IMAGE: https://previews.123rf.com/images/stefanholm/stefanholm1509/stefanholm150900243/45712576-Rain-on-asphalt-or-tarmac-road-creating-ripples-high-contrast-during-autumn--Stock-Photo.jpg

BREE Stormwater Research Updates

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University of Vermont
June 6, 2017

The UNIVERSITY of VERMONT

VERMONT EPSCoR

BREE Basin Resilience to Extreme Events in the Lake Champlain Basin

OVERVIEW

1. BREE “Stormwater Sub-Group”
   - Ecological Systems & Social Systems Team Members
   - Vision & Direction
   - Data Collection Plan
2. Household ‘Green Stormwater Infrastructure’ (GSI) Survey
3. Municipal Stormwater Survey
4. Hydrologic Modeling Update

BREE STORMWATER SUB-GROUP

Ecological Systems & Social Systems Team Members

Hurley, Adair, Bomblies, Bowden, DeWoolkar, Koliba, Kujawa, Merrill, Rizzo, Wemple

Jory Hecht, Qing Ren

(and any others are welcome to join us!)

Past meetings:

1/10/17 at UVM

2/17/17 at City of South Burlington Public Works Office

3/27/17 at UVM

VISION & DIRECTION

Changing hydrological connectivity in the watershed (in urban stormwater or rural settings) may bring about nonlinear responses to climate extremes that can have pronounced ecological and biogeochemical consequences.

Improved "green" infrastructure can considerably reduce the connectivity of urban landscapes to the receiving water body during extreme events. Reduced connectivity decreases peak discharge from extreme rainfall events and intercepts pollutants that would otherwise have contributed to loading with traditional stormwater infrastructure.

ALL ABM will also be calibrated to take into account the adoption of BMPs to promote resilience in the following areas: green and traditional stormwater management, river corridor management, forest conservation and agricultural production.

Certain land uses (agricultural practices, stormwater drainage) will increase the connectivity of the ecological system's terrestrial-aquatic boundaries (flow from land to streams, rivers and receiving waters of the Lake) and reduce system resilience to extreme weather events (by bypassing, removing, or creating less effective riparian "filters").

Agents make decisions affecting land use in both urban (e.g. stormwater BMP adoption) and rural (e.g. agricultural BMP adoption and farming practice) settings.

Within the model, some areas are being drained by traditional stormwater infrastructure, and some areas contain green BMPs.

Watershed governance networks are responsible for regulating land use, constructing and maintaining stormwater and water treatment infrastructure, and incentivizing the behaviors of land users through subsidies, grants, technical assistance and public information.

We include aspects of the built environment in both the social and ecological systems research group work. Multiple forms of constructed drainage infrastructure (ditches, tile drains, stormwater) function to enhance connected pathways for the transport of water, sediment and nutrients to lakes during extreme events. Strategies for resilience could include design of green infrastructure to mitigate the impacts of extreme events along connected pathways.

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BREE Basin Resilience to Extreme Events in the Lake Champlain Basin

VISION & DIRECTION

The Stormwater Sub-Group aims to:

- Pursue rigorous research on the aspects of stormwater management and design most relevant to BREE, spanning ecological and social systems research, to best inform Integrated Assessment Modeling.

- Recognize the ongoing hydro-ecological, policy, governance, and economic dialogues concerning stormwater challenges and solutions in the Lake Champlain Basin and ensure that our modeling efforts reflect the existing context, yet also give momentum to novel and as-yet-unidentified scenarios that broaden the scope of solutions and optimize the LC basin's resilience to extreme events.

DATA COLLECTION PLAN

Engagement with Municipalities
→ South Burlington, St. Albans City, etc.

Collecting and organizing past studies for key watersheds, including those conducted by BREE investigators, State & municipalities, and other researchers

Identify data gaps and opportunities for building off current projects (ongoing research, upcoming construction)
→ work with incoming PhD student, and future summer interns (Summer 2018 and beyond) to gather data that will fill some of these gaps, including potential empirical data collection at key stream reaches, land uses, etc.

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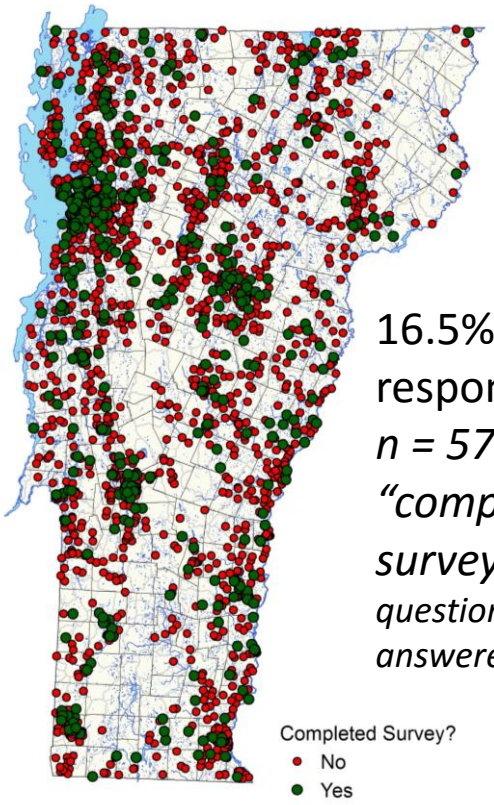
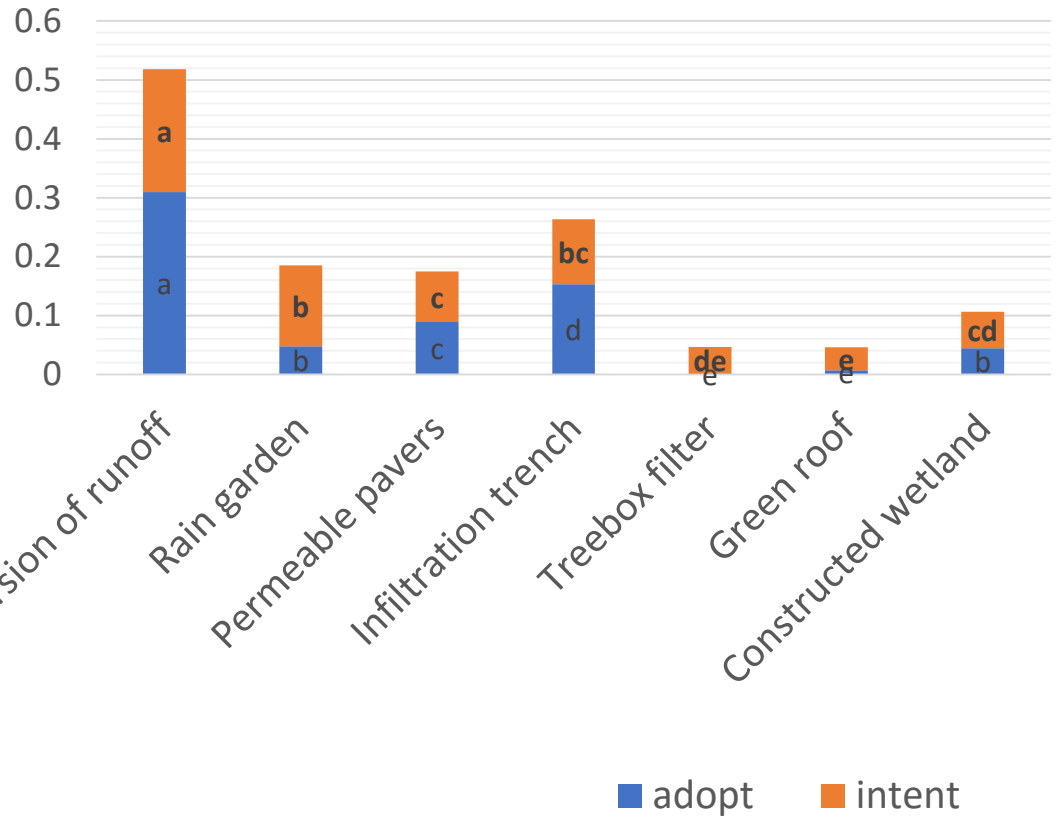
A survey of residential Green Stormwater Infrastructure across social and physical boundaries

Coleman *et al.* [in preparation]



16.5% response rate; *n = 577 "completed" surveys (not all questions answered)*

Average proportion of respondents with *adoption of GSI Practices* and *intent to adopt*



VERMONT EPSCoR

RACC Research on Adaptation to Climate Change

BREE Basin Resilience to Extreme Events in the Lake Champlain Basin

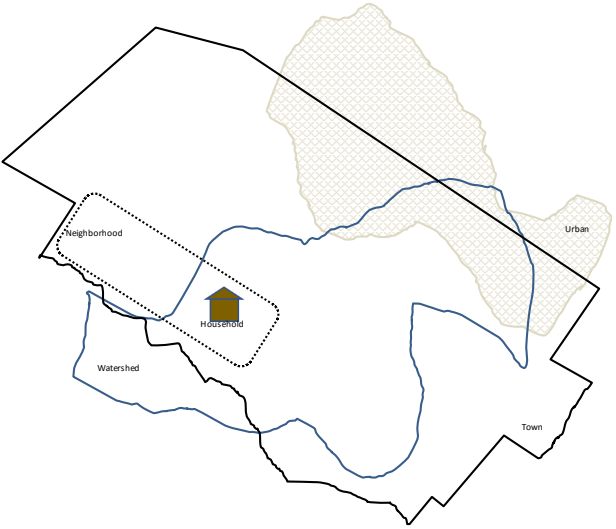
The University of Vermont

Castleton University

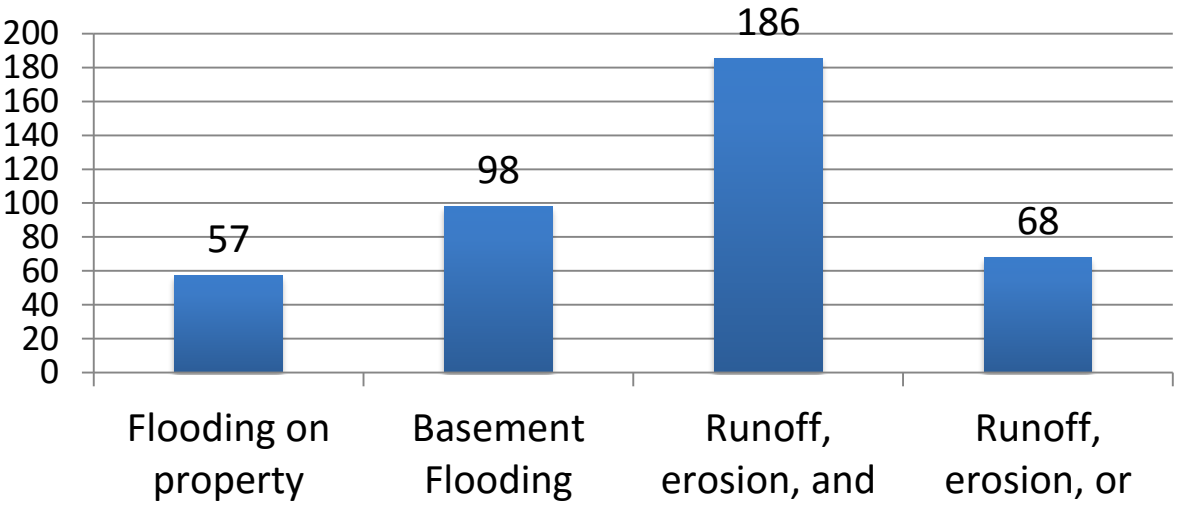
A survey of residential Green Stormwater Infrastructure across social and physical boundaries

Coleman *et al.* [in preparation]

Does adoption and intent to adopt GSI vary with external social and physical landscape conditions?



Runoff and Flooding Problems at Residence



Neighborhood:

26% perceive stormwater and/or flooding is a problem

VERMONT EPSCoR | RACC Research on Adaptation to Climate Change | BREE Basin Resilience to Extreme Events in the Lake Champlain Basin | The University of Vermont | Castleton University

Crowdsourcing Delphis: Designing solutions to complex environmental problems with broad stakeholder participation

S. Coleman, S. Hurley, C. Koliba & A. Zia

In Press *Global Environmental Change*

Highlights:

- An iterative approach to identify solutions to complex problems, such as water resources and climate change.
- Stakeholder-generated input facilitates science, policy, and practice.
- Outputs inform transdisciplinary science of integrated assessment models, land use change, and governance research.

Crowdsourcing Solutions to Climate Change

www.css2cc.org

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RACC Research on Adaptation to Climate Change

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MUNICIPAL STORMWATER SURVEY

Status: 'Going Live' this summer!

Target Audience: the survey will be disseminated via a set of list-serves that include municipal officials and decision makers about stormwater management throughout Vermont– survey population will range from mayors, to public works directors to planners, to road crew leaders

Includes Questions that Address:

- Awareness of current **stormwater regulations and regulatory status** of Town or City
- Leven of engagement with various **VT and regional agencies and programs, and other towns**
- Stormwater **decision making** entities protocols
- **Funding** mechanisms and sources
- Participation in existing **state-wide watershed planning endeavors** (e.g. Tactical Basin Planning, River Management, Road Erosion Inventories)
- Current presence of stormwater BMPs and GSI in jurisdiction
- Existing **capacity** (equipment, labor, finances) to maintain stormwater infrastructure, including conventional and green BMPs
- potential **barriers** to implementation of GSI for municipalities
- **Aesthetics** of green infrastructure designs in VT downtown settings
- and more…

Please choose the appropriate response for each item:

Visual Appeal

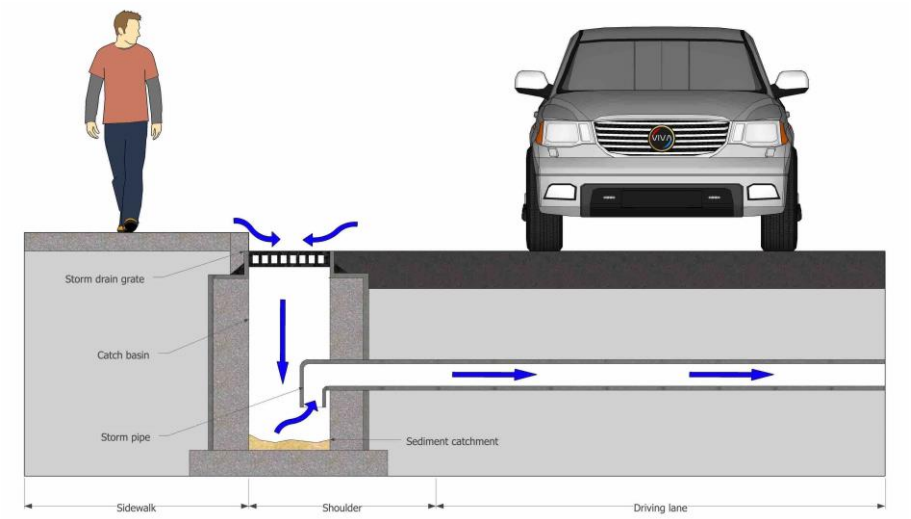
Visual Appeal

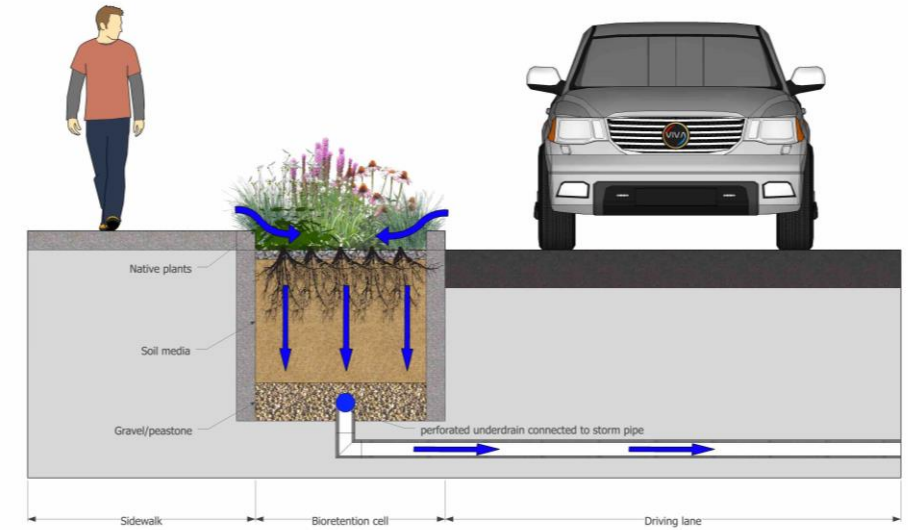
Ability to Maintain

Ability to Maintain

Rate image displayed	Very appealing	Appealing	Somewhat appealing	Neutral	Somewhat unappealing	Unappealing	Very Unappealing
	○	○	○	○	○	○	○

Very able to maintain	Able to maintain	Somewhat able to maintain	Neutral	Somewhat unable to maintain	Unable to maintain	Very unable to maintain
○	○	○	○	○	○	○





WHAT ARE LANDSCAPE VISUALIZATIONS?

A technique used in landscape design, planning, architecture, and similar professions **to help stakeholders imagine proposed changes** in the landscape.

Landscape visualizations complement other forms of communication and have been found to be accessible to audiences from an array of backgrounds, including laypersons.

(Lewis and Sheppard, 2006)

Lewis, J.L. and Sheppard, S.R.J. (2006). Culture and communication: Can landscape visualization improve forest management consultation with indigenous communities? Landscape and Urban Planning 77: 291–313

Green Infrastructure in the Public Right of Way

WHAT TYPES OF RESEARCH STUDIES USE LANDSCAPE VISUALIZATIONS?

- Participatory and cross-cultural research (Appleton & Lovett, 2003; Tress & Tress, 2003; Lewis & Sheppard, 2006; Ghadirian and Bishop, 2008; Griffoen et al., 2011)
- Climate change planning or impacts (Nicholson-Cole, 2005; Sheppard, 2005; Mansergh et al., 2008; Burch et al., 2010; Sheppard et al., 2011)
- Forest & landscape management (Falcao et al., 2006; Lewis & Sheppard, 2006; Paar, 2006; Ghadirian and Bishop, 2008)
- Environmental planning (Paar, 2006; Pettit et al., 2011)
- Park/trail use and impacts (Manning and Freimund, 2004; Manning et al., 2005)
- Alternative energy siting (wind, solar) (Lange et al., 2008)
- Flood risk (Burch et al., 2010)
- Agricultural practices (Appleton & Lovett, 2003; Tress & Tress, 2003)
- Aesthetic preferences (Lange et al., 2008)
- Urban design and planning
  - – density comparisons
  - – proposed building renovations or construction
  - – changes to the public realm/parks/streetscape

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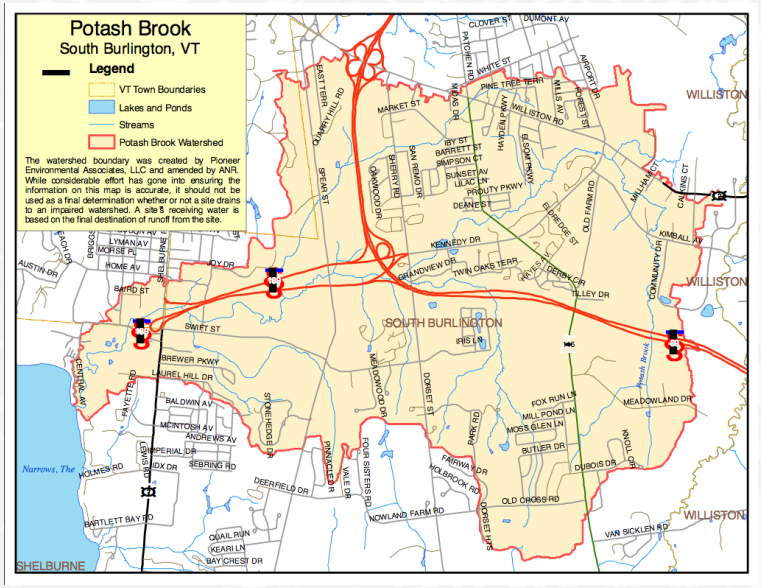
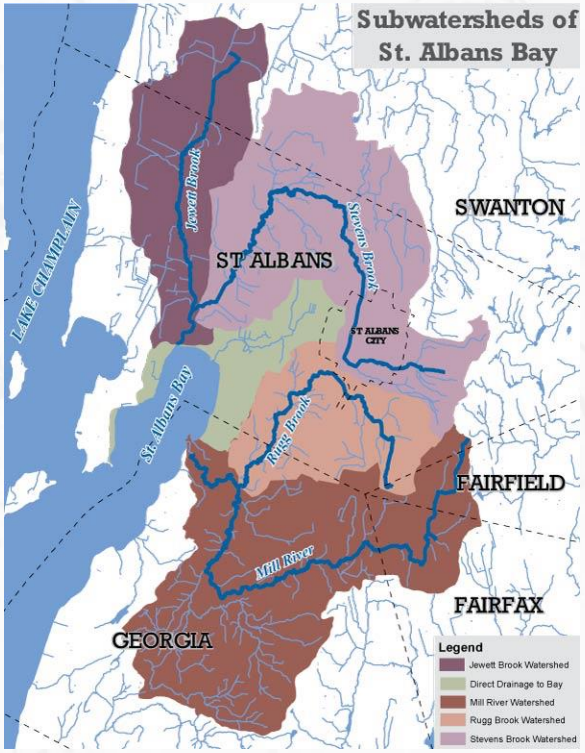
HYDROLOGIC MODELING UPDATE

Potash Brook Watershed



https://h20resources.files.wordpress.com/2014/04/potash.png

St. Albans Bay Watershed



http://www.saintalbanswatershed.org/StAlbans-Watershed-Map.jpg

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HYDROLOGIC MODELING UPDATE

– Best Management Practices (BMPs)

1. BMP selection -- and their modeled spatial distributions -- can reflect an array of planning scenarios that respond to different political, economic, land use, and biophysical (soil, slope, proximity to waterbody, geomorphology, etc.) contexts. New development and retrofits of existing development should both be accounted for.

2. Conventional BMPs and Green Stormwater Infrastructure can be modeled; BREE models should incorporate conventional and alternative stormwater infrastructure, reflecting (newly updated) 2017 Vermont Stormwater Management Manual, along with other BMPs supported by stakeholders, e.g. select "alternative BMPs" and non-structural BMPs.

3. Prioritization for modeling can be based on:
   - outputs of aforementioned municipal survey
   - technical ability to effectively model a given BMP using our chosen hydrologic models
   - exisiting literature, plus selective empirical data collection, potentially including longitudinal data from key watersheds.

HYDROLOGIC MODELING UPDATE → *Arne Bomblies*

Draft BMP priority lists for BREE stormwater modeling

List A – has been modeled in SWMM
Bioretention without underdrain, or raingarden
Bioretention with an underdrain connecting to storm sewer
Infiltration/storage trench
Infiltration/storage basin
Vegetated or Grass swale
Gravel-bed wetland
Wet detention/retention ponds
Pervious/porous pavement (asphalt, concrete, etc., designed for stormwater infiltration and storage)

List B – could be modeled in SWMM- less significant in the literature
Tree pit/cell/box – could be modeled similar to bioretention
Cistern (200+ gal.) – basically a giant bathtub to model
Green Roof – possibly modeled as very thin bioretention
Road drainage such as culverts and ditches
Road drainage with storm sewer/pipes

List C – lower priority for research
Dry well
Dry detention pond/basin (surface, non-infiltration)
Shallow surface wetland
Rain barrel (30-55 gal.)
Pervious/porous pavers (blocks, bricks, designed for stormwater infiltration and storage)
Gutter/downspout disconnection to vegetated area

Landscape Visualizations can be described as:

- Before & After
- Existing versus Proposed
- Alternative Futures/Options
- Trends