Avalanche accidents involving people along transportation corridors and the implications for avalanche operations

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How many people are involved in transportation corridor accidents?
How much of a factor are delayed avalanches for accidents along transportation corridors?
Do avalanche programs make a difference?
DATA
USA 1902-2014
Canada 1904-2014
Switzerland 1909-2014
Italy 1978-2014

Parameters
road/railroad
user/worker
open/closed
delayed avalanche
worker activity
damage to people
<table>
<thead>
<tr>
<th>Country</th>
<th>Accidents</th>
<th>Fatal Accidents</th>
<th>Persons involved</th>
<th>Fatalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada 1904-2014</td>
<td>91</td>
<td>19</td>
<td>192</td>
<td>87</td>
</tr>
<tr>
<td>Italy 1978-2014</td>
<td>69</td>
<td>15</td>
<td>117</td>
<td>28</td>
</tr>
<tr>
<td>Switzerland 1909-2014</td>
<td>142</td>
<td>54</td>
<td>537</td>
<td>115</td>
</tr>
<tr>
<td>U.S. 1902-2014</td>
<td>106</td>
<td>35</td>
<td>411</td>
<td>152</td>
</tr>
<tr>
<td>all</td>
<td>408</td>
<td>123</td>
<td>1257</td>
<td>382</td>
</tr>
</tbody>
</table>
## User (1978-2014)

<table>
<thead>
<tr>
<th>Country (N)</th>
<th>Corridor status = open</th>
<th>Transport type = road</th>
<th>Delayed avalanche = yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada (39)</td>
<td>100%</td>
<td>100%</td>
<td>3%</td>
</tr>
<tr>
<td>Italy (29)</td>
<td>96%</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Switzerland (46)</td>
<td>87%</td>
<td>93%</td>
<td>9%</td>
</tr>
<tr>
<td>U.S. (35)</td>
<td>100%</td>
<td>97%</td>
<td>22%</td>
</tr>
<tr>
<td>all (149)</td>
<td>95%</td>
<td>97%</td>
<td>8%</td>
</tr>
</tbody>
</table>

## Worker (1978-2014)

<table>
<thead>
<tr>
<th>Country (N)</th>
<th>Corridor status = open</th>
<th>Transport type = road</th>
<th>Activity = snow clearing</th>
<th>Delayed avalanche = yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canada (8)</td>
<td>75%</td>
<td>75%</td>
<td>50%</td>
<td>33%</td>
</tr>
<tr>
<td>Italy (11)</td>
<td>22%</td>
<td>91%</td>
<td>100%</td>
<td>0%</td>
</tr>
<tr>
<td>Switzerland (14)</td>
<td>25%</td>
<td>79%</td>
<td>92%</td>
<td>36%</td>
</tr>
<tr>
<td>U.S. (17)</td>
<td>47%</td>
<td>94%</td>
<td>50%</td>
<td>41%</td>
</tr>
<tr>
<td>all (50)</td>
<td>41%</td>
<td>86%</td>
<td>79%</td>
<td>29%</td>
</tr>
</tbody>
</table>
Temporal Trends
Case Studies

### British Columbia

- **Number of accidents or fatalities**
- **Years:** 1950-2010
- **Graph categories:**
  - All accidents
  - Accidents with fatalities
  - Fatalities

### Colorado

- **Number of accidents or fatalities**
- **Years:** 1950-2010
- **Graph categories:**
  - All accidents
  - Accidents with fatalities
  - Fatalities
Limitations

- Various sources, different recording methods
- Fatal vs nonfatal accident reporting
- Not a complete study
Workers

Industry standards and continuous quality training

Right equipment for the job
Workers

Eliminate uncertainty
Since 1995 majority of fatalities have been workers clearing snow or debris

Delayed Avalanches pose a serious threat to workers and users

Significant decrease in avalanche accidents and fatalities with avalanche safety programs
Acknowledgments

- ANEIVA and Avalanche Center of Arabba
- Canadian Avalanche Center
- Colorado Avalanche Information Center
- British Columbia Ministry of Transportation
- Alaska Railroad Corporation
- WSL Institute for Snow and Avalanche Research SLF
- Alaska Department of Transportation and Public Facilities
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