GEOB 448 - Directed Studies
Fraser Basin Project: ArcGIS Analysis
Project Summary
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General Project Questions / Goals:

- How can we improve the Large-Scale, Physically Based, Distributed Suspended Sediment Transport Model on the Fraser River Basin?
- Do Glaciated basins organize in such a way where only the main stem (first order stream) contributes sediment to the outlet?
- Can we identify major tributaries in the Fraser Basin that are not contributing sediment (i.e. disconnected) to the main stem?
- Can we create an Index for potential sediment generation based on topographical variance as a proxy - assuming there is a relationship?

Data Used:

- GMTED 2010 DEM, accessed via Nasa Glovis Web-Viewer, 7.5 arc-second resolution, type: median, link: https://www.usgs.gov/centers/eros/science/usgs-eros-archive-digital-elevation-global-multi-resolution-terrain-elevation?qt-science_center_objects=0#qt-science_center_objects
    - Created mosaic raster combining:
        - 30n120w_20101117_gmted_med075
        - 30n150w_20101117_gmted_med075
        - 50n120w_20101117_gmted_med075
        - 50n150w_20101117_gmted_med075
- BC provincial boundary shapefile, Open Data Canada, Province and Territory Cartographic Boundary Files: 2011 Census2
- BC Freshwater Atlas Lakes Shapefile, BC Data Catalogue
- BC Major Watershed Boundaries, BC Data Catalogue

Project Workflow:

Pt. 1 – Fraser Basin and Watershed Delineation

1. Download DEM data from Nasa Glovis. Zip file contains 7 data types – use median/mean files. 4 DEM files downloaded: (30N-120W; 30N-150W; 50N-120W; 50N-150W)
2. Input DEM data into ArcMap. Checked spatial reference. Created mosaic raster (combined 4 DEM's into one) Clipped to BC provincial boundary.
3. Used "Fill" in the Spatial Analyst Toolbox to fill sinks.
4. Generated flow direction raster using filled DEM as the input surface raster.
5. Found the cells (x,y location) corresponding to the sub-basin station locations listed in (Tsuruta et al. 2018). Lat/Lon locations accessed from WSC. Created an individual xy point layer for each station.
6. Delineated each individual watershed separately using the "watershed" tool, and the xy point layer for each station. Resulted in14 separate watershed raster layers, each representing all upstream cells where water would flow into the station pour point.

7. Checked watershed delineation by comparing areas listed in (Tsuruta et al. 2018), and those calculated in from the flow accumulation raster. (used #cells x cell size for area)

Pt. 2 – Identify Stream Network

8. Generated flow accumulation raster using the flow direction raster as input. Reclassified with 2 classes with a threshold accumulation value of 25000. (Value was chosen to classify only major tributaries).
9. Created raster with only flow accumulation cells using the raster calculator: "Flow accumulation raster" >= threshold value. The output was a stream network raster with 2 classes, and pixel values of 0 and 1.
10. Clipped the stream network raster to the Fraser Basin Boundary. Basin polygon was accessed from the BC Data Catalogue: "Major BC Watersheds."
11. Calculated stream order using the stream order tool, with the raster calculator (above) and the flow direction raster as input. Used Strahler method. Used "Stream to Feature" tool to create a vector shapefile, using the stream order raster and flow direction raster as input.

Pt. 3 – Identify and Classify Major Tributaries

12. Identify the main river (Fraser) and its major tributaries from the stream order network.
13. Downloaded BC Lake Polygon feature layer from BC Data Catalogue: "Fresh Water Atlas – Lakes."
14. Identified sediment contributing and non-contributing tributaries by looking at where tributaries intersect with lakes / sinks. Created separate layer of tributaries that do not flow into lakes.

Results:

14 watersheds were delineated using ArcMap 10.6. (Figure 1). Watershed areas were relatively similar (< 5% difference) to those outlined in Table 5 in (Tsuruta et al., 2018), with the exception of Stuart, Hanceville and Nechako having 9.7, -12.6, and -14.9% difference (Table1).

24 first order tributaries were in identified using ArcMap 10.6. from the flow accumulation raster. 20 of these tributaries were found to have no lake inflow, and therefore may be able to contribute sediment to the main stem of the Fraser River. (Figure 2).

References:

Tsuruta, K., Hassan, M. A., Donner, S. D., & Alila, Y. (2018). Development and application of a large-scale, physically based, distributed suspended sediment transport model on the Fraser River Basin, British Columbia, Canada. *Journal of Geophysical Research: Earth Surface*, *123*(10), 2481-2508.

Appendix:

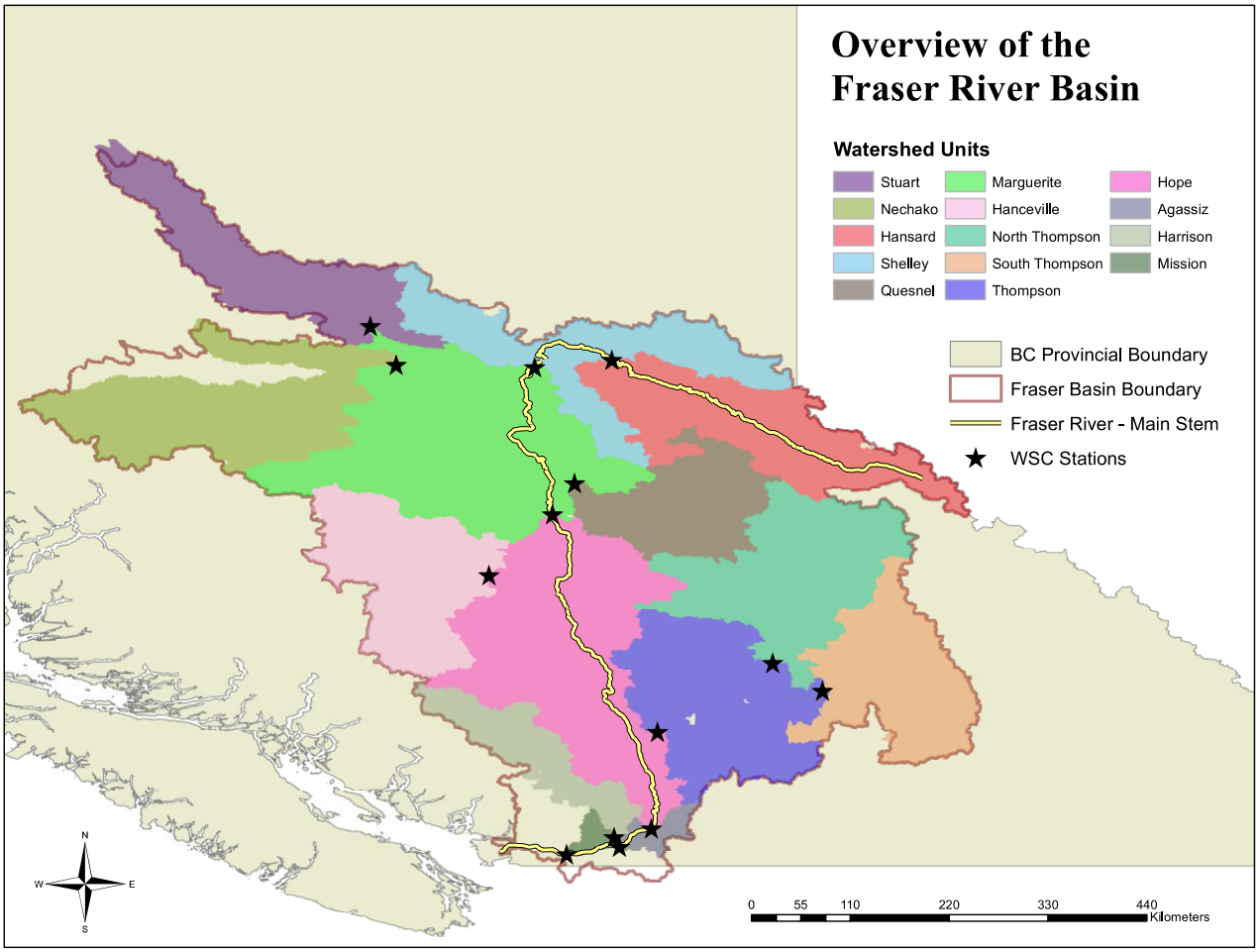

Figure 1. Overview of the Fraser River Basin. Map shows the 14 watershed units within the Basin, the main stem of the Fraser River, as well as WSC station locations as mentioned in (Tsuruta et al., 2018). Map Generated in ArcMap 10.6.

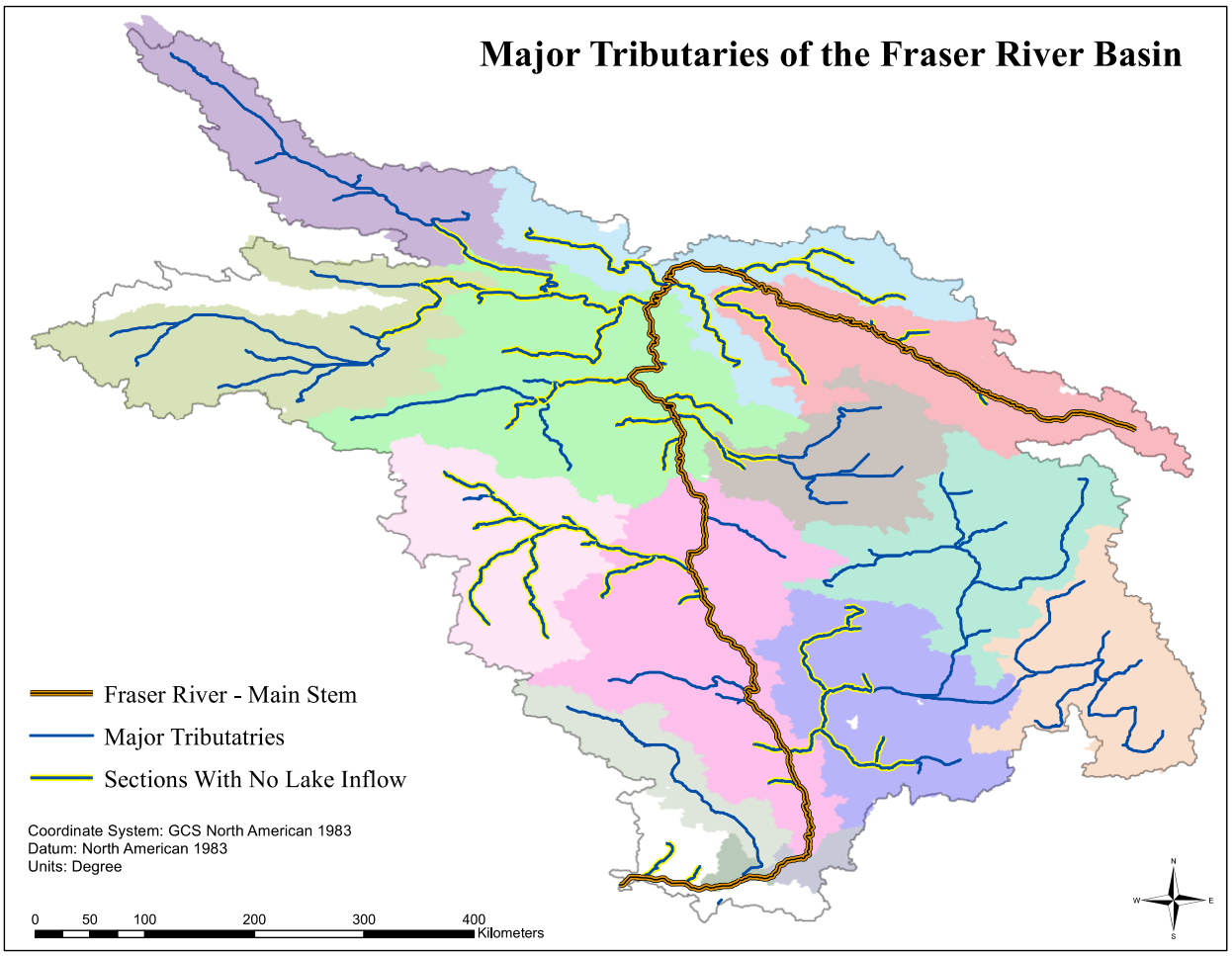

Figure 2. Major Tributaries of the Fraser River Basin. Map shows tributaries identified using the flow accumulation tool in ArcMap 10.6. Highlighted sections of the stream network are those which do not have any lake inflow.

WSC ID	Description	Latitude	Longitude	WSC Area (km2)	ArcMap WShed cell count	Calculated ArcMap Area (km^2)	Difference from Tsuruta et al, 2018	Diff %	FLAG - large difference?
08MG013	HARRISON	49.30042	-121.82964	7890	227840	7543	*-347.3176115*	*-4.402*	
08KH006	QUESNEL	52.842675	-122.22617	11500	356961	11817	*317.2553023*	*2.75874*	
08JE001	STUART	54.41686	-124.27062	14200	470729	15584	*1383.56451*	*9.74341*	x
08LE031	SOUTH THOMPSON	50.76311	-119.74312	15800	466463	15442	*-357.6621534*	*-2.26368*	
08KA004	HANSARD	54.07876	-121.84703	18000	553747	18332	*331.8896795*	*1.84383*	
08MB012	HANCEVILLE	51.921915	-123.08063	19300	509290	16860	*-2439.866952*	*-12.6418*	x
08LB064	NORTH THOMPSON	51.04093	-120.24046	19600	593401	19645	*44.64216997*	*0.22777*	
08JC001	NECHAKO	54.024211	-124.00863	25200	647637	21440	*-3759.865721*	*-14.9201*	x
08KB001	SHELLEY	54.005221	-122.62607	32400	1016011	33635	*1235.218909*	*3.8124*	
08LF051	THOMPSON	50.355187	-121.39502	55400	1640174	54298	*-1101.75762*	*-1.98873*	
08MC018	MARGUERITE	52.530189	-122.44494	114000	3444516	114031	*31.29463675*	*0.02745*	
08MF005	HOPE	49.38592	-121.45121	217000	6481376	214567	*-2432.932723*	*-1.12117*	
08MF035	AGASSIZ	49.207256	-121.77587	218000	6526093	216047	*-1952.568747*	*-0.89567*	
08MH024	MISSION	49.126038	-122.30281	228000	6784057	224587	*-3412.626157*	*-1.49677*	

Table 1. Watershed units of the Fraser Basin associated with Water Survey of Canada stations listed in (Tsuruta et al., 2018). Table shows relevant attributes of each watershed unit delineated in ArcMap 10.6.