A Debris Flow Model to Analyze Regional Forest Policies

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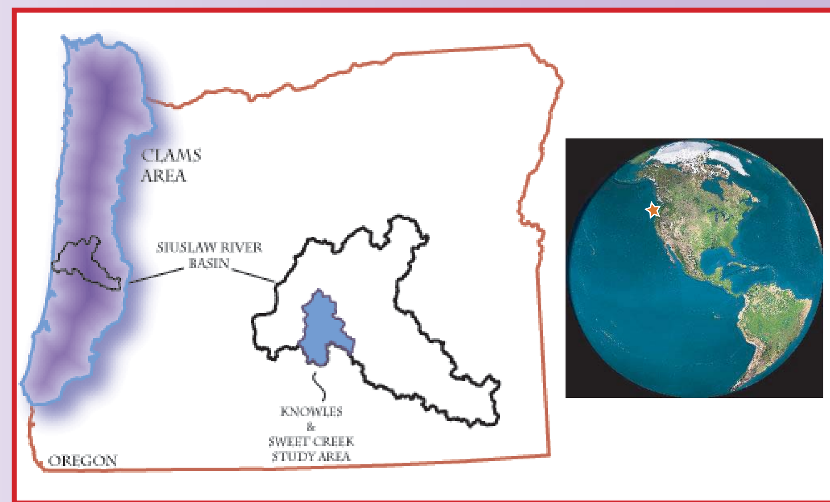
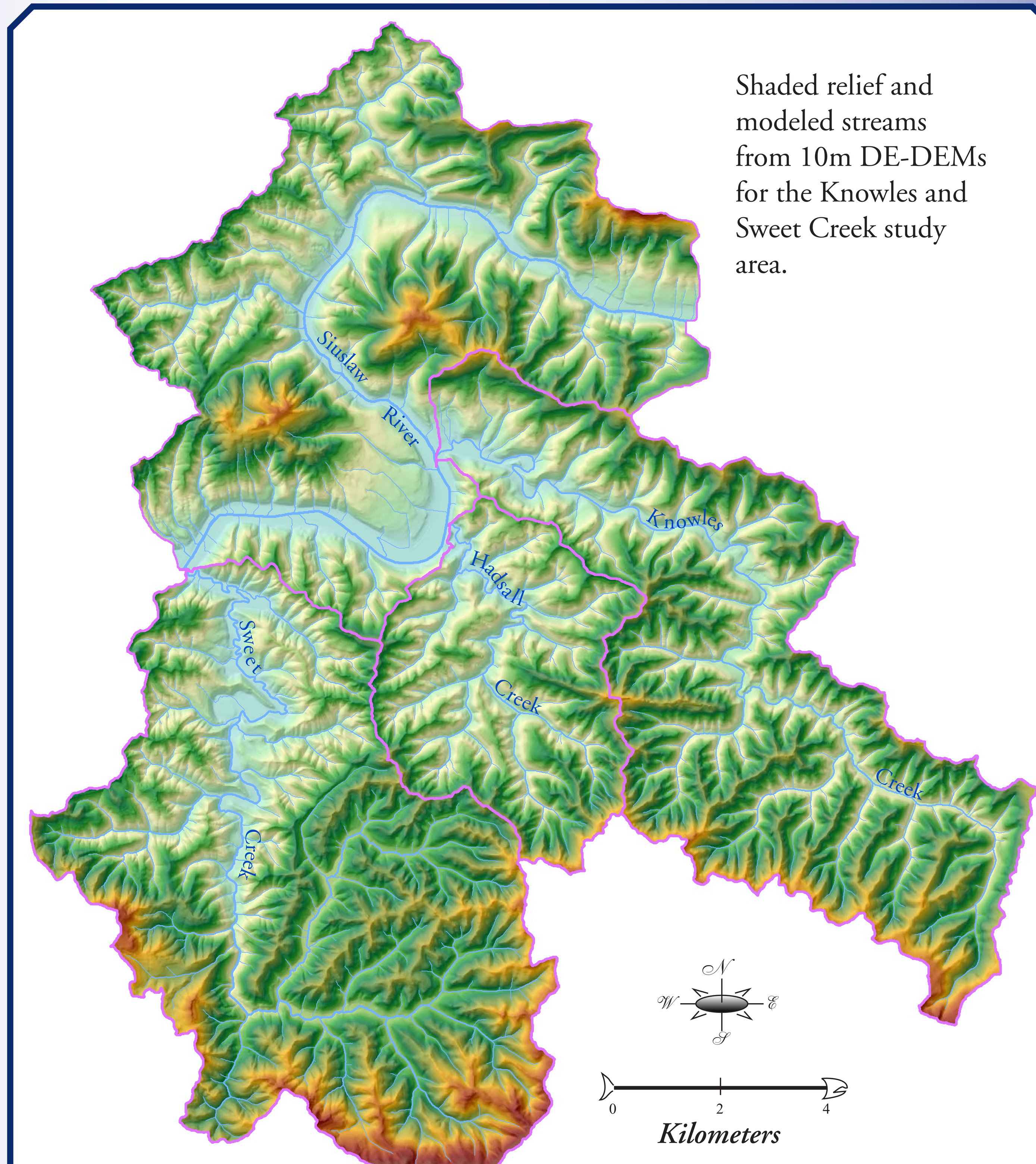
Introduction

Debris flows are often important mechanisms delivering sediment and wood to streams in montane regions such as the Coastal Province of Oregon. Land management practices may alter the frequency, magnitude, and quality of materials delivered by debris flows. An empirically-calibrated model for estimating the probability of debris flow initiation and relative volume of material deposited in salmon-bearing channels was developed by the Coastal Landscape Analysis and Modeling Study (CLAMS). This is one of several models that will be used to project forest policy effects on biodiversity over the next 100 years for the entire CLAMS study area.

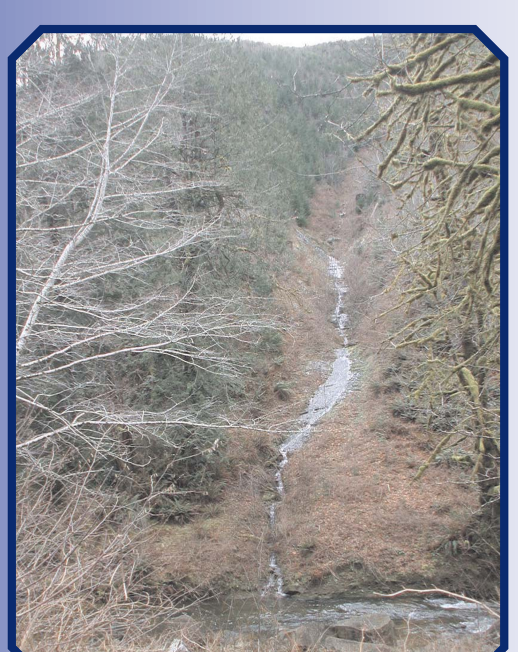


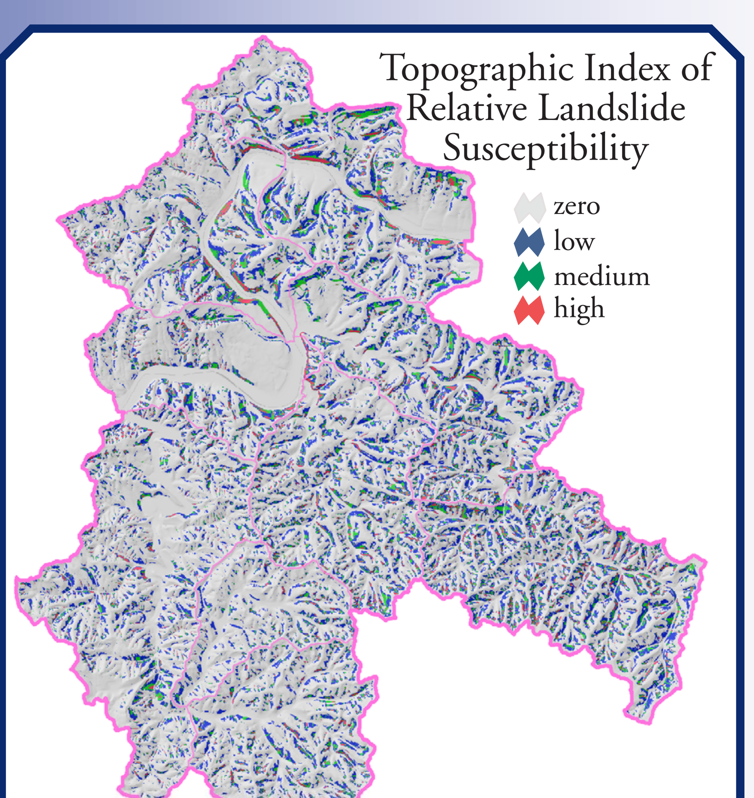
Methods

Ten meter Drainage Enforced Digital Elevation Models (DE-DEMs) were foundations for models including those generating: 1) a topographic index of relative landslide susceptibility for each pixel based on surface gradient, contributing drainage area, and local topographic convergence (Montgomery and Dietrich 1994); 2) a stream network based on contributing drainage area and topographic convergence; and 3) a calibrated probability for each pixel in the stream network that a debris flow will continue downstream based on surface gradient, debris volume, and tributary junction angle.

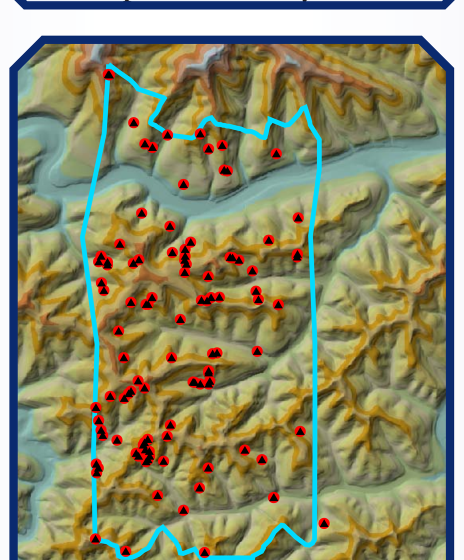


Shaded relief and modeled streams from 10m DE-DEMs for the Knowles and Sweet Creek study area.

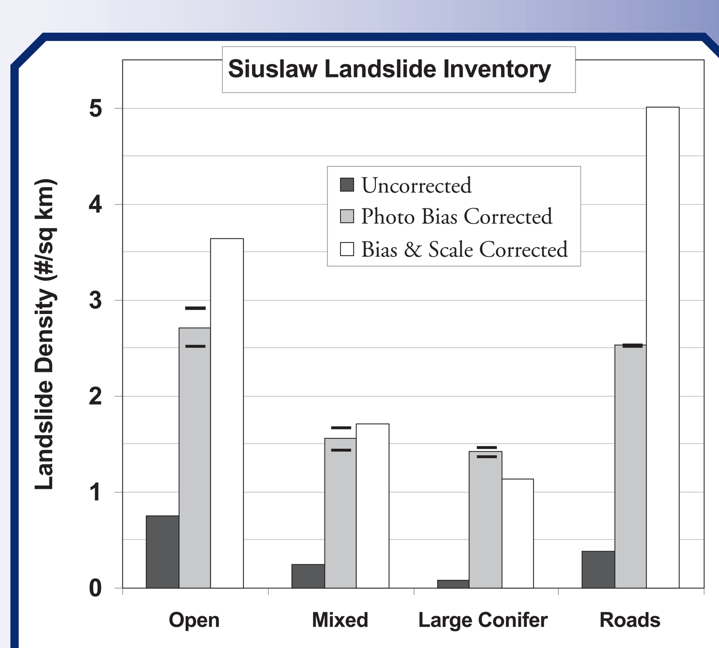




Topographic Index of Relative Landslide Susceptibility



1996 Landslide Inventory, Oregon Department of Forestry, Mapleton Study Area



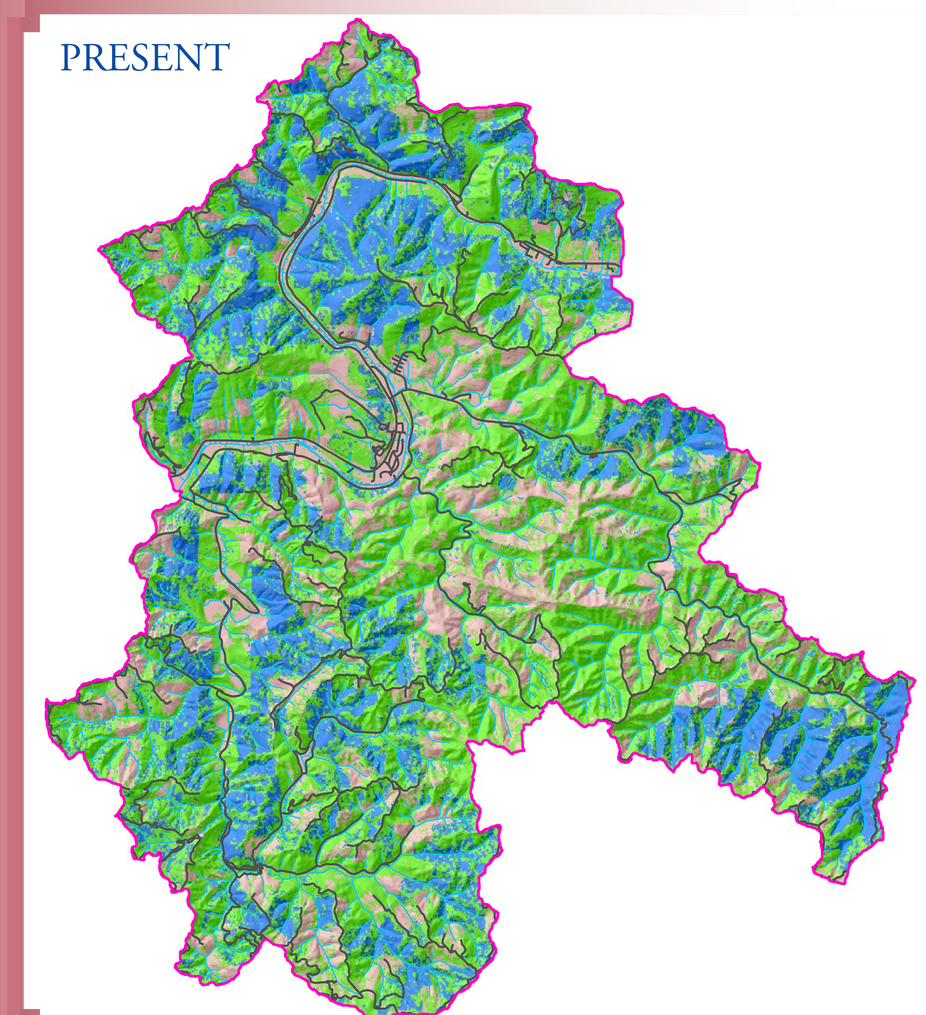
A spatatially-distributed topographic index of relative landslide susceptibility was created for the study area. The topographic index was translated to landslide density (# / km^2) using the 1996 Oregon Department of Forestry field-based landslide inventory for the Mapleton study area and the 1996 Siuslaw National Forest air photo-based landslide inventory. Landslide densities were empirically calibrated for roads and forest cover (i.e., successional state) with the Siuslaw inventory. Inventories were corrected for topographic variability and for bias in aerial photos towards identifying larger landslides.

Results

Present forest cover (i.e., successional state) was derived from classified Thematic Mapper satellite imagery (Ohmann and Gregory in press). Future forest cover was simulated for current forest policy using the LAndscape Modeling and Policy Simulator (LAMPS) of the CLAMS project (Bettinger and Lennette 2002). Inputs include topography, roads, and forest cover

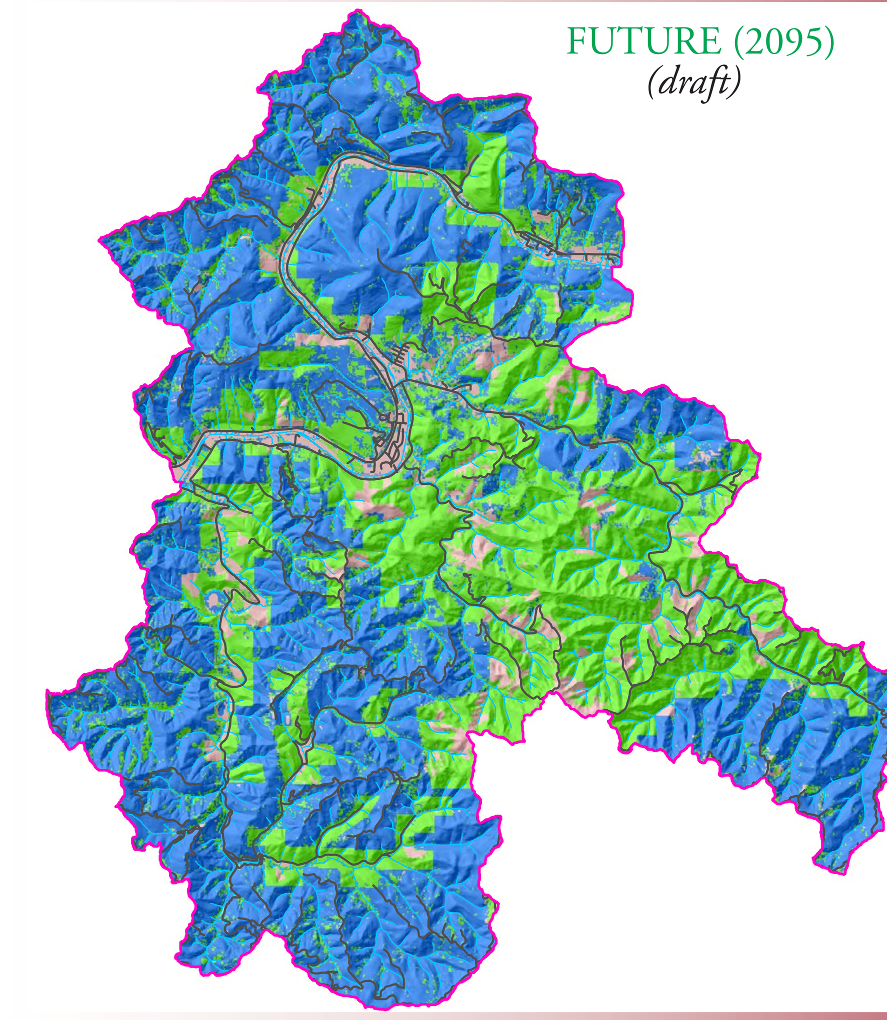
INPUTS

PRESENT



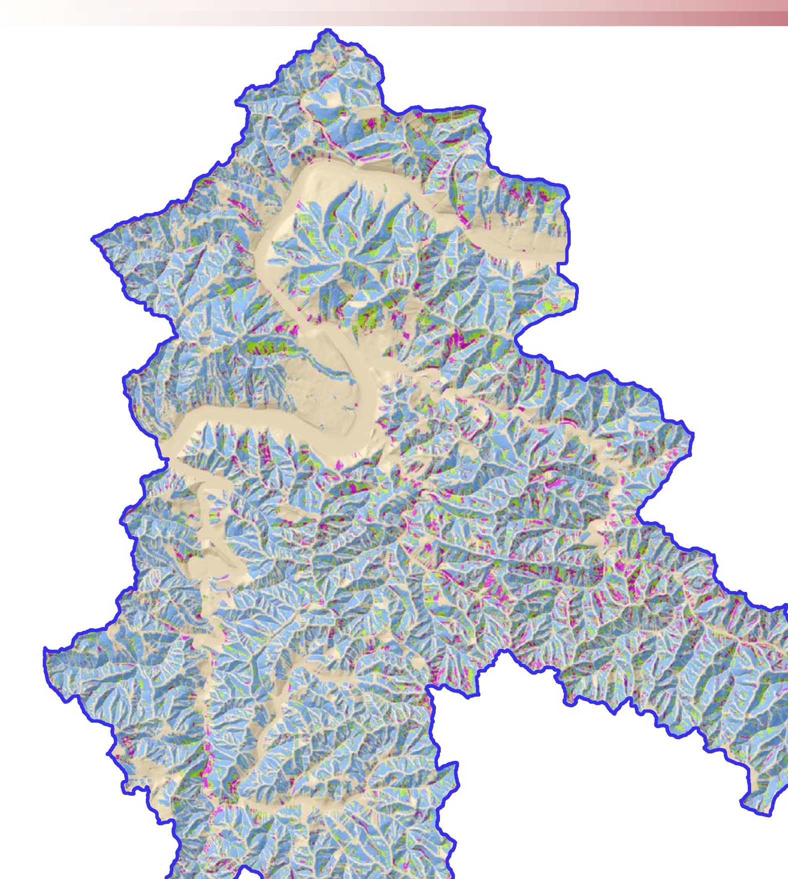
Forest Cover
- Early
- Mid
- Late
- Roads

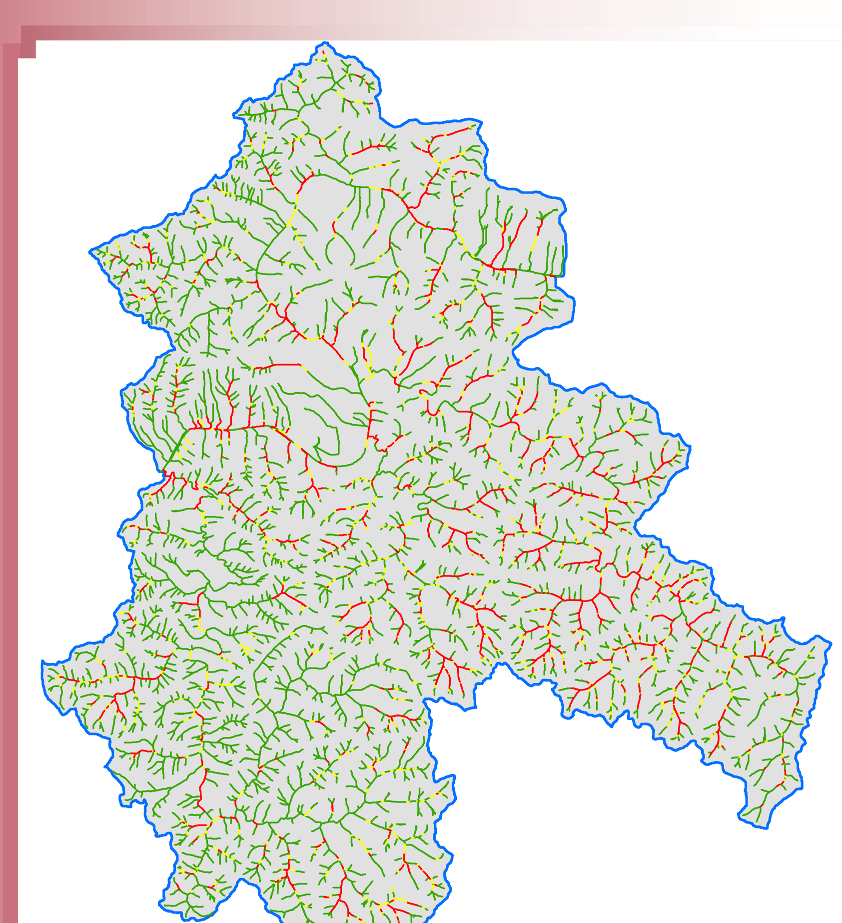
FUTURE (2095)
(draft)



OUTPUTS

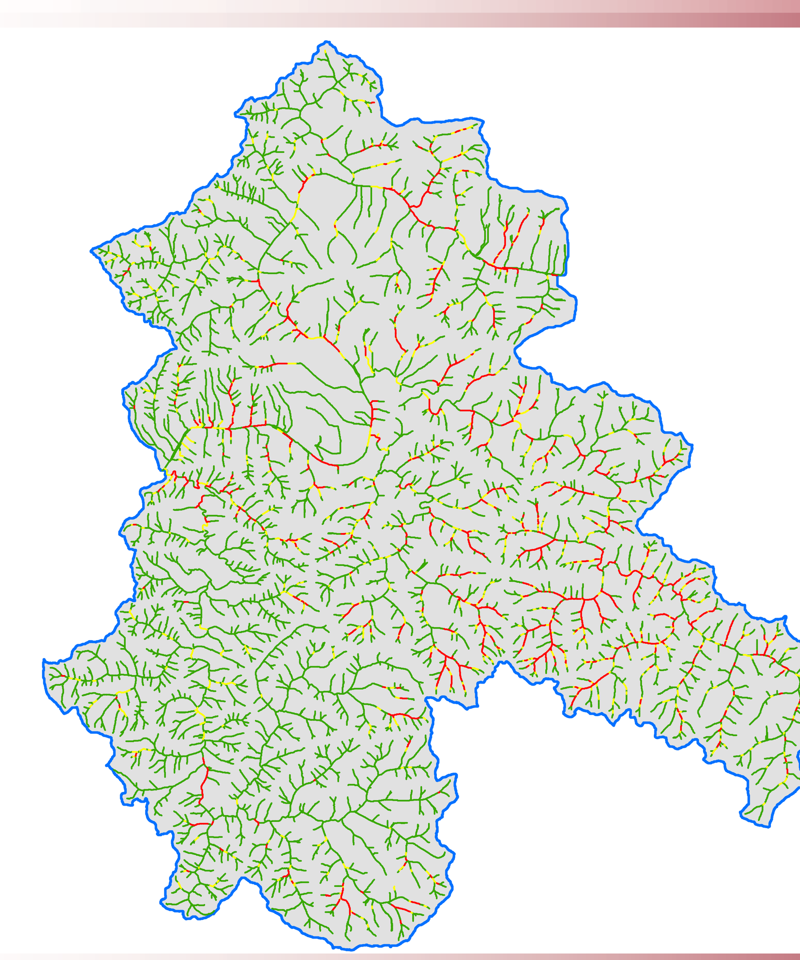
Calibrated Landslide Densities
- zero
- Low
- High





Relative Debris Flow Deposit Volumes
- Low
- High

Deposit volumes integrate effects of potential debris flow initiation, channel gradient, tributary junction angles, scour length and forest cover.



Conclusions

Models of slope stability and material routing were developed that can be used to compare potential effects on stream channels of current and alternative forest policies. Outputs from the models may also aid in defining debris flow hazards to roads and structures. Because estimates of landslide delivery potential and debris flow volumes are tied to forest cover, these models lay the foundation to examine how spatial and temporal variability in vegetation cover, either natural or management driven, may alter the distribution of aquatic habitat.

Cartography by Kelly Christiansen