IPA Action Group
Rock glacier inventories and kinematics

Pre-workshop of Task 1

RG inventories: experiences from the PermaNET project (Interreg 2007-2013 Alpine Space)

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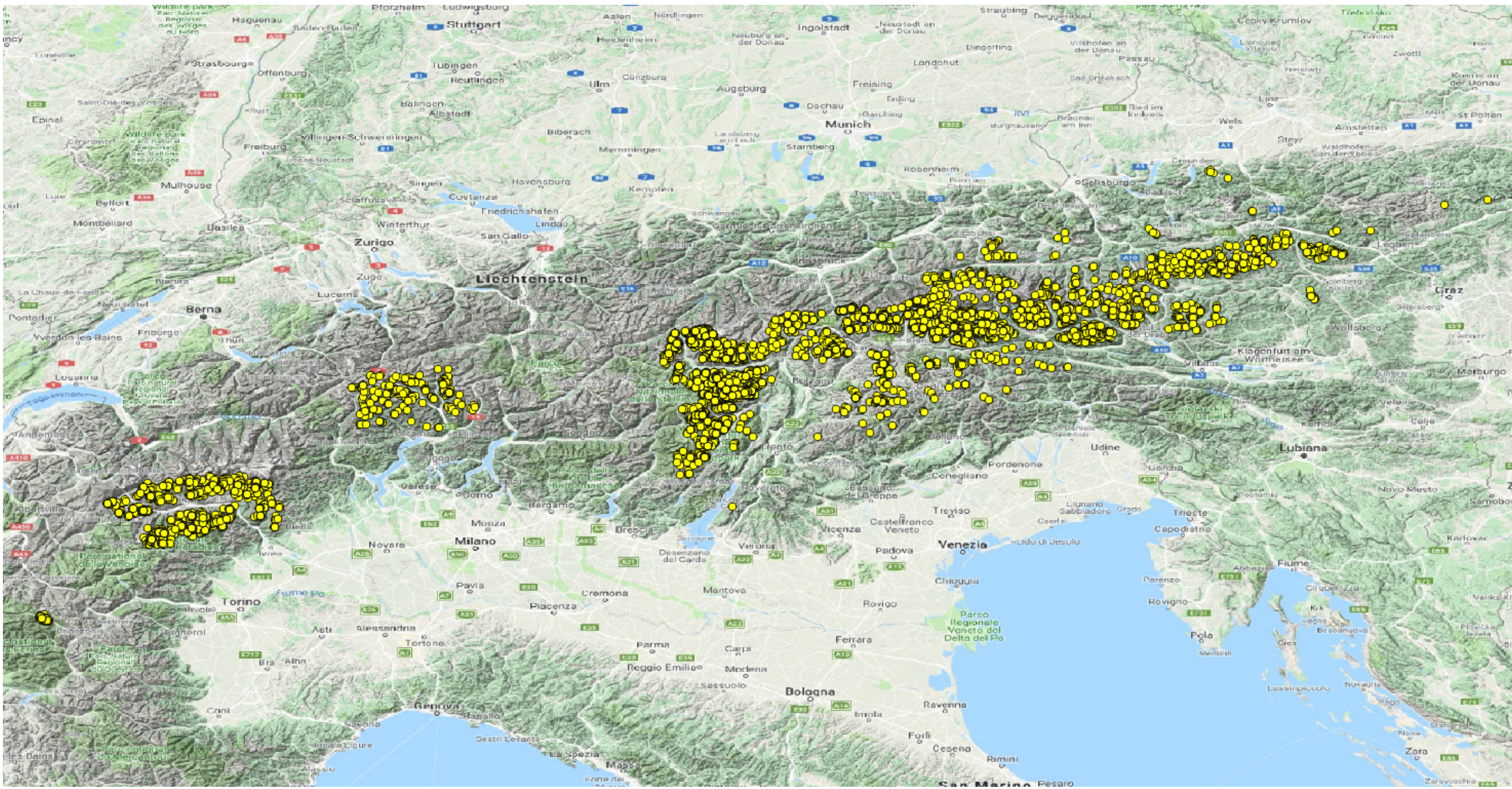
Wednesday 20th Chambéry (FR)

The PermaNET rock glacier dataset includes 7 inventories from:

- Italy (Valle d’Aosta, Piemonte, Veneto, Trentino)
- Austria
- Switzerland (Ticino)
- France (Massif du Combeynot)

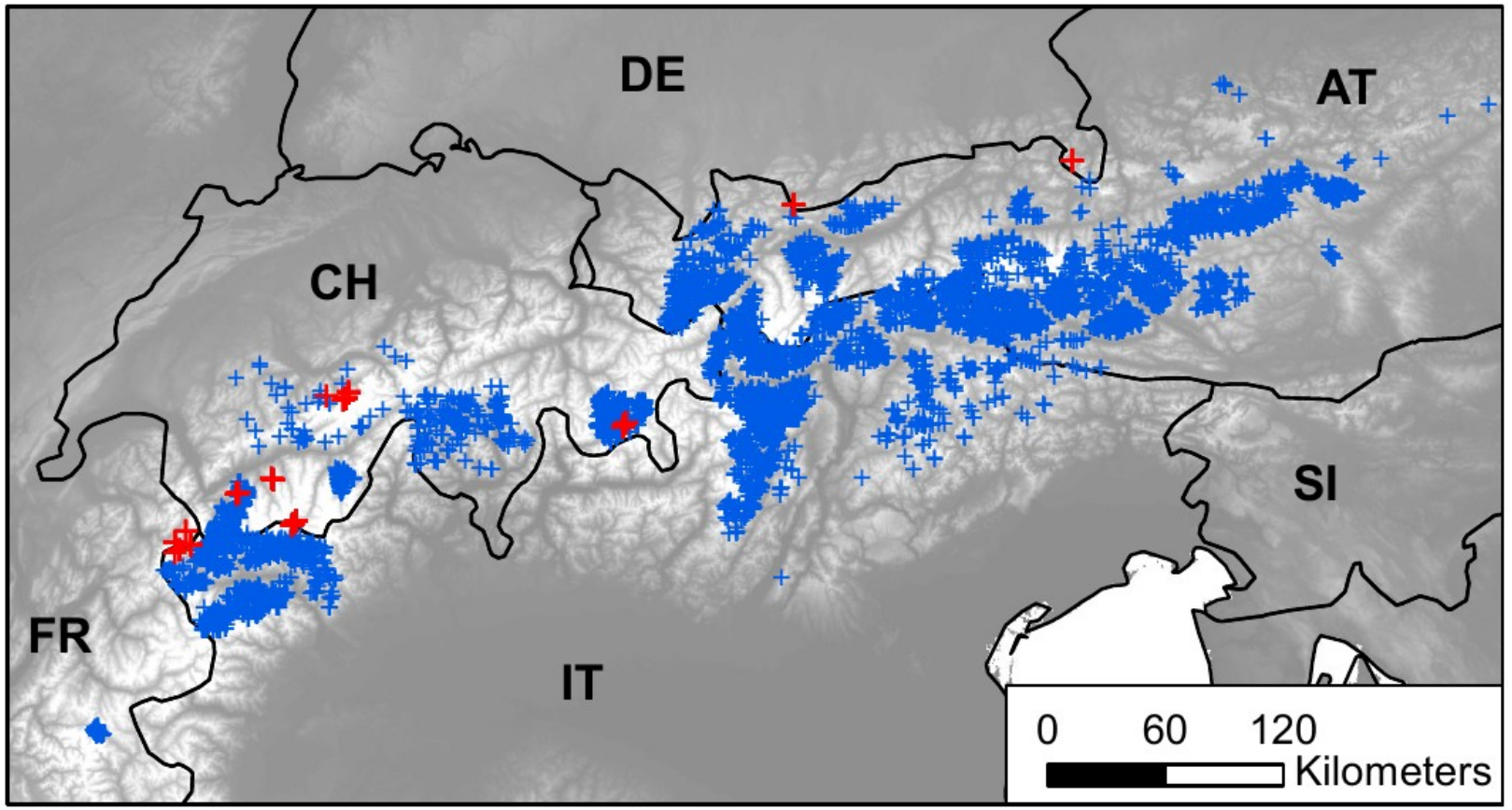
with a total of 4795 rock glaciers



From Boeckli et al. 2012 “A statistical approach to modelling permafrost distribution in the European Alps or similar mountain ranges” The Cryosphere, 6, 125–140, 2012.

The final data set used as basis for the model development includes **2184 intact and 4218 relict rock glaciers** from Austria, France, Italy and Switzerland

Response variable	Country	Region	N (intact/relict)	Source
RG status	AT, CH, FR, IT	Various regions	1625/3916	Cremonese et al. (2011)
RG status	CH	Entremont, Valais	115/137	Delaloye et al. (1998)
RG status	CH	Engadina, Graubünden	115/137	Frauenfelder et al. (2001); Frauenfelder (2005)
RG status	CH	Engadina, Graubünden	18/6	Hoelzle (1998)
RG status	CH	Aletsch region, Bern	11/13	Imhof (1998)
RG status	CH	Printse valley, Valais	115/137	Reynard and Morand (1998)
RG status	CH	Fletschhorn area, Valais	50/22	Frauenfelder (1998)
RG status	CH	Prealps, Vaud	0/25	Schoeneich et al. (1998)



2 Rock glaciers

Please enter your inventories into the according Excel list. The inventory should be a ArcGIS shapefile of polygons, with complete projection information and attribute table. Please add the requested columns to the attribute table of the shapefile and fill in the correct values. You know your data best, so we rely on each data owner to interpret his/her inventory in view of the common classification. Please supply each inventory as a zip file together with relevant documentation, e.g., publications.

Information to be added in the rock glacier **inventory list (i.e., excel sheet)**:

RGI_ID	Number your entered rock glacier inventory
RGI_name	Name of the inventory
RGI_file_name	Filename of the corresponding shapefile
RGI_coordinate_system	Specifiy the coordinate System of your shapefile
RGI_delineation_base	Specify how the rock glaciers were delineated (e.g. air photo, map, field observation etc.)
RGI_mapping_strategy	Specify your rock glacier mapping strategy (e.g. random sample of rock glaciers / all rock glaciers/ only large rock glaciers etc.)
RGI_year	When was the rock glacier inventory established (YYYY)
RGI_responsible_name	First and last name of responsible person / data owner. This person is to be contacted for any questions and also for impending publications.
RGI_responsible_email	E-mail address of responsible person / data owner.
RGI_publication	Is the rock glacier inventory discussed (specifically) in a publication? Give reference: Authors, Year. Title, Journal, Pages.

PermaNET guidelines for contributors

Information for rock glaciers, to be entered in the **attribute table of** the rock glacier **shapefile** for each rockglacier:

Degree of activity	1 Intact 2 Relict	Active / inactive (i.e. contains ice) (i.e. does not contain ice)

RG_field_evidence: Do you have field evidence for this rock glacier (e.g. measurements)?
Y Yes
N No

RG_activity_data: Is there InSAR (A), geodetic (B), photogrammetric (C), GPS (D) or other (E) data for this rock glacier?
1 no data
2 indicates activity
3 indicates no activity
e.g. C2: there is photogrammetric data indicating activity

RG_vegetation_front: Is there vegetation on the front of the rock glacier?
Y Yes
N No
U Unknown

RG_vegetation_tongue: Is there vegetation on the tongue of the rock glacier?
Y Yes
N No
U Unknown

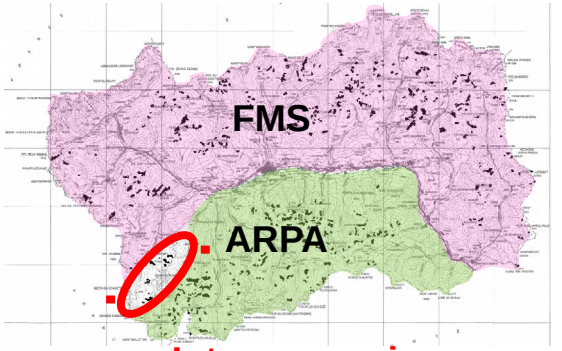
RG_glacier_above: Is there a glacier or perennial snow field in the root zone of the rock glacier?
G Glacier
P Perennial snow field
N No

RG inventory of Valle d’Aosta

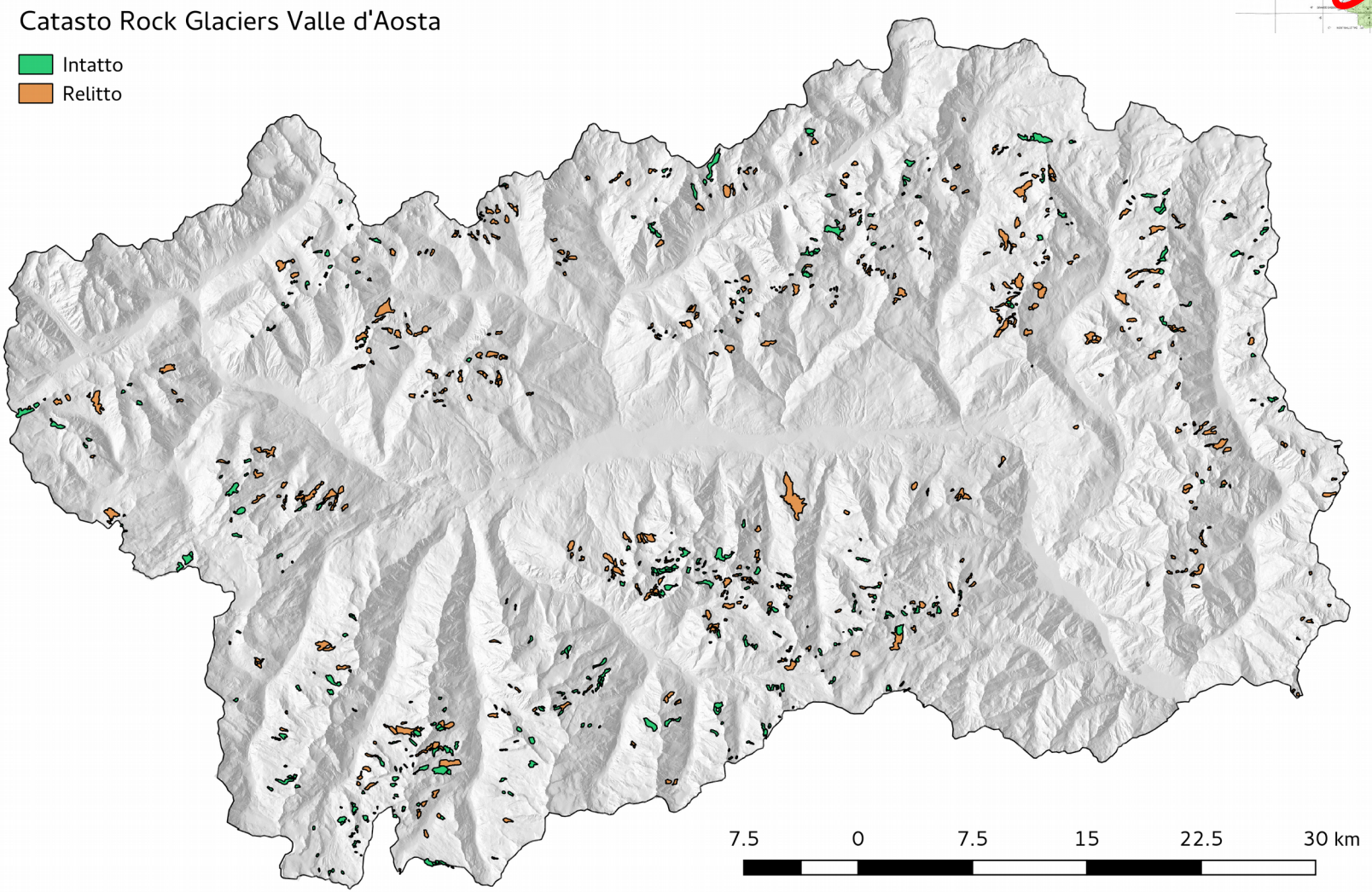
RG inventory of Valle d'Aosta

Total 937 rockglaciers
409 intact (active & incative)
538 relict

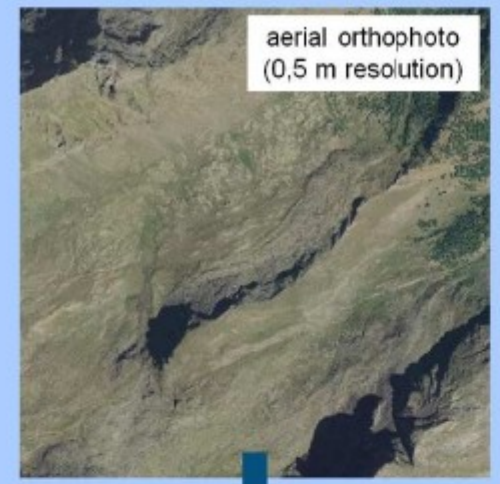
2 indipendent operators

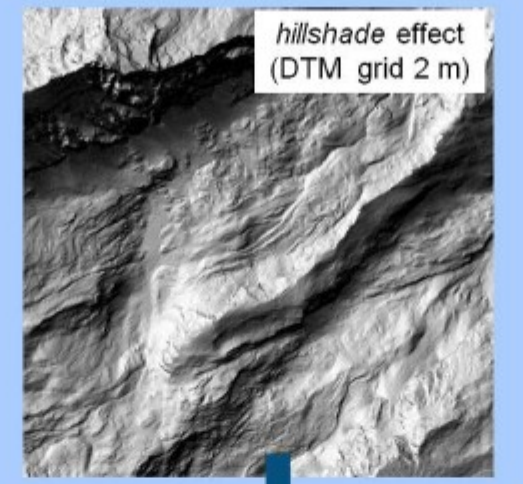


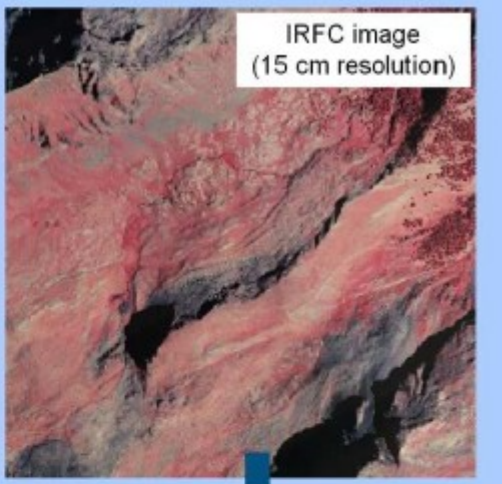
Intercomparison area



1. Methodology







shape files:
- perimeter
- lenght ("flow line")
- width (3 segments)
- front scarp line

FIELD NAME		FIELD DESCRIPTION		FIELD NAME		FIELD DESCRIPTION
RG ID		Progressive number	ROCK GLACIER CHARACTERISTICS	Degree of activity	Act	Intact (Active/Inactive)
NAME		Name, most significant place close to the RG			REL	Relict
X		Centroid coordinates (UTM ED50)		Geometry	TR	Tongue shaped
Y					LO	Lobate
MAP		Regional map number			SU	Superimposed
LAT		Centroid coordinates (WGS84)		Form	SI	Simple
LON					COMPL	Complex
Max elevation	General tools ArcGIS calculation functions based on DTM	Maximum elevation o the polygon perimeter		Complexity (*)	MP	Multipart
Min elevation		Minimum elevation o the polygon perimeter			ML	Multilobe
Max elevation of the scarp		Maximum elevation o the upper part of the front scarp. (if evident)			MU	Multiunit
Max elevation of the crest		Maximum elevation o the ascendign slope the RG			MR	Multiseat
Lenght		Calculated from the polyline shape		Alimentation	SNOW	Nivale (debrisic)
Width		Mean of 3 different segments			TALUS	Talus-like/mixed
Area		Derived from the polygon shape		Location	CI	Cirque
Aspect		Mean aspect of the polygon			SL	On slope
Slope		Mean slope of the polygon			FS	Foot of slope
Possibles interferences		Actual and future possible interferences with constructions			VM	Valley bottom
Notes					SK	Skilech
Notes 2		Annotations related to field surveys		Relation with glacial form	OUT	Outcrown
Aerial photographs		Aerial photographs characteristics			MRN	Moraine
Other cartographic data				Relation with vegetation limits	AB	Above vegetation limits
Other available material		Historical iconography, other pictures			BCM	Below the continuous meadow limit
Monitoring or study activities					BTL	Below the tree limit
Degree of Cavity	DC	Perimeter delimitation: CHOICE		Morphological features	LRF	Longitudinal ridges
	DIP	Uncertain perimeter delimitation in the frontal part			TRF	Transverse ridges
	DIM	Uncertain perimeter delimitation in the upper part			RVW	Rivulian axis
	DAC	Degree of activity, certain			HLB	Hollow, belly
	DAV	Degree of activity, uncertain			CP	Presence of conical pits
	DMC	Morphological trait, certain				
	DIM	Morphological trait, uncertain				
	DPA	Shade in the orthophoto				

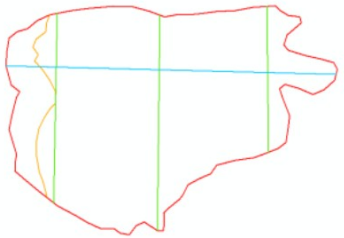
table with data and descriptive information

Each deposit was manually bounded inside a GIS environment crossing the visual information coming from the stereoscopic vision of IRFC images, hillshade effect derived from DTM and ortophotos. Main geomorphic parameters were automatically calculated using the DTM. Other data were collected in a detailed table filled for each rock glacier; the fields were chosen on the example of existing rock glaciers inventories (Seppi et al., 2005) and on ***PermaNET Evidences Database*** guidelines.

RG inventory of Valle d'Aosta

Attribute Table

	FIELD NAME	POSSIBLE CHOICES	EXPLANATION
GENERAL	RG_ID		Progressive number
	NAME		Name of the most significant place close to the RG (e.g.: lake, peak, ...)
	X		Coordinates given by ArcGIS for the centroid in UTM ED50
	Y		
	MAP		Number of the CTR (Regional Cartography) map
	LAT		Coordinates X,Y converted to geographics WGS84
	LON		
MORPHOMETRY	Max elevation	Derived from ArcGIS calculation functions based on DTM	Maximum elevation of the polygon perimeter
	Min elevation		Minimum elevation of the polygon perimeter
	Max elevation of the scarp		Maximum elevation of the upper part of the front scarp (if evident)
	Max elevation of the relief		Maximum elevation of the peak/ridge above the RG
	Lenght		Calculated from the polyline shape
	Width		Mean of 3 different segments (in a polyline shape); the first is the lower one, in the frontal part
	Area		Derived from the polygon shape
	Aspect		Mean aspect of the polygon
	Slope		Mean slope of the polygon



4 shape files for each rock glacier are created:

- Rock glacier perimeter (polygon shape file)
- Rock glacier lenght (polyline shape file)
- Rock glacier width (polyline shape file)
- Rock glacier upper front scarp (polyline shape file)

RG inventory of Valle d'Aosta

Attribute Table

ROCK GLACIER CHARACTERISTICS	Degree of activity	A/I	Intact (Active/inactive)
		REL	Relict
	Geometry	TS	Tongue shaped
		LO	Lobate
		EQ	Equidimensional
	Form	SI	Simple
		CO (*)	Complex
	Complexity (*)	MP	Multipart
		ML	Multilobe
		MU	Multiunit
		MR	Multiroot
	Alimentation	MOD	Morainic-derived
		TAD	Talus-derived
	Location	CI	Circle
		SL	On slope
		FS	Foot of slope
		VB	Valley bottom
	Relation with glacial form	GL	Glacier
		GLR	Glacieret
		SNB	Snowbank
	Relation with vegetation limits	AB	Above vegetation limits
		BCM	Below the continuous meadow limit
		BTL	Below the tree limit
	Morphological features	LRF	Longitudinal ridges
		TRF	Transverse ridges
		SWB	Swollen body
		HLB	Hollow body
		CP	Presence of conical pits

RG inventory of Valle d'Aosta

Attribute Table

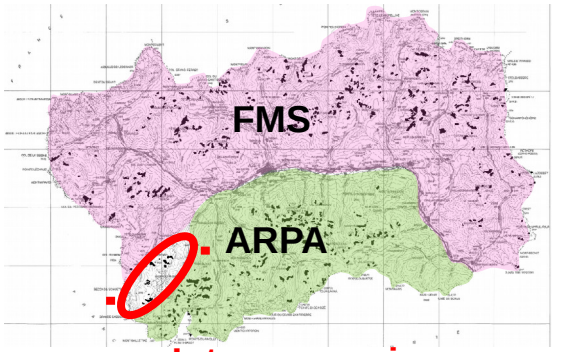
OTHER INFORMATION	Possibles interferences		Actual and future possible interferences with infrastructures (e.g:tracks, ski tracks or pillar of cable way, rock glacier directly above tha valley bottom, possibly dangerous for debris flows)
	Notes		
	Notes 2		Annotations related to field surveys and subsequent changes in the RG characteristics identification
	Aerial photographs		Aerial photographs characteristics
	Other cartographic data		
	Other available material		Historical iconography, other pictures
	Monitoring or study activities		
DEGREE OF QUALITY	Degree of Quality	DC	Perimeter delimitation certain
		DIF	Uncertain perimeter delimitation in the frontal part
		DIM	Uncertain perimeter delimitation in the upper part
		GAC	Degree of activity certain
		GAI	Degree of activity uncertain
		CMC	Morphological features certain
		CMI	Morphological features uncertain
		SHA	Shade in the ortophotos

RG inventory of Valle d'Aosta

An almost perfect correspondence exists in 9 cases in features bounding; in these cases also main rock glacier characteristics, such as degree of activity, geometry and elevation of the front, correspond. In 6 cases one operator bounds the feature while the other only puts a preliminary localisation point; in 4 cases preliminary points match while in 9 cases there is no agreement.

Mean elevation [m]	Max elevation [m]	Min front elevation [m]	Length [m]	Width [m]	Area [m^2]	Aspect [°]	Slope [°]
3	2	0	40	1	5002	9	1
48	50	1	197	35	32060	8	1
1	25	0	94	28	618	1	0
3	2	2	13	1	567	5	0
4	1	3	40	12	440	6	0
1	13	0	69	16	1556	3	0
17	8	0	30	91	67539	6	0
7	5	0	215	7	10001	2	1
3	1	0	125	190	1053	0	0

2 indipendent operators



Intercomparison area

conclusions

- an high degree of subjectivity affects rock glacier definition (localisation, bounding, features)
- the uncertainty concerns rock glaciers with a poorly evident shape. Good agreement exists for sharply-defined ones
- some parameters are defined with a better agreement: min front elevation, degree of activity, geometry

	Mean elevation [m asl]	Max elevation [m asl]	Min elevation [m asl]	Elevation of the closet relief [m asl]	Length [m]	Width [m]	Area [m^2]	Aspect [°]	Slope [°]
OPERATOR 1	2752	2844	2663	3154	465	179	91760	260	25
OPERATOR 2	2686	2781	2605	3112	420	183	91374	246	24