Journal of Environmental Sciences Studies

Journal home page: www.jess.ir

Assessing agricultural security on the outskirts of hilly cities in the face of climate change and land use in the 2050 (Sanandaj study area)

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Received: (2022-09-24)
Accepted: (2022-11-20)

Abstract

The importance of food security is one of the most important parameters of the sustainability of a society or ecosystem. There are three basic pillars to sustainability that agricultural security and sustainability is a top priority for any society. With climate change and agricultural use, this security is sensitive and important in mountainous areas where agricultural lands are limited and underdeveloped. In a recent study, in order to identify the trend of land use change and climate change, I studied food security for the 2050 horizon in mountainous areas that have high sensitivity and vulnerability; Therefore, for their study, sentenl2 satellite images were used to extract land user and monthly climatological data for climatic parameters from 2000 to 2020. For the 2050 period, RCP climate modelling and land use change were produced by the method of producing the effect of climate on land use and agricultural cover. The results of climate change showed an increasing trend of rain with high peak frequency and a decrease in snow level and increase in temperature in mountainous areas. These parameters for the input in the LCM model show that the per capita reduction of forests will be seen from 818 square meters to 284 square meters and in the agricultural sector from 410 square meters per capita of rainfed farmers will increase to 652 square meters per person in 2000, despite this increase; Agriculture, the results of the model show that agricultural production in steeper slopes with more severe climate fluctuations will cause less production and more environmental degradation. Aquaculture will be the biggest loser of climate change during 2050; Gardens will also be among the resources and type of agricultural activity during the forecast period. With the bankruptcy of water resources and climate fluctuations, drought and sudden cold of the mountains will be justified, so the per capita in this city will be limited to 25 meters.

Keywords: Climate Change, Mountain Farm, Time Sires,DPSRI, Sanandaj

Introduction

According to the United Nations definition in 1986, food security is defined as the access of all people to adequate food at all times to maintain a healthy body(FAO Stat 2014). According to this definition, food availability, access to food and sustainability in food intake are the three main pillars(Argent 2019). Food safety and food safety are now addressed in development documents and used by officials. Food security is the access of all members of a society to adequate and healthy food for a healthy and active life at all stages of life, and household income is an important factor in ensuring food security in a social system(HLPE 2013; Development 1995). In recent years, unsustainable agricultural system has led to instability in production and endangered food security(Hossein et al. 2010). Various Factors Today, world food security is threatened by various factors such as agricultural land constraints, water scarcity, high energy prices, declining investment in agricultural research and increasing food waste, so it is important to consider ways to deal with those threats(Comino et al. 2014; Razpotnik Viskovic and Komac 2018). Evidence shows that according to the country's production capabilities, in case of agricultural development by increasing crop yield per unit area, control of pests and diseases, increasing soil and water range, reducing production waste, improving nutrition pattern can achieve sustainable food security at the macro level(Oñate-Valdivieso and Bosque Sendra 2010; "WHO | Iran" 2020) Due to the pressure on the fragmentation of agricultural lands and the creation of property due to socio-economic tensions, especially in mountainous areas that are faced with land suitable for agriculture, the security and stability of agriculture is in serious danger(Alonso-Pérez et al. 2012; Wojtkowski 2008; Sefidi et al. 2011). In the suburbs, the need for land to provide housing and recreational areas has created a serious pull to destroy and stop farming in the suburbs. Among the various activities in rural areas, agriculture is the one that has suffered the most from climate change(Pachri et al. 2013; Adhikari et al. 2018). This claim is confirmed by the observations of the International Committee on Climate Change. It is unpredictable and also the severity of climate events caused by climate change such as storms, droughts, floods have increased. Climate change models show that in the future, the temperature of all regions will change and affect rainfall patterns, consequently affecting agricultural production as well as food security and nutrition(Zheng et al. 2014). However, in some countries, it may lead to increased production of some crops by expanding the potential for agricultural density in temperate regions. One of the weaknesses of climate models is the lack of local effects of climate change, which has caused great concern for food insecure areas(Al-Kaisi et al. 2015) Most studies have shown that climate change has a significant impact on crop yields. Ultimately, it affects food security, and studies have shown that in sub-Saharan Africa and South Asia, agricultural productivity will fall from 20% to 9%. The 2016 World Food Program (WFP) shows that agricultural production per hectare is growing at an average rate lower than the global population, meaning that food produced is unable to meet global demand. The Food and Agriculture Organization reported that the climate affects the production and change of different food patterns These risks can have a greater impact on local populations such as small villages and suburbs Rural areas in Asia are in dire straits as a result of climate change These consequences lead to a decrease in agricultural production and an increase in food prices(Sylvestre et al. 2013). The combination of these events ultimately leads to natural and human challenges, increasing tensions and exacerbating the phenomenon of migration. According to the preliminary report of the general census in Iran, agriculture in 2010, the area of agricultural lands of the country (including agriculture, fallow and orchards) without considering forest, afforestation and rangeland management is reported to be about 1.5 million hectares, which is compared to the 2000 general agricultural census. It was announced that 1.5 million hectares would show a decrease of 6.5 percent, which is one of the important reasons for this decrease, including frequent formal and informal changes in land use from agricultural to non-agricultural. Also in the above period, a decrease of 3% of the area of agricultural lands for planting annual crops is observed (Statistics Center of Iran 2015) (Kavian and Jafarian Jeloudar 2011). In general, any action that hinders the exploitation and continuation of agriculture in agricultural lands and orchards is considered a change of use, and all measures that are taken in agricultural and garden lands. It is considered as an example of land use change without observing the relevant rules and regulations and obtaining permission from the commission and approval of the agricultural organization in the form of plans and preventing the continuation of production, operation and continuation of agriculture. For example, harvesting or increasing sand, excavation, embankment, excavation, construction and construction, etc. In the last few years, about 3,000 hectares of irrigated agricultural land around the cities and districts that have had the highest yields have been destroyed and turned into villas, buildings, industrial, etc., which is estimated to have been lost in the 1990s. About 1.7 million tons of basic necessities of the country were lost and in the same year 4.7 million tons of cereals were imported from foreign countries(Bahrami et al. 2010) Due to the negative effects of land use change, several studies have investigated this issue. In its research, it has studied the economic, social, agricultural and environmental consequences of land use changes (Vaz et al. 2012). The results showed that the two factors of population growth and tourism demand had the greatest impact on land use change and sales in this area. The results of study in Isfahan show that during 3 years (1918-1993) about 4 thousand hectares of the best agricultural lands in this region have changed their use and become residential, urban, industrial and workshop areas(Mohammadi, Hasheminejad, and Taebi, n.d.). Abdullahi et al., in their studies showed that with the increase and development of land use changes, a range of environmental changes is seen that is more related to the change of use of agricultural areas to residential and industrial(Kamal, Muhammad, and Abdullah 2020). Increasing Work opportunities and income are among the positive effects of this land use change(Phillips and Gholamalifard 2016). examined the factors affecting land use change in rural areas of Rasht city and the results of field observations and questioning of users indicate that the most important factor in changing land use is rangeland forestry and economic factors(Dumka et al. 2019). Jamalipour et al ,2015. Using the two-stage Tobit-Hekman model, investigated the factors affecting the formation of land use change in Tonekabon, Mazandaran(Assessment et al. 2012). Agricultural plots, area under cultivation of land, price of agricultural land and horticultural and agricultural insurance and the negative impact of variables on family size, level of education, experience, price of horticultural land, price of agricultural and horticultural products and satisfaction of support institutions on the rate of land use change in an analysis of the change of use of urban lands in Tabriz concluded that the process of destruction is threatening and with the continuation of the current trend, 5 hectares of green spaces and lands around the city of Tabriz will be built. Continued sporadic development will not only lead to the destruction of suburban environments, but will also lead to spatial and social disruption of the city and increase development costs such as the commissioning of urban infrastructure(Feizizadeh, Jankowski, and Blaschke 2014). According to studies and changes in life today, the process of land degradation and conversion in different aspects of life can be felt and understood. has it. In mountainous areas, cities are rapidly transforming the surrounding fertile lands into residential or smallholder areas that do not have significant production capacity due to lack of land and dimensions for further development. Today, climate change has added to recent pressures, dragging agriculture alongside petty property into the abyss of absolute bankruptcy; Therefore, in order to better plan and maintain a sustainable framework, it is important to first outline the dimensions of destruction and the segregation of the share of each land use and climate change in agricultural areas. Finally, by formulating a plan, identify potential areas and protect them from existing dangers and threats; Therefore, the aim of the recent study is to estimate the damages of land use change and climate change on fertile farms and to map food security in these areas by 2050.

2. Materials and Methods

2.1. area of study

The study area of Sanandaj city is one of the cities of Kurdistan province in western Iran. The center of this city is Sanandaj. The central part of Sanandaj city is divided into sections: Abidar village, Arandan village, Hosseinabad village, Suburban (Sanandaj), Naran village, Sarab Qamish village (fig.1). The population of this city according to the census of 2016, was equal to 501,402 people. The climate of the study area is cold, semi-arid and prone to humidity. It has mild weather in spring and summer. The average temperature in Sanandaj is 15.20 ° C in spring, 25.24 °C in summer, 10.40 °C in autumn and -1.60 °C in winter. The maximum temperature in July is about 44 °C and the minimum in February is -13.5 ° C. The average annual rainfall is 500 mm and the maximum is 61 mm per day(Naqi, Al-Jiboori, and Al-Madhhachi 2021) (Figure.1).

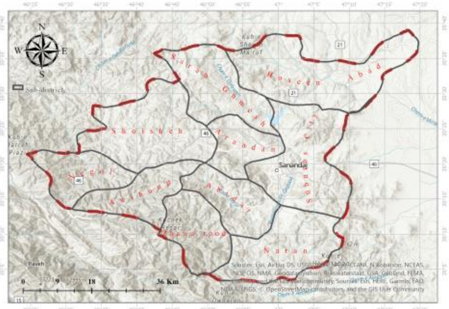
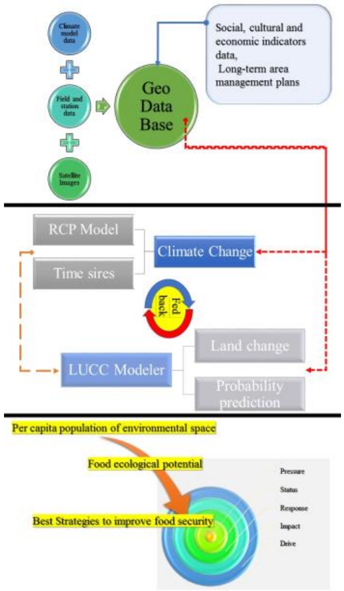


Figure 1 :Area of study

Data used

In the recent study, three basic steps were observed to achieve the goals. In the first stage, a spatial database of climatic information, land use from the region in the field and remote sensing were used. In step 2, the overall modeling of the region in the form of climate change and its effect on the parameters of land use change and changes in the natural conflict were investigated for The future of 2050 was predicted. The third step was to investigate per capita food equations, natural potential of environment and DPSIR model was designed to find the best exposure strategy (figure.2). In order to study the dynamics and changes in land cover, it is necessary to prepare maps that show the state of the land at different times. Therefore, in this research, to prepare a map; Land use the remote sensing images of ETM+, OLI and TM meters of Landsat satellite belonging to the years 2000, 2010, 2020 with a spatial magnification of 30 meters have been used.



1. **Figure 2 :Flowchart of research steps for study food security**

Satellite image processing

Landsat satellite data have initial geometric correction that all images were examined from this aspect and no need for correction was felt. In this study, the monitored method based on the maximum probability algorithm has been used to classify the images. In this regard, in order to perform supervised classification on satellite images, the first step in classifying is to define the areas that are used as educational examples for each class. The required educational samples were selected with prior knowledge of the area and using visual interpretation as well as the use of Google Earth environment on a false color image. After mapping urban and non-urban areas, the Mode filter with 3*3 kernel window was used to remove single and scattered pixels to obtain uniform layers(Shakeri 2020). An error matrix was used to interpret and evaluate the accuracy of the classified map, because the accuracy of detecting changes in the event depends on the accuracy of the production maps of different years. In this study, to evaluate the overall accuracy, the statistical parameters of kappa coefficient and overall accuracy were calculated for each of the maps(Mwaniki et al. 2015).

Land Change Modeler

Detection of land use change is an essential tool for environmental analysis, planning and management. Land change modeling, LCM algorithm has been designed and developed to study the trend of change in order to detect the urgent and growing problem of land change and the analytical needs of biodiversity conservation. Land change modeling provides a tool that can be used to evaluate and experimentally model land use change and its impact on habitats and natural landscapes. Modeling steps are done in 4 steps: 1- Examination of changes; 2- Transmission force modeling; 3- Modeling land use changes; 4- Assessing the accuracy of modeling(Oñate-Valdivieso and Bosque Sendra 2010). The LCM model requires two land cover maps belonging to different times as input. In this study, reductions and increases in each land use, net change, unchanged areas and transfer from each land use to another land use in different land cover classes as a map with part Analysis of model changes was evaluated.

Modeling the trend of spatial-temporal changes of climatic parameters

LARS-WG software model was used to model the climate change trend. Required meteorological data including daily rainfall, minimum temperature, maximum temperature and sunny hours were used from Sanandaj synoptic station. In order to better scenario the two scenarios RCP2.5, RCP8.5 for the 2050 horizon were used(Khwarahm 2020).

Trend analysis

Existence or absence of trend and time series analysis is performed based on two parametric or non-parametric methods. The parametric method is based on a regression method between time series data and time. Nonparametric methods, on the other hand, are more useful for time series that do not have a specific statistical distribution function. The most important analysis procedures were used to analyze the trend, which are:

Medium trend (Theil-Sen)

This test is a robust nonparametric estimator that is recommended to evaluate the amount of change in a short time or with noise. In this procedure, the median slope is calculated by comparing the values of the time series pixels. In the long time series, the results are the same as OLS, but for short series with many disturbances, the results are more reliable because by determining the breaking point in the range of 29%, it means that changes below this range are not considered(Semenov and Stratonovitch 2015).

Mann-kendall

The Mann-kendall index is a nonlinear trend and calculates the degree to which the trend is constantly increasing or decreasing and its range is between +1 and -1; A positive value indicates that the trend is constantly increasing and a negative value of the trend is constantly decreasing, and zero indicates that there is no trend. Kendall s is defined as follows (Eq.1, Eq.2):

Eq.1 $$S = \sum_{i=1}^{n-1} \sum_{j=i+1}^{n} sign(x_i - x_j)$$

Eq.2 $$sign(x_i - x_j) = \begin{cases} 1 & if \quad x_i - x_j < 0 \\ 0 & if \quad x_i - x_j = 0 \\ 1 & if \quad x_i - x_j > 0 \end{cases}$$

Where Eq.1 And Eq.2 n is the duration of the series and xi and xj are the observations at times i and j(Hansen, Sato, and Ruedy 1997).

In Mann-Kendall, significance is expressed based on the importance expressed as Z scores and the probability of random occurrence of the observed trend (ρ) (Eq.3):

Eq. 3 $$z = \begin{cases} \frac{s-1}{\sqrt{\mathrm{var(s)}}} & for \quad s > 0 \\ 0 & for \quad s = 0 \\ \frac{s-1}{\sqrt{\mathrm{var(s)}}} & for \quad s < 0 \end{cases} \quad \rho = 2\left[1 - \varphi(|z|)\right]$$

In fact, a statistical test is used for H0 hypothesis if the absolute value of Z is greater than Zα / 2 where α represents the lowest level of significance. (That is, with a level of 5%, Z0.025 = 1.96) Which confirms the null hypothesis that the trend is significant(Li et al. 2013).

DPSIR model

DPSIR model is (drivers, pressures, state, impact and response model of intervention) is a causal framework for describing the interactions between society and the environment: Human impact on the environment and vice versa because of the interdependence of the components. This framework has been adopted by the European Environment Agency. The components of this model are

Driving forces: e.g. industry, tourism, economic growth

Pressures: e.g. pollution, land-use change, population growth

States : e.g. water quality, soil quality, air quality, habitat, vegetation

Impacts : e.g. ill public health, habitat fragmentation, economic crisis, environmental damage, biodiversity loss

Responses : e.g. taxes, environmental laws

This framework is an extension of the pressure-state-response model developed by OECD.

As a first step, data and information on all the different elements in the DPSIR chain is collected. Then possible connections between these different aspects are postulated. Through the use of the DPSIR modelling framework, it is possible to gauge the effectiveness of responses put into place(Helming et al. 2013).

2. Results and discussion

Climate change

The importance of ecological and climatic parameters has a special place in the process of agricultural activities. Before addressing climate change practices, a look at the results of climate change over the past three decades is not without merit, so the results of spatial and temporal analyzes show serious changes in all parameters. Rainfall is the first and most important parameter in agriculture, indicating extensive changes in its temporal and spatial routine. According to the results of Figure 3, rapid and short-term falls during the period 2000 to 2020 have had an increasing trend of 5 cm. In recent years, from 2018 to early 2020, there has been an increasing trend with high peak frequency, meaning that from this period, this sector has had a turning point and has had a trend. However, at the end of the 2020 period, the drought and rainfall trend seem to be repeating itself (Figure 3). According to the results of comparing the rainfall period of the city with the shortening of the rainfall period, the flood procedure experiences light rainfall in low repetition. In 2000, the peak or threshold had normal changes and continuous rainfall, now for 2021, this procedure is out of the normal sinusoidal cycle of nature and has been transferred to the precipitation phase faster. In general, the peak rainfall in the city starts 15 days later and reaches its peak in March, while in late May, the rainfall reaches almost zero. This is while in the normal course of 2000, the rain will end in July (Figure 4). In discussing the location of these changes, it was shown that the three districts of Zhavroud, Abidar and Sanandaj do not have a positive trend at all, so these areas will not have the appropriate opportunity for progress in terms of rainfall and rainfed agriculture. Instead, rainfall will be heavier in 62% of other areas near oak forests (Figure 5). Temperature, evaporation and transpiration are two other important parameters in the growth and water requirement of different plant species. In the study of temperature trends in the whole period, it was observed that 0.75℃ be added to the total temperature of the study area. As a result, outside the time discussion and in the general view, the number and range of heat peaks has increased from 2.5℃ with a severe peak to 4 severe peaks of 3°C in consecutive years 2018 to 2021. It is interesting to note that on the other hand, the decrease in average temperature has significant changes and the decrease in these peaks will be clearly seen (Figure 6). In terms of temperature cycle in the whole region, similar periods show that with the elimination of the season in Sanandaj city, the heat starts 2 days earlier, at the same time, this cycle will return to the first state 1 day later. As a result, the city is moving towards tropical change. Accordingly, the temperature peaked in August, which in all regions is 5 degrees warmer than the base year of 2000. At the bottom of the period, frost and lowering of the temperature level are limited and problematic, so that the coldest day for the whole study area averaged 0, which is the same value in the base period -4 degrees Celsius (Figure 7). Spatially, the concern for heating in the heights of the city leads to monthly changes of 0.072 degrees per month for 81% of the area. Along the Sanandaj River, these temperature changes due to water flow and irrigated agriculture and horticulture have slight changes with heating of 0.041 degrees per month (Figure 8). In the study of snow level changes, the trend of changes is not traceable and therefore large snow peaks in general have decreased sharply since 2009. The volume of groundwater and storage in this area has decreased sharply and in certain months of the year the groundwater level is expected to decrease significantly. Now the trend of the chart shows that the negative peaks have been minimized since 2013 due to the lack of level reduction (Figure 9). According to the charts, the level has reached 60,000 hectares in 2021 by eliminating the trend of snow peak season from 80,000 hectares. Changes in trend indicate that snowfall has decreased in level and period, starting 9 days later and reaching a minimum area in 11 days earlier (Figure 10). Have. Accordingly, 42% of the areas that are severely reduced are at altitudes above 3000 m (Figure 11).

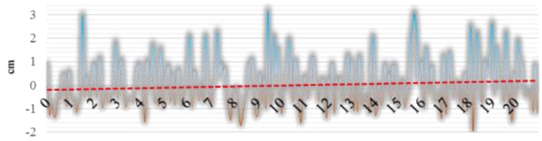


Figure 3 - Time trend of rainfall range changes from 2000 to 2020

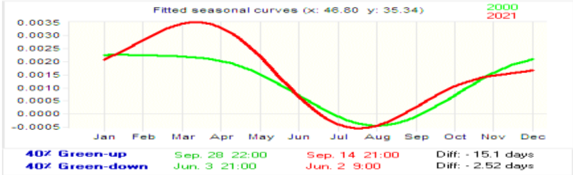


Figure 4- Changes in the rainfall period of the base year and 2020

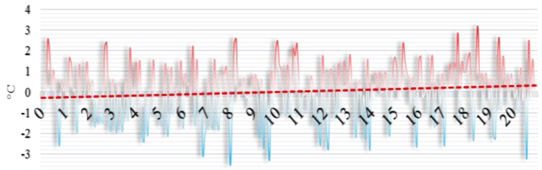


Figure 6 - Time trend of temperature range changes from 2000 to 2020

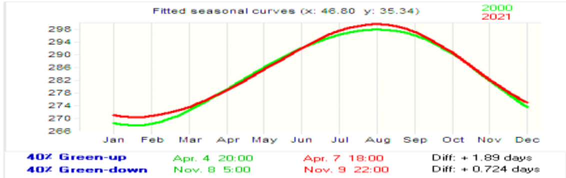


Figure 7- Changes in temperature period of base year and 2020

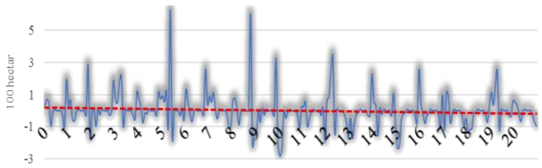


Figure 9- Time trend of snow cover changes from 2000 to 2020

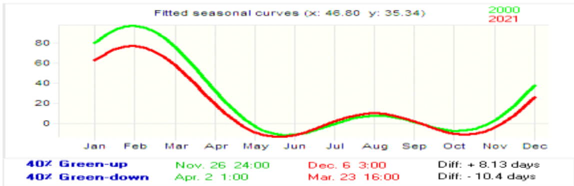
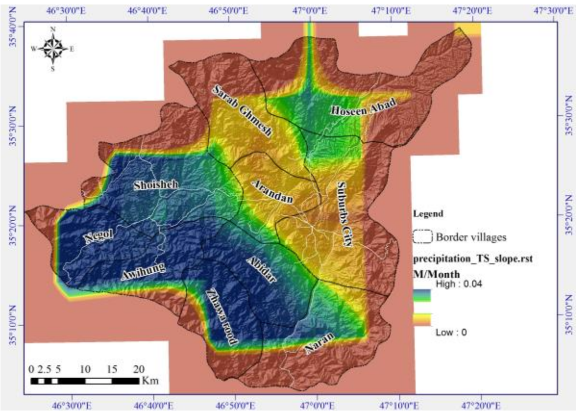
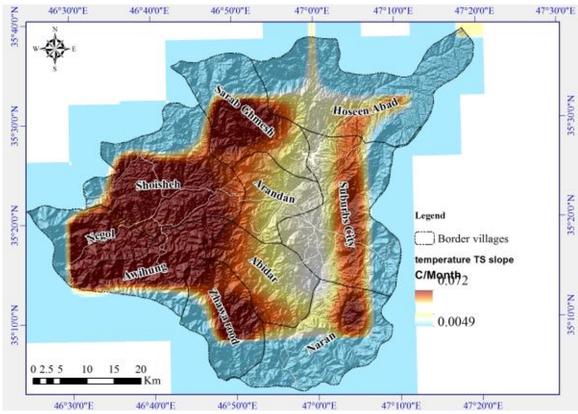


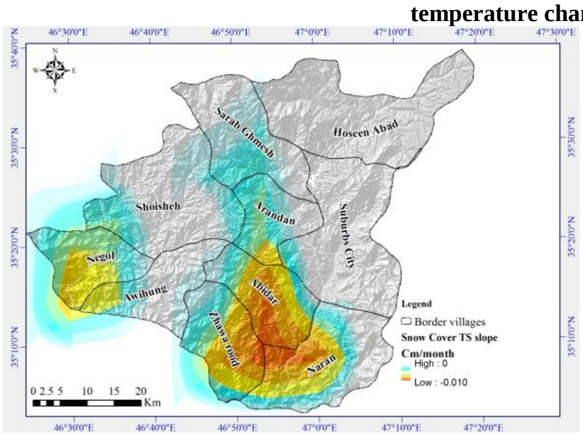
Figure 10- Changes in the snow cover period of the base year and 2020



3. **Figure 5- Procedure for spatial changes in the slope of rainfall changes**



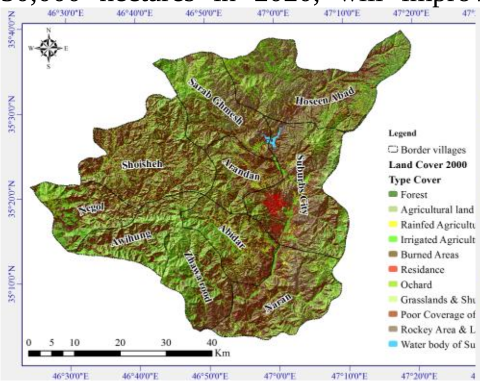
4. **Figure 8- Procedure of spatial changes Slope of monthly temperature changes**



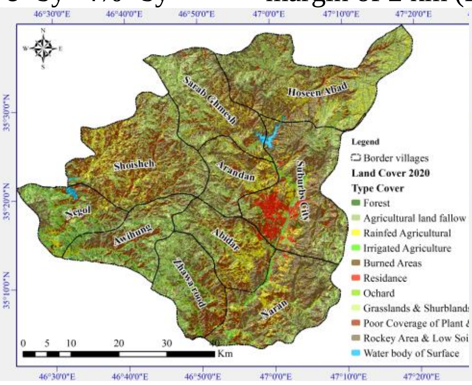
5. **Figure 11- Spatial changes procedure of the slope of monthly snow changes**

land use change

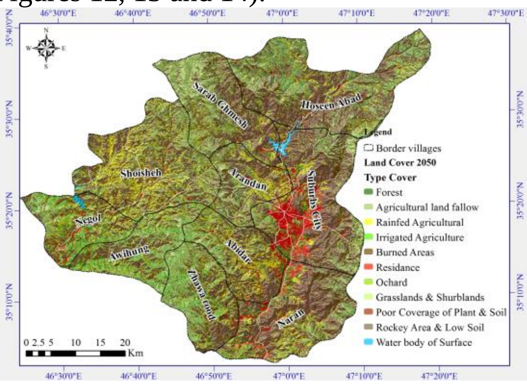
By entering the data of climate change in the land use forecasting section, the estimation of land use change in the period of 2050 was predicted by spatial changes. According to the results of the study of spatial and temporal changes in land use during 2000, the area of agricultural areas is equal to 10% of the area, which has the highest area of dryland farming with an area of 17,000 hectares. During the 20-year period, this type of rainfed agriculture has doubled its original area and covers an area of 33,000 hectares. Rainfed agriculture is projected to grow by 50 percent over the next 30 years, with a final area of 42,000 hectares affected by land use change. A noteworthy point from the growth of this type of agriculture will be the move to more foothills and heights with more limited production capacity. A noteworthy point from the assessment of the ecological potential of agricultural resources is the release of a large area of rainfed fields due to land use change or lack of better profitability in this basin; Therefore, 6,000 hectares of agriculture will be abandoned and out of harvest in 2000, it will reach an area of 37,000 hectares during the final modeling period of 2050. However, considering the climate inputs to the LCM model, it can be hoped that this volume of agricultural land, which has an area of 50,000 hectares in 2020, will improve by 4% by returning to production. The worrying point of this type of abandoned land is its unusual growth around Sanandaj city, in the 3 km margin of Sanandaj city, 82% growth can be seen, which is ready for this land use to become other land uses. Type of irrigated agriculture Due to climate change and the loss of more water resources, this type of agriculture is more marginalized and its destruction will not be far from expectation. It is more related to the livestock industry, indicating the complete bankruptcy of this type of activity with lack of access to resources and increased costs) to 3.8 thousand hectares in 2020 and also in 2050 this amount to 650 hectares in just a few small spots downstream of the dam. Winter is limited. Gardening is also one of the activities related to agriculture, which is one of the limited activities in the future during the study period of statistics due to climate change. Most of the activity of this type of land use is limited to the Sanandaj river, which has high access to surface water resources. The study clearly proves the dependence of this type of activity on water resources, 38.8 thousand hectares in the period 2000 has reached 6 thousand hectares for 2020. It is expected that the land use area will reach 1.6 thousand hectares, which will eventually be limited to the lower reaches of the Sanandaj River and at a margin of 2 km (Figures 12, 13 and 14).



6. **Figure 12- Land use 2000**



7. **Figure 13- Land use 2020**



8. **Figure 14- Land use predicted in 2050**

According to the obtained results, according to the population growth trend of Sanandaj city in 2010, it reached 417177 people, and in 2020, the population reached 501402 people. Based on the relation $P_t = P_0 (r + 1)^t$, the population of Sanandaj city will reach 652,356; Therefore, according to Table 1, per user in this city was calculated; Therefore, the reduction of forests per capita from 818 square meters to 284 square meters will be seen; Therefore, in the field of agriculture and food security, the production of statistics shows that from 410 square meters per capita of dryland farmers will increase to 652 square meters per person in 2000. Despite this increase in area, expecting a reduction in production quality due to climate change will not be unexpected. With this description, according to climate maps, 80% of rainfed agricultural areas are suffering from water bankruptcy and atmospheric fluctuations in temperature and evaporation, which will be expected to supply water and water network can solve the existing problem. Water agriculture will be the biggest loser of climate change during 2050, as the per capita water farmer will reach 10 square meters per person due to access to water resources; Therefore, gardens will be among the resources and type of agricultural activity during the forecast period with the bankruptcy of water resources and climate fluctuations with drought and sudden mountain cold, so the per capita in this city will be limited to 25 meters. It is predicted that for the next periods, the process of dam construction and water storage behind the dams in the region will continue and the per capita surface water will increase to 25 meters per person.

Table 1- Land use changes and people per capita in natural resources.

Legend	Land use changes (hectar)			people per capita		
	2000	2020	2050	2000	2020	2050
Forest	34,127.76	15,973.89	18,538.06	818.06	318.58	284.17
Agricultural land fallow	6,313.23	49,345.80	37,465.41	151.33	984.16	574.31
Rainfed Agricultural	17,131.14	33,192.86	42,567.17	410.64	662	652.51
Irrigated Agriculture	6,968.18	3,896.92	650.82	167.03	77.72	9.98
Burned Areas	4.61	4,253.07	12,147.34	0.11	84.82	186.21
Residences	1,939.77	6,313.15	14,789.08	46.5	125.91	226.7
Orchard	38,818.75	6,323.74	1,629.11	930.51	126.12	24.97
Grasslands & Shrublands	30,875.84	42,951.2	44,113.54	740.11	856.62	676.22
Poor Coverage of Plant & Soil	111,978.7	50,501.4	3,682.16	2,684.20	1,007.20	56.44
Rocky Area & Low Soil	53,860	88,511	125,056	1,291	1,765	1,917
Water body of Surface	437.6	1,191.76	1,674.52	10.49	23.77	25.67

According to the results of the analysis of agricultural products production statistics from the Ministry of Agriculture and Forestry in the years 2000 and 2020, the production volume of wood and forest products has increased from 85 tons to 369 tons per year, and according to the changes in land use and Climate change scenarios in 2050, this volume of production will reach 437 tons per year, and for the $RCP_{2.5}$ scenario, which is optimistic, the maximum amount of production will reach 457 tons per year. At the same time, according to the climate changes of the $RCP_{4.5}$ scenario, the volume of wood and timber production from natural and artificial forests has been limited to 88 tons per year, and finally, due to the increase in population and the decrease in per capita area, it is actually a serious threat to the agricultural sector, focusing on production. It will cause forest products. In the Grains and Legumes products sector, statistics show that although the per capita land dedicated to these products has doubled, the production of this sector has increased from 3 million tons to only 4 million tons per year. Only 0.33% growth, which the current situation clearly shows, is the limitation of agriculture in places that are not suitable for this activity, its productivity is practically limited and uneconomical. By analyzing the combination of climate change and land use change, it shows that in 2050, the maximum production is 3,462,047 tons per year. The lowest production volume will be 965,803 tons. Therefore, if we consider the added area per capita in 2050 for these products, the volume of production and demand is very small. Ecological potential faces the most severe limitations. In other sectors of agricultural products such as Edible and summer vegetable and Fruit and garden products or Fodder production The sharp decline in production will be more than 50% and therefore any development and sustainability in this sector will be associated with high risk. Climate change has the greatest influence on increasing ecological risk. Therefore, providing a solution and formulating a coherent plan to reduce these threats should be the first priority of evaluators. Today, all three categories of products examined in this section are severely reduced and lack economic justification (Table-2).

Table 2- The trend of changes in the production of agricultural products and the prediction of climate change scenarios

Production/year	2000	2020	2050	RCP 2.5	RCP 4.5
Foresty and wood	85,000	369,024	437,480	457,590	88,566
Grains and legumes	3,025,000	4,024,180	3,462,047	4,989,983	965,803
Edible and summer vegetable	127,000	90,750	75,264	112,530	21,780
Fruit and garden products	1,398,000	87,540	48,612	108,550	21,010
Fodder production	6,948,000	2,735,980	1,207,226	3,392,615	656,635
Aquaculture	214,700	681,068	664,725	844,524	163,456

Based on the DPSRI model, there are 5 main drivers to support agriculture in mountainous areas and against the pressures of land use changes and climate changes. which respectively include: 1- the use of transgenic crops adapted to climate changes and the conditions of mountainous areas (such as wheat and barley) 2- the approval and legal support of adaptive agriculture and dealing with land use changes by using the execution of orders and heavy fines for land use changes Incompatible lands and land uses with environmental factors 3- Documented and local land use plan based on the changes that should be made and specifying each type of activity in which area, for example, the development of gardens mixed with pastures such as dry grapes that require minimal soil cultivation and They have water. 4- Agricultural equipment and infrastructures; This issue is the most basic incentive for the group of farmers and environment friends of the region to integrate sustainability and compensate the costs and pressures brought to this sector. Providing equipment such as water pumps and piping for recycled water, construction of small dams and managed watersheds based on change process maps 5- Community education The goal: in this issue, improving the quality of education in general will cause all-round growth and give direction to the society. It is the farmers who still do not have a correct view on correcting the risky methods of the environment The scores for this section also indicate that the driving part of the law (0.27) will have the highest importance in the region; Unfortunately, in the local and national laws, there is no coordination in the law sector and the policies are always contradictory, the second most important driver is education; Agricultural activity and the elimination of risky traditional practices or changes in land use for low-risk profitable activities threaten the security of agriculture in mountainous areas with the greatest threat in terms of erosion and sedimentation. Therefore, the results show that any incentive action puts an additional pressure on all existing problems. The opinion of agricultural experts and field studies show that there are 6 general categories of pressures; The first pressure on society's health (0.25) includes water, soil and air pollution due to changes in climate and land use that exist now. Degradation of the environment and hidden malnutrition (0.19) due to per capita changes and high costs of food supply and the removal of government subsidies are jointly ranked as the second pressure that has been placed on the food and agriculture system. The recent issue has been introduced by agriculture to the society and the environment, and finally it has dangerous consequences. In recent years, the change of practice from traditional to industrial agriculture with the lack of infrastructure has put a lot of pressure on the agricultural system, which is becoming more important with the new wave of drivers at the same time as climate and land use changes (0.18). The problems of work and employment in the agricultural sector cause problems in the studied society, more than 60% of which are somehow related to agriculture. Another pressure on agriculture is internal and external migration in the region. Unfortunately, according to statistics, out of 39 villages in the study area, 11 villages have been evacuated, and 17 villages have a population of more than 12,000 people who migrated to their cities and engage in temporary seasonal farming. The results of the State section show that three categories of actions will take place if the status quo continues and agricultural security decreases; The first issue of direct government intervention in entering food security (0.35) managed the issue by acquiring and planning temporarily. Finally, with the increase in energy and cost, the agricultural system will return to its downward trend. It is the second most important topic in relation to the product-oriented practice in agriculture (0.33). This effect is important in regulating the type of activities and harvest of products. The last issue in this sector is agriculture with an ecological approach; In this regard, although there is a consensus on the least probability that it will be successful, it will definitely affect the entire region and reduce the intensity of destruction and change.

The Impact section is extremely important, the results of which show that by including the appropriate strategy, water resources play the first and most important role in the region, so water resources (0.28) were very important in the agricultural security of mountainous areas. The economic consequence (0.23) is considered the second major effect. Social changes and injustice (0.15) is the third Impact of the changes in the agricultural pattern in mountainous areas and is a serious threat to agricultural security. This procedure has been continued in the past, and with any change, its amount increases. In the next ranks, the soil and air suffer destruction and pollution, which should be taken into consideration in making decisions. The results show that 5 categories of answers should be considered for the consequences of food security; The first thing is to create a network of subsidies and penalties to improve agricultural security, this system should be smart and lead to the elimination of threatening actions in the region. On the contrary, it is an incentive to exploit optimal agriculture. Agriculture with environmentally friendly practices is the second answer and strategy, which is extremely important in maintaining the agricultural base in the region. The third useful strategy is definitely using an e-government to closely monitor and obtain statistics of production, destruction and demand in the agricultural sector. In this matter, every person can directly communicate with the government or managers and adjust their transactions and work based on this procedure. In this regard, the development of mobile applications plays a useful role. On the other hand, the e-government will directly supervise the agricultural activity and the intermediate parts between agriculture and the government will be removed, better management and implementation will be done, and the agricultural activity of each region will be managed locally and individually. All the mentioned items can play a role as a network (figure- 15).

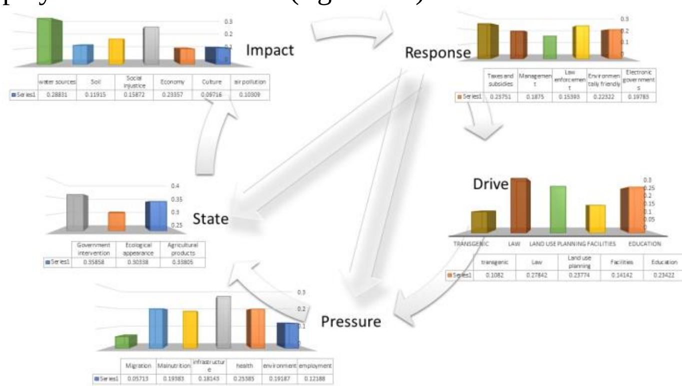


Figure 15- Chart DPSRI model based on statistics and variables for agricultural security

9. Conclusion

The present study examined all tangible indicators of climate change and land use. According to the obtained results, mountainous areas are strongly affected by climate change from all sides. According to the results of climate change pseudonymization, other mountainous climate changes observed in the study will be relatively more severe than plain areas. We will have more spring rainfall type(Tarasenko et al. 2021). It should be noted that rainfall in the mountain station will fluctuate more than the plain station. The minimum and maximum temperatures also have the most changes in mountainous areas(Meixner et al. 2016). The case of temperature changes and lack of freezing and frosting of the soil, especially at altitudes above 1580 meters, will be of great concern in reducing the fertility of crops and failure to open the seed pods in the soil(Liu et al. 2019). Will and with the change of the beginning of the heat period occurs unhealthy in terms of time. As a result, 81% of agricultural farms that are at altitudes above 1500 meters and slopes above 5% are practically inefficient and will not have good production quality(Mukheibir and Ziervogel 2007) . Also, the results of rapid and short-term rainfall during the period 2000 to 2020 were seen with an increasing trend of 5 cm with high peak frequency, which worries about accurate investment and loss of water resources and floods and soil washing and seed bank are very worrying and security Will jeopardize food and agricultural opportunities in other non-rainforest sectors (Zheng et al. 2014). Severe currents around the city of Sanandaj and the Sanandaj River will definitely cause more damage to the agricultural industry in this sector. Including 45 million meters of rivers, 16,000 hectares of agricultural land are located along the rivers, 25% of which are exposed to severe and destructive floods, which will have more risk and damage than plain areas (Daneshpour and Pajouh 2014). Snow cover in mountainous areas will have the most snow changes from 80,000 hectares to 60,000 hectares in 2021. Changes in the trend show that the snowfall has decreased in level and period, so that it started 9 days later and will reach the minimum area in 11 days earlier. Based on the spatial results, snow-covered areas above 2500 meters have the highest monthly snowfall rate. Accordingly, 42% of the areas that are severely reduced are at altitudes above 3000 meters. Snow resources ensure the security of the agricultural industry and contribute to the gradual growth and reduction of temperature (Tarasenko et al. 2021). Compared to other agricultural areas in mountainous areas, lower latitudes are more dependent on snowfall (Dierauer, Allen, and Whitfield 2020). Snow cover is very important for agriculture because it changes the radiation and thermal balance of the subsoil, protects the soil from frost and frost, accumulates winter rainfall and is the most important source of increasing soil moisture reserves in dry areas. And below dry in the spring. Winter rainfall is up to 30% of the annual normal. The soil moisture reserves formed with their help absorb up to 42% of the total water consumption for grain yield in summer and up to 75% in dry summer (Koneti, Sunkara, and Roy 2018) Due to extensive and direct interactions with the environment, the agricultural sector is most affected by the process of climate change. So far, little attention has been paid to climate change and its risks in the agricultural sector. In particular, water and land have been overshadowed by food security and the spread of poverty in agricultural communities is a clear consequence of the phenomenon of climate change in agriculture. Cultivation and yields change. This threatens global food security (Brockhaus et al. 2012) Reduces agricultural production due to frost, frost, freezing, drought, flood, erosion, flooding of agricultural lands, changes in the rainy season, and reduced irrigation efficiency(Tarasenko et al. 2021; Alemu and Mengistu 2019). To be. Therefore, the results of land use change during the 20-year period of this type of rainfed agriculture in the study area reaches twice the original area, but the remarkable point of the growth of this type of agriculture will be moving to more foothills and heights with more limited production capacity (Orians and Millar 1992). A noteworthy point from the assessment of the ecological potential of agricultural resources is the release of a large area from rainfed fields due to change of use or lack of better profitability in this basin (Sharma et al. 2021). 6,000 hectares of agricultural land abandoned and out of harvest in 2000 will reach an area of 37,000 hectares during the final modeling period of 2050. This is the only concept of unplanned and powerless harvests and lack of profitable production against existing costs (Chen et al. 2017). The role of the government in meeting the basic needs of agriculture and supporting this sector is important. Even by providing financial resources and equipment, or by extensive water supply, or by training and encouraging farmers to cultivate barren lands, a large part of which will be decommissioned. However, considering the climatic inputs to the LCM model, it can be hoped that this volume of agricultural land, which has an area of 50,000 hectares in 2020, will improve by 4% by returning to production. Which is not yet in the world standard (Oñate-Valdivieso and Bosque Sendra 2010)The worrying point of this type of abandoned land is its unusual growth around Sanandaj city, in the 3 km margin of Sanandaj city, 82% growth can be seen that the readiness of this land user to convert It has other uses (Norsa’adah et al. 2020). Types of irrigated agriculture Due to climate change and the loss of more water resources, this type of agriculture has been further marginalized and its destruction will not be far from expectation. It is more related to the livestock industry, indicating the complete bankruptcy of this type of activity with lack of access to resources and increased costs) to 3.8

thousand hectares in 2020 and also in 2050 this amount to 650 hectares in just a few small spots in the downstream of the winter dam is limited (Köhl et al. 2015). Gardens are also among the activities related to agriculture, which are among the limited activities in the future during the study period of statistics due to climate change. Most of the activity of this type of land use is limited to the Sanandaj river, which has high access to surface water resources. The study clearly proves the dependence of this type of activity on water resources, 38.8 thousand hectares in the period 2000 has reached 6 thousand hectares for 2020. It is expected that its land use area will reach 1.6 thousand hectares, which will eventually be limited to the lower reaches of the Sanandaj River and at a margin of 2 km. Based on the DPSRI model, five strategies should be pursued in the study area to reduce the effects of land use changes and climate changes. In this regard, the importance of subsidies and legal fines to maintain agriculture and make it more sustainable is the first strategy for the bankrupt and heavily changed region. Changing agriculture from a native and inefficient and destructive industrial pattern towards sustainability and measures in harmony with the environment, such as forestry mixed with agriculture, elimination of native products that have little yield, and the development of an intelligent management with electronic government, where intermediaries are removed and the profit of agriculture and Inflation will be controlled. Also, person-to-person management and access to government services guarantee sustainable agricultural development.

10. Funding declaration

The working team of this article has not used any financial support from public and private organizations and departments.

11. data availability

Research data are free available in standardized and classified formats.

12. conflict of interest

Based on the position of the authors, they have an equal position and share in writing and research. There is no conflict of interest.

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