Sustainability Town Hall

Daniel Brown, Research Associate, GLISA
Greenhouse Gases

Carbon dioxide \((\text{CO}_2)\)

Methane \((\text{CH}_4)\) and Nitrous oxide \((\text{N}_2\text{O})\)

Fluorinated gases

Water Vapor
U.S. Greenhouse Gas Sources

- Electricity: 33%
- Transportation: 28%
- Industry: 20%
- Commercial and Residential: 11%
- Agriculture: 8%
The Greenhouse Effect: Step 1

Most solar radiation passes through the Earth’s atmosphere to the Earth’s surface.

Sunlight reflected to space has little affect on the Earth.

Some is reflected back into space by clouds or the Earth’s surface.
The Greenhouse Effect: Step 2

Solar Radiation is absorbed by the Earth’s surface and is re-emitted as infrared radiation.

Greenhouse gases absorb infrared radiation emitted from the surface.
The Greenhouse Effect: Step 3

Earth’s temperature is hospitable for human life because of the natural greenhouse effect.
Increased emissions of greenhouse gases have changed the Earth’s energy balance.

The Greenhouse Effect: Step 4

- Increased Greenhouse Gas Concentrations.
- More IR is re-emitted back to the surface.
- Less IR escapes to outer space.
Global Carbon Cycle

The natural cycle adds and removes CO$_2$ to keep a balance. Humans add extra CO2 without removing any.
A natural change of 100ppm normally occurs over 5,000 to 20,000 years.

The recent increase of 100ppm has taken 120 years.

Fact Source: EPA. Image Source, Scripps Institute of Oceanography
Migrating Climate

Hayhoe et al (2010)
The Great Lakes are Warming

- Lake Superior is warming twice as fast as nearby air.

- Winter ice cover is decreasing.

- Lake Superior could have little to no open-lake ice cover during a typical winter within the next 30 years.

Average Great Lakes ice coverage declined 71% percent from 1973 to 2010.

AMS, 2011

Austin and Colman, 2007
Agriculture Vulnerability: Spring 2012 and Cherry Crops

- The early warming was extreme weather event.

- The seasonal warming fits a pattern of a more variable climate.

- The early warming followed by a normal hard freeze was devastating to cherry buds.
More Hot Days

Source: UCS 2012
The Intensity of the heaviest 1% of precipitation events increased by 31% in the Midwest and by 67% in the Northeast from 1958 to 2007.
Observed increases in total precipitation and more frequent intense storms are already impacting the area.
Rising temperatures, degrading infrastructure, and more severe precipitation may conspire to increase risks to water quality.

The impacts could be felt in many sectors, including public health, recreation and tourism, and environmental management.
Impacts of Climate Change in the Great Lakes Region

Changes in temperature and precipitation throughout the region will lead to many impacts in both engineered and natural environments.

- Fish
- Water
- Energy
- Forests
- Agriculture
- Biodiversity
- Public Health
- Transportation
- Birds and Wildlife
- Tourism and Recreation
Climate Change Impacts and Adaptation on Campus
Climate Change Impacts on College Campuses

• University of Michigan Student Population: 43,426
• U-M Total Student, Staff, and Faculty Population: 68,565
• 18th largest city in Michigan!
Ann Arbor Climate Changes

- Warmer average temperatures
- Warmer low and nighttime temperatures
- More potential for extreme heat and drought
- Shorter winters
- More total precipitation
- More severe precipitation events
Agriculture and Food Networks

• Increasing extreme events may challenge regional food networks.

• Some crops may benefit in the near future from more CO\textsubscript{2} and longer growing seasons until negated by warmer temperatures.

• Perennial crops will be more vulnerable to the pace of climate change.
Heat and Health

The number of heat waves that pose risks to human health have increased in most major Midwestern cities.

Increasing overnight, minimum temperatures have increased at a faster rate, limiting relief during hot periods.
Potential Infrastructure Impacts

Freeze-thaw damage, near Marquette, MI

Expansion buckling near Marshall, MI, 2011

Flood Damage and Stormwater
Adapting Campuses to Climate Change Impacts

- Maintaining and increasing campus tree canopy
- Tree species diversification
Adapting Campuses to Climate Change Impacts

- Porous surfaces
  - Porous pathways
  - Porous pavers
- On-site stormwater management
  - Rain gardens
  - Bio-swales
  - Retention ponds
  - Below grade retention systems
Adapting Campuses to Climate Change Impacts

• Alternative energy to increase grid security
• Infrastructure and building upgrades
  – Improved HVAC systems
  – Green roofs
  – White roofs
  – Blue roofs
Adapting Campuses to Climate Change Impacts

• Local food movement integration
  – On-site farmers markets
  – Sourcing local products
  – Encouraging low-impact agricultural practices
What does U-M gain from adaptation?

• New education and research opportunities
• Greater interest from prospective students
• Increased support from funders and donors
• Improved employee recruitment and retention
• Enhanced community relations
• Reduced exposure to price volatility in energy markets
• Better preparation for carbon regulation
A Few Examples of University Michigan Adaptation Initiatives

- North Campus stormwater management
- Farmers Market on campus
- 7 green roofs
- U-M soccer complex porous pavement
- Planet Blue building efficiency upgrades (including HVAC upgrades)
- Geothermal at U-M golf practice facility
Best Practices from Peer Institution

Micro-grid expansion
• Howard University, Washington, DC
• University of California San Diego

HVAC Improvements and Energy Behavior Change
• Valencia College, Orlando, FL
Best Practices from Peer Institution

Expansion of Porous Pavement and Pavers Program
• Cornell University, Ithaca, NY

Diversification of Tree Species
• Georgia Tech, Atlanta, GA
Stormwater Management
Why here? Why now?

Brian Boyer, P.E.
Environmental Engineering Manager

Kieser & Associates, LLC
536 E. Michigan Ave., Suite 300
Kalamazoo, MI 49007
(269) 344-7117
Why here? Why now?

- Water quality protection
- Campus infrastructure/asset protection
- Capital improvement planning
- Future MS4 permit requirements
- Informed decision-making
WMU Stormwater Management

- Reduce stormwater flooding
- Protect investments
- Regulatory compliance (TMDL)
- Sustainable improvements
- Stormwater Neutral™

Waldo Football Stadium

Power Plant Streambanks

Steam lines from Power Plant
WMU Management Prioritization

Cost-Effectiveness Urban Retrofit BMPs
TP Load Reduction Analysis ($/lb) (20-yr life cycle costs)

- **Existing BMPs TP ($/lb)**
- **Proposed BMPs TP ($/lb)**

- **PROPOSED GRANT PROJECT**
  - **$388/lb**

- **Increased Weir Height**
  - **$96/lb**

- **Infiltration**
  - **$1,879/lb**

- **Rain Garden**
  - **$63,580/lb**

Other local urban stormwater BMP retrofits implemented/proposed in the Portage-Arcadia Creek Watershed since 1998.
Progress Towards Management Goals

TMDL Compliance

Stormwater Neutral™

Runoff Volume

GOAL ACHIEVED!

52 %

TMDL REDUCTION GOAL

100% GOAL!

92 %

Off-Campus Offsets
(Net-zero Phosphorus discharge)

51 %
KVCC Stormwater Management

- Eliminate all outfalls (…and MS4 permit)
- Stormwater Neutral™ goal
- Sustainable SW management
  - MDEQ 319 Grant Project (25% match)
    - Serves 31 acres of campus
    - Treats of 50-yr storm
    - Irrigation for athletic fields
    - Built-in educational curriculum
Stormwater Management

- 5th largest city in Bay Area
- Pending Phosphorus/Nitrogen TMDL (WQ goal)
- Quantify current loads
- ID reduction options
- Prioritize (cost-effectiveness)
- Seek water quality offsets

Average Treatment Costs for Urban Stormwater

<table>
<thead>
<tr>
<th></th>
<th>TN ($/lb)</th>
<th>TP ($/lb)</th>
<th>TSS ($/ton)</th>
<th>Volume ($/ft³)</th>
<th>Area Served ($/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TN</td>
<td>380</td>
<td>2,000</td>
<td>11,825</td>
<td>0.08</td>
<td>2,730</td>
</tr>
<tr>
<td>TP</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TN + TP (Combined) ($/lb)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>245</td>
</tr>
</tbody>
</table>
Stormwater Management Strategy

1. Identify stormwater footprint
2. Quantify existing stormwater loads
3. Set goals
4. Quantify existing stormwater controls
5. Assess current status
6. Prioritize (cost-effectiveness/environmental metrics)
7. Implement (capital improvements/grants)
8. Track progress!