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Climate Change and Global Warming; Climate Change Vulnerability in local scale

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ABSTRACT

Climate change refers to any apparent change in the patterns expected of the climate, which occurs in the long term in a particular region or for the entire global climate. These changes are due to unusual occurrences in the Earth's climate. Iran, like many countries, is exposed to climate phenomena, which in turn will exacerbate the crisis of water and drought. In this study, we will analyze this issue against the phenomenon of climate change in order to estimate the vulnerability of Iran, and to this end, we will use the CVI vulnerability index on the provincial scale. By utilizing the results of this research, it will be clear those suitable solutions to increase adaptation to climate change conditions. The results of this research indicate that Hamadan and Alborz provinces have the highest vulnerability and therefore have the least adaptability to climate change compared to other provinces. On the other hand, Khuzestan and Tehran provinces have the lowest degree of relative vulnerability due to rich water resources, literacy rate and industry's GDP. Given the many differences in vulnerability, decision-makers can develop provincial-level policies to control more vulnerability.

Key words: Climate change, Sensitivity, Exposure, Climate Vulnerability Index, Adaptive Capacity.

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1. INTRODUCTION

Climate change is one of the most important challenges in human life. This issue exacerbates phenomena such as extreme events (droughts and floods), the prevalence of contagious diseases, ocean elevation changes. The estimation of vulnerability estimates and, consequently, the preparedness of systems in dealing with these changes are important issues related to the change of morality. In order to develop a strategy to adapt to these global changes, it is necessary in the first step to make an accurate assessment of this vulnerability. Environmental, economic and social indicators all over the world are used to highlight human conditions and natural ecosystems. The index structure varies depending on the measurements and the requirements of the report. Two types of structures are identified for indicators: the first group is the structures that measure the system conditions, and the second group measures the causal relationships. Many of today's indicators are a combination of the two categories that identify the current situation and factors that exacerbate the situation (SRWP, 2010). It is difficult to set a benchmark for vulnerability (Danning, et al., 2001). For the first time in 2001, the Climate Vulnerability Index 3 was presented (Sullivan and Maugh) and UNESCO, as the key indicator of the evaluation. The United Nations World Water Development Report has also been used, and the climate change vulnerability index can show human vulnerability in any arbitrary location, which reflects a wide range of social and physical factors shows the spatial scale. This indicator is based on the concepts of the Poverty Index (WPI). In order to obtain this indicator, social, economic, environmental and physical data are combined to provide realistic estimates of vulnerability (Sullivan & Maugh, 2005).

Over the past ten years, there have been a number of indicators of vulnerability, sustainability and quality of life. Among them, the Social Security Index (SVA) (Vintage 6, 2004), the Common Vulnerability Index (PVI) (Edger 7, 2004, the Environmental Vulnerability Index (2009, 8UNEP) (EVI), the Biological Sustainability Index The Environment (ESI) (Esti et al., 2005), the Human Development Index (HDI) (Board of Sharps 10 et al., 2009) and the Human Welfare Index (HWI) (Prescott Allen, 2001-11).

Many of these attempts were national comparisons and less attention to regional levels. In other words, these indicators are used for the same comparison to describe the whole country, although there are significant differences in terms of sensitivity, exposure and

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effects in each country. Studies in the field of assessing the development of quantitative indicators of climate sensitivity and adaptability continue at various scales (Han et al., (2009). Climate change sensitivity and adaptation indicators, like all other indicators, are facing a lot of problems (Eriksen & Kelly, 2007). It should be noted that the knowledge necessary to understand the vulnerability of climate diversity and its relationship with the identification of hazards does not have sufficient growth. One of the problems is the lack of appropriate methods for integrating different factors. Iran is located in the Middle East region. This country is limited to the Caspian Sea to the north and to the Gulf of Oman to the south. Iran is the second largest country in the Middle East, and has a climate variable in terms of climate. Its temperature ranges from -20 ° C to + 50 ° C throughout the country (Madani,2014). Rainfall dispersion is not the same throughout the country. (UNFCCC 2003). In central parts of Iran rainfall is less than 50 mm and on the coast of the Caspian Sea up to 1000 mm per year. The average annual precipitation is about 240 mm, which is less than one third of the world's annual rainfall. The volume of annual precipitation in Iran is estimated at 400 billion cubic meters, of which about 105 billion cubic meters will be converted to surface waters (Iranian Water and Power Resources Development Company, 1390 Per capita income of each person during the period from 1962 to 2012 decreased by 70% (FAO, 2010). (The main reason for this is the rapid population growth of 3.7 times), and the decline in rainfall (Iran's Statistics Center. 2011 the highest water content (92%) is used for agricultural purposes. According to the definition of the Intergovernmental Panel on Climate Change (IPCC), vulnerability is affected by the magnitude and severity of climatic events in which a system is exposed to negative impacts. IPCC (2007) .Therefore, vulnerability assessment is important. Integrating large and complex data sets is critical to reviewing the status quo and for environmental decision making. Accordingly, vulnerability is assessed in the Iranian provinces using the Critical Vulnerability Index (CVI). This indicator is applicable to large scale areas. This means that while local or regional areas are being evaluated, local changes within the country can also be revealed. Although there has not been any discussion of the choice of indicators or specific indicators so far (Sullivan And Huntington, 2009) .Nevertheless, this issue is one of the most important achievements in this field and serves as a framework for analyzing and evaluating vulnerabilities (Polski, et al., 2007).

2. METHODOLOGY

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The CVI Index is used to manage integrated water resources. This index is an indicator of the WPI index and consists of six main axes for demonstrating the impact of climate change on water resources. These components include resources (R), geographic features (G), utilization and economic efficiency (U), access (A), capacity (C), conservation of environmental integrity (E). Each of the main components of WPI, namely resources, access, capacity, use and the environment, are related to human vulnerability, and those variables that are exclusively related to the effects of climate change are considered to be CVI calculations. In this regard, numerous country-level studies have been conducted on a regional scale. The selection below indicators should be made with regard to the vulnerability and climate change relationship. The best way to select these sub-indicators is to consult with relevant specialists. Table (1) shows the selected data for this study. After selecting the relevant data, the final indicator for the different regions will be derived from the averaging of these six components.

$$CVI = \frac{r_r R + r_a A + r_c C + r_U U + r_e E + r_g G}{r_r + r_a + r_c + r_U + r_e + r_g} \qquad (1)$$

In the above relation, r is the weight of the component of each factor that is considered here to be consistent with global research (Sullivan and Maugh, 2005). Obviously, indicators are different in units and scales, so each one These variables should first be normalized to be comparable. In 2002, the method developed by the United Nations Development Program (UNDP) to extract the "Human Development Index" was used to provide data Uniformly and standardized with values between 0 and 100. (UNDP ,2002).

$$\text{Indicator Value} = \frac{100 \times (\text{Real amount} - \text{Minimum amount})}{\text{Maximum value} - \text{Minimum amount}}$$

In variables marked with *, the index value is reversed using (index value- 100). This is necessary to ensure that the values of the indicators with high values indicate sensitivity in all cases. For example Regarding the level of literacy, wherever the level of literacy is high, human capital is more available and less vulnerable, while by reversing the index value, whatever The index has a higher value, the lower the level of literacy and hence the greater the vulnerability.

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Table 1, Vulnerability Index Variables

CVI components	Variable	Unit	Resource
Resources (R)	Surface water assessment *	Million cubic meters	Country Water Planning
	Underground water discharge rate	Million cubic meters	Country Water Planning
	Rain *	Millimeter per year	Iran Water Resources Management Co.
	Assessment of water storage capacity and resource reliability*	Million cubic meters	Country Water Planning
Access (A)	Access to safe water and sanitation *	Man	Water and Wastewater Company of Iran
	Population covered by wastewater treatment plants *	Man	Water and Wastewater Company of Iran
	The amount of agricultural land in the blue	Hectare	Ministry of Agriculture
Capacity (C)	Income *	Rial	Statistical Center of Iran, Economic Accounts Office
	Water investment as a percentage of total fixed investment	Rial	Country Water Planning
	Training level *	Man	Ministry of Education
	Death rate below 5 years	Man	Ministry of the Interior
Utilization and economic efficiency (U)	Household water consumption rate	Liters overnight	Water and Wastewater Company of Iran

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	Use of agricultural, industrial and urban water and their contribution to GDP *	Rial	Statistical Center of Iran, Economic Accounts Office
Environmental integrity preservation (E)	Livestock density	Number of livestock on the area	Ministry of Agriculture
	Types of ways covered by the Ministry of Roads and Transportation	Kilometer	Ministry of Roads and City Planning
	Abandon habitat	Hectare	Organization of forests and pastures and watershed management of the country
	Droughts	-	State Meteorological Organization
Geographical Features (G)	Average distance from the provincial centers	Kilometer	Organization of road and transportation
	Human population density	Number of people per area	Statistical Center of Iran
	Vegetation cover *	Hectare	Organization of forests, pastures and watershed management of the country

The variables marked with * must be reversed to reflect negative effects. For example, high rainfall can increase water resources, thereby reducing water vulnerability or increasing the density of the livestock by increasing vulnerability. This means that the rain rating should be reversed to reflect its impact on the overall CVI score.

3. RESULTS

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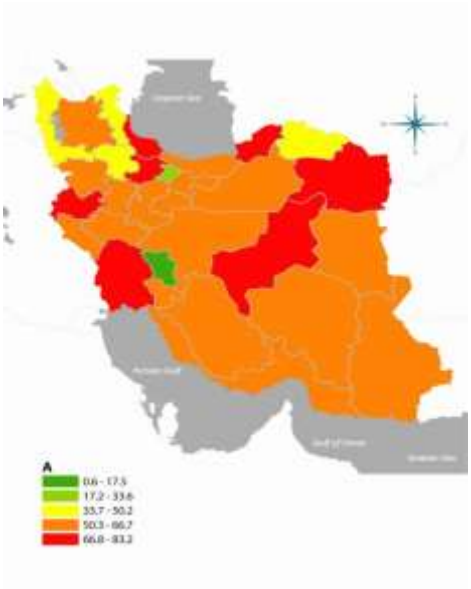
On the basis of indicators, components, calculations and zonation's, six planes were mapped. The map illustrates the effects of climate change and global warming on Iran's territorial boundaries. Based on computations and design drawings, the number of one finalized map of Iran's vulnerability to climate change and global warming has been achieved.



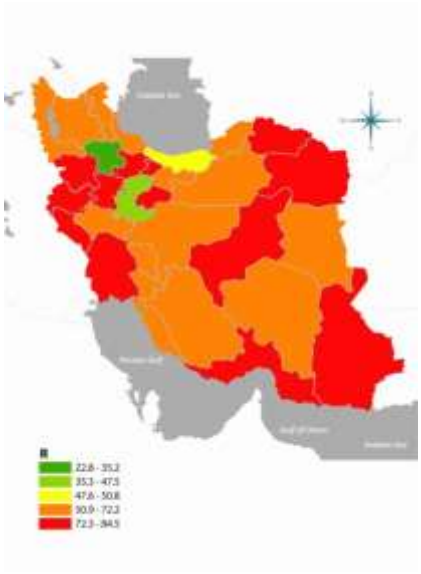


Figure.1.Component; Access (A)

Figure.2.Component;Resources (R)

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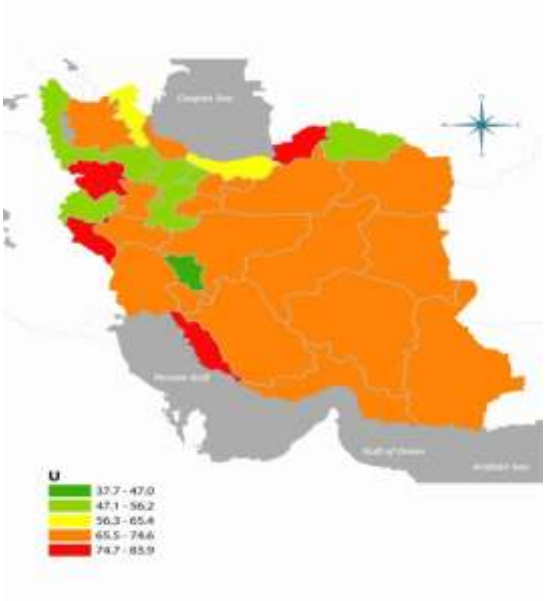


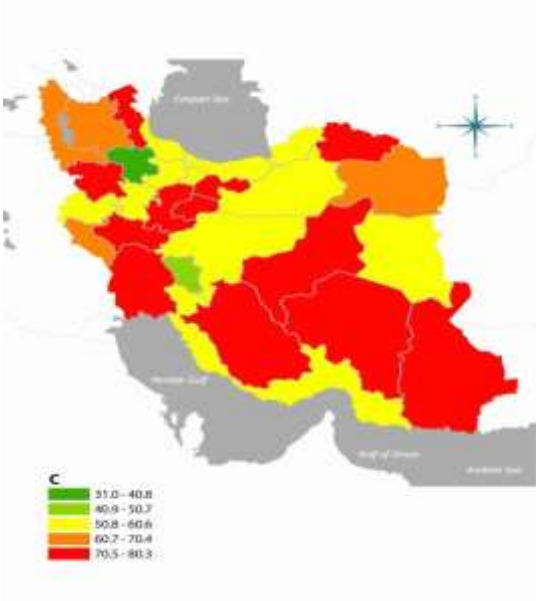
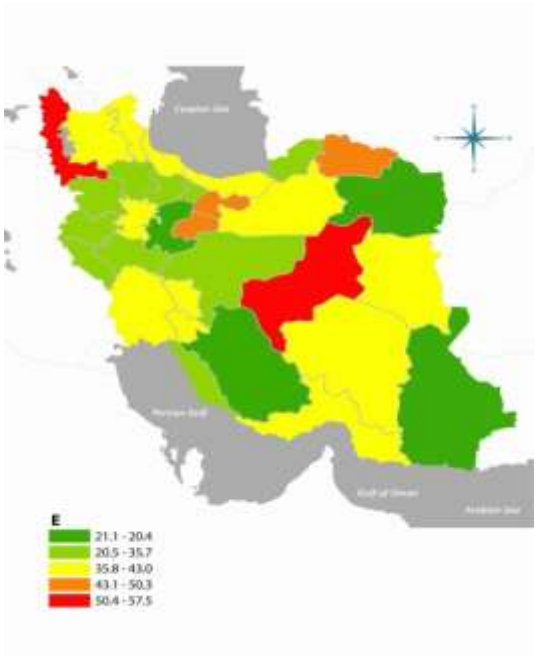


Figure.3. Component; Utilization and economic

Figure. 4. .Component; Capacity (C)

efficiency (U)



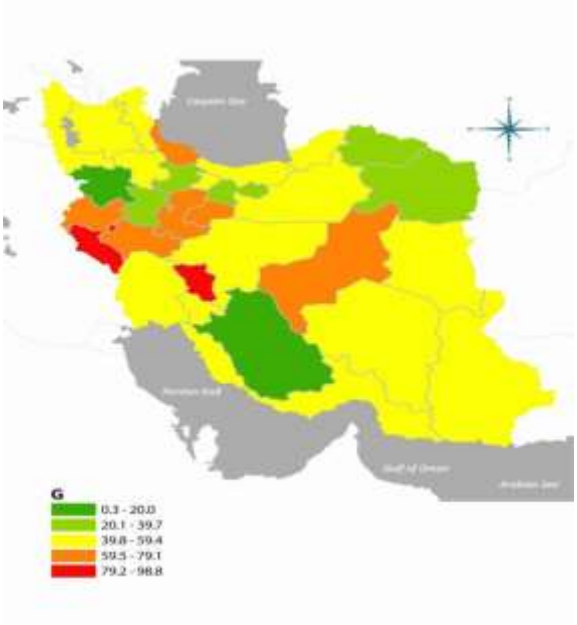


Figure. 4. .Component; Environmental integrity

Figure.5. Component; Geographical

preservation (E) **Features (G)**

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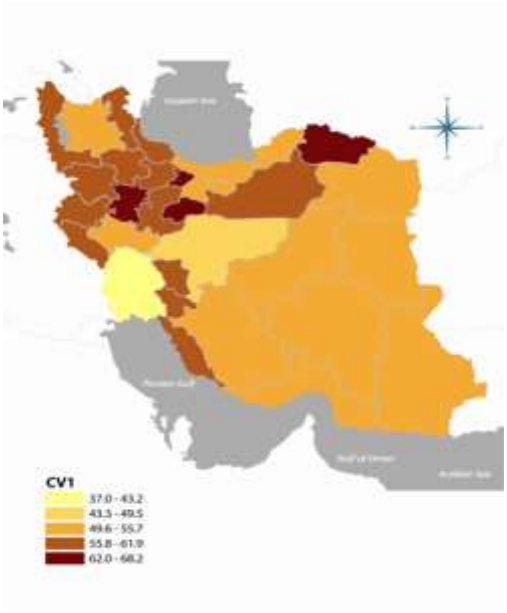

Figure.6. Iran Climate Iran's climate vulnerability

Climate Vulnerability Index in provinces in Iran

CVI components	Resources (R)	Access (A)	Capacity (C)	Utilization and economic efficiency (U)	Environmental integrity preservation (E)	Geographical Features (G)
56	69	58	62	66	30	49

This research shows the vulnerability of Iran's provinces to climate change using the CVI (Climate Observation Index) in 2016. The results of this study show that Hamadan, Alborz and Qom provinces are the most and provinces of Khuzestan, Tehran and Isfahan have the least degree of vulnerability to climate change phenomenon than other provinces of the country. Having the highest frequency of drought and the lowest amount of vegetation and minimum available data are the main reasons for increasing vulnerability. On the other hand, having adaptive capacity, income, and education level is one of the best reasons for low relative vulnerability.

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