IMPACT OF ECONOMIC GROWTH, ENERGY CONSUMPTION AND URBAN POPULATION TO CLIMATE CHANGE IN INDONESIA PERIOD 1985-2019

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Abstract

Economic growth, energy consumption and urban population have positive and significant impact to climate change. The condition of economic growth, energy consumption and urban population in Indonesia during the period 1985-2019 continued to increase and that also will increase the CO2 emission and will make the heat trapped on earth and increasing earth temperature and it made the climate change. In addition, energy consumption is one indicator by which the level of technology can be measured, in which the widespread use of environmentally friendly technology can reduce energy consumption of fossil fuels. However, it can also lead to an increase in energy consumption through increased levels of efficiency, increased income and human nature which tends to be wasteful and ineffective.

Keyword: *Economic Growth, Energy Consumption, Urban Population, CO2 Emission and Climate Change*

1. INTRODUCTION

Climate change is a serious problem for the world today, including Indonesia. This climate change can increase the volume of sea level, trigger changes in seasonal patterns which will certainly disrupt farmers' harvests, and can even eliminate biodiversity because they are unable to adapt to temperature changes.

In Indonesia itself, there are several impacts of climate change, for example tropical cyclone Seroja in April 2021 which occurred due to an increase in temperature in Indonesian waters by 4 degrees Celsius. This tropical cyclone caused environmental damage such as landslides and floods that occurred in NTT and it became the largest cyclone after 2008. In addition, the heat wave that occurred in Russia killed 55,000 people, destroyed 9 million hectares of crops, and caused forest fires (KOMPAS, 2021).

Because of the many negative impacts, countries in the world have made efforts to reduce the impact of climate change, one of which was the holding of the Paris COP21 conference in Paris on December 12, 2015 which resulted in an agreement that all countries would limit the increase in global temperature below 2 degrees Celsius due to a 50% increase in carbon dioxide (CO2) emissions from 1990 to the present (SDG, 2018). The release of CO2 emissions into the air causes a greenhouse effect so that it will increase the earth's temperature or global warming which of course leads to climate change. In Indonesia itself CO2 emissions have increased dramatically from 1985, this can be seen in graph 1.2 below.

In 1985, CO2 emissions in Indonesia were still low at 84,706 metric tons, increasing from year to year, until in 2019 CO2 emissions reached 632,085 metric tons. The increase in CO2 emissions is inseparable from human activities, especially in urban areas related to development and economic growth which generally consumes petroleum as an energy source.

Economic growth is closely related to energy consumption, because higher energy consumption causes an increase in economic growth (Omri, 2014). Industrialization coupled with energy consumption that is not environmentally friendly, especially in developing countries, increases greenhouse gas emissions, especially CO2. Moreover, with the increasing human population, the more demand for energy such as oil, coal, natural gas and other energy

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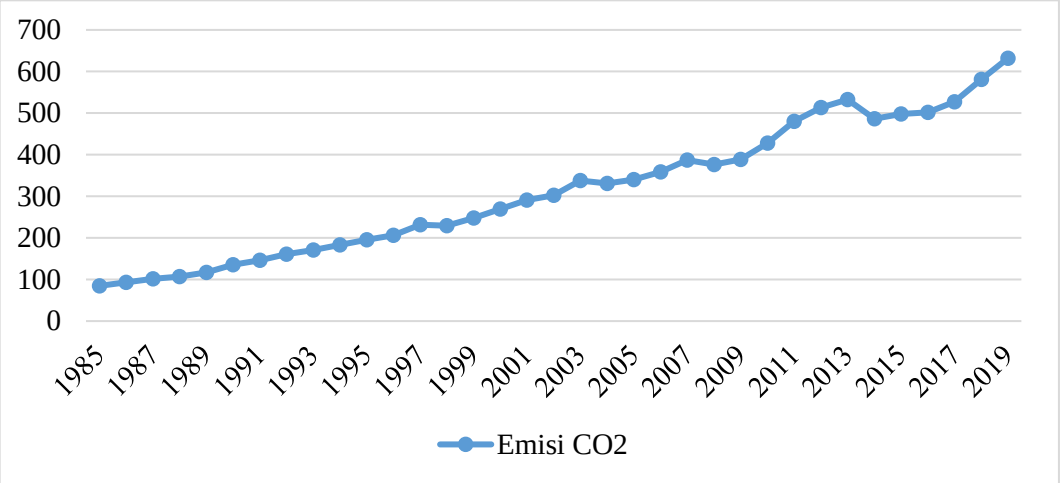
will certainly release a lot of CO2. This CO2 gas contributes to global warming by 56%, which of course changes the temperature on the earth's surface and the climate changes too (Ridwan, 2017).



Source: World Bank, 2020

Figure 1
Indonesia's CO2 Emission in Metric Tons

There have been many studies and research conducted regarding the relationship between economic growth, population, energy consumption and increased CO2 emissions that cause the earth's surface temperature to rise and cause climate change. According to Kurnia (2018) in his research, economic growth has no effect because in developed countries, people will use environmentally friendly technologies, while energy consumption has a positive effect on CO2 emissions because accelerating the industrialization process requires the use of a lot of energy. In addition, according to Zarzoso et al (2006) economic growth and energy use in European Union countries have a positive effect on CO2 emissions, although Germany and the UK have a negative correlation between economic growth and emission levels.

However, according to Ridwan (2017), economic growth and energy consumption will increase CO2 emissions, because using technology that reduces CO2 emissions will reduce the rate of economic growth. Then according to Ibrahim et al (2019), the human population has a positive effect on CO2 emissions due to the large use of energy and transportation, this is in line with Anqing Shi's research (2001) that population is one of the main factors in increasing carbon dioxide emissions, especially in developing countries.

From the description above, economic growth, energy consumption and human population have a positive impact on carbon dioxide emissions, although there are certain conditions that make the results contradictory. With the increase in CO2 emissions, there will be a greenhouse effect which will increase the earth's temperature and make changes to the climate.

Based on the description above, researchers are interested in researching "The Effect of Economic Growth, City Population and Energy Consumption on Climate Change in Indonesia in 1985-2019.

2. LITERATURE STUDY

Economic Growth

Economic growth is a process of changing economic condition in a country on an ongoing basis to get to a situation that is considered better for a certain period of time. Economic growth can be seen from their gross domestic produk (GDP). The higher the GDP of a region indicates the development of economic activities, both production, consumption,

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investment and trade activities in the area, which then has an impact on labor absorption.

1. Classical Growth Theory
   This theory was pioneered by Adam Smith, David Ricardo, Malthus, and John Stuart Mill. According to this theory, economic growth is influenced by four factors, namely the population, the amount of capital goods, land area and natural resources and the technology used. This theory pays attention to the effect of population growth on economic growth. This theory assumes that land area and natural resources and technology have not changed. The relationship between per capita income and population is called the optimal population theory. According to this theory, initially population growth will lead to an increase in per capita income. However, if the population continues to increase, the law of diminishing returns will affect the production function, namely marginal production will decrease, and will lead to a state of per capita income equal to marginal production.
2. Neo Classical Growth Theory
   Developed by Robert Solow, Edmund Phelps, Harry Johnson and J.E. Meade. In neo classical analysis economic growth depends on the increase and supply of factors of production and the rate of technological progress because the economy will continue to experience a level of full employment and the capacity of capital equipment will be fully utilized from time to time.
3. Harrod-Domar Growth Theory
   Harrod-Domar's growth theory is a direct development of John Maynard Keynes' macro growth theory. According to Harrod Domar, every economy basically has to reserve or save part of its national income to add or replace capital goods. To spur the process of economic growth, new investment is needed which is a net addition to the reserves or capital stock.
4. Schumpeter Theory
   This theory emphasizes innovation made by entrepreneurs and says that technological progress is largely determined by the entrepreneurial spirit in the community who is able to see opportunities and dare to take risks to open new businesses, as well as expand existing businesses.

Urban Population

Urban population refers to people living in the cities or the population inhabiting ares that have a greater population and more compact than rural areas. People want to live in the cities because they want to get the better education and have higher-income jobs. The United Nations predict that people living in urban centers will steadily increase as people migrate from rural areas to cities.

The area or urban area fulfills 3 requirements, namely:

1. Population density of 500 people or more per square kilometer
2. The number of households working in the agricultural sector is 25 percent or less, and
3. Has eight or more types of urban facilities (schools, hospitals, markets, banks, electricity, telephones, maternity homes, cinemas, restaurants, factories, etc.).

Energy Consumption

Energy consumption refers to all the energy that used to perform an action, manufacture something or simply inhabit a building. Energy consumption doesn’t necessarily come from a single energy source. Some of energy itself uses fossil energy such as oil and coal, and some uses environmentally friendly energy.

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Furthermore, energy itself consists of two components, namely exergy (exergy) which is a useful component that can be converted to do various useful jobs while the useless one is called anergy. Examples for exergy are solar radiation energy, chemical energy stored in coal, oil, and gas, nuclear energy, potential and kinetic energy, and electrical energy. So the term "energy" which is generally used when talking about this energy carrier is the same as saying "exergy". When combustion or friction processes convert exergy into heat, energy is produced.

So according to Kummel energy consumption is defined as the process of losing all or part of the exergy to do work, giving rise to a lot of energy, namely when energy is used to heat or move something.

Climate Change

Climate is a measure of the mean and variability of the relevant quantities of certain variables, such as temperature, precipitation or wind. Ministry of Environment define climate change is a change in the physical conditions of the earth's atmosphere, including temperature and distribution of rainfall which has a wide impact on various sectors of human life. According to the United Nations (UN) climate change is climate change caused either directly or indirectly by human activities that alter the composition of the global atmosphere and natural climate variability in the time period that has been compared. Climate change occurs due to increasing concentrations of carbon dioxide gas and other gases that cause greenhouse gas effects and raise the earth's surface temperature and lead to climate change.

Basically, Greenhouse Gases are needed to keep the earth's temperature stable. However, the increasing concentration of greenhouse gases makes the atmosphere layer thicker. The thickening of the atmospheric layer causes the amount of geothermal heat trapped in the earth's atmosphere to increase, resulting in an increase in the earth's temperature, which is called global warming.

Intergovernmental Panel on Climatte Change (IPPC) states that global warming can cause significant changes in physical and biological systems such as increased intensity of tropical storms, changes in precipitation patterns, seawater salinity, changes in wind patterns, affects the reproductive period of animals and plants, species distribution and population size, frequency of pest attacks. and disease outbreaks, and affects a variety of ecosystems found in high latitudes, high altitudes, and coastal ecosystems. Therefore, adaptation must be balanced with mitigation, namely efforts to reduce sources and increase sinks (absorbers) of greenhouse gases, so that the development process is not hampered and sustainable development goals can be achieved.

Previous Research

In the research of Usenobong and Godwin (2012), energy consumption has an effect on climate change. According to Oluyomi et al, (2020) energy consumption affects CO2 emissions. According to Kurnia (2018) in his research, economic growth has no effect, while energy consumption has an effect on CO2 emissions. According to Zarzoso et al (2006) economic growth and energy use affect CO2 emissions, and two countries have a negative correlation between economic growth and emission levels, while the impact of population on emissions has different impacts for low, middle and upper countries (2008). According to Ridwan (2017), economic growth and energy consumption affect CO2 emissions. Then according to Ibrahim et al. (2019) and Anqing (2001), the human population has a positive effect on CO2 emissions which of course will affect the increase in earth's temperature and make the climate change.

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3. RESEACRH METHODS

Data

This study used secondary data in the form of time series data. The data used includes data on CO2 emissions (metric tonnes), energy consumption data (per capita), and real GDP per capita. The data is sourced from the World Bank and Indonesian Meteorology and Geophysics Agency. This research also uses other sources such as journals, articles and other literatures.

Model Spesification

The analytical tool in this study uses multiple linear regression analysis based on Ordinary Least Square (OLS), time series data along with statistical tests and classical assumption tests. The data processing tool used is the E-views 9.0 program. The following regression equation model is used:

$$CLMTt = \beta 0 + \beta_1 GDPt + \beta_2 ECON_t + \beta_3 URPOP_t + et$$

Keterangan :

CLMT	= Climate Change
β0	= Intercept/regression constant
β1, β2, β3	= Coefficient Estimate
GDP	= Gross Domestic Product (GDP)
ECO	= Energy Consumption
URPOP	= Urban Pupulation
e	= error

4. RESULT AND DISCUSSION

Multiple Regression

Table 1. Multiple Regression Output

Dependent Variable: Y
Method: Least Squares
Date: 05/20/22 Time: 13:11
Sample: 1986 2019
Included observations: 34

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.98E+14	3.70E+14	1.613580	0.1171
LNX1	-0.074699	0.128894	-0.579539	0.5666
LNX2	-226572.3	5562210.	-0.040734	0.9678
LNX3	-0.095781	0.242577	-0.394848	0.6957

R-squared	0.113296	Mean dependent var	4.18E+14
Adjusted R-squared	0.024626	S.D. dependent var	2.41E+14
S.E. of regression	2.38E+14	Akaike info criterion	69.15301
Sum squared resid	1.70E+30	Schwarz criterion	69.33258
Log likelihood	-1171.601	Hannan-Quinn criter.	69.21425
F-statistic	1.277724	Durbin-Watson stat	0.900137
Prob(F-statistic)	0.299858		

Source : Processed Data, E-views 9.0

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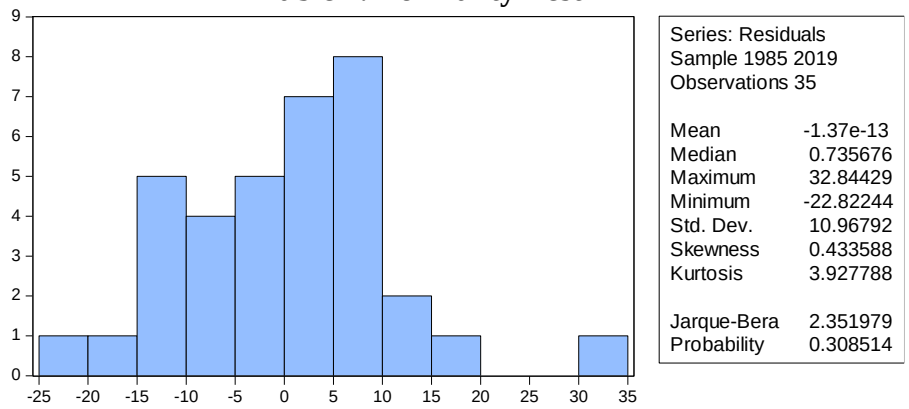
Based on the results of the statistical regression in Table 1, we conclude the results of multiple linear regression for the CO2 emission variable are as follows:

CLMT = 5,98 - 0,074699GDP - 226572,3ECON - 0,095781URPOP + ei

The coefficient results show that the coefficient value for the Gross Domestic Product (GDP) variable is 0.074 and has a negatif relationship, which means that when the GDP variable increases, it will increase Climate Change by 0.027 with a probability value of 0.000 <0.05 degree of error of 5% so that it is statistically significant to Climate Change. The coefficient results for the variable Energy Consumption (ECON) 11.9996 which have a positive relationship, if the variable energy consumption increases, it will increase Energy Consumption by 11.9996, and if people's energy consumption decreases, the use of CO2 emissions will also decrease. The probability value of this variable is 0.0000 (ECO) with a degree of error of 5% (0.05), so that the energy consumption variable is statistically significant to Climate Change. And for the coefficient result for the Urban Population (URPOP) is 1 billion and has a positive relationship, so that's means that when Urban Population increase, it will increase climate change by 1 billion with probability value 0.0047 < 0.05 degree of error 5% and Urban population is statistically significant to climate change.

Normality Test

Table 2. Normality Test



Source : Processed Data, E-views 9.0

The normality test used in this study was the Jarque Bera Test. The results of the residual normality test in the attachment show that the jarque fallow value is 2.352 > 0.05 with a p value of 0.309 > 0.05. so that H0 is accepted, which means that the data distribution residuals are normal

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Multicollinearity Test

Table 3. Multicollinearity Test

Dependent Variable: Y
Method: Least Squares
Date: 05/20/22 Time: 13:27
Sample: 1986 2019
Included observations: 34

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.98E+14	3.70E+14	1.613580	0.1171
LNX1	-0.074699	0.128894	-0.579539	0.5666
LNX2	-226572.3	5562210.	-0.040734	0.9678
LNX4	-0.095781	0.242577	-0.394848	0.6957

R-squared	0.113296	Mean dependent var	4.18E+14
Adjusted R-squared	0.024626	S.D. dependent var	2.41E+14
S.E. of regression	2.38E+14	Akaike info criterion	69.15301
Sum squared resid	1.70E+30	Schwarz criterion	69.33258
Log likelihood	-1171.601	Hannan-Quinn criter.	69.21425
F-statistic	1.277724	Durbin-Watson stat	0.900137
Prob(F-statistic)	0.299858		

Source : Processed Data, E-views 9.0

The data above shows that the value of Centered VIF for both Variable Gross Domestic Product (GDP) is lee than 10, while energy consumption and urban population is above than 10, so it can be stated that there is multicollinearity problem in the model.

Heterokedacity Test

Table 4. Heterokedacity Test

Heteroskedasticity Test: Harvey

F-statistic	2.537195	Prob. F(3,31)	0.0747
Obs*R-squared	6.899626	Prob. Chi-Square(3)	0.0752
Scaled explained SS	7.005382	Prob. Chi-Square(3)	0.0717

Source : Processed Data, E-views 9.0

The heteroscedasticity test in this research model uses Harvey test. In this test, it can be indicated by the Prob value. Chi square (3) at Obs * R-squared which is equal to 0.0752 > 0.05 then H0 is accepted and there is no problem with the assumption of non-heterocedasticity..

R^2 Test

From the results of the calculation of multiple linear regression analysis, it can be seen that the value of the R2 coefficient is 0.99 which is almost close to 1. Thus, it means that climate changein Indonesia during the period 1985-2019 can be explained around 99% by the Gross Domestic Product variable, Energy Consumption and Urban Population. While the remaining 1% is explained by other variables not included in this research model.

F Statistic Test

F statistic in this result is 2158.504 with probability 0.000 < 0.05 so that H1 is accepted that economic growth, energy consumption and urban population variable is simultaneously affect the climate change.

Economic Growth (GDP)

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In the table 1, GDP variable coefficient is 0.026 with a positive sign, the interpretation is when GDP changes by 1%, it will cause an increase in the emission level of 0.026%. This result are consistent with the research Zarzoso dkk (2006) and Ridwan (2017) that in their research that economic growth have a significant and positive effect on volume of CO2 emissions. If volume of CO2 emission increase it will increase temperature and will change the climate.

In Indonesia, because the community has not felt the impact directly, the environmental sustainability is not yet a very important issue. This can be exacerbated by the environmental damage that occurred during the pre-industrial period to industry, where most of it was caused by efforts to increase production which incidentally was foreign production, and the country had little or no profit at all.

Energy Consumption

The increasing energy consumption encourages the industrialization process like fossil fuel and electricity system. The more they use energy the more CO2 emission let out and the heat trapped on earth. We can see in the table 1, Energy consumption variable coefficient is 11.99955 with a positive sign, the interpretation is when energy changes by 1%, it will cause an increase climate change 11.99%.

The same result was stated by Kurnia (2018), Zarzoso dkk (2006) and Ridwan (2017) that energy consumption had a significant and positive impact on CO2 emission and of course it will increase temperature and make the climate change.

Urban Population

In this study we found that Urban population had a significant and positive impact to climate change that can be seen on the table 1 with coefficient 1.29E-06 with positive sign and probability 0.0047. we have the same result with Ibrahim dkk (2019) and Anqing Shi (2001), population have positive impact to CO2 emission because citizens will consume more energy and use transportation.

5. CONCLUSION

Based on the result, economic growth, energy consumption and urban population have positive and significant impact to climate change. The condition of economic growth, energy consumption and urban population in Indonesia during the period 1985-2019 continued to increase and that also will increase the CO2 emission and will make the heat trapped on earth and increasing earth temperature and it made the climate change. In addition, energy consumption is one indicator by which the level of technology can be measured, in which the widespread use of environmentally friendly technology can reduce energy consumption of fossil fuels. However, it can also lead to an increase in energy consumption through increased levels of efficiency, increased income and human nature which tends to be wasteful and ineffective.

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Reference

A.Oluyomi Osobajo, Afolabi Otitoju, Martha Ajibola Otitoju dan Adekunle Oke, (2020) *The Impact of Energy Consumption and Economic Growth on Carbon Dioxide Emissions*, MDPI, United Kingdom

Adi Kurnia Chandra, (2018) *Analisis Pengaruh Pertumbuhan Ekonomi dan Penanaman Modla Asing Terhadap Emisi Karbon Dioksida di Delapan Negara ASEAN Periode 2004-2013*, Jurnal Ilmiah Mahasiswa Universitas Surabaya Vol.7 No.1 2018, Surabaya.

Aqualdo Nobel, Eriyati dan Toti Indrawati, (2012) *Penyeimbang Lingkungan Akibat Pencemaran Karbon yang Ditimbulkan Industri Warung Internet di Kota Pekanbaru*, Jurnal Ekonomi Vol. 20 No.3 September 2012, Riau

F. Usenobong Akpan, (2012) *The Contribution of Energy Consumption to Climate Change : A Feasible Policy Direction*, International Journal of Energy Economics and Policy Vol.2 No.1 2012, pp.21-33, Nigeria.

Fariz Mohammad and Sri Muljaningsih (2015) *Pengaruh Konsumsi energy Terhadap Pertumbuhan Ekonomi di Indonesia Periode 1980-2012*, Jurnal Ilmiah Vo.3 No.2, Malang.

Fauzi Ridwan, (2017) *Pengaruh Konsumsi Energi, Luas Kawasan Hutan dan Pertumbuhan Ekonomi Terhadap Emisi CO_2 di 6 (Enam) Negara Anggota ASEAN : Pendekatan Analisis Data Panel*, Ecolab Vol.11 No.1 Januari 2017 : 1-52.

Julismin, (2013) *Dampak dan Perubahan Iklim di Indonesia*, Jurnal Geografi Vol.5 No.1 2013, Medan.

Kartiasih Fitri dan Adi Setiawan, (2019) *Aplikasi Error Correction Mechanism dalam Analisa Dampak Petumbuhan Ekonomi dan Konsumsi Energi dan Perdagangan Internasional Terhadap Emisi CO_2 di Indonesia*, Media Statistika 13(1) 2020 : 104-115, Jakarta.

Kummel, Reiner, (2011) *The Second Law of Economics*, New York : Springer.

Ma'ruf Ahmad and Latri Wihastuti, (2008), *Pertumbuhan Ekonomi Indonesia : Determinan dan Prospeknya*, Jurnal Ekonomi dan Studi Pembangunan Vol.9 No.1 April 2008 : 44 -55, Yogyakarta.

Martínez-Zarzoso, I., Bengochea-Morancho, A., & Morales-Lage, R., (2006) *The Impact of Population on CO2 Emissions: Evidence From European Countries*. Social Science Research Network Electronic Paper Collection.

Mohammed Ibrahim Lawal and Mukhtar Abubakar, (2019) *Impact of Population Growth on Carbon Dioxide (CO_2) Emission : Empirical Evidence from Nigaria*, Jurnal Perspeektif Pembiayaan dan Pembangunan Daerah Vo. 6 No.6 May-June 2019, Borno State.

Nurbandi Wahyu dan Indinna Sofia Astuti, (2018) *Kajian Perubahan Iklim Ditinjau dari Pengaruh Tingkat GDP Per Kapita Terhadap Emisi CO_2 di Asia tenggara Tahun 1980-2014*, Jurnal Meteorologi Klimatologi dan Geofisika Vol.5 No. 3 November 2018, Yogyakarta.

Phimphantanvong Hatthachan, (2013) *The Impact of Economic Growth on Evironmental Condition in Laos*, Vol 4 (5) 2013, Italy.

Shi Anqing, (2001) *Population Growth and Global Carbon Dioxide Emissions*, Development Research Group The World Bank June 2001 Version.

Tjiptoherijanto Prijono, (1999) *Urbanisasi dan Pengembangan Kota di Indonesia*, Jurnal kependudukan dan kebijakan Vo.10 No.2 1999, Yogyakarta.

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