Full Proposal Submission:

A New i-Tree Tool for Assessing Forest Impacts on Urban Ecosystems

2011 U.S. Forest Service
National Urban and Community Forestry
Challenge Cost-Share Grant Program

Principal Investigators:	**Charles Kroll and Theodore Endreny** **SUNY ESF, Syracuse, NY**
Partnership:	**USDA Forest Service Northeastern Research Office**
	The Davey Tree Expert Company

Introduction

This project will develop, test, and distribute an innovative new software toolset to improve our ability to manage urban and community forests to both mitigate and adapt to climate change. Such a spatially-distributed modeling toolset is currently not available to urban and community planners, and thus the localized impact of changes in forest cover cannot be quantified over the urban landscape. With this new toolset we improve prediction of climate and land use change impacts on urban forest structure and assess the urban and community forest's ability to sequester carbon, conserve energy, regulate air temperatures, reduce air pollutants, reduce stormwater quantity, and improve stormwater quality. This has important ramifications for understanding and quantifying the importance of trees on both environmental quality and human health. The 11 new letters of support from local, city, and state foresters that are included with this full proposal submission document the enthusiastic support for this project and the proposed toolset by the constituencies who need it most.

This full proposal submission document builds upon and clarifies our preproposal. Our project improvements are based on the review committee's thoughtful suggestions and comments, as expressed in a written review and a January 20, 2011 phone-interview. These improvements include additional explanation of partner roles, an improved financial match with no increase in the overall budget request, and better articulation of our plan for dissemination of project results to urban and community planners. The following sections include: responses to discussion questions, responses to general comments, responses to comments to applicants, updates to budget, updated letters of partnership, additional letters of support, and Federal Forms AD-1047, AD-1048, and AD-1049.

Responses to Discussion Questions

1) Please discuss your partners and each of their roles and the resources they bring to the project. The Council is interested in seeing national and regional partners participating in this project. Do you feel your partners bring this national and regional perspective to the project? Are there other possible partners you could engage that would strengthen the projects?

This project has a strong partnership between university professors, a federal agency, and a private company. The university partners are the two co-Principle Investigators (PIs) of this proposal, Drs. Charles Kroll and Theodore Endreny of SUNY ESF's Department of Environmental Resources Engineering. Both of these researchers have a history of successful collaboration with the USDA Forest Service, including work on improving current modules of the i-Tree software suite. Each has managed large research projects that have produced both working tools as well as scholarly publications. Drs. Kroll and Endreny will be responsible for the following aspects of this project:

a) Project Coordination
b) Modeling of carbon sequestration, air quality, heat island effects, stormwater quantity, and energy savings due to trees in urban areas
c) Software design and testing

d) Assessment of underlying assumptions of models
e) Writing of journal manuscript for peer-reviewed publications
f) Presentations at NUFAC annual meeting and national conferences
g) Mentoring of graduate students

Our partner with a federal agency is Dr. Dave Nowak of the USDA Forest Service's Northern Research Station located in Syracuse, NY on the SUNY ESF campus. Dr. Nowak was a creator of the original lumped UFORE model which forms the basis of the new spatially distributed toolset. As a partner on this project, Dr. Nowak will:

a) Provide oversight on software product design and model testing to make sure desired outcomes are achieved
b) Supply plot-scale and spatial data sets that are necessary for this project
c) Provide expertise and staff time as needed to assist with model development
d) Test the new modeling package to ensure accuracy and usability
e) Help integrate this new product within the i-Tree modeling suite
f) Assist with distribution and promotion of the new model
g) Assist in writing peer-reviewed papers on the model and model results

The updated letter of partnership from Dr. Nowak that is included with this full proposal submission articulates these roles. Dr. Nowak has successful ongoing collaboration with both of the PIs on this project, as well as with The Davey Tree Expert Company (herein referred to as Davey Tree), our second partner on this project.

Davey Tree is one of the largest employee-owned companies in the United States, with over 7000 employees in offices across the United States. This company provides tree, shrub and lawn care; large tree moving; grounds management; vegetation management and consulting services. Davey Tree has been collaborating with the USDA Forest Service on the development, distribution, and promotion of the current i-Tree software suite which is located online at www.itreetools.org. As a partner on this project, Davey Tree will:

a) Provide a 1:1 match of $53,653 for 1200 hours of computer programming and support expertise for development, integration, and dissemination of this new modeling toolset through i-Tree.
b) Collaborate with us to integrate the results of this project into a functional, integrated tool called "i-Tree Landscape" within the i-Tree platform (www.itreetools.org).
c) Leverage and advance their investment in i-Tree to create a more accessible and scientifically advanced platform available for urban forest analysis
d) Take advantage of their framework for model development, world-wide dissemination, user support and long-term refinement.

The updated letter of partnership from Scott Maco, Manager of Ecosystem Services at Davey Tree, is included with this full proposal submission. Maco's letter confirms these roles and provides short biographies for personnel who will be involved with this project.

In addition to these partnerships, we have obtained 11 new letters of support from a wide variety of local, city, and state foresters who will either be involved with the project or support its completion. The following table summarizes these letters, which are included at the end of this full proposal submission. The first four letters are from urban and community forest managers involved with each of our three study areas: Los Angeles, CA; Syracuse, NY; and Baltimore, MD. Each indicates a willingness to be involved with all aspects of the project, with a focus on coordinating local data sets for model development, testing, and validation. Additional letters are from individuals who would take advantage of the results from this project. These letters indicate a willingness to provide additional locations for model development, testing, and use, and opportunities for regional dissemination and distribution of our project results, and testing of our new toolset.

Summary of Letters of Support

Author	Title	Organization
George Gonzalez	Chief Forester	City of Los Angeles, CA
Stephen Harris	City-County Arborist	Syracuse Department of Parks, Recreation & Youth Programs
Marian Honeczy	Supervisor	Urban & Community Forestry, Maryland Dept. of Natural Resources
Steven W. Koehn	Director of State Forests	Maryland Department of Natural Resources
Carl Garrison III	State Forester	Virginia Department of Forestry
Paul Revell	Urban and Community Forestry Coordinator	Virginia Department of Forestry
Steven G. Scott	State Forester and Director	Tennessee Division of Forestry
Paul D. Ries	Urban and Community Forestry Program Manager	Oregon Department of Forestry
James R. Clark	Vice President	HortScience
Gene Hyde	City Forester	City of Chattanooga, TN
Melanie Choukas-Bradley	Author	City of Trees: The Complete Field Guide to the Trees of Washington

2) Does the i-Tree toolkit link to carbon storage & sequestration models?

Absolutely. Tree based carbon uptake, storage and sequestration reduces carbon dioxide, a primary greenhouse gas responsible for global warming. In the current i-Tree software suite, which is based on the original Urban Forest Effects (UFORE) model, tree biomass equations are coupled with urban tree growth estimates to forecast the amount of carbon stored and sequestered by trees (from roots to leaves). Tree growth estimates are made based on species, condition, site conditions, and land use. The scientific methodology employed to estimate carbon storage and sequestration can be found in Nowak (1993) and Nowak et al. (2002).

3) Could the project plan to have a more diverse set on cities with more diverse geography or smaller cities?

We tried to represent diversity in city geography and size, and use this section to explain our efforts and constraints. In the initial phase of this project, where model development and testing is occurring, it is important to have study areas where a substantial amount of data is available (such as tree plot information, local meteorology, and air quality data). As mentioned in the preproposal, each of the 3 proposed study sites was chosen due to the presence of these data sets, as well as ancillary data that may be employed to better assess model assumptions (such as high intensity airplane captured LiDAR imagery of the surface elevations for determining tree locations and physical characteristics). Baltimore, MD [240 sq km city area, 620,000 people in 2010] was chosen due to its temperate climate, rapid expansion, and extensive past analyses with the Urban Forest Effects (UFORE) and other regional atmospheric models. Syracuse, NY [66 sq km city area, 140,000 people in 2010] was chosen due to its proximity to the PIs and our Forest Service partners, the recent collection of high intensity LiDAR by the PI, and recently installed air quality towers. Los Angeles, CA [1290 sq km city area, 3,800,000 people in 2010] was chosen due to its arid climate, recent localized studies of the impact of urban and community forests, and the frequent occurrence of urban heat island and adverse air quality conditions. One of our letters of support from Paul Reis, the Urban and Community Forestry Program Manager for the Oregon Department of Forestry, commends us on our choice of a western city (Los Angeles), which are often overlooked in such projects. Multiple officials in Colorado have recently contacted us with interest in being a pilot study site; while there was not time to integrate this request into our proposal, we will consider these sites for future application studies.

It is important to note that the model developed in this project will be applicable within any urban or community setting with only minimal local information. The urban area does not need high cost site data such as extensive tree surveys or LiDAR elevation data to use our model; those data are needed only to develop and test the model. Our goal is to develop a widely employed toolset that will help communities of all sizes evaluate the impact and management of forests to both mitigate and adapt to climate change, while improving our environmental and the health and safety of its inhabitants.

4) What conferences and meetings would you be focusing on – academic or practitioner meetings?

We will attend the annual fall National Urban and Community Forestry Advisory Council meeting each year of the project to discuss our progress and provide knowledge for designating future innovation grant priorities and processes. We will also attend a number of conferences to help promote our project and to facilitate the use of our new software. While these conferences have yet to be decided, we expect to focus primarily on national conferences which a large number of practitioners attend. We have identified the Arbor Day Foundation's Partners in Community Forestry National Conference and Society of American Forester's National Convention as two potential conferences which will satisfy our goals.

5) What other funds are supporting this?

An extremely important improvement in this full proposal submission is the reallocation of some of the original budget to Davey Tree, and their dollar-for-dollar match of these funds. Please note that there is no increase in our requested total direct and indirect costs, only an increase in quantity and diversity of our match. In our original budget we had allocated a total of $53,653 in salary and benefits for a part-time (20%) post-doctoral associate. These funds will now go to Davey Tree, who is committed to the success of this project (see updated letter of partnership for these details). Davey Tree will be involved with all phases of final model construction, integration, and deployment. Our partnership with Davey Tree is in keeping with their historical partnership with the USDA Forest Service to create the current i-Tree software suite. This partnership resulted in urban and community foresters using i-Tree as a planning and assessment tool throughout the world. The letters of support included with this submission repeatedly indicate the importance of i-Tree tools to support the management of urban and community forests. Davey Tree diversifies our dollar-for-dollar match, providing a total of $107,306 of services to this project. Davey Tree can provide a team of experts with wide ranging skills to support this project. Included with the updated letter of partnership from Davey Tree are short biographies for 6 Davey Tree employees who will be involved with this project.

In addition to these resources, SUNY ESF will provide all computational software and hardware for this project. While the final model will be developed with a simple modeling framework to be accessed online via any computer, the testing of the model and its fundamental assumptions required additional computational power. SUNY ESF, with support from Dr. Kroll and the Department of Environmental Resources Engineering, has just invested in a new multi-node computational system, which will be available for all necessary analyses in this project. This is a huge benefit to this project that is not included in the matching funds.

Additional discussion of our final proposal budget and supporting funds is discussed under Responses to General Comments 2) below.

6) The proposal does not address the Davey's contributions and will need to if the full proposal is requested.

This is discussed under Responses to Discussion Questions 1) above and in the letter from Scott Maco of Davey Tree.

7) You mentioned on how widely this application is used around the world, and that needs to be included in your proposal description.

Based on data from formal model downloads and user requests for model support, there have been over 5000 applications of the original UFORE model in the United States, and over 6000 applications worldwide. The toolset we will develop will be more useful than any previous model, since the user will be able to estimate the localized impact of changes in urban and community forests on a variety of environmental and economic variables. Given the importance of our proposed project, the fact that no other competing product exists, and our aggressive plan for project distribution and dissemination, we expect wide use of our resulting toolset.

In Responses to Comments to Applications 4) below, links to citations for i-Tree usage and technical background are provided.

8) City planners need to use this to make decisions for long range planning. I would like to see it planner user friendly. How do you make it planner friendly? The review panel is asking the applicant to address planners by providing workshops and specific outreach to planners for long range planning.

Based on this comment, we have worked closely with our Forest Service partners examining ways to ensure that we: 1) widely promote the availability of our toolset to local to regional urban and community forest officials across the nation, and 2) provide multiple opportunities and options for toolset training and feedback on toolset ease of use. We feel both of these issues are crucial to the overall success of our project.

To promote our toolset, we will use a variety of strategies. Online access to the toolset will allow us to optimize web site design to maximize internet search effectiveness. Given the large number of UFORE/i-Tree application users (currently over 6000), this appears to be a very effective way to promote and disseminate our toolset. There is also an i-Tree online user forum which provides additional opportunities to make users aware of our new toolset. Forum users must register to gain access and receive alerts about the basic i-Tree software updates. We will use this tailored connection to alert likely users of the availability of our new i-Tree toolset. This approach reaches beyond traditional conferences, webinars, and postings on others websites. As mentioned previously, we plan to present our project's results at national conferences that have a wide variety of potential model users (practitioners, managers, academics, and students). Finally, publication of our scholarly findings will educate the academic audience of the availability of this novel toolset.

We plan to have multiple opportunities and options for toolset training. Most of these dissemination and distribution plans are web-based, thus allowing us to create, beta-test, and

distribute effective and efficient teaching tools that can reach national and regional audiences. These web-based training tools have fewer participant obstacles (e.g. limited seating, travel time) and much lower costs (e.g. travel, lodging, meals) than in-person training sessions. One major training tool will be online seminars (webinars). These webinars will be developed in collaboration with the PIs, their graduate students, and our Forest Service and Davey Tree partners. These webinars will be executed multiple times with real-time user chat feedback, and archived and posted online for future use by new or returning users. We will also create "youtube" training videos for the toolset which will be posted on the i-Tree website. These videos will provide keyboard and screen shot instructions on how to employ the toolset in practice. We will also produce training manuals and modules which will be located on the i-Tree website. Such manuals are available for download for current i-Tree tools. All of these training modules will be thoroughly tested prior to their launch by using our network of project supporters. We will provide surveys during all training sessions to obtain feedback on how to improve the model usability, documentation, and training.

Responses to General Comments

1) The dissemination and distribution plans of project results and products are consistently weak in a majority of the proposals. If a full proposal is requested, please elaborate on your plans to reach a national and regional audience including both traditional and nontraditional stakeholders. Reach beyond others websites, local partners, traditional conferences and the forest service to find innovative communication techniques.

We elaborate on our dissemination and distribution plans under Responses to Discussion Questions 8) located above.

2) In the full proposals, a detailed budget narrative should be included. The budget should clearly define how match is being met, and more detailed cost breakdown, including indirect costs, that will enable the Council to assess the value of the return on the federal investment in these projects.

We provide a detailed budget narrative for each category of the budget below.

Budget Category A. Senior Personnel:

PI Kroll has allocated 10% of his academic year time to this project. Of this 10%, 1% will be paid by the USDA Forest Service, and 9% by SUNY ESF (as match). In addition, PI Kroll has requested 2 weeks of summer salary. The projected increase in salary over the 3 years is 4.5%/year, and federally negotiated benefits on these salaries are a weighted mean of 53.36%, 60.42%, and 63.99% a year for the next 3 years for the academic year and 17% a year on summer salary.

PI Endreny has allocated 5% of his academic year time to this project. Of this 5%, 1% will be paid by this grant, and 4% by SUNY ESF (as match). In addition, PI Endreny has requested 2 weeks of summer salary. The projected increase in salary over the 3 years is 4.5%/year, and

federally negotiated benefits on these salaries are a weighted mean of 53.36%, 60.42%, and 63.99% a year for the next 3 years for the academic year and 17% a year on summer salary.

Budget Category B. Other Personnel:

Two PhD students will be funded on this project. Both will be paid $22,000/year. Salary for one PhD student will come exclusively from this grant, while the academic year salary ($13,000) for the second PhD student will come from a State supported Graduate Assistantship allocated by the Department of Environmental Resources Engineering (as match). Summer funding for the second student will come from this grant. The projected increase in salary over the 3 years is 4.5%/year, and federally negotiated benefits on these salaries are a weighted mean of 13%, 13.75%, and 15% a year for the next 3 years.

Budget Category C. Permanent Equipment:

No permanent equipment will be purchased for this project. All computations hardware and software will be provided by SUNY ESF, including a newly purchased multi-node computational system for advanced environmental simulations. While these resources provide an incredible resource to this project, they are not accounted for in our match.

Budget Category D. Travel:

Travel expenses during the first 2 years of this project are estimated at $3000 a year, with $4500 in year 3. These funds will be used to attend the annual fall National Urban and Community Forestry Advisory Council meeting each year, as well as 1 national conference in the first 2 years and 2 conferences in year 3. Based on our consistent record of presentations at national conferences, we are planning to present information on this project and the new i-Tree toolset at these conferences. These presentations will further advance dissemination and distribution of the toolset by promoting these packages.

Budget Category E. Participant Support Costs:

Due to our use of webinars, videos, and email based training and support, we have no such costs.

Budget Category F. Other Direct Costs:

We are requesting $1000 in year 1 for materials and supplies, and $1300 a year in years 2 and 3. These funds will be used for publication costs and incidental office supplies, such as mailings, photocopying, and needed technical documents.

Davey Tree will be paid $16,980 in year 1, with an increase of 4.5% a year for a total of $53,653 for this project. These are the exact sums and distribution provided in the original budget for our Postdoctoral Associate. A discussion of the importance and use of these funds in located under Responses to Discussion Questions 5) above.

This project will pay the tuition costs for 1 PhD student for 3 years. Note that after year 2 when the PhD student is post-candidacy exam, tuition costs will be reduced to 1 credit a semester.

Budget Category G. Total Direct Costs:

The total direct costs requested to support this project is $257,183, the same amount that was in our original pre-proposal.

Cost-Sharing Table (Match):

Our actual match for this project exceeds the requested match amount by 40% (a 1.4:1 match). These matching funds are as follows:

a) 9% of PI Kroll's academic year time (including benefits)
b) 4% of PI Endreny's academic year time (including benefits)
c) 1 month a year of time and benefits from an Instructional Support Specialist paid by SUNY ESF. This time has been allocated to assist with all project computational needs.
d) Academic year salary and tuition for our 2nd graduate student (including benefits).
e) Indirect cost recovery on the total direct costs from the match. There will be no indirect costs charged to this project. These are only used for our match.
f) Unrecoverable indirect costs on the total direct costs from this grant. Again, there will be no indirect costs charged to this project. These are only used for our match.

3) The Literature reviews need to be strengthened within the topic area. Consider past research or work that your proposal builds upon; justifies the need for this project; identify how this project may differ from past work, and / or supports the innovation of this proposal.

This was a general comment to all finalists, but we closely examined the issue and the separate comment about our proposal being too academic in places (see comment 3 in the next section). As such, we decided to not add more to our literature review. We reexamined our preproposal literature review and believe it justifies the need for this project, explains how the project differs from past work, and describes how it is innovative. If there are specific areas of weakness in the literature review, we would be happy to address them.

<u>Responses to Comments to Applications</u>

While we appreciate the many positive comments on our proposal (i.e. we agree with the reviewers that this project creates an innovative and indispensable tool for urban forestry scenario planning and prioritization applications), in this section we provide responses only to the negative comments provided.

1) Suggest that the proposal's scope include an add on a workshop to actually train planners to use the tool.

Yes, we are including training in our scope. This is discussed under Responses to Discussion Questions 8) located above.

2) Some reviewers were confused by budget justification for unrecoverable indirect, please clarify.

We agree the matching methods will benefit from additional explanation. This is discussed under Responses to General Comments 2) located above.

3) The proposal is a little too academic in nature overall. While the academic merits are good, there needs to be more of a collaborative technology transfer component.

We agree an academic focus resided in certain sections of the preproposal and we have better balanced this in our final product with more text on dissemination and technology transfer. The ultimate goal of this project is to create a novel spatially-distributed toolset to allow urban and community foresters to assess the localized impact of trees on environmental and economic variables, and to evaluate the ability of forests to mitigate and adapt to climate change. To build trust in the model, we present the academic merits of this project; users will know this project was funded based on its sound science and innovative dissemination strategies. The sound science will thoroughly test the model assumptions using advanced simulation techniques. While these techniques will not be required by the final user, they allow us to assess the tradeoffs between model complexity and model output. Due to these analyses, the assumptions of the resulting model will be scientifically justified, and the uncertainty of model assumptions quantified.

4) It needs more convincing evidence (citations, descriptions, featured case studies, and letters of support) that the intended target (planners) is using toolkit.

We agree the sponsors of this project should have numbers and evidence to base their investment, and we provide these data. The convincing evidence is discussed under Responses to Discussion Questions 1) located above, where 11 new letters of support are discussed. Citations for a series of reports based on current i-Tree tools can be found at http://www.itreetools.org/resources/reports.php. An extensive list of technical reports and journal articles which describe the basis of the UFORE/i-Tree model and applications of this model can be found at http://www.ufore.org/about/05-00.html.

5) The grant should support a student thesis in education/outreach that develops i-Tree training workshop for planners.

We agree that the educational and outreach components of this project are instrumental in its success. To address this, one chapter of one of the PhD students will focus solely on this issue, and will provide the templates for all training webinars, videos, and manuals.

6) The tool should include a "scenario development" module to evaluate different potential urban forestry program outcomes or tree planting design schemes, etc.

This comment excited us and we worked closely with our research partners to develop these scenarios based on tested and successful scenario tools. The toolset we will create allows the user to perform many "scenario developments". The USDA Forest Service's Northeastern Research Station has been building an i-Tree model which will be called i-Tree Forecast. This model uses temporal tree plot data to develop estimates of tree species growth and die-back. In addition, the toolset will allow users to design changes in their landscape, assess how those changes will impact model output, and model how those changes might evolve over time. A graphical user interface (GUI) will be design to allow such landscape changes to be easily implemented and interpreted. The model will provide "optimal" tree planting scenarios for carbon sequestration and climate change mitigation targets. These scenarios show communities the target number of plantings and their approximate spatial location, along with species and age distribution.

7) The evaluation criteria is discussed in general terms, but not explicitly specified.

As suggested, we will follow "SMART" goals for project evaluation. Here "SMART" stands for objectives which are **S**pecific, **M**easurable, **A**ttainable, **R**ealistic, and **T**imely. Below we specify how each criterion will be addressed.

We have defined 5 ***specific*** project objectives, each of which contributes to the final product. These objectives are to:

1) Develop a spatially distributed i-Tree toolset, with a consistent database platform to maximize model portability and usability.
2) Compare the impact of employing different data sources as inputs and parameters for the distributed i-Tree toolset.
3) Perform case studies with the new modeling system at three US cities, determining the impact of forest and climate change on these urban ecosystems.
4) Employ Systems Engineering techniques to develop optimal urban forestry and management plans.
5) Disseminate the results from this project at conference presentations, in peer-reviewed journal articles, and online via the i-Tree Software Suite.

Our objectives are ***measurable***, and in the preproposal we defined the steps needed to obtain each objective. Our partners, the USDA Forest Service's Northeastern Research Station and Davey Tree, have the same ultimate objective, to produce usable tools for practitioners to analyze forest structure and function. The projects PIs and their partners have an established working relationship with a history of both producing these tools and creating scholarly publications.

We have the ability, skills, oversight, and computational and financial resources to ***attain*** each research steps and reach our objectives. We have developed a timeline of project milestones (included in the preproposal), and will hold phone, e-mail, and/or face-to-face meetings with our partners at least monthly throughout the project. These meetings will allow us to assess our

progress, strategize on upcoming project steps, and make any necessary adjustments to our research plan to reach our goals and outcomes. Based on these meetings, we will produce quarterly progress reports which will be the basis for producing project annual reports and presentations. Annual presentations to the National Urban and Community Forestry Advisory Council will also provide additional feedback on our project.

While our objectives are expansive, they are also ***realistic*** based on our initial i-Tree knowledge base, our dedicated and tested team focus, and our past record of success. Based on consultation with our project partners and review of our budget and timeline, we believe our goal of producing a novel toolset to improve urban and community forest management for climate change mitigation and adaptation is realistic. We have put together a team of experts who have a history of success, and who are committed to and excited by this project.

Finally, the steps in our project are ***timely***. We are prepared to release this carbon sequestration and climate change mitigation toolset at a time when cities are increasingly facing decisions about climate change, energy use, green infrastructure and human health, all of which are impacted by urban and community forests. We are able to incrementally build the i-Tree toolset across this project timeline, giving our users a chance to use and comment on toolset development and identify any gaps. We have ongoing research collaboration with our partners that are the perfect precursors to this project being nimble and responsive to timely adjustments in model features. We have developed various model components and are ready to refine model functions and test model assumptions and applicability.

In terms of final product assessment, a chapter of one graduate student thesis will assess the dissemination and training success of our spatially distributed i-Tree software toolset. We will pilot our toolset prototype with our supporters who have provided letters with this final proposal. As part of this exercise, we will develop survey tools to obtain feedback on improving the model, model documentation, and the training exercise. We will also have survey tools targeting each of the webinars, to improve the model use, accessibility, and distribution.

Additional Citations

Nowak, D.J. 1993. Atmospheric carbon reduction by urban trees. Journal of Environmental Management 37: 207-217.

Nowak, D.J., Stevens, J.C., Sisinni, S.M., Luley, C.J. 2002. Effects of urban tree management and species selection on atmospheric carbon dioxide. J. Arboric. 28(3): 113-122.

Updated Budget

A New i-Tree Tool for Assessing Forest Impacts on Urban Ecosystems

PIs: Kroll and Endreny, SUNY ESF

Full-Proposal Budget
Submitted to USDA Forest Service
National Urban and Community Forest Challenge Cost-Share Grant Program
Urban Forest Innovation Grants Funding Opportunity
Funding Opportunity Number USDA-FS-UCF-01-2011

A New i-Tree Tool for Assessing Forest Impacts on Urban Ecosystems
October 1, 2011 - September 30, 2014

USDA-FS-NUCFAC-Kroll:10q4:rbs **2/28/11** CFDA 10.675

CATEGORY	**Year 1 10/1/11 - 9/30/12**	**Year 2 10/1/12 - 9/30/13**	**Year 3 10/1/13 - 9/30/14**	**TOTAL**
A. Senior Personnel:				
PI: Charles Kroll @ 10% AY (USDA-FS 1%; ESF 9%)	1,040	1,087	1,135	3,262
Summer Salary - 2 weeks	5,199	5,433	5,677	16,309
CoPI: Theodore Endreny @ 5% AY (USDA-FS 1%; ESF 4%)	1,022	1,068	1,116	3,207
Summer Salary - 2 weeks	5,111	5,341	5,581	16,033
Total Senior Personnel	12,372	12,929	13,510	38,811
B. Other Personnel:				
( ) Postdoctoral Associate	0	0	0	0
(1) Other Professional - Instructional Support Spec - 1 month (100% ESF)	0	0	0	0
(2) Graduate Students- 1 @ 50% CY and 1 summer only	31,000	32,395	33,853	97,248
( ) Undergraduate Students	0	0	0	0
	43,372	45,324	47,363	136,058
Benefits @ 53.36%, 60.42%, 63.99% IFR	3,439	3,997	4,359	11,796
Regular @ 41.5%, 42.5%, 43.5%	0	0	0	0
Summer Salary @ 17%	1,753	1,832	1,914	5,498
Graduate Students @ 13%, 13.75%, 15%	4,088	4,556	5,078	13,722
Undergrad Students @ 5%	0	0	0	0
Total Benefits	9,280	10,384	11,351	31,015
Total S, W and B	52,652	55,708	58,714	167,074
C. Permanent Equipment:				
	0	0	0	0
Total Equipment	0	0	0	0
D. Travel:				
1. Domestic	3,000	3,000	4,500	10,500
2. Foreign	0	0	0	0
Total Travel	3,000	3,000	4,500	10,500
E. Participant Support Costs:	0	0	0	0
1. TuitionFees/Health Insurance	0	0	0	0
2. Stipends	0	0	0	0
3. Travel	0	0	0	0
4. Subsistence	0	0	0	0
5. Other	0	0	0	0
Total PP	0	0	0	0
F. Other Direct Costs:				
1. Materials and Supplies	1,000	1,300	1,300	3,600
2. Publication Costs	0	0	0	0
3. Consultant Services - Davey Tree	16,980	17,869	18,804	53,653
4. ADP/Computer Services	0	0	0	0
5. Subawards/Consortium/Contractual Costs	0	0	0	0
6. Equipment or Facility Rental/User Fees	0	0	0	0
7. Alterations and Renovations	0	0	0	0
8. Other:				
Tuition *	10,349	10,763	1,244	22,356
	0	0	0	0
Subtotal (6. Other)	10,349	10,763	1,244	22,356
Total Other Direct Costs	28,329	29,932	21,348	79,609
G. Total Direct Costs	83,981	88,640	84,562	257,183
H. Indirect Costs @ 0% MTDC (not allowed by sponsor)	0	0	0	0
I. Total Direct and Indirect Costs	**83,981**	**88,640**	**84,562**	**257,183**

* Tuition is being budgeted for 1 credit hour per semester in Yr 3; PI or student will be responsible for any tuition in excess of this amount.

COST-SHARING TABLE	**10/1/11 - 9/30/12**	**10/1/12 - 9/30/13**	**10/1/13 - 9/30/14**	**TOTAL**
PI: Charles Kroll @ 10% AY (USDA-FS 1%; ESF 9%)	8,955	8,955	8,955	26,865
CoPI: Theodore Endreny @ 5% AY (USDA-FS 1%; ESF 4%)	3,913	3,913	3,913	11,738
(1) Other Professional - Instructional Support Spec - 1 month (100% ESF)	6,014	6,014	6,014	18,041
(1) 50% Graduate Assistant (paid from State Funds)	6,500	6,500	6,500	19,500
Benefits - IFR @ 53.36%	6,866	6,866	6,866	20,599
Benefits - Regular @ 41.5%	2,496	2,496	2,496	7,487
50% Tuition for Graduate Assistant (paid from State Funds)	5,175	5,381	622	11,178
Total Direct Cost	39,918	40,125	35,365	115,408
Indirect Costs @ 56% MTDC	20,956	21,072	18,407	60,436
Unrecoverable Indirect Costs	41,234	43,611	46,658	131,503
Total ESF Cost-Sharing	102,108	104,808	100,430	307,347
Davey Tree Expert Company (I-Tree Model Integration)	16,980	17,869	18,804	53,653
Total Cost-Sharing	**119,088**	**122,677**	**119,234**	**361,000**
			Match =	**140%**

Updated Letters of Partnership

A New i-Tree Tool for Assessing Forest Impacts on Urban Ecosystems

PIs: Kroll and Endreny, SUNY ESF

USDA United States Department of Agriculture | Forest Service | Northern Research Station | 5 Moon Library SUNY-ESF Syracuse, NY 13210

nrs.fs.fed.us/units/urban/ dnowak@fs.fed.us Fax: (315) 448-3216 Phone: (315) 448-3200

Date: February 23, 2011

National Urban and Community Forestry Challenge Cost-Share Grant Program
USDA Forest Service
Sidney Yates Building (1- Central)
201 14th Street S.W., MS-1151
Washington, DC 20250-1151

Dear NUCFAC Committee,

This letter is in support of the NUCFAC 2011 proposal: "A New i-Tree Tool for Assessing Forest Impacts on Urban Ecosystems" by Drs. Kroll and Endreny. This proposal is important to help improve the ability of current urban ecosystem models (i.e., i-Tree: www.itreetools.org) to model and map urban forest effects and benefits at the fine scale. These fine scale analyses are important for linking tree effects to specific local conditions and human population so that more detailed local designs of urban forests can be created to improve environmental quality and human health.

As we are located on the same campus, our research unit works closely with SUNY-ESF in the research and development of several urban forest models and databases and is eager to continue this collaboration through this proposed essential work. Our research unit will be intimately involved with this project and contribute staff time and expertise, and collaborate throughout the project to help develop a spatially distributed model that will be integrated within the i-Tree modeling suite.

As a partner on this project we will:
a) Provide oversight on software product design and model testing to make sure desired outcomes are achieved.
b) Supply plot-scale and spatial data sets that are necessary for this project.
c) Provide expertise and staff time as needed to assist with model development.
d) Test the new modeling package to ensure accuracy and usability.
e) Help integrate this new product within the i-Tree modeling suite
f) Assist with distribution and promotion of the new model
g) Assist in writing peer-reviewed papers on the model and model results

The work of this proposal will greatly advance urban forest modeling capabilities to help guide urban forest management in the future. Please let me know if you have any questions.

Sincerely,

David J. Nowak
Project Leader

Corporate Headquarters
1500 North Mantua Street
P.O. Box 5193
Kent, OH 44240-5193
330-673-5685
Toll Free: 800-828-8312
FAX: 330-673-0860

November 22, 2010

National Urban and Community Forestry Advisory Council
USDA Forest Service
Sidney Yates Building (1- Central)
201 14th Street S.W., MS-1151
Washington, DC 20250-1151

Subject: Letter of Partnership

To Whom It May Concern,

I am writing to inform you of the Davey Tree Expert Company's interest and willingness to partner and support the project titled "A New i-Tree Tool for Assessing Forest Impacts on Urban Ecosystems" with Drs. Charles Kroll and Ted Endreny, College of Environmental Science and Forestry, State University of New York. In partnering, we commit to an in-kind project match equal to 100% of our federal request: $53,653.

This project fills a critical need by going beyond currently available tools to provide scalable spatial analysis of urban forest resources. In doing so, it will help managers of urban forest resources to better understand the services trees provide and facilitate a broader range of planning and decision making needs. Developed as an i-Tree product, this new tool will provide resource managers with access to sophisticated models and functions that are currently unavailable as usable management tools.

As project partners, we will collaborate to integrate the results of this project into a functional, integrated tool called "i-Tree Landscape" within the i-Tree platform (www.itreetools.org). As such, we will leverage and advance a substantial investment already made by Davey Tree and our cooperators to develop i-Tree into the most accessible and scientifically advanced platform available for urban forest analysis. As an integrated function of i-Tree, this work will take advantage of an established framework for development, world-wide dissemination, user support and long-term refinement.

We look forward to making "i-Tree Landscape" an accessible and science-based reality for urban forest managers. With our collaboration and early involvement, we will provide the necessary programming and support expertise needed to make efficient use of funds for broad dissemination of this new model through i-Tree.

Thank you for your consideration.

Sincerely,
/s/ Scott Maco
Scott Maco

Manager, Ecosystem Services
Davey Tree Expert Company
11253 Champagne Pt. Rd. NE
Kirkland, WA 98034
Phone: 425-605-0383
Toll Free: 866-853-3749
Fax: 425-605-0863

Cc: Charles Kroll, Ted Endreny, Greg Ina

2011 NUCFAC Project Team: The Davey Tree Expert Company

Project Lead

Scott Maco – Manager of Urban Ecosystem Services

Scott Maco provides management and leadership for the Urban Ecosystem Services working group at the Davey Institute. His primary focus is on applied research and development of urban forest assessment and management tools. Specifically, Scott works to create new technologies that provide better access and understanding of trees' environmental benefits and how ecosystem services can be enhanced by managing urban forest structure. Scott has 15 years of experience in planning, design, and implementation of urban forestry enhancement projects and developing the tools to facilitate effective resource management. Building on his experience working for the USDA Forest Service's Center for Urban Forest Research, Scott continues to lead development of the i-Tree Tools software suite. Additionally, Scott provides leadership for many ongoing federal, state, university and local cooperative research projects, including the development of a national pest detection and reporting protocol (I-PED), the urban forest health information center (UFORHIC), tree suitability modeling, and web-accessible tree benefit calculators. Scott is the author of several peer-reviewed articles on urban forest assessment and a frequent contributing writer for industry journals and magazines. Amongst other awards, Scott was a recipient of the 2008 Forest Service Chief's Honor Award for "Engaging Urban America." Scott holds a Master of Science in Horticulture and Agronomy from the University of California, Davis and a Bachelor of Science in Urban Forestry from the College of Forest Resources, University of Washington.

Primary Staff

Mike Binkley - Research and Development Analyst, GIS

Mike Binkley is a Geographic Information Systems (GIS) specialist with 15 years of experience whose primary responsibility is the application of new technology to Davey endeavors. Past projects include the use of GIS analysis to resolve environmental and natural resource management issues, the development of Davey's GIS-based Asset Manager software and handheld field data collection software, as well as online mapping and web design, GPS vehicle tracking, satellite derived land cover classification, and cartographic design. As such, he strives to maintain extensive knowledge of contemporary GIS software as well as common operating system software and hardware platforms. In addition, he teaches GIS programming part-time at Kent State University. Mr. Binkley holds a Master of Arts in Geography – GIS from Kent State University and a Bachelor of Science with Honors in Natural Resource Conservation with minors in Climatology and Geography from the same institution.

Lianghu Tian - Research and Development Analyst, IT

Lianghu Tian brings 14 years of expertise in information technology, digital image processing, remote sensing and Geographic Information Systems (GIS) to Davey. Currently, Lianghu is a Research & Development Analyst. He manages IT activities, application design, and research and development projects for The Davey Institute. Tian specializes in computer programming, network administration, SQL database server administration, remote sensing

satellite image processing, neural networks, web design and GIS. Before joining Davey, Tian completed various research projects in the United States (including Managing Urban Sprawl and Land Resource Changes by Remote Sensing and Geographic Information Systems; Great American Secchi Dip-in Program and Satellite Image Processing and Geographic Information Systems), as well as research projects in China including Gold Mine Detection by Remote Sensing, Urban Information Systems and Land Resource Information Systems. He has published numerous articles in his fields of expertise and has won several distinguished awards. Tian holds a PhD from Kent State University, a Master of Arts from Kent State University and earned both Master and Bachelor of Science degrees in information and image processing and remote sensing from Zhejiang University in China.

Al Zelaya - Research Urban Forester

Al Zelaya is a Research Urban Forester for The Davey Tree Expert Company. His primary responsibilities include development, research, training, website administration and providing technical support for urban forestry environmental service projects. His current focus includes support and integration tasks related to i-Tree, IPED (pest detection protocol) and SDAP (storm damage assessment protocols) initiatives. Al has more than 10 years experience working in urban forestry, arboriculture and natural areas management. Most recently, he was a Regional Urban Forestry Coordinator for the Wisconsin Department of Natural Resources and a County Forestry Crew Chief in Northern Illinois. He is also a graduate from the Municipal Foresters Institute (MFI) program and currently is a member of the MFI instructor cadre. Mr. Zelaya has a Bachelor of Arts Degree from DePaul University in Chicago, Ill., and is currently working on completing a master's degree in Natural Resources and Environmental Sciences from the University of Illinois. Al is an ISA certified arborist and a member of the Society of Municipal Arborists, the International Society of Arboriculture and the Society of American Foresters.

David Ellingsworth – Lead i-Tree Programmer

David Ellingsworth is a lead programmer for the i-Tree development team. His primary responsibilities include the development and maintenance of i-Tree Streets. David has experience developing with variety of programming languages including Java, .Net, C++, C, PHP, Perl, HTML, and CSS. He holds a Bachelors of Science in Computer Science from The University of Akron, an Associates of Business in Software Development and an Associates of Business in Network Communications Technology from Lorain County Community College. Prior to joining the i-Tree team, he developed web-based applications in .Net and ASP for Software Answers.

Michael Kerr – Lead i-Tree Programmer

Michael Kerr is a lead programmer for the i-Tree development team. His primary responsibilities include development for i-Tree Eco, i-Tree Hydro, and i-Tree's Pocket PC applications. He also develops and maintains the i-Tree Installation package. Michael studied Computer Science at Youngstown State University. He specializes in programming C#, VB.NET, VB6, and VBA applications along with configuration, installation, and software maintenance. Past projects include converting i-Tree Eco and i-Tree Streets to the .NET Compact Framework, the i-Tree Eco Report Generator, an XML to MDB conversion library, and a Pocket PC communication library.

Letters of Support

A New i-Tree Tool for Assessing Forest Impacts on Urban Ecosystems

PIs: Kroll and Endreny, SUNY ESF

CITY OF LOS ANGELES
CALIFORNIA

ANTONIO R. VILLARAIGOSA
MAYOR

DEPARTMENT OF PUBLIC WORKS
BUREAU OF STREET SERVICES

NAZARIO SAUCEDA
INTERIM DIRECTOR
RON OLIVE, ASST. DIRECTOR
JOSEPH CRUZ, ACTING ASST. DIRECTOR
1149 S. BROADWAY, SUITE 400
LOS ANGELES, CA 90015

REQUESTS FOR SERVICE
3-1-1 ~or~ (800) 996-CITY
Email: BSS.BOSS@lacity.org
TDD: (213) 473-3231
FAX: (213) 473-4150

March, 2, 2011

Dear NUCFAC Committee,

This letter is in strong support of the NUCFAC proposal "A New i-Tree Tool for Assessing Forest Impacts on Urban Ecosystems" by Drs. Kroll and Endreny. This type of tool will be very useful to our city and cities across the United States in improving urban forest planning and management to sustain human and environmental health in our cities. We will be happy to offer any assistance we can in the development, testing or use of these tools.

George Gonzalez,
Chief Forester
City of Los Angeles

PARKS, RECREATION AND YOUTH PROGRAMS

STEPHANIE A. MINER, MAYOR

February 25, 2011

National Urban and Community Forestry Challenge Cost-Share Grant Program
USDA Forest Service
Sidney Yates Building (1- Central)
201 14th Street S.W., MS-1151
Washington, DC 20250-1151

RE: A New i-Tree Tool for Assessing Forest Impacts on Urban Ecosystems

To whom it may concern:

I am writing to extend my support of this research initiative and eagerness to have Syracuse, NY serve as a Case Study City.
This research is timely. Syracuse is currently the only city in the country required by law to mitigate CSOs using green infrastructure techniques. Managed through Onondaga County's Water Environment Protection, this initiative will capture 250 million gallons of storm-water (6% of a one-year storm) by 2018 using many techniques including the creation of green streets and tree planting.

As City-County Arborist, I will be overseeing a street-tree planting initiative (8,500 trees over the next 8 years) that has not been matched in this city in 40 years. There is a perfect opportunity for collaboration now and well into the future.

Thank you.

Sincerely,

Stephen Harris, City-County Arborist
Syracuse Department of Parks, Recreation & Youth Programs
412 Spencer St.
Syracuse, NY 13204

PARKS, RECREATION AND YOUTH PROGRAMS

STEPHANIE A. MINER, MAYOR

February 25, 2011

National Urban and Community Forestry Challenge Cost-Share Grant Program
USDA Forest Service
Sidney Yates Building (1- Central)
201 14th Street S.W., MS-1151
Washington, DC 20250-1151

RE: A New i-Tree Tool for Assessing Forest Impacts on Urban Ecosystems

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This research is timely. Syracuse is currently the only city in the country required by law to mitigate CSOs using green infrastructure techniques. Managed through Onondaga County's Water Environment Protection, this initiative will capture 250 million gallons of storm-water (6% of a one-year storm) by 2018 using many techniques including the creation of green streets and tree planting.

As City-County Arborist, I will be overseeing a street-tree planting initiative (8,500 trees over the next 8 years) that has not been matched in this city in 40 years. There is a perfect opportunity for collaboration now and well into the future.

Thank you.

Sincerely,

Stephen Harris, City-County Arborist
Syracuse Department of Parks, Recreation & Youth Programs
412 Spencer St.
Syracuse, NY 13204

MARYLAND
DEPARTMENT OF
NATURAL RESOURCES

Martin O'Malley, *Governor*
Anthony G. Brown, Lt. *Governor*
John R. Griffin, *Secretary*
Joseph P. Gill, *Deputy Secretary*

February 23, 2011

National Urban and Community Forestry Challenge Cost-Share Grant Program
USDA Forest Service
Sidney Yates Building (1-Central)
201 14th St. SW, MS-1151
Washington, DC 20250-1151

RE: A New i-Tree Tool for Assessing Forest Impacts on Urban Ecosystems proposal

Dear Sir:

The Maryland Department of Natural Resources Forest Service supports this proposal as submitted. The proposal will develop a landscape ecosystem service tools for i-Tree. One of the proposed test sites is Baltimore, MD which will greatly assist the City in its goal of increasing urban tree canopy coverage. Once completed, these tools will be of great assistance to the urban landscapes of all sizes in Maryland. This tool will very beneficial to the Maryland Forest Service with regards to climate adaptation and carbon mitigation as well as other new federal and state initiatives.

Again the Maryland Forest Service supports this proposal.

Sincerely,

Marian Honeczy, AICP, CA
Supervisor, Urban & Community Forestry

MARYLAND
DEPARTMENT OF
NATURAL RESOURCES

Martin O'Malley, *Governor*
Anthony G. Brown, Lt. *Governor*
John R. Griffin, *Secretary*
Joseph P. Gill, *Deputy Secretary*

March 1, 2011

National Urban & Community Forestry Challenge Cost-Share Grant Program
USDA Forest Service
Sidney Yates Building (1-Central)
201 14th Street SW, MS-1151
Washington DC 20250-1151

Dear NUCFAC Committee,

I am writing this letter in strong support of the NUCFAC proposal "A New i-Tree tool for Assessing Forest Impacts on Urban Ecosystems" by Drs. Kroll and Endreny. This type of tool will be very useful to Baltimore and to other cities across the United States in improving urban forest planning and management to sustain human and environmental health in our cities. In Maryland, the Maryland Forest Service is very interested in tools that would help quantify carbon mitigation and pollution abatement strategies for our urban areas. We will be happy to offer any assistance we can in the development, testing or use of these tools.

I thank you for this opportunity to show my support for this worthy effort.

Sincerely,

Steven W. Koehn

Steven W. Koehn
Director/ State Forest

Carl E. Garrison III
State Forester

COMMONWEALTH of VIRGINIA

DEPARTMENT OF FORESTRY
900 Natural Resources Drive, Suite 800
Charlottesville, VA 22903
www.dof.virginia.gov
Phone: 434.977.6555 ~ Fax: 434.296.2369

February 24, 2011

Dear NUCFAC Committee:

I am writing in strong support of a NUCFAC proposal being submitted by Dr. Kroll and Dr. Endreny titled *A New i-Tree Tool for Assessing Forest Impacts on Urban Ecosystems*. The i-Tree suite toolbox is already being employed by communities in Virginia to help manage our urban forests. The product that would be produced under this proposal will serve to increase the utility and effectiveness of that toolbox.

The Virginia Department of Forestry has been vigorously promoting the use of i-Tree with our municipal forester partners. In addition, we have been working with the urban forestry program at Virginia Tech to complete UFORE analysis in selected communities. Through these efforts, we have increased awareness among public officials and local/regional planners about the ecosystem services values provided by urban tree canopy (UTC). The new product resulting from this project will provide valuable information that will complement ongoing efforts that encourage more urban tree plating to deal with air quality, water quality, and storm water management issues.

The Virginia Department of Forestry has already facilitated urban tree canopy (UTC) analysis in 30 Virginia municipalities and several of these communities are already using this work to revise and update their urban forest management plans. We would be delighted to assist in involving these communities in the development, testing, and/or use of this tool. Further, we can assist in publicizing this effort to our urban forestry partners through our round tables and forums in Northern Virginia and in the Tidewater area. We are excited to hear about this further enhancement of i-Tree and urge you to give strong consideration to this proposal.

Sincerely,

/s/ Paul F. Revell

Urban & Community Forestry Coordinator

Carl E. Garrison III
State Forester

COMMONWEALTH of VIRGINIA

DEPARTMENT OF FORESTRY
900 Natural Resources Drive, Suite 800
Charlottesville, VA 22903
www.dof.virginia.gov
Phone: 434.977.6555
Fax: 434.296.2369

March 1, 2011

Dear NUCFAC Committee:

I am writing to support the NUCFAC proposal submitted by Dr. Kroll and Dr. Endreny titled *A New i-Tree Tool for Assessing Forest Impacts on Urban Ecosystems.* The i-Tree suite toolbox is being employed by communities in Virginia to help manage urban forests. The product produced under this proposal will serve to increase the utility and effectiveness of that toolbox.

The Virginia Department of Forestry is promoting the use of i-Tree with our municipal forester partners. In addition, we have been working with the urban forestry program at Virginia Tech to complete UFORE analysis in selected communities. Through these efforts, we have increased awareness among public officials and local/regional planners about the ecosystem service values provided by urban tree canopies (UTC). The new product resulting from this project will provide valuable information that will complement ongoing efforts that encourage more urban tree planting to deal with air quality, water quality, and storm water management issues.

The Department has facilitated urban tree canopy (UTC) analysis in 30 Virginia municipalities. Several of these communities are using this work to revise and update their urban forest management plans. We would be delighted to offer our assistance in involving these communities in the development, testing, and/or use of this tool. Also, we can assist in publicizing this effort to other urban forestry partners through our round tables and forums in Northern Virginia and in the Tidewater area.

We are excited to hear about further enhancement of i-Tree and urge you to give strong consideration to this proposal.

Sincerely,

Carl E. Garrison III
State Forester

TENNESSEE DEPARTMENT OF AGRICULTURE
DIVISION OF FORESTRY
ELLINGTON AGRICULTURAL CENTER
BOX 40627, MELROSE STATION
NASHVILLE, TENNESSEE 37204
(615) 837-5520

March 2, 2011

Dear NUCFAC Committee:

I am in strong support of the NUCFAC proposal "A New i-Tree Tool for Assessing Forest Impacts on Urban Ecosystems" by Drs. Kroll and Endreny. The suite of i-Tree tools has opened doors for me; as I believe it has for other state foresters in our efforts to quantify the benefits and values of urban forest resources. These tools have given us the means to tell the story of urban forestry as we work with communities in our individual states. This proposal takes those efforts one step further and allows us to talk on a site specific scale with decision makers.

The Tennessee Division of Forestry will be happy to offer any assistance we can in the development, testing or use of these tools.

Sincerely,

Steven G. Scott
State Forester and Director
Division of Forestry
Tennessee

Oregon
John A. Kitzhaber, MD, Governor

Department of Forestry
State Forester's Office
2600 State Street
Salem, OR 97310
503-945-7200
FAX 503-945-7212
TTY 503-945-7213 / 800-437-4490
http:/ /www.odf.state.or.us

"STEWARDSHIP IN FORESTRY"

March 1, 2011

National Urban and Community Forestry Advisory Council
US Forest Service,
1400 Independence Avenue, SW,
Washington, DC 20250-1151.

Dear Council,

This letter is in support of a 2011 U.S. Forest Service National Urban and Community Forestry Challenge Cost-Share Grant Program Urban Forest Innovation Grant proposed by the SUNY-ESF and Dr. David Nowak. As a practicing urban forester and educator for over 25 years, I've come to depend on the excellent work of Dr. Nowak and his colleagues.

This current proposal, *A New iTree Tool for Assessing Forest Impacts on Urban Ecosystems* by Dr. Kroll and Dr. Endreny, would be a valuable addition to the iTree suite. This type of tool will be very useful to cities across the United States in improving urban forest planning and management to sustain human and environmental health in our cities.

I'm particularly supportive of the investigative methodology including a pilot test using a city in the western US, which is often over-looked in such projects. I'm certain that my colleagues in the West will be glad to assist with the development of this new tool.

Sincerely,

Paul D. Ries

Paul D. Ries
Urban and Community Forestry Program Manager
Affiliate Faculty, Oregon State University College of Forestry

February 18, 2011

National Urban & Community Forestry Advisory Council
US Forest Service
201 14th Street SW
Washington, D.C. 20250

Dear Sir or Madam:

I am writing to express my strong support for the proposal "A New i-Tree Tool for Assessing Forest Impacts on Urban Ecosystems" submitted by Drs. Charles Kroll and Ted Endreny to the Council's Challenge Cost-share Grant program.

The i-Tree tool has proven very useful to cities across the United States. i-Tree allows users like myself to evaluate the structure and function of urban forests. I've been fortunate to have used i-Tree in a number of urban forestry projects, as both an aid to planning and management and to describe how urban forests enhance human and environmental health.

I urge you to give this proposal your strongest consideration. My firm would be happy to assist in the development, testing and application of the proposed tools.

Thanks very much.

Sincerely,

James R. Clark, Ph.D.
Vice President

HortScience, Inc. | 2150 Rheem Dr., Suite A | Pleasanton, CA 94588
phone 925.484.0211 | fax 925.484.5096 | www.hortscience.com

Department of Public Works
City Wide Services
900 East 11th Street
Chattanooga, TN 37403
423 757-7283

February 21, 2011

Mr. Chuck Kroll
NUCFAC
USDA Forest Service
1400 Independence Ave., SW
Washington, D.C. 20250

Dear NUCFAC Committee,

I write this letter in strong support of the NUCFAC proposal, "A New i-Tree Tool for Assessing Forest Impacts on Urban Ecosystems" by Drs. Kroll and Endreny. This type of tool will be very useful to our nation's cities for improving urban forest planning and management to sustain human and environmental health in our towns, villages, and cities.

Here in Chattanooga we have used the i-Tree suite of tools for the metrics it has provided to demonstrate the volumes of carbon sequestration, stormwater interception, air pollution reduction as well as the monetary values that for each of these services that trees provide. This information was cited in our Climate Action Plan to show that trees play a major role in helping to reduce our carbon footprint. Additionally we were also a Beta test site several years ago for the new i-Tree pest module that has now been incorporated into the system.

Quite naturally we would be happy to discuss the opportunity for testing this new component when the time is right.

Thanks and good luck with your project.

Gene Hyde

Gene Hyde, City Forester

Melanie Choukas-Bradley
7100 Oakridge Avenue
Chevy Chase, Maryland 20815

www.melaniechoukas-bradley.com
mcb@melaniechoukas-bradley.com

February 22, 2011

Dear NUCFAC Committee,

I am writing to express my strong support for the NUCFAC proposal entitled "A New i-Tree Tool for Assessing Forest Impacts on Urban Ecosystems" by Drs. Kroll and Endreny. This tool will be invaluable to cities across the United States for bettering urban forest planning and management.

As the author of *City of Trees: The Complete Field Guide to the Trees of Washington, D.C.* (University of Virginia Press) and a natural history field studies teacher, I am ever mindful that one of the most important things we can do in Washington, D.C. and in cities across America is to support and sustain healthy urban tree canopies. Urban trees contribute to human health and the health of the ecosystems within each city and its larger watershed.

I strongly and enthusiastically support this proposal!

With all best wishes,

Melanie Choukas-Bradley

Forest -Service use only.

Control Number: _____

COVER SHEET

2011 U.S. Forest Service
National Urban and Community Forestry Challenge Cost-Share Grant Program

Proposals are due by 11:59 PM Eastern Standard Time, November 29, 2011

INNOVATION GRANT CATEGORY:
(Estimated total amount available is $855,000, $285,000 per category)
(Select only one)

- [x] How Management of Urban and Community Forests Can Help Mitigate Greenhouse Gas Emissions or Help Communities Adapt to Climate Change
- [ ] The Influence of Urban and Community Forests upon Public Health
- [ ] The Influence of Urban and Community Forestry upon Economic Development

PROJECT CONTACT NAME, ORGANIZATION, ADDRESS, PHONE NUMBER, FAX NUMBER AND **EMAIL ADDRESS**:

Dr. Charles N. Kroll, SUNY College of Environmental Science and Forestry
1 Forestry Drive, 402 Baker Laboratory
Syracuse, NY 13210
315-470-6699 (phone) 315-470-6958 (fax)
cnkroll@esf.edu

PROJECT TITLE:

A New i-Tree Tool for Assessing Forest Impacts on Urban Ecosystems

FUNDING REQUEST AND MATCH (Note: Matching amount must at a minimum equal requested amount.)

REQUESTED: $257,183 + MATCHING: $ 309,780 = TOTAL PROJECT: $566,963

OUTREACH:

Note: if one checks "Yes" in either of the boxes below, the applicant will be required to describe either how the plan to outreach to the identified population and/or provide a description of your minority or underserved organization.

Is this project being developed to reach a minority or underserved population? ☐ Yes ☑ No

Is this pre-proposal being submitted by a minority or underserved population (owned/operated/directed) business, organization or college/university? ☐ Yes ☑ No

PROJECT PARTNERS:

NAME: Dr. David J. Nowak

LETTER OF SUPPORT INCLUDED: YES ☑ NO ☐

NAME OF ORGANIZATION: USDA Forest Service

MAILING ADDRESS 1:

1 Forestry Drive, 5 Moon Library

CITY: Syracuse STATE: NY ZIP CODE: 13210

PHONE: 315-448-3212 EMAIL: dnowak@fs.fed.us

##########

NAME: Dr. Satoshi Hirabayashi

LETTER OF SUPPORT INCLUDED: YES ☑ NO ☐

NAME OF ORGANIZATION: The Davey Tree Expert Company

MAILING ADDRESS 1: 1550 N. Mantau Street

CITY: Kent STATE: OH ZIP CODE: 44240-5193

PHONE: 315-657-4012 EMAIL: shirabay@syr.edu

PROJECT PARTNERS Continued:

NAME:

LETTER OF SUPPORT INCLUDED: YES ☐ NO ☐

NAME OF ORGANIZATION:

MAILING ADDRESS 1:

CITY: STATE: ZIP CODE:

PHONE: EMAIL:

##########

NAME:

LETTER OF SUPPORT INCLUDED: YES ☐ NO ☐

NAME OF ORGANIZATION:

MAILING ADDRESS 1:

CITY: STATE: ZIP CODE:

PHONE: EMAIL:

ABSTRACT: Summarize the proposed project in 200 words or less.

This project creates a new spatially distributed i-Tree toolset that is an exciting addition to existing USDA Forest Service (FS) technologic infrastructure and data sets. Our spatially distributed i-Tree toolset quantifies carbon mitigation, climate adaptation, and pollution abatement management strategies for urban communities. This proposal extends our partnership with the USDA FS Northern Research Station to break the spatial lumped i-Tree Eco/Hydro models (e.g. toolset) into smaller planning units that are integrated across the urban landscape. Our toolset allows communities to plan urban forest designs and quantity and assess their impact on carbon storage, air temperature, energy use, and air and water pollution. We use our new toolset to test current i-Tree Eco/Hydro inputs and assumptions, and develop alternative distributed inputs, including those derived from remote sensing and output from US EPA models (e.g. WRF and CMAQ). Our project has a national significance, with an input and parameter structure that takes advantage of available national databases. Case studies include Baltimore, MD, Syracuse, NY, and Los Angeles, CA, though the model can readily be applied in other US cities. The resulting toolset are integrated within the USDA Forest Service's online i-Tree Software Suite for wide dissemination.

PROPOSAL OUTLINE: (The Innovation proposal is not to be more than 10 single spaced pages.) Please make sure each page is numbered and has the project title.

1. **Category Application**

2. **Scope and Applicability/Justification- Proposal objectives:**

3. **Literature Review: (Appendix and cited in narrative where applicable)**

4. **Organization/Methodology:**

5. **Product:**

6. **Collaboration:**

7. **National Distribution/Technology Transfer of Your Findings:**

8. **Project Evaluation:**

9. **Experience/Personnel/Adequacy of Resources: (Appendix)**

10. **Budget and Funding (Appendix)**

Attachments for Appendix:

SF 424, SF 424 (a) and SF 424 (b) (Make sure DUNS number is on SF424 form)
A copy of indirect cost rate or negotiated rate with cognizant Federal agency
List of Literature reviewed and cited. Make sure narrative statements based on the literature review is cited
Letters of Partnership from Partners
Letters of Support from Stakeholders

1. Category Application

Climate change impacts are often discussed at global to regional scales, but smaller spatial scales (e.g., neighborhood) are important when developing carbon mitigation and climate adaption strategies (Clark et al., 2010; IPCC, 2007). This novel project extends the widely used USDA Forest Service i-Tree toolset, formerly known as the Urban Forest Effects (UFORE) Model, so it may run at the range of spatial scales important in carbon mitigation and climate adaptation. Our work brings together a team involved in the recent updates to the UFORE model, which include changing its name to i-Tree Eco and developing i-Tree Hydro, which are part of the Forest Service's i-Tree Modeling Suite at www.itreetools.org. We use the term toolset to refer to our combined work on the Eco and Hydro models in i-Tree tools. Our proposed work creates a spatially distributed version of the i-Tree toolset. The current version of the i-Tree toolset is spatially lumped, meaning that the entire urban setting is simulated as a single unit. The spatially lumped i-Tree toolset uses a statistical sample of the trees in a city to estimate at city-scale tree effects on carbon sequestration, energy use, pest infestations, air pollution, stormwater volumes, and water quality. The spatially distributed i-Tree toolset will use tree data from a range of nested scales to estimate tree effects at the city-block to neighborhood to entire city scale.

While the spatially lumped i-Tree toolset provides excellent city-scale information for urban planners and managers as well as the general public, it is currently not functional at the fine scales at which local planning occurs. These scales are important for linking tree effects to specific local conditions and residential populations. At these scales detailed local designs of urban forests can be created, and the impacts of these designs on the local ecosystem (e.g., carbon sequestration, pollutant filtering, and urban cooling) can be quantified. These designs not only improve environmental quality and human health, but also impact economic conditions by providing value-added services to the local community. The ultimate goal of this work will be the development, testing, and distribution of this new spatially distributed i-Tree toolset, as well as the investigation and development of a risk-based decision support framework to allow planners to link specific urban forest effects with national environmental regulations, and to optimize the benefits of urban forests. Risk assessment is critical in climate adaptation work.

Our spatially distributed i-Tree toolset breaks the urban landscape into cells, and the model components will be run within each of these cells with communication between cells. This will not only allow us to quantify the impact of local changes in urban and community forests, but also will improve our representation of how these local changes impact regional patterns. For instance, with our new modeling toolset, we can identify areas of high air pollutant concentrations or elevated temperatures, where these adverse environmental conditions intersect with high population areas, and predict the effect of changes in the urban forest structure on these conditions. While the horizontal resolution of our cells will be determined by the user and input data, we expect to run our simulations with a 30 meter horizontal resolution, which is consistent with the resolution the National Land Cover Dataset (NLCD).

The spatially distributed i-Tree toolset will function on a city-scale, but the flexibility of the modeling toolset will allow its portability and applicability to any urban area across the United States with only minimal local information. The modeling toolset will take advantage of national databases of meteorology, air quality, air pollutant emissions, and transportation

statistics. The proposed toolset will be distributed via the Forest Service's online i-Tree Software Suite, and thus will be available for use throughout the United States and abroad.

The proposed project aligns with the goals of the 2011 National Urban and Community Forest Advisory Council's Urban Forest Innovation Grant Category 1: How Management of Urban and Community Forests Can Help Mitigate Greenhouse Gas Emissions or Help Communities Adapt to Climate Change. The project will advance the use of urban and community forest resources in mitigating greenhouse gas emissions (specifically CO2), reducing atmospheric pollutants, and alleviating the impacts of climate and urban heat island effects, and quantify these effects at a local scale. The toolset we develop will help communities plan for, adapt to, and mitigate the negative impacts of climate change by quantifying forest effects on urban ecosystems at nested scales. This toolset expands our knowledge and improves our management strategies.

The spatially lumped i-Tree models assess a statistical distribution of urban forest structure to predict forest effects at the city-scale, including:

- Amount of pollution removed by urban forests,
- Total carbon stored and net carbon sequestered by urban forests,
- Impact of trees on building energy use,
- Compensatory value of urban forests,
- Potential impact of infestations on urban forests, and
- Impact of urban forests on stormwater management (i-Tree Hydro)

Our spatially distributed i-Tree toolset will quantify forest structure at user-selected scale (e.g., 30x30 m, block, neighborhood, city), predict forest effects at the modeled scale, and integrate small scale results across the larger scale urban landscape.

We plan for 3 case studies (Baltimore, MD, Syracuse, NY, and Los Angeles, CA), but the new toolset will be transferrable to any urban area throughout the United States. This is due to our team building on nationally developed Forest Service parameter databases and a flexible modeling format that accesses nationally available input data. This modeling format will allow users to run our models in most US cities by simply providing location data and urban forestry information.

This research takes advantage of the ongoing partnership between USDA Forest Service Northern Research Station's personnel and SUNY ESF researchers. The keystone partnership is with Dr. David J. Nowak, Research Forester and Project Leader for the Northern Research Station, and his staff. Dr. Nowak was the developer of the original UFORE model, and has been working with both PIs of the proposal on updating and improving this model. PI Kroll recently had a paper accepted on new developments of i-Tree Eco's dry deposition model (Hirabayashi et al., 2010a), while PI Endreny has been involved with all developments of i-Tree Hydro (Wang et al., 2005ab, 2006, 2008), a model that estimates the hydrologic fluxes across the urban landscape and the impact of trees on these fluxes. The distributed structure of our new modeling toolset will integrate all components of i-Tree Eco and i-Tree Hydro. We are also partnering with the Davey Tree Expert Company, who is responsible for the online i-Tree Modeling Suite interface. Letters of support from these partners are included in the Appendix of this proposal.

2. Scope and Applicability/Justification

Given the national scope of this project, the close partnership with the USDA Forest Service, the planned dissemination of our model via the Forest Service's i-Tree Modeling Suite, and the goal of producing both an exciting new usable toolset as well as peer-reviewed scholarship, we feel this project addresses the intent of Category 1 of the National Urban and Community Forest Advisory Council's Urban Forest Innovation Grant program. The final product is something that urban forest planners and managers greatly need, as currently available tools provide only a rough understanding of how localized changes in urban and community forests impact the urban ecosystem, carbon sequestration, and climate adaptation. With our new spatially distributed i-Tree toolset, we allow for communities to develop integrated urban ecosystem designs and predict how these designs react to potential changes in climate.

The project's objectives are to:

1. Develop a spatially distributed i-Tree toolset, with a consistent database platform to maximize model portability and usability.
2. Compare the impact of employing different data sources as inputs and parameters for the distributed i-Tree toolset.
3. Perform case studies with the new modeling system at three US cities, determining the impact of forest and climate change on these urban ecosystems.
4. Employ Systems Engineering techniques to develop optimal urban forestry and management plans.
5. Disseminate the results from this project at conference presentations, in peer-reviewed journal articles, and online via the i-Tree Software Suite.

The i-Tree toolset (formerly UFORE models) has had a diverse group of users, including scientists, university students, local city planners and managers, and various public groups. The toolset has been applied to cities across the world, and as the tools and associated manuals are now available online, the number of applications of this modeling system is expanding. While the primary target audience of our work is urban planners and managers, we expect that all of the above groups will benefit from our project, and the modeling toolset we develop, as well as related manuals and background information, will be easily accessed via i-Tree Modeling Suite.

The timing is perfect for this project. The PIs have been collaborating with Dr. Dave Nowak, the UFORE/i-Tree creator, on transforming the i-Tree models onto a new windows base computing package (it originally was written in the statistical package SAS). The collaborations resulted in the successful training of multiple graduate students, including Dr. Satoshi Hirabayashi, who is currently employed by The Davey Tree Expert Company, a private company that is responsible for the online i-Tree interface. These collaborations have not only resulted in new and improved software designs and modeling products, but also peer-reviewed journal articles. For instance, Hirabayashi, PI Kroll, and Nowak (2010a) recently developed a flexible computing format to perform advanced sensitivity analyses on the inputs to the dry deposition component of i-Tree Eco. This work helped identify the most sensitive model inputs (air and surface temperatures, leaf area index (LAI), vegetative resistances, and ambient atmospheric pollutants). This work was not only crucial to improving our understanding of this i-Tree Eco component, but also provided us with information to aid in creating a distributed model.

In addition, the development and evolution of i-Tree Hydro has occurred through the collaboration between Dr. Nowak's group and PI Endreny (Wang et al., 2005ab, 2006, 2008). The evolution of i-Tree Hydro will not only allow us to understand how water availability impacts urban forest health, but also how urban forests can help regulate urban air temperatures, reducing heat island effects and heating and cooling costs. The proposed research is the next logical step in this analysis, and would continue a highly successful and proven partnership between the PIs and the USDA Forest Service. Beginning this project in the fall of 2011 will allow us to continue our ongoing partnerships, and build on our successful momentum.

3. Literature Review (See Appendix)

4. Organization/Methodology

This section describes the logical steps that will be performed to reach our desired objectives and ultimate goals. The organization of this section is based on the objectives listed in Section 2.

Objective 1: Develop a spatially distributed i-Tree toolset, with a consistent database platform to maximize model portability and usability.

The major goal and objective of this project is the development of a distributed modeling toolset for i-Tree Eco and i-Tree Hydro. The modeling toolset will allow users to both quantify and visualize model inputs and outputs at local scales across the urban landscape. A distributed model breaks up the study area into a number of cells, and the model is run within each cell. While the cells could be of varying size, we propose to employ a 30 m horizontal resolution cell size, which is consistent with the NLCD (Homer et al., 2004). For example in Baltimore, MD, the simulation would change from 1 cell (spatially lumped) to 250,000 cells (spatially distributed). On a common desktop computer, we expect distributed run times to be below 5 minutes. Our spatially distributed toolset will not only allow the user to gather more detailed information regarding local environmental conditions, but also quickly and efficiently identify environmental "hot spots" where urban forest planners and managers should focus their attention to improve ecosystem health, maximize carbon sequestration, or build in adaptation features.

For our distributed modeling toolset, we are proposing a component-based binary standard based on ArcObjects with an ArcGIS platform. An advantage of this system will be the development of a consistent platform for data storage, retrieval, and analysis. This will include a pre-processor utility that efficiently accesses national databases and converts these data sets to a consistent format employed by and interchanged between all i-Tree subcomponents. Using a three layered software design (presentation, logic, and data management) where layers are compiled into ActiveX dynamic link libraries, we will develop our modeling toolset using Visual Basic. This system is discussed in more details in the Section 3 Literature Review, located in this proposal's Appendix.

Objective 2: Compare the impact of employing different data sources as inputs and parameters for the distributed i-Tree toolset.

As we move from a spatially lumped to a distributed i-Tree modeling system, we are presented with numerous options for distributed inputs. While the current i-Tree Eco model requires a

single temporal input of environmental variables (i.e., city-scale hourly air temperature), the new modeling system uses spatially distributed inputs. This is particularly important for the dry deposition component of i-Tree Eco and i-Tree Hydro. Hirabayashi (2009) developed an initial prototype for a distributed dry deposition component of the i-Tree Eco model, with spatially distributed inputs for temperature, leaf area index (LAI), and ambient air quality. This included the USDA Forest Service's multiple-regression temperature difference model (Heisler et al., 2007) that relates air temperature differences between local weather measurements and land and atmospheric conditions. Distributed LAI values were obtained from regression equations baseed on tree cover percentage estimates (Nowak et al., 1998) for six land cover types (Homer et al., 2004). Distributed ambient air quality was obtained by coupling this modeling system with a Gaussian plume point- and line-source model. We used standard Gaussian model assumptions and simulated the plume through model space given no significant chemical reactions, deposition, and other physical processes (Haug, 1996; Liu and Liptak, 1997; Baukal and Schwartz, 2001). This model can be enhanced to consider reactive or secondary pollutants (Johnson, 1976). We plan to explore potential model improvements suggested by Hirabayashi (2009).

To assess the validity of our distributed i-Tree toolset inputs and assumptions, we will loosely couple our modeling system with outputs from EPA and NWS (National Weather Service) forecasting models. We use the NWS's mesoscale Weather Research and Forecasting (WRF) meteorological model (Michalakes et al., 2001, 2006) and the EPA's Community Multiscale Air Quality (CMAQ) model (Byun et al., 1999; Byun and Schere, 2006). WRF is used to create meteorological inputs, while CMAQ provides urban scale air quality inputs. Table 1 contains the proposed simulations that will be run to examine how output from the i-Tree Eco dry deposition component is impacted by these distributed inputs. We run these sophisticated WRF and CMAQ models to demonstrate whether our assumptions regarding i-Tree toolset inputs and parameters are valid and quanitify the tradeoffs between model complexity and model results.

Table 1: Example of i-Tree Eco dry deposition simulations with different input data sets.

Simulation	Temperature Input from	LAI Input from	Pollutant Concentration Input from	Dry Deposition Estimation by
1	A	A	A	A
2	W	A	A	A
3	A	W	A	A
4	A	A	C	A
5	W	W	C	C

Note: A = ArcUFORE-D, W = WRF, C = CCTM

We will also examine the assumptions of the i-Tree Hydro model, and expand its ability to better simulate urban hydrologic pathways. The current i-Tree Hydro model uses proven tree-based water balance calculations for distinct topographic regions or indices (Beven and Kirby, 1979) across the city to predict discharge for an urban watershed. Processes include canopy interception with seasonally changing LAI, tree-evaporation and cooling, and overland flow from connected impervious cover. Wang et al. (2005a) showed this model was successful in simulating general hydrologic patterns across the urban landscape. Here we expand i-Tree

Hydro to use distributed meteorological inputs and estimate tree response to available light and water and tree effects on cooling and heating costs as well as human thermal comfort.

We propose to advance the simulation of urban hydrology and energy and better represent how the urban forest affects urban residents. Specifically, we: a) represent a new surface runoff scheme sensitive to local tree plantings; b) simulate cold climate hydrology to represent cities with snow and climate change; c) simulate urban pollutant runoff; and d) represent spatially distributed runoff routing and pollutant filtering. I-Tree Hydro will be coupled with the WRF model and its Noah and Urban Canopy land cover modules. This coupling integrates the i-Tree Hydro water balance output of soil moisture and evaporation to examine improvements to WRF predicted urban heat island (UHI) simulation and forecasts. The WRF and related models are widely used as a rigorous and efficient tool to simulate and predict UHI.

Objective 3: Perform case studies with the new modeling system at three US cities.

We will test our model by applying it for the 2005 – 2008 years in three US cities: Baltimore, MD; Syracuse, NY; and Los Angeles, CA. The USDA Forest Service has previous applied the current version of i-Tree Eco in each of these cities, and thus the necessary forest field plot data is already available for this analysis. Our rational for choosing each of these cities follows.

Baltimore, MD has been a staging ground for numerous USDA Forest Service experiments, including numerous applications of iTree. Baltimore, a city of 209 km^2 with a 20.4% tree coverage, is one of NSF's Urban Long-Term Ecological Research (LTER) sites, and thus databases of urban characteristics and change are readily available. Baltimore was the case study for Hirabayashi's recent analysis of the i-Tree Eco dry deposition model, and thus the PIs research team has already compiled all of the necessary data sets for this region. Hourly meteorological data is available from the Baltimore Washington International Airport (BWI) weather station (NCDC 2008), and air pollution concentration data is available from the U.S. EPA's Air Quality System (AQS) (US EPA 2009). In addition, we have access to WRF and CMAQ outputs for this study area, and will be able to compare our modeling output to confirm its validity. Baltimore represents our temperate climate study region.

Syracuse, NY is our second study area. The PIs home university (SUNY ESF) and the Dr. Nowak's Forest Service's office are both located in Syracuse, and thus access to local information pertinent to this study is easily available. Syracuse was recently chosen as an NSF ULTRA site, and thus there are ongoing environmental analyses which will aid our study. SUNY ESF researchers have recently installed 2 air quality monitoring systems which measure EPA regulated criteria air pollutants. In addition, PI Kroll recently coordinated a high intensity LiDAR image ($\geq$ 2 pts/m^2) for the entire Syracuse region. This data source will allow us to identify all trees within this study area, and provides detailed information for the Forest Service's distributed air temperature model (Heisler et al., 2006, 2007). Syracuse represents our cold climate study area.

The final study area chosen is Los Angeles, CA. The USDA Forest Service has an ongoing i-Tree Eco study of Los Angeles, and thus much of the data required in our analysis is already available. Los Angeles has historically suffered from numerous adverse environmental

conditions, including elevated air pollutant concentrations and urban heat island. The use of urban forests to alleviate some of these problems is already occurring within this region. Trees cover 11.1 % of Los Angeles, with another 13.8% shrub cover. Los Angeles presents an ideal study area since results from our analysis should have an immediate impact on quantifying the effect of ongoing changes to urban and community forests. Los Angeles represents our arid climate study area.

Once we have developed our modeling toolset in these urban areas, we will simulate how changes in climate and urban and community forests impact the urban ecosystem. We are interested in the impact of these changes as well as how strategically planned urban forests may mitigate these impacts.

Objective 4: Employ Systems Engineering techniques to develop optimal urban forestry and management plans.

Another novel component of the proposed project is the use of mathematical systems engineering techniques to identify optimal urban and community forest designs. We propose to develop a number of different objective functions to optimize, including:

- Maximizing criteria pollutant removal
- Minimizing the cost to reducing pollutant levels below federal air quality standards
- Minimizing the exposure risk of air pollutants and temperatures to urban inhabitants
- Maximizing the removal of greenhouse gases by urban and community forests

This analysis will provide us with information to address how to maximize the input of new forest plantings, regardless of their scale.

Here we propose the use of Simulated Annealing (SA) to search for optimal urban forest management plans. SA is a generic probabilistic technique for locating near-optimal solutions for complex systems. SA is named for annealing in metallurgy, which involves controlling the internal energy of a system to maximize crystal formation. In optimization, SA searches for nearby solutions which either improve the objective function, or worsen the objective function with a certain probability. By potentially moving to a worse state, the SA algorithm is less likely to get stuck at local optimal solutions, and is more likely to find near global optimal solutions. The SA algorithm has been applied to many large scale complex optimization problems, and has been shown to perform well for problems with spatial attributes.

Objective 5: Disseminate the results from this project at conference presentations, in peer-reviewed journal articles, and online via the i-Tree Modeling Suite.

This not only is an objective of our project, but also a requirement of this proposal. As such, the dissemination of products and results is discussed in Section 5 (Products) and Section 7 (National Distribution/Technology Transfer of Findings) located below.

5. Products

There are many deliverables from this project, and the scope of these products will be widely disseminated. We will develop a new spatially distributed i-Tree toolset. This modeling toolset is developed to access databases available in all major cities across the United States, and any

cities in the world where urban forest field plot data and hourly time series of meteorological and air quality data are available. This toolset will be disseminated using the USDA Forest Service's i-Tree Modeling Suite which is available online at www.itreetools.org. The current versions of i-Tree Eco and i-Tree Hydro are available from this online resource, with supporting meta-data and documentation. This site is maintained by the Davey Tree Expert Company (a project partners), in collaboration with the USDA Forest Service's Northern Research Station Project Leader Dr. Dave Nowak This modeling package will be available free of charge for all potential users. Primary stakeholders include urban planners and managers, who can utilize output from this toolset to aid in making decisions regarding the local-scale impact of urban and community forests. University professors and students will be able to utilize this toolset to better understand urban forest effects, while members of the public, including secondary teachers and students, should be able to access our toolset to improve their understanding of the importance of trees in urban areas.

Both PIs of this project have a history of collaboration with the USDA Forest Service that resulted in improved forest resource tools and scholarly publication. As this project supports two PhD students as well as a part-time post-doctoral associate, we envision numerous scholarly publications resulting from this project. This publication will provide the scientific evidence to support the validity of model assumptions and parameters. These publications will be cited on the itreetools.org web site, and be accessed primarily by university professors and students who wish to better understand the background and development of the distributed modeling toolset.

We will also present our findings at national conferences through the project. This will be in oral and/or written form. We have budgeted to attend 2 meetings a year during the first 2 years of the project, and 3 meetings during the final year. We will select conferences to attend based on our ability to expose the largest potential audience to our work.

6. Collaboration

The PIs primary collaborators are with the USDA Forest Service's Northern Research Station and the Davey Tree Expert Company. Both PIs have ongoing research and outreach collaborations with Dr. Dave Nowak, Project Leader of the Northern Research Station. Dr. Nowak is a founding and on-going creator for the i-Tree model. He has a long history of advancing our understanding and ability to predict the effects of urban and community forests. A letter of support from Dr. Nowak is included in this proposal.

We have been also working with the Davey Tree Expert Company, who is responsible for developing and maintaining the www.itreetools.org web site. Our primary contact will be with Davey Tree Expert Company's Dr. Satoshi Hirabayashi, a broadly trained engineer and software designer who received their PhD under the guidance of PI Kroll at SUNY ESF. Dr. Hirabayashi developed the initial prototype of a distributed version of the UFORE dry deposition model, and will be intimately involved with database and software design to ensure an efficient, effective, and reproducible software product. In addition, the Davey Tree Expert Company will help facilitate the dissemination of our software product via the i-Tree tools website.

7. National Distribution/Technology Transfer of Your Findings

The distribution and technology transfer of our findings is partially discussed in section "5. Products" of this proposal. The primary distribution/technology transfer of our findings will be via the USDA Forest Service's online i-Tree Modeling Suite (www.itreetools.org). This web site provides users the ability to download models, user manuals, and background information on a variety of Forest Service tools. The availability of these tools online creates a much larger distribution of these products, and will aid in the distribution of our results.

The primary target of the proposed project is urban planners, managers, and foresters. We consider these individuals well connected to the USDA Forest Service, and they historically seek out i-Tree assistance to aid in urban design for ecosystem and human benefits.

Keywords: UFORE, i-Tree, Urban Forest Effects, Distributed Modeling, Dry Deposition, Urban Hydrology, Mitigation, Adaptation, Urban Heat Island, Urban Planning, Management, Design

8 Project Evaluation

Both of the PIs are active in running an accredited engineering department. To maintain accreditation through the American Board of Engineering and Technology (ABET) we have developed a rigorous assessment protocol, which provides feedback loops that continually improve our program. We use this experience to develop a thorough project evaluation. We use clear performance criteria and regular evaluations to monitor progress toward project objectives.

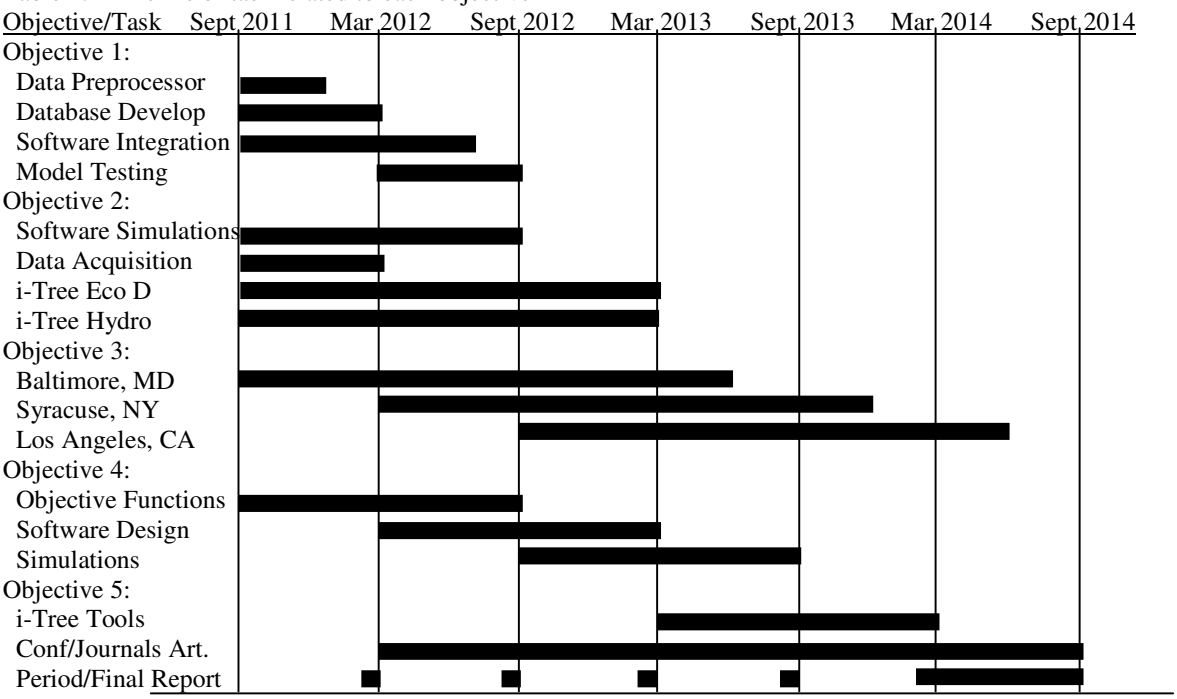
Project evaluation centers on attaining our objectives, which are described in Section 4. Organization/Methodology. As suggested, we will follow "SMART" goals for project evaluation. We have defined ***specific*** project objectives, each of which contributes to the final product. Our objectives are ***measurable***,and for each objective we define steps to obtain that objective (see Table 2). We have the ability, skills, oversight, and computational and financial resources to ***attain*** each of these steps. While our objectives are expansive, they are also ***realistic*** based on our past record of success. Finally, the steps in our project are ***timely***, with Table 2 outlining a time line of steps for each objective.

9. Experience/Personnel/Adequacy of Resources

Both of the PIs have a long history of successfully integrating research, teaching, and outreach in their professional activities. Both also have experience successfully managing large research budgets. Each works on the integration of GIS tools and environmental modeling, with experience in both deterministic and stochastic modeling. We work closely with Drs. Nowak and Hirabayashi, our partners on this project who will provide oversight and guidance.

The PI's home department, Environmental Resources Engineering, at SUNY ESF recently upgraded their existing computational facilities. This includes the purchase of 7 high-end, multi-core, servers, a 20-node Linux cluster, and multi-year research-grade software licenses. The purpose of this investment was to support projects exactly like that outlined in this proposal. All computational requirements of this project will be supplied by our department, at no cost to the project. This is important when we perform simulations for our optimization routines.

Table 2: Timeline of task related to each objective



10. Budget Justification

A majority of the proposed budget involves personnel costs. We propose to have 2 PhD level graduate students working on this project for the 3-year duration, with one student focusing on dry deposition modeling within i-Tree Eco, and the other advancing i-Tree Hydro. Both graduate students will be involved with all software design. One graduate student will be completely funded by this project ($22,000/year stipend plus tuition), while the other graduate student will be funded from this project for the summer ($9000). During the academic year this student will be paid entirely from departmental funds as a Graduate Assistant, with half of their time dedicated to this project. Both graduate students will reduce their tuition burden to 1 credit a semester after year 2 (which is typical for post-candidacy exam PhD students). In addition, a 1/4 –time post-doctoral student will be involved with the software engineering design, and the implementation of developed software products within the i-Tree Modeling Suite.

Both Principal Investigators have requested 2 weeks of summer salary a year. 10% of PI Kroll's academic year will be dedicated to this project (9% cost-share), with 5% of PI Endreny's academic year (4% cost share). In addition, annually 1 month of an Environmental Resources Engineering Professional Staff Member's time is dedicated to this project. This staff member will be instrumental in addressing the hardware and software needs of this project.

In addition, $3000/year has been requested in travel costs in years 1 and 2, and $4500/year for year 3. $500/year has been set aside to attend the Council's Annual Fall Meeting, while the remaining travel resources are to attend 2 conferences during year's 1 and 2, and 3 conferences during year 3. In addition, we have requested $1000 in supplies during year 1, and $1300 in supplies during year 2 and 3. These supplies will cover additional computing costs, such as printer and data storage supplies.

Applicant: The Research Foundation of SUNY with a place of business at SUNY College of Environmental Science and Forestry
Project: A New i-Tree Tool for Assessing Forest Impacts on Urban Ecosystems
Total Cost: $257,183

Category	Federal Funds (requested)	Non-federal Match Cash	Non-federal Match In-kind	Total	Source of Matching Funds
Personnel:					
PI: Charles Kroll – 10%AY*	**3,262**	**0**	**26,865**	**30.127**	**SUNY ESF**
2 weeks/Yr Summer Salary*	**16,308**	**0**	**0**	**16,309**	
CoPI: Theodore Endreny – 5% AY*	**3,207**	**0**	**11,738**	**14,945**	**SUNY ESF**
2 weeks/Yr Summer Salary*	**16,033**	**0**	**0**	**16,033**	
1–Other Professional – 1 Month/Yr**	**0**	**0**	**18,041**	**18,041**	**SUNY ESF**
1– Postdoctoral Associate, hourly	**37,644**	**0**	**0**	**37,644**	
1– Graduate Student @ 50% CY	**69,015**	**0**	**0**	**69,015**	
1– Graduate Student, summer	**28,233**	**0**	**0**	**28,233**	
1– Graduate Student @ 25% CY***	**0**	**0**	**19,500**	**19,500**	**ERE funds**
Fringe Benefits:					
State, 53.36%, 60.42%, 63.99%	**11,796**	**0**	**20,599**	**32,395**	**SUNY ESF**
Summer, 17%	**5,498**	**0**	**0**	**5,498**	
Regular Employee, 41.5%	**16,010**	**0**	**7,487**	**23,497**	**SUNY ESF**
Graduate Student, 13% - 15%	**13,722**	**0**	**0**	**13.722**	
Total Salaries, Wages and Fringe	**220,728**	**0**	**104,230**	**324,958**	
Travel	**10,500**	**0**	**0**	**10,500**	
Supplies	**3,600**	**0**	**0**	**3,600**	
Other Direct Costs:					
Tuition****	**22,356**	**0**	**11,178**	**33,534**	**ERE funds**
Total Direct Costs	**257,183**	**0**	**115,408**	**372,591**	
Indirect Costs - 56% MTDC	**0**	**0**	**62,869**	**62,869**	**SUNY ESF**
Unrecoverable Indirect Costs	**0**	**0**	**131,503**	**131,503**	**SUNY ESF**
Total Cost	**257,183**	**0**	**309,780**	**566,963**	

Budget Notes:

* PI Kroll will spend 10% of his time during the academic year, as well as 2 weeks per year in the summer, working on the project. Nine percent of the 10% academic year time will be cost-shared by SUNY-ESF. CoPI Endreny will spend 5% of his time during the academic year, as well as 2 weeks per year in the summer, working on the project. Four percent of the 5% academic year time will be cost-shared by SUNY-ESF.

** One month (per year) of an Instructional Support Specialists' time will be cost-shared by SUNY-ESF.

*** Half of a Graduate Assistantship will be cost-shared by the Environmental Resources Engineering Department at SUNY-ESF.

**** Half of the tuition costs for the Graduate Assistantship will be cost-shared by the Environmental Resources Engineering Department at SUNY-ESF.

Project duration will be three years.

3. Literature Review

This literature review provides background material and information to explain how the proposed study builds upon previous work, much of which involves work that the PIs and their Partners have been involved with. The last award from the National Urban and Community Forestry Advisory Council related to quantifying urban forest effects was in 1997 (Abdollahi, 1997); this work was integrated into the original UFORE model. The Council "defines innovation to include new, unfamiliar, or uncommon effort to address . . . priority issues." Given this definition, the proposed project is clearly novel in that it creates a new modeling toolset that will greatly improve the quantification of the impact of forests at local planning scales.

Global population growth is one of the most important environmental issues of the millennium. It drives deforestation, agricultural land expansion, urban sprawl, and the pollution of air, water and soil. The United Nations estimated about 50% of the current world's population lives in urban areas; by 2050 it will be around 70% with an estimated population of 1.19 billion (UN, 2007). With continuing urban development and the concentration of population in urban centers, megacities (population equal to or more than 10 million) have become significant contributors of air pollution from associated changes in transportation systems and industrial production (Molina and Molina, 2004, Mage et al., 1996), altering biogenic and anthropogenic emissions and processes (Song et al., 2008). The burning of fossil fuels in automobiles, by industries, for power generation, and domestic fuel use, produces most of the classical air pollutants. In addition, this concentration of people and infrastructure creates elevated temperatures in urban areas, a phenomenon referred to as Urban Heat Island (UHI) effect. All of these conditions are potentially exasperated by future climate change and fluctuation. This proposal addresses the quantification of how urban and community forests effect urban environmental conditions, and how forest resources can be utilizes to best improve urban environmental conditions for the well being of the urban ecosystem and its inhabitants.

This literature review is developed around 3 topics related to this proposal:

1) The Impact of Trees on Urban Air Pollutants and Urban Heat Islands
2) Moving Towards a Distributed UFORE Model
3) Database and Software Structure

Each of these topics is briefly discussed below. This is followed by a list of references for this proposal.

<u>1) The Impact of Trees on Urban Air Pollutants and Urban Heat Islands</u>

Air pollutants are responsible for many adverse effects on human health, from minor nose and throat irritations to more severe impacts such as hospital admissions and premature mortality, especially affecting the elderly and young, individuals with chronic obstructive pulmonary cardiovascular disease, individuals with influenza, and asthmatics (EPA, 2007). As urban populations grow, the incidences of these adverse health effects will also increase. Because urban trees interact with the atmosphere and the surrounding urban spaces, they can affect urban air quality, potentially, in two ways: by changing emissions to directly affect air quality, and by changing land–air energy exchange that lead to changing local meteorological conditions, which indirectly influence air quality.

Urban trees convert carbon dioxide (CO_2) to oxygen (O_2) through photosynthesis, intercept

particulate matter (PM) and facilitate the removal of airborne gaseous pollutants by uptake through its leaf stomata, and lower local air temperatures by transpiring water and providing shade on surfaces (Beckett et al., 1998; Nowak, 1994). This cooling effect has been known to reduce the emissions of anthropogenic volatile organic compounds (VOCs), and to reduce local ozone (O_3) levels by altering the O_3-forming processes, including photochemical smog formation, which is exacerbated by high temperatures. Trees serve as temporary retention site for airborne particles. Trees also modify air flow, which affects the transport and distribution of pollutants.

Conversely, VOC emissions by some tree species can contribute to O_3 formation through its reaction with the oxides of nitrogen (NO_x) and carbon monoxide (CO) in the presence of light. Studies have shown that increase in surface temperatures and reduction in wind speeds tend to change O_3 levels (Sanchez-Ccoyllo et al. 2006). The studies of Wang et al. (2009) showed that similar modifications in temperature and wind speeds produced an opposite effect on secondary organic aerosol (SOA) formation. O_3 is one of key oxidants for reactive organic gases to form SOA. These ecosystem functions vary by plant species, canopy area, type and characteristics of air pollutants, and local meteorological environments (Fowler, 2002; Nowak, 1994).

Urban Heat Island (UHI) is an effect where a localized urban area is warmer than the surrounding area. This is due to the retention and dissipation of heat from urban structures. UHI causes increased energy consumption, elevated emissions of air pollutants and greenhouse gases, compromised human health and comfort, and impaired water quality (EPA, 2010). Forest mitigation of UHI, through direct cooling (e.g. shade) and indirect cooling (e.g., evapotranspiration), is an important component of strategies to mitigate UHI.

2) Moving Towards a Distributed UFORE Model

The Urban Forest Effects (UFORE) model is a computer model implemented in SAS (Statistical Analysis Software) that utilizes field, meteorological, and air pollution data to quantify urban forest structure and numerous forest-related effects (Nowak and Crane, 2000). The model consists of five components: UFORE-A (Anatomy of the urban forest), UFORE-B (Biogenic volatile organic compound emissions), UFORE-C (Carbon storage and sequestration), UFORE-D (Dry deposition of air pollution), and UFORE-E (Energy conservation). In addition, the hydrologic model UFORE-Hydro has also been develop and implemented in urban settings. These UFORE models have been integrated into the Forest Service's online i-Tree software suite, where it is now referred to as i-Tree Eco/i-Tree Hydro. See Hirabayashi et al. (2010b) for a thorough description of UFORE-D model, and Wang et al. (2005ab, 2006) for a full description of UFORE-Hydro.

UFORE can be described as a lumped parameter model. In a lumped parameter approach, a spatially heterogeneous environment in a region (model's spatial domain) is represented by a single lumped value (such as a mean value). With this information, a lumped model functions within a discrete spatial object, and computes outputs without attempting to determine the precise spatial distribution of the processes within the object (Maidment, 1996). This approach may be employed due to a lack of computational power or necessary spatially variable data. In spite of their assumptions of homogeneity of input data over a region, lumped models often

produce reasonable and useful results provided their parameters are calibrated properly (Koren et al., 2001).

Distributed models break space into discrete units, usually square cells (rasters), triangular irregular networks (TINs), or irregular objects. The spatial realm of a model may be one-dimensional, two-dimensional and, sometimes, three-dimensional. All models are lumped at the scale of the cell or triangle. It is recognized that a distributed model has both benefits and drawbacks. Distributed models allow us to account for the heterogeneity within the study area, and typically improve our ability to better describe the heterogeneous processes within the study area. A distributed model also allows the ability to develop spatially distributed inputs and parameters, many of which have an impact on model output. Distributed models can have some drawbacks, including overparameterization, excessive data requirements, and tradeoffs between horizontal scale and computational time (Beven, 1985; Michaud and Sorooshian, 1994). Distributed models are nonetheless attractive because of their potential as tools for studying spatially complex environmental processes and their ability to utilize environmental field data.

Hirabayashi et al. (2010a) performed a sensitivity analysis of the UFORE-D model. This model was first developed with a component-based modeling approach, where functions of the model were separated into components that are responsible for user interface, data input/output, and core model functions. Taking advantage of the component-based approach, three UFORE-D applications are developed: a base application to estimate dry deposition at an hourly time step, and two sensitivity analyses based on Monte Carlo simulations with a Latin hypercube sampling (LHS-MC) (Saltelli et al., 2000; Mészáros et al., 2009) and a Morris one-at-a-time (MOAT) sensitivity test (Morris, 1991; Mészáros et al., 2009). With the base application, dry deposition of CO, NO_2, O_3, PM10, and SO_2 in the city of Baltimore was estimated for 2005. The sensitivity applications were performed to examine UFORE-D model parameter sensitivity. In general, dry deposition velocity was sensitive to temperature and leaf area index (LAI). Temperature had a non-linear effect on all pollutants, while LAI was important to NO_2 deposition with a nearly linear effect. PAR and wind speed had limited effects on dry deposition of all pollutants; dry deposition was affected by PAR and wind speed only up to their threshold values. The component-based approach allowed for seamless integration of new model elements, and provides model developers with a platform to easily interchange model components. This analysis allowed us to identify the most sensitive input parameters, for which we will develop spatial estimates for our distributed modeling toolset.

We will also be evolving and integrating UFORE-Hydro in our distributed modeling toolset. Currently UFORE-Hydro is a warm climate semi-distributed hydrologic model which addresses the impact of trees on the hydrologic cycle. The UFORE-Hydro model uses watershed hydrology functions developed within the topographic index (TI) based TOPMODEL (Beven and Kirby, 1979) to predict discharge for an urban watershed (Wang et al, 2008). Forest effects simulated by UFORE-Hydro included canopy interception with seasonally changing leaf area index (LAI), and urban effects included overland flow from directly connected impervious cover. The success of UFORE-Hydro and the recognition of its limitation are the motivation for continued work with this model.

Specifically, we look to advance UFORE-Hydro to: represent a new surface runoff scheme; simulate cold climate hydrology; simulate of urban pollutant runoff; and represent spatially distributed runoff routing and pollutant filtering. Further, UFORE-Hydro will be used in a coupled modeling scheme with the NOAA's WRF model (Michalakes et al., 2001, 2006) to integrate the UFORE-Hydro water balance output of soil moisture and evaporation to examine improvements to WRF predicted urban heat island (UHI) simulation and forecasts. The WRF model and its land surface modules are widely used as a rigorous and efficient tool to simulate and predict UHI.

3) Database and Software Structure

We are proposing a component-based binary standard (COM) to be employed in this study. COM defines a protocol to connect one software component with another at run time, making reusable software components that can be dynamically interchanged in a system (Chappell, 1996). COM is a client/server architecture; the server component provides functionalities, and the client component uses that functionality. ArcGIS, a common GIS software platform, is composed of many COM components, collectively called ArcObjects. ArcObjects provides all of ArcGIS's functionality such as accessing and managing geospatial data, performing geospatial computations, and visualizing computational results (Zeiler, 2001). It is therefore very straightforward to reuse ArcObjects in different COM-based applications, replace a component in ArcObjects with a new one, or integrate COM-based components in ArcObjects-based applications. In this study, i-Tree Eco is will be developed as a menu bar (for example see Figure A-1) that can be imported into ArcGIS.

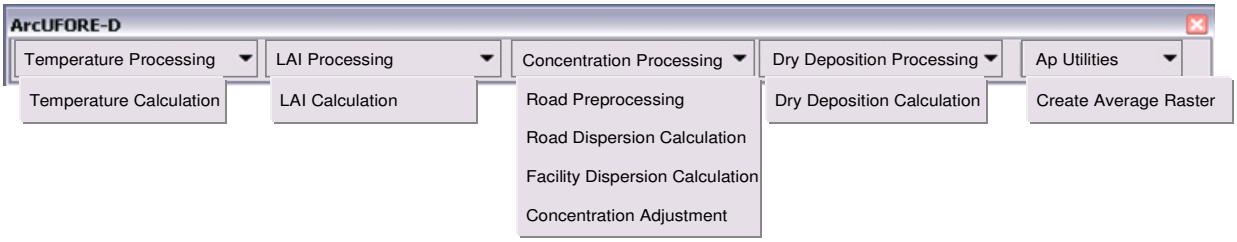


Figure A-1. An extension toolbar for the i-Tree Eco model's dry deposition component.

One tremendous advantage of the proposed system will be the development of a consistent platform for data storage, retrieval, and analysis. This will include a pre-processor utility that efficiently accesses national databases and converts these data sets to a consistent format that can employed by and interchanged between all i-Tree subcomponents.

To facilitate this project an information system will be designed around three layers: presentation, logic, and data management layers (Alonso et al., 2004). The presentation layer provides a user interface and an overall control of applications. The logic layer controls a system's functionality by performing detailed processing. The data management layer handles data access and management. Based on this architecture, functionalities of each developed tool are separated into components. Components in the logic and data management layers will be compiled into ActiveX dynamic link libraries (DLL) using Visual Basic (VB) 6.0. The DLLs are COM server components that provide services to clients in the form of COM interface implementations (MSDN, 2009).

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Date: November 20, 2010

To: NUCFAC 2011 Challenge Cost-Share Program

This letter is in support of the NUCFAC 2011 proposal: "A New i-Tree Tool for Assessing Forest Impacts on Urban Ecosystems". This proposal is important to help improve the ability of current urban ecosystem models (e.g., i-Tree: www.itreetools.org) to model and map urban forest effects and benefits at the fine scale. These fine scale analyses are important for linking tree effects to specific local conditions and human population so that more detailed local designs of urban forests can be created to improve environmental quality and human health. These more detailed local scale analyses will be not only be important for guiding local forest designs, but helping link specific urban forest effects with national environmental regulations.
The work of this proposal is tackling a complex and important area of research and will greatly advance urban forest modeling capabilities to help guide urban forest management in the future.

Our research unit has working closely with SUNY-ESF in the research and development of several urban forest models and databases and is eager to continue this collaboration through this proposed essential work. Our research unit will be intimately involved with this project and contribute staff time and expertise, and collaborate throughout the project to help develop a spatially distributed model that will be integrated within the i-Tree modeling suite.

Sincerely,

/s/ *David J. Nowak*

David J. Nowak
Project Leader

THE DAVEY TREE EXPERT COMPANY
CORPORATE OFFICE, 1500 N. MANTUA ST., P.O. BOX 5193, KENT, OHIO 44240-5193
TEL. 330-673-9511

KARL J. WARNKE, CHAIRMAN, PRESIDENT & C.E.O.

11/29/2010

To: NUCFAC 2011 Challenge Cost-Share Grant Program

I wish to strongly support the NUCFAC 2011 proposal: "A New i-Tree Tool for Assessing Forest Impacts on Urban Ecosystems". As a Ph.D. student at SUNY-ESF and a research assistant at the USDA Forest Service Northern Research Station, I had been a primary developer of the lumped/distributed versions of the USDA Forest Service's Urban Forest Effects (UFORE) model. Upon the completion of my Ph.D. program, I joined The Davey Tree Expert Company to continuously work on the development/integration of the UFORE model and the company's i-Tree tools.

This proposal will provide significant improvements on the urban and community forest resource managements in the United States. With the distributed models proposed, effects of the urban and community forests such as sequestrating carbon, improving air quality, and mitigating urban heat island effects can be spatially quantified and identified at a fine scale. i-Tree is a powerful yet user-friendly system, which is freely accessible from the i-Tree web site (www.itreetools.org). Since its initial release in 2006, numerous communities and organizations have used i-Tree to report lumped effects of forests in parcels, neighborhoods, cities, and states. The combination of the proposed models and i-Tree will provide more powerful tools to estimate localized effects of urban and community forests.

As a GIS/environmental modeler at The Davey Tree Expert Company, I will participate in this project to develop the proposed distributed model and integrate it into i-Tree tools.

Sincerely,

Satoshi Hirabayashi

Satoshi Hirabayashi
GIS/Environmental Modeler
The Davey Tree Expert Company

State University of New York
College of Environmental Science and Forestry
Department of Environmental Resources Engineering

November 27, 2010

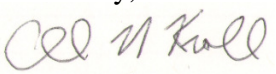
NUCFAC Review Panel,

I am writing this letter to support of my own proposal "A New i-Tree Tool for Assessing Forest Impacts on Urban Ecosystems". I am a Professor and Chair of Environmental Resources Engineering (ERE) at SUNY ESF. As Chair of ERE, I have the authorization to allocate departmental resources, including usage of computational software and hardware, staff time, and Graduate Assistant allocation. Our department recently had a large capital investment in our computational facilities. This includes the purchase of 7 high-end, multi-core, servers, a 20-node Linux cluster, and multi-year research-grade software licenses. The purpose of this investment was to support projects exactly like that outlined in this proposal. All computational requirements of this project will be supplied by our department, as no cost to the project. This will be particularly important to test the underlying assumption of our atmospheric deposition modeling, where we will test current model inputs versus those derived from EPA's Community Multiscale Air Quality (CMAQ) model and NOAA's Weather Research and Forecasting (WRF) model. CMAQ and WRF simulations will benefit greatly from available advanced computational resources.

In addition, I authorize the use of one of our Professional Staff members to be allocated to this project for 1 month/year for the duration of the project. This staff member will be responsible for the maintenance and upgrades to all software and hardware needs of this project. In addition, a ½-time New York State Graduate Assistant will be allocated for this project. This PhD level student will work 10 hours a week throughout the academic year on this project.

Our department and college continues to contribute high quality research in partnership with leading Federal Agencies, including our ongoing work with the USDA Forest Service's Northern Research Station's Project Leader Dr. Dave Nowak and his staff. Support for this project will allow this effective and productive partnership to continue to the benefit of both the Forest Service and urban planners, managers, and constituents throughout the country.

Sincerely,



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Professional Preparation:

Tufts University	Mechanical Engineering	B.S. 1987.
Tufts University	Civil and Environmental Engineering	M.S. 1989.
Cornell University	Civil and Environmental Engineering	Ph.D. 1996

Appointments:

Chair	Environmental Resources Engineering SUNY ESF	2008 - present
Professor	Environmental Resources Engineering SUNY ESF	2009-present
Associate Professor	Environmental Resources Engineering SUNY ESF	2002-2009
Assistant Professor	Environmental Resources Engineering SUNY ESF	1996-2002
Lecturer	Civil and Environmental Engineering Cornell University	1995 – 1996
Teaching Assistant	Civil and Environmental Engineering Cornell University	1991 – 1995
Staff Engineer	GZA GeoEnvironmental	1989 - 1991

Publications:

Relevant listing (indicates graduate student)*

- Hirabayashi*, S., C.N. Kroll, and D.J. Nowak, "Component-based UFORE-D development and sensitivity analyses", Environmental Modeling and Software, in press.
- Hirabayashi, S., C.N. Kroll, and D.J. Nowak, 2010. Urban Forest Effects-Dry Deposition (UFORE-D) Model Descriptions, http://www.itreetools.org/eco/resources/UFORE-D%20Model%20Descriptions.pdf, accessed November 21, 2010.
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- Zhang*, Z., and Kroll, C.N. (2007). The baseflow correlation method with multiple gauged sites, *Journal of Hydrology,* 347(3-4), 371-380.
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- Vogel, R.M., and Kroll, C.N. (1992). Regional Geohydrologic-Geomorphic Relationships for the Estimation of Low-Flow Statistics, *Water Resources Research*, 28(9): 2451-2458.

Synergistic Activity:
- Chair of Environmental Resources Engineering, 2008 - present
- International Association of Hydrologic Science Prediction at Ungauged Basins Low Streamflow Prediction Low Streamflow Prediction Coordinator, 2004 – 2008.
- Board of Directors, Cayuga Lake Watershed Network, 2007 – 2008.
- SUNY ESF Representative, Consortium of Universities to Advance Hydrologic Science, Inc. (CUAHSI), 2004 – 2007.
- Undergraduate Curriculum Coordinator, Environmental Resources Engineering, SUNY ESF, 2006 – 2010.

Collaborators and Co-Editors:
Burns, D. (USGS), Douglas, E. (UMass), Endreny, T. (ESF), McDonnell, J. (OregStU), Nowak, D. (USDA Forest Service), Olden, J. (UWash), Poff, N. (CSU), Vogel, R. (Tufts),

Graduate Advisors:
Jery Stedinger, Cornell University; Rich Vogel, Tufts University

Thesis Advisor & Postgraduate-Scholar Sponsor:
• Past Advisees (1 MPS, 11 MS, 5 PhD) / Current Advisees (2 MPS, 1 MS, 2 PhD)
• Current and Last 5 Years: Matonse, A. (NYS DEP), Bwalya, D. (Lusaka Water and Sewerage, Zambia), Korik, A. (ARCADIS), Hirabayashi, S. (USDA Forest Service), Zhang, Z. (Susquehanna Basin River Commission), Luz, J. (Federal University of Bahia, Brazil), Ahmed, O. (Dept. of Environment, Kenya), Ellsworth, S. (ESF), Dusseult, J. (ESF), Pendleton, E. (Anchor, QEA), Song, P (ESF), Cabaraban, M. (ESF), Casper, M. (ESF)

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Professional Preparation:

Cornell University	Natural Resources Management	B.S. 1990
North Carolina State University	Soil & Water Engineering	M.S. 1996
Princeton University	Water Resources Engineering	Ph.D. 1999
Channel Design Training	ASCE & FEMA courses	1wk 2001
Stream Restoration Training	US Fish & Wildlife courses	4wks 2002-3

Appointments:

Professor	SUNY, Environmental Resources & Forest Engineering	2009-present
Associate Professor	SUNY, Environmental Resources & Forest Engineering	2005-2009
Assistant Professor	SUNY, Environmental Resources & Forest Engineering	1999-2005
Research Scholar	National Aeronautics & Space Administration GSRP	1997-1999
Research Scholar	Environmental Protection Agency EMAP	1994-1996
Research Associate	Environmental Law Institute, Washington DC	1992-1994
Volunteer	U.S. Peace Corps & Honduras Forest Service	1990-1992

Publications:

Relevant listing (indicates graduate student)*

- Wang*, J., T.A. Endreny, and D.J. Nowak, "Mechanistic Simulation of Tree Effects in an Urban Water Balance Model", Journal of the American Water Resources Association, 44(1):75-85, 2008.
- Wang*, J., T.A. Endreny, and J.M. Hassett, "Power Function Decay of Hydraulic Conductivity for a TOPMODEL-based Infiltration Routine", Hydrological Processes, 20(18): 3825-3834, 2006.
- Wang*, J., T. A. Endreny and J. M. Hassett, "A Flexible Modeling Package for Topographically Based Watershed Hydrology" Journal of Hydrology 314(1-4): 78-91, 2005.
- Wang*, J., J. M. Hassett and T. A. Endreny, "An Object Oriented Approach to the Description & Simulation of Watershed Scale Hydrologic Processes", Computers and Geosciences. 31(4): 425-435, 2005.
- Endreny, T.A. and N.E.A Imbeah*, "Generating Robust Rainfall Intensity-Duration-Frequency Estimates with Short-Record Satellite Data", *Journal of Hydrology*, 371(1-4):182-191, 2009.

Other Selected Publications

- Endreny, T.A. and M. Higgins*, "Adding Radar Rainfall and Calibration to the TR-20 Watershed Model to Improve Dam Removal Flood Analysis", *ASCE Journal of Water Resources Management and Planning*, 134(3):314-317, 2008.

- Endreny, T.A., "Simulation of Soil Water Infiltration with Integration, Differentiation, Numerical Methods & Programming Exercises", *International Journal of Engineering Education*, 23(3):608-617, 2007.
- Endreny, T.A. and V.B. Collins* "Implications of Sub-Optimal Stormwater Recharge Basin Arrangement on Groundwater Mounding", *Ecological Engineering*, 35: 670-677, 2009.
- Black*, J. and T.A. Endreny. "Increasing Stormwater Outfall Duration, Magnitude, and Volume through Combined Sewer Separation", *ASCE Journal of Hydrologic Engineering*, 11(5): 472-481, 2006.
- Endreny, T.A. and E.F. Wood, "Watershed Weighting of Export Coefficients to Map Critical Phosphorus Loading Areas", *Journal of the American Water Resources Association*, 39(1): 165-181, 2003.

Synergistic Activity:
- Advise undergraduate students in Engineers without Borders (EWB) using sustainable design for water supply and ecological restoration in Latin America: 2003-present.
- Monitor and report on stream restoration stability for Onondaga County: 2005-present.
- Created and maintain fluvial geomorphology training modules for NOAA UCAR and NWS: http://www.fgmorph.com: 2003-present.
- Report SUNY ESF daily 7-am weather observations for NWS Cooperative Observers Program, and use data in *ESF in the High School* outreach activities: 2000-present.
- Served as Fulbright Scholar in Cyprus by teaching engineering hydrology and conducting watershed and river restoration research on both political sides of island: 2006.

Collaborators and Co-Editors:
Kroll, C. (ESF), Lautz, L (Syraucse U.), McGrath, K (ESF), Nowak, D. (USDA Forest Service), Siegel, D. (Syracuse U.), Spuches, C. (ESF)

Graduate Advisors:
Eric Wood, Princeton University, Greg Jennings, North Carolina State University

Thesis Advisor & Postgraduate-Scholar Sponsor:
- Past Advisees (10 MPS, 12 MS, 2 PhD) / Current Advisees (1 MPS, 6 MS, 4 PhD)
- Current and Last 5 Years: Becker, J. (ESF), Black, J. (NYC DEP Engineer), Chimaliza, M. (Malawi Govt), Chu, H. (ESF), Collins-Williams, V. (ESF Outreach), Crispell, J. (QEA Consultant), Fabian, M. (QEA Consultants), Fay, M. (ESF), Han, B. (ESF), Higgins, M. (BBL Consultant.), Imbeah, N. (Gradient Consultant), Jeffords, B. (ESF), Khan, S. (NYC DEP), Kight, M. (ESF), Kulkarni, S. (ESF), Leong, J. (Hazen Sawyer Consultant), Munzimi, Y (DR Congo Government), J. Resig (Consultant), Robinson, J. (ESF), Soulman, M. (Consultant), Thomas, K. (ESF), Tordisillas, J. (Philippines Mining Consultant), Wang, J. (SFWD, FL), Zhou, T. (ESF), Y. Yang (ESF)