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Climate Change Impacts on Iranian Ecosystems

With review on Climate Change Study Methods



By:
Mostafa Jafari

In the Name of God

Climate Change Impacts on Iranian Ecosystems

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Climate Changes: Natural Ecosystems and Urban Areas

**By:
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Climate Changes: Natural Ecosystems and Urban Areas

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Dear Brother Mostafa,

I was reading the book (**Climate Change Impacts on Iranian Ecosystems**) while attending my many other commitments; I am really sorry for the delay.

The book is timely, comprehensive, and its content relevant and very interesting. It definitely will represent a valuable contribution to better understanding the interactions and impacts between natural ecosystems, urban areas and the current context of climate change. It will no doubt provide an excellent tool for scientists, students, decision makers and even the general public, for awareness raising and behavior changes;

Looking forward reading your book soon,

Pape Djiby Koné

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Summary

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Summary:

Importance of Global Warming and its' effects on natural resources, plants, animal and in general on human life are among subjects that received attention of scientists and politicians in recent years. United Nations Framework Convention on Climate Change as a legal document has been signed in Rio and approved by governments. To control and reduced gas emission and keep them in certain level Kyoto Protocol was agreed. I.R. Iran was among those governments signed convention in Rio and ratified later. Acceptance and ratification of Kyoto Protocol by the Government of I.R. of Iran announced officially to the secretariat. Hence, from two points of view, technical and political, this issue could be considered.

Carbon dioxide and other produced gases have involved in warming up the Earth. Scientists found this warming up resulted from increase evaporation and density of water steam in atmosphere. As a result,

precipitation pattern including rain or snow will change. Other fact and projection shows, warm and dry regions, will become warmer and drier. Climate change is a phenomenon that simultaneously effects with change in temperature precipitation and carbon dioxide, so, changes in all three factors should be considered in the same time.

Climate change issue and study of global warming attract scientists significantly. Four reports published by Intergovernmental Panel on Climate Change show lack of adequate research result on climate change for the Region and it means there are not significant published research from the Near East and Central Asia, which could be used for compellation of the reports.

I.R. of Iran is located in the North Temperate Zone from 25 to 40 degrees latitude and 44 to 63 degrees longitude, with a total area of approximately 1,650,000 square kilometers. A 50% of total lands area is covered with high mountain ranges. Elevations range from 26 meters below sea level on the shores of the Caspian Sea to 5671 meters above sea level at the pick of the Mt. Damavand.

Drought or water deficiency is one of the most critical climatic factors in Iran. About 50% of Iran can be classified as arid or semi-arid zones. Climate parameters, particularly precipitation varies significantly in different parts of the country. There is not a good annual rainfall distribution in most regions of Iran, which limits the plant development and growth. Not only high temperature in southern, central and lowlands of Iran is a limiting factor, but also low temperature in northern, western and highlands is another limiting factor too.

Forest ecological zones in Iran could be categorized as follow:

- a) North, Caspian forest,
- b) West, Zagros forest,
- c) North West, Arasbaran forest,
- d) South, Subtropical forest in Persian Gulf areas, and
- e) Central, Scattering forests.

The Caspian forest possesses a closed canopy of deciduous forest, unlike the arid to semi-arid landscape throughout most of Iran. These forests belong to the broadleaf deciduous biome, which is widely distributed from North America to Europe and Asia. There are close similarities in the physiognomic and taxonomic aspects between Caspian forests and European and American deciduous forests. The Caspian region receives the larger part of the country's precipitation while the central desert (Dasht-e-Lut) is faced with permanent drought.

Some of the main species of Caspian forest could be listed as *Fagus orientalis*, *Carpinus betulus*, *Acer velutinum*, *Quercus castaneifolia*, *Fraxinus excelsior*.

Analysis of climate change factors in Caspian Zone forests investigated for past half century. In a research work whole forest areas in southern part of Caspian Sea were monitored by study on vegetation map and visiting field. Four meteorological stations data, in three points representing major part of Hyrcanian Forests from wet part in west to drier part in east, used for investigation.

Most of climatic factors including maximum, minimum and mean annual temperature; daily and annual precipitations were investigated. Mainly, trends of mean annual temperature and annual precipitations were used for conclusion. It can clearly be concluded that during last half century, climate in forest area in Caspian region become warmer. Precipitation trends especially in Anzali station that has highest precipitation records in Iran and also in Gorgan station have decreased. Precipitation trends in Rasht and Baboulsar stations have shown positive change.

During last 49 years in Rasht station mean annual temperature increased about 1.28 °C and even its minimum temperature shows 2.45 °C increases. Increase mean annual temperature in Baboulsar station in last 54 years is about 1.44 °C and its minimum temperature shows 1.80 °C increases.

Decrease of annual precipitation in Anzali station during last 54 years of records is about 409.4 mm and amount of decrease of precipitation for the period of last 53 years in Gorgan station is about 55.6 mm.

Distribution of plants are directly depends upon temperature and precipitation conditions in each climatic zone. In study zones especially in Gilan and Gorgan areas temperatures shown more than one degree increases and main species of vegetation cover moved upward about 100 meters.

As consequences of climate change factors like temperature and precipitations, trends of wind have changed in Caspian region. The number of days with thunder and storm (DWTS) and its relation with changing factors investigated in the Caspian region over the last half century.

Thunder and storm fluctuations as consequences of climate change were studied. The results indicated that, as consequence of climate change by means of increasing temperature and changing precipitation trends, number of days with thunder and storms (DWTS) also increased in forest area in the Caspian region, during last half century. The number of days with thunder and storms in last half century especially in last 25 years in Rasht and Gorgan stations showed a sharp increase. This is in the same line of increasing mean annual temperature about 1.28 °C and minimum temperature about 2.45 °C in Rasht station. Also it is against decrease of precipitation for the period of last 53 years in Gorgan station which is about 55.6 mm.

Under coastal climate condition like in Anzali and Baboulsar stations, have a fluctuating trend of DWTS but also showed a mild increase in the trend of DWTS during last fifty years. This is in favor of increase mean annual temperature in Baboulsar station in last 54 yeas is about 1.44 °C and its minimum temperature about 1.80 °C increases. Also again it is against decrease of annual precipitation in Anzali station during last 54 years of records which is about 409.4 mm and amount of decrease of precipitation for the period of last 53 years in Gorgan station that is about 55.6 mm.

Climate projections in different scales covering Astara region in Gilan province were investigated. The IPCC documents and other research outcomes projected a range of possible trends for surface temperature increase and precipitation changes over the next century. They also

showed that how the trend should vary in various time scales. However, over the next two decades, the climate models predict that Global Mean Surface Temperatures are expected to rise.

Climate change projections are created according to the available climatic data and based upon various scenarios in different extent and time scales. National institutes like in I.R. of Iran are using downscaling projections for more precise results.

Various climate change projections in global, continental, regional and local scales have been examined in special forest ecosystem in Astara. To study past climate conditions, main climatic factors namely temperature and precipitation as well as relative humidity and wind were considered. Heating degree days, cooling degree days and sunshine hours were analyzed.

Downscaling climate projections in national and local scales have some agreement and disagreement with global, continental and regional projections. According to all reports in different scales temperature of Astara region, in last half century has been increased. Longer time period will face with higher values of increasing temperature in the study area. Astara include in both of Central Asia and West Asia sub-regions. Projection for temperature change in Central Asia sub-region is not in agreement with national and local downscaling results.

Precipitation in last fifty years decreased in Middle East, with some seasonal increase. Gilan province experienced decrease of precipitation in Anzali and increase in Rasht stations. Precipitation in Astara increased with some seasonal decrease and changes.

According to the global projection based upon scenario A1B (2090-2099) in winter season, west of Caspian Sea including Astara will experience 10% increase of precipitation and in summer time 20% decrease of precipitation. This is in agreement with Central Asia sub-region projection and in disagreement with West Asia sub-region projection. Projection for precipitation changes in Middle East and results obtained from downscaling program in national and local scales are more or less in the same line and in agreements with these

projections. It seems for future projection of precipitation in Astara area we can use global, Central Asia sub-region, Middle East, national and local downscaling projections.

A National Research Project on Climate Change Impacts on Forest Ecosystems in RIFR is ongoing with the project title of: "Investigation on Climate Change Effects on Forest Ecosystems in Gilan and Mazandaran Provinces with Emphasize of Wood Dendrology Studies".

Investigation on different wood specimens as discs or increments cores, and also collecting old trees samples and ancient wooden material, on their annual rings will provide basic knowledge to give following outcomes:

- 1- With considering tree annual rings as response to the effect of climate factors, past climate condition could be estimated.
- 2- With using meteorological data for the period that data are available and investigation on correlation of annual ring width and climatic data, climate condition of the years which data are not available could be interpreted and explained.

Methodology of the project could summarize as follow:

- 1- Project areas are in Hyrcanian forest zone in North of Iran, in southern part of Caspian Sea, on northern slope of Alborz mountain range. Hyrcanian forest is a narrow line of temperate forest with rainfall from more than 2000 mm per year in west down to about 600 mm per year in east.

First phase of the project is for a period of three years.

- 2- In the beginning, working sites and also tree species have been selected. Nature of tree rings and distance of site to the meteorological stations and availability of data are important factors for these selections. The project concentrates on dendroclimatology, to study effect of climate change on forest ecosystems.

Candidate tree species mainly could be among Beech (*Fagus orientalis*), Hornbeam (*Carpinus betulus*), Maple (*Acer velutinum*), Oak (*Quercus castaneifolia*), Alder (*Alnus subcordata*) or in second priority among Linden (*Tilia*), Walnut (*Juglans*), Chestnut (*Castanea*), Poplar (*Populus*), or Ash (*Fraxinus excelsior*).

- 3- Obtain wood specimens by coring or discs (if harvesting is in processes)
- 4- Measurements of tree rings width (crossdating by skeleton plotting)
- 5- Tree ring proxy
- 6- Dendrology analysis for chronology and climate elements correlations.

According to the results which would be provided by this research project, periodical drought and warmness may be forecasted. With this knowledge, estimations and forecasts, better management and programming for sustainable management would be expected.



Photo 1: East gate of RIFR, 6 January 2008 (photo has taken by the author)



Photo 2: Garden in front of the main entrance of RIFR, 2 January 2008 (photo has taken by the author)



Photo 3: Main road in the garden of RIFR, 6 January 2008 (photo has taken by the author)

1- Preface

Importance of climate issue in the world engages all scientists, policymakers, and international negotiators, as the United Nations Secretary-General Ban Ki-moon introduced the Caring for Climate (C4C) in July 2007. The Secretary-General challenged Global Compact participants to exercise leadership on climate issues by: a) making climate change a leadership issue for strategy and operations; b) setting emission reduction targets and exploring low-carbon technologies; c) supporting public policy efforts aimed at achieving low carbon economies; and d) sharing experiences and publicly disclosing progress made on an annual basis (Hultmann, 2009).

Most of the scientists and politicians pay attentions to the climate change issues, but it is necessary and very important that carefully constructed message by scientists not being lost in the political noise.

Arid and semi-arid zone are very sensitive and vulnerable to the climate change impacts. Vulnerability to climate change and other hazards constitutes a critical set of interactions between society and environment. The Central Asia are particularly vulnerable due to physical geography, which dominated by temperate deserts and semi-deserts. Aridity is expected to increase across the entire Central Asian region. Temperature increases are projected to be particularly high in summer and fall, accompanied by decreases in precipitation (Lioubimtseva and Henebry, 2009).

Ecosystems are communities of plants, animals, microbes, and the physical environment in which they exist. They can be characterized by their biological richness, by the magnitude of flows of energy and materials between their constituent species and their physical environment, and by the interactions among the biological species themselves, that is, by which species are predators and prey, which are competitors, and which are symbiotic (NAST, 2000). Ecologists often categorize ecosystems by their dominant vegetation, such as the deciduous broad-leafed forest ecosystems, the short-grass prairie ecosystems, or the desert ecosystems. The term "ecosystem" is used not only to describe natural systems (such as coral reefs, alpine

meadows, old growth forests, or riparian habitats), but also for plantation forests and agricultural systems, although these ecosystems obviously differ in many important ways from the natural ecosystems they have replaced (NAST, 2000).

RIFR has responsibility of conservation, protect, improvement and rehabilitation research in the field of renewable natural resources including forest, range and desert ecosystems in national scale. Forests could play a major role in the alleviation of poverty in many different parts of the world. However, forests are dynamic, and their rate of change is accelerating as a result of anthropogenic activities. Climate change, for example, will alter the nature of many protection forests in mountainous areas, exposing the inhabitants to increased risk from natural hazards. It will also affect the viability of plantation forests established in drier areas to combat desertification. Air pollution has already destabilized many forests, and is likely to be an increasing problem in the forests surrounding urban areas in developing countries. Many impacts remain uncertain, and there remains a great need to integrate the biophysical knowledge that currently exists with socio-economic information associated with the impact on forest-dependent communities (Innes and Hickey, 2006).

Assessment, evaluation and consideration of climate change impact on natural ecosystems are difficult and still needs to be improved. Climatologists use two types of data to monitor climate change. The first are historical measurements of temperature, precipitation, humidity, pressure, and wind speed taken at thousands of locations across the globe. Because observing methods, instruments, and station locations have changed over time, climatologists use various methods to crosscheck and corroborate these historical data sets. For example, satellite and balloon records confirm that the planet has been warming for the past four decades, although rates of atmospheric and surface warming differ somewhat from decade to decade. To peer further back into the past, climatologists also analyze physical, biological, and chemical indicators. For example, past climate conditions can be inferred from the width of tree rings, air trapped in ancient ice cores, and sediment deposited at the bottom of lakes and

oceans. Taken together, this information demonstrates that the Earth's climate over the past 10,000 years has been relatively stable compared to the 10,000 years that preceded this period and compared to the 20th century (NAST, 2000).

According to the long term goals and also shorter term objectives of RIFR caused its' interest to deal with research on climate change issues and related studies. The national assessments of vulnerability and adaptation on forest, range and desert ecosystems has been completed by the author in year 2007 and also managing a national project to investigate impact of climate change on Hyrcanian forest ecosystems by using dendrochronology method is under going.