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12-2011

Stakeholder Participation in Large Scale Complex Systems Modeling: Lessons from an UrbanSim Users Community

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Recommended Citation

**Stakeholder Participation in Large Scale Complex Systems Modeling:
Lessons from an UrbanSim Users Community**

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Capstone Requirement for
Master of Community Planning & Development
Edmund S. Muskie School of Public Service
University of Southern Maine

Professor Jack Kartez, Capstone Advisor
December 15, 2011

Abstract

Complex systems models for urban and regional simulation are increasingly being used as tools within decision-making processes underscoring the need to involve stakeholders in the modeling process. Stakeholder participation can serve both learning and community-building purposes, improving model legitimacy, saliency and accuracy and resolving conflicts over competing interests. However, the complex and highly technical nature of modeling activities has the potential to serve as an important barrier to stakeholder engagement. Members of an online UrbanSim user community were contacted in order to examine stakeholder participation in the development and implementation of UrbanSim models. For analysis purposes, a participation hierarchy was devised, representing three general levels of participation in the modeling process. It was expected that the complexity of UrbanSim models would likely stand as a barrier to the engagement of non-specialists in modeling processes, especially within the development phase. When participation did occur it would most likely take place within the less complex and less time and resource-intensive implementation phase. The type of stakeholder-involved modeling employed at this stage would likely best be characterized as informative modeling, the lowest level in the hierarchy, in which participants are updated on model progress but have little to no influence on the model. The results of the study's online survey-structured focus group provide some evidence that UrbanSim users are indeed effectively including stakeholders in both model development and implementation and are using higher level forms of participation than expected.

I. Introduction

Large scale complex systems models for simulation are being created and applied by a growing

number of researchers, consultants, planners and public entities (Waddell & Ulfarsson, 2004) in

response to increasing complexity of urban and regional dynamics. Whether these models are

developed for research purposes or for use as planning and policy tools, there is considerable

support for the inclusion of stakeholders in model development and implementation (Borning,

Waddell, & Förster, 2008; Sterk, van Ittersum, & Leeuwis, 2011; Voinov & Bousquet, 2010;

Waddell & Ulfarsson, 2004). Participation of stakeholders, defined within this study as those

from outside the core modeling group who may be the future users of the model or model results

or whom may be impacted by the use of the model, has the potential to provide a number of

benefits to both project team and stakeholders. The benefits of stakeholder participation can be

described as falling into two categories, contextualization of scientific knowledge and

community or network-building (Sterk et al., 2011). In the development of research models,

stakeholder participation can enrich problem and goal definition and can offer modelers

important insights into the systems they aim to model (Souchère et al., 2010; Standa-Gunda et

al., 2003; Thompson, Forster, Werner, & Peterson, 2010). In this context, stakeholders provide

local on-the-ground knowledge that may be unknown to the modeling team. When models are

created as future planning and policy tools, stakeholder participation provides a venue for shared

learning and may improve the accuracy and saliency of model inputs, and consequently, outputs

(Jonsson, Andersson, Alkan-Olsson, & Arheimer, 2007; Siebenhuner, 2004; Sterk et al., 2011).

Involvement of stakeholders in the modeling process also builds stakeholders' understanding of

and trust in modeling, which may significantly affect the model's legitimacy as a planning tool

(Jonsson et al., 2007). Effective methods of participation may ensure that development of urban

and regional simulation models considers both the mental models of stakeholders and experts'

technical understanding of the complex systems existing within the study area.

Although there are possibly numerous benefits of the inclusion of stakeholders in the modeling

process, the complexity and technical nature of modeling activities have the potential to serve as

barriers to participation of non-specialists. As model complexity increases, the effort that both

the technical modeling team and the stakeholder group must put forth increases. This study was

conducted in order to explore the state of stakeholder participation within the context of these

complex models used for urban and regional simulation. The UrbanSim platform was chosen as

the focus of this study because it is a highly complex and data intensive modeling system.

UrbanSim involves the integration of multiple interacting models, each of which is complex in

its own right. The combination of these models in attempt to realistically describe urban and

regional change provides exponentially more complexity.

A virtual focus group was implemented through the use of a fifty-question online survey hosted

by Qualtrics, Inc. The questions were devised to gain insight into the stakeholder participation

practices of UrbanSim users. Particular attention was paid to the stage of modeling at which

stakeholders were engaged, level of participation utilized, and perceived value of stakeholder

input to model quality. The results of this study indicate that stakeholder participation is being

utilized as a robust element of the UrbanSim modeling process.

This introduction is followed by a brief overview of large scale complex systems models and

UrbanSim specifically. Section three explores the importance of stakeholder participation within

complex systems modeling as presented in the literature. The fourth section of the paper

introduces the research design and methods used in this study and the framework used for

analysis. Section five presents a summary of survey results. This is followed by a discussion of

results in the sixth section. Section seven concludes this work with a discussion of implications

for future directions and research.

II. Large Scale Complex Systems Models and UrbanSim

Policy and planning actions can have long-term, multi-jurisdictional effects on the viability and

livability of communities (Borning et al., 2008). Informed decision-making requires that there

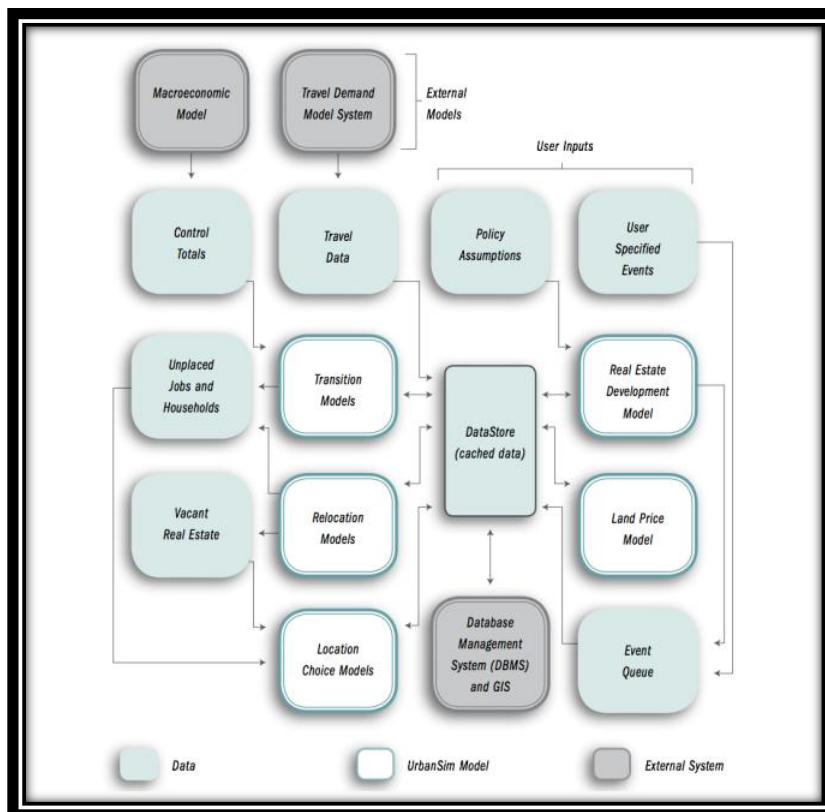be methods for assessing the scale and scope of policy and planning intervention impacts.

However, it has become increasingly difficult to accurately determine the effects of actions taken

within our complex, interconnected urban and regional environments (Waddell & Ulfarsson,

2004; Waddell, Wang, & Liu, 2008). Demographic pressures, climate concerns, and competition

for scarce resources (Waddell & Ulfarsson, 2004) have led complex systems models to become

an appropriately more prevalent method for modeling the intricacies and impacts of human

activity. These models are vital to understanding multi-dimensional problems, "characterised by

globally interlinked, complex, synergetic, cumulative, highly dynamic and often non-linear

causal chains and significant time lags between causes and effects in the interplay between social

and natural systems (Siebenhuner, 2004, p. 2)."

Within urban and regional planning, the trend in complex systems modeling is the coupling of a

transportation model and an urban/regional land use model. The resulting model can be used as

a base to which further enhancements to improve realism are appended (Waddell et al., 2008).

This is a fair characterization of the UrbanSim platform developed as an open source software

application for urban and regional simulation, first released on the web in 1998. The newest

implementation of UrbanSim runs on the Open Platform for Urban Simulation (OPUS) and is

freely downloadable on the UrbanSim website[1].

UrbanSim is a platform for the integration of multiple interacting models. It uses "models for demographic transition, economic transition, household relocation, employment relocation, household location choice, employment location choice, real estate development, and land prices (Waddell & Ulfarsson, 2004, p. 227)." Any one of these components on its own is complex. Combining them in attempt to realistically describe urban and regional change provides exponentially more complexity. Figure 1 illustrates the complexity of the UrbanSim model environment and interacting components. UrbanSim is also very data intensive further adding to the demands of the modeling platform.

Figure 1. UrbanSim: A Complex and Data-Intensive Modeling Platform

(Waddell et al., 2008, pp. 110)
Image downloaded from http://opusdiscovery.blogspot.com/2011/02/understanding-opus-user-guide.html

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[1] http://www.urbansim.org/Download/WebHome

UrbanSim "represents an ongoing interdisciplinary research development effort to provide operational tools to support the assessment of land use, transportation and environmental policies and plans within metropolitan areas (Waddell & Ulfarsson, 2004, p. 206)." The software was developed on the premise that participation and the sharing of ideas are integral to solving complex problems. UrbanSim models have been developed across the United States and throughout the world, from Seattle to Seoul (Waddell et al., 2008).

Paul Waddell, original developer of UrbanSim, continues to stress the importance of stakeholder participation throughout his publications (Borning et al., 2008; Waddell & Ulfarsson, 2004). UrbanSim was created with the intent to encourage participatory modeling and decision-making to "increase the likelihood of a cooperative resolution, as compared to the frequently observed political gridlock now observed in many metropolitan regions (Waddell & Ulfarsson, 2004, pp. 206–207)." Waddell, Liu, & Wang (2008) list three outcome goals of UrbanSim, each relating directly to stakeholder participation. These three goals are as follows:

> *Enable a wide variety of stakeholders (planners, public agencies, citizens, and advocacy groups) to explore the potential consequences of alternative public policies and investments using credible, unbiased analysis.*
>
> *Facilitate mode effective democratic deliberation on contentious public actions regarding land use, transportation, and the environment, informed by the potential consequences of alternative courses of action that include long-term cumulative effects on the environment, and distributional equity considerations.*
>
> *Make it easier for a community to achieve a common vision for its future and its broader environment and to coordinate their actions to produce actions that are consistent with this vision.* (Waddell et al., 2008, pp. 106–107)

Waddell and Ulfarsson (2004) speak strongly to the need for stakeholder participation. The authors state that "in a democratic context that involves many stakeholders with conflicting values and priorities, it is neither feasible nor appropriate to deal with major land use and transportation policies and investments as isolated choices to be decided by planners or bureaucrats within the bounds of a single organization (Waddell & Ulfarsson, 2004, p. 203)." In the authors' opinion, it is simply inappropriate to exclude stakeholders from the modeling process. They underscore the need for transparency in model development as well as the inclusion of a wide range of stakeholder interests in order to avoid "any significant biases that favor one stakeholder perspective over another (Waddell & Ulfarsson, 2004, p. 212)." As the following section demonstrates, stakeholder participation in modeling is not only an ethical choice, but is also vital to the content and quality of the resulting model.

III. The Role of Stakeholder Participation in the Modeling Process: Lessons from the Literature

Those who may be the future users of a simulation model or its results or who may in some way be impacted or perceive they might be impacted by the use of a model are increasingly more likely to require that their voices be heard. Waddell and Ulfarsson (2004) point out that the previously accepted technocratic planning practices have "become very inconsistent with the current context demanding more democratic analysis and decision processes (Waddell & Ulfarsson, 2004, pp. 205–206)."

Stakeholder participation within model development and implementation serves two broad purposes: contextualization of scientific knowledge and community-building (Sterk et al., 2011). Where the two purposes meet in the creation of shared knowledge and understanding, there is the

greatest opportunity for tangible change (Sterk et al., 2011, p. 314). Aside from these two

purposes, an additional purpose remains the integrity of planning in the public interest.

Participation in the modeling process allows interaction between stakeholders and the modeling

team which facilitate the integration of scientific and experiential information. Stakeholders are

able to see how their experiences are represented in the model. Modelers become privy to

contextualizing factors which might be integrated into the model to improve accuracy and

saliency. In this way, participation increases relevancy, commitment to the model and model

outputs and the chances that the model will have real world impacts (Sterk et al., 2011, p. 314).

This process can also reveal the underlying assumptions and values of the modeling team and the

ways in which modeler attitudes might be influencing model construction. Participation in

model development, rather than solely in the implementation phase, allows for this

contextualizing activity to take place (Sterk et al., 2011).

As opposed to being simply a results-based problem-solving exercise, modeling has come to be

seen as an opportunity for shared learning (Sterk et al., 2011). Particularly in the context of

urban and regional simulation modeling, models can be vehicles for conflict resolution and

community-building (Sterk et al., 2011). Stakeholder learning "impacts are not limited to

learning about a land system, but extend to learning about the views, norms and values of other

actors (Sterk et al., 2011, p. 315)." Processes of shared learning help to link stakeholders and to

foster interdependence (Sterk et al., 2011).

Participation of stakeholders or future users in model development is a factor in the ability of the

model to affect change (Sterk et al., 2011). The authors found that successful modeling

processes took on a learning role and at least one other role, and included the involvement of

multiple stakeholders (Sterk et al., 2011). Shared learning and problem-solving processes are far more influential than previously identified critical success factors "such as the need for proper timing, the ease of use of graphical user interfaces and transparency and the representation of uncertainties in computer models (Sterk et al., 2011, p. 312)". Sterk et al (2011) are unwavering in their characterization of the importance of stakeholder participation in the modeling process:

> *In our studies, all cases where a land use model contributed to problem solving exhibited some degree of participation in model development, ranging from a few meetings to discuss the problem definition and research questions, informing the envisaged users about the progress and tune the research again, to collaborative data collection of modellers and stakeholders.* (Sterk et al., 2011, p. 314)

Undoubtedly, stakeholder participation in modeling efforts, especially when initiated at early development stages, can be effective in allowing models to do what they are meant to do, inform real world decision-making processes.

IV. Research Design and Methods

This research was conducted in response to the increasing necessity of the use of complex systems models and the importance of stakeholder participation in this challenging process. When it comes to understanding participation methods, who participates, how they participate, whether or not they learned anything, and whether or not they produced anything (Siebenhüner, 2004) are the data of most importance. Fifty survey questions were developed in order to direct a focus group of UrbanSim modelers from an UrbanSim users community to address these areas of interest.

Summary of Survey Instrument

Survey questions were aimed at ascertaining the following types of information: respondent and project characteristics (respondent type, such as college or university researcher, public official,

etc.; country in which model developed/implemented; linkages to ecological processes; purpose

of model creation, such as use a policy tool, etc.; current stage of model

development/implementation), general stakeholder characteristics (stakeholder type, such as

local agency, non-profit groups, etc.; level of technical expertise), stakeholder engagement

characteristics (level of participation in terms of the developed three-level hierarchy;

participation methods; length/regularity of engagement), impacts of stakeholder participation,

and methods used for reporting model results. The complete survey instrument is documented in

Appendix A.

There were two important features that needed to be addressed to properly pose questions to

UrbanSim users: (1) model development and model implementation should be considered

separately, and (2) a framework with which to allow focus group participants to characterize the

level of participation they used or were using in their projects was necessary.

Separate Assessment of Model Development and Implementation

It was important to look at model development and model implementation separately for two

primary reasons. First, contextualization of scientific knowledge is thought to occur primarily in

the development phase of the modeling process (Sterk et al., 2011). Theses contextualization

activities are thought to effect model quality and model output usefulness and legitimacy. In

contrast, participation solely within the implementation phase is far less likely to affect the

workings of the model. This divergence in the saliency of participation activities requires that

participation activities be reported separately for development and implementation phases.

A second reason to ask questions separately for the two phases is because these phases differ in

the amount of time and resources required to effectively participate stakeholders. In general,

development phase participation needs can be expected to be more intensive than those of implementation.

Stakeholder Participation Hierarchy

Some authors have categorized the participation of stakeholders in the modeling process according to the style and details of the participation process (Voinov & Bousquet, 2010). Rather than focus on the details of the participation techniques, this study focuses on the degree of influence afforded the stakeholders. Degree of participation in planning processes can range from tokenism to true shared decision-making. In an approach similar to Arnstein's ladder of citizen participation (1969), this research sorted stakeholder participation methods into categories based upon levels of stakeholder involvement.

Three broad categories, co-modeling, participatory modeling, and informed modeling, were created to allow focus group participants to characterize their participation type similarly across projects and participation styles. At the top of the ladder, representing the highest level of stakeholder involvement within the modeling process is co-modeling, in which participants are involved in all six dimensions of participation as defined by Jonsson et al (2007): (1) issue of the process, (2) who is a stakeholder, (3) construction/choice of model(s), (4) setup of the model, (5) use of the model and (6) process design. Co-modeling corresponds roughly to the top two rungs of Arnstein's ladder, citizen control and delegated power, the highest degrees of citizen power. Just below co-modeling is participatory modeling, in which stakeholders have influence within some of the six dimensions. Participatory modeling is similar to the partnership rung of Arnstein's ladder. Stakeholders have little to no influence on the six dimensions within informative modeling, the lowest of the three rungs on this ladder. Informative modeling corresponds to what Arnstein referred to as placation, consultation and informing.

To illustrate the differences between these three levels of modeling with stakeholders, imagine that three once mostly rural regions with small urban cores began to experience rapid growth, suburbanization and all of the effects, both good and bad, that come with such growth. The city planners of the urban core cities, Maineville, Pinetown, and Oceanland, alarmed at the sudden demographic and economic changes in their regions, each contacted the planning schools at their local universities.

The town planners in Maineville, along with their university partner, decided to use a co-modeling approach. They worked together to determine a list of stakeholders who were invited to meet. These stakeholders suggested other stakeholders who should be included. The group as a whole designed the modeling process and defined the problem and study area. Through bi-monthly collaborative meetings, the group chose the type of model to use, developed model assumptions, created the model, and gathered relevant data. Once the group felt that the model appropriately addressed the problem focus, the model was applied to the study area and model results were explored and reported. Through this process, non-specialists were able to participate directly in model development. They worked hand-in-hand with the modeling team and learned about the modeling platform and the principles of complex systems modeling.

Pinetown opted for a participatory modeling approach which required a less intensive commitment for stakeholders and modelers. Potential stakeholders were contacted to participate in a process designed by the planners and modelers. Six meetings were conducted in which the stakeholders' knowledge of local conditions was solicited. These meetings were held once every two months over the course of a year, with each meeting centered on a specific issue such as traffic, employment, natural resources, real estate, etc. Each meeting topic was set by the modeling team and dictated by the needs of the model. It is of note that the term participatory

modeling is used in many places within the literature to generally refer to modeling processes in which stakeholders are involved in any capacity. Here, participatory modeling specifically refers to the process as described above in which stakeholders were invited to inform model inputs, assumptions and indicators, but did not work directly with the model.

The Oceanland planning/modeling team employed an informative modeling approach in addressing their growth concerns. This process was far less time and resource intensive for both the stakeholder group and planning/modeling team. The Oceanland planners and their university partner identified a stakeholder group and sent them a letter early on in the process. This letter gave a brief explanation of the modeling project and asked them if they wanted to be kept informed as the project progressed. Two meetings were scheduled for the coming year, one to coincide with the end of the development phase and the other following model implementation. A website was set up allowing stakeholders and the public to view and download reports associated with the modeling effort. Informative modeling allowed stakeholders to be kept up to date on the modeling process, although there was little to no opportunity for stakeholder comments or questions.

Survey Implementation

The survey was hosted by the online survey service, Qualtrics[2]. It was intended to take no longer than 15 minutes to complete and focus group participants were informed of the survey's compatibility with smart phone and tablet devices. Two of the fifty questions were of a short-answer text format, while the remaining questions were multiple-choice.

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[2] The output and anlysis for this paper was generated using Qualtrics Labs, Inc. software, Version 24633 of the Qualtrics Research Suite. Copyright © 2011 Qualtrics Labs, Inc. Qualtrics and all other Qualtrics Labs, Inc. product or service names are registered trademarks or trademarks of Qualtrics Labs, Inc., Provo, UT, USA. http://www.qualtrics.com

In order to reach UrbanSim users, permission was obtained from Dr. Paul Waddell, owner of the

UrbanSim web portal and developer of the UrbanSim platform, to send out a message to the

UrbanSim user community. Site registration facilitated sending a message that would potentially

be seen by all of the UrbanSim users who had signed up to receive e-mail messages. Dr.

Waddell was unsure of the number of users that the survey might reach. This method was

presented as the best likely for reaching the small population of UrbanSim users located

throughout the globe.

Initial contact was made through the listserv on September 6, 2011. The message sent to

UrbanSim users, available in its entirety in Appendix B, summarized the research for potential

participants and included a link to the consent agreement and online survey. The survey was

available until midnight on September 30, 2011. Reminder e-mails were sent out on September

19, 2011 and September 28, 2011 in attempt to maximize response rates.

V. Results

In total, seventeen UrbanSim users agreed to participate in the focus group. However, only

thirteen respondents actually began the survey. All thirteen of these respondents completed the survey.

Respondents come from three countries and four different kinds of institutions. The majority of respondents were from the United States. Two respondents reported that their UrbanSim project is in France and one respondent was working in Belgium. As seen in Table 1, two respondents report that they are

Table 1. Number of Respondents by Organization Type

Respondent Type	
Local agency	2
Regional agency	4
State agency	0
Federal agency	0
Other public agency	0
College or University	5
Research institute	1
Consulting firm	0
Non-profit environmental or conservation organization	0
Other non-profit organization	0
Business or industrial firm	0
Other	0
Total	**12**

from local agencies, four are from regional agencies, five from colleges and universities and one

respondent is part of a research institute. One respondent left this question blank.

Respondents report a variety of geographic model scopes. As reported in Table 2, six

respondents have models which incorporate a metropolitan region, three involve a metropolitan

region as well as an outlying rural area, two projects use a county or city/county area, one uses a

single municipality, and one uses a natural/geological boundary to define the model region.

Only five of respondents report that their model

incorporates ecological processes or links to a model

incorporating ecological processes. Ecological

processes were defined to include wildlife habitat,

wetlands, air/water quality, water supply, etc.

Table 2. Geographic Scope of Models	
Single municipality	1
Metropolitan region	5
Metropolitan region(s) plus outlying rural areas	3
Watershed or other natural systems	0
Other	3
Total	**12**

Of the twelve respondents reporting that they were familiar with the model development process

of the model with which they were working, five respondents stated that model development was

being conducted primarily for research purposes, but with the intention to contribute to policy

and planning decisions in the future. Six of the respondents were creating models primarily for

use as a policy and planning tool. Only one respondent was creating the UrbanSim model

primarily for research purposes, with no goal of affecting policy or planning.

Respondents were at various stages of model development and implementation. Of those

familiar with the model development process of the model with which they are working, eight of

the respondents report having an operational UrbanSim model. Two of the models are in the

development stage, but the model is not yet complete. Two respondents report that they are in

the planning stage of their UrbanSim project, but have not yet begun model development.

Stakeholder Participation in Model Development

Seven out of the twelve respondents familiar with the development process of the model stated

that stakeholders were going to be or had been engaged. Five respondents had not included or

were not planning to include stakeholders in model development. The five respondents

foregoing stakeholder participation were two local agencies, one regional agency and two

colleges or universities. The respondents from these institutions reported that they chose not to

include stakeholders because they felt participation was not relevant to the development of their

models. One of these five respondents went further to explain that the model was "primarily

seen as a technical task at this stage."

Of those respondents who used participation, all would choose to use the same amount of

stakeholder participation in future modeling efforts. Of the five respondents who did not use any

stakeholder participation, two stated that they would like to increase the level of participation in

future modeling endeavors.

The one respondent whose model was being created solely for research purposes did not include

stakeholders in the model development process. In contrast, three of the five respondents creating an UrbanSim model primarily for research purposes but with the hope for use as a future policy or planning tool chose to

Table 3. Stakeholders Involved in Development Phase? Tallies by Respondent Type and Model Purpose

Respondent Type	Yes	No	Total
Local agency	0	2	2
Regional agency	3	1	4
College or University	4	2	6
Total	**7**	**5**	**12**

Model Purpose	Yes	No	Total
Primarily research purposes, with no goal of affecting policy or planning	0	1	1
Primarily for research purposes, but with the intention to contribute to policy and planning decisions in the future	3	2	5
Primarily for use as a current or future policy and planning tool	4	2	6
Total	**7**	**5**	**12**

include stakeholders in model development. Analysis of study participants creating a model for

use primarily as a policy and planning tool revealed that four out these six respondents were

engaging stakeholders. These findings are presented in Table 3.

Table 4 reports many of the findings related to stakeholder participation in the development

process. Not surprisingly, none of the UrbanSim projects reported their level of participation to

be characterized as co-modeling. However, the number of respondents reporting their level of

stakeholder participation to be participatory (4/6) was twice the number of those reporting the

participation level to be informative (2/6).

Table 4. Tallies by Model Development and Stakeholder Characteristics

Stage of model development	
Planning of model development process	4
Scoping of geography and/or model focus	2
Data collection and/or storage	5
Development of model inputs and/or assumptions	5
Total	**6**
Stakeholder knowledge	
No prior knowledge or experience	1
Some prior knowledge or experience	3
Significant prior knowledge or experience	1
Total	**5**
Stakeholder participation typology	
Co-modeling	0
Participatory modeling	4
Informed modeling	2
Total	**6**
Additional modeling education	
Introduced to systems thinking, complexity sciences and/or sustainability sciences	0
Engaged in interactive exercises to strengthen understanding of principles	2
Provided a primer in the use of simulation for decision-making, scenario planning and alternative futures planning	5
Other	1
Total	**5**
Meeting frequency	
Very Often (approximately once per week)	0
Quite Often (approximately once per month)	4
Occasionally (approximately once per quarter)	2
Seldom (approximately once or twice per year)	0
Rarely (less than once per year)	0
Total	**6**

Overall, survey respondents plan to include or have already included stakeholders in many aspects of the model development process. The most commonly reported model development activities were data collection and/or storage activities (5/6) and development of model inputs and assumptions (5/6). Four of the respondents stated that they would involve or had already involved stakeholders in the planning of the model development process itself. Just two out of the six respondents reported scoping of geography and/or model focus as an activity in which stakeholders had been or would be involved. Only one of the respondents reporting that stakeholders would be involved in the model development process had not yet initiated participation activities as of survey implementation.

In general, stakeholder groups were being provided additional learning concerning model development in association with their participation in the project. Respondents reported that stakeholders were being introduced to knowledge relating to the use of simulation for decision-making, scenario planning and alternative futures planning. In addition, two of the six respondents reported that stakeholder groups were being engaged in interactive exercises to strengthen understanding of principles. One of the respondents specifically detailed that the model team and stakeholders were learning the science of land use change together.

Generally, stakeholder groups involved in model development were not described as having significant familiarity with modeling concepts and processes or significant modeling experience. Only one respondent characterized the stakeholder group as being within this most skilled category. Three of the remaining five respondents characterized the stakeholders as having some modeling knowledge and experience. One respondent reported that the stakeholder group with which the model team was working had no modeling knowledge or experience. Most of the

respondents (4/6) met with or planned to meet with the stakeholder groups approximately once

per month, with the remainder (2/6) meeting on a quarterly basis.

The stakeholder groups involved in the focus group's models are presented in Table 5. Local

agencies were the most represented stakeholder group (5), followed by colleges and universities

(4), regional agencies (3), and non-profit
environmental or conservation organizations
(2). State agencies, public schools, other
public agencies, and water and electric
utilities were all reported once.

Impacts of Stakeholder Participation in

Model Development

Table 6 displays some results concerning

impacts of stakeholder participation within

Table 5. Tallies by stakeholder groups involved in model development

Stakeholder Group	
Local agency	6
Regional agency	3
State agency	1
Federal agency	0
Other public agency	1
Colleges or Universities	5
Research institutes	0
Non-profit environmental or conservation organizations	2
Other non-profit organizations	0
Businesses or industrial firms	0
Public schools	1
Hospitals or health organizations	0
Neighborhood organizations or other community-based groups	0
Other	1
Total	**6**

model development. Four out of the five respondents who had already used stakeholder

participation in the model development process agreed or strongly agreed that participation of

stakeholders has improved overall accuracy of their UrbanSim model. The fifth respondent

neither agreed nor disagreed with the statement that stakeholder participation had improved

model accuracy. Two respondents felt that stakeholder participation had provided novel or

useful alternative assumptions or parameters. Three of the five respondents agreed or strongly

agreed that stakeholder participation improved the usefulness or robustness of rules for

simulation. In addition, all of the respondents agreed or strongly agreed that participation of

stakeholders had a positive effect on stakeholder trust of the model.

Table 6. Impact of Stakeholder Participation in Development Phase

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Not Applicable/ Too Soon to Tell
Participation of stakeholders has improved overall accuracy of our UrbanSim model.	0	0	1	3	1	0
Participation of stakeholders has provided novel or useful alternative assumptions or parameters.	0	0	2	2	0	1
Participation of stakeholders improved the usefulness or robustness of rules for simulation.	0	0	2	2	1	0
Participation of stakeholders had a positive effect on stakeholder trust of the UrbanSim model and trust of modeling in general.	0	0	0	3	2	0
Overall, stakeholders seemed to be satisfied with their participation in model development.	0	0	0	4	0	1

Stakeholder Participation in Model Implementation

Analysis of the responses concerning implementation of UrbanSim models shows that four out

of twelve respondents had not yet implemented their model. Of the eight that had, only four

were planning to include stakeholders in the model implementation process. Three of the

respondents who chose not to include stakeholders in model implementation stated that

participation was not relevant to the implementation of the model. The remaining respondent

choosing not to include stakeholders did so as a result of logistical difficulties. Similarly to the

model development analysis, respondents who used participation this time would prefer to use

the same or better participation in the future. Of those who did not use stakeholder participation,

only one would choose to use a greater amount of participation in the future.

Within the implementation phase there was an even split between participatory modeling (2) and

informed modeling (2). As was the case in the model development phase, none of the

respondents reported using a co-modeling framework for the engagement of stakeholders.

Stakeholders involved in model implementation are receiving some education in the use of simulation for decision-making, scenario planning alternative futures planning. Three respondents reported this method for strengthening stakeholder knowledge of large scale complex systems modeling. One respondent reported that interactive exercises would be used to aid in communicating complex systems modeling knowledge.

Stakeholder groups included in the implementation process are similar to those represented in the development process. The implementation phase also saw the inclusion of businesses and industrial firms in addition to those groups involved in model development. According to respondents, three stakeholder groups were meeting about once per month, while one group was meeting approximately quarterly.

Stakeholders involved in model implementation were characterized as having some or no modeling familiarity or experience by respondents. Only one survey participant stated that his or her model's stakeholder group had a significant amount of knowledge or experience in complex systems modeling.

Impacts of Stakeholder Participation in Model Implementation

Participation in implementation does not seem to have been as successful a process in terms of contributing to model accuracy, with one respondent answering that they disagreed with the statement that participation of stakeholders has improved overall accuracy of the UrbanSim model and one reporting that he or she neither agreed nor disagreed. However, participation of stakeholders was reported to have provided novel or useful alternative assumptions or parameters in all four of the projects which employed participation. All four respondents also agreed or

strongly agreed that participation had a positive effect on stakeholder trust of the UrbanSim

model and modeling in general. These findings are displayed in Table 7 below.

Table 7. Impact of Stakeholder Participation in Implementation Phase

	Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree	Not Applicable/ Too Soon to Tell
Participation of stakeholders has improved overall accuracy of our UrbanSim model.	0	1	1	2	0	0
Participation of stakeholders has provided novel or useful alternative assumptions or parameters.	0	0	0	3	1	0
Participation of stakeholders improved the usefulness or robustness of rules for simulation.	0	0	2	2	0	0
Participation of stakeholders had a positive effect on stakeholder trust of the UrbanSim model and trust of modeling in general.	0	0	0	3	1	0

Model Communication with Stakeholder Group and Others

In communicating model outcomes with the stakeholder group, three quarters of the respondents

state that they will be using a technical formal presentation. Interactive methods such as

simulation or allocation exercises or role-playing games will be used by two respondents. Two

survey participants report that they will be using printed maps and graphs to communicate with

stakeholders. One of the modeling groups has chosen to use a website to aid in communicating

with stakeholders.

Eight respondents reported that they will be communicating model results to a client, interest

group or the public. Seven of these respondents will be giving a presentation, five have chosen

to use some interactive methods, five will be using printed maps and graphs, and six will be

communicating results via a website. One respondent, who reported that his or her modeling

team was or would be using a website for communication, stated that they would also be using

some other method, though the method was not specified. Of those who had already presented

results, all agreed or strongly agreed that results were well-accepted by the client or public.

VI. Discussion

It was expected that the complexity of the UrbanSim platform would preclude stakeholder

participation, especially within the more time and resource intensive development phase.

Participation would be expected to occur most during the implementation phase of the modeling

process. At this stage the model would be more concrete and less open to stakeholder influence.

Participation at this late stage would occur primarily as informative modeling, the lowest level of

participation in the three-category hierarchy developed for this study.

Survey results demonstrate that stakeholder participation is indeed being employed in the

UrbanSim modeling process. Seven out of twelve respondents reported stakeholder engagement

in model development and four out of eight reported participation in the implementation phase.

This result is in support of the hypothesis that UrbanSim models utilize stakeholder participation

despite the complexity of the modeling platform. It is unlikely that these rates of participation

were affected by stakeholder technical expertise as the majority of respondents involving

stakeholders in the modeling process reported that stakeholders had some or no prior experience.

As the statistics above indicate, however, it appears that participation is more prevalent in the

development phase than in the implementation phase. Due to the small size of the focus group,

statistical inferences cannot be made about the difference between rates of stakeholder

participation for the two modeling phases. However, the results do provide preliminary support

that the initial expectation was incorrect.

The survey results also provide evidence that the expectation that participation would occur primarily as informative modeling is incorrect. Within the development phase, four out of six of the respondents reported that participation was best characterized as participatory modeling, while only two reported participation as informative modeling. In analysis of the implementation phase data it was found that two respondents described their participation as participatory modeling and two as informative. Although co-modeling was not used by any of the modeling teams, the use of participatory modeling was greater than expected.

It seems possible that the unexpected higher levels of participation may be due at least in part to the participatory ideals of the UrbanSim platform developers. Given that UrbanSim is an open source software and that works published by the original developer celebrate the use of stakeholder participation (Borning et al., 2008; Waddell & Ulfarsson, 2004), there might be some conflict between the desire to include stakeholders in the modeling process and the inherent difficulty with which stakeholders could be engaged as a result of model complexity. Although the complexity of UrbanSim models would likely stand as a barrier to the engagement of non-specialists in modeling processes the developers' commitment to participation might contribute to a culture amenable to stakeholder participation.

Given the survey results it is important that the reported effectiveness of stakeholder participation be discussed briefly. Overall, the inclusion of stakeholders in the modeling process was seen as beneficial to both the modeling team and stakeholders. Particularly within the development phase of UrbanSim model creation, a participatory modeling framework allowed for improved model accuracy, the integration of novel assumptions and inputs and stakeholder acceptance and trust in the model. This finding is not trivial, echoing previous research in the effectiveness of stakeholder participation (Sterk et al., 2011).

Although survey results provided sufficient evidence that stakeholders are being engaged in

UrbanSim modeling processes, a significant portion of survey respondents claimed that

stakeholder participation was not relevant to the model development or implementation.

Unfortunately, respondents were not asked to explain the reasoning behind this comment. Lack

of this data makes it impossible to determine if these views are legitimate or if modelers are

simply not aware of the positive impacts that stakeholder participation can have on model

accuracy and the usefulness and novelty of model inputs and assumptions. Two of the

respondents reporting that stakeholder participation was not relevant to the modeling process

were working on models in which the primary purpose was to create a policy and planning tool.

Stakeholder participation is not only relevant to the creation of policy and planning tools, it is

vital. The importance of stakeholder participation in modeling needs to be more widely

acknowledged if models used to direct policy are to be legitimate tools.

VII. Conclusions

Urban and regional dynamics are sufficiently complex to necessitate the development and use of

models which are able to appropriately assess effects of alternative plans and policies (Waddell,

Liu, & Wang, 2008). If decisions are to be made based upon the results of such models, those

likely to be affected by the impacts of those decisions should be invited to participate in the

model's development and implementation. Participation helps to reduce bias in model inputs

and assumptions, allows stakeholders and modelers to engage in processes of social learning, and

increases stakeholder trust in the model.

Model complexity and lack of stakeholder experience in modeling are not sufficient excuses for

neglecting stakeholder participation in large scale complex systems modeling. UrbanSim model

teams are managing to find meaningful roles for stakeholders in the modeling process despite the

complexity of the modeling platform. This study also suggests that stakeholder participation in the model development process might be more highly correlated to improvements in model quality than is participation in the implementation phase of the model. This result is further support of the value of the contextualization of scientific knowledge made possible by participatory modeling. Future research in the study of stakeholder participation in the development and implementation of large scale complex systems models for urban and regional simulation would benefit planning and policy decision-making processes by focusing on ways in which participation efforts can reach the co-modeling level.

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APPENDIX A. Final Draft of Survey Instrument

Q1.1 Consent for Participation in Research

<div align="center">

Muskie School of Public Service, University of Southern Maine
"Stakeholder Participation in the Development and Implementation of Large Scale Complex
Systems Models: Lessons from an UrbanSim User Community"
Sandra Hughes Goff, Principal Investigator
Jack Kartez, PhD, Faculty Advisor
Charles Colgan, PhD, Faculty Advisor

</div>

You are being asked to be in a study of the participation methods used to involve stakeholders in the development and implementation of UrbanSim models. You were selected as a possible participant because you signed up as a member of the UrbanSim user community e-mail list. If you have questions at any time, please contact Sandra Goff at sandra.goff@maine.edu or (207) 239-2506. Your participation in this study is voluntary. You must be at least 18 years of age to participate.

About the Principal Investigator: I became interested in urban and regional simulation modeling as a graduate research assistant at the Muskie School of Public Service in Portland, Maine, USA. While pursuing a Master of Community Planning & Development degree, I have been assisting on a project that is using UrbanSim to create a model of the Portland and Bangor, Maine regions. In the fall of 2011 I will begin doctoral studies in Ecology and Environmental Sciences at the University of Maine. The research of which you are being asked to be a part is a large component of a final project required for receipt of my Masters degree.

Purpose of Study: The purpose of this study is to gain an overview of the ways in which stakeholders are being participated in UrbanSim modeling projects. Throughout this study, stakeholders are defined as those from outside the technical modeling team who may be the future users of the UrbanSim model or who may become impacted by the model's use. Generally, stakeholders range from business leaders to public officials to advocacy groups to private citizens. This research seeks to identify the range of stakeholder participation across all types of UrbanSim projects. Each type of participant or UrbanSim project will likely have a different need or desire for including stakeholders in the modeling process and some may involve stakeholders only minimally or not at all. All English-speaking UrbanSim users are encouraged to participate in this study, regardless of the level of stakeholder participation that was used or will be used during the development and/or implementation of the model. We expect that approximately 50 UrbanSim users will be participants in this research study. It is anticipated that participants will come from a variety of sectors, from academia to planning and policy entities.

Description of Study Procedures: If you agree to participate in this study, you are asked to complete this online survey before 11:00PM EST on September 7, 2011. The survey should take no more than 15 minutes to complete. If you would like to receive a copy of the completed research paper, you may send an e-mail to the Principal Investigator at sandra.goff@maine.edu. A copy of the final paper will be sent as an e-mail attachment upon completion.

Risks to Being in Study: There are no foreseeable risks associated with participation in this study.

Benefits of Being in Study: As a participant in this study you are entitled to receive a copy of the research paper detailing the range of practices used to include stakeholders in the development and implementation of UrbanSim models. In addition, your participation contributes to knowledge that could be used to improve the design of stakeholder participation aspects of current and future UrbanSim projects. Improved participation methods may lead to more successful modeling products, and where appropriate, implementation of more potent policy and planning tools.

Payments/Costs: You will not receive any compensation/reimbursement for your participation in this study and there is no cost to you to participate.

Confidentiality and Privacy of Data: Only one of the questions in the following survey asks for identifying information. The question asks if there is a project or group name that could be used to compile answers that come from UrbanSim users working on the same model. Once surveys have been coded to reflect their relationship to other surveys from the same UrbanSim model, the identifying information will be destroyed. Please note that, as is the case for all of the questions within the survey, answering this question is completely voluntary. The records of this study will be kept confidential to the extent allowed by law. Research records will be kept in a password protected file on the computer of the principal investigator, with a password protected backup on an external hard drive. Access to the records will be limited to the researchers; however, please note that sponsors, funding agencies, regulatory agencies, and the Institutional Review Board may review the research records. The findings of this study will be presented orally and as a research paper as a final requirement of the Master of Community Planning and Development degree at the Edmund S. Muskie School of Public Service at the University of Southern Maine. There is an additional intention to publish findings within the academic literature in the future. Within all published materials and presentations, survey results will be reported in a general manner. An example of the way in which data might be used is "models developed by "x" type of group were more likely to use "y" type of participation method," etc. This study will include the use of an online survey hosted by Qualtrics. Only the principal investigator will have access to the online survey account. Internet Protocol (IP) addresses are supplied to the PI by Qualtrics, Inc., allowing for the potential identification of the computer used to respond to the survey. These IP addresses will not be used by the researchers other than to verify the number of times the same subject responded to the survey. The IP addresses will be deleted from any downloaded data and replaced with a code that cannot identify the original respondent. Once the data has been downloaded to the PIs computer and coded, the IP addresses and survey data will be permanently deleted from the Qualtrics, Inc. website. The de-identified data will be retained by the PI until project completion. The Qualtrics website displays the following security statement:

Data security is very important to us at Qualtrics. Many of our clients demand the highest levels of data security and have tested our system to be sure it meets their standards. In each case, we have surpassed expectations and received high praise from elite companies. Qualtrics has SAS 70 Certification and meets the rigorous privacy standards imposed on health care records by the Health Insurance Portability and Accountability Act (HIPAA). All Qualtrics accounts are hidden behind passwords and all data is protected with real-time data replication[1].

Voluntary Participation/Withdrawal: Your participation in this study is voluntary. If you choose to participate, please remember that you may decline to answer any or all of the questions within the survey and you may discontinue participation at any time.

Contacts and Questions: The researchers conducting this study are Sandra Hughes Goff (principal investigator) and Jack Kartez, PhD (faculty advisor) or Charles Colgan (faculty advisor). For questions or more information concerning this research you may contact them at sandra.goff@maine.edu (207) 239-2506 or jackk@maine.edu (207) 780-5389 or csc@usm.maine.edu (207) 780-4008. If you have questions about your rights as a research participant you may contact the Human Protections Administrator at usmirb@usm.maine.edu or at 207-228-8434.

Copy of Consent Form: If you choose to continue with the survey, you give your consent to participate in this study and may print a copy of this page for your records.

[1] Retrieved March 8, 2011, from http://www.qualtrics.com/security-statement/

Q1.2 Statement of Consent

○ I understand the above description of this research and the risks and benefits associated with my participation as a research subject. If I choose to proceed with the survey I am indicating my agreement to take part in the research and do so voluntarily.
○ I do not wish to participate in this research

If By clicking here I certify ... Is Selected, Then Skip To End of Block

Q1.3 If you would like a copy of the research paper resulting from this study, please e-mail sandra.goff@maine.edu.Thank you for your time.If you unintentionally declined to participate in this study, you may return to the consent form by clicking the "Go Back" button at the bottom left of this screen.

If If you would like a copy of... Is Displayed, Then Skip To End of Survey

Q2.1 Many different types of organizations have become involved in creating and implementing UrbanSim models. Which of the following best describes the organization with which you are affiliated?

- ○ Local agency
- ○ Regional agency
- ○ State agency
- ○ Federal agency
- ○ Other public agency
- ○ College or University
- ○ Research institute
- ○ Consulting firm
- ○ Non-profit environmental or conservation organization
- ○ Other non-profit organization _____
- ○ Business or industrial firm
- ○ Other _____

Q2.2 Which of the following best characterizes your organization's role within UrbanSim model development or implementation?

- ○ We are the primary modeling team
- ○ We are the primary client for whom the model is being created/implemented
- ○ We are a stakeholder group which has been involved in model development and/or model implementation
- ○ Other _____

Q2.3 In which country is your UrbanSim project based?

Q2.4 Which of the following best characterizes the geographic scope of your model?

- ○ Single municipality
- ○ Metropolitan region
- ○ Metropolitan region(s) plus outlying rural areas
- ○ Watershed or other natural systems
- ○ Other _____

Q2.5 Does your UrbanSim model incorporate or link to models of ecological processes or do you plan to create these linkages in the future? Ecological processes include air quality, water supply, wildlife habitat, etc.

❍ Yes
❍ No

If No Is Selected, Then Skip To This first set of questions is focuse...

Q2.6 Which of the following ecological processes is/will be incorporated into your UrbanSim model? (please check all that apply)

❑ Air quality
❑ Water quality
❑ Water supply
❑ Wildlife habitat
❑ Critical areas, i.e., wetlands
❑ Other _____

Q2.7 This first set of questions is focused on the development of UrbanSim models. For the purposes of this research, the development stage is considered to be the work period between the commencement of UrbanSim model construction and the point at which the model is ready for operational use.

Q2.8 Were you involved with or are you familiar with the proceedings of the development stage of the UrbanSim model with which you are affiliated?

○ Yes
○ No

Q3.1 UrbanSim models are created for a variety of reasons, ranging from academic research to policy development. Which of the following best describes the purpose of your model development?

○ Primarily research purposes, with no goal of affecting policy or planning
○ Primarily for research purposes, but with the intention to contribute to policy and planning decisions in the future
○ Primarily for use as a current or future policy and planning tool
○ Other _____

Q3.2 Which of the following best characterizes the stage of development of your project?

○ We are planning to create an UrbanSim model, but have not yet begun model development
○ We are in the process of developing an UrbanSim model, but it is not yet operational
○ We have developed an operational UrbanSim model
○ We have developed an operational UrbanSim model and it is being applied/implemented

Q3.3 For the purposes of this research, stakeholders are defined to be representatives from groups outside of the primary UrbanSim modeling team who may be the future users of the model or model results, or who may be affected by the use of the model.Were stakeholders from outside of the technical UrbanSim modeling team involved within the model development process in any capacity or are there definite plans to include stakeholders?

○ Yes
○ No

Answer If Were stakeholders from outside of the technical UrbanSim ... No Is Selected

Q3.4 Which of the following led to the decision to forego stakeholder participation in the development of the UrbanSim model? (please check all that apply)

❑ Not relevant to the development of the model
❑ Insufficient resources
❑ Logistical difficulties, i.e., time constraints, scheduling issues
❑ Other _____

Q4.1 Representatives from which of the following groups were involved/will be invited to become involved in the development of your UrbanSim model (please check all that apply):

❑ Local agency
❑ Regional agency
❑ State agency
❑ Federal agency
❑ Other public agency
❑ Colleges or Universities
❑ Research institutes
❑ Non-profit environmental or conservation organizations
❑ Other non-profit organizations _____
❑ Businesses or industrial firms
❑ Public schools
❑ Hospitals or health organizations
❑ Neighborhood organizations or other community-based groups
❑ Other _____

Q4.2 At which stage(s) of model development do you plan to involve stakeholders? (please check all that apply)

❑ Planning of model development process
❑ Scoping of geography and/or model focus
❑ Data collection and/or storage
❑ Development of model inputs and/or assumptions
❑ Other _____

Q4.3 At which stage(s) of model development have non-specialists been involved to date? (please check all that apply)

❑ Planning of model development process
❑ Scoping of geography and/or model focus
❑ Data collection and/or storage
❑ Development of model inputs and/or assumptions
❑ Other _____
❑ We have not yet involved the stakeholder group in model development

If We have not yet involved th... Is Selected, Then Skip To This next section will focus on the m...

Q4.4 Stakeholders likely come to model development with varying levels of familiarity with modeling concepts and processes and varying levels of modeling experience. Overall, how would you characterize the modeling knowledge and experience of the stakeholder group as a whole at project commencement?

❍ No prior knowledge or experience
❍ Some prior knowledge or experience
❍ Significant prior knowledge or experience

Q4.5 This next section will focus on the methods used to involve stakeholders in model development.

Q4.6 Which of the following most accurately represents the participation methods used or to be used in including stakeholders in model development? If you have/will have stakeholder groups with differing levels of involvement, please choose the category which best characterizes the most intensive stakeholder involvement used or to be used.

❍ Co-modeling: This is the highest level of stakeholder involvement. Stakeholders are involved directly in model development, working hand-in-hand with the modeling team and must learn about UrbanSim and the principles of simulation modeling.
❍ Participatory modeling: Stakeholders are invited to inform model inputs, assumptions and indicators.
❍ Informed modeling: Stakeholders are updated on modeling progress and may be provided the opportunity to comment.

Q4.7 Which of the following were/will be offered in an effort to introduce stakeholders to principles of large scale complex modeling?

❑ Stakeholders were/will be introduced to systems thinking, complexity sciences and/or sustainability sciences
❑ Stakeholders were/will be engaged in interactive exercises to strengthen understanding of principles
❑ Stakeholders were/will be provided a primer in the use of simulation for decision-making, scenario planning and alternative futures planning
❑ Other _____

Q4.8 How often did/will the project team meet with stakeholders?

❍ Very Often (approximately once per week)
❍ Quite Often (approximately once per month)
❍ Occasionally (approximately once per quarter)
❍ Seldom (approximately once or twice per year)
❍ Rarely (less than once per year)
❍ Other _____

Answer If At which stage(s) of model development have non-specialis... We have not yet involved the stakeholder group in model development Is Not Selected

Q4.9 The following questions focus on the ways in which stakeholder participation has affected your UrbanSim efforts. Please indicate your degree of agreement with the following five statements.

Answer If At which stage(s) of model development have non-specialis... We have not yet involved the stakeholder group in model development Is Not Selected

Q4.10 Participation of stakeholders has improved overall accuracy of our UrbanSim model.

❍ Strongly Disagree
❍ Disagree
❍ Neither Agree nor Disagree
❍ Agree
❍ Strongly Agree
❍ Not Applicable/Too Soon to Tell

Answer If At which stage(s) of model development have non-specialis... We have not yet involved the stakeholder group in model development Is Not Selected

Q4.11 Participation of stakeholders has provided novel or useful alternative assumptions or parameters.

❍ Strongly Disagree
❍ Disagree
❍ Neither Agree nor Disagree
❍ Agree
❍ Strongly Agree
❍ Not Applicable/Too Soon to Tell

Answer If At which stage(s) of model development have non-specialis... We have not yet involved the stakeholder group in model development Is Not Selected

Q4.12 Participation of stakeholders improved the usefulness or robustness of rules for simulation.

○ Strongly Disagree
○ Disagree
○ Neither Agree nor Disagree
○ Agree
○ Strongly Agree
○ Not Applicable/Too Soon to Tell

Answer If At which stage(s) of model development have non-specialis... We have not yet involved the stakeholder group in model development Is Not Selected

Q4.13 Participation of stakeholders had a positive effect on stakeholder trust of the UrbanSim model and trust of modeling in general.

○ Strongly Disagree
○ Disagree
○ Neither Agree nor Disagree
○ Agree
○ Strongly Agree
○ Not Applicable/Too Soon to Tell

Answer If At which stage(s) of model development have non-specialis... We have not yet involved the stakeholder group in model development Is Not Selected

Q4.14 Overall, stakeholders seemed to be satisfied with their participation in model development.

○ Strongly Disagree
○ Disagree
○ Neither Agree nor Disagree
○ Agree
○ Strongly Agree
○ Not Applicable/Too Soon to Tell

Q5.1 Which of the following best describes your attitude toward including stakeholders in the model development process in future modeling projects.

❍ I would prefer to use a greater degree of stakeholder input in future projects
❍ I would prefer to use the same degree of stakeholder input in future projects
❍ I would prefer to use a lesser degree of stakeholder input in future projects

Q6.1 This next set of questions is focused on the implementation of UrbanSim models. For the purposes of this research, the implementation stage begins when there is an operational model available for application to a particular policy, problem, or need.

Q6.2 Were you involved in the implementation of the UrbanSim model or are you familiar with the proceedings of the model's implementation?

❍ Yes
❍ No
❍ Model not yet implemented

Q7.1 Were stakeholders from outside of the technical UrbanSim modeling team involved in implementing the model in any capacity or are there definite plans to include stakeholders?

❍ Yes
❍ No

Answer If Were stakeholders from outside of the technical UrbanSim ... No Is Selected

Q7.2 Which of the following led to the decision to forego stakeholder participation in the implementation of the UrbanSim model? (please check all that apply)

❑ Not relevant to the development of the model
❑ Insufficient resources
❑ Logistical difficulties, i.e., time constraints, scheduling issues
❑ Other _____

Q8.1 Representatives from which of the following groups were involved/will be invited to become involved in implementing the UrbanSim model (please check all that apply):

- ❑ Local agency
- ❑ Regional agency
- ❑ State agency
- ❑ Federal agency
- ❑ Other public agency
- ❑ Colleges or Universities
- ❑ Research institutes
- ❑ Non-profit environmental or conservation organizations
- ❑ Other non-profit organizations _____
- ❑ Businesses or industrial firms
- ❑ Public schools
- ❑ Hospitals or health organizations
- ❑ Neighborhood organizations or other community-based groups
- ❑ Other _____

Q8.2 This next section will focus on the methods used to involve stakeholders in model implementation.

Q8.3 Which of the following most accurately represents the participation methods used or to be used in including stakeholders in model implementation? If you have/will have stakeholder groups with differing levels of involvement, please choose the category which best characterizes the most intensive stakeholder involvement used or to be used.

- ❍ Co-modeling: This is the highest level of stakeholder involvement. Stakeholders are involved directly in model implementation, working hand-in-hand with the modeling team and must learn about UrbanSim and the principles of simulation modeling.
- ❍ Participatory modeling: Stakeholders are invited to inform model inputs, assumptions and indicators.
- ❍ Informed modeling: Stakeholders are updated on modeling progress and may be provided the opportunity to comment.

Q8.4 Which of the following were/will be offered in an effort to introduce stakeholders to principles of large scale complex modeling?

❑ Stakeholders were/will be introduced to systems thinking, complexity sciences and/or sustainability sciences
❑ Stakeholders were/will be engaged in interactive exercises to strengthen understanding of principles
❑ Stakeholders will be provided a primer in the use of simulation for decision-making, scenario planning and alternative futures planning
❑ Other _____

Q8.5 How often did/will the project team meet with stakeholders?

○ Very Often (approximately once per week)
○ Quite Often (approximately once per month)
○ Occasionally (approximately once per quarter)
○ Seldom (approximately once or twice per year)
○ Rarely (less than once per year)
○ Other _____

Q8.6 Which of the following methods were/will be used to communicate model output with stakeholders? (please check all that apply)

❑ Formal, technical presentation
❑ Interactive methods, i.e., simulation or allocation exercises, role-playing games
❑ Printed maps and graphs
❑ Website
❑ Other _____

Q8.7 Have stakeholders been involved to date in the implementation of the UrbanSim model?

❍ Yes
❍ No

If No Is Selected, Then Skip To End of Block

Q8.8 Stakeholders likely come to participate in model implementation with varying levels of familiarity with modeling concepts and processes and varying levels of modeling experience. Overall, how would you characterize the modeling knowledge and experience of the stakeholder group as a whole at project commencement?

❍ No prior knowledge or experience
❍ Some prior knowledge or experience
❍ Significant prior knowledge or experience

Q8.9 The following questions focus on the ways in which stakeholder participation has affected your UrbanSim efforts. Please indicate your degree of agreement with the following five statements.

Q8.10 Participation of stakeholders has improved overall accuracy of our UrbanSim model.

❍ Strongly Disagree
❍ Disagree
❍ Neither Agree nor Disagree
❍ Agree
❍ Strongly Agree
❍ Not Applicable/Too Soon to Tell

Q8.11 Participation of stakeholders has provided novel or useful alternative assumptions or parameters.

❍ Strongly Disagree
❍ Disagree
❍ Neither Agree nor Disagree
❍ Agree
❍ Strongly Agree
❍ Not Applicable/Too Soon to Tell

Q8.12 Participation of stakeholders improved the usefulness or robustness of agent-based rules for simulation.

○ Strongly Disagree
○ Disagree
○ Neither Agree nor Disagree
○ Agree
○ Strongly Agree
○ Not Applicable/Too Soon to Tell

Q8.13 Participation had a positive effect on stakeholder trust of the UrbanSim model and trust of modeling in general.

○ Strongly Disagree
○ Disagree
○ Neither Agree nor Disagree
○ Agree
○ Strongly Agree
○ Not Applicable/Too Soon to Tell

Q9.1 Which of the following best describes your attitude toward including stakeholders in model implementation in future modeling projects.

○ I would prefer to use a greater degree of stakeholder input in future projects
○ I would prefer to use the same degree of stakeholder input in future projects
○ I would prefer to use a lesser degree of stakeholder input in future projects

Q10.1 Were model results presented or will they be presented to a client, interest group, or the public upon project completion?

○ Yes
○ No

Answer If Were model results presented or will they be presented to... Yes Is Selected

Q10.2 Which of the following methods were/will be used to communicate the results of the model? (please check all that apply)

❑ Presentation
❑ Interactive methods, i.e., simulation or allocation exercises, role-playing games
❑ Printed maps and graphs
❑ Website
❑ Other _____

Answer If Were model results presented or will they be presented to... Yes Is Selected

Q10.3 Please state your level of agreement with the following statement: Presentation of model results were well-received by client/interest group/public.

❍ Strongly Disagree
❍ Disagree
❍ Neither Agree nor Disagree
❍ Agree
❍ Strongly Agree
❍ Model results not yet presented

Q11.1 I would greatly appreciate any additional information you would like to provide regarding your experiences with stakeholder engagement in the development and implementation of UrbanSim models.

Q11.2 Is there a title for your particular group, planning process or project that could be used in consolidating survey responses which pertain to the same UrbanSim model/project? This information will not be used in any capacity other than to avoid erroneously double-counting projects and will be permanently deleted once answers have been compiled.

Q11.3 If you would like to receive a copy of the final research paper, you may send an e-mail to the primary investigator at sandra.goff@maine.edu

APPENDIX B. Study Recruitment Message Sent to UrbanSim Users Group
Dear Current and Past Users of UrbanSim:

I am writing to you today to ask you to take part in research concerning the participation of stakeholders[3] in the development and implementation of UrbanSim models. This research is part of my final work as a Master of Community Planning and Development student at the Muskie School of Public Service at the University of Southern Maine.

You were selected as a possible participant because you signed up as a member of the UrbanSim user community e-mail list. All English-speaking past and current UrbanSim users are encouraged to participate. Participation in this research involves completion of an online survey hosted by Qualtrics, Inc, a respected, secure online survey website.

Questions in the survey focus on the stage of modeling at which stakeholders were/will be engaged and the methods of participation that were/will be utilized. This research seeks to identify the state of stakeholder participation across all types of UrbanSim projects, regardless of the level of stakeholder participation that was used or will be used during the development and/or implementation of the model. Input from users at all stages of model development or implementation is encouraged.

This survey should take no longer than 15 minutes. If you agree to participate, you are asked to complete this online survey before 11:00PM EST on September 30, 2011. For your convenience, this survey has been successfully tested on the iPhone, but may also be compatible with other smart phone devices and tablets.

Please use the link below to access the online survey.
https://qtrial.qualtrics.com/SE/?SID=SV_cN19Mf6xxevI2OM

If you have been involved with more than one UrbanSim model, you may complete the survey for each project. The first section of the online survey contains a consent form and will allow you to accept or decline participation. If you agree to participate you are welcome to decline to answer any or all of the survey questions or discontinue participation at any time.

To receive a copy of the completed research paper, you may send an e-mail to me at sandra.goff@maine.edu. A copy of the final paper will be sent as an e-mail attachment upon project completion. I hope you will join me in my efforts to explore stakeholder participation in UrbanSim model construction and use by completing the online survey.

Sincerely, Sandra Goff

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[3] Throughout this study, stakeholders are defined as those from outside the technical modeling team who may be the future users of the UrbanSim model or who may be impacted by the model's use. Generally, stakeholders range from public officials to advocacy groups to private citizens.

APPENDIX C. Notice of IRB Review and Approval

UNIVERSITY OF
SOUTHERN MAINE
USM
Institutional
Review Board

IRB Protocol Number: 032211-24

DATE: May 12, 2011

TO: Sandra Goff
Faculty Mentor: Jack Kartez, Ph.D., Charles Colgan, Ph.D.

FROM: Jennifer Hutchinson

RE: Stakeholder Participation in Agent-Based Urban Simulation Modeling

Notice of IRB Review and Approval
Expedited Review as per Title 45 CFR Part 46.110, 63 Fed. Reg. 60364-60367, #7,
(Nov. 9, 1998) Title 45 CFR 46.117 (c)

The project identified above has been reviewed by the University of Southern Maine's Institutional Review Board (IRB) for the Protection of Human Subjects in Research using an expedited review procedure. You have been granted a waiver of documentation of the informed consent process.

- The research presents no more than minimal risk of harm to subjects and involves no procedures for which written consent is normally required outside of the research context.

This approval is based on the assumption that the materials, including changes/clarifications that you submitted to the IRB contain a complete and accurate description of all the ways in which human subjects are involved in your research.

This approval is given with the following conditions:

1. You are approved to conduct this research only during the period of approval cited below;

2. You will conduct the research according to the plans and protocol submitted;

3. You will immediately inform the Office of Research Integrity and Outreach (ORIO) of any injuries or adverse research events involving subjects;

4. You will immediately request approval from the IRB of any proposed changes in your research, and you will not initiate any changes until they have been reviewed and approved by the IRB. The Protocol Revision and Amendment Form can be found at: http://www.usm.maine.edu/orc/irb/form_protocol.htm

5. If your research is anticipated to continue beyond the IRB approval dates, you must submit a Continuing Review Request to the IRB at least 60 days prior to the IRB approval expiration date.

Approval Period: May 12, 2011- May 11, 2012

The University appreciates your efforts to conduct research in compliance with the federal regulations that have been established to ensure the protection of human subjects in research.

Sincerely,

Jennifer Hutchinson
Research Integrity Administrator
Human Protections Administrator
Office of Research Integrity and Outreach