Relationship Between Human Society and Environmental Factors Based on Linear Regression

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Abstract

This research analyzes the relationship between the democracy level, happiness, and the environmental factors – air and water pollution. The relationship between democracy, the environment, and human health is complex; each factor affecting the other. A country's level of democracy can significantly impact the environment, with democracies generally having stronger environmental regulations and more public participation in decision- making. This paper aims to prove that those indexes are related by using linear regression and analysis. Linear regression is a data mining method. The primary motivation for using linear regression is to build a model that can accurately predict the target variable based on the value of the independent variable. The model is implemented in Python. In the evaluation chapter, there are 8 graphs representing the correlations. The dataset is from 'world- air-quality-report,' 'world-happiness-report,' and 'democracy-index.' Air quality seems to have slightly more effects on happiness than the level of water pollution. Both of them are related to the democracy level. This relationship is explained by the fact that if democracy levels are better, the environment is healthier. Since the happiness of society is affected by both democracy and environmental quality, the paper concludes: Higher levels of democracy lead to a deeper consideration of environmental issues, which in turn increases the overall happiness of human beings in said society. I will conduct more experiments on the other factors with multi-factor linear regression related to this research so that a more detailed analysis can be made.

I. Introduction

Protecting the environment has become a trend in recent years as people around the world have become increasingly aware of the negative

impact that human activities have on the environment. With growing concerns about issues like climate change, pollution, and the depletion of natural resources, people realize the need to take action to protect our planet. Various factors, including scientific research, media coverage, and advocacy efforts by environmental organizations, have driven this shift in awareness. Additionally, consumers increasingly demand sustainable and environmentally-friendly products, and businesses recognize the importance of reducing their environmental impact. As a result, protecting the environment has become a popular trend and a top priority for many people, businesses, and governments worldwide.

This trend of protecting the environment has been shown to be beneficial not only to the environment but also to humans. Firstly, a healthy environment provides essential resources such as clean air and water, fertile soil, and a diverse range of plant and animal life necessary for human survival and health. Secondly, the environment plays a crucial role in regulating the Earth's climate and weather patterns, which can have a significant impact on human health and safety. Climate change, in particular, poses a considerable threat to human health, as rising temperatures and more extreme weather events can lead to a range of health problems, from heat-related illnesses to food and water insecurity. Finally, protecting the environment is also essential for maintaining biodiversity and ecological balance, which can help to prevent the spread of disease and ensure the long-term sustainability of natural resources. Therefore, it is vital to prioritize the protection of the environment to promote human well-being and ensure a sustainable future for all.

Democracy is relevant to the environment because it provides a framework for citizen participation and decision-making. In a democratic society, citizens have the right to express their opinions and to hold their leaders accountable for their actions. This means that citizens can play an active role in shaping environmental policies and can voice their concerns about issues like climate change, pollution, and habitat destruction. Additionally, a democratic society is more likely to promote transparency and accountability in decision- making, which can help ensure that environmental policies are based on scientific evidence and are in the best interest of society as a whole. Furthermore, democracy promotes the rule of law and can help enforce environmental regulations and hold polluters accountable for their actions.

The relationship between democracy, the environment, and human wellness is complex, with each factor influencing the other. The level of democracy in a country can significantly impact the environment, with democratic countries typically having stronger environmental regulations and more public participation in decision-making. This can lead

to better environmental outcomes, which in turn can improve human wellness by reducing exposure to environmental hazards and promoting a healthier, more sustainable living environment.

In this paper, chapter I contributes to 3 points: 1) How protecting the environment has become a trend in modern societies, 2) What benefit protecting the environment brings for humans, and 3) The correlation between democracy and the environment.

In chapter II, the paper discusses 4 points:

1) Democracy: the negative impacts of corruption on the environment and the economic, social, technological, and political factors influencing the relationship between society and the environment, 2) Wellness: the need to focus on happiness and life expectancy, 3) Environmental policies and democracy: the need to ensure transparency and accountability in democratic processes to implement effective environmental policies, and 4) Environmental sustainability and human wellness: the harm the environment can bring to overall human wellness.

In chapter III, it explores on linear regression through 3 points: 1) What linear regression is and its motives, 2) The uses of SST and coefficient of determination, 3) example of linear regression.

In chapter IV, the results of evaluations are described and analyzed based on the dataset from the 'world air quality report,' 'world happiness report,' and 'democracy index.'

In chapter V, the paper concludes by interpreting the overall results and suggesting methods to improve its performance in the future.

II. Background

A. Democracy

a. Corruption

Corruption is a pervasive issue that can undermine democracy and negatively impact efforts to protect the environment. In many cases, corrupt officials may prioritize their own interests or those of powerful groups over the needs of the broader population or the environment. This can lead to a range of harmful practices, from lax enforcement of environmental regulations to the exploitation of natural resources for personal gain, often at the expense of the environment and the public interest [6].

Moreover, corruption can undermine public trust in democratic institutions and reduce the effectiveness of environmental policies and regulations. When citizens perceive their governments as corrupt, they may be less likely to engage in democratic processes, such as public participation and advocacy for environmental protection [8]. This can lead to a lack of public oversight and accountability for environmental policies, creating a permissive environment for corrupt actors to exploit natural resources and undermine environmental protections.

To address corruption in democratic societies, it is essential to strengthen governance structures and promote transparency and accountability. This can

include measures such as anti-corruption laws, regulations, enforcement mechanisms, and initiatives to encourage public participation and engagement in environmental decision-making processes.

b. **Other factors**

While corruption can play an important role in promoting sustainable practices and protecting the environment, it is crucial to recognize that other factors also influence the relationship between a democratic society and the environment. For example, economic factors such as income inequality and the pursuit of economic growth can lead to environmentally harmful practices such as overconsumption and resource depletion. Social factors such as cultural values and attitudes towards nature can also impact environmental outcomes. Additionally, technological advances and scientific knowledge can play a crucial role in promoting sustainable practices and mitigating the harmful impacts of human activities on the environment. Therefore, in order to promote a sustainable relationship between society and the environment, it is essential to consider a range of factors, including economic, social, technological, and political factors, and to work toward solutions that address the complex and interconnected nature of environmental issues.

B. **Wellness**

a. **Happiness**

Human happiness is a complex and multifaceted concept influenced by various factors, including social, economic, and environmental conditions. Environmental sustainability can play a crucial role in promoting human happiness in the relationship between human society and the environment. A clean and healthy environment can provide a sense of security, stability, and connection to the natural world, contributing to feelings of contentment and well-being. In contrast, environmental degradation and destruction can lead to a sense of disconnection from the natural world and contribute to negative emotions, such as stress, anxiety, and sadness. Therefore, promoting environmental sustainability is essential not only for protecting the planet but also for fostering human happiness and well-being. By recognizing the interconnectedness of human society and the environment, we can work towards creating a more sustainable and happy future for all.

b. **Life expectations**

Life expectancy is an important indicator of human wellness and has been found to be strongly linked to environmental factors. For example, a study of the Canadian Census Health and Environment Cohort found that exposure to ambient PM2.5, O3, and NO2 was associated with increased mortality rates over a 16-year follow-up period[3]. In urban areas, where populations are exposed to high levels of pollution, the negative impact on life expectancy can be particularly significant.

However, air pollution is not the only environmental factor that can contribute to reduced life expectancy. Exposure to toxic chemicals, contaminated water, and poor

sanitation can also significantly impact human health. For example, exposure to lead can lead to cognitive and developmental delays in children, while exposure to mercury can cause neurological damage and impaired cognitive function[4]. Inadequate access to clean water and sanitation can also contribute to the spread of disease, leading to reduced life expectancy.

On the other hand, access to clean air, water, and green spaces has been linked to increased life expectancy and improve overall human wellness. Research has shown that exposure to nature and green spaces can positively impact mental health, reducing stress and improving overall well-being [9]. Similarly, access to clean air and water is essential for maintaining good health and well-being.

In addition to these individual factors, sustainable development and environmental conservation efforts can also positively impact life expectancy. The United Nations' Sustainable Development Goals (SDGs) include a range of environmental protection and sustainable development targets, such as ensuring access to clean water and sanitation, promoting sustainable cities and communities, and protecting biodiversity and ecosystems[10].

Achieving these goals can help ensure everyone has access to the resources they need to live healthy, fulfilling lives. Ultimately, it is clear that the environment plays a critical role in shaping human wellness and life expectancy.

C. **Environmental policies and democracy**

Environmental policies are a crucial aspect of promoting sustainable development and ensuring the protection of the environment for future generations. Democracy can play a vital role in formulating and implementing these policies, as it allows citizens to participate in decision-making processes that affect their environment and well-being.

Democratic societies are more likely to implement effective environmental policies compared to non-democratic societies. A study by Lee and Strazicich (2003) found that democratic governments were more likely to reduce carbon emissions and implement environmental regulations compared to non-democratic governments[1]. This is because democratic societies provide citizens with greater opportunities to voice their opinions and concerns regarding environmental issues, and elected officials are more accountable to their constituents.

However, corruption in democratic societies can undermine the effectiveness of environmental policies. A study by Apergis and Payne (2014) found that corruption negatively affects the implementation of environmental policies and hinders efforts to promote sustainable development[2]. This highlights the importance of ensuring transparency and accountability in democratic processes to ensure that environmental policies are implemented effectively.

Moreover, environmental policies in

democratic societies should be designed to promote social and environmental justice. Environmental policies disproportionately affecting marginalized communities can exacerbate existing inequalities and contribute to environmental injustice. Therefore, policies should be designed to ensure that the benefits and costs of environmental policies are distributed fairly across society. The principles of environmental justice emphasize that all individuals have the right to a safe, healthy, and sustainable environment, and policies should be designed to ensure that this right is upheld for all members of society.

D. Environment and Human Wellness

The relationship between the environment and human wellness is complex and multifaceted, with numerous factors influencing the extent to which environmental conditions impact human health. Exposure to environmental pollutants, such as air and water pollution, has been linked to a range of health problems, including respiratory diseases, cardiovascular disease, and cancer. Moreover, climate change poses a significant threat to human health, with rising temperatures and more frequent extreme weather events leading to heat stress, malnutrition, and the spread of infectious diseases.

Despite these risks, there are also significant benefits to be gained from promoting a healthy environment. Access to green spaces, for example, has been shown to improve mental health and well-being, reduce stress levels, and encourage physical activity[7]. Moreover, sustainable environmental practices, such as reducing carbon emissions and promoting renewable energy sources, can help mitigate climate change's harmful impacts and promote a more sustainable future for all.

Given the significant impact of environmental conditions on human health, it is essential that we prioritize environmental protection as a critical component of public health initiatives. This includes promoting sustainable practices, reducing exposure to environmental pollutants, and advocating for policies and regulations that protect the environment and public health.

III. Linear Regression

A. Linear Regression

Linear regression is a statistical method used for finding the linear relationship between a dependent variable and one or more independent variables[5]. It is one of the simplest and most widely used techniques in machine learning and data analysis. In a linear regression model, the dependent variable is modeled as a linear combination of the independent variables with coefficients. These coefficients are estimated from the data, and the resulting regression equation can be used to make predictions about the dependent variable based on new values of the independent variables.

The primary use for linear regression is to build a model that can accurately predict the target variable based on the values of the independent variables. This is useful for tasks such as predicting stock prices, housing prices, or the likelihood of a

customer making a purchase based on their demographics. The method used in linear regression involves finding the line of best fit (also known as the regression line) that minimizes the difference between the observed values of the target variable and the values predicted by the model. The line of best fit is found by minimizing the sum of the squared differences between the observed values and the predicted values, known as the mean squared error (MSE).

B. **Correlation**

In linear regression analysis, the variance of the dependent variable can be estimated as the sum of the squared differences from the mean (hereinafter referred to as the Sum of Squared Total, SST)[5].

The coefficient of determination is a number between 0 and 1, represented by the variable R, and the closer the coefficient of determination is to 1, the more accurate the regression is for the observed data. The equation for the coefficient of determination is modeled as follows:

$$R^2 = \frac{SSR}{SST} = 1 - \frac{SSE}{SST}$$

C. **Example of Linear Regression**

Consider <table 1> below. The <figure 1> represents the scatter graph and the trend line returned from the linear regression with correlation value (R squared).

x	y
1	2
2	4
3	6
4	8
5	10
6	12
7	13
8	14
9	15
10	16
1.2	1
2.3	3
3.4	5
4.5	7
5.6	9
6.7	11
7.5	12
8.4	13
9.1	14
10.8	15

Table 1

R squared value is over 0.9. Since the value is near 1, the variables in this dataset are significantly correlated. If the user puts x as 6.5, the model returns the predicted value based on the red trend line of about 11.

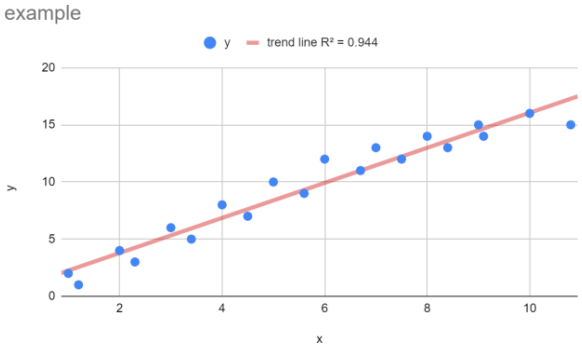

Figure 1

IV. **Evaluation**

The evaluation data are from 'world-air- quality-report 2020 and 2021', 'world happiness report 2020 and 2021', and 'democracy index 2020 and 2021'. Evaluation codes are implemented in Python. The graphs in this chapter includes R squared value. The linear model is for single factors (in 2- dimensional dataset).

A. **2020 air quality and democracy index (cities)**

In <figure 2>, the red line represents a trend line between air quality and democracy index by cities in 2020. As the democracy values get high, so do the air quality values.

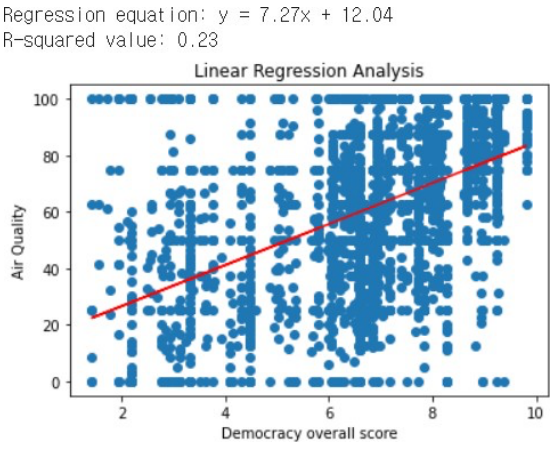

Figure 2

B. **2020 air quality and democracy index (countries)**

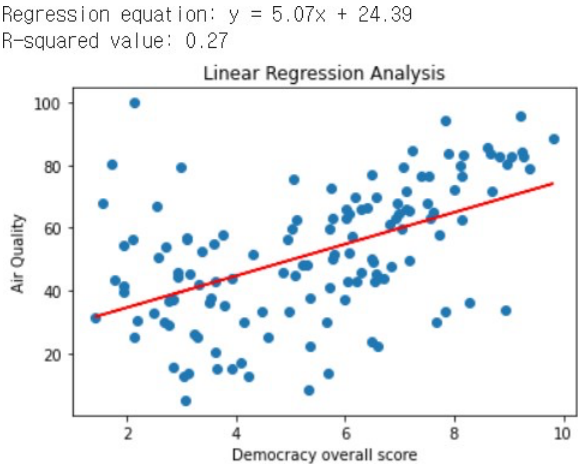

Figure 3

In <figure 3>, the red line represents a trend line between air quality and democracy index by countries in 2020. As the democracy values get high, so do the air quality values. The level of correlation is higher than the data in section A.

C. **2020 air quality and happiness (countries)**

In <figure 4>, the red line represents a trend line between happiness by countries and air quality in 2020. As the quality of air increases, so does the happiness level. This implies that air quality somehow affects the happiness of human beings.

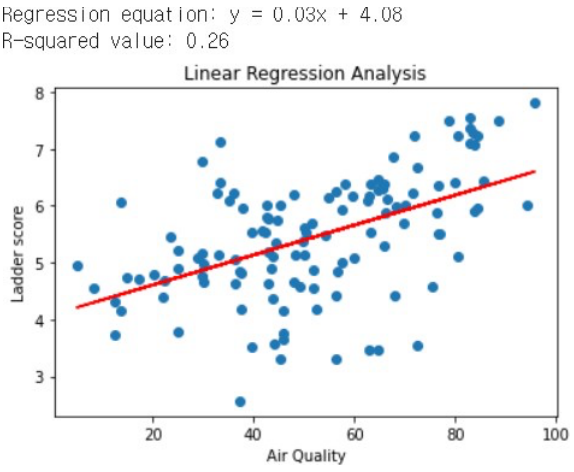

Figure 4

D. **2020 water pollution and democracy index (cities)**

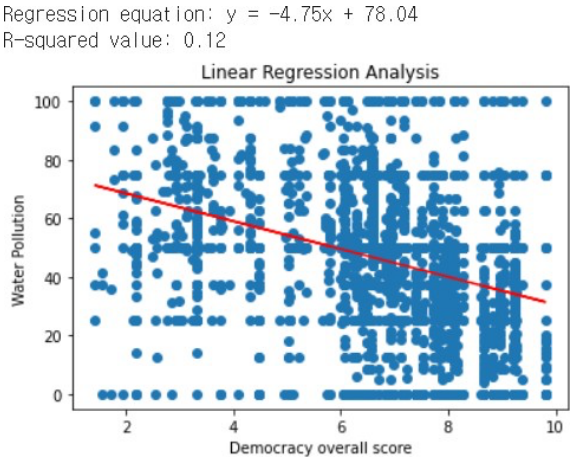

Figure 5

In <figure 5>, the red line represents a trend line between water pollution and democracy index by cities in 2020. As democracy values increase, water pollution decreases.

E. **2020 water pollution and democracy index (countries)**

In <figure 6>, the red line represents a trend line between water pollution and democracy index by countries in 2020. As the democracy values get high, the water pollution level gets low. The level of correlation is higher than the data in section C and lower than in section B.

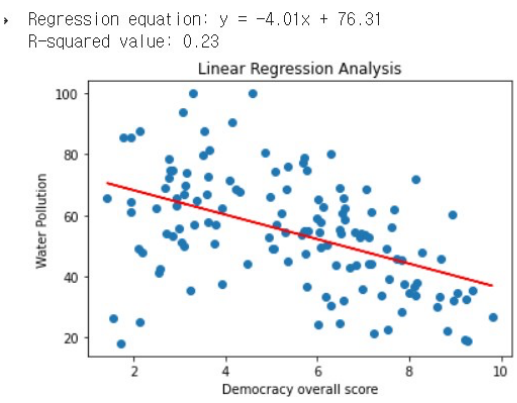

Figure 6

F. **2020 water pollution and happiness (countries)**

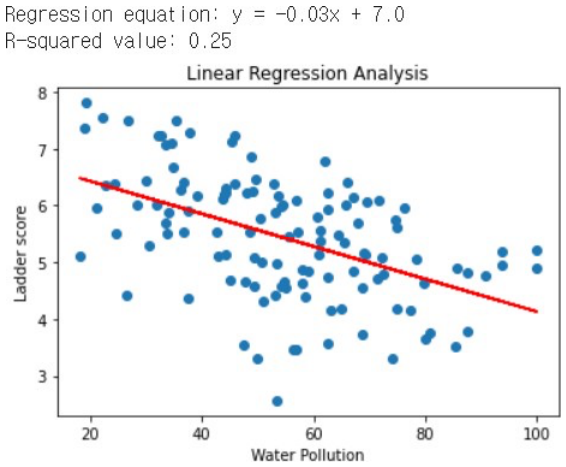

Figure 7

In <figure 7>, the red line represents a trend line between happiness by countries and air quality in 2020. As the pollution of water increases, the happiness level decreases. This implies that water pollution negatively affects the happiness of human beings.

G. **2021 air quality and democracy (countries)**

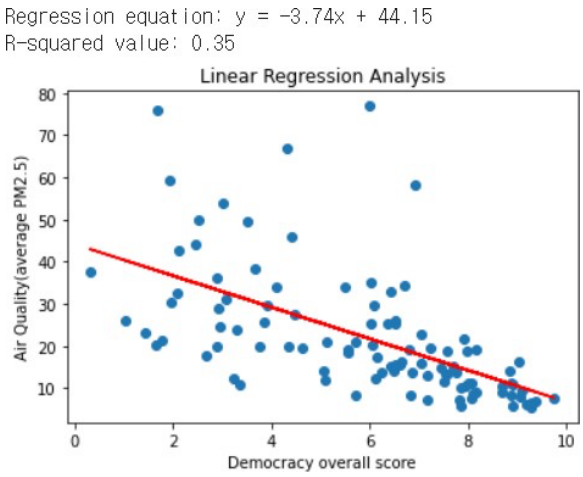

Figure 8

In <figure 8>, the red line represents a trend line between air pollution level and democracy index by countries in 2021. As the democracy values increase, so does the air quality.

H. 2021 air quality and happiness (countries)

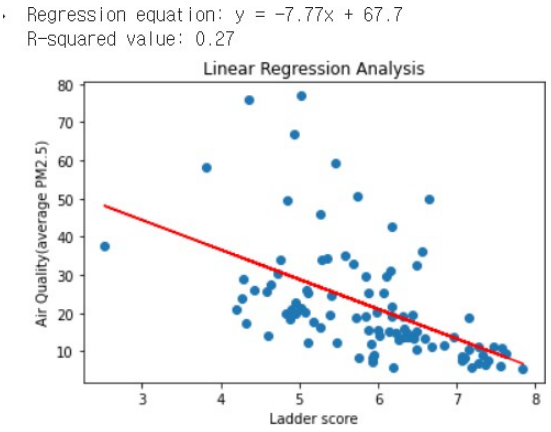

Figure 9

In <figure 9>, the red line represents a trend line between air pollution levels and happiness by countries in 2021. As the happiness values increase, so does the air quality.

I. 2021 democracy index and happiness (countries)

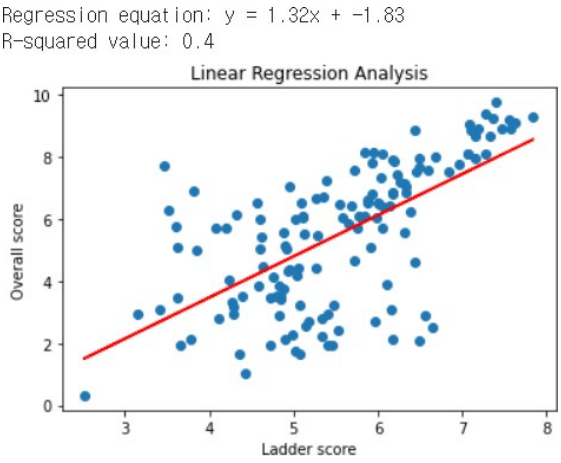

Figure 10

In <figure 10>, the red line represents a trend line between happiness and democracy index by countries in 2021. The correlation level is highest among other pairs. This implies that the democracy level affects the happiness level, and environmental factors also affect democracy – which means they too affect the happiness level with other factors based on the experiments above.

V. Conclusion and Future works

In 2020, I compared air quality, demarcation, water poll, and demarcation. The data seemed to be poorly refined by city, so it came out more accurately when calculated by country by average. Air quality is higher than water pollution, so it's a little more relevant. Happiness and pollution are not much different from air or water, so we can verify air quality again in 2021, and the correlation is higher. This means that if the elements at the democratic level are higher, the environment is healthier. Since the happiness of society is influenced by both democracy and the quality of the environment, this paper concludes: Higher democracy involves an in-depth consideration of environmental issues leading to the overall well-being of humans.

For future works, more experiments will be conducted on other factors with multi-factor linear regression related to this study so that more in-depth analysis can be made. The critical factors include image and video data. Adopting deep learning may enable us to analyze the relationship between those factors and predict the trend.

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