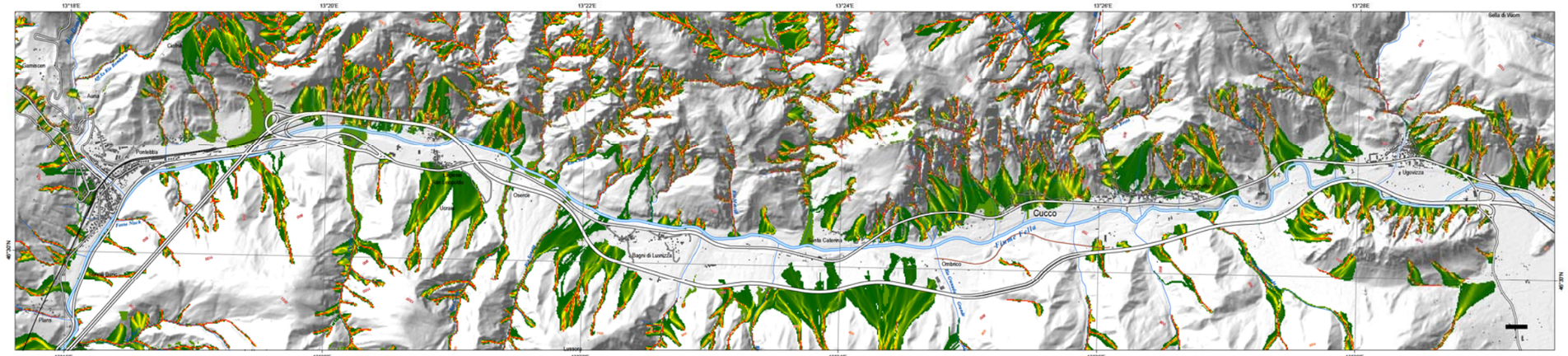
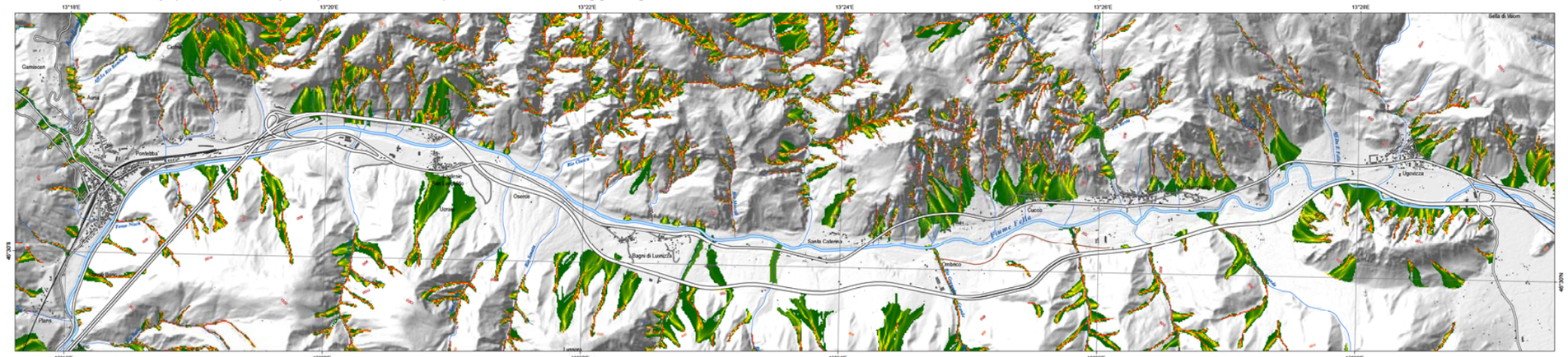
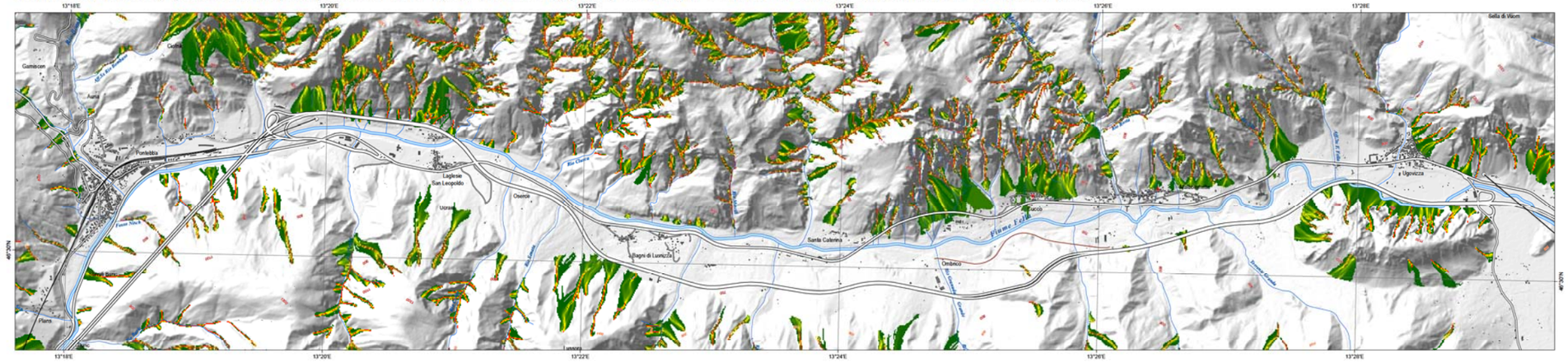
Debrisflow intensity (maximum impact pressure in KPa) for a major triggering event with estimated Return Period between 100 and 500 years



Debrisflow intensity (maximum impact pressure in KPa) for a moderate triggering event with estimated Return Period between 25 and 100 years



Debrisflow intensity (maximum impact pressure in KPa) for a minor triggering event with estimated Return Period between 10 and 25 years

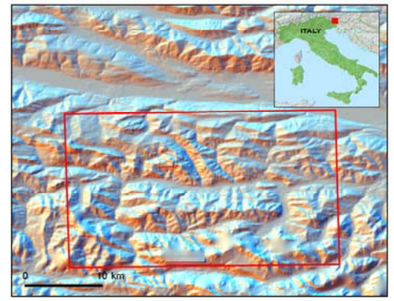


Debrisflow intensity maps

for different return periods

Fella River/ Italy

Overview map



Legend

Population
- Settlement

Hydrology
- River
- Stream

Debris flow runout susceptibilty
- Very High (35 KPa)
- Moderate
- Very Low (0 KPa)

Infrastructure / Transport
- Motorway
- Primary road
- Secondary road
- Residential road
- Railway
- Railway tunnel

Elevation
- Normal Contourline
- Index Contourline

Contour Interval 20 meter

Interpretation

The debris flow run-out modeling was carried out using the Flow-R software (University of Lausanne). Source areas were identified based on thresholds in planar curvature, slope and flow accumulation and were also concidered only for the very high susceptibility areas. Source points were also added of past debris flow events from 4 different return periods which were determined from historic landslide and rainfall data. The 4 different return periods are: (1) 1-10 years (frequent events), (2) 10-25 years (minor events), (3) 25-100 years (moderate events) and (4) 100-500 years (major events). Two parameters were required to model the run-outs for each return period in the Flow-R model: the minimum travel angle and the maximum velocity. These two parameters were back calibrated based on 1 or 2 landslides from each return period.The back calibration included 2 sets of parameters, a minimum and maximum in order to include uncertainty in the parameter values. The table shows the model parameters used to produce the run-out maps for each return period.
The output of the run-out modeling was the maximum probability. In order to estimate an intensity value for the modeled run-outs, we transferred the probability values into impact pressures using linear transfer functions (See Figure). These functions are based on two factors: the spatial distribution and variation of the probability values within the debris flow morphology and the estimated impact pressures in the field based on damage assessments of past events. As the severity for events with lower return periods increases, so does the impact pressure. Therefore, the minimum and maximum run-out maps of each return period is assigned a different transfer curve. The transfer functions used for each return period are shown in the table. Run-out polygons from the historic inventory of each return period were also included in the intensity map and were assigned average modeled intensity values (at building locations) corresponding to the same return periods.

Data Sources

The landslide susceptibility map was first applied to identify the very high susceptibility zones for source areas. The Digital Elevation Model (DEM) of the Fella River Basin aquired from laser scanning in 2003 was used to calculate the thesholds for plan curvature, slope and flow accumulation. The historic debris flow inventory produced through the analysis of historic archives and interpretation of aerial and satellite imagery between 1996 and 2011 by the Italian Landslide AVI and IFFI projects, the Geological Service of Friuli-Venezia Giulia (FVG) region and landslide experts from the University of Trieste.
Data collection was coordinated by Simone Frigerio and Alessandro Pasuto (CNR-IRPI)

Cartographic Information

Scale 1:25,000

0 0.5 1 2 3

Kilometers

Framework

This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement n° 312461 (Increasing Resilience through Earth Observation - IncREO - www.increo-fp7.eu). The IncREO project is coordinated by Airbus Defence & Space (Spot Image S.A.).

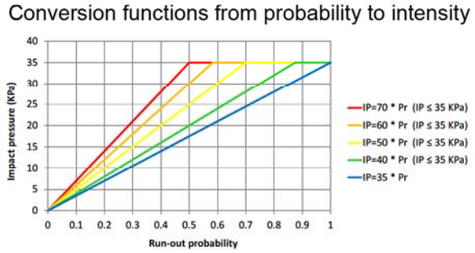
Work package partners:

Compilation of the landslide inventory was done by Lixia Chen and Haydar Hussin (UT-ITC).
Landslide initiation modelling was done by Haydar Hussin (UT-ITC), Simone Sterlacchini, and Paola Reichenbach (CNR-IRPI).
Runout modelling was done by Haydar hussin and Cees van Westen (UT-ITC)
Map produced by: Koert Sijmons (GeoMapa) © 2014

Parameters used in the modelling

Scenario (Return period)	Range	Travel angle (degrees)	Velocity (m/s)	Transfer function	Spatial probability
Major (100-500y)	Maximum	13	15	IP = 70 * Pr (if IP ≤ 35, else IP=35)	0.194
	Minimum	15	10	IP = 60 * Pr (if IP ≤ 35, else IP=35)	0.245
Moderate (25-100y)	Maximum	15	10	IP = 60 * Pr (if IP ≤ 35, else IP=35)	0.1
	Minimum	18	8	IP = 50 * Pr (if IP ≤ 35, else IP=35)	0.131
Minor (10-25y)	Maximum	17	8	IP = 50 * Pr (if IP ≤ 35, else IP=35)	0.028
	Minimum	20	8	IP = 40 * Pr (if IP ≤ 35, else IP=35)	0.05
Frequent (1-10y)	Maximum	20	5	IP = 40 * Pr (if IP ≤ 35, else IP=35)	0.006
	Minimum	22	4	IP = 35 * Pr	0.006

Conversion functions from probability to intensity



● Points located in the maps

Damage from the 2003 debris flow event

Damage from the 2003 debris flow event