Comparison of 10 and 30m Digital Elevation Models (DEMs) for Aquatic Data Development

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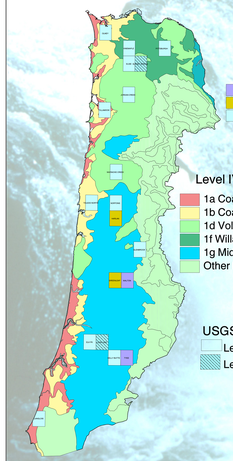
Purpose

The aquatic component of the Coastal Landscape Analysis and Modeling Study (CLAMS) is attempting to predict inchannel habitat structure from riparian, upslope, and instream attributes for the Coastal Province of Oregon. Preliminary investigations indicated available stream data (1:24,000) and 30m Digital Elevation Models (DEMs) were inadequate for our use. These 30m DEMs were created by the USGS with different methods resulting in two classes of quality, with those designated as level 2 being the best. An alternative to using the existing 30m DEMs was to have 10m Drainage Enforced (DE)-DEMs produced for the Coastal Province.

Objective

Evaluate the benefits of acquiring 10m DE-DEMs for the study area by comparing results from these data with those obtained from 30m DEMS (level 1 or 2) to:

* Derive hill slopes and channel gradients
* Delineate watershed boundaries
* Generate streams



Source: Ecoregions of Western Washington and Oregon. 1998 Paters et al.

DEM Development and Selection:

For portions of the study area, 10m DE-DEMs (hydrologically corrected, higher resolution DEMs developed by Averstar) were produced. These data met USGS level 3 specifications that required DEMs to be drainage enforced. Depending upon land ownership, these were produced with differing source hydrography data (i.e., USGS-DLG Digital Line Graph, USFS-CFF Cartographic Feature Files, and BLM-WODDB Western Oregon Digital Database) and source contour data (i.e., USGS-DLG and BLM-WODDB).

To evaluate differences in hill slope classes, watersheds and stream generation:

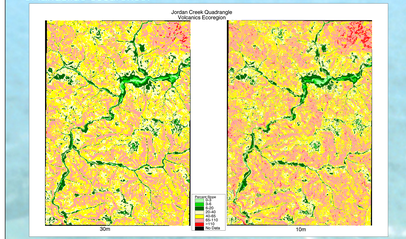
1) Two 7.5' quadrangles were selected in each of five ecoregions for a total of ten across the Coastal Province. For each quadrangle, results from a 10m DE-DEM and 30m DEM (level 2) were compared.

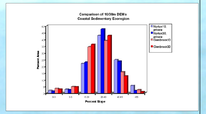
2) Two adjacent 7.5' quadrangles were selected in two ecoregions. One of each pair was available as a 30m DEM (level 1) and the other as a 30m DEM (level 2). For both quadrangles of the pair, results were compared with those from a 10m DE-DEM.

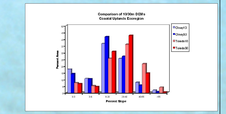
3) Three pairs of adjacent quadrangles were selected. Each member of the pair represented a different land ownership class. Results from a 10m DE-DEm and 30m DEM (level 2) were compared for the three quadrangle pairs with respect to each other and the source hydrography data for that ownership.

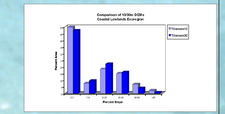
Hill Slope Comparison

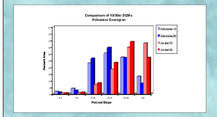
Hill slopes were generated for the 10m DE- and 30m DEM using the slope algorithm in Arc/Info's grid module. Slopes were classified into groups that influence anadromous salmonid habitat. The two lowest slope classes are associated with good fish habitat. Twenty-percent is generally the upper gradient limit for salmonid habitat. Slopes greater than 40% reflect differing probabilites of landslide occurence.



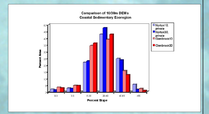


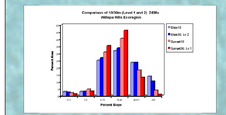


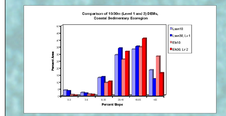


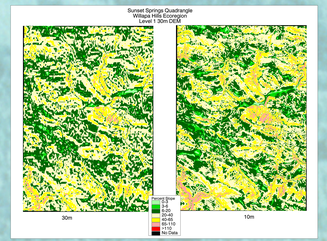


The 10m DE-DEM represents more area in the > 65% slope class in all ecoregions. The difference between the 10m DE- and 30m DEM is most noticable in the steeper terrain found in the Volcanics Ecoregion. The 10m DE-DEM also represents slightly more area in the lowest slope class (0 - 3%).





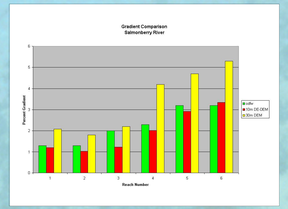




The same pattern exists in the comparison of slopes between 10m DE-DEMs and 30m level 1 DEMs - underestimation of steep slopes and low gradient areas. However, a visual comparison of the level 1 30m DEM with the 10m DE-DEM shows distinct artifacts (often referred to as corn rows) that can influence analytical results.

Channel Gradient Comparison

Channel gradient was calculated using both 10m DE- and 30m DEMs. These were compared to reach gradients measured in the field by the Oregon Department of Fish and Wildlife.

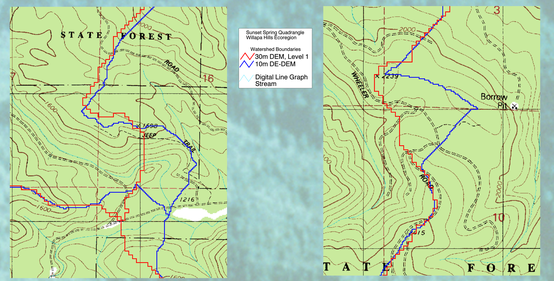


Gradient calculated using 10m DE-DEMs more closely approximated field measurements than gradient calculated from 30m DEMs with the exception of Reach 3. In all six reaches the 30m DEM overestimated percent gradient. The 10m DE-DEM underestimated percent gradient in five of the six reaches.

Salmonberry River
Volcanics Ecoregion

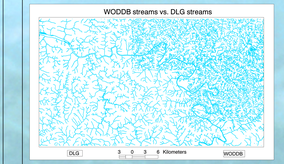
Watershed Generation Comparison

Watersheds were delineated using the USGS "Watershed Weasel" with the same threshold value (1100 ha) for the 10m DE- and 30m DEM. These watersheds met the National Resource Conservation Service's guidelines for 6th code hydrologic units.



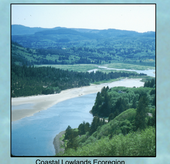
The watershed boundaries generated from 10m DE-DEMs produced watersheds:
1) with outlets matching 1:24,000 stream confluences (a), and
2) that more consistently followed ridgelines (a & b).

Stream Generation Comparison



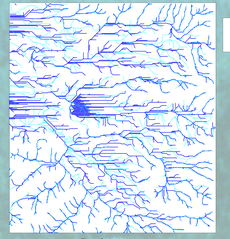
Differences in drainage density are commonly found across jurisdictional boundaries where USGS DLG streams have been augmented by field surveys and aerial photographs and may also occur across quadrangle boundaries due to dissimilarities in mapping techniques and map dates. Modeled streams eliminate differences in drainage density found across these boundary types.

Streams were generated using the same initiation thresholds for 10m DE- and 30m DEMs. To evaluate positional accuracy, modeled streams were compared to existing 1:24,000 streams layers (e.g., USGS-DLG)



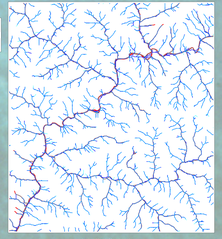
Coastal Lowlands Ecoregion

Volcanics Ecoregion



Tillamook Quadrangle
Coastal Lowlands Ecoregion

10m DE-DEM
30m Level 2 DEM
DLG



Jordan Creek Quadrangle
Volcanics Ecoregion

Although less of a problem in steeper terrains, modeled streams can: 1) create non-existent, parallel streams and 2) cut across meander bends. In all terrains, the drainage enforcement and higher resolution of the 10m DE-DEM produced a more realistic stream layer that resulted in: 1) consistent drainage densities and stream orders, 2) a more positionally accurate stream layer that can improve the characterization of the stream buffer relative to topography, vegetation, etc., and 3) tributary junction angles more indicative of actual angles where DEM is drainage enforced (especially important for debris flow routing).

Conclusions

DEMs are an intergral part of the aquatic component of CLAMS. Using the higher resolution and drainage enforcement offered by the 10m DE-DEM improves our ability to:

* Model potential landslide susceptibility
* Characterize topography
* Derive a watershed layer to characterize the landscape and provide predictive units for model results
* Produce a consistently densified stream layer

These improvements go beyond research applications and have relevancy for various groups interested in aquatic resources, such as other state and federal agencies, private entities, non-profit groups, and watershed councils.

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