Risk Assessment and Mapping Using Earth Observation Data In Iran

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Different Types of Disasters in Iran

Drought

Epidemic

Earthquake

Mudflow

Floods

Sand Storm

Volcanic Eruption

Tornado

Hailstorm

Landslide

Wildfire

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

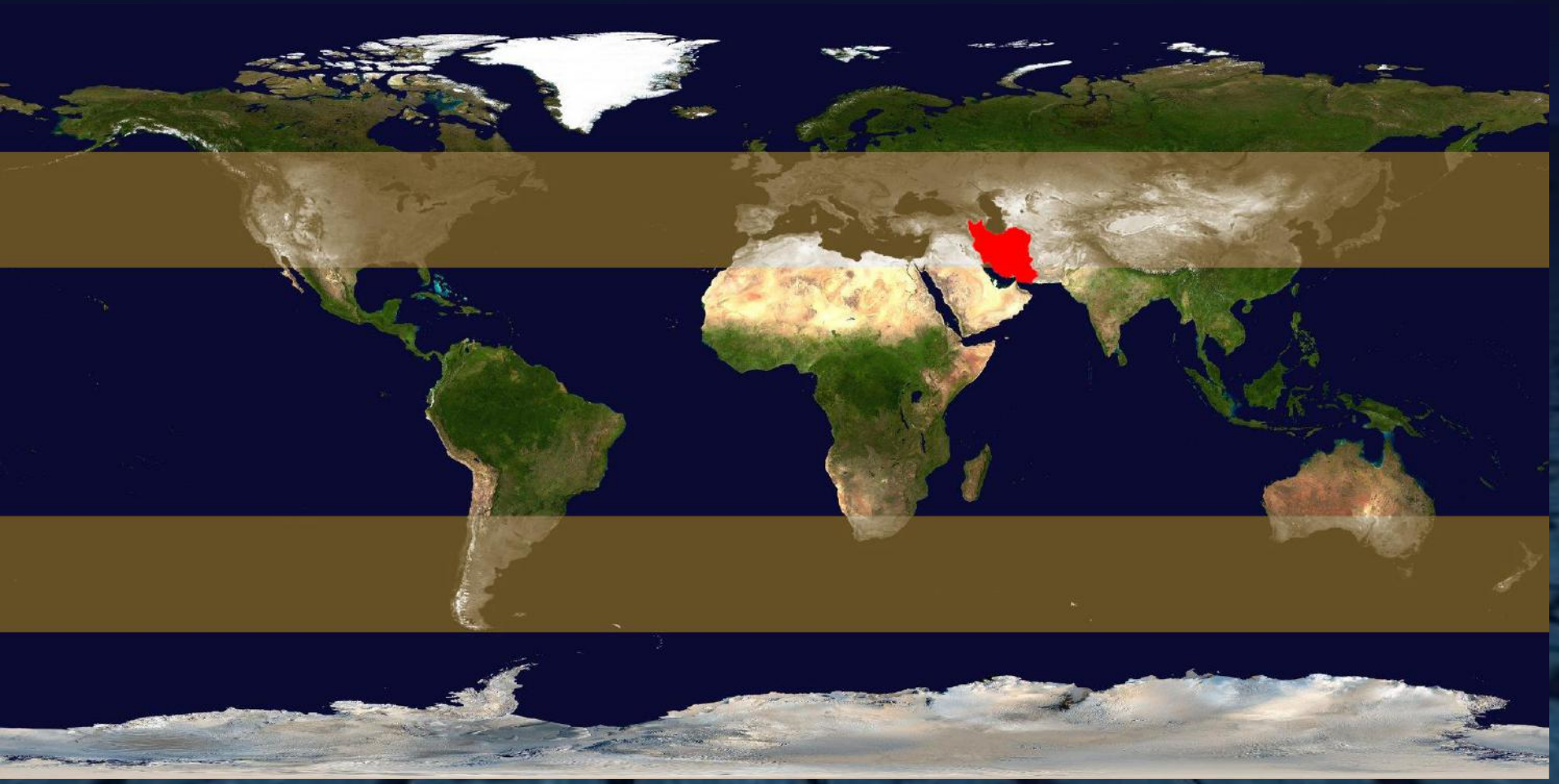
B) Drought Prediction

C) Drought Risk Mapping

Part (A)

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

One Severe Drought
in every 10 years

1989-1991

1998-2001 → Total Damages=$7.5 Billion
Losing 800,000 head of livestock
80 percent damages in annual cereal crops.

2008-2011

Part (B)

The Important Activities involved in Major Aspects of disaster risk management

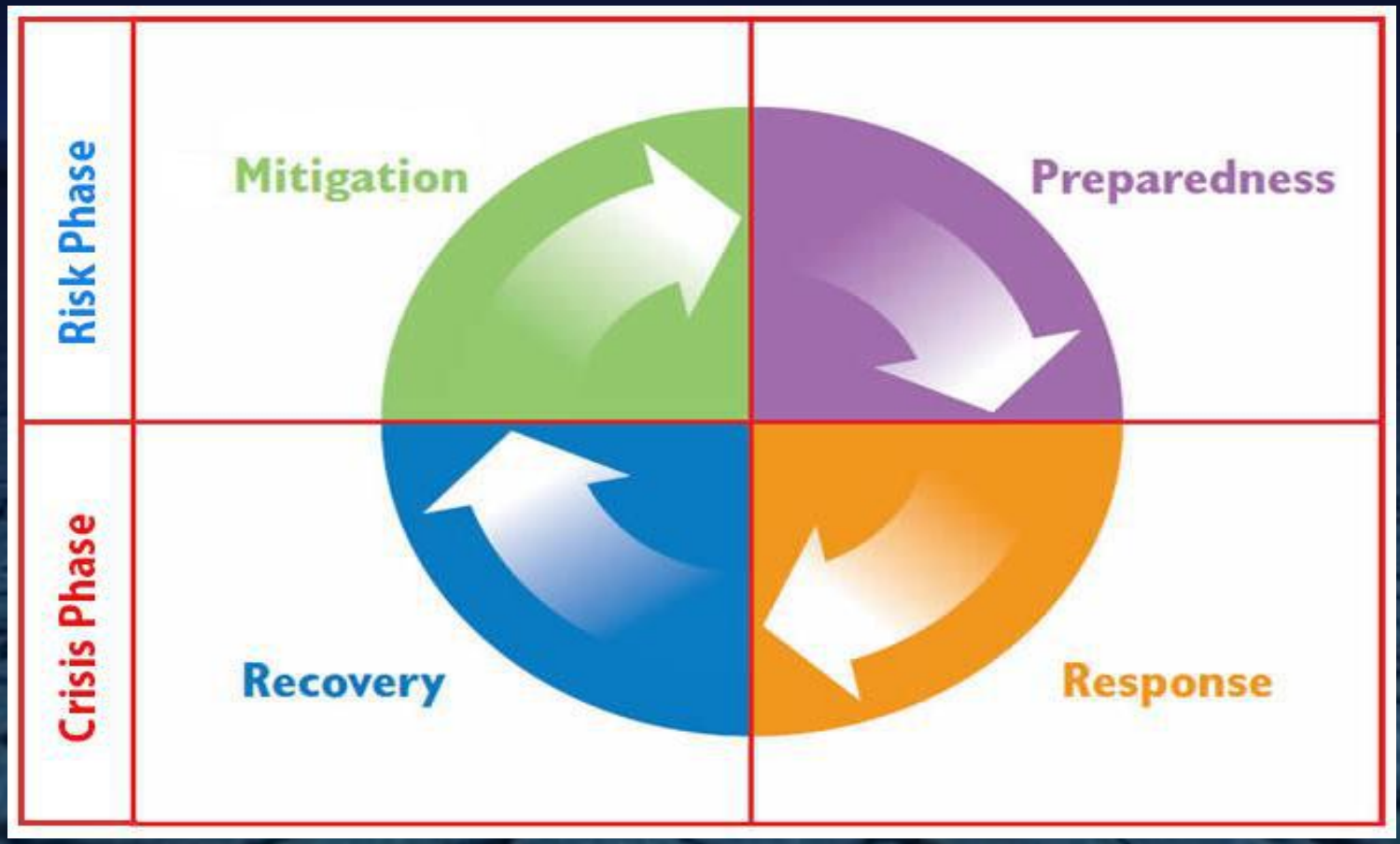


Diagram of Disaster Management Phases

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

Part (C)

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

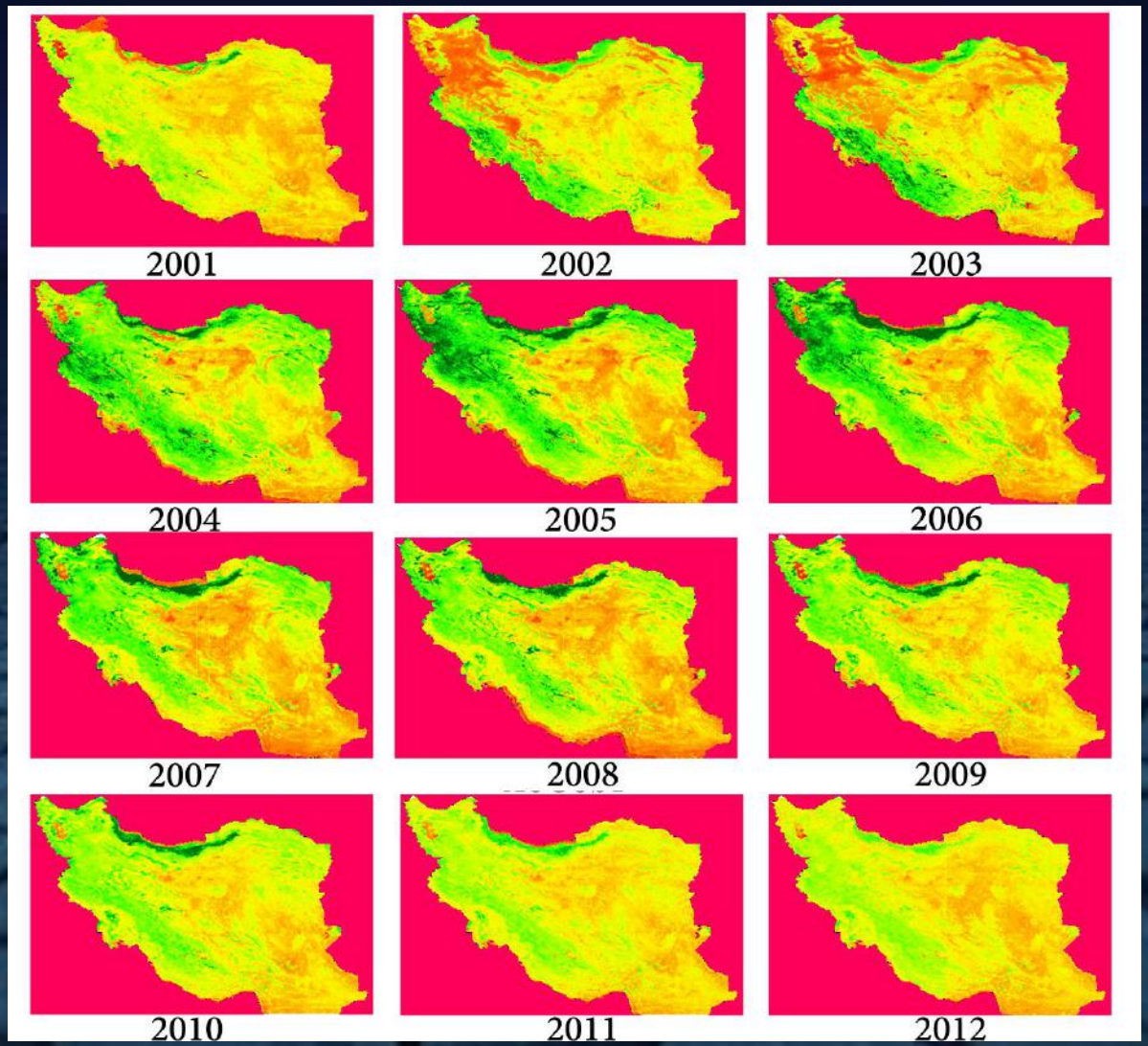
EARTH OBSERVATION SATELLITE SYSTEMS

Earth observation satellite receiving facilities

Iranian Space Agency

Monthly NDVI Map of August in Iran by NOAA/AVHRR (1997-2011)

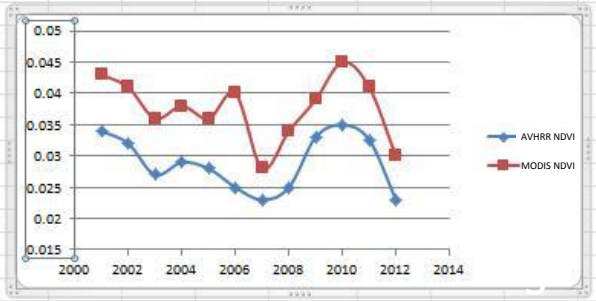
Monthly NDVI Map of August in Iran by Terra/MODIS (2001-2011)

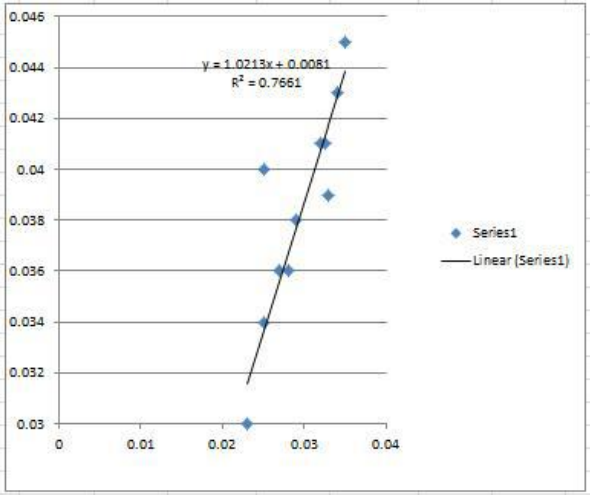


Periods of Data & Regression Relationship

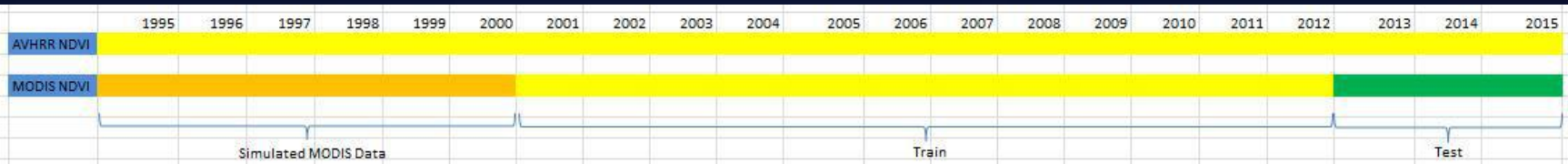
	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
AVHRR NDVI																					
MODIS NDVI																					
	Simulated MODIS Data						Train												Test		
AVHRR NDVI Values	0.04	0.05	0.065	0.09	0.078	0.042	0.034	0.032	0.027	0.029	0.031	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	
	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	





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



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		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
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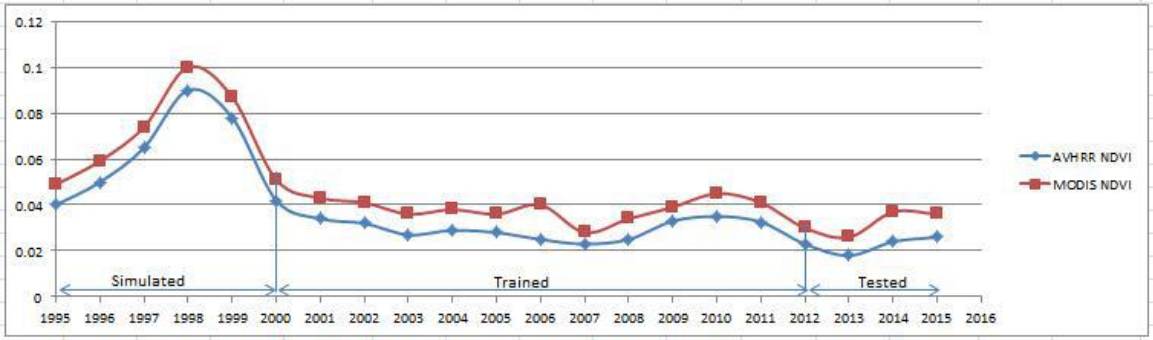
Tested Data	2013	0.018	0.026
	2014	0.024	0.037
	2015	0.026	0.036



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)

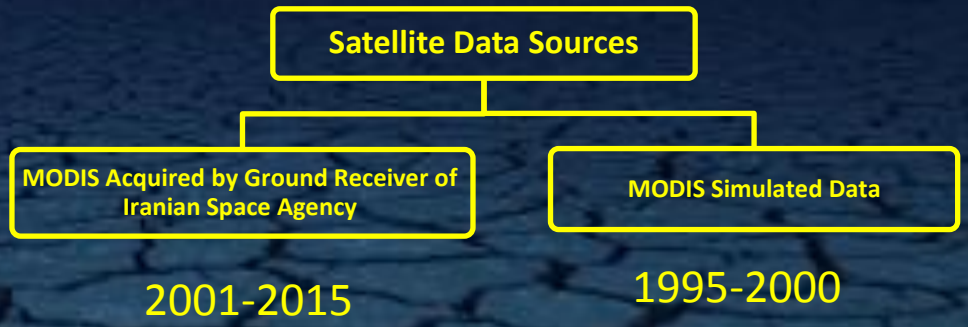
Meteorological Data Series for 30 Years

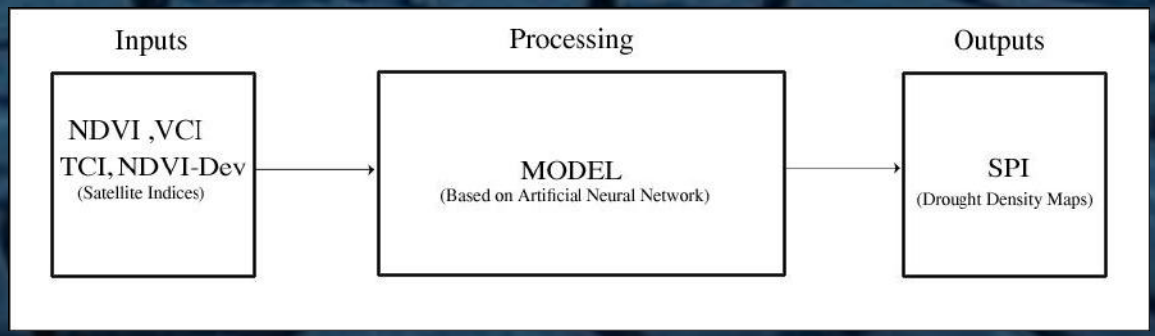
Iran Climate Map

Iran Basin Map

Output

Standardized Precipitation Index





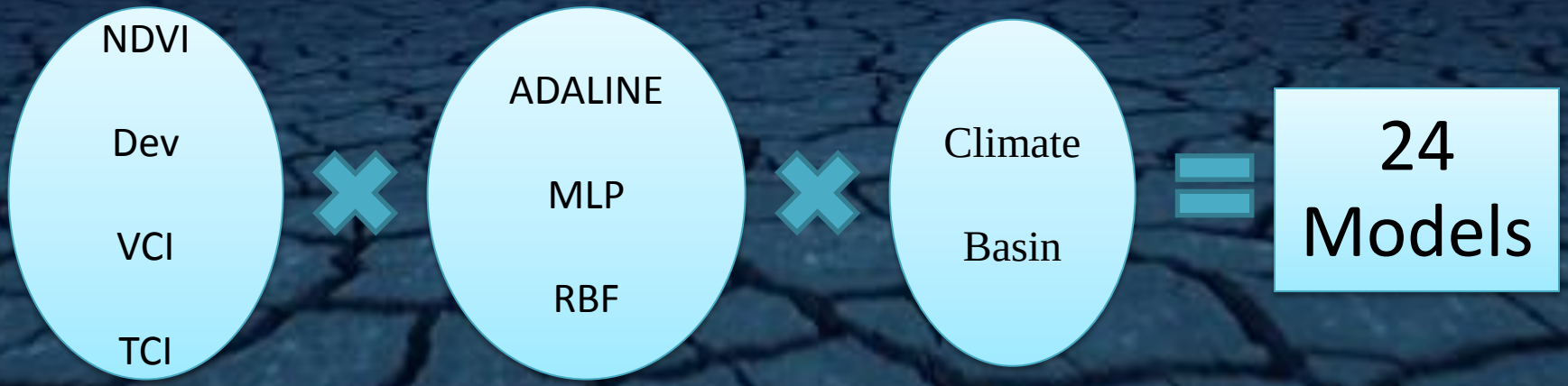
A Schematic Diagram of the Model

Models

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

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

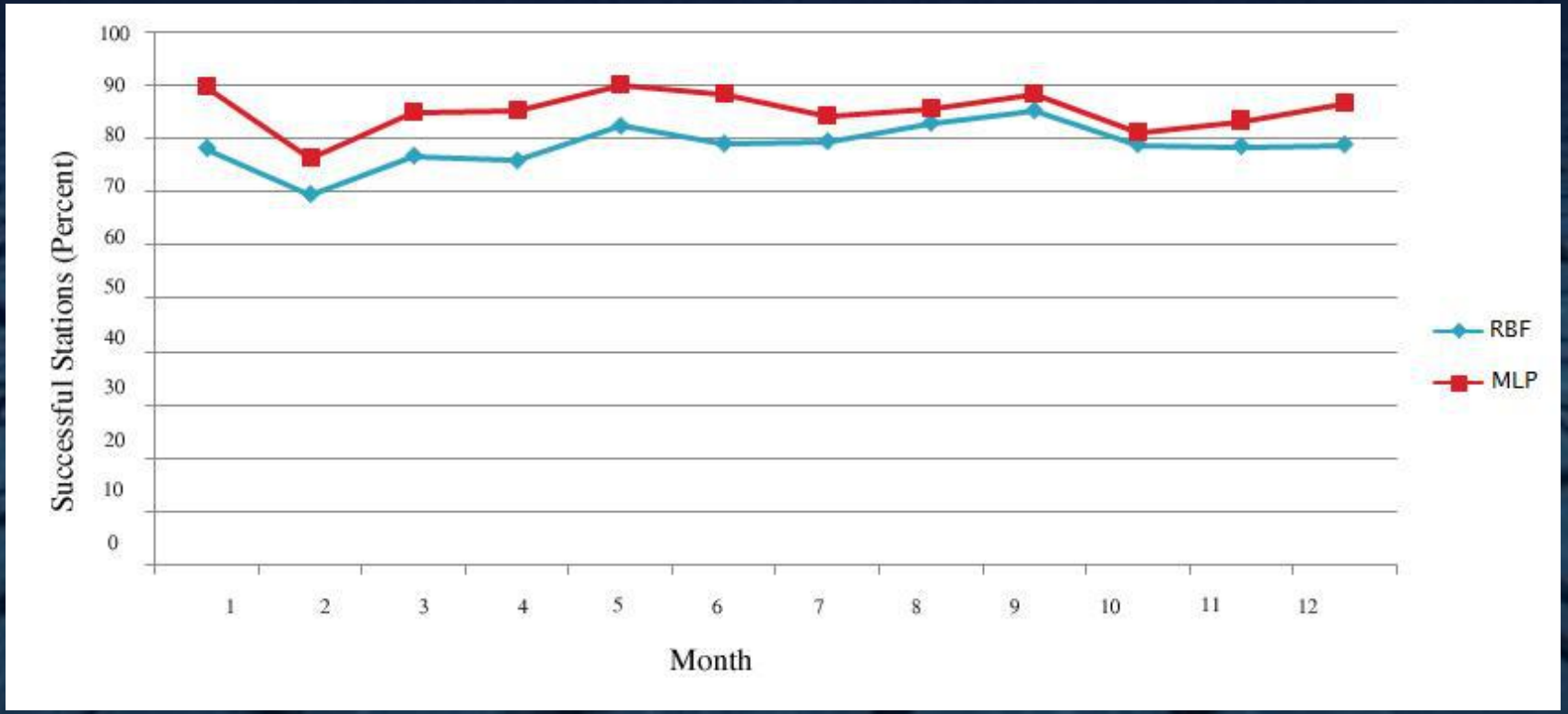
Data Classification Based on Climate and Basin



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

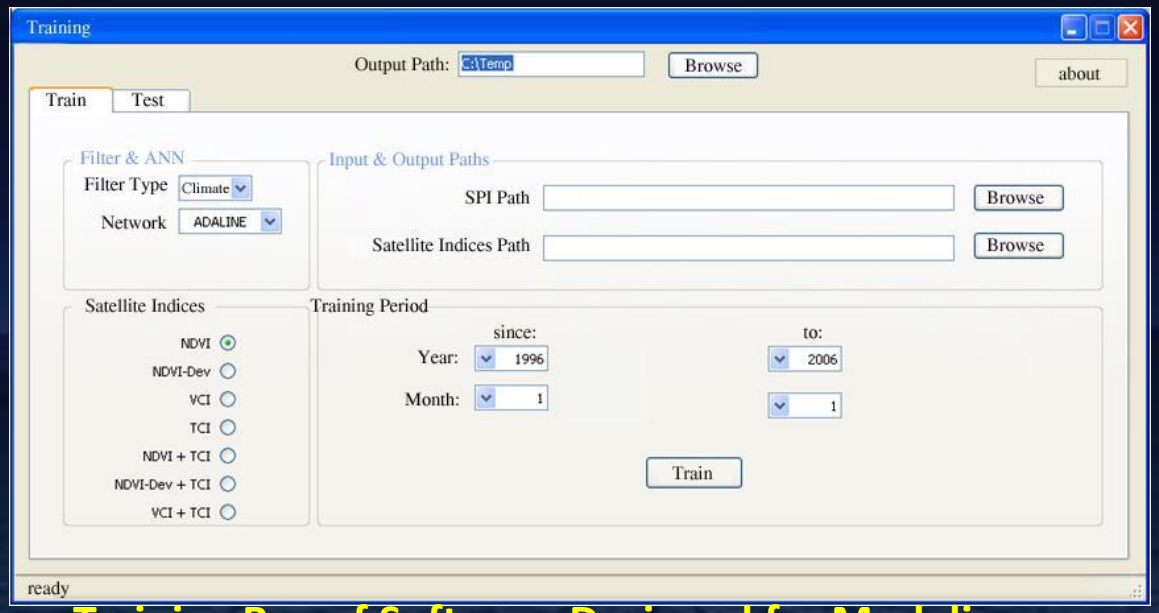


Other Satellite Based Drought Index Will be Used in This Research in the Next Steps

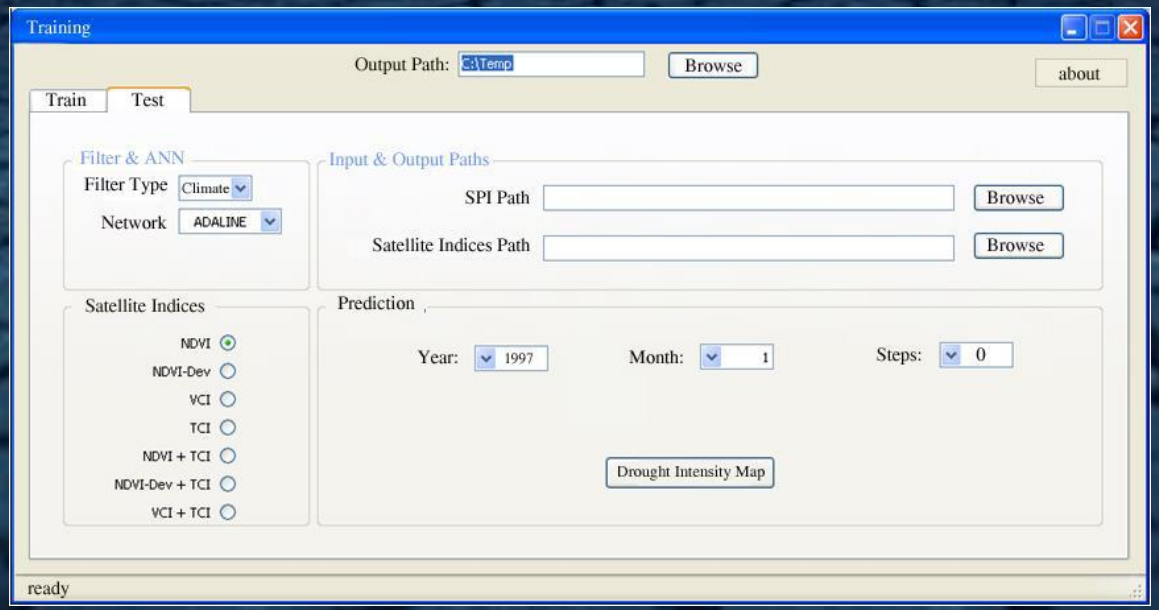
$$EVI = G \times \frac{(NIR - RED)}{(NIR + C1 \times RED - C2 \times Blue + L)}$$

Enhanced Vegetation Index

Software Designed for Running ANN for Drought Prediction

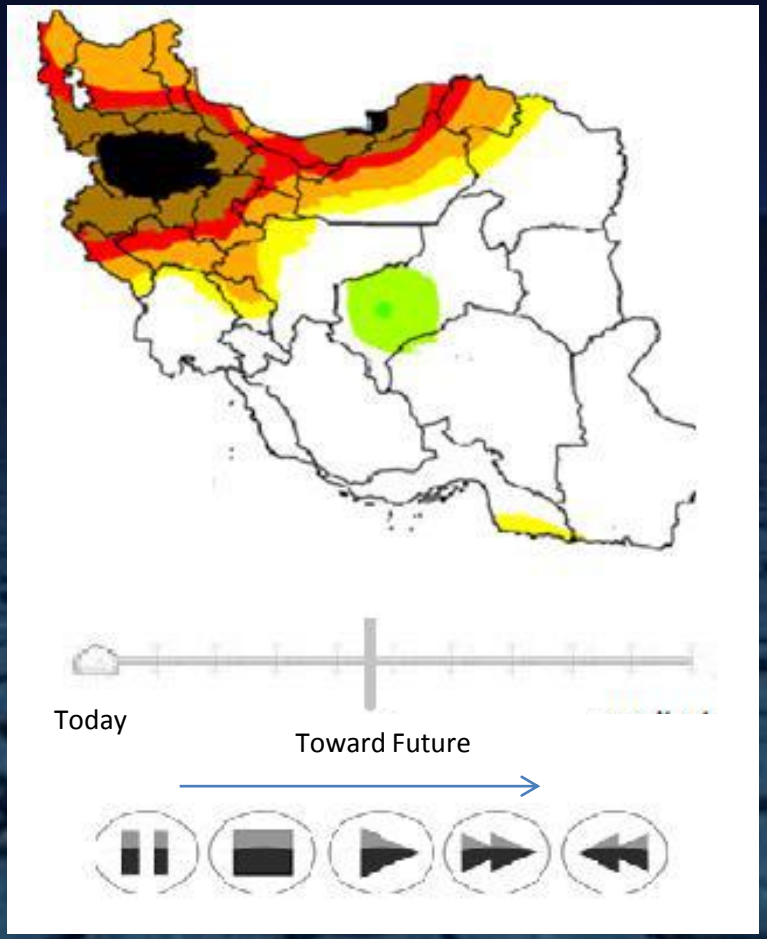


Training Box of Software Designed for Modeling



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

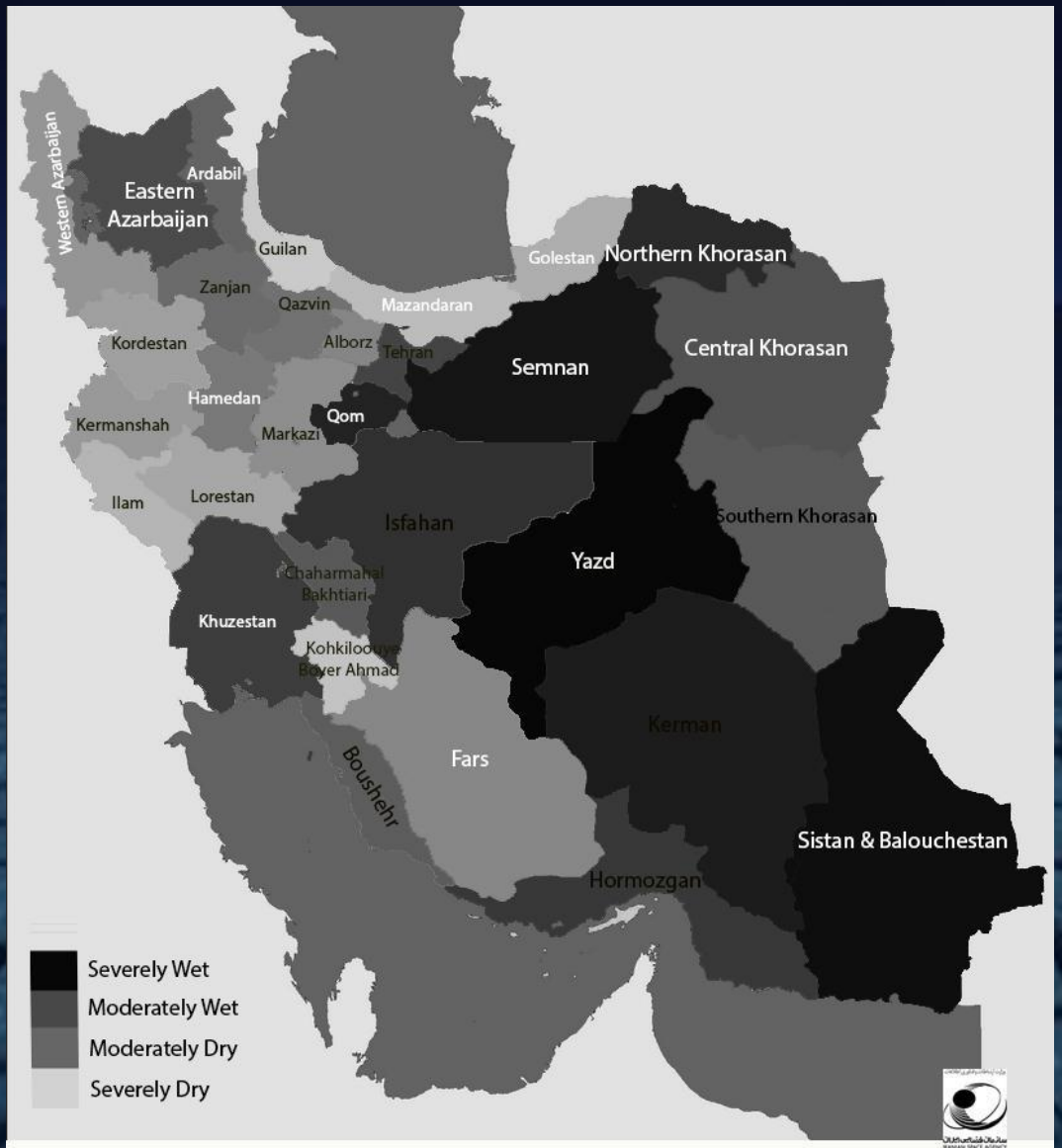
Hazard X Vulnerability X Exposure= Risk

Step (1)

Preparing Drought Hazard Map

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

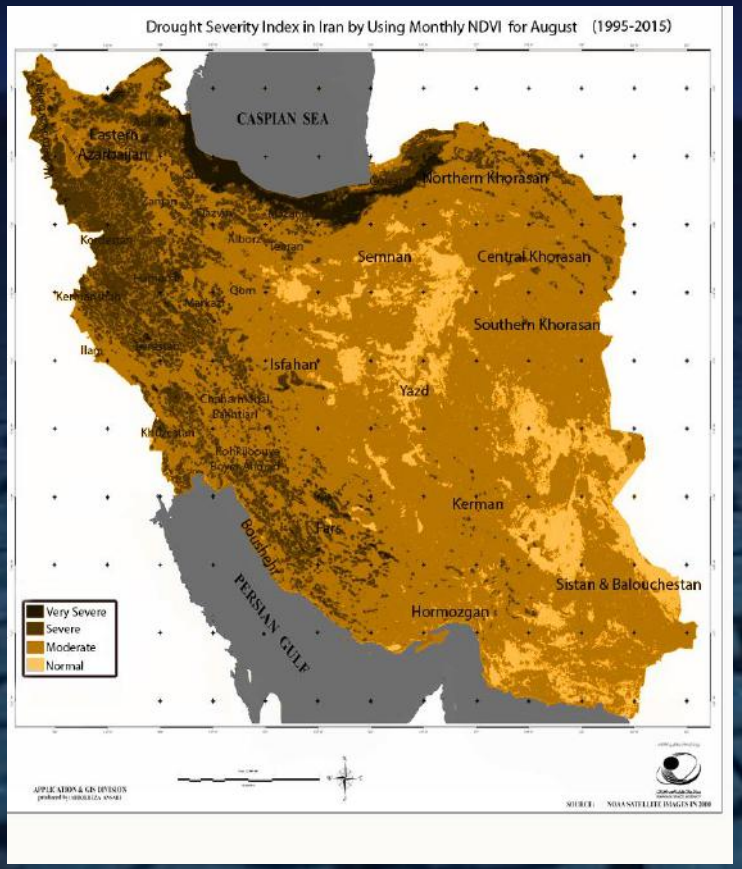
Hazard Assessment by Using Meteorological Data

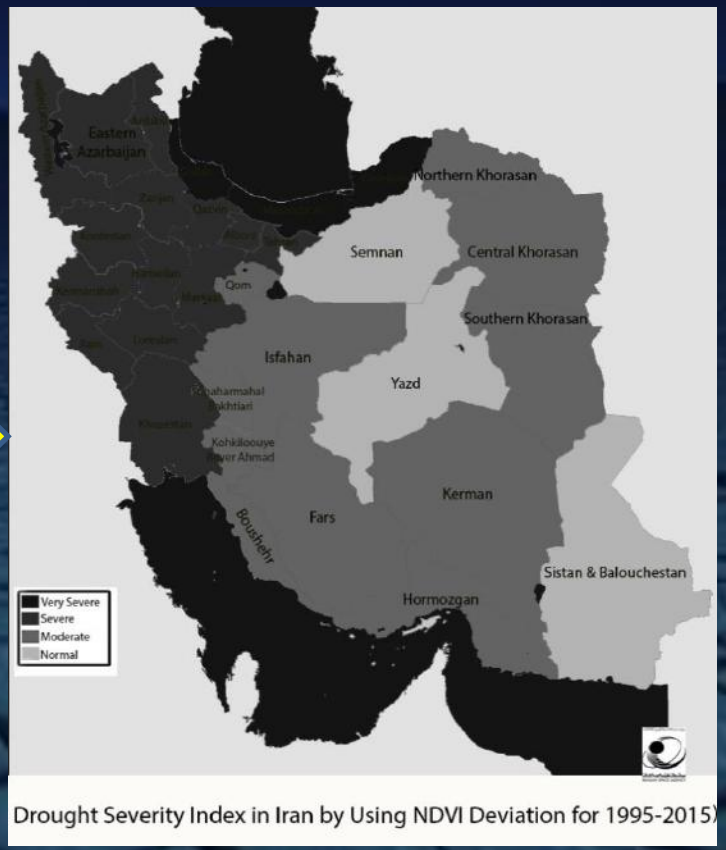


Precipitation Deviaton for 60 Years in Iran for each Province(1950-2010)

Hazard Assessment by Using Remote Sensing Data

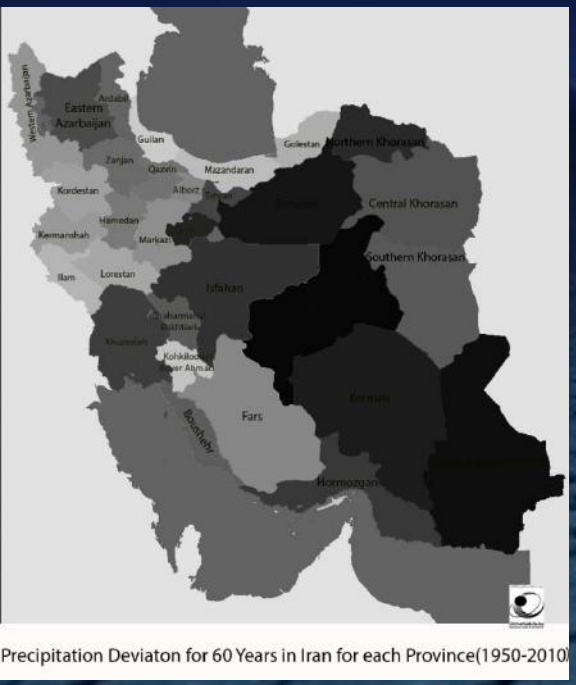
Drought Severity Index by using Terra/MODIS Satellite Data





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

Drought Severity Index= $NDVI_i$-$NDVI_{mean}$



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

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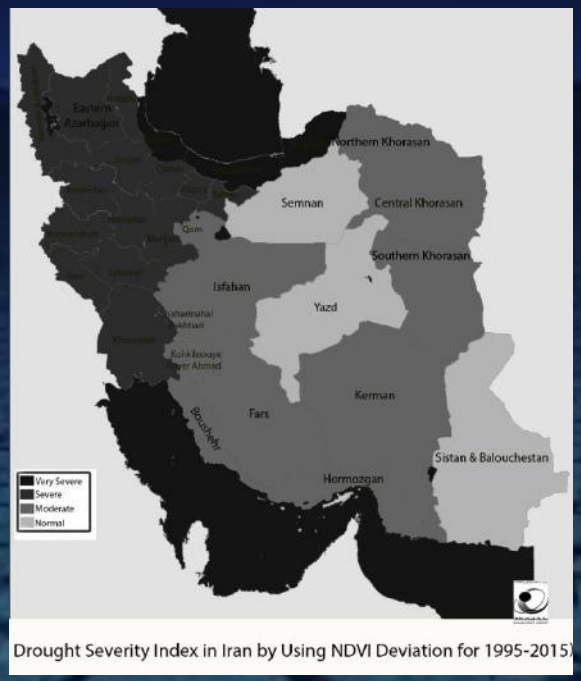

Drought Severity Index in Iran by Using NDVI Deviation for 1995-2015)

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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:

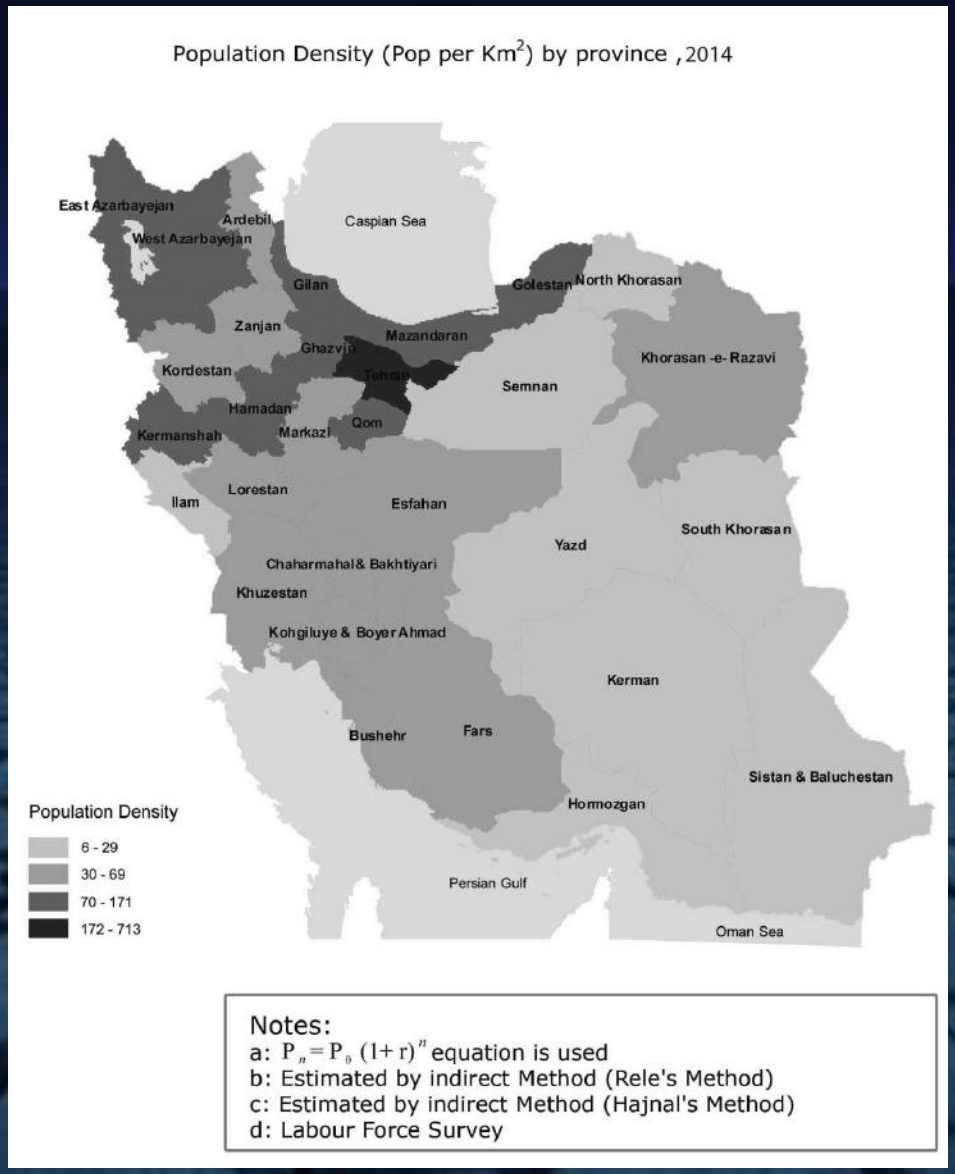
Poverty level:

Agricultural occupation:

Physical/infrastructural factors:

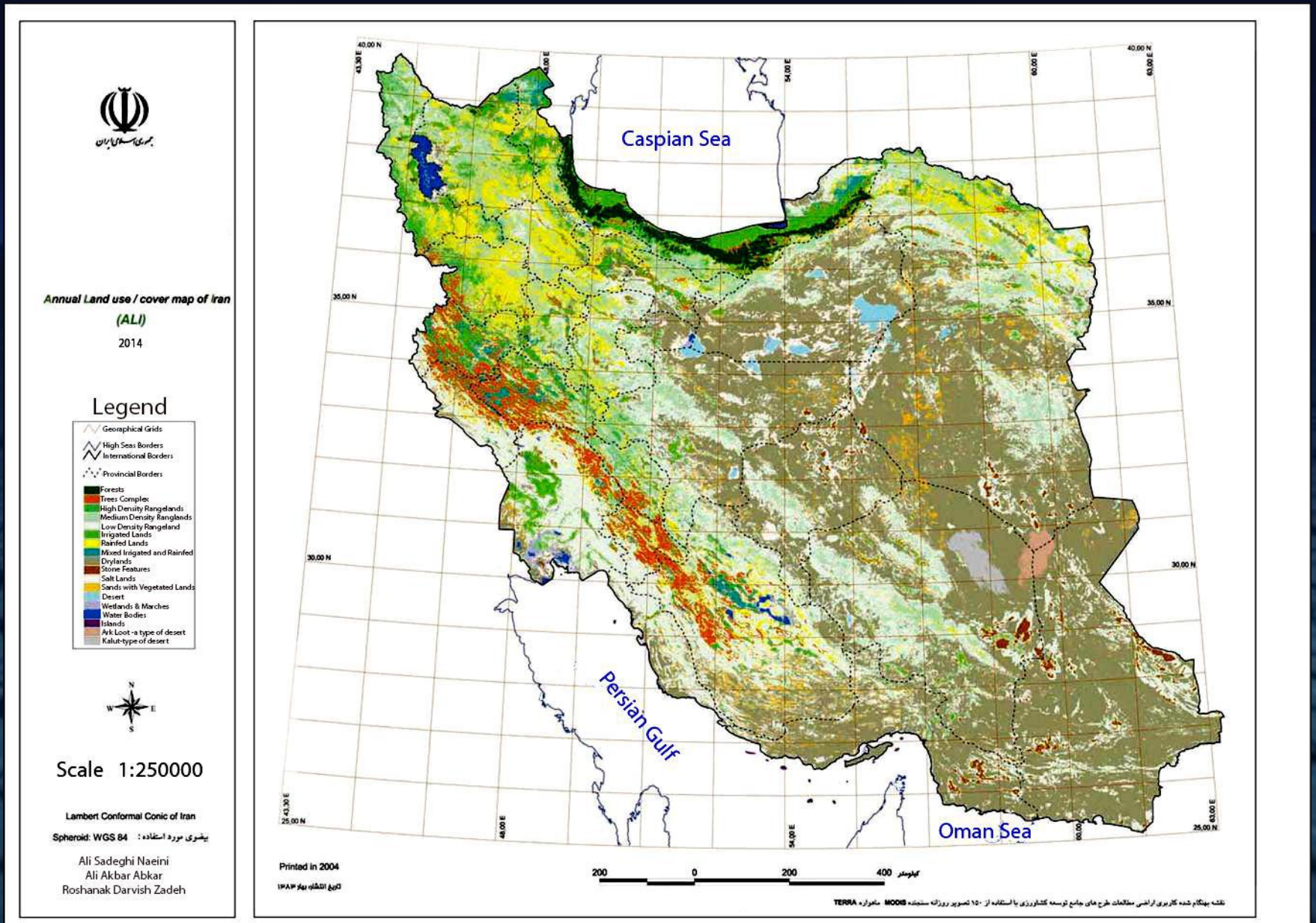
Land Use Map

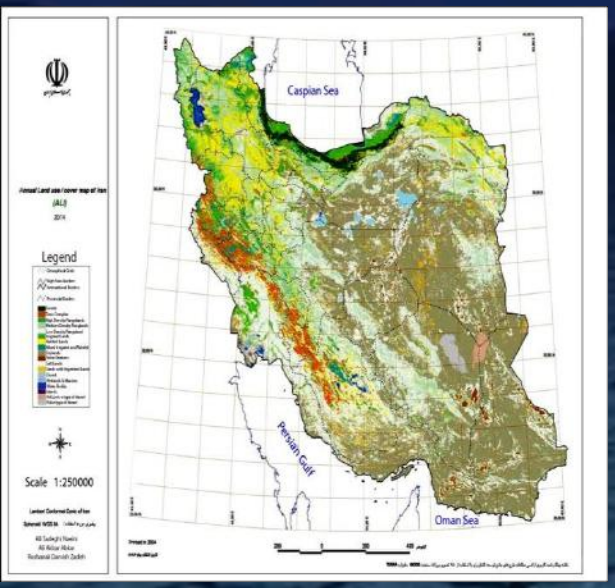
Population Density Map of Iran



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





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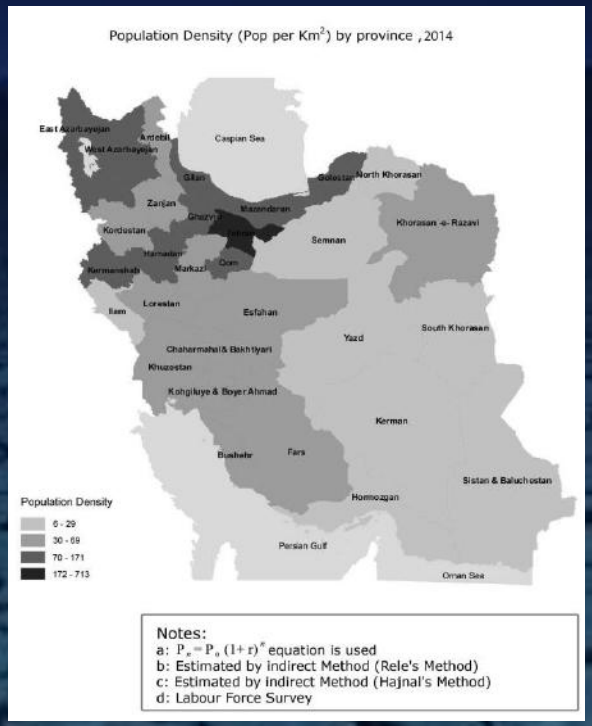

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Output Landuse Map by Using Remote Sensing Data

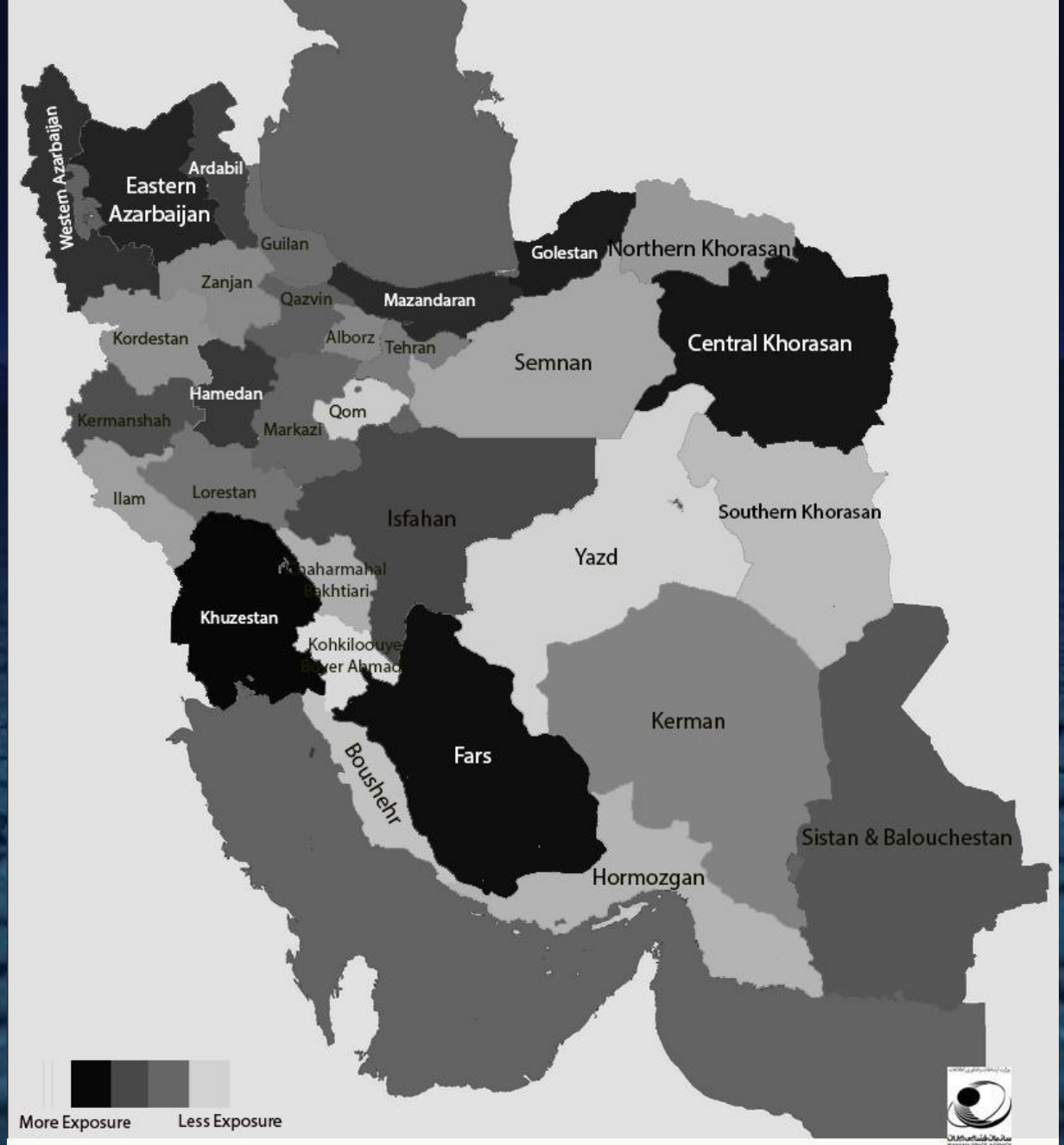
Population Density Map

Final Vulnerability Map

Step (3)

Preparing Drought Exposure Map

The interaction between element at the risk and natural hazard

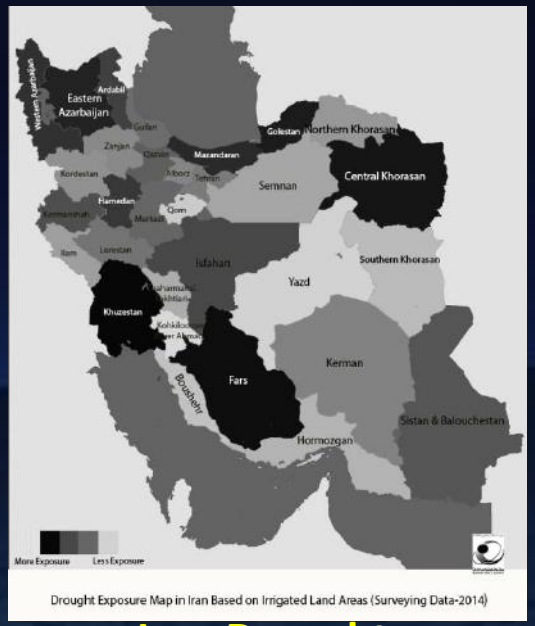


Drought Exposure Map in Iran Based on Irrigated Land Areas (Surveying Data-2014)

Data Source: Iranian Ministry of Agriculture

X

X



Iran Drought Hazard Map

Iran Drought Vulnerability Map

Iran Drought Exposure Map

Hazard X Vulnerability X Exposure= Risk

Iran Drought Risk Map


Caspian Sea
Western Azarbaijan
Eastern Azarbaijan
Ardabil
Zanjan
Qazvin
Kordestan
Alborz
Tehran
Semnan
Northern Khorasan
Central Khorasan
Hamedan
Kermanshah
Qom
Southern Khorasan
Ilam
Lorestan
Isfahan
Yazd
Chaharmahal Bakhtiari
Khuzestan
Kohkiloo Boyer Ahmad
Kerman
Fars
Boushehr
Sistan & Balouchestan
Hormozgan
Persian Gulf
Oman Sea
Very Severe
Severe
Moderate
Normal
Iran Drought Risk Map (2015)


Thank you!