Climatic Change (2007) 84:59–73
DOI 10.1007/s10584-007-9267-y

The clean development mechanism's contribution to sustainable development: a review of the literature

Karen Holm Olsen

Received: 14 February 2006 / Accepted: 11 April 2007 / Published online: 24 May 2007

Abstract The challenges of how to respond to climate change and ensure sustainable development are currently high on the political agenda among the world's leading nations. The Clean Development Mechanism (CDM) is part of the global carbon market developing rapidly as part of the Kyoto response towards the mitigation of global warming. One of the aims of the CDM is to achieve sustainable development in developing countries, but uncertainty prevails as to whether the CDM is doing what it promises to do. Close to 200 studies on the CDM have been carried out since its birth in 1997 including peer-reviewed articles and reports from the grey literature. This review of the literature serves to assess the state of knowledge on how the CDM contributes to sustainable development (SD) including poverty alleviation. The main finding of the review is that, left to market forces, the CDM does not significantly contribute to sustainable development.

1 Introduction

"We face serious and linked challenges in tackling climate change, promoting clean energy and achieving sustainable development," the leaders of the Eight Nations agreed when they met in Gleneagles, Scotland on 6–8 July 2005 (Blair et al. 2005). The challenges of climate change and SD are at the top of the political agenda among the world's leading nations. In parallel to the G8 dialogue on climate change and SD, the majority of developed countries have committed to targeted emission reductions through the Kyoto Protocol of 1997, which entered into force in February 2005. Accordingly, a carbon market is developing rapidly as a step towards the stabilisation of greenhouse gas concentrations in the atmosphere to avoid global warming. The CDM is part of the emerging carbon market and aims to achieve both

K. H. Olsen
Research Network for Environment and Development, University of Copenhagen,
c/o Institute of Geography, Øster Voldgade 10, 1350 Copenhagen K, Denmark
URL: http://www.rened.dk

K. H. Olsen (✉)
UNEP Risø Centre, Risø National Laboratory, P. O. Box 49, 4000 Roskilde, Denmark
e-mail: karen.olsen@risoe.dk

SD in developing countries and cost-effective reduction of greenhouse gasses in developed countries. In spite of its stated objective, uncertainty prevails as to whether the CDM is doing what it claims it will do in terms of achieving SD.

An extensive body of literature has developed covering close to 200 studies on economic, political, methodological and SD aspects of how the CDM works. However, no overview of knowledge exists on the different aspects of and debates about the CDM. This review of the literature serves to communicate to the readership an analysis of how the CDM contributes to SD. Based on research findings, the paper argues that, by 2006, the CDM has not significantly contributed to SD.

Methodologically the review is based on 19 studies focusing on SD aspects of the CDM selected from the wider analytical literature on the CDM, including both peer-reviewed articles and reports from the grey literature. The literature was accessed in June 2005 using three sources: (1) The American-based Web of Science gave 102 hits on peer-reviewed articles on the CDM. The list of journals had a bias towards American journals and did not include important journals such as International Environmental Agreements and Mitigation and Adaptation Strategies for Global Change. (2) The IISD cyber library gave 171 hits including both peer-reviewed journals and reports from the grey literature. (3) In addition the grey literature on CDM was searched via the Internet using Google. In October 2006 the literature review has been updated with new and forthcoming studies.

The review is structured to first provide the historical background for the debate on how the CDM contributes to SD. Included in this background section is a brief description of how the CDM operates and an overview of the CDM project portfolio by September 2006. Second, the analytical literature on how the CDM contributes to SD is assessed, focusing on research findings within a typology of four groups of studies: forward looking, sustainability impact, carbon forestry and a small mixed group of studies. Finally, conclusions are drawn on the contribution of the CDM to SD including a brief outline of policy implications and the need for further research.

2 The Clean Development Mechanism – origins and key characteristics

2.1 The origins of the CDM

The CDM has its history in the larger debates on linkages between ‘climate change’ and ‘SD,’ two concepts which emerged in research and policy in the late 1980s. Historically the concepts have remained largely divided for a long period of time. While the climate change debate has been natural science-driven, the SD debate has been framed in a more social and human science oriented approach. The historical divide is well analysed and described in the literature (Cohen et al. 1998; Michaelis 2003; Najam et al. 2003; Swart et al. 2003). The divide continued until around 2001–2002, when the International Panel on Climate Change (IPCC) in the Third Assessment Report and delegates at the World Summit on Sustainable Development created platforms to direct the focus towards integration and linkages between climate change and SD. Since then an emerging and growing literature has dealt with the following issues identifying synergies and trade-offs between climate change and SD: (1) *Views from the South* (Davidson et al. 2003; Najam et al. 2003; Sokona et al. 2002), (2) *Equity* (Ghersi et al. 2003; Metz et al. 2002), (3) *Adaptation and Poverty* (Bloom 2004; Burton and May 2004; Devereux and Edwards 2004; Huq and Reid 2004) and (4) *The CDM’s contribution to SD.* As the last issue is the focus of the paper, it will be analysed in Section 3.

The actual birth of the CDM took place in the process leading up to the Kyoto negotiations. After adoption of the Kyoto Protocol – including the CDM – in 1997, the 'baby' has been called many names: 'the Kyoto surprise,' 'the win–win mechanism,' 'a bridge between North and South' and 'the front-runner of the Kyoto Regime' (Grubb et al. 1999; Matsuo 2003). The names reflect the initial optimism and high expectations that the CDM would reconcile major differences between the North and the South over climate change and development. As the agreement on CDM took place in the final stages of the negotiation process, there was little time left to discuss terms and conditions and hence it was decided upon without provisions on how it should be operated. It was not until COP7 in Marrakesh in 2001 that the Executive Board for the CDM was established and the main part of the 'rule book' was decided upon. When the institutional set-up governing the CDM was discussed and decided upon, developing countries argued that an international standard for SD would impinge on their sovereignty (Figueres 2005). Hence, the responsibility for achieving SD was delegated to Designated National Authorities (DNAs) at national level. Since then the issue about the CDM's contribution to SD has not directly been addressed in international policy negotiations. Rather, it has been repackaged and addressed indirectly in debates about 'programmatic CDM' (Baron and Ellis 2006; Figueres 2005) and in the research literature.

2.2 Key characteristics of the CDM

The CDM can be briefly characterised by how it operates and by an overview of the current status of the CDM project portfolio. Basically the CDM is a market mechanism in the sense that the price of a certified emission reduction (CER), which is measured in tonnes of CO_2e, is negotiated between buyers and sellers (UNDP 2006). Annex 1 countries with emission reduction targets – or authorised public or private entities within these – are allowed to invest in project activities that reduce GHG emissions and contribute to SD in non-Annex 1 countries. Participation in the CDM is voluntary but to have a project registered with the Executive Board, i.e. the governing body of the CDM, all parties involved are required to obtain a Letter of Approval from their DNA to document this. In non-Annex 1 countries, the DNA must approve that each CDM project contributes to SD as defined nationally. Methodologically, it is the responsibility of the project developer to document in a Project Design Document (PDD) that the emission reductions are 'real, measurable and long-term.' This means that reductions must go beyond the business-as-usual scenario (the baseline) and be additional to any emission reductions that would have occurred in the absence of the project (additionality).

Rapid changes have occurred in the CDM project portfolio, especially since April 2005. The number of projects in the UNEP Risø CDM pipeline (Fenhann 2006) has multiplied and grown more than twelvefold from 91 projects in April 2005 to 1,145 projects in September 2006. Described by numbers of projects the biggest project types – as of 14 September 2006 – are: Biomass energy (22%), hydro power (17%), energy efficiency – industry (12%), wind (12%) and agriculture (10%). HFC projects (15) and N_2O projects (6) account for only about 2% of the total number of projects (Fenhann 2006). Described by volumes of credits per year, however, the most important types are: HFC projects (34%), N_2O (10%), landfill gas (10%), biomass energy (7%), energy efficiency – industry (7%), hydro power (6%) and wind (6%) (Fenhann 2006). When the portfolio is characterised by the distribution of CDM projects across countries, a skewed geographical pattern emerges. The top four countries – measured by the number of projects hosted by each country – are: India (411), Brazil (187), China (158) and Mexico (103), which represent 75% of all CDM

projects globally (Fenhann 2006). Distributed by region, Asia and the Pacific have taken the lead from Latin America, hosting 60% and 36% respectively of all CDM projects. Compared to April 2005, when there were only 91 CDM projects in the pipeline, the picture looked different with mainly Latin American countries dominating the pipeline. Sub-Sahara Africa, the Middle East, Europe and Central Asia are marginalised with only a few projects (43), comprising only 3.8% of all CDM projects (Fenhann 2006).

3 Analysis of how the CDM contributes to sustainable development

The assumed synergy and win–win potential in the dual aim of the CDM do not reflect the whole picture about its contribution to SD. A review of the literature on the CDM and SD shows a number of mismatches and conflicts. To provide an overview, the literature is divided into a typology of four groups according to the research questions raised, the approaches and data used and, most importantly, the key findings: (1) Forward-looking studies trying to predict future SD impacts, (2) Methodological development of criteria and indicators to assess the sustainability impact of CDM projects, (3) Forestry carbon projects analysed with regard to their SD contribution, and lastly, (4) A mixed group of studies raising different questions using various approaches. The number of studies in each group varies and reflects a high research interest in carbon forestry projects, whereas other project types such as energy or industrial projects have received less attention as case studies. Before reviewing the literature for research findings a note of clarification on the conceptual basis for studying SD is useful, as well as how it is linked with the CDM and poverty alleviation.

3.1 Conceptual clarification

Theoretically different approaches and definitions of SD exist, but entering this field will detract too much from the operational and practical use of the concept, which is the focus of this review. For a theoretical introduction see chapters two and three in Markandya and Halsnæs (2002). In the methodological literature there seems to be a consensus that SD encompasses at least three dimensions: the social, the economic and the environmental dimensions (Kolshus et al. 2001; Najam et al. 2003; Olhoff et al. 2004). Included in the social dimension is poverty alleviation and equity as general criteria. When it comes to practical and concrete assessments of sustainability impacts of CDM projects there is no single, authoritative and universally accepted approach or methodology applicable to any CDM project regardless of project type and location. As DNAs are delegated the authority to confirm whether a CDM project assists in achieving SD or not, actual definitions vary according to what different host countries consider as their development priorities. Problems with this pragmatic approach to defining SD are identified in the literature. One problem is the fact that different stakeholders prioritise different aspects of SD (Brown and Corbera 2003; Kim 2003). As power relations among stakeholders are unequal it is often the resource-strong stakeholders who are able to define the terms for the carbon trade (Nelson and de Jong 2003). A second problem is the tendency for non-Annex I countries to compete to attract CDM investments and create an incentive to set low sustainability standards, which can lead to the problem known as ‘a race to the bottom’ (Sutter 2003). In addition, a critique is raised that SD criteria are not clearly defined by the DNAs (Brown et al. 2004), which re-enforces the question of who should assure the sustainability of CDM projects and how? The literature addressing these issues is assessed below.

3.2 Research findings in the literature

3.2.1 Forward-looking studies

Early studies from 2000–2001, before the Marrakesh Accords, try to analyse the possible future contribution of the CDM to SD. Three studies aim to predict, respectively, how far the CDM will advance SD goals (Austin and Faeth 2000), whether the CDM will further or impede SD (Banuri and Gupta 2000), and whether the CDM can be a leverage for development (Mathy et al. 2001). A fourth study argues for the inclusion of community forestry projects in the CDM based on significant co-benefits such as rural development and biodiversity (Klooster and Masera 2000). Common to the studies is a lack of CDM project data, as it is too early in the CDM's development for sufficient evidence to be available. Instead, the studies use data based on, for example, literature reviews from potential CDM projects in Brazil, India and China (Austin and Faeth 2000), simulation and modelling of the leverage effect of CDM investments on development (Mathy et al. 2001), or assessments of the impact of CDM investment on SD using three different economic approaches (Banuri and Gupta 2000).

None of the studies conclude with certainty on any of the questions raised. Findings, however, tend to be positive about the prospects for SD and point to the possible, significant co-benefits CDM projects can bring to developing countries such as investments, technology transfer, addressing local and regional environmental problems, and advancing social goals etc. The conclusions also raise and discuss problematic aspects of how and how much the CDM can contribute to SD. An issue raised in several studies is the need to recognise and respond to the non-carbon benefits of CDM projects, as only the carbon benefits are valued on the carbon market.

3.2.2 Sustainability impact studies

How to assess the sustainability impact of CDM projects using criteria and indicators is the common research question in this group of studies (Anagnostopoulos et al. 2004; Begg et al. 2003; Fichtner et al. 2002; Huq 2002; Kolshus et al. 2001; Markandya and Halsnæs 2002; Olhoff et al. 2004; Sutter 2003). Differences between the methodologies arise when it comes to the selection of specific criteria and indicators for measurement, which tend to vary with the type of project assessed and whether the assessment of impacts applies at project/local level, or regional or national level. For example, Anagnostopoulos et al. (2004) and Fichtner et al. (2002) have developed approaches which are especially oriented towards energy sector CDM projects, applicable respectively at project level and to a portfolio of projects. Begg et al. (2003) focus on small-scale CDM projects using examples of different types of energy projects in Tanzania, Kenya and Ghana, whereas Sutter (2003) aims to improve existing SD assessment tools with his contribution, 'The Multi-Attribute Utility Theory for CDM Project Assessment.' The main differences exist in the way indicators are constructed and weighted against each other for evaluating the different aspects of SD using qualitative or quantitative methods or a mix of the two. Olhoff et al. (2004) and Sutter (2003) both review the advantages and disadvantages of the different approaches available to evaluate the sustainability of CDM projects. Among eight partly overlapping categories of approaches, the most commonly referred to and used are checklists and multi-criteria assessments or a combination of the two. One example is the SouthSouthNorth (SSN) Matrix tool (SouthSouthNorth 2004), a combination of the checklist and multi-criteria approaches. It is based on a scoring system, where qualitative

values are assigned to each criterion based on selected quantifiable indicators. The scores can be added and generate a total score for each CDM project assuming equal weights to all indicators. A critique of the tool is that, while relatively simple to use, it is based on subjectively assigned scores. Another example is the Gold Standard, a variant of the multi-criteria approach and a label for 'high-quality' CDM projects (Schlup 2005). In addition to requirements of positive benefits using the sustainability assessment tool adopted from the SSN Matrix Tool, an environmental impact assessment and explicit public participation must be conducted.

A general finding from applying any of the sustainability assessment tools to case studies of CDM projects is that trade-offs exist between the two objectives of the CDM in favour of cost-effectiveness (Kolshus et al. 2001; Markandya and Halsnæs 2002; Sutter 2003). The problem of trade-offs can be illustrated by a case study on abatement options for energy efficiency and cleaner coal in Shanxi, China. When analysing six different abatement options it is found that e.g. briquetting is one of the most expensive options for reducing emissions of CO_2. However, under a strong dual-aim CDM regime, it would be the most cost-effective option for providing local health benefits (Kolshus et al. 2001). As SD benefits are not monetised in the carbon market, the SD objective tends to be given a lower priority than the cost-effective reduction of GHGs. The conclusion is profound, as it shows that the initial assumption of the synergy and win–win relationship between the dual aims of the CDM does not hold for many projects. In sum, the studies show that methods for assessing the sustainability impact of CDM projects are useful and necessary but not sufficient to solve the conflict between the dual aims of the CDM.

3.2.3 Carbon forestry studies

The common research interest for this group of studies is the local SD contributions of forest carbon sequestration projects. Originally, sinks projects were not included in the CDM, and subsequent policy discussions on how to account for the temporary character of many forests proved a controversial issue. In Marrakesh 2001 it was decided that only afforestation and reforestation projects would be included under land use, land-use change and forestry activities (LULUCF), conservation activities would be excluded and that a cap would limit the amount of carbon that can be credited through sinks projects to 1% of base-year emissions of the claiming Party, multiplied by a factor of five. Feeding into this process of policy development, research projects have highlighted the importance of the potential link of forestry sinks with poverty alleviation and other development benefits at local level (Brown et al. 2004; Leach and Leach 2004). Common for most of the studies is a geographical focus on Latin American countries and the use of case studies from early CDM or other carbon forestry projects including conservation (Brown and Corbera 2003; Brown et al. 2004; May et al. 2004; Nelson and de Jong 2003). The exception is one study from India (Gundimeda 2004), which analyses data from almost 70,000 households to study the potential implications of using forests for CDM projects for the livelihoods of rural poor.

Conclusions from the studies point to many problematic aspects of realising the promise of SD at project and local level. Examples of trade-offs between the dual objectives are found in several studies. From following 'Fondo Bioclimatico,' a carbon mitigation project in Mexico, Nelson and de Jong (2003) find there has been a decoupling of SD benefits from carbon credits in order to prioritise economic concerns. Goals of community development were separated from the carbon contracts and instead SD initiatives are addressed by a farmers' organisation. Using the same project in their analysis, Brown et al. (2004) arrive at

the same conclusion. May et al. (2004) find that the adoption of rigid SD criteria happens at the expense of the number and type of investors a country can attract. On the basis of such trade-offs, where the goal of cost-effectively reducing GHGs is prioritised at the expense of the goal of contributing to SD, Brown et al. (2004) question the ability of the carbon market itself – and market mechanisms in general – to provide real and equitable benefits for SD. A second set of conclusions regards local equity issues in the distribution of costs and benefits from CDM forestry projects. Evidence indicates that middle-income communities and relatively well-off farmers with property rights to forests are more likely to be beneficiaries than poor households or women-headed households with no land titles and less formal rights to access forest resources (Brown and Corbera 2003; Brown et al. 2004; May et al. 2004). A third set of conclusions regards the role of institutions for managing, negotiating and supporting CDM projects. So far it has been difficult to establish effective institutions for mediating different and unbalanced stakeholder interests. Cross-sector and cross-scale institutional frameworks are found to be necessary for ensuring equity and SD objectives (Brown et al. 2004). In India, Gundimeda (2004) arrives at a similar conclusion about the importance of mediating institutions to ensure that CDM forest projects result in equity and SD for local people. A mechanism for benefit sharing is proposed among investors and user groups of common property resources (forests), as otherwise benefits are most likely to be grabbed by influential households. In summary, the studies of early CDM forestry projects show that, left solely to the market, existing institutions for managing and supporting CDM projects are unlikely to achieve the objectives of local equity and SD.

3.2.4 Mixed studies

This group of three studies is characterised by its differences rather than commonalities in their choice of analytical approach and use of data. One study is a case study of South Africa based on interview data that analyses the disparity of views about and expectations of the CDM between local stakeholders and investors (Kim 2003). Another study analyses how market structures can impact on the level of development benefits to developing countries, but the analysis is not empirically grounded (Humphrey 2004). A third study is an assessment of the CDM regarding the balance between achieving its dual aims primarily based on readings of policy and legal texts describing the CDM and the Kyoto Protocol (Halvorssen 2005).

The findings, however, are partly overlapping and confirm earlier conclusions. From analyses of stakeholder perceptions, Kim (2003) finds that disparate views and expectations between national stakeholders and international investors are likely to be a stumbling block for the CDM. Government representatives have taken a reactive rather than a proactive approach to the CDM based on a profound scepticism of the principles of the mechanism dating back to early international negotiations. For example, it is feared that the CDM will be used to harvest the 'low-hanging fruit,' i.e. exhaust the cheapest and easiest means of reducing emissions, and leave the more expensive options for later when developing countries might have to commit to emission reduction targets. Other key stakeholders from the energy and mining sectors are concerned that the CDM will impact negatively on the domestic coal market and domestically developed technology including schemes for nuclear power. Investors, on the other hand, perceive the issue of equity to be the least relevant to the CDM, contrary to users of CDM projects from, for example, a solar homes CDM project, which rank development benefits the highest. From a different type of analysis of the market structures developed by the CDM, Humphrey (2004) arrives at a similar conclusion: CDM projects need to be oriented more towards generating

development benefits, as trade-offs between profit-maximising investors and the SD objectives are evident. Furthermore, host countries and their DNAs may have little to bargain with when defining SD standards, due to the global scope of the CDM and investors' wide choice of location. Extra means are therefore needed to increase the development impact. Suggestions within the current CDM regime include certification of 'development-friendly' investment funds on the supply side and branding of a 'fair CDM' label or 'green certificates' separating the project from the label on the demand side. Contrary to these critical conclusions on the performance of the CDM in realising its SD objective, Halvorssen (2005) concludes that, assuming host country systems are put in place and other implementation procedures are ironed out, the CDM looks like a promising tool.

3.2.5 Overview and comparison of the research findings

For an overview of the research literature and key findings of the various studies see Table 1.

Common to most of the forward-looking and sustainability impact studies is the fact that they do not draw conclusions on the CDM's actual contribution to SD, only on the 'potential,' 'theoretical' or 'possible' contribution to SD, which tend to be positive. In the early, forward-looking studies, no data on CDM projects yet existed. Without empirical data against which to critically assess the CDM's objectives, the conclusions tend to be in line with the initial assumptions about synergies and win–win opportunities. This is true also for other studies not using empirical data (Anagnostopoulos et al. 2004; Halvorssen 2005). Critical remarks are made, however, by the early studies pointing to the lack of an operational definition of SD at international level and 'the danger of the low-hanging-fruits' being exploited with little or no benefits for SD. In the group of sustainability impact studies the conclusions are more mixed. Still, the majority of studies are positive about 'the potential' and 'likely' SD benefits of CDM projects rather than the actual SD benefits and their magnitude. Focus is on the development of sustainability assessment approaches at project level, and barriers to achieving SD point to the SD criteria being neglected, a lack of institutional capacity to approve CDM projects and repeatedly the problem of trade-offs is identified, i.e. that CDM projects leading to cheap emission reductions are preferred over more expensive projects with a higher contribution to SD. The critique is most clearly explained by Sutter (2003), who argues that it will be difficult to realise the promise of SD because of the problem of trade-offs. In the group of carbon forestry studies the conclusions are more sceptical, even negative, claiming e.g. that the SD benefits are 'more hypothetical than real' (Brown et al. 2004). The conclusions contradict other findings that community forestry projects do contribute to SD (Huq 2002; Klooster and Masera 2000). Most of the studies, except one, are case studies and focus on equity issues in the distribution of SD benefits among different groups of stakeholders at local level. This perspective is a more critical approach than what is used in forward-looking and sustainability impact studies and the conclusions are more sceptical. The same critical perspective is applied in one of the 'mixed studies' (Kim 2003) and the conclusions are similar, pointing to the disparity in investor and host country perspectives on SD as a barrier to achieving SD. In summary, the problem of trade-offs between the two objectives of the CDM in favour of cost-effective reductions of GHGs is a barrier to achieving SD, which is identified in most studies in the literature across the groups. The reason for trade-offs is generally agreed to be the way in which the CDM is designed as a market mechanism.

3.3 New and forthcoming studies

Research findings on how the CDM contributes to SD have so far been primarily on a project-by-project basis. However, within the last year since late 2005 and during 2006, one conference paper and two forthcoming studies have added to the literature with studies of the contribution of the CDM to SD at aggregated levels, i.e. for all CDM projects in the portfolio rather than at the project level. A common perspective of the studies is the argument for the need for an international standard for sustainability assessment to counter weaknesses in the existing institutional set-up. In a paper for the conference 'Climate or Development?' held at the Hamburg Institute of International Economics in Germany, 28–29 October 2005, Sutter and Parreno (2005) analyses the portfolio of registered CDM projects approved by 30 August 2005. At that time there were only 16 registered projects against 299 by 14 September 2006. Nevertheless, using the MATA-CDM approach developed earlier (Sutter 2003) it is found that only 1% of the registered projects are likely to deliver a high contribution to SD, while 72% of the projects are expected to represent real and measurable emission reductions. The portfolio of projects is dominated by a few large HFC projects with a high likelihood of reducing emission reductions but with little contribution to SD. The trade-off is evident, and the study concludes that trade-offs are strongly in favour of the cost-efficient emission reduction objective and that the SD objective is being neglected (Sutter and Parreno 2005).

Research findings are not yet accessible for reference in two forthcoming studies. One is by Olsen, K.H. and Fenhann, J. from the UNEP Risø Centre in which 744 CDM projects at the validation stage by 3 May 2006 are analysed in terms of their SD benefits using a new methodology for text analysis and qualitative assessment of how CDM projects intend to contribute to SD. Another study is by Cosbey, A. from the International Institute for Sustainable Development (IISD) in which 215 CDM projects registered by 15 June 2006 are analysed using the 'development dividend framework,' i.e. a methodology for measuring the benefits to developing countries beyond those strictly related to climate change. A common motivation for undertaking the studies is the need to address the deficit in the CDM's contribution to SD – as identified in the literature – through increased efforts at international level, possibly through an international standard and methodology for sustainability assessment additional to national requirements.

4 Conclusion

From the review of the literature on how the CDM contributes to SD a consensus is emerging that the CDM is beginning to do what a true market is meant to do. It is widely documented that this involves trade-offs between the two goals of the mechanism in favour of producing low-cost emission reductions at the expense of achieving SD benefits (Brown et al. 2004; Cosbey et al. 2005; Ellis et al. 2004). The critique is put forward that "the CDM does not work" in that it does not drive SD and does not fund renewable energy projects or carbon forestry projects with high development co-benefits (Pearson 2005). However, the problem can be turned around. The real problem is that the CDM works perfectly as it produces the lowest-cost emission reductions. Left out of the market, however, are the SD benefits. While rhetorically mandated in the Kyoto Protocol, they are not monetised and therefore play a limited role in directing investments.

The policy implication of the main challenge is how to respond to the fact that left to market forces, the CDM does not significantly contribute to SD in developing countries. In

Table 1 Overview of the research literature and key findings of the various studies

Forward-looking studies	Approach and data	Contribution to SD	Barriers for SD
(Austin and Faeth 2000)	Case studies	Potential SD benefits of CDM projects exist	Trade-offs between the two objectives of the CDM exist
	Literature review India, China and Brazil		A danger is the CDM will only be a cost-reduction tool for developed countries
(Banuri and Gupta 2000)	Three economic approaches	In theory the CDM is expected to contribute to SD	The 'low-hanging fruits' (low-cost options)will be exploited first
	Assessment of likely impacts of CDM investments on SD		No operational definition of SD at international level
			SSA-Africa may be marginalised
(Mathy et al. 2001)	Simulation and modelling CDM investments' leverage effect on SD	The CDM conceals a significant potential for SD benefits	Institutional, political and social barriers can limit income from the CDM
(Klooster and Masera 2000)	Case study Community forest management in Mexico	Forest management fosters SD	Barriers to community forest management include social, economic and technical obstacles
Sustainability impact studies			
(Anagnostopoulos et al. 2004)	Development of a framework for SD assessment of individual CDM projects No empirical data	The CDM could create trends towards SD in developing countries	Lack of institutional capacity to approve CDM projects' contribution to national SD criteria
(Begg et al. 2003)	A multi-criteria decision analysis approach Small-scale projects in Tanzania, Kenya and Ghana	Small-scale projects can deliver SD benefits	Barriers for small-scale projects include financial, poverty, social and cultural, knowledge, technological and institutional issues
(Fichtner et al. 2002)	Integration of SD in energy systems modelling to determine efficient mitigation strategies	No conclusions are made on the xCDM's actual contribution to SD	The criterion of SD has hitherto been neglected

	Germany, Russia and Indonesia		
(Kolshus et al. 2001)	Case studies Literature review China and Brazil	The CDM can help developing countries choose an SD path	Trade-offs between the two objectives of the CDM The concept of SD is vague and not defined operationally
(Olhoff et al. 2004)	An introduction and overview of approaches to design CDM projects in support of SD case studies	Case studies illustrate the potential for synergies between development and climate change objectives	Trade-offs between SD criteria exist
(Sutter 2003)	Multi Attribute Utility Theory for SD assessment Case studies in India, South Africa and Uruguay	Realising SD in the CDM is difficult	Trade-offs between the two objectives of the CDM The absence of an international sustainability standard
(Huq 2002)	A review of the WB Prototype Carbon Fund's experience with regard to its use of SD indicators	Small-scale projects in least developed countries and community forestry projects contribute the most to SD	Project-by-project assessment of SD rather than in a systematic manner Lack of capacity in host countries
Carbon forestry studies			
(Brown and Corbera 2003)	Case study of a forest carbon project in Mexico A Multi-Criteria Assessment Framework of stakeholder interests, roles and perspectives	The promise of SD is not easily realised at local level	The carbon market itself is a restraint to realising local SD benefits Lack of strong cross-scale institutions to balance unequal stakeholder priorities
(Brown et al. 2004)	Case studies of forest carbon projects in Bolivia, Brazil, Belize and Mexico A multi-criteria analysis model of stakeholder priorities	The SD benefits from CDM projects are often more hypothetical than real	Trade-offs exist between carbon sequestration and SD The achievement of SD benefits is constrained by the carbon market itself Women are often marginalised
(May et al. 2004)	Case studies Two carbon sequestration projects in Brazil and Bolivia	Little attention is given to local SD and far more to carbon absorption	Trade-offs exists between rigid SD criteria and the ability to attract investors Poor households are not the most likely to benefit

Table 1 (continued)

Forward-looking studies	Approach and data	Contribution to SD	Barriers for SD
(Nelson and de Jong 2003)	Case study of a pilot carbon mitigation project in Mexico	Goals of local SD were set aside and carbon contracts came in focus	An organised voice for carbon farmers is lacking
(Gundimeda 2004)	Economic analysis using the almost ideal demand system (LA-AIDS) Data from almost 70,000 households in rural India	If CDM projects are to be sustainable on common pool resource (CPR) land in India, user groups must manage the lands	Short-term needs for fuel wood are in conflict with the need to keep carbon in storage If carbon sequestration becomes profitable, influential households are likely to grab the land
Other studies			
(Kim 2003)	Case study of South Africa Analysis of stakeholder perceptions	Achievement of SD is stymied by the disparity in expectations between investors and host country stakeholders	Barriers include limited capacity in the host country, scepticism concerning the SD benefits and fear of negative impact on the economy and technological markets
(Halvorssen 2005)	Assessment of the CDM's objectives based on a reading xof policies and laws	The CDM looks to be a promising tool in assisting developing countries achieve CSD	Host country systems need to be put in place and verification procedures must be ironed out
(Humphrey 2004)	Analysis of how market structures can impact on the level of SD benefits	Actual SD benefits depend also on the nature of projects	Trade-offs between profit maximising investors and SD objectives are evident

a report entitled 'Realizing the Development Dividend: Making the CDM Work for Developing Countries,' the problem has been phrased this way: "Will the CDM's sustainable development objective become a victim of the success of its market mechanism?" (Cosbey et al. 2005). Five key issues of concern are identified in how the CDM is failing to achieve SD as mandated in the Kyoto Protocol: (1) Defining SD, (2) Lowering transaction costs, (3) Managing the market, (4) Access to finance and use of overseas development assistance, and finally, (5) Negotiating the CDM post 2012. Suggestions on how to respond to the concerns raise issues such as proposals for policy-based or sectoral CDM, i.e. top-down set standards or baselines for a sector (Bosi and Ellis 2005), and are discussed as main topics of the wider policy debate on the future of the CDM and SD. Policy-oriented analysis addresses a number of these issues and directly informs the ongoing policy debate (Cosbey 2006; Ellis 2006; Figueres 2005).

In a wider perspective, the challenges for basic research remain the further reintegration of the historically separate debates on climate change and SD. Given the challenge that achieving the ultimate goal of the Climate Convention and the Kyoto Protocol is dependent on development paths and socio-economic choices at least as much as on climate policy, issues of how to integrate mitigation policy into development policy and sector frameworks are important and of long-term interest beyond the dedicated community on climate policy and research.

Acknowledgements The review was funded by the Danish Ministry of Foreign Affairs under the grant to the Research Network for Environment and Development (ReNED) in preparation for the conference 'The Clean Development Mechanism (CDM) – Linkages to Poverty Reduction and Sustainability' on 27 October 2005 in Copenhagen, Denmark. I am very grateful for the comments received from the members of the Scientific Committee of the Conference and the two anonymous reviewers. The usual disclaimers apply.

References

Anagnostopoulos K, Flamos A, Kagiannas AG, Psarras J (2004) The impact of clean development mechanism in achieving sustainable development. Int J Environ Pollut 21:1–23

Austin D, Faeth P (2000) How much sustainable development can we expect from the Clean Development Mechanism? An overview. In: Austin D, Faeth P (eds.) Financing sustainable development with the Clean Development Mechanism, World Resources Institute, pp 1–12

Banuri T, Gupta S (2000) The Clean Development Mechanism and sustainable development: an economic analysis. In Manila GP (ed.), Implementation of the Kyoto Protocol, Asian Development Bank

Baron R, Ellis J (2006) Sectoral crediting mechanisms for greenhouse gas mitigation: institutional and operational issues. Organisation for Economic Co-operation and Development, Paris, pp 1–34

Begg K, Parkinson S, v. d. Horst D, Wilkinson R, Theuri D, Gitonga S, Mathenga M, Amissah-Arthur H, Atugba S, Ackon S, Ageby S, Meena H, Mwakifwamba S, Mwakasonde S (2003) Encouraging CDM energy projects to aid poverty alleviation. Final report of project R8037 under the DFID KAR programme, Centre for Environmental Strategy, University of Surrey, pp 1–113.

Blair T, Chirac J, Putin V, Bush GW, Schröder G, Koizumi J, Berlusconi S, Martin P, Barosso JM (2005) The Gleneagles Communiqué, pp 1–10

Bloom G (2004) Health in a changing world. Ids Bulletin-Institute of Development Studies 35:38–41

Bosi M, Ellis J (2005) Exploring options for sectoral crediting mechanisms, International Energy Agency (IEA) & Organisation for Economic Co-operation and Development (OECD), pp 1–44

Brown K, Corbera E (2003) Exploring equity and sustainable development in the new carbon economy. Climate Policy 3:41–56

Brown K, Adger WN, Boyd E, Corbera-Elizalde E, Shackley S (2004) How do CDM projects contribute to sustainable development? Tyndall Centre for Climate Change Research, pp 1–53.

Burton I, May E (2004) The adaptation deficit in water resource management. Ids Bulletin-Institute of Development Studies 35:31–37
Cohen S, Demeritt D, Robinson J, Rothman D (1998) Climate change and sustainable development: towards dialogue. Glob Environ Change 8:341–371
Cosbey A (2006) Defining and measuring the development dividend. Meeting of the Expert Task Force of the IISD, International Institute for Sustainable Development, 12
Cosbey A, Parry JE, Browne J, Babu YD, Bhandari P, Drexhage J, Murphy D (2005) Realizing the development dividend: Making the CDM work for developing countries. Phase 1 Report – Prepublication Version, International Institute for Sustainable Development (IISD), pp 1–72
Davidson O, Halsnæs K, Huq S, Kok M, Metz B, Sokona Y, Verhagen J (2003) The development and climate nexus: the case of Sub-Saharan Africa. Climate Policy 3:97–113
Devereux S, Edwards J (2004) Climate change and food security. Ids Bulletin-Institute of Development Studies 35:22–30
Ellis J (2006) Issues related to a programme of activities under the CDM, OECD, Paris, p 26
Ellis J, Corfee-Morlot J, Winkler H (2004) Taking stock of progress under the Clean Development Mechanism (CDM). Organisation for Economic Co-operation and Development (OECD), Paris, pp1–51
Fenhann J (2006) UNEP Risø CDM Pipeline 14 September 2006. [Available online from http://www.CD4CDM.org]
Fichtner W, Graehl S, Rentz O (2002) International cooperation to support climate change mitigation and sustainable development. Int J Environ Pollut 18:33–55
Figueres C (2005) Policies and programs under the CDM, Sectoral CDM: Opening the CDM to the yet unrealized goal of sustainable development. International Journal of Sustainable Development Law and Policy 2:1–19
Ghersi F, Hourcade J-C, Criqui P (2003) Viable responses to the equity-responsibility dilemma: a consequentialist view. Climate Policy, 3:S115–S133
Grubb M, Vrolijk C, Brack D (1999) The Kyoto protocol. A guide and assessment. Royal Institute of International Affairs, London, UK.
Gundimeda H (2004) How sustainable is the sustainable development objective of CDM in developing countries like India? Forest Policy and Economics 6:329–343
Halvorssen AM (2005) The Kyoto protocol and developing countries – the Clean Development Mechanism. Colo J Int Environ Law Policy 16:1–16
Humphrey J (2004) The Clean Development Mechanism: how to increase benefits for developing countries. Ids Bulletin-Institute of Development Studies 35:84–89
Huq S (2002) Applying sustainable development criteria to CDM projects: PCF experience. Prototype Carbon Fund, World Bank, pp 1–37.
Huq S, Reid H (2004) Mainstreaming adaptation in development. Ids Bulletin-Institute of Development Studies 35:15–21
Kim JA (2003) Sustainable development and the CDM: a South African case study. Tyndall Centre for Climate Change Research, pp 1–18
Klooster D, Masera O (2000) Community forest management in Mexico: carbon mitigation and biodiversity conservation through rural development. Glob Environ Chang 10:259–272
Kolshus HH, Vevatne J, Torvanger A, Aunan K (2001) Can the Clean Development Mechanism attain both cost-effectiveness and sustainable development objectives? Center for International Climate and Environmental Research (CICERO),Oslo, pp 1–22
Leach G, Leach M (2004) Carbonising forest landscapes? Linking climate change mitigation and rural livelihoods. Ids Bulletin-Institute of Development Studies 35:76–83
Markandya A, Halsnæs K (2002) Climate change and sustainable development, prospects for developing countries. Earthscan, London.
Mathy S, Hourcade J-C, de Gouvello C (2001) Clean development mechanism: leverage for development? Climate Policy 1:251–268
Matsuo N (2003) CDM in the Kyoto negotiations. Mitig Adapt Strategies Glob Chang 8:191–200
May PH, Boyd E, Veiga F, Chang M (2004) Local sustainable development effects of forest carbon projects in Brazil and Bolivia. International Institute for Environment and Development (IIED), London, pp 1–112
Metz B, Berk M, den Elzen M, de Vries B, van Vuuren D (2002) Towards an equitable global climate change regime: compatibility with Article 2 of the Climate Change Convention and the link with sustainable development. Climate Policy 2:211–230
Michaelis L (2003) Sustainable consumption and greenhouse gas mitigation. Climate Policy 3:S135–S146
Najam A, Rahman AA, Huq S, Sokona Y (2003) Integrating sustainable development into the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Climate Policy 3:S9–S17

Nelson KC, de Jong BHJ (2003) Making global initiatives local realities: carbon mitigation projects in Chiapas, Mexico. Glob Environ Change 13:19–30
Olhoff A, Markandya A, Halsnæs K, Taylor T (2004) CDM sustainable development impacts. UNEP Risø Centre, pp 1–88
Pearson B (2005). The Clean Development Mechanism and sustainable development. [Available online from http://www.tiempocyberclimate.org/newswatch/comment050301.htm.]
Schlup M (2005) The gold standard: linking the CDM to development and poverty reduction, climate or development? Hamburg Institute of International Economics, Hamburg, Germany
Sokona Y, Najam A, Huq S (2002) Climate change and sustainable development: views from the South. International Institute for Environment and Development (IIED), p 5
SouthSouthNorth (2004) SouthSouthNorth CDM Toolkit, Module 1, SouthSouthNorth, Cape Town, pp 1–11
Sutter C (2003) Sustainability check-up for CDM projects. Wissenschaftlicher Verlag, Berlin, pp 253
Sutter C, Parreno JC (2005) Does the current Clean Development Mechanism deliver its sustainable development claim? Climate or development? Hamburg Institute of International Economics, Hamburg, Germany
Swart R, Robinson J, Cohen S (2003) Climate change and sustainable development: expanding the options. Climate Policy 3:S19–S40
UNDP: (2006) An assessment of progress with establishing the Clean Development Mechanism. United Nations Development Program (UNDP), pp 1–164