DETAILED REPORT OF CONTRACTOR
FOR FIRST PROGRESS MEETING

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SECTION 1: TECHNICAL REPORT

According to the proposed work programme for DAMOCLES project the research team of the University of Padova (Mario A. Lenzi, Vincenzo D'Agostino, Carlo Gregoretti, Diego Sonda, Francesco Comiti) has carried out the following activities included in the Workpackage WP1 "Development of functional relationships for debris flow behaviour" and WP3 "Development of a small basin debris flow impact model":

? Setting up the contracts with the following subcontractors: Avalanche Center of Arabba, (Veneto Region) and Autonomous Province of Trento
? Recruitment by public selection of 1technician
? Computer hardware purchase
? Organisation of the research team and scientific coordination of activities
? Acquisition of existing data on debris flow characteristics in small basins located in the Veneto Region and in the Autonomous Provinces of Trento and Bolzano
? Acquisition of the numeric and cartaceous cartography
? Setting up of the high-precision topographic surveying of the Rio Lenzi fan (test area C) in order to create a detailed fan DEM to perform simulations of debris flow propagation using a 1-D and 2-D user-friendly models

SECTION 2: RESULTS

2.1 PROGRESS OF WORK

2.1.1 WP1 "Development of functional relationships for debris flow behaviour":

? Creation of a database concerning debris flow torrents in the Autonomous Province of Bolzano using a standard form to be used by both Research Institutes and Technical Services
? Development of a methodology for the assessment of debris flow volumes

2.1.2 WP3 "Development of a small basin debris flow impact model":

? Implementation of GIS techniques to obtain the Digital Terrain Model (DTM) and Thematic Maps (geolithology, land use, basic hazards) for two study basins (Rio Lenzi and Rio Rudan)
? Survey of about 80% of the Rio Lenzi fan (test area C)

2.2 RESOURCES EMPLOYED

2.2.1 Personnel

RESEARCH TEAM	PERSON-MONTHS
Administrative responsible	2
Responsible Scientist	3
Researcher	4
Researcher	2
PhD student	5
Technician	4
TOTAL	20

2.2.2 Activities

ACTIVITIES	MONTHS
Organisation of the research team and scientific coordination of activities	**3**
Setting up the contracts with subcontractors;Recruitment through public selection of 1 technician; Computer hardware purchase	**2**
Acquisition of existing data on debris flow torrents located in the Veneto Region and in the Autonomous Provinces of Trento and Bolzano **(WP1)**	**1/2**
Acquisition of the numeric and cartaceous cartography **(WP3)**	**1**
Creation of a database concerning debris flow torrents in the Autonomous Province of Bolzano **(WP1)**	**1/2**
Development of a methodology for the assessment of debris flow volumes **(WP1)**	**2**
Setting up of the high-precision topographic surveying of the Rio Lenzi fan (test area C) and survey of about 80% of the Rio Lenzi fan **(WP3)**	**8**
Implementation of GIS techniques to obtain the DTM and Thematic for two study basins (Rio Lenzi and Rio Rudan) **(WP3)**	**3**
TOTAL	**20**

2.2.3 Meetings and travels

- ? Field investigations and topographic survey of the Rio Lenzi fan
- ? Two technical coordination meetings at Trento and two technical coordination meetings at Arabba
- ? Participation at the start-up meeting at Milan

2.3 DEVIATION FROM THE WORK SCHEDULE

According to the proposed activities the planned goals have been fulfilled.

2.4 DATABASE OF DEBRIS FLOW TORRENTS

In order to make up a simple and user-friendly archive of all the debris flow-prone streams, a data collection from several sources (“Ufficio Bacini Montani, Prov. Autonoma di Bolzano”, “CARFRA project, Ufficio Geologia e Prove Materiali, Prov. Autonoma di Bolzano”, CORINE database, First Intervention Squad reports (FI), newspapers and others publications) was carried out for the Alto-Adige Region first (Bertotto, 2000).

A standard form to be used in the setting up of the database was developed, featuring administrative characteristics, morphometry, geology and geomorphology, land use, water discharges and recorded debris flow events.

30 streams have been inserted in the database so far, but the available data will allow to increase their number in the future.

The database file (in a “Word 2000” version) is attached in the annexe 2.

2.5 ASSESSMENT OF DEBRIS FLOW VOLUMES

The estimation of debris flow magnitude, i.e. the volume of debris material discharged during a single event, is a basic step toward the assessment of debris flow hazard. A number of methods, including empirical and statistical formulas (e.g. Takei, 1984, Kronfellner-Kraus,1985, D’Agostino et al., 1996), geomorphological approaches (Hungr et al., 1984, Scheuringer, 1988, Thouret et al., 1995), and combined methods (Spreafico et al., 1999) have been proposed for the volumes assessment.

Although several estimation procedures are available, the assessment of debris flow magnitude poses still serious problems. The analysed area is a vast mountainous region in the eastern part of the Italian Alps. It corresponds to the Provinces of Trento and Bolzano and to Veneto and Friuli - Venezia Giulia Regions (Fig. 1).

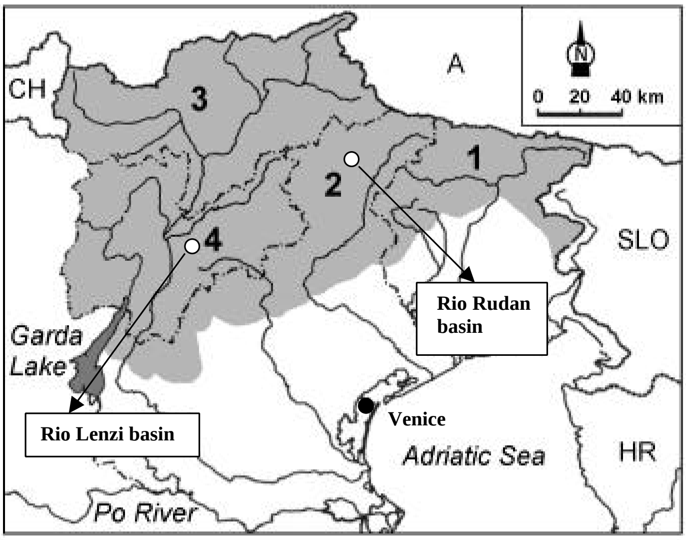

Fig. 1 - Location map; the shaded area correspond to the the mountainous zone of the: 1-Friuli Venezia Giulia, 2-Veneto, 3-Autonomous Province of Bolzano, 4- Autonomous Province of trento

The central and southern parts of the area, encompassing the Dolomites, are mostly characterised by sedimentary and volcanic rocks. In the inner belt of the alpine range, outcrops of metamorphic rocks prevail, whereas massive cristalline rocks occur in the western part of the considered region.

Quaternary deposits are widespread throughout the alpine valleys. They consist of glacial and fluvio-glacial deposits, scree, landslide accumulations and alluvial fans. Complex orography influences the climatic characteristics of the Eastern Italian Alps causing high variability in the spatial distribution of precipitation and temperature. As far as the precipitation is concerned, valleys parallel to the Alpine structure are characterised by relatively dry conditions, with annual precipitation of about 500-600 mm, whereas transverse-oriented valleys have a higher precipitation rate (1500-2000 mm); annual amounts of precipitation exceed 3000 mm in some prealpine areas.

Seasonal distribution of precipitation is continental, with summer maximum, in the inner part of the alpine range, whereas spring and autumn maxima are observed in the prealpine belt. Landslides and debris flows frequently occur in the studied region, often resulting in high risk because of the heavy urbanisation in valley floors and on alluvial fans and of the presence of important transportation routes.

Earliest data begin from mid-19th century; amongst the floods that occurred in the considered period, two major events (September 1882 and November 1966) should be mentioned, which affected vast areas and caused serious damage.

Table 1 presents some basic statistics on the morphometric characteristics of the basins for which quantitative data on debris flow volumes have been collected. The range in drainage basin area is rather wide, however small basins (< 5 km^2) prevail, corresponding to about 75 % of the total sample.

Table 1 - Morphometric parameters of studied basins

	Basin area (km^2)	Main channel length (km)	Main channel slope (%)
Median	2.44	2.5	38
Minimum	0.07	0.4	13
Maximum	32.7	14.8	82

Figure 2 shows a scatterplot of debris flow magnitude versus drainage basin area; when more than one event has been recorded in the same basin, only the largest value was plotted. An upper limit can be outlined, which approximately correspond to an unit value of 70000 m^3km^{-2}; this value, which confirms the findings of a previous study (Marchi and Tecca, 1996), express the maxima that were attained in the considered region on the occasion of high intensity storms in basins where large amounts of sediment were available. The upper envelope does not show a clear tendency to a reduction of volumes per unit area for increasing basin size.

A particular case is represented by two basins in which the mobilisation of large landslides resulted in multiple surges debris flows which lasted for several days and discharged huge amounts of sediment (Fig. 2). Concerning the lower limit of debris flow volumes, minimum values of 1000 m^3 are often observed, only in two cases lower values being reported.

These values represent a lower level of perception for the personnel involved in torrent control and in watershed management more than a physical limit of debris flow magnitude. Debris flows of lower magnitude actually occur, but they are reported only for a very few basins carefully surveyed because of their dangerousness. Even taking into consideration debris flows other than the largest event in each basin, volumes in the range of 300 - 800 m^3 would be reported only for a very few streams. The increase of magnitude M (m^3) with basin area A_d (km^2) is very limited and the lower envelope can be expressed by the following equation:

$$M\ ?\ 1000\ ?A_d^{0.3} \qquad (1)$$

Since also small magnitude debris flows can prove very hazardous, e.g. when they affect railways and motorways, the lower envelope drawn in figure 2 can help defining minimum values of magnitude to be considered in the design of debris flow attenuation measures. The two envelope lines drawn in Figure 2 are merely intended to outline the volume range of debris flows in Northeastern Italy and do not represent statistical relations between debris flow magnitude and basin area.

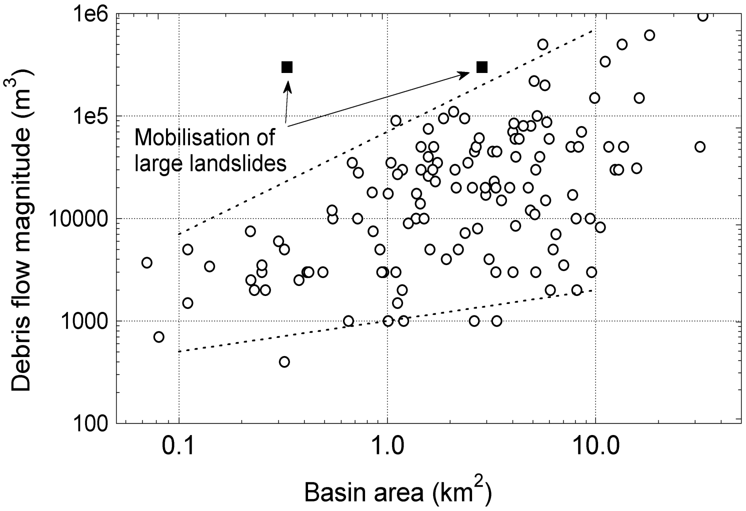

Figure 2 - Scatterplot of debris flow volumes (magnitude) versus drainage basin area

An analysis aimed at assessing the relationships between debris flow magnitude and morphometric and geolithologic characteristics of the basins was carried out for a sample of basins lying in the Provinces of Trento and Bolzano (Fig.1). The analysis of historical records in the archives of the Forest Offices of these provinces made it possible to extract the largest debris flows occurred over a long time period (about 100 years). On these basis, debris flow volumes may be deemed representative of high intensity, centennial frequency events. A previous analysis conducted by D'Agostino (1996) and D'Agostino et. al. (1996) on the debris events occurred in the eastern part of the Province of Trento, proposed a relation to asses the magnitude of the total sediment volume yielded.

The relation assumes, as independent variables, the catchment area A (km^2), the mean gradient of the stream S (%) and a dimensionless geological index (GI). The latter parameter expresses the erodibility of the lithology feeding the channel network. Its value is computed weighting the score associated to each geolithological class (Tab. 2) in proportion to the area of the basin covered by the class.

Table 2 - Lithological classes and geological index (GI) values

	GI value
Quaternary deposits	5
Schists and phyllites	4
Marls, marly-limestone, siltstones, etc.	3
Volcaniclastic rocks	2
Dolomite and limestone rocks	1
Massive igneous and metamorphic rocks	0

Local fracture and alteration conditions of the rock are also taken into account to define *GI* estimates. D'Agostino et al. (1996) equation results:

$$M = 45 \cdot A^{0.9} \cdot S^{1.5} \cdot GI \tag{2}$$

Eq. (2) was obtained by means of a multiple regression, imposing to minimise the mean square error.

Following an analogous procedure, a largest set of data including also the most notable events occurred in the upper part of the Adige basin (Province of Bolzano), was processed. The determination of the independent variables was conducted using standard topographic and geologic maps. No *GI* values less than 0.5 occurred in the sample; in case they should be set to 0.5. The relation obtained is the following:

$$M = 70 \cdot A \cdot S^{1.28} \cdot GI \tag{3}$$

Eq. (3) gives a level of accuracy lower than eq. (2): this fact can be ascribed to the wider region under study that involves less homogenous geologic and climatic conditions.

The loss function selected (eq. 3) induces a tendency to an overestimation in the forecast equation. In fact, the data included in the sample differ even of three order of magnitude, passing from the lowest (700 m^3) to the highest (950000 m^3), and the most severe events have more influence on the determination of the parameters that produce the minimum error. Considering the heterogeneity of the sample and the "biased" nature of the phenomenon, the use of the three parameter *A*, *S* and *GI* confirms its robustness for assessing empirical equations on a regional context where historical data are available.

2.6 STUDY BASINS

2.6.1 BASIN CHARACTERISTICS

Two basins are involved in this research: Rio Lenzi (test area C), located within the Autonomous Province of Trento, and Rio Rudan, in the Province of Belluno (Veneto Region) Their main morphometric characteristics are summarised in Table 3 and their location is shown in Fig. 1.

The two catchments are essentially different as to their geology. The Rio Lenzi catchment presents (Piccoli, 2000, see Fig. A2 in the annexe 1) an igneous upper part whereas in middle and lower parts quaternary morainic deposits predominate.

On the other hand, the Rio Rudan basin is characterised by a dolomitic nature: high-sloped (subvertical) rocky cliffs make up the upper part along with a narrow, steep valley covered with talus deposit. Eluvial deposits cover most of the lower part, with a minor percentage of morainic, alluvial and fluvio-glacial materials (see Fig. A7 in the annexe 1). Both the basins have a typical Alpine climate with annual precipitation ranging from 930 to 1100 mm in the Rio Lenzi and from 950 to 1500 mm for Rio Rudan basin. Precipitation occurs mainly as snowfall from November to April. Runoff is usually dominated by snowmelt in May and June whilst summer and early autumn floods represent an important contribution to the flow regime.

In the Rio Lenzi catchment, the vegetation cover mainly consists of forest stands made up by spruce (*Picea abies* Karst.) and larch (*Larix decidua* Mill.); toward the timberline (at 1900 - 2100 m a.s.l.) the latter is associated with *Pinus cembra* L. to form the last sparse woodlands before the ecological conditions impose shrubs (moorland) and grasslands.

Table 3 – Main morphometric characteristics of the two study basins

	Rio Lenzi	Rio Rudan
Catchment area (km^2)	2.43	3.003
Average elevation (m.a.s.l.)	1880	1689
Minimum elevation (m.a.s.l.)	1363	801
Maximum elevation (m.a.s.l.)	2409	3264
Mean catchment gradient (%)	53	98
Length of the main channel (km)	2.29	4.02
Main channel mean gradient (%)	26	34

As far as the Rio Rudan catchment is concerned, the vegetation pattern is rather different. In the lower part the forest stands are made up by broadleaves such as beech (*Fagus sylvatica* L.) and ash (*Fraxinus excelsior* L.) mixed with spruce. Upslope, due to the high soil permeability, gradient and general slope instability, the Scotch Pine (*Pinus sylvestris* L.) predominates, blending with increasing patches of shrubs (*Pinus mugo* Turra, *Salix* spp.) moving toward the upper part of the basin (above 1800 m a.s.l.) where *Pinus mugo* forms a continuos belt under the dolomitic cliffs.

In Table 4 are summarised the difference between the study basins regarding the land use:

Table 4 – Land use distribution in the two study basins

Land use	Rio Lenzi (%) (*Test area C*)	Rio Rudan (%)
Thick woodland	54.5	50.6
Sparse woodland	0.3	5.5
Shrubs	0.9	14.9
Grassland	41.1	1.2
Unproductive (bare grounds, waterbodies, roads)	2.9	27.8
Urban area	0.3	-

Both the basins are prone to generate debris flows as it results from many historical records.

In the 1882 an extraordinary precipitation event occurred all around Trento, triggering a massive debris flows in the Rio Lenzi basin. Several deep erosion (still active) were incised in the upper part, delivering huge amounts of sediment to the main channel which built many lateral deposits downstream. The urbanised fan was flooded with severe damages. In 1917 and 1951 other smaller debris flow events affected the catchment fan. In the 1966 other extraordinary rainfalls produced a debris flow which flooded on the lower part of the fan leaving boulder up to 0.5 m large.

2.6.2 DEM IMPLEMENTATION

The GIS WODITEM (Watershed Oriented Digital Terrain Model) (Cazorzi, 1996), a raster-type geographical information system especially devised for hydrological investigations in mountain basins, was used in order to create the Digital Elevation Model (DEM) for the two basins, from which the slope and aspect raster maps were produced. A grid base of 10?10 m was used, apart from the Rio Lenzi fan where a 5?5 m grid was adopted. Pits were identified and removed in the raster elevation map; a synthetic channel network was then extracted from the basin DEM. Digital Terrain Model (elevation, slope and aspect) and thematic maps were created and edited using Arcview 3.1 software. Some examples of the above raster maps are presented in the annexe 1.

2.6.3 RIO LENZI FAN SURVEY

In order to develop a physical based, user-friendly 1-D (channel routing) and 2-D (propagation on the fan) models for the debris flow, a high-detailed elevation map is much needed if the topography is assumed to be the determining factor upon the movement downstream of the flow, assumption which is taken to simplify the numerous variables affecting the phenomenon.

The existing topographic maps do not offer the proper accuracy (1:1000 - 1:500 scale), therefore a high-precision topographic survey was needed for the fan area.

A classical survey methodology was adopted by using a total station system: about 80% (see Fig. A4 in annexe 1) of the fan has been covered so far, measuring 6608 points with spatial density varying according to the local morphology and to the proximity to the channel. In fact the survey methodology has to consider all the natural (large boulders, past sediment heaps) and artificial (walls, roads, buildings) structures, that might affect the debris flow trajectory.

The Aulitzky methodology for debris flow hazard mapping was also applied to fan: the synthetic maps are shown in the annexe 1 (Fig. A5 in annexe 1). The high precision of the elevation model obtained in this way will allow comparison with quicker and cheaper survey techniques (GPS, photointerpretation, laser scanning) which are more likely to be adopted for operative purposes, given the high cost of a topographic survey so detailed as that it is being carried out.

SECTION 3: NEXT PROJECT ACTIVITIES

- **Task 1 - Topographic surveys: main channel**

  The channel topography of the Lenzi stream along the fan area will be measured in detail. In the main stem several structures are present, like check dams, riprapping, bridges. The bottom profile and the cross-section surveyed will take into consideration the main hydraulic discontinuities inducted by the presence of such works.

  The measurements will be conducted in view of their use in the 1-D submodel for debris flow routing.
- **Task 2 - Topographic data processing**

  A digital terrain model (square cells 2?2 m) will be realized for representing the fan area. Data processing will also provide a linking procedure between the digital terrain model of the fan and the detailed topography of the main channel of the fan..
- **Task 3 - Development of 1-D sub-model for debris flow routing**

  The first phase to asses the hazard-areas in view of an user-friendly tools is represented by a sub-model able to simulate the routing of a debris flow along the main channel, to divert part of the flow in occasion of inadequate conveyance and to take into account the presence of check-dam, bed profile flattening, and constraints in the cross-section. The sub-model will be developed by means of a Muskingum-Cunge approach, specifically adapted for the debris flow rheology and considering the relative submergence of the front (ratio between the diameter of the material making up the front and the flow depth). The main input data for the sub-model are: the channel topography, the sedimentology of the debris flow flood, the geotechnics of the debris flow. The sub-model will be developed in view of an integration of the main algorithms into the Digital Terrain Model of the fan area.
- **Task 4 – Preparation of the first year scientific final report**
- **Task 5 – Preparation of the first year administrative-financial report**

Table 5 – Timetable for the next activities

	Sept	Oct	Nov	Dec	Jan	Feb
Task 1	----------------------------------					
Task 2			----------------			
Task 3			--			
Task 4						---------------
Task 5						--------

SECTION 4: REFERENCES

Bertotto, B., *Le colate detritiche nei bacini dell'Alto Adige*, Degree thesis in Environmental and Forest Science, University of Padova, 124 pp., 2000.

Cazorzi, F., Watershed Oriented DIgital TErrain Model - Users Guide Version Windows 95, Lab. IDEA, University of Padova, (in Italian), 1996.

D'Agostino, V., *Analisi quantitativa e qualitativa del trasporto solido torrentizio nei bacini montani del Trentino Orientale*, In: Scritti dedicati a Giovanni Tournon. Associazione Italiana di Ingegneria Agraria - Associazione Idrotecnica Italiana, 111-123, 1996.

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Marchi, L., and Tecca, P.R., *Magnitudo delle colate detritiche nelle Alpi Orientali Italiane*. Geoingegneria Ambientale e Mineraria, 33(2/3), 79-86, 1996.

Kronfellner-Kraus, G., *Quantitative estimation of torrent erosion*, International Symposium on Erosion, Debris Flow and Disaster Prevention, Tsukuba, Japan, 107-110, 1985.

Piccoli, E., *Definizione delle aree di pericolo in relazione a fenomeni di debris flow: il caso di studio del Rio Lenzi*, Degree thesis in Environmental and Forest Science, Univ. of Padova, 221 pp., 2000.

Scheuringer, E., *Ermittung der massgeblichen Geschiebefracht aus Wildbach-Oberlauten, Wildbach und Lawinenverbau*, 52, 109, 87-95, 1988.

Spreafico, M., Lehmann, Ch., and Naef, O., *Recommandations concernant l'estimation de la charge sédimentaire dans les torrents*, Groupe de travail pour l'hydrologie opérationnelle, 1999.

Takei, A., *Interdependence of sediment budget between individual torrents and a river-system*, Int. Symp. Interpraevent 1984, Villach, Austria, vol. 2, 35-48, 1984.

Thouret, J.-C., Vivian, H., and Fabre, D., *Instabilité morphodynamique d'un bassin-versant alpin et simulation d'une crise érosive (L'Eglise-Arc 1800, Tarentaise)*, Bull. Soc. géol. France, 166(5), 587-600, 1995.

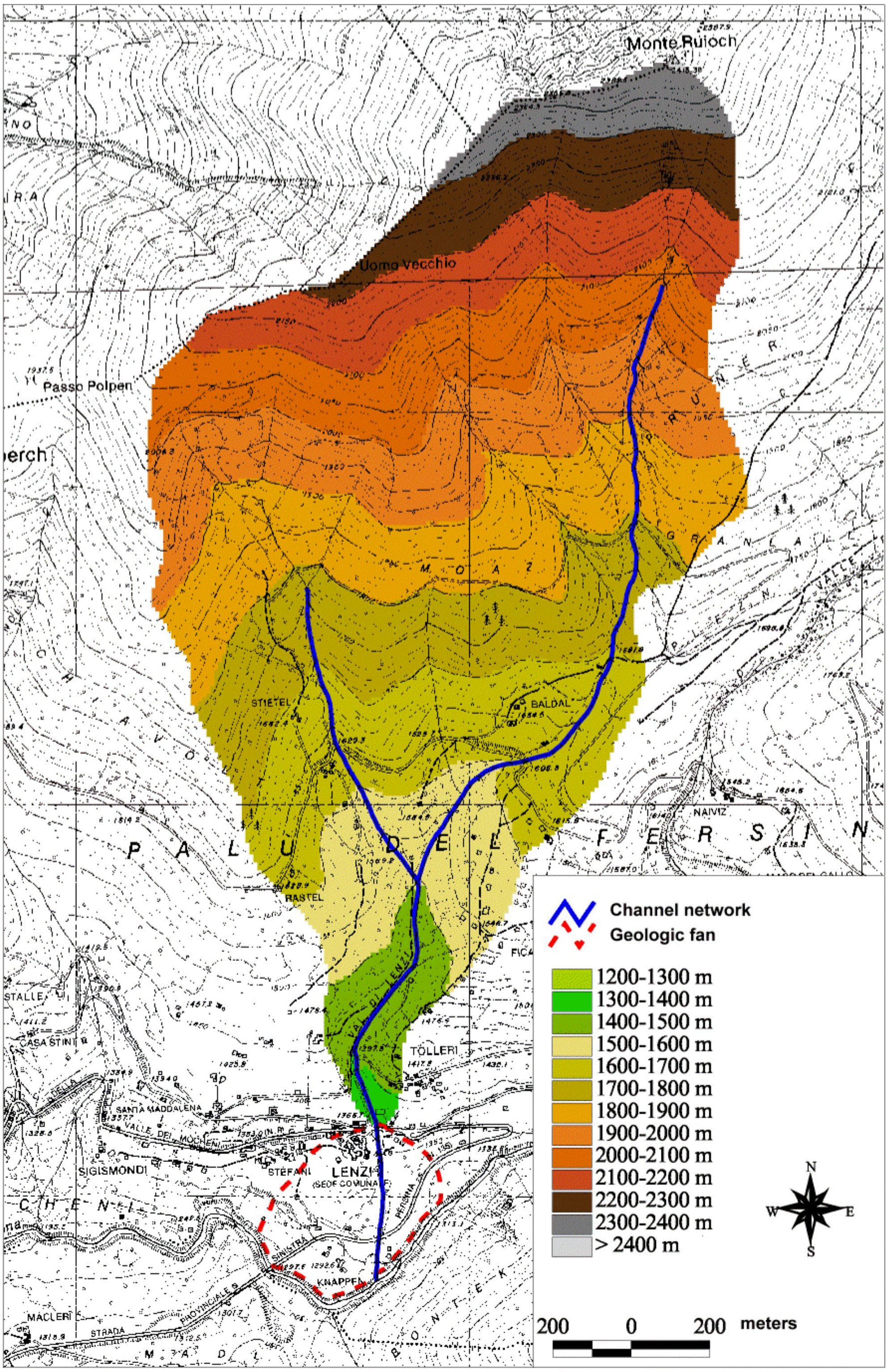
SECTION 5: PUBLICATIONS

D'Agostino, V., Marchi, L., *Debris flow magnitude in the Eastern Italian Alps: data collection and analysis*. Presented at the XXV General Assembly of the European Geophysical Society, Nice, France, 25-29 April 2000, in press.

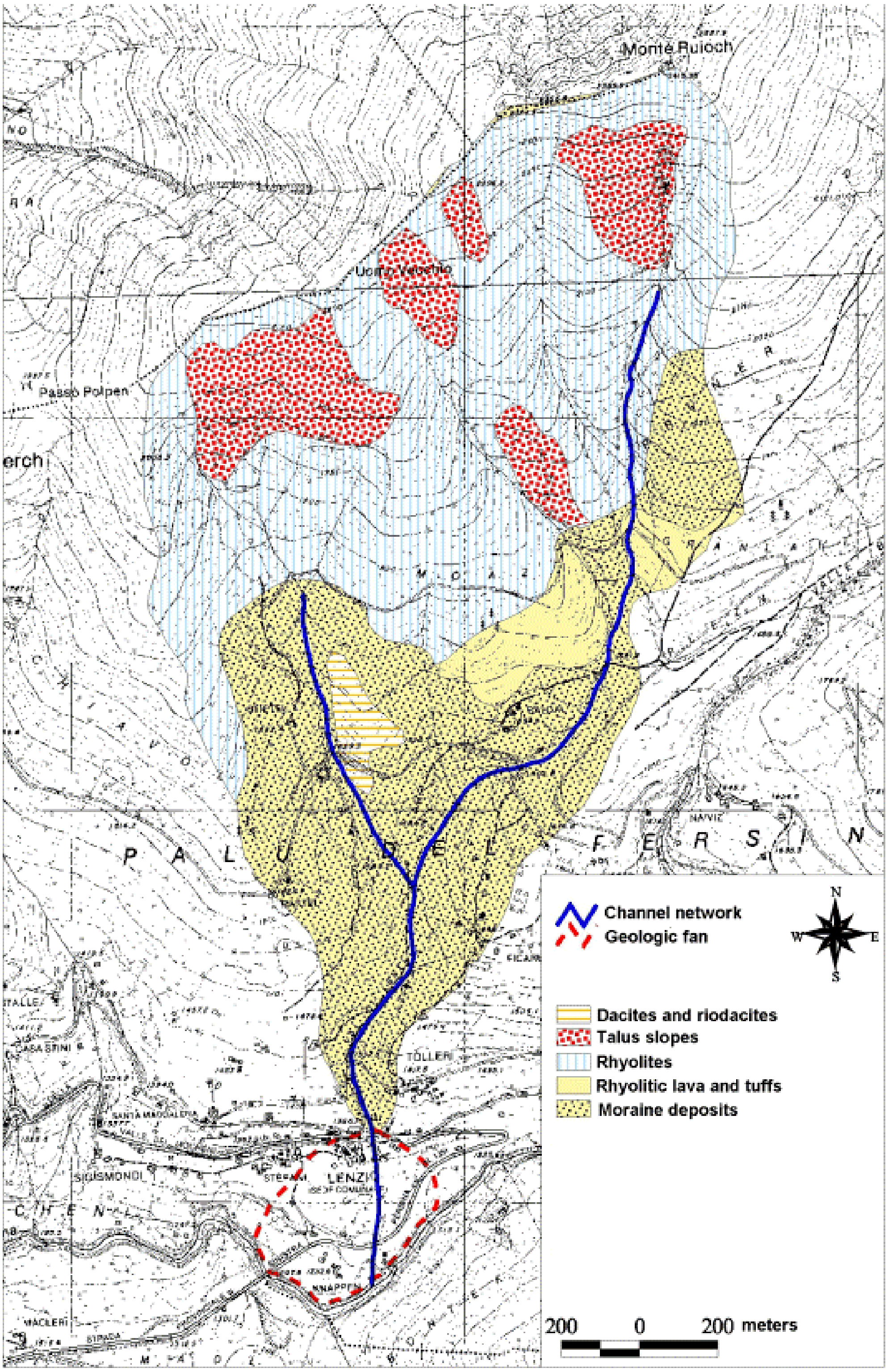
SECTOIN 6: KEYWORDS

- ? **Topographic high-precision surveying**
- ? **Debris fan**
- ? **Geographical Information System**
- ? **Digital Terrain Model**
- ? **Debris flow volumes**
- ? **Debris flow historical events**
- ? **Alps**

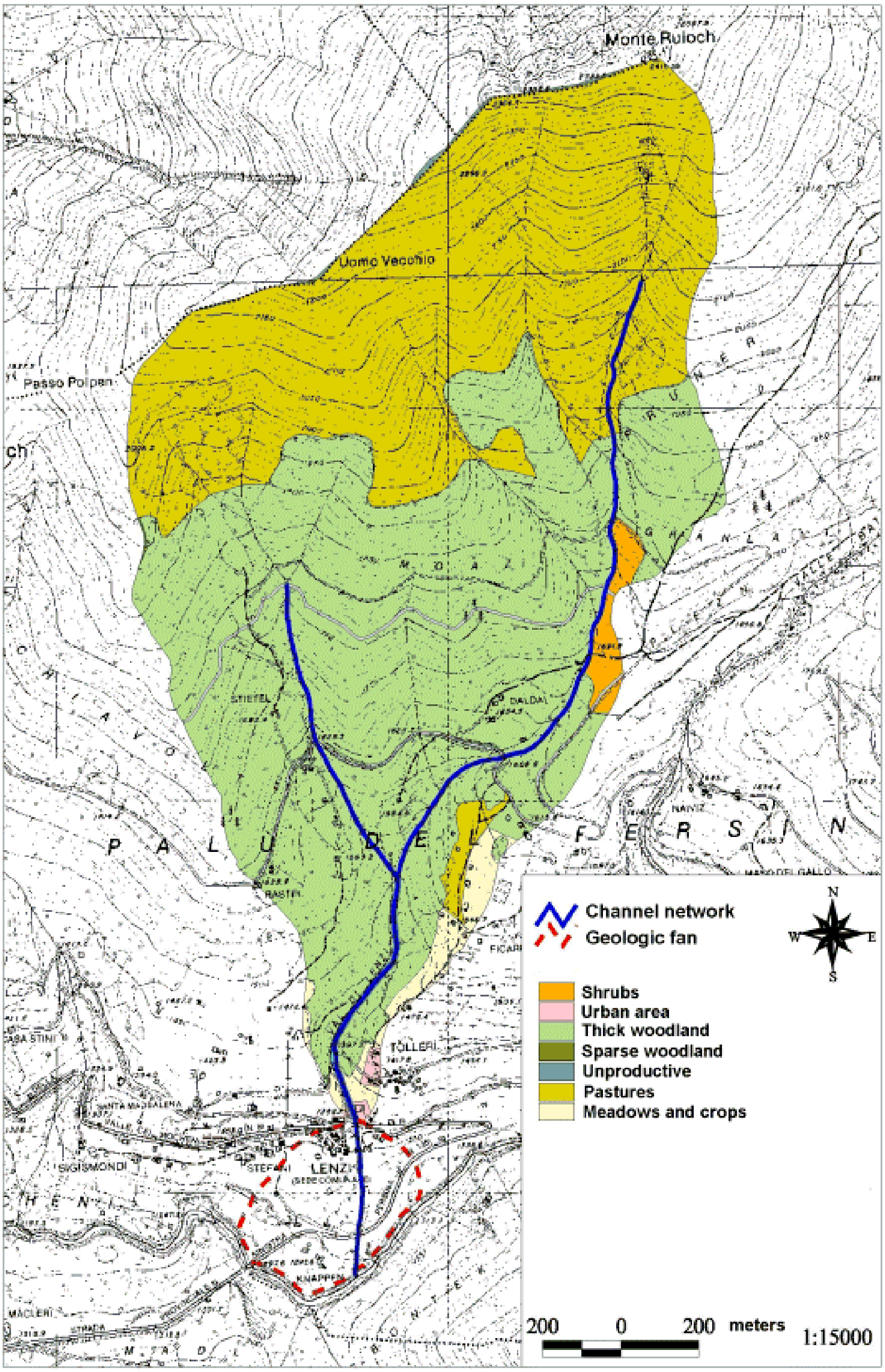
ANNEXE 1



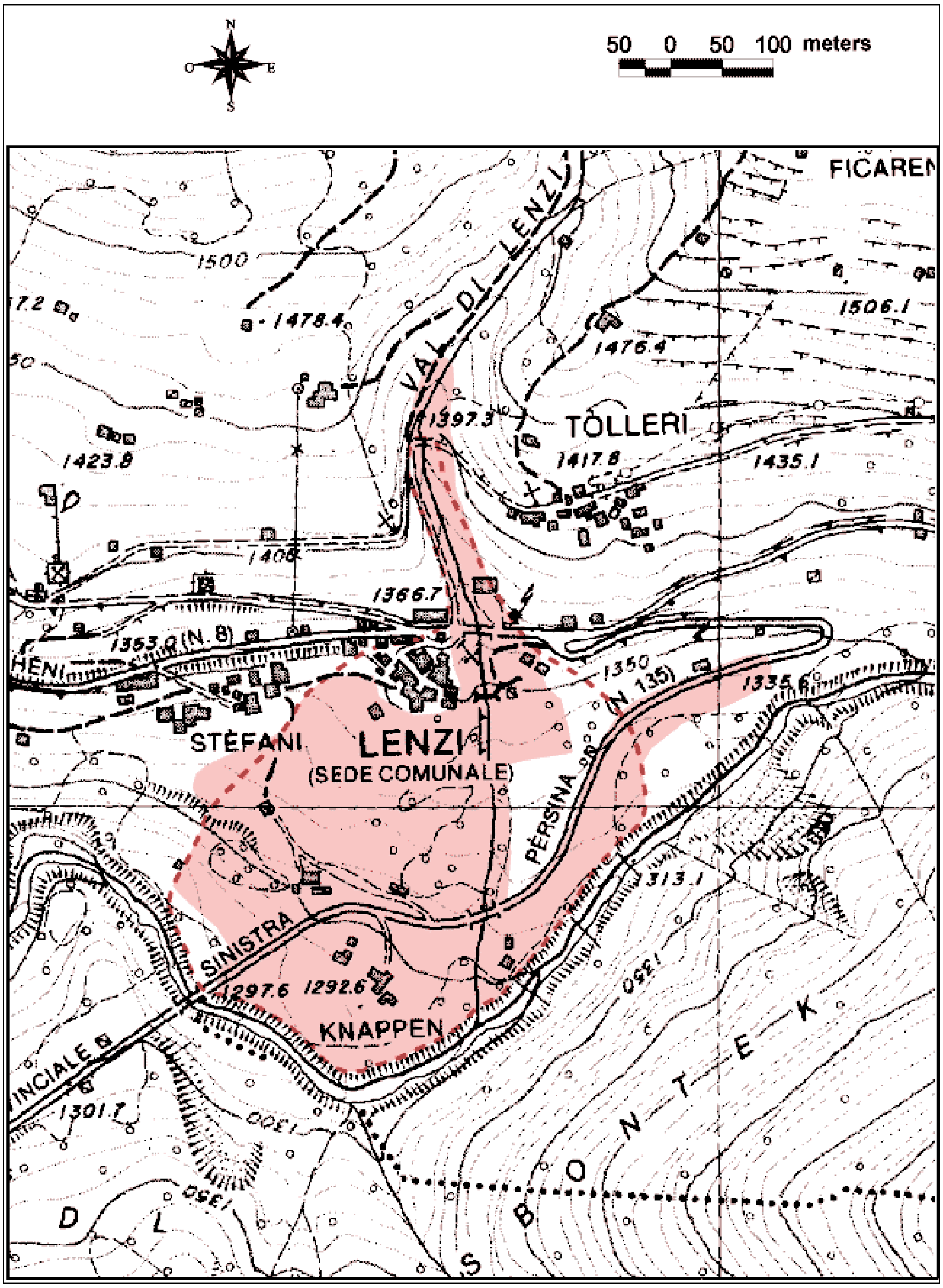
A1 – The Digital Elevation Model (DEM) of the Rio Lenzi basin (after Piccoli, 2000).



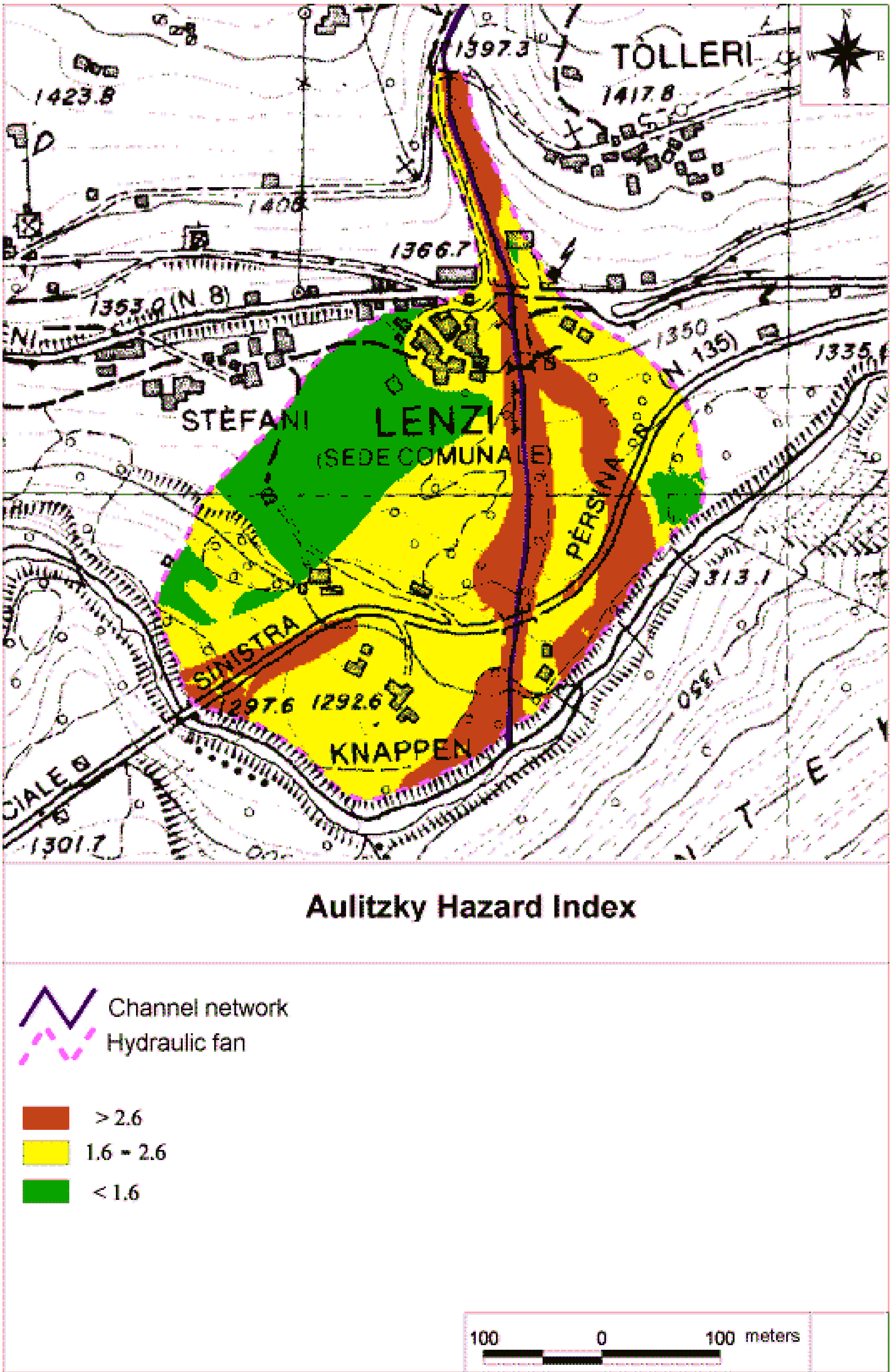
A2 - The geologic map of the Rio Lenzi basin (after Piccoli, 2000).



A3 – The land use map of the Rio Lenzi basin (after Piccoli, 2000).

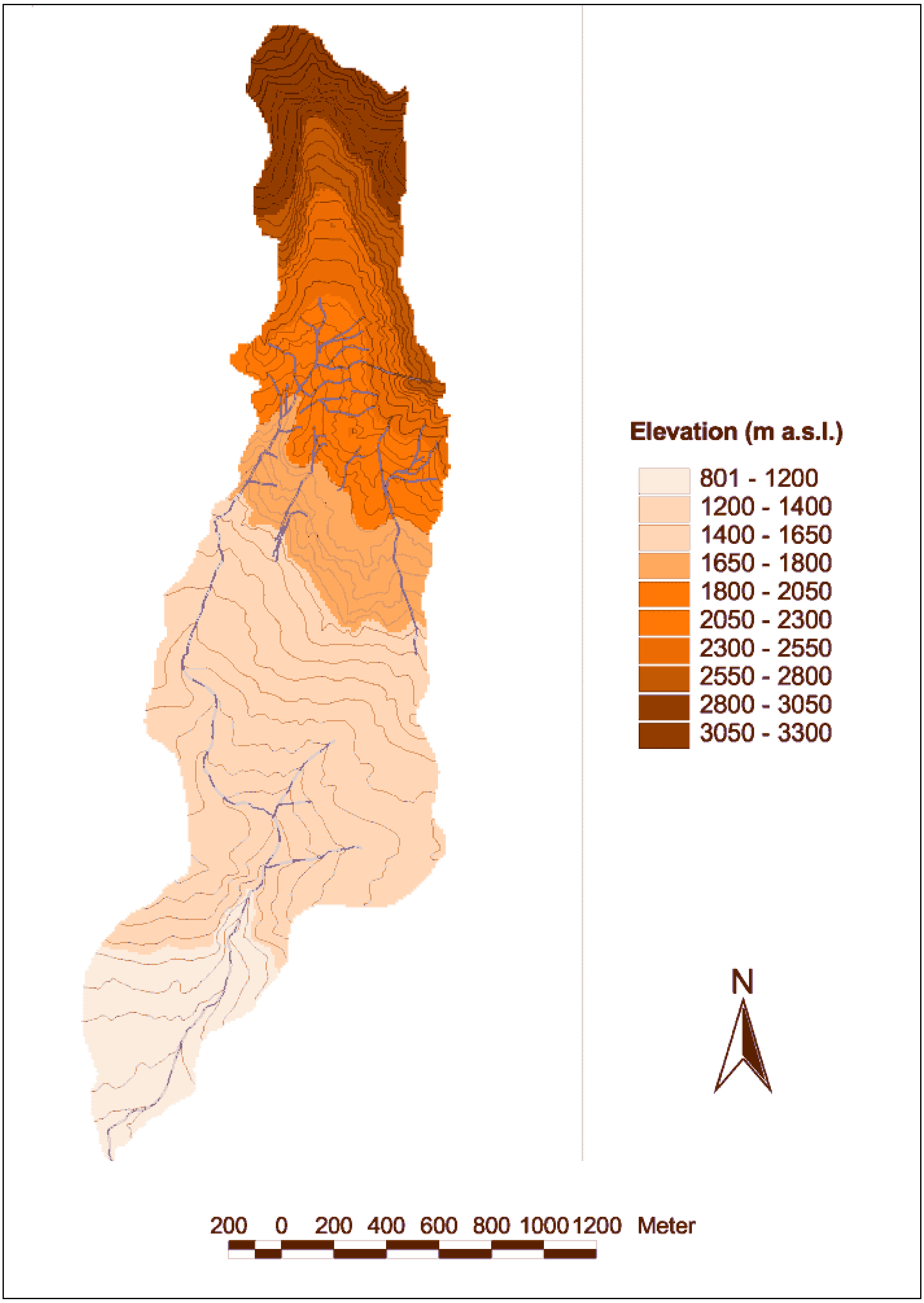


A4 – The surveyed portion (shaded) of the Rio Lenzi fan.

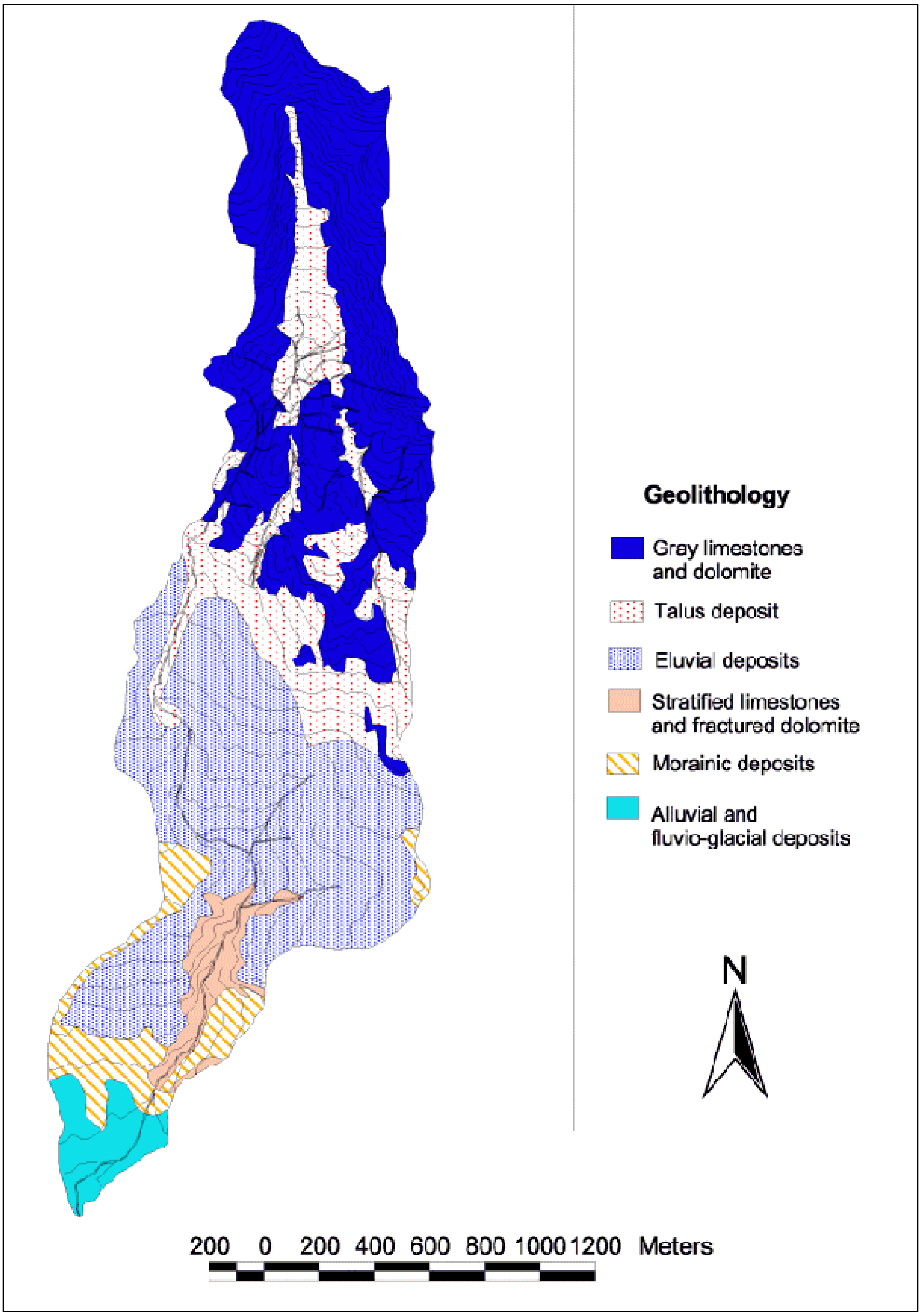


Aulitzky Hazard Index

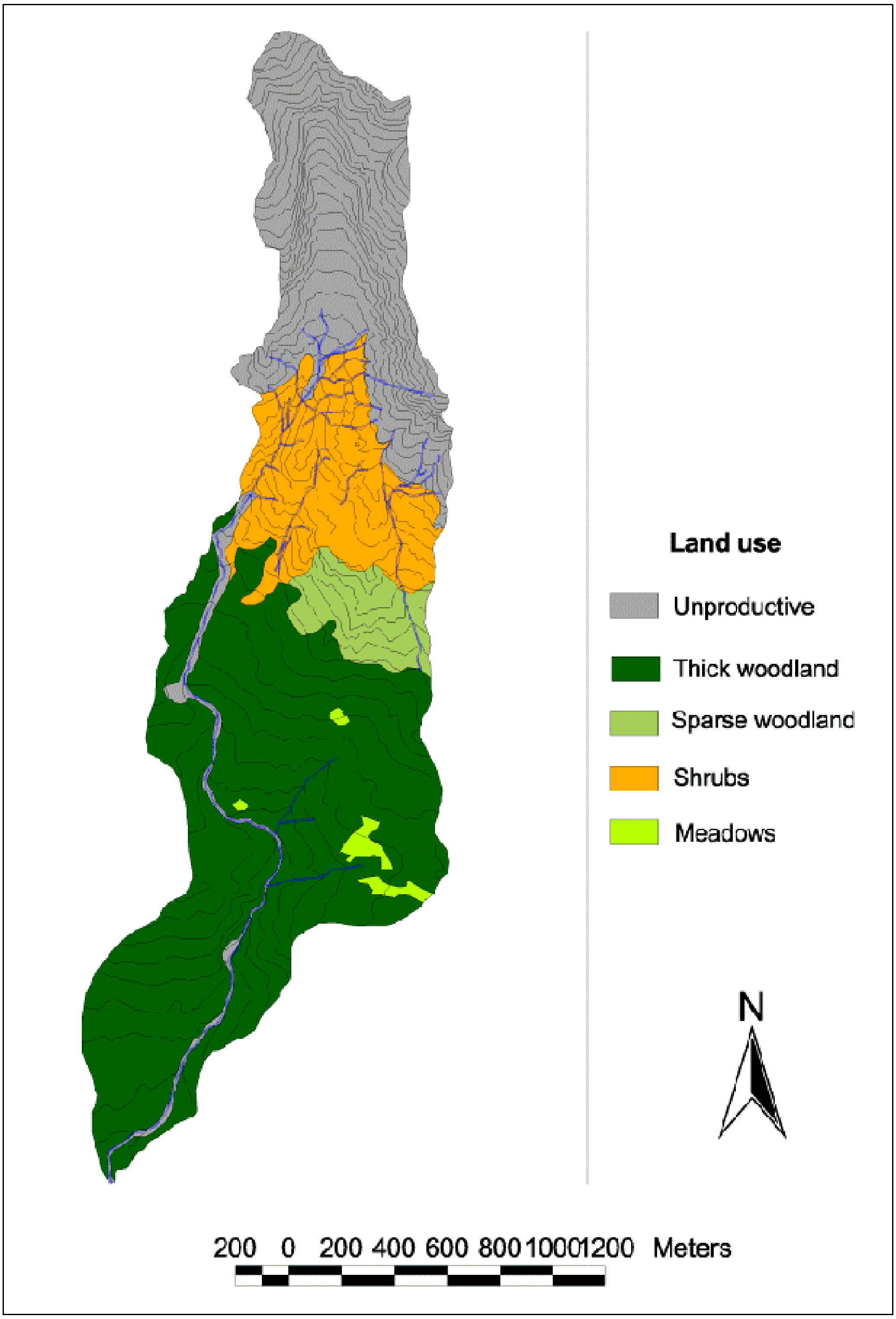
A5 – The Aulitzky hazard map (after Piccoli, 2000).



A6 – The The Digital Elevation Model (DEM) of the Rio Rudan basin.


Geolithology
Gray limestones and dolomite
Talus deposit
Eluvial deposits
Stratified limestones and fractured dolomite
Morainic deposits
Alluvial and fluvio-glacial deposits
N
200 0 200 400 600 800 1000 1200 Meters

A7 - The geologic map of the Rio Rudan basin.



A8 - The land use map of the Rio Lenzi basin.

DEBRIS FLOW TORRENTS
IN THE TRENTINO-ALTO ADIGE REGION

- GENERAL FEATURES

- MORPHOMETRY

- GEOLOGY AND GEOMORPHOLOGY

- LAND USE

- WATER DISCHARGES

- RECORDED DEBRIS FLOW EVENTS

Data sources:

"Ufficio Bacini Montani, Prov. Autonoma di Bolzano",
for general information, hydrologic data and part of the geology;

"CARFRA project, Ufficio Geologia e Prove Materiali, Prov. Autonoma di Bolzano",
for part of the geology and most of the recorded events;

CORINE database, for land use information;

First Intervention Squad reports (FI), newspapers and other, where specified.

Stream: Rio Calce

General features

Administrative code	Nr.	1951
Municipality		Curon Venosta
Stream name		Calcara or Calce/ Kalcherbach
Survey map	1:10000	004 14
Topographic Coordinates	**(outlet section)**	**E 1613.615**
		N 5186034
CARFRA Code	Nr.	1648
Collection drain	**Nr., name**	1949, Rio Piz or Roja
Next collection drain	**Nr., name**	1944, Adige (upstream of Resia Lake)

Morphometric characteristics

Basin area		(km^2)	1.20
Basin Altitude	*- maximum*	(m)	2763
	- mean	(m)	2379
	- minimum (fan top)	(m)	1820
	- confluence	(m)	1775
Basin Slope	*- maximum*	(°)	52.44
	- mean	(°)	23.08
	- minimum	(°)	0.51
Average aspect		(°)	121.39
Channel lenght		(km)	2.34
Channel mean slope		(°)	16.41
Fan mean slope		(°)	15.99

Geologic and geomorphologic characteristics

Upper reach	Paragneiss
Medium reach	Paragneiss with breccias, limestones, argilloschists and moraine
Lower reach	Alluvium mixed with talus
notes	

Land use (%)

Crops	-
Woodlands	2.96
Grasslands	64.15
Heath and shrub lands	-
Scattered vegetation cover	32.89
Bare rocks	-
Other	-

- Actual woodland upper limit (m) :
- Potential woodland upper limit (m):

Water discharges (m^3s^{-1})

Maximum	
Mean	
Minimum	

Debris flow events

Date	**Magnitude (m^3)**
15 Sept. 1965	1000

Notes

Debris flow triggered by heavy rainfall; the gravel blocked the road to Resia and the aquiduct

Stream: Rio Cengles

General features

Administrative code	Nr.	2078
Municipality		Lasa
Stream name		Cengles / Tschengelserbach
Survey map	1:10000	011 16
Topographic Coordinates	**(outlet section)**	**E 1625350**
		N 5163273
CARFRA Code	Nr.	1607
Collection drain	**Nr., name**	1, Adige
Next collection drain	**Nr., name**	-

Morphometric characteristics

Basin area		(km^2)	10.53
Basin Altitude	*- maximum*	(m)	3366
	- mean	(m)	2286
	- minimum (fan top)	(m)	950
	- confluence	(m)	877
Basin Slope	*- maximum*	(°)	67.86
	- mean	(°)	33.94
	- minimum	(°)	0.00
Average aspect		(°)	185.41
Channel lenght		(km)	5.90
Channel mean slope		(°)	21.34
Fan mean slope		(°)	3.33

Geologic and geomorphologic characteristics

Upper reach	Micaschists, paragneiss, talus debris, moraine and anphibolits
Medium reach	Micaschists, paragneiss and moraine
Lower reach	Alluvium and alluvial fans
notes	Steep catchment with diffused slope instabilities

Land use (%)

Crops	-
Woodlands	27.53
Grasslands	18.08
Heath and shrub lands	6.33
Scattered vegetation cover	27.48
Bare rocks	20.17
Other	0.41

- Actual woodland upper limit (m) : 2100
- Potential woodland upper limit (m): 2200

Water discharges (m^3s^{-1})

Maximum	69.3
Mean	0.188
Minimum	0.075

Debris flow events

Date	**Magnitude (m^3)**
10 July 1989	8.200
27 Aug. 1971	?
Summer 1992	3.000
Notes The 1971 event originated from a landslide which ended in the stream bed, then turning into a flow that flooded with logs and debris the town, destroying two bridges.	

FI n.90177 and 92121

Alto Adige, 28/8/71 and 11/7/89

Stream: Rio Chiesa

General features

Administrative code	Nr.	1725
Municipality		Naturno
Stream name		Chiesa / Kirchbach
Survey map	1:10000	013 09
Topographic Coordinates	**(outlet section)**	**E 1653117**
		N 5168770
CARFRA Code	Nr.	1663
Collection drain	**Nr., name**	1, Adige
Next collection drain	**Nr., name**	-

Morphometric characteristics

Basin area		(km^2)	2.36
Basin Altitude	*- maximum*	(m)	2918
	- mean	(m)	1733
	- minimum (fan top)	(m)	600
	- confluence	(m)	531
Basin Slope	*- maximum*	(°)	62.43
	- mean	(°)	36.11
	- minimum	(°)	0.51
Average aspect		(°)	172.51
Channel lenght		(km)	4.37
Channel mean slope		(°)	27.57
Fan mean slope		(°)	4.39

Geologic and geomorphologic characteristics

Upper reach	Paragneiss, micaschists, ortogneiss, granitic gneiss and moraine
Medium reach	Ortogneiss. Paragneiss, micaschists and moraine
Lower reach	Alluvial fans and alluvium
notes	Very steep and unstable catchment, poorly wooded, frequent events of solid transport with large boulder

Land use (%)

Crops	14.98
Woodlands	-
Grasslands	16.32
Heath and shrub lands	1.41
Scattered vegetation cover	60.84
Bare rocks	6.45
Other	-

- Actual woodland upper limit (m) : 1800-2100
- Potential woodland upper limit (m): 2150

Water discharges (m^3s^{-1})

Maximum	12.7
Mean	0.02
Minimum	0.008

Debris flow events

Date	**Magnitude (m^3)**
12 Aug. 1958	?
15 July 1988	7200
Summer 1994	1300
Notes The 1958 event, triggered by intense rainfall, caused three victims. In the 1988 the debris flow stopped upstream of the retention check-dam.	

Proceedings of the workshop on “Upland hydraulics”, Bressanone, 8-13/10/84
FI n.89059 and 95027

Stream: Rio Gadria

General features

Administrative code	Nr.	1821
Municipality		Silandro – Lasa
Stream name		Gadria or Allitz / Gadriabach or Allitzerbach
Survey map	1:10000	012 09 and 012 13
Topographic Coordinates	**(outlet section)**	**E 1631502**
		N 5165620
CARFRA Code	Nr.	-
Collection drain	**Nr., name**	1, Adige
Next collection drain	**Nr., name**	-

Morphometric characteristics

Basin area		(km^2)	15.75
Basin Altitude	*- maximum*	(m)	3175
	- mean	(m)	2251
	- minimum (fan top)	(m)	1100
	- confluence	(m)	840
Basin Slope	*- maximum*	(°)	65.08
	- mean	(°)	31.14
	- minimum	(°)	0.51
Average aspect		(°)	177.11
Channel lenght		(km)	8.32
Channel mean slope		(°)	12.73
Fan mean slope		(°)	6.86

Geologic and geomorphologic characteristics

Upper reach	Micaschists, moraine and talus debris
Medium reach	Micaschists, paragneiss, talus slopes, milonites
Lower reach	Alluvial fans
notes	The catchment is steep and unstable in its medium-upper part

Land use (%)

Crops	2.50
Woodlands	10.10
Grasslands	35.17
Heath and shrub lands	-
Scattered vegetation cover	31.40
Bare rocks	20.83
Other	-

- Actual woodland upper limit (m) : 1900-2100
- Potential woodland upper limit (m): 2200

Water discharges (m^3s^{-1})

Maximum	100
Mean	0.17
Minimum	0.07

Debris flow events

Date	**Magnitude (m^3)**
25-26 July 1992	31000
Notes	

Alto Adige 27/7/92

FI n. 92154

Stream: Rio Graves

General features

Administrative code	Nr.	1515
Municipality		S. Leonardo in Passiria
Stream name		Graves / Grafelsbach
Survey map	1:10000	013 03
Topographic Coordinates	**(outlet section)**	**E 1.669.783**
		N 5.181.791
CARFRA Code	Nr.	1791
Collection drain	**Nr., name**	1469, Passirio
Next collection drain	**Nr., name**	1, Adige

Morphometric characteristics

Basin area		(km^2)	8.05
Basin Altitude	*- maximum*	(m)	2768
	- mean	(m)	1791
	- minimum (fan top)	(m)	620
	- confluence	(m)	540
Basin Slope	*- maximum*	(°)	68.45
	- mean	(°)	32.01
	- minimum	(°)	0.51
Average aspect		(°)	225.64
Channel lenght		(km)	6.29
Channel mean slope		(°)	16.40
Fan mean slope		(°)	11.53

Geologic and geomorphologic characteristics

Upper reach	**Paragneiss, micascists, moraine and slope debris**
Medium reach	Paragneiss, micascists, gneiss
Lower reach	alluvial fans
notes	Erosion areas in the upper part of the basin for local moraine deposits on the hillslopes

Land use (%)

Crops	0.24
Woodlands	56.69
Grasslands	22.80
Heath and shrub lands	-
Scattered vegetation cover	8.57
Bare rocks	11.70
Other	-

- Actual woodland upper limit (m) : 1950-2050
- Potential woodland upper limit (m): 2100

Water discharges (m^3s^{-1})

Maximum	45.8
Mean	0.11
Minimum	0.044

Debris flow events

Date	**Magnitude (m^3)**
3 july 1940	10.000
Notes A landslide triggered the event by obstructing the stream; downstream 2 houses were destroyed with 8 victims.	

Stream: Rio Lana

General features

Administrative code	Nr.	1724
Municipality		Naturno
Stream name		Lana / Lahnbach
Survey map	1:10000	013 09
Topographic Coordinates	**(outlet section)**	**E 1654478**
		N 5169170
CARFRA Code	Nr.	1657
Collection drain	**Nr., name**	1, Adige
Next collection drain	**Nr., name**	-

Morphometric characteristics

Basin area		(km^2)	4.86
Basin Altitude	*- maximum*	(m)	3065
	- mean	(m)	1892
	- minimum (fan top)	(m)	630
	- confluence	(m)	520
Basin Slope	*- maximum*	(°)	68.22
	- mean	(°)	39.78
	- minimum	(°)	0.00
Average aspect		(°)	162.93
Channel lenght		(km)	4.83
Channel mean slope		(°)	25.47
Fan mean slope		(°)	7.36

Geologic and geomorphologic characteristics

Upper reach	Micaschists, paragneiss and granitic gneiss
Medium reach	Micaschists, paragneiss, ortogneiss and moraine
Lower reach	Alluvium and alluvial fans
notes	Very unstable catchment and steep torrent; moraine and talus at the slopes toes

Land use (%)

Crops	8.09
Woodlands	-
Grasslands	21.96
Heath and shrub lands	-
Scattered vegetation cover	58.69
Bare rocks	7.36
Other	3.91

- Actual woodland upper limit (m) : 1800-2100
- Potential woodland upper limit (m): 2150

Water discharges (m^3s^{-1})

Maximum	26.9
Mean	0.043
Minimum	0.017

Debris flow events

Date	**Magnitude (m^3)**
7 Aug. 1995	10000

Notes

Caused by a big storm, the debris flow obstructed the underpass of the National Road n.38 and flooded the carriageway. The day after the phenomenon occurs again but in a lighter magnitude.

FI n. 95116

Alto Adige 8/8/95

Stream: Rio Lega

General features

Administrative code	Nr.	1526
Municipality		S. Leonardo in Passiria
Stream name		Lega or Clava / Kellitz or Kehltalbach
Survey map	1:10000	013 03 and 013 04
Topographic Coordinates	**(outlet section)**	**E 1671407**
		N 5184904
CARFRA Code	Nr.	1794
Collection drain	**Nr., name**	1496, Passirio
Next collection drain	**Nr., name**	1, Adige

Morphometric characteristics

Basin area		(km^2)	1.86
Basin Altitude	*- maximum*	(m)	2318
	- mean	(m)	1548
	- minimum (fan top)	(m)	830
	- confluence	(m)	615
Basin Slope	*- maximum*	(°)	67.46
	- mean	(°)	36.26
	- minimum	(°)	3.25
Average aspect		(°)	274.55
Channel lenght		(km)	2.25
Channel mean slope		(°)	32.85
Fan mean slope		(°)	14.28

Geologic and geomorphologic characteristics

Upper reach	Paragneiss, micaschists and gneiss
Medium reach	Paragneiss, micaschists and gneiss
Lower reach	Alluvial fans
notes	Extremely steep catchment; moraine deposits on the slopes; Bank erosion phenomena along the channel

Land use (%)

Crops	-
Woodlands	56.23
Grasslands	-
Heath and shrub lands	-
Scattered vegetation cover	43.77
Bare rocks	-
Other	-

- Actual woodland upper limit (m) : 1750-2000
- Potential woodland upper limit (m): 2100

Water discharges (m^3s^{-1})

Maximum	12.5
Mean	0.036
Minimum	0.015

Debris flow events

Date	Magnitude (m^3)
27 June 1998	95000
16 Aug. 1966	?
1950	?
Notes The 1950 event caused 10 victims; the 1998 one was triggered by a storm initiated around 8 pm.	

Report by "Ripartizione 30, Acque pubbliche e opere idrauliche, Lachmann S."
Report by "Ufficio Bacini montani ovest, Spagnolo M.", 1/7/98
Alto Adige 18/8/66
Dolomiten 29/6/98

<u>Stream: Marbeltal</u>

General features

Administrative code	Nr.	-
Municipality		**Curon Venosta**
Stream name		Marbeltal
Survey map	1:10000	004 15
Topographic Coordinates	**(outlet section)**	**E 1618655**
		N 5184940
CARFRA Code	Nr.	1848
Collection drain	**Nr., name**	1901, Rio Carlino
Next collection drain	**Nr., name**	1944, Lago Resia

Morphometric characteristics

Basin area		(km^2)	0.55
Basin Altitude	- *maximum*	(m)	2584
	- *mean*	(m)	1974
	- *minimum (fan top)*	(m)	1570
	- *confluence*	(m)	1530
Basin Slope	- *maximum*	(°)	55.96
	- *mean*	(°)	34.75
	- *minimum*	(°)	1.60
Average aspect		(°)	233.52
Channel lenght		(km)	1.75
Channel mean slope		(°)	29.29
Fan mean slope		(°)	14.74

Geologic and geomorphologic characteristics

Upper reach	Calceschists, dolomites and limestones
Medium reach	Ladinic dolomites and paragneiss
Lower reach	Talus slopes and alluvial fans
notes	

Land use (%)

Crops	-
Woodlands	30.12
Grasslands	-
Heath and shrub lands	35.55
Scattered vegetation cover	-
Bare rocks	34.33
Other	-

- Actual woodland upper limit (m) :
- Potential woodland upper limit (m):

Water discharges (m^3s^{-1})

Maximum	
Mean	
Minimum	

Debris flow events

Date	**Magnitude (m^3)**
6 July 1994	10000
Notes The event started around 6 pm after an intense hail storm initiated around 5 pm.	

Stream: Rio Masul

General features

Administrative code	Nr.	1492
Municipality		Scena
Stream name		Masul / Masulbach
Survey map	1:10000	013 07
Topographic Coordinates	**(outlet section)**	**E 1668116**
		N 5176482
CARFRA Code	Nr.	1435
Collection drain	**Nr., name**	1469, Passirio
Next collection drain	**Nr., name**	1, Adige

Morphometric characteristics

Basin area		(km^2)	15.90
Basin Altitude	*- maximum*	(m)	2676
	- mean	(m)	1700
	- minimum (fan top)	(m)	490
	- confluence	(m)	440
Basin Slope	*- maximum*	(°)	68.80
	- mean	(°)	34.30
	- minimum	(°)	0.51
Average aspect		(°)	221.63
Channel lenght		(km)	7.78
Channel mean slope		(°)	13.73
Fan mean slope		(°)	5.73

Geologic and geomorphologic characteristics

Upper reach	Granite, limestones, paragneiss and micaschists
Medium reach	Paragneiss, micaschists and moraine
Lower reach	Recent alluvium and alluvial fans
notes	Highly unstable catchment, with large landslides, in the upper part; Talus and moraine with variable thickness are the covering deposits.

Land use (%)

Crops	7.19
Woodlands	57.62
Grasslands	4.61
Heath and shrub lands	-
Scattered vegetation cover	14.22
Bare rocks	16.36
Other	-

- Actual woodland upper limit (m) : 1850-2050
- Potential woodland upper limit (m): 2100

Water discharges (m^3s^{-1})

Maximum	88.4
Mean	0.245
Minimum	0.098

Debris flow events

Date	Magnitude (m^3)
3 Aug. 1988	150000
Notes The debris flow was composed of fine sediments and logs.	

FI n. 8646

Stream: Rio Ramini

General features

Administrative code	Nr.	2147
Municipality		Laces
Stream name		Ramini / Ramining or Lengbach
Survey map	1:10000	012 14
Topographic Coordinates	**(outlet section)**	**E 1642603**
		N 5136317
CARFRA Code	Nr.	-
Collection drain	**Nr., name**	1, Adige
Next collection drain	**Nr., name**	-

Morphometric characteristics

Basin area		(km^2)	11.55
Basin Altitude	*- maximum*	(m)	2900
	- mean	(m)	1667
	- minimum (fan top)	(m)	690
	- confluence	(m)	640
Basin Slope	*- maximum*	(°)	66.11
	- mean	(°)	26.23
	- minimum	(°)	0.00
Average aspect		(°)	187.88
Channel lenght		(km)	6.33
Channel mean slope		(°)	15.25
Fan mean slope		(°)	1.59

Geologic and geomorphologic characteristics

Upper reach	Quartziferous phyllite, talus, moraine and micaschists
Medium reach	Micaschists, moraine, ortogneiss and limestones
Lower reach	Alluvial fans
notes	Areas subject to landslides are present in the catchment

Land use (%)

Crops	1.35
Woodlands	51.00
Grasslands	11.55
Heath and shrub lands	3.23
Scattered vegetation cover	30.29
Bare rocks	2.58
Other	-

- Actual woodland upper limit (m) : 2050-2200
- Potential woodland upper limit (m): 2200

Water discharges (m^3s^{-1})

Maximum	37.8
Mean	0.16
Minimum	0.064

Debris flow events

Date	**Magnitude (m^3)**
23 May 1983	50000
Notes 15000 m^3 settled upstream of the retention check-dam, as reported by the First Intervention Squad.	

FI n. 8644 and 8675

Stream: Tovo di Tel

General features

Administrative code	Nr.	1695
Municipality		Parcines - Lagundo
Stream name		Tovo di Tel / Töllgraben
Survey map	1:10000	013 05, 013 06 and 013 10
Topographic Coordinates	**(outlet section)**	**E 1660743**
		N 5171855
CARFRA Code	Nr.	-
Collection drain	**Nr., name**	1, Adige
Next collection drain	**Nr., name**	-

Morphometric characteristics

Basin area		(km^2)	6.05
Basin Altitude	*- maximum*	(m)	2632
	- mean	(m)	1667
	- minimum (fan top)	(m)	-
	- confluence	(m)	418
Basin Slope	*- maximum*	(°)	66.41
	- mean	(°)	32.91
	- minimum	(°)	0.00
Average aspect		(°)	161.21
Channel lenght		(km)	5.80
Channel mean slope		(°)	19.47
Fan mean slope		(°)	-

Geologic and geomorphologic characteristics

Upper reach	Paragneiss, micaschists, granitic gneiss and moraine
Medium reach	Paragneiss, micaschists and moraine
Lower reach	Alluvial fan
notes	Very unstable and degrading catchment

Land use (%)

Crops	12.60
Woodlands	42.03
Grasslands	21.65
Heath and shrub lands	4.18
Scattered vegetation cover	17.11
Bare rocks	2.42
Other	-

- Actual woodland upper limit (m) : 1850-1950
- Potential woodland upper limit (m): 2100

Water discharges (m^3s^{-1})

Maximum	56.2
Mean	0.137
Minimum	0.055

Debris flow events

Date	Magnitude (m^3)
20 July 1987	2000
Notes	

FI n. 88079

Stream: Rio Viastrata

General features

Administrative code	Nr.	1530
Municipality		S. Leonardo in Passiria
Stream name		Viastrata / Pfistradbach
Survey map	1:10000	013 03 and 013 04
Topographic Coordinates	**(outlet section)**	**E 1672044**
		N 5187052
CARFRA Code	Nr.	-
Collection drain	**Nr., name**	1529, Rio di Valtina
Next collection drain	**Nr., name**	1469, Passirio

Morphometric characteristics

Basin area		(km^2)	12.38
Basin Altitude	*- maximum*	(m)	2696
	- mean	(m)	1893
	- minimum (fan top)	(m)	-
	- confluence	(m)	761
Basin Slope	*- maximum*	(°)	71.28
	- mean	(°)	36.14
	- minimum	(°)	0.72
Average aspect		(°)	193.69
Channel lenght		(km)	6.79
Channel mean slope		(°)	13.09
Fan mean slope		(°)	-

Geologic and geomorphologic characteristics

Upper reach	Paragneiss, micaschists, moraine, gneiss, talus and recent alluvium
Medium reach	Paragneiss, micaschists, gneiss and talus
Lower reach	Moraine, paragneiss and micaschists
notes	Steep hillslopes

Land use (%)

Crops	0.60
Woodlands	30.64
Grasslands	20.79
Heath and shrub lands	8.72
Scattered vegetation cover	31.78
Bare rocks	7.47
Other	-

- Actual woodland upper limit (m) : 1700-2050
- Potential woodland upper limit (m): 2100

Water discharges (m^3s^{-1})

Maximum	51.6
Mean	0.210
Minimum	0.084

Debris flow events

Date	**Magnitude (m^3)**
27 June 1998	30000
Notes	

Stream: Rio Bianco

General features

Administrative code	Nr.	951
Municipality		Fortezza
Stream name		Bianco / Weissenbach
Survey map	1:10000	007 16
Topographic Coordinates	**(outlet section)**	**E 1697426**
		N 5186589
CARFRA Code	Nr.	1217
Collection drain	**Nr., name**	25, Isarco
Next collection drain	**Nr., name**	1, Adige

Morphometric characteristics

Basin area		(km^2)	6.44
Basin Altitude	*- maximum*	(m)	2113
	- mean	(m)	1640
	- minimum (fan top)	(m)	800
	- confluence	(m)	773
Basin Slope	*- maximum*	(°)	71.84
	- mean	(°)	33.64
	- minimum	(°)	0.00
Average aspect		(°)	185.97
Channel lenght		(km)	3.84
Channel mean slope		(°)	16.40
Fan mean slope		(°)	7.80

Geologic and geomorphologic characteristics

Upper reach	Granite
Medium reach	Granite
Lower reach	Talus slopes and alluvial fan

notes	Straight long valley on a tectnonic line; it receives debris from degrading lateral valleys; on its left side (less steep) sediments accumulate and then are transported downstream by debris flow

Land use (%)

Crops	-
Woodlands	64.36
Grasslands	14.31
Heath and shrub lands	1.45
Scattered vegetation cover	19.83
Bare rocks	-
Other	0.05

- Actual woodland upper limit (m) : 2000
- Potential woodland upper limit (m): 2000

Water discharges (m^3s^{-1})

Maximum	29.30
Mean	0.16
Minimum	0.051

Debris flow events

Date	**Magnitude (m^3)**
14 Aug. 1998	3000
6 Aug. 1985	7000

Notes
The 1985 event consisted of large boulder and logs in a sandy matrix; it flooded the central part of the alluvional fan, eroded the stream bed, blocked the road bridge and invaded the carriageway.

Marchi and Tecca (1996) Magnitudo delle colate detritiche nelle Alpi Orientali italiane, GEAM-Geoingegneria Ambientale e Mineraria, Giugno-Settembre;
Mortara, Sorzana and Villi (1986) L’evento alluvionale del 6 agosto 1985 nella vallata del fiume Isarco…, Memorie di Scienze Geologiche, Vol.XXXVIII, Padova, dicembre, 427,457;
Report by "Ripartizione 30, Ufficio Acque Pubpliche e Opere Idrauliche, Lachmann S."

Stream: Rio Boccia

General features

Administrative code	Nr.	-
Municipality		Fortezza
Stream name		Rio Boccia / Gupfental or Kupferbach
Survey map	1:10000	007 15 and 014 03
Topographic Coordinates	**(outlet section)**	**E 1696135**
		N 5186717
CARFRA Code	Nr.	1850
Collection drain	**Nr., name**	25, Isarco
Next collection drain	**Nr., name**	1, Adige

Morphometric characteristics

Basin area		(km^2)	0.41
Basin Altitude	*- maximum*	(m)	1768
	- mean	(m)	1245
	- minimum (fan top)	(m)	875
	- confluence	(m)	801
Basin Slope	*- maximum*	(°)	70.85
	- mean	(°)	35.58
	- minimum	(°)	1.01
Average aspect		(°)	88.94
Channel lenght		(km)	1.10
Channel mean slope		(°)	31.26
Fan mean slope		(°)	9.74

Geologic and geomorphologic characteristics

Upper reach	Biotitic granite fading to granodiorite
Medium reach	Biotitic granite fading to granodiorite
Lower reach	Talus slope
notes	Very steep and small valley

Land use (%)

Crops	-
Woodlands	96.25
Grasslands	-
Heath and shrub lands	-
Scattered vegetation cover	3.75
Bare rocks	-
Other	-

- Actual woodland upper limit (m) :
- Potential woodland upper limit (m):

Water discharges (m^3s^{-1})

Maximum	
Mean	
Minimum	

Debris flow events

Date	Magnitude (m^3)
14 Aug. 1998	3000

Summer 1997	?
6 Aug. 1985	?
Notes In 1997 fine sediment filled up the retention basin for the protection of the railway.	

Report by "Ripartizione 30, Ufficio Acque Pubpliche e Opere Idrauliche, Lachmann S."

Stream: Rio Cornale

General features

Administrative code	Nr.	249
Municipality		Bressanone
Stream name		Cornale / Karnolbach
Survey map	1:10000	015 05 and 015 09
Topographic Coordinates	**(outlet section)**	**E 1704190**
		N 5176886
CARFRA Code	Nr.	-
Collection drain	**Nr., name**	248, Rienza
Next collection drain	**Nr., name**	25, Isarco

Morphometric characteristics

Basin area		(km^2)	2.61
Basin Altitude	*- maximum*	(m)	1991
	- mean	(m)	1240
	- minimum (fan top)	(m)	700
	- confluence	(m)	550
Basin Slope	*- maximum*	(°)	60.19
	- mean	(°)	24.80
	- minimum	(°)	0.72
Average aspect		(°)	280.63
Channel lenght		(km)	3.57
Channel mean slope		(°)	17.69
Fan mean slope		(°)	15.00

Geologic and geomorphologic characteristics

Upper reach	Quartziferous phyllite
Medium reach	Quartziferous phyllite
Lower reach	Quartziferous phyllite and talus
notes	

Land use (%)

Crops	28.45
Woodlands	71.55
Grasslands	-
Heath and shrub lands	-
Scattered vegetation cover	-
Bare rocks	-
Other	-

- Actual woodland upper limit (m) :
- Potential woodland upper limit (m):

Water discharges (m^3s^{-1})

Maximum	
Mean	
Minimum	

Debris flow events

Date	Magnitude (m^3)

1994	1000
Notes	

Stream: Rio Eores

General features

Administrative code	Nr.	232
Municipality		Bressanone and Funes
Stream name		Eores / Afererbach
Survey map	1:10000	014 12 and 015 09
Topographic Coordinates	**(outlet section)**	**E 1701385**
		N 5172544
CARFRA Code	Nr.	
Collection drain	**Nr., name**	25, Isarco
Next collection drain	**Nr., name**	1, Adige

Morphometric characteristics

Basin area		(km^2)	31.65
Basin Altitude	- *maximum*	(m)	2650
	- *mean*	(m)	1661
	- *minimum (fan top)*	(m)	615
	- *confluence*	(m)	545
Basin Slope	- *maximum*	(°)	76.37
	- *mean*	(°)	26.45
	- *minimum*	(°)	0.00

Average aspect	(°)	199.82
Channel lenght	(km)	14.79
Channel mean slope	(°)	7.14
Fan mean slope	(°)	4.00

Geologic and geomorphologic characteristics

Upper reach	Limestones, Gardena sandstones and quartziferous phyllite
Medium reach	Quartziferous phyllite and talus
Lower reach	Quartziferous phyllite, moraine and alluvial fan
notes	The upper part of the catchment is unstable

Land use (%)

Crops	10.33
Woodlands	62.42
Grasslands	14.93
Heath and shrub lands	6.34
Scattered vegetation cover	2.63
Bare rocks	3.34
Other	-

- Actual woodland upper limit (m): 1950
- Potential woodland upper limit (m): 2000

Water discharges (m^3s^{-1})

Maximum	64.60
Mean	0.714
Minimum	0.228

Debris flow events

Date	**Magnitude (m^3)**
26 July 1992	50000
6 Aug. 1906	?
Notes	
In 1906 the alluvial fan was flooded and the Brennero railway was interrupted	

Mortara, Sorzana and Villi (1986) L'evento alluvionale del 6 agosto 1985 nella vallata del fiume Isarco…, Memorie di Scienze Geologiche, Vol.XXXVIII, Padova, dicembre, 427,457;

Stream: Rio Inferno

General features

Administrative code	Nr.	-
Municipality		Fortezza
Stream name		Inferno / Holleffluchtbach
Survey map	1:10000	007 15
Topographic Coordinates	**(outlet section)**	**E 1695589**
		N 5187593
CARFRA Code	Nr.	1224
Collection drain	**Nr., name**	25, Isarco
Next collection drain	**Nr., name**	1, Adige

Morphometric characteristics

Basin area		(km^2)	0.68
Basin Altitude	- *maximum*	(m)	1976
	- *mean*	(m)	1518
	- *minimum (fan top)*	(m)	900
	- *confluence*	(m)	820

Basin Slope	*- maximum*	(°)	64.30
	- mean	(°)	40.64
	- minimum	(°)	1.52
Average aspect		(°)	200.71
Channel lenght		(km)	1.58
Channel mean slope		(°)	32.83
Fan mean slope		(°)	10.86

Geologic and geomorphologic characteristics

Upper reach	Granite
Medium reach	Granite
Lower reach	Talus and alluvial fan
notes	Medium and upper reaches very steep in friable rock; on the left side the valley is very incised with large amount of accumulated debris

Land use (%)

Crops	-
Woodlands	26.30
Grasslands	6.54
Heath and shrub lands	-
Scattered vegetation cover	67.16
Bare rocks	-
Other	-

- Actual woodland upper limit (m) : 1950
- Potential woodland upper limit (m): 1950

Water discharges (m^3s^{-1})

Maximum	4.88
Mean	0.066
Minimum	0.017

Debris flow events

Date	Magnitude (m^3)
14 Aug. 1998	5000
6 Aug. 1985	700
3 Aug. 1969	500
4 Nov. 1966	35000
27 July 1962	500
6 Sept. 1960	300
28 June 1959	2500
9-10 Aug. 1957	1000
26 July 1953	1000

Report by "Ripartizione 30, Ufficio Acque Pubpliche e Opere Idrauliche, Lachmann S."

Marchi and Tecca (1996) Magnitudo delle colate detritiche nelle Alpi Orientali italiane, GEAM-Geoingegneria Ambientale e Mineraria, Giugno-Settembre;

Mortara, Sorzana and Villi (1986) L'evento alluvionale del 6 agosto 1985 nella vallata del fiume Isarco…, Memorie di Scienze Geologiche, Vol.XXXVIII, Padova, dicembre, 427,457;

Stream: Rio Lasanca

General features

Administrative code	Nr.	252
Municipality		Luson
Stream name		Lasanca or Luson / Lüsnerbach
Survey map	1:10000	015 01
Topographic Coordinates	**(outlet section)**	**E 1705807**
		N 5180946
CARFRA Code	Nr.	-
Collection drain	**Nr., name**	248, Rienza
Next collection drain	**Nr., name**	25, Isarco

Morphometric characteristics

Basin area		(km^2)	92.66
Basin Altitude	*- maximum*	(m)	2804
	- mean	(m)	1724
	- minimum (fan top)	(m)	-
	- confluence	(m)	593
Basin Slope	*- maximum*	(°)	79.68
	- mean	(°)	27.62
	- minimum	(°)	0.00
Average aspect		(°)	188.32
Channel lenght		(km)	19.57
Channel mean slope		(°)	5.71
Fan mean slope		(°)	-

Geologic and geomorphologic characteristics

Upper reach	Limestone, quartziferous phyllite and diorite
Medium reach	quartziferous phyllite and talus
Lower reach	quartziferous phyllite
notes	Talus and lateral landsliding in the upper part; the lower part consists mainly in a creek

Land use (%)

Crops	7.34
Woodlands	62.13
Grasslands	23.93
Heath and shrub lands	1.22
Scattered vegetation cover	3.34
Bare rocks	1.77
Other	0.27

- Actual woodland upper limit (m): 1950
- Potential woodland upper limit (m): 2000

Water discharges (m^{3}s^{-1})

Maximum	120
Mean	1.93
Minimum	0.615

Debris flow events

Date	Magnitude (m^3)
26 July 1992	30000
Notes The debris flow originated in a sub-basin, then flowed along the Rio Lasanca down to the confluence with the Rienza	

Stream: Rio Mezzaselva

General features

Administrative code	Nr.	952
Municipality		Fortezza
Stream name		Mezzaselva / Schachertalbach
Survey map	1:10000	007 15
Topographic Coordinates	**(outlet section)**	**E 1694691** **N 5187858**
CARFRA Code	Nr.	1228
Collection drain	**Nr., name**	25, Isarco
Next collection drain	**Nr., name**	1, Adige

Morphometric characteristics

Basin area		(km^2)	1.04
Basin Altitude	*- maximum*	(m)	2084
	- mean	(m)	1552
	- minimum (fan top)	(m)	900
	- confluence	(m)	822
Basin Slope	*- maximum*	(°)	73.08
	- mean	(°)	42.08
	- minimum	(°)	1.01
Average aspect		(°)	199.30
Channel lenght		(km)	1.88
Channel mean slope		(°)	28.72
Fan mean slope		(°)	10.49

Geologic and geomorphologic characteristics

Upper reach	Biotitic granite and granodiorite
Medium reach	Biotitic granite and granodiorite
Lower reach	Talus
notes	Very steep non-symmetric valley, like the neighbouring ones on this side of the Isarco valley.

Land use (%)

Crops	-
Woodlands	24.49
Grasslands	11.17
Heath and shrub lands	-
Scattered vegetation cover	64.35
Bare rocks	-
Other	-

- Actual woodland upper limit (m) :
- Potential woodland upper limit (m):

Water discharges (m^3s^{-1})

Maximum	
Mean	
Minimum	

Debris flow events

Date	**Magnitude (m^3)**
14 Aug. 1998	10000
25 July 1991	?
13 July 1991	?
6 Aug. 1985	35000

Notes

1985: the debris flow covered the fan with a debris layer up to 3 m-thick, flooded the road and obstructed the Isarco temporarily.
25/7/1991: boulders up to 10 m^3 were carried down, the national road, the motorway and the railway were blocked because the obstruction of the Isarco.
25/7/1991: the debris flow flooded a 150 m-long stretch of the motorway.
1998: a large amount of debris filled up the retention basin without any damages.

Mortara, Sorzana and Villi (1986) L'evento alluvionale del 6 agosto 1985 nella vallata del fiume Isarco…, Memorie di Scienze Geologiche, Vol.XXXVIII, Padova, dicembre, 427,457;

Alto Adige 7/8/85 and 14/7/91

Stream: Rio Tinne

General features

Administrative code	Nr.	1207
Municipality		Chiusa, Velturno and Vilandro
Stream name		Tinne / Tinnebach
Survey map	1:10000	014 011
Topographic Coordinates	**(outlet section)**	**E 1696307**
		N 5168056

CARFRA Code	Nr.	-
Collection drain	**Nr., name**	25, Isarco
Next collection drain	**Nr., name**	1, Adige

Morphometric characteristics

Basin area		(km^2)	55.83
Basin Altitude	*- maximum*	(m)	2573
	- mean	(m)	1699
	- minimum (fan top)	(m)	-
	- confluence	(m)	511
Basin Slope	*- maximum*	(°)	74.41
	- mean	(°)	23.44
	- minimum	(°)	0.00
Average aspect		(°)	160.92
Channel lenght		(km)	14.73
Channel mean slope		(°)	6.25
Fan mean slope		(°)	-

Geologic and geomorphologic characteristics

Upper reach	"Chiusa" diorite, quartziferous phyllite and moraine
Medium reach	"Chiusa" diorite, paragneiss and quartziferous phyllite
Lower reach	"Chiusa" diorite, paragneiss
notes	

Land use (%)

Crops	12.99
Woodlands	36.89
Grasslands	28.29
Heath and shrub lands	7.93
Scattered vegetation cover	11.08

Bare rocks	2.72
Other	0.10

- Actual woodland upper limit (m): 1800
- Potential woodland upper limit (m): 1900

Water discharges (m^3s^{-1})

Maximum	70.89
Mean	1.046
Minimum	0.335

Debris flow events

Date	**Magnitude (m^3)**
9 Aug. 1921	500000
Autumn 1993	15600
Notes The 1921 event was triggered by a very violent storm localised only on half the catchment; the town of Chiusa was flooded with 4 victims.	

Marchi and Tecca (1996) Magnitudo delle colate detritiche nelle Alpi Orientali italiane, GEAM-Geoingegneria Ambientale e Mineraria, Giugno-Settembre;

Mortara, Sorzana and Villi (1986) L'evento alluvionale del 6 agosto 1985 nella vallata del fiume Isarco…, Memorie di Scienze Geologiche, Vol.XXXVIII, Padova, dicembre, 427,457;

Stream: Rio Cor

General features

Administrative code	Nr.	386
Municipality		S.Martino in Badia
Stream name		Cor / Corbach or Ciansbach / Rü de Cor
Survey map	1:10000	015 011 and 015 12
Topographic Coordinates	**(outlet section)**	**E 1722058**
		N 5174170
CARFRA Code	Nr.	-
Collection drain	**Nr., name**	281, Rio Gadera
Next collection drain	**Nr., name**	248, Rienza

Morphometric characteristics

Basin area		(km^2)	1.10
Basin Altitude	*- maximum*	(m)	1869
	- mean	(m)	1533
	- minimum (fan top)	(m)	1140
	- confluence	(m)	1088
Basin Slope	*- maximum*	(°)	55.57
	- mean	(°)	31.07
	- minimum	(°)	1.13
Average aspect		(°)	249.43
Channel lenght		(km)	1.60
Channel mean slope		(°)	20.45
Fan mean slope		(°)	15.31

Geologic and geomorphologic characteristics

Upper reach	“ValGardena” sandstone
Medium reach	“ValGardena” sandstone
Lower reach	Alluvial fan
notes	Steep upper part with deep gullies

Land use (%)

Crops	-
Woodlands	100
Grasslands	-
Heath and shrub lands	-
Scattered vegetation cover	-
Bare rocks	-
Other	-

- Actual woodland upper limit (m) :
- Potential woodland upper limit (m):

Water discharges (m^3s^{-1})

Maximum	6.50
Mean	0.023
Minimum	0.007

Debris flow events

Date	**Magnitude (m^3)**
Summer 1988	3000
Notes	

Stream: Rio di Croda Rossa

General features

Administrative code	Nr.	598
Municipality		Rasun Anterselva
Stream name		Croda Rossa / Rotwandbach
Survey map	1:10000	009 10
Topographic Coordinates	**(outlet section)**	**E 1741271**
		N 5196961
CARFRA Code	Nr.	1001
Collection drain	**Nr., name**	584, Rio di Anterselva
Next collection drain	**Nr., name**	248, Rienza

Morphometric characteristics

Basin area		(km^2)	2.71
Basin Altitude	*- maximum*	(m)	2814
	- mean	(m)	2214
	- minimum (fan top)	(m)	1750
	- confluence	(m)	1638
Basin Slope	*- maximum*	(°)	70.97
	- mean	(°)	35.64
	- minimum	(°)	0.50
Average aspect		(°)	220.77
Channel lenght		(km)	3.02
Channel mean slope		(°)	16.58
Fan mean slope		(°)	8.88

Geologic and geomorphologic characteristics

Upper reach	Paragneiss, micaschists and talus
Medium reach	Paragneiss and talus
Lower reach	
notes	The rocky slopes are intensely degraded and the debris accumulates along the channel

Land use (%)

Crops	-
Woodlands	30.39
Grasslands	9.43
Heath and shrub lands	2.91
Scattered vegetation cover	29.89
Bare rocks	27.39
Other	-

- Actual woodland upper limit (m): 2100
- Potential woodland upper limit (m): -

Water discharges (m^3s^{-1})

Maximum	9.40
Mean	0.025
Minimum	0.008

Debris flow events

Date	Magnitude (m^3)
6 July 1994	8000
Notes	

Stream: Rio di Fossadura

General features

Administrative code	Nr.	409
Municipality		S. Vigilio di Marebbe
Stream name		Fossadura / Hochalmbach
Survey map	1:10000	015 08 and 015 12
Topographic Coordinates	**(outlet section)**	**E 1725285**
		N 5175661
CARFRA Code	Nr.	1580
Collection drain	**Nr., name**	389, Rio di S.Vigilio
Next collection drain	**Nr., name**	281, Rio Gadera

Morphometric characteristics

Basin area		(km^2)	5.15
Basin Altitude	*- maximum*	(m)	2484
	- mean	(m)	1943
	- minimum (fan top)	(m)	1305
	- confluence	(m)	1203
Basin Slope	*- maximum*	(°)	66.70
	- mean	(°)	30.53
	- minimum	(°)	0.00
Average aspect		(°)	224.79
Channel lenght		(km)	4.55
Channel mean slope		(°)	12.45
Fan mean slope		(°)	6.01

Geologic and geomorphologic characteristics

Upper reach	“Sciliar” dolomite and talus
Medium reach	“Werfen” and “Bellerophon” formations, “Dark” limestones
Lower reach	Alluvial fan

notes	Local moraine deposits and debris mounds (boulder in a fine matrix) are present on the lower part of the slopes

Land use (%)

Crops	-
Woodlands	31.22
Grasslands	13.67
Heath and shrub lands	-
Scattered vegetation cover	49.88
Bare rocks	5.14
Other	-

- Actual woodland upper limit (m) : 2000
- Potential woodland upper limit (m): -

Water discharges (m^3s^{-1})

Maximum	13.50
Mean	0.07
Minimum	0.023

Debris flow events

Date	Magnitude (m^3)
27 July 1995	?
Summer 1990	3000
July 1945	?

25 July 1937	?
1934	?
1882	?

Notes

27 july 1995: a hailstorm bursted about 7 pm around Piz de Peres and Monte Parcaccia, at 8 pm the debris flow fell down (it lasted for about half an hour) and obstructed the Rio di S.Vigilio channel. The "Ciamur" area was flooded with mud and stones.
1945: the channel bed was elevated by 1 m for the debris and brushwood aggradation.

Biscuola Elena, Studio del debris flow della valle di Fossadura. Tesi di Laurea in Scienze geologiche, Univ. Ferrara

Stream: Rio Grigio

General features

Administrative code	Nr.	481
Municipality		Villabassa
Stream name		Grigio / Graubach
Survey map	1:10000	016 06
Topographic Coordinates	**(outlet section)**	**E 1742872**
		N 5180295
CARFRA Code	Nr.	
Collection drain	**Nr., name**	248, Rienza
Next collection drain	**Nr., name**	25, Isarco

Morphometric characteristics

Basin area		(km^2)	3.53
Basin Altitude	*- maximum*	(m)	2372
	- mean	(m)	1654
	- minimum (fan top)	(m)	1205
	- confluence	(m)	1158
Basin Slope	*- maximum*	(°)	71.71
	- mean	(°)	27.68
	- minimum	(°)	0.50
Average aspect		(°)	184.93
Channel lenght		(km)	4.41
Channel mean slope		(°)	13.82

Fan mean slope	(°)	4.73

Geologic and geomorphologic characteristics

Upper reach	"Mendola" dolomite, "Dark" limestones, "Werfen" and "Bellerophon" formations
Medium reach	"ValGardena" sandstone, "Verrucano" and quartziferous phyllite
Lower reach	Moraine and ancient alluvium
notes	The upper part is steep but rather stable and wooded

Land use (%)

Crops	0.79
Woodlands	94.43
Grasslands	-
Heath and shrub lands	-
Scattered vegetation cover	-
Bare rocks	4.78
Other	-

- Actual woodland upper limit (m) : 2000
- Potential woodland upper limit (m): -

Water discharges (m^3s^{-1})

Maximum	12.50
Mean	0.55
Minimum	0.018

Debris flow events

Date	Magnitude (m^3)
26-27 July 1998	15000
Notes	

Alto Adige 28/7/98

Stream: Rio Molino

General features

Administrative code	Nr.	567
Municipality		Val Casies
Stream name		Molino / Mühlbach
Survey map	1:10000	009 14, 009 15, 016 02 and 016 03
Topographic Coordinates	**(outlet section)**	**E 1743950**
		N 5186378
CARFRA Code	Nr.	1290
Collection drain	**Nr., name**	531, Rio di Casies/Pudio
Next collection drain	**Nr., name**	248, Rienza

Morphometric characteristics

Basin area		(km^2)	3.07
Basin Altitude	- *maximum*	(m)	2472
	- *mean*	(m)	1936
	- *minimum (fan top)*	(m)	1300
	- *confluence*	(m)	1228
Basin Slope	- *maximum*	(°)	62.40
	- *mean*	(°)	28.61

	- minimum	(°)	0.50
Average aspect		(°)	127.11
Channel lenght		(km)	3.58
Channel mean slope		(°)	15.38
Fan mean slope		(°)	4.83

Geologic and geomorphologic characteristics

Upper reach	Ortogneiss and moraine
Medium reach	Ortogneiss
Lower reach	Alluvial fan
notes	The upper part presents many incisions and degrading areas, the medium part is a mainly rocky.

Land use (%)

Crops	-
Woodlands	54.93
Grasslands	23.94
Heath and shrub lands	-
Scattered vegetation cover	6.64
Bare rocks	14.48
Other	-

- Actual woodland upper limit (m) : 2000
- Potential woodland upper limit (m): 2100

Water discharges (m^3s^{-1})

Maximum	13.50
Mean	0.052
Minimum	0.018

Debris flow events

Date	**Magnitude (m^3)**
1-2 June 1962	4000

Notes

A 80m-long (2000 m^2) wooded slope slid for about 40 m into a right-side tributary, along which the sediments reached the main channel and then the valley bottom, at “Colle di Dentro”.
Several check-dams have been subsequently built along the channel, for the large number of erosion areas and shallow landslides on the left-side slope.

Stream: Rio Petzl

General features

Administrative code	Nr.	594
Municipality		Rasun / Anterselva
Stream name		Petzl / Pötzelbach
Survey map	1:10000	009 10
Topographic Coordinates	**(outlet section)**	**E 1783529**
		N 5195456
CARFRA Code	Nr.	
Collection drain	**Nr., name**	584, Rio Anterselva
Next collection drain	**Nr., name**	248, Rienza

Morphometric characteristics

Basin area		(km^2)	1.92
Basin Altitude	- *maximum*	(m)	2528
	- *mean*	(m)	2037
	- *minimum (fan top)*	(m)	1520
	- *confluence*	(m)	1298

Basin Slope	- *maximum*	(°)	73.50
	- *mean*	(°)	32.81
	- *minimum*	(°)	0.00
Average aspect		(°)	230.03
Channel lenght		(km)	2.25
Channel mean slope		(°)	22.26
Fan mean slope		(°)	9.87

Geologic and geomorphologic characteristics

Upper reach	Paragneiss and moraine
Medium reach	Paragneiss
Lower reach	Alluvial fan
notes	The medium-upper part is steep and mainly rocky

Land use (%)

Crops	-
Woodlands	49.52
Grasslands	24.15
Heath and shrub lands	0.10
Scattered vegetation cover	26.24
Bare rocks	-
Other	-

- Actual woodland upper limit (m) : 2100
- Potential woodland upper limit (m): -

Water discharges (m^3s^{-1})

Maximum	8.50
Mean	0.035

Minimum	0.013

Debris flow events

Date	Magnitude (m^3)
6 July 1997	4000
Notes	

Stream: Rio Riscione

General features

Administrative code	Nr.	428
Municipality		Brunico
Stream name		Riscione / Reischacherbach
Survey map	1:10000	019 04
Topographic Coordinates	**(outlet section)**	**E 1724431**
		N 5186667
CARFRA Code	Nr.	-
Collection drain	**Nr., name**	248, Rienza
Next collection drain	**Nr., name**	25, Isarco

Morphometric characteristics

Basin area		(km^2)	4.01
Basin Altitude	*- maximum*	(m)	2255
	- mean	(m)	1321
	- minimum (fan top)	(m)	-
	- confluence	(m)	829
Basin Slope	*- maximum*	(°)	59.30
	- mean	(°)	18.54
	- minimum	(°)	0.00
Average aspect		(°)	215.19
Channel lenght		(km)	6.01
Channel mean slope		(°)	10.19
Fan mean slope		(°)	-

Geologic and geomorphologic characteristics

Upper reach	Quartziferous phyllite
Medium reach	Quartziferous phyllite
Lower reach	Alluvial terraces
notes	Small erosions in the upper part

Land use (%)

Crops	35.83
Woodlands	61.04
Grasslands	2.45
Heath and shrub lands	-
Scattered vegetation cover	-
Bare rocks	-
Other	0.68

- Actual woodland upper limit (m) : 1900
- Potential woodland upper limit (m): 2000

Water discharges (m^3s^{-1})

Maximum	9.50
Mean	0.048
Minimum	0.015

Debris flow events

Date	**Magnitude (m^3)**
Summer 1991	3000
Notes	

Stream: Rio Rosso

General features

Administrative code	Nr.	774
Municipality		Valle Aurina
Stream name		Rosso / Rotbach
Survey map	1:10000	002 15, 008 03 and 008 04
Topographic Coordinates	**(outlet section)**	**E 1722495**
		N 5205998
CARFRA Code	Nr.	1246
Collection drain	**Nr., name**	630, Aurino
Next collection drain	**Nr., name**	248, Rienza

Morphometric characteristics

Basin area		(km^2)	7.02
Basin Altitude	*- maximum*	(m)	3318
	- mean	(m)	2107
	- minimum (fan top)	(m)	1040
	- confluence	(m)	995
Basin Slope	*- maximum*	(°)	64.45
	- mean	(°)	33.90
	- minimum	(°)	0.50
Average aspect		(°)	128.32
Channel lenght		(km)	5.12
Channel mean slope		(°)	16.50
Fan mean slope		(°)	5.77

Geologic and geomorphologic characteristics

Upper reach	Granitic and aplitic gneiss, moraine
Medium reach	Granitic and aplitic gneiss, moraine
Lower reach	Granitic and aplitic gneiss, moraine
notes	Moraine deposits with debris at the confluence, talus at the slope toes; Downstream the small glaciers a wide degrading area is present and its sediments tend to accumulate between 1900 and 1600 m a.s.l.. From this point the debris moves down during very intense rainfalls.

Land use (%)

Crops	5.08
Woodlands	10.50
Grasslands	4.19
Heath and shrub lands	-
Scattered vegetation cover	42.73
Bare rocks	32.05
Other	5.46

- Actual woodland upper limit (m) : 1700-1900

- Potential woodland upper limit (m): 2100

Water discharges (m^3s^{-1})

Maximum	19.50
Mean	0.120
Minimum	0.043

Debris flow events

Date	**Magnitude (m^3)**
6 Aug. 1985	3500
29 June 1959	?
Autumn 1928	?
17 Aug. 1878	?

Notes

6/8/1985: Slope failures in the upper part, deposition in the lower reach at the retention check-dams.
17/8/1878: After intense rainfall and sudden snow melting the debris flow obstructed the Aurino channel, flooding the town of S.Martino.
29/6/1959: Rio Rosso with the other neighbouring torrents forced the Aurino stream to move its channel to the left side.

Mortara, Sorzana and Villi (1986) L'evento alluvionale del 6 agosto 1985 nella vallata del fiume Isarco…, Memorie di Scienze Geologiche, Vol.XXXVIII, Padova, dicembre, 427,457;

Stream: Rio di Troghe

General features

Administrative code	Nr.	485
Municipality		Dobbiaco
Stream name		Troghe / Trogerbach
Survey map	1:10000	016 07
Topographic Coordinates	**(outlet section)**	**E 1745643**
		N 5177933

CARFRA Code	Nr.	1035
Collection drain	**Nr., name**	248, Rienza
Next collection drain	**Nr., name**	25, Isarco

Morphometric characteristics

Basin area		(km^2)	1.18
Basin Altitude	*- maximum*	(m)	2378
	- mean	(m)	1715
	- minimum (fan top)	(m)	1350
	- confluence	(m)	1254
Basin Slope	*- maximum*	(°)	70.11
	- mean	(°)	31.59
	- minimum	(°)	0.50
Average aspect		(°)	120.81
Channel lenght		(km)	2.32
Channel mean slope		(°)	23.24
Fan mean slope		(°)	6.03

Geologic and geomorphologic characteristics

Upper reach	"Mendola dolomite", "Werfen" formation
Medium reach	"Werfen" formation (clayey sandstone)
Lower reach	Alluvial fan
notes	Debris is produced by intense rock degradation in the upper part, it accumulates at the cliffs' toes, moving downstream during intense rainfall events; the alluvial fan originated the Dobbiaco Lake.

Land use (%)

Crops	-
Woodlands	71.66
Grasslands	-
Heath and shrub lands	-
Scattered vegetation cover	-

Bare rocks	28.34
Other	-

- Actual woodland upper limit (m) :
- Potential woodland upper limit (m):

Water discharges (m^3s^{-1})

Maximum	7.20
Mean	0.025
Minimum	0.007

Debris flow events

Date	**Magnitude (m^3)**
6 July 1994	30000
25 July 1992	30000
Aug. 1991	30000
July 1983	?
Autumn 1966	?

Notes

The 1994 event covered a 100m-wide area.
In 1991 the Rio di Troghe and the Rio Kontschir flooded a camping site placed downstream.

Stream: Rio Cisles

General features

Administrative code	Nr.	160
Municipality		S. Cristina-Selva (Gardena)
Stream name		Cisles / Cislesbach
Survey map	1:10000	028 01
Topographic Coordinates	**(outlet section)**	**E 1708991**
		N 5159499
CARFRA Code	Nr.	1060
Collection drain	**Nr., name**	129, Rio Gardena
Next collection drain	**Nr., name**	25, Isarco

Morphometric characteristics

Basin area		(km^2)	17.52
Basin Altitude	*- maximum*	(m)	3000
	- mean	(m)	2171
	- minimum (fan top)	(m)	1434
	- confluence	(m)	1395
Basin Slope	*- maximum*	(°)	76.49
	- mean	(°)	24.75
	- minimum	(°)	0.00
Average aspect		(°)	185.15
Channel lenght		(km)	8.68
Channel mean slope		(°)	9.42
Fan mean slope		(°)	6.69

Geologic and geomorphologic characteristics

Upper reach	Moraine, dolomite and talus
Medium reach	Marls, sandstones (“S. Cassiano” and “Werfen” formations), alluvium, moraine
Lower reach	Alluvial fan
notes	Tectonically very disturbed catchment

Land use (%)

Crops	5.08
Woodlands	14.34
Grasslands	37.77
Heath and shrub lands	2.24
Scattered vegetation cover	9.19
Bare rocks	30.24
Other	1.15

- Actual woodland upper limit (m) : 2050
- Potential woodland upper limit (m): 2100

Water discharges (m^3s^{-1})

Maximum	37.05
Mean	0.257
Minimum	0.086

Debris flow events

Date	**Magnitude (m^3)**
24 March 1951	1000000

Notes

A large landslide moved from the Piz Cudcena into the channel where it was fluidified. During the first days it moved at about 60 meters/hour, then it stopped for the temperature drop. In the first days of April the debris moved again for the temperature rise and reached the Rio Gardena.

Alto Adige 25/3/51