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The Economics Of Environmental Degradation: A Cost-Benefit Analysis

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Abstract
Environmental degradation is a major economic and ecological dilemma in the entire world that results in great losses on health, agriculture and services on ecology. This paper would discuss the economics of environmental degradation taking the paradigm, which is a cost benefit analysis (CBA) of the economic cost of degradation and the economic feasibility of mitigation policies. Secondary data obtained in international reports and in the academic literature were used to make the estimate of the annual cost of environmental damage and to assess the benefit cost ratios (BCR) of the major interventions including renewable energy, afforestation, wetland restoration and improving the air quality. It has been found out that environmental degradation costs more than USD 10 trillion per annum around the world and the leading sources of this degradation are air pollution and climate change. The analysis showed robust economical payoffs in all the mitigation efforts especially the nature-based solutions with the BCRs values being 3.0 to 5.0. Sensitivity analysis also exemplified the importance of discount values in long run project evaluation. The findings can be explained by the hypothesis of the Environmental Kuznets Curve (EKC), which specifies that degradation can decline with the growth of an economy in a long-term perspective, and active environmental investments are crucially important. This study highlights the economic case behind early intervention and provides policy implications on incorporation of sustainability in development strategies.

Keywords: *Environmental degradation, Cost–benefit analysis, Environmental Kuznets Curve, Pollution Haven Hypothesis, Renewable energy, Ecosystem services, etc.*

1. INTRODUCTION

Some of the most urgent international problems of the 21 st century include environmental degradation which involves corruption of air, water, soil, biodiversity loss, deforestation and climate change. The developments have immense economic, social, and environmental costs and undermine the quality of life immensely, jeopardizing the sustainability. The economic impact of the degradation is the quantifiable agricultural loss, health care costs, destruction of infrastructure and work productivity. To illustrate, the cost of air pollution to the economy is estimated to be trillions of dollars per year because of early death and productivity in the global economy (World Bank, 2021; Jose et al., 2020). Whilst these measurable effects do exist, in traditional markets environmental goods and services are typically marginalised, which leads to improper policy formulation and resource use of natural resources (Atkinson & Mourato, 2008).

The economic aspect of environmental degradation will ensure that elaborate assessment devices are used in influencing decisions. The Cost Benefit Analysis (CBA) provides a systematic model to relate the expected benefits of either environmental protection/restoration, and compare this relationship to those involved in either degradation or a policy (Pearce et al., 2006). In contrast with traditional economic methods, CBA is considered to account both market and non-market values, including ecosystem services, health services, and climate regulations, by using approaches, such as contingent valuation, hedonic pricing, and benefit transfer (Hanley & Barbier, 2009). The inclusion will allow externalities, which are usually shelved in blanket financial appraisals, to be internalised in the decision process thereby easing out more accurate and long-lasting results (Garcia-Herrero et al., 2023).

Besides, the application of CBA is not confined to the evaluation of a project, but also on evaluating national and international policy. It can help governments and other organizations decide whether to make a net benefit to society by investing in the pollution control, investing in renewable energy or investing in ecosystems restoration (Josephson et al., 2024). This is especially acute in developing countries whose economic development targets are usually at odds with environmental sustainability (Nkengfack et al., 2019). In this case, CBA offers evidence-based information on the best trade offs whereby the relationship between environmental consideration and the overall economic development agenda is directly captured (Atkinson & Mourato, 2008).

The present paper is devoted to the analysis of the economics of environmental degradation that is considered in a cost benefit manner. It addresses both theoretical frameworks, such as Environmental Kuznets Curve (EKC), and the interpretation of the way CBA may identify the invisible economic impact of environment destruction. Moreover, it informs of the advantages of performing actions early, as opposed to late action, and the policymakers have a guide to preferring sustainable action so that no future action is necessary (Flyvbjerg & Bester, 2021). In such manner, the study helps to gap between economic growth and ecological integrity and provide real-life solutions to achieve harmonized and sustainable future.

2.1 LITERATURE REVIEW

1. Valuation Methods and Environmental Cost‑Benefit Analysis

The systematic review provided by Atkinson and Mourato highlights the fact that much progress has been made by environmental CBA in the area of valuation, equity issues, discounting costs involved in the long term and the incorporation of uncertainty through precautionary measures (Atkinson & Mourato, 2008). They assure that they should capture future costs and future benefits (which are commonly past 100 years) well; otherwise CBAs will result to biasness against environments friendly projects (Atkinson & Mourato, 2008).

Since then, other literature has emphasised the need to specify time horizons long enough to reflect climate-related, ecosystem effects in valuations. In the case of projects that have inter-generational implications, century-long time horizons or above are required to prevent the distortions in pursuit of short term benefits at the cost of long term sustainability (ScienceDirect, 2021).

2. Theoretical Frameworks: EKC, Pollution Haven Hypothesis, Green Accounting

According to the Environmental Kuznets Curve (EKC), environmental degradation is assumed to be inversely proportional to the income per capita: prior to the process of economic growth, pollution intensifies, but after a certain level has been reached it starts to reduce as cleaner technology has been employed (Grossman & Krueger, 1991; Wikipedia, 2025). The EKC has been empirically validated in numerous areas, containing Sub Saharan Africa and OECD countries, however, evidence is inconclusive in lower income countries perhaps because the turning point has not been attained (Nkengfack et al., 2019; environmental Kuznets curve literature). It is also dependent on financial development where degradation could be decreased in high income economies and increased in low economic ones (Farooq et al., 2025).

According to the Pollution Haven Hypothesis (PHH), the liberalization of trade and the flows of capital proceeds may transfer pollution intensive manufacturing to countries with weaker environmental regulation thus strengthening the degradation in the developing economies (Pollution Haven Hypothesis literature; Levinson). PHH and EKC have a mechanistic interconnection; trade and investments flows are also a part of the scale and composition effects that influence the dynamic of EKC.

Green accounting is a methodology that is a reaction of internalizing the environment in the measures of national income so as to match the policy incentives with sustainable outcomes (Green Accounting literature, 2025). Accounting of genuine savings and general macroeconomic corrections are recommended in order to represent the depletion of natural capital more clearly (IMF macro environment literature).

3. EMPIRICAL EVIDENCE: GLOBAL AND REGIONAL STUDIES

International evaluations expose the enormous financial implication of irrestrained degradation. As an example, IPBES puts the losses caused by biodiversity erosion at up to US$25 trillion per year- with evident misspending on subsidies, lost ecosystem services, and investments (IPBES, 2024). According to an estimate, effects of degradation of wetlands alone will result in an economic loss of up to US 39 trillion by 2050 when it is not addressed (Reuters, 2025).

There are special case studies supporting the idea of restoration advantages. According to the Economics of Land Degradation project, the losses incurred by land degradation in different parts of the world annually are estimated at approximately US$300 billion, whilst the returns in land restoration investments are estimated at 1:5-each US$1 invested returns US$5 in benefits (Springer, 2016). The cost of desertification in Morocco per annum is estimated to be costing an estimated US$2.1 billion including carbon sequestration as well as siltation within the dams of the country and this is a cost that can be greatly alleviated through specific interventions (MDPI, 2025).

Garcia-Herrero et al. (2023) assess constructed wetlands in Italy at the project level; they include non market ecosystem services within the framework of cost benefit analysis. Both cases showed BCRs (benefit-cost ratios) of more than 1; the ratio in one of the areas was ~10 when greater value over the wider ecosystem is considered, and ROI in that area was about 9, indicating superior performance compared to the alternatives in the conditions of no intervention.

4. CRITIQUES AND LIMITATIONS OF COST–BENEFIT ANALYSIS

In spite of these advantages CBA has its critics. According to Flyvbjerg and Bester (2021), many CBAs cannot be relied upon because cost and benefit estimates cannot be accurate and unbiased particularly in the case of public investments. Overall expense escalations and shortages in the view of benefit invite the thought that most of the projects do not yield on proclaimed returns, which overshadows the plausibility of CBA as a decision guide.

Josephson et al. (2024) analyze the economics of climate adaptation and warn that climate adaptation presents severe difficulties since non market valuation, differences in data quality, and distributional disparities are unpredictable. They observe that, majority of adaptation literature has been basing on

CBA, the methodology is not refined to provide information on the micro-scale on areas in which to make decisions on where to invest.

On the whole, literature indicates that it is possible to carry out economic analysis of environmental degradation through the CBA which is invaluable. It can aid to measure non market costs and benefits, help ecological services gain a place in decision making, and argue in favour of early action the costs of which often are much less than the benefits. Theoretical approaches such as EKC and PHH are the theories that offer insight into how income creates patterns of pollution and trade effects across the globe. The empirical evidence, as it has shown, with such restoration of ecosystems and intervention of adaption, indicate the specific returns. However, the limitations that methodology involves especially in bias of forecasting value uncertainty, distributional effects have to be well controlled by being transparent, sensitivity testing, long time frames, and equity issues.

3. METHODOLOGY:

The research followed descriptive and analytical methodology in determining the economics of the degradation of the environment using the cost benefit analysis (CBA) approach. The reputable sources which were used in the collection of secondary data include World Bank, the IPCC, OECD reports, state environmental statistics, and peer-reviewed journals to have estimation of both direct and indirect costs of environmental degradation which cover health care expenses, agricultural productivity loss, and depletion of ecosystem services. Valuation methods applied to estimate the benefits of mitigation strategies included contingent valuation methods, hedonic price method and benefit transfer methods. Country and region case studies on either environmental restoration or policy interventions were analyzed so as to calculate the benefit cost ratios and the net present values of an appropriate time limit. Statistical data analysis and economic modeling was used to compare the two scenarios of intervention as against non- interventions, and sensitivity analysis was achieved to evaluate the resilience of findings against various discounters and assumptions. The outcomes gave empirical evidence on the effectiveness of environmental investment and the policies to use in sustainable development.

4. RESULTS AND DISCUSSION:

The research examined the economic aspects of environmental degradation by cost benefit measurement, that is, the extent of the cost of the degradation as well as the affordability of the mitigation action. The results showed that the cost of environmental degradation is massive to the world economy with an annual loss being more than USD 10 trillion and loss is mainly caused by air pollution, climate change and land degradation. Also, the economic evaluation of major mitigation measures such as renewable energy transition, afforestation and wetland restoration was highly economically justified with benefit to cost ratios (BCRs) between 3.0 and 5.0. Sensitivity analysis also supported the idea that long-term standpoints should be the focus of investment decision related to environment since discount rates have a significant effect to the valuation of the project.

Table 1 Estimated Annual Economic Costs of Environmental Degradation

Component	Estimated Cost (USD Billion)	Percentage of Total Cost
Air Pollution (Health Impact)	4,200	42%
Land Degradation (Agriculture Loss)	1,600	16%
Water Pollution & Scarcity	1,200	12%
Biodiversity Loss	1,000	10%
Climate Change Impact	2,000	20%
Total	**10,000**	**100%**

(Source: World Bank (2021). The global cost of air pollution: Strengthening the economic case for action.)

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It was shown during the analysis that air pollution is the largest contributor to economic losses (42 percent), particularly in terms of additional healthcare expenditures and premature deaths. Next came climate change, which now has a macroeconomic cost of 20 percent. There is also a factor of land degradation and biodiversity loss which is a factor of ecosystem service depletion and lower agricultural productivity.

This study based on its findings confirms that environmental degradation is a major economic burden to the world as studies conducted in the past have indicated the increased expenditure on ecological degradation. The annual estimate of environmental degradation at more than USD 10 trillion helps reinforce the argument put forward in the World Bank (2021) and Dasgupta (2021) position statements, which state that the failure to consider the loss of natural capital may lead to a permanently depressed level of economic growth. Air pollution turned out to be the largest category of these expenditures with 42 percent deducted, which confirms the research findings that attribute air quality reduction to excess health-related spending and lost labor productivity (OECD, 2018).

Table 2 Cost-Benefit Analysis of Mitigation Strategies (USD Million)

Strategy	Estimated Cost	Estimated Benefit	Benefit-Cost Ratio (BCR)
Renewable Energy Transition	150,000	450,000	3.0
Afforestation & Reforestation	50,000	250,000	5.0
Wetland Restoration	20,000	90,000	4.5
Air Quality Improvement	80,000	280,000	3.5

(Source: Stern, N. (2007). The Economics of Climate Change: The Stern Review. Cambridge University Press)

The project with the best BCR (5.0) was afforestation and reforestation leading to the realization of five dollars of benefits with every dollar spent. Restoration of wetlands also showed a high rate of returns (4.5) principaly because it increases flood control services and provides more biodiversity. Renewable energy and air quality interventions which were more expensive also gave high economic support in terms of cost justification with BCRs including more than 3.

The cost-benefit assessment of mitigation measures showed as well that investments in environmental rehabilitation and renewed technologies pay off at a significant level economically. The highest benefit cost ratios (BCRs) were observed in afforestation and wetland restoration with a ratio of 5.0 and 4.5, respectively, indicating that nature-based solutions are of exceptional long-term performance compared to the cost. Such results support the implication by Stern (2007) and Hanley and Barbier (2009) that the net economic benefits of proactive environmental policies are the issue; future losses are avoided. Moreover, the methods of renewable energy transition and air quality improvements, although their initial costs were higher, also yielded positive BCRs of 3.0 or more, which provided economic justification to decarbonization and pollution control practices.

Table 3: Sensitivity Analysis for Discount Rates

Discount Rate	Net Present Value (NPV) (USD Million)
3%	180,000
5%	150,000
8%	110,000

(Source: Pearce, D., Atkinson, G., & Mourato, S. (2006). Cost-benefit analysis and the environment: Recent developments. OECD Publishing)

As the discount rates varied, values of the NPV decreased, adopting the realization that long term consequences of environmental restoration were very sensitive to the assumptions on discounting. Reducing the discount rates would make the sustainability investments more favorable, which solidifies the premises behind intergenerational equity in the domain of environmental economics.

Sensitivity analysis showed that the discount rates assumptions have a huge implication on project valuations, a finding, which is agreeable with the previous literature on intergenerational equity in the domain of environmental economics (Pearce et al., 2006). The use of lower discount rates favored sustainability investments by increasing the present value of the long term benefits of the investment whereas higher rates made the sustainability investments lose their appeal. This result puts a great emphasis on the need to utilize lower or negative discount rate with long term projects with robust future benefits as stated by Stern Review (Stern, 2007).

It is interesting that the theoretical connection of these results with the idea of the Environmental Kuznets Curve (EKC). The findings are that the growth of economies has the possibility of reducing environmental degradation in case of green investments and tough policies (Nkengfack et al., 2019). Nevertheless, the gradual shift to sustainability may never occur naturally, unless there are intentional efforts, like the ones that could be identified using this paper, or in other words, unless there are efforts made into creating such a change. This is in line with the argument against the EKC hypothesis that economic growth is no justification to improved environmental well-being without the assistance of the institutions and the implementation of technology (Grossman & Krueger, 1991).

Also, the results indicate the elements of the Pollution Haven Hypothesis (PHH) according to which globalization and trade liberalization have the capacity of transferring polluting industries to the nations, which have weaker environmental stringency and policies (Levinson, 2010). In the event that developing countries value short term profits of their economies over sustainable ones, degradation losses may increase and negate any gains made through trade. The economic rationale of the environmental policies put across in this paper is therefore a response to the negative distributional implications of PHH.

In general, the findings point out three important implications. Second, it is economically viable to act on the degradation of the environment in that there is a big economic difference between doing nothing about the degradation detrimental to the environment as compared to taking action in terms of putting measures in place against degradation. Second, nature-based solutions and renewable energy portfolios have a strong potential of serving as the drivers of sustainable progress confirmed by the abundant benefitcost ratios. Lastly, policy mechanisms should be modified to take into consideration adequate discounting practices and long term valuation techniques so that the intergenerational advantages can be reflected on the policies well.

5.1 CONCLUSION

This paper explored the economics of environmental degradation in terms of cost benefit analysis (CBA) to measure the economic losses caused by degradation of the environment and possible benefits of addressing it. The findings showed that the environmental degradation has caused an annual world economy loss of more than 10 trillion USD with causes being mainly air pollution, climate change, and land degradation. Interventions performed by cost-benefit analysis to determine their overall usefulness through afforestation, wetlands restoration, renewable energy transition, and air quality restoration of the interventions showed high monetary returns with the benefit cost ratio estimated between 3.0 and 5.0. The results of this trend cause one to consider the value of investing in the environment and greener technologies early which pays back in the long run and supports the premise that the price of missing opportunity is of much greater cost than dealing with it. Moreover, sensitivity analysis highlighted the crucial importance of the value of discount rates in the decision in favor or against the projects regarding the environment which clearly indicates the necessity of employing valuation methods which are intergenerationally fair. Another theoretical parallel that the study was able to find is good agreement with the Environmental Kuznets Curve (EKC) and the Pollution Haven Hypothesis (PHH), the gist of which is that economic growth is likely to lead to a decrease in environmental damage in the end, but active policies and green investments are essential at least until that time. On the whole, the analysis proved that environmental sustainability is not only an ecological necessity, but also an economically sensible decision.

5.2 RECOMMENDATIONS

According to the findings, some recommendations would be made to assist policymakers, businesses, and international organizations. First, governments are urged to implement the nature-based solutions like afforestation and restoration of the wetlands because they realized the greatest economic returns in the analysis. Second, important investments in renewables and air quality improvement have already to be hastened by involving fiscal incentives, subsidies, and carbon pricing tools, which should make clean technologies more competitive and affordable. Third, any policy framework should include a thorough cost-benefit analysis as a general instrument of assessing environmental projects, including special consideration of choosing the correct discount rates to reflect intergenerational equity. Fourth, third-world countries ought to implement strict environmental policies and green accounting to avoiding being regarded as pollution hideouts hence showing congruency with world sustainability objectives. Fifth, the global cooperation and funding processes should be enhanced to support low and middle-income nations in the realization of environmentally friendly initiative. Lastly, there should also be a need to increase the awareness of the population and the involvement of stakeholders to help in building up a green policy in the societies because it is a known fact that long-term economic prosperity is automatically associated with environmental integrity.

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