Erosion Rate vs. Susceptibility: Shoreline Positions, USGS DSAS, and Hazard Classification

Melanie Perello | NOAA Coastal Management Fellow

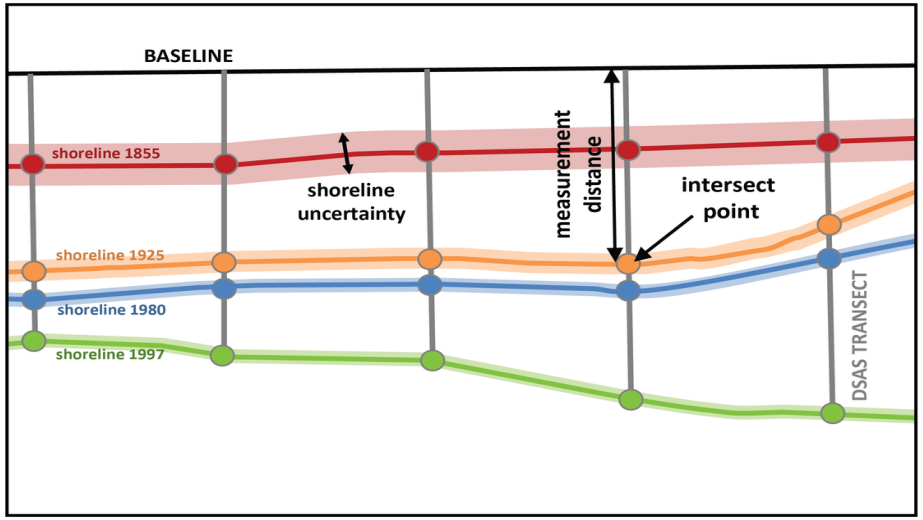
DEPARTMENT OF NATURAL RESOURCES

Erosion Rate vs. Susceptibility

- Erosion (Recession) Rate: average landward movement of the shoreline over time
  - Measured in distance over time (ft/yr)
- Erosion Susceptibility: vulnerability of a shoreline area to erosion.
  - Erosion rate, geology, land use, water levels, wave energy
- Erosion Hazard: Official classification based on erosion rate, susceptibility, and/or risk to property (structures/infrastructure).
  - Typically defined by state agencies or LGUs

USGS Digital Shoreline Analysis System (DSAS)

- DSAS 5.0 is a ESRI add-on produced by the USGS and is publically available
  - Developed in 1990s for assessing national shoreline change
- DSAS does two things:
  - Generates perpendicular transect lines between a baseline and shoreline segment(s)
  - Measures distance along transect and generates metrics based on time and uncertainty



Historical Shoreline Positions

- Refer to the same features for accurate analysis
  - Vegetation, ordinary high-water, low-water or wet/dry lines
  - If different features used, must estimate correlate between them
- Shorelines can be from different sources (photos, LIDAR, charts, maps)
- Baseline: NOAA & USACE Hardened Shorelines dataset (2014)

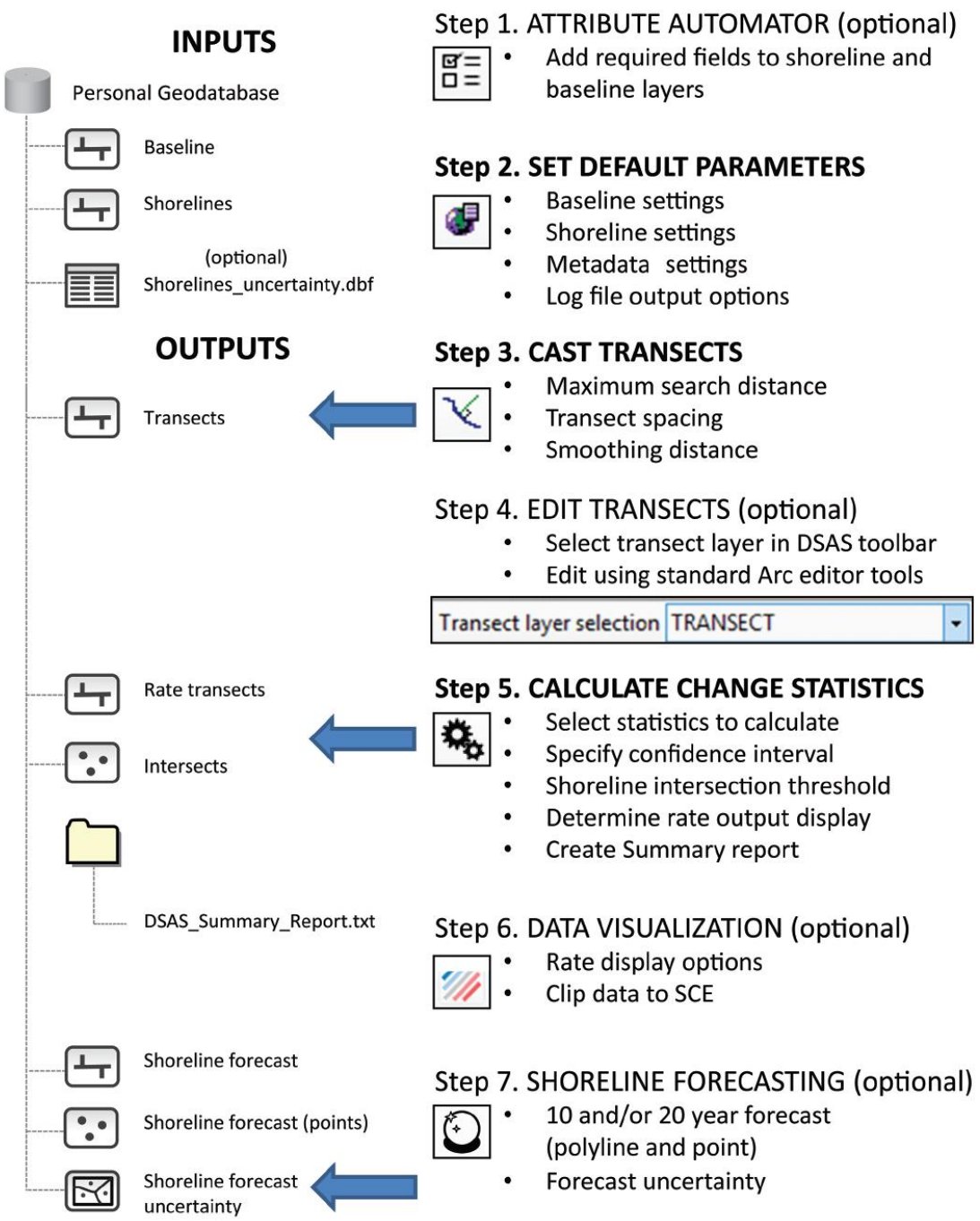
Recognize Error Exists

$$\sqrt{U_g{}^2 + U_d{}^2 + U_t{}^2 + Ua^2 + UDR_G{}^2 + ULIDA_R{}^2 + Up_d{}^2}$$

Error Calculator Table

Measurement Error/Uncertainty (meters)	Aerial Imagery (1930 - 1960)	Aerial Imagery (1960 - 1990)	Aerial Imagery (1990 - 2020)	Ortho-Quad Digital Raster Graphics (DRGs) (1940s - 1990s)	Harbor Chart/T-Sheet (1800s - 1950s)	Harbor Chart/T-Sheet (1980s - present)	LIDAR Breakline	Paper Map (1800s - 1940s)	Paper Map (1940s - present)
Georeferencing (U_g)	4			4	4	4		4	4
Digitizing (U_d)	1	1	1	1	1	1		1	1
T-Sheet Survey (U_t)					10	3		10	3
Digital Raster Graphics (U_{DRG})				15					
Aerial Photography (U_a)	10	1.5	3						
LIDAR Total Positional Uncertainty (U_{pi})							4		
Interpretation of Shoreline (U_{pd})	0.27	0.27	0.27	0.27	0.27	0.27		0.27	0.27
TOTAL ERROR/UNCERTAINTY (meters) =	**10.8200**	**1.8229**	**3.1738**	**15.5587**	**10.8200**	**5.1062**	**4.0000**	**10.8200**	**5.1062**

Using DSAS



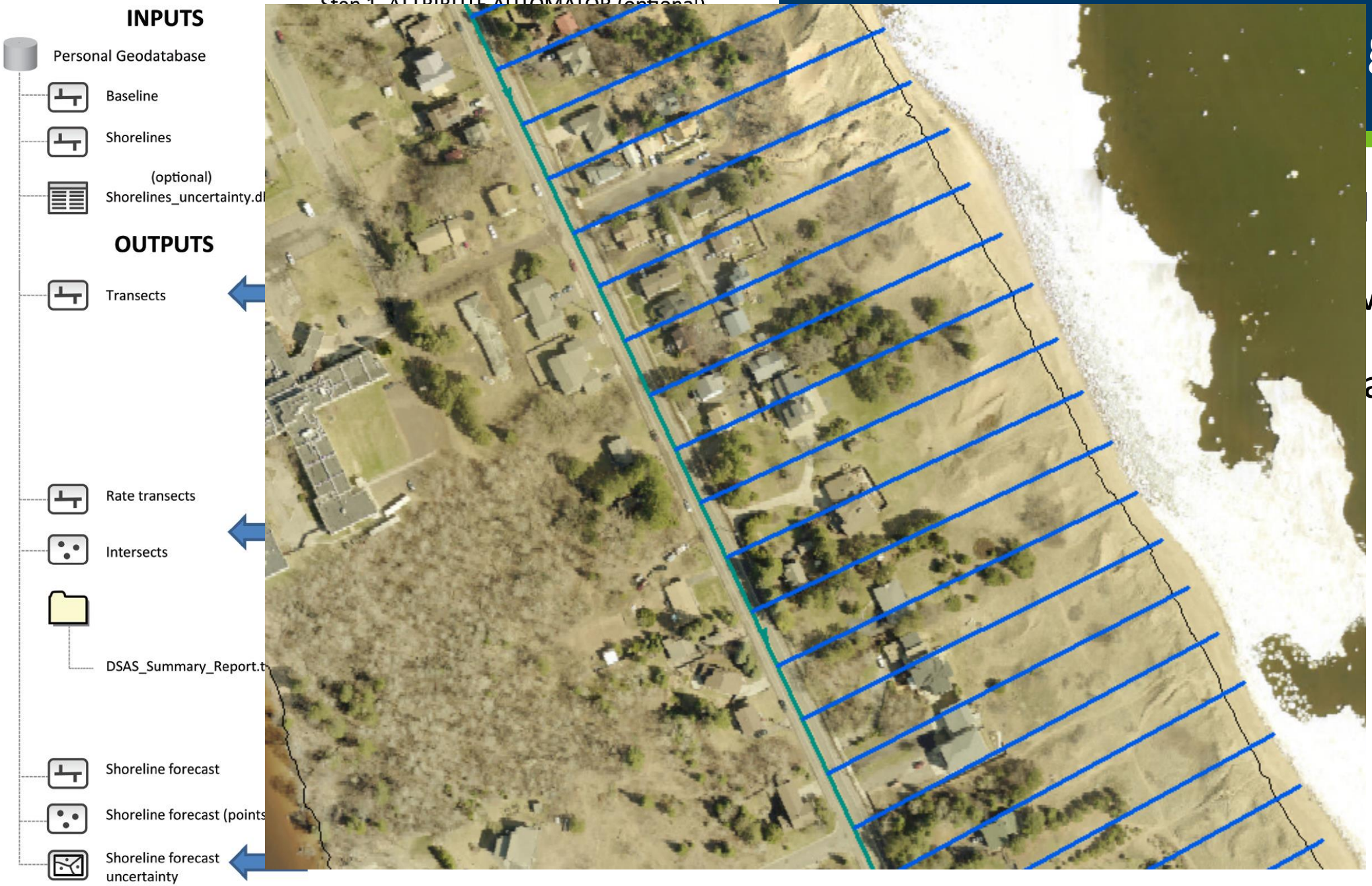
- Input historical shorelines and baseline
- Define how transects are drawn
- Determine what statistics to calculate

g DSAS

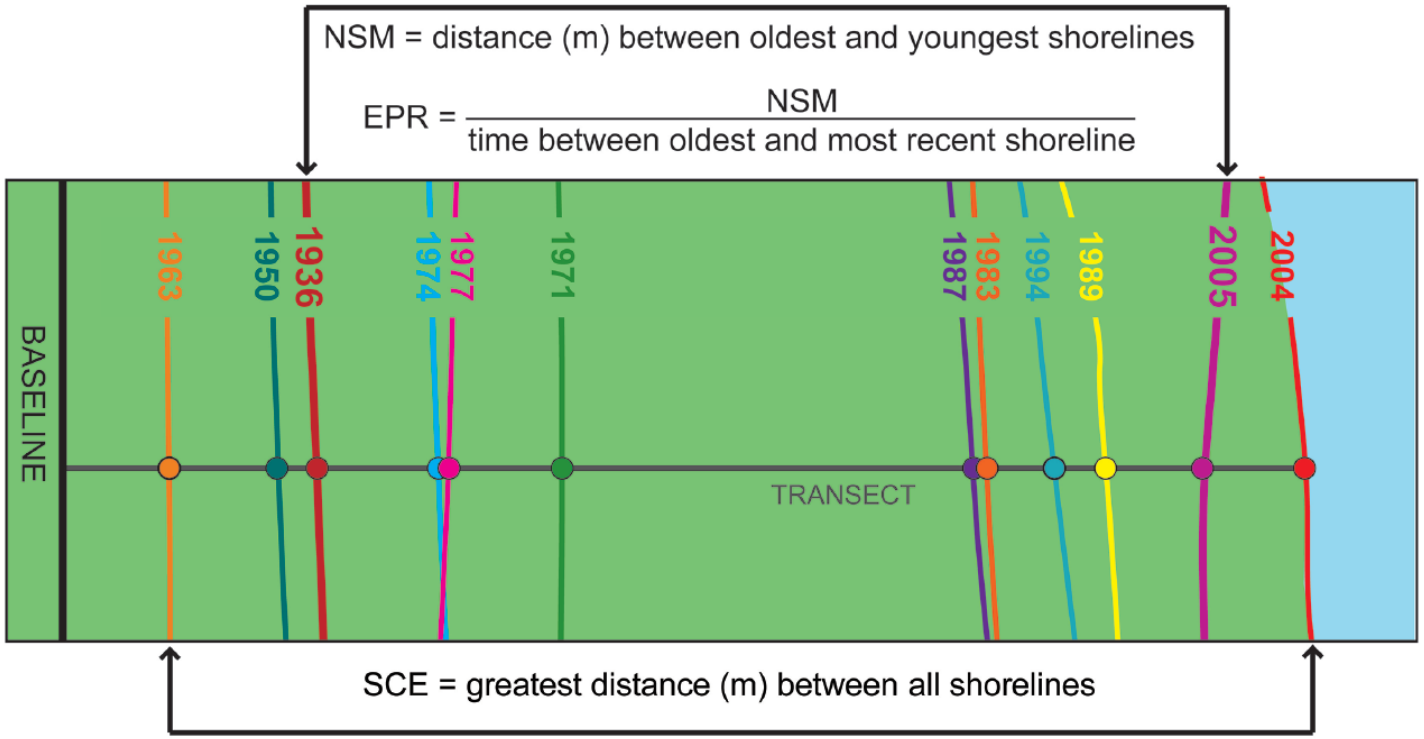
baseline

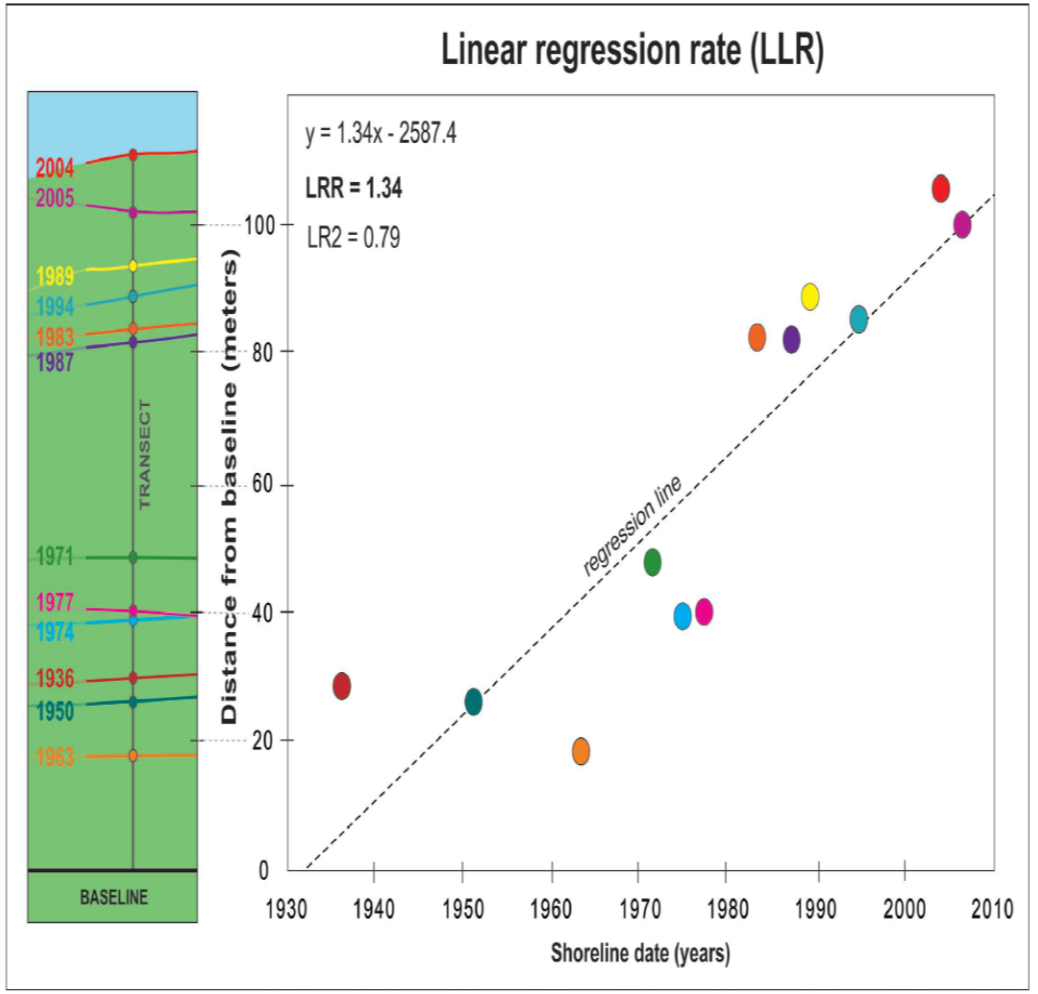
vn

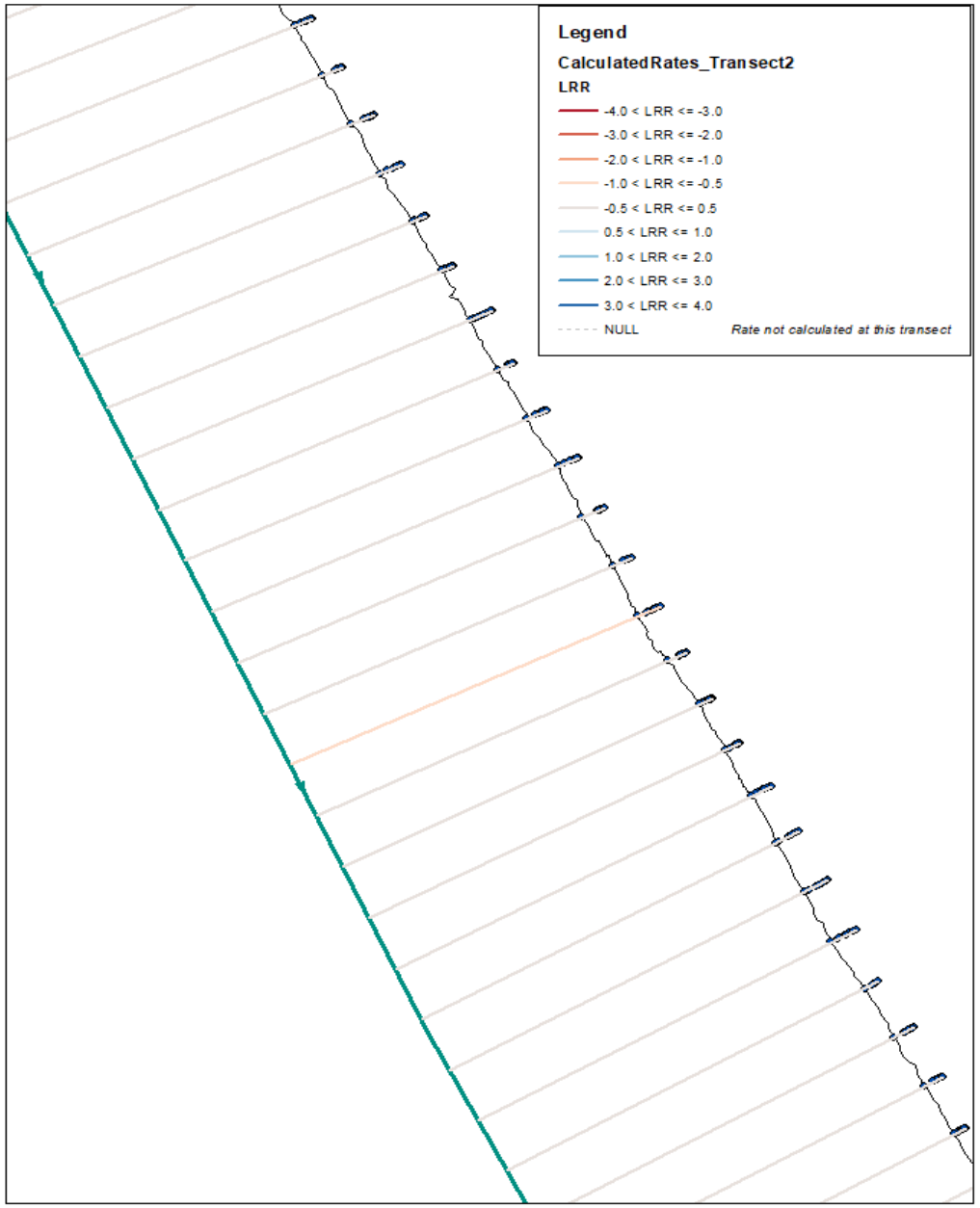
alculate



Calculations







Data Interpretation

- How to interpret and display erosion rates?
  - Current discussion point for CEHM
- Recognize that calculations depend on the inputted shorelines and timeframe
  - Rates calculated over long-term (1940s to 2010s) would be lower than ….
  - Rates calculated over a highly variable short-term (e.g., 2010s)

Establishing Erosion Hazard Areas

- Erosion rate and/or susceptibility used to establish official erosion hazard areas (EHA)
- Reference vs. On-site Assessment
- NSMB classification: Officially 1 ft/yr, actually Johnson defined high as areas with rates of 0.46 – 1.1 ft/yr and non-bedrock shoreline

	Minnesota	Wisconsin	Michigan	Ohio	Pennsylvania	New York
Erosion Hazard Area	High Erosion Potential (0.46 to ≥ 1 ft/yr) with non-bedrock shorelines	Recession Rates Only	High Risk Erosion Area (HREA; ≥ 1 ft/yr over 15 yrs)	Coastal Erosion Area (CEA) based on threshold. 5 ft standard error divided by years between images and multiplied by 30 (to estimate 30 years of recession). Measured recession rates times 30 that are greater than this value is a CEA. Anything below this threshold receives no designation.	Bluff Recession Hazard Area (BRHA) are identified by analysis of recession rates, a review of existing or potential damage to property or structures, and an examination of the causes of erosion at the site. Before designation of a BRHA there is a public comment period and notification to the local municipality.	Natural Protective Feature Areas (NPFA); Structural Hazard Area (SHA) where recession (≥ 1 ft/yr)
Current Map	1980s	2015	2018	2018	2018	1980s
Data Used	Imagery	Imagery	Imagery	Imagery	Control Point Field Measurements	LiDAR, Imagery
Transects	250 m	10 m	150 ft	100 ft	0.5 km	50 m
Geological vs. Vegetation Erosion Hazard Line	Geological	Geological	Vegetation	Geological	Geological	Geological
Field Work Component			Yes		Yes	Yes

Thank You!

Melanie Perello

melanie.perello@state.mn.us

218-834-1404