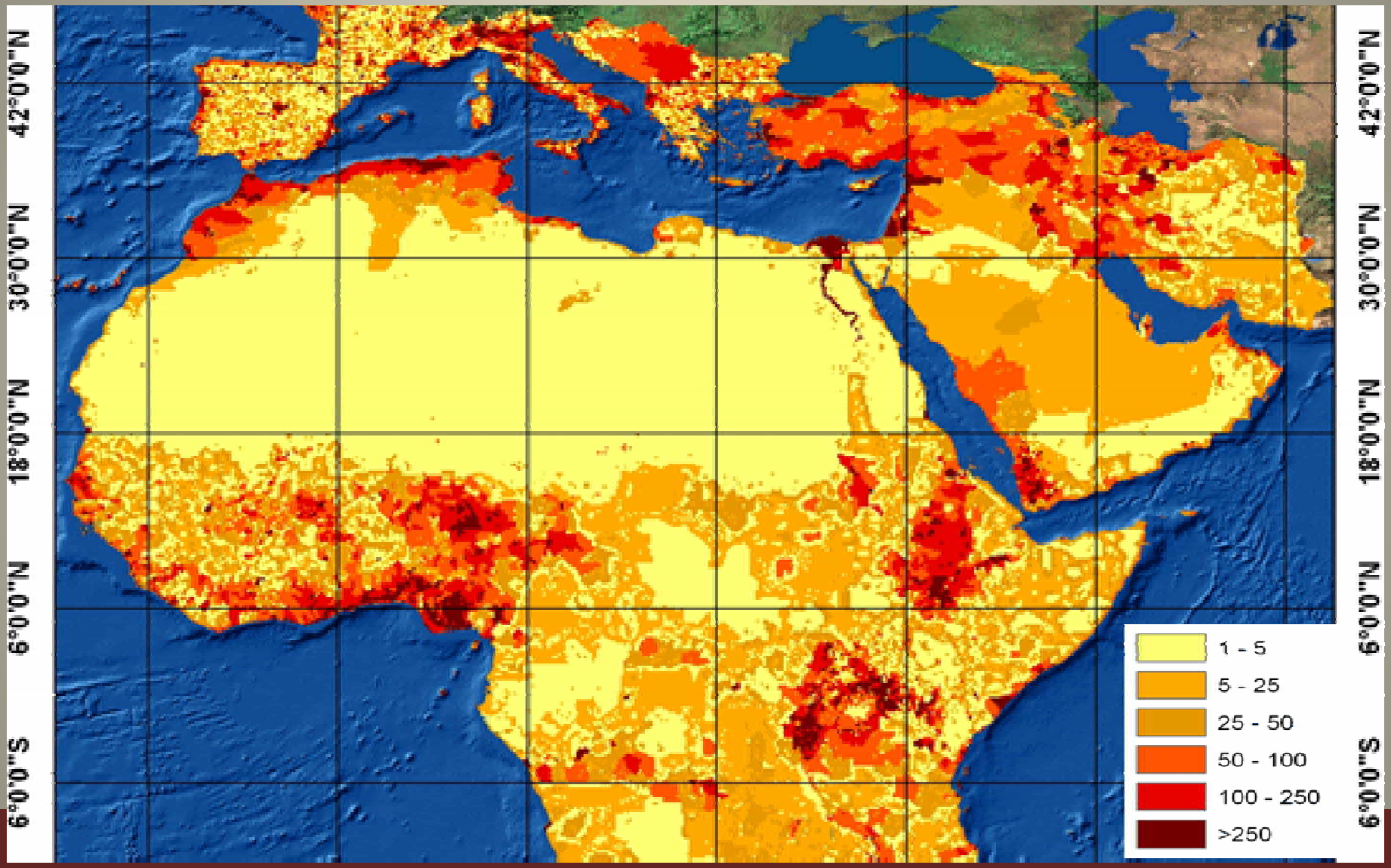

Vegetation Changes 2000 - 2011
24°0'0"E
36°0'0"E
48°0'0"E
30°0'0"N
18°0'0"N
6°0'0"N
Very high degraded
No changes
Very High developed
0 250 500 1,000 1,500
Kilometers
N


Vegetation Changes 2000 - 2011
10°0'0"W
20°0'0"E
40°0'0"N
30°0'0"N
20°0'0"N
Very high degraded
No changes
Very High developed
N
0
300
600
1,200
1,800
Kilometers
10°0'0"W
0°0'0"
10°0'0"E
20°0'0"E

AREAS AFFECTED BY LAND DEGRADATION AND DROUGHT

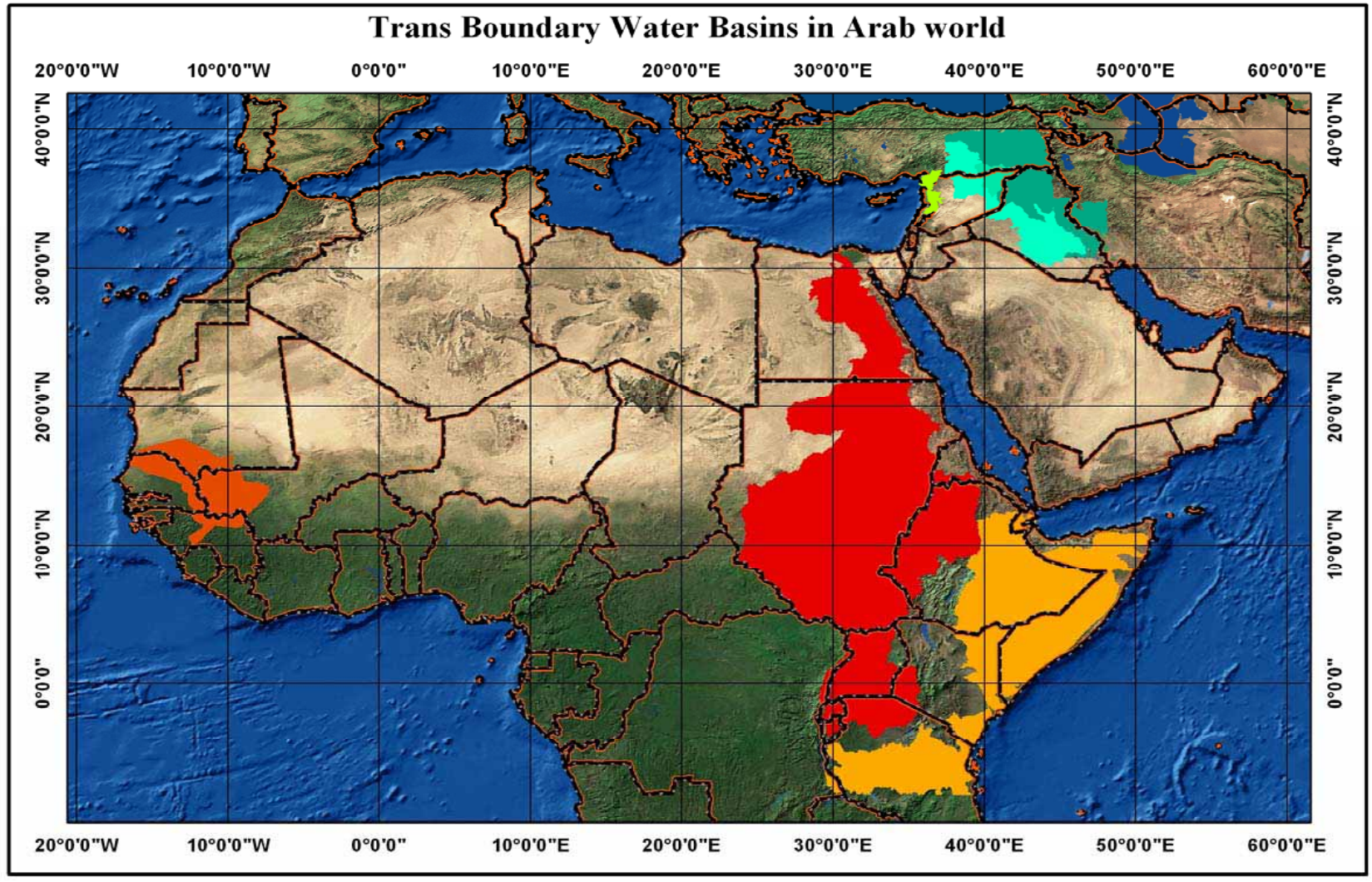


Population density map



Country	Total	Affected Population		Level of Affection					
	population	Total		Highly		Moderately		Slightly	
	Person	Person	%	%	Person	%	Person	%	Person
more than 75 %									
Gaza Strip	1710257	1631699	95.4	23.1	394595	37.3	637533	35.1	599571
Lebanon	4140289	3659245	88.4	14.9	615930	23.7	980977	49.8	2062338
Morocco	32309239	28489205	88.2	3.4	1084323	25.6	8279726	59.2	19125155
Kuwait	2646314	2182391	82.5	38.7	1024692	30.2	799656	13.5	358043
Qatar	1951591	1604689	82.2	11.7	228063	35.1	685045	35.4	691580
West Bank	2622544	2155328	82.2	3.1	80084	20.6	539562	58.6	1535681
Syria	22530746	18154031	80.6	20	4511188	32.2	7256524	28.3	6386319
50 - 75%									
Iraq	31129225	22414138	72	22	6848353	29.5	9185593	20.5	6380192
Djibouti	774389	546459	70.6	9.1	70750	41.7	322737	19.8	152972
Algeria	35406303	24702390	69.8	8.4	2968549	24.4	8649945	37	13083896
Tunisia	10732900	7489320	69.8	11	1177323	21	2255575	37.8	4056423
Jordan	6508887	3940650	60.5	6.8	444253	11.7	759343	42.1	2737054
UA Emirates	5314317	2876597	54.1	0.1	6651	12	640022	42	2229925
25 - 50%									
Sudan	34206710	16755837	49	3.7	1277099	21.1	7201304	24.2	8277435
Somalia	10085638	4763780	47.2	14	1408350	28.9	2913056	4.4	442374
Mauritania	3359185	1449593	43.2	2.7	89834	19.1	642136	21.4	717624
Saudi Arabia	26534504	11026083	41.6	3	790694	12	3174464	26.6	7060925
Yemen	24771809	10145643	41	5	1226404	17.4	4311169	18.6	4608071
Libya	6733620	2478479	36.8	4.2	280180	11.1	744411	21.6	1453888
Oman	3090150	977462	31.6	1.3	41180	6.5	200541	23.8	735742
Egypt	83688164	21387582	25.6	1.7	1417875	6	5023838	17.9	14945869

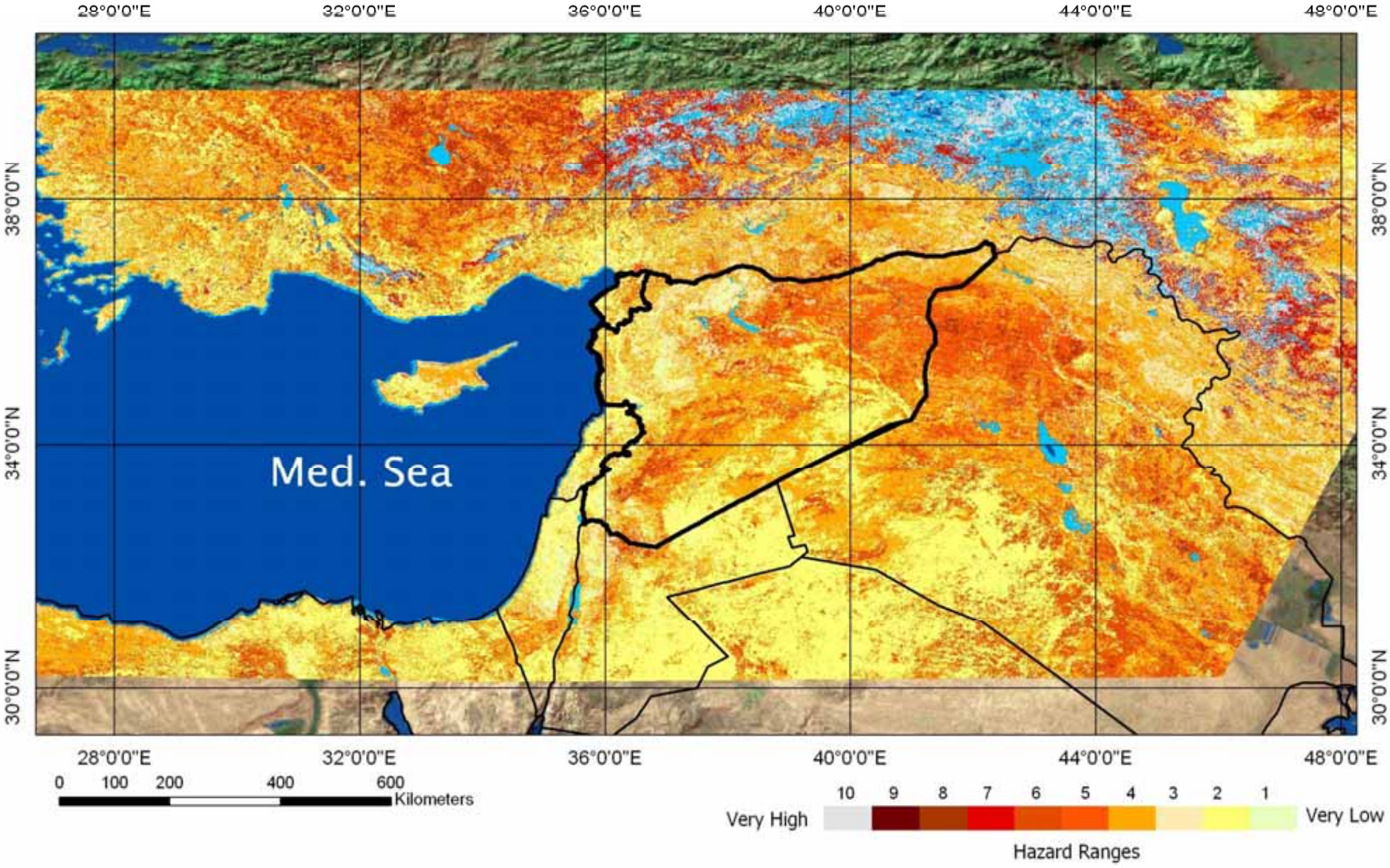
The Arab region has the highest reliance on external water resources; more than 65% of the annually renewable resources originate outside the boundaries of the Arab region the major rivers in the region are the Nile River, the Euphrates and Tigris Rivers and the Senegal River. All these challenges in the region lead to a complicated hydro-political problem facing many Arab countries.

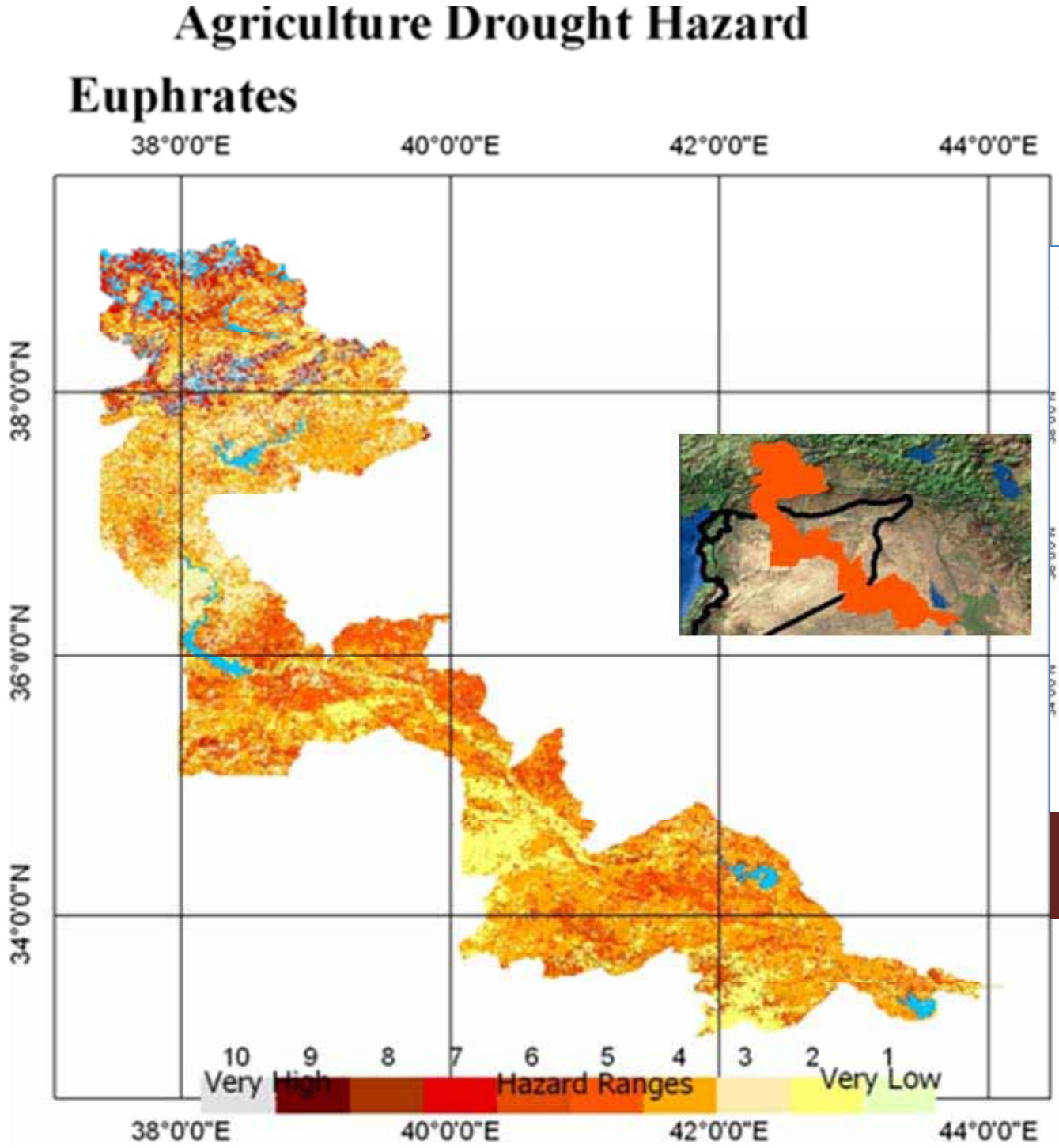


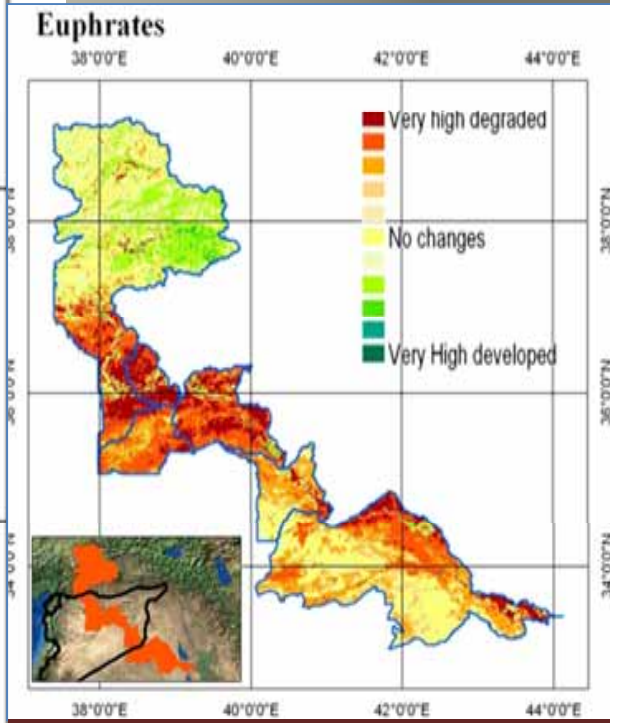
Agriculture Drought and Land Degradation in Arab Region

Trans-boundary River's Basin

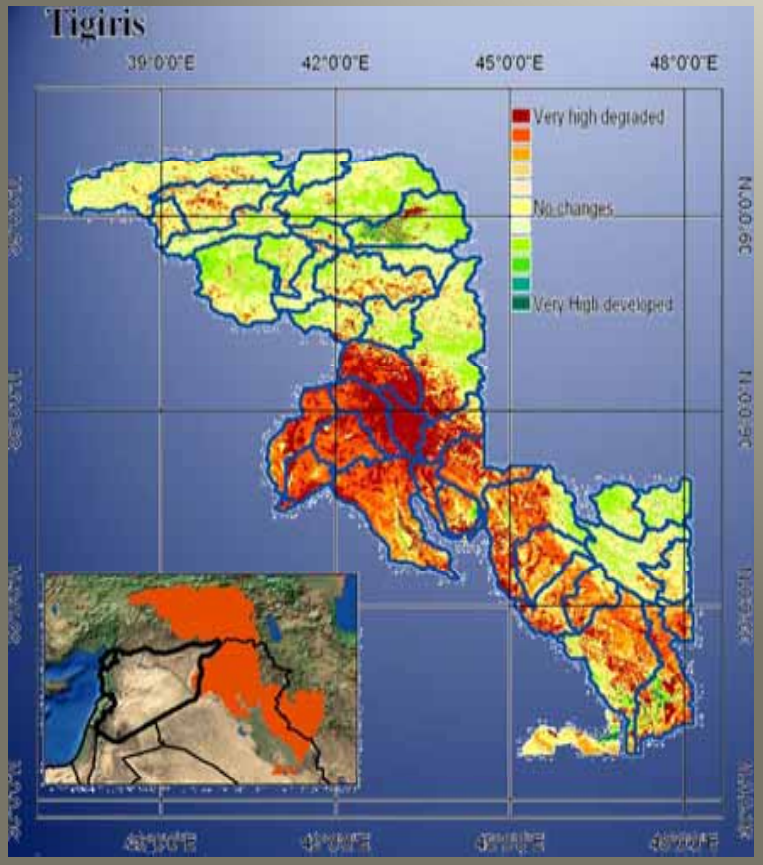
Agriculture Drought Hazard





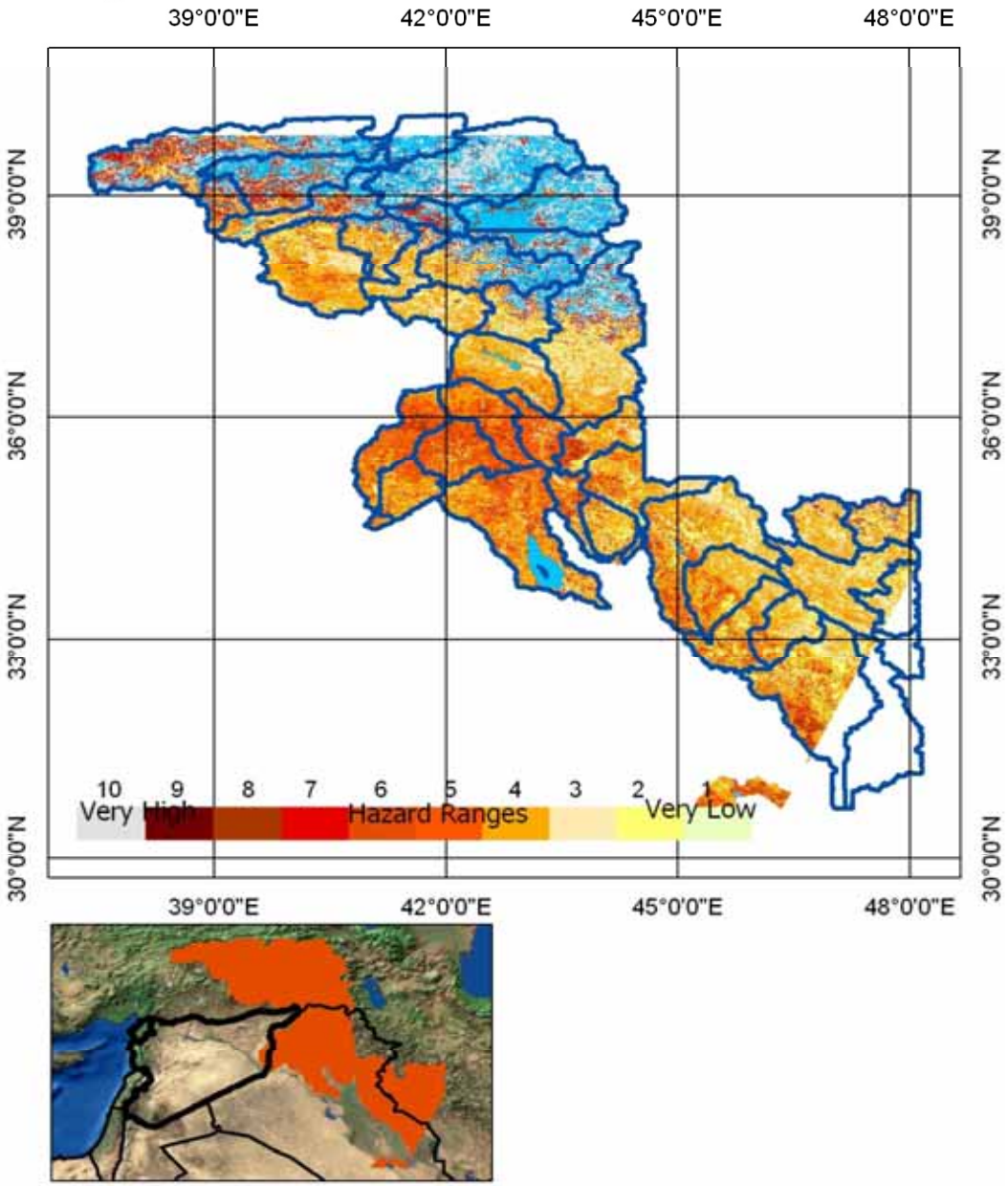


Land Degradation Map in Euphrates River's Basin



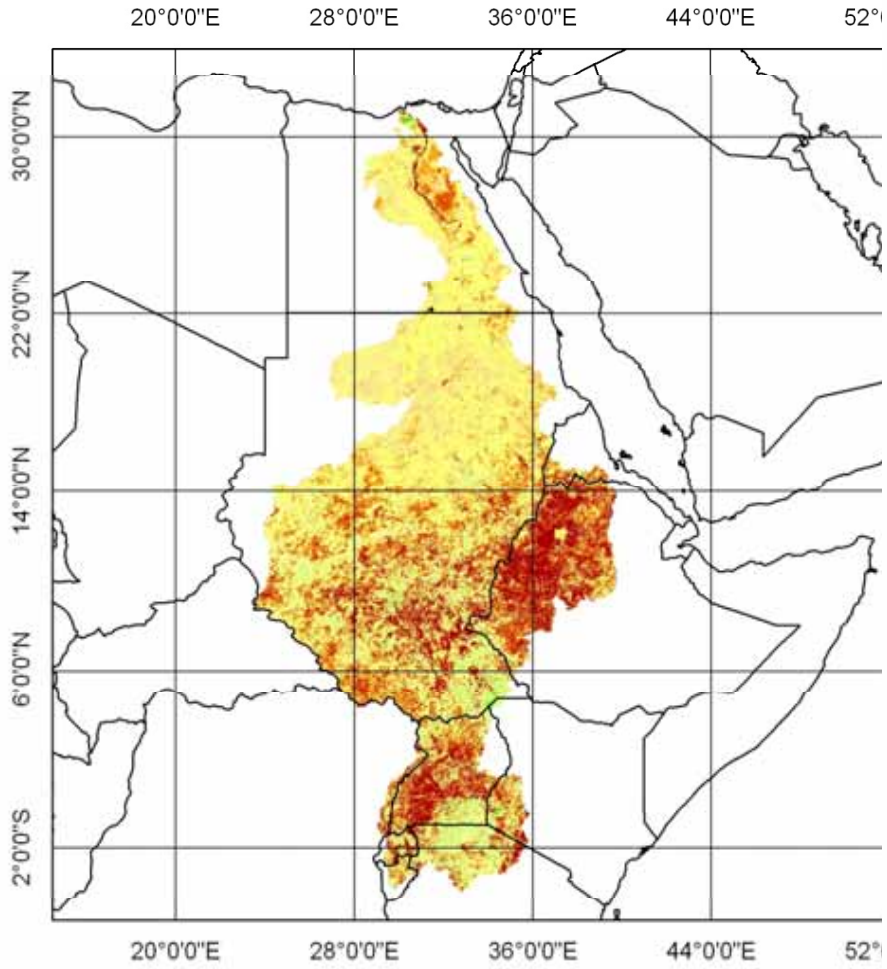
Land Degradation Map in Tigris River's Basin

Agriculture Drought Hazard



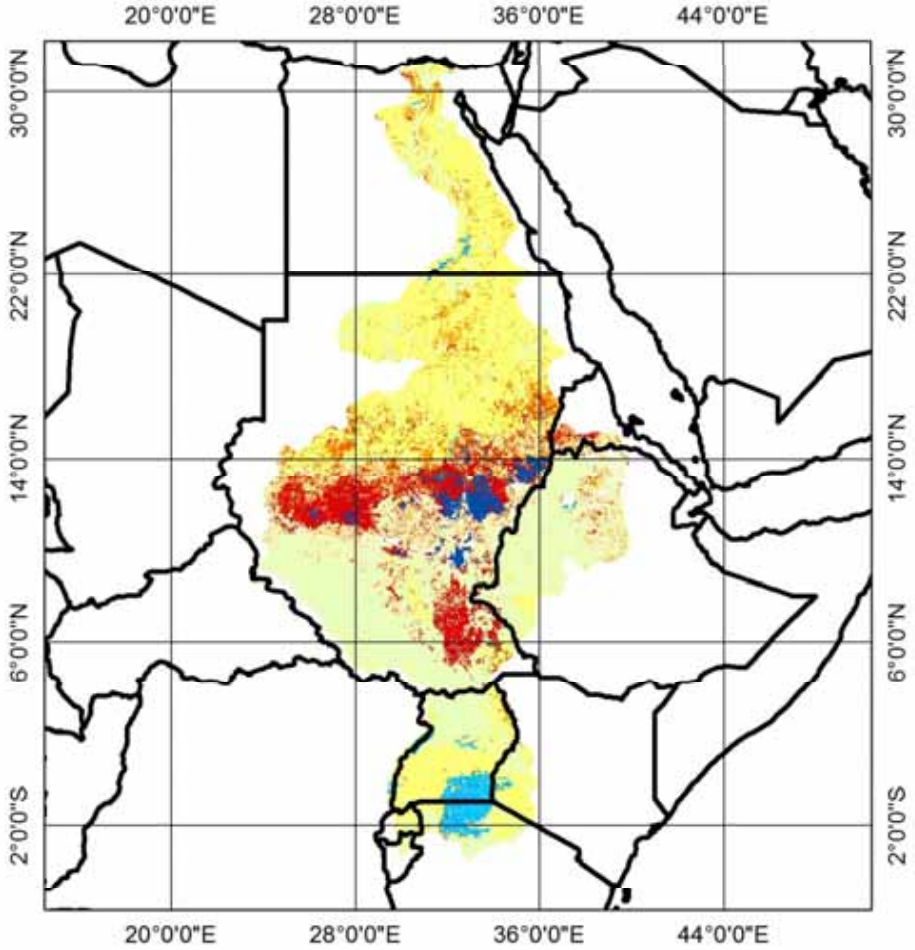
Vegetation Changes 2000 - 2011

Nile basin



Agriculture Drought Hazard

Nile basin



DROUGHT VULNERABILITY

the literature describes the relationship between vulnerability and capacity in two ways, which are not mutually exclusive (Bohle, 2001 ; IPCC, 2001; Moss et al., 2001 ; Yodmani, 2001 ; Downing and Patwardhan, 2004 ; Brooks et al., 2005 ; Smit and Wandel, 2006 ; Gaillard, 2010):

VULNER ABILITY

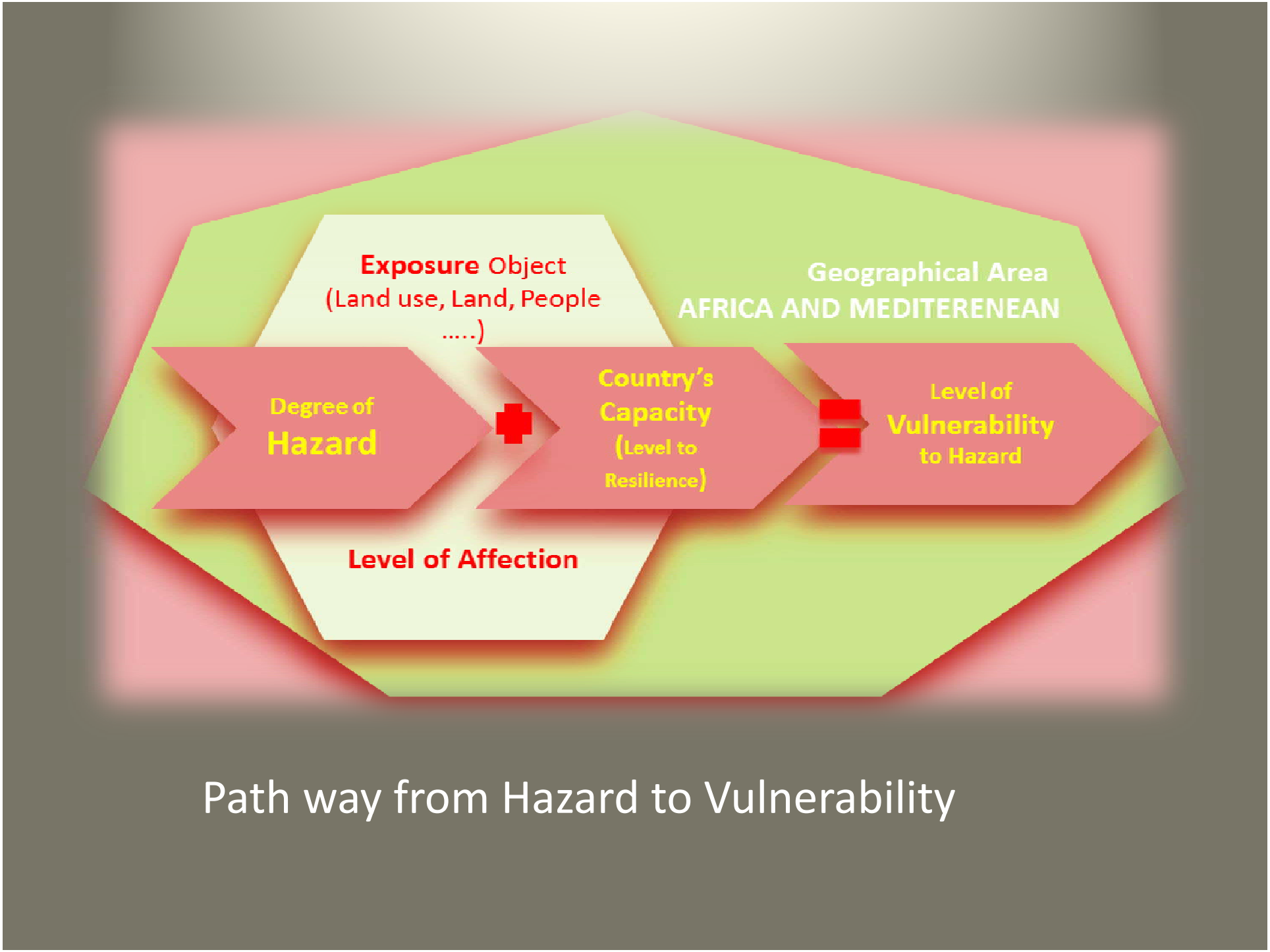
Vegetation LAND –USE including Negative change in vegetation Cover Land degradation in Arab Countries and River's Basins

LOSS IN CROPS

Affected POPULATION

COUNTRY CAPACITY

1) Vulnerability is, among other things, the result of a **lack of capacity**.
2) Vulnerability is the opposite of capacity, so that **increasing capacity means reducing vulnerability, and high vulnerability means low capacity.**



Path way from Hazard to Vulnerability

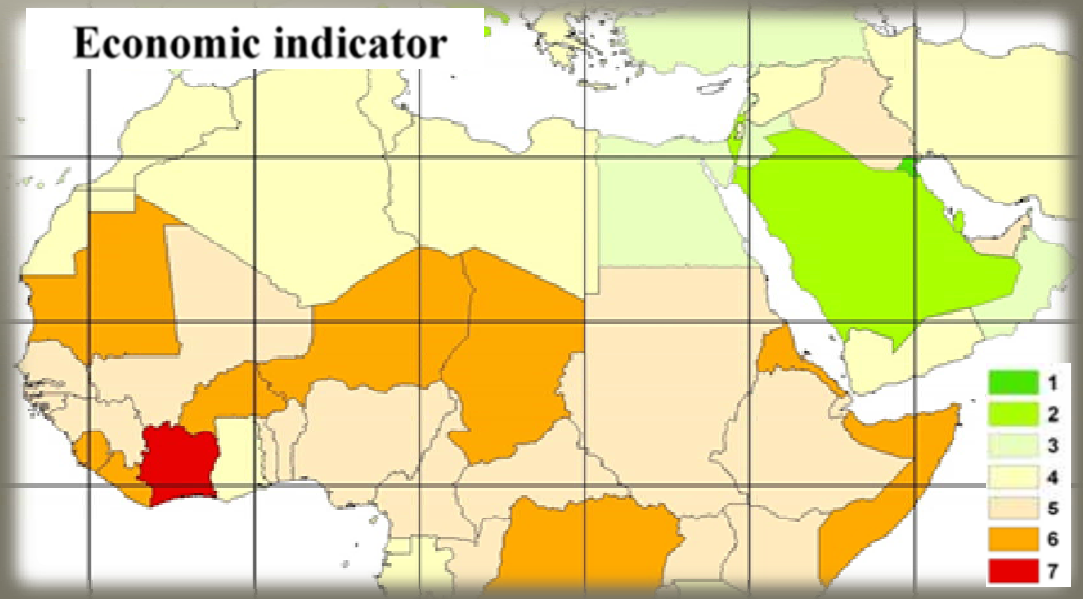
Main Steps for Assessing Vulnerability could be Ordered as Follows:

Step 1:	**Assessing The Main Economical Capacity Characteristics of the Studied Countries.**
Step 2:	Assessing The Main Population Capacity Characteristics of the Studied Countries.
Step 3:	Assessing The Main Land Use and Water Availability Capacities Characteristics of the Studied Countries.
Step 4:	Assessing the Main Water Availability and Water Use Capacities Characteristics of The Studied Countries.
Step 5:	Ranking Countries According to Their Overall Resilience Capacities.
Step 6:	Identifying the most ADH Vulnerable Countries and describe their Degree of Affection by ADH in Rainfed Agriculture, Rangelands, Forestry, Land Degradation.

Step 1: Assessing The Main Economical Capacity Characteristics of the Studied Countries.

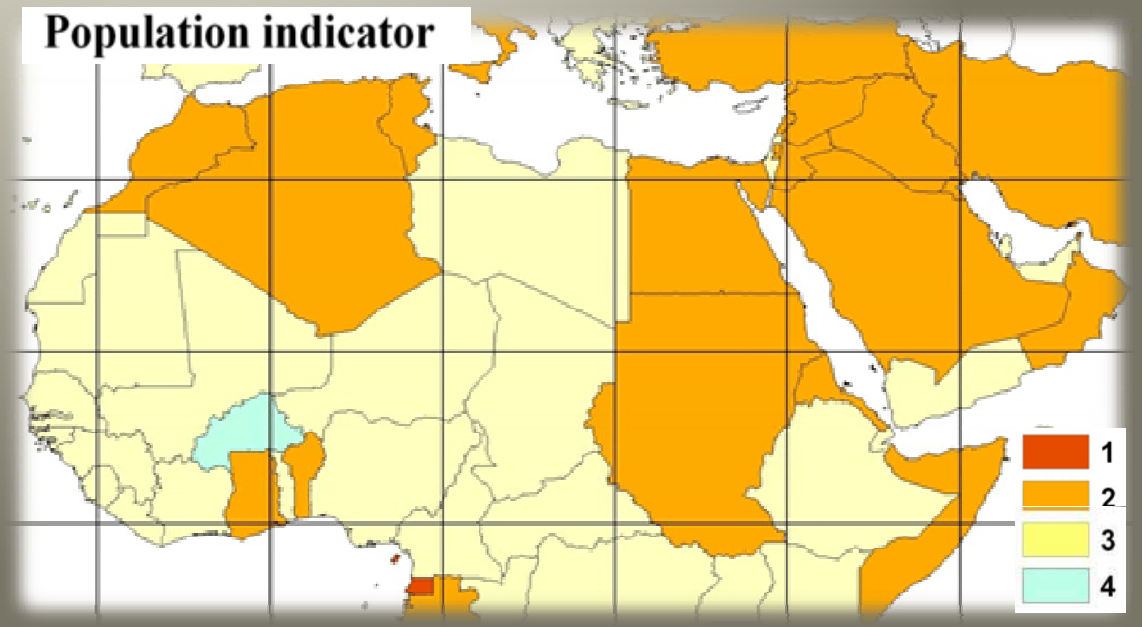
Countries main economical capacity characteristics were selected for the study are:

EcA. GDP in Million US$.
EcB. GDP Growth rate.
EcC. NGI US$.
EcD. Agriculture Share In GDP %.
EcE. Labor Force % in Agriculture.
EcF. Unemployment Rate %.
EcG. Below Poverty Line %.
EcH. Agriculture, value added per agricultural worker (USD) 2009-1999.
EcI. Evaluation of the Value of Total Agriculture Production and Food Production Value (millions of 2004-2006 in ($).
EcJ Change in crop production value per ha %



Step 2: Assessing The Main Population Capacity Characteristics of the Studied Countries.

- **PoA.** Mean Population Density person/Km^2
- **PoB.** People in working age (15-64) years %.
- **PoC.** Population growth rate.
- **PoD.** Net migration rate: for each 1000 person.
- **PoE.** Females % of Labour force in Agriculture- 2011.
- **PoF.** Average Agriculture population Change 2011 - 2001%.



Step 3: Assessing The Main Land Use Capacity Characteristics of the Studied Countries.

LuA Arable Area % from Total

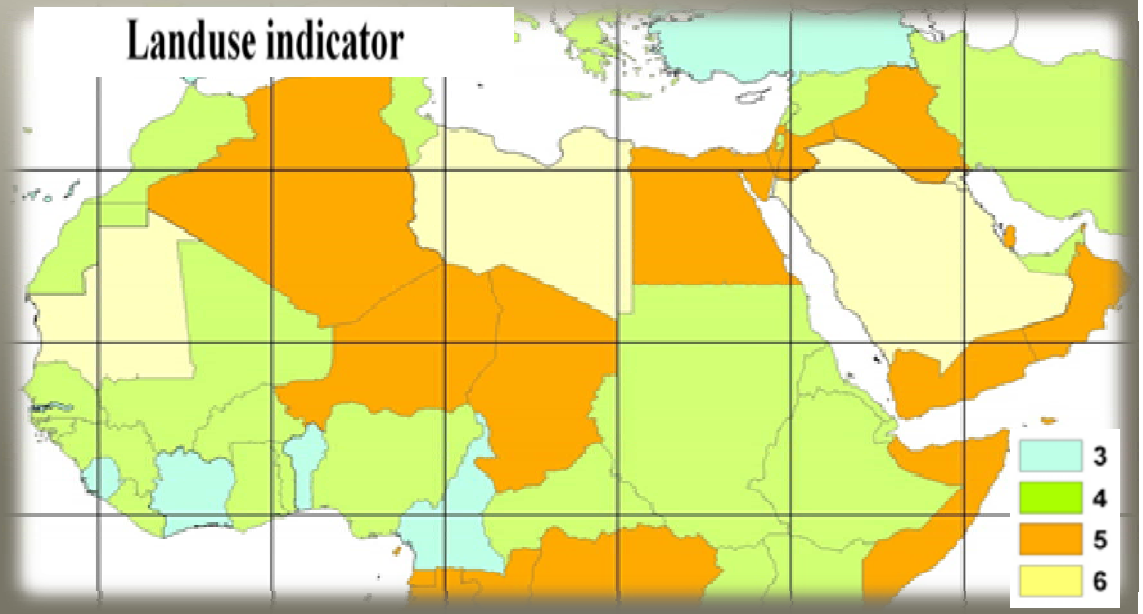
LuB Change in Arable Areas 1999 - 2009

LuC Permanent Crops Area % from Total

LuD Change in Permanent Crops Areas 1999 - 2009

LuE Forest Area % from Total

LuF. Change in Forest Areas 1999 - 2009



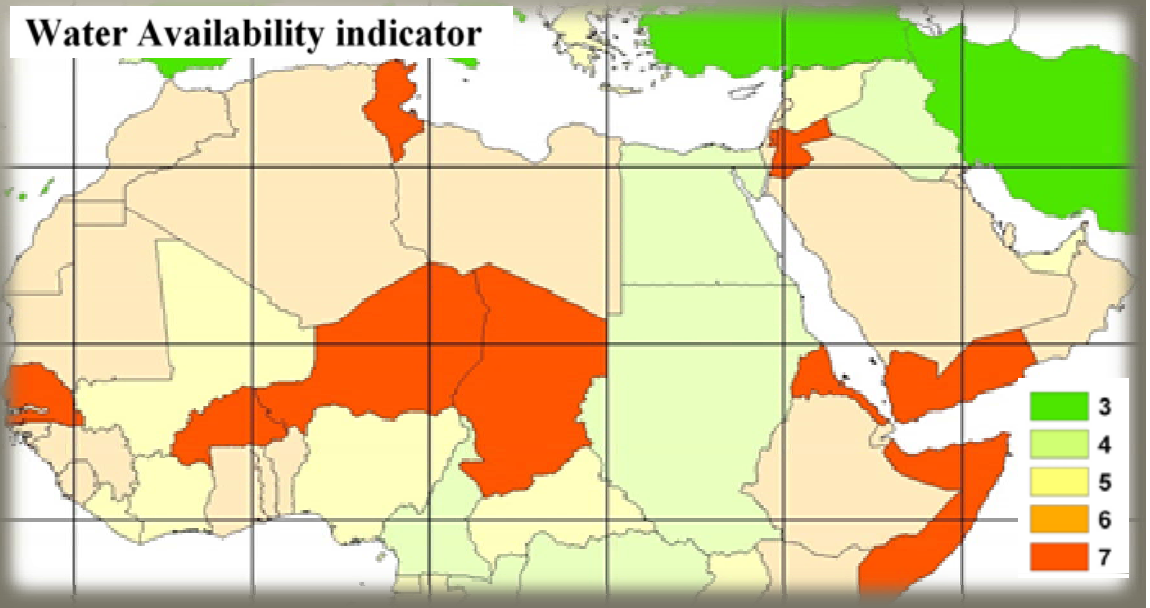
Step 4: Assessing the Main Water Availability Capacity Characteristics of The Studied Countries.

WaA Total Renewable Water Resources cu km

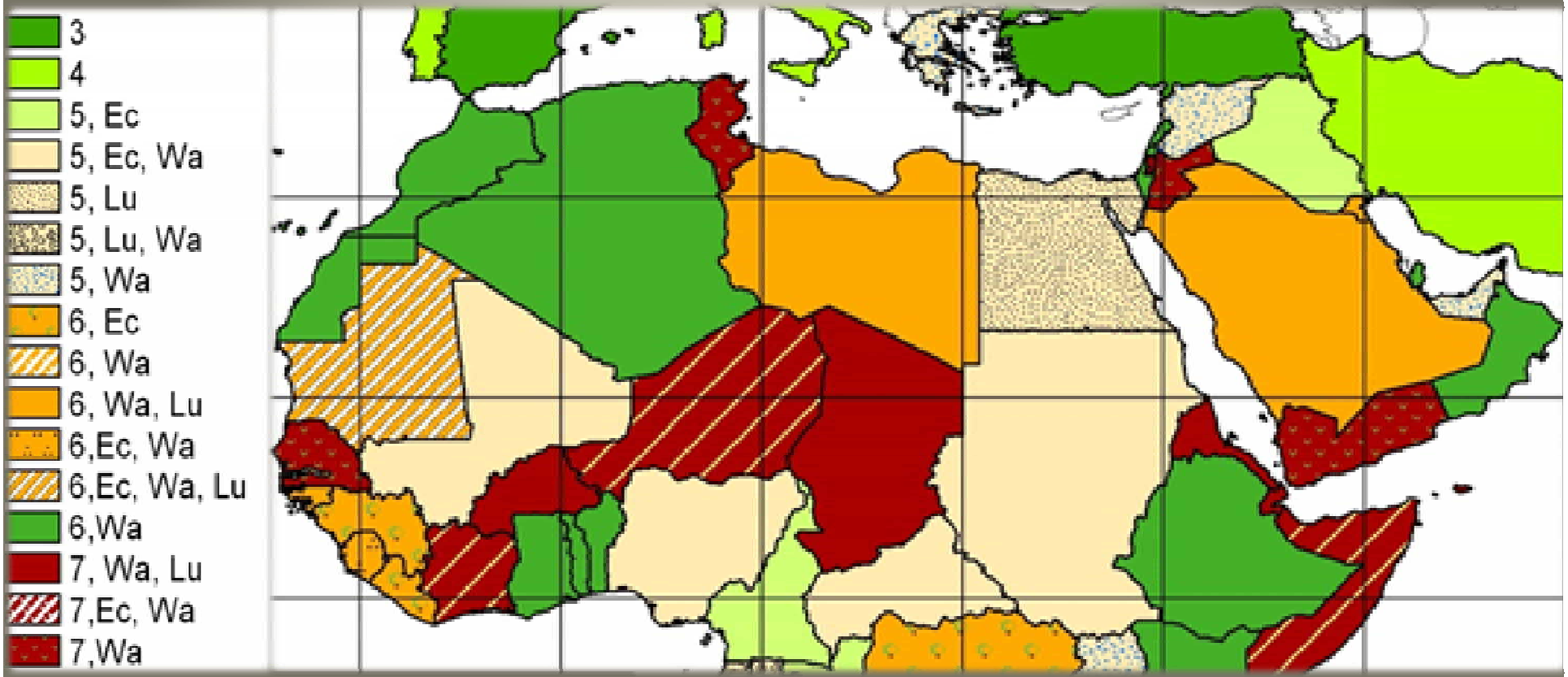
WaB Fresh water Withdrawal Total Cu km/y

WaC Fresh water Withdrawal agricultural %

WaD Fresh water Withdrawal per Capita Cu km/y



Capacity Evaluation indicator



Vulnerability Classes to ADH

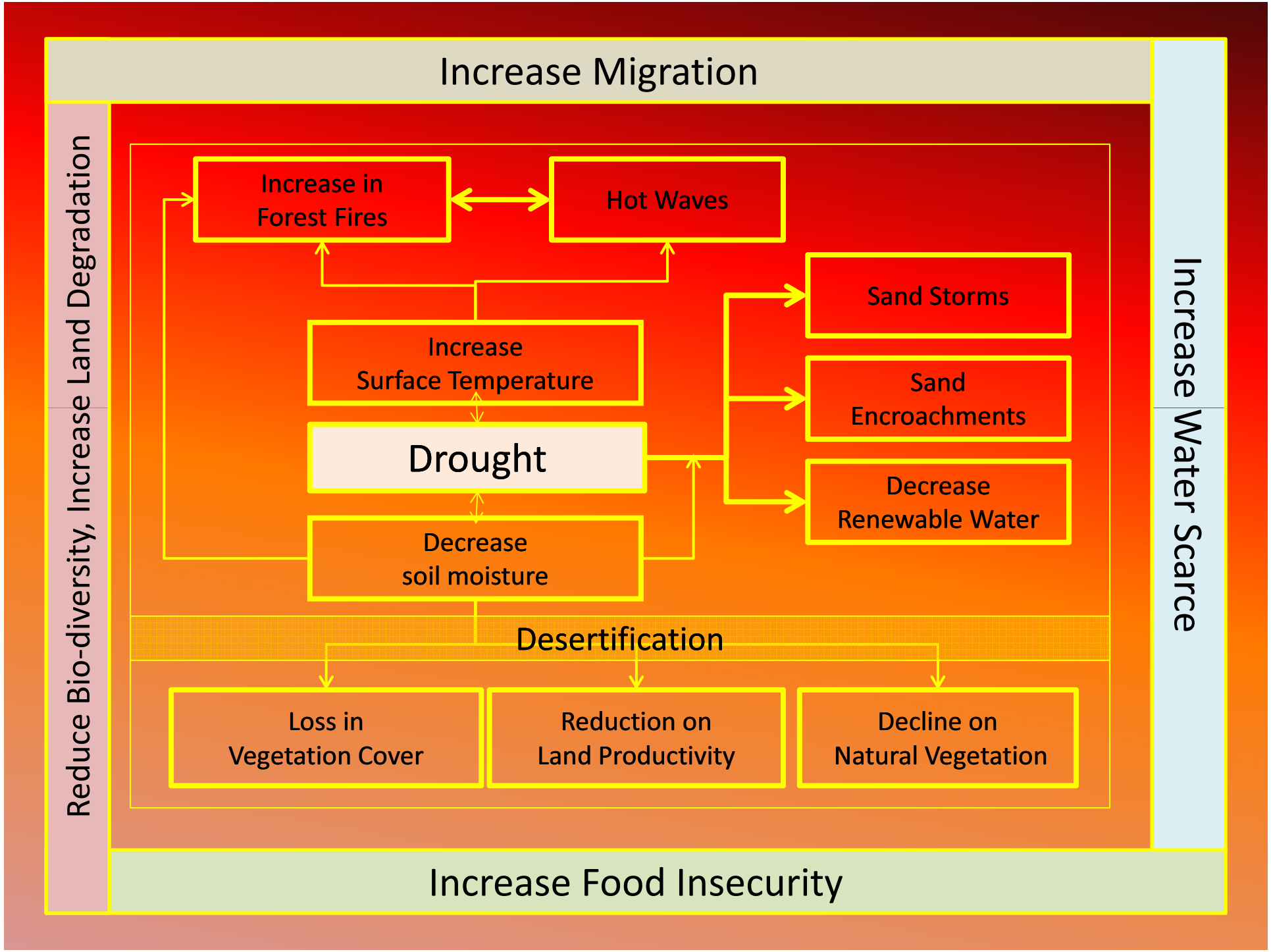
Vulnerability classes	Countries
High to Moderate Vulnerability: moderate coverage of ADH 45-60 %, moderate severity and very Low to low capacity	Somalia,
Moderate Vulnerability: high coverage of ADH 75 – 85%, moderate severity and moderate capacity	Morocco, Syria and (Kuwait, has a very low vegetation cover).
Moderate Vulnerability: high to moderate coverage of ADH 60-75 %, moderate severity and high to moderate capacity	Tunisia, Djibouti, and Iraq
Moderate to Low Vulnerability: very high coverage of ADH >85 %, high severity and very high capacity	Lebanon (Qatar, has a very low vegetation cover)
Moderate to Low Vulnerability: moderate to low coverage ADH 30-45 %, moderate to low severity and moderate to low capacity	Sudan, Saudi Arabia and UAE (UAE has a very low vegetation cover).
Low Vulnerability: low coverage of ADH 15-30 %, low severity and high to moderate capacity	Jordan, Yemen, Mauritania, Algeria, Libya, and Oman,
Low Vulnerability: low coverage of ADH 15-30 %, low severity and low capacity	Egypt,

DROUGHT RISK – LOSSES

RISK

AGRICULTURAL DROUGHT SOCIO ECONOMICA LOSSES

AVAILABLE STATISTICAL DATA ANALYSIS


Increase Migration
Reduce Bio-diversity, Increase Land Degradation
Increase Water Scarce
Increase in Forest Fires
Hot Waves
Increase 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

Affected Population in Arab Region

Total	Affected Population		Level of Affection					
population	Total		Highly		Moderately		Slightly	
Million Person	M. Person	%	M. Person	%	M. Person	%	M Person	%
350	188	54	26	7	65	19	97	28

Country	HAZARD COVERAGE AND SEVERITY in %				AFFECTED VEGETATION LAND USE			
	ADH coverage	ADH severity	LD coverage	LD severity	Forest	Rangelands	Rainfed	Total
Lebanon	**89.62**	**39.83**	9.5	7.1	1.07	18.32	63.45	82.84
Gaza Strip	**89.6**	**44.78**	**69.2**	**56.7**				
Qatar	**86.37**	**51.49**	**45.9**	**13.3**		0.41	0.09	0.5
Morocco	**84.22**	**34.04**	**14.5**	**3.6**	0.22	17.6	22.28	40.1
Kuwait	**83.12**	**73.83**	**83**	**44.7**		0.17	0.09	0.26
West Bank	**80.99**	**23.76**	**37.5**	**26.2**		22.04	47.52	69.56
Syria	**79.79**	**49.89**	**63.1**	**51.6**	0.23	16.77	19.64	36.64
Tunisia	**69.8**	**30.77**	**27.3**	**13**	0.34	10.52	13.49	24.35
Iraq	**68.87**	**49.26**	**64.1**	**51**	0.02	13.43	8.29	21.74
Djibouti	**68.33**	**47.82**	**82.2**	**69.3**		19.69	0.05	19.74
Somalia	**56.53**	**52.57**	**50.2**	**39.1**	0.11	37.47	11.04	48.62
Saudi Arabia	**39.71**	**15.59**	**68.7**	**28.9**	0	0.47	0.14	0.61
U. A. Emirates	**39.68**	**6.83**	**35.3**	**6**		0.13	0.1	0.23
Sudan	**33.3**	**14.95**	**47.4**	**26.7**	0.61	**16.05**	**7.1**	**23.76**
Yemen	**29.46**	**13.67**	**46.3**	**20.4**	0	2.32	0.99	3.31
Jordan	**28.73**	**10.09**	**29.1**	**9.3**		**33.2**	**25.13**	**58.33**
Algeria	**25.52**	**12.75**	**40.5**	**2.9**	0.1	3.8	3.6	7.5
Mauritania	**24.77**	**10.64**	**36.9**	**8.9**		8.73	2.01	10.74
Oman	**19.43**	**3.58**	**38**	**9.5**	0.01	0.55	0.17	0.73
Libya	**16.8**	**3.46**	**45.8**	**6.2**		0.62	0.22	0.84
Egypt	**15.9**	**3.98**	**47.3**	**10.7**		0.1	0.23	0.33

AFFECTED AGRICULTURE AREAS

Land Use	Area in million Ha	Affected Areas %
Rangelands	205	19%
Rainfed	65	9%

CROP(s) LOSSES

Country	Duration	Potatoes		Wheat		Maize		Sorghum		Millet		Crops Total Losses	
	1999-2011	Million		Million		Million		Million		Million			
		Ton	US$	Ton	US$	Ton	US$	Ton	US$	Ton	US$	Million Ton	Million US$
Morocco	Million Ton	1.37	411.6	3.91	1171.64							1588.52	
	Million US$	-0.91	-271.61	-8.73	-2620.12								-2901.37
Egypt	Million Ton	2.6	779.09	7.27	2182.11							2971.07	
	Million US$	-3.81	-1143.8	-3.93	-1177.73								-2329.27
Algeria	Million Ton	1.85	555.56	2.17	651.32							1210.9	
	Million US$	-3.25	-974.34	-2.91	-873.87								-1854.37
Syria	Million Ton	0.57	171.54	3.94	1183.34							1359.39	
	Million US$	-0.45	-136.34	-5	-1500.34								-1642.13
Iraq	Million Ton	0.68	205.37	1.88	563.85							771.78	
	Million US$	-0.68	-203.43	-2.91	-872								-1079.02
Saudi Arabia	Million Ton	0.41	121.74	2.16	648.17			0.24	18.11			790.83	
	Million US$	-0.32	-97.2	-2.61	-782.98			-0.1	-7.8				-891.01
Tunisia	Million Ton	0.34	100.85	1.27	379.83							482.29	
	Million US$	-0.16	-47.75	-2.22	-666.78								-716.91
Lebanon	Million Ton	0.43	128.85	0.14	41.19							170.61	
	Million US$	-0.55	-165.54	-0.02	-5.49								-171.6
Yemen	Million Ton	0.23	69.77	0.16	47.79			0.38	28.33			146.66	
	Million US$	-0.16	-49.24	-0.24	-71.79			-0.49	-36.4				-158.32
Libya	Million Ton	0.24	72.91									73.15	
	Million US$	-0.33	-99.97										-100.3
Jordon	Million Ton	0.13	38.77									38.9	
	Million US$	-0.17	-49.8										-49.97
Somalia	Million Ton					0.19	13.92	0.12	8.9			46.21	
	Million US$					-0.4	-29.9	-0.13	-9.99				-49.45
Mauritania	Million Ton	0.01	4.34			0.02	1.15	0.07	5.56	0.01	0.46	11.62	
	Million US$	-0.01	-3.58			-0.01	-0.62	-0.12	-8.99	0	-0.14		-13.47
Oman	Million Ton	0.02	4.89					0.02	1.37			6.3	
	Million US$	-0.02	-5.47					-0.06	-4.41				-9.96
Kuwait	Million Ton	0.02	6.84									6.86	
	Million US$	-0.02	-5.48										-5.5
TOTAL												9675.09	-11972.7

Erian 2013, Estimated Agriculture (**Crops and Rangelands**) drough and Land Degradation t direct and indirect losses of about …….

US$ 2.2 billion annually

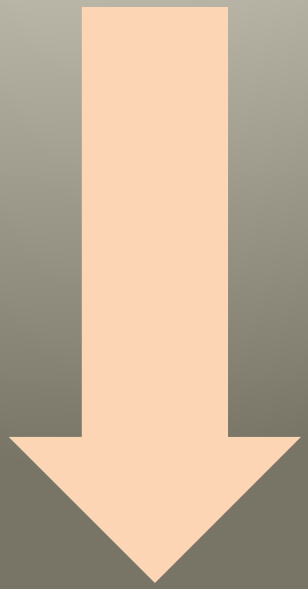
during the period from 2000-2010,

"The Arab awakening was driven not only by political and economic stresses, but, less visibly, by environmental, population and climate stresses as well. If we focus only on the former and not the latter, we will never be able to help stabilize these societies."

On Going Activity

Drought

GAR 13

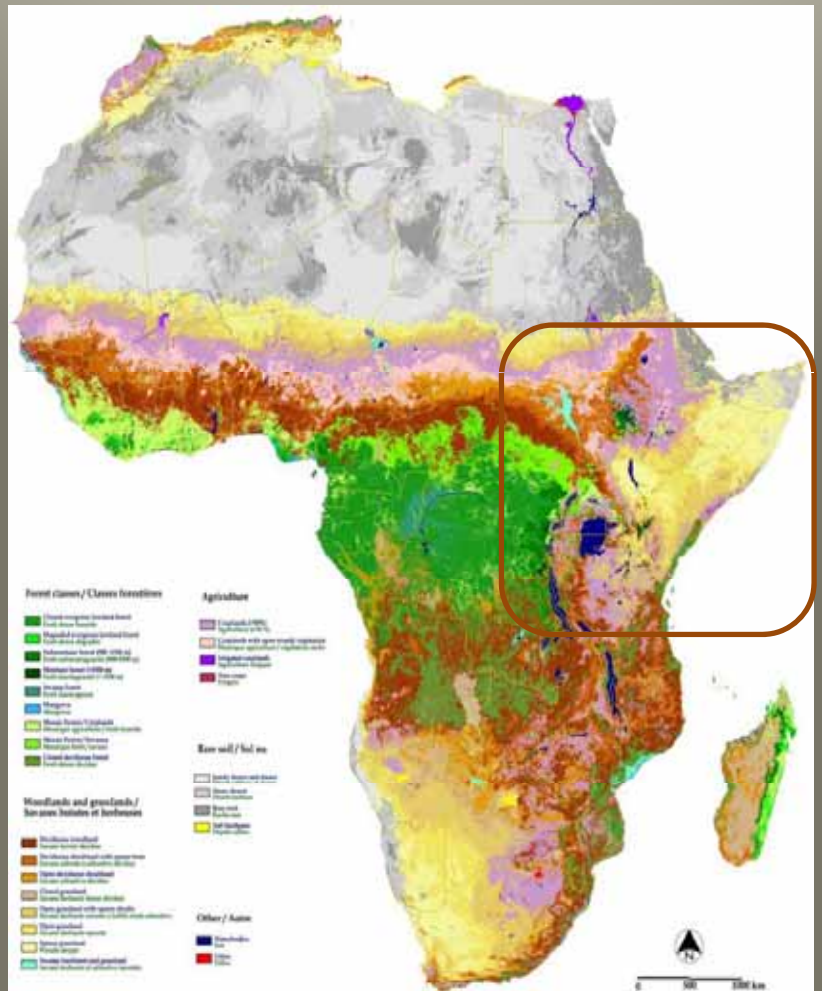


GAR 15

Hazard

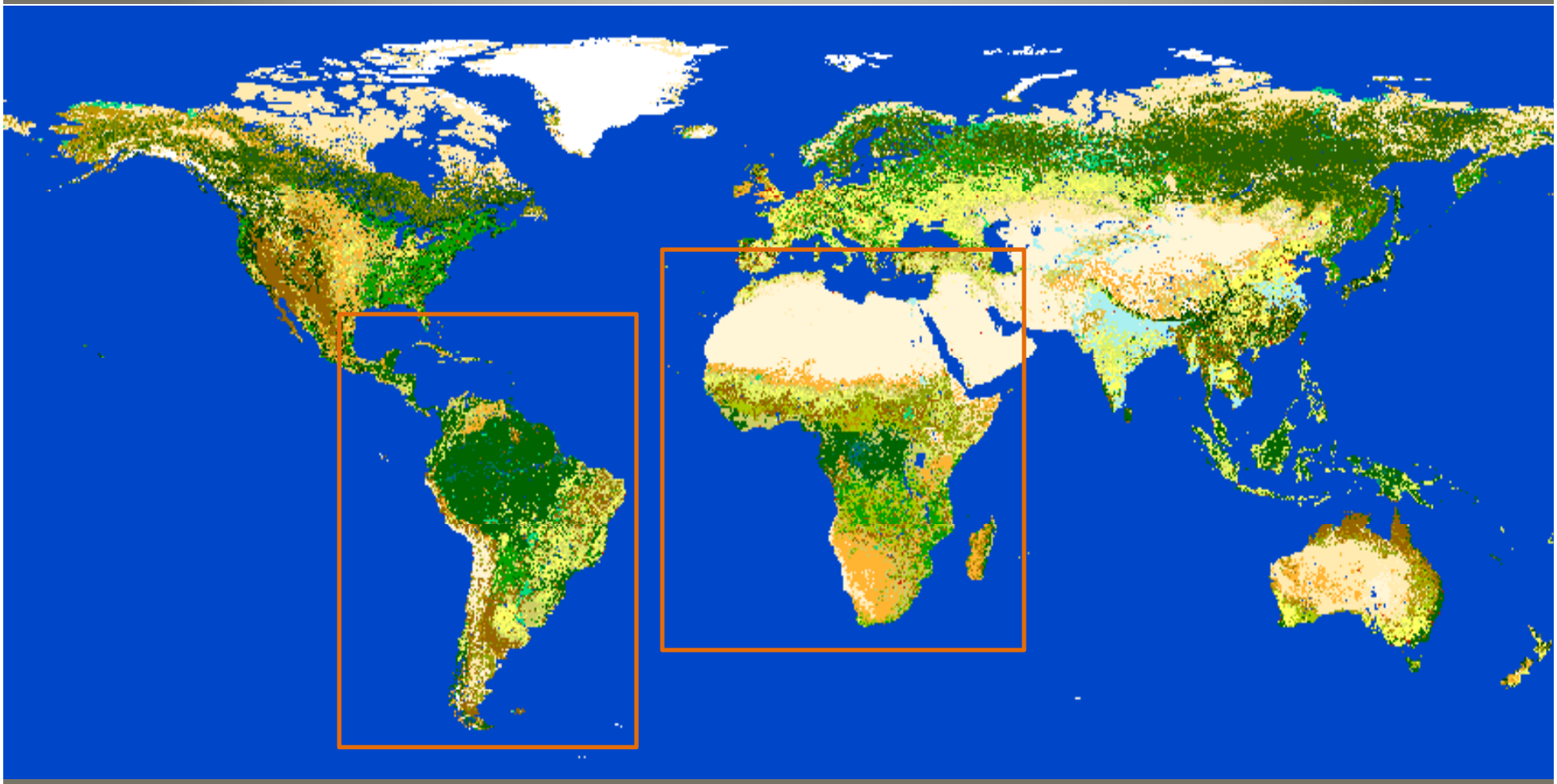
Correlation between drought and yield

Losses

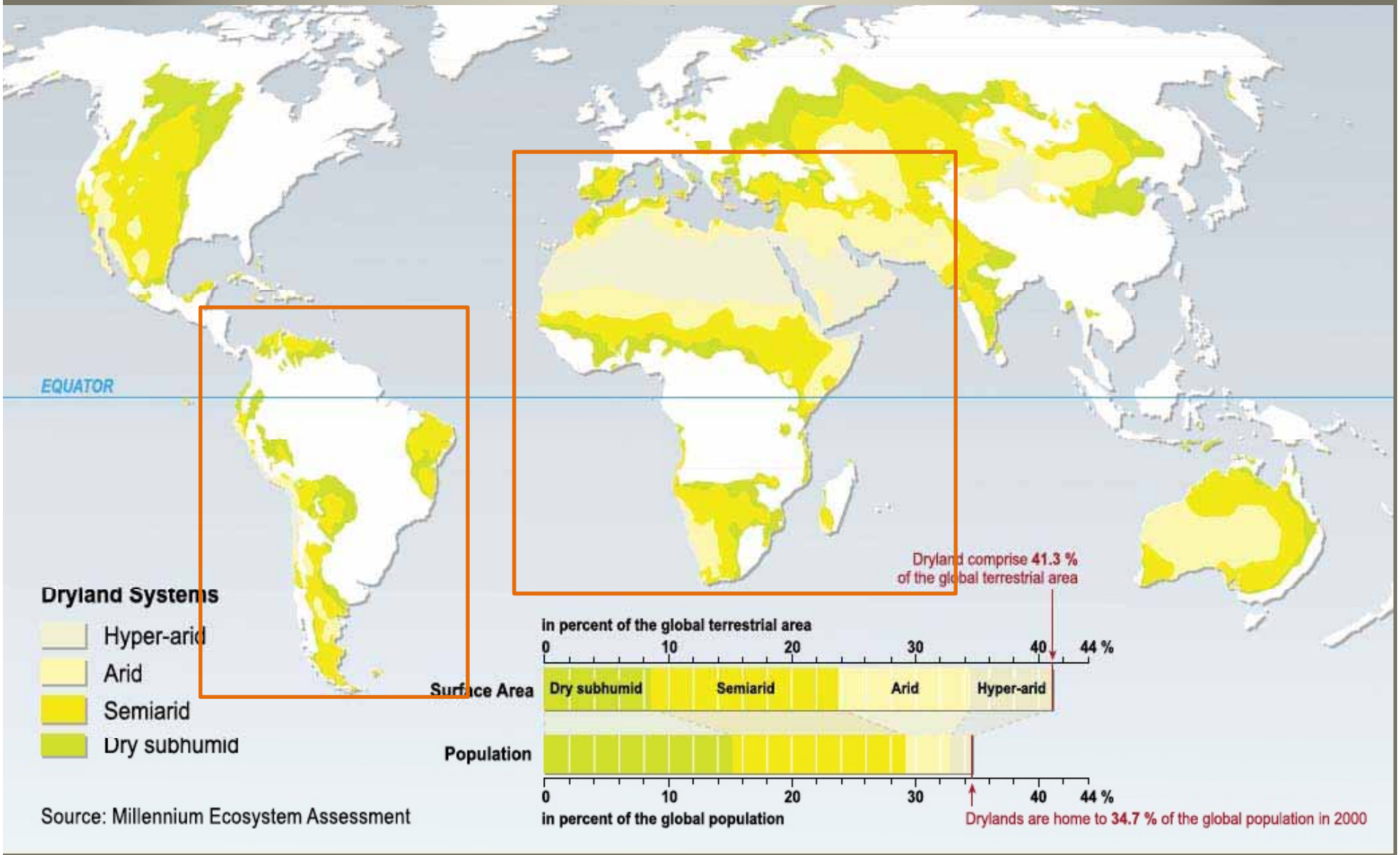


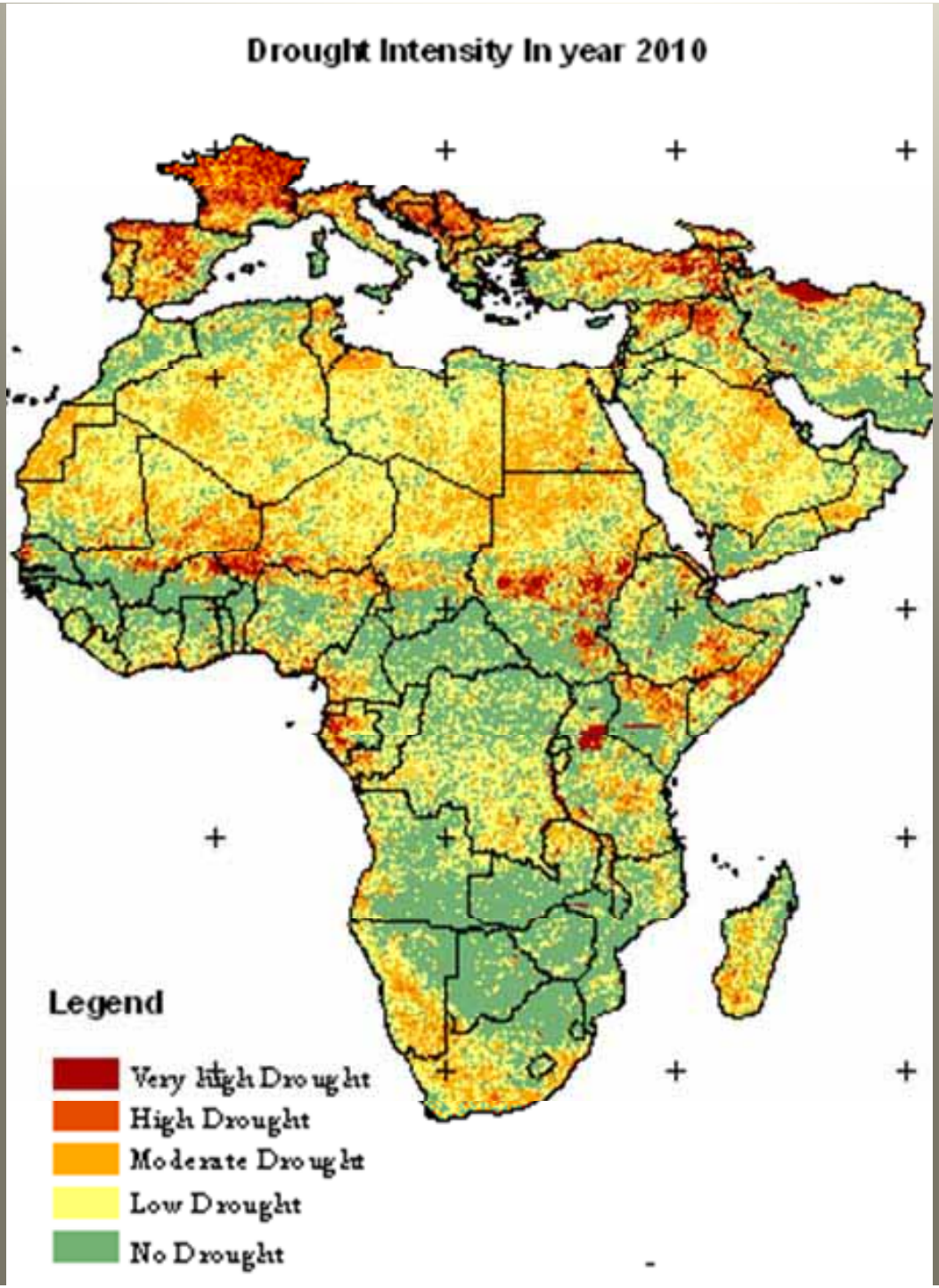
Characterizing
Drought in different Land Cover Classes

2

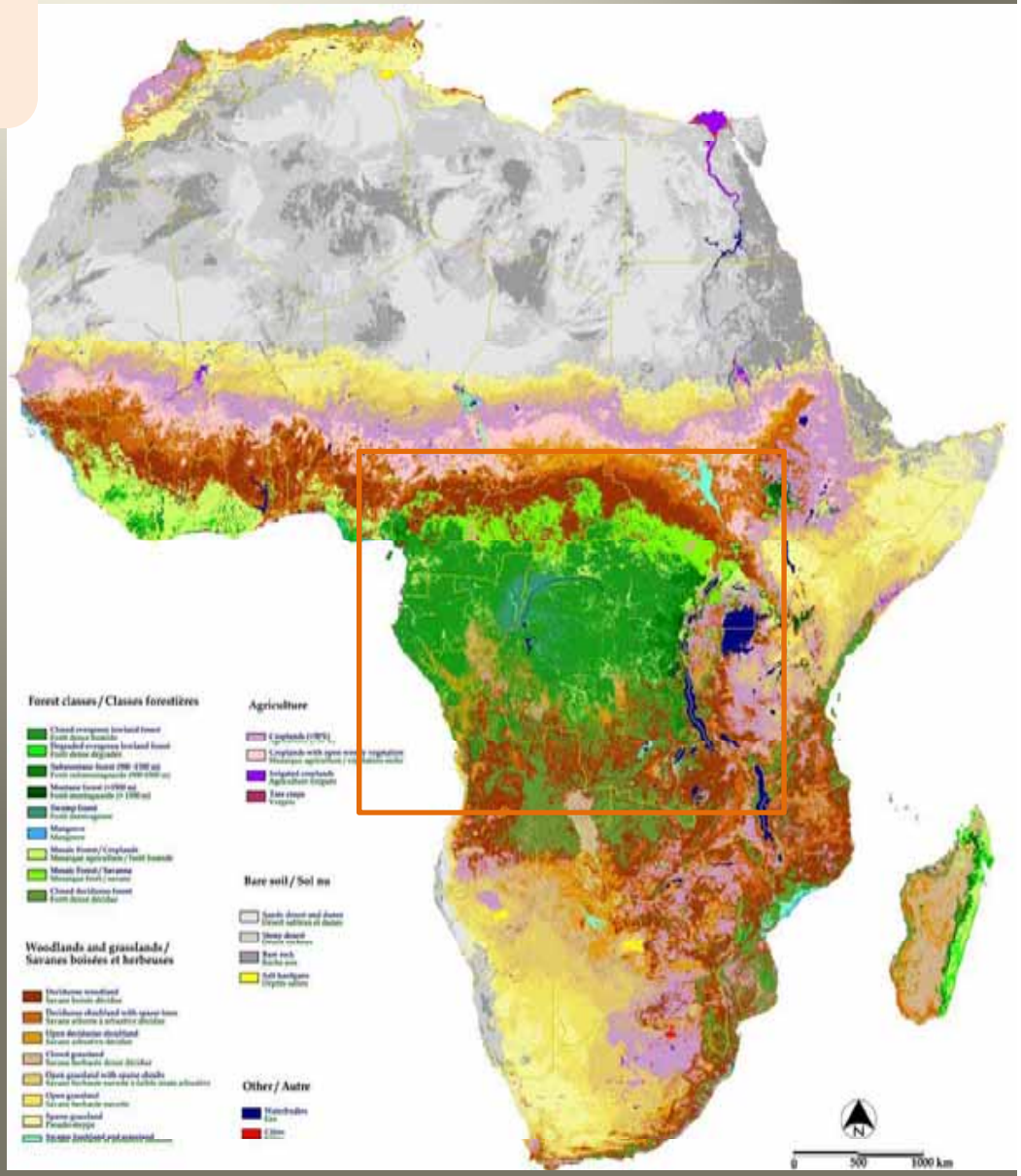


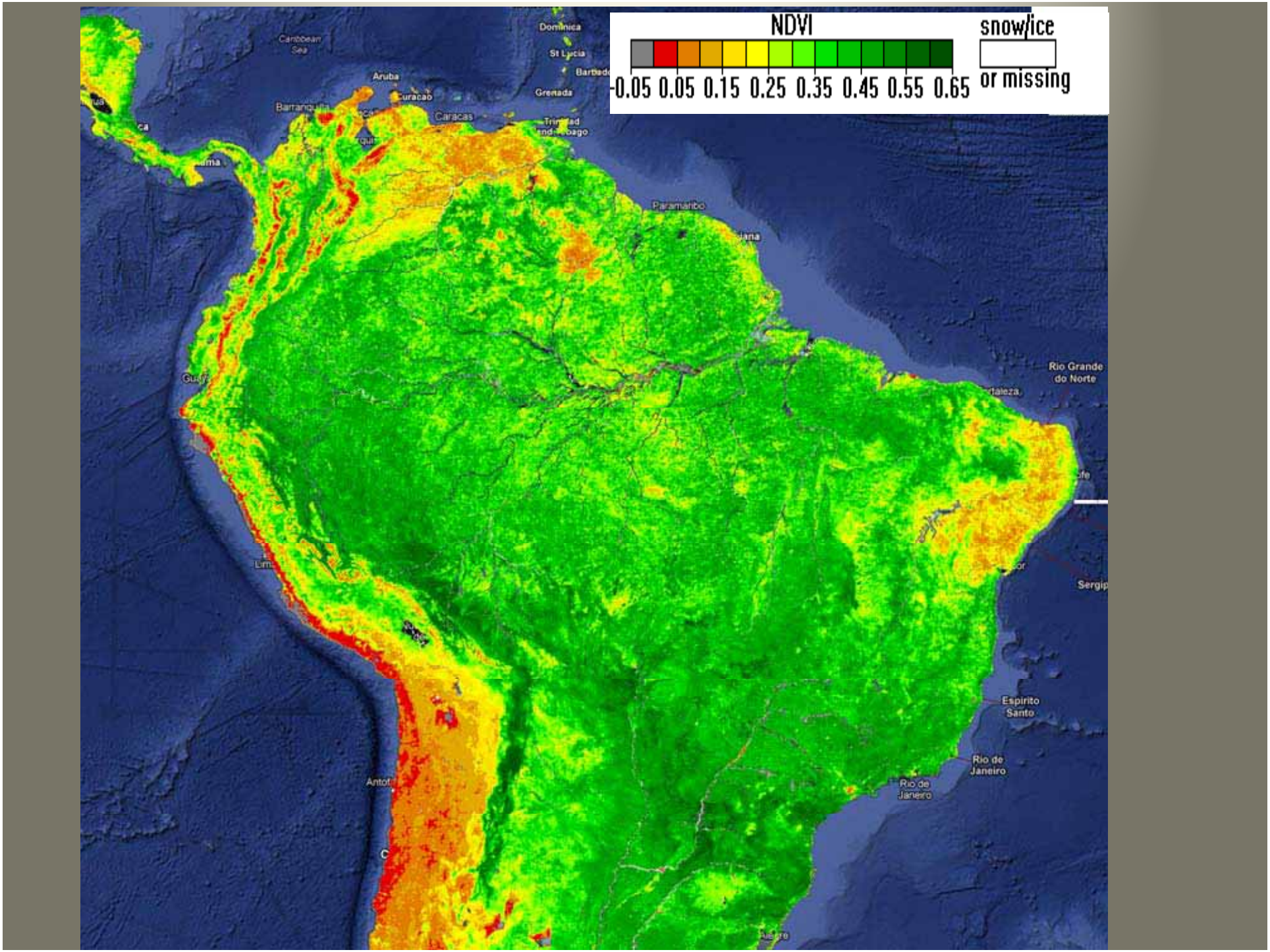
a. Drought in Dry Lands

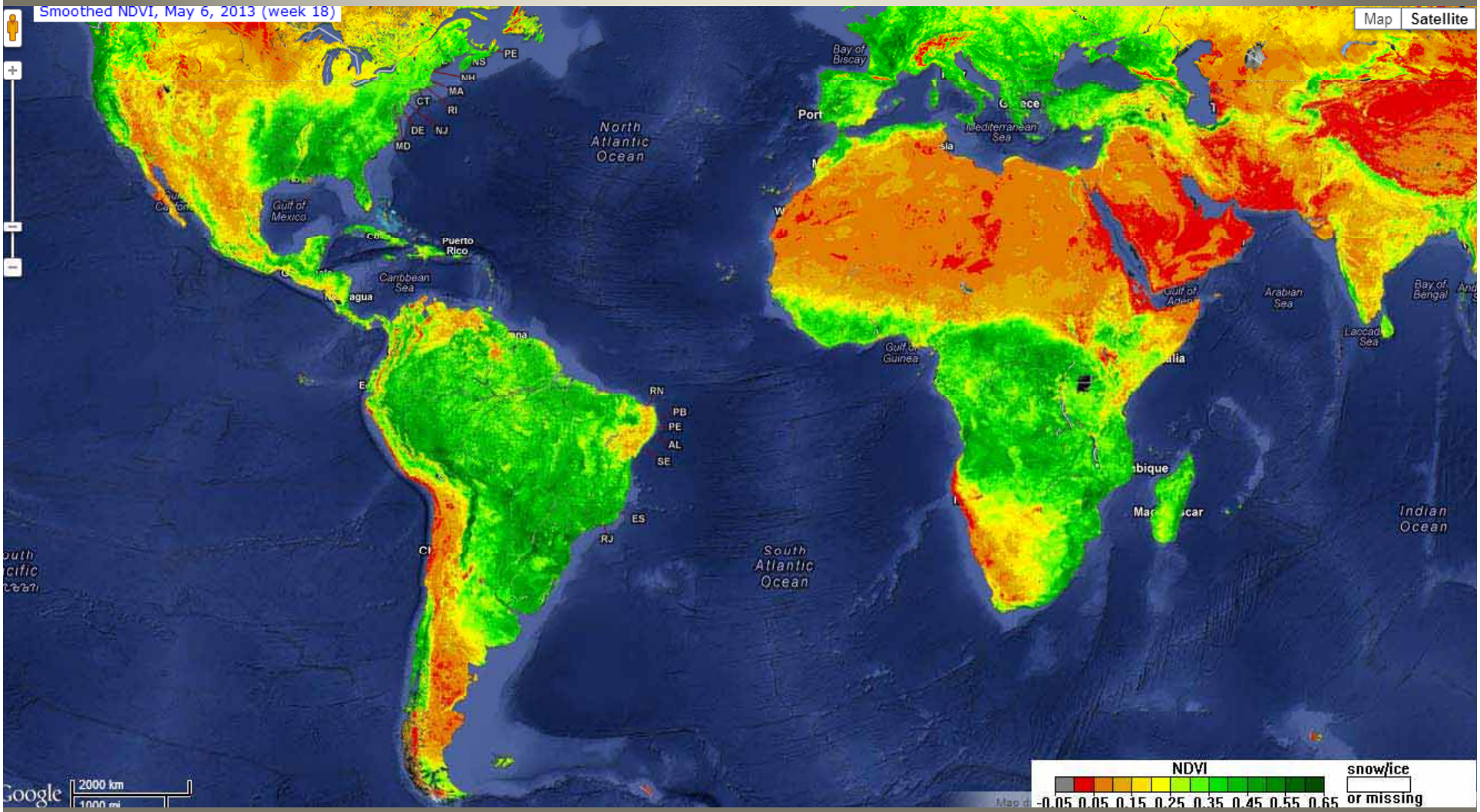


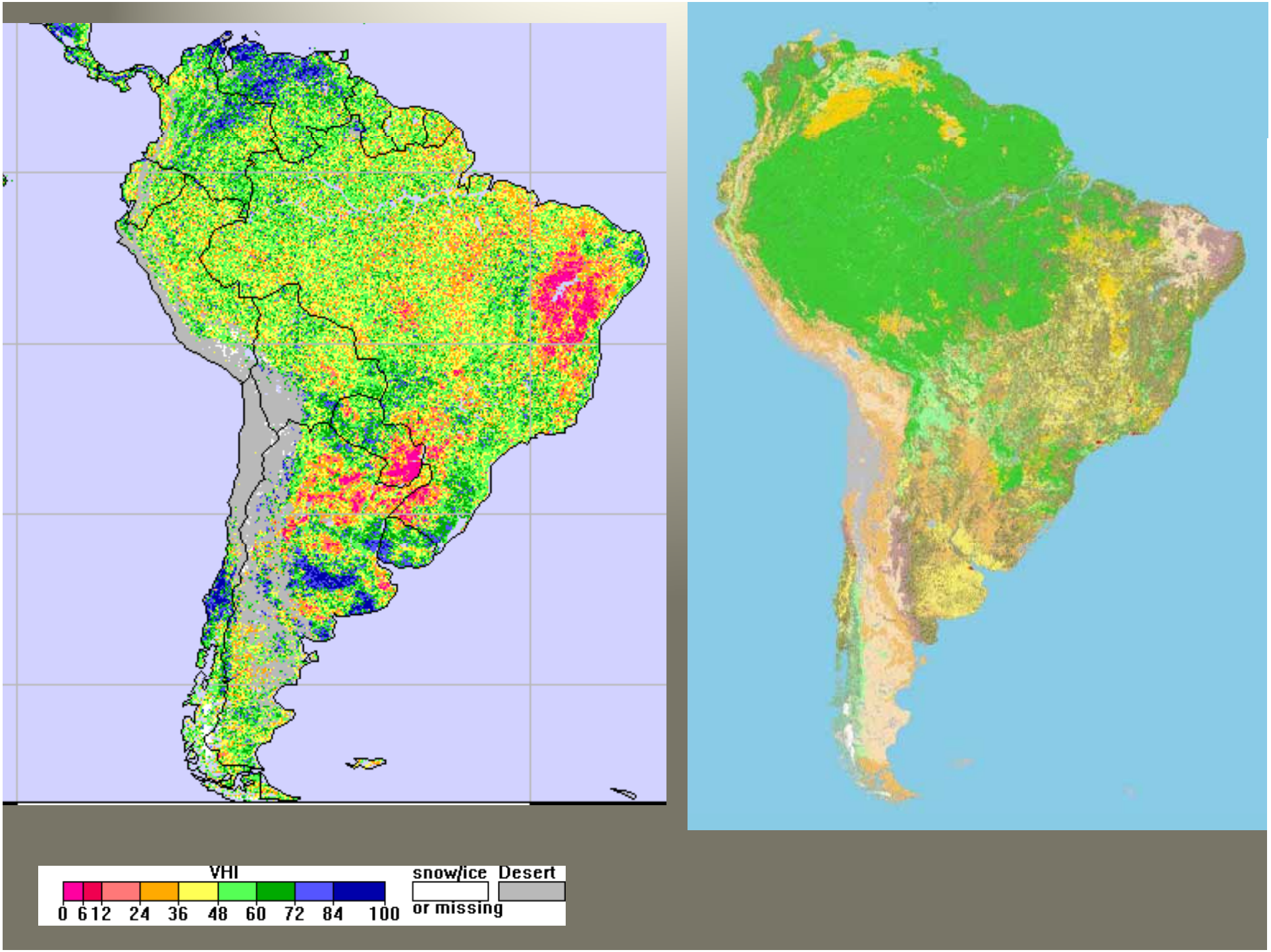

Drought Intensity In year 2010
Legend
Very High Drought
High Drought
Moderate Drought
Low Drought
No Drought

b. Drought in Basins




NDVI
-0.05 0.05 0.15 0.25 0.35 0.45 0.55 0.65
snow/ice
or missing
Caribbean Sea
Dominica
St Lucia
Aruba
Curacao
Grenada
Caracas
Paramaribo
Rio Grande do Norte
Espirito Santo
Rio de Janeiro
Rio de Janeiro


Smoothed NDVI, May 6, 2013 (week 18)
Map
Satellite
North Atlantic Ocean
South Atlantic Ocean
Indian Ocean
Gulf of Mexico
Caribbean Sea
Puerto Rico
Bay of Biscay
Mediterranean Sea
Gulf of Guinea
Arabian Sea
Bay of Bengal
Laccadive Sea
PE
NS
NH
MA
CT
RI
DE
NJ
MD
RN
PB
PE
AL
SE
ES
RJ
NDVI
-0.05 0.05 0.15 0.25 0.35 0.45 0.55 0.65
snow/ice
or missing
Google
2000 km


VHI
0 6 12 24 36 48 60 72 84 100
snow/ice
Desert
or missing

ACSAD

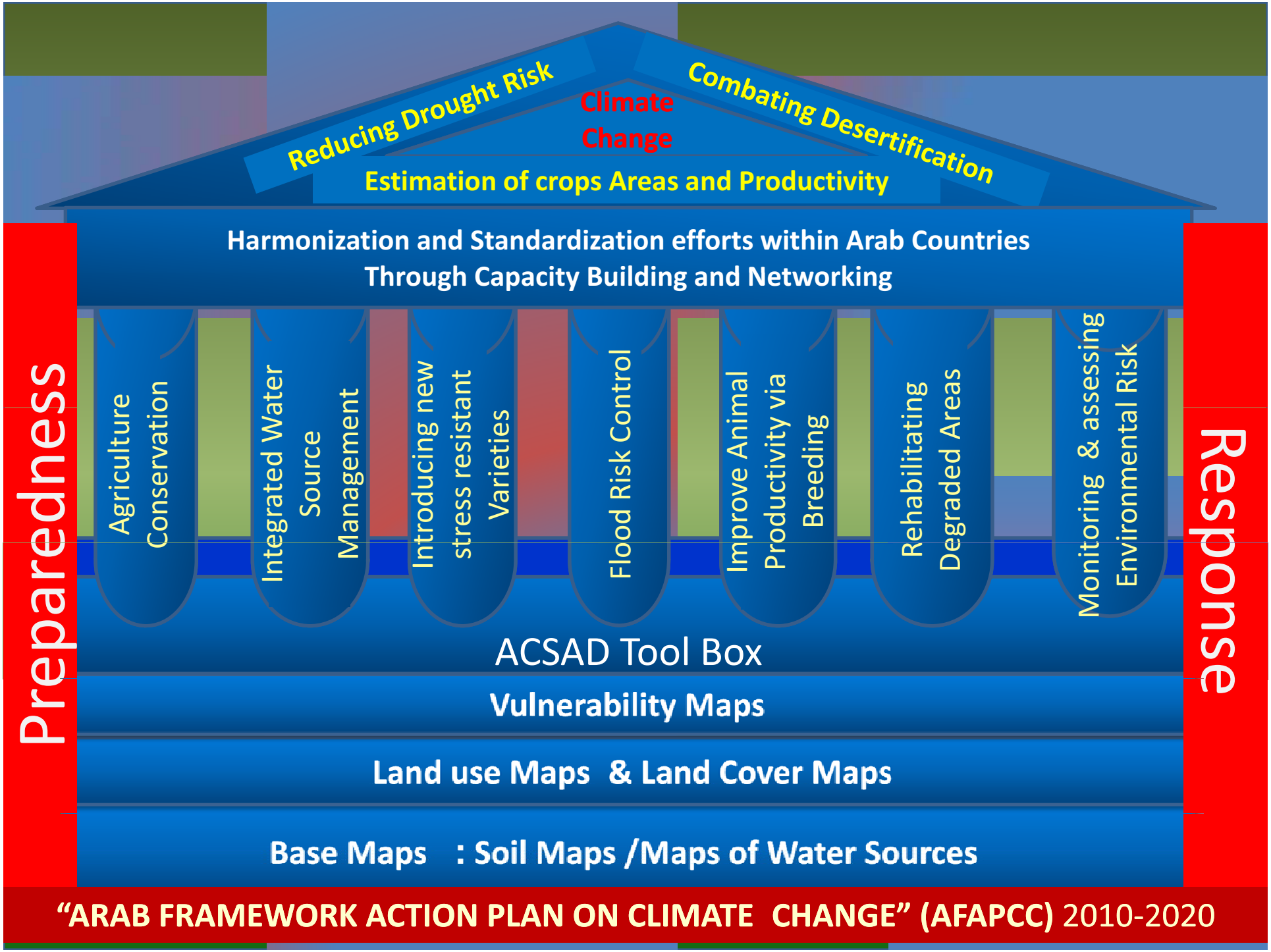
ACSAD is a specialized Arab organization working within the framework of the League of Arab States

with the objective of unifying the Arab efforts which aims at

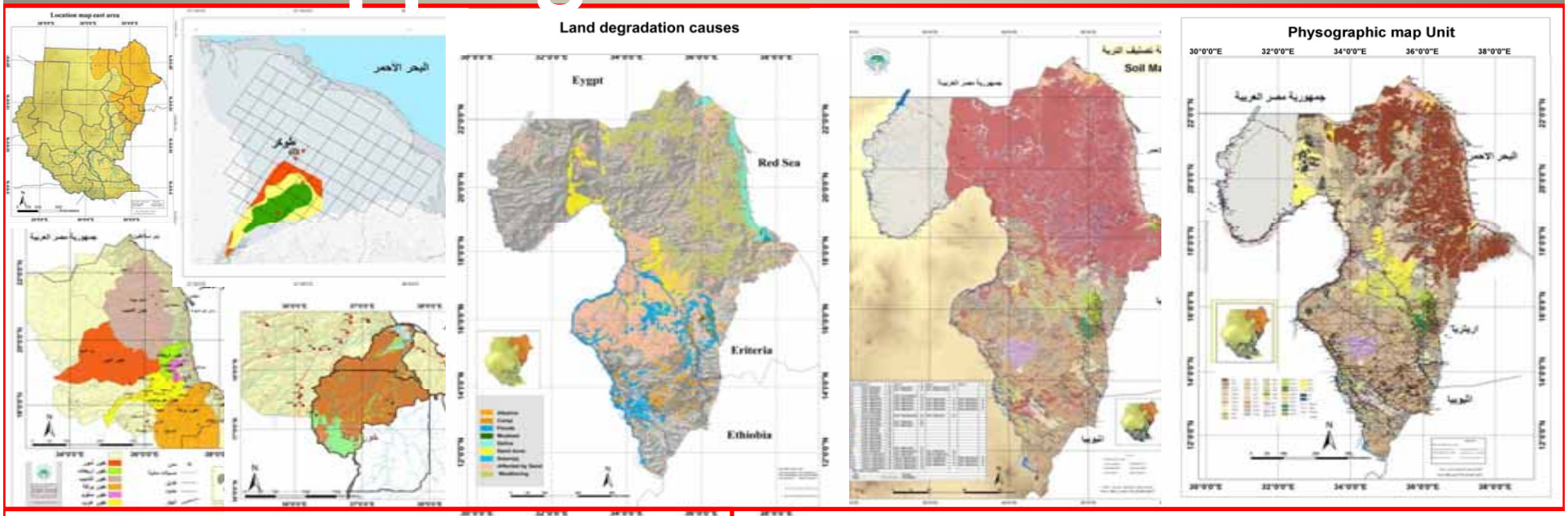
www.acsad.org

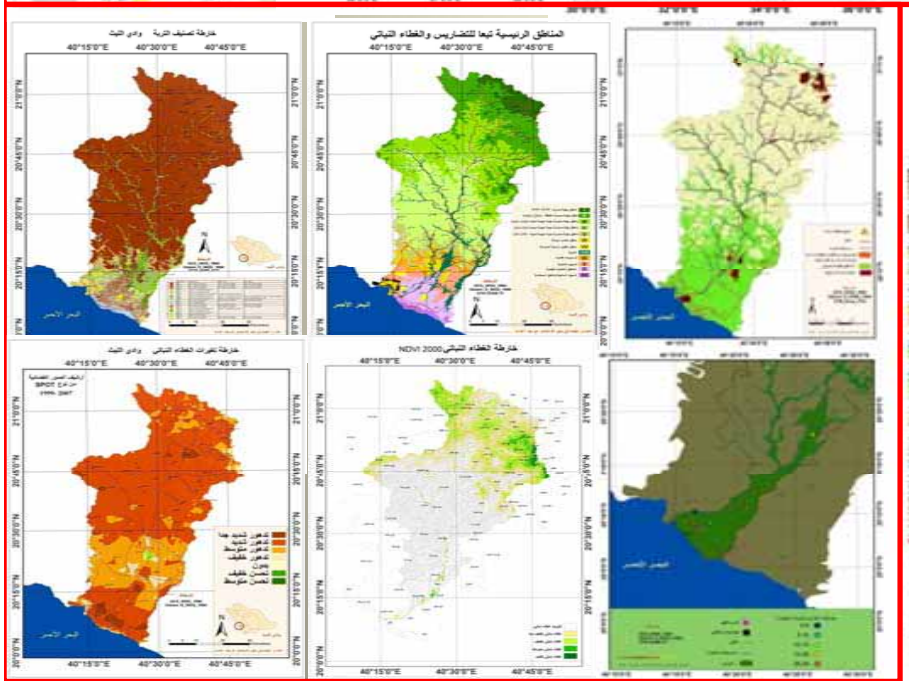
- **develop the scientific agricultural research in the arid and semi-arid areas,**
- **help in the exchange of information and experiences**
- **make use of the scientific progress and the modern agricultural techniques in order to increase the agricultural production.**

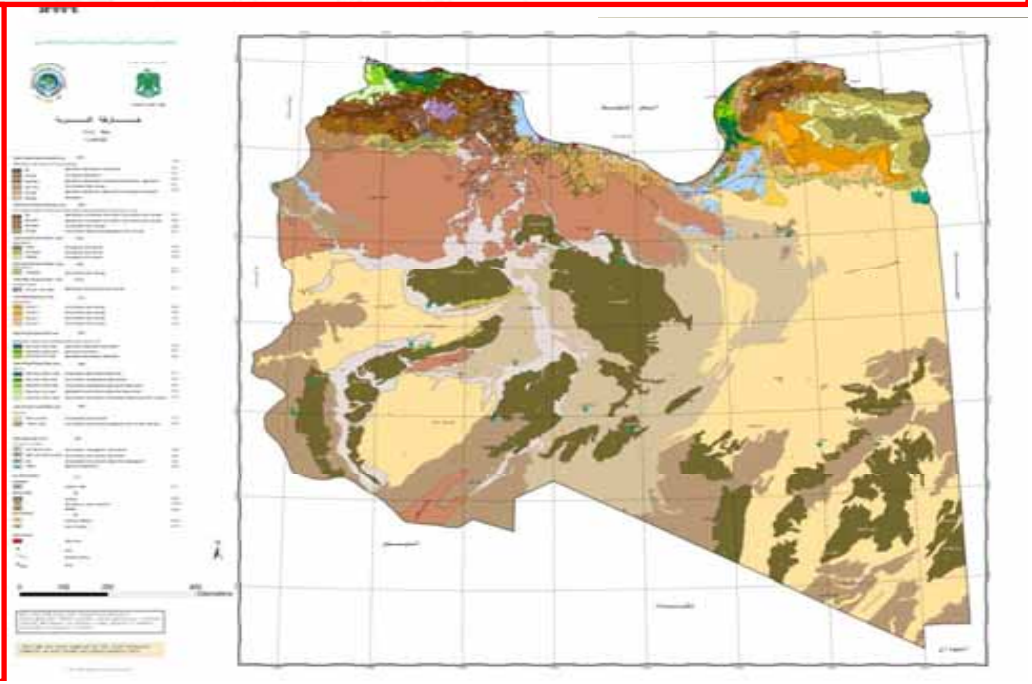
The Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD) established in Damascus, Syria in 1968.


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
Preparedness
Response
Agriculture Conservation
Integrated Water Source Management
Introducing new stress resistant Varieties
Flood Risk Control
Improve Animal Productivity via Breeding
Rehabilitating Degraded Areas
Monitoring & assessing Environmental Risk
ACSAD Tool Box
Vulnerability Maps
Land use Maps & Land Cover Maps
Base Maps : Soil Maps /Maps of Water Sources
"ARAB FRAMEWORK ACTION PLAN ON CLIMATE CHANGE" (AFAPCC) 2010-2020

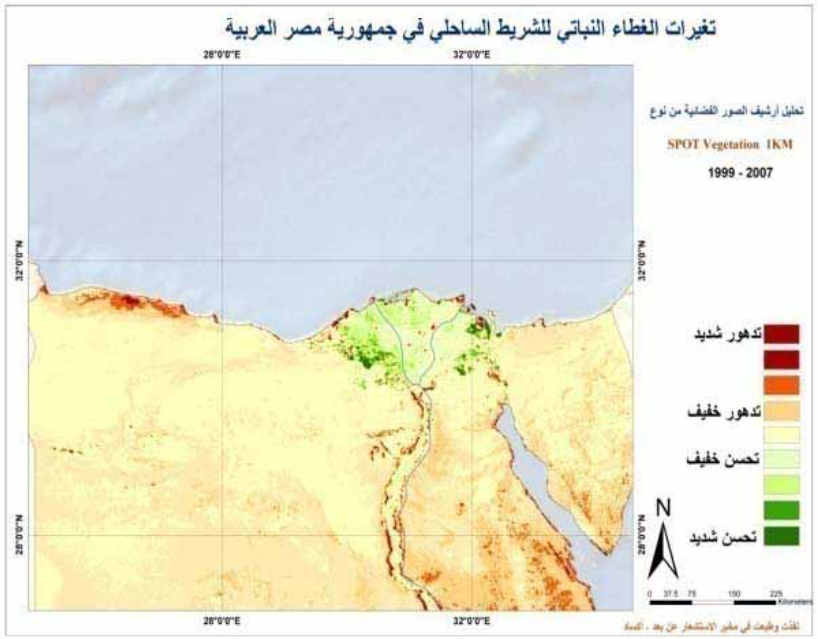
Mapping Nature Recourses

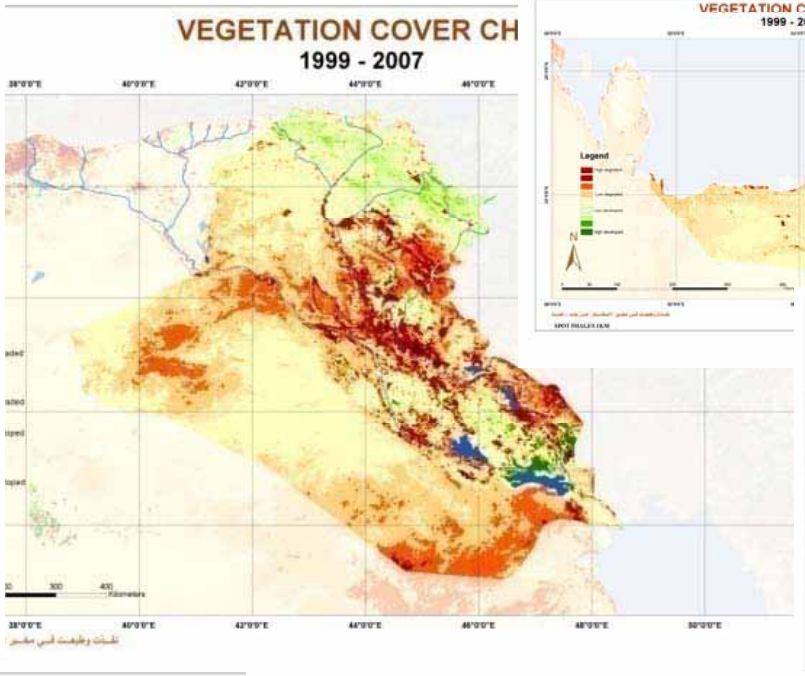


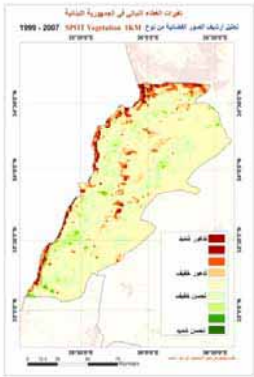




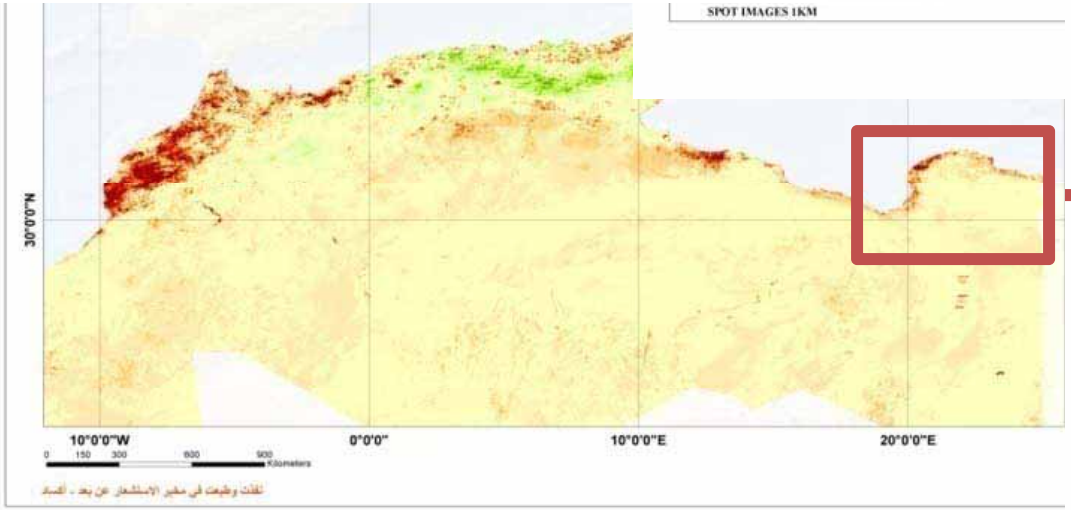
Mapping Risk Areas

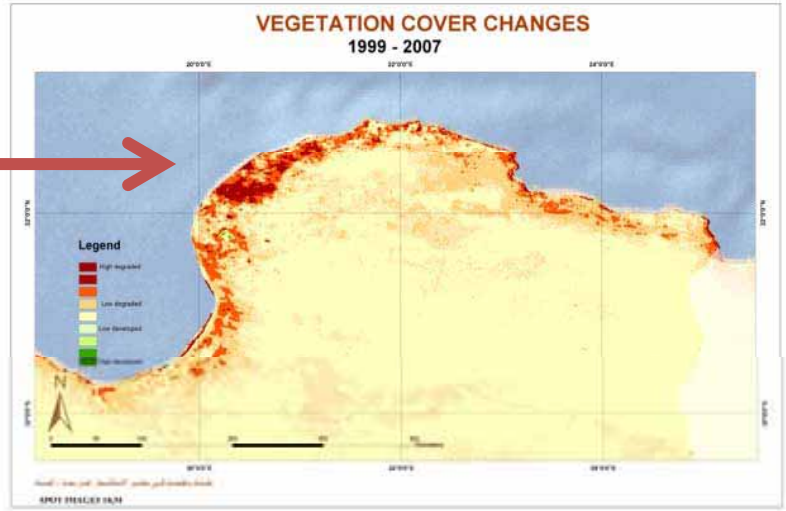






SPOT IMAGES 1KM

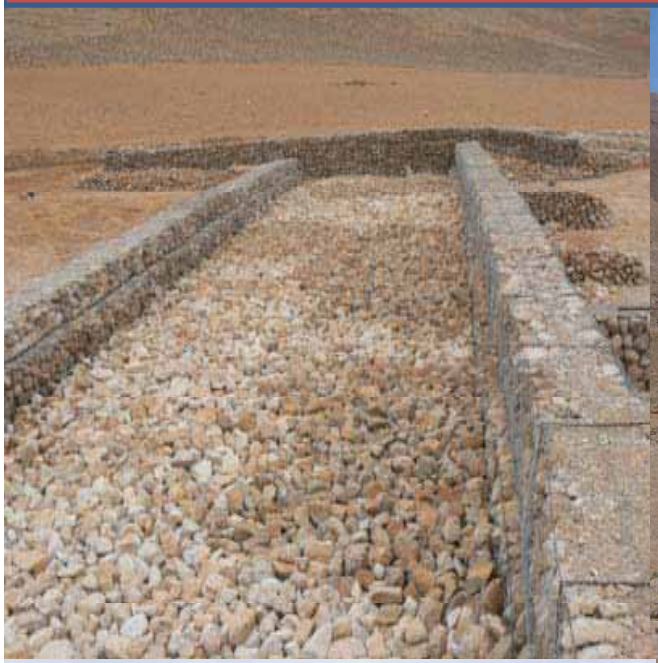




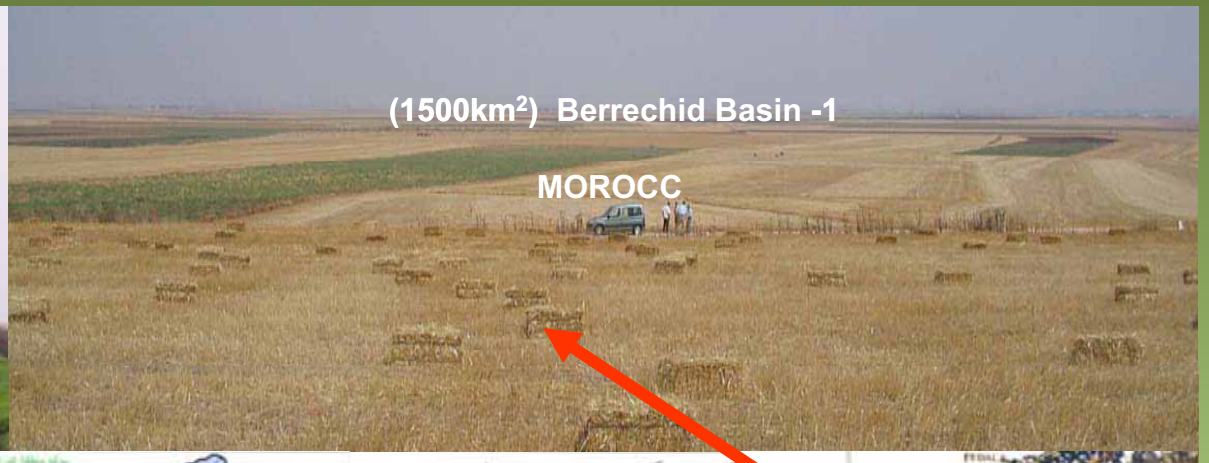
Introduce new Varity of Seeds
Tolerant to Drought, Heat , Salinity and Diseases

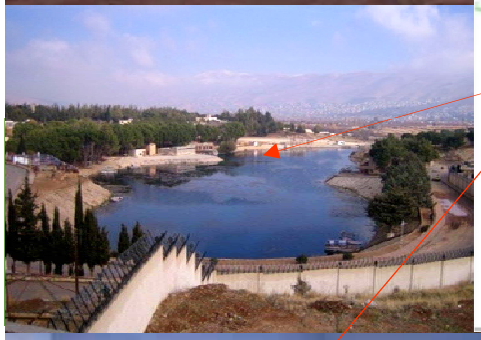
Water Harvesting, Supplementary Irrigation, Rehabilitating Depredated Areas

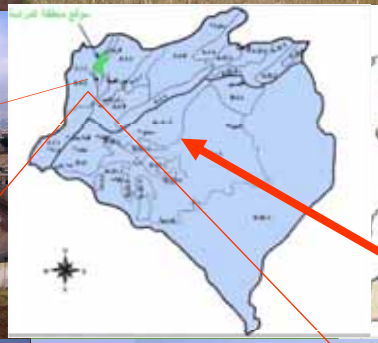
Floods Control

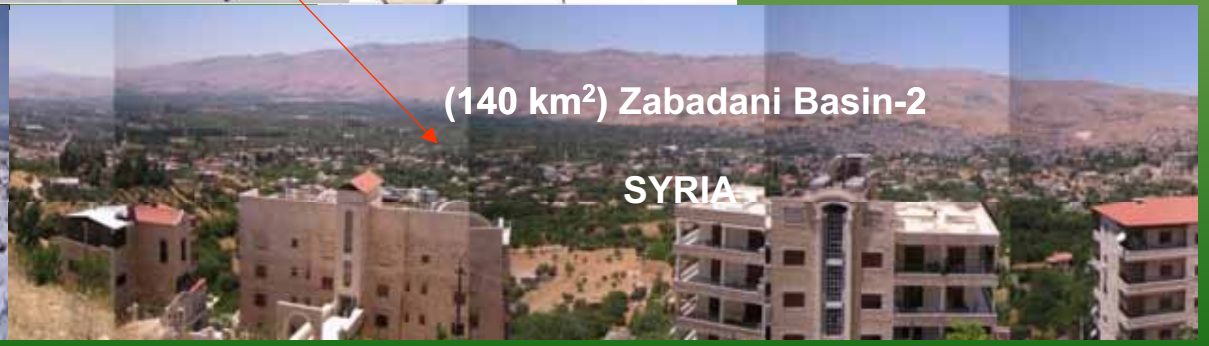


Integrated Water Management System





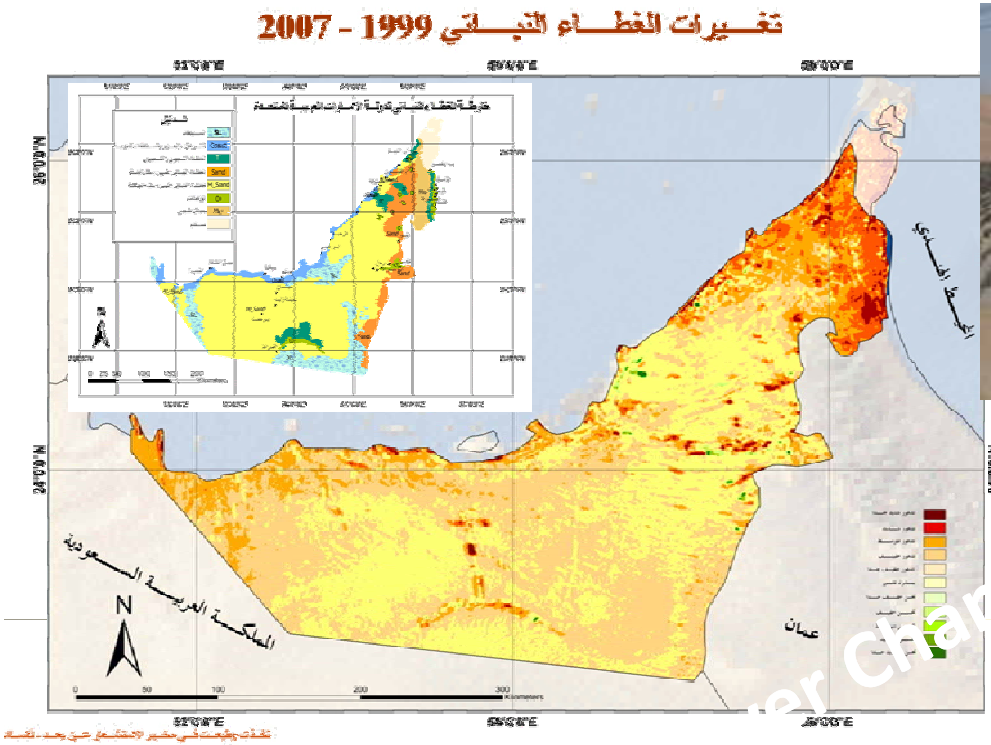


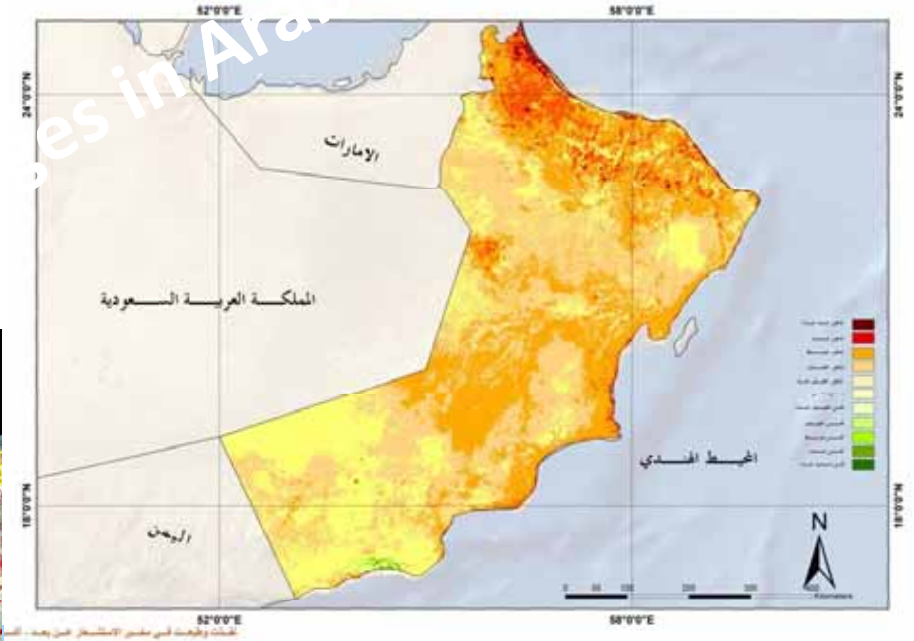


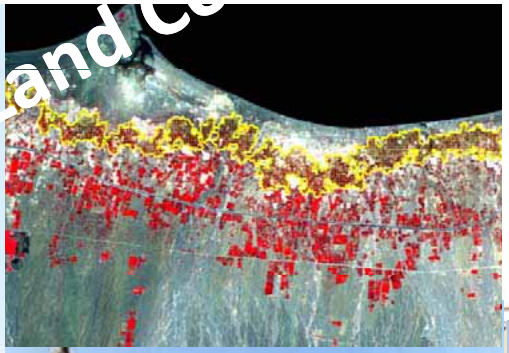
Use of non-traditional Water and Increase Irrigation Efficiency

Sustainable Land Management

- Land Use Mapping ،
- Conservation Agriculture
- Manure and organic solid waste recycling
- Crop Rotation.





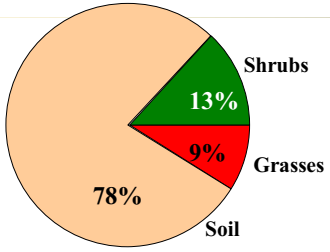


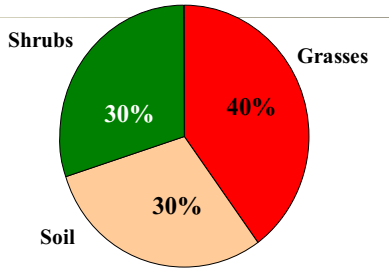
Syrian Badia/ steppe, Thulaithowat area; highly degraded rangeland

Vegetative density in protect area and unprotected area

Following a participatory approach with the local population.

Development of plant cover (%) at the pilot site, 10 years after rehabilitation





MONITORING AND COMBATING DESERTIFICATION IN THE JORDANIAN STEPPE

Before Rehabilitation 1999

After Rehabilitation 2004

Sorrah protected Area 2005

CHANGE ITEMS	2000	2005
No. of Species	31	50
Veg. Coverage(%)	46	63
Grazing Productivity (kg/ha)	125	572
Grazing Capacity (Sh. head/ha/180day)	0.46	2

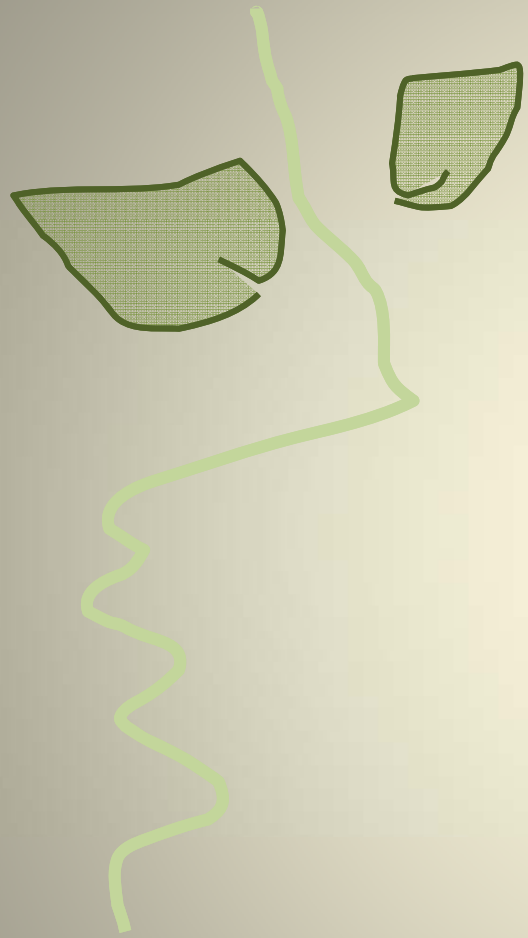

Sand Dunes and Sand sheets fixation

Improve Small Cartel Productivity

Training

- ACSAD was appointed by the league of Arab states to follow up and co-ordinate UNCCD activities in the Arab countries

ENVIRONMENTAL COOPERATION ASPA



Thank You

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A Bedouin woman uses water from an ICRC/SARC water truck.