Five years use of Pulse Doppler RADAR- technology in debris-flow monitoring in comparison with other well established technologies.

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Umhausen

System Umhausen/ Tirol/ Austria
Principle of the Radar

- The RADAR emits modulated pulses
- Max. measurement distance $R=2.5$ km
- RG-length $r_{RG}=15-250$ m
- Velocities up to 300 km/h are detected simultaneously in each RG
- If there is a hazardous event (fast moving objects), an alarming trigger is activated.
Technology and Benefits of the System

- Reliable recognition of avalanches and mudslides
  - Minimization of false alerts
- Recognition of risk in real time
  - Maximum warning
- Multifunctional measuring and alert system
  - Water level
  - Debris flow/flood
  - Heavy rainfall
  - Snow avalanche
- Low installation requirements
  - Only a mast and a power supply of 40 W
## Specification

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Quantity</th>
<th>Tolerance</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode</td>
<td>Pulse/PCM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td>10,0-10,5</td>
<td></td>
<td>GHz</td>
</tr>
<tr>
<td>Power C.</td>
<td>40</td>
<td>&lt;</td>
<td>W</td>
</tr>
<tr>
<td>Range</td>
<td>30-2500</td>
<td></td>
<td>m</td>
</tr>
<tr>
<td>Targetsize</td>
<td>1</td>
<td>min &gt; at 2km</td>
<td>m²</td>
</tr>
<tr>
<td></td>
<td>0,25</td>
<td>min &gt; at 1km</td>
<td>m²</td>
</tr>
<tr>
<td>Velocity</td>
<td>0,2-100</td>
<td>min/max</td>
<td>m/s</td>
</tr>
<tr>
<td>RG</td>
<td>128</td>
<td>max</td>
<td></td>
</tr>
<tr>
<td>RG-length</td>
<td>15-250</td>
<td>min/max</td>
<td>m</td>
</tr>
</tbody>
</table>
Lattenbach View
Example Data Lattenbach

Data Analysis 23-26.08.2012: Example Data Frame

- Sum of Velocity Spectrum
- 1 Frame each 0.3 s
- Velocity Spectrum of Cursor Position
Water Level Lattenbach

Data Analysis 23-26.08.2012: RG 6 Low Water Level
Data Analysis 23-26.08.2012: RG 6 High Water Level → Alarm
Data Analysis 23-26.08.2012: Water Level Radar versus Ultrasound sensor U1;U2
Data of RG 4: 2 months (07/08 2014)
Debris Flow Lattenbach

Small Debris Flow Event from 26.08.2012 RG6

Debris Flow Data

Velocity Spectrum
Debris Flow Lattenbach

Small Debris Flow Event from 26.08.2012 RG5

Debris Flow Data

Velocity Spectrum
Debris Flow Lattenbach

Small Debris Flow Event from 26.08.2012 RG4

Debris Flow Data

Velocity Spectrum
Debris Flow Lattenbach

Debris Flow Event from 09.08.2015 21:03
Debris Flow Lattenbach

Debris Flow Event from 09.08.2015 21:03
Debris Flow Lattenbach

Debris Flow Event from 09.08.2015 21:03

Velocity Spectrum
Debris Flow Lattenbach

Debris Flow Event from 09.08.2015 21:03

Velocity Spectrum
Technology and Benefits of the System

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Debris Flow Lattenbach
Debris Flow Lattenbach

Debris Flow Event from 09.08.2015 21:03

Velocity Spectrum
Umhausen

System Umhausen
Debris Flow Umhausen

System Umhausen Event from 04.08.2015 19:30
Debris Flow Umhausen

System Umhausen Event from 04.08.2015 19:45
Debris Flow Umhausen

System Umhausen Event from 04.08.2015 19:46

NO PHOTO
Debris Flow Umhausen

System Umhausen Event from 04.08.2015 20:00
Debris Flow Umhausen

System Umhausen
Debris Flow Umhausen

System Umhausen RG 1 over 45 Minutes

Debris Flow Peak at 19:46
RG1 over Time

Velocity Spectrum
Debris Flow Umhausen

System Umhausen: Different Moving Objects
### Debris Flow Detection Rate for installed Radar Systems:

<table>
<thead>
<tr>
<th>Place of Radar</th>
<th>Years of operation</th>
<th>Alarm and Debris Flow</th>
<th>False Alarm</th>
<th>No Alarm Debris Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lattenbach Austria</td>
<td>2012-</td>
<td>4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Umhausen Austria</td>
<td>2014-</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Dongchuan China</td>
<td>2015-</td>
<td>0</td>
<td>0</td>
<td>1*</td>
</tr>
</tbody>
</table>

*...system defect after lightning*
Conclusion

- We are able to detect reliable even smallest debris flows and avalanches
- We are able to detect very accurate water levels
- We are able to trigger an alarming system within a second
- We are also able to detect heavy rainfalls up in the sky
Thank You