Duluth Flood of June 2012: Stream Visual Assessments

Karen Gran, Molly Wick
University of Minnesota Duluth
Department of Geological Sciences

On behalf of the many volunteers who walked the streams of Duluth in the aftermath of the flood
Igneous Rocks

Sandstone

Siltstone, shale

MESOPROTEROZOIC ROCKS
KEWEENAWAN SUPERGROUP
NORTH SHORE VOLCANIC GROUP
Upper southwest sequence:
- Lakewood basalts
Lower southwest sequence:
- Ely's Peak basalts
Miscellaneous rock types:
- Undifferentiated volcanic rocks
- Rhyolite

MIDCONTINENT RIFT INTRUSIVE SUPERSUITE
DULUTH COMPLEX
- Inclusion of magnetic rock
- Layered series
- Trachytic and gabbro
- Arsenicitic series
- Plagioclase-rich gabbroic cumulates
- Felsic series
- Undifferentiated intermediate rocks

MISCELLANEOUS INTRUSIONS
- Mafic intrusion
- Gabbro intrusion
- Norland sill - gabbro
- Gabbro dike

SEDIMENTARY ROCKS
- Fond du Lac Formation:
  sandstone and shale

PALEOPROTEROZOIC ROCKS
ANIMIKIE GROUP
- Virginia Formation:
  - Siltstone, shale, mudstone
  and greywacke

OTHER
- Bedrock not mapped

Site:
- Intensive survey
- Rapid assessment

Fitzpatrick et al. 2006
Miller et al., 2002
Series of different lake levels as different outlets were uncovered by retreating ice.
A useful way to classify and think about streams in the Duluth area...

Montgomery and Buffington, 1997
Sensitivity to change

Stream Power

Lester River, Fitzpatrick et al. 2006
Changes in valley types (and thus channel-valley interactions)
Impacts Observed

- Infrastructure Damage
- Loss of Riparian Corridor
- Bank/Bluff Erosion, Landslides
- Large-scale Deposition
- Debris Jams
- Stream Morphology Changes

But! Not every reach of every stream experienced damages!
The Dataset

• Volunteer-collected data from over 41 streams
Damage to Infrastructure

- Blocked/Undermined Culverts
- Roads, Bridges, Trails
- Trash in Streams

Upper Chester Creek: Triggs Ave.

Lower Chester Creek
Culvert Damage – Knowlton Creek

- Culvert Replacement underway (St. Louis River Area of Concern project)
- Source of sediment aggradation downstream
Culvert Damage – Coffee Creek

Damage to culvert
Flow over culvert along foundation of home
Bridge Damage

Merritt Creek

Lincoln Park, Miller Creek

Lester River- walking bridge blown out
Road Damage

Coffee Creek - 10th Street

Kingsbury Creek – Hwy 2

Miller Creek – Lincoln Park Drive
Lower Chester Creek
Case Study: Infrastructure Damage
Chester Culvert under the Armory
Lower Chester Creek: Case study for infrastructure damage

- Road & parking lot damage
- Dam breach
- Aggradation in pond

2 Trail bridges out
Chester Creek
St. Scholastica Culvert & Parking Lot
Loss of Canopy & Riparian Vegetation

- Filter pollutants from surface runoff
- Moderate stream temps (shade)
- Stabilize banks
- Provide or enhance habitat

- Associated with bank erosion & deposition of sediment
- Recovery

Sargent Creek
Merritt Creek
Mission Creek
Sargent Creek
East Amity Creek
Clay Slumps & Bluff Erosion

Sargent Creek

Lester River
Clay Slumps & Bluff Erosion

Slumps take out trail/roads

Miller Creek
Even protected bluffs failed

Lower Chester Creek
Merritt Creek
Bank Erosion

Gogebic Creek

Sargent Creek

Chester Creek – soccer fields

Brewery Creek

Chester Creek
Amity & Lester –
Case Studies for Bank & Bluff Erosion
Amity & Lester Bank Erosion
Slumps & Bluff Erosion
Quantifying Bluff Erosion

• Terrestrial Laser Scanner
• Calculate volume of erosion/deposition on 9 bluffs
• Preliminary Results

Data courtesy of Grant Neitzel, M.S. Candidate, UMD Geological Sciences
Total Net Volume Change: \(-15 \, \text{m}^3\)

May 2, 2012 – June 27, 2012
Net Volume Change: \(-11 \, \text{m}^3\)

Nov 9, 2011 – May 2, 2012
Net Volume Change: \(-4 \, \text{m}^3\)

Data courtesy of Grant Neitzel, M.S. Candidate, UMD Geological Sciences
Amity Restoration Site:
Before & After the Flood

*Photos courtesy of Elaine Ruzycki, NRRI*

- St. Louis County Soil & Water Conservation District Project
- Bluff re-graded & revegetated - Nov. 2009

4/11/2012 – After Snowmelt
6/21/2012 – After Flood

4/11/2012 – After Snowmelt

5/31/2012 – After May Storm

6/21/2012 – After Flood

7/19/2012 – Post-Flood

Photos courtesy of Elaine Ruzycki, NRRI
Deposition

- Aggradation
- Pool-filling, loss of habitat
- Large rock moved in
- Buildup of debris
Cobble Deposition
In channel & on floodplain

Sargent Creek
Coffee Creek
Knowlton Creek

Knowlton Creek

Sargent Creek
Debris!

Amity Creek

Sargent Creek

Miller Creek

Knowlton Creek

Chester Creek - Niagara St. culvert
Changes in Stream Morphology: Head Cuts and Avulsions

Mission Creek - Incised tributary

Steep cut in channel due to incision propagating upstream

Abandonment of current channel and formation of new channel

East Amity looking downstream, avulsion along trail

Sargent Creek
Upper Chester

Multiple thread channel formed & obstructed.
Case Study – Mission Creek

For the size of the watershed, one of the most impacted

Blue Line = post-flood channel

Debris Guard

Blowout area

Map & photos courtesy of Karl Koller, DNR
Channel Avulsion:

Channel blocked by debris jam & diverted into road

Looking upstream

Old channel

New channel

Old channel

New channel along road
Mission Creek

Experienced 2 major flooding events prior to 2012
Hwy 23 culvert can’t handle debris → installed debris guard

- Debris catching structure - clogged up
- Caused channel to flow around it, widened the channel

- Bridge on Hwy 23 filled with debris
  - Backed up water
Mission Creek

- Debris structure diverted water out of channel, blew out the road
- Deposited cobble/gravel (~200 feet wide)
- Widened valley: 100 – 300 feet wide
Little or No Negative Impacts

- Bedrock & cascade reaches
- Wetland reaches
- Forested/healthy riparian Corridors
- Decreasing damage going upstream

Keene Creek
Forested Areas & Healthy Riparian Corridors

Kingsbury Creek - upstream of Hwy 2

East Amity - just downstream of Jean Duluth
Bedrock Reaches

- Often found in downstream reaches
- Low erodibility
Wetland Reaches

- Upper reaches – low slopes
- Attenuates flow downstream

Upper Chester, at Rice Lake Road

West Amity, just upstream from Woodland
Case Study for Minimal Flood Impacts: Upper Coffee Creek
Major Impacts

• Infrastructure Damage
• Loss of Riparian Corridor
• Bank/Bluff Erosion, Landslides
  • Large-scale Deposition
  • Debris Jams
• Stream Morphology Changes
Thank You

to all the volunteers who walked streams and helped put together this summary!