Geomorphic Roads Analysis and Inventory Package

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Roads are pervasive in managed landscapes and can be detrimental to habitat. Mass wasting, fine sediment, altered flow regimes (enough roads), habitat fragmentation.
Many things we can do to mitigate those effects
Closing  Repair and Upgrade  Maintenance
But what is the relative Urgency and Priority  Where and when to spend limited resources
How do we make decisions – what is the information needed to make good decisions
Information Needed:
Cumulative Effects - Total sediment  Spatial distribution of effects  Multiple effects
Treatment/BMP effectiveness
Current conditions
GRAIP
While many of our existing tools – E.G. R1/R4 or ECA/ERA type models rely on line coverages – where are roads and how many

Substantial recent science says that how roads affect the environment depends largely on where they discharge water and sediment at drain points

Until now, no tools took advantage of such data if they were available, GRAIP is design to do that
What is GRAIP?

- Database
- Inventory method
- Analysis tools
- Learning tools

PACKAGE

Wooden graip used to dig up potatoes (19th cent).
Flow Paths and Routing

Flow Path: Wheel Tracks
DRAINNUM=68.02

Ditch
DRAINNUM=68.01

Flow Path: Wheel Tracks
DRAINNUM=68.02

Flow Path: Wheel Tracks
DRAINNUM=68.02
<table>
<thead>
<tr>
<th></th>
<th>Need Maintenance %</th>
<th>Need Replacement %</th>
<th>Total Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>In View</td>
<td>16</td>
<td>2</td>
<td>524</td>
</tr>
<tr>
<td>IN SF Payette</td>
<td>13</td>
<td>2</td>
<td>7165</td>
</tr>
</tbody>
</table>

Legend:
- Road
- Ditch_rel
- CONDIT_1
  - 0
  - 1-20%
  - 20-80%
  - 80-100%
  - Flows around pipe
  - Partially Crushed
  - Totally Crushed
  - Rusted significantly

Kilometers
ArcGIS Tool Bar
Sediment production by road segment

\[ \text{Sed Prod} = B \times L \times S \times V \times R \]

- **B**: Erosion base rate
- **L**: Flow path length
- **S**: Flow path slope
- **V**: Vegetation factor
- **R**: Road surface factor

“\( B \)” can be determined experimentally or using a physically based model (e.g. WEPP)

Zena Creek data from Megahan was used for a base rate for this work
2.1 million tons of road sediment delivered per year
Routed Sediment per Unit Area

Spec Sed
Mg/km²/yr
- 0.0 - 0.5
- 0.6 - 1.0
- 1.1 - 1.5
- 1.6 - 3.0
- 3.1 - 5.0
- 5.1 - 10.0
- 10.1 - 35.0

Kilometers
Mass Wasting
- Gullies
- Landslides
Shallow Landslide Risk

With Roads
Habitat Fragmentation
From Clarkin et al 2003 Oregon fish passage guide
Unique Habitat Patches

< 25% Slope
> 1 km²
Learning about methods

◊ Road line analysis
  – Inventory from existing road maps
  ◦ No information about drainage
  – Relating road location to impacts
◊ GRAIP
  – GPS based field inventory
    ◦ Current condition
    ◦ Drainage links
  – Estimating specific effects of roads and drains
Individual Road Segments

Sediment Production GRAIP (Mg)

Sediment Production Boised (Mg)

\[ y = 0.4844x + 2.089 \]

\[ R^2 = 0.5486 \]
$y = 0.5732x - 49.1$

$R^2 = 0.9866$

$\text{Sediment Production GRAIP (Mg)}$

$\text{Sediment Production Boised (Mg)}$
$y = 0.1618x - 13.977$

$R^2 = 0.8699$
Slope Position

- Less than 25%
- 25-50%
- 50-75%
- 75% or greater

% of Drain points with Gullies

Slope Position Class (Valley to Ridge)
Slope

8.55º = 15%
17.2º = 31%
28.7º = 55%

% of Drain Points with Gullies

S <= 8.55º 8.55º < S <= 17.2º 17.2º < S <= 28.8º S < 28.8º

Slope Class

0 5 10 15 20 25 30 35

% of Drain Points with Gullies

S <= 8.55º 8.55º < S <= 17.2º 17.2º < S <= 28.8º S < 28.8º

Slope Class
ESI = $L_{\text{road}}S^2_{\text{hillside}}$

% of Drain Points with Gullies

0  5  10  15  20  25  30

< 1.25 1.25 - 8 8 - 25 25 <

ESI Classes (m)
## BMP Effectiveness

<table>
<thead>
<tr>
<th>Drain Type</th>
<th>Sediment Produced (Kg)</th>
<th>Sediment Delivered to Channel (Kg)</th>
<th>Fractional Delivery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ditch Relief</td>
<td>3,904</td>
<td>799</td>
<td>0.20</td>
</tr>
<tr>
<td>Stream Crossing</td>
<td>1,053</td>
<td>1,053</td>
<td>1.00</td>
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<tr>
<td>Non-Engineered</td>
<td>1,767</td>
<td>249</td>
<td>0.14</td>
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<tr>
<td>Water Bar</td>
<td>1,341</td>
<td>175</td>
<td>0.13</td>
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<tr>
<td>Diffuse</td>
<td>556</td>
<td>42</td>
<td>0.08</td>
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<tr>
<td>Broad Based Dip</td>
<td>435</td>
<td>10</td>
<td>0.02</td>
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<tr>
<td>Leadoff Ditch</td>
<td>256</td>
<td>32</td>
<td>0.13</td>
</tr>
<tr>
<td>Sum</td>
<td>9,316</td>
<td>2,363</td>
<td>0.25</td>
</tr>
</tbody>
</table>
Conclusion

- **Database** – location, condition, linkage, updateable
- **Inventory** – repeatable, efficient, electronic
- **Analysis** – comprehensive, spatial, presentable
- **Learning** – practices, designs, analysis, formalized
- **Community** – improvement, technology
  transfer, application, policy