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Author(s): Karlyn Eckman, Valerie Were, Valerie Brady, Jesse Schomberg, Richard Axler and Chris Kleist

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URBAN STORMWATER

Stormwater affects fresh water resources by carrying pollutants such as vehicle wastes, road salts, pet waste, and grass clippings to streams, and by causing flooding downstream. In cities, stormwater flows across impervious surfaces and into underground storm sewer pipes to nearby water bodies. Cities manage stormwater using infrastructure, planning, regulations, and education and outreach activities to promote responsible stewardship practices (e.g., rain gardens).

The City of Duluth, Minnesota, faces significant challenges in managing urban stormwater. Duluth's storm sewer system includes 431 miles of underground pipe, 12,000 catch basins, 5000 manholes, 3000 culverts, and numerous ponds and sediment basins (Kleist *et al.*, 2011b). Duluth is built on steeply sloping hills and clay soils atop shallow bedrock, and has 44 named streams, including 16 designated trout streams. In Duluth's Lakeside neighborhood, stormwater drains into a branch of Amity Creek (Figure 1), a trout stream impaired for turbidity, and ultimately into Lake Superior. Stormwater from uphill neighborhoods affects people living further downhill. A ten-inch/day rainfall on June 19-20, 2012, caused major damage in the region, resulting in more than $200 million in flood damage to infrastructure and homes.

Figure 1. Amity Creek Flows Downhill Through Parks and Residential Neighborhoods to Lake Superior

EVALUATING RESIDENTIAL STORMWATER PROJECTS

Assessing quantifiable results from stormwater projects designed to reduce stormwater impacts and benefit residents is often challenging for water resource professionals. They are pressed to show effects and justify project costs but often lack training in practical, cost-effective evaluation methods, particularly relating to educational outcomes and behavior change. Many are trained in the biophysical sciences and are unfamiliar with social science research or the tools available for assessing some aspects of project success quickly and cost-effectively. Duluth Public Works is charged with reducing stormwater runoff and pollution into urban streams and rivers that flow into Lake Superior. In part, reducing runoff means that residents need to adopt practices to capture stormwater on their lots. However, the problem remains of enticing homeowners to adopt these practices. City utilities staff, educators and scientists teamed up with homeowners in this small-scale pilot project to determine the best ways to reduce stormwater runoff from the Lakeside neighborhood. Our team evaluated both biophysical (i.e., reductions in stormwater runoff and pollutants) and social (i.e., knowledge gained, practices accepted) outcomes.

Comparison of pre- and post-construction surveys showed approximately a 10% increase in respondent knowledge about stormwater, and strong evidence of adoption of stormwater practices as a result of project efforts to promote voluntary conservation practice adoption

THE LAKESIDE STORMWATER REDUCTION PROJECT (LSRP)

The overall goal of LSRP was to identify effective methods to reduce runoff to Amity Creek, which is similar to many sediment and turbidity impaired streams along Lake Superior's north shore (Figure 2).The LSRP project was designed as an adaptive research project on three adjoining streets in the Lakeside neighborhood, comparing a residential block, in which project personnel assisted homeowners with installation of stormwater runoff reduction treatments, to two "reference" blocks left "as is" (Figure 3). Stormwater runoff rapidly washes particulate materials into the stream and exacerbates instream channel and bank erosion. While stormwater runoff reduction was a primary project goal, we also evaluated the effect of education and awareness efforts on changing people's understanding and actions relating to water quality issues. A broader project objective was to assess whether helping homeowners install stormwater treatments is a workable runoff reduction strategy that could be applied throughout the Great Lakes Basin.

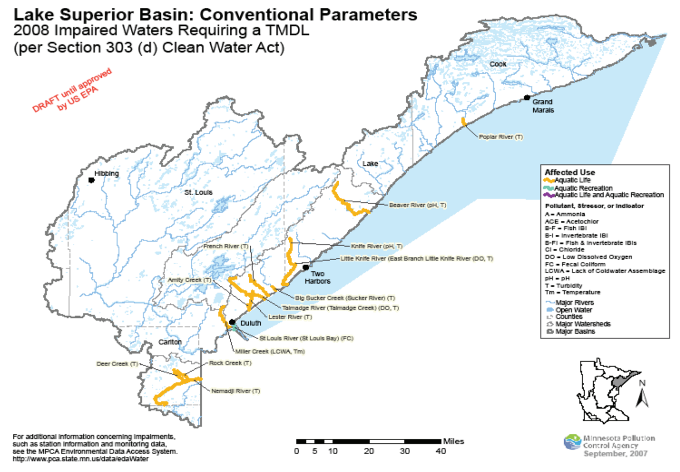

Figure 2. Impaired Streams on Minnesota's North Shore of Lake Superior.

A knowledge, attitudes, and practices (KAP) study was used to assess how the homeowner's views on stormwater management changed over the course of the project, with surveys administered both before and after construction activities. A KAP study is a targeted social survey that measures changes in human knowledge, attitudes, and practices in response to a specific project activity, usually education or outreach in a specific geographic area (Eckman *et al.* 2012). The Duluth KAP study was intended to document existing stormwater problems, assess residents' willingness to participate in the project, and identify possible barriers to adoption. Both pre- and post-construction surveys were conducted in-person, with trained surveyors going door-to-door the year prior to construction (April 2008), and the year following construction (October 2010). Repeated attempts were made over the course of a week during each survey period to contact all residents in the study area (83 households). Surveys were read to residents, and their responses were recorded by the surveyors. Following the pre-construction survey, a community workshop introduced the project, after which some homeowners recruited their neighbors. Outreach and education occurred throughout the project (2008-2010), and consisted primarily of one-on-one discussions with residents about stormwater during design and installation of runoff reduction treatments (Eckman *et al.*, 2011).

For the project's biophysical monitoring, project personnel installed automated monitoring equipment in storm pipes in early 2008 to get a year of pre-construction data on runoff volume, turbidity and water temperature (Kleist *et al.*, 2011a). Stormwater treatments were designed in 2008 following the community workshop, and were installed in 2009. Staff worked closely with homeowners to install stormwater treatments (e.g., rain gardens, tree and shrub plantings, rain barrels and other structures) to ensure that the homeowners understood how the treatments worked and knew how to maintain them. After runoff reduction treatment installations, stormwater runoff was monitored for another year (2010).

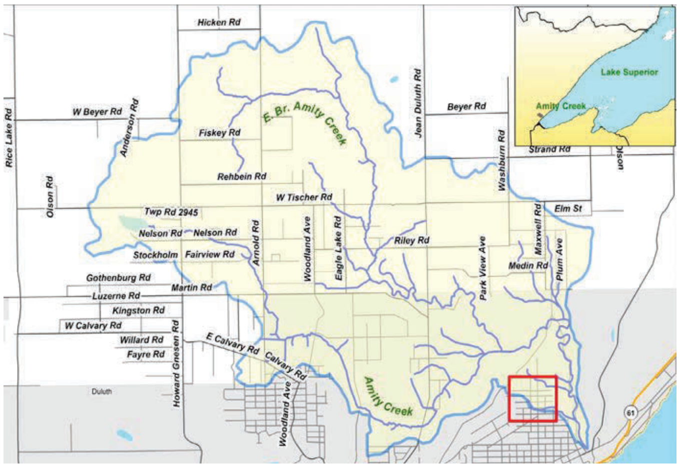

Figure 3. Amity Creek and the Lakeside Neighborhood.

RESULTS AND DISCUSSION

During the pre-construction survey, many homeowners told surveyors that they had experienced problems due to runoff, and told stories about flooded basements, collapsed retaining walls, and ice "glaciers" in driveways (Eckman *et al.*, 2011). Respondents were concerned about water quality. Three-quarters said they were willing to adopt practices to reduce runoff. This baseline survey identified gaps in respondents' knowledge about specific stormwater questions, which helped us to customize educational messages. Key barriers to adoption included perceived cost, lack of time, uncertainty, and lack of information (Eckman *et al.*, 2011). This helped us to refine our education and outreach strategy, as well as helping staff target appropriate runoff reduction strategies for each resident of the treatment street who was willing to participate.

Residents of the treatment street proved very willing to participate in the project, allowing project staff to install runoff reduction treatments on 22 of the 25 properties. Staff planted 250 trees and shrubs; installed 22 rain barrels; constructed 5 rain gardens, 12 rock_sump storage basins and two swales; and re-dug a stormwater ditch in which they installed 5 ditch checks (Kleist *et al.*, 2011b). Capacity of these installations is roughly 2800 gallons, which is approximately 2.5% of measured stormwater runoff. When planted trees and shrubs reach their full development, they should increase infiltration capacity by a factor of 20 according to very conservative estimates based on published values (Kleist *et al.*, 2011a).

Automated water quality monitoring data in storm pipes showed the greatest runoff reduction in the treatment street, although this was not significant because homeowners' treatments could not capture stormwater in streets or driveways (Brady *et al.*, 2010). There was about a 20% greater reduction in runoff for the treatment street after runoff reduction installations than for the control street for small to moderate storm events; while we would like to attribute this completely to our installations, we did not have enough pre-installation storm events to prove that other factors were not also at work (Kleist *et al.*, 2011a). Peak flows also appear to have been reduced for 1 inch and smaller rainstorms, but we were unable to accurately measure this reduction.

Most runoff was caused by roadbeds, thereby limiting the potential for residential treatments to reduce the total volume of water. We found that road resurfacing on a control street greatly increased runoff into storm sewers (Kleist *et al.*, 2011a).

Participation in the KAP surveys was strong, with 72% and 76% response rates, respectively, for pre- and post-construction surveys (Eckman *et al.*, 2011). We believe that our response rates were so high because we sent all residents a letter telling them to expect the survey crews, when they would be working, and how they would be dressed and could be identified. Survey crews were also persistent, returning repeatedly to residences over the course of a week.

Comparison of pre- and post-construction surveys showed approximately a 10% increase in respondent knowledge about stormwater, and strong evidence of adoption of stormwater practices as a result of project efforts (Eckman *et al.*, 2011). All residents who accepted runoff reduction installations said that they were still maintaining them a year later, although we did not attempt to independently verify these claims. Attitudes about responsibility for managing stormwater shifted from "the City's responsibility" in the pre-installation survey, to a shared sense of responsibility between the City and homeowner in the post-installation survey (Eckman *et al.*, 2011). This change in attitude differed depending on amount of contact with project staff, with residents of the treatment street showing twice the increase in willingness to share stormwater runoff responsibility (30% increase) relative to the control streets (15%).

The project succeeded as an educational and demonstration project, increasing residents' awareness about the impacts of stormwater on Amity Creek. It fostered adoption of stormwater management practices by homeowners, even in control streets. We noted that other homeowners requested stormwater treatments and that adoption occurred beyond the project area (Brady *et al.*, 2010). Residents who received treatments were generally satisfied with them and would recommend them to others. A side effect of the project was that staff were able to reduce or solve many of the water and stormwater problems that residents of the treatment street reported in the pre-installation survey. Staff willingness to assist residents in this way generated good will for the project by those with the worst water problems.

As a result of the KAP study, we now have a much better understanding of homeowners' needs, their understanding of water quality and stormwater issues, and their acceptance of stormwater treatments. Project results, including flow monitoring, are reported at www.lakesuperiorstreams.org. Based on this project's results, the Regional Stormwater Protection Team (RSPT) designed a stormwater KAP study that was administered by phone to over 1000 residents in the Duluth-Superior and outlying area. Combining data from all these surveys has helped RSPT determine which stormwater educational messages are no longer needed, and where knowledge gaps remain and should be the target of future education and outreach campaigns.

Since the project ended in 2010, treatments are being maintained by homeowners (Figure 4). They functioned well during the 2012 extreme rain event, but there was little to no actual flooding in this neighborhood because of topography and receiving somewhat less rainfall than locations further west in Duluth. In summary, while residents were willing to try to help with the stormwater runoff problem, our results re-emphasized the understanding that finding long-term solutions means rethinking the design of City streets, driveways, gutters and nonporous surfaces to maximize infiltration.

Figure 4. Rain Garden After One Year.

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REFERENCES

Brady, Valerie, Chris Kleist, Jesse Schomberg, Jerry Henneck, and Karlyn Eckman, 2010. Stormwater's Biotic Impacts and Human Solutions. Keynote address to the Minnesota Wastewater Operators Association, July 28, 2010, Grand Rapids, Minnesota.

Eckman, Karlyn, Valerie Brady, Jesse Schomberg, and Valerie Were, 2011. The Lakeside Stormwater Reduction Project (LSRP): Evaluating the Impacts of a Paired Watershed Study on Local Residents. Paper presented June 3, 2011, at IAGLR 2011 54th Annual Conference on Great Lakes Research, Duluth Minnesota.

Eckman, Karlyn, Lynne Kolze, Kimberly Nuckles, and Valerie Were, 2012. Meta-Analysis of the KAP Study Evaluation Method in Environmental Projects. Paper presented at the American Evaluation Association Annual Conference, October 25, 2012.

Kleist, Chris, Valerie Brady, and Jesse Schomberg, 2011a. Duluth Residential Stormwater Reduction Demonstration Project for Lake Superior Tributaries. A 319 Demonstration Project Final Report to the Minnesota Pollution Control Agency, Contract No. B10575. NRRI/TR-2011/36, July 30, 2011.

Kleist, Chris, Valerie Brady, Jesse Schomberg, and Karlyn Eckman, 2011b. The Lakeside Stormwater Reduction Project: Reducing Stormwater Runoff With Small BMPs. Presentation at the October 2011 Minnesota Water Resources Conference, October 2011.

FIND OUT MORE about stormwater issues in the western Lake Superior Basin at http://www.lakesuperiorstreams.org/weber/LSRP/.

AUTHOR LINK Karlyn Eckman, PhD
173 McNeal Hall, 1985 Buford Ave.
Univ. of Minnesota Water Resources Ctr.
St. Paul, MN 55118
(612) 625-7678 / Fax (612) 625-1263

E-MAIL eckma001@umn.edu
vwere@umn.edu
vbrady@d.umn.edu
jschombe@d.umn.edu
raxler@d.umn.edu
ckleist@duluthmn.gov

Karlyn Eckman has worked in water and food security programs in Asia, Africa, and North America since 1981 for the United Nations FAO and others. Karlyn received a PhD in Forestry and Watershed Management from the Univ. of Minnesota and holds Masters Degrees from the Univ. of Minnesota and Johns Hopkins Univ. Karlyn currently works at the Univ. of Minnesota Water Resources Center, focusing on evaluating the social impacts of environmental projects.

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