Public Willingness to Pay for Ecosystem Services: Water Quality in the Triangle region, North Carolina

by

Ruth Jihyung Joo

Dr. Dean Urban, Advisor
Sept. 2011

Masters project submitted in partial fulfillment of the requirements for the Master of Environmental Management degree in the Nicholas School of the Environment of Duke University 2011
Introduction

Ecosystem Services are the “biological underpinnings essential to economic prosperity and other aspects of our well-being” (Daily, 1997). The definition of well-being includes aesthetic enjoyment, various forms of recreation, maintenance of human health, physical damage avoidance, and consumption of food and fiber (Boyd & Banzhaf, 2006). The Millennium Ecosystem Assessment (MEA 2005) distinguishes ecosystem services between supportive, provisioning, regulating and cultural services (Kroeger & Casey, 2007). Provisioning services are the products of nature such as timber and fuel, regulating services include climate and flood control, supporting services are all ecosystem functions such as pollination and nutrient cycling, and finally, the cultural services provide humans with aesthetic and recreational values (Kremen & Ostfeld, 2005).

Payment for ecosystem service (PES) is a “voluntary transaction where a well-defined ecosystem service is ‘bought’ by a buyer from a service provider, if the service provider secures service provision” (UNEP, 2009). Mainly, PES is comprised of 2 possible program types: either user-financed programs or government funded programs. For user-financed programs, the buyers are the actual users of the ecosystem services. In government-financed programs, buyers are others such as, government, an NGO, or an international agency, acting on behalf of the users of the ecosystem services (Engel et al., 2008). PES usually generates funds through charges such as tax collecting, government subsidies, tradable permits or tradable development rights, and achieves market friction reduction by providing information about the origin of products (Jack et al., 2008).

There are various payment schemes for ecosystem services. These include incentive programs such as Conservation Reserve Program; compliance markets such as wetland
mitigation banks, which are available for those who meet the mitigation requirements (Kroeger & Casey, 2007); voluntary markets such as the carbon market; and voluntary payments through donations to various conservation NGOs. Lastly, there are potential local taxes and bonds to pay for the services.

The Conservation Reserve Program (CRP) is an example of incentive program for ecosystem services application on agricultural lands. The program began in the 1950s but was established in its current form by the 1985 Farm Bill. CRP “provides technical and financial assistance to eligible farmers and ranchers to address soil, water, and related resource concerns on their lands in an environmentally beneficial and cost-effective manner” (USDA, 2010). Eligible participants are able to receive an annual rental payment based off the productivity of the soil and cost-share assistance to establish vegetative cover practices (50% of the participants cost). Potential contracts are ranked according to the Environmental Benefits Index, which evaluates the wildlife habitat benefits, water quality improvements, and air quality benefits that are likely to occur as a result of the project (USDA, 2010).

An example of a compliance market of ecosystem services is the wetland mitigation market, which requires developers to offset wetland destruction by purchasing credits in mitigation banks consisting of restored wetlands under legislation under the Clean Water Act (Kremen and Ostfield, 2005). Other payment schemes for ecosystem services include trust funds and local taxes or bonds. In North Carolina, there are 4 separate conservation trust funds since 1986 to protect land and water of the region. Conservation trust funds include the Clean Water Management, Natural Heritage, Parks and Recreation and the Farmland Preservation Trust Funds. These conservation trust funds allow the state to support land acquisition and other conservation efforts for ecosystem service provision. In addition to the trust funds, a reliable
form of potential funding to achieve conservation objectives is local funding (Hart, 2006), which includes bonds, property taxes and local sales taxes. Currently, many conservation organizations are seeking state legislation that would enable them to adopt dedicated open space taxes and fees at the local level.

Lately there has been a lot of interest in developing and activating payments for ecosystem services, in the hope that a more realistic accounting of the value of these services would help pay for conservation of natural habitats providing these services, for instance, by making these open space values more competitive with the value of lands for development. Payments for ecosystem services are also known to be a better tool to achieve conservation goals, by making conservation financially attractive (Kroeger & Casey, 2007), and it promotes environmentally sustainable management practices.

However, payment schemes for ecosystem services are complicated in a few issues: the valuation is difficult because of the various nonstandardized currencies; and the flow of benefits is complicated such that it often is not obvious who should pay for the services. For example, the provision of water quantity, as well as, quality is a key ecosystem service. It seems clear who should pay: the people who use the water. However, because the boundaries of human systems do not often match the boundaries of natural systems (e.g., watersheds), the situation is not so simple. The true cost of water can depend on two modes of intervention: (a) protect the source of watershed, or (b) clean water downstream at a water treatment plant. New York City provides an example of how the cost of upstream prevention can be much less than that of the cost of the downstream cure: NYC saved million dollars by protection watersheds in the Adirondacks instead of building more water treatment plants (Mass, 2011).
The Triangle region of the North Carolina Piedmont provides a more complicated scenario for payments for the provision of water. The Triangle region resides within the upper Neuse River basin and upper Cape Fear River basin, encompassing 4-6 different counties. The Neuse River basin is the third largest basin among the 17 river basins in the North Carolina. The headwater streams merge into Falls Lake reservoir to form the Neuse River, and below the Falls Lake reservoir, the river and streams flow through the broad flat terrain of the Coastal Plain. The basin water serves 18 different counties, and it encompasses the urban area that has grown at the fastest rates in the state (NC Division of Water Resources, 2010). The water quality and biodiversity of the river basin has been decreasing throughout the years of the development (NC Department of Environment and Natural Resources, 2006). Moreover, the demand for clean water in the region is increasing rapidly due to immigration, and the population is expected to nearly double by 2030 (Hart, 2006).
Jordan Lake is a 14,000 acre reservoir in the Upper Cape Fear River Basin, and it lies almost entirely within Chatham County with a small portion in Durham County (Fig. 1). The lake is the main drinking water source for Cary, Apex, Morrisville, Northern Chatham, and the Wake county portion of Research Triangle Region (NC Department of Environment and Natural Resources, 2007). However, the research from US Environmental Protection Agency shows that the entire lake is polluted by excessive nitrogen and phosphorus, and the large ratio of the nitrogen and phosphorus in the lake comes from polluted runoff from upstream development in Durham county and land around the lake (NC Department of Environmental and Natural Resources, 2007). Due to growing effects of eutrophication and contamination of the lake, there have been conflicts between Durham and Chatham County concerning the development of land around the lake and the cost of water quality protection (Khanna, 2009). At the city level, there have been conflicts between city of Raleigh and city of Durham because the stormwater runoff from Durham flows into Falls Lake and Jordan Lake, which is a drinking water source of Wake County, and other recreational place for the Triangle region (Bartlett, 2005).

Addressing this issue, this research aims to study the potential of developing water quality ecosystem service payment scheme: payments for land protection to improve the water quality in the region: figuring out how much people would be willing to pay for the upstream land conservation to improve their water quality. Previous research shows that land owners are strongly interested in the markets related to clean water provision (Kramer & Jenkins, 2009), and land conservation of the water reservoir area is a cost-effective way to conserve water quality by preventing surface runoff flowing into the water reservoir. Moreover, land conservation improves other ecosystem services such as protecting of rural quality of life, making productive agricultural lands, and protecting biodiversity and wildlife habitat (Hart, 2006).
To explore payment schemes for the provision of clean water in the Triangle region, and to discover residents’ Willingness to Pay (WTP) for water quality service, I had four specific questions:

- What are the public perceptions and opinions on conservation of ecosystem services in the Triangle region?
- How much is the public willing to pay for conservation of open space that provides ecosystem services in the Triangle region?
- What is water quality perception and future willingness to pay for conservation of upstream land for water quality improvement?
- How much is the public willing to pay for their community land for improvement of downstream water quality?

**Methods**

**Survey Design**

The 25 questions web survey consisted of four main categories addressing the four research questions: (1) public awareness of ecosystem services, (2) present behavior and opinions on conservation of ecosystem services in the Triangle region, (3) water quality perception and future willingness to pay for conservation of upstream land for improvement of household water quality, and (4) willingness to pay for their community land for improvement of downstream water quality.

For awareness of the ecosystem services, the questionnaire asked questions to gauge the public knowledge on ecosystem services such as identification, types, relationships and sources of the ecosystem services, followed by the present behavior and opinions on conserving the ecosystem service provision sources, such as open space around the area. The last part of the questionnaire includes questions on public willingness to pay for conservation of open space for water quality improvement. Contingent Valuation Method (CVM) was used, which uses a questionnaire to create a realistic but hypothetical market, and allows respondents to indicate their willingness to pay (WTP) value (Loomis et al., 2000). The scenarios for willingness to pay
questions include spatial components, asking WTP for conservation of upstream land for improvement of their water quality, and WTP for conservation of land to improve downstream water quality. The survey was designed to ask in discrete choice format: for example, giving respondents a multiple choice of the payment amount cards.

**Interviews and pretesting**

Informal interviews were conducted with 10 acquaintances. In open ended interviews, the topics of ecosystem services and willingness to pay for protection of open space to protect water quality were addressed; responses helped clarify working and presentation details in the survey. Before the survey implementation, five staff members and five graduate students from Duke University completed the online pretesting to assess questionnaire clarity, comprehensiveness and acceptability (Rea & Parker, 2005).

**Sampling**

A list of random household addresses of four counties (Durham, Orange, Wake and Chatham County) was acquired from a selected marketing firm (Direct Mail Tools, www.directmailtools.com). The invitation letter with the web survey link (Appendix A) was mailed to 2000 households in counties according to the ratio of population of each county (Wake 65%, Durham 20%, Orange 10% and Chatham 5%).

**Implementation**

The final questionnaire was uploaded on Qualtrics, an online survey server (Qualtrics.com). The web survey was opened for 11 weeks (from March 21 to June 3, 2011). An invitation letter to the web survey was sent, followed by two reminder postcards at three and eight weeks after the invitation letter. 13 paper questionnaires were sent out to households upon their request. The web survey was estimated to take ten minutes to complete, and the respondents
had an option to participate in a random drawing for a $75 gift upon completion of the survey.

**Analysis**

The analysis includes comparison on four different county residents’ responses using descriptive statistics. The data was cross-tabulated according to their residency, to yield the mean WTP value for conservation of ecosystem services. The mean WTP values were tested through t-tests for statistical difference between counties.
Results

Out of 2000 households sampling, there were 201 completed responses (response rate 10.05%). Respondent’s gender and age distribution was evenly distributed (Fig. 2 & Fig. 3), while majority of respondents’ race were white or Caucasian (76%) (Fig. 4), and they were highly educated and high income population (Fig. 5 & Fig. 6). 82% of the respondents had 4 year college or higher degree, and 29% of the respondents indicated that their annual household income is $90,000 or higher. Also, 32% of the respondents responded that they are members of at least one conservation organization.

Table 1. Survey respondents and their percentage by county residency

<table>
<thead>
<tr>
<th>County</th>
<th>Responses</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wake</td>
<td>113</td>
<td>56.22</td>
</tr>
<tr>
<td>Durham</td>
<td>58</td>
<td>28.86</td>
</tr>
<tr>
<td>Orange</td>
<td>25</td>
<td>12.44</td>
</tr>
<tr>
<td>Chatham</td>
<td>5</td>
<td>2.49</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>201</strong></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Figure 2. Gender of respondents in percentage
Figure 3. Age distribution of respondents in percentage

Figure 4. Race of respondents in percentage
The respondents’ demographics reflect the finding of previous studies addressing environmental and conservation behavior, that the highly educated and higher income population tend to be more involved in conservation activities or payments (Scott & Willits, 1994 & Chen et al, 2011). These studies explain that more educated people are more likely to be involved in conservation because they are exposed to more information about the environmental degradation and harm, and higher income people can pay more for conservation since they have more
degrees of freedom to emphasize when their needs are well satisfied (Scott & Willits, 1994). Also, because the questionnaire was a web based survey, the study had limited response bases on who has web access or computer literacy, although efforts were made to send paper copies to the people request. Due to low response rate from rural counties, such as, Orange County and Chatham County (Table 1), they were excluded from statistical difference analyses.

For knowledge and awareness of water quality questions, 25.4% of the respondents indicated that they are not aware of their reservoir of their household drinking water. Also, 30.3% respondents answered that they are not aware of their upstream city or town that can affect their household’s water reservoir quality by surface runoff and 47.3% did not identify downstream city or town where the water reservoir quality is affected by surface runoff from their community.

However, people are very willing to conserve ecosystem services sources, such as, land and water (Fig. 7), and they are very willing to conserve the open spaces, considering the population increase and environmental degradation in the area. Especially, among the ecosystem service types, people scored significantly higher on clean water and clean air as important ecosystem services in the Triangle region, compared to other ecosystem services, such as farming or forest production, providing wildlife habitat, stabilizing climate, renewing soils or nature recreation (p<0.05) (Fig. 8).
Figure 7. Percent response on agreeing the statement: “We need to conserve land and water that provides ecosystem services in the Triangle region”

Table 2. Mean importance of different types of ecosystem services of the Triangle region (scale importance 1-5)

<table>
<thead>
<tr>
<th>Ecosystem Services</th>
<th>Importance of the Services (Mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean water</td>
<td>4.94</td>
</tr>
<tr>
<td>Clean air</td>
<td>4.87</td>
</tr>
<tr>
<td>Farming production</td>
<td>3.94</td>
</tr>
<tr>
<td>Forest production</td>
<td>3.78</td>
</tr>
<tr>
<td>Providing wildlife habitat</td>
<td>4.09</td>
</tr>
<tr>
<td>Stabilizing climate</td>
<td>4.05</td>
</tr>
<tr>
<td>Renewing soils</td>
<td>4.18</td>
</tr>
<tr>
<td>Nature recreation and tourism</td>
<td>4.12</td>
</tr>
</tbody>
</table>

Figure 8. Mean importance of different types of ecosystem services in the Triangle region (scale importance 1-5)
For method of payments for open space conservation, residents preferred to pay voluntarily through conservation organizations (52%) or when paying utility bills (32%), and 29% respondents indicated that they are willing to pay higher local tax to the local government, and 28% said that they are willing to pay a new local tax that supports a conservation program (Fig. 9).

![Preferred Ways to Fund for Conservation](image)

More than half of respondents answered that surface runoff from parking lots, yards and streets as well as agriculture are the greatest factor that most degrades the quality of household drinking water supply quality (Fig. 10), and people wanted more governmental regulation change, such as, change in state regulation on surface runoff (63%) and stricter land use control (79%) to improve their water quality (Fig. 11). Also, 61% of respondents thought that protecting private land around the water body from development is the best way to improve their household water quality (Fig. 11).
Figure 10. Residents’ perception on factors that pollute their drinking water supply the most

**Factors that Pollute Drinking Water Quality**

<table>
<thead>
<tr>
<th>Factor</th>
<th>% Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leakage of septic systems</td>
<td></td>
</tr>
<tr>
<td>Dirt eroding from construction sites</td>
<td></td>
</tr>
<tr>
<td>Trash and pollutants from recreation activities on water sites</td>
<td></td>
</tr>
<tr>
<td>Rainfall runoff from yards, parking lots, and streets</td>
<td></td>
</tr>
<tr>
<td>Rainfall runoff from farms and agricultural operations</td>
<td></td>
</tr>
<tr>
<td>Industry drainage from manufacture plants</td>
<td></td>
</tr>
<tr>
<td>Urban wastewater such as sewage</td>
<td></td>
</tr>
</tbody>
</table>

Figure 11. Respondents’ opinions on the best way to improve water quality in the water bodies that supply drinking water in the Triangle region

**Best Way to Improve Water Quality in the Triangle**

| Opinion                                                        | % Response |
|                                                               |            |
| We do not need to improve the water quality                  |            |
| Building more treatment facility to restore the water quality |            |
| Protecting private land around the water from development    |            |
| Stricter land use control (i.e. Zoning) near water supply sources |        |
| State regulation of polluted surface water runoff            |            |

16
In Durham County, 93% of respondents perceived the city of Durham as upstream that affects the water reservoir quality, and 69% of Wake county respondents perceived the city of Raleigh as downstream community that is affected by polluted surface runoff (Fig. 12). However, about 18% of Durham county respondents answered that Raleigh and Cary are their downstream city or town that can be affected by upstream water quality, while 30% of Wake county respondents answered that city of Durham is the upstream city that affects their water quality by surface runoff (Fig. 12).

Table 3. Mean Willingness to Pay ($) per month for upstream land conservation for residents' water quality improvement, and WTP ($) for downstream water quality improvement by conserving land of residents’ community

<table>
<thead>
<tr>
<th>Residency</th>
<th>Durham</th>
<th>Wake</th>
<th>Orange</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean WTP($) for upstream conservation</td>
<td>10.3</td>
<td>9.96</td>
<td>9.36</td>
</tr>
<tr>
<td>Mean WTP($) for downstream water quality</td>
<td>9</td>
<td>6.74</td>
<td>7.14</td>
</tr>
</tbody>
</table>
Both Durham WTP and Wake WTP values are higher for upstream conservation than downstream conservation (Fig. 13). Wake county respondents had significantly higher mean WTP for upstream conservation (p<0.05). For downstream water quality improvement, Durham county people were more willing to pay for downstream water quality compared to Wake County residents (p=0.07). This portrays that Wake county residents are willing to pay more for upstream communities outside their county to protect their water quality that is treated for their households. Also, the result implies that Durham population feels responsible to protect the quality of water bodies within the county that supply drinking water for other downstream communities.
Table 4. Mean WTP ($) per year for conservation of open space around water areas from development

<table>
<thead>
<tr>
<th>Residency</th>
<th>Durham($)</th>
<th>Wake($)</th>
<th>Orange($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little River</td>
<td>26.14</td>
<td>6.64</td>
<td>22.5</td>
</tr>
<tr>
<td>Eno River</td>
<td>35.53</td>
<td>8.34</td>
<td>38.4</td>
</tr>
<tr>
<td>Lake Michie</td>
<td>31.36</td>
<td>5.95</td>
<td>5.81</td>
</tr>
<tr>
<td>Falls Lake</td>
<td>33.4</td>
<td>30.78</td>
<td>6.88</td>
</tr>
<tr>
<td>Crabtree Creek</td>
<td>12.78</td>
<td>24.06</td>
<td>4.69</td>
</tr>
<tr>
<td>Lower Haw River</td>
<td>15.69</td>
<td>9.4</td>
<td>9.15</td>
</tr>
<tr>
<td>Jordan Lake</td>
<td>26.11</td>
<td>20.42</td>
<td>15.83</td>
</tr>
<tr>
<td>Swift Creek</td>
<td>11.39</td>
<td>17.23</td>
<td>4.56</td>
</tr>
<tr>
<td>Harris Lake</td>
<td>10.18</td>
<td>11.99</td>
<td>4.56</td>
</tr>
</tbody>
</table>

Figure 14. Mean WTP ($) per year for conservation of open spaces around water areas from development

People are more willing to pay for conservation of open space where they live nearby or which are their reservoirs (Fig. 14). For example, Durham county residents are more willing to pay for Eno River conservation, which resides within the county, and for Lake Michie and Little River, which are their water reservoirs (p<0.05). Orange county residents showed significantly higher willingness to pay values for Eno River and Little River conservation (p<0.05). Wake county residents have higher WTP values for Crabtree Creek and Swift Creek (p<0.05), which
resides within their county. However, Jordan lake, Falls Lake, and Harris Lake are neither case; both Durham and Wake population are highly willing to pay for conservation of these water bodies, despite their locations. This seems to be due to their locations, in which they share the water and their importance in the state population for water reservoir and recreational purpose.

**Summary**

In summary, people are not very aware of their water sources in the region, and the residents are very willing to conserve land and water that provides ecosystem services, given the population increase and environmental degradation. For payment method for conservation, residents responded that they prefer voluntary payments to the conservation organization or through utility bills.

The mean WTP value for Durham residents for upstream land conservation for water quality improvement was $10.3 per month, and Wake residents were willing to pay $9.96 per month. Mean WTP for Durham residents to conserve their land around water body for downstream community water quality improvement was $9 per month, while Wake residents are willing to pay $6.74 per month. For conservation of open spaces around the water resources, Durham residents were much more willing to pay for conservation of Little River, Eno River and Lake Michie open spaces compared to Wake residents, while Wake residents were much more willing to pay for conservation of Crabtree Creek and Swift Creek. However, for Falls Lake and Jordan Lake, there were not much difference in the WTP values between Durham and Wake residents.

**Recommendations**

*Environmental Education and Community Based Environmental Management*

In this research, many residents responded that they are not aware of their water sources (25.4%),
and their downstream communities (47.3%). Environmental awareness on drinking water quality, their sources and conservation should be improved at the community level. Especially, community-level education on the water reservoir, impact of surface runoff and nutrient loading can facilitate successful conservation of the water sources and its surrounding open spaces. Community-based actions also can be taken to clean up the land and open space around the water body. Community-based environmental management is environmental planning and management that requires local participation, operated by environmental organizations or institutions. In the process, community-based environmental management aims to reach both environmental goals and socioeconomic goals. Environmental goal includes sustainable water quality management, and socioeconomic goals include social equity, conflict resolution, empowerment, education and economic development of the local community (Kellert et al., 2000).

- Consider tighter restrictions in the water quality improvement

In this study, respondents replied that surface runoff is perceived as the greatest factor that pollutes their drinking water supply and stricter land use planning (79%) or regulations on polluted surface runoff and development (63%) are responded to be the best ways to improve their household water quality. Currently, surface runoff and water quality regulation is primarily addressed through Clean Water Act, to regulate on discharges from point source conveyances into navigable waterways (Achterman & Mauger, 2010). Under the Clean Water Act, US Environmental Protection Agency set wastewater standards for industry and set water quality standards for all contaminants in surface waters. While current regulations and programs are focused on industrial runoff, these restrictions and permit based programs can be broaden, and the standard can be set tighter.

- Facilitate more voluntary donation in utility bills and higher local tax
This study shows that 32% of respondents are interested in voluntary donation for conservation of the land around the water body to improve their water quality. Tools for voluntary donation included in the water or other utility bills can be implemented in city level, by enabling voluntary donation upon water bill payment both online and offline. Moreover, 29% of respondents replied that they are willing to pay higher tax to the local government for open space conservation. In the future, collecting higher local tax or generating open space tax can be considered as potential conservation funding source in local legislation.

- Development of payment schemes for water quality

Voluntary payments for water quality can be developed in the Triangle region through development and increase in water fund scheme. Water funds like Clean Water Management Trust Fund is a good example of public and private partnership focused around sustainable finance source for water quality conservation. Through the trust funds, downstream people can finance conservation and livelihood projects to secure their water service sustainability. Water users can voluntarily invest money in the trust fund and the revenue can be used to finance conservation projects in the watershed (Goldman, 2010).
Reference


Kramer, Randall & Aaron Jenkins.(2009) Ecosystem services, Markets, and red wolf habitat: results from a farm operator survey. Nicholas Institute for Environmental Policy Solutions, Duke University


Appendix A. Survey Invitation Letter

Dear Resident of Triangle Region:

My name is Ruth Joo, I am a graduate student researcher at the Nicholas School of the Environment at Duke University. I am conducting a survey to answer the questions of people’s awareness and opinion on land and water conservation in the Triangle region. I am writing to households in Durham, Orange, Wake and Chatham counties of North Carolina as part of my research, which is why you have received this letter.*

Your household is one of a small number that has been asked to participate. Although your participation is completely voluntary, your participation will help ensure the results truly represent the county resident opinions. Even if you are not knowledgeable about land and water conservation of the area, your opinion is important.

The questionnaire should take about 10 minutes to complete, and your responses will remain confidential. We do not know your names and your names are not on our mailing lists. Further, your answers will never be associated with your mailing address. The responses you provide will be used for my master’s thesis project and the report will be made available to the local government, conservation leaders and interested citizens.

The person filling out the survey must be 18 years or older.

For your convenience, the survey can be completed online: just enter this web page address in your internet browser, and then type in your access code to begin the survey.

URL/web address: http://tinyurl.com/waterNC
Your access code: 0492254

We realize that some households may not have internet access. If you do not have internet access but would like to participate, please call (919) 638 9714, and we will send a paper questionnaire.

By giving your thoughts and opinions about land and water of the Triangle region, you will be helping us out a great deal. Upon completion of the survey, you’ll be given an opportunity to participate in a drawing to win $75 VISA GIFT CERTIFICATE by providing your address or an email address.

This information will not be linked to any of your data so that confidentiality is still ensured. We expect your chances of winning the drawing are 1/500. If you win one of the gift certificates, we will need to collect your name, address, and social security number on a Payment Verification Form. This form will be sent only to Duke Accounting and will not be linked to your survey responses.

If you have any questions about this survey or if you have any difficulties answering survey, I can be reached at above number or by email jj96@duke.edu.

I hope you enjoy completing the survey, and look forward to receiving your responses.

Sincerely,

Ruth Joo

Candidate for Master of Environmental Management, 2011
Nicholas School of the Environment
Duke University

* If you do not want to participate, please contact me to remove your address from my mailing list, and you will not receive any follow-up correspondence about this research.

Appendix B. Questionnaire
Ecosystem Services of the Triangle Region

Dear Resident of Triangle Region:
Your household has been selected to participate in this survey by Ruth Joo, a researcher at Nicholas School of the Environment, Duke University. This survey was designed to answer the questions about people’s awareness and opinion on land and water conservation in the Triangle region.

Please have one adult (age 18 or older) in your household complete this survey. You must be 18 years or older to complete this survey.

Your participation on this survey is completely voluntary. Although you do not have to answer every question or complete the survey or interview, we could greatly benefit from your full participation, and we appreciate your time and effort.

The questionnaire should take about 10 minutes to complete, and your responses will remain confidential. We do not know your names and your names are not on our mailing lists, further, your answers will never be associated with your mailing address. The responses you provide will be used for master’s project presentation at Duke University, and the report will be made available to the local government, conservation leaders and interested citizens in August, 2011.

By giving your thoughts and opinions about land and water of the Triangle region, you will be helping us out a great deal. Upon completion of the survey, you’ll be given an opportunity to participate in the drawing to win $75 Visa gift certificate by providing your address or an email address.

This information will not be linked to any of your data so your confidentiality is still ensured. We expect your chances of winning the drawing are 1/500. If you win one of the gift certificates, we will need to collect your name, address, and social security number on a Payment Verification Form. This form will be sent only to Duke Accounting and will not be linked to your survey responses.

If you have any questions about this survey or if you have any difficulties answering survey on the internet, I can be reached at (919) 638 9714 or by email jj96@duke.edu.

You can also contact my advisor, Professor Dean Urban at 919-613-8076 or at deanu@duke.edu.

If you have any questions about your rights as a human subject in this research, please contact the Duke University IRB at (919) 684-3030 or ors-info@duke.edu.

I hope you enjoy completing the survey, and thank you very much for your participation.
1. Which county do you live in?
   - Durham
   - Orange
   - Wake
   - Chatham
   - Other; please specify ____________________

2. What is your zip code? ________________

3. How long have you been living in your county? Please round to the closest whole number of years. ____________

4. Ecosystem Services refers to the benefits nature gives to the society, such as, purifying water and air, providing farming and forest products, providing wildlife habitat, stabilizing climate and renewing soils, and human recreation. What types of ecosystem services are important in the Triangle region? Please score the services from not important at all (1) to very important (5).

<table>
<thead>
<tr>
<th></th>
<th>1 not important at all</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5 very important</th>
<th>I don't know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clean air</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farming production</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forest production</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Providing wildlife habitat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stabilizing climate</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Renewing soils</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nature recreation and tourism</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. Ecosystem Services refers to the benefits nature gives to the society, such as, purifying water and air, providing farming and forest products, providing wildlife habitat, stabilizing climate and renewing soils, and human recreation. Do you agree or disagree with the following statement? “We need to conserve land and water that provides ecosystem services in the Triangle region.”
   - Strongly agree
   - Somewhat agree
   - Neither Agree nor Disagree
   - Somewhat Disagree
   - Strongly Disagree

6. Are you a member of any environmental group in the Triangle region?
   - No, I’m not a member of any conservation group or organization.
   - Yes, I’m a member of an environmental/conservation organization(s); please specify. ____________________

7. Open Space is undeveloped land or common areas that are reserved for parks, walking trails, or other natural uses. This can include stream corridors, forests, wildlife habitat, farmland and natural areas that provide benefits to the public.
How often do you use open spaces in the Triangle region? (Open space activities include: walking, running, biking, bird-watching, fishing, hiking, hunting, picnicking, and water sports.)
- I use open spaces daily.
- I use open spaces at least once a week, but not daily.
- I use open spaces at least once a month, but not weekly.
- I use open spaces at least once a year, but not monthly.
- I never use open spaces in the area.
- Others; please specify ____________________

8. A study has shown that the population of the Triangle region is expected to double by 2030. Considering the above statement, to what degree do you want to see open space conserved in the Triangle region?

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not willing</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
<tr>
<td>Strongly willing</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
<td>〇</td>
</tr>
</tbody>
</table>

9. If you are given opportunity to fund for open space conservation, in what ways would you prefer to fund? Please check all that apply.
- By making voluntary donation to environmental/conservation organization(s).
- By making voluntary donation when paying utility bills.
- By paying higher local tax to the city or county.
- By paying a new local tax into a conservation program.
- I do not want to fund for conservation of open space.
- Others; please specify. ____________________

This map shows 4 counties of the Triangle region and their important water areas such as lakes and rivers.

10. Suppose there is a program in which your county funds open space conservation of the Triangle region. The funding will go toward protecting the open spaces around water areas from development.
If you were given the choice to make donation with your yearly property tax payment towards these conservation funds, what is the MAXIMUM amount you would be willing to pay as one time donation for each open space conservation? Please consider above map for locations.

<table>
<thead>
<tr>
<th>Water Body</th>
<th>$0</th>
<th>$1</th>
<th>$2</th>
<th>$5</th>
<th>$10</th>
<th>$20</th>
<th>$50</th>
<th>$100</th>
<th>$200</th>
<th>$500</th>
<th>$1000</th>
<th>&gt;$1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Little River</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eno River</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lake Michie</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Falls Lake</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crabtree Creek</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower Haw River</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jordan Lake</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Swift Creek</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harris Lake</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

11. What water body is the source of your household drinking water? Please check all that apply.
   - Groundwater from private well
   - Falls lake reservoir
   - Jordan lake reservoir
   - Lake Michie reservoir
   - Little River reservoir
   - Other; please specify ____________________
   - I don't know

12. Based on your current knowledge, please check one city (or town) that can affect your water reservoir quality the most by polluted surface water runoff.
   - Durham
   - Chapel Hill
   - Raleigh
   - Cary
   - Pittsboro
   - I don't know

13. Based on your current knowledge, please check one city (or town)'s water reservoir quality that is most affected by polluted surface water runoff from your community.
- Durham
- Chapel Hill
- Raleigh
- Cary
- Pittsboro
- I don't know

14. How clean would you say the drinking water supply you get your drinking water from is?

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very unclean:Very clean</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
15. What type of activities do you think most degrades the quality of your household drinking water supply? Please check all that apply.
- Urban wastewater such as sewage
- Industry drainage from manufacture plants
- Rainfall runoff from farms and agricultural operations
- Rainfall runoff form yards, parking lots, and streets
- Trash and pollutants from recreation activities on water sites
- Dirt eroding from construction sites
- Leakage of septic systems
- Others; ____________________

16. What do you think is the best way to improve water quality in water bodies that supply drinking water in the Triangle region? Please check all that apply.
- State regulation of polluted surface water runoff
- Stricter land use control (ie. zoning) near water supply sources
- Protecting private land around the water from development
- Building more treatment facility to restore the water quality
- We do not need to improve the water quality
- Others; ____________________

17. Which range below best describes your average total water bill (including conservation fee, such as, stormwater fee) on a monthly basis?
- I do not pay water bills.
- Less than $10
- More than $10~less than $20
- More than$20~less than $30
- More than$30~less than $40
- More than$40~less than $50
- More than$50~less than $60
- More than$60~less than $70
- More than$70~less than $80
- More than$80~less than $90
- More than$90~less than $100
- More than $100; please specify. ____________________
18. Scenario A
Suppose you are given a choice to make a voluntary donation in your water bill every month. The donation will be used to conserve upstream land OUTSIDE of your county that protects the quality of water that is treated for YOUR household.

Taking into consideration what you currently pay as water bill, what is the MAXIMUM amount you would be willing to pay as one time donation described in the scenario?

- None
- $1
- $5
- $10
- $15
- $20
- $25
- $30
- $35
- $40
- $45
- $50
- Other; please specify. ____________________

**Answer If Scenario A**

Suppose you are given a choice to make a vol...

None is selected.

What is the reason for your choice? Please check all that apply.

- I already pay too much water bill.
- It is not my responsibility to pay for land and water conservation.
- I do not want to pay for land conservation in other counties.
- I’m willing to pay, but can’t afford to pay.
- The local government should budget conservation from the fund that are already available.
- Others; please specify. ____________________
19. Scenario B
Suppose you are given a choice to make a voluntary donation in your water bill every month. The donation will be used to protect the quality of water bodies that supply drinking water for other communities DOWNSTREAM of you, by purchasing or conserving important open spaces in YOUR county.
Taking into consideration what you currently pay as water bill, what is the MAXIMUM amount you would be willing to pay as one time donation described in the scenario?
☐ None
☐ $1
☐ $5
☐ $10
☐ $15
☐ $20
☐ $25
☐ $30
☐ $35
☐ $40
☐ $45
☐ $50
☐ Other; please specify. ____________________

Answer If Scenario B
Suppose you are given a choice to make a voluntary donation in your water bill every month. The donation will be used to protect the quality of water bodies that supply drinking water for other communities DOWNSTREAM of you, by purchasing or conserving important open spaces in YOUR county. Taking into consideration what you currently pay as water bill, what is the MAXIMUM amount you would be willing to pay as one time donation described in the scenario?
☐ None
☐ $1
☐ $5
☐ $10
☐ $15
☐ $20
☐ $25
☐ $30
☐ $35
☐ $40
☐ $45
☐ $50
☐ Other; please specify. ____________________

What is the reason for your choice? Please check all that apply.
☐ I already pay too much water bill.
☐ It is not my responsibility to pay for land and water conservation.
☐ I do not want to pay for improving water quality of other counties.
☐ I’m willing to pay, but can’t afford to pay.
☐ The local government should budget conservation from the fund that are already available.
☐ Others; please specify. ____________________

20. What is your gender?
☐ Male
☐ Female
☐ Prefer not to answer
21. What is your age?
   ○ 21 or under
   ○ 22-34
   ○ 35-44
   ○ 45-54
   ○ 55-64
   ○ 65 or above
   ○ Prefer not to answer

22. What is your race?
   ○ White/Caucasian
   ○ African American
   ○ Hispanic
   ○ Asian
   ○ Native American
   ○ Pacific Islander
   ○ Other: ____________________
   ○ Prefer not to answer

23. What is the highest level of education you have completed?
   ○ Less than High School
   ○ High School / GED
   ○ Some College
   ○ 2-year College Degree
   ○ 4-year College Degree
   ○ Master’s Degree
   ○ Doctoral Degree (PhD)
   ○ Professional Degree (JD, MD)
   ○ Prefer not to answer
24. What is your annual household income level?
☐ Below $20,000
☐ $20,000 - $29,999
☐ $30,000 - $39,999
☐ $40,000 - $49,999
☐ $50,000 - $59,999
☐ $60,000 - $69,999
☐ $70,000 - $79,999
☐ $80,000 - $89,999
☐ $90,000 or more
☐ Prefer not to answer

25. At this time, please feel free to tell us any comment or opinion you have about land and water conservation in the Triangle region. Your response is completely confidential.

Thank you very much for participating in the survey.

***If you'd like to sign up for $75 Visa gift certificate drawing, please provide your address or email address here.
______________________________