Carbon Emissions Offsets from Urban Forests: Michigan State University and the Chicago Climate Exchange

Fast Facts

Activity: Carbon Accounting and Urban Forest Management

Launch Date: 2009

Purpose: To offset the greenhouse gas emissions from Michigan State University's T.B. Simon Power Plant.

Tree Ownership: All trees included in the project are on land owned by Michigan State University.

Funding: A small grant was awarded to an undergraduate research assistant to work on the project. Otherwise, no direct funding was involved.

Protocol: The Chicago Climate Exchange's (CCX) *Forest Carbon Sequestration Protocol* was used for this project. Specifically, the CCX Afforestation/Reforestation: Widely Spaced Tree Plantings guidelines were used for the campus trees and the CCX Sustainably Managed Forest Project guidelines were used for the forested natural areas.

Verifier: The project was audited internally by CCX staff.

Payment Mechanism: There was no payment mechanism for this internal offset project. The total carbon sequestered by the MSU trees was subtracted from the emissions of the campus power plant and put towards the annual emissions reduction target of the university.

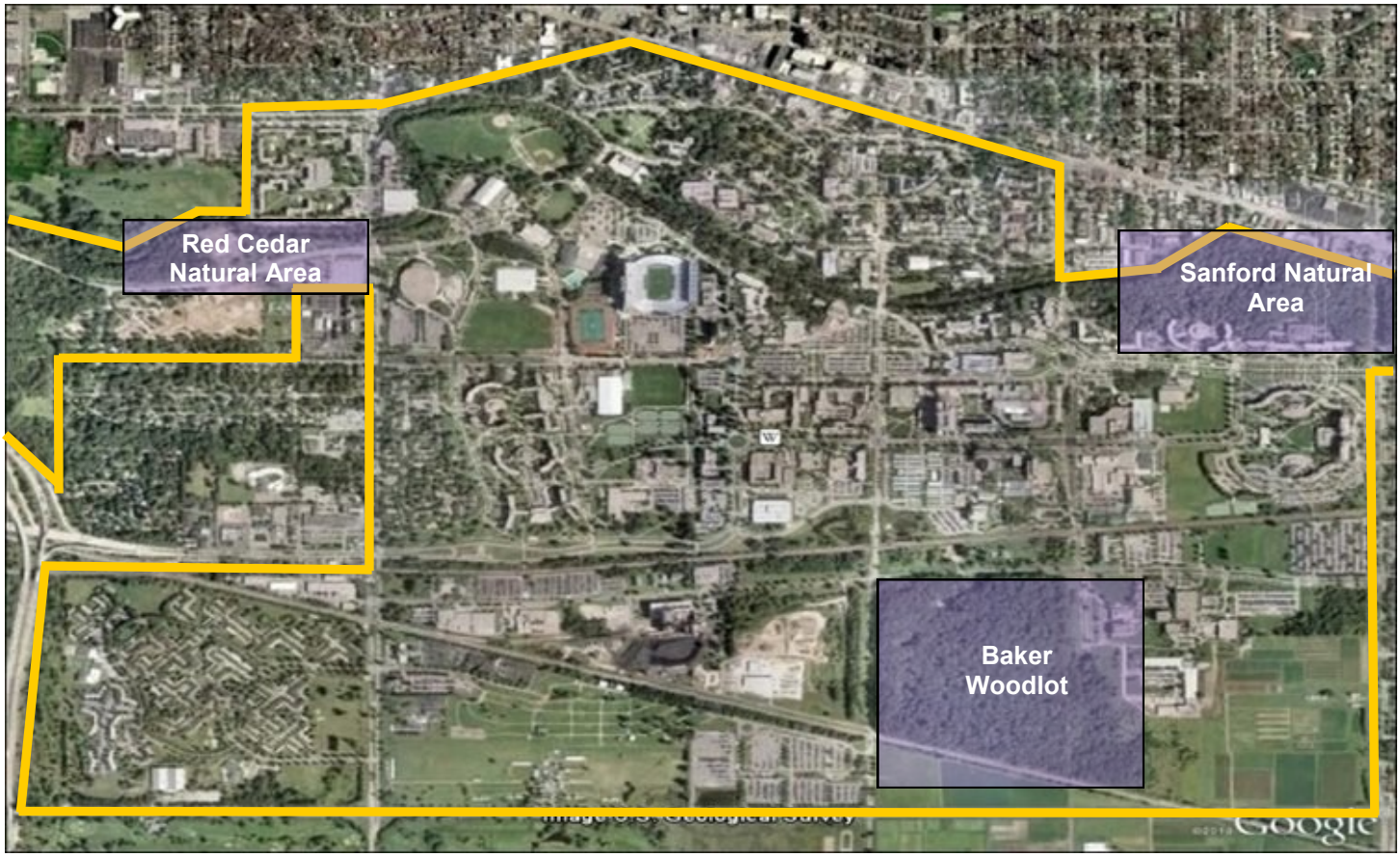
Price: The project did not involve the sale of carbon offsets.

Climate Benefits: In 2009 221.8 tons of CO2 equivalent (tCO2e) were reported as sequestered by the campus trees from 2003—2009 and in 2010 54 tCO2e were sequestered by the campus trees and 54 tCO2e were sequestered by the forested natural areas.

Co-Benefits: MSU students gained forestry methodology experience and MSU demonstrated the applicability of the CCX protocol for urban forests.

Overview

In November 2009 Michigan State University (MSU) submitted the first ever proposal to the Chicago Climate Exchange (CCX) for an urban forestry project. Under the lead of Dr. David MacFarlane, Associate Professor of Forestry at MSU and member of the CCX's forestry committee, the project's focus was to quantify the carbon sequestered by trees planted on campus since 1990 and those managed in three large university natural areas. MSU, a CCX institutional member since 2007, then used the carbon offsets internally towards its overall greenhouse gas (GHG) emissions reduction target of 6%, compared to 2000 emissions. This project incorporated an extensive existing campus tree inventory and database, undergraduate researchers, collaboration across campus, and an expansion of the CCX carbon sequestration look-up table for individual tree species (14).



Michigan State University is located in East Lansing, MI and consists of 5,239 contiguous acres with over 550 buildings and 18 miles of roads. The developed main campus, shown above and outlined in yellow is about 2,100 acres with the remaining 3,139 acres as experimental farms, outlying research facilities, a golf course, and natural areas. The student population for the 2009-2010 year was approximately 47,100 (2, 14). Background picture taken from @Google Earth.

The Project

Michigan State Univeristy supports over 47,000 students and 10,000 employees (14). Over 90% of the university's emissions come from the T.B. Simon Power Plant, producing both electricity and steam for campus heating and cooling. MSU has been an institutional member of the Chicago Climate Exchange since 2007, which means that the administration voluntarily made a legally binding commitment to reduce its GHG emissions by 6% compared to the year 2000 by 2010 (4). Each April, MSU was required to submit an annual report on its emissions reductions. The CCX membership is consistent with and corresponds to MSU's *Be Spartan Green* initiative to reduce GHG emissions by 15%, reduce energy use by 15%, and reduce landfill waste by 30%, all by the year 2015 (2, 7, 12, 13).

In 2009, the same year that the CCX released its *Forest Carbon Sequestration Project Protocol*, MSU submitted a project proposal for its campus tree and natural areas, encompassing a suggested strategy of "urban managed forests". Dr. David MacFarlane, Associate Professor of Forest Measurements and Modeling in MSU's Department of Forestry and technical advisor to the CCX on matters relating to carbon sequestration in forests, was the lead on the project and essentially wanted to demonstrate the applicability of the CCX protocol's. The basis of the project was to quantify the carbon sequestered both by MSU's campus trees and by the natural forested areas owned and managed by the university. The total carbon offset would then be put towards MSU's emissions reduction target. The offsets vwould not be registered for public sale but instead would be included in the university's annual report to the CCX (4, 5, 9, 14).

The CCX *Forest Carbon Sequestration Project Protocol* includes guidelines for both Afforestation/Reforestation projects and Sustainably Managed Forest projects; as previously mentioned MSU implemented both through its overall urban managed forests project (3). Dr.

MacFarlane decided to involve student researchers to complete both components of the roughly one-year project. Undergraduate Lisa Parker received a small grant from the Undergraduate Research Office at MSU to assist with the afforestation portion while Dr. MacFarlane's Forestry Biometry class, Ms. Parker, and graduate student Neil VerPlanck were involved with the sustainably managed forest piece.

Trees located within the boundaries of the urban main campus were the focus of the afforestation component, which followed the guidelines detailed under the CCX heading "Widely Spaced Tree Plantings". MSU houses over 2,300 species of flora from around the globe and also has many woodland and wetland areas. The Campus Planning and Administration (CPA) office has maintained a rigorous plants database since 1989, which , for the purposes of the project ,means that every tree planted on campus since that time has a record (18). In accordance with approved CCX methodologies, trees that met three specific requirements were included in the afforestation component:

1) Those at least 1" in diameter at breast height,
2) Those planted on or after January 1, 1990, which is the baseline date for the CCX protocol, and
3) Those in fair or good general health.

From the CPA plants database, MacFarlane and Parker identified 4,987 campus trees that were eligible, representing 361 unique species and 75 genera. However, the CCX look-up table for "Widely Spaced Tree Planting" afforestation projects, titled *Tree Types and Growth Rates Applied to Urban and Suburban Tree Plantings* (included in the appendix of the protocol) at the time included only 100 tree species and 41 genera (3). These 100 species represented the most commonly planted in the U.S. but Dr. MacFarlane felt that the look-up table should be expanded to encompass the range of species on MSU's campus. With the assistance of Ms. Parker and using primarily M.A. Dirr's *Manual of woody landscape plants: Their identification, ornamental characteristics, culture, propagation, and uses* (6) and the USDA Plants Database (19), each additional species was assigned a growth rate depending on its membership in one of six classes: fast, medium, or slow growing and hardwood or softwood. This method was consistent with the existing CCX look-up table and if there was a conflict between different sources in the literature regarding growth rates or if there was insufficient information then the slowest growth rate was applied to account for assumptions made (see Figure 1 for the expanded look-up table).

MSU is committed to the maintenance and creation of green space in its overall sustainability objectives. The drawing above depicts a proposed central campus park to replace five parking lots, included in the most recent Campus Master Plan. As of May 2011 this particular project is on hold due to funding constraints (2).

The sustainably managed forests project component was focused on quantifying the carbon sequestered in three of eight forested natural areas on MSU's campus. The Sanford Natural Area is a 34-acre floodplain forest, the Red Cedar Natural Area has 46.7 acres of native floodplain forest (3 of which were a previous campus tree nursery), and the Baker Woodlot is a 78-acre beech-maple forest (11). Together they total 158.7 acres, or

MSU's Campus Planning and Administration office maintains a relational plants database that is tied to GIS and holds records on the location and condition of over 25,425 plants on campus. The image to the left depicts the database for an unidentified area on campus: each plant is uniquely identified and indicated on the map.

CCX	mT Co2	MSU	mT Co2	CCX	mT Co2	MSU	mT Co2
Abies	0.5432	Abies	0.5432	Larix	0.1757	Larix	0.1757
Acer	5.5962	Acer	5.5962	Liquidambar	1.0213	Liquidambar	1.0213
Aesculus	0.2401	Aesculus	0.2401	Liriodendron	0.3228	Liriodendron	0.3228
Ailanthus	0.0450	Ailanthus	0.0450			*Maackia*	0.0566
Alnus	0.2922	Alnus	0.2922			*Maclura*	0.0047
		Amelanchier	0.1094	Magnolia	0.2013	Magnolia	0.2013
		Araucaria	0.0052	Malus	4.4058	Malus	4.4058
Betula	1.2082	Betula	1.2082			*Metasequoia*	0.0613
		Carpinus	0.1572			*Nyssa*	0.6166
Carya	0.0128	Carya	0.0128	Ostrya	0.0697	Ostrya	0.0697
		Castanea	0.0346			*Paulownia*	0.0063
Catalpa	0.0318	Catalpa	0.0318			*Phellodendron*	0.1476
		Cedrus	0.0036	Picea	3.1694	Picea	3.1694
Celtis	0.4977	Celtis	0.4977	Pinus	2.1713	Pinus	2.1713
		Cercidiphyllum	0.4961	Platanus	1.0595	Platanus	1.0595
Cercis	0.6904	Cercis	0.6904	Populus	0.0138	Populus	0.0138
		Chamaecyparis	0.3937	Prunus	0.2655	Prunus	0.2655
		Chionanthus	0.0240			*Pseudolarix*	0.0051
		Cladrastis	0.0701	Pseudotsuga	0.3190	Pseudotsuga	0.3190
Cornus	1.0715	Cornus	1.0715			*Pyrus*	0.9452
		Corylus	1.0499	Quercus	4.0883	Quercus	4.0883
		Cotinus	0.1131			*Rhus*	0.0919
		Cotoneaster	0.4809	Salix	0.4383	Salix	0.4383
Crataegus	0.0641	Crataegus	0.0641	Sassafras	0.0830	Sassafras	0.0830
		Cryptomeria	0.0633			*Sequoiadendron*	0.0132
		Diospyros	0.0061			*Sophora*	0.1656
		Eucommia	0.1704	Sorbus	0.2004	Sorbus	0.2004
Fagus	0.1138	Fagus	0.1138			*Stewartia*	0.0077
Fraxinus	3.6788	Fraxinus	3.6788			*Styrax*	0.0253
Ginkgo	0.8092	Ginkgo	0.8092			*Syringa*	0.1393
Gleditsia	0.4533	Gleditsia	0.4533	Taxodium	0.6981	Taxodium	0.6981
Gymnocladus	0.2505	Gymnocladus	0.2505			*Taxus*	0.0493
		Halesia	0.1749	Thuja	1.9123	Thuja	1.9123
Ilex	0.0064	Ilex	0.0064			*Thujopsis*	0.0019
Juglans	0.1065	Juglans	0.1065	Tilia	2.3108	Tilia	2.3108
Juniperus	0.0504	Juniperus	0.0504	Tsuga	0.1459	Tsuga	0.1459
		Koelreuteria	0.1129	Ulmus	0.9982	Ulmus	0.9982
						Zelkova	0.5332
				CCX Sum	**39.8325**	**MSU Sum**	**46.1687**

Figure 1: The table to the right illustrates the expanded look-up table for urban tree growth rates and carbon sequestration developed by Dr. MacFarlane and his assistants. Using the existing CCX table with 41 genera, the total sequestered carbon in MSU's campus trees would have been 39.8 tCO2e but with the additional 34 genera added by Dr. MacFarlane and Ms. Parker, the quantified carbon sequestered was 46.2 tCO2e . The look-up table was expanded in order to provide more accuracy for a wider range of species.

or 64.2 ha, and all three are Category 1 natural areas, meaning that they are managed at the highest level of protection and the lowest level of usage. In 2009 Dr. MacFarlane's Forest Biometry undergraduate students collected data from the natural areas using traditional forestry methods to establish a baseline. Subsequently, master's student Neil VerPlanck did the carbon accounting and converted the totals to CO2 using approved CCX biomass equations, such as those included in Jenkins et al.'s *National-scale biomass estimators for United States tree species* (8).

For 2009, the total amount of carbon sequestered by the campus trees within the CCX contract period (2003-2009) was calculated to be 221.8 tCO2e, which was subtracted from MSU's internal emissions and reported in the annual report to the CCX. In 2010 54 tCO2e were sequestered by the campus trees and 53 tCO2e from the campus natural areas. The 2010 figures represent less than 1% of the approximately 600,000 tCO2e emitted from the T.B. Simon Power Plant that year (4, 14).

Since the CO2 offsets were used in MSU's internal emissions accounting processes and were not in any way released for public sale, the CCX determined that there was little to no public risk associated and decided to verify the project internally. Regarding the afforestation component, since it was essentially a census using the comprehensive existing CPA plants database, the verification procedures were based on data analysis and auditing. For the sustainably managed forests piece, the three campus natural areas are under permanent restrictions regarding forest management practices and there is an extremely low risk that they will be managed in any way that will increase or decrease CO2 sequestration in the foreseeable future (11, 14).

Participant Perspectives

Dr. MacFarlane expressed overall satisfaction with the urban managed forests project and noted that it received significant accolade across campus. Additionally, he noted that the project has generated discussions on campus about the value of trees and carbon. Logistically speaking, MacFarlane said that it took about a year of "academic time" to finish the project. On one hand, it could have been finished much faster if MSU had hired a consultant to focus on the project instead of depending on the intermittent work of

MacFarlane (who was not paid specifically for this project) and his students. On another hand, however, the nearly complete tree census in the form of the CPA plants database provided an important foundation that other similarly sized institutions or communities might not have, which could effect the timing and cost of a similar project elsewhere.

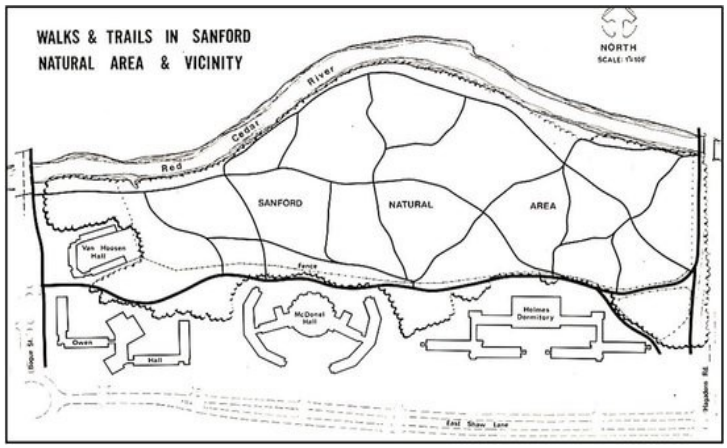
As noted earlier, the emissions offset by MSU's campus trees and natural areas represents an extremely small portion of the institution's total annual emissions. "The bottom line", said MacFarlane, "is that it takes a lot of trees to offset the emissions of a large power plant. Even with the high densities of trees on the MSU campus, the numbers just don't add up".

That being said, however, MacFarlane noted that the MSU community was very excited about this project and he recognizes that people nationwide are committed to greening initiatives and their multiple benefits. That sentiment was echoed by Lynda Boomer, who said that it was worth the effort of implementing the project to drive home the point that MSU highly values its tree resource. Dr. David Skole noted that while the carbon offsets from the trees was a small fraction of the overall campus emissions, it was still a good thing to do and that it compliments university policy regarding no net loss of green space on campus. He believes that forestry offsets play an important role in emissions reductions: they can be implemented relatively quickly and can be a compliment to the upgraded facilities, emissions reductions, and alternative energy sources that may take significant time and money to implement. In a recent article from MSU's online newspaper, Skole stressed the importance of offsets "as a way to facilitate the transition to a greener future".

MacFarlane noted two major problems with urban forestry carbon projects at this point in time. The first is a general uncertainty in carbon markets and the low trading price of carbon in those markets. "Right now we're planting trees for a lot of other purposes and then there's an additional carbon benefit but that carbon piece doesn't really have an economic value. That doesn't mean that it's not valuable, it's just that there isn't a considerable monetary value. If the price per ton of carbon was really high", said MacFarlane, "then you'd certainly have a lot more people at MSU thinking about how to bring in more trees". The second is the issue of being an early adopter: in a time when many are anticipating federal regulation of GHG emissions, knowing that projects or initiatives that are implemented now might not count in the future can be a disincentive. As an example, prior to its involvement with the CCX, MSU had removed several old apartment buildings and replaced them with a park and a significant number of trees but couldn't include the offsets from the project since it fell outside of the CCX contract period.

Along the same lines, Dr. Skole expressed that the biggest issue for forestry's role in carbon markets at this point is the need for legislation to be passed to address these problems. Ultimately, said MacFarlane, "to see wide-scale replication of this type of a project there would need to be the incentive to go through the steps, which means that we would have to make a much greater commitment to planting trees for the purpose of mitigating emissions and we would have to be willing to pay more for that service in order to achieve a large carbon value from it".

MSU's woodlands and wetlands encompass more than 700 acres in 27 sites. These areas are used for research, demonstration, recreation, and provide resources for teaching. The Campus Natural Area Committee heads stewardship of the areas and use of the areas falls under the Office of Land Management. For the CCX carbon project, carbon sequestered by three natural areas was quantified. Above: the Red Cedar River flows through campus and adjacent to the Red Cedar Natural Area. Below: Trail maps of the natural areas, such as the Sanford Natural Area, are available online to provide the community with recreation opportunities (11).



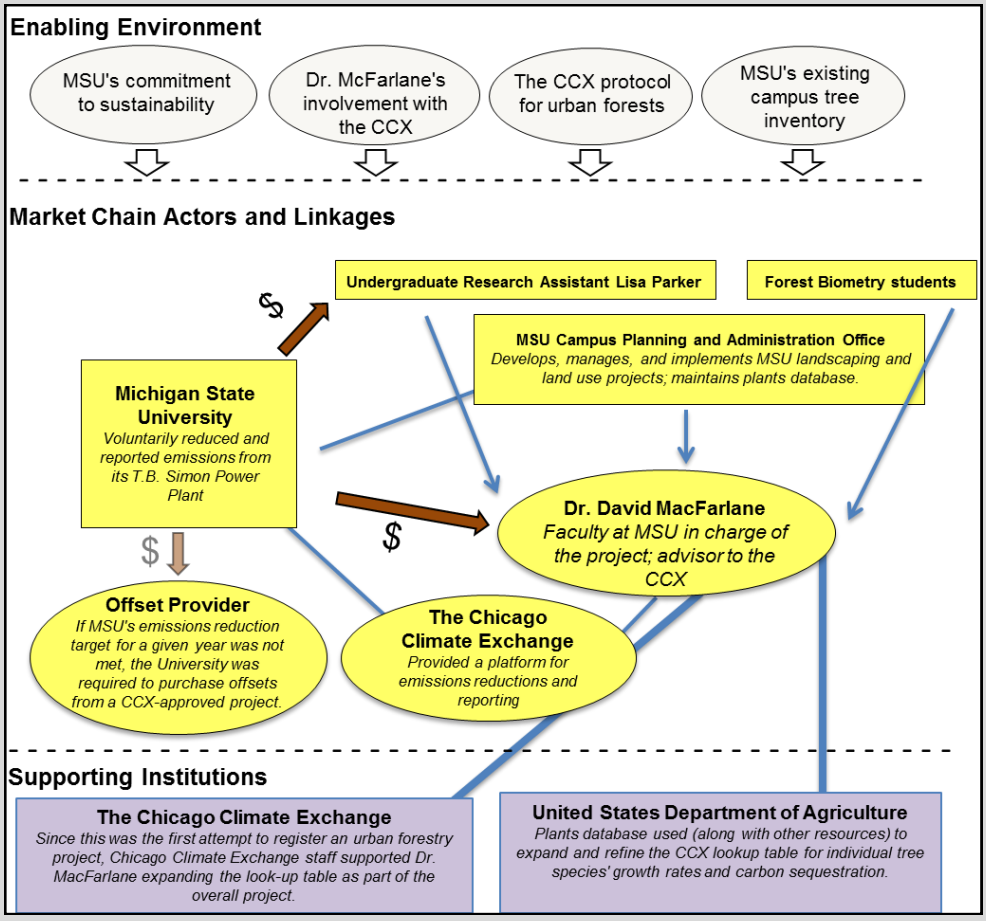
Looking Forward

At the close of 2010, Phase II of the CCX completed as scheduled, marking the end of the cap-and-trade and offsets program. In late 2010, shortly after being acquired by IntercontinentalExchange, CCX staff announced that they would implement a new program geared towards registering offsets (but not trading them) for 2011 and 2012. For its institutional members, such as MSU, this change means that the platform for voluntary emissions reductions no longer exists within the CCX (5). According to Lynda Boomer, MSU did reach its emissions reduction target of 6% by 2010, actually surpassing the goal to reach 9% of the 2000 baseline. This was achieved primarily through switching fuels at the T.B. Simon Power Plant from coal to a mixture of natural gas and biomass.

While MSU will no longer be contractually committed to reducing emissions through the CCX, Boomer noted that since the university emits over 25,000 tCO2e annually, it will be required to report emissions under the Environmental Protection Agency's Greenhouse Gas Reporting Program (1, 19). Hence, the carbon accounting that was central to the project will likely still have a place within MSU's overall sustainability policy. Steve Troost, Campus Planner for the CPA at MSU pointed out that in the last two years, nearly 2,000 trees have been planted on the main campus. The value of trees and the educational opportunities around the "campus carbon inventory" are certainly recognized at MSU.

Market Chain Map

The market chain map summarizes the roles of participants and contributors to market-based initiatives (8). The Enabling Environment section indicates the external factors that facilitated the development of this urban forest carbon program. The Market Chain Actors and Linkages section includes the producers, purchasers, facilitating intermediaries and flow of funds. The Supporting Institutions section lists entities that provided critical support, but were not part of the market transaction. Because forest carbon markets are newly emerging, the same organizations may show up in more than one capacity as they work to develop all of the components needed for a successful, market-based program. The dollar signs indicate flow of funds.



MSU's commitment to sustainability, its membership in CCX, the existence of CCX's protocol suitable for urban forests and a pre-existing campus tree survey were all conditions that contributed to the decision of MSU to pursue this project. One individual, Dr. MacFarlane, played a critical role due to his desire to demonstrate application of CCX protocols and ability to engage student researchers. Although no credits were sold, transaction participants are shown in the market chain section because the carbon sequestered was verified by CCX and applied towards MSU's commitment to reduce carbon emissions. As in many other cases, U.S. Forest Service research reports supported the carbon accounting process.

Lessons Learned

MSU's tree inventory and carbon accounting project represents the only approved CCX urban forestry project. Since the CCX officially ended its carbon offsets program in 2010, no other institutions will have the opportunity to register a similar project on that specific platform. However, the applicable and replicable potential of the MSU project is evident. With a large residential population, buildings and facilities, a structured governing system, and its own power plant, the university is much like a small city and as municipalities, states, and regions continue to adopt and implement climate policy, there is much to be taken from the institution's approach to trees and emissions reductions. Specific lessons learned include:

MSU's trees light up the campus in yellows, oranges and reds in the fall. By exploring the MSU's campus it is evident how important the campus urban forest is to administrators and the MSU community at large. This carbon project reflects the high valuation of campus trees.

- Dr. MacFarlane and the other key players at MSU were able to implement this project with relative ease and timeliness largely due to the availability of the comprehensive and regularly updated Campus Planning and Administration office's plants database. A specific feature of the inventory that has proven key for accurate carbon accounting is having the year that each tree was planted, which serves as a base-line. *Maintaining a tree inventory in an urban setting is important for many reasons, but this project demonstrates its applicability—and necessity—in voluntary carbon market participation*.

- Whether in a classroom or community setting, *the MSU project demonstrates an opportunity to incorporate people into a successful carbon project that might not have had knowledge of carbon markets before.* This type of experiential learning is fundamental in communicating climate science, policy, and institutional approaches to reducing emissions.

- Since the MSU project was the first registered through the CCX, its designers were able to test out the protocol its applicability in urban forestry. Recognizing room for improvement, Dr. MacFarlane and his MSU students expanded the CCX carbon look-up tables, which resulted in a larger final carbon figure for the university's trees. *MSU's experience with this project can inform similar institutions considering a carbon project.*

- *The current state of the carbon market presents challenges for urban forestry projects.* At the time of this project, the trading price of carbon on the CCX was extremely low. This paired with the high costs of urban tree planting and maintenance in cities creates a challenging situation for urban forestry. How can a group expect to raise adequate funds for tree plantings through carbon markets if the offsets are perceived to have no value? To have actual climate impact and to be financially feasible, either the market for carbon will need to change or groups will need to become creative in the design of carbon projects for urban trees.

Project Partners

Michigan State University

Michigan State University is a public research institution with nearly 50,000 students. MSU operates like a small city in order to support its population; the T.B. Simon Power Plant co-generation facility produces 100 megawatts of energy to provide electricity and heat for the institution. In 2005 the administration began to focus on sustainability and lowering MSU's environmental impact through the *Boldness By Design Environmental Stewardship Initiative* (13). One of the priority action areas was energy and in 2007 University President Lou Anna K. Simon and Vice President for Finance Operations Dr. Fred Poston signed an agreement with the Chicago Climate Exchange, committing MSU to reduce its GHG emissions by 6% by 2020 from a year 2000 baseline . The CCX membership was the impetus for multiple emissions reduction initiatives on campus, including the urban managed

forests carbon project. In April of 2008, 2009, 2010, and 2011 MSU was required to submit a report to demonstrate its adherence to an emissions reduction schedule of 1-2% reduction per year; if reductions weren't met the university would need to purchase carbon offsets from Michigan forest owners or other institutions, such as it did from the University of Iowa to achieve its 2007 target reduction of 25,000 tCO2e (1, 17, 21).

The urban managed forests project proposal was submitted in late 2009 by Dr. MacFarlane, Dr. Poston, Lynda Boomer, Energy and Environmental Engineer with the MSU Physical Plant Division, and Assistant Vice President for the Physical Plant Ronald Flinn. Dr. David Skole, Professor of Global Change Sciences in the Department of Forestry, also sits on the Offsets Committee of the CCX, is an advisor to the CCX Forestry Committee, and has played a lead role in MSU's membership (14).

The Chicago Climate Exchange

The Chicago Climate Exchange was established in 2003 and was the first voluntary GHG reduction and offset trading platform in the United States. Through 2010, verified emissions reductions of over 450 CCX members totaled nearly 700 million metric tons of CO2e. Industrial emissions reductions accounted for nearly 90% of the overall total while just over 10% was mitigated by carbon offsets purchased through the CCX. Projects registered through the offsets program were guided by a set of ten established protocols, ranging from Agricultural Methane to Renewable Energy Systems to Sustainably Managed Rangeland. The CCX *Forest Carbon Sequestration Protocol* was released in 2009, including guidelines for urban forestry projects under the heading of "Afforestation/ Reforestation: Widely Spaced Tree Plantings" (5).

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