IMPACT ANALYSIS OF CLIMATIC CONDITIONS ON THE RABI CROPS AND GREEN ECONOMIC DEVELOPMENT IN SWAT VALLEY OF PAKISTAN

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ABSTRACT: This study presents an estimate of the impact of climatic variables on *Rabi* crops and green economic development in Swat valley, Pakistan. A statistical analysis was used to estimate the impact of climate on *Rabi* crop production for the period of 1981-2013. The unit root test, covariance analysis and Johansson Co-integration tests were used to estimate the short-term and long-term impact of independent variables on *Rabi* crop production. The results showed that three independent variables were significant at 10 % and dependent variable as at 1 %. The R^2 value 0.82 indicated that 82 % variation in *Rabi* crop production is explained by the modeled variance and the combined effect of the independent variables. Moreover, temperature and rainfall during the *Rabi* season have the negative impact on the production of *Rabi* crops (Wheat and Barley) in the Swat valley. Overall analysis indicates that crop production in Swat valley is most affected by local climate. It was concluded that the development of a water conservation framework and availability of the fertilizers at the local market would promote sustainable *Rabi* crop production in the Swat valley.

Keywords: Climate conditions, *Rabi* crops, green economic development, Local climate, Swat.

(Received 18.02.2020 Accepted 19.03.2020)

INTRODUCTION

At present climate change is an inevitable and hence brought about long-lasting variations in the global climatic parameters. The change in the climate was observed after Industrial Revolution due to natural and anthropogenic activities across the globe, but the most important was the massive induction of carbon dioxide (CO_2), chlorofluorocarbons (CFC's), methane and other gases (Abbas *et al.,* 2020b) into the atmosphere. Carbon dioxide (CO_2) and other greenhouse gases, which acts as blanket that was absorbing infrared radiation and preventing it from escaping into outer space. The heating effect on the earth surface and atmosphere has increased temperature and process known as global warming (Mobeen *et al.,* 2017). The phenomenon of ongoing global warming is the consequence of anthropogenic activities occurred from the mid of the 20th century, which is increasing with high rate have a negative impact on the agricultural sector all over the world (Arshad *et al.,* 2017).

Asia is the most vulnerable to climate change, but the numerous environmental and social based communities through the disaster-prone continent grapple that ranging from rivers blocked with waste to runaway expansion, intensify the impacts of a changing climate (Masson *et al.,* 2018; Abbas *et al.,* 2018a). Climate change is predominantly affected by the accumulation of the GHGs in the atmosphere. In Pakistan, the annual mean surface temperature is continuously increasing since the start of the 20th century (Khan *et al.,* 2019; Liese, 2010).

Environmental surroundings have polluted day by day rapidly from climatic stress, and urbanization, which not only expands the hurdles of development (Abbas *et al.,* 2020a; Breisinger and Diao, 2008). Researchers have argued that ex-urban migration and suburban development patterns are creating negative impacts, including habitat fragmentation, water and air pollution, increased the cost of infrastructure and social disharmony (Abbas *et al.,* 2018b; Cuong, 2014).

Very consideration was given to evaluate the role of long-established views, which act as significant for determining variation in agricultural pattern and meaning of socio-ecological landscape through the concept of agriculture sector development and community participation. The community participation is of two types. The first one is that the community is involved from the very beginning of activities like making of the decision analysis, evaluation, and implementation. The second participation is that community involved in an implementation process of pre-designed projects or activity without taking community needs into priority and consideration (Eboh *et al.,* 2012).

Climate has a negative effect on the agricultural production by different types of impacts. With high temperatures and high intensity in rainfall changed the land use patterns that decrease agricultural yields and production from both rain-fed and the irrigated areas. The most chances of drought occurrence may lay down hydro-power impact, which increase the intensity of the floods (Saigal, 2017).

The agro-ecological channel was characterized by two ways, which created contact which local-level communities will take part in environmental activities, which brough a change in the green economy. The green economy defines the economy that the main objective is to create reducing environmental risks and ecological scarcities which leads towards for sustainable development without degrading the environment. It has the closest relationship with ecological economics, but has a more politically applied focus.

Several authors have emphasized the Cobb–Douglas production function and its impacts on crop production and green economic growth was critically examined (Douglas, 1928; Stern, 2004; Xepapadeas, 2005; Yu *et al*., 2010; Ozturk, 2010; Tiwari, 2011; Deryugina and Hsiang, 2014; Sozi and Asongu, 2016; Abbas *et al*., 2020). Cobb-Douglas, (1928) has defined the production function that observed the effect of the labor and capital on total productivity. Stern, (2004) explained that labor and capital was not enough to investigate the total factor.

Xepapadeas, (2005) stated that for an accurate estimate of total factor productivity, correct assessment of the energy consumption, total employed labor force and total fixed capital. Yu *et al.*, (2010) said that the total output production function was obtained by the correct measurement of the capital, labor, and energy. Ozturk *et al.* (2010) was declared that production function in energy consumption was obtained by population, education and price. Tiwari, (2011) explained that for better crop productivity, efficiency, correct measurement GDP per capita. Deryugina and Hsiang (2014) described that total output in production function was obtained by capital, labor. Ssozi and Asongu, (2016) was investigated the production function of the gross domestic product cannot be obtained only from the capital, labor, energy but also included trade openness and financial development. Abbas *et al.*, (2020b) was also analyzed the impact of socioeconomic factors on environmental degradation using input and output function.

Green economy development is contributed to increasing production in the agriculture sector through fulfillment of human and environmental needs. Decentralization is a sign of green economic enhancement through domestic contribution to the mechanism (Ge and Zhi, 2016). The objective of this research is to analyze the impact of climate on Rabi crops (Wheat and Barley) and Green economic development in Swat valley of Pakistan.

MATERIAL AND METHODS

Swat valley is a mountainous area with rugged topography and varying altitudes, which were ranging from 721 meters to 5815 meters that run above mean sea level from south to north to the foothills of the Hindu Kush Mountain range. The region is blessed with an abundance of water resource in the form of Swat River. It has forests, lush green valleys, plains, and the glaciers. The green valley which is known as the "Switzerland of Pakistan" is enriched with special flora and fauna species unlike elsewhere in the world.

The present study investigates data which were included *Rabi* crops (Wheat and Barley) production, area, temperature and rainfall for the period of 1981-2013. Annual Wheat and Barley area and production data was taken from agricultural census yearbooks, KPK development statistics and Federal Bauru of Statistics, Islamabad. Population data was collected from Population Census of Pakistan included 1981, 1998 and 2014. Monthly climate data set was collected from (PMD) Pakistan Meteorological Department, Lahore. Climate data in the Rabi season was tabulated from November to April.

Econometric Model Specification: In order to investigate the impact of climate on Rabi crops (Wheat and Barley) and green economic development in Swat valley of Pakistan. The statistical methods were used for the estimation of the impact of climate on Rabi crop production. The unit root tests, Johnson Co-integration test and error correction model. The impact of climate on the agricultural production was investigated. Then we considered that agricultural *Rabi* crops (Wheat and barley) production depends upon the temperature, rainfall and area in the following equation.

GED (Green Economic Development) = f (*TAr*, *Temp*, *R*ain).

Economic development = Total production (*TPro*)

TAr = Total Area

Temp = Temperature

*R*ain = Rain

The selection of the total temperature, rain, crop area shows as expressive, which depends on green development. The variables are extremely correlative, which relay on the agriculture division that will determine and explain the rate of green sector's enlargement.

Equation: $$\Delta \mathbf{GEG_t} = \boldsymbol{\beta_0} + \sum_{k=1}^{n} \boldsymbol{\beta_1}\, \Delta \mathbf{TAr_{t-k}} + \sum_{k=1}^{n} \boldsymbol{\beta_2}\, \Delta \mathbf{Temp_{t-k}} + \sum_{k=1}^{n} \boldsymbol{\beta_3}\, \Delta \mathbf{Rain_{t-k}} + \boldsymbol{\mu_t} \quad \ldots\ldots \mathbf{Eq.\,1}$$

$\boldsymbol{\beta} =$ Indicate the multiplier impact in which describes that how change in a dependent variable takes to modify by one unit varies in an independent variable.

$\boldsymbol{\beta_1} =$ Indicate the short-run impact, $\boldsymbol{\mu_t} =$ error correction term or adjustment effect

RESULTS AND DISCUSSION

Unit Root Test: The unit root test investigates that time series data are constant or stationary. Without the stationarity of data, the empirical study shows the results might be ambiguous. A stationary time series is considered as a series that move back to its mean value and observed the fluctuation within the consistent range. Table-1 shows the results of unit root tests for the dependent and independent parameters at 1% and 10 % level of significance. All the values be observed in the range which reject the null hypothesis. So, there is problem of unit root problem measured in investigating parameters. The result shows that *TAr* is significant as the first difference because of its value of P is lesser as compared to its sign assessment.

Table-1: Unit root test for the stationarity of data.

Variable	Method	Unit Root Test	P-value	Cross Section
LN *TPro*	Levin, Lin &Chu t *	-2.454***	0.0000	1
	Im, Pesaran and Shin W stat	-5.159***		
LN *Tar*	Levin, Lin &Chu t *	2.570**	0.0029	1
	Im, Pesaran and Shin W stat	-0.13002**		
LN *Temp*	Levin, Lin &Chu t *	-5.353*	0.0178	1
	Im, Pesaran and Shin W stat	-6.914*		
LN *R*ain	Levin, Lin &Chu t *	-8.506**	0.0013	1
	Im, Pesaran and Shin W stat	-7.713**		

The overall results were indicated that dependent variable *TPro* on independent variables *R*ain, and *Temp* was stationary at level. Out of the four variables, three variables were significant at 10 percent and one variable as one percent. The analysis incorporated that some independent variables observed stationarity at level. While, others be measured stationary at 1st difference. In this situation, the Johnson Co-integration test might be used for the Co-integration.

Johnson Co-integration Test: The results of unrestricted co-integration rank test are stated in Table- 2. The eigenvalues is showed the sufficient impact of all independent variables rainfall, temperature and the area of Rabi crop production. The results revealed that the production of *Rabi* crops has increased with the increased area, but rainfall has a negative impact on the total rabi crops which reduced the production. Furthermore, the current adaptations in the Swat district were brought a negative impact on Rabi crop production.

Table-2: Johanson Unrestricted Cointegration Rank Test.

Unrestricted Co-integration Rank Test (Trace and Maximum Eigenvalue)						
Hypothesized No.	**Statistics**		**0.05 C.V**		**Prob.****	
CE (s)	Trace	Eigenvalue	Trace	Eigenvalue	Trace	Eigenvalue
None	62.26575	28.54643	79.62767	33.87687	0.00172	0.0189***
At most 1	33.71932	17.40720	49.74324	27.58434	0.05172	0.0545**
At most 2	16.31212	10.11191	38.79801	21.13162	0.04902	0.0434***
At most 3	6.200205	3.999835	17.59371	14.26460	0.05719	0.0085**
At most 4	2.200370	2.200370	3.841466	3.841466	0.01380	0.0013***

Error Correction Model (ECM) Test: Area of rabi crops has shown the significant and positive relationship with rabi crops (Wheat and Barley) production. It shows that the area increase, this would cause in increase in production for the short term period as in Table-3. The R^2 value 0.82 indicates that 82 % variation in Rabi crop production is explained by the modeled variance due to the combined effect of the independent variables such as area, temperature and rainfall. The F-statistic value is 21.865 observed. It shows that the model is observed to be good fitted. The results revealed that one unit increase in area that changes the 1.147unit in production. Whether, Temp observed to be negative to increase production in Swat valley. On the same way, the outcomes of the short run period show the constant sign of the coefficient in the model for the long run relationship.

Table- 3. Error Correction Model (ECM) of *Rabi* Crop production.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-37.25286	11.39025	-3.270591	0.0037***
D (*TAr*)	1.475865*	0.069764	21.15504	0.0000***
D (*Temp*)	-1.144779*	0.694799	-1.647640	0.1143*
D (*R*ain)	-0.006399***	0.033165	-0.192931	0.8489*
T Pro (-1)	-0.226922**	0.064343	-3.526751	0.0020***
T Ar (-1)	0.332663**	0.082598	4.027483	0.0006***
Temp (-1)	1.715894*	0.801142	2.141811	0.0441**
*R*ain (-1)	0.045451***	0.054298	0.837052	0.4120**

R-squared	0.827634
Adjusted R-squared	0.753763
S.E. of regression	10.13842
Mean dependent variance	-0.101673
S.D. dependent variance	20.43120
Durbin-Watson stat	1.763545
Sum squared residue	2158.537

***, **, * levels of significance at the one, five, and ten percent the respectively.

ECM can be derived from the Johnson Cointegration test, which showed short-run dynamics with long-run equilibrium in the measurement of *Rabi* production. Besides, the outcome of the error correction model indicated that *Rabi* crop production has the long-run and short- run relationship. Rainfall and Temperature have a negative impact on GEG as *TPro* reacted as an optimistic approach (Melnikova *et al.*, 2016; Herbest *et al*., 2016).

Results revealed that significant positive and negative effects observed on *Rabi* crop production of *Tar*, *Temp* and *Rain*. The results indicated an effect on development strategies during the *Rabi* season. The green economic development has been affected by climatic variations. However, climate factors like temperature and rainfall are very vital to the wheat productivity, efficiency and risk measurement (Kirby *et al.*, 2016).

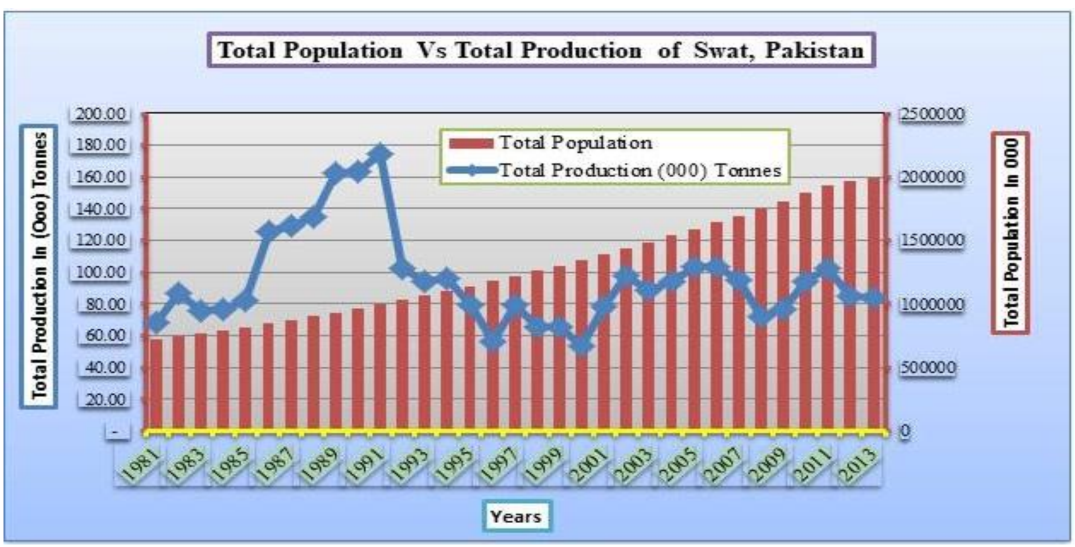

Figure-1. Total Population between total production trend of Swat, Pakistan.

According to Population Census Organization, 1998 the total area of Swat is observed 5337 Km^2 and population density is 236 per Km^2. The total population of Swat was recorded 125,7715 with an average annual growth rate 3.37 % in 2017. Such increase in urbanization and coarse texture of the soil, less cultivated area was recorded in the Swat valley. This reduction in the area has the negative impact on crop production in Swat valley. The observed population in 2013 is 206,7708. The urban population as compared to total population increased during 1981-2013 above five times compared with over three times growth in total population.

The link between population and production is complex. The results revealed that crop production has increased due to the area increased. As shown in the Figure 1, the trend of the production has decreased from onward 1994 to 2013 due to increased the trend of the population. The trend of population growth of the Swat district has decreased according to the per capita share of land.

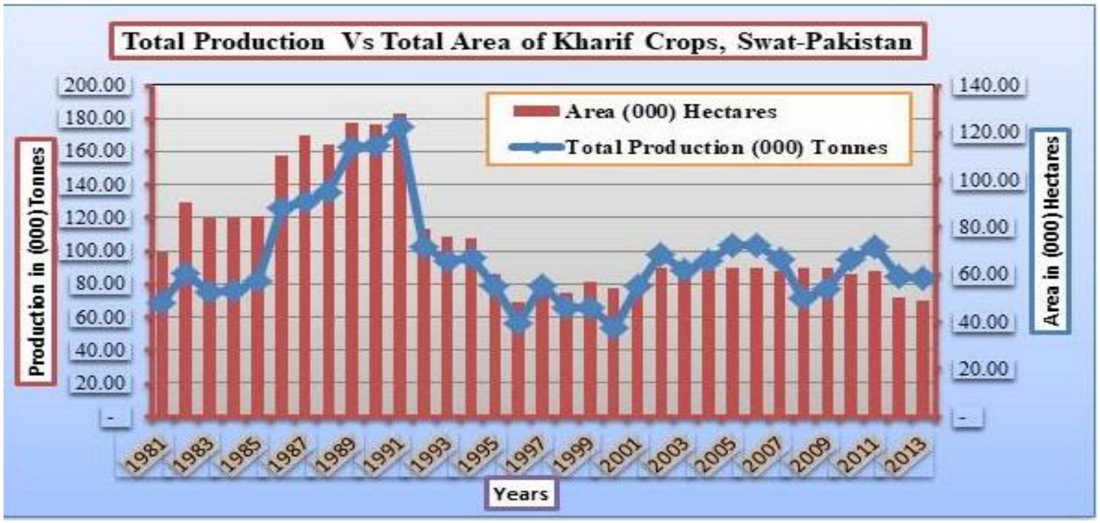

Figure-2. Total Production and total area of Rabi crop of Swat, Pakistan.

If rabi crop production is increased, the cultivated area is also increased. According to Development Statistics of Khyber Pakhtunkhwa, 2014 that total *rabi* crop production is 174.6 tons observed in 1991high as compared to 83.65 tons in 2013. The area 128.1 to 49.18 hectares was reported from 1995 to 2013 (Figure 2). The results have documented that variation of crop production is varied with temperature and rainfall. So, rainfall is negative and significantly correlated with the production of rabi crops. The other external factors were underlined towards agriculture development failure due to poor water supply system, rugged topography, poor drainage network for irrigation/ quality seeds, un-planned management practices, ignorance of traditional knowledge and new technologies, illiteracy, lack of community participation.

Per Capita availability of total production (Wheat and Barley) in the Swat: The estimated per capita availability of *Rabi* crop production (Wheat and Barely) has based over different periods using climate variation conditions. The significant impact of rainfall and temperature on rabi crop production has observed. Furthermore, the population is also increased which has the negative impact on production in Swat valley. Such, the rising population creates the stress of food security and economically unstable. The result indicated that in 2013 the per capita availability was 4.06 kg, whereas 2011 was 5.30 kg that showed a decrease of per capita availability. For the rainfall scenarios, the production of rabi crops was increasing with decreasing rainfall pattern. It would increase the trend of per capita availability of rabi crops. The rabi crop production showed a upward trend from 12.6 % in the 1994. The decreasing trend was also observed in 2001 with the rate of -14.8 %. The main reason for the irregular pattern of the crops production is the erratic nature of rainfall pattern and green economy exchange system (Abbas *et al.*, 2016a).

Conclusion: The significance of this study was to analyze the variations in rainfall and temperature which would have negatively impacted the *Rabi* crop production in Swat valley. The mean temperature above normal was negatively influencing the *Rabi* crop production by influsing the duration of the different growth stages of the wheat and barley crop and the on their production. Thus, the results of this study are useful in determining the agro-climatic strategies for sustainable crop production through better agronomic practices in moutanious regions of Pakistan and in South Asia as well.

REFERENCES

Abbas, S., S.A. Shirazi, M.S. Hussain, M. Yaseen, K. Shakarullah, S.S. Wahla and M. Khurshid (2020a). Impact of climate change on forest cover: Implications for carbon stock assessment and sustainable development in HKH region-Pakistan. J. Pak. Vision. 21(1): 67-88.

Abbas, S., S. Kousar, M. Yaseen, Z. A. Mayo, M. Zainab, M. J. Mahmood and H. Raza, H. (2020b). Impact assessment of socioeconomic factors on dimensions of environmental degradation in Pakistan. SN. App. Sci. 2(3): 1-16.

Abbas, S., S.A. Shirazi and S. Qureshi (2018a). SWOT analysis for socio-ecological landscape variation as a precursor to the management of the mountainous Kanshi watershed, Salt Range of Pakistan. Int. J. Sus. Dev. Wor. Eco. 25(4): 351-361.

Abbas, S., M.S. Hussain, S. Im, S. Lee and S.A. Shirazi (2018b). Urban growth and its effect on temperature trends of Lahore city, Pakistan. J. Clim. Res. 13(3): 231-245.

Abbas, S., K. Khan and Z. Ali (2016a). Green economic growth: an opportunity for sustainability and poverty alleviation, HKH region, Pakistan. Sci. Int. Lahore. 28(4): 3715-3720.

Abbas, S., K. Khan and A.A. Khan (2016b). REDD Plus and their impact on green economy development: Implication for sustainable forest development, Swat valley, HKH region, Khyber Pakhtunkhwa, Pakistan. Sci. Int. Lahore. 28(5): 4657-4664.

Arshad, M., T.S. Amjath-Babu, T.J. Krupnik, S. Aravindakshan, A. Abbas, H. Kächele and K. Müller (2017). Climate variability and yield risk in South Asia's rice–wheat systems: emerging evidence from Pakistan. Pad.Wat. Env. 15(2): 249-261.

Breisinger, C. and X. Diao (2008). Economic transformation in theory and practice: what are the messages for Africa. Intl. F. Policy. Res. Inst. 797(1): 1-60.

Viet Cuong, N. (2011). Does agriculture help poverty and inequality reduction? Evidence from Vietnam. Agri. Eco. Rev.11 (1): 44-56.

Douglas, P. H. (1976). The Cobb-Douglas production function once again: its history its testing and some new empirical values. J. Polit. Eco. 84(5): 903-915.

Deryugina, T. and S.M. Hsiang (2014). Does the environment still matter? Daily temperature and income in the United States. National Beaureau of Economic Research; United States. 47 p.

Eboh, E. C., M. Oduh and O. Ujah (2012). Drivers and sustainability of agricultural growth in Nigeria. Afric. Instit. Appli. Econ, Enugu. 8 (1): 21-24.

Ge, Y. and Q. Zhi (2016). Literature review: The green economy, clean energy policy and employment. Ener. Proce. 88(1): 257-264.

Herbst, R. S., P. Baas, D.W. Kim, E. Felip, J.L. Pérez-Gracia, J.Y. Han and M. Majem (2016). Pembrolizumab versus docetaxel for previously treated, PD-L1-positive, advanced non-small-cell lung cancer: a randomised controlled trial. Lanc. 387 (1): 1540-1550.

Khan, N., S. Shahid, T. bin Ismail and X.J. Wang (2019). Spatial distribution of unidirectional trends in temperature and temperature extremes in Pakistan. Theo. Appli. Clima. 136 (3-4): 899-913.

Kirby, J. M., M., Mainuddin, F. Mpelasoka, M.D. Ahmad, W. Palash, M.E. Quadir and M.M. Hossain (2016). The impact of climate change on regional water balances in Bangladesh. Clim. chan, 135(3-4): 481-491.

Liese, A. (2010). Explaining varying degrees of openness in the food and agriculture organization of the United Nations (FAO). Transnational actors in global governance . Springer. London. 109 p.

Mobeen, M., H. Ahmed, F. Ullah, M.O. Riaz, I. Mustafa, M.R. Khan and M.U. Hanif (2017). Impact of climate change on the precipitation pattern of district Sargodha, Pakistan. Inter. J. Clim. Chan. Stra. Manag. 9 (1): 21-35.

Melnikova, N.V., A.A. Dmitriev, M.S. Belenikin, N.V. Koroban, A.S. Speranskaya, A.A. Krinitsina and N.V. Kishlyan (2016). Identification, expression analysis, and target prediction of flax genotroph microRNAs under normal and nutrient stress conditions. Front. plant sci. 7(1): 399- 413.

Masson-Delmotte, V., P. Zhai, H.O. Pörtner, D. Roberts, J. Skea, P.R. Shukla and S. Connors (2018). IPCC, 2018: Summary for policy makers. Glo.warm. 1(2018): 1-89.

Ozturk, I., A. Aslan and H. Kalyoncu (2010). Energy consumption and economic growth relationship: Evidence from panel data for low and middle income countries. Energ.Poli. 38 (8): 4422-4428.

Stern, D. I. (2004). Economic growth and energy. Encycl. Ener. 2 (1): 35-51.

Saigal, S. (2017). REDD+ and other key emerging concepts in Forestry: relevance for India. Ma India's forests in a changing climate. 17 (2): 16-34.

Ssozi, J. and S.A. Asongu (2016). The effects of remittances on output per worker in sub-saharan Africa: A production function approach. South African. J. Econom. 84(3): 400-421.

Tiwari, A.K. (2011). Energy consumption, CO_2 emissions and economic growth: Evidence from India. J. Intern. Bus. Econ. 12 (1), 85-122.

Xepapadeas, A. (2005). Economic growth and the environment. Handbook of environmental economics. Else. 3(1): 1219-1271.

Yu, W., M. Alam, A. Hassan, A.S. Khan, A. Ruane, C. Rosenzweig and J. Thurlow (2010). Climate change risks and food security in Bangladesh. Routledge. 139 p.