MEASURING PUBLIC PREFERENCES OVER STORMWATER MANAGEMENT OUTCOMES IN ILLINOIS: WILLINGNESS TO PAY AND WILLINGNESS TO HELP

SUMMARY REPORT

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II. Problem and research objective

Problem: Stormwater runoff is the cause of many environmental problems in Illinois and elsewhere such as flooding, soil erosion and water pollution. Urbanization increases runoff problems; permeable surfaces are replaced by impervious surfaces that limit water infiltration, which starves streams of groundwater that supports base flows during dry periods. The flows of urban stormwater have been dealt with using large-scale engineering solutions that convey the water rapidly to streams, rivers, detention ponds. These technologies increase pollutant loads in streams and tend to make stream flows excessively fast and heavy during storms, scouring stream beds, and further degrading aquatic habitat in urban water bodies (NRC 2009; Brabec 2009).

New strategies for mitigating stormwater runoff have been developed that may manage stormwater with a broader suite of environmental benefits. These green infrastructure technologies (often called Low Impact Development (LID) tools or Best Management Practices (BMPs)) such as landscape infiltration systems, pervious pavements, and green roofs (USEPA 2000) mimic nature in order to capture, temporarily store, treat, and/or infiltrate stormwater. The results can be improved water quality, increased groundwater recharge, and/or healthier aquatic

habitat (NRC 2009). The U.S. EPA is considering new regulations (USEPA n.d) that would effectively require widespread implementation of BMP development approaches, but the total benefits of that change are hard to estimate given gaps in the literature on the benefits of stormwater management.

In the absence of strict federal stormwater regulations, the City of Chicago through its Water Agenda has taken several steps to address stormwater management issues. The Chicago City Council passed its "Chicago Stormwater Management Ordinance" designed to promote programs that minimize the negative stormwater impacts of new development and redevelopment in the city (City of Chicago 2011). The Ordinance applies to certain types of new developments and redevelopment and requires specific practices to ensure that stormwater is responsibly managed in accordance with the goals of the Water Agenda. Thus, the City has begun promoting green building design and BMPs, has taken steps to prevent polluted stormwater from roadways from discharging directly into Lake Michigan and the Chicago and Calumet Rivers, and is also working to comply with National Pollutant Discharge Elimination System (NPDES) Phase II requirements. There is a strong movement to encourage green infrastructure in order to comply with NPDES and regulation to incorporate LID requirements in new and re-developments where feasible. However, authorities struggle with the lack of benefit estimates to use in cost-benefit analyses of any such regulations.

Although there is general consensus on the environmental benefits and cost-effectiveness of BMPs and despite governmental efforts to promote them, they have not been widely implemented. Reasons for the lack of adoption include political issues, lack of professional education and training, regulatory conflicts and inflexibility, lack of funding for research and development and personal beliefs, knowledge and preferences (Roy et al. 2008).

Empirical evidence of people's preferences over stormwater management control can help to shape the way policy makers design incentives when they intend to promote the use of new environmental technologies and thus overcome the barriers that seem to hinder the widespread implementation of apparently cost-effective stormwater management tools. The particular results from this research could be used as a tool for the development of policies and sustainability efforts in the Chicago area and potentially in other urban areas in Illinois.

This project produces information about how much people value different kinds of environmental improvements that can be accomplished with LID stormwater management approaches. The results of this project can also help policy makers understand people's attitudes about using decentralized stormwater solutions instead of conventional concrete infrastructure, and people's willingness to volunteer to help maintain such decentralized solutions. That knowledge could help city, state, and federal policy makers to make choices about stormwater policies, since such policies vary in the extent to which they accomplish different environmental

objectives (Birol et al. 2006). Finally, this research contributes to academic research on choice experiment methodology by exploring payment through time as well as money.

Objectives: The objectives of the project are to improve public policy in Illinois regarding stormwater management and to advance scientific understanding of consumer behavior and the value of improving environmental attributes affected by stormwater control. Specific objectives are:

Objective 1: Estimate the values that citizens place on multiple attributes of stormwater management outcomes.
Objective 2: Assess whether people are willing to take on stewardship of stormwater control facilities where they live.
Objective 3: Inform stormwater policy making in Chicago and other urban areas of Illinois.
Objective 4: Identify the role that questions about volunteer time can play in choice experiment surveys to estimate values of a wide range of public goods.

II. Methodology

Choice experiment survey: Choice experiment (CE) survey methodology (Louviere and Hensher 1982) has been used widely for decades in marketing and economics to estimate consumers' willingness to pay for goods or services. This approach asks respondents to choose between different hypothetical goods or scenarios defined in terms of their attributes. We use a CE survey asking respondents to indicate preferences between different hypothetical stormwater-control scenarios which vary in key attributes: pollution levels in area water bodies; aquatic habitat in area streams/rivers; frequency of floods; monetary cost to the household; and time the household would have to spend maintaining and/or installing BMPs. The questions are given in varied orders to control for ordering and learning effects.

We use CE for several reasons. First, the outcomes of a stormwater-management strategy – flooding, water quality, cost, and aquatic habitat quality – can actually vary in different directions from one another depending on the nature of a city's strategy. For example, flooding can be reduced with large sewer infrastructure, but that is likely to worsen water quality. Thus, it makes sense to describe a scenario of stormwater management outcomes in which the attributes vary separately from each other. Second, given this feature of stormwater runoff management, CE methods provide valuable information to policy makers by determining which type of features of environmental quality people care about the most and consequently should be prioritized.

Survey instrument: An online choice experiment survey was answered by 500 residents of Chicago. Following recommendations for stated choice surveys (Mattews et al., 2006), the survey instrument provided respondents with background information about stormwater management problems and controls and then presented respondents with a number of binary-choice questions, each of which asked them to choose between a pair of hypothetical stormwater-control scenarios and the status quo, meaning that respondents could also choose to have no new stormwater management projects in their area. This opt-out option leaves flooding and environmental quality the same, and entails no cost. The choice questions are followed by a demographic questionnaire and questions about respondents' experiences with stormwater issues.

The final list of attributes and levels was refined according to input from water management experts and focus groups. The focus groups were moderated by hired experienced professionals, with the participation of 6-7 people per group and a total duration of 90 minutes each. The participants replied to advertisements posted in Craigslist and were rewarded with a $25 gift card. Each participant answered a complete questionnaire and the moderator asked about aspects such their perceptions of the general purpose of the survey, level of difficulty, language, amount of questions, attribute levels, own flooding experience and general suggestions.

We administered the survey online through the company Qualtrics, which provided both the software and the respondents' panel. Web-based surveys guarantee a given number of responses with panels of respondents who are paid to participate in surveys on a regular basis. The flexibility and relative low cost of web-based surveys make them a good alternative for research, especially with declining response rates in mail surveys (Groves, 2006; de Leeuw and de Heer, 2002). The company is able to ensure that the sample is representative of people from a wide range of income levels.

Experimental design: The experiment consists of three treatment groups, to which respondents were randomly assigned in equal numbers. To evaluate the effect of having a time attribute to capture the value people have for features of a scenario, Treatment #1 (Time and Money) was presented with both time- and money-cost attributes, Treatment #2 (Money-only) with only a money-cost attribute, and Treatment#3 (Time-only) with only a time-cost attribute.

We compare the total value estimates between groups to quantify the effect that a second non-monetary "payment" attribute has on those estimates. We use econometric methodology (mixed multinomial logit) to account for preference heterogeneity in the sample and to evaluate how the new attribute behaves in different sub-groups of the sample.

Statistical analysis: Choice experiments are based on random utility maximization theory (McFadden 1973) where the different attributes contribute to utility together with a random component to capture the unobserved differences. The indirect utility function capturing the

utility of each scenario to each respondent is specified to have a linear functional form. The coefficients on attributes capture the marginal utilities of those attributes to respondents. The coefficient on money captures the marginal utility of money. The coefficient on time is the sum of the scarcity value of time and the marginal utility that a respondent obtains from volunteer activity.

Neoclassical economic theory predicts that time is valued at its opportunity cost (i.e. the person's wage rate). We use data from respondents who report a positive wage to test whether individuals do value their time at their current wage rate. We also test whether marginal willingness to pay for stormwater projects varies with respondents' income levels.

III. Principal findings and significance

Preliminary results show that people in Chicago place a positive value on improving elements of environmental quality, both water quality and aquatic health. The survey shows that aquatic health and hydrological function are important to individuals in our sample. Flooding reduction is not significant in the treatment in which people are presented with both time and money payments, even after controlling for individual flooding experience. Only 33% of the respondents recall at least one flooding event in the past year and, out of those who did, fewer than 6% experienced more than four flood events. These results suggest that people do not see flooding as a major hazard or inconvenience and are not willing to pay both money and time to avoid flooding. Thus, promoting the environmental benefits of stormwater management projects appears to be an important factor in inducing public acceptance of different policies, perhaps more than emphasizing reduction in the prevalence of flooding. If individuals understand that fees they pay go toward maintaining or improving the environmental quality of that body of water, they might be more willing to accept and participate in the fee program in exchange for those benefits.

We calculated people's average marginal willingness to pay and willingness to help to obtain various attributes (flood reduction, environmental improvement). These numbers can be interpreted as the amount of dollars per month people would be willing to give or the number of hours people would spend each month in helping with decentralized stormwater management projects in their neighborhood for one percent reduction of flooding, or a discrete improvement in quality. These values can be used to calculate the total benefits of a stormwater management plan.

Results suggest that people do not value their time at their wage rate. If time were truly valued according to hourly wages, people reveal themselves willing to pay much more through in-kind contributions of time than through direct payments of money. In addition, current results

reveal the surprising result that high income people are willing to pay less money for stormwater improvements. This finding could have two sources. First, income and political affiliation could be correlated such that income is standing as a proxy for anti-tax ideology. Second, people of different income categories may have different direct experiences with the benefits of stormwater management. High income people might be located in areas where there is less significant flooding. Also, wealthy people are better able to afford substitute locations for local surface waters for activities such as fishing and swimming, so their willingness to pay to improve water quality in the waters in and around Chicago might be lower.

IV. Notable achievements

- Traditional economic valuation research only permits people to express value for environmental amenities in terms of money; we develop a novel valuation method that permits individuals to express value in terms of time spent as well as money paid.
- We find that people see contributing time helping as a valid mode of payment, and the wage value of the time they are willing to devote to helping is greater than the amount of money they would be willing pay directly for the same program.
- Our estimates of the values of water quality and aquatic habitat improvements can inform cost-benefit estimates of urban stormwater programs and regulations.
- The findings imply that programs that allow residents to pay both through fees and through helping may be better able to capture a full range of value from residents of diverse financial means.

V. Student supported with funding

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VI. Publications and presentations

- Very preliminary results were presented by Amy Ando at the W3133 Multistate Research Group Annual Meeting in Coeur d'Alene, Idaho in February 2013.
- Catalina Londoño defended her doctoral dissertation on May 8, 2013, which includes the results of this study.
- The final results of the project have not been presented or published yet. However, they will be presented at the Annual Meeting of the American Applied Economics Association in Washington DC in August 2013. The research will be part of the doctoral dissertation of

Catalina Londoño which will be deposited by August 2013 and at least two peer reviewed papers in academic journals.

VII. References

Birol, E., K. Karousakis, and P. Koundouri (2006), Using economic valuation techniques to inform water resources management: A survey and critical appraisal of available techniques and an application, *Science of the Total Environment*, *365*(1-3), 105–122, doi:10.1016/j.scitotenv.2006.02.032.

Brabec, E. A. (2009), Imperviousness and land-use policy: Toward an effective approach to watershed planning, *Journal of Hydrologic Engineering*, *14*(4), 425–433, doi:10.1061/(ASCE)1084-0699(2009)14:4(425).

City of Chicago (2012), *Stormwater Management Ordinance Manual*, Chicago.

Groves, R. M. (2006), Nonresponse rates and nonresponse bias in household surveys, *Public Opinion Quarterly*, *70*(5), 646–675, doi:10.1093/poq/nfl033.

De Leeuw, E., and W. de Heer (2002), Trends in household survey nonresponse: A longitudinal and international comparison, in *Survey Nonresponse*, edited by R. M. Groves, D. A. Dillman, J. L. Eltinge, and J. A. Little Roderick, pp. 41–54, Wiley, New York.

Louviere, J. J., and D. A. Hensher (1982), On the design and analysis of simulated choice or allocation experiments in travel choice modelling, *Transportation Research Record*, *890*, 11–17.

Mattews, K. E., M. L. Freeman, and W. H. Desvousges (2006), How and how much?, in *Valuing Environmental Amenities Using Stated Choice Studies*, edited by B. Kanninen, pp. 111–133, Springer, Arlington, VA.

McFadden, D., and K. Train (2000), Mixed MNL models for discrete response, *Journal of Applied Econometrics*, *15*(5), 447–470.

National Research Council (2009a), *Urban stormwater management in the United States*, The National Academies Press, Washington, DC.

Roy, A. H., S. J. Wenger, T. D. Fletcher, C. J. Walsh, A. R. Ladson, W. D. Shuster, H. W. Thurston, and R. R. Brown (2008), Impediments and solutions to sustainable, watershed-

scale urban stormwater management: Lessons from Australia and the United States, *Environmental Management*, *42*(2), 344–359.

U.S Environmental Protection Agency (2000), *Low impact development (LID): A literature review*, edited by O. of Water., Washington, DC.

U.S Environmental Protection Agency (n.d.), Federal Regulatory Programs, [online] Available from: http://water.epa.gov/infrastructure/greeninfrastructure/gi_regulatory.cfm (Accessed 25 October 2012)