Lake Superior North Watershed – Implementation
CEHM Task Force Meeting – Phase 1
9:00 AM – 12:00 P.M. March 13th, 2019
UMD Civil Engineering Conference Center 221b

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One Watershed
One Plan

Present: Stacey Stark, Geospatial Analysis Center, John Swenson – Earth and Environmental Services UMD, Charlie Moore - ARDC, Steve Graham – Geospatial Analysis Center Research Associate, Sonja Smerud – Lake SWCD/LSN1W1P, Brandon Krumweide – NOAA Coastal Management Great Lakes Geospatial Coordinator, Clint Little – MNDNR Lake Superior Coastal Program, Ilena Hansel – Cook SWCD/LSN1W1P

Project overview / status - Sonja/ Charlie 10min

Research of relevance - John Swenson 20-30 min

- Geologist/Geophysics background – longer-term modeling of how landforms change
- Shoreline erosion in the western arm of Lake Superior – family in 1967 (NE 52nd Ave E), retreat rate is a little under 10cm per year
- More bedrock variability in Duluth region – focus of work
    - Lake is rising at fastest rate nearer to Duluth
    - Type of bedrock/material is important in controlling the retreat rate
    - Concepts applicable along the whole shore
- Process has likely been occurring for 1200 years (lake level is rising relative to land, providing underlying fuel for bluff retreat)
- See photo: Underlying bedrock separated by glacial till overtop; thin veneer of active beach cobbles (sitting on bedrock); diabase dike (intrusive rock is more resistant to weathering) "headland"; most of retreat driven by weathering more than wave retreat – *"bedrock weathering is rate-limiting process"* – weathers most profoundly in the freeze/thaw of spring; weathering builds a till slope which will later fail during a rain event – long-term rise in lake level drives a transgression (the shoreline is moving land)
- Why is lake level rising in Lake Superior? Gravitational equilibrium (post-glacial isostatic rebound) – 1cm/year (geologically speaking is SUPER fast)
- Lake Superior: SW rebounding, N rebounding fast than the S (Duluth has a rise and far eastern part of lake is experiencing a lake level fall) – Duluth coastline is drowning
- Manville & Craymer (2005) rates of relative lake level rise
- Lambert & Swenson (2016) – multiple-century scale erosion rates; this sets the context for what we're doing (useful for zoning – could define setbacks based on 10cm per year)
- Photo: transgressive surface (wave "buzz saw" creates a scour path – mobilizing weathered bedrock)
- 2010 LiDAR draped on top of bedrock geology, with green zone buffer. Measured off-shore slope in near-shore region and "backed out" the bluff retreat rate.
    - Restricted echogram retreat rate to ground-truth the LIDAR rate (echogram study of the shore would be beneficial) – understand long-term rates by looking off-shore

        - Nigel twin-hulled z-boat with a side-scan sonar device and run it along the coastline; NOAA has automized a fleet of them
        - Back-scanner data from kingfisher boat
        - Could be a way to estimate slope cheaply for this project; could overlap with javal-text (topobathyic data collection)
    - 5cm/year bedrock-cored north shore bluffs retreat with considerable variability due to lithology (PARTICULARLY any felsic volcanic units, more common near Duluth = RHYOLITE)
    - Most pronounced coves are situated in the rhyolite areas, basalt areas retreat at a lower rate; anywhere with intrusive rocks or sills (i.e. Endion sill) erode even slower; sedimentary areas do erode slowly as well. More intrusive rock areas in the North would be less likely to weather, yet haven't been tested to same degree.
    - South Shore: same idea as North Shore just greater; glacial till; retreat rates are about an order of magnitude higher (roughly the same as calculated aerial photo bluff retreat rates). Retreat rate not as stochastic as other mass-moving processes like landsliding (rate of retreat is limited more by weathering)
- Not all erosion is limited by lake rise, but it is the background for all erosion along Lake Superior. Long-term rates on North Shore +/-5cm
    - Better mapping
    - Better ID till thickness data
    - Better ID of bedrock data (sporadic but thorough but not continuous along the shore)
        - John Green (need to digitize/vectorize his maps)
    - Visually analyzing the coastline is very useful
    - Policy implementation could be based on detailed analysis of the coastline (including local analysis of the geology)
    - Time scale: couple of months of work, not overly complicated; 10m water depth (wouldn't have to be super expensive process)
- Where is the sediment going? Don't know this with data - Conceptually, bluffs weather and the weathered material forms cobbles; cobbles get in littoral system and get further mechanically weathered – tend to go from pebble to mud, cobbles just don't make sand; the sand that "survives" ends up trapped upstream of the Duluth Canal, starving Park Point, and the clay/mud gets deposited off-shore
    - Transgressive surface consistent along the shore – wiped clean of sediment
- Putting research/"geological scale" in terms of a 30-year mortgage
    - Long-term rates tend to hold true with the short-term (decadal) rates
    - "avg chunk of this coastline is going to retreat this much" is hard to say but it is doable
    - 7% of your current parcel will be eroded
    - Using standoff events with before/after pictures (landowner site visits) can correlate with some of the larger-scale data
    - Long-term data frames the problem, additional data
        - Frequency magnitude distribution of actual slumps, particularly in areas that have the biggest glacial tills > probability of a big event
        - Zoning: average rate, worst case, best case scenario
        - Javal text 2019 summer vertical surfaces data collection (500m on land coastal "bluff front" and 1000m off-shore with dual-band topo-bathy LIDAR system) to support NOAA coastal management program (focused on sediment movement in the littoral area)
- Carol Johnston 1ft/year NSMB recession rate
- 2007 cost-share project 52nd street near John Swenson – regraded till and was planted; became headward eroded and within a few years it weathered away
- Don't mitigate these issues, you zone around them
- Great Lakes Coastal Resiliency Project (USACE) – moving two things forward: 1) sediment analysis budget, 2) NOAA hardened shoreline classification 1:2000 scale
    - USACE – assessing structures
    - Repeat every 5 years

    - Manmade structure relationship with natural shoreline
    - Sound data to make policy decisions upon
- Erosion rates: so hard to determine, need long-term observations
- If you hard-armor (i.e. around the lakewalk), the energy will be diverted to other softer parts of the shoreline… energy has to be diverted/absorbed somewhere else; or reduce wave energy from the bottom (rough the bedform, so the transgressive surface isn't so smooth, and the rough bottom can absorb some of the energy) – 1/2m high cribs dissipates wave energy off-shore rather than refracting it to my neighbors

Resources/research of relevance - Brandon Krumwiede 20-30 min

- US Interagency Elevation Inventory
    - Can get a lot of information on the data set via https://coast.noaa.gov/inventory/
    - Explains point level – shouldn't interpolate the data as it creates a lot of variability
    - https://coast.noaa.gov/llv Lake Level Viewer (similar to sea level rise viewer)
        - Inundated up to and exceeding the high water level mark and interpolating
        - Topography
        - No sediment transport, just based on passive inundation – BATHTUB model (not taking into seiche effects)
        - Shows change in geomorphic processes, and can have a biological connection (i.e. piping plover and Asian botulism)
        - DEMS available for download (Lake and Cook all available at 3m for entire length of LSN coast)
        - Green band of LIDAR
        - 68ft for bathymetry
        - Now Version 2 is on the server (better bathy)
        - NPS Sleeping Bear Dunes multi-beam data informs the bathy as well (up to 165ft out)
        - In addition to LIDAR, also collecting hyperspectral imagery (see Illinois Coastal Management Program) > GLRI project on how coastal erosion is impacting nearshore habitats
        - Summer 2019: Isle Royale and Apostle Islands multi-beam data getting public and filling gaps; hydrodynamic modeling; habitat for cisco
        - Layout for the code of the viewer is all available (and as a web-viewer link)
        - Rethink where this data is hosted – host on lake viewer NOAA?
        - "Superior 6" is the Lake/Cook dataset – "Superior 5" includes Duluth and the south shore
- Imagery: NGIS Oblique Imagery 2016 Collection – NOAA Coastal Imagery Viewer
    - PlanetLabs 5X5 (3m resolution imagery flown every day) – request for RND proposals – wetland viewing or turbidity
    - Coastal Oblique flights occur every five years since 2002 - Next Coastal Program Oblique is 2022 (last was 2017)
    - NOAA Digital Coast > Data Access Viewer > imagery (also land cover data)
- Great Lakes Coastal Flood Study data sets (www.greatlakescoast.org > Technical Resources > USACE Oblique Imagery 2012 > LIDAR NOAA > 2012 classification of the shoreline (also tabular for attribute fields)
    - ASFCM (Association of State Flood Plan Managers) is hosting data now but it may be pulled as FEMA has to host it
- Don't need bedrock to calculate the retreat rate, but lake level rise and slope (could do with transects)
- 1.19m change in water levels
- NOAA digital coast as a clearing house for other coastal data, or a voice to get people directed to the appropriate sources (i.e. Poplar WRAPS, St. Louis River Fond Du Lac Reservation Ecological Assessment, Wild Rice Survey; 2018 NOAA story highlight of Two Harbors Stormwater Management) – https://coast.noaa.gov/digitalcoast/stories/ and Coastal Zone Mangement

Program https://coast.noaa.gov/czm/mystate - https://coast.noaa.gov/states/stories/flood-control-investment/ City of Two harbors; can also search coastal erosion on stories to look at how other countries have done coastal erosion hazards
- Coastline miles: 189 miles (1975 NOAA pamphlet 1:60,000 – 1:120,000).
- Can get a lot of information on the data set via https://coast.noaa.gov/inventory/

To include moving forward for Phase 2: (15min)

- Data
    - Bedrock testing and better bedrock base
    - Aggregate natural shoreline rather than parcel data – don't do what FEMA did (model transects) – using geopolitical boundary breaks instead of using natural system boundary breaks
    - State statutes for setbacks
    - Include: NRRI (Carol Johnston; periphyton project Elaine Rezincki), MNSeaGrant, South St. Louis – 1W1P and elected officials advocacy
- November 2020 Phase 2 complete – yes is feasible in this timeline
- Historical Aerial Photos to Georeference – stretching window of observations out
    - Todd Lindall (historic paper maps)
    - Excavation of beaches (i.e. Thompson Bay) for railroad grade
    - USGS has digitized their old maps
    - City of Duluth original platting – bluff delineated in the original surveys
    - Government Land Office – when was first platting? (century scale bluff-line)
- Water level at that time frame (bluff may not have moved but the water has)
- Tracing events: degenerative frequency magnitude based on landowner data (derive products from the data but not sharing)
- Oblique imagery – identify fresh slump or scar w/undergraduate or intern help
    - Magnitude of the event scales with the slump (natural breaks that make sense)
    - Google earth pro timeslider (sites needed to check out)
- Aggregate the data so there isn't a privacy concern
- Ground truthing: bare minimum GPS location and geo-tagged photo; something for scale; specific notes of a given location; clinometer would be extra helpful

Next meeting: look at some of the pilot areas, get data in one spot ("proof a concept")
Adjourn 12:12pm