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Market-Based Approaches Toward the Development of Urban Forest Carbon Projects in the United States

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1. Introduction

1.1 Urban forestry in the United States: Status and scope

The United States has observed unprecedented urban growth over the last few decades. Nowak et al. (2005) noted that between 1990 and 2000, the share of urban land area in the nation increased from 2.5% to 3.1%. Existing urban areas in the U.S. 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. Further, Walton and Nowak (2005) predicted that this urban area will continue to expand through 2050, eventually covering up to 8.1% of the country's area. Some of the expected urban development will come at the expense of currently forested areas. This may further the scope of afforestation and subsequent reforestation as part of urban forest management.

Increasing with the area of urban land is the geographical coverage of urban forests. Urban areas nationwide support more than 3.8 billion trees (Nowak et al. 2002), whereas as many as 70 billion trees are estimated to be growing in the urban and urbanizing areas throughout the nation (Bratkovich et al. 2008). A brief look at urban tree inventory data at individual state and city levels confirms that urban trees are a significant component of forest resources at local and regional levels. Table 1 presents canopy coverage and tree inventory data for five selected states and cities to illustrate the relative stocking of urban trees at individual state and municipal level (Nowak et al. 2001). Some of the states have smaller urban canopy coverage, but are densely stocked. Recent urban forest inventories also suggest that there is substantial variation of tree stocks among the United States cities, which ranges from roughly 15 trees per acre in Jersey City, New Jersey to about 113 trees per acre in Atlanta, Georgia (Nowak et al. 2010).

1.2 Issues facing urban forestry in the United States

Sustainable management of forest resources nationwide, regardless of their ownership and management objectives, is facing a number of challenges. Urban forestry is no exception. Sustainable forest management implies conservation and sustainable use of forest resources across all ownerships including urban forests, which are typically managed by local governments (e.g., municipality, city, metropolitan council, town). While population growth

State	Urban tree cover (%)	Urban trees (thousands)	City	Urban tree cover (%)	Urban trees (thousands)
Georgia	55.3	232,906	Atlanta	36.7	9,420
Alabama	48.2	205,847	Boston	22.3	1,180
Ohio	38.3	191,113	Baltimore	21.5	2,600
Florida	18.4	169,587	Oakland	21.0	1,590
Tennessee	43.9	163,783	New York	20.9	5,220

Note: Adopted from Nowak et al. (2010,p. 39)

Table 1. Tree cover and number of trees for selected U.S. states and cities

and development pressures accelerate the loss of wild lands and expansion of urban and suburban areas, protecting and managing trees for a variety of societal and environmental benefits often remains up to local governments. Urban forest management in the United States and elsewhere is facing substantial challenges which threaten the long-term conservation and management of urban tree and park resources. Major factors currently under consideration in the U.S. include the following:

- Disease and pest infestation
- Invasive species
- Wildfires
- Heavy recreational use
- Fragmentation
- Air pollution
- Lack of community participation
- Insufficient funding

Recent forest disturbance research (Holmes et al., 2008) illustrates a range of biological and socio-economic threats to the United States forest systems. A number of invasive stem borers and sap sucking pests such as Emerald Ash Borer, Gypsy Moth, Hemlock Woolly Adelgid have already killed thousands of trees of high amenity and ecological value. A number of exotic plant species including Kudzu, Chinese Privet, and English Ivy have invaded native landscapes in urban parks and roadside plantations. Increasing air pollution due to auto emissions and atmospheric pollution from industrial plants that are often located near urban areas have negatively affected the physiology and ecology of urban landscapes. Furthermore, with rapid population growth, per capita public open space is declining and existing urban forest resources in some areas are being ecologically destroyed due to heavy use (Poudyal et al. 2009). On the other hand, garnering sufficient community participation in urban tree management is challenging due to changing socio-demographics and ethnic heterogeneity in major metropolitan areas. Residents living in a heterogeneous community usually show varying levels of interest towards the maintenance and management of community resources like urban trees, which makes planning and implementation complicated (Gaither et al. 2011).

Another big challenge facing urban forestry right now is insufficient funding. A perennial source of income could greatly contribute to making the urban forest programs financially self-sufficient and sustainable. Indeed, with sufficient funding, local governments could put together efforts aimed at managing many of the other issues listed above. This is why it is important to address the marketability and revenue generating potential of ecosystem services that urban forests provide.

1.3 Towards a financially self-reliant urban forestry

As stated in the preceding section, local government budget problems, and the lack of adequate funding for tree care and maintenance has been considered a major issue in the United States. Mere tree planting along roadsides or on vacant lots within city limits does not define urban forestry. Rather, it involves tree care and maintenance and management (e.g., pruning, clearing, disposal), for which about two-thirds of an urban forest project budget needs to be typically allocated (American Public Works Association, 2007). However, urban forest projects during tough economic times are often overlooked when setting funding and management priorities. Private individuals, albeit usually appreciative of the amenity benefits of urban trees, do not always support the 'tax approach' to finance tree care and management programs. Urban forests bear some characteristics of 'public goods,' meaning that once an output or service is supplied, nobody can be effectively excluded from enjoying it, thereby leading to free-rider problems (Freeman, 2003). Private firms and for-profit organizations have few incentives to provide and maintain such resource. Therefore, if the good or service is to be provided, government must play a major role, either by direct provision or by providing incentives to the private sector.

The sustainable management of urban trees will require continuous funding and a reliable and well-established income generating mechanism at local level. The Urban and Community Forestry Program of United States Department of Agriculture aims at enabling the development of self-sufficient local urban and community forestry programs nationwide. As the provision of a range of public services and basic infrastructure compete for tax revenue, local governments are required to look for external sources of funding to keep their urban forestry programs operating adequately. In many cases, forest management programs, regardless of their location and ownership, will not be sustainable unless they are financially self-sufficient.

Because of the aesthetic and amenity purposes of urban forest management, neither timber neither timber harvesting nor planting of fast-growing cash tree crops are compatible options, or even a debatable alternatives. However, among a wide range of ecosystem services, carbon sequestration is especially promising. Nowak & Crane (2002) estimated that urban forests in the conterminous United States can store 770 million tons of atmospheric carbon, valued at $14.3 billion, assuming conversion to tradable carbon credits and then-current prices. Translating those numbers into annual terms, the United States urban forests absorb nearly 23 million tons of carbon, which can generate $460 million in revenue -- again assuming conversion to tradable carbon credits and concurrent prices. By appropriately managing urban trees and forests for maximum carbon sequestration, cities can collect revenue from selling credits for carbon absorbed and stored in urban trees. Revenue generated in this manner will not strain local tax revenue collections, and will help fund sustainable urban forest management. Given the fact that markets for carbon offset credits have recently emerged, carbon credits become worth investigating.

Federal and state agencies are trying to promote carbon trading in community and urban forestry as evidenced by a series of recently published policy documents. For example, a recently released USDA Forest Service document on open space conservation strategy has listed promotion of market-based approaches to enhance carbon-credit trading as one of the top thirteen priority actions (USDA Forest Service, 2007). Despite its significant potential and increasing policy emphasis, the market for urban forest carbon credits has not been well developed. This outcome in part is a result of the lack of appropriate and broadly accepted

market protocols, and the limited understanding of entrepreneurial principles associated with this product. Developing carbon markets will require a thorough understanding of the preferences and expectations of potential buyers per the characteristics, quality, and price of carbon credits. It will also require information about the technical and managerial capacities of the potential sellers to develop carbon offset projects. This chapter highlights some of the findings of a recently completed comprehensive research project in the United States that examined the capacities, interests, and expectations of both the potential sellers and buyers of carbon credits generated from urban forest projects.

2. Objective

The objective of the material presented in this chapter is to address the feasibility of establishing a market for urban forest carbon credits. This will be achieved by assessing the interest of key stakeholders involved in potential market for this output. Stakeholders' perspectives will be discussed in a broader context of making urban forestry a source of carbon credits that will help make it financially self-sufficient and sustainable.

3. Approach

The project started with the identification of key stakeholders in a potential market for urban forest carbon credits. In order to establish a market, potential buyers and sellers of the urban carbon credits must be identified. Given the nature of ownership, local governments and municipalities were considered as the sellers of urban forest credits. A web-based survey was implemented during 2007-2008, contacting urban foresters, arborists and other officials responsible for overseeing their urban forest. Contact details of those officials were obtained from the Society of Municipal Arborists (SMA). The survey questionnaire focused on cities' current urban forest information and management practices, existing stock and available technical and managerial expertise, and interest in participating in an urban forest carbon offset trading program.

Identifying the potential buyers was challenging given that the United States market for forest urban carbon credits has not been well developed. However, because credit buyers in the United States are voluntarily participating in carbon trading rather than complying with mandatory government regulations, existing credit buyers may have unique preferences for credits sourced from specific locations such as urban forests. Therefore, businesses and organizations that are currently participating in carbon markets were identified as the potential buyers of urban forest credits. While many buyers purchase carbon credits from over-the-counter (OTC) market, surveying them is difficult due to the lack of their contact information. For this reason, primary buyers of carbon credits at the Chicago Climate Exchange (CCX), which was the largest carbon trading platform in North America, were surveyed as the potential buyers.

All CCX members and associate members were invited to complete a survey that covered questions regarding their attitudes and perceptions related to climate change, government regulation of greenhouse gas emissions, and their preferences for credits sourced from a variety of carbon project types, including urban forestry. Some of the questions were related to their willingness to purchase urban forest carbon credits and the price they were willing to pay. This survey was conducted during late 2009.

4. Key observations

This section presents some basic statistics and summary of survey responses from the surveys of both the buyers and sellers.

4.1 Seller's survey

From a total of 277 successfully delivered surveys, an adjusted response rate of 54% was achieved. The group of responding municipalities was highly diverse in terms of population size and regional location. About one-fifth of respondents in the sample represented large cities (with population larger than 100,000) and another one-fifth represented small cities (population less than 20,000). Roughly one-third of the respondents were from mid-size cities (with population between 20,000 and 50,000). Respondents from the Northeast region were slightly underrepresented (6%) while other regions (i.e., Midwest, 37%; South, 27%; and West, 31%) were more uniformly represented. Only one-fifth of the respondents were familiar with the Chicago Climate Exchange which, at the time of survey, was the only actively operating carbon trading platform in the country. Further details on respondent's characteristics can be found in Poudyal et al., (2010).

Local government units that responded to the survey indicated that they were maintaining or managing urban forest resources of some sort within their jurisdiction. The exact form of urban forests varied from urban parks, forest patches within city limits to individual trees along streets, roadside tree plantings and protected vegetation along critical riparian buffer areas. More importantly, a clear majority of responding municipalities (63%) had an official designated to oversee the urban tree care and management activities. Similarly, about 56% of the respondents had at least a portion of their forest resource recently inventoried. A similar survey of U.S. cities recently conducted by the United States Conference of Mayors suggested that as much as 55% of cities had a current inventory of urban tree canopy (Nowak et al., 2010).

When asked if local governments were currently participating in any climate change initiatives, respondents identified a number of projects, including remodeling and construction of energy efficient buildings, using alternative fuel vehicles, capturing landfill methane, and planting trees. More importantly, tree planting was the most common initiative undertaken recently (85% of the respondents) to help mitigate climate change (Figure 1). Similarly, about 50% in the sample indicated either using alternative fuel vehicles or constructing/remodeling energy efficient buildings as a recently undertaken initiative to mitigate climate change. It seems that local governments' tree plantation investments in recent years, and perhaps in the near future, would give them an advantage in initiating active-management-based urban forest offset projects. This is necessitated because the already planted stocks do not meet the 'additionality' criterion, unless they are placed under an intensive management regime to boost their carbon sequestration rate.

Prior to reading the questionnaire, approximately one-third of the respondents were familiar with the idea of carbon storage and offset selling. However, very few of the responding municipalities were familiar with existing market platforms like the Chicago Climate Exchange where they could sell their carbon credits. When asked if their city would be willing to participate in a carbon offset selling scheme, 29 out of 150 (roughly 20%) indicated that they were interested or very interested in such a program. On the other hand, 15 respondents (about 2%) indicated that their city was uninterested or not at all interested in carbon trading at this point. An econometric model was estimated to examine factors that

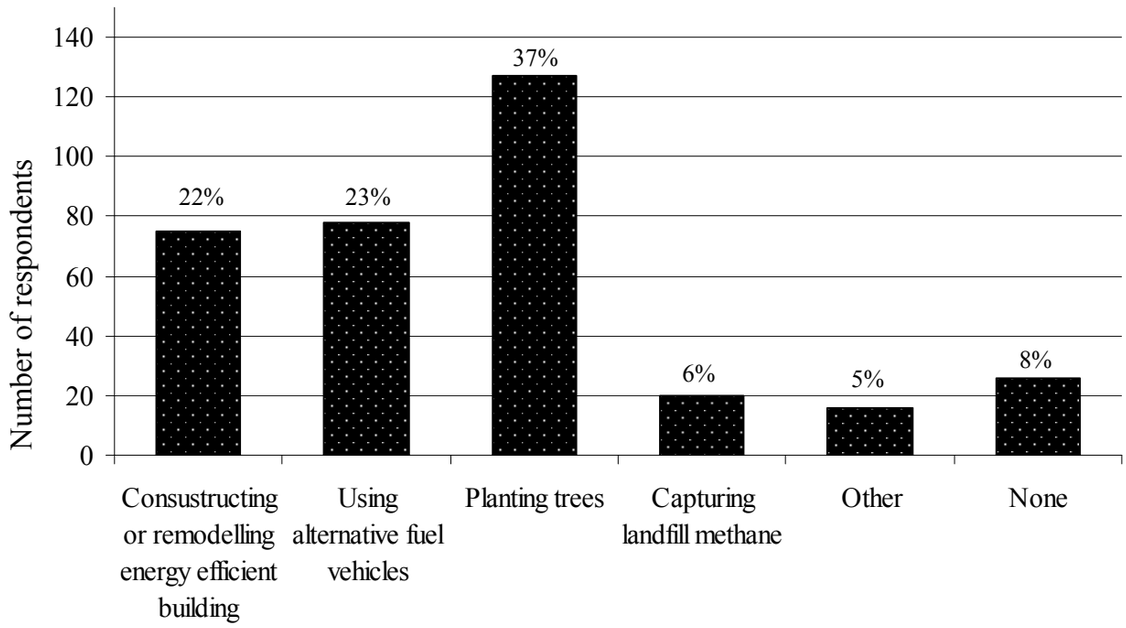

Fig. 1. Number of municipal governments currently participating in various climate change mitigation initiatives

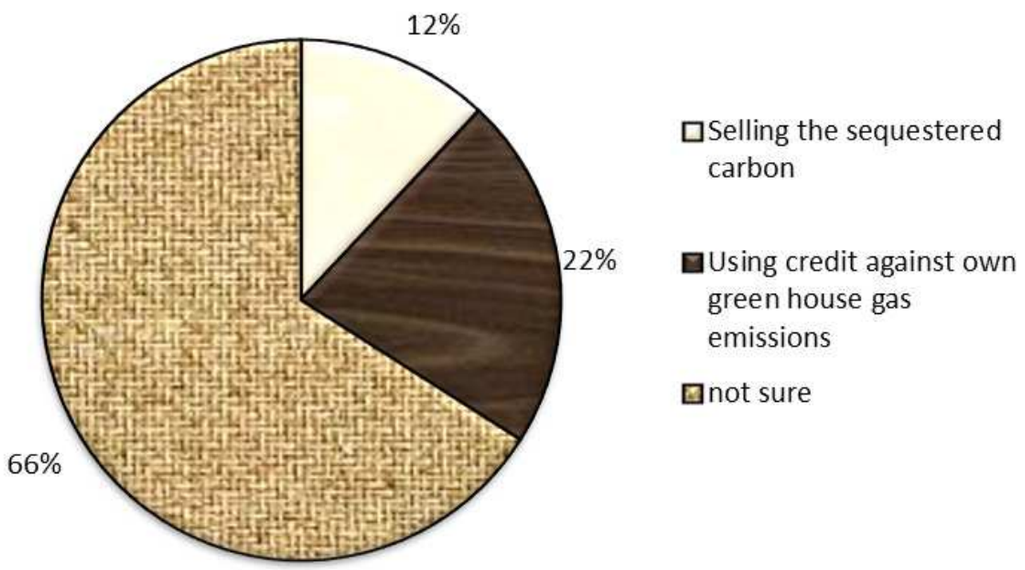

Fig. 2. Local government's plan to utilize the certified carbon credits sourced from their urban forests

influenced respondent's willingness to participate in carbon trading program. Detailed results in Poudyal et al., (2010) indicate that a local government's decision to participate in carbon trading was positively influenced by staff's knowledge of carbon sequestration and familiarity with carbon trading intuitions such as CCX, potential interest of voters, level of urbanization, and a city's need for generating revenue. This observation indicates that along with the increasing need of local governments to generate revenue combined with rising environmental awareness of voters and urban congestion, more local government units will be interested in selling carbon credits though urban forest projects.

Cities which were yet to generate certified offset credits were asked about their plans for using their credits. A majority (66%) were unsure, which is a common response for such a hypothetical question (Figure 2). Among the remaining one-third who had tentative plans regarding the utilization of their certified credits, a significantly higher number of respondents (22%) indicated that they will count the credits against the city government's green house gas emissions rather than selling them to interested buyers (12%). Hence, as the public pressure grows for environmental compliance, and as government units require more credits to offset their own emissions, some local governments may have fewer credits left to sell in the market. How these currently 'unsure' respondents will decide the use of their carbon credits could largely determine whether this may become an issue at all.

4.2 Buyer's survey

From a total of 155 successfully delivered addresses, an adjusted response rate of 41% was achieved. Respondent businesses and organizations (i.e., members and associate members at the CCX) were diverse in terms of their business characteristics such as profit motive, employment and geographical scope of business operations. Slightly more than half in the sample were private or for-profit organizations, whereas just about a quarter of the sample were public or non-governmental organizations. The remaining one–fifth were government institutions. About half of them confined their business operations to the United States. About one-half of all respondents had a target of reducing their greenhouse gas emissions by 5% in the near future. In terms of their carbon trading history, one-half of the sample had been participating in carbon trading for 3 or more years. Respondents, on average, purchased about thirty three thousand metric ton equivalents of carbon dioxide offset credits in the most recent calendar year (i.e., 2008). Further details of respondents' characteristics can be found in Poudyal et al., (2011).

Overall, current buyers of carbon credits in the North American market were found to be pro-environmental and generally supportive of government regulation to control the greenhouse gas emissions. Discussing buyer attributes in detail is beyond the scope of this chapter, but a rigorous analysis of their responses can be found in Poudyal et al. (2011). Buyers were asked to rank credit types by the location of an offset project. Respondents showed much higher preference for credits sourced from local projects than those generated from regional or international projects (Figure 3). Since a number of businesses and organizations interested in offsetting their emissions are located around urban areas, a noticeably higher preference for locally generated credits shows a potentially high value of such credits to buyers.

A more specific question required respondents to rank carbon credits generated from different sources. As Figure 4 shows, buyers clearly placed the highest value on the credits

sourced from renewable energy projects. However, their preference for urban forest credits was relatively higher than those sourced from agriculture or methane soil projects. Urban forest credits were found as desirable as rural forestry credits among the credit buyers in the North American market.

Figure 4 suggests that urban forest carbon credits may be fairly competitive in the market. However, whether they will generate more revenue compared to other credit types is a separate question. Buyers' responses in terms of willingness to offer a premium for specific credit types varied substantially among various types of projects. In addition to urban forest credits, respondents were asked to consider offering premiums for credits sourced from three other types of projects: (1) projects promoting nature conservation in developing countries; (2) projects aimed at alleviating poverty in developing countries through carbon payment to forest landowners; and (3) rural forest projects in the United States. While a modest (roughly 15%) number of respondents consistently rejected the idea of paying premium for any kind of carbon credits, many respondents had favored offering a premium for credits sourced from a range of projects. Among the projects listed above, roughly 55% of respondents indicated that they would be willing to pay a premium for urban forest credits. None of the other projects generated a higher level of support or willingness to offer premium. Compared to the current market price of credits for which the source is not generally disclosed, urban forest credits, if known, could draw a significant premium.

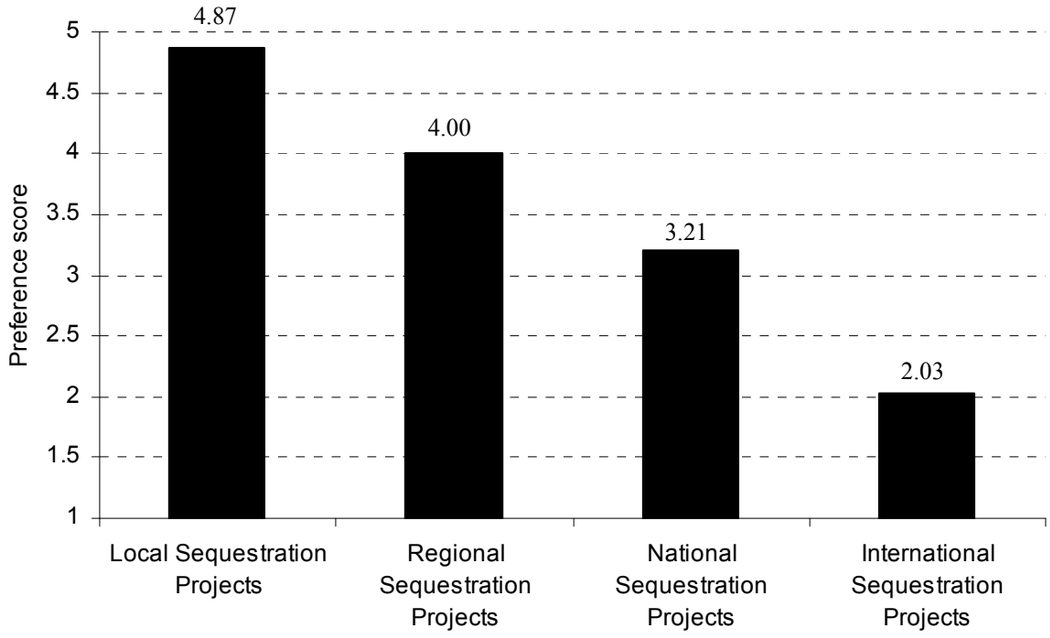

Fig. 3. Buyers' preference for carbon credits by project location

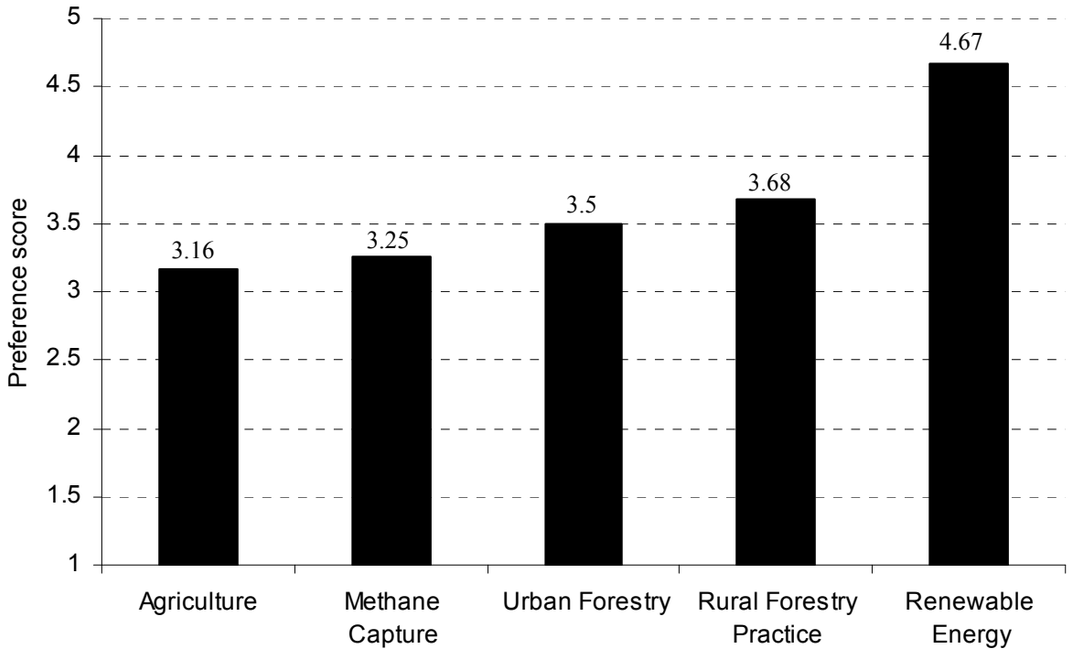

Fig. 4. Buyers' preference for carbon credit by project types

5. Concluding remarks

Buyers and sellers of carbon offsets are interested in this new urban forest output. Urban forest credits are more desirable than other types of credits and buyers are willing to pay a higher price. This will certainly help local governments to be more competitive in the offset market. In fact, this could present an opportunity to be active in localized markets and generate sufficient revenues while preserving urban forests in the long-run and providing a wide range of co-benefits to the society. We argue that promising financial potential provides incentives for local governments to utilize marginal and abandoned industrial lands to increase urban canopy coverage, and to adopt stricter tree management ordinances to boost the carbon storage capacity of public trees. Nowak et al. (2010) noted that about one half of the sample in a recent survey of the United States cities with population of 30,000 or more indicated that expanding tree canopy is their goal and as much as 95% of them have even adopted some sort of tree management ordinance (City Policy Associates, 2008). Current local government initiatives are not necessarily motivated by the need to develop an offset market, but these recent developments when considered together with our results suggest that local governments adopting such policy initiatives may have an advantage with early entrance into the carbon market. Thanks to a number of federal programs that currently offer federal funds to help local communities establish sustainable, clean and green communities, local governments could establish such innovative projects. The Climate Showcase Community Grants of the US Environmental Protection Agency, Sustainable Communities Grants of US Department of Housing and Urban Development, and US Department of Energy's Energy Efficiently and Conservation Block Grants are just a few examples (American Public Works Association, 2007).

However, some research results suggest that the long-term viability of urban forests as a source of carbon credit may be debatable. First, as Nowak et al., (2010) note that increasing tree coverage may increase the potential for storing additional carbon in urban tress, but the maximum tree coverage will entail additional risk and costs, such as wildlife risk along high density residential areas, human-wildlife conflict due to expanded habitat for birds and animal species, and water usage. A long-term strategy for optimizing the social, economic and ecological benefits might be needed to make this effort sustainable. Second, researchers are still debating the net carbon footprint of urban forest projects themselves. Third, our results suggest that more municipalities are likely to use their offset credits against their own emissions targets if they have to comply with a mandatory emission reduction regulations in the future. As more cities sign the Mayors Climate Change Protection Agreement, larger number of carbon offsets will have to be used by cities themselves to improve their green image and meet their constituents' environmental expectations. But again, whether this issue will remain a real concern will largely depend on how the interest and responses of the currently "unsure" group will unfold against increasing demand for carbon credit in future.

Nevertheless, given some of the unique characteristics of urban forest, cities could still produce surplus and market offset credits. Nowak and Crane (2002) argued that by fostering larger trees and by inducing energy savings effects, an urban tree may store four times more carbon than a single tree in a forest stand. However, this assertion should be viewed cautiously as it was derived from a simulation study rather than an empirical measurement of actual sequestration between urban trees and its rural counterparts.

In any case, it seems that there are increasing signs of favorable views and interest among administrators and urban forestry professionals to initiate projects generating carbon offsets. For example, our observations of sellers' motivations and their interests corroborates the findings from a recent survey of members of Society of Municipal Arborists, in which researchers observed that urban forestry professionals are embracing ecosystem services such as climate management, habitat protection, and biodiversity conservation as departmental goals beyond their traditional focus on enhancing property values and protecting utility lines (Young, 2010). It is reasonable to assume that there might be a shift in the way both residents and city managers view the significance and utility of urban forest resources. Part of the enthusiasm and favorable view of professionals probably relies on the availability of practical and user-friendly computer models such as i-Tree or UFore (http://www.itreetools.org) that are useful in quantifying and valuing city forests' offset capacity. All these factors broaden the scope of future urban forest management to include benefits like carbon offset credits.

Key findings highlighted in this chapter provide a holistic view of the market potential and opportunities for making urban forest projects financially self-reliant and more sustainable. Of specific interest to stakeholders are the deeper understanding of the preferences, motivations, and expectations of potential players in the context of establishing markets for urban forest carbon credits. This information could be used to develop new and expand existing market protocols for carbon credits sourced from urban forestry projects.

While this study was based in the United States, the challenge of generating income from urban and community forest projects is likely transferable to other developed countries. Accordingly, many local governments outside the United States are also working to measure and quantify carbon credits generated by their urban forests. While European and Scandinavian countries are already leading in several climate and carbon offset initiatives,

some Asian countries (Liu & Li, 2011) and African countries (Stoffberg et al., 2010) have also begun quantification and valuation of carbon sequestration in their urban forests. As more cities and local governments look for ways to make their urban forest projects financially self-sufficient and sustainable, policy implications and recommendations available in this chapter and associated publications should be useful in guiding urban forest management in the United States and beyond.

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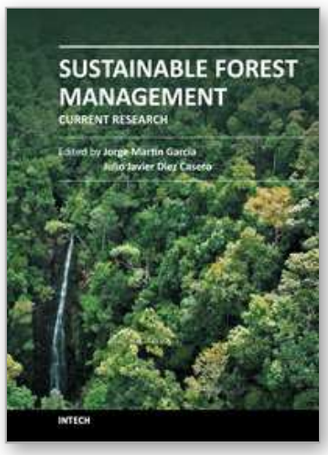

Sustainable Forest Management - Current Research

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Sustainable forest management (SFM) is not a new concept. However, its popularity has increased in the last few decades because of public concern about the dramatic decrease in forest resources. The implementation of SFM is generally achieved using criteria and indicators (C&I) and several countries have established their own sets of C&I. This book summarises some of the recent research carried out to test the current indicators, to search for new indicators and to develop new decision-making tools. The book collects original research studies on carbon and forest resources, forest health, biodiversity and productive, protective and socioeconomic functions. These studies should shed light on the current research carried out to provide forest managers with useful tools for choosing between different management strategies or improving indicators of SFM.

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