

# **Risk Assessment and Mapping Using Earth Observation Data In Iran**

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# Different Types of Disasters in Iran

Drought  
Epidemic  
Earthquake  
Floods  
Mudflow  
Sand Storm  
Volcanic Eruption  
Tornado  
Wildfire  
Hailstorm  
Landslide

More than 90 percent of damages among all disasters in Iran

# Outline:

## Part (A)

- Iran
- A) Location
- B) Climate
- C) Drought History

## Part (B)

- The Important Activities involved in Major Aspects of Disaster Risk Management

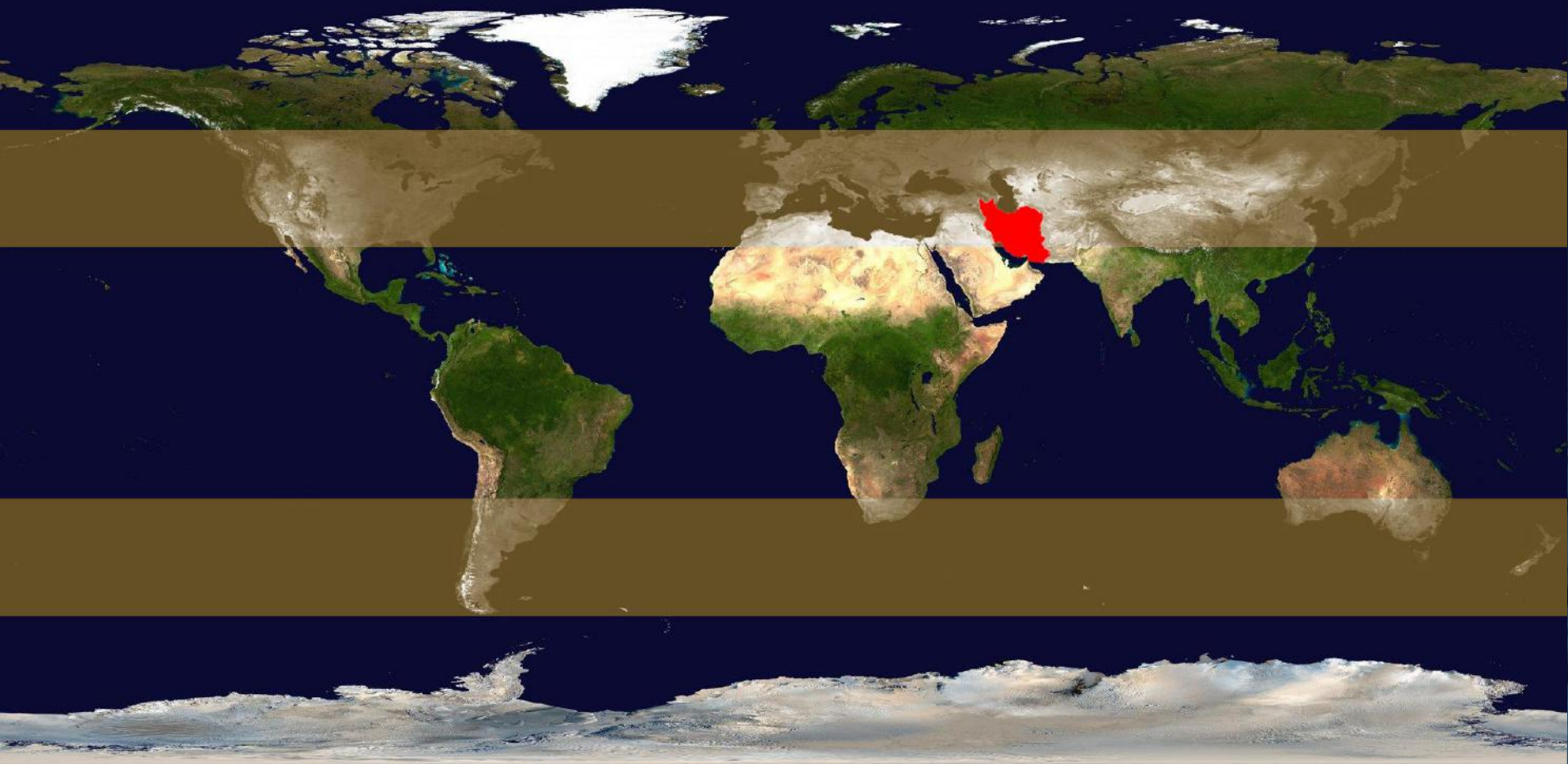
## Part (C)

- Drought Risk Assessment Activities and Projects in Iranian Space Agency
- A) Drought Monitoring
- B) Drought Prediction
- C) Drought Risk Mapping

# Iran Location:



# Iran Climate:






**Desert Belt of the World**

# Iran Climate:



Annual precipitation rate =240 mm (about one third of world average precipitation)

-  Caspian Mild
-  Mountains
-  Arid and semi arid

# Drought in Iran: History

## The most severe drought periods in Iran during last 60 years

1956-1958

1970-1973

1983-1984

1989-1991

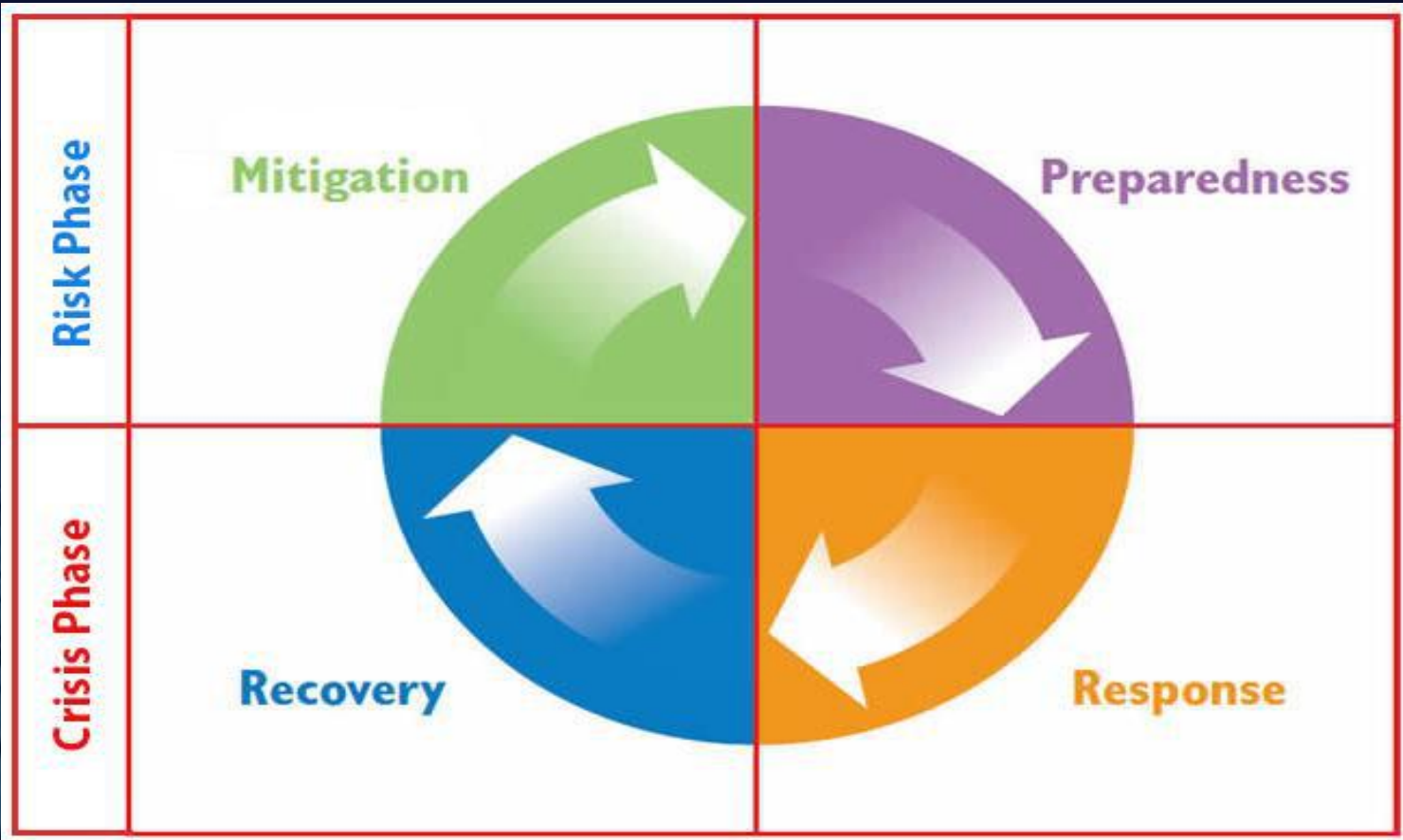
1998-2001

2008-2011

One Severe Drought  
in every 10 years

Total Damages=\$7.5 Billion  
Losing 800,000 head of livestock  
80 percent damages in annual cereal crops.

# The Important Activities involved in Major Aspects of disaster risk management



**Diagram of Disaster Management Phases**



## Mitigation:

### Aim:

To minimize or mitigate the consequences of impacts

## Preparedness:

### Aim:

Activities that reduce the degree of risk to human life and property.

## **The Examples of Activities in Mitigation Phase**

- Legislation
- Insurance Strategies
- Tax incentives and disincentives
- Land-use Management
- Risk mapping
- The development of technological solutions

## **The Examples of Activities in Preparedness Phase**

- Long-term activity: Disaster Prediction
- Short-term activity: Disaster warnings

# Projects & Activities in Drought Risk Assessment in Iranian Space Agency

- A) Drought Monitoring
- B) Drought Risk Mapping
- C) Drought Prediction



# **A) Drought Monitoring Phase:**

## **Inter-sensor Relationship Between MODIS and AVHRR Data for Monitoring Drought in Iran**

**Target:** Simulating MODIS Data for the period of 1995-2001

**Method:** Regression Modeling

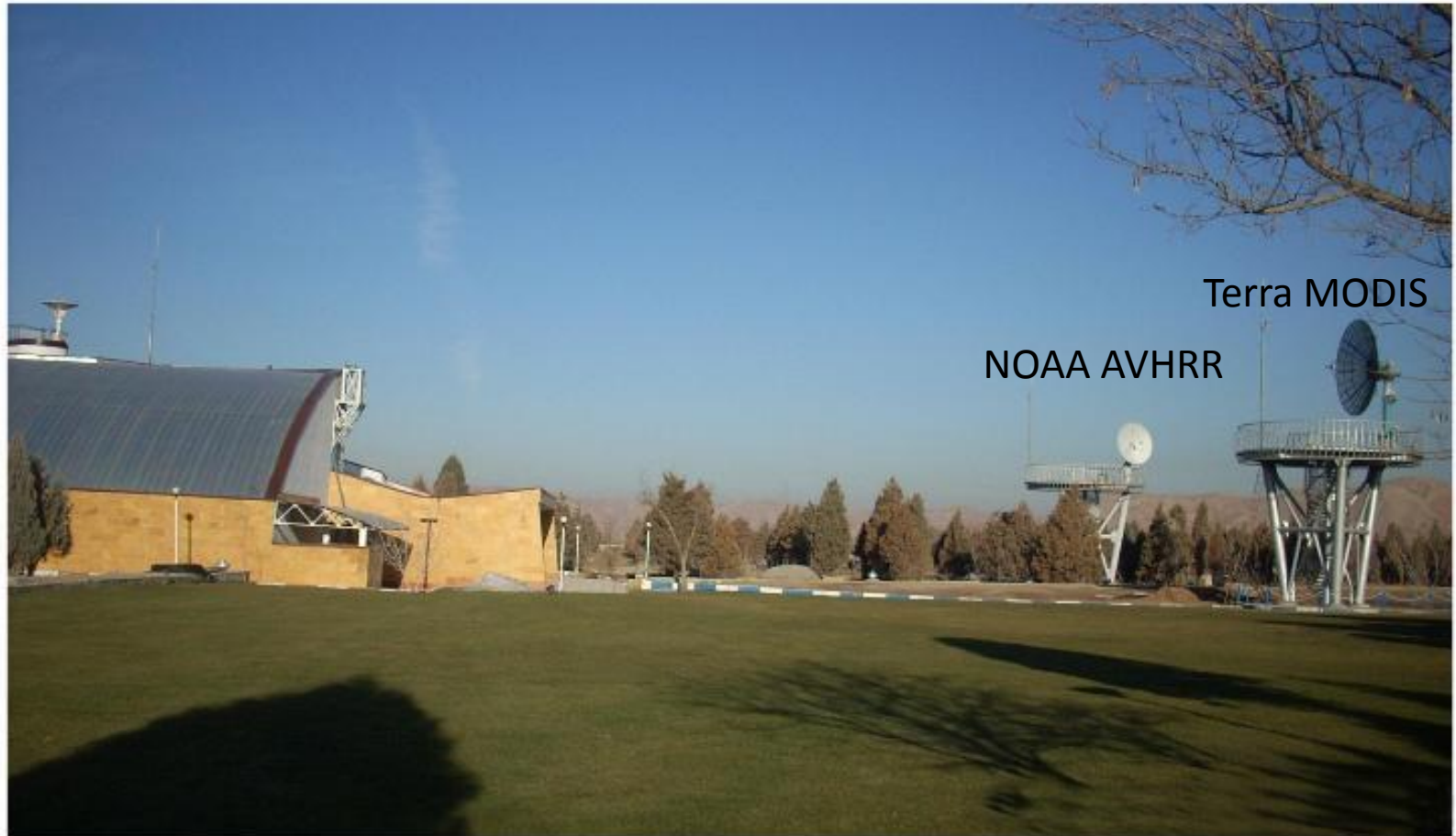
**Inputs:** Vegetation Indices of NOAA/AVHRR (1.1Km) & Terra/MODIS (250m)

**Outputs:** Simulated NDVI of MODIS for the period of 1995-2001

## Source of Data

# EARTH OBSERVATION SATELLITE SYSTEMS

## Earth observation satellite receiving facilities



Terra MODIS

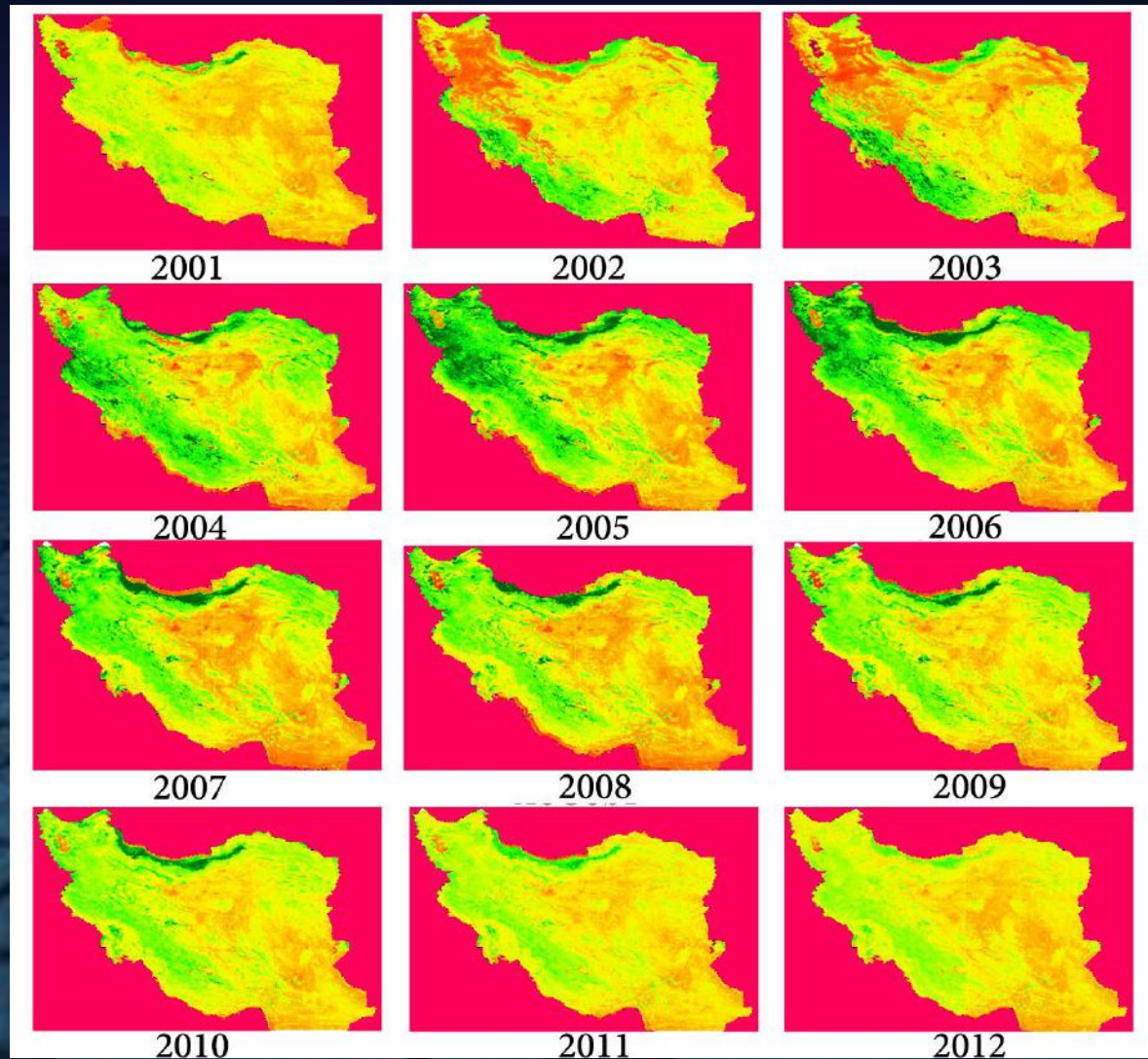
NOAA AVHRR

www.iasa.ac.ir

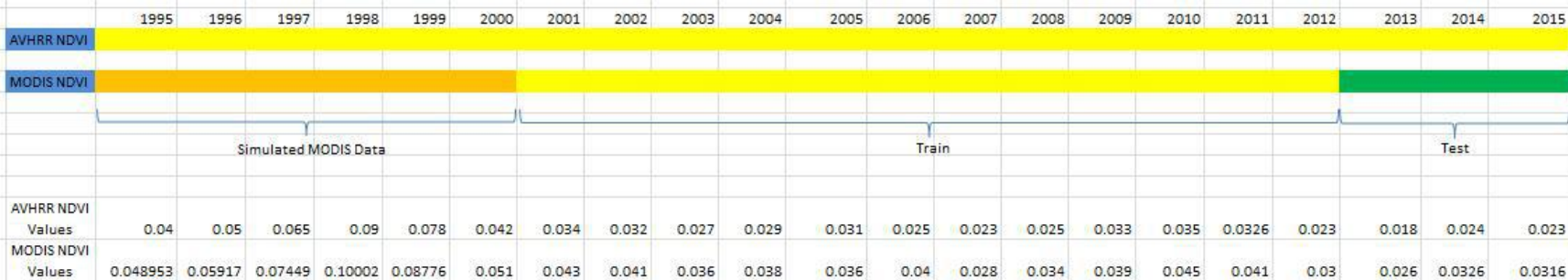
Iranian Space Agency



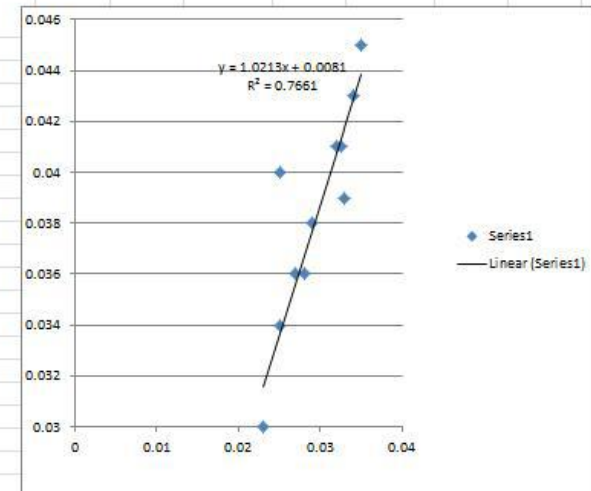
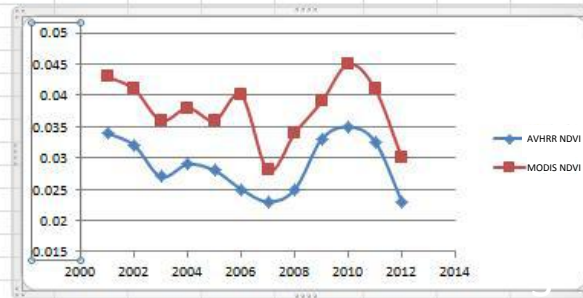
## Monthly NDVI Map of August in Iran by Terra/MODIS (2001-2011)



# Periods of Data & Regression Relationship



		AVHRR NDVI	MODIS NDVI
Simulated Data	1995	0.04	
	1996	0.05	
	1997	0.065	
	1998	0.09	
	1999	0.078	
	2000	0.042	
Trained Data	2001	0.034	0.043
	2002	0.032	0.041
	2003	0.027	0.036
	2004	0.029	0.038
	2005	0.028	0.036
	2006	0.025	0.04
	2007	0.023	0.028
	2008	0.025	0.034
	2009	0.033	0.039
	2010	0.035	0.045
	2011	0.0326	0.041
	2012	0.023	0.03
Tested Data	2013	0.018	
	2014	0.024	
	2015	0.026	

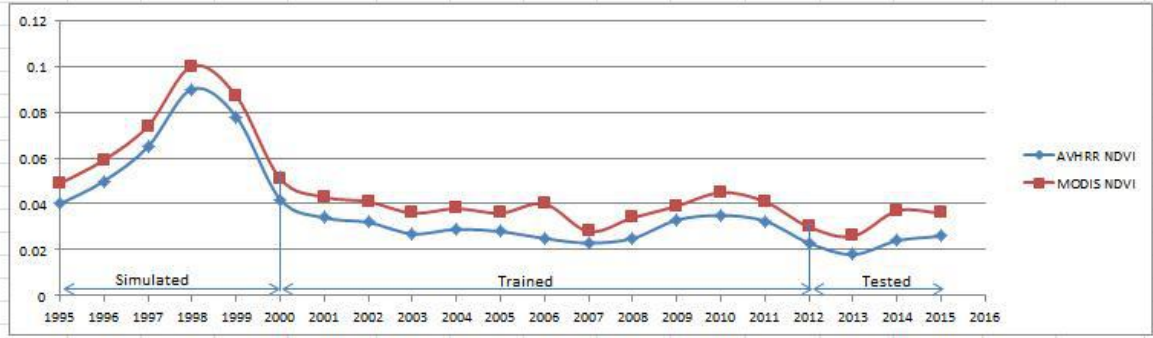


$$NDVI_{MODIS} = 1.0213NDVI_{NOAA} + 0.0081$$



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
AVHRR NDVI	[Yellow bar]																				
MODIS NDVI	[Yellow bar]																			[Green bar]	
	Simulated MODIS Data					Train													Test		
AVHRR NDVI Values	0.04	0.05	0.065	0.09	0.078	0.042	0.034	0.032	0.027	0.029	0.031	0.025	0.023	0.025	0.033	0.035	0.0326	0.023	0.018	0.024	0.023
MODIS NDVI Values	0.048953	0.05917	0.07449	0.10002	0.08776	0.051	0.043	0.041	0.036	0.038	0.036	0.04	0.028	0.034	0.039	0.045	0.041	0.03	0.026	0.0326	0.0316

		AVHRR NDVI	MODIS NDVI
Simulated Data	1995	0.04	0.0489
	1996	0.05	0.05917
	1997	0.065	0.074
	1998	0.09	0.1
	1999	0.078	0.087
	2000	0.042	0.051
Trained Data	2001	0.034	0.043
	2002	0.032	0.041
	2003	0.027	0.036
	2004	0.029	0.038
	2005	0.028	0.036
	2006	0.025	0.04
	2007	0.023	0.028
	2008	0.025	0.034
	2009	0.033	0.039
	2010	0.035	0.045
	2011	0.0326	0.041
	2012	0.023	0.03
Tested Data	2013	0.018	0.026
	2014	0.024	0.037
	2015	0.026	0.036



# B) Drought Prediction

## Natural Drought Management System by Using Space Technologies

### Target:

Drought Monitoring & Prediction by Using Terra/MODIS Satellite Data.

### Method:

Exploring Relationship between Satellite and Meteorological Indices by Using Artificial Neural Network Models.

### Inputs:

MODIS Vegetation Indices for 20 Years (1995-2015)

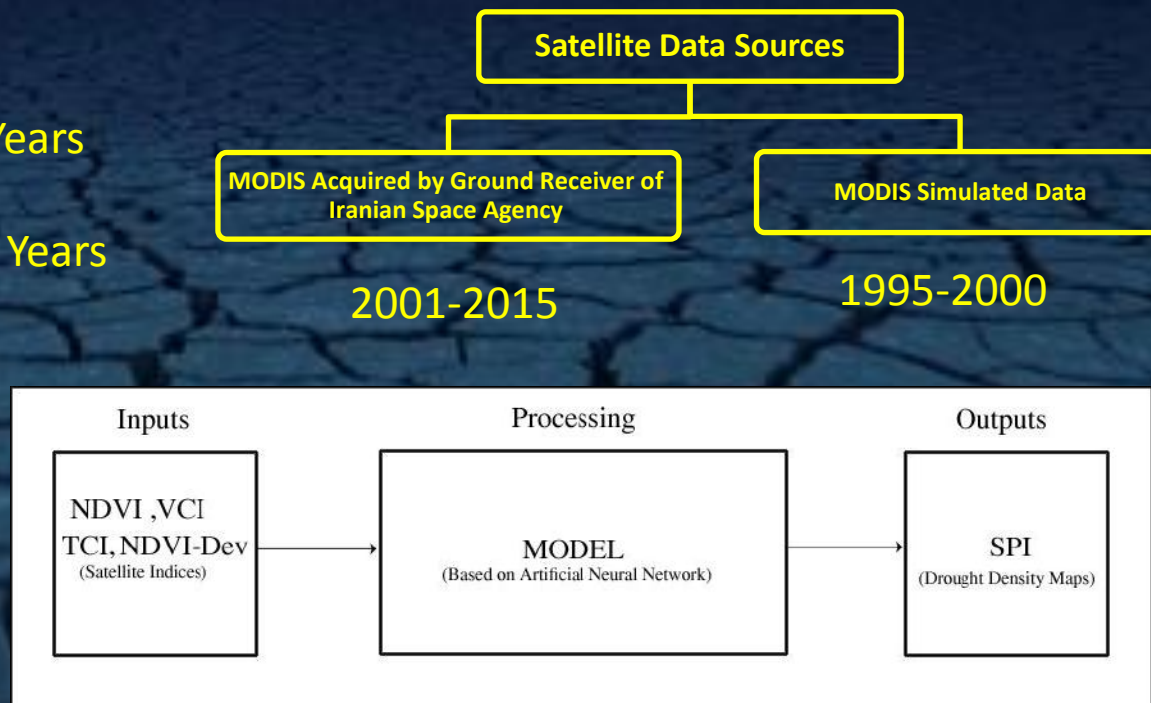
Meteorological Data Series for 30 Years

Iran Climate Map

Iran Basin Map

### Output

Standardized Precipitation Index



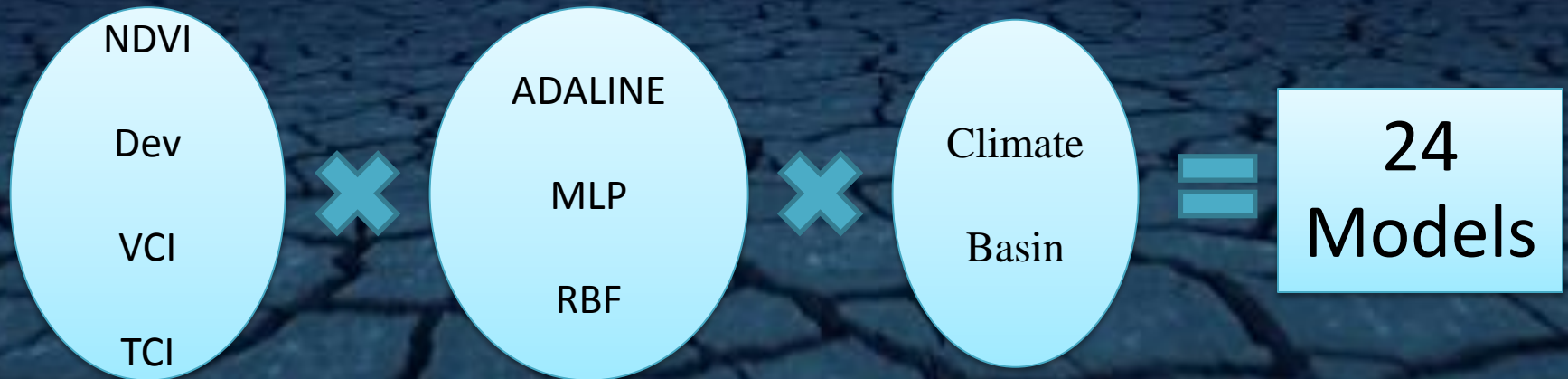
A Schematic Diagram of the Model

# Models

Satellite Indices: NDVI, NDVI-Dev , VCI, TCI

Neural Network Models : ADALINE, MLP(Multi-layer Perceptron), RBF(Radial Basis Function)

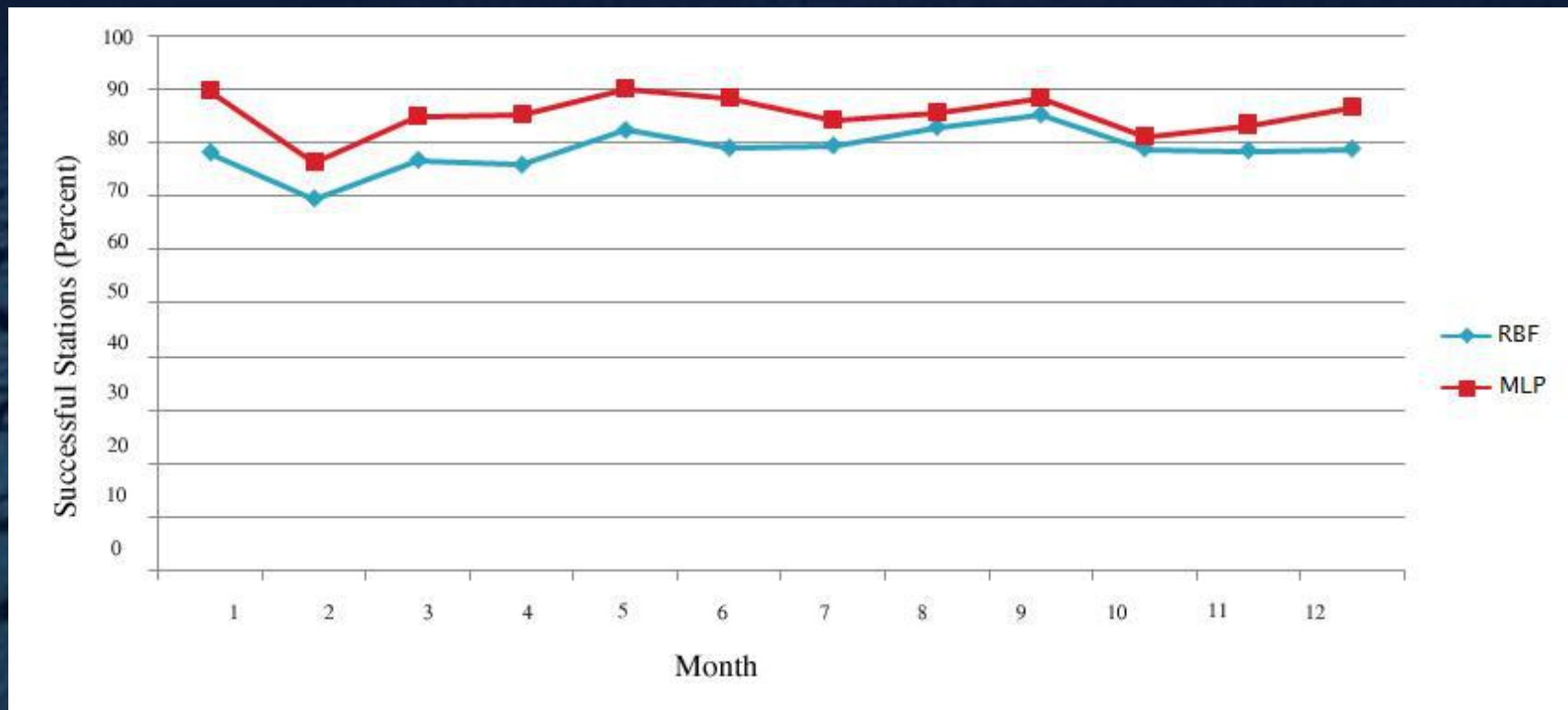
Data Classification Based on Climate and Basin



## Last Conclusions:

The best Index (among satellite indices assessed in this research) for drought prediction is TCI.

MLP is the best ANN Model for Drought Prediction by Using TCI



# Other Satellite Based Drought Index Will be Used in This Research in the Next Steps

$$EVI = G \times \frac{(NIR - RED)}{(NIR + C1 \times RED - C2 \times Blue + L)}$$

**Enhanced Vegetation Index**

# Software Designed for Running ANN for Drought Prediction

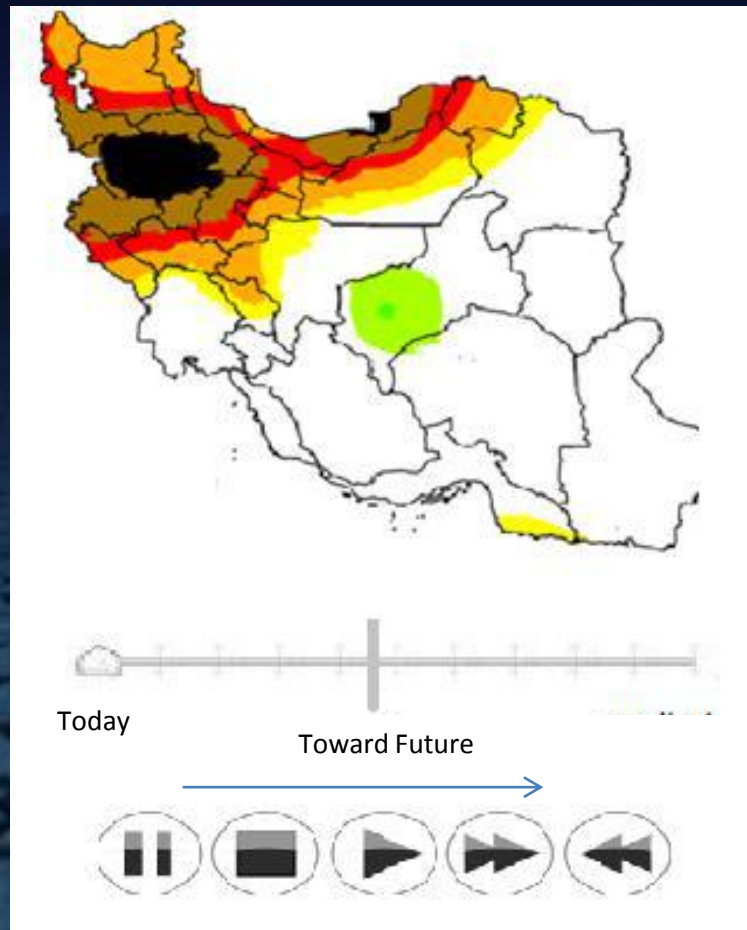
The screenshot shows the 'Training' window of the software. It features a blue title bar with standard window controls. Below the title bar, there is an 'Output Path' field containing 'C:\Temp' and a 'Browse' button. A status bar at the bottom left shows 'ready'. The main interface is divided into several sections: 'Train' and 'Test' tabs are at the top left. The 'Filter & ANN' section includes a 'Filter Type' dropdown set to 'Climate' and a 'Network' dropdown set to 'ADALINE'. The 'Input & Output Paths' section has two text boxes for 'SPI Path' and 'Satellite Indices Path', each with a 'Browse' button. The 'Satellite Indices' section contains a list of indices with radio buttons: NDVI (selected), NDVI-Dev, VCI, TCI, NDVI + TCI, NDVI-Dev + TCI, and VCI + TCI. The 'Training Period' section has 'since' and 'to' fields, each with 'Year' and 'Month' dropdowns. The 'since' values are Year: 1996, Month: 1, and the 'to' values are Year: 2006, Month: 1. A 'Train' button is centered at the bottom.






## Training Box of Software Designed for Modeling

The screenshot shows the 'Test' window of the software. It has a similar layout to the training window. The 'Train' and 'Test' tabs are at the top left, with 'Test' selected. The 'Filter & ANN' section is identical to the training window. The 'Input & Output Paths' section is also identical. The 'Satellite Indices' section is identical. The 'Prediction' section has 'Year' (1997), 'Month' (1), and 'Steps' (0) dropdowns. A 'Drought Intensity Map' button is centered at the bottom. The status bar at the bottom left shows 'ready'.

## Test Box of Software Designed for Modeling

# Drought Prediction Map



- Extreme Drought 
- Severe Drought 
- Moderate Drought 
- Mild Drought 
- Normal 

The prediction time range until now = 3 month

# C) Drought Risk Mapping

## Remote Sensing Applications in Preparing Drought Risk Map of Iran

### Step (1) – Preparing Drought Hazard Map

Meteorological Data Layer Map

Remote Sensing Data Layer



Drought Hazard Map

### Step (2) – Preparing Drought Vulnerability Map

Population Density Map of Iran

Annual Landuse Map of Iran by Using MODIS Data



Drought Vulnerability Map

### Step (3) – Preparing Drought Exposure Map

Irrigated Lands Area based on statistics

### Step (4) – Preparing Drought Risk Map

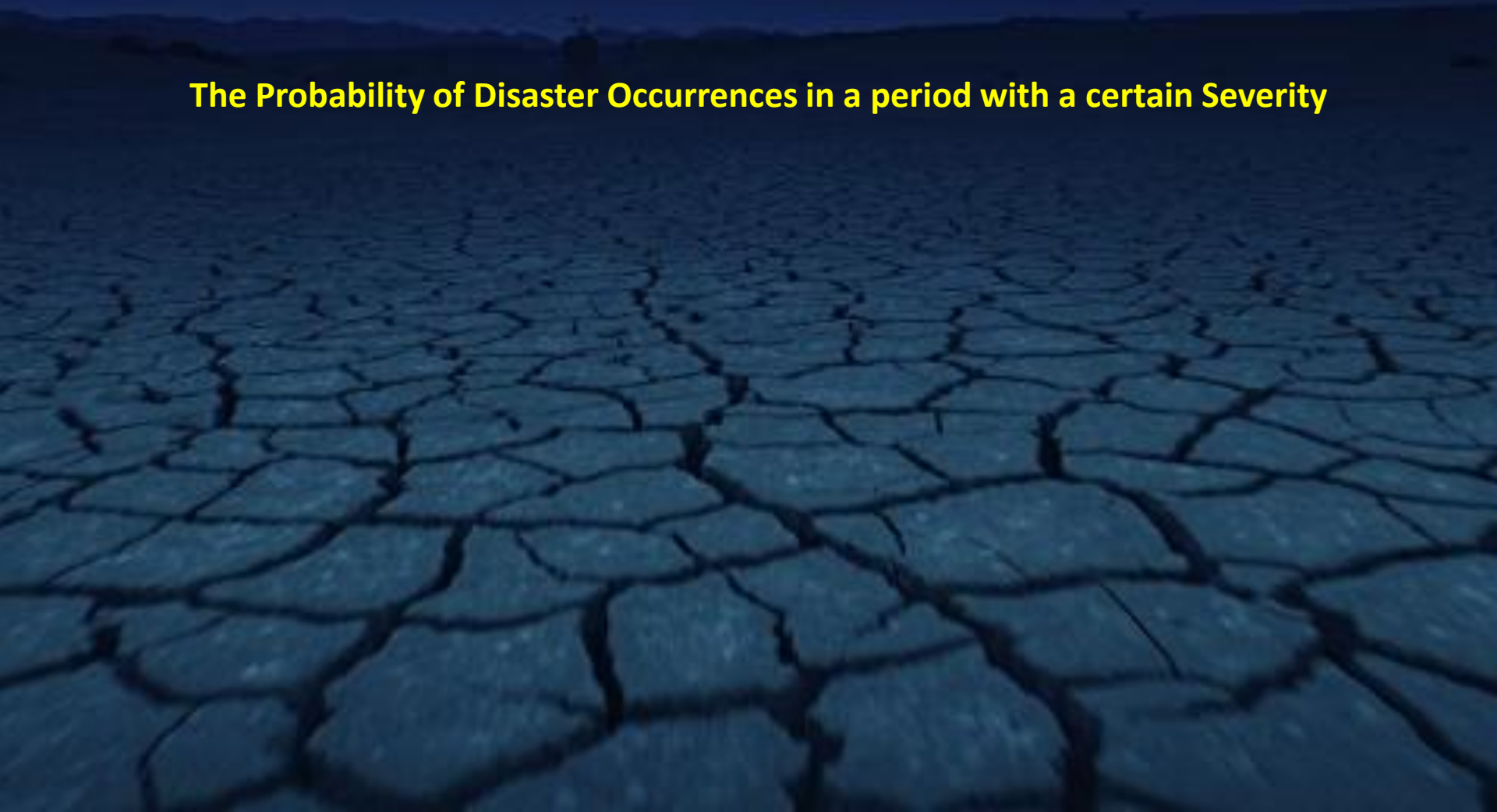
**Hazard X Vulnerability X Exposure = Risk**



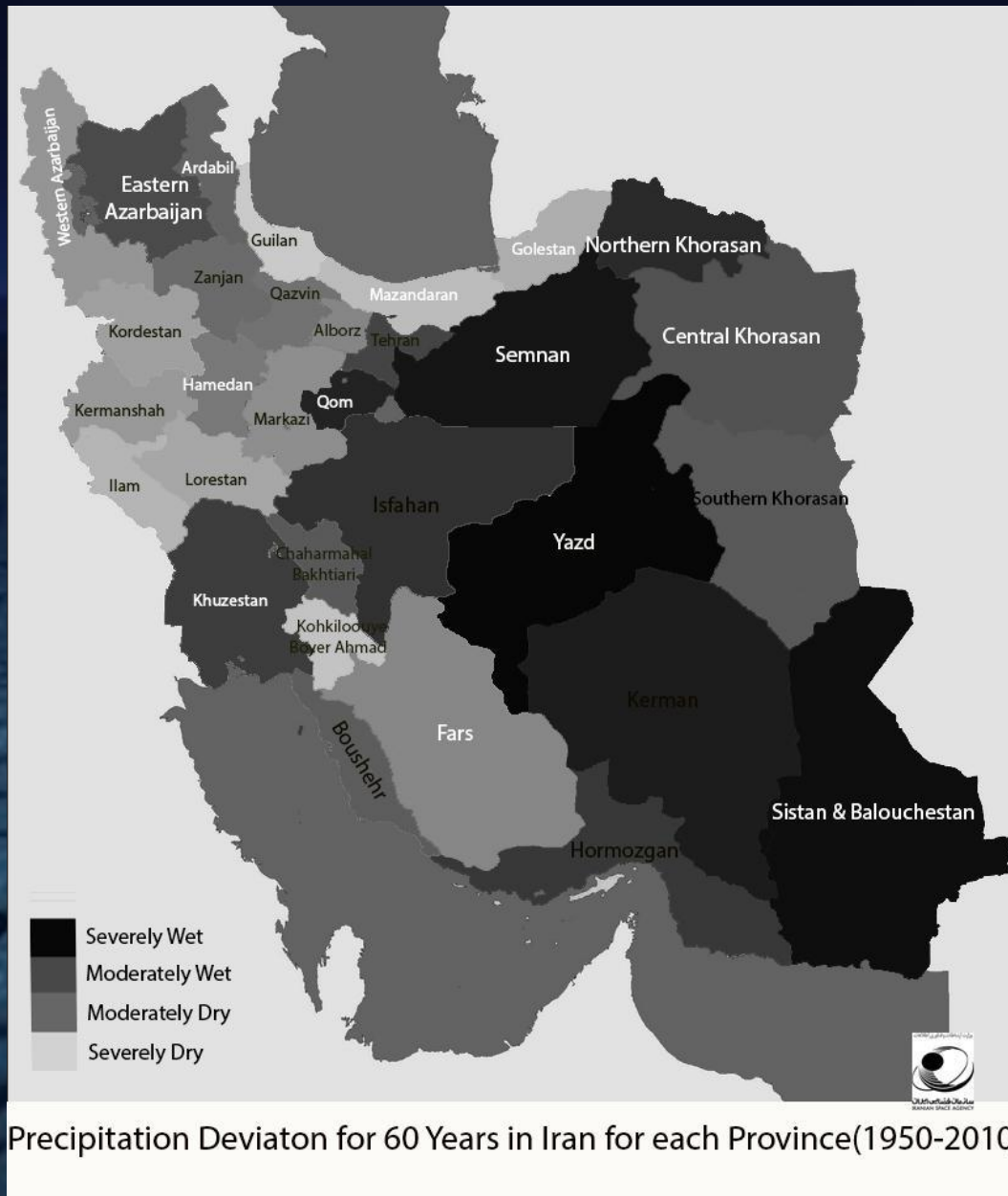
# Step (1)

## Preparing Drought Hazard Map

**The Probability of Disaster Occurrences in a period with a certain Severity**

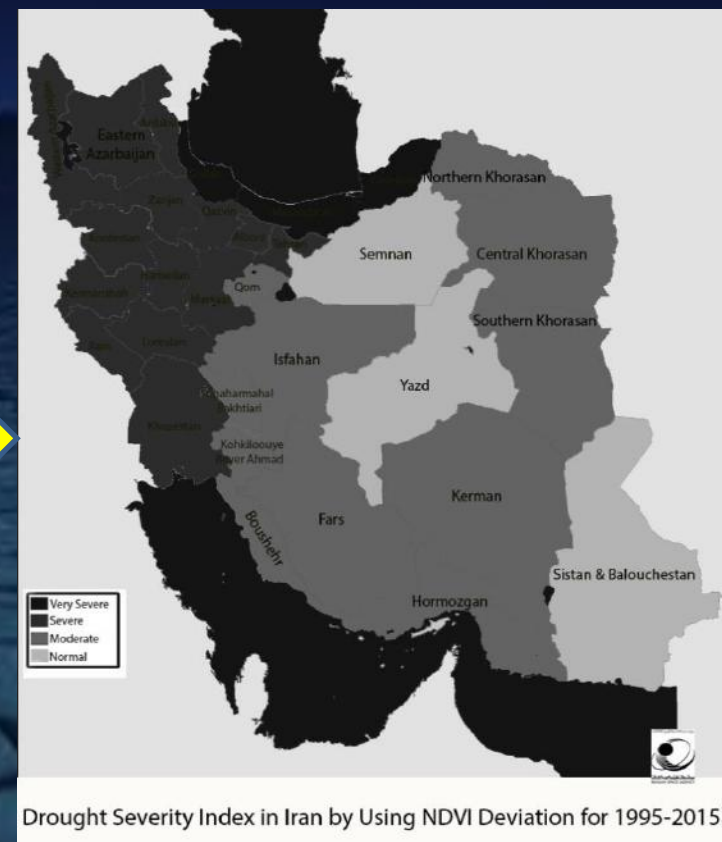
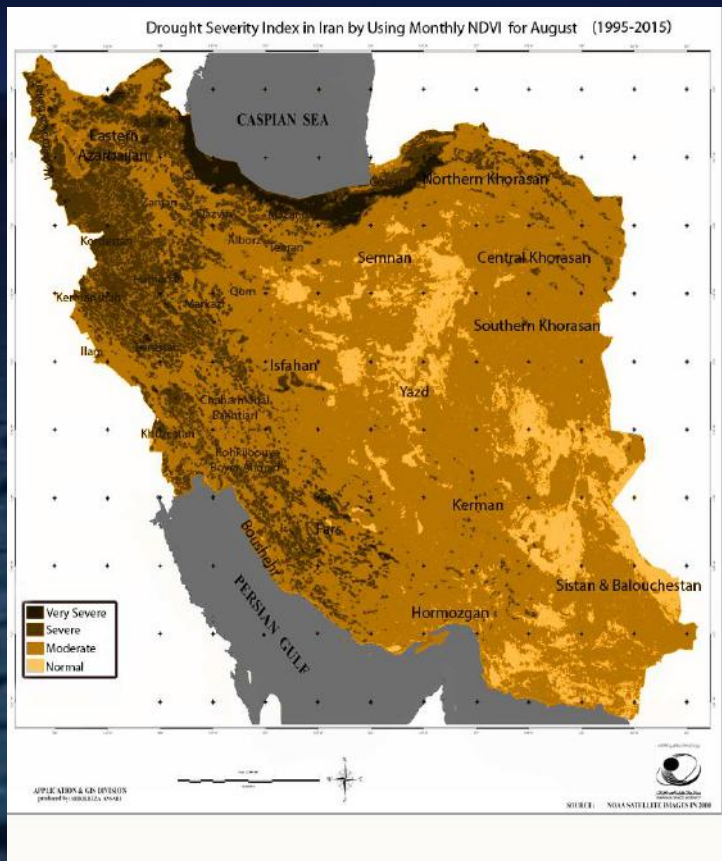


# Hazard Assessment by Using Meteorological Data

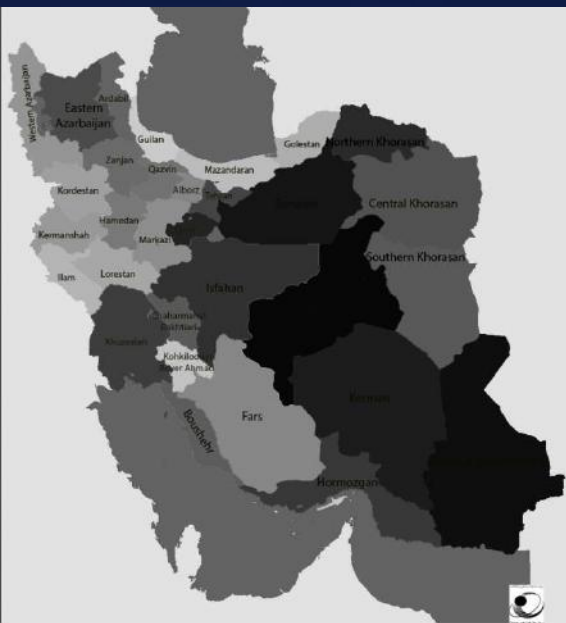


# Hazard Assessment by Using Remote Sensing Data

## Drought Severity Index by using Terra/MODIS Satellite Data

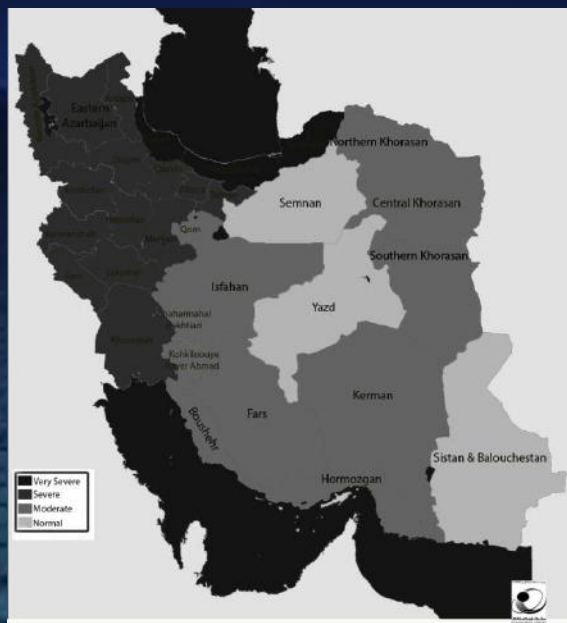


$$\text{Drought Severity Index} = \text{NDVI}_i - \text{NDVI}_{\text{mean}}$$



Precipitation Deviaton for 60 Years in Iran for each Province(1950-2010)

+



Drought Severity Index in Iran by Using NDVI Deviation for 1995-2015

=



Iran Drought Hazard Map (2015)

**Output Hazard Map by Using Meteorological Data**

**Output Hazard Map by Using Remote Sensing Data**

**Final Hazard Map**

# Step (2)

## Preparing Drought Vulnerability Map

**Degree of resilience to the impact of natural hazards**



# Vulnerability Indicators & Factors

## Socio-economic indicators:

Population density:

Female to male ratio:

Poverty level:

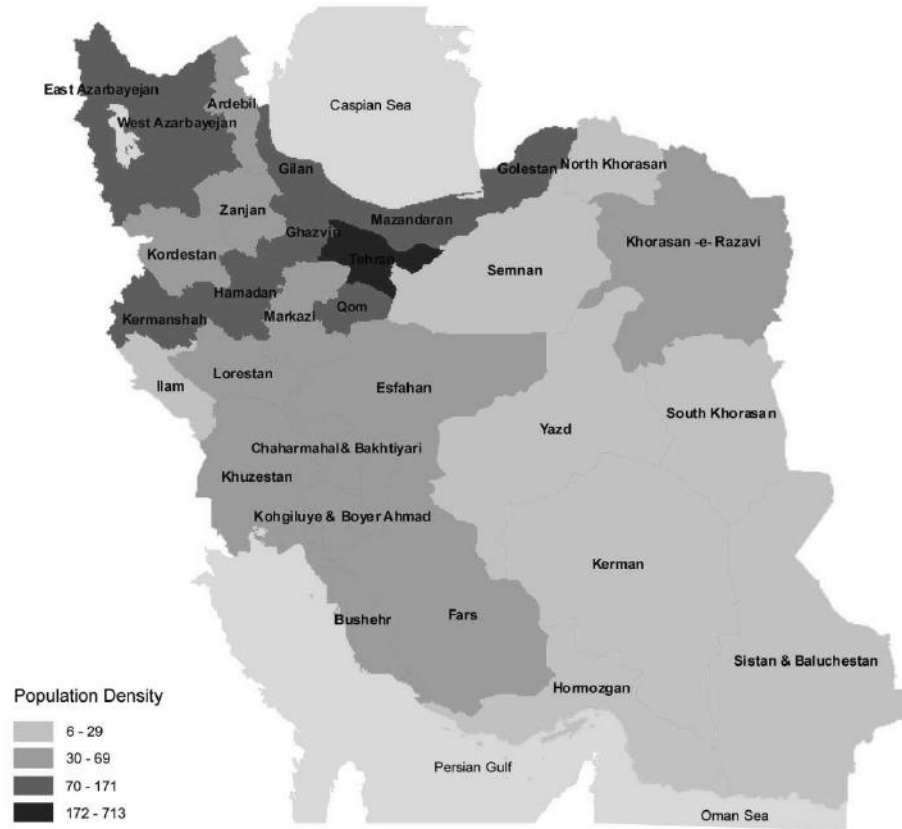
Agricultural occupation:

## Physical/infrastructural factors:

Land Use Map

# Population Density Map of Iran

Population Density (Pop per Km<sup>2</sup>) by province ,2014



## Notes:

a:  $P_n = P_0 (1+r)^n$  equation is used

b: Estimated by indirect Method (Rele's Method)

c: Estimated by indirect Method (Hajnal's Method)

d: Labour Force Survey

# Annual Landuse Map of Iran by Using MODIS Data



Annual Land use / cover map of Iran  
(ALI)  
2014

## Legend

- Geophysical Grids
- High Seas Borders
- International Borders
- Provincial Borders
- Forests
- Trees Complex
- High Density Rangelands
- Medium Density Rangelands
- Low Density Rangeland
- Irrigated Lands
- Rainfed Lands
- Mixed Irrigated and Rainfed
- Drylands
- Stone Features
- Salt Lands
- Sands with Vegetated Lands
- Desert
- Wetlands & Marshes
- Water Bodies
- Islands
- Ark Loot - a type of desert
- Kalut-type of desert



Scale 1:250000

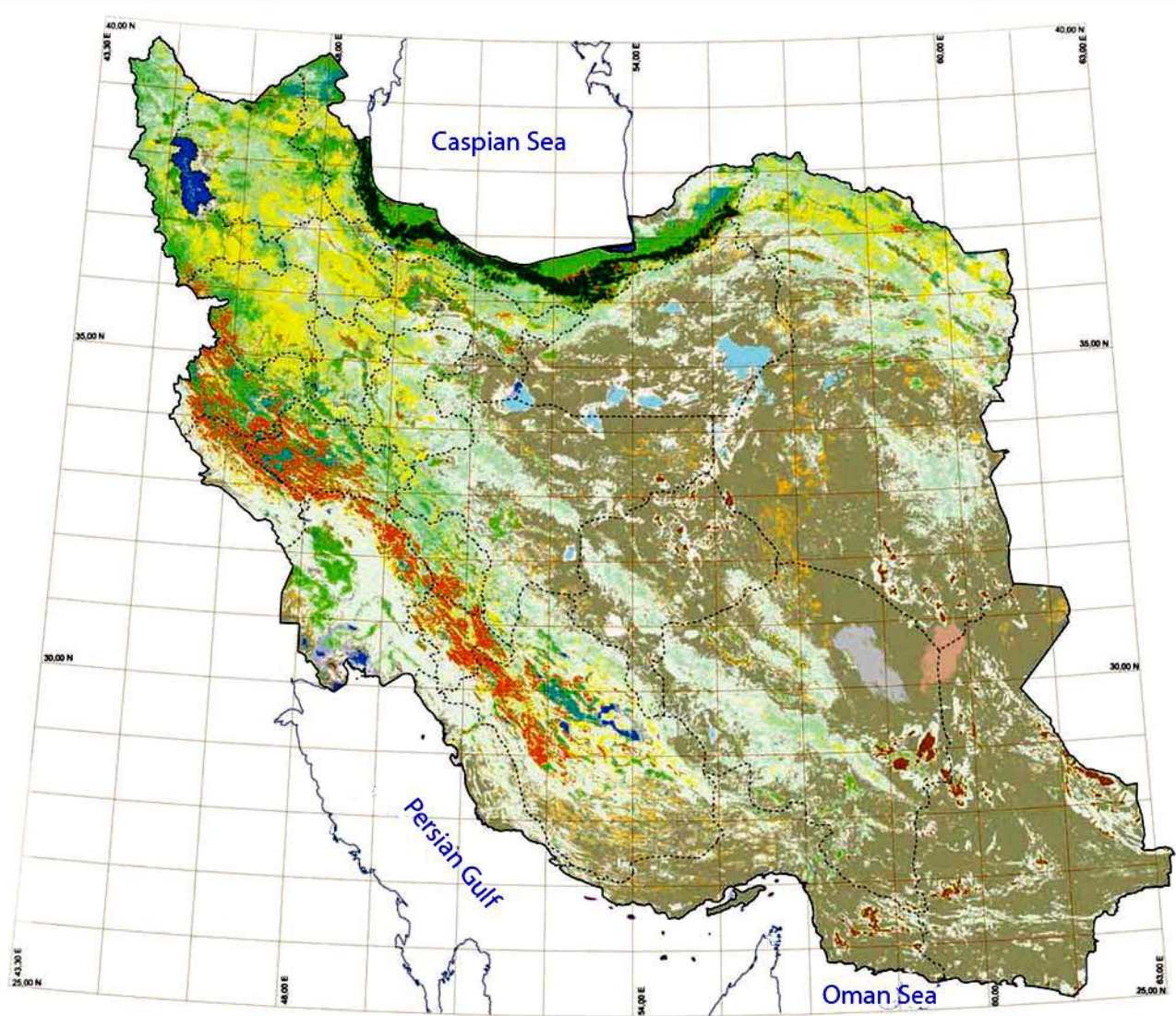
Lambert Conformal Conic of Iran

Spheroid: WGS 84 : پیشروی مورد استفاده :

Ali Sadeghi Naeini  
Ali Akbar Abkar  
Roshanak Darvish Zadeh

Printed in 2004

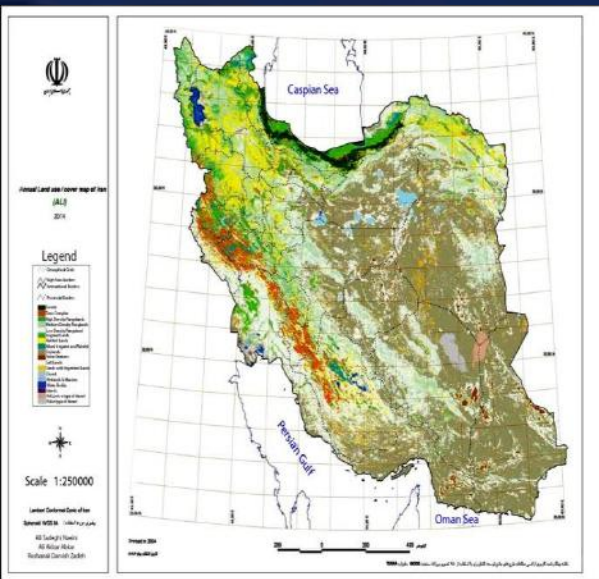
تاریخ انتشار: بهار ۱۳۸۳



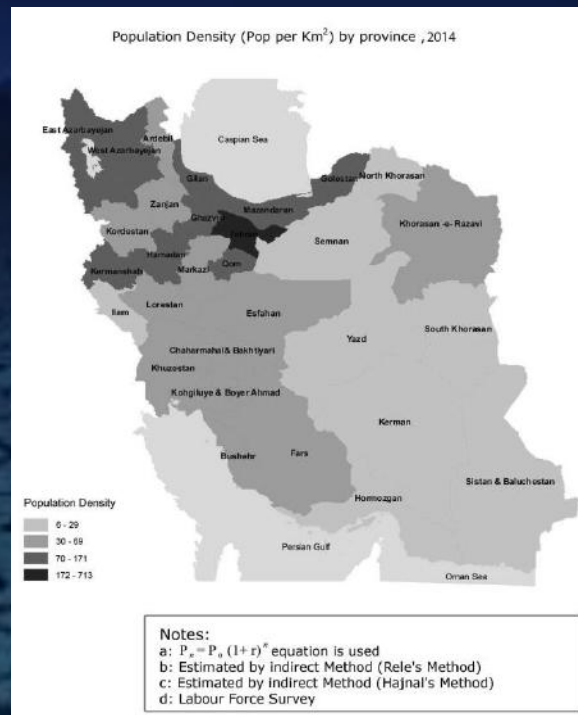
0 200 400 کیلومتر

نقشه بهنگام شده کاربری اراضی منطبقاً بر طرح های جامع توسعه کشاورزی با استفاده از ۱۵- تصاویر روزانه سنسور MODIS ماهواره TERRA





**Output Landuse Map by Using Remote Sensing Data**



**Population Density Map**

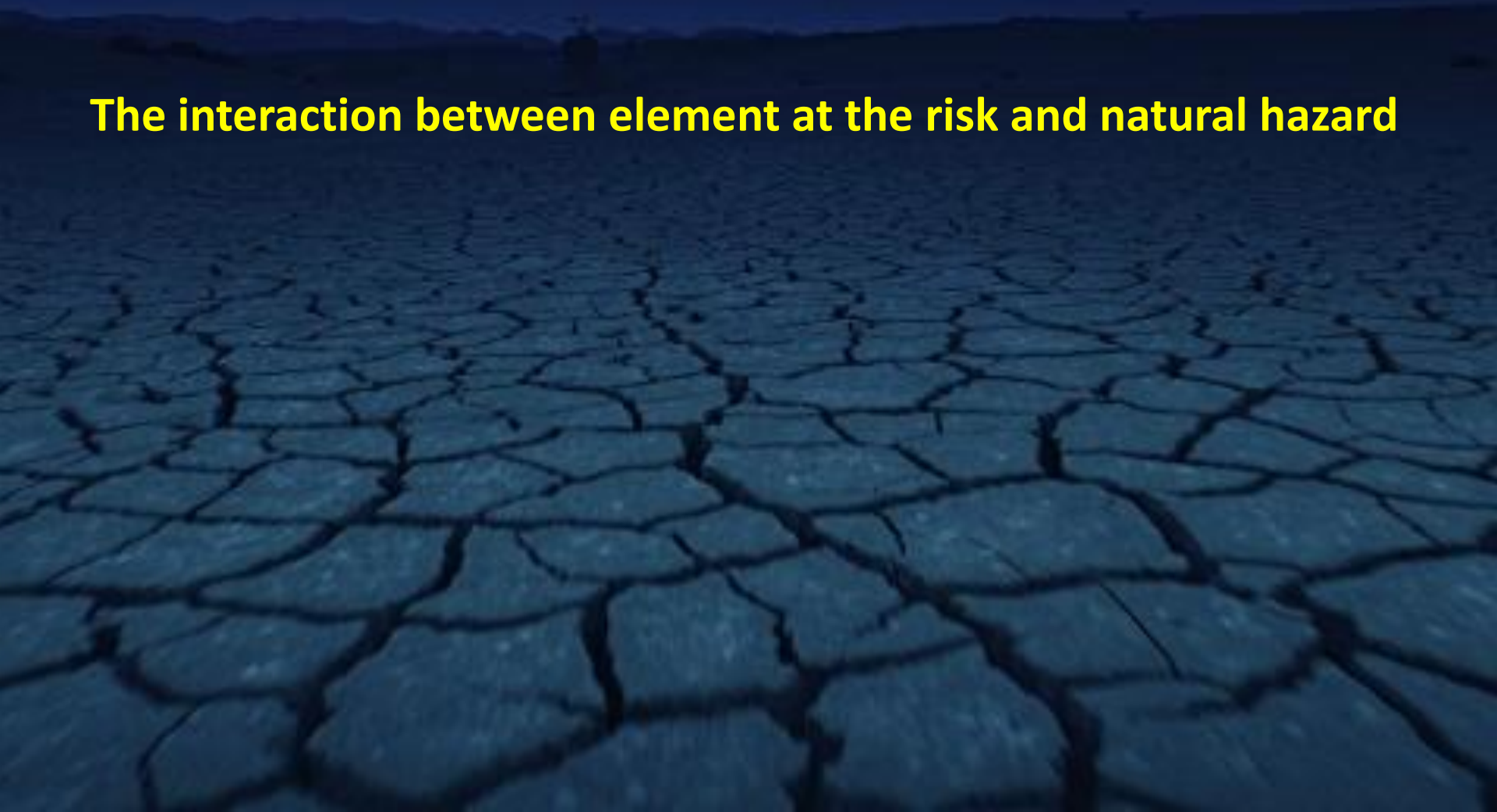


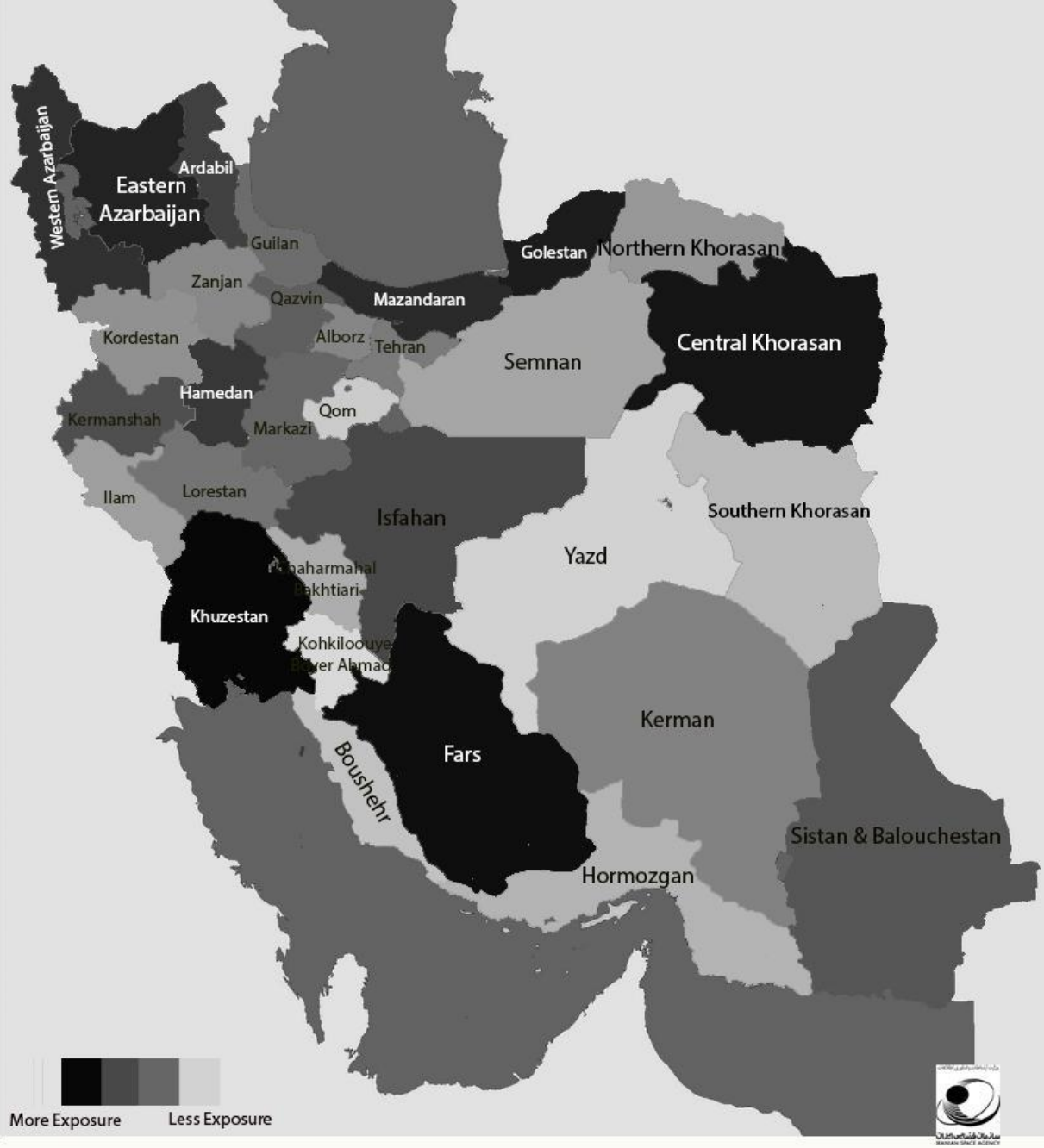
**Final Vulnerability Map**

# Step (3)

## Preparing Drought Exposure Map

**The interaction between element at the risk and natural hazard**





Data Source:  
Iranian Ministry  
of Agriculture

Drought Exposure Map in Iran Based on Irrigated Land Areas (Surveying Data-2014)



**Iran Drought Hazard Map**



**Iran Drought Vulnerability Map**



**Iran Drought Exposure Map**

X

X

**Hazard X Vulnerability X Exposure = Risk**



**Iran Drought Risk Map**



Iran Drought Risk Map (2015)



مرکز ملی پیش‌بینی و مدیریت  
خشکسالی و کم‌آبی

The image shows a vast, flat, and cracked landscape, likely a dry lake bed or salt flat, under a dark, overcast sky. The ground is covered in a complex network of dark, irregular cracks that form a mosaic-like pattern. The overall color palette is dark and monochromatic, with shades of black, dark grey, and deep blue. In the center of the image, the words "Thank you!" are written in a bright, yellow, sans-serif font. The text is centered both horizontally and vertically, standing out prominently against the dark background.

**Thank you!**