Urban Forests and Carbon Markets: Buyers' Perspectives

Neelam C. Poudyal, Jacek Siry, and J.M. Bowker

ABSTRACT

Currently, carbon credit prices frequently do not reflect the type and location of offset projects. Because of the social image and ancillary benefits, buyers may place higher value on credits sourced from certain types of projects such as urban forestry. This study surveyed carbon credit buyers participating in the Chicago Climate Exchange to assess their preferences for credits from various offset projects. Specifically, it evaluated the desirability of carbon credits sourced from urban forestry projects and analyzed buyers' preferences, motivations, and attitudes toward a price premium for credits from urban forests. Results indicate that the buyers are largely interested in knowing the type and location of offset projects. Locally generated credits were strongly preferred to those produced farther away, and credits sourced from urban forestry projects were more desirable than those sourced from other common projects currently in the market, such as methane capture or agriculture. Buyers indicated environmental and social benefits, offset quality, environmental responsibility, and public image as motivations for preferring credits sourced from urban forestry projects, for which they were also willing to pay a modest price premium. Furthermore, significant differences in preferences and willingness to pay were observed between buyers with different corporate goals, emission levels, and geographical scope of operation.

Keywords: urban forestry, carbon credits, market, buyers, offset projects, carbon credit price

Forests capture and store vast amounts of carbon in biomass and soils. Forests in the United States were estimated to sequester more than 750 million tn of CO_2 in 2003 alone (US Environmental Protection Agency 2005). Domestic forest carbon credits accounted for about 7 million tn in 2008, making it the second largest source of carbon offsets in the Chicago Climate Exchange (CCX) registry. Carbon sequestered through private and industrial forest practices provides virtually all of the current forest-based carbon offset credits in US and European markets. However, the future demand for carbon could be substantially higher as governments continue deliberately introducing new climate change mitigation regulations. A potential new source of carbon credits, beyond the boundaries of industrial and nonindustrial private forestland, is urban forests (Rowntree and Nowak 1991, McPherson 1994, Jo and McPherson 2001). There is a growing interest among environmental groups, local governments, and their voting constituents to store carbon in urban trees and sell the offset credits to generate revenue (Poudyal et al. 2010).

Existing urban forest resources in the United States offer ample marketing opportunities. Urban areas maintain average tree coverage of 27% (Nowak et al. 2001) and consist of millions of trees along streets and in parks, riparian buffers, and other public areas. Research findings indicated that there are 4 billion urban trees in the United States (Nowak et al. 2001) and another 70 billion are growing in metropolitan areas nationwide (Bratkovich et al. 2008). Nowak and Walton (2005) projected that the share of urban land in the United States will increase to 8.1% by 2050. An earlier study by Nowak and Crane (2002) estimated that urban forests in the conterminous United States can absorb 22.8 million tn of atmospheric carbon annually. Based on this finding, the total carbon storage capacity in urban forests in the conterminous United States was estimated at 700 million tn. Additionally, there is a growing interest at the local government level to initiate carbon storage projects and carbon credit trading. For example, the Mayors Climate Protection Center was established in 2007 to help municipal governments mitigate and reduce the impacts of global warming. The center currently has more than 1,000 members, who are committed to reducing their greenhouse gas (GHG) emissions through various actions such as land-use management and/or bipartisan campaigning to establish a national emission trading system. A recent survey of likely sellers of urban forest carbon credits indicated that local governments in the United States have technical and managerial capability to implement offset projects and that they are genuinely interested in selling the carbon stored in urban trees and forests (Poudyal et al. 2010).

However, little is known about buyers'

Received March 10, 2010; accepted February 23, 2011.

Neelam C. Poudyal (npoudyal@warnell.uga.edu) is assistant professor, and Jacek Siry (jsiry@warnell.uga.edu) is associate professor, Warnell School of Forest Resources, University of Georgia, Athens, GA 30602-2152. J.M. Bowker (mbowker@fs.fed.us) is research social scientist, Southern Research Station, USDA Forest Service, Atlanta, GA 30602.

preferences for carbon credits sourced from urban forests. Current market carbon credit prices do not necessarily reflect the type and location of offset projects. Despite the fact that revenue generated from sales of carbon credits could help communities in many ways, the source of offset credits is largely unknown to the buyers. For example, buying offset credits generated by storing carbon in urban trees could help local governments raise revenue to manage trees and greenery and also would benefit residents with aesthetic beauty and other ecosystem services. Similarly, buying offset credits from rural forestry projects could help fuel local economic growth and potentially contribute to alleviating poverty (Lipper and Cavatassi 2004, Antle and Stoorvogel 2009).

An earlier survey of carbon credit buyers concluded that buyers want to purchase the credits from reliable agencies (Neeff et al. 2009). From an intuitive standpoint, we expect that urban forest credits should be desirable for businesses because of the credibility of local governments that implement offset projects and their joint benefits (e.g., ecosystem services) to the local population. Joint benefits could be important because they would help businesses earn social recognition and potentially improve their green image. Offering a price premium for carbon stored in cities in which businesses operate or market their products and services may be very important to companies for positive image promotion. Because most companies are located in big cities or urban areas, carbon credit purchases from local projects may be viewed as an effort to promote environmental and social responsibility. However, we currently do not know whether buyers prefer carbon credits sourced from certain locations (e.g., local versus regional) or whether they are willing to pay more for credits sourced from certain project types (e.g., urban forestry versus agriculture).

Appropriate market protocols could be developed once there is a clear understanding of the demand side of the market (e.g., buyers' preferences and willingness to pay, to name a few) for urban forest carbon credits. This can be achieved in several ways. First, a growing interest by credit buyers with strong preferences for certain offset project types and specific characteristics may encourage existing market platforms to revise or advance their market protocols to accommodate such specific credit. The case of urban forestry projects at the CCX provides an example. Eligibility requirements at the CCX require trees to have been planted since 1990, tree owners to be insignificant GHG emitters, and a 15-year commitment period—these requirements are not difficult for urban forestry projects, given their public ownership and long-term conservation goals. Clearly, there are some technical challenges including density-space requirements and the relevancy of growth and carbon uptake tables the CCX uses to monitor and quantify the carbon. However, recent developments in urban forestry technology have made expanding the growth rate tables for individual trees possible, along with taking advantage of customized look-up tables. As a result of these developments, the CCX, which did not initially consider urban forestry projects for carbon registry, has recently approved its first urban forestry carbon project (CCX 2009). In addition, there are other potential registries and markets that in the future may consider trading urban forest carbon credits. Second, once the existing over-the-counter sellers become aware of the fact that the buyers have different preferences for such credits, they will find incentives to supply these credits. Third, with the emergence of information that such market segment exists, local government units and municipalities, who are the owners and managers of urban forestry projects, could label their products and jointly establish new market platforms.

A limited number of studies have attempted to address these issues. For example, Ashford et al. (2008) analyzed trends in carbon offset sales to examine what buyers think are important factors in selecting offset credits. Hamilton et al. (2008, 2009) assessed company motivations for participating in voluntary carbon markets. However, these three studies were based on sales and retirement data obtained from credit suppliers and may not necessarily reflect the buyers' stated preferences and intentions. Recently, Neeff et al. (2009) surveyed 141 corporate participants in carbon markets to examine their attitudes and preferences for project characteristics as well as their willingness to pay for forest carbon credits.

Other studies have adopted contingent valuation surveys to assess individual willingness to pay to offset personal carbon footprints. For example, Brouwer et al. (2008) surveyed air travelers to elicit their willingness to pay for offsetting emissions from personal flights. Ott (2009) conducted an online survey of the general Internet public to determine how much they were willing to pay for offsetting emissions associated with a hypothetical vacation trip. However, the respondents in these two studies were not the typical buyers such as businesses or organizations with voluntary or mandatory emission reduction targets. Also, a particular market segment, such as urban forest carbon credits, was not the focus of any of these previous studies.

Because previous studies did not examine buyers' perspectives regarding urban forest carbon credits, this study surveyed current and prospective buyers of carbon credits to address this knowledge gap. The specific objective of the present study was to assess buyers' preferences and attitudes toward a price premium for urban forest carbon credits. It also evaluated motivations and issues that can be important for buyers' decisions regarding purchases of urban forest carbon credits, and it compares the desirability of urban forest credits with other types of carbon projects. In addition, we statistically tested the difference in preferences and the willingness to pay for urban forestry carbon credits among buyers with different business characteristics.

Methods

Individual businesses and organizations (private, public, and nonprofit) currently involved in buying carbon credits were identified as potential respondents for a survey questionnaire addressing the objectives stated previously. Because a major objective of this study was to assess opinions of actual primary carbon credit buyers and ascertain if they were willing to pay a price premium for credits sourced from urban forests, only businesses and organizations currently involved in carbon trading at the CCX were targeted.

Two categories of CCX participants were queried: members and associate members. Members are businesses and organizations with a commitment to reduce their direct emissions whereas associated members are those with a commitment to reduce their indirect emissions. Other member categories, such as aggregators and liquidity providers, were not surveyed because they are not primary users of carbon credits and may have little influence on ultimate credit demand. The targeted group was very diverse in terms of geographic location and business sector. Respondents represented manufacturing, real estate, information technology, financial services, electric power generation,

consulting, electronics, and forest products sectors.

A modified Tailored Design Method for mail questionnaires (Dillman 2000) was adopted to administer the survey consisting of 28 questions. Most of the questions consisted of a statement followed by a 5-point Likert scale format answer to let respondents indicate their level of agreement/disagreement/importance with the statement. In the first section, respondents were asked questions about their attitudes and perceptions related to several issues including climate change, existing emission control regulations, and relationships with their clients. Questions in the second section asked them to indicate their preference for four types of credits based on the location of offset projects: (1) international sequestration projects (e.g., projects outside the country of emission source), (2) national sequestration projects (e.g., projects within the country of emission source), (3) regional sequestration projects (e.g., projects within a region of emission source such as the Southeast or Midwest United States), and (4) local sequestration projects (e.g., within 200 mi of emission sources). Similarly, they were also asked to indicate their preference for credits generated from five major types of carbon offset projects including (1) rural forestry, (2) urban forestry, (3) agriculture (agriculture methane or agriculture soil carbon), (4) methane gas (coal mine methane or landfill methane), and (5) a permanent switch to renewable energy.

The third group of questions focused on their motivations and interest in purchasing urban forest carbon credits. Valuation questions in this section used the standard payment card format (Welsh and Poe 1998; Cho et al. 2005) to elicit their willingness to pay above the current market price for credits sourced from urban forestry. The payment card contained a range of premium options in line with the clearing price at the time of the survey and allowed respondents to indicate the maximum premium (above the market price) their institution would be willing to offer for a carbon credit sourced from an urban forestry project. Questions about price premiums were asked in three different scenarios. The first scenario was a typical valuation question as in nonmarket studies (Cho et al. 2005), which offered no options other than the offset credit to buyers for the price they pay. In the second scenario, buyers were told that they would receive a certified sign or logo from the city acknowledging the purchase of carbon stored in the city's trees. The idea was to determine whether offering official recognition would make a difference in willingness to pay (i.e., whether the recognition had additional value). In each of these two scenarios, respondents were provided with a range of prices to indicate the premium they were willing to offer. Those included \$0.00, 0.01, 0.05, 0.10, 0.15, 0.25, 0.50, 0.75, 1, and an open-ended amount of more than \$1 (in US dollars). The header of the payment card reminded respondents of the concurrent market price for a credit (then \$0.50).

A third scenario was developed to allow for the possibility of mandatory carbon emissions regulations. Currently, only voluntary carbon markets exist in the United States and many parts of the world outside Europe. Carbon credit prices in the European Union Emission Trading System are currently much higher than prices in North American markets such as the CCX, largely because of the presence of legal mandates to reduce emissions. Carbon credit market prices in the United States and elsewhere are expected to increase if governments introduce mandatory regulations. The presence of regulations could make a difference in buyers' willingness to pay and, ultimately, the market clearing prices for carbon credits. So this scenario allowed for higher market prices for credits in the presence of mandatory regulations. The motivation was to better understand buyers' willingness to pay premiums for urban forest credits in the presence of mandatory regulation. This hypothetical scenario considered mandatory regulations in the United States to be implemented in a few years, leading to higher prices of carbon credits. Using European markets as a reference, six price levels were assumed: \$5, 10, 15, 20, 25, and 30 (in US dollars) per metric ton CO_2 emission credit. For each price scenario, respondents were asked to indicate how much more they were willing to pay for credits sourced from urban forests.

The final set of questions was about the characteristics of survey participants such as workforce size and asset value. Respondents were also asked to provide comments on a preallocated space at the end of the survey. Experts in the area of urban forestry and natural resource valuation surveys reviewed the instrument, [1] which was later pretested on a subset of respondents.

Altogether, there were 186 potential respondents from the CCX list of members and associate members at the time of survey. Initially, we tried to contact as many participants as possible by telephone. Because organizational structures of many participant organizations were rather complex, initial telephone contact was made for two reasons. First, it helped us find an appropriate official in charge or someone capable of completing the survey. Second, it provided an early confirmation of their participation and an opportunity to choose the mode of survey delivery (regular mail or e-mail) to maximize the response rate. Regardless of the delivery mode, the implementation process was the same for all respondents. In cases where an initial phone call was unsuccessful, the survey was sent by regular mail addressed to the chief executive officer of the organization.

The survey was implemented in the fall of 2009. A copy of the survey along with a personalized cover letter or e-mail message was mailed or e-mailed to participants. After 2 weeks, a reminder with a copy of the questionnaire was sent. Because of low response rate, a third reminder, along with a copy of the questionnaire, was sent to potential respondents in the mailing list, whereas those who preferred e-mail were contacted in the fourth round.

Survey responses were digitalized and processed for summary and statistical analysis. The χ^2-best and t-test statistics were used to test for differences in mean preference, ranking, and the willingness to pay for carbon credit, as well as for differences among respondents with different business characteristics.

Results

Of 186 contacts, 31 had undeliverable mail or e-mail addresses and 15 were unwilling to participate. A total of 58 responses were received. The exclusion of undeliverable addresses and those who refused participation yielded an adjusted response rate of 41%. Excluding the participants who refused to participate in the survey is probably justifiable because most of them expressed their unwillingness to participate at the time of the early contact, even before examining the actual content of the survey. Others, who refused to participate after receiving the survey cited company policy or changes in their portfolio of projects as major reasons for being unable to participate in the survey. Therefore, we assume that their refusal was not to protest the ideas incorporated in the survey and that they are randomly distributed among market participants.

Table 1. Respondents' characteristics.

Variable	Statistics
Ownership	
Private/For profit	55%
NGO or public organizations	25%
Government	20%
Median employment in organization	1,150
Geographical scope of business	
United States only	48%
North America	10%
Worldwide	35%
Other	7%
Target of reducing GHG emissions	
No target	36%
<5%	10%
6–10%	23%
11–20%	12%
21–50%	9%
51–75%	2%
76–100%	5%
Participation in carbon trading	
<1 yr	7%
1–3 yr	40%
3–5 yr	22%
>5 yr	29%
Estimated annual emissions (median), metric ton of CO_2 equivalent	47,150
Carbon credits purchased in 2008 (mean), metric ton	32,920

NGO, nongovernmental organization.

Table 2. Respondents' preferences for credits from carbon projects in various locations.

Location of carbon projects	Preference (%) 5 Most preferred	4	3	2	1 Least preferred	No preference	Mean preference score
International	0	9.3	7.4	18.5	24.1	40.7	2.03
National	5.6	13.0	33.3	7.4	1.9	38.9	3.21
Regional	5.6	46.3	5.6	0	0	42.6	4.00
Local	52.0	7.4	0	0	0	40.7	4.87

Note: A Pearson's χ^2-test rejected the null hypothesis of the same preference level between companies with domestic and international operations for international projects ($\chi^2 = 10.66$; $P = 0.03$), national projects ($\chi^2 = 9.80$; $P = 0.08$), regional projects ($\chi^2 = 7.85$; $P = 0.04$), and local project ($\chi^2 = 12.05$; $P = 0.00$). However, similar tests of the difference in preference for each project type yielded insignificant statistics between private and nonprofit companies, small and large companies, and companies with high and low annual emission rates.

Respondents were diverse. In terms of ownership, roughly 55% were private or for profit agency, about 25% were nongovernmental organizations or public organizations, and the remaining 20% were government entities (Table 1). Regarding the size of their workforce, respondents varied from as low as 2 to as high as 21,000 with a median size of nearly 1,150. In terms of the geographical scope of businesses, nearly 48% of all respondents indicated the United States as the only marketing or primary area of business and another 35% indicated worldwide operations.

Although nearly all respondents had a rough estimate of their annual GHG emissions, only about two-thirds of them had a target set for reducing emissions in the near future. Nearly one-half of the respondents had been participating in carbon trading for more than 3 years. In 2008, the respondents bought, on average, 33,000 CO_2 equivalent credits.

Respondents' Environmental Awareness and Emissions Regulations

We examined general attitudes and opinions of offset buyers regarding emission regulations, preferences for proenvironmental customers, and their current initiatives toward emission offsets. A clear majority (73%) of respondents felt that their customers would favor a company that reduces its GHG emissions. Similarly, 86% indicated favorability toward suppliers who reduce GHG emissions, if the costs were comparable with other suppliers. Roughly, two-thirds (67%) of respondents agreed that their company would consider paying a premium to suppliers who reduced GHG.

When asked about their preferences for government regulations toward reducing GHG emissions, nearly two-thirds (66%) of the respondents indicated that they preferred government regulations as opposed to no government regulation of GHG emissions. However, fewer respondents (55%) indicated a preference for mandatory regulations as opposed to voluntary regulations with standards.

Respondents' Preferences for Offset Projects

We assessed how buyers value and show preferences for credits sourced from offset projects that are various distances from the source of emissions or their business facilities. The idea of global carbon cycle indicates that the effect of CO_2 is global. Therefore, the physical location of the offset project does not matter as long as it sequesters atmospheric carbon (Ramseur 2008). However, we wanted to know if the location of offset project mattered to buyers. Knowing whether they preferred to buy credits from local projects may indicate their preference for buying urban forest credits from local cities. Results indicated that as many as 75% of the respondents were interested in knowing the location of offset projects that generate carbon credits that they purchase. When asked to rank their preferences for credits from the projects based on location, nearly 52% considered credits from local sequestration projects as the most preferred (Table 2).

Respondents' preferences for carbon credits by location of offset projects are presented in Table 2. Based on a 5-point preference ranking scale (5 = most preferred and 1 = least preferred), respondents placed the highest preference score, 4.87, on credits sourced from local projects, followed by 4.00 for credits from regional projects, and 3.21 for credits from projects generally within the country. International offset projects were ranked last with a preference score of 2.03.

We also tested whether preferences for credits from specific projects differed by the company's location of business operation, profit or nonprofit motive, company size (big companies with more 1,000 employees and small companies with less than 1,000 employees), and emission levels (large emitters of more than 100,000 metric tn of annual CO_2 emissions and small emitters of less than 100,000 metric tn of annual CO_2 emissions). A Pearson χ^2-test indicated that respondents with domestic (only within the United States) and international operations had statistically different preferences for credits generated from international projects ($\chi^2 = 10.66$; $P = 0.03$), national projects ($\chi^2 = 9.80$; $P = 0.08$), regional projects ($\chi^2 = 7.85$; $P = 0.04$), and local projects ($\chi^2 = 12.05$; $P = 0.00$). There were no statistically significant differences in preferences for those projects between private and nonprofit companies, between small and large companies, and between large and small emitters.

Carbon credits currently traded in the carbon market do not disclose information about the source of the carbon to the buyers. As a result, based on the market data alone, it is difficult to determine if buyers prefer cred-

its generated from certain types of offset projects or possibly place a higher value on credits from certain projects. Almost 72% of survey respondents indicated that they would be interested in knowing the type of project from which their purchased credits were generated. Pearson χ^2-test results indicated that the level of interest was not statistically different among respondents based on their ownership type or geographical scope of business.

Considerable variation in survey responses was observed regarding the level of preference that respondents placed on credit sourced from different types of offset projects. Information presented in Table 3 indicates that nearly 54% of respondents appeared to have the highest preference for carbon credits generated from permanent switch to renewable energy projects, and 17% of the respondents had highest preference for credits from rural forestry projects. Only 7.5% indicated that credits generated from urban forestry projects were the most preferred.

However, a comparison of respondents' preferences indicated that carbon credits sourced from urban forests were indeed highly desirable when compared with other commonly traded credits in the market (Table 3). On the 5-point preference ranking scale (5 = most preferred and 1 = least preferred), urban forest carbon credits placed third with a preference score of 3.50, behind credits generated from permanent switch to renewable energy (4.67) and credits from rural forestry (3.68). Credits generated from methane capture projects and agriculture projects were ranked behind urban forestry with scores of 3.25 and 3.16, respectively. However, the difference in the level of preference between rural forestry credit and urban forestry credit was not statistically significant ($t = 1.72$; $P = 0.09$). A Pearson χ^2-square test showed that the respondents with domestic operations only showed a significantly higher level of preference for urban forestry credits compared with their counterparts with domestic and international operations ($\chi^2 = 11.16$; $P = 0.04$). In contrast, the respondents with worldwide operations indicated a significantly higher level of preference for renewable energy credits than domestic operators. ($\chi^2 = 8.36$; $P = 0.03$). Furthermore, preferences for methane gas capture projects were statistically different between large emitters and small emitters ($\chi^2 = 13.30$; $P = 0.02$) and also between small businesses and big businesses ($\chi^2 = 14.26$; $P = 0.01$), with small businesses placing significantly higher levels of preference than their larger counterparts.

Table 3. Respondents' preferences for credits from various types of carbon projects.

Location of carbon projects	Preference (%) 5 Most preferred	4	3	2	1 Least preferred	No preference	Mean preference score
Urban forestry[a]	7.4	27.8	16.7	2.0	5.6	40.7	3.50
Agriculture	7.4	18.5	13.0	13.0	5.6	42.6	3.16
Methane gas capture[b]	13.0	20.4	13.0	0	11.1	35.2	3.25
Permanent switch to renewable energy[c]	53.7	11.1	0	3.7	0	31.5	4.67

[a] Pearson's χ^2-test rejected the null hypothesis of the same preference level between companies with domestic and international operations as well ($\chi^2 = 11.16$; $P = 0.04$).
[b] Pearson's χ^2-test rejected the null hypothesis of the same preference level between small businesses and big businesses ($\chi^2 = 14.26$; $P = 0.01$), and high emitters and low emitters ($\chi^2 = 13.30$; $P = 0.02$).
[c] Pearson's χ^2-test rejected the null hypothesis of the same preference level between companies with domestic and international operations ($\chi^2 = 8.36$; $P = 0.03$).

Table 4. Importance of urban forestry carbon credits' attributes to respondents.

Attributes	Importance (%) Important	Neither important nor unimportant	Unimportant
Community economic and environmental benefits[a]	71.4	20.0	8.6
Proximity to business[a]	29.4	50.0	20.6
Linkage with core business[a]	31.4	51.4	17.2
Environmental responsibility[a]	71.4	20.0	8.6
High quality of credits[b]	68.6	20.0	11.5
Public image[a]	70.6	14.7	14.7
Relationship with local governments	52.9	32.4	14.7

[a] Pearson's χ^2-test rejected the null hypothesis of the same importance for community and environmental benefits ($\chi^2 = 11.99$; $P = 0.00$), proximity to business ($\chi^2 = 9.52$; $P = 0.04$), linkage with core business ($\chi^2 = 9.33$; $P = 0.05$), environmental responsibility ($\chi^2 = 15.34$; $P = 0.00$), and public image ($\chi^2 = 10.98$; $P = 0.02$) between large emitters and small emitters.
[b] Pearson's χ^2-test also rejected the null of the same importance of high quality credits between small businesses and large businesses ($\chi^2 = 8.03$, $P = 0.09$).

Motivations and Attitudes toward Urban Forest Carbon Credits

An important objective of this study was to assess the motivations and intentions of buyers toward purchasing urban forest credits. Respondents were asked about the importance of certain attributes of urban forest credits. Attributes included community economic and environmental benefits, public image, environmental responsibility, carbon credit quality, linkage with core business, proximity, and relationship with local governments. Among seven attributes, community economic and environmental benefits, public image, and environmental responsibility associated with urban forestry projects were revealed as important by nearly 71% of respondents (Table 4). Similarly, 69% considered the potentially high quality of carbon credits from urban projects as important, whereas the remaining attributes were considered relatively unimportant. The relationship with local governments was important to 53% respondents, although proximity to their business and connection to their core business were thought important by only 30% of respondents. In terms of the 5-point ranking scale (5 = extremely important and 1 = extremely unimportant), environmental responsibility scored the highest importance rating (4.00), whereas proximity to business received the lowest importance rating (3.08).

A Pearson χ^2-test indicated statistically significant differences in importance placed by large emitters and small emitters on various attributes of urban forest carbon credits. For example, respondents with smaller annual emissions placed significantly higher levels of importance on community and environmental benefits ($\chi^2 = 11.99$; $P = 0.00$), proximity to business ($\chi^2 = 9.52$; $P = 0.04$), linkage with core business ($\chi^2 = 9.33$; $P = 0.05$), environmental responsibility ($\chi^2 = 15.34$; $P = 0.00$), and public image ($\chi^2 = 10.98$; $P = 0.02$) than those with

larger annual emissions. The test also showed that small businesses and large businesses would place significantly different levels of importance on the relationship with local government when deciding to buy urban forestry credits ($\chi^2 = 8.03$; $P = 0.09$). Respondents with a larger workforce placed a higher level of importance on this attribute.

Price Premiums for Urban Forestry Carbon Credits

Understanding the value buyers place on credits generated from urban forest projects is important to evaluate marketability and revenue generation potential. We asked respondents whether they would be willing to pay more for credits generated from selected projects to evaluate how they value carbon credits from urban forestry in comparison with alternative carbon sources. When asked if they were willing to pay more for urban forest generated carbon storage, about 55% agreed (Table 5). Comparatively, a lower proportion of respondents showed a higher willingness to pay for credits sourced from other projects. For example, 34% were interested in paying more for credits sourced from forestry projects in the rural United States or for credits from projects promoting nature conservation in developing countries, and 48% were willing to pay more for credits from projects aimed at alleviating poverty in developing countries through carbon payments to forest landowners. Although this observation confounds somewhat with buyer preference rankings explained previously, it corroborates a willingness among companies to support urban forest projects.

Current market price [2] data do not offer information about the value of project types from which credits are sourced. Hence, we attempted to elicit the economic premium, if any, that buyers might place on urban forest credits. It should be noted that credit prices are highly variable in voluntary markets. CCX prices at the time of survey were taken as a base price. This point was underlined in the willingness to pay question to remind buyers of current market price, which was \$0.50 at the time of the survey.

In the first valuation scenario, which did not offer any recognition logo or official sign of purchase to buyers, a majority of respondents (53%) selected the value of \$0 in the payment card, indicating that they were not willing to pay more for urban forest, as opposed to any other type of, carbon credit. A small percentage (10%), however, indicated a willingness to pay more than at least one-half of the market price of \$0.50/credit. About 27% did not respond. On average, [3] buyers were interested in paying an additional \$0.10 for credits sourced from urban forest projects, or about 20% of the market price at that time. Although a *t*-test indicated that the nonprofit organizations were willing to pay a significantly higher premium for urban forestry credits than their for-profit counterparts ($t = 2.28$; $P = 0.02$), there was no significant difference in stated willingness to pay between small and large companies, large and small emitters, and companies doing business domestically only and companies doing business domestically and internationally.

The second valuation scenario, offering official recognition of urban-sourced purchases, yielded an average willingness to pay of \$0.17 more than the stated market price of \$0.50. This premium is nearly 34% of the market price. The difference in stated premium between these two scenarios can most likely be attributed to perceived advertising benefits associated with the official recognition.

When asked to indicate their expected willingness to pay in case of mandatory regulation leading to higher prices of carbon credits, slightly more than two-thirds of the respondents stated their expected willingness to pay for these hypothetical scenarios. The premium for urban forest credits expressed as a percentage of assumed base prices is shown in Figure 1. The results indicated that the respondents were willing to pay as much as 7% more for urban forest credits when the market price is \$5. Expected premium for urban forestry credit decreases to 3% when the market price is \$10

Table 5. Willingness to pay a premium for credits from various types of carbon projects.

Types of carbon projects	Willing to pay premium? (%)		
	Agree	Neither agree nor disagree	Disagree
Urban tree project in a city the company selects	55.2	31	13.7
Project promoting nature conservation in developing countries	34.5	51.7	13.8
Project aimed at alleviating poverty in developing countries through carbon payment to forest landowners	48.2	37.9	13.8
Projects managing forests in the rural United States	34.5	48.3	17.2

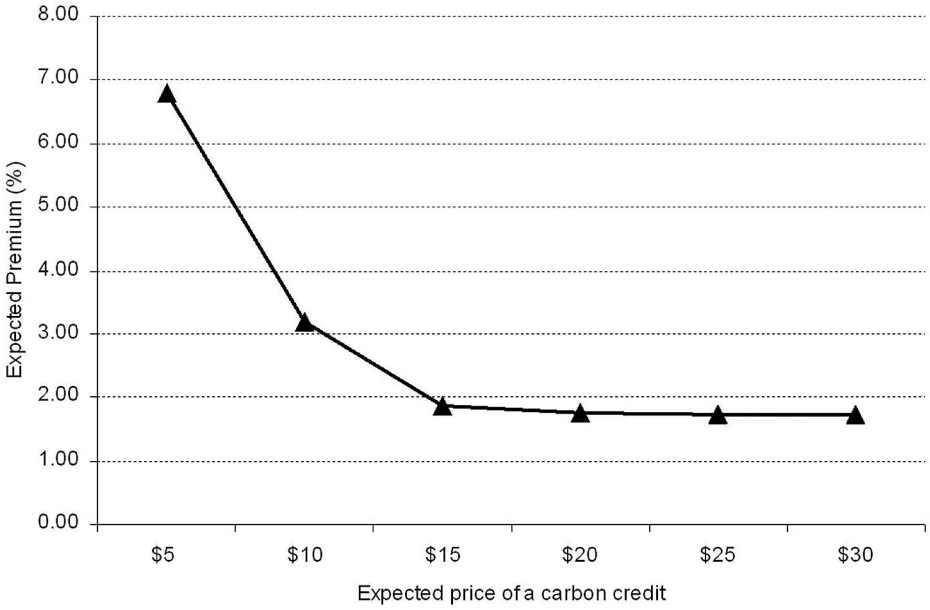

Figure 1. Willingness to pay price premium for urban forest carbon credits at various price levels.

and decreases further to nearly 2% in case of $15. The expected premium dropped to 1.75% when the price was $20 and stayed relatively constant for the next two price levels.

Discussion and Conclusion

Markets for forest carbon credits are growing around the world. However, our understanding of the market potential for credits sourced from urban forests is limited. This study sought to begin to address this knowledge gap by surveying businesses and organizations that are currently engaged in carbon trading in the CCX. The results provide important findings that may have several policy implications in carbon offset project management and urban forestry, particularly in establishing markets for urban forest credits.

First, it presents current buyers' perspectives on the characteristics of offset projects—particularly the desirability of carbon credits sourced from urban forests. Buyers' opinions and perceptions of various offset projects presented in this study can be helpful in meeting the current and anticipating future market demand. Buyers appear to be very interested in knowing the location and type of projects generating credits that they buy. Findings from this study indicate that the closer the location of an offset project to the source of emissions or business operations, the higher the buyers' preference for credits from such projects. In other words, local projects were strongly preferred. Although there is no predecessor in peer-reviewed scientific literature in this area, our observation is consistent with some of the findings incorporated in recent survey reports of national and international business organizations. For example, Hamilton et al. (2008, p. 44) found that over-the-counter customers of carbon credits in the United States and Australia preferred to buy offsets from projects close to home. Similarly, Ashford et al. (2008) also found that buyers place high value on location of projects while selecting their carbon credit suppliers. Because most of the larger emitters are often located within urban or urbanizing areas, this evidence suggests a good marketing scope for local carbon credit projects such as urban forestry. It should be noted, however, that the willingness to pay for locally generated credit such as urban forestry was different between private, for-profit companies and nonprofit organizations, possibly suggesting a difference in the perceived value and corporate motivations.

Second, buyers appear to place importance on the type of project generating the carbon credit. Because the preference for project type and location differs among buyers, credit sellers may promote sales and maximize revenue by identifying the appropriate submarkets. Our result that the highest preference is for credits generated from projects that permanently switch to renewable energy is consistent with the over-the-counter sales record, i.e., a majority (51%) of credits traded in 2008 were sourced from this project type (Hamilton et al. 2009). Nonetheless, the credits sourced from urban forestry were more desirable than those from other common projects in the market such as agriculture or methane capture. Similarly, buyers revealed that factors such as the high quality of carbon credits, economic and environmental benefits to community, corporate environmental responsibility, and public image were more important than relationships with local government, linkage with core business, and proximity in deciding to purchase urban forest credits. This is consistent with the findings of a recent survey, albeit not peer reviewed, conducted by a group of business organizations that buyers put a lot of importance on community and environmental benefits of offset projects (Neef et al. 2009) and that quality criteria such as additionality and certification are important to buyers (Hamilton et al. 2008). These results suggest that proenvironmental and propublic attributes of urban forest carbon credits make them more desirable than other types of credits among the buyers. This is not surprising, however, in voluntary markets in North America, where buyers are more likely to be motivated by their corporate responsibility, goodwill intentions, and public relations than government regulations. Because of the cobenefits urban forest projects yield to local communities, businesses and organizations buying such credits can display the company's support for green projects and garner local public support.

Third, despite the fact that buyers valued some salient attributes of urban forest carbon credits, others were not willing to pay more for them. Still, a significant portion of buyers were genuinely interested in paying more for credits sourced from urban forestry. When the market price for a credit was $0.50, buyers were offering 20% more for the credits sourced from urban forestry projects. This premium can be viewed as the value buyers place on environmental and public relations benefits associated exclusively with the urban forestry credits. More importantly, buyers offered an even higher premium (35% more than the market price of $0.50) for urban forest credits if the local city selling carbon credits provided them with some recognition acknowledging their purchase of the carbon stored in city trees. Because some companies have already started marketing their products along with the message of their voluntary investment to become carbon neutral, an official recognition from local governments may be appealing and desirable to credit buyers. Investment and advertisement of the Carbon Neutral Project through the Volkswagen Forest in the lower Mississippi alluvial plain by Volkswagen is one example of such corporate initiatives to promote a positive public image (Volkswagen of America 2009).

Even in the assumed scenario of higher prices due to presence of mandatory regulations, survey respondents still showed tangible support for urban forestry credits. They were willing to pay a premium for urban forestry credits as a percent of credit value in that scenario, but the value of the premium declined with higher credit prices. However, this information should be viewed cautiously because many unforeseen factors may come into play between now and the time when such mandatory regulation is fully implemented.

In summary, strong buyer preferences for locally generated credits and the comparatively higher desirability of urban forestry projects suggest that urban forest credits could be very competitive in the market and arguably meet expectations of the current buyers. Because earlier studies (Ashford et al. 2008, Neef et al. 2009) also concluded that buyers assign high importance to credibility of the implementing organization, urban forestry could be favored over various alternative sources. Furthermore, the extra premium that the buyers are offering indicates their support for the cobenefits of urban forestry projects and could help city and municipal governments bring in extra revenue to cover the costs of tree care and forest management. Local government and city agencies may see benefits in providing some incentives such as recognition in a form of an official sign, logo, or certification, and then sell their offset product for higher prices. Similar policy instruments such as local tax deductibility might also be investigated to

incentivize buyers to purchase urban forest credits and encourage them to make their business carbon neutral. Establishing appropriate market protocols and disclosing the type and location of carbon projects in existing markets would help in strategic marketing of carbon stored in urban trees and forests. Future research will hopefully take the information presented here into account to recommend appropriate transaction structures and trading platforms for urban forest carbon credits.

Finally, a caveat of this study should be noted. Because we surveyed existing offset buyers currently participating in the CCX, our findings should not be extrapolated to those who are not currently buying offset credits. However, our sample is representative of the early adopters, who are in the market now, and the findings should be interpreted accordingly.

Endnotes

[1] A copy of survey questionnaire is available from authors on request.

[2] The price as described here is for a credit representing the offset of 1 metric tn of CO_2 equivalent.

[3] Because the maximum premium option in the payment card was more than $1, an exact upper bound was not known. Although there are many ways people use to compute an average of censored data, none of them is free of criticism. In our case, however, we added one standard deviation to the lower bound for those choosing the premium option of more than $1.

Literature Cited

Antle, J.M., and J.J. Stoorvogel. 2009. Payments for ecosystem services, poverty, and sustainability: The case of agricultural soil carbon sequestration. *Nat. Resour. Manag. Policy* 31: 133–161.

Ashford, L., J. Barker, C. Davey, N. Dikeman, J. Harris, R. Mountain, N. Thorubrn, and N. Wheeland. 2008. *Carbon offsetting trends survey 2008.* EcoSecurities and Climatebiz, Oxford, UK. 28 p.

Bratkovich, S., J. Bowyer, K. Fernholz, and A. Lindburg. 2008. *Urban tree utilization and why it matters.* Dovetail Partners, Inc. Available online at www.dovetailinc.org/files/DovetailUrban0108ig.pdf; last accessed Mar. 5, 2010.

Brouwer, R., L. Brander, and P. Beukering. 2008. A convenient truth: Air travel passenger's willingness to pay offset their CO_2 emission. *Climate Change* 90(3):299–313.

Chicago Climate Exchange (CCX). 2009. *CCX Offset report*, Vol. 1, No. 5. Chicago Climate Exchange, Chicago, IL. 3 p.

Cho, S., D. H. Newman, and J.M. Bowker. 2005. Measuring rural homeowner's willingness to pay for land conservation easements. *For. Policy Econ.* 7:757–770.

Dillman, D.A. 2000. *Mail and internet surveys: The tailored design method.* John Wiley and Sons, New York. 480 p.

Hamilton, K., M. Sjardin, T. Marcello, and G. Xu. 2008. *Forging a frontier: State of the voluntary carbon markets 2008.* Ecosystem Marketplace and New Carbon Finance, Washington, DC. 79 p.

Hamilton, K., M. Sjardin, A. Shapiro, and T. Marcello. 2009. *Fortifying the foundation: State of the voluntary carbon markets 2009.* Ecosystem Marketplace and New Carbon Finance, Washington, DC. 108 p.

Jo, H.K., and E.G. McPherson. 2001. Indirect carbon reduction by residential vegetation and planting strategies in Chicago, USA. *J. Environ. Manag.* 61:165–177.

Lipper, L., and R. Cavatassi. 2004. Land-use change, carbon sequestration and poverty alleviation. *Environ. Manag.* 33(1):374–387.

McPherson, G. E. 1994. Using urban forests for energy efficiency and carbon storage. *J. For.* 92(10):36–41.

Neeff, T., L. Ashford, J. Calvert, C. Davey, J. Durbin, J. Ebeling, T. Herrera, T. Janson-Smith, B. Lazo, R. Mountain, S. O'Keeffe, S. Panfil, N. Thorburn, C. Tuite, M. Wheeland, and S. Young. 2009. *The Forest Carbon Offsetting Survey 2009.* EcoSecurities Group, Dublin, Ireland. 33 p.

Nowak, D.J., M.H. Noble, S. M. Sisinni, and J.F. Dwyer. 2001. Assessing the US urban forest resource. *J. For.* 99(3):37–42.

Nowak, D.J., and D.E. Crane. 2002. Carbon storage and sequestration by urban trees in the USA. *Environ. Pollut.* 116:381–389.

Nowak, D.J., and J.T. Walton. 2005. Projected urban growth (2000–2050) and its estimated impact on the US forest resource. *J. For.* 103(8):383–389.

Ott, C. 2009. *Willingness to pay for opt-in offsets in the voluntary carbon market.* Senior Thesis, Barnard College, Columbia Univ., New York. 59 p.

Poudyal, N.C., J. Siry, and J.M. Bowker. 2010. Urban forest's potential to supply marketable carbon emission offsets: A survey of municipal governments in the United States. *For. Policy Econ.* 12:432–438.

Ramseur, J.L. 2008. *The role of offsets in a greenhouse gas emissions cap-and-trade program: Potential benefits and concerns.* US Congressional Research Service, CRS Rep. RL 34436. Washington, DC. 39 p.

Rowntree, R.A., and D.J. Nowak. 1991. Quantifying the role of urban forests in removing atmospheric carbon dioxide. *J. Arboricult.* 17(10):269–275.

US Environmental Protection Agency. 2005. *Greenhouse gas mitigation potential in U. S. forestry and agriculture.* EPA 430-R-05-006, Office of Atmospheric Programs, Washington, DC. 154 p.

Volkswagen of America. 2009. Carbon neutral project through the Volkswagen forest. Available online at www.vw.com/vwhype/carbon-neutral/en/us/; last accessed Jan. 10, 2010.

Welsh, M.P., and G.L. Poe. 1998. Elicitation effects in contingent valuation: Comparison to a multiple bounded discrete choice approach. *J. Environ. Econ. Manag.* 36(2):170–185.