climate policy

policy analysis

Financing climate adaptation with a credit mechanism: initial considerations

KARL HARVEY SCHULTZ*

Climate Mitigation Works Limited, PO Box 46555, London N1 4EG, UK

Climate mitigation credits have mobilized considerable resources for projects in developing countries, but similar funding to adapt to climate change has yet to emerge. The Copenhagen Accord targets up to US$50 billion per year in adaptation funding, but commitments to date have been trivial compared to what is needed. Although there are some studies and suggestions, it remains unclear where the money will come from and how it will be disbursed. Beyond this, many development experts believe that the main hurdle in climate adaptation is effective implementation. A framework, based on the polluter pays principle, is presented here regarding the mobilization of resources for adaptation in developing countries using market mechanisms. It is assumed that mitigation and adaptation are at least partly fungible in terms of long-term global societal costs and benefits, and that quantifying climate vulnerability reductions is possible at least sometimes. The scheme's benefits include significant, equitable and flexible capital flows, and improved and more efficient resource allocation and verification procedures that incentivize sustained project management. Challenges include overcoming political resistance to historical responsibility-based obligations and scepticism of market instruments, and, critically, quantifying climate impact costs and verifying investments for vulnerability reduction credits.

Keywords: adaptation finance; adaptation policy; Climate Investment Funds; economic efficiency; financial mechanisms; market mechanisms

Les crédits liés à la mitigation climatique ont mobilisé des ressources considérables pour les projets dans les pays en développement, mais un financement similaire pour l'adaptation liée au changement climatique reste encore à se matérialiser. L'Accord de Copenhague cible jusqu'à US$50 milliards par an de financement pour l'adaptation, mais les engagements à ce jour ont été insignifiants comparés à l'effort requis. Alors que des études et suggestions ont été avancées, la source des fonds et la manière dont ils seront alloués reste incertaines. En outre, plusieurs experts sur le développement pensent que l'obstacle principal à l'adaptation liée au climat concerne la mise en vigueur. Un cadre basé sur le principe du pollueur-payeur est présenté pour la mobilisation de ressources sur la base des mécanismes de marché pour l'adaptation dans les pays en développement. Il est supposé que la mitigation et l'adaptation sont au moins partiellement fongibles en termes de coûts et bénéfices sociétaux planétaires à long terme et qu'une quantification de la diminution de la vulnérabilité au changement climatique est au moins parfois possible. Les bénéfices du système comprennent: flux de capitaux considérables, équitables, et flexibles; une allocation des ressources meilleure et plus efficace et des processus de vérification qui favorisent une gestion soutenue des projets. Les défis incluent: surmonter la résistance politique aux obligations liées à la responsabilité historique et le scepticisme vis-à-vis des instruments de marché, et, de prime importance, la quantification des coûts liés aux impacts climatiques et la vérification des investissements pour les crédits de réduction de la vulnérabilité.

Mots clés : finance des mesures d'adaptation; politique d'adaptation; Fonds d'investissement climatique; efficacité économique; mécanismes financiers; mécanismes de marché

1. Introduction

The explosion in scale of international capital investment in GHG mitigation measures began when the EU Emissions Trading Scheme (EU ETS) incentivized companies with emissions caps to identify

*E-mail: karl@climate-mitigation.com

http://dx.doi.org/10.1080/14693062.2011.605563 ISSN: 1469-3062 (print), 1752-7457 (online) www.tandfonline.com/tcpo Routledge Taylor & Francis Group

low-cost emission reduction options. The result has been the development of, and investment in, a variety of projects to generate certified emission reductions (CERs) under the Kyoto Protocol's Clean Development Mechanism (CDM). Approximately 2500 projects have been registered by the CDM, and by 2012 these will result in about 950 million tonnes of CO_2e emissions reductions, worth approximately €11 billion on the carbon market, and leveraging much more than that in investment (UNEP Risoe, 2010; Point Carbon, 2011). With the International Energy Agency (IEA) estimating that it will cost an additional US$10 trillion in investment by 2030 to stabilize atmospheric concentrations and avert catastrophic warming, the private sector and indeed most governments accept the essential role of carbon markets in financing climate mitigation (IEA, 2009).

The cost of climate change impacts (CCIs), and the investment needed to adapt to climate change, are similarly immense. Studies indicate investment costs could be between US$50 billion/year and $300 billion/year, with two-thirds of these costs accruing in developing countries (Parry et al., 2009). However, an analysis of existing climate funds finds that only about $1.3 billion of international assistance has so far been disbursed or approved for adaptation measures (Climate Funds Update, 2011). Although the Copenhagen Accord targets $100 billion/year by 2020 to finance mitigation and adaptation, the known 'new' pledges total only $11.9 billion for the period 2010–2012 (the majority of which is for mitigation) (Climate Funds Update, 2011; Fast Start Finance, 2011). There is already evidence that some of the pledged funds are reallocations from existing Overseas Development Assistance (ODA) commitments (Adam, 2010).

A debate is raging regarding the sourcing and disbursement mechanisms of the Copenhagen Accord funds (Brown and Kaur, 2009). The Accord notes that funding will come from a 'wide variety of sources, public and private, bilateral and multilateral, including alternative sources of finance', and establishes the Copenhagen Green Climate Fund through which a 'significant portion of such funding should flow' (UNFCCC, 2009, Decision 2/CP/15). A UN High-Level Advisory Group on Climate Change Financing (UN, 2010) has proposed a variety of bold measures, including taxing carbon transactions, international financial flows, redirecting fossil energy subsidies and direct government treasury funding. However, these suggestions have not yet led to funding decisions and, historically, governmental fiscal transfers for ODA have not met the governments' own commitments (Hamilton and Fay, 2009).

There are currently over 20 funds that manage climate programmes. Although their mandates and funds management vary and provide much needed support, two general criticisms are that they have high administrative costs and that their collective funding is inadequate (Baca, 2010). Funds typically provide resources (e.g. money, consultants) to national ministries and local governments for specific projects or building capacity. Research has shown that, in order to be effective, climate adaptation must focus on local-level issues. Indeed, a major barrier in developing countries is their lack of adaptive capacity due to backlogs in protective infrastructure and services, and limitations in governments' resources and skills (Adger et al., 2003). In addition, many local governments are unwilling to work with the most vulnerable groups (such as slum dwellers), who they perceive to be part of the problem rather than valued constituents (Moser and Satterthwaite, 2008). So while top-down financing and implementation has a critical role, adaptation measures may work best when the funders and project developers directly identify, work, and forge agreements with affected communities.

Alternatives to top-down adaptation finance include employing indices of vulnerability (to serve as benchmarks for insurance protection that farmers could purchase against severe weather events; Hellmuth et al., 2009), micro-finance facilities (which could resource the small-scale adaptation interventions of some of the most vulnerable households; Agrawala and Carraro, 2010), and government loan and equity guarantees (which could stimulate private investment in adaptation; Brown and Kaur, 2009).

Overall, although the funding on the table is necessary and worthwhile, it looks insufficient for what is needed. Indeed, although climate finance is a hot topic, there are only a few interesting alternatives to top-down funding and implementation. Considering the top-down funding structures that have so far been proposed, there is a risk that the resources that are allocated will be inefficiently and unfairly disbursed, and that many communities will be left vulnerable to climate change.

Given this rather bleak assessment of the existing top-down options, what alternative mechanism could both raise the needed funds and efficiently mobilize these in a flexible, bottom-up and equitable way?

2. A proposed structure for market-based adaptation financing

Before proposing a market-based scheme to finance climate adaptation, it is important to introduce the four main assumptions that motivate the structure. The first is that wealthier countries have a responsibility to support climate adaptation in developing countries. The development of higher-income countries has been due, in part, to the abundant use of fossil fuels during industrialization. Major industrialized nations are responsible for 74% of cumulative emissions from 1850 to 2000, compared with 10% from the largest-emitting developing nations (WRI, 2010). Now that the science is robust, linking GHGs and climate change, and while accepting that all countries will eventually have to limit their emissions, the 'polluter pays principle', as articulated in international law as Principle 16 in the Rio Declaration on Environment and Development, declares that 'national authorities should endeavour to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of Pollution . . . .' (UN, 1992, Principle 16). In other words, industrialized countries have a responsibility to pay for climate adaptation in the developing world.

A second assumption of the proposed structure is that decisions between financing mitigation or adaptation in developing countries are at least somewhat fungible and, to optimize results, they may often be made by a well-regulated market. To accept that only a certain level of warming is tolerable (e.g. 2°C), emissions must unequivocally decline to reach atmospheric GHG concentrations (e.g. 350 ppm) consistent with this level. Beyond this point, however, the theoretical global net social welfare utility can be achieved through the use of either adaptation or mitigation measures. Market players will make the most economically rational decisions to efficiently allocate scarce resources in addressing climate change.

The challenges to creating a market-based scheme include ensuring that it transparently, efficiently and flexibly provides quantifiable and verifiable incentives, resulting in real and additional greenhouse mitigation and climate vulnerability reduction for poor communities. The third assumption is that quantifying vulnerability reduction is possible, at least in some key areas such as flood defence, the provision of water for human consumption and agriculture, and measures to prevent the landslides that destroy human settlements and transportation infrastructure. Over time, quantifying vulnerability reduction will improve for a wider variety of interventions.

The final assumption of the proposed structure is that a tradable credit mechanism can improve the economic efficiency of climate adaptation (Baumol and Oates, 1971). Market-based environmental schemes, such as tradable environmental permits, have been shown to provide cost savings over non-market mechanisms of between 50 and 90% (Tietenberg, 1985). Other studies investigating the variety of mechanisms (allowances, offset credits, etc.) that may be used have considered the efficiency benefits, but acknowledge that certain conditions must apply to optimize these efficiency gains (Stavins, 2003). Efficiency gains may not occur if transaction costs are high, if there is insufficient

TABLE 1 Hypothetical case of a VRC project

	Quantity	Calculation
Demand drivers		
Global cumulative emissions, 1850–2000	1 trillion tCO_2e	
Wealthy countries	750 billion tCO_2e	
Developing countries	250 billion tCO_2e	
UN official estimate of developing-country CCI costs	US$200 billion/year	Average costs (that in practice would probably be broken down into periods). By Year 2 this declines by 1% to US$198 billion/year
100-year CCI costs	US$20 trillion	100 years × US$200 billion/year
Developing country costs/tCO_2e caused by wealthy country emissions	US$26.67/$tCO_2e$	US$20 trillion/750 billion tCO_2e
Example of Wealthy Nation Liability and System: the 'United European Principate' (UEP)		
Cumulative emissions 1850–2000	60 billion tCO_2e	
UEP may for each year:		
■ Reduce its emissions by these 60 billion t/100 years (= 600 million t)		
■ Secure allowances from other wealthy countries		
■ Reduce emissions in developing countries		
■ Secure VRCs and reduce the expected value costs of climate vulnerability by 600 million t × US$26.67/t = $16 billion		
or		
■ A combination of the above		
UEP chooses to reduce or offset the required 600 million tCO_2e/year through the facilities covered under an existing ETS and have industry figure out how it will comply.		
Example of Company Covered by UEP's Compliance Scheme: CoalWindEnergy (CWE), an electric utility		
CWE baseline emissions	1.1 million tCO_2e	
CWE allocations under existing ETS	1.0 million tCO_2e	
Further reduction under historical emissions retribution regime	0.1 million tCO_2e	
CWE total allocations	0.9 million tCO_2e	1.0 million–0.1 million tCO_2e
Total emission 'deficit'	200,000 tCO_2e	Of which 0.1 million tCO_2e must be met through existing ETS allowances or mitigation credits
CWE actions for the year		
Reduce own emissions	50,000 tCO_2e	Reduces coal burn by efficiency improvements and introduction of biomass
Purchase of allowances and emission credits	75,100 EUAs and CERs	

Continued

TABLE 1 Continued

	Quantity	Calculation
Purchase of VRCs	74,900	From storm-drainage project on small island state
The VRC producing project: storm drains		
The project is for an informal settlement in a large secondary city. The settlement already suffers flooding and contamination of groundwater, leading to health issues. Both problems will increase with sea-level rise and more severe weather as a result of climate change		
Design document estimate of vulnerability reduction costs caused by project	US$1 billion over 50-year project life	This is reviewed and formally validated by a UN accredited vulnerability reduction auditor
Year 1: UN accredited verification of % vulnerability protection from estimate in design document	94%	Verification shows that portions of the drainage system are not properly constructed, resulting in some storm-water exiting into the community
VCRs issued for Year 1	74,900	1-year/50-year project life × 94% expected vulnerability reduction/US$26.67 CCI
Year 2, % vulnerability protection	104%	The above faults were fixed and extra maintenance resulted in protection exceeding design document's estimate
99-year future average CCI costs estimate, calculated in Year 2	US$198 billion/ year average	A surge of adaptation investments and improvements in impact modelling result in a 1% drop in estimated impact costs/year (99 years because first year of 100 years retribution 'paid' by wealthy countries)
Year 2, CCI/t	US$26.4/t	99 years × US$198 billion/year/(750 billion tCO_2e – 1/100 years/750 billion tCO_2e)
Year 2, VRC issuance	79,572	US$2,000,000 × 104%/26.14/t
To consider project economics		
Opportunity cost	Allowance price = US$50 Credit price = US$45	
Life cycle cost of storm drainage project	US$15/VRC	

VRC = vulnerability reduction credit; CCI = climate change impact; ETS = emissions trading scheme; EUA = European Union allowance; CER = certified emission reduction.

monitoring and enforcement, if there is the possibility of achieving market power, or if there are uninternalized externalities (Tietenberg, 2002). Although programme design may manage all these concerns, and non-market regimes may also fall prey to these issues, credit mechanisms in the environmental area have also faced criticism for a variety of political, social and ethical reasons. For example, Bührs (2010) argues that such credit mechanisms are inherently unethical because they neither stigmatize nor punish polluters who harm both people and their environment.

It is assumed here that other policies will limit future emissions, and that the principal risks to the proposed scheme consist in poor programme design. As such, a review is warranted of the tools, players,

and proposed framework of, and manner in which, the framework could be tested, followed by a discussion of design challenges.

The tools of this framework include:

- emission allowances for polluters under a cap-and-trade scheme (C&T),
- emission reduction credits and vulnerability reduction credits (VRCs) – offsets applicable for this compliance regime.

The players include:

- industrialized nations, with obligations (based on their cumulative emissions) to reduce emissions or reduce climate vulnerability in developing nations;
- developing nations, who will approve and host vulnerability reduction projects;
- third-party project developers, investors and technology providers, who together may provide the exogenous resources to reduce vulnerabilities;
- communities in developing countries where vulnerability reduction activities are identified, negotiated and undertaken;
- third-party validators of projects for registration, and verifiers of vulnerability reduction for crediting;
- an international body to register projects, issue credits, manage an international credit transaction log, determine CCI costs, and set rules on baseline and monitoring methods.

The proposed framework applies the four assumptions and mobilizes the preceding tools and actors to form a demand and supply for VRCs as follows:

Demand creation:

1. Calculate cumulative emissions for industrialized countries.
2. Estimate and periodically revisit the future 100-year cumulative costs of CCI for developing countries. Periodically redefine 'developing countries'.
3. Based on (1) and (2), calculate the CCI/tCO_2e emissions.
4. Wealthy countries need, in the next 100 years, to pay back developing countries for all their cumulative emissions by further reducing their own emissions, securing international emission reduction credits or emission allowances, or gaining VRCs from adaptation measures in developing countries.
5. VRC credit issuances are calculated, based on periodic assessments of the expected value of the CCI, for the remainder of the 100-year obligation. This incentivizes polluters seeking credits to identify, fund and manage the most beneficial projects over time.

Supply creation:

1. Countries may finance these measures directly through government treasuries or delegate their obligations to a third party, such as an emitting facility.
2. Developing countries must review and approve all projects, and may create policies on the allocation of VRC funds. Countries may allow third parties (e.g. municipalities, private companies) to sell VRCs directly from the projects they own.
3. An international body runs mitigation and VRC credit registries, accredits third-party validation and vulnerability reduction verification auditors, approves project registrations and issues credits.

4. Adaptation measures are registered, based on reasonable baseline estimates (at project, programme or sector levels), and credits are issued based on activities resulting in additional reductions in vulnerability to climate change.
5. Calculations and issuance of the emission reduction credits may follow existing (e.g. CDM) or new approaches.
6. Issuance of VRCs follows verification by third-party accredited auditors of the estimates of the percentage effectiveness reduction in the vulnerability costs. The number of VRCs issued is based on this percentage, and any changes in the residual average costs/tonne of global CCIs for the remainder of the 100-year obligation noted in the demand creation process.

Table 1 uses a hypothetical case to illustrate the system in practice. Refinements should be made to the demand and supply methodologies based on further research.

This approach to issuing VRCs provides incentives for investors to sustain their projects as credits are only awarded after a project has demonstrated it has, for a defined period, reduced vulnerability to the impacts forecast in the design document. However, the project does not have to risk the possibility that project-level impacts of climate change differ from those expected in the project design document. Rather, third-party accredited auditors will review monitoring reports on the ability of the investment to protect against the forecasted changes for the past period (e.g. year) for which the project is seeking VRCs, not the actual climatic conditions and impacts.

A proposed pilot project might be the best approach for policy makers to gain empirical evidence and know-how prior to scaling up. Volunteer emitters from industrialized countries could be identified in order to engage with an auditing/engineering company, project developer or investor to implement a relatively simple project. Based on what works and what does not, improvements to the scheme could form the basis of an international framework.

3. Challenges and issues in system design

The two most challenging demand side issues are (i) getting developed countries to accept responsibility for the damage their historical emissions have caused to developing countries, and (ii) estimating the CCI cost in them. Establishing an accepted global CCI cost estimate is both an analytical challenge (owing to omissions, double counting, scaling-up from limited empirical data, separating out climate impacts from others; see Agrawala et al., 2008) and a political challenge. Many studies have focused on adaptation costs rather than impact costs, or combined adaptation with residual impacts. As such, the proposed framework will benefit from improved global climate impact cost assessments. Political decisions need to be made. However, to maximize CCI analytical integrity, estimates would best be undertaken by the Intergovernmental Panel on Climate Change (IPCC).

On the supply side, creating baseline and monitoring methodologies for project-level vulnerability reduction is challenging and sometimes impossible. Downscaled climate scenarios are essential, as are sound empirical estimates of the vulnerabilities and costs. Costs may be under-counted, as some are not easily quantified. However, by encouraging and implementing a pilot programme, a global regime of baseline methodologies can formulated, one that may be improved upon based on project experience. The CDM, for instance, has resulted in the periodic revision of 203 baseline methodologies (UNFCCC, 2011). These methodologies will also provide a wealth of data to aid in improving global CCI cost estimates.

If VRC issuance is too low to justify investment, or there are project and country risks, the VRC trading scheme may not finance certain critical adaptation measures. Although it does not matter

where climate mitigation takes place to reduce global warming, the benefits of adaptation are mainly local. If there is a risk that a VRC market may ignore certain areas, countries or project types, then both non-market measures and careful management of the VRC market are warranted. For instance, measures must be taken to ensure that vulnerable communities in the least developed countries and countries with corrupt or inept governments are not ignored, simply because it is easier to work in middle-income countries with good governance regimes. This particular challenge is not unique to market-based adaptation finance and applies equally to the use of centralized funds. Thus, overcoming these investment disparities may be better achieved through the use of market approaches rather than by top-down funding from governments.

Regulatory certainty is also important, and encourages private sector investment. The financing regime should include a commitment that VRCs can be issued for registered projects for the anticipated project life cycle.

Furthermore, VRCs should only be issued for those projects that directly help the poor and materially vulnerable in developing countries. It would be improper for VRCs to be issued for investment in a port facility that only benefits international shipping conglomerates, rather than in a storm drainage system that reduces flooding in a poor urban neighbourhood. As such, the VRC market could have positive or negative lists of project types, or provide extra VRC issuances for projects meeting certain criteria such as project type, per capita income or others, to incentivize priorities or provide a more equitable distribution of VRC generating investments. Governments in developing countries need to be incentivized to encourage direct engagement between developers, investors and vulnerable communities. Moreover, the registration process must ensure transparency.

In many cases, using conventional public financing mechanisms or targeted debt and equity guarantees is the only way to fund certain projects or programmes. Clearly, resources must be mobilized for non-market interventions, in areas such as disaster preparedness, public health initiatives and civil service capacity building.

One approach to incentivizing pro-poor adaptation activities is the quantification of vulnerability reduction, based on average impacts costs for a similar intervention in an industrialized country. This would overcome the risk that the poorest communities may be ignored due to the low financial value of exposed assets. In addition, it may also help to address the 'development deficit', while maintaining the kind of cost efficiencies that a credit scheme offers (Bührs, 2010). To the extent that CCIs, but also adaptation costs per capita, are lower in least developing countries, and per capita vulnerability reduction potential is most significant in poorer communities, this approach would create a greater incentive to support projects for the poor in the poorest countries, overcoming many of the (potentially greater) investment risks and challenges.

Some of the palpable benefits of the scheme thus include the potential for project-based VRCs to overcome or avoid some institutional barriers (e.g. the hostility of local government to supporting adaptation investments in informal settlements), the creation of incentives that provide direct benefit to the community involved, and the very involvement of the community itself. Companies (especially those that have caps on their emissions in industrialized countries) and third-party developers and investors will be highly motivated to identify and engage with communities where there is significant and relatively low-cost vulnerability reduction potential. A rigorous VRC issuance regime will force them to maintain a keen eye on their projects if they wish to reap benefits, and the result will be accountability and sustainability. As the finance does not need to be funnelled through any particular organization, such as a local government that is hostile to vulnerable communities, funds can go where they are needed and, relatively speaking, where they should be well spent.

There is a risk that a disproportionate share of the investment is allocated for mitigation rather than adaptation. This should be avoided as there is a morally compelling need and obligation stemming

from the 'polluter pays principle' to finance adaptation in developing countries. The proposed credit mechanism offers an opportunity to effectively meet much of this need, so system design should strive to incentivize adaptation.

A potential 'supply release mechanism' could be incorporated into the scheme to ensure that a minimum level of finance is allocated to adaptation, using conventional financing mechanisms (e.g. grants to government programmes). Such a mechanism could be triggered for a given period if the share of mitigation reduction credits exceeds a certain level, such as 65% of all credits. At this point, the capped entity could be required to pay, at the estimated adaptation cost/tonne, into a fund that could then allocate resources towards adaptation measures using grants, loans or other means. Alternatively, as noted above, market regulations could be imposed to create greater issuance of VRCs per verified expected vulnerability reduction value. This latter measure could be undertaken in a flexible manner to target specific countries or project types, or could be adjusted for the market as a whole.

4. Conclusions

As with the case of climate mitigation, the use of market mechanisms alone to reduce vulnerabilities to climate change is insufficient. Even with the most cleverly designed schemes, funds cannot be allocated to protect all vulnerable communities or all natural systems. However, this is a problem for all financing alternatives. Requiring that polluters pay to reduce vulnerabilities is probably the fairest or most equitable approach. In addition, the proposed scheme promises to be flexible and efficient. It is also perhaps the best way to raise funds and does not risk the so-called 'donor fatigue' that plagues ODA.

To the author's knowledge, this is the first published article on the design of a market-based vulnerability reduction crediting mechanism, and it therefore constitutes a first step in an essential process of multidisciplinary research and debate on the economics, policy framework and technical alternatives for baseline and crediting methodologies. Future key areas of work include applying the lessons of project-based mitigation credit schemes, considering criteria for imposing cumulative emissions obligations, better understanding the extent to which supply and demand for adaptation investment is stimulated through the international framework and national policies, identifying the most appropriate project types, creating appropriate baselines and methodologies for measuring vulnerability reduction values, improving understanding of climate change impact costs and risks, modelling and performing scenario analyses against the alternative design options, and coming up with governance and implementation frameworks at international, national and community levels. A pilot scheme could address all these issues.

Acknowledgements

I am grateful to Abyd Karmali, Phillip Kent, Jonathan Young, Roland Mader, Linus Adler and the anonymous reviewers who provided valuable feedback on the concept and the article.

References

Adam, D., 2010, 'Climate fund "recycled" from existing aid budget, UK government admits. Move appears to contradict repeated government pledges that climate aid would be additional to existing aid programmes', *The Guardian*, 25 January [available at www.guardian.co.uk/environment/2010/jan/25/climate-aid-uk-funding].

Adger, N., Huq, S., Brown, K., Conway, D., Hulme, M., 2003, 'Adaptation to climate change in the developing world', *Progress in Development Studies* 4(3), 179–195.

Agrawala, S., Carraro, M., 2010, Assessing the Role of Microfinance in Fostering Adaptation to Climate Change, Environment Working Paper No. 15, Organisation for Economic Co-operation and Development, Paris.

Agrawala, S., Crick, F., Jetté-Nantel, S., Tepes, A., 2008, 'Empirical estimates of adaptation costs and benefits: a critical assessment', in: S. Agrawala, S. Fankhauser (eds), *Economic Aspects of Adaptation to Climate Change: Costs, Benefits and Policy Instruments*, Organisation for Economic Co-operation and Development, Paris, 29–84.

Baca, M., 2010, 'Call for a pilot program for market-based adaptation funding', *International Law and Politics* 42, 1337–1381.

Baumol, W.J., Oates, W.E., 1971, 'The use of standards and prices for protection of the environment', *Swedish Journal of Economics* 73, 42–54.

Brown, J., Kaur, N., 2009, Financing adaptation: matching form with function, Background Note, Overseas Development Institute, London.

Bührs, T., 2010, *Sharing the Atmosphere: A Proposal for an Equitable and Sustainable Global Trading Scheme for Greenhouse Gas Emissions*, Working Paper 264/10, Center for the Study of Globalisation and Regionalisation, Department of Politics and international Studies, University of Warwick, Warwick, UK.

Climate Funds Update, 2011, 'Overall distribution of funds: December 2010', Climate Funds Update [available at www.climatefundsupdate.org].

Fast Start Finance, 2011, Contributing Countries, Fast Start Finance, The Netherlands [available at: www.faststart-finance.org/content/contributing-countries].

Hamilton, K., Fay, M., 2009, 'A changing climate for development', *Finance & Development* 46(4), 10–12.

Hellmuth, M.E., Osgood, D.E., Hess, U., Moorhead, A., Bhojwani, H. (eds), 2009, *ANNEX Index Insurance and Climate Risk: Prospects for Development and Disaster Management*, Technical Report 10-10, Climate and Society No. 2, International Research Institute for Climate and Society (IRI), Columbia University, New York, NY.

IEA (International Energy Agency), 2009, *World Energy Outlook – 2009*, Organisation for Economic Co-operation and Development/International Energy Agency, Paris.

Moser, C., Satterthwaite, D., 2008, *Towards Pro-poor Adaptation to Climate Change in the Urban Centres of Low- and Middle-Income Countries*, Climate Change and Cities Discussion Paper 3, Human Settlements Discussion Paper Series, International Institute for Environment and Development, London.

Parry, M., Arnell, N., Berry, P., Dodman, D., Fankhauser, S., Hope, C., Kovats, S., Nicholls, R., Satterthwaite, D., Tiffin, R., Wheeler, T., 2009, *Assessing the Costs of Adaptation to Climate Change: A Review of the UNFCCC and Other Recent Estimates*, International Institute for Environment and Development and Grantham Institute for Climate Change, London.

Point Carbon, 2011, *Point Carbon's OTC Price Assessments*, Point Carbon, Oslo, Norway [available at www.pointcarbon.com].

Stavins, R., 2003, 'Experience with market-based environmental policy instruments', *Handbook of Environmental Economics* 1, 355–435.

Tietenberg, T., 1985, *Emissions Trading, an Exercise in Reforming Pollution Policy*, Resources for the Future, Washington, DC.

Tietenberg, T., 2002, The Tradable Permits Approach to Protecting the Commons: What Have We Learned?, Working Paper No. 36, Fondazione Eni Enrico Mattei (FEEM), Venice, Italy.

UN, 1992, *Report of the United Nations Conference on Environment and Development (Rio de Janeiro, 3–14 June 1992). Annex I: Rio Declaration on Environment and Development*, A/CONF.151/26 (Vol. I), United Nations, New York [available at www.un.org/documents/ga/conf151/aconf15126-1annex1.htm].

UN, 2010, *Report of the Secretary-General's High-Level Advisory Group on Climate Change Financing*, United Nations, New York [available at www.un.org/climatechange/agf].

UNEP Risoe, 2010, *CDM/JI Pipeline Analysis and Database*, United Nations Environment Programme Risoe Centre on Energy Climate and Sustainable Development, Roskilde, Denmark [available at www.cdmpipeline.org].

UNFCCC, 2009, *Report of the Conference of the Parties on its Fifteenth Session, held in Copenhagen from 7 to 19 December 2009. Addendum. Part Two: Action Taken by the Conference of the Parties at its Fifteenth Session*, FCCC/CP/2009/11/

Add.1, United Nations Framework Convention on Climate Change, Bonn, Germany [available at http://unfccc.int/resource/docs/2009/cop15/eng/11a01.pdf].

UNFCCC, 2011, *Approved Methodologies by Scope*, United Nations Framework Convention on Climate Change, Bonn, Germany [available at http://cdm.unfccc.int/Statistics/Methodologies/ApprovedMethPieChart.html].

WRI, 2010, *Climate Analysis Indicators Tool (CAIT)*, Version 3.0, World Resources Institute, Washington, DC [available at http://cait.wri.org].