

**TRADING IN ECOSYSTEM SERVICES:  
CARBON SINKS AND THE CLEAN DEVELOPMENT  
MECHANISM**

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I. INTRODUCTION

One reason that ecosystem services are declining is that people can consume them for free.<sup>1</sup> Valuable services such as water filtration, pollination and climate stabilization<sup>2</sup> are public goods in the sense that they cannot be provided to an individual without simultaneously being provided to all.<sup>3</sup> The inability to fence others off from these services makes it impossible to charge a price for enjoying them. This leads to wasteful consumption of ecosystem services and removes the incentive to invest in providing more ecosystem services.<sup>4</sup> The result is the depletion of ecosystem services.

If part of the problem is that people can consume ecosystem services for free, then part of the solution may lie in finding ways to make them pay for the privilege.<sup>5</sup> Ideally, the price should be equivalent to the value that the service provides to society. It should rise as the ecosystem and associated services become

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1. James Salzman, *Creating Markets for Ecosystem Services: Notes from the Field*, 80 N.Y.U. L. REV. 870, 882 (2005) [hereinafter Salzman, *Notes*]; JAMES SALZMAN & BARTON H. THOMPSON, JR., ENVIRONMENTAL LAW AND POLICY 16 (2003). There are other reasons that ecosystem services are declining, including the structural mismatch between ecosystem and political timeframes; however, the fact that ecosystem services are often public goods is one of the main causes of their depletion.

2. See Robert Costanza et al., *The Value of the World's Ecosystem Services and Nat. Capital*, 387 NATURE 253, 256 (1997) (estimating the global value of ecosystem services at \$33 trillion per year including \$1.692 trillion for water supply, \$117 billion for pollination, and \$684 billion for climate regulation); James Salzman, *Valuing Ecosystem Services*, 24 ECOLOGY L.Q. 887 (1997) (discussing literature on the valuation of ecosystem services).

3. SALZMAN & THOMPSON, *supra* note 1, at 15.

4. *Id.* at 16.

5. Salzman, *Notes, supra* note 1, at 884 (“a key challenge in implementing an ecosystem services approach lies in creating a market where none exists”).

scarcer and should fall as they become more abundant. This would better signal to society the need to conserve and invest in ecosystem services. For the reasons just described, the market alone will not achieve this. Government or some other non-market actor will need to lend a hand.<sup>6</sup>

Government can charge for the consumption of ecosystem services in at least three ways. It can require those who harm ecosystems to pay a fee equivalent to the associated loss in ecosystem services.<sup>7</sup> It can pay a subsidy to those who act to conserve and/or restore ecosystems and the services they provide.<sup>8</sup> Or, it can use a trading approach. Under this third method a government would require a reduction in the overall amount of environmental harm, award entitlements to create this harm such that the aggregate amount of these rights equals the reduced level of environmental harm, and then allow these entitlements to be traded.<sup>9</sup> Those who can improve their environmental performance at the least cost will tend to do so and will trade away their rights to cause the harm. Those who find it more expensive to improve will tend to purchase entitlements. The result should be that the lower-cost actors end up making the bulk of the environmental improvements, thereby allowing society to achieve its environmental goals at less expense.<sup>10</sup> In the pollution control area, the best-known initiative of this type is the Acid Rain Trading Program under which utilities and other emitters can trade permits to emit sulfur dioxide (SO<sub>2</sub>).<sup>11</sup>

While many have come to accept trading as a useful way to control pollution, fewer embrace it as a way to protect ecosystem services. In their leading article on the topic, Professors Salzman and Ruhl argue that ecosystem goods often are not fungible in the way that tons of SO<sub>2</sub> or other pollutants are.<sup>12</sup> They maintain

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6. *Id.* at 884-85 (government can step in to correct market failure).

7. *Id.* at 885 (discussing use of taxes and fees as an environmental regulatory instrument); SALZMAN & THOMPSON, *supra* note 1, at 45. For example, government could require those who destroy a wetland to pay a fee equivalent to the value of the water filtration, flood protection, species habitat, and other services that the wetland provides. One problem with this approach is that it will often be difficult to assess in monetary terms the amount of damage to the ecosystem service and so to charge the correct fee. *Cf.* NAT'L RES. COUNCIL COMMITTEE ON ASSESSING AND VALUING THE SERVICES OF AQUATIC AND RELATED TERRESTRIAL ECOSYSTEMS, VALUING ECOSYSTEM SERVICES 1 (2005) (illustrating methods used to value ecosystem services).

8. For example, government could pay farmers to preserve wetlands on their property rather than to drain them for agricultural use. Farmers who decide to drain their wetland would pay a "price" equivalent to the opportunity cost of foregoing the subsidy. Salzman, *Notes, supra* note 1, at 886; *see also id.* at 892-899 (discussing Australian and Costa Rican initiatives which use payments to enhance the provision of ecosystem services).

9. SALZMAN & THOMPSON, *supra* note 1, at 45.

10. *Id.*

11. *See* 42 U.S.C. § 7651 (1990).

12. *See* James Salzman & J.B. Ruhl, *Currencies and Commodification of Environ-*

that, absent rigorous and costly administrative review, it is often impossible to tell whether one acre of wetlands, critical habitat, or other ecosystem-based good provides the same environmental functions as another. Programs that would allow trading in wetlands and other habitats accordingly face a Hobson's choice between robust markets in ill-defined goods, and anemic markets in more rigorously reviewed (and hence far more costly) commodities. Trading in ecosystem services founders on the horns of this dilemma.

The current article offers a fresh look at ecosystem service trading. It argues that Salzman and Ruhl's concerns about fungibility apply only to one category of such trades and do not govern another important branch of these transactions. For Salzman and Ruhl, the Wetlands Mitigation Banking Program (WMBP) is the paradigmatic ecosystem trading initiative.<sup>13</sup> The WMBP awards credits to those who restore wetlands or create new ones, and allows them to store these credits in a mitigation "bank."<sup>14</sup> Developers who fill wetlands, and are legally required to replace them, can purchase the banked wetlands credits and use them to meet the mitigation requirement.<sup>15</sup> The WMBP thus promotes a market in which one ecosystem service, i.e. the service that the new wetland provides, replaces another, i.e. that which the filled wetland provided. We refer to these as ecosystem service for ecosystem service (ESS for ESS) trades. Salzman and Ruhl provide great insight into this category of ecosystem service transactions.

They say less about programs in which an ecosystem service takes the place of pollution reduction technology. An example would be the Kyoto Protocol's Clean Development Mechanism (CDM). Under this initiative, developing countries can gain greenhouse gas (GHG) removal "credits" by expanding forests that soak up carbon and remove it from the atmosphere.<sup>16</sup> They can then trade these credits to developed countries that can use them to meet their binding GHG emission reduction commitments under the Kyoto Protocol.<sup>17</sup> In the absence of this trading opportunity these developed nations would, in many cases, have sought to

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*mental Law*, 53 STAN. L. REV. 607, 665 (2000).

13. *See id.* at 648-57 (2000) (describing and discussing the WMBP).

14. *See id.* at 654; ENVTL. L. INST., WETLAND MITIGATION BANKING 3 (1993).

15. Salzman & Ruhl, *supra* note 12, at 654-55; Royal C. Gardner, *Banking on Entrepreneurs: Wetlands, Mitigation Banking, and Takings*, 81 IOWA L. REV. 527, 581-87 (1996); Federal Guidance for the Establishment, Use and Operation of Mitigation Banks, 60 Fed. Reg. 58,605 (Nov. 28, 1995).

16. Alexander Gillespie, *Sinks and the Climate Change Regime: The State of Play*, 13 DUKE ENVTL. L. & POL'Y F. 279, 279 (2003).

17. For a more complete description of this program see *infra* notes 30-32, 49-54 and accompanying text.

achieve these GHG reductions by installing new pollution control or energy efficiency technologies. The CDM allows them to purchase ecosystem-based GHG removal credits instead. In other words, it allows parties to use ecosystem services in place of technology-based services. We refer to these as ecosystem service for technology-based service (ESS for TBS) trades. In dollar terms, ESS for TBS trades are quite significant. While still in its infancy, the CDM has already accounted for approximately \$400 million in carbon sequestration-based credits.<sup>18</sup>

This article will describe the Clean Development Mechanism and will set out some of the different views about this young program. It will then show that Salzman and Ruhl's framework for thinking about ecosystem service trades, which is so fundamental to any assessment of ESS for ESS trades, does not shed nearly as much light on the CDM or on other ESS for TBS trading systems. This article will provide an alternative framework that spells out the potential benefits, and risks, of ESS for TBS trading.

The article will proceed as follows. Part II will further describe carbon sinks and how they can generate tradable credits under the CDM. Part III will explore the policy debate over the CDM program. It will set out the arguments for, and against, trading in carbon sink-based credits. As will become clear, this debate has relevance for ESS for TBS trading more generally and so is worth describing in some detail. Finally, Part IV will draw on the CDM experience to develop broader lessons about ecosystem services trading. It will explore ESS for TBS exchanges as a separate category of ecosystem service trading, will explain in more detail how they differ from ESS for ESS exchanges and, drawing on the CDM experience, will map out a new analytical framework for evaluating them.

## II. CARBON SINK TRADING UNDER THE CLEAN DEVELOPMENT MECHANISM

The 1992 United Nations Framework Convention on Climate Change (UNFCCC) is the broad international agreement that es-

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18. Sebastian Scholz & Ian Noble, *Generation of Sequestration Credits under the CDM*, in LEGAL ASPECTS OF IMPLEMENTING THE KYOTO PROTOCOL MECHANISMS: MAKING KYOTO WORK 265, 282-83 (David Freestone & Charlotte Streck, eds., 2005) [hereinafter LEGAL ASPECTS OF KYOTO]. The dollar value is difficult to measure since the price per ton for sequestration credits varies widely at this early stage of the market. The estimate of \$400 million is based on the 2004 announcement of the Brussels Region Government of Belgium that it had invested in a carbon sink project in the Democratic Republic of Congo and Cote D'Ivoire at prices of between \$10 and \$20 per ton. Gillespie, *supra* note 16, at 283.

establishes the effort to stabilize the climate.<sup>19</sup> It requires signatory nations to commit themselves to stabilizing greenhouse gas (GHG) emissions “at a level that would prevent dangerous anthropogenic interference with the climate system.”<sup>20</sup> At a 1997 meeting in Kyoto, Japan, the parties to the UNFCCC reached a supplemental agreement known as the Kyoto Protocol.<sup>21</sup> This document requires developed nations that are parties to the UNFCCC to reduce their GHG emissions by a specified percentage from their 1990 level.<sup>22</sup> These obligations, which are to be achieved by 2012, are set out in Annex B of the Kyoto Protocol<sup>23</sup> and the nations with GHG reduction commitments are known as “Annex B Parties.” The commitments range from the European Union nations’ collective agreement to achieve an eight percent reduction, to Iceland’s agreement to limit itself to a ten percent increase.<sup>24</sup> Overall, the Annex B Parties commit to a 5.2 percent reduction from the 1990 levels.<sup>25</sup>

#### *A. The Clean Development Mechanism*

Annex B Parties will achieve most of their required reductions by installing energy efficiency measures or other GHG reduction technologies at facilities located within their own borders. However, the drafters of the Kyoto Protocol considered the fact that it would sometimes be possible to achieve the reductions more cheaply in other nations and that a ton of reductions achieved anywhere in the world would make essentially the same contribution to climate stabilization.<sup>26</sup> After much debate, the drafters of the Kyoto Protocol decided to allow Annex B parties to purchase the rights to emissions reductions achieved in other nations and use them to meet their own GHG reduction commitments. The Kyoto Protocol sets up three “flexibility mechanisms” to facilitate this trade in emissions allowances or credits. These are International Emission Trading,<sup>27</sup> Joint Implementation<sup>28</sup> and the Clean

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19. U.N. Framework Convention on Climate Change, May 9, 1992, S. TREATY DOC. No. 102-38 (1992), 1771 U.N.T.S. 108 [hereinafter UNFCCC].

20. *Id.* art. 2.

21. Kyoto Protocol to the U.N. Framework Convention on Climate Change, Dec. 10, 1997, UN Doc. FCCC/CP/1997/7/Add.2, reprinted in 37 I.L.M. 22 (1998) [hereinafter Kyoto Protocol].

22. *Id.* art. 3(1).

23. *Id.* Annex B.

24. *Id.*

25. David Freestone, *The UN Framework Convention on Climate Change, the Kyoto Protocol, and the Kyoto Mechanisms*, in LEGAL ASPECTS OF KYOTO, *supra* note 18, at 1, 10.

26. *Id.* at 13.

27. Kyoto Protocol, *supra* note 21, at art. 17 (mechanism allowing Annex B Parties to transfer Kyoto emissions rights—known as Assigned Amount Units (AAU)—to one another); see Rutger de Witt Wijnen, *Emissions Trading under Article 17 of the Kyoto Protocol*,

Development Mechanism.<sup>29</sup>

The Clean Development Mechanism (CDM) focuses on emissions reduction projects in developing nations that are parties to the UNFCCC.<sup>30</sup> The CDM awards emission reduction credits to such projects where they reduce GHG below baseline levels.<sup>31</sup> It then allows Annex B Parties to purchase the rights to these credits and use them to meet their emission reduction obligations. In essence, the CDM allows Annex B Parties to invest in GHG reduction projects in developing nations as an alternative to installing energy efficiency or other GHG reduction technologies at home. In this way, it seeks to promote technology transfer to, and sustainable development in, developing nations.<sup>32</sup>

### *B. Carbon Sinks, the Climate Regime and the CDM*

One of the major issues facing the negotiators of the UNFCCC and, later, the Kyoto Protocol was whether GHG removals achieved through carbon sinks should have equal status with GHG emission reductions achieved through technology-based measures such as energy efficiency projects. A carbon sink is a process, activity, or mechanism that removes GHG or GHG precursors from the atmosphere and then stores them.<sup>33</sup> The two main carbon sinks are forests and oceans.<sup>34</sup> They are part of a global carbon cycle in which carbon shifts among four great carbon stores—the geological, the oceanic, the terrestrial and the atmospheric reservoirs.<sup>35</sup> The key goal of climate change initiatives is to reduce the amount of carbon in the atmospheric store and increase the amount that is sequestered in one of the other three reservoirs.

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*in* LEGAL ASPECTS OF KYOTO, *supra* note 18, at 403 (providing a more detailed description of the mechanism allowing transfer of Kyoto emission rights).

28. Kyoto Protocol, *supra* note 21, at art. 6 (mechanism allowing one Annex B Party to invest in an emissions reduction project in another Annex B Party and then acquire the emissions reduction credits, known as Emissions Reduction Units (ERU)); Charlotte Streck, *Joint Implementation: History, Requirements, and Challenges*, *in* LEGAL ASPECTS OF KYOTO, *supra* note 18, at 126 (providing a detailed description of Emission Reduction Units).

29. Kyoto Protocol, *supra* note 21, at art. 12.

30. *Id.*; Maria Netto & Kai-Uwe Barani Schmidt, *CDM Project Cycle and the Role of the UNFCCC Secretariat*, *in* LEGAL ASPECTS OF KYOTO, *supra* note 18, at 175.

31. U.N. Framework Convention on Climate Change, *Report of the Conference of the Parties on its Seventh Session, Held at Marrakesh from 29 October to 10 November 2001, Decision 17/CP.7, Draft Decision*, ¶¶ 43-48, U.N. Doc FCCC/CP/2001/13/Add.2 [hereinafter Marrakesh Accords]; see Rutger de Witt Wijnen, *Emissions Trading under Article 17 of the Kyoto Protocol*, *in* LEGAL ASPECTS OF KYOTO, *supra* note 18, at 406, 408.

32. Netto & Barani Schmidt, *supra* note 30, at 176.

33. Gillespie, *supra* note 16, at 279.

34. Yadvinder Mahli, Patrick Meir & Sandra Brown, *Forests, Carbon and Global Climate*, 360 PHIL. TRANSACTIONS: MATHEMATICAL, PHYSICAL AND ENGINEERING SCIENCES 1567, 1569 (2002).

35. *Id.*

Forests and oceans remove carbon from the atmosphere through photosynthesis.<sup>36</sup> Each year, forest and oceans exchange twenty-five times more carbon with the atmosphere than is released by human activities.<sup>37</sup> In forest ecosystems, trees and other plants carry out the photosynthesis and store the carbon as biomass in vegetation or in soils,<sup>38</sup> which is where two-thirds of terrestrial carbon is sequestered.<sup>39</sup> Activities that affect the amount of biomass in forests and other terrestrial ecosystems accordingly have the potential to remove significant amounts of carbon from, or add carbon to, the atmosphere.<sup>40</sup> In oceans, phytoplankton carry out the photosynthesis.<sup>41</sup> They draw carbon dioxide (CO<sub>2</sub>) from ocean water which is replaced by CO<sub>2</sub> from the atmosphere, thereby lowering the atmospheric carbon stock.<sup>42</sup>

There was much debate over the role that carbon sinks would play in the UNFCCC and the Kyoto Protocol.<sup>43</sup> Nations with large forests, including the United States, argued strongly in favor of including GHG removals through carbon sinks as a recognized means of meeting GHG reduction obligations.<sup>44</sup> Other nations objected to the idea due to the perceived uncertainties surrounding this method and argued that the international agreements should focus exclusively on emissions and not on sinks.<sup>45</sup> The debate led to the collapse of the Sixth Conference of the Parties to the UNFCCC, held at the Hague in 2000, where the United States walked out due to disagreement over the sinks issue.<sup>46</sup>

Ultimately, the UNFCCC adopted a comprehensive approach that encompassed “all relevant sources, sinks and reservoirs of greenhouse gases and adaptation.”<sup>47</sup> The Kyoto Protocol has somewhat narrowed this scope by excluding oceans and by recognizing, for emission reduction purposes, only those sink removals achieved through land-use change and forestry practices, specifically “afforestation, reforestation and deforestation.”<sup>48</sup>

The Clean Development Mechanism reflects this narrowing of

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36. *Id.*

37. *Id.*

38. *Id.* at 1571.

39. ROGER A. SEDJO, BRENT SOHNGEN & PAMELA JAGGER, *Carbon Sinks in the Post-Kyoto World in CLIMATE CHANGE ECONOMICS AND POLICY: AN RFF ANTHOLOGY* 4 (Michael E. Tolman ed., 1998).

40. Mahli et al., *supra* note 34, at 1572.

41. *Id.* at 1582; *see also* Gillespie, *supra* note 16, at 280.

42. Gillespie, *supra* note 16, at 280.

43. *Id.* at 284-301 (summarizing this debate).

44. *Id.* at 285.

45. *Id.*

46. *Id.* at 288.

47. *Id.* at 285; UNFCCC, *supra* note 19, art. 3(3).

48. Kyoto Protocol, *supra* note 21, at art. 3(3); Gillespie, *supra* note 16, at 281.

scope. For credit production purposes, the CDM recognizes only those sink activities that involve afforestation or reforestation.<sup>49</sup> The CDM does not acknowledge other terrestrial or oceanic sinks, nor does the CDM recognize carbon storage through forest preservation or improved forest management. The CDM defines the baseline for reforestation purposes as the state of a nation's forests in 1990.<sup>50</sup> It awards GHG removal credits for projects that enhance these forests beyond baseline levels and that meet certain other program criteria.<sup>51</sup> These include requirements related to monitoring,<sup>52</sup> an "additionality" requirement under which the developing country must demonstrate that the afforestation or reforestation project would not have occurred but for the CDM project,<sup>53</sup> as well as other project requirements. The CDM established an institution, the CDM Executive Board, whose functions include reviewing all CDM projects to make sure that they meet the requirements imposed by the CDM.<sup>54</sup> Once the Executive Board certifies a project's GHG reductions or removals, it issues the corresponding Certified Emission Reduction (CER) credits. Annex B Parties can then acquire these credits for use in meeting their Kyoto commitments.

### III. ARGUMENTS FOR AND AGAINST CARBON SINK TRADING

There has been a fierce debate over the inclusion of carbon sinks in the UNFCCC and Kyoto Protocol in general, and in the CDM baseline-credit trading scheme in particular. Proponents of including carbon sinks in the CDM have argued that carbon sinks often reduce atmospheric GHG for less cost than comparable technology-based measures.<sup>55</sup> Consequently, carbon sinks present an opportunity for cost savings that will make it easier for countries to participate in the climate stabilization effort.

Proponents also cite the environmental co-benefits of reducing carbon through forest sinks rather than through energy efficiency or other technology-based measures. They explain that ecosystems such as forests or peat bogs, which have the greatest potential as

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49. Marrakesh Accords, *supra* note 31, at Decision 17/CP.7, ¶ 7(a).

50. Scholz & Noble, *supra* note 18, at 268.

51. See Marrakesh Accords, *supra* note 31, at Annex ¶¶ 35-63 (setting out requirements used in sink-based and technology-based CDM projects).

52. *Id.* at ¶¶ 53-60.

53. *Id.* at ¶¶ 43.

54. *Id.* at ¶¶ 5-19 (establishing the Executive Board and defining its role).

55. Roger A. Sedjo & Michael Toman, *Can Carbon Sinks Be Operational? RFF Workshop Summary*, Resources for the Future Discussion Paper 01-26, at 1-2 (July 2001) (reflecting a strong sentiment from workshop participants that "sinks could be relatively inexpensive and effective for carbon management").

carbon sinks, also tend to be rich in biodiversity and to play an important role as species habitat.<sup>56</sup> Thus, the protection of climate through the use of carbon sinks can have a positive effect on another of the world's most pressing environmental problems, the loss of biodiversity. Critics respond that monoculture plantings can often produce the quickest carbon sink returns and that the CDM may accordingly lead to replacement of biodiversity-rich old growth and heterogeneous forests with biodiversity-poor monoculture plantations.<sup>57</sup> Proponents agree that such unintended consequences would be detrimental, but contend that they can be addressed by implementing additional rules or incentives.<sup>58</sup>

In addition to biodiversity, proponents point to other important co-benefits of expanding forests such as watershed protection, water purification, soil rehabilitation, recreational opportunities and the increase in aesthetic values.<sup>59</sup> Proponents also cite the benefits to poor people in the developing countries where CDM projects are necessarily located. These benefits include income that the sale of the carbon sink credits will generate,<sup>60</sup> as well as opportunities for additional food and timber, cash income from employment in the projects,<sup>61</sup> and the potential for forest-based tourism with associated jobs and income. Benefits to the poor create a positive feedback loop with biodiversity since poverty is often one of the root causes of biodiversity loss through overuse of forest resources.<sup>62</sup>

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56. Izabella Koziell & Ian R. Swingland, *Collateral Biodiversity Benefits Associated with 'Free-Market' Approaches to Sustainable Land Use and Forestry Activities*, 360 PHIL. TRANSACTIONS: MATHEMATICAL, PHYSICAL AND ENGINEERING SCI. 1807, 1811 (2002). "The fact that such 'carbon-rich' areas are also 'biodiversity-rich' offers some potential for simultaneous action on biodiversity and carbon issues." *Id.*

57. See, e.g., Greenpeace, *Sinks in the CDM: After the Climate, Biodiversity Goes Down the Drain*, 2 (Dec. 19, 2003) (expressing concern that CDM projects will result in "[l]arge scale plantations with non-native monocultures, possibly using genetically modified organisms and displacing local inhabitants").

58. Roger A Sedjo, *Harvesting the Benefits of Carbon "Sinks,"* 133 RESOURCES 10, 11-12 (1998) [hereinafter Sedjo, *Harvesting*].

59. Sandra Brown et al., *Changes in the Use and Management of Forests for Abating Carbon Emissions: Issues and Challenges under the Kyoto Protocol*, 360 PHIL. TRANSACTIONS: MATHEMATICAL, PHYSICAL AND ENGINEERING SCIENCES 1593, 1596 (2002) (citing "industrial wood and fuel production; traditional forest uses; protection of soil, water and biodiversity; recreation; rehabilitation of damaged lands"); Ian R. Swingland et al., *Preface*, 360 PHIL. TRANSACTIONS: MATHEMATICAL, PHYSICAL AND ENGINEERING SCIENCES 1563 (2002); Benoit Bosquet, *Specific Features of Land Use, Land-Use Change, and Forestry Transactions*, in LEGAL ASPECTS OF KYOTO, *supra* note 18, at 281, 286.

60. John O. Niles et al., *Potential Carbon Mitigation and Income in Developing Countries from Changes in Use and Management of Agric. and Forest Lands*, 360 PHIL. TRANSACTIONS: MATHEMATICAL, PHYSICAL AND ENGINEERING SCIENCES 1621 (2002).

61. Bosquet, *supra* note 59, at 286.

62. Koziell & Swingland, *supra* note 56, at 1808; Ian R. Swingland et al., *Preface*, 360 PHIL. TRANSACTIONS: MATHEMATICAL, PHYSICAL AND ENGINEERING SCIENCES 1563 (2002).

Given these major benefits, one might expect environmentalists and others to embrace carbon sink trading. Instead, many have greeted the idea with intense skepticism and have expressed a preference for technology-based CDM projects rather than sink-based ones.<sup>63</sup> This criticism is rooted in a number of key concerns. First, critics maintain that it is often difficult to define an accurate baseline for the size and quality of heterogeneous forests, many of which tend to exist in a patchwork rather than a fully continuous state.<sup>64</sup> Critics also claim that it is more difficult to measure and continuously monitor CO<sub>2</sub> removals from sinks than from energy efficiency measures. They point out that, in contrast to facility-based energy efficiency projects, carbon sinks tend to be spread out over a wide geographic area and can only be observed through sampling and modeling. Proponents respond that adequate measurement and monitoring technologies exist and could be required by international protocols.<sup>65</sup> For example, they cite the development of remote-sensor technologies for measuring forests, including the use of satellites, low-flying planes and Global Positioning System devices.<sup>66</sup> Used in combination, these technologies can produce three-dimensional images that can be used to measure the height and crown diameter of individual trees in order to arrive at estimates of biomass.<sup>67</sup> Proponents also cite principles of “forest inventory, soil sampling, and ecological surveys” that they claim are well-tested.<sup>68</sup> They assert that trade in carbon sinks under the CDM will lead to improvements in these monitoring methods and technologies.

Critics point out that it is often difficult to assess what a “business as usual” scenario would be with respect to forests, and so to determine whether a carbon sink is truly “additional.”<sup>69</sup> Forests are varied and diverse environments that are in a continual state of change due to both human and natural causes. Identifying how such a resource would have developed in the absence of a carbon sink project is a challenging task. Critics also raise questions

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63. See e.g., Greenpeace, *supra* note 57, at 4 (calling for greater investment in “new energy saving/efficiency technologies” rather than in carbon sink projects).

64. Sedjo & Toman, *supra* note 55, at 3-4; Sedjo, *Harvesting*, *supra* note 58, at 11.

65. Sedjo & Toman, *supra* note 55, at 2 (obstacles to credible use of sinks are “mainly technical and can be overcome.”).

66. Sandra Brown, *Measuring, Monitoring, and Verification of Carbon Benefits for Forest-Based Projects*, 360 PHIL. TRANSACTIONS: MATHEMATICAL, PHYSICAL AND ENGINEERING SCIENCES 1672 (2002) (describing tools and techniques for measuring and monitoring forests); Sedjo & Toman, *supra* note 55, at 2 (describing remote sensing technologies).

67. Brown, *supra* note 66, at 1675.

68. Sedjo & Toman, *supra* note 55, at 2.

69. Sedjo, *Harvesting*, *supra* note 58, at 11.

about the “permanence” of sink-related reductions.<sup>70</sup> They argue that a ton of CO<sub>2</sub> prevented through an energy efficiency measure or plant shutdown is gone forever, whereas carbon sinks only soak up carbon so long as the forest is maintained. If a forest burns, or illegal logging takes place, the CO<sub>2</sub> will be released.<sup>71</sup> Proponents respond that the permanence problem is overstated and that while individual forest sinks may come and go the “objective is to increase the aggregate amount of forest sinks” over time and that this can be monitored and achieved.<sup>72</sup> The CDM program itself seeks to respond to the permanence concern by requiring parties to recertify forest sinks every five years and to replace the credits they generate every sixty years.<sup>73</sup>

Critics further raise the problem of “leakage.” This refers to the situation where a CDM project’s protection of one forest increases the pressure to exploit another forest that is outside the CDM project boundaries. This can undermine the apparent gains from the CDM project itself.<sup>74</sup> The proponents of carbon sink trading acknowledge that this is a significant issue, although they claim that it can be addressed through use of a countrywide baseline and monitoring of overall changes from that benchmark.<sup>75</sup> This seems like a daunting task, especially in developing countries where governance structures tend to be weak and relatively opaque.

Finally, critics argue that the availability of low-cost reductions from sink-based projects would remove the pressure on developed nations to come up with new technologies to improve energy efficiency.<sup>76</sup> This will ultimately hurt developing countries that would lose out on the opportunity to benefit from these technological developments. These critics argue that the Kyoto Parties should be required to employ technology-based solutions and should not be able to rely on sinks. Proponents respond that carbon sink projects are not intended to replace energy efficiency technologies but rather to provide some cost-effective breathing room while these technologies are being developed.<sup>77</sup> They point out that, under the

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70. Sedjo & Toman, *supra* note 55, at 3.

71. Scholz & Noble, *supra* note 18, at 269.

72. Sedjo & Toman, *supra* note 55, at 3.

73. Scholz & Noble, *supra* note 18, at 269-270.

74. *Id.*, at 274; Sedjo & Toman, *supra* note 55, at 4.

75. Sedjo & Toman, *supra* note 55, at 4.

76. Sandra Brown et al., *supra* note 59, at 1594 (2002); Bosquet, *supra* note 59, at 285-86. See also David Driesen, *Free Lunch or Cheap Fix: The Emissions Trading Idea and the Climate Change Convention*, 26 B.C. ENVTL. AFF. L. REV. 1 (1998) (arguing that GHG emissions trading in general will have the effect of dampening innovation in environmental technologies).

77. Roger A. Sedjo, *Forest ‘Sinks’ as a Tool for Climate-Change Policymaking*, 143

Marrakesh Accords, parties can use credits from sinks-based CDM projects to cover only one percent of their base year emissions.<sup>78</sup> To meet their Kyoto commitments, parties will accordingly need to rely on technology-based solutions as well.<sup>79</sup> This should give the parties sufficient incentive to engage in technology development.

#### IV. LESSONS FOR ECOSYSTEM SERVICES TRADING

Can the carbon sink trading experience teach us any general lessons about trading in ecosystem services? As mentioned above, it is useful to begin this inquiry by distinguishing between two types of ESS exchanges.<sup>80</sup> In the first category are those trading systems in which one ecosystem service is purchased so that another may be built upon, or otherwise damaged (ESS for ESS trades). In the second are programs that allow the purchaser of an ecosystem service to substitute it for a technology-based service (ESS for TBS trades). The ESS for TBS nature of the Clean Development Mechanism is at the heart of the policy debate over this program. It is at the center of the proponents' argument that afforestation and reforestation are a cost-effective solution because they cost less than technology-based solutions.<sup>81</sup> It is also at the root of the critics' objection that the availability of low-cost carbon sink credits will prevent innovation in energy efficiency technologies.<sup>82</sup>

New York City's decision to comply with federal drinking water standards by acquiring lands and taking other steps to protect the Catskills watershed, rather than by building a \$6-8 billion water filtration plant, is another example of exchanging an ecosystem service provided by the land (the watershed) for a technology-based service (the filtration plant).<sup>83</sup> This arrangement differs from the CDM in that it constitutes a single regulatory "deal" and does not create an active market with many traders. But the government's decision to allow New York City to purchase an ecosys-

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RESOURCES 21, 23 (2001) (describing sinks as "a temporary low-cost mitigation strategy that can buy humanity three to five decades to make the more fundamental adjustments") [hereinafter Sedjo, *Policymaking*]; Bosquet, *supra* note 59, at 286; Mahli et al., *supra* note 34, at 1588.

78. Marrakesh Accords, *supra* note 31, at ¶ 7(b).

79. Bosquet, *supra* note 59, at 285 ("sinks cannot flood the market so long as the 1 percent rule . . . remain[s] in place").

80. See *supra* notes 13-18 and accompanying text.

81. See *supra* note 55 and accompanying text.

82. See *supra* notes 76-79 and accompanying text.

83. For an in-depth description of this project see James Salzman, Barton H. Thompson & Gretchen C. Daily, *Protecting Ecosystem Services: Science, Economics and Law*, 20 STAN. ENVTL. L. J. 309, 315-16 (2001).

tem service and use it in place of a technology-based service is, in substance, quite similar to the Kyoto Protocol decision to allow Party nations to purchase carbon sink credits and substitute them for energy efficiency projects at home.

As was briefly sketched out above, Professors Salzman and Ruhl, in their insightful article on environmental trading markets (ETM),<sup>84</sup> have created a very useful analytical framework for thinking about ESS for ESS trades. A fuller description of their contribution is warranted here. Salzman and Ruhl explain that the success of an ETM largely depends on the fungibility of the environmental goods being traded (e.g. a ton of emissions, a wetland). If these commodities are not equivalent then the environmental effects of the trade remain unknown.<sup>85</sup> They demonstrate that wetland mitigation trades present significant problems with respect to fungibilities of “type.”<sup>86</sup> Each wetland provides a unique basket of services that may include water purification, groundwater recharge, flood control and species habitat.<sup>87</sup> To know whether the wetland being purchased and preserved offers equivalent ecosystem services to the one being built upon it is necessary to evaluate and compare their contributions in each of these service areas. As Salzman and Ruhl demonstrate, this is a complex and expensive endeavor that is fraught with uncertainty. The result is that “practical constraints . . . in terms of costs, time demands, and complexity—have prevented wetland mitigation banking from ensuring currency adequacy.”<sup>88</sup> Regulators have largely thrown up their hands and relied on pure acreage as a measure of trading equivalency. This does not ensure that environmental protection goals will be met.<sup>89</sup> The complexity and cost involved in constructing “apples to apples” comparisons in ESS for ESS trades represent a major hurdle for this type of trading program.

As illustrated by carbon sink trading, fungibility of type is not as large an obstacle when ecosystem services are substituting for

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84. Salzman & Ruhl, *supra* note 12.

85. *Id.* at 611.

86. *Id.* at 629, 662-63. They also demonstrate issues with respect to fungibilities of space, *id.* at 627, and time, *id.* at 630. By fungibilities of space, Salzman and Ruhl refer to the fact that the location at which the environmental good is provided can affect its impact on human health and the environment. An example would be a trading program in which a group of nearby facilities buy up a large number of emission rights and then increase their own emissions to the point that they create a local emissions “hotspot.” *Id.* at 627-28. By fungibilities of time, they refer to situations in which the environmental good that is being purchased, and the one that it is replacing, are provided at different time periods. For example, a reduction in ozone-forming pollutants during the winter is far less environmentally beneficial than the same reduction during the summer ozone season. *Id.* at 630.

87. *Id.* at 612, 657.

88. *Id.* at 665.

89. *Id.*

technology-based services (ESS for TBS exchanges). Carbon sinks and energy efficiency projects are largely fungible with respect to the one service at issue—the removal of GHG from the atmosphere.<sup>90</sup> It is true that forest carbon sinks, like wetlands and other ecosystem services, provide a basket of services. They provide not only carbon removal but also species habitat, watershed protection, water filtration, timber resources (if properly managed), recreational opportunities and aesthetic pleasures.<sup>91</sup> In these respects, they are not fungible with energy efficiency projects which generally offer none of these benefits.

Yet in the ESS for TBS trading context these differences appear, not as an obstacle, but as a socially beneficial surplus from the trade itself. The purchaser is paying for carbon removal. But the trade also produces other co-benefits to human society and the environment. These co-benefits are directly linked to the fact that the trade is for an *ecosystem* service since it is in the nature of ecosystems to provide such baskets of services. This “co-benefit surplus” should be a consistent feature of ESS for TBS trades. It is present when a developing country’s expansion of a forest replaces an Annex B Party’s installation of energy efficiency technology. It is equally present when New York City relies on land preservation and conservation in place of a water filtration plant to clean its water supply. However, the surplus does not usually emerge from ESS for ESS trades since both the resource that the buyer is damaging, and the one that the seller is protecting, potentially offer all the services in the basket. In the ESS for ESS context, the multi-service nature of ecosystems results in complexity and cost rather than a social surplus. The co-benefit surplus is one of the primary arguments in favor of including carbon sink trading under Kyoto. This could be generalized into an argument in favor of trading systems that involve the substitution of ecosystem services for technology-based services.

Drawing on Professor Jonathan Wiener’s work, another virtue of the co-benefit surplus is that it should help to secure the “Voluntary Assent” needed to draw developing countries into the climate change regime.<sup>92</sup> Professor Wiener argues that the traditional discourse about the relative merits of environmental regulatory tools has always assumed that the state or some other such actor would

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90. Some fungibility issues arise from the Kyoto Protocol’s decision to recognize six GHG’s and to translate them into carbon dioxide equivalents. But these issues are not unique to carbon sinks and affect trades that involve purely technology-based measures. They cannot be said to constitute a problem inherent to *ecosystem services* trading.

91. See *supra* notes 56-62 and accompanying text.

92. Jonathan Baert Wiener, *Global Environmental Regulation: Instrument Choice in Legal Context*, 108 YALE L. J. 677 (1999).

have the power to implement and enforce the chosen method.<sup>93</sup> That premise does not hold in the international arena, which is based on consensus and voluntary assent.<sup>94</sup> These conditions favor regulatory systems that can efficiently encourage voluntary participation.<sup>95</sup> Weiner argues that where regulated parties (in this context, nations) can choose whether or not to participate in the regulatory scheme this changes the calculus in ways that favor economic incentive systems over command-and-control methods, and trading approaches over subsidies or pollution taxes.<sup>96</sup>

In the specific context of international ecosystem services trading—such as carbon sink trading under the CDM—the co-benefit surplus would seem to bolster Wiener’s account of the virtues of trading. Co-benefits such as water purification, flood control, species habitat and recreational opportunities tend to be localized. This means that the developing country will generally capture more of these co-benefits than the purchasing developed nation.<sup>97</sup> So long as this does not result in purchasing countries demanding a large price discount it should provide developing nations with more of an incentive to engage in the international climate regime than would a trading system that limited itself to technology-based solutions. This should help to secure their voluntary assent to and participation in the international effort.

The carbon sink example also demonstrates that there are significant risks posed by trading systems that allow ecosystem services to replace technology-based services. As explained above, carbon sink removals are harder to measure and monitor than technology-based GHG reductions.<sup>98</sup> This stems, in part, from the fact that these sinks are ecosystem services that must necessarily be spread out over wide areas and do not lend themselves to continuous emissions monitoring at the stack. While there is some progress being made in this area through remote sensing and other technologies, carbon sinks will always be at a disadvantage when it comes to counting and accountability. This downside will probably be true of many ecosystem services when they are compared to their technology-based counterparts.<sup>99</sup> The difficulties in

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93. *Id.* at 683.

94. *Id.*

95. *Id.* at 742-55.

96. *Id.* at 780.

97. The purchasers, as members of a global society, also benefit from species preservation and from the increased income and stability in the developing nation; however, it is the developing host nation that captures the majority of this co-benefit surplus.

98. *See supra* notes 64-68 and accompanying text.

99. *Cf. Salzman & Ruhl, supra* note 12, at 612 (wetlands mitigation program “can suffer from a lack of accountability (or, more accurately, a lack of countability)”).

measuring and monitoring carbon sinks may also make these projects more prone to “leakage” than technology-based alternatives. While pollution control measures can create leakage (customers shift from the higher-priced pollution reducer to the high polluting, cheaper competitor), it should be easier to track and monitor such shifts in demand, and therefore to address them. Shifting use of forestlands will likely prove more difficult to track.

Carbon sinks also exacerbate the problem of emission reduction “permanence.” A technology-based solution, such as an energy efficiency project that stops a ton of pollutant from being emitted to the atmosphere, permanently prevents pollution. A carbon sink’s GHG benefit exists only so long as the forest remains healthy and sound. Again, this lesson can probably be generalized to ESS as a whole which, as natural systems, are more subject to variation and change over time than a piece of technology. Carbon sinks also present uncertainties with respect to their efficacy in removing GHG from the atmosphere. Some models project that a rise in global temperatures may increase soil and plant respiration, thereby reducing forests’ functionality as a carbon sink.<sup>100</sup> While these projections are highly questionable,<sup>101</sup> that very uncertainty may constitute the lesson. Ecosystems are more complex than technology and so can generate more uncertainties with respect to their ultimate environmental effects.

In sum, the carbon sink example suggests a theoretical framework for thinking about when ESS for TBS trading programs should be utilized as a supplement to TBS-only command-and-control or trading regimes. The first piece of this framework is the idea that ESS for TBS trades can yield cost savings and will generally produce a co-benefit surplus that is not available from TBS-only regimes. The second is that ESS for TBS exchanges create additional difficulties in the areas of measurement, monitoring, permanence, and leakage. These downsides, too, are directly linked to the fact that ecosystem services are being substituted for technology-based services. This suggests a rough formula: ESS for TBS exchanges should be incorporated into a trading regime only where the co-benefit surplus plus cost savings outweighs the difficulties associated with measurement, monitoring, permanence and leakage. Where the reverse is true, they should not be used. This is, in a nutshell, the debate over the use of carbon sinks that has played out over the past years in the context of the Clean Development Mechanism.

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100. Brown et al., *supra* note 59, at 1598-99.

101. *Id.*

Making this determination in the context of a given ESS for TBS trading opportunity will be an inexact science. However, it is possible to identify some factors that should be incorporated into the analysis. Policymakers should assess:

1. The nature and magnitude of the co-benefits associated with using an ecosystem rather than a technology-based service to accomplish environmental ends;
2. The potential cost savings associated with ecosystem services when compared to a technology-based approach;
3. Whether the regulatory system is part of national law where Unitary Fiat is the rule, or international law where Voluntary Assent is required;
4. Whether the co-benefits inure principally to the host nation, and whether this is likely to be a developing country;
5. The nature and extent of the measurement, monitoring, permanence and leakage difficulties;
6. The availability of technologies (e.g. remote sensing) that can lessen these difficulties;
7. The governance characteristics of the jurisdiction that would host the ecosystem service and its enforcement capabilities;
8. The nature of the technology-based alternatives and the degree of certainty and accountability that they offer.

While this is not an exhaustive list, it should assist with determining whether a given ESS for TBS trading scheme would yield important environmental and social benefits, or whether it would ultimately fail to deliver the environmental goods.

