Environmental Performance of Island Countries: A Basis for Best-fit Models of Environmental Sustainability

Asia Pacific Journal of Multidisciplinary Research
Vol. 8 No.3, 46-54
August 2020 Part III
P-ISSN 2350-7756
E-ISSN 2350-8442
www.apjmr.com
ASEAN Citation Index

Joje Mar P. Sanchez[1], Isidro Max V. Alejandro[2]
[1,2]College of Teacher Education, Cebu Normal University, Philippines
sanchezj@cnu.edu.ph[1], alejandroi@cnu.edu.ph[2]

Date Received: June 1, 2020; Date Revised: August 14, 2020

Abstract –*This paper analyzed several factors which could define environmental sustainability of island countries in the world: human development index (HDI), gross domestic product (GDP), green growth (GG), ecological footprint (EF), climate risk (CR), disaster risk (DR) and environmental performance (EPI) from their respective data banks. An exploratory data analysis was conducted to determine the relationship between the factors and EPI, and genetic algorithm was utilized to formulate regression models best-fit for such relationship. Findings from these models reveal that HDI, GDP, GG and EF have strong association with EPI, while CR and DR have weak association. This led to the conclusion that environmental sustainability of island countries is affected by the people's environmental awareness and resource consumption, nation's wealth and way of living, and economy's green technology utilization. Effective environment education, government-private sector research collaboration and efficient implementation of environmental programs are recommended.*

Keywords –*environmental performance, island countries, environmental sustainability*

INTRODUCTION

The environment is one of the three key areas of sustainable development [1]. Due to its fragility, sustainable development goals of UN are directed towards the physical environment, including clean water, clean energy, sustainable communities, climate action, and wildlife. All member nations are aligning their goals to such SDGs to provide a safe and secured place for people to live in. However, providing this sustainable place proves to be a challenge to many governments, especially the island countries. Constituents of these island countries are vulnerable to outside natural forces such as disasters, pollution, climate change and dangers to biodiversity, which could threaten their survival [2]. Vulnerability and susceptibility to these disruptions in the balance of natural forces and human-induced impacts contribute to the environmental performance of island countries in achieving the sustainable goals of living in the current and next century.

Environmental performance of countries is determined through examining several factors derived from big data sets over time. Gallego-Àlvarez et al. [3] subjected socio-economic, institutional and political factors to regression analysis in order to explore the different forms of relationships exist between the said factors and the environmental performance of countries worldwide. Economic wealth, education and institutional factors are found out to be determinant factors of such performance. This study of Gallego-Àlvarez et al. [3] highlights the role of the government in environmental sustainability, where the emphasis of sustainability indicators is directed towards the people and economic factors. Moldan et al. [4] stated that there is a need for indicators, which could link the people and economic factors to the environmental dimension. Two indicators on the stated factors are commonly accepted: Human Development Index and Gross Domestic Product; these indicators essentially satisfy the criteria on salience, credibility and legitimacy [5], [6]. HDI and GDP could describe the extent of social and economic sustainability of countries; however, only covering half of the nature-society systems that people are in. This suggests that the third key dimension – the environmental factors – be included in the regression analysis to provide a more complete picture of environmental sustainability at a global scale.

Environmental factors are represented as indices formulated and scored through assessments of available data sets by experts and scientific organization with an aim to represent the extent of how people interact with their environment. In fact, interpretations on these indices help the government to create environmental policies and the people to decide effectively on environmental concerns [7]. Though these indices are as vital as HDI and GDP, only few studies deal with the determination of the environmental factors which could explain environmental sustainability, as there are many approaches in using the indices as determinants of the ability of countries to sustain a healthy, safe and secured place to live in [7], [8]. There are studies that approach sustainability in terms of economic systems and social indicators, but very limited in terms of the environmental aspect. With this, the study explored environmental performance of island countries in terms of economic, social and environmental factors. The results of the current study is significant to the government of island countries such as the Philippines, Haiti and Maldives as basis for policy-making, as well as to the people of these countries as guide in understanding their responsibility as stewards of the environment; thus, the conduct of the study.

OBJECTIVES OF THE STUDY

The study explored environmental performance of island countries in terms of economic, social and environmental factors; determined the relationship of these factors; and used the findings of the regression models formulated as basis for the development of a theory on environmental sustainability.

MATERIALS AND METHODS

Research Design

The study employed exploratory data analysis in order to determine the association of several indicators of sustainability to the environmental performance of island countries in the world. In the context of this study, an island country is defined as a sovereign state whose primary territory is composed of one main island (e.g. Madagascar and Taiwan), group of islands (e.g. Philippines and Comoros) or parts of islands (e.g. Haiti and Dominican Republic), and does not have any continental land boundary, thereby not including Malaysia, Argentina and USA. Thirty-eight countries across the Atlantic, Indian and Pacific oceans are included in the study as areas of interest in the data exploration.

Source of Data

The exploratory analysis utilized the available data of island countries on the following indices. Human Development Index (HDI) is the measure of human development derived from UNDP (2016) reports. Gross Domestic Product (GDP) gives the market value of goods and services, as reflected from United Nations Institute of Statistics (2017) data set. Green Growth Productivity (GGP) shows how countries utilize green technologies, as given by the Organization for Economic Co-operation and Development (2017). Environmental Footprint (EF) measures the demand on and supply of nature as calculated by Global Footprint Network (2016). Climate Risk (CR) determines the extent of weather-related loss events impacts, as obtained from German Watch (2018) report. Disaster Risk (DR) indicates disaster risk severity, as reported by UN University- Institute for Environment and Human Security (2016).

The indicator **HDI** measures the extent of human development in countries, in terms of health, education and standard of living dimensions [9]. **GDP** indicates the market value of goods and services yielded by a country within a year [10]. In addition to these indicators are environmental indicators: GG, EF, CR and DR. **GG** characterizes the progress of countries towards the use of green technologies in social and economic activities [11]. **EF** measures the demand on and supply of nature [12]. **CR** determines the extent of the impacts of weather-related loss events [13]. **DR** indicates the severity of the disaster risks in countries [14]. The aforementioned people, economy and environment factors could determine the environmental performance of countries, and be used as basis for a theory in environmental sustainability.

Instrumentation and Data Collection Procedure

The study followed the basic data mining procedure by Han [15]. In this procedure, the data is cleaned of inconsistent or irrelevant data. Out of these cleaned data, only HDI, GDP, GG, EF, CR and DR of identified island countries are selected as part of the mining process. Since data were in continuous numeric number, data set was not transformed. Afterwards, the selected data undergo data analysis using genetic algorithms. Patterns are then obtained, analyzed and interpreted.

Data Analysis

To determine the effect of people, economy and environment factors to the environmental performance of island countries, data on HDI, GDP, GG, EF, CR, DR and EPI are subjected to regression analysis using genetic algorithms. Specifically, data science application is utilized to determine the best-fit model equation of the relationship of independent variables (i.e. HDI, GDP, GG, EF, CR and DR) to the dependent variable (EPI), to be represented as:

$$EPI = f\{HDI, GDP, GG, EF, CR, DR\} \qquad \text{Eq.1}$$

The formula building blocks are set as c_, x_, +, -, *, /, cos and sin, and the confidence of the test run is set at 100%.

RESULTS AND DISCUSSION

Human Development Index

The endeavor of countries to provide a healthy lifestyle, an effective acquisition of knowledge and a decent way of living affect many aspects of environmental sustainability. In particular, effective acquisition of knowledge about the environment could determine how countries perform environmentally. This relationship is shown in the graphs of Figure 1.

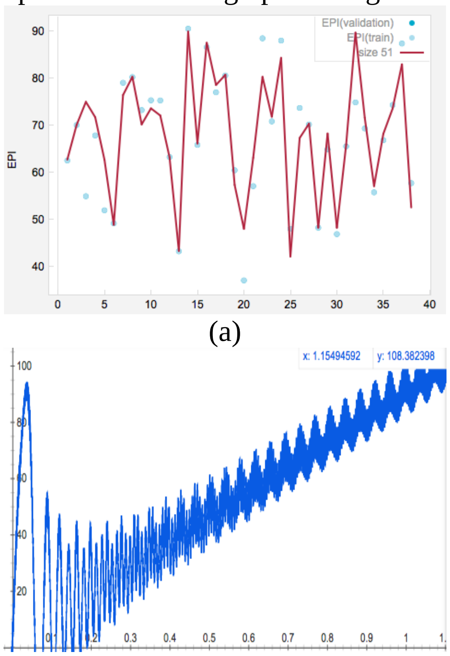


Figure 1. HDI vs EPI (a) output/row graph, (b) model graph

As gleaned in Figure 1, when the HDI of an island country increases, then its EPI also increases. This means that when citizens are able to do desirable things for their country, then they are able to contribute more to environmental preservation mechanisms, thereby leading to a higher environmental performance. This is evident in the higher EPI values of very high human developed countries such as Ireland, Iceland, New Zealand and United Kingdom, and in the lower EPI values of low human developed countries such as Papua New Guinea, Comoros and Haiti [9].

The relationship between HDI and EPI of island countries can be best described according to the model:

$$EPI = 3.2 + 87.9HDI + 3.7sin(165.5HDI) + 3.2sin(11612.4HDI) + sin(11612.4HDI)sin(165.5HDI) + \frac{3.2sin(1004.2HDI^2)}{HDI} \quad \text{Eq. 2}$$

This model explains 83% R-squared which means that there is more variance among HDI and EPI values accounted by the regression model. By having so, there is a greater chance that the observed indices fit the regression model, thereby giving more than 75% probability of predicting the environmental performance of island countries over time.

Results of the graph are in coherence with the finding of Harju-Autti and Kokkinen [16] which stated that the greater awareness among the citizens leads for the people to do more desirable things for their country, particularly the environment. Higher human developed countries, such as Japan and United Kingdom, have higher environmental knowledge, thereby having greater environmental performance. On the other hand, lower human developed countries like that of Indonesia, belong to the lower range for environmental awareness, thereby having a lower environment performance. Therefore, the ability of an island country to immerse their citizens through effective environmental education could lead to efficient environmental performance. The governments of island countries should put investment on environmental education so to strongly campaign environmental awareness among their citizens, to effectively equip them skills and values in environmental protection, and to proactively engage them in preservation and green innovation practices.

Gross Domestic Product

The national income of a country can describe how decent is the standard of living of the people. The standard of living may be associated with how people contribute to the environmental performance. This association is shown in the graphs below.

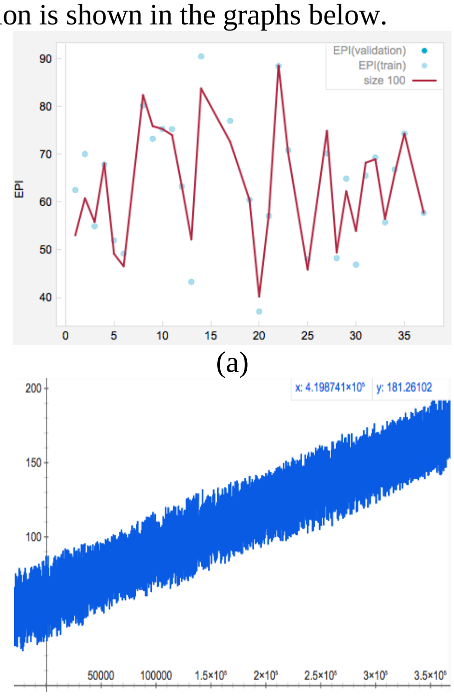


Figure 2. GDP vs EPI (a) output/row graph, (b) model graph

Figure 2 exposes the 95% direct proportionality relationship between GDP and EPI of island countries. This suggests that when there is an increase in the national income of countries, then there is a corresponding increase in their environmental performance. Island countries with higher income such as Japan, United Kingdom and Iceland can have more financial opportunities to perform well in their environmental aspect. However, those with lower GDP like that of São Tomé and Príncipe and Comoros may have difficulty in providing such mechanisms to improve the environmental situation [10].

How EPI increases over the increase in GDP can be best simplified using the model below:

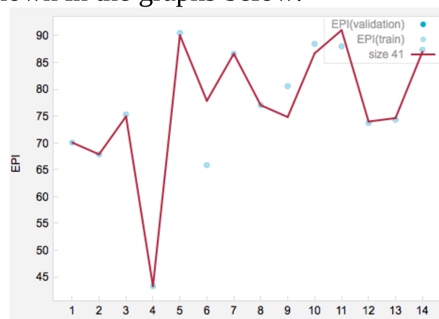
$$EPI = 58.9 + 0.0003GDP + 8.5sin(3.9 + 9.1GDP) + sin(5.3 + 0.008GDP) - 11.6\,cos(4.8 + 2.2GDP) - 11.6sin(3.8 + 9.1GDP)\,\sin\{sin(5.3 + 0.008GDP)\} \quad \text{Eq. 3}$$

Slightly higher than the HDI vs EPI model, the GDP vs EPI model explains 95% R-squared which means that greater variance among the GDP and EPI values is accounted by the model. Therefore, all observed values in the future could be fitted in the regression model.

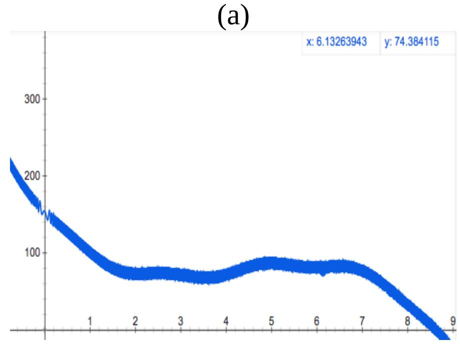
The characteristics of the model supports the study of Harju-Autti and Kokkinen which found out that there is a strong, positive correlation between a nation's wealth and its environmental awareness, leading to more environmentally performing citizenry [16]. Wealthier countries have derived their assets from the environment, and to maintain and improve their natural resource assets, the government provides more mechanisms for greener technologies as well as environmental preservation programs. The United Kingdom, for example, considers the natural environment as the core responsibility of the citizens, and as such, the environment is managed for sustained, long-term economic growth [17]. On the other hand, São Tomé and Príncipe, a least developed country, had limited financial resources, indicating an increase use of marine and coastal ecosystems for mining, construction and tourism development, thereby leading to major environmental degradation [18]. Government support and private investments on environmental policy-making and impact researches could enhance the island country's struggle to preserve and protect the environment from economic exploitation and further ecological damage. These investments on environmental researches and developments help island countries improve the state of their environment, as well as yield more efficient policies in enhancing environmental condition.

Green Growth Productivity

Efficient use of greener technologies in economic activities could affect the island countries' performance on the environmental dimension of sustainable development. The relationship between GGP and EPI can be shown in the graphs below.



(a)



(b)

Figure 3. GGP vs EPI (a) output/row graph, (b) model graph

As seen in Figure 3, there is a fluctuating relationship between GGP and EPI, suggesting an inverse, constant and direct proportionality in its graph. An inverse relationship between GGP and EPI is observed at GGP values from 0-1.5 and again from 7 up, which indicates that when there is an increase in green productivity, then there will be a lower environmental performance. Moreover, a constant relationship is seen in the graph at GGP values 1.5-4.0 and 5.0-7.0, noting a very slight difference in environmental performance as green productivity increases. Furthermore, a direct proportionality is also derived at GGP values 4-5. These relationships could be due to the changing contexts of economy-environment interface, as well as the gradual shift of island countries to greener technologies in economic productivity.

The association between GGP and EPI is best described through the model below:

$$EPI = 153.1 + 18.5GGP^2 + 4.3sin(2.9GGP) + 7.5sin(3.0 + 440.1GGP^2) - 70.9GGP - 1.4GGP^3 \quad \text{Eq. 4}$$

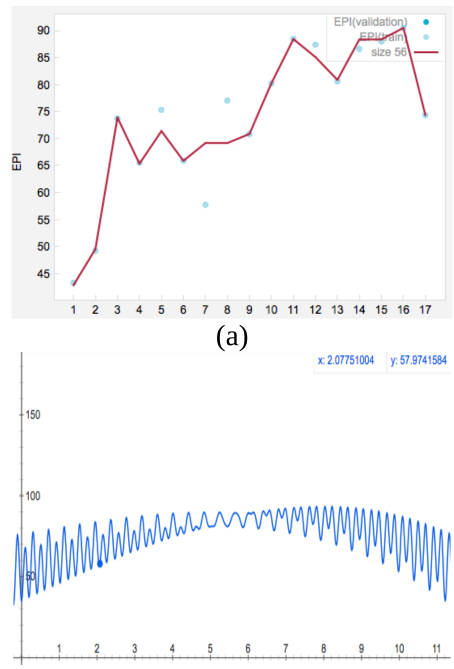
The model, same as GDP vs EPI model, explains 91% R-squared, suggesting that there is greater variance among GGP and EPI values taken into account by the regression equation. There is a 91% probability that EPI of an island country could be predicted using an increase or decrease of the GGP level, signifying a very fit model for a fluctuating association.

The finding of the GGP vs EPI model adheres to the trend observed in a report of United Nations and Asian Development Bank, which stated that there is a changing context in the economy-environment interface, as affected by a changing landscape and evolving policy changes [19]. This changing context gives countries, in general, to adhere to economic progress which fosters environmental sustainability, and therefore recalibrating economic activities in order to align goals to the sustainable development goals of UN. In fact, Asia-Pacific countries like the Philippines and Indonesia are recalibrating economic activities through building a sustainable island infrastructure, which creates opportunities to increase environmental performance, e.g. use of sustainable transport helps lower greenhouse gas emissions and air pollution while it enhances economic accessibility and resource mobility [19-20]. Depending on the landscape and policy changes, green growth productivity affects environmental performance at varying degrees of association.

Another aspect taken into consideration is the gradual shift of island countries to green economic productivity. This gradual shift might be due to the available resources that countries have in order to pursue green growth and development. These green growth constraints include inadequate infrastructure, lack of human and social capital, and environmental externalities [21]. Despite these constraints, some island countries have endeavored to shift from fossil fuel-based economy to green economy. For instance, Haiti though having a high GPP index, has lower EPI, and may gradually increase its environmental performance through its green economy transition, which aims to provide a platform for resource use efficiency. This efficiency leads to positive impacts on the sustainability of Haiti, and yields more investments in green and climate risk-resilient infrastructure [22]. Sustainable infrastructures for green growth and development could contribute positively to the environmental performance of island countries, especially those which are climate- and disaster-stricken areas.

Ecological Footprint

Human consumption on available natural resources in island countries could affect the environmental performance, given the limited resources offered by landforms surrounded by big bodies of water. The effect of EF to the EPI of countries is illustrated in the graphs below.



(a)

(b)

Figure 4. EF vs EPI (a) output/row graph, (b) model graph

As exposed in Figure 4, there is an increasing trend of EPI when EF increases, until at EF=6.0; beyond this EF, EPI has decreasing trend. This shows that human consumption, at a greater rate, on natural resources indicates an increased environmental performance, until such time that there will be scarcity of resources, thereby eventually lowering EPI as EF continues to increase. This relationship is shown in the case of the countries having the extreme values: Haiti and Trinidad and Tobago. The former has low utilization of its resources, that an increase of Haitians' resource consumption could increase the environmental performance of the country. On the other hand, the latter has very high utilization of its resources, that there is a need to decrease Trinidians and Tobagians' resource depletion in order to increase its environmental performance [12].

The effect of EF to EPI is best predicted using the following model:

$$EPI = 71.9 + 10.8EF - 0.06EF^3 - 4.3sin(15.3EF) - 36.6cos(15.3EF)^2 - 6.7EFsin(15.3EF)^2 \quad \text{Eq. 5}$$

This model explains 93% R-squared which intends to account greater variances in its model equation. The model can almost predict all observed EPI through associating the EPI with EF values, therefore, the best fit model to explain EF and EPI's association in describing environmental sustainability of island countries.

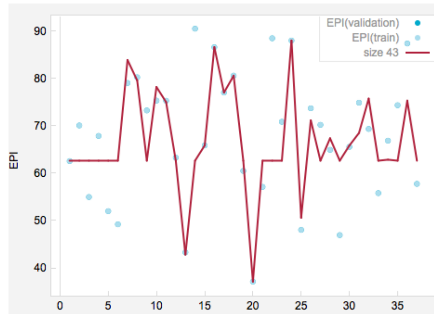
The model partially supports the finding by the study of Vačkár [23], which revealed that the extent of human appropriation of natural resources is significantly positively correlated with the environmental performance of countries. This means that an increase in the utilization by citizens on the productive aspects of ecosystems, as well as the their pressures on the physical environment and biodiversity will initially result to increased environmental performance until there is overconsumption of resources and the environmental performances is decreased. Under consumption and overutilization of resources undermine how island countries perform towards environmental sustainability.

Low EF island countries such as Haiti and Comoros performed low environmentally due to disasters for the former and to infrastructure underdevelopment. Comoros, in particular, has very few natural resources; despite these minimal resources, there are no significant construction projects for these resources to be used [24], thus, the country struggles to efficiently use their resources for the benefit of their people. Moreover, there are fewer infrastructures for energy consumption, especially electricity. In fact, only less than 70% of Comorians have access to electricity, and access disparities on electrictrification are evident [25]. Sustainable infrastructures will not only address green growth and development, but also address the underdevelopment of public works in islands such as transport, roads and buildings, which are essential in the environmental performance of island countries.

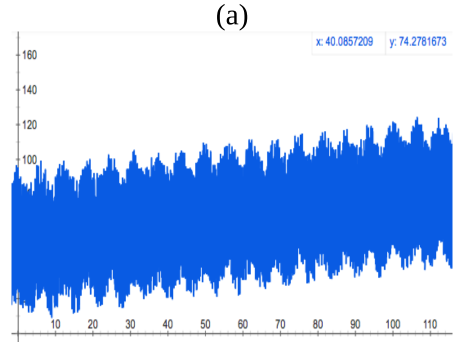
Optimum EF countries include high human developed countries like Japan, Iceland and New Zealand, which utilize their natural resources efficiently, thereby paving their programs and endeavors towards higher environmental performance. Beyond the optimum EF lies Trinidad and Tobago, whose government pursued policy-making, which absorbed "rent" too rapidly, impeding diversification and creating prosperity vulnerable to economic collapse [26]. Overconsumption of resources, oil and petroleum in TT's case, would lead to scarcity, or worst complete depletion, thereby affecting sustainability of island countries' state as independent of continental nations.

Climate Risk

Risks due to changes in the climate condition of an island country can affect the environmental performance towards sustainability. How these risks affect environmental performance is illustrated in the graphs below.



(a)



(b)

Figure 5. CR vs EPI (a) output/row graph, (b) model graph

Figure 5 exposes that when CR increases, then EPI also increases. This means that when a country is less affected by natural disasters caused by climate change, its ability to perform in the environmental aspects of sustainability increases. This relationship is evident in the frequent disastrous weather conditions in Haiti, which cripples the country to perform well environmentally. This is in contrast with Iceland and Malta, which are less visited by such disasters, and due to this, they perform well on its environmental responsibilities.

The effect of CR to EPI is best predicted using the following model:

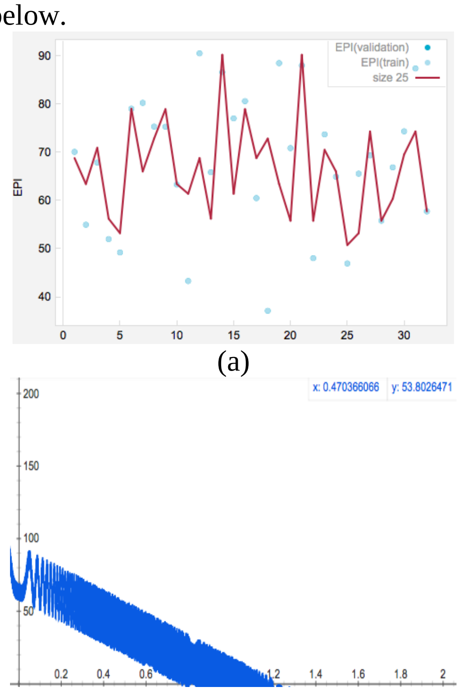
$$EPI = 52.3 + 0.3CR + 12cos(3513.6CR) + 6.5cos(16.4CR) + 5.7cos(0.5 + CR) + 21.9cos(5.4 + 144.7CR) \quad \text{Eq. 6}$$

CR vs EPI model explains only 55% R-squares which means that more than 50% of the variances is accounted for the model equation. The model can only predict 0.55 probability of the EPI values based on the observed CR values. Though having only 55% fit, this model is best fit model to predict future EPI values based on CR indices, as provided by current data on these variables.

The model is in support to the finding of Jagers et al. [27] that island nations are located in areas visited frequently by severe climate conditions, making them vulnerable to environment shocks. Sri Lanka, for instance, is located in South Asia, which is a climate change prone area, and experiences the adverse results of climate change to the environment [28]. These results impact many sectors of the society, especially the farmers and agricultural workers, resulting to severe hardships among the constituents [29]. Climate change-related hazards affect the landscape of island countries, thereby severing the natural resources, causing these countries to be prone to economic and social disability. As such, governments are advised to derive more realistic precautionary measures and take immediate action when climate hazards occur.

Disaster Risk

Exposure, vulnerability and susceptibility to natural disasters contribute to the environmental performance of island countries. The relationship between the risks and environmental performance is illustrated in the graphs below.



(a)

(b)

Figure 6. DR vs EPI (a) output/row graph, (b) model graph

As illustrated in Figure 6, EPI increases as DR decreases. This means that when island countries are very exposed to natural disasters, their ability to preserve and mitigate the environment is greater than those very vulnerable to such natural hazards. This relationship is clearly exemplified by the lower environmental performance of Vanuatu due to its location in disaster-prone area, and by the higher environmental performance of Malta and Iceland. However, some countries such as the Philippines and Tonga, both in the Pacific Ocean where most natural disasters occur, have higher environmental performance, whereas others like Barbados and Grenada where fewer disasters occur have lower environmental performance [14]. This relationship can be explained through the model:

$$EPI = 76.7 - 76.7DR - 5.7cos(6111.2DR) - 13.5cos(-1239.8DR^2) \quad \text{Eq. 7}$$

The best-fit model can only explain 33% R-squared, which means that there are less variances accounted by the regression equation. This explains why some countries have inverse relationship in terms of DR and EPI, thereby suggesting that some disaster-prone countries such as the Philippines and Tonga have employed initiatives to preserve and mitigate these hazards for them to protect and secure the people and the environment, thereby leading to perform better environmentally. With this, the government and the citizenry should cooperate in providing means in mitigating hazards caused by disasters, and in offering more sustainable ways of addressing negative effects of disasters, taking into consideration the protection and preservation of the environment.

CONCLUSION AND RECOMMENDATION

The study subjected different economic, social and environmental indices to regression analysis against the island countries' EPI values. Economic and social indices GDP and HDI have direct relationship with EPI accounting 95% and 83% predictability, respectively, based on the formulated model. Among the environmental indices, GGP and EF have fluctuating relationship with EPI but their models account 91% and 93% predictability. CR has direct association while DR has indirect association with EPI and CR and DR models only fit 33% and 55% circumstances in the future. Therefore, HDI, GDP, GGP and EF models best fit explain their association with EPI, while DR and CR best-fit model only account little predictability, therefore, these cannot surely associate with EPI, an index of sustainability of countries.

In other words, environmental sustainability of island countries is affected by the people's environmental awareness and resource consumption, nation's wealth and way of living, and economy's green technology utilization. Exposure, vulnerability and susceptibility to natural disasters may have affected many aspects of sustainability of island countries, however, the government's formulation of effective and efficient preservation and mitigation programs coupled with the people's awareness of and responsibility towards the environment describe environmental sustainability.

Effective environmental education, increased government and private sector collaboration on environmental research and policy-making, and efficient implementation of research-based programs are recommended as interventions of island countries in maintaining and improving environmental performance. Infrastructures, which efficiently utilize the resources of the limited island countries, are recommended to help them attain sustainability in the utilization and distribution of natural resources. It is suggested that island countries develop stricter policies on resource consumption in order to monitor such utilization and to prevent overconsumption that could affect the future generation.

ACKNOWLEDGMENT

The authors wish to extend their gratitude to the Center for Research and Development of Cebu Normal University and Dr. Roberto N. Padua for giving the training on data mining research that paved way for the conception and completion of this paper.

REFERENCES

[1] United Nations Educational, Scientific and Cultural Organization (2014). *UN decade of education for sustainable development (2005-2014)*. URL:https://bit.ly/2WAZ0H8

[2] Schmidt, CW. (2005). Keeping afloat: A strategy for small island nations. *Environ Health Perspect*, 113(9), A606-A609

[3] Gallego-Àlvarez, I., Vicente-Galindo, MP., Galindo-Villardon, MP. and Rodríguez-Rosa, M. (2014). Environment performance in countries worldwide: Determinant factors and multivariate analysis. *Sustainability*, 6, 7807-7832. doi: 10.3390/su6117807

[4] Moldan, N., Hák, T., Kovanda, J., Havránek, M. and Kušková, P. (2004). *Composite indicators of environmental sustainability*. Palermo: Statistics, Knowledge and Policy: OECD World Forum on Key Indicators

[5] Cash, DW., Clark, W., Alcock, F., Dickson, NM., Eckley, N. and Jaeger, J. (2004). Salience, credibility, legitimacy and boundaries: Linking research, assessment and decision making. *Global Environmental Assessment Project, Harvard University*, URL:https://bit.ly/3fPCnGt

[6] Parris, TM. and Kates, RW. (2003). Characterizing and measuring sustainable development: *Annu Rev Environ Resour*, 28, 13.1-13.28

[7] Singh, RK., Murty, HR., Gupta, SK. and Dikshit, AK. (2009). An overview of sustainability assessment methodologies. *Ecol Indic*, 9, 189-212

[8] Mayer, L. (2008). Strengths and weaknesses of common sustainability indices for multidimensional systems. *Environ Int*, 34, 277-291

[9] United Nations Development Programme (2018). *Human development index (HDI)*. URL:https://bit.ly/2LtCCsU

[10] Leamer, EE. (2009). *Macroeconomic patterns and stories: A guide for MBAs*. Verlag: Springer.

[11] Organization fro Economic Co-operation and Development (2017). *Green growth indicators 2017*. URL:https://bit.ly/2y2ScZk

[12] Global Footprint Network (2016). Data Explorer. URL:https://bit.ly/3dGLBDc

[13] Eckstein, D., Künzel, V. and Schäfer, L. (2018). *Global climate risk index 2018*. Berlin: Germanwatch e.V.

[14] United Nations University- Institute for Environment and Human Security (2016). *World risk report 2016*. Berlin: Bündnis Entwicklung Hilft

[15] Han, J. and Kamber, M. (2006). *Data Mining: Concepts and Techniques. 2nd Edition*. San Francisco: Morgan Kaufmann Publishers

[16] Harju-Autti, P. and Kokkinen, E. (2014). A novel environmental awareness index measured cross-nationally for fifty seven countries. *J Envi Res Tech*, 4(4), 178-198

[17] Everett, T., Ishwaran, M., Ansaloni, GP. and Rubin, A. (2010). Economic growth and the environment. *Defra Evidence and Analysis Series*, paper 2. URL:https://bit.ly/361u9GI

[18] Costa Alegre, ME. (2009). *Towards a national ocean policy in Sao Tome and Principe*. New York: Division for Ocean Affairs and the Law of the Sea. URL:https://bit.ly/363invs

[19] United Nations and Asian Development Bank (2012). *Green growth, resources and resilience*. Bangkok: UN and ADP

[20] Shaheen, SA. & Lipman, TE. (2007). Reducing greenhouse emissions and fuel consumption: Sustainable approaches for surface transportation. *Int Assoc Traffic Safety Sci Res*, 31(1), 6-20

[21] Organization for Economic Co-operation and Development (2011). Towards green growth: A summary for policy makers. URL:https://bit.ly/3dJGVME

[22] Farrell, S., Lombardi, N. and Bassi, AM. (2014). *Green economy transition in Haiti: Challenges and opportunities*. Castellanza: KnowlEdge Srl

[23] Vačkár, D. (2011). Ecological footprint, environmental performance and biodiversity: A cross-national comparison. *Ecol Indic*, 16(2012), 40-46
[24] USA International Business Publications (2012). *Comoros mineral & mining sector investment and business guide*. Washington, D.C.: USA IBP
[25] United Nations Environment Programme (2016). Comoros. URL:https://bit.ly/3fLuKAS
[26] Auty, RM. (2016). Natural resources and small island economies: Mauritius and Trinidad and Tobago. *J Dev Stud*, DOI: 10.1080/00220388.2016.1160063
[27] Jagers, SC., Povitkina, M., Sjöstedt, M. & Sundström, A. (2016). Paradise islands? Island states and environmental performance. *Sustainability*, 8, 285; doi:10.3390/su8030285
[28] Bhandari, M. (2012). *Environmental performance and vulnerability to climate change: A case study of India, Nepal, Bangladesh and Pakistan*. Climate Change Management.
[29] United Nations Development Programme and Global Environment Facility/ Small Grants Programme (2016). Coping with Climate Change and Variability: Lessons from Sri Lankan Communities. URL:https://bit.ly/3fWxcou

COPYRIGHTS