Environmental Policy in The Caribbean: A Comparative Approach

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Abstract. The study of environmental policies and their effectiveness gained substantial scientific attention when the effects of industrialization and urbanization started to impair human health in the late 19th and early 20th centuries. However,despite the significance of the issue, little is known at the implementation stage, especially in the Caribbean. Consequently, thisstudy examines environmental policies and practices in the Caribbean, highlights both successes and failures, and gives a summary of the main mechanisms the region has used. On a sample of 10 countries, the study employs both qualitative (secondary data sources) and quantitative method (OLS models). Key findings include: (1) Regulations and standards for pollution reduction management in the Caribbean are weak. (2) Difficulty in implementing current regulations and slow implementation. (3) Lack of public understanding about the need to deal with environmental risks and challenges. (4) Adopted environmental policies are ineffective in dealing with environmental concerns due to a lack of facilities and finance, as well as human resources due to government recruitment restrictions. We recommend that all Caribbean countries have in place an adequate legal framework.

Keywords: Environmental Policy, Effectiveness, Command, Control.

1 Introduction

1.1 Research background

When the consequences of industrialization and urbanization began to affect human health in the late nineteen and early twenties centuries, the study of environmental policies and their effectiveness acquired a significant scientific interest [37]. Scholars' work began to highlight the hazards of pollution, raising public awareness of environmental issues and resulting in extensive regulation systems in various industrialized nations. To address these needs, governments frequently use a variety of policies, measures, instruments, and approaches such as regulations and laws, fees and taxes, tradable permits, voluntary agreements (VAs), instructive tools, funding for research and development, and trade assistance.

ICONIC-RS 2023, September 21-22, Bali, Indonesia

DOI 10.4108/eai.21-9-2023.2348145

Environmental protection laws have been in place since ancient times. Around 4,500 and 2,700 years ago, respectively, the Indus, or Harappan, civilization at Mohenjo-Daro and the ancient Roman civilization constructed their first sewer systems. Environmental policies are necessary for two main issues: first, environmental effects are externalities to the economy. Polluters typically do not suffer the consequences of their acts; instead, they occur to others. Second, because it is widely assumed that natural resources are infinitely abundant, their prices are excessively low [9]. These elements come together to form *"The tragedy of the commons,"* as American ecologist Garrett James Hardin describes it [23].

Reducing the harmful environmental effects of human activity is the main objective of environmental policy instruments and international agreements. According to the literature, there are four main standards for assessing environmental policy tools: Effectiveness for the environment, cost-effectiveness, distributional considerations, and institutional viability [32][15]. In this research, we only consider the effectiveness of environmental policy. The design, implementation, participation, rigor, and compliance of any policy determine its environmental effectiveness. However, despite the significance of the issue, the efficacy of environmental policy has not yet been determined independently. At the implementation stage in the Caribbean, little is known about the various instrument types. This study attempts to make an effort to reduce that gap and to shed light on what has been accomplished so far in literature. The design, implementation, participation, rigor, and compliance of any policy determine its environmental effectiveness. Specifically, the analysis analyzes the efficiency of different governments' monitoring and enforcement tactics for ensuring compliance with environmental rules.

1.2 Caribbean Countries profile

The Caribbean region consists of three regions: the Greater Antilles, the Lesser Antilles, and the ABC Islands. The topography is predominantly tropical, and the climate is significantly influenced by rainfall and sea temperature, with hurricane season bringing natural calamities regularly. The archipelago spans over 1.06 million kilometers across the continents of North and South America. It has 34 countries, territories, and dependencies because there are thirteen sovereign states and twenty-one non-countries. French, English, Spanish, Dutch, and Antillean Creole are the prominent languages. Many countries have significant social development issues, such as economic inequality and unemployment. Except for Cuba, the three largest countries have poverty rates of 56% (Haiti, which has exceptionally significant challenges), 44.1 (Jamaica), and 16.4% (Dominican Republic). In the Caribbean, maintaining ambient air quality standards is difficult [11][26]. Given that climatological and meteorological elements (such as wind speed and direction, local temperature, poor air circulation, humidity level, and precipitation) have a major effect on air quality, climate change is anticipated to worsen the situation [20][5]. Despite the Caribbean countries' low contribution to GHG emissions, climate change presents an important risk to all these nations due to their size and geographical location. Additionally, there is scientific evidence that links human activity to long-term weather patterns [18].

Fig. 1. Caribbean Map.

2 Literature Review

2.1 Conceptual Definition

Policy Definition

There is no clear-cut definition of what is meant by the word "policy." Most definitions of policy describe it as agenda-setting that includes some sort of action. A policy is a methodical, organized process that defines and resolves problems in a logical order. A convenient way to express politics is to combine it with other factors related to decision-making and action [12].

Policy - The setting direction, overall intentions, and goals (e.g. greenhouse gas emission reduction targets).

Programs - Planning and management structures for implementing policies such as decreasing emissions of carbon dioxide (CO2) from industry.

Plan – a particular aspect or function of a program (e.g. promoting emission reductions through incentives to promote corporate energy efficiency). In his study on environmental processes and practices in Australia, Thomas [33] gave an example of a policy cycle. He demonstrated that the policy cycle' illustrates a sequence that begins with the identification of a challenge or issue, followed by agenda formulation, enlisting support, implementation, and assessment. It can be implied that policy is a systematic, ordered process by which issues are defined and addressed in a logical sequence.

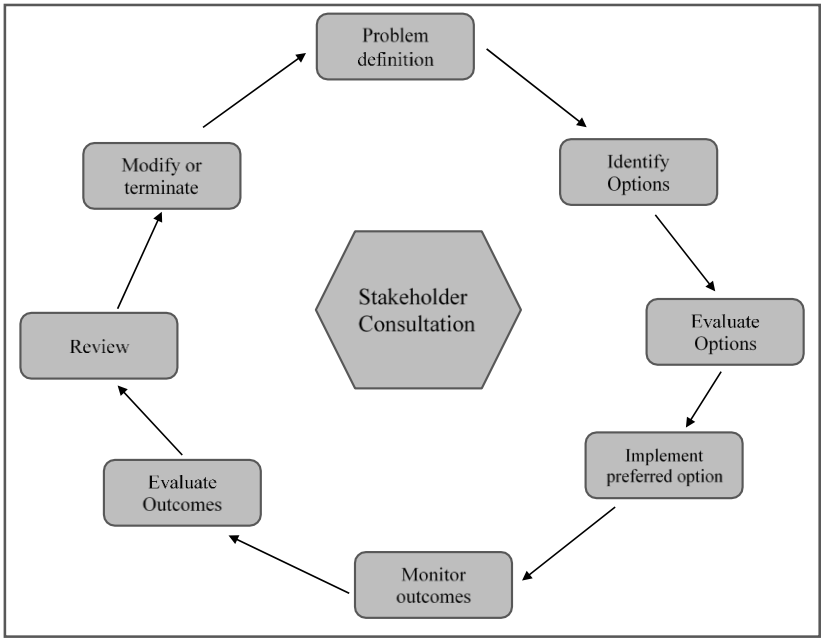

Fig. 2. A modified version of the policy cycle [33].

2.2 Environmental Policy Instruments

According to the book Principles of Environmental Science, environmental policy instruments link policy development and decision-making with the execution of policies [8]. Beginning with policy formation, political issues are converted into operational goals, appropriate methods are chosen, and objectives are met through their implementation. International environmental agreements have existed since the 1940s, but it was not until the 1980s that an increasing number of new agreements and conventions contributedto the globalization of environmental policy. Environmental policy and management are now seen as larger efforts requiring the active involvement of individuals, communities, NGOs, and corporations.

Many strategies have been created to persuade people who contribute to environmental issues to change their behavior. Policy style emerges from the convergence of: "(a) the government's approach to problem-solving, (b)the relationship between the government and other actors in the political process" [29]. There are different national approaches according to whether it was consensual or coerced, however specific components of policy creation and implementation reveal policy styles. For example, Rayner claimed thatdifferences in political culture influence the choice of political instruments [27]. Policymakers may use a variety of strategies to support environmental policy (Figure 2). Regulation (command and control), market-based instruments, voluntary instruments, and information are the four basic categories of policy instruments. The approaches are not mutually exclusive: all rely on education and knowledge to some extent, as indicated by their central position. Self-regulation, for example, is included in voluntary approaches, whereas economic tools mightbelong to regulation.

Fig. 3. Policy instrument. Adapted from Young. M.

Command and Control Regulation

Historically, environmental policy has relied on public regulation, which is frequently related to command-and-control measures like zoning, emission standards, permits, prohibitions or limits on inputs and outputs, and technological and design requirements. Regulation is "the use of legal instruments (norms and rules)to put into effect public policies" [13].

Governments should impose environmental rules along with a range of sanctions to deter polluters from taking acts that increase costs to society. The severity of the environmental hazard determines the command-and-control procedures. To maintain social optimality, some demand a license or must adhere to several corporate rules and standards. Regulations fall into two categories: structure and society [21][34]. Market provisions,such as limits on the entry or exit of new businesses and regulations that define guidelines governing professional services, are at the heart of structural regulation. Although they are widely used, some consider control tools to be too strict, intrusive, and unnecessary and have failed to change environmental behavior in many cases. Regulations are difficult to apply uniformly and can disrupt current production and consumption patterns. Furthermore, regardless of the organizational and financial capabilities of the company, it cannot be done properly by simply applying emission limits and requiring the usage of capital modern technology.

Enforcement and Compliance

Compliance is the process by which people, organizations, and industries change their

operations to comply withthe law. Compliance enforcement is aimed at persuading individuals to act, not act, or continue to act [6]. The compliance approach is influenced by regulatory bodies' theoretical knowledge. The rational approach argues that “regulators can offer positive incentives, such as compliance subsidies, by example the tax breaks, which can contribute to corporate compliance by influencing business compliance” influence their cost-benefit calculations” [24]. Coercion refers to actions taken by the government to hold violators accountable for their violations. It gives government agencies the power to impose sanctions. A high percentage of environmental standard violations is due to inadequate monitoring [16].

2.3 Environmental Policy Evaluation and Effectiveness

Effectiveness refers to the ability of organizations involved in the response to use their resources to achieve their goals. Policy effectiveness (outcomes) is defined as the extent to which environmental policy measures (policy outputs) help the environment. Decision-making has direct consequences on policy outcomes. On the othery outcomes, on the other hand, are broader societal or environmental changes that are often thought to be the result of a specific set ofpolicy outputs [1]. A policy is said to be effective if there is a significant relationship between policy outputs and outcomes and if the policy measures improve environmental quality.

Some scholars have significantly contributed to the work on environmental effectiveness. These studies assess the efficiency of the public sector by linking public spending to socio-economic parameters considered in public expenditure [2][31]. Their cross-country assessments show large efficiency gaps between countries, regardless of their economic level. A recent study has begun to investigate the source of these inefficiencies. Afonso and St. Aubyn studied the variations in the effectiveness of OECD expenditures on education and concluded that parents' educational level and income are important variables [3]. Another study, using a semi-parametric econometric method for 19 OECD countries from 1980 to 2000 [1] discover that countries with right-wing and strong governments, high voterparticipation rates in elections, and decentralized fiscal systems are expected to have higher public sector efficiency.

Measurement of the effectiveness of the environmental policy requires historical indicators to measure the reductionin the problem after treatment required for measuring the effectiveness of environmental policy [10]. And also examine how well the regulatory institution's officials implemented the regulatory policy [30]. The administration's success is heavily reliant on the qualifications and attitudes of its personnel in general, and professionals in particular, as well as the collaboration of governmental institutions [17].

3 Research Method

The methodology described above has been applied to a group of 10 Caribbean countries. The countries in our sample are similar in the sense that they have all ratified the Kyoto Protocol. Further, the countries represented in the sample relied heavily on command-and-control regulation. C&C regulation is an old-fashioned environmental policy that is still widely practiced in the Caribbean [36]. According to our review of the literature, the most common tools to bring industries into compliance are prohibition, suspension, licensing, monitoring, and fines. Therefore, these instruments are used as independent variables in this paper to explain the variation of the dependent variable. The dependent variable is the discount of adverse environmental impact.

This study uses a qualitative as well as a quantitative approach. An important result of environmental governance is a variance in air pollutant emissions, which is the subject of the empirical study. In terms of environmental policy, air pollution is a significant and still extremely relevant issue. The pollutants under consideration are $PM_{2.5}$, CO_2, and PM_{10}. All these gaseous pollutants might harm either human health or climate change reduction. To analyzedata information, the study employs a comparative case study approach. A case study is considered comparative if it employs concepts applicable to other countries and/or attempts to draw broad conclusions [14]. There are three methods: single-N (or "case studies"), small-N (a few cases), and large-N (many examples).

3.1 Statistical Analysis

This study presents a set of Ordinary Least Squares models (OLS) with robust effects in which the observation unitis the country. The theoretical research model consists of the following dependent and independent variables:

Independent variables	**Dependent variables**
➢ *Preventives actions* Banning, licensing, monitoring ➢ *Regulatory punishment* Fines, notices, warning	➢ Reduction in air pollution (Level of $PM_{2.5}$ or PM_{10} in the air). ➢ Reduction in climate change (gas concentration or temperature).

Fig. 4. Independent and Dependent Variables

We present the formula of econometric model:

$$OLS = Y_i = \alpha + X_i + \varepsilon \quad (1)$$

Y_i = compliance to regulation

X_i = independent variables

The dependent variables Y_i are control of air pollution and control of greenhouse concentration. The independentvariables X_i are air pollution monitoring tools. Population and economic growth were added as control variables.

3.2 Hypotheses

a. Preventive measures do not have a significant impact on avoiding or mitigating the negative effects of airpollution.

b. Regulatory penalties do not have a significant impact on preventing and mitigating the negative impacts of airpollution.

$$\text{Ho: } \beta 1=\beta 2=\beta 3=0$$

$$\text{At } \alpha. \leq 0.05.$$

3.3 Data Sources

This study uses secondary data to assess the effectiveness of Caribbean environmental protection laws and their enforcement by responsible authorities: Regulations, laws or decrees, Ministries' annual reports (environment, agriculture, and finance), World Bank database, United Nations Environment Programme (UNEP), newspapers/media/other electronic sources.

Table 1. Summary characteristics of the islands in the study

Island Name	Political Status	Area (Km2)	GDP (2018 USD/person)	Population (1,000s)
Antigua & Barbuda	Sovereign	443	16,728 96	96
Bahamas	Sovereign	10,010	32,218	386
Barbados	Sovereign	430	107,997	287
Dominican Republic	Sovereign	48,320	8,051	10,627
Grenada	Sovereign	344	10,641	111
Haiti	Sovereign	27,750	868	11,123
Jamaica	Sovereign	10,831	5,354	2935
Trinidad & Tobago	Sovereign	5,128	17,130	1390
Belize	Sovereign	22,970	3,987,80	419
St.Lucia	Sovereign	606	10,566	182

4 Findings and Discussion

4.1 Secondary Data Results

Major Pollutant Sources in The Caribbean

According to the study, human activities associated with the combustion of fossil fuels are the primary cause of air pollution in the Caribbean [4][19]. Despite their minor contribution to global GHG emissions, some air pollutants, particularly GHGs, alter the composition of the atmosphere,exacerbating the health effects of air pollution on Caribbean people. The majority

of Caribbean countries, uses the WHO Air Quality Guidelines (AQG) for ambient PM2.5 (10 g/m3 annual mean and 25 g/m3 24-h mean) and PM10 (20g/m3 annual mean and 50 g/m3 24-h mean) as a gauge of urban air quality [22].

In the Caribbean, the use of fossil and biomass fuels for transportation, heating, and cooking generates considerable amounts of critical air pollutants such as $PM_{2.5}$, PM_{10}, carbon monoxide, nitrogen dioxide, lead, sulfur dioxide, ground-level ozone, and CO_2. Crude oil and petroleum products (such as gasoline), coal and coalproducts, natural gas, peat, and biomass (including wood and wood waste, charcoal, and the biomass component of municipal rubbish) are the primary sources of these pollutants. Each member state emits a different amount of CO_2, which also plays a different part in air pollution and climate change. For instance, Grenada, with a population of 104,000, and Barbados, with a population of 256,000, both have a gross national income per capita of US$ 8430.

Table 2. Comparison between $PM_{2.5}$ and CO_2 composition.

Measurement	Air pollutants	Major sources (anthropogenic)	Major impacts
CO2	CO2	Fossil fuels, industrial processes, land use changes	Climate change
PM2.5 (Constituted by liquid and solid components in different proportions)	Sulfuric Dioxide (SO2)	Power generation, industry, domestic and commercial heating	Serious health problems. Forest decline and soil acidification
	Nitrogen oxides (N0X) and ammonia (NH3)	Power generation and transport (NOX) intensive agriculture (NH3)	
	Acid deposition	Secondary pollutant formed from S02 and N0x);	
	Ozone (03)	Secondary pollutants formed from S02 and N02	
	Toxic metals (e.g lead and calcium)	Smelting industry; transport	
	Pollutants organic pollutants (P0Ps)	Industry, fuel combustion, pesticide use	

4.2 Regulations and Standards for Air Quality

In terms of implementing ambient air quality standards, developing rules, policies, and procedures to monitor airpollution, and lowering emissions from several significant sources, the Caribbean region has made some progress. However, a framework for preventing and controlling air pollution, as well as the capability to implement and enforce current plans and regulations, are still lacking in several countries and medium-sized cities that are undergoing an urban boom. Key stakeholders from a variety of fields, including the environment, health, energy,transportation, industry, and agriculture, as well as the private and academic sectors, must take part in the development of a national or subnational air quality strategy, action plan, or framework. In some countries, the development of appropriate strategies is impeded. It is challenging to establish successful solutions in some countries due to a lack of data from air quality monitoring, emissions inventories, source apportionments, or when health impacts and the associated costs are not evaluated.

With the help of numerous partners and stakeholders, the Intergovernmental Network on Air Pollution in the Caribbean has the potential to greatly enhance regional information and knowledge exchange. The Sustainable Development Goals, the Forum of Latin American and Caribbean Environment Ministers' and other related international initiatives can serve as a roadmap for the advancement of the region's air quality agenda. Secondarydata demonstrated that some Caribbean nations have joined environmental protection campaigns aimed at preventing and reducing harmful environmental effects. Precautionary measures include setting license availability, import and production specifications, and terms and conditions. They also include banning the import, production, and distribution of goods that harm the environment. -Inspection -Monitoring: Penalty Categories - Notices -Warning -Fines. The Ministry of Natural Resources, Ministry of Energy, Ministry of Health, Ministry ofWater and Irrigation, Ministry of Environment, Ministry of Industry and Trade, Ministry of Agriculture, or Ministry of

Transportation is generally in charge of environmental protection. The Bahamas, Grenada, Dominican Republic, Jamaica, and Trinidad and Tobago made the highest progress in terms of regulation implementation.

However, there is a gap between science and policy. Governments have not worked together to ensure that there are enough surface meteorological monitoring stations to collect data information. One such area is Haiti, Antigua and Barbuda, those two countries lack meteorological stations despite having several industrial facilities and challenging topography. The introduction of small new industries and the failure to effectively reduce pollution from domestic burning, waste burning, biomass burning, vehicle emissions, and mining activities within air pollution hotspots makes achieving the desired air pollution reduction difficult. For effective management of air quality, institutional collaborations between governmental entities and research institutions may close the knowledge gap between science and strategic policy development and implementation. Further, there are insufficient standards and regulations to mitigate pollution, difficulties in enforcing current regulations, and a slow pace of law enforcement.

Table 3. Concentration levels of the main components of air pollution allowed in the Caribbean compared to World Health Organization (WHO) and the United Protection Agency (EPA).

Standards by country	**PM10 (Ug/m3) Annual**	**PM2.5 (Ug/m3) Annual**	**S02 (Ug/m3) Annual**	**C02 (ppm) 8hr**	**N02 (Ug/m3) Annual**
WHO	20	10	-	-	40
EPA	-	12	80	9	100
Antigua & Barbuda	WL	WL	WL	WL	WL
The Bahamas	20	25	70	50	40
Barbados	WL	WL	WL	WL	WL
Belize	No data	No data	No data	No data	No data
Dominica	WL	WL	WL	WL	WL
Grenada	30	12	50	60	35
Guyana	WL	WL	WL	WL	WL
Haiti	WL	WL	WL	WL	WL
Jamaica	40	15	55	80	60
Suriname	35	15	65	70	30
Trinidad & Tobago	50	15	50	75	40

WL: without legislation -: No data

4.3 Descriptive Statistic Results

Fixed-effect model estimation

Fixed-effects (within) regression **Number of obs = 310**

Group variable: i Number of groups = 10

R-squared: Obs per group: min = 11

Within = 0.2846 avg = 11\.0

Between = 0.0271 max= 11

Overall = 0.0956 F(3,97) = 12.86

Table 4. Regression results

Corr (u_i, Xb) = -0.5249 Prob > F = 0.0000

Specification	Coefficient	Std. errs.	t	P>|t|	[95% conf.	interval]
Variables						
Investment inc	-.134356	.068982	-5.12	0.004	-.1203676	-.1253563
Tax inc	-.144669	.032516	-4. 64	0.001	-.4640876	-.6455478
Income, ln	-.1379221	.003324	-3.08	0.340	-.1435676	-.4325430
FDI	.2648642	.044688	5.93	0.000	.1761709	.3535575
$PM_{2.5}$	-.1335621	.0441236	-3.13	0.002	-.2254952	-.0503489
PM_{10}	-.1372541	.0441139	-3.46	0.858	-.1785708	-.1489065
$C0_2$						
_cons	-1.81284	4.356264	-0.42	0.678	-10.45882	6.833138
sigma u	4.6267442					
sigma_e	5.4178712					
rho	.42172427 (fraction of variance due to u_i)					

F test that all u_i=0: F (9, 97) = 3.28 Prob > F = 0.0016

In this table, we can observe how the error (-0.5249) is correlated with the model. We have a total number of 10 groups. The coefficient results indicate when the independent variables increase in one unit. 42.17% of the variance is due to differences across panels. “rho” is known as the infraclass correlation. Further, the fact that p- value < 0.05, we can argue that the model is good (F-stat <0, 0016). Numerous studies have identified antiquatedregulatory and legislative frameworks, as well as a lack of financial incentives, as barriers to environmental protection in the Caribbean (Blechinger, 2015). It is not surprising, then, that four of the investment and tax policiestested were significantly correlated in at least one of the total technology-specific regressions. Therefore, we can argue that this analysis shows that policy instruments help to

reduce negative externalities on Caribbean islands, but it also emphasizes the importance of carefully designing policies to suit the specific type and island characteristics.

4.4 Comparative Perspectives and Challenges

In this section, we highlight the similarities between the 10 countries after discussing the regulatory and policy initiatives. The difficulties facing these countries' regulations and policies are also covered. Most of the countriesare fundamentally concerned about adopting regulatory and policy frameworks for reducing environmental issues.Although the Caribbean region shares several similarities. There are some differences between the frameworks and the implementation. Among all the countries, Trinidad and Tobago is the most industrialized. To support environmental protection, governments adopt a variety of rules and policies. However, there is a lack of evaluationof regulation and policy outcomes intended. The environment may benefit from the established rules and policiesfor promotion, nevertheless, the quality may also be negatively impacted by the laws and policies. It is challengingto pinpoint the precise effects of a given regulation or policy on the quality of the environment. Governments tendto highlight the existence of laws and policies, but they don't explain how these laws and policies can help or hurtwhile addressing an issue. Additionally, a lack of public awareness of environmental issues and the importance ofdealing with environmental threats.

Table 5. Perspectives and challenges

Themes	Cases
1. Specific laws and policies for reducing air pollution or regulation on the location of new investment projects and enterprises.	**Trinidad and Tobago** and **the Dominican Republic** have made the biggest progress. **Grenada** resorts to government policy and corporations as a mechanism to build up policy.
2. Government program for reducing pollution	**Trinidad and Tobago**, **Belize**, and **Jamaica** provide solid programs for joint ventures.
3. Incentives regulation	All countries issue tax regulation incentives.
4. Financial support for Policy outputs.	All countries establish financial schemes that help support environmental policy creation. However, the % is low.
5. Prohibiting the cutting, transporting, and distribution of trees from forests.	**Haiti** has the lowest score. The vegetation cover is lower than 3%.
6. Sustainability	**Guyana, The Bahamas** applied initiation policies but lacks continuity to nurture their strategies.

7. Monitoring the dumping of plastic residuals, byproducts, and plastic garbage protected the soil.	Low/ Enforcement actions are not seriously taken against violators and are frequently forgiving.
8. Banning and not licensing importing dangerous materials and residuals.	Lenient because sentences are brief and exchangeable for little money.

Limitations of the Study

This research has some restrictions. Since some information may not have been available in any of the sources, some of the data may be lacking. The fact that policy goals are extremely diverse and frequently qualitative makesit difficult to implement this type of research question with a comparative research design. Regression specifications' limited capacity to be causally interpreted is a major limitation of the current work. That's the reason we advocate for correlative interpretation of data. This study gathers pertinent data from secondary sources and cannot fully capture the full impact of the reduction policy's implementation.

5 Conclusion and recommendation

This study's objective is to evaluate the Caribbean region's environmental policy strategy for effectiveness. Both quantitative and qualitative techniques were employed. Significant findings showed that the Caribbean lacks adequate norms and laws for decreasing pollution. the complexity of putting present laws into effect and the sluggishness of law enforcement. Public ignorance about environmental problems and the significance of addressing environmental risks. Inadequate funding, capacity, and poor human resources as a result of governmental hiring practices all contribute to adopted environmental policies' failure to address environmental challenges.

Therefore, it is crucial to advise that a thorough legal system be put in place in all Caribbean nations. Additionally,the command-and-control strategy itself has been shown to be ineffective as a solitary tool for environmental policy in the experience of developed nations. The moment has come for Caribbean islands to reevaluate rights-and price-based regulations. Finally, every government should adopt a resolute anti-corruption policy. For futurework, although rigorous quantitative evaluations of environmental regulations are becoming more common (an encouraging trend), the evidence base remains limited in the Caribbean. Some gaps need to be filled. Studies on countries other than upper-middle and high-income countries are required. Although data availability is a constraint, there are undoubtedly middle- and low-income countries where studies on air and water quality are feasible, possibly using remotely sensed data [35].

References

[1] Adam A, Delis M, Kammas P (2011) Public sector efficiency: leveling the playing field between OECD countries. Public Choice 146(1):163–183

[2] Afonso A, Schuknecht L, Tanzi V (2005) Public sector efficiency: an international comparison. Public Choice

[3] Afonso A, St. Aubyn M (2006) Cross-country efficiency of secondary education provision: a semi-parametricanalysis with non-discretionary inputs. Econ Model 23(3):476–491

[4] Akpinar-Elci M, Sealy H (2014) Climate change and public health in small island states and Caribbean countries. In: Global climate change and public health. Springer, New York, pp279–292

[5] Akpinar-Elci, Muge, and Olaniyi Olayinka. "The Impact of Climate Change and Air Pollution on the Caribbean." Climate Change and Air Pollution: The Impact on Human Health in Developed and Developing Countries (2018): 349-360.

[6] Anderson, J. E. (2010). Public policymaking, 7th ed. Cengage Learning; 7 editions.

[7] Blechinger, P., Richter, K., & Renn, O. (2015). Barriers and solutions to the development of renewable energy technologies in the Caribbean. In Decentralized Solutions for Developing Economies: Addressing Energy Poverty Through Innovation (pp. 267- 284). Springer International Publishing.

[8] Boersema, J. J., & Reijnders, L. (2009). Principles of environmental sciences (pp. 3-14). Netherlands: Springer.

[9] Bueren, Ellen van. "Environmental policy". Encyclopedia Britannica, 11 Feb. 2019, https://www.britannica.com/topic/environmental-policy. Accessed 3 January 2023.

[10] Carlough, L. (2002). General Deterrence of Environmental Violation: A Peek into the Mind of the Regulated Public. Portland, Oregon: Department of Environmental Quality.

[11] Cifuentes LA, Krupnick AJ, O'Ryan R, Toman M (2005) Urban air quality and human health in Latin America and the Caribbean: Inter-American Development Bank

[12] Cocklin, C. (2009). Environmental policy. Elsevier.

[13] Fullerton, D., Leicester, A., & Smith, S. (2008). Environmental taxes (No. w14197). National bureau of economic research.

[14] Gerring, John. "What is a case study and what is it good for?" American political science review 98.2 (2004): 341-354.

[15] Goulder, Lawrence H., and Ian WH Parry. "Instrument choice in environmental policy." Review of environmental economics and policy (2008).

[16] Hawkins, K. (1984). Environment and enforcement: Regulation and the social definition of pollution.

[17] Helmut, W. &. (2002). Capacity Building in National Environmental Policy A Comparative Study of 17 Countries. New York: Springer-Verlag Berlin Heide1berg. https://archive.ipcc.ch/publications_and_data/ar4/wg3/en/ch13s13-1-2.html

[18] IPCC (2007) Climate Change 2007: synthesis report. Contribution of Working Groups I, II and III to the fifthassessment report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri RK, ReisingerA (eds)]. IPCC, Geneva, 104 pp

[19] IPCC (2014) Climate Change 2014: synthesis report. Contribution of Working Groups I, II and III to the fifth assessment report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri RK, Reisinger A (eds)]. IPCC, Geneva, 151 p

[20] Jacob DJ, Winner DA (2009) Effect of climate change on air quality. Atmos Environ 43(1):51–63

[21] Kay, J. V. (1990). „Regulatory Reform: An Appraisal" in Majone, Giandomenico (ed.) Deregulation or Re- regulation. London: Pinter Publishers, pp. 223-251.

[22] Krzyzanowski M, Cohen A (2008) Update of WHO air quality guidelines. Air Qual Atmos Health1(1):7–13

[23] Ostrom, Elinor. "Tragedy of the commons." The new palgrave dictionary of economics 2 (2008): 1-4.123(3):321–347

[24] Pearce, D., Atkinson, G., & Mourato, S. (2006). Cost-benefit analysis and the environment: recent developments. Organisation for Economic Co-operation and development.
[25] Policy Style in Western Europe, pp 11-16. London: George Allen and Unwin
[26] Prospero JM, Collard FX, Molinie J, Jeannot A (2014) Characterizing the annual cycle of African dust transport to the Caribbean Basin and South America and its impact on the environment and air quality. Glob Biogeochem Cycles 28(7):757– 773
[27] Rayner, S. (1993). Introduction to the special issue: National case studies of institutional capabilities to implement greenhouse gas reductions. Global Environmental Change 3(1), 7--11.
[28] Review of Policy Research, 38(3), 347-369.
[29] Richardson, J., Gustafsson, G. and Jordan, J. (1982). The concept of policy style. In Richardson, J. (ed.)
[30] Stéphane, J. G.-w. (2007). Regulatory Management Systems Across OECD Countries. OECD.
[31] Tanzi V, Schuknecht L (2000) Public spending in the 20th century. Cambridge books online. Cambridge University Press, Cambridge
[32] Taylor, Christopher, et al. "Selecting policy instruments for better environmental regulation: a critique and future research agenda." Environmental policy and governance 22.4 (2012): 268-292.
[33] Thomas, I. (2005). Environmental Management: Processes and Practices for Australia. Sydney: The Federation Press.
[34] VISCUSI, W. "Kip; HARRINGTON, Joseph E. y VERNON, John. Economics of Regulation and Antitrust. Fourth Edition." (2005).
[35] Weigand, M., Wurm, M., Dech, S., & Taubenböck, H. (2019). Remote sensing in environmental justice research—a review. ISPRS International Journal of Geo-Information, 8(1), 20.
[36] Willis, K. (2011). Theories and practices of development. routledge.
[37] Woods, N. D. (2021). The State of State Environmental Policy Research: A Thirty-Year Progress Report.