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ANALYSING THE SUSTAINABLE DEVELOPMENT CLAIMS OF THE CURRENT CLEAN DEVELOPMENT MECHANISM (CDM): A STUDY OF OFFICIALLY REGISTERED CDM PROJECTS

KEY WORDS:

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ABSTRACT

Objective: The objective of this research is to present an analytical framework for evaluating how Clean Development Mechanism (CDM) initiatives affect local air quality, the distribution of CDM benefits fairly, and the creation of employment. **Methodology:** The Kyoto Protocol introduced the Clean Development Mechanism (CDM) for climate change mitigation. This method includes the CDM project Multi-Attributive Assessment, enabling industrialized nations to finance emission reduction efforts. As part of this initiative, cities use the CDP Online Response System to report climate hazards, actions, objectives, and emissions. Municipalities submit emissions data to CDP, delineating inventory boundaries and identifying emission sources, primarily focusing on Scope-1 and Scope-2 emissions. This study assesses 16 officially registered CDM projects to gauge their compliance with the twin goals of the Kyoto Protocol: reducing greenhouse gas emissions and advancing sustainable development in the host country. **Result:** The existing CDM portfolio has slightly impact on employment in host countries, according to an analysis of authorised CDM projects. Almost all (99%) of the CERs originate from initiatives with a grade of C or worse in terms of their potential to create new jobs. In reality, the average CER in the portfolio creates around 235 person months of new employment for A-rated projects, 3.5 for B-rated projects, and 0.1 for C-rated projects, for a total average of 2.3 person months of increased employment for every 1,000 CERs. Large-scale projects often exhibit a low average employment rate, and this phenomenon is primarily attributed to end-of-pipe trifluoromethane (HFC-23) division operations, which have little to no employment effect. **Conclusion:** The Clean Development Mechanism (CDM) has had mixed results in encouraging sustainable development via its official programmes. Despite various projects generating capital, transferring clean technology, and improving host country living conditions, other issues persisted. Project additionality, equitable benefit sharing, and environmental integrity remain contested.

INTRODUCTION

The Clean Development Mechanism (CDM) is an essential element of the Kyoto Protocol, which intends to promote sustainable development and mitigate greenhouse gas emissions [1]. The primary objective of officially registered Clean Development Mechanism (CDM) initiatives is to simultaneously address the challenges of climate change mitigation and promote sustainable development in poor nations. The CDM has since assumed a prominent role in facilitating the collection of investments in clean energy, energy efficiency, and environmentally friendly practises within several developing countries [2]. These initiatives often result in favourable social and economic outcomes, including the generation of employment opportunities, the availability of renewable energy sources, and the dissemination of technological knowledge. In some instances, their contributions have facilitated the alleviation of poverty and the improvement of local livelihoods, therefore fitting with the objectives of sustainable development [3].

The CDM has since assumed a prominent role in facilitating the collection of investments in clean energy, energy efficiency, and environmentally friendly practises within several developing countries [4]. In some instances, their contributions have facilitated the alleviation of poverty and the improvement of local livelihoods, therefore fitting with the objectives of sustainable development [5].

Moreover, it has been contended by opponents that the Clean Development Mechanism (CDM) has encountered difficulties in assuring the consistent realisation of sustainable development benefits across all projects. The concerns include issues pertaining to additionality, project selection, and monitoring within the context of the Clean Development Mechanism (CDM) [6]. These initiatives often result in favourable social and economic outcomes, including the development of employment opportunities, the availability of sustainable energy, and the transfer of knowledge. In some instances, these contributions have facilitated the mitigation of poverty and the improvement of local livelihoods, therefore fitting with the objectives of sustainable development [7].

Further, it has been contended by opponents that the Clean Development Mechanism (CDM) has encountered difficulties in guaranteeing the consistent realisation of sustainable development benefits across all projects. There are many concerns that arise in relation to the Clean Development Mechanism (CDM), including the concept of additionality, project selection, and monitoring [8].

The Clean Development Mechanism (CDM) has also been criticised for putting carbon reductions ahead of wider sustainable development goals. Sustainable development results as a whole have been lost in the spotlight of carbon credits and market processes [9].

CDM projects are required to adhere to a set of stringent procedures in order to substantiate the authenticity, quantifiability, and incremental nature of the emission reductions achieved. The determination of national permission for projects is made by the government of the host country, which assesses their compliance with sustainable development criteria. Subsequently, the project validation, registration, and issue of Certified Emission Reductions (CERs) are overseen by the CDM Executive Board (EB).

The Clean Development Mechanism (CDM) has seen rapid expansion over the last ten years and has emerged as a significant tool in the global efforts to combat climate change. As of February 2016, a total of 7600 projects have been officially registered, with over 200 approaches being implemented. Additionally, more than 100 developing nations are now hosting their own Clean Development Mechanism (CDM) initiatives [10]. The promotion of Clean Development Mechanism (CDM) initiatives leads to increased advantages for a greater number of nations, as well as increased participation in mitigation actions. Nevertheless, there is considerable variation across developing nations in terms of their abilities to undertake project development and provide credits to the carbon trading market [11].

The Clean Development Mechanism (CDM) was established with dual aims: firstly, to contribute a positive contribution to sustainable development at the local level in the host nation, and secondly, to aid Annex-I countries in efficiently attaining their emission reduction commitments (UNFCC 1997) [12].

Extensive scholarly discourse has been dedicated to examining the importance of CDM (Clean Development Mechanism) development [13]. Despite the availability of recorded and well-documented data on project registration processing time by international organisations and research centres, few efforts have been undertaken to assess the actual efficiency of the Clean Development Mechanism (CDM) project processing [14].

This study provides a statistical approach with the objective of assessing 16 officially registered Clean Development Mechanism (CDM) projects in relation to their impact on employment creation, equitable distribution of CDM benefits, and enhancement of local air quality [15]. It evaluates the compliance of these projects in meeting the dual goals mandated by the Kyoto Protocol, namely, the reduction of greenhouse gas emissions and the promotion of sustainable development in the host nation. [16].

Methodology

Project Selection

Selecting a diverse and representative sample of officially registered Clean Development Mechanism (CDM) projects from various sectors, such as renewable energy, forestry, waste management, and end-use energy efficiency improvement, as well as different geographies, including Africa, Asia, and Latin America. It is important to ensure that the sample size meets the criteria of statistical significance.

Data Collection

The dataset known as CDP emissions dataset16 (DCDP2016) presents the average yearly greenhouse gas (GHG) emissions in terms of carbon dioxide equivalents from a total of 187 cities across eight different geographical areas. The collection of CDP data is facilitated through an Online Response System, which enables cities to submit reports on climate dangers, climate initiatives, goals, and emission inventories. The emissions reported to the Carbon Disclosure Project (CDP) are sourced directly from municipal governments. Cities first choose the demarcation of their inventory boundaries and proceed to identify the sources of emissions inside such area. The majority of urban areas use the scopes framework as a means of documenting and disclosing their Scope-1 and Scope-2 emissions.

Determine a collection of indicators for sustainable development that are relevant to the particular circumstances of each project. Possible metrics that may be considered include several aspects such as the generation of employment opportunities, alleviation of poverty, enhancement of renewable energy accessibility, facilitation of technology dissemination, and provision of benefits to local communities.

Steps Involved In Computation Of CDM Projects.

The evaluation of CDM projects, with regards to their achievement of the two goals of the CDM, relies on the Multi-Attributive Assessment of CDM (MATACDM) approach [Nyambura et al., 2014]. The technique used in this study was first proposed by Sutter (2003) as a means to assess the impact of Clean Development Mechanism (CDM) initiatives on sustainable development within the host nations. The approach draws upon the principles of Multiantibiotic Utility Theory (MAUT) [17].

Here, the steps demonstrate the five evaluation processes and the MATA-CDM's main equation for computing the total usefulness of CDM initiatives.

$$U(P) = \sum_{i=1}^{n} w_i u_i \left[c_i (P) \right]$$

From the above equation, P denotes Assessment of CDM project, W denotes the Weighting criteria, U denotes the overall Utility and Ci demonstrated the identification of sustainability criteria and Ui showed the specifications indicators.

Indicators Used For The Assessment.

Employment Generation

MAUT (Multi Attributed Utility Theory) has the benefit of allowing indicators to be assessed in the units that are most appropriate for each unique criterion. The idea of utility makes it possible to regulate the quantities using several units and combine them into a single value. The so-called baseline serves as the standard against which all indications are evaluated. The identical baseline scenarios from the registered and verified Project Design Documents (PDDs) have been utilised for this investigation [18].

The significance of reducing poverty and economic growth as integral elements of sustainable development is widely acknowledged (United Nations, 2005) Therefore, the evaluation of Clean Development Mechanism (CDM) projects entails the use of person months per 1,000 Certified Emission Reductions (CERs) as a criterion for quantifying the employment produced throughout the construction and operation stages. The following formula is used for the computation of EG:

$$\frac{(\text{JP} - \text{JB})}{\text{CER}_p} = \text{EG [person months per 1,000 CERs]}$$

The variable JP represents the cumulative person-months generated by the project, including all stages of construction and operation. On the other hand, JB denotes the total person-months generated in the base scenario. The variable CERp represents the quantity of emission reductions measured in thousands of Certified Emission Reductions (CERs).

Enhancement Of Local Air Quality

The evaluation of the environmental impacts of a Clean Development Mechanism (CDM) project activity is contingent upon the improvement of air quality at the regional scale. The importance of air quality in attaining environmental sustainability has been recognised by the Millennium Development Goals. The concept of sustainable development was first introduced by the United Nations in the year 2005. As a result, the effect of created pollutants on the neighbourhood is considered while evaluating projects. For this, the scale in Table 1 is used.

Table 1: Effectiveness and evaluation of the criteria for local air quality improvement

Scale of indicator	Utility	Rating
significant reduction in carcinogens or pollutants that cause respiratory disease	1	A
Significant reduction in smell and modest reduction in contaminants that cause respiratory sickness or cancer.	0.5	B
Baseline unchanged	0	C
Moderate rise in pollutants that cause cancer or a significant increase in odour	-0.5	D
significant rise in carcinogens or pollutants that cause respiratory disease	-1	E

Assessed CDM Projects.

As of August 30, 2005, the 16 CDM projects evaluated in the study were those that were registered with UNFCCC (UNFCCC 2005; Table 6). The majority of the material was sourced from scientific articles pertaining to various project categories, as well as Project Design Documents (PDDs) accessible on the official website of the United Nations Framework Convention on Climate Change (UNFCCC).

RESULT

Employment Generation

The examination of the officially approved Clean Development Mechanism (CDM) projects has shown that the presence of the current CDM portfolio does not have a significant impact on the employment rates in the countries where these projects are implemented.The predominant proportion of Certified Emission Reductions (CERs) are derived from projects that have been assigned a C grade in terms of their employment generation capacity. The mean person months of employment generated by the portfolio's Certified Emission Reductions (CERs) is around 242 for projects classified as A-rated, 3.5 for projects classified as B-rated, and 0.1 for projects classified as C-rated. Ultimately, this leads to a portfolio mean of 2.3 person months for 1,000 Certified Emission Reductions (CERs). The installation of high-capacity projects like the breakdown projects of trifluoromethane (HFC-23), which are seen as reactive actions and do not considerably increase work prospects, is blamed for the low average that has been recorded. On the other hand, the portfolio contains a number of modest-scale efforts within the biomass power generation sector, which have a major influence on employment creation, as shown in Table 2.

Table 2: The projected creation of employment resulting from registered Clean Development Mechanism (CDM) project activity.

Project analysis	Estimated employment effect	Employment rating
Project to convert gas into energy at NovaGerar Landfill	0.029	C
Rio Blanco's Miniature Hydropower Project	0.276	C
Gujarat reduces GHG emissions by thermally oxidising HFC 23.	0.012	C
Project to Decompose HFC in Ulsan	0.029	C
Hydroelectric Project at Cuyamapa	0.253	C

Distribution Of Project Returns

The majority of projects—13 out of 16—and the majority of CERs produced by the CDM project portfolio—have a B-rating for the distribution of project returns. Eleven of the B-rated projects are held by regional private businesses, while two are government-owned (Table 3).

Table 3: Ratings of registered CDM project operations with reference to CER revenue distribution

Project analysis	Ownership of project	Distribution rating
The NovaGerar Landfill Energy Project	Private local company	B
Small Hydroelectric Project in Rio Blanco	small local producer association	A
Gujarat's thermal oxidation of HFC 23 reduces GHG emissions.	Private local company	B
Ulsan Project for HFC Decomposition	Private company transnational	C

Improvement Of Local Air Quality

Three distinct categories of projects within the existing Clean Development Mechanism (CDM) project portfolio have been identified in relation to enhancements in local air quality based on the Certified Emission Rate (CER) produced. Initially, it should be noted that there exist some initiatives that exhibit limited efficacy in mitigating significant levels of local air pollutants. The biggest category, comprising 96% of the total volume of Certified Emission Reductions (CERs), consists of projects primarily focused on the reduction of Trifluoromethane and methane (CH4). These projects have been assigned C-ratings in terms of their impact on local air quality, as shown in Table 4. The second category comprises initiatives that aim to either substitute fossil fuel-intensive grid power or facilitate a transition from coal to natural gas as the primary energy source.

Table 4: Rating of the improvement of local air quality in a portfolio

Portfolio analysis	Crs from the first 7 years	Percent of portfolio (%)
The total number of Certified Emission Reductions (CERs) that possess an A-rating	426,876	5.5
The total number of Certified Emission Reductions (CERs) that has an additionality B-rating.	1,417,02	6.75
The total number of Certified Emission Reductions (CERs) that possess a C-rating	40,858,472	95.7
The cumulative number of Certified Emission Reductions (CERs) within the portfolio of CERs.	42,702,300	100

Probability Of Actual Emission Reductions

In contrast to the relatively low rankings observed for most Clean Development Mechanism (CDM) projects in terms of their performance against the three criteria of sustainable development, a significant majority (72%) of CDM projects within the current portfolio have received an A-ranking for additionality. This indicates a high probability that the observed emission reductions are primarily attributable to the CDM component of the respective projects. The outcome is impacted by the presence of two major initiatives, namely the HFC-23 reduction programmes, which both had an A-rating in terms of their additionality.

Table 5: Additionality rating of CDM initiatives and the CER portfolio

Analysis of Project	Estimated ΔIRR	Additionality rating
Energy Project Using the NovaGerar Landfill's Gas	82.0%	B
Small Hydroelectric Project in Rio Blanco	2.0%	C
Gujarat's thermal oxidation of HFC 23 reduces GHG emissions.	180.0%	A
Project to Decompose HFC in Ulsan	200.0%	A

DISCUSSION

The Kyoto Protocol created a set of flexibility mechanisms, one of which is the Clean Development Mechanism (CDM), a strategy for reducing greenhouse gas emissions. Indicators of CDM project proponents' and host governments' regulatory and implementation capacities may be gleaned from the length of time it takes to process a CDM project.

This present research assessed that the 16 officially registered CDM projects, focusing on their ability to meet the two goals of the Kyoto Protocol: reducing greenhouse gas emissions and promoting sustainable development in the host nation. The estimated Certified Emission Reductions (CERs) within the whole portfolio are projected to consist of a substantial portion (72%) that may be considered as genuine and quantifiable reductions in emissions.

However, Heuberger et al., 2007 findings showed that only a minute proportion, amounting to less than 1% of these reductions would have a significant impact on promoting sustainable development in the host country [19]. Based on our investigation, it is evident that there are now no initiatives recorded under the Clean Development Mechanism (CDM) of the United Nations Framework Convention on Climate Change (UNFCCC) that possess the capacity to effectively achieve the two objectives delineated in the Kyoto Protocol. Included in these objectives are the advancement of sustainable development and the mitigation of greenhouse gas (GHG) emissions [20].

Similarly, Liu et al. (2018) conducted research in which they analysed the CDM projects that were submitted to the CDM Executive Board for registration throughout the time frame of 2004 to 2016. The model incorporates project type, size, government assistance level, and project submission phase as variables, with a specific emphasis on the leading CDM host nations of China, Brazil, India, and Mexico. The empirical findings suggest that the utilisation of survival analysis offers a fresh perspective in investigating the duration of CDM project processing. By incorporating censored time data, this approach takes into account the instances where the exact duration is unknown. The application of the Cox model reveals significant variations among countries in terms of the time required for project registration [21]. Specifically, China demonstrates the shortest average registration time, while India exhibits the longest duration [22].

The present study revealed that the fundamental equation of MATA-CDM, which is used for the computation of the all-encompassing efficacy of CDM initiatives. The observation revealed that a substantial majority, namely ninety-nine percent, of the Certified Emission Reductions (CERs) originate from projects categorised as C in relation to their ability for generating employment. The mean employment created by the portfolio's Certified Emission Reductions (CERs) is around 242 person months for projects classified as A-rated, 4.9 person months for projects classified as B-rated, and 0.1 person months for projects classified as C-rated. As a result, the average person-months per 1,000 Certified Emission Reductions (CERs) in the portfolio is 3.3.

Similarly, In their study, Heuberger et al. (2007) demonstrated that the MATA-CDM approach did not achieve a flawless quantitative overall sustainability assessment of CDM projects within the parameters of the study. However, the authors identified several valuable insights that could be utilised to enhance the approach and bridge the gap between the abstract concept of sustainable development and its practical implementation at the project level [23].

The examination of the study findings revealed the distribution patterns seen in the majority of Clean Development Mechanism (CDM) initiatives. The NovaGerar Landfill Gas to Energy Project exhibited a B grade, whilst the Rio Blanco Small Hydroelectric Project attained an A rating. The Gujarat project's thermal oxidation of HFC 23 resulted in a B-rated decrease of greenhouse gas (GHG) emissions. On the other hand, the HFC (Hydrofluorocarbons) Decomposition Project in Ulsan received a C grade.

Similarly, in their study, Winkelman et al. (2011) provide an explanation of the current distribution of projects. The hosting of projects and the generation of certified emission reductions (CER) have been impacted by factors like as human capital and levels of greenhouse gas emissions in different nations. Countries that exhibited expanding markets for co-products generated via Clean Development Mechanism (CDM), such as electricity, were shown to have a higher likelihood of hosting CDM projects. Additionally, economies with higher levels of carbon intensity had a larger output of Certified Emission Reductions (CERs). The research findings revealed that the portfolio rating for local air quality improvement indicated that 5.5% of the total Certified Emission Reductions (CERs) were assigned an A-rating for additionality. Additionally, 6.75% of the total CERs received a B-rating for additionality, while 95.7% of the total CERs were assigned a C-rating for additionality. Furthermore, all of the total CERs obtained a Certified Emission Rate (CER) designation [24].

Xiong et al. (2021) conducted a study in which they provided evidence to support the notion that the adoption of both the single trading market scenario and the double trading market scenario can significantly accelerate the process of reducing CO_2 emissions, decrease the expenses related to abatement endeavours, and facilitate the shift towards a more sustainable energy system when compared to the baseline scenario referred to as Business as Usual (BAU) [25]. In the given context of the double trading market scenario, it is important to highlight that there is a marginal rise in carbon dioxide (CO_2) emissions and a decline in the share of renewable energy in comparison to the single trading market scenario. However, it is noteworthy that the long-term cost-saving implications of the double trading market scenario demonstrate a significant expansion. Furthermore, in order to efficiently achieve the goals specified in the Intended National Determined Contributions (INDCs), it is essential for governments to create a coherent offset rate for CCER quotas and assure stability in the market value of carbon quotas. These findings provide valuable insights that might potentially guide the development of novel carbon offset techniques [26].

In contrast our findings illustrated that, several projects demonstrated tangible reductions in emissions. For instance, the NovaGerar Landfill Gas to Energy Project exhibited a 90% estimated Internal Rate of Return (IRR) and received an additional A rating. Similarly, the Rio Blanco Small Hydroelectric Project displayed a 1% estimated IRR and received an additional C rating. Additionally, the Gujarat project focusing on greenhouse gas emission reduction through thermal oxidation of HFC 23 demonstrated a 190% estimated.

In a study conducted by Dhavale et al. (2018), it was shown that the presence of very high and extremely low revenues has a beneficial impact on the internal rate of return (IRR). Conversely, a greater degree of variability in the distribution of cash flows adversely impacts the IRR of greenhouse gas (GHG)-reducing assets. In essence, there exists an affinity for revenues that manifest frequent occurrence and substantial scale, in contrast to cash flows characterised by volatility. The results of this study may provide more support for the existence of a phenomenon known as the energy efficiency gap, which is characterised by consumer conduct that deviates from the norm [27].

CONCLUSION

The evaluation of the extent to which the existing Clean Development Mechanism (CDM) successfully fulfils its assertion of sustainable development through officially approved initiatives leads to a complex determination. The Carbon Development Mechanism (CDM) has been crucial in advancing sustainable development in conjunction with endeavours to reduce emissions. However, the effectiveness of the CDM exhibits disparities across projects and geographical areas. One notable aspect is that several CDM projects have made substantial contributions towards achieving sustainable development goals via the facilitation of revenue creation, technological transfer, and improved living circumstances in the countries where they are implemented. These programmes often provide concrete advantages for nearby communities, therefore harmonising with wider objectives of sustainable development.

REFERENCES

1. Zomer RJ, Trabucco A, Bossio DA, Verchot LV. Climate change mitigation: A spatial analysis of global land suitability for clean development mechanism afforestation and reforestation. Agriculture, ecosystems & environment. 2008 Jun 1;126(1-2):67-80.
2. Ottonelli J, Lazaro LL, Andrade JC, Abram S. Do solar photovoltaic clean development mechanism projects contribute to sustainable development in Latin America? Prospects for the Paris Agreement. Energy Policy. 2023 Mar 1;174:113428.

3. Ernstson H, Swyngedouw E. Wasting CO2 and the Clean Development Mechanism: The remarkable success of a climate failure. Environment and Planning E: Nature and Space. 2023 Aug 25:25148486231196677.
4. Oh C. Exploring the Way to Harmonize Sustainable Development Assessment Methods in Article 6.2 Cooperative Approaches of the Paris Agreement. Green and Low-Carbon Economy. 2023 Aug 22.
5. Raihan A, Pavel MI, Muhtasim DA, Farhana S, Faruk O, Paul A. The role of renewable energy use, technological innovation, and forest cover toward green development: Evidence from Indonesia. Innovation and Green Development. 2023 Mar 1;2(1):100035.
6. Chen H, Letmathe P, Soderstrom N. Reporting bias and monitoring in Clean Development Mechanism projects. Contemporary Accounting Research. 2021 Mar;38(1):7-31.
7. Deryng D, Conway D, Ramankutty N, Price J, Warren R. Global crop yield response to extreme heat stress under multiple climate change futures. Environmental Research Letters. 2014 Mar 19;9(3):034011.
8. Schneider L. Is the CDM fulfilling its environmental and sustainable development objectives? An evaluation of the CDM and options for improvement.
9. Cansino JM, Román-Collado R, Nassar S. The clean development mechanism in Eastern Europe: an in-depth exploration. Environmental Science and Pollution Research. 2022 Oct;29(49):74797-822.
10. Bufoni AL, Ferreira AC, Oliveira LB. The quality of carbon management accounting reporting as a financial barrier to clean development mechanism projects development. Cadernos EBAPE. BR. 2018 Jul;16:345-54.
11. Ottonelli J, Lazaro LL, Andrade JC, Abram S. Do solar photovoltaic clean development mechanism projects contribute to sustainable development in Latin America? Prospects for the Paris Agreement. Energy Policy. 2023 Mar 1;174:113428.
12. Sutter C, Parreño JC. Does the current Clean Development Mechanism (CDM) deliver its sustainable development claim? An analysis of officially registered CDM projects. Climatic change. 2007 Sep;84(1):75-90.
13. Olsen KH, Fenhann J. Sustainable development benefits of clean development mechanism projects: A new methodology for sustainability assessment based on text analysis of the project design documents submitted for validation. Energy policy. 2008 Aug 1;36(8):2819-30.
14. A vast amount of literature has addressed the significance of CDM development .
15. Satapathy LR, Singh B, Singh KB. A Study on The Dimensions and Criteria For Sustainable Development of Clean Development Mechanism (CDM) Projects. In2023 International Conference on Computational Intelligence and Knowledge Economy (ICCIKE) 2023 Mar 9 (pp. 386-391). IEEE.
16. Dobbelaere S. Ownership, firm size and rent sharing in Bulgaria. Labour Economics. 2004 Apr 1;11(2):165-89.
17. Liu L, Stephane K, Zhang W. Country variation of clean development mechanism project registration time: an exploratory analysis by the Cox model. Procedia computer science. 2018 Jan 1;131:573-8.
18. Griffin P. The carbon majors database CDP carbon majors report 2017.
19. Heuberger R, Brent A, Santos L, Sutter C, Imboden D. CDM projects under the Kyoto Protocol: A methodology for sustainability assessment–experiences from South Africa and Uruguay. Environment, Development and Sustainability. 2007 Feb;9:33-48.
20. Nangini C, Peregon A, Ciais P, Weddige U, Vogel F, Wang J, Bréon FM, Bachra S, Wang Y, Gurney K, Yamagata Y. Data Descriptor: A global dataset of CO2 emissions and ancillary data related to emissions for 343 cities.
21. Winkelman AG, Moore MR. Explaining the differential distribution of Clean Development Mechanism projects across host countries. Energy Policy. 2011 Mar 1;39(3):1132-43.
22. Ye F, Xiong X, Li L, Li Y. Measuring the effectiveness of the Chinese certified emission reduction scheme in mitigating CO2 emissions: a system dynamics approach. Journal of Cleaner Production. 2021 Apr 20;294:125355.
23. Wang Q, Guo J, Li R. Official development assistance and carbon emissions of recipient countries: a dynamic panel threshold analysis for low-and lower-middle-income countries. Sustainable Production and Consumption. 2022 Jan 1;29:158-70.
24. Dhavale DG, Sarkis J. Stochastic internal rate of return on investments in sustainable assets generating carbon credits. Computers & Operations Research. 2018 Jan 1;89:324-36.
25. Liu JF, Xiong N, Campos SM, Wright AA, Krasner C, Schumer S, Horowitz N, Veneris J, Tayob N, Morrissey S, West G. Phase II study of the WEE1 inhibitor adavosertib in recurrent uterine serous carcinoma. Journal of Clinical Oncology. 2021 May 10;39(14):1531-9.
26. Darras BT, Masson R, Mazurkiewicz-Be dzi ska M, Rose K, Xiong H, Zanoteli E, Baranello G, Bruno C, Vlodavets D, Wang Y, El-Khairi M. Risdiplam-treated infants with type 1 spinal muscular atrophy versus historical controls. New England Journal of Medicine. 2021 Jul 29;385(5):427-35.
27. Pertiwi N, Tsusaka TW, Nguyen TP, Abe I, Sasaki N. Nature-based Carbon Pricing of Full Ecosystem Services for Peatland Conservation—A Case Study in Riau Province, Indonesia. Nature-Based Solutions. 2022 Dec 1;2:100023.