Improvement of rating curve through Manning's Equation and LiDAR

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Disaster Risk Exposure and Assessment for Mitigation (DREAM) Project

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Recovery from disaster

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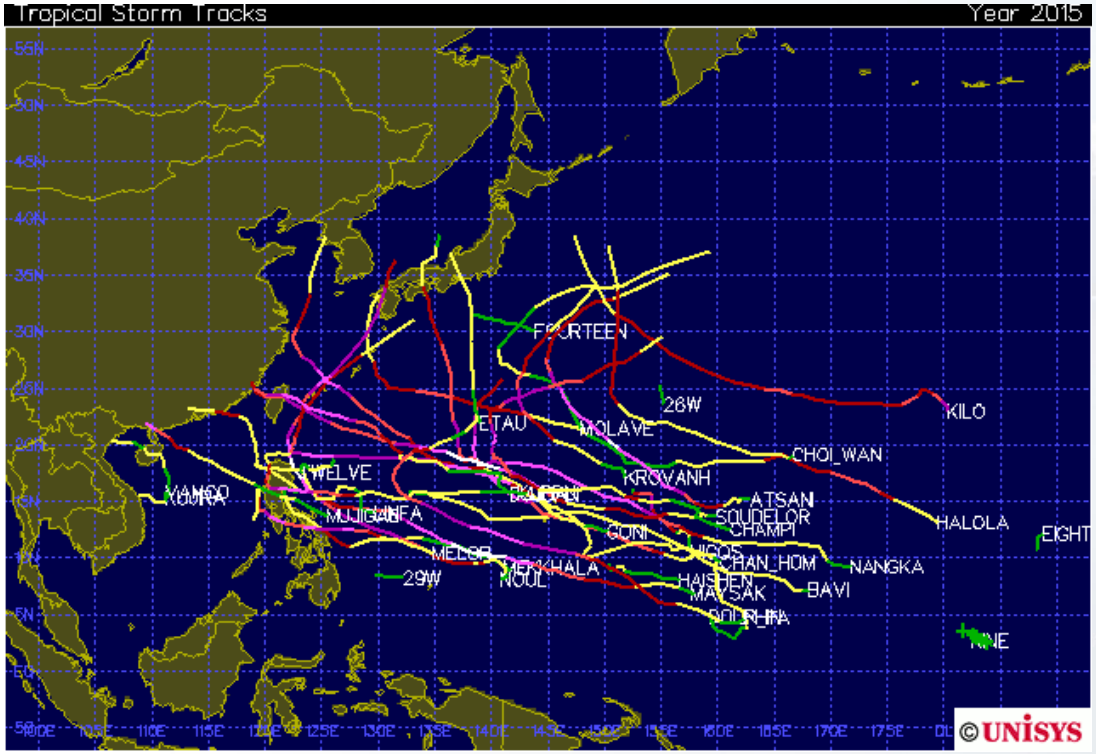
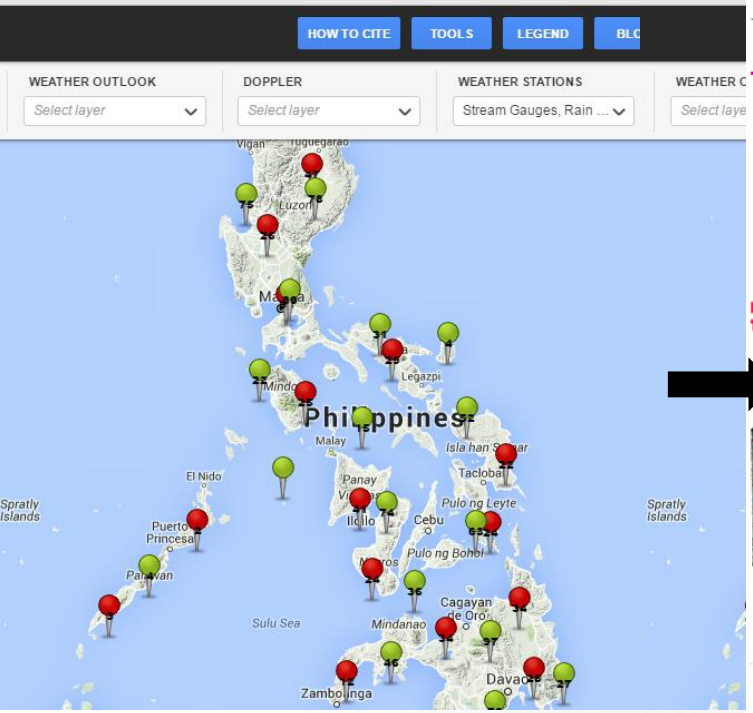
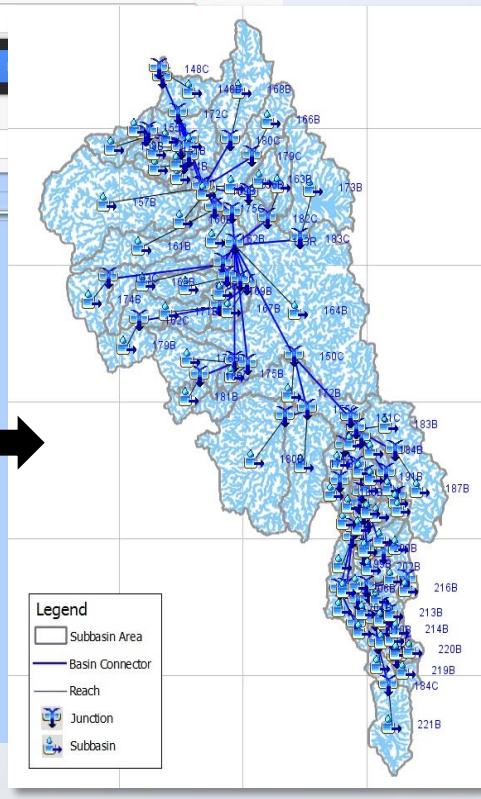
Philippines and flooding



Name	Year	USD
Haiyan (Yolanda)	2013	2.02 billion
Bopha (Pablo)	2012	1.04 billion
Rammasun (Glenda)	2014	871 million
Parma (Pepeng)	2009	608 million
Nesat (Pedring)	2011	333 million
Fengshen (Frank)	2008	301 million
Megi (Juan)	2010	255 million
Ketsana (Ondoy)	2009	244 million
Mike (Ruping)	1990	241 million
Angela (Rosing)	1995	241 million

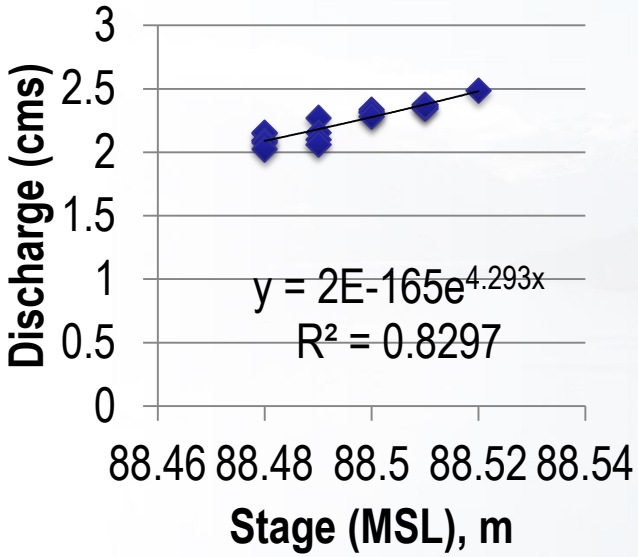
Meteorological Sensors in the Philippines



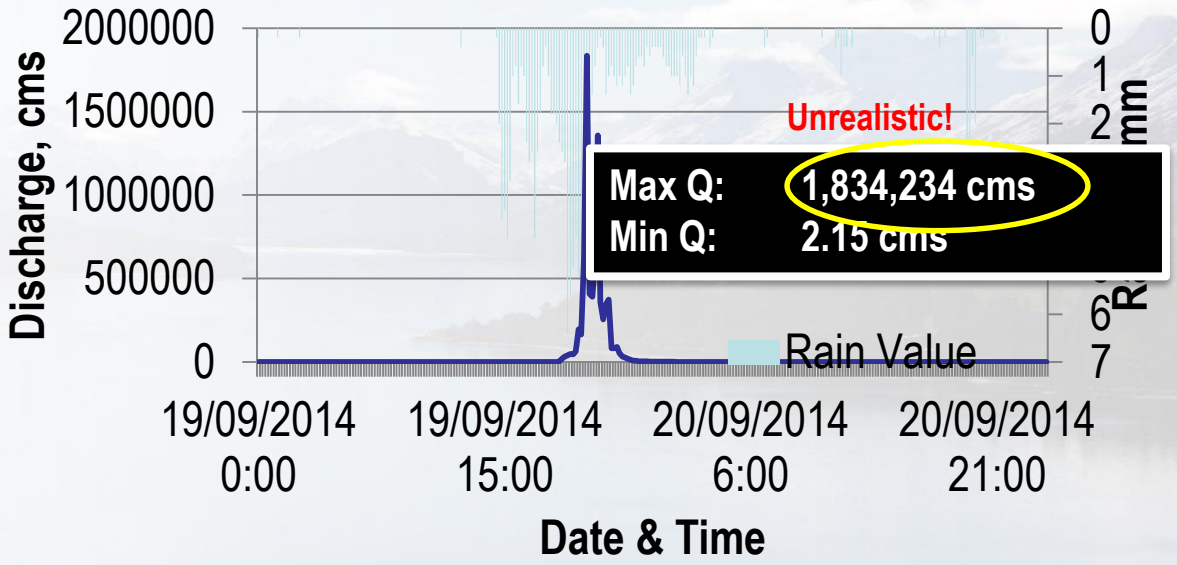


Only baseflow discharge is available!

Surveyed Flow Data
Dipalo Bridge, Pangasinan



Dipalo Bridge Hydrometry
September 19-20, 2014

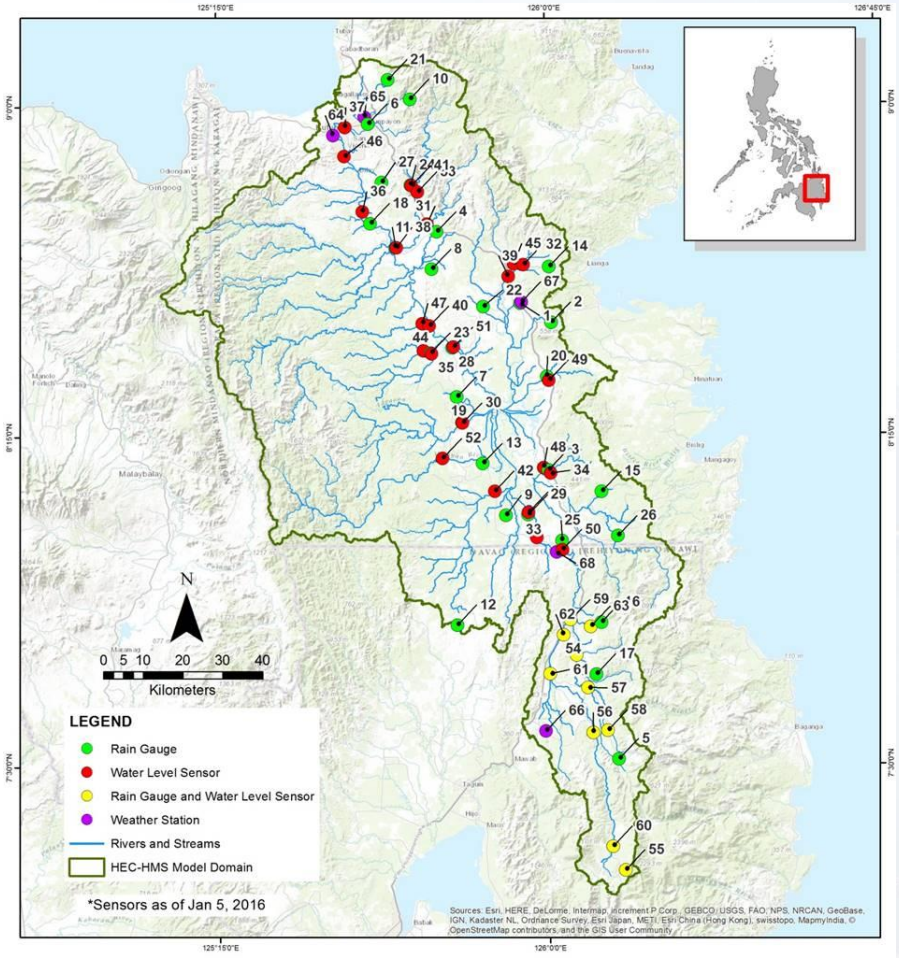


River Measurements for Rating Curves

Problem with baseflow measurements only

- In-situ river discharge measurements during high flows are dangerous and expensive to capture.
- The opportunities to gather field measurement are rare

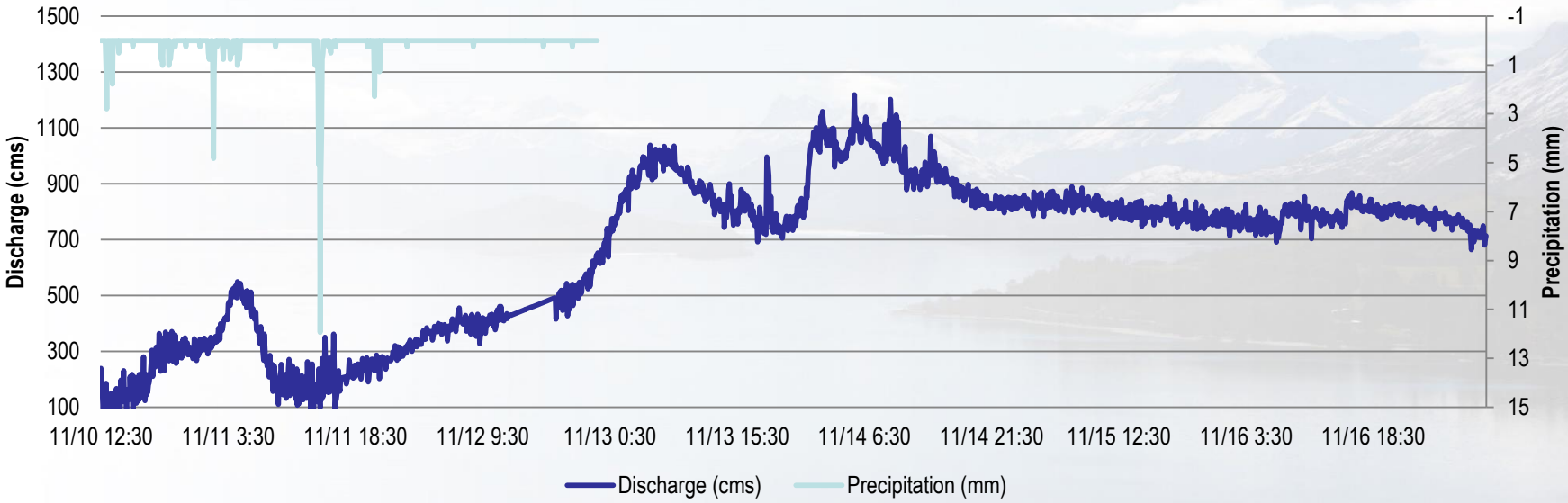
!Nonetheless, this is required to develop a **good** elevation-discharge relationship, or rating curve.



Agusan River Basin

- Typhoon Yolanda Date:
  November 10-16, 2013
- Typhoon Yolanda Total Precipitation:
  73mm (Mat-I Rain Gauge)
- Agusan River Watershed Size:
  10,921 km2
- Location of discharge measurement:
  Dankias, Las Nieves
  (8°45'1.55"N, 125°35'14.52"E)

Hydrograph of TS Yolanda



Problem

Using only baseflow data of the Agusan River Basin, which procedure for extending the rating curve will best fit the actual river hydrograph?

Techniques for extending the rating curve

1. Simple hydraulic technique	Bankfull discharge estimated using Manning's Equation
2. Computational hydraulic technique	Discharge estimated at every point of the cross-section using Manning's Equation
3. HECRAS, using LiDAR	Rating curve tool; a hybrid cross-section is used

Manning's Equation

$$Q = AV = A\frac{1}{n}R^{2/3}S^{1/2}$$

Where:

Q = Discharge (m^3/s),
A = Cross-sectional area of flow (m^2),
n = Manning's roughness coefficient,
R = Hydraulic radius (m)
S = Slope of the hydraulic grade line

Equation (2). Manning's Equation (Manning's *n* and slope are constant)

$$Q = \frac{A^{5/3}}{P^{2/3}} \times k$$

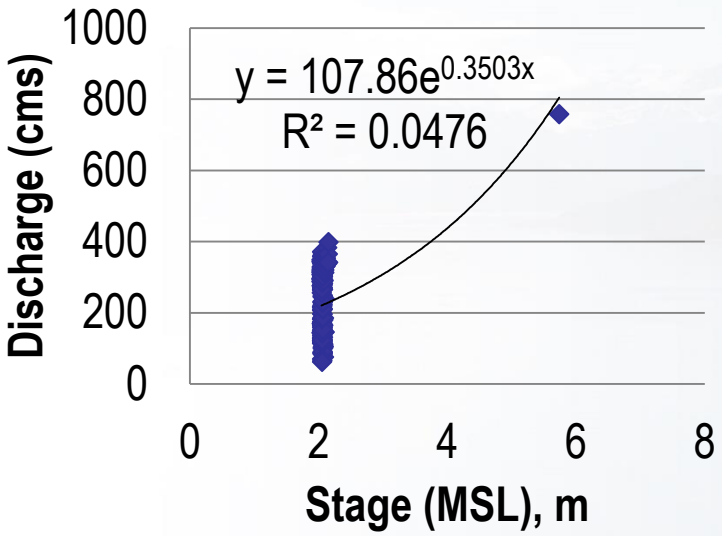
Where:

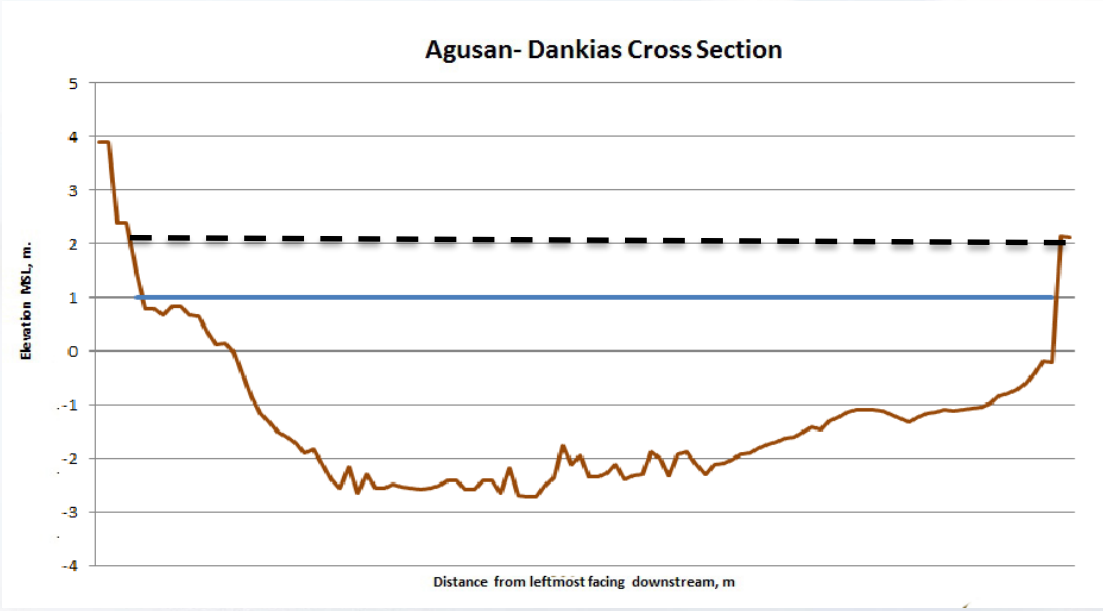
$$k = \frac{1}{n} S^{1/2}$$

Equation (3). Manning's Equation for bankfull discharge

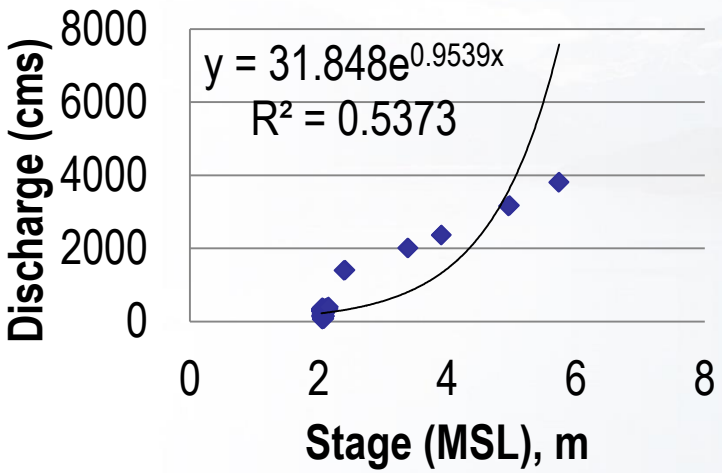
$$Q_{full} = k_{ave} \frac{A_{full}^{5/3}}{P_{full}^{2/3}}$$

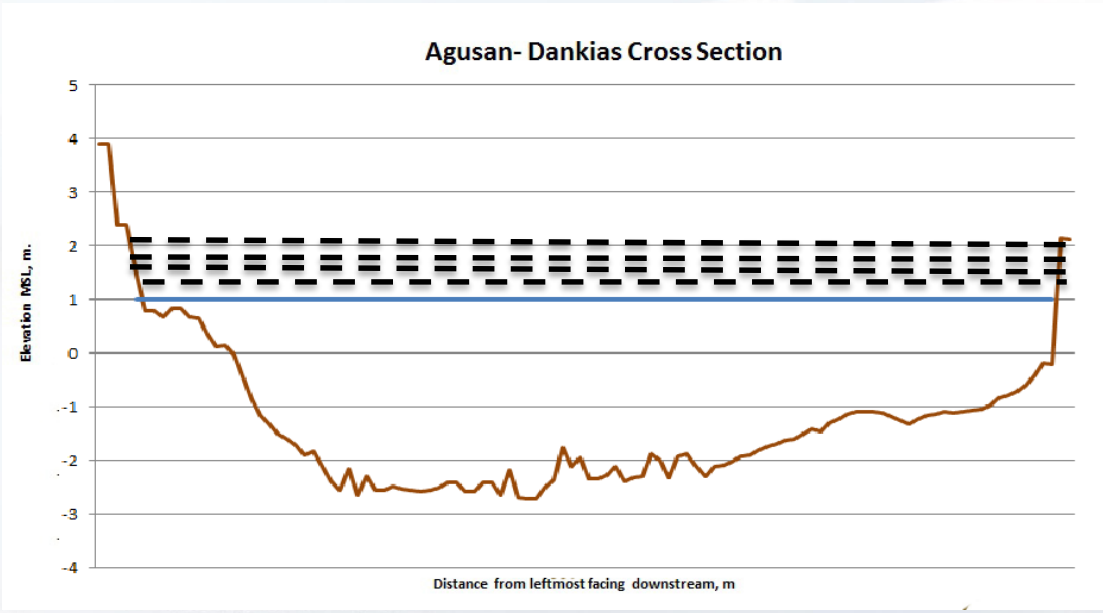
Simple hydraulic technique



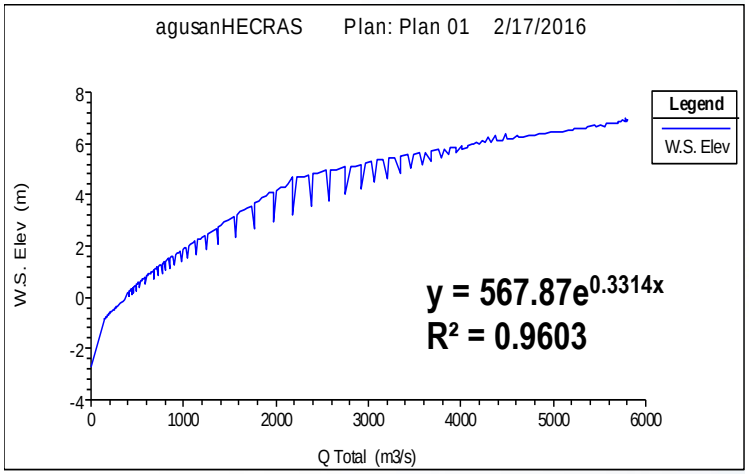


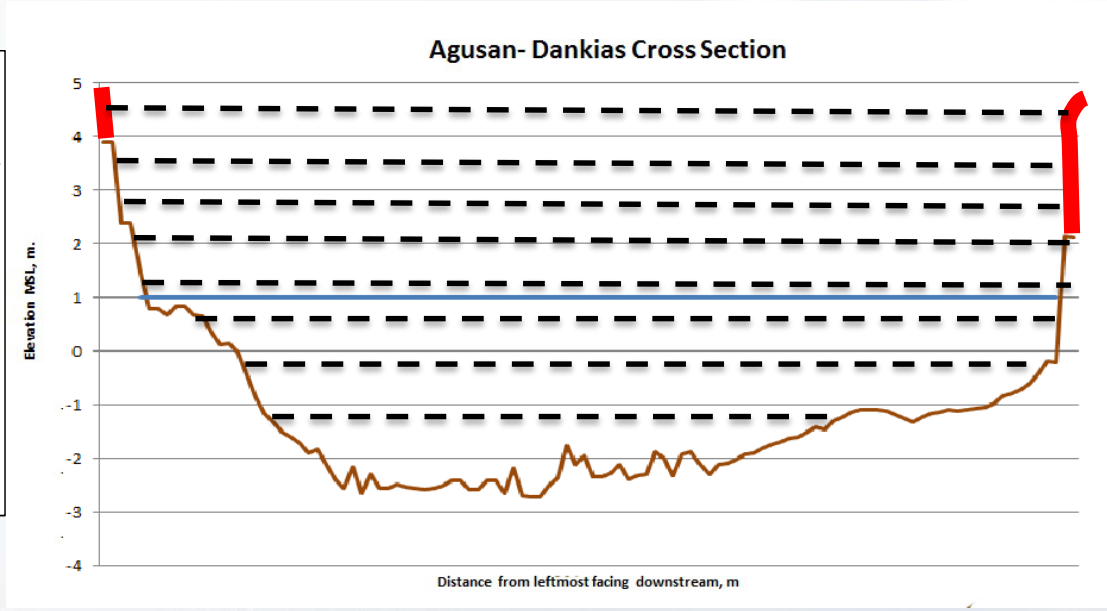
Computational hydraulic technique



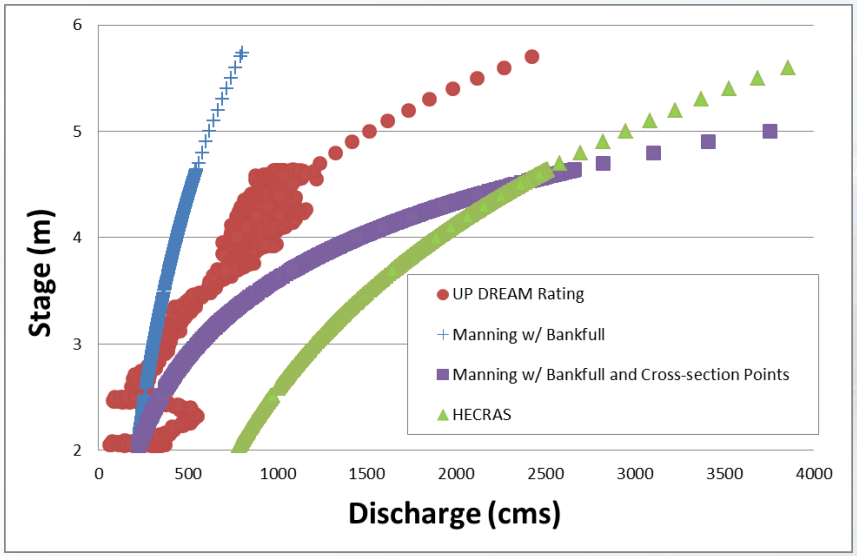


HECRAS, using LiDAR





Results



R-squared		
Manning's with Bankfull	Manning's with Bankfull and Cross-section Points	HECRAS
0.888	0.851	0.890

Recommendations:

- Possible validation can be done by comparing actual flood events and the result of a watershed-floodplain model calibrated using discharge generated rating curve