



Costruire in Zone di pericolo – le analisi di compatibilità come analisi di rischio

Bauen in Gefahrenzonen - Kompatibilitätsanalysen als
Beispiel für eine lokale Risikoanalyse

Building in hazard zones - compatibility analyses as an
example of a local risk analysis

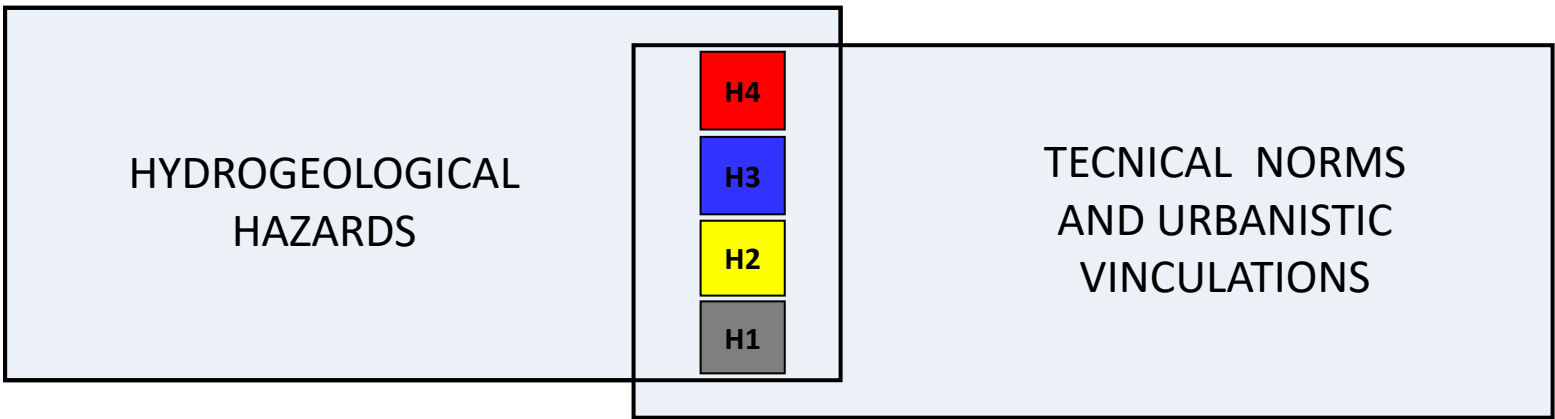
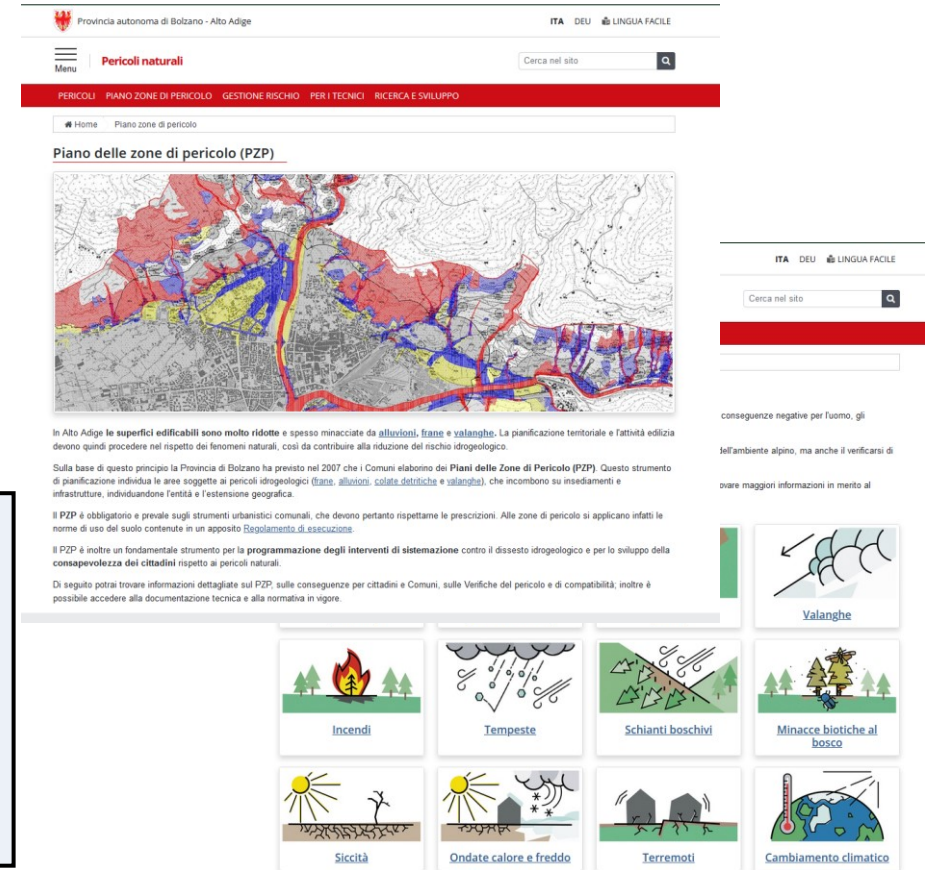
Rovereto, 07/03/2024

Volkmar Mair, Claudia Strada, Kathrin Lang, Daniel Costantini & Pierpaolo Macconi



- Introduction of hazard maps in order to control urban development and construction activities according to the principle of risk reduction
- important instrument for spatial planning prevention and also for the planning of protection measures and civil protection activities risk management

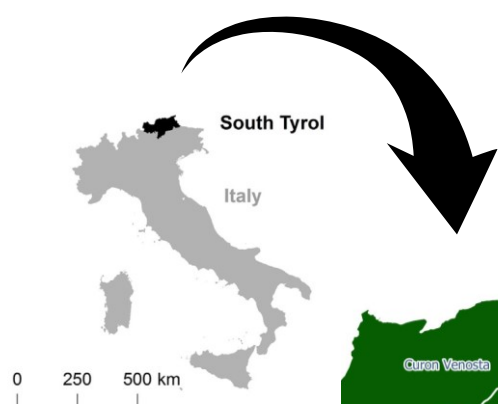
For more detailed information, please visit the following website:
<https://pericoli-naturali.provincia.bz.it/it/home>



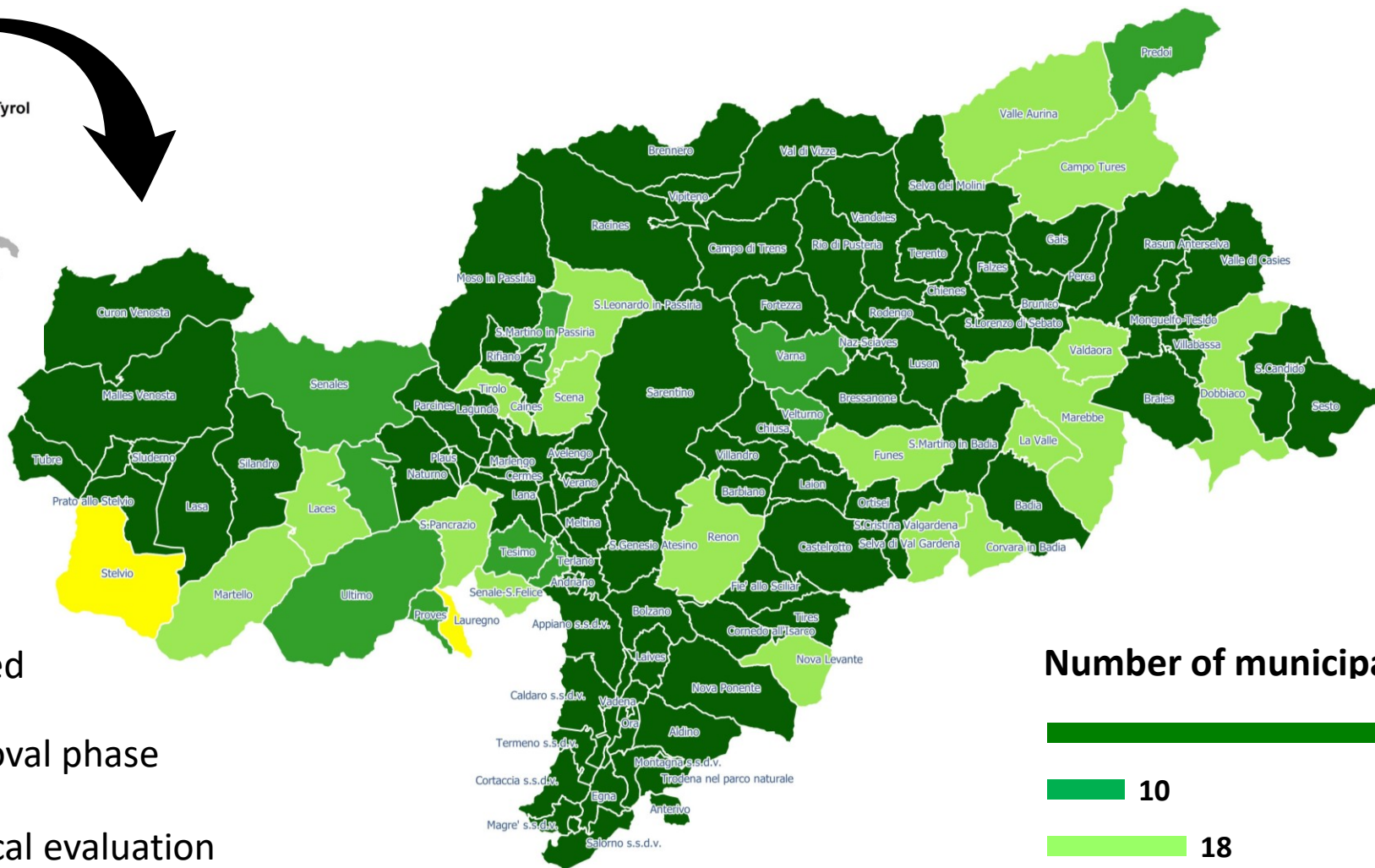


Current status of hazard maps in the Autonomous Province of Bolzano

<https://pericoli-naturali.provincia.bz.it/it/stato-di-attuazione-in-alto-adige>

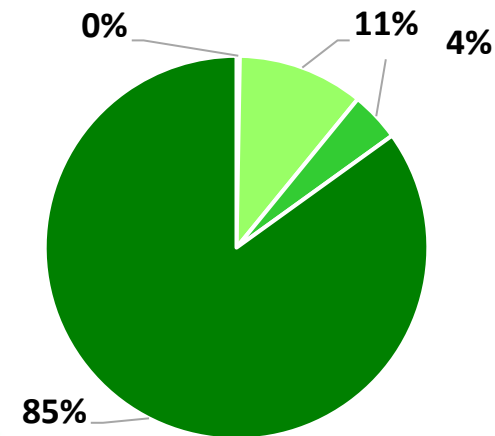


0 250 500 km



- approved
- in approval phase
- in technical evaluation
- in elaboration

Number of inhabitants



Number of municipalities



Based on approved hazard maps, the **public administration** and **other stakeholders** have a very good basis for multi-scale and target-specific risk analyses

The **intersection of hazard maps with different data exposure**, collected in a specific database, via different geoprocessing routines, opens up a multitude of possibilities

Basic data for risk management

- ✓ Addresses with number of inhabitants and companies with number of employees



- ✓ Number and type of buildings



- ✓ Strategic civil protection facilities

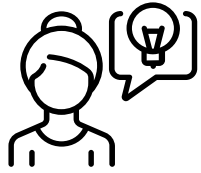


- ✓ Network infrastructures (electricity, water, wastewater, telecommunications)



- ✓ Transport infrastructures (with characteristics such as average daily traffic volume)

Possibilities for reducing risk



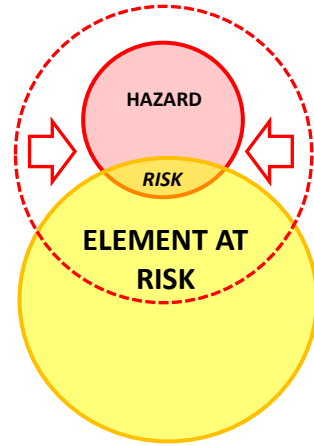
$$R = H \times V \times E$$

H = Hazard

V = Vulnerability

E = Element at risk

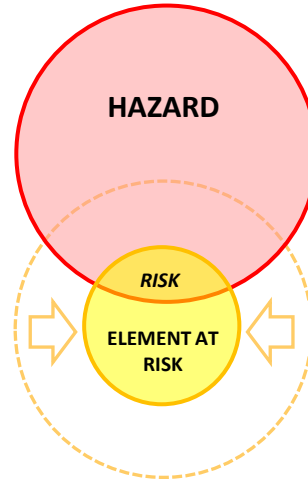
HAZARD REDUCTION



PROTECTIVE MEASURE



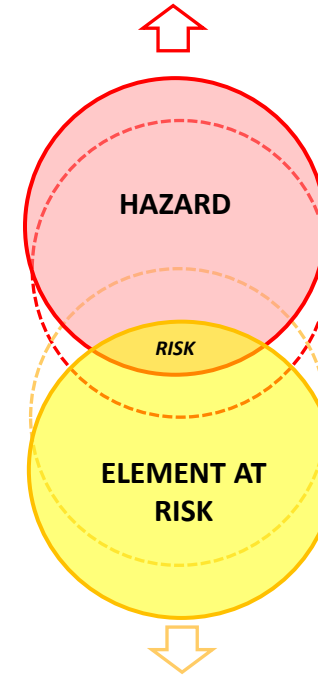
VULNERABILITY REDUCTION



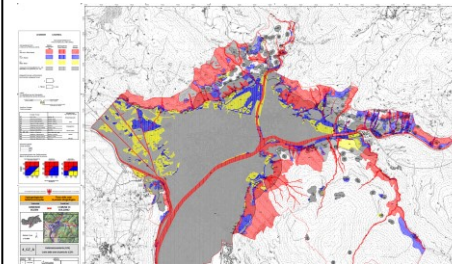
COMPATIBILITY



EXPOSITION REDUCTION



URBANISTIC PLANNING



MANAGEMENT OF RESIDUAL RISK



CIVIL PROTECTION SYSTEM



With 4 documents everything is regulated:

At the beginning: Provincial law, (Art. 22/bis introduced in 2007)

Today: Provincial law N°9/2018, Art. 55, 56

Guidelines for hazard zone planning (introduced by resolution of the provincial government dated 28.08.2008, No. 2741.) Today: resolution of prov. governm. Nr. 989 dated 13. 09.2016

AUTONOME PROVINZ BOZEN - SÜDTIROL
Abteilung 27 - Raumordnung

PROVINCIA AUTONOMA DI BOLZANO - ALTO ADIGE
Ripartizione 27 - Urbanistica

Legge provinciale 11 agosto 1997, n. 13 (1)
Legge urbanistica provinciale

Art. 22/bis (Piani delle zone di pericolo)

(1) La Landesregierung genehmigt die Richtlinien zur Erstellung der Gefahrenzonenpläne. Mit der Genehmigung werden die Bestimmungen über die zulässigen Vorhaben und der Maßnahmen zur Abwendung von Gefahren oder Schäden durch Naturereignisse, differenziert nach Grad und Art der festgestellten Gefahr, festgelegt.

(2) Die Gemeinden erstellen innerhalb von drei Jahren ab Genehmigung der Richtlinien gemäß Absatz 1 Gefahrenzonenpläne unter Beachtung der genannten Richtlinien oder passen innerhalb dieser Frist die bereits vorhandenen Studien zur Klassifizierung des hydrogeologischen Risikos denselben an. Die Erstellung von übergemeindlichen Gefahrenzonenplänen wird bevorzugt, wo dies aufgrund der naturräumlichen Situation angebracht ist.

DELIBERAZIONE DELLA GIUNTA PROVINCIALE
28 luglio 2008, n. 2741

Direttive per la redazione dei piani delle zone di pericolo secondo la legge urbanistica provinciale, legge provinciale 11 agosto 1997, n. 13, articolo 22/bis

LA GIUNTA PROVINCIALE
delibera

le direttive allegate sono approvate.

La presente deliberazione e le direttive

BESCHLUSS DER LANDESREGIERUNG

Richtlinien zur Erstellung der Gefahrenzonenpläne gemäß Landesraumordnungsgesetz

beschließt

beiliegenden Richtlinien sind genehmigt.

Implementing regulation on Hazard Zone Plans (introduced by decree of the Governor dated 05.08.2008, No. 42.)

Today: decree of the Governor, dated 10.10.2019, Nr. 23

PROVINCIA AUTONOMA DI BOLZANO - ALTO ADIGE

DECRETO DEL PRESIDENTE DELLA PROVINCIA
5 agosto 2008, n. 42
(Registrato alla Corte dei Conti il 5.11.2008, registro 1, foglio 29)

Regolamento di esecuzione concernente i piani delle zone di pericolo

IL PRESIDENTE DELLA PROVINCIA
vista la deliberazione della Giunta provinciale n. 2740 del 28.7.2008

il seguente regolamento:

Art. 1
Ambito di applicazione

1. Il presente regolamento detta, in esecuzione dell'articolo 22/bis, comma 1, della legge provinciale 11 agosto 1997, n. 13, il regolamento denominato legge, le norme per la redazione dei piani delle zone di pericolo. A questo scopo vengono individuati gli interventi, nonché le misure di difesa ammissibili nelle zone esposte a pericolo idrogeologico.

2. Il presente regolamento detta altresì la procedura per la prevenzione o la riduzione del pericolo idrogeologico e anche per le aree non indagate nei piani delle zone di pericolo, in quanto al momento dell'indagine non sussistono e non sono previsti impianti o attività potenzialmente in pericolo o dalle quali possa scaturire pericolo per impianti che si trovino al di fuori di esse.

3. Le norme del presente regolamento non si applicano per le piste da sci ai sensi della legge provinciale 26 febbraio 1981, n. 6, e funivie di cui legge provinciale 30 gennaio 2006, n. 1.

AUTONOME PROVINZ BOZEN - SÜDTIROL

DEKRET DES LANDESHAUPTMANNES
om 5. August 2008, Nr. 42
(Registriert beim Rechnungshof am 5.11.2008, Register 1, Blatt 29)

Durchführungsverordnung betreffend die Gefahrenzonenpläne

DER LANDESHAUPTMANN
hat den Beschluss der Landesregierung Nr. 2740 vom 28.7.2008 zur Kenntnis genommen und

erlässt

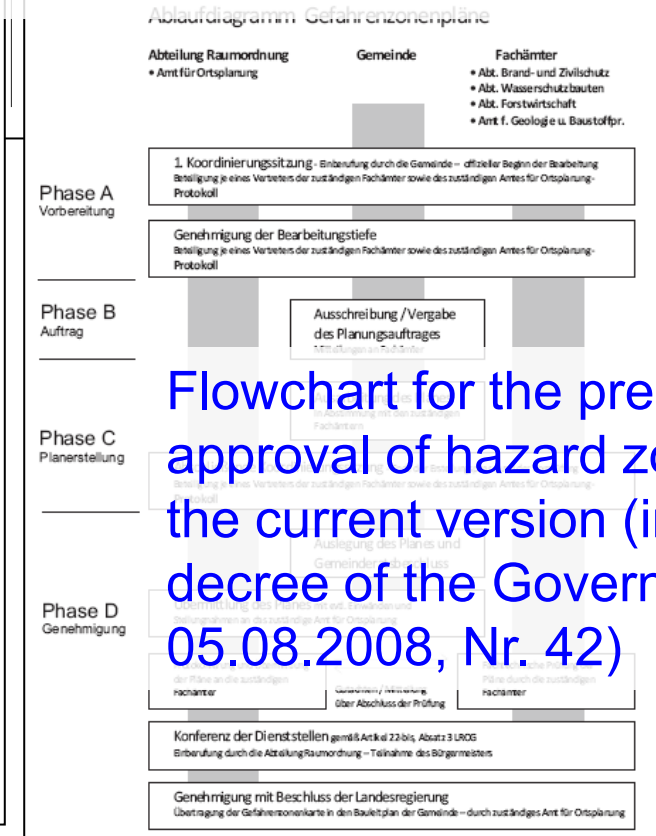
folgende Verordnung:

Art. 1
Anwendungsbereich

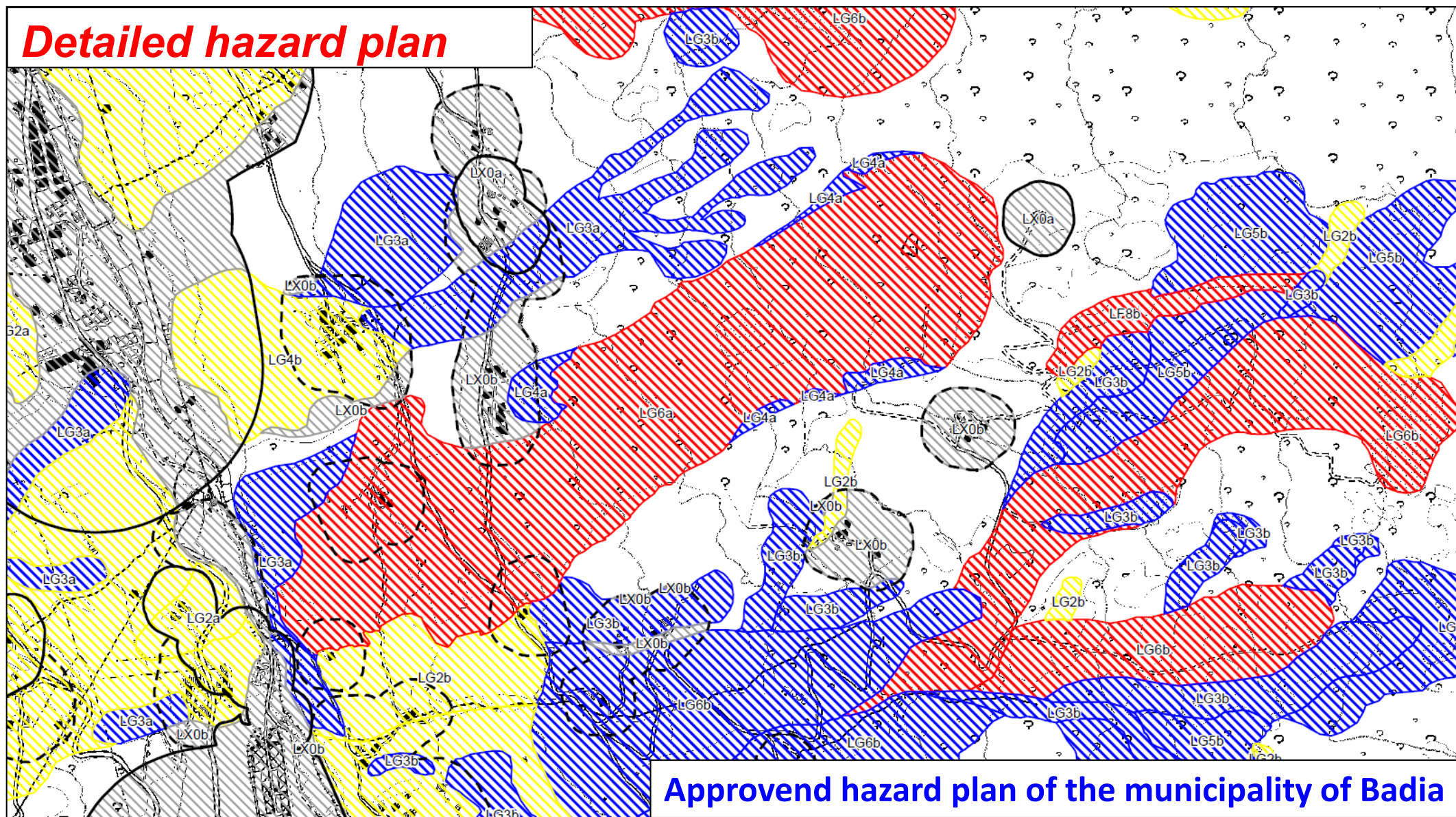
1. Diese Verordnung legt in Durchführung von Artikel 22/bis Absatz 1 des Landesgesetzes vom 11. August 1997, Nr. 13, in der Folge als Gesetz bezeichnet, die Bestimmungen für die Abwendung oder Reduzierung der mit Gefahrenzonenplan ausgewiesenen Gefahren durch Naturereignisse fest. Zu diesem Zweck werden die Eingriffe sowie die Schutzmaßnahmen bestimmt, die in Zonen mit hydrogeologischer Gefahr zulässig sind.

2. Diese Verordnung legt weiters die Vorgangsweise zur Abwendung oder Reduzierung von Gefahren durch Naturereignisse für Gebiete fest, die keine Gefahrenzone bilden, sowie für Gebiete, die nicht im Gefahrenzonenplan untersucht wurden, da dort zum Zeitpunkt der Untersuchung keine potentiell gefährdeten Einrichtungen oder Tätigkeiten bestehen oder vorgesehen sind und von dort auch keine Gefahr für außerhalb liegende Einrichtungen ausgehen kann.

3. Die Bestimmungen dieser Verordnung gelten nicht für Skipisten im Sinne des Landesgesetzes vom 26. Februar 1981, Nr. 6, und Seilbahnen gemäß Landesgesetz vom 30. Jänner 2006, Nr. 1.



Flowchart for the preparation and approval of hazard zone plans in the current version (introduced with decree of the Governor, dated 05.08.2008, Nr. 42)





Hazard analysis for buildings (Art. 10)

area "examined and not H4-H2"
dangerous

Ok

Area with "very high hazard"

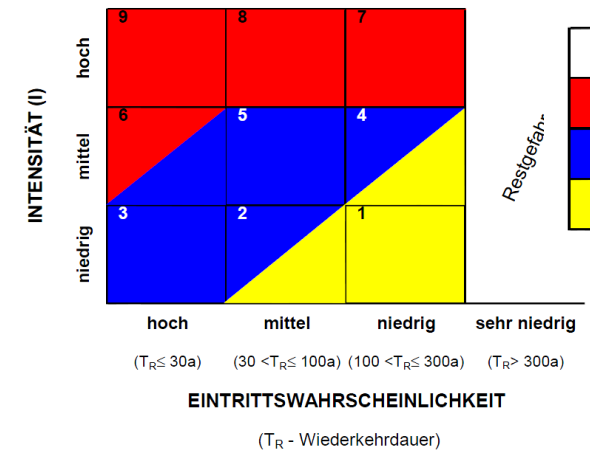
Area with "high hazard"

Only ordinary and extraordinary maintenance possible!!!
Possible cubature relocation

(Art. 11) Compatibility analysis:
Reassessment of the hazard after installation of protective structures and/or the specific risk after object protection measures

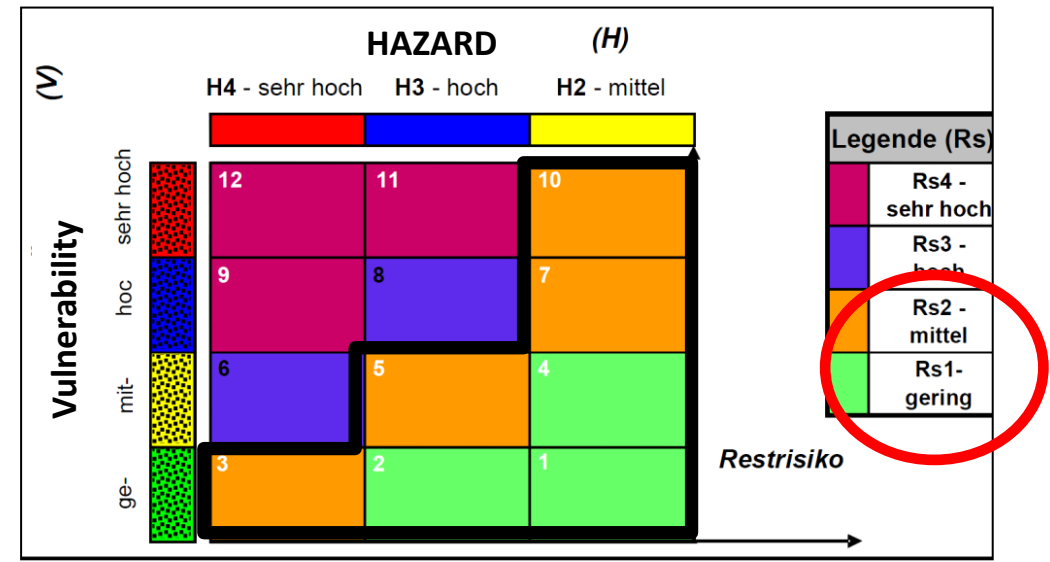
Specific risk "Rs2"

a) MASSENBEWEGUNGEN, WASSERGEFAHREN:



Legende (H):

	H4	sehr hoch
	H3	hoch
	H2	mittel

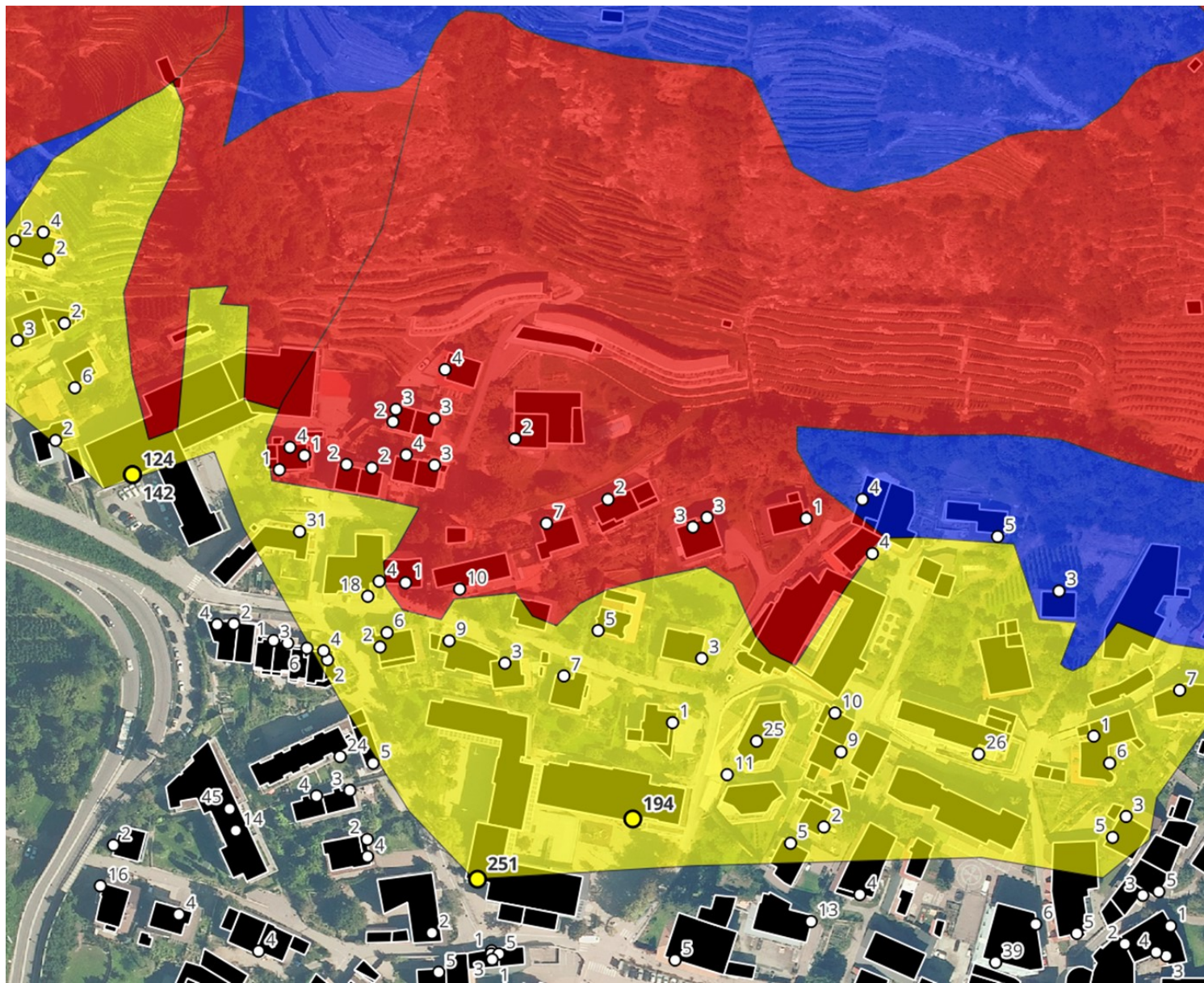


Legende (Rs):

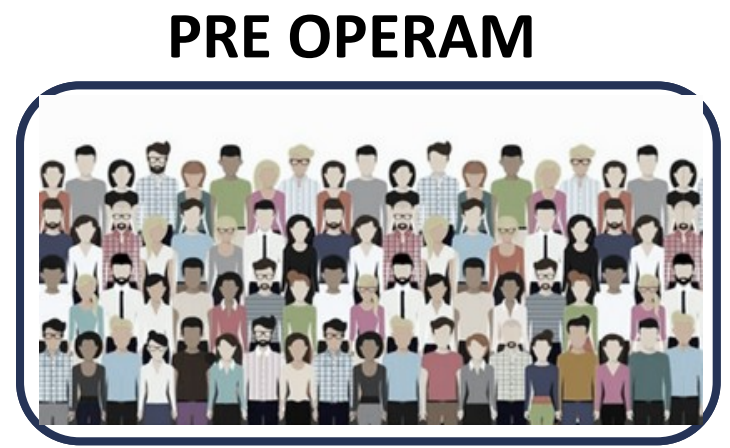
	Rs4 - sehr hoch
	Rs3 - hoch
	Rs2 - mittel
	Rs1 - gering



Case study 1: Hazard reduction for an area in the municipality of Silandro (BZ)



- RED (H4)**
Very high hazard zones, serious damage to buildings and infrastructure is possible, people are at danger both inside and outside buildings
- BLUE (H3)**
High hazard zones, functional damage to buildings and infrastructure is possible, people outside buildings are at danger
- YELLOW (H2)**
Zones with medium danger, minor damage to buildings and infrastructure is to be expected, without any particular danger to persons
- GREY**
Examined zones that are not exposed to any danger at the time of the study



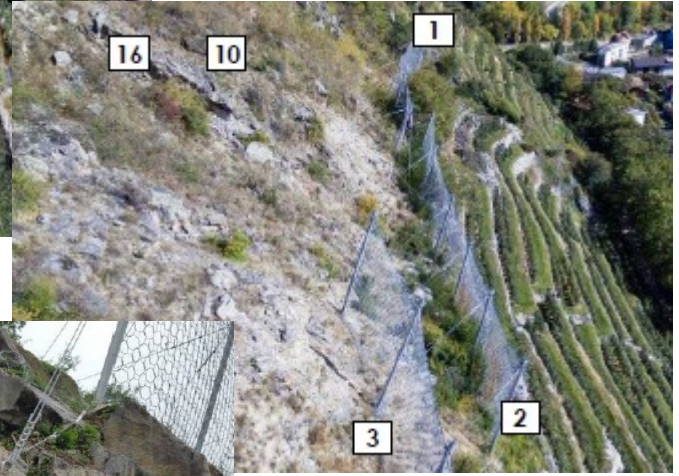


Case study 1: Hazard reduction for an area in the municipality of Silandro (BZ)



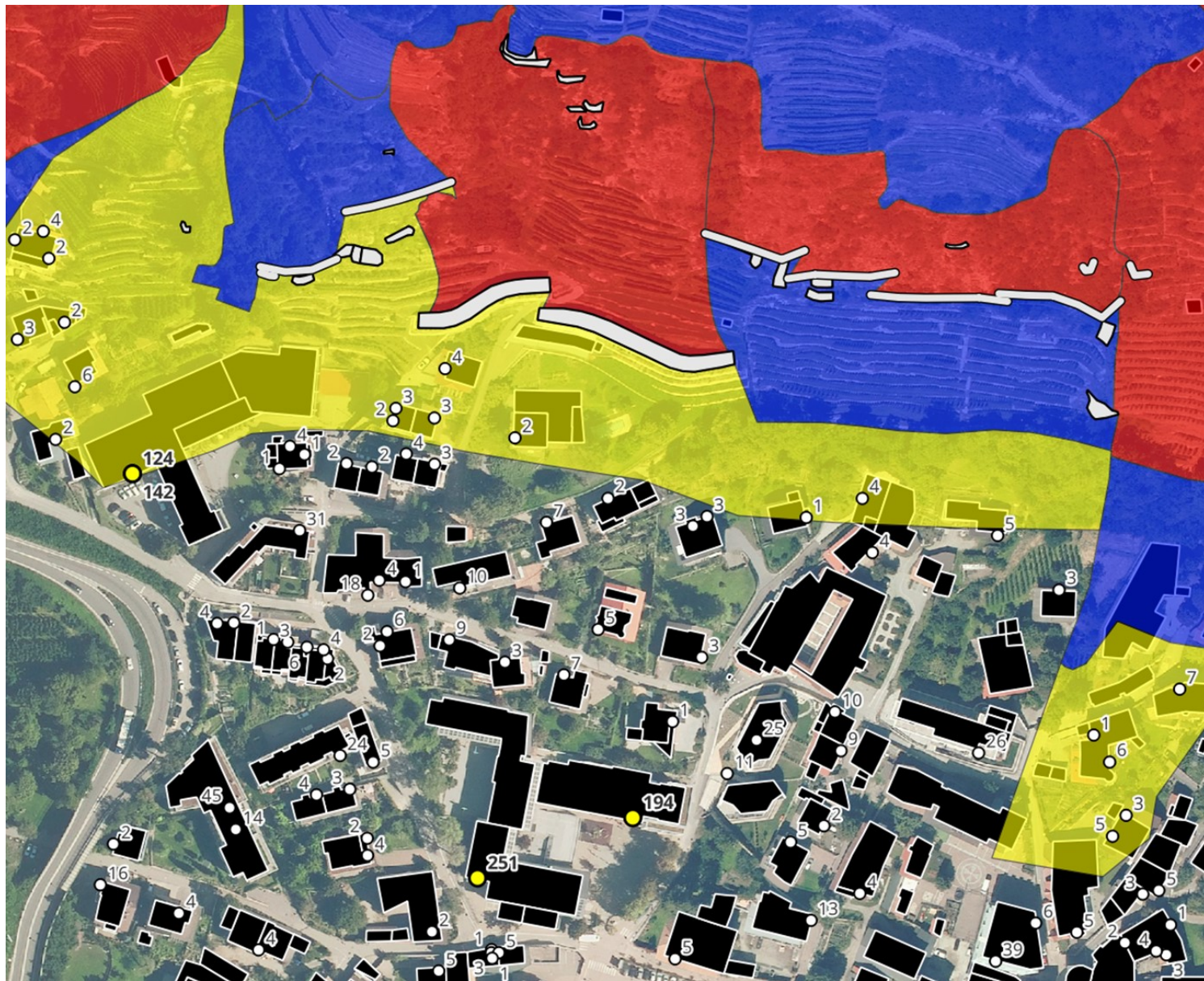
Rockfall event 2013

Rockfall mitigation measures





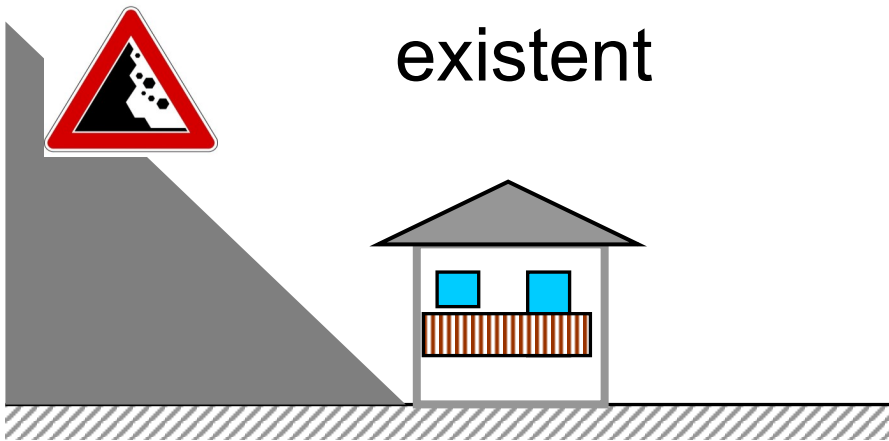
Case study 1: Hazard reduction for an area in the municipality of Silandro (BZ)



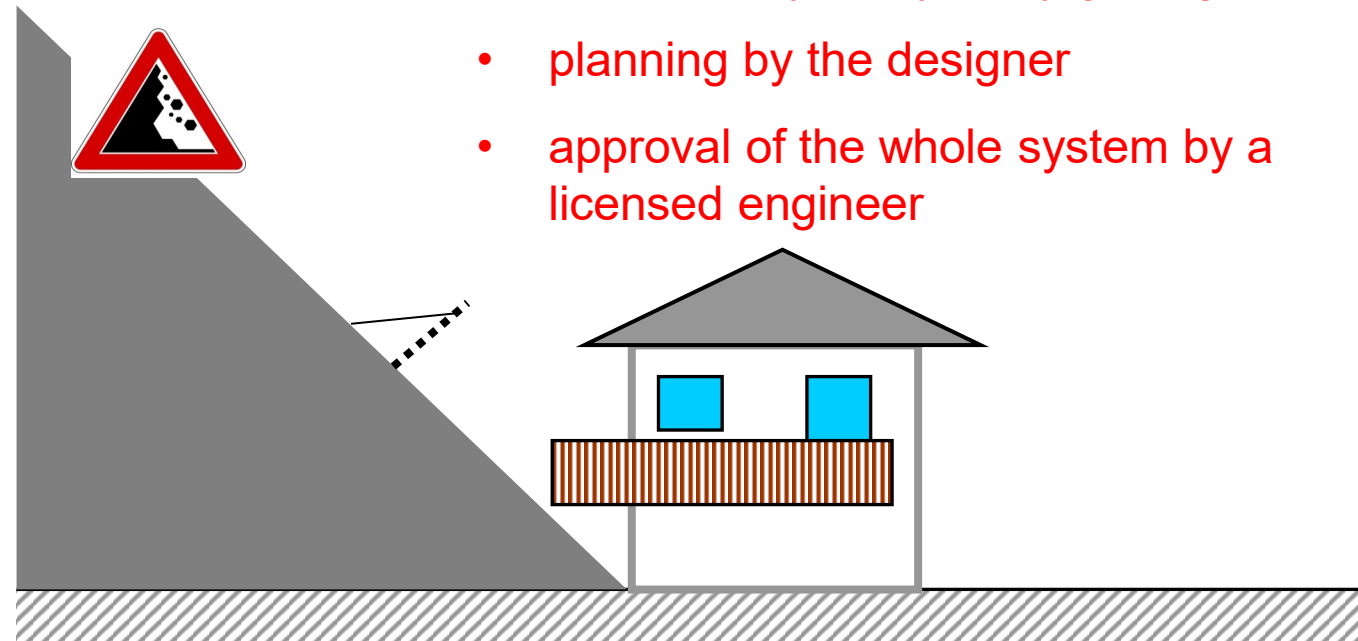
POST OPERAM



!! Prioritization of protective measures and corresponding cost-benefit analyses as well as comprehensible planning with the limited financial resources available !!

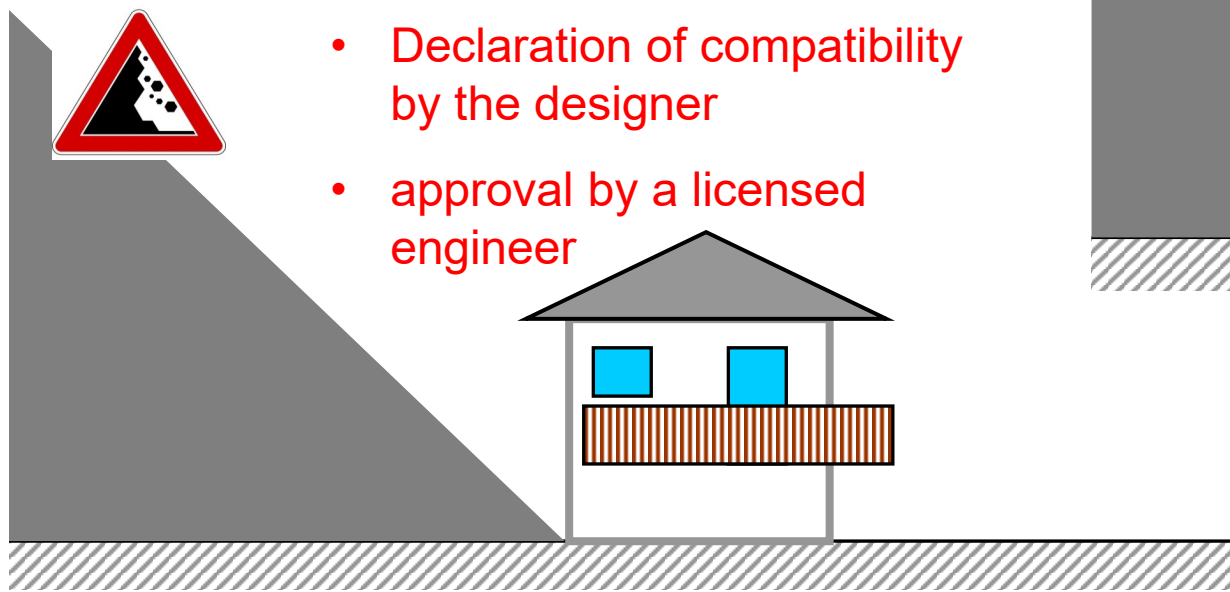


existent



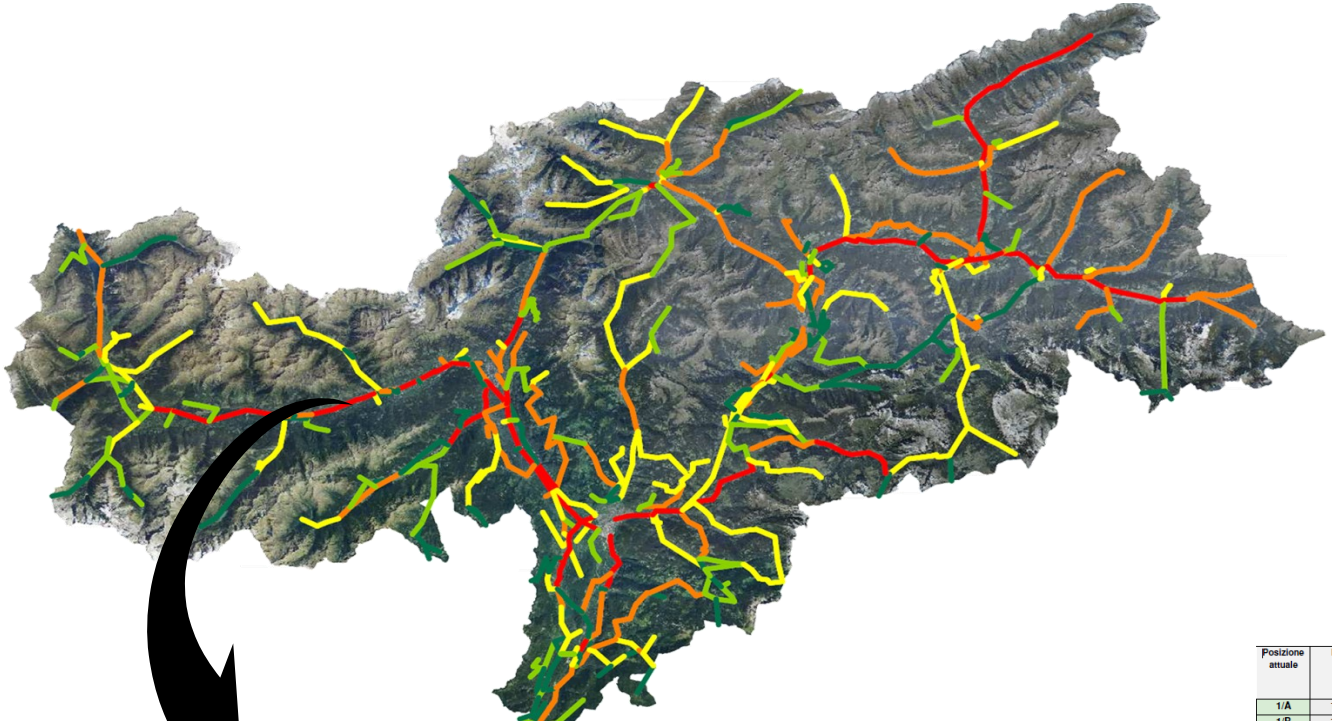
new

- compatibility analysis by geologist
- planning by the designer
- approval of the whole system by a licensed engineer

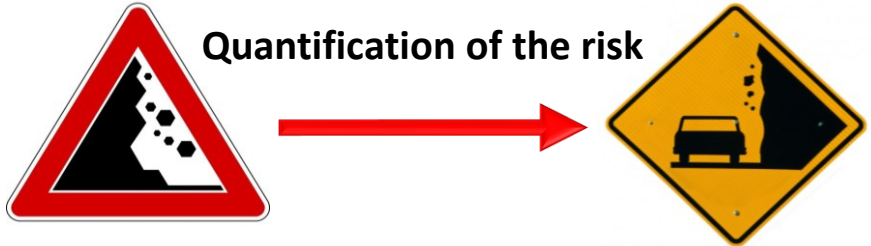


new

- Declaration of compatibility by the designer
- approval by a licensed engineer



Priority list since 2014 for the protection of the existing infrastructure (2745 km!) in the Autonomous Province of Bolzano

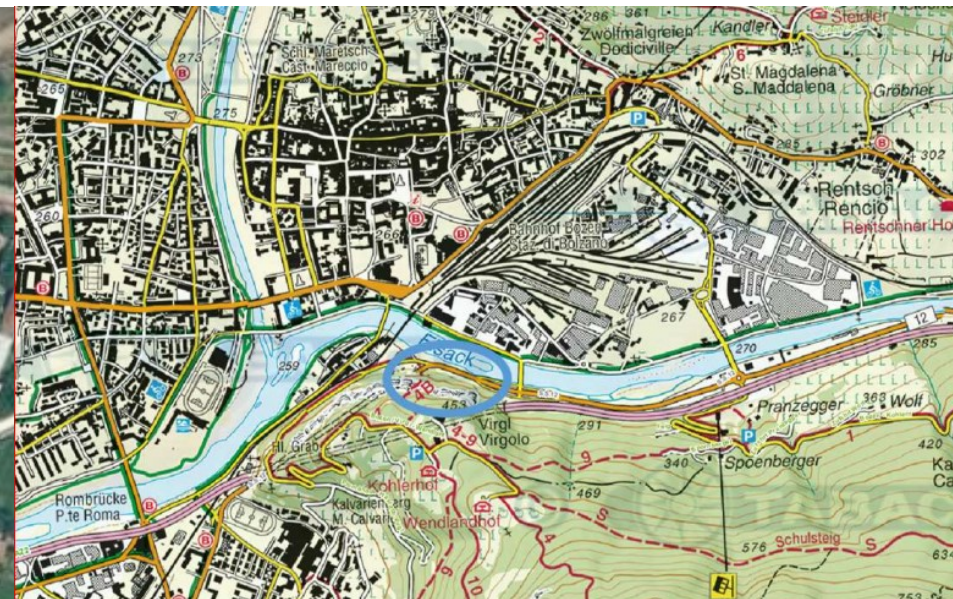
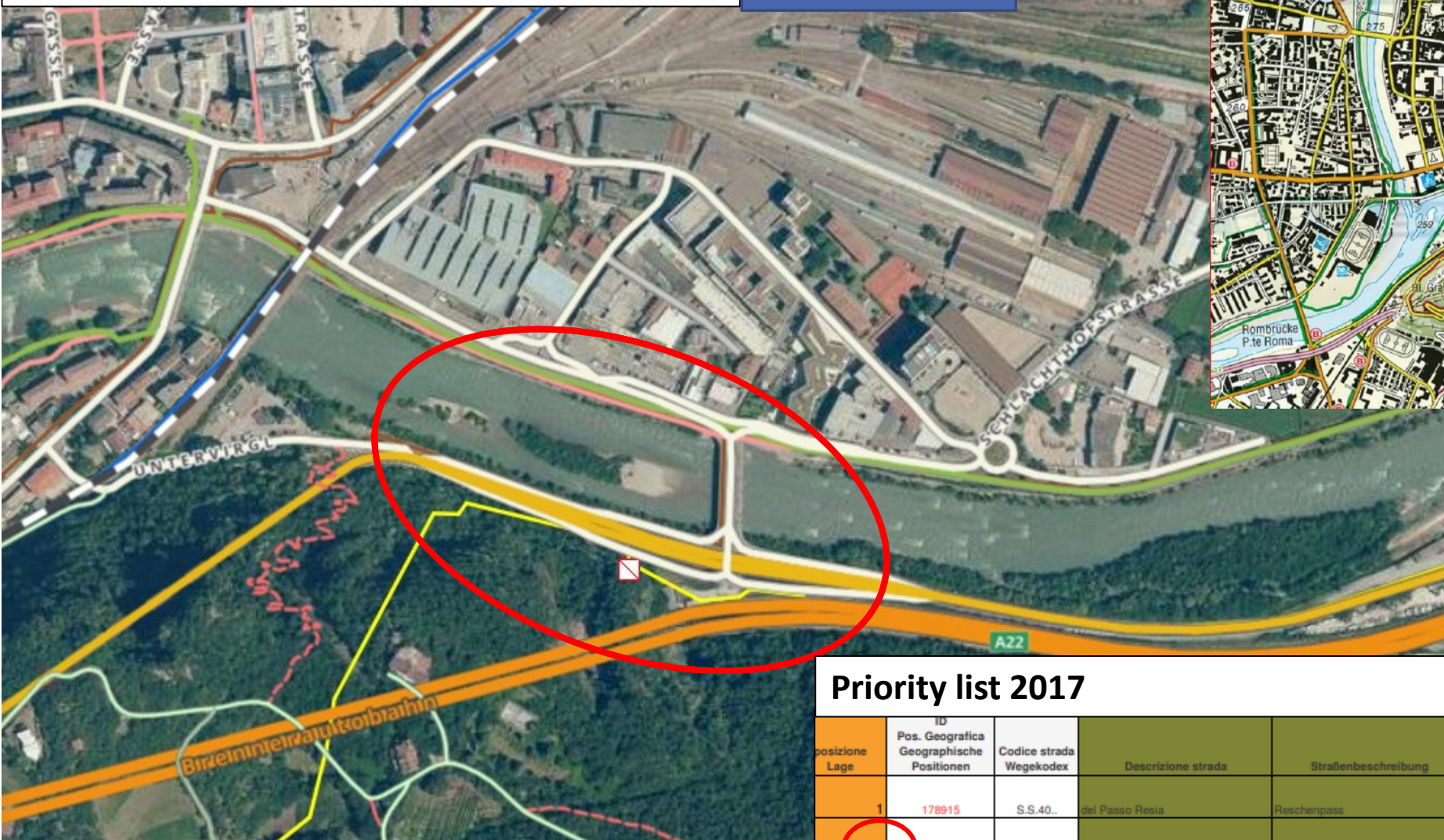


Posizione attuale	ID	Strada Strada	Strassenbeschreibung	descrizione strada	da Km	a Km	H FINALE GEFÄHR PERICOLOSITÀ	d SCHADENSHÖHE DANNO ATTESO	r Risikoeffizienten Coefficienti di rischio	Costo/Kosten
1/A	178856	S.S.38.	Staatsstraße Stilfserjoch	dello Stelvio	173,45	173,91	92,83	0,56	51,70	3.300.000,00
1/B	178856	S.S.38.	Staatsstraße Stilfserjoch	dello Stelvio	175,7	175,95	92,83	0,56	51,70	8.000.000,00
1/C	178856	S.S.38.	Staatsstraße Stilfserjoch	dello Stelvio	173,9	175,3	92,83	0,56	51,70	33.200.000,00
2	268087	S.S.40.	Reschenpass	del Passo Resia	23	24,5	96,39	0,44	42,05	18.000.000,00
3	180623	S.S.44.	Jaufenpass	del Passo di Giovo	9,94	10,1	98,00	0,34	33,08	
4	281569	S.S.12.	Brenner Staatsstraße	dell'Abetone e del Brennero	427,55	427,62	100,00	0,32	32,11	2.132.000,00
6	255870	S.S.38.	Staatsstraße Stilfserjoch	dello Stelvio	173,45	173,91	90,17	0,32	26,54	3.445.000,00
7	223296	S.P.508.	Pfitscherjoch	Val di Vizze	71,372	71,412	73,56	0,37	27,55	7.043.380,40
8	268106	S.S.12.	Brenner Staatsstraße	dell'Abetone e del Brennero	449,56	450,55	91,67	0,30	27,45	
9	267493	S.P.105.	Tarsch - Matscherthal	Tarces - Mazia	5	5,614	86,50	0,28	25,22	
10	221523	S.S.12.	Brenner Staatsstraße	dell'Abetone e del Brennero	467,01	467,67	83,11	0,32	26,93	1.150.000,00
11	268107	S.P.13.	St. Pauls - Umerrain	S. Paolo - Riva di sotto	2	2,5	92,33	0,29	26,92	3.642.717,17
12	199758	S.S.38.	Staatsstraße Stilfserjoch	dello Stelvio	182,83	183,31	84,44	0,32	26,71	
13	284963	S.P.99.	Jenesien	San Genesio	3,75	4,12	94,17	0,28	26,52	501.865,00
14	172708	S.S.12.	Brenner Staatsstraße	dell'Abetone e del Brennero	438,4	438,64	63,11	0,42	26,45	1.284.916,00
15		S.P.508	Pfitscherjoch	Val di Vizze	70+500	71+370	76,56	0,33	26,28	1.287.000,00
16	268108	S.P.48.	Rein in Taulers	Riva di Tures	6,27	7,25	84,56	0,31	26,01	
17	290795	S.P.137.	Durnholz	Valdurna	5,2	5,7	83,83	0,31	25,93	1.021.769,77
18	173875	S.S.241.	Eggental und Karerpass	di Val d'Ega e Passo Costalunga	5,25	5,25	84,22	0,31	25,77	4.711.100,00
19	264585	S.P.130.	Radain	Redagno	2,31	5,28	90,17	0,28	25,52	
20	227672	S.P.48.	Rein in Taulers	Riva di Tures	6,115	6,16	83,56	0,31	25,50	287.991,00
21	208207	S.S.242.	Grödental und Sellajoch	di Val Gardena e Passo Sella	10,355	10,566	91,89	0,28	25,44	1.407.830,41
22	176642	S.S.244.	Gadertal	di Val Badia	5,05	5,11	87,00	0,29	25,35	
23	199988	S.P.48.	Rein in Taulers	Riva di Tures	6,3	6,64	87,00	0,30	26,10	1.287.496,00
24	196410	S.S.12.	Brenner Staatsstraße	dell'Abetone e del Brennero	411,635	412,52	80,22	0,31	25,22	1.248.681,13
25	176436	S.P.3.	Schnalstal	Val Senales	1,4	1,43	81,39	0,30	24,69	
26	268104	S.P.24.	Blumau - Waldbruck	Prato Isarco - Pome Gardena	21,36	21,56	91,22	0,27	24,68	3.702.000,00
27	268111	S.S.508.	Sarnal und Pflschjoch	di Val Sarentino e del Passo di Vizze	15,38	15,75	88,28	0,28	24,65	993.000,00
28		S.S.508	Sarnal und Pflschjoch	di Val Sarentino e del Passo di Vizze	52,8	53,9	93,33	0,26	24,54	1.783.412,20
29	271349	S.P.149.	Meransen	Maranza	1,78	2,18	79,11	0,30	23,44	1.994.502,39
30	255653	S.S.242.	Grödental und Sellajoch	di Val Gardena e Passo Sella	2,23	2,27	89,61	0,26	23,37	



Example: City of Bolzano; Virgolo

TGM = 38000

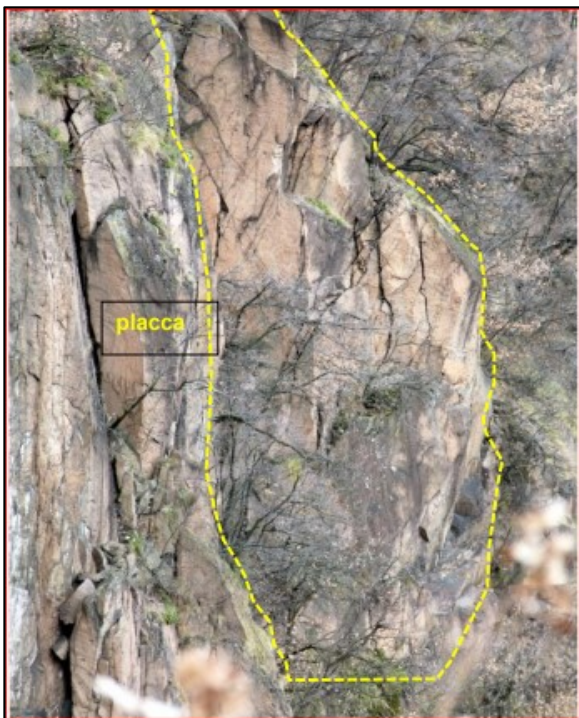


Priority list 2017

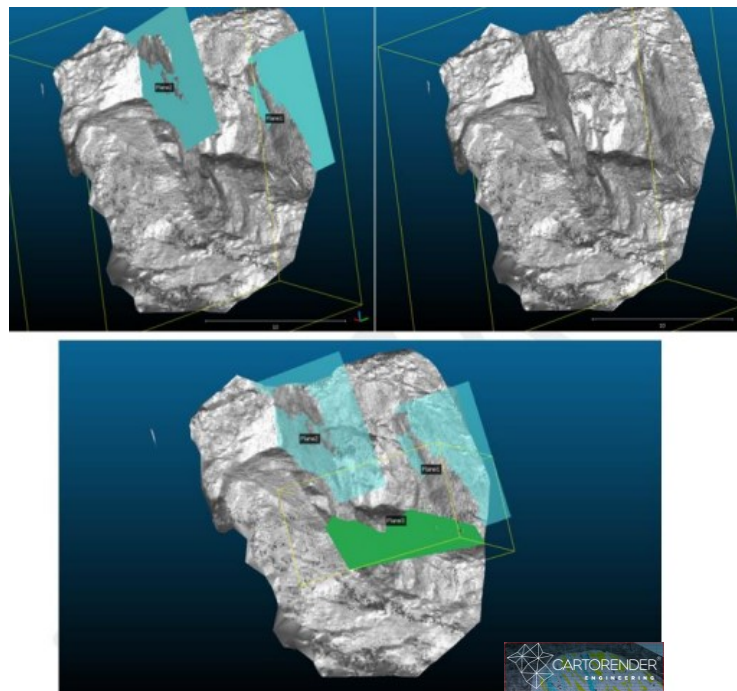
posizione Lage	ID Pos. Geografica Geographische Positionen	Codice strada Wegekodex	Descrizione strada	Straßenbeschreibung	da Km von Km	a Km Km	bis Km	Pericolosità finale Endgültige Gefahr	Danno atteso Erwartere Beschädigung	Coefficiente di rischio Risikokoeffizient
1	178915	S.S.40..	del Passo Resia	Reschenpass	23,00	24,50		96,39	0,88	85,16
2	222087	S.S.12..	dell'Abelone e del Brennero	Brenner Staatsstraße	438,40	438,58		91,28	0,49	44,55
3	210265	S.S.42..	del Tonale e della Mendola	Tonale und Mendelpass	223,35	224,80		99,89	0,38	37,88



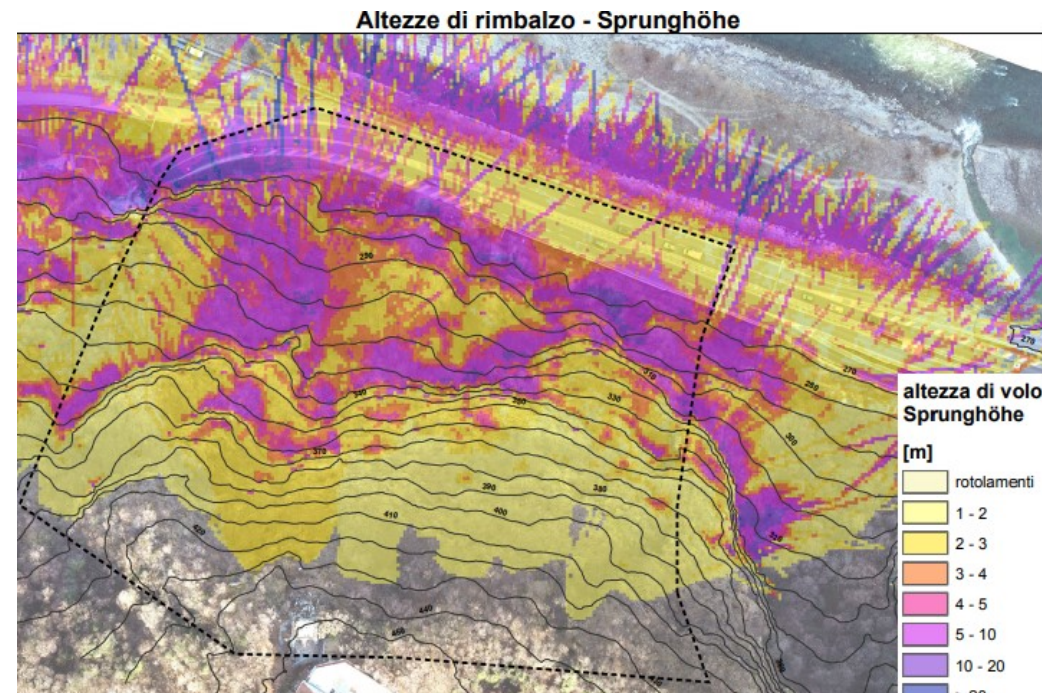
Technical and economic feasibility 31/10/2018 – 24/05/2019



Locate and define unstable areas



Estimate volumes and project blocks



Identify and define trajectories, probability of reaching vulnerable targets, jump height, impact energy

Identify proposed mitigation costs:

Slope:	euro	515.653,20 + 5% imprevisti
Channel:	euro	731.837,98 + 5% imprevisti
Total:	euro	1.306.865,74

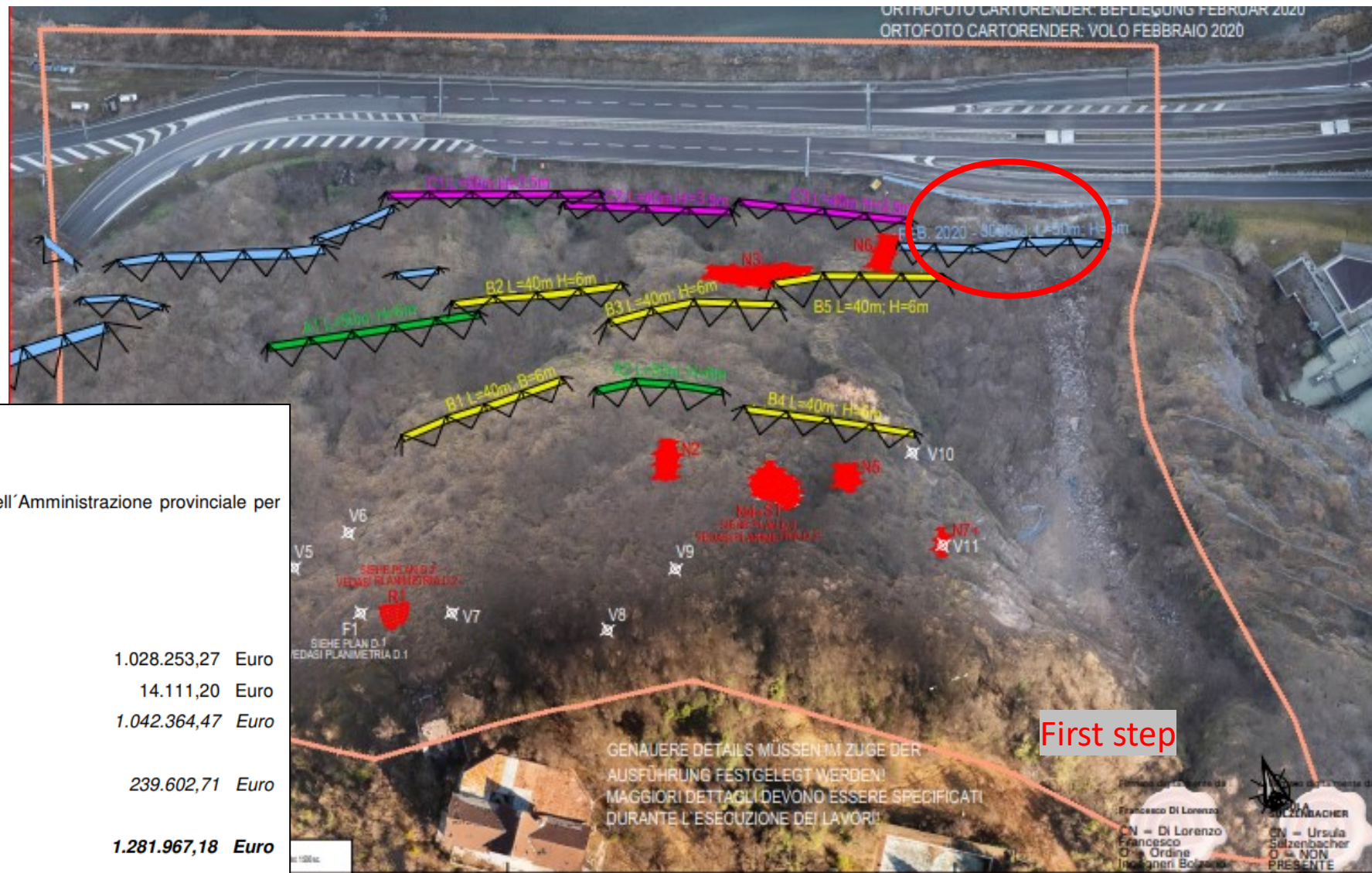


First step: emergency response





Second step: Planning and implementation of mitigation works



7. Sintesi dei costi

Per la definizione dei costi è stato utilizzato l'attuale prezzario dell'Amministrazione provinciale per opere civili non edili.

I costi totali possono essere riassunti come segue:

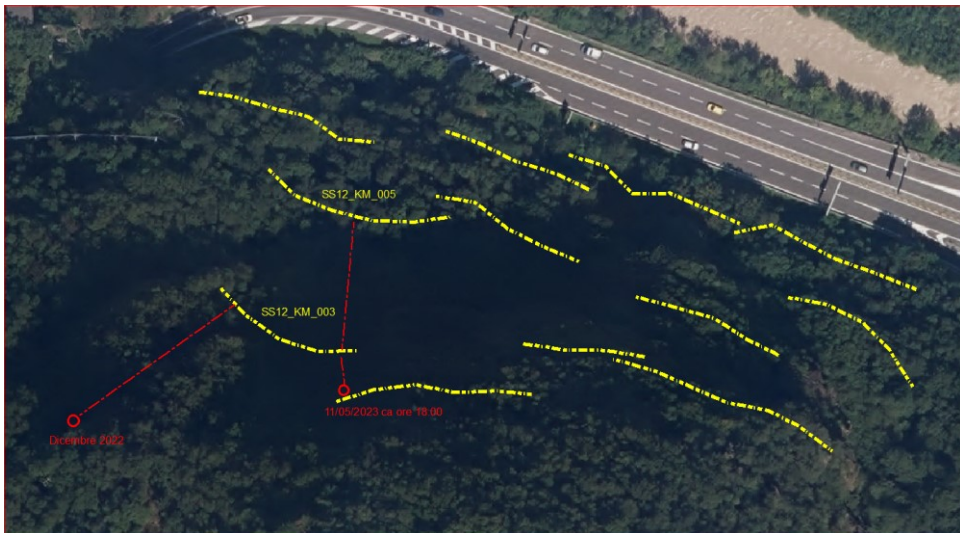
Importo a base d'asta	1.028.253,27	Euro
Costi per le misure di sicurezza	14.111,20	Euro
<i>I. Importo complessivo dei lavori</i>	<i>1.042.364,47</i>	<i>Euro</i>
<i>II. Somme a disposizione dell'amministrazione</i>	<i>239.602,71</i>	<i>Euro</i>
III. IMPORTO TOTALE (I + II)	1.281.967,18	Euro

First step

Francesco Di Lorenzo
 Francesco Di Lorenzo
 Ordine
 Ingegneri Bologna
 CN = Di Lorenzo
 CN = Ursula
 Selzenbacher
 O = NON
 PRESENTE



Case study 2: Hazard reduction on state and provincial roads: the use of the priority list



Priority list 2021

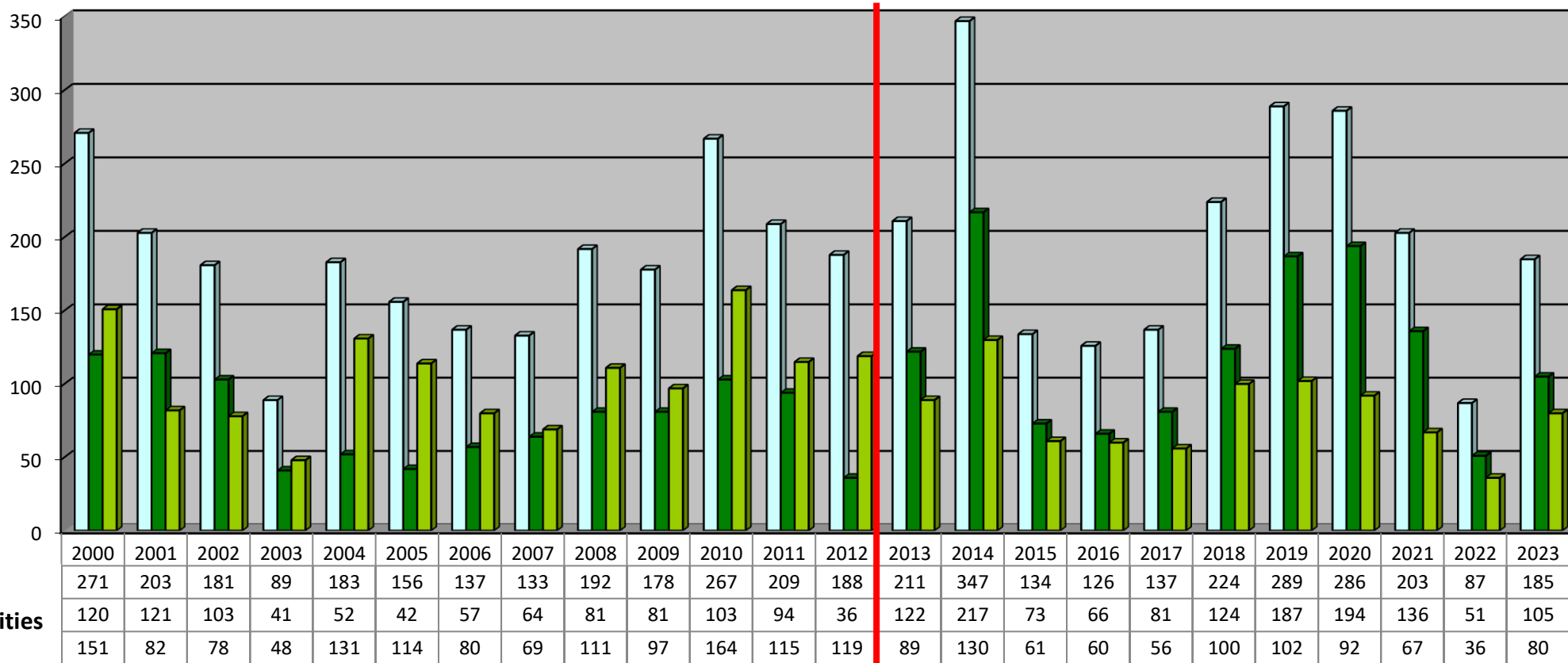
Posizione attuale	ID	Strada Strada	Strassenbeschreibung	descrizione strada	da Km	a Km	H FINALE GEFAHR PERICOLOSITÀ	d SCHADENSHÖHE DANNO ATTESO	f Risikoeffizienten Coefficienti di rischio
1/A	178856	S.S.38..	Staatsstraße Stilfserjoch	dello Stelvio	173,45	173,91	92,83	0,56	51,79
1/B	178856	S.S.38..	Staatsstraße Stilfserjoch	dello Stelvio	175,7	175,95	92,83	0,56	51,79
1/C	178856	S.S.38..	Staatsstraße Stilfserjoch	dello Stelvio	173,9	175,3	92,83	0,56	51,79
2	268087	S.S.40..	Reschenpass	del Passo Resia	23	24,5	96,39	0,44	42,05
3	180623	S.S.44..	Jaufenpass	del Passo di Giovo	9,94	10,1	98,00	0,34	33,08
4	261569	S.S.12..	Brenner Staatsstraße	dell'Abetone e del Brennero	427,55	427,62	100,00	0,32	32,11
6	255870	S.S.38..	Staatsstraße Stilfserjoch	dello Stelvio	173,45	173,91	90,17	0,32	28,54
7	223296	S.P.508..	Pflitscherjoch	Val di Vizze	71,372	71,412	73,56	0,37	27,55
8	268106	S.S.12..	Brenner Staatsstraße	dell'Abetone e del Brennero	449,56	450,55	91,67	0,30	27,45
9	267493	S.P.105..	Tarsch - Matschertal	Tarces - Mazia	5	5,614	88,50	0,28	25,22
10	221523	S.S.12..	Brenner Staatsstraße	dell'Abetone e del Brennero	467,01	467,67	83,11	0,32	26,93
11	268107	S.P.13..	St. Pauls - Unterrain	S. Paolo - Riva di sotto	2	2,5	92,33	0,29	26,92
12	199758	S.S.38..	Staatsstraße Stilfserjoch	dello Stelvio	182,83	183,31	84,44	0,32	26,71
13	284963	S.P.99..	Jenesien	San Genesio	3,75	4,12	94,17	0,28	26,52
14	172708	S.S.12..	Brenner Staatsstraße	dell'Abetone e del Brennero	438,4	438,64	63,11	0,42	26,45



Review of the efficiency of the implemented system

Statistics on the missions of the geological emergency service

Average number of missions : **192,3 per year**



- Missions
- Municipalities
- Roads

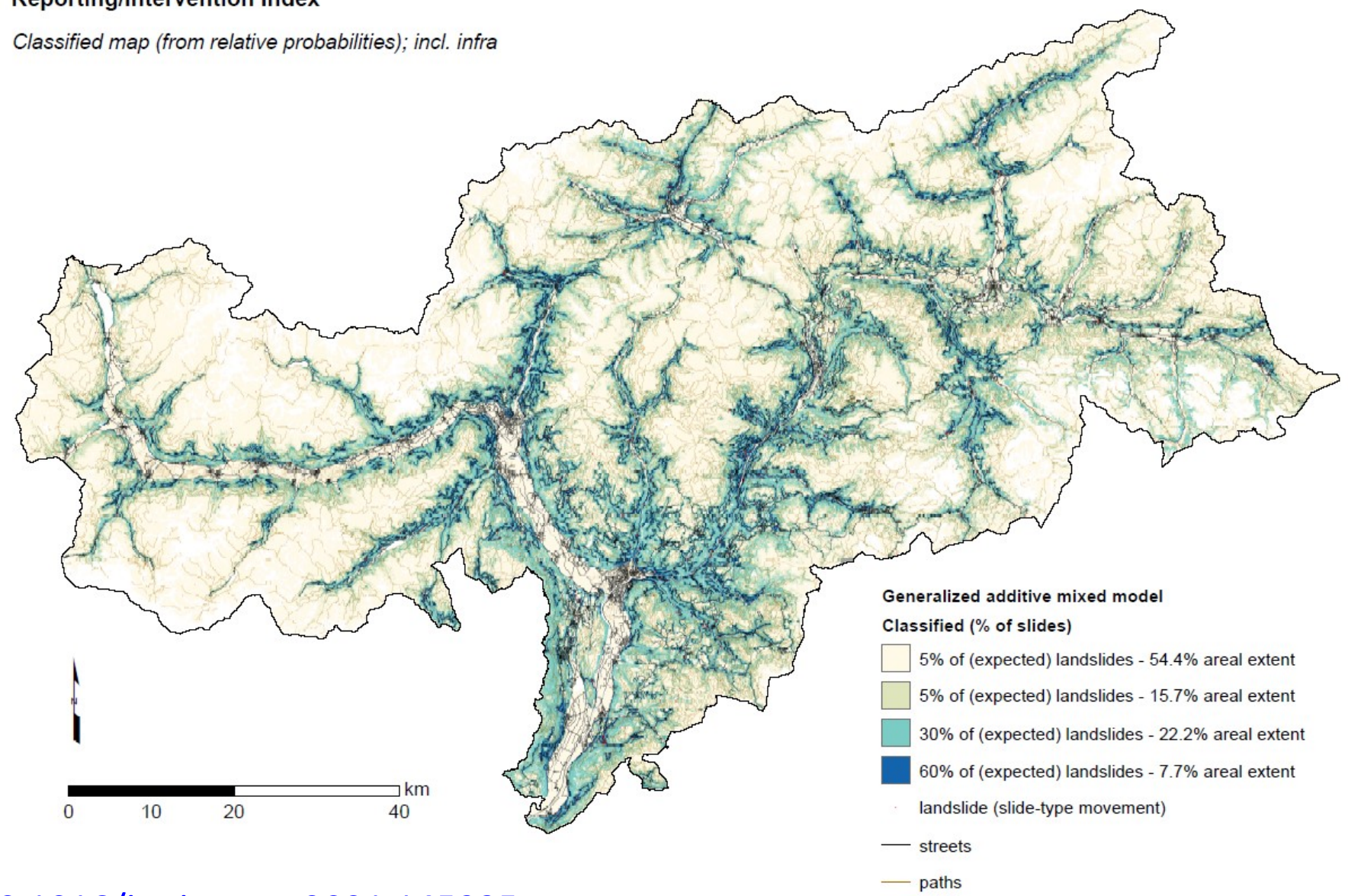
Average number: 181 per year
76,5 Municipalities
104,5 Roads

Average number : 202,6 per year
123,3 Municipalities
79,3 Roads



Reporting/Intervention Index

Classified map (from relative probabilities); incl. infra



AUTONOME PROVINZ BOZEN - SÜDTIROL



PROVINCIA AUTONOMA DI BOLZANO - ALTO ADIGE

PROVINZIA AUTONOMA DE BULSAN - SÜDTIROL

Thank you!

Dr. Geol. Volkmar Mair

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Office for Geology and building materials testing