ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 5, Issue 2 , February 2018

The potential impacts of climate change on crops in Albania Case study 'Shkodra region'

Ada METALIU

Ph.D. Candidate: Agricultural University of Tirana, Albania. Department of Economy and Rural Development Policy

ABSTRACT: Recent studies have shown how climate change has affected agriculture sector, increasing difficulties in farm management and food security. Intensity of rainfall and melting snow in winter as well as heat waves, have caused a lot of damages to rural households in the last decades. According to the IPCC (2014), climate change has brought more negative impacts than positive impacts to most of the crops. This paper states the facts that; even in the local areas in Albania, average temperature has increased while average precipitation has decreased as well as increase in extreme weather events throughout the decades. It also shows some main aspects of the impacts of temperatures and precipitation in maize yield in the Shkodra region, located in northwest of Albania. Historical regional data from 1961 to 2010 are obtained for both climate variables and maize yield. In addition to, the perceptions of 185 farmers interviewed there, were other sources in identifying climate impacts in the region. The major findings imply that in 50 years, the average temperature has increased while average precipitation has decreased and such changes have had impact on maize yields in Shkodra region. Based on farmer's experiences extreme weather events poses the major risk for the region.

KEYWORDS: Climate change, maize yield, extreme events, smallholders

I. INTRODUCTION

According to latest studies, surface temperature is projected to rise over the 21st century under all assessed emission scenarios. It is very likely that heat waves will occur more frequently and last longer, while extreme weather events will become more intense and occur in muntrie regions, IPCC, (2014). According to the First, Second and Third National Communication of Albania under UNFCCC, (2003, 2019, 2016), all scenarios reveal a likely increase in annual temperatures related to 1990 for all time horizons. Albanian climate is subtropical Mediterranean climate, which is characterized by mild winter with abundant precipitation and hot, dry summer. According to first national Communication of Albania under UNFCCC, (2003). the average annual precipitation of Albania is about 1,485 mm/year while annual mean temperatures vary from 7C°, over the highest zones up to 15°C. From the scenario for Albania such values are going to change as result of Climate change .Below we have shown the scenario of temperature for Albania.

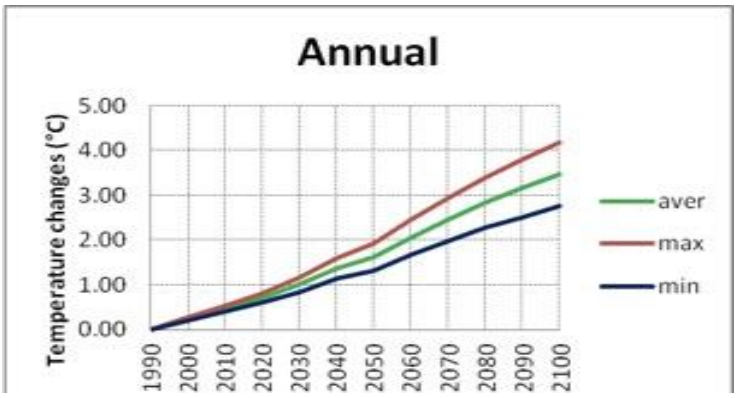

Figure 1. Likely changes of annual temperature. Source Third National Communication of Albania under UNFCCC 2016.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 5, Issue 2 , February 2018

Annual precipitation is expected to decrease, Third National Communications of Albania under UNFCCC (2016). The projected results are shown in the figure below.

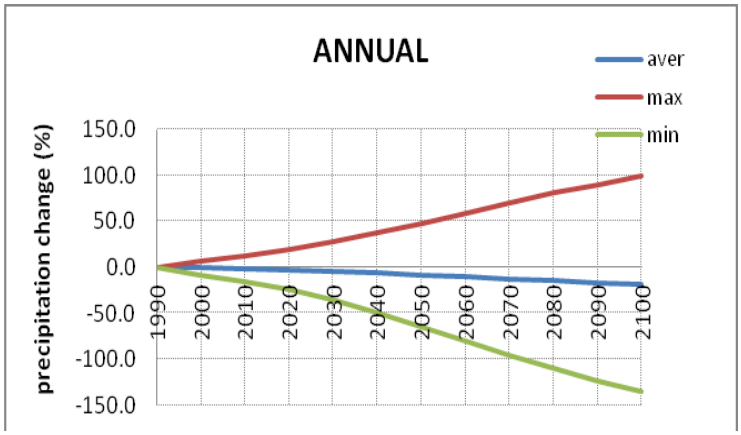

Figure 2. Projected annual precipitation. Source, Third National communication of Albania to UNFCCC 2016**.**

As being directly affected by changes to climate patterns, agriculture sector will face many challenges as well. In the study of Ciscar JC at al. (2014) climate change resulted with positive impacts in crops around Europe. According to IPCC (2014), such changes are likely to increase cereal yields in Northern Europe but decrease yields in Southern Europe. In study of Iglesias Ana at al. (2009) decreases of crop productivity in Southern Europe are caused by shortening of the growing period, with subsequent negative effects on grain filling. As being part of south east Europe imply that Albanian agriculture is also affected by such consequences and it is expected higher impacts if we do not take immediate actions.

From the report of IPCC (2014), It is expected that climate change will increase irrigation needs, while future irrigation will be constrained by reduced runoff, by the increases of demand from other sectors, and by economic costs. In the study of Robert Mendelsohn (2009). In developing countries, irrigation appears to be a very effective tool to counteract the harmful effects of heat stress.As being very sensitive to expected reduction of water resources in the future, such conditions will increase the vulnerability to climate change in Shkodra region. Even though Shkodra have many water resources(rivers and lakes), most of the farmers do not have access of these resources for irrigation. Needless to say,most of electricity in Albania are produce by hydropower plant and some of them are built in Shkodra region which has brought inequity of water use for other sectors such as agriculture. From the questionnaires, most of the water used for irrigation, came from well and irrigation channel, few farmers had access to lakes and rivers while for some farmers the rain was the only source of water for irrigation. **The figure 3.** shows the results from questionaries' conducted in Shkodra region regarding to the source of water for irrigation.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 5, Issue 2 , February 2018

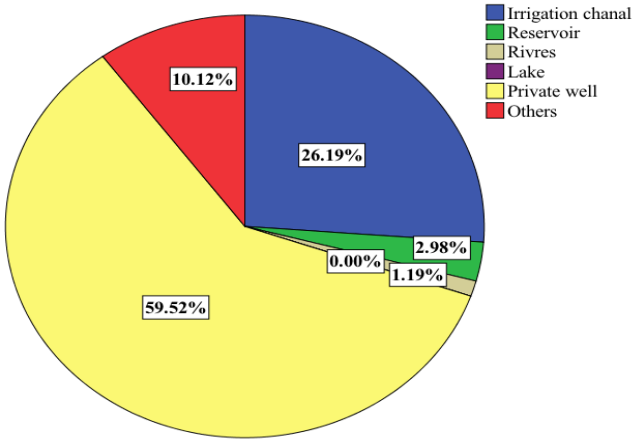

Figure 3. Source of water for irrigation. Source from the questionnaires in Shkodra region 2016

From previous findings, heat waves are also going to bring losses in agriculture production. Climate sensitivity indicate that higher temperatures are likely to be harmful in many developing countries where the climate is marginal, water is inadequate, and temperatures are high Rosenzweig and Parry (1994); Reilly at, al. (1996). In the Third National Communication of Albania to UNFCCC, (2016), it is mentioned that, as heat stress becomes more severe, it will bring reduction in processes of plant photosynthesis, will cause physical water loss, plant starvation through rapid use of food reserves, as well as inefficiency of food.According to Le Houerou, (1993), the threshold of temperature in maize is 25-to30^{0}C which is optimum range, low range is 8 to 13^{0}C, while the maximum range goes 32 to 37^{0}C. If we compare these thresholds with expected increases of temperature for Albania, it will affect negatively maize yields in the local area of Shkodra.

II. METHODOLOGY

The study area includes four geographical positions in the Shkodra region (hills, field, mountain and costal area). The figure below shows the map of Albania and our study are.

Figure 4.Physical map of Albania

Shkodra climate is characterized by a mild winter and a hot dry summer. Annual precipitation of the region, reaches 1700 mm/year, and about 66% of total rainfall is recorded in Autumn and Winter. Shkodra region is known for its rich

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 5, Issue 2 , February 2018

hydrographic resources where we can mention Drin river (285km), Buna(44km) and Kir(51km) SkadarLake which inhabits an area of 368 $km^2$where 149 $km^2$are parts of Shkodra.

To identify the main impacts of climate change, we interviewed 185 smallholders in 14 municipalities in Shkodra region. The questionnaires were designed to get an overview of farms' characteristics and impacts of climate change in agriculture according to farmers perceptions. To identify the trend for climate variables in the previous decades and its impact on crops we gathered secondary data for precipitation, temperature and maize yield, (1961- 2010) for Shkodra region. Climate variables were obtained from the Institute of Geosciences, Energy, Water and Environment while data for maize yield were acquired from Ministry of Agriculture from 1961-2010. Climates data were provided monthly, while data for maize yield refers to annual data for the Shkodra region. We run SPSS and XLSTAT program to analyse the relationship among climate data and crops. We used Mann-Kendall test in XLSTAT to examine the trend for climate variables.

Because of the absence of suitable data (incomes, soil type, costs of production), it was difficult to choose an appropriate climate model in our study. Hence, we used a nonlinear regression model to measure monthly and seasonal impacts of climate variables in maize yield by removing the trend from the function.

III. FINDINGS

From the analysis of the data collected from questionnaires, it resulted that farmers in Shkodra were mostly smallholders where average size reached up to 1.1 ha per farm. Even though are identified as family farms, not all members of the family contribute in the farm activities. Most of the farms can be characterized as subsistence farming, by having poor irrigation system, low level of mechanization and high cost of production. In 14 communes included in the survey, agriculture was the main activity for farmers. According to climate change results, the majority of the farmers have observed changes in weather patterns in the last decades. Based on their perceptions and observations, the summer season is becoming wormer while in Autumn, rainfall begins much later than normal.

They have also experienced days with higher temperature during Winter, as well as frost and snow at the end of Spring which has caused lot of damages during vegetative stage (flowering) on their plants. According to them such changes has reduced crops, increased cost of production and brought more pests and diseases in their plants. Based on their observations, changes in rainfall regime and increases of average temperature has shifted the production season as well as changes in the time of planting. Farmers have admitted that extreme weather events pose the major risk for their crops.

According to historical data for the region, there have been many floods through decades mainly flashfloods which was also admitted by farmers in some of the communes in Shkodra (Bushatiti, Kozmaç, Oblike, Dajç and Mjedë). According to the secondary data, for the region, there have been some changes in average annual temperature and precipitation. The following figure clearly shows an increase in average annual temperatures over 5 decades.

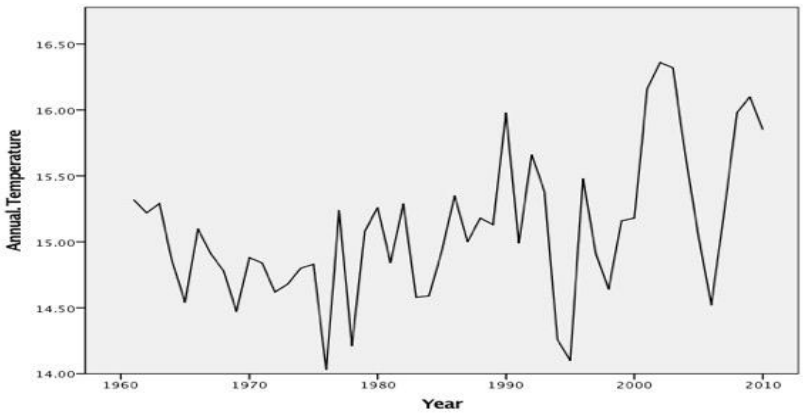

Figure 5. Annual temperatures in Shkodra region (1961-2010)

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 5, Issue 2 , February 2018

On the other side, graphical presentation, showed a decrease trend for precipitation from 1961 to 2010.

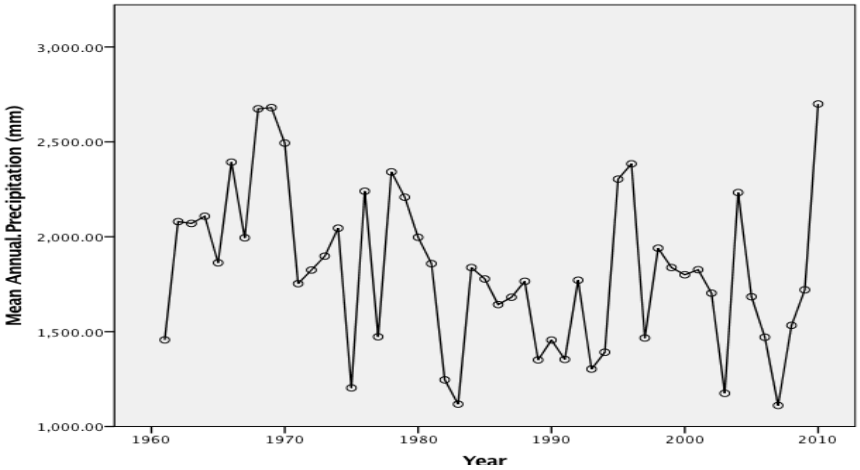

Figure 6 Annual precipitation in Shkodra region (1961-2010)

The Men Kendall test also determined an increase of average temperatures and decrease of average precipitation from 1961-2010.

Table1. Testi Mann-Kendall trend test/ Two-tailed test (annual mean temperature and precipitation (1961-2010):

Mann-Kendall trend test / Two-tailed test		
	Annualmean. temperature	Annual meanprecipitation
Kendall'stau	0.280	-0.241
S	342.000	-295.000
Var(S)	14286.667	14291.667
pvalue(Two-tailed)	**0.004**	**0.014**
alpha	0.05	0.05

The p-value is computed using an exact method.

From the results, p-value was less than alpha = 0.05, 0.014 which imply the existence of the trend for both annual temperatures and precipitation. Temperatures from 1961 to 2010 showed an increase trend, while annual precipitation resulted with a decrease trend in five decades. The trend for summer and spring temperatures were also statistically significant which resulted with an increase tendency.

Table2. Mann-Kendall trend test, average temperatures in Summer and Spring

Mann-Kendall trend test / Two-tailed test		
	Average temperature in Summer	Average temperature in Spring
Kendall's tau	0.226	0.346
S	276.000	421.000
Var(S)	14284.667	14274.333
p-value (Two-tailed)	**0.021**	**0.000**
alpha	0.05	0.05

The p-value is computed using an exact method.

The trend for maize yields, were run in SPSS and resulted statistically significant with an increase of tendency for the selected period 1961-2010. The results are shown in the following table.

ISSN: 2350-0328
International Journal of Advanced Research in Science, Engineering and Technology
Vol. 5, Issue 2 , February 2018

Table 3. Estimation of trend parameter for maize yield.

Dependent variable: Maize yield(kv/ha)

Equation	Summary of the model					Evaluation of parameters	
	R Square	F	df1	df2	Sig.	Constant	b1
Growth	.618	77.774	1	48	**.000**	2.860	**.027**
Exponential	.762	77.774	1	48	.000	3.146E-22	.027

Independent variables years (Y)

The equation derived from the table is as follows:

$$Maize\ yield = 2.86\, Y^{0.027}$$

$$LnMaize\ yiled = ln\ 3.146 + ln\ 0.027Y$$

Our main goal was to identify if there was any impacts of temperatures and precipitation on maize yield by removing trend from the model. The equation below shows the results from nonlinear regression analysis (Cobb Douglas model).

Table 4. Estimated parameters for the model

Parameter Estimates							
	Parameter	Estimate	Std. Error	95% Confidence Interval		95% Trimmed Range	
				Lower Bound	Upper Bound	Lower Bound	Upper Bound
Asymptotic	a	23.242	23.590	-24.271	70.755		
	b1	.599	.186	.224	.973		
	b2	-.646	.380	-1.412	.120		
	b3	-.067	.032	-.132	-.002		
	b4	.471	.054	.363	.580		
Bootstrap[a,b]	a	23.242	26.573	-29.267	75.751	9.032	109.391
	b1	.599	.200	.204	.993	.146	.978
	b2	-.646	.272	-1.182	-.109	-1.239	-.145
	b3	-.067	.044	-.155	.020	-.195	-.028
	b4	.471	.037	.397	.545	.398	.557

a. Based on 150 samples.

b. Loss function value equals 2245.413.

$$Maize\ yiled = 23.24 * Tm.D^{0.59} * Tm.Pran^{-0.646} * Rm.Pr^{-0.67} * Tr^{0.471}$$

Where: Tm.D indicate average temperatures in winter season, Tm.Pran. are average temperatures in Spring, Rm.Pr its average temperatures in April, Tr indicate trend of maize yield

From the results, 23.24 indicates the productivity of maize yield without considering the variables included in the model, while the exponential values in the equation (0.59; -0.646; -0.67), indicate the elasticity for maize yield according to changes in temperatures and precipitation from 1961 to 2010. By removing trend impacts from the model, we can say that spring temperatures and rainfall in April have affected negatively maize yields in past five decades while winter temperatures have had positive impacts.

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 5, Issue 2 , February 2018

IV. CONCLUSION

From previous studies we realized that climate change is going to have adverse effects on agriculture sector in Albania. Because of farm conditions in our study area, the consequences of climate change are expected to be higher. The majority of the farmers, didn't have access of water resources exist in the area, which made their farms vulnerable to water stress. Based on farmers' perceptions, they have observed seasonal changes of climate patterns while extreme weather events displayed the major risk for the area. According to the results from secondary data, annual mean temperature and temperature in summer has increased however precipitation showed a decrease trend in the past fifty years. By removing trend from the model of maize yield, average temperature in winter have had positive impacts while temperature in spring and precipitation in April have had negative impacts in maize yield from 1961-2010.

V.ACKNOWLEDGEMENT

This article is part of my Ph.D. research study in which I am very thankful to my supervisor Prof. Dr MyslymOsmani, my family and friends for guiding and supporting during the research. This research was produced with the financial support of the Prince Albert II of Monaco Foundation. The contents of this document are solely the liability of Ms. Ada Metaliu and under no circumstances may be considered as a reflection of the position of the Prince Albert II of Monaco Foundation and the IPCC."

REFERENCES

[1]. Ciscar JC, Feyen L, Soria A, Lavalle C, Raes F, Perry M, Nemry F, Demirel H, Rozsai M, Dosio A, Donatelli M, Srivastava A, Fumagalli D, Niemeyer S, Shrestha S, Ciaian P, Himics M, Van Doorslaer B, Barrios S, Ibáñez N, Forzieri G, Rojas R, Bianchi A, Dowling P, Camia A, Libertà G, San Miguel J, de Rigo D, Caudullo G, Barredo JI, Paci D, Pycroft J, Saveyn B, Van Regemorter D, Revesz T, Vandyck T, Vrontisi Z, Baranzelli C, Vandecasteele I, Batista e Silva F, Ibarreta D., (2014). Climate Impacts in Europe. The JRC PESETA II Project. JRC Scientific and Policy Reports, EUR 26586EN

[2]. First National Communication of Republic of Albania under UNFCCC., (2003). Ministry of Environment, Forestry and Water Administration.

[3]. Iglesias Ana, Garrote Luis, Quiroga Sonia, Moneo Marta., (2009). Impacts of climate change in agriculture in Europe. PESETA-Agriculture study. Universidad Politécnica de Madrid. JRCScientific and Technical Reports. EUR 24107 en.

[4]. IPCC., (2012). *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX)*. A Special Report of Working Groups I and II of the intergovernmental Panel on Climate Change. Cambridge University Press: Cambridge, UK, and New York, NY, USA, pp.582.

[5]. IPCC., (2014). Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, 151 pp

[6]. Le Houérou, H.N. Agroforest Syst., (1993). 21: 43. https://doi.org/10.1007/BF00704925

[7]. Mendelsohn, R. and A. Dinar., (2009). Climate Change and Agriculture: An Economic Analysis of Global Impacts, Adaptation, and Distributional Effects Edward Elgar Publishing, England, 2009.

[8]. Nicholas Stern., (2007). The Economics of Climate Change: The Stern Review. Cambridge University Press, Jan 4, 2007 - Business & Economics - 692 pages.

[9]. OsmaniMyslym., (2013). *MetodatiEkonometrisë*. ISBN 978-9928-134-29-5.

[10]. Seo, N. and R. Mendelsohn., (2008). "A Ricardian Analysis of the Impact of Climate Change on South American Farms" Chilean Journal of Agricultural Research 68(1): 69-79.

[11]. Second National Communication of Republic of Albania under UNFCCC., (2009). Ministry of Environment, Forestry and Water Administration.

[12]. Third National Communication of Republic of Albania under UNFCCC., (2016). Ministry of Environment, Forestry and Water Administration.

[13]. Robert Mendelsohn., (2009). The Impact of Climate Change on Agriculture in Developing Countries, Journal of Natural Resources Policy ResearchVol. 1, No. 1, 5–19, January 2009.

[14]. Rosenzweig, C. & Parry, M. L., (1994). Potential impact of climate change on world food supply, Nature, 367, pp. 133–138.

[15]. VjetariStatistikor., (2008). Ministria e BujqësisUshqimitdheMbrojtiessëKonsumatorit.

[16]. VjetariStatistikor., (2009). Ministria e BujqësisUshqimitdheMbrojtiessëKonsumatorit.

[17]. William R. Cline., (2007). Global Worming and Agriculture Impact Estimates by Country. Center fr Global Development Peterson Institute for International Economics. ISBN-13978-0-88132-403-7.

ISSN: 2350-0328

International Journal of Advanced Research in Science, Engineering and Technology

Vol. 5, Issue 2 , February 2018

[18]. William Nordhaus And Paul Sztorc., (2013). DICE 2013R: Introduction and User's Manual. Second edition October 31, 2013 Copyright William Nordhaus 2013 First edition: April 2013 Website: dicemodel.net.

[19]. World Bank., (2009). Reducing Vulnerability to Climate Change in Albania Agricultural Systems.

[20]. Wolfram Schlenker; Micheal J. Roberts., (2006). Estimating the impact of climate change on Crop yields. The importance of nonlinear temperature effects.

AUTHOR'S BIOGRAPHY

Ada Metaliu

Ada Metaliu received B.S. in (2008) from Agricultural University of Tirana, Albania; M.Sc. (2012) from Mediterranean Agronomic Institute of Chania,Crete. Greece., and expected to receive the Ph.D. in (2018) from Agricultural University of Tirana, Albania. She received Ph.D. scholarship (2015), from IPCC program and Prince Albert II of Monaco foundation. She joined Climate leader, in 2017 at Climate reality project in Pennsylvania, USA.
In 2014, completed her practical work as assistant lecturer at Agriculture University of Albania, department of Economy and Rural Policy. She is member of European Association of Agricultural Economists EAAE.