Correlating landslide susceptibility and risk using Factor of Safety and probabilistic models:

PRESENTER:

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Landslides are common natural disasters that vary in type of rock movement. Mapping landslide susceptible zones are key for risk and policy management.

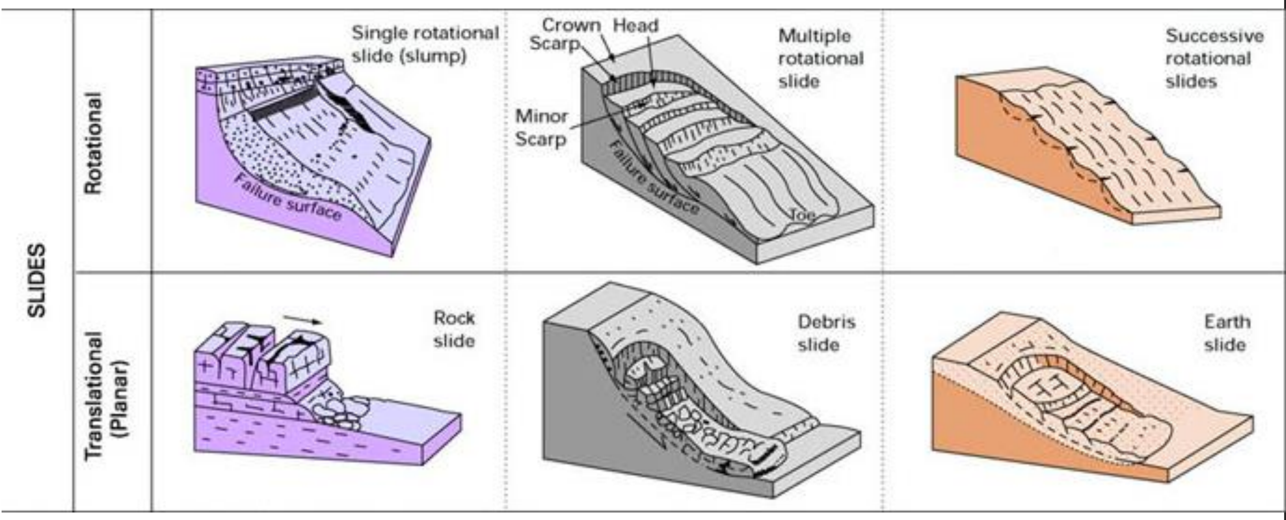


Figure 1: Landslide types based on geometry

METHODS

Figure 2: Models used in ArcGIS to map landslides which were applied to a watershed in Washington state, Japan, and India.

RESULTS

2-dimensional models incorporate both rotational and translational landslide geometry. **Slope** the most influential factor in landslide triggering.

$$FS(rotational) = \frac{c + \gamma.\tan\phi \sum_{i-1}^{x} z_i * \cos^2\beta}{\gamma \sum_{i-1}^{x} z_i .\sin\beta * \cos\beta}$$

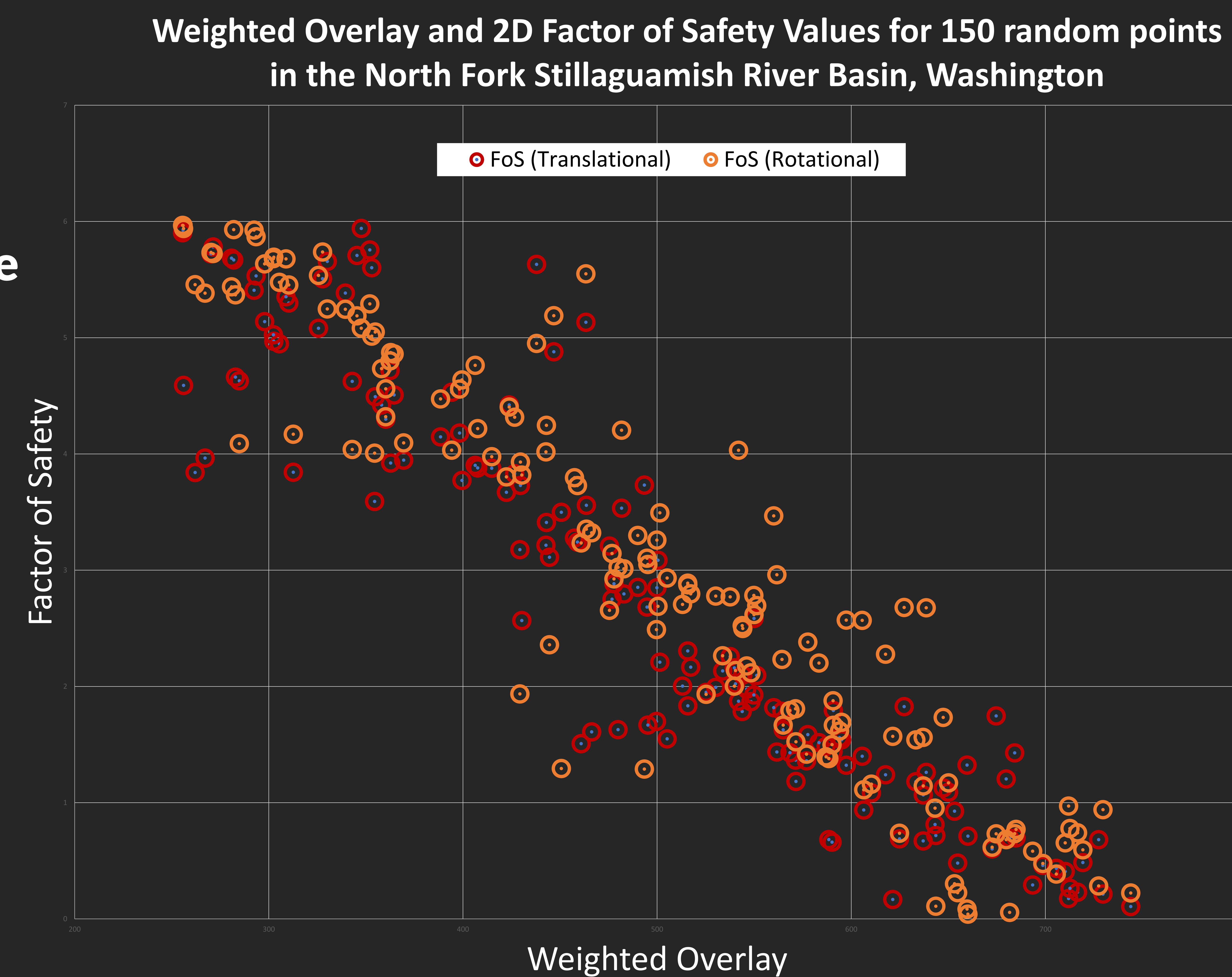
$$FS(translational) = \frac{c + \gamma.z.\cos^2\beta * \tan\varphi}{\gamma.z.\sin\beta * \cos\beta}$$

Figure 3: 2D Factor of Safety Equations

Factor of safety does not encapsulate the variety of factors that can trigger a landslide (e.g. **hydrology, geology, topology or land use**). This is achieved using **statistical modelling**.

Landslide mapping needs to move away from sole slope analysis to help communicate the complexity of these disasters to regions at risk.

Landslide analysis is not uniform as indicated by the different conditional factor rankings.



Calculated **eigenvalues from the logistic regression** and **frequency ratio values** help rank landslide conditioning factors for the **weighted overlay** analysis.

Figure 4: Top 5 factors (out of 12) for each watershed

#	Washington	Japan	India
1	Geology	Slope	Geology
2	Slope	Geology	Rainfall
3	Rainfall	Distance to Drainage	Drainage Density
4	Distance to Drainage	Elevation	Distance to Drainage
5	Drainage Density	Rainfall	Slope

Randomly selected locations **(n=150)** on both weighted overlay and factor of safety maps correlated strongly **(R^2 > 0.85)** in **all three watersheds**. **Rotational symmetry** was minutely preferred. This shows that factor of safety is a good proxy for landslide susceptibility, although it doesn't outline impactful conditioning factors.

The impacts of climate change can exacerbate landslide frequency through increased **rainfall**, altered **sediment transport**, and changes in **erosion**. Landslide mapping protocols need to be holistic and dynamic to be **informative**, and educative to the populations at risk.

Figure 5: Landslide caused by heavy rainfall in Uttarakhand, India

The effect of **seismicity** and **liquefaction** were not included in this, because of low availability of public data. However, these factors have a known effect on landslide susceptibility.

Next steps for this research include looking at **anthropogenic** effects and impacts of landslide susceptibility and risk. This was a factor that was mid-ranked in all three watersheds.

Proximity to **infrastructure and poor building codes** can magnify landslide damage. This has major implications for natural disaster policies in order to allocate sufficient resources towards mitigation and management.