DAMOCLES - EVG1-1999-00027P

University of Milano Bicocca INTERIM REPORT

March – September 2000

DETAILED REPORT OF CONTRACTOR FOR FIRST PROGRESS MEETING

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1. Summary

The April to September 2000 period has been mainly dedicated to data collection for database implementation (WP2, objective 1). Data collection has been performed on three valleys in the Central Alps (Lombardy), that have been recognized as possible Focus Area B: Valcamonica, Valseriana and Valsassina. In particular, the following data have been collected so far:

- historical events;
- rainfall data;
- lithological and structural maps;
- land-use and vegetation maps;
- landslide inventories and geomorphological maps;
- Digital Terrain Models.

A catastrophic rainstorm in the Valsassina area (June 28th, 1997) as been documented with detailed information about rainfall intensities and debris flows occurrence.

A Review of rockfall simulation models (WP2, objective 3) has been realised (in Italian) and will be delivered to all the partners after translation. A preliminary release of a distributed model for rockfall simulation has been produced by CNR-IRPI Perugia (partner

AC3 - see CNR-IRPI Interim Report) by implementing some AML Arc/Info macro language. A different code is under development and will be completed in the next year.

Basin and fan morphometric and geological data have been collected for more than 100 alluvial fans located in the Lombardy Region (for WP1). On-field description of geomorphological features has been started for alluvial fans located within the candidate areas for Focus Area B.

Finally, a comprehensive description of debris flow characteristics for a river basin in Focus Area B (Grigna river) has been realised (for WP3).

2. Activity

2.1 Activity for WP2

2.1.1 Data collection and creation of GIS database

Three main valleys in the Central Alps (Lombardy region) have been recognized as possible focus Area B:

- Valsassina (Lecco province),
- Valseriana (Bergamo province) and
- Valcamonica (Brescia and Bergamo province).

Data collection with field survey, aerial photo interpretation and literature review has been accomplished cooperating with CNR-IRPI Perugia (Assistant contractor) and the Geological Survey of the Lombardy Region (subcontractor).

Historical data about landslide and flood events for the last two centuries have been collected for Valsassina and Valcamonica using different bibliographic sources and direct witnesses reports. Data from Valsassina have been already introduced in a Microsoft Access database (figure 1) including 449 reports.

A catastrophic storm (Valsassina, June 28th, 1997) has been described in detail through the collection of radar images (figure 2) and rain gauge data; an accurate landslide inventory for the event has been accomplished (figure 3) starting and improving a preexisting dataset.

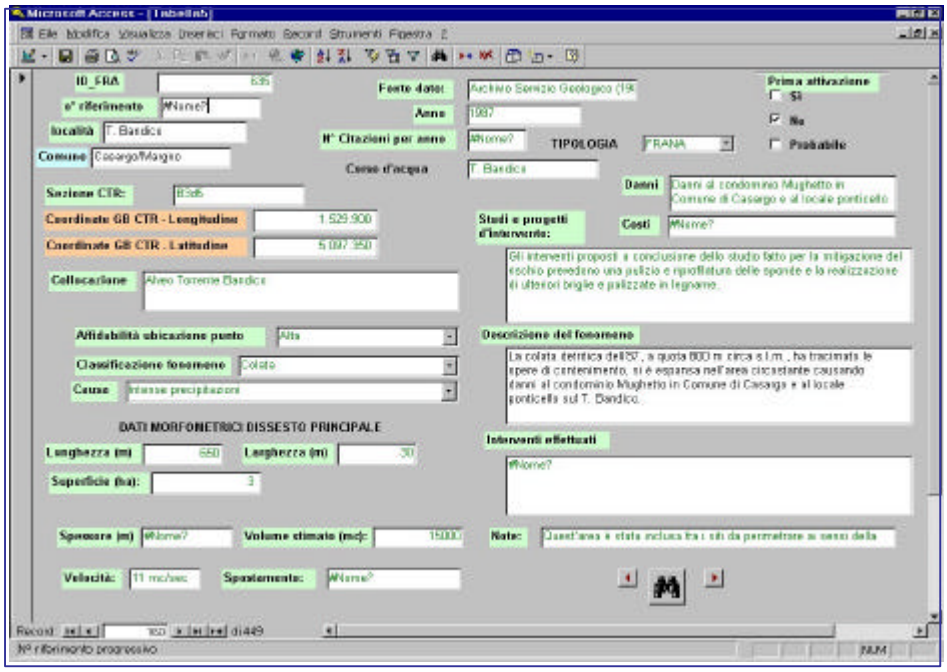

Figure 1: example of historical event database for Valsassina

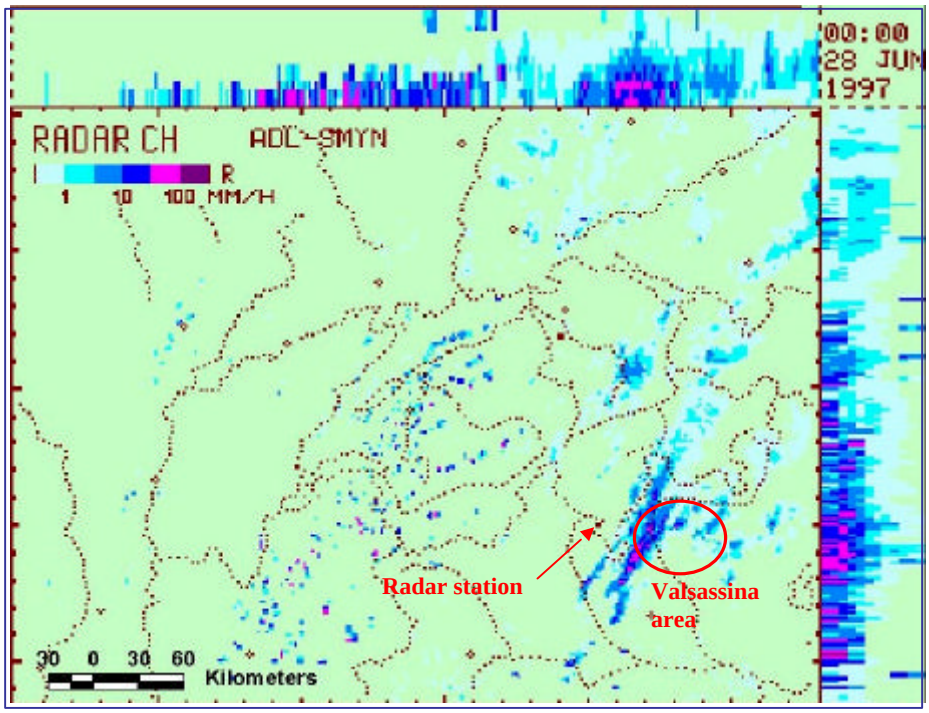

Figure 2: Image from the Swiss Meteorological Radar System for the 28th June, 1997 rainstorm (pixel size: 2 km; images are taken every 30 minutes).

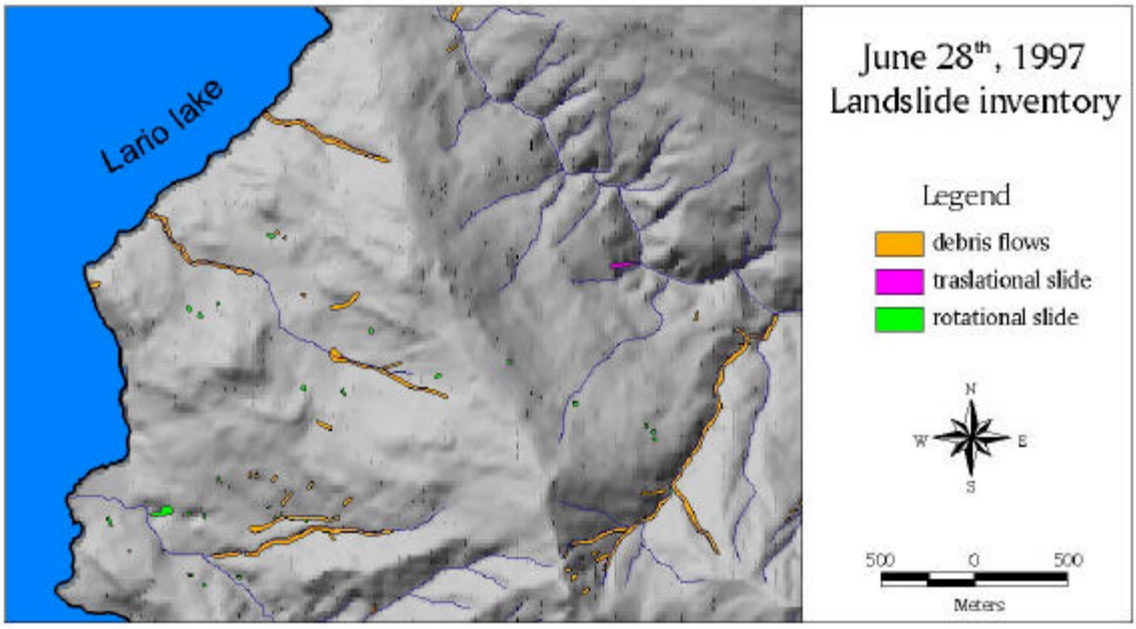

Figure 3: example from the landslide inventory map for the 28th June 1997 event.

A geotechnical characterization of soils for the area interested by the storm is under progress.

Data of 4 rain gauges (Barzio, Bellano, Lecco and Pagnona) from the Valsassina area have been transformed in digital format and analysed in order to describe the rainfall regime within the area.

Geological maps have been created in digital format for the three areas using all the available literature data. The existing cartography (at different scales: 1:10,000, 1:25,000, 1:50,000 and 1:100,000) has been critically revised in order to obtain updated and homogeneous geological maps of the possible Focus area B (figure 4). Lithological and structural maps have been derived through reclassification of the original geological units. Land use maps have been compiled using a preexisting regional cartography (scale 1:10,000, Regione Lombardia, 1986).

A comprehensive revision of the landslide inventory map for the Valsassina area (Regione Lombardia, 1998), through air photo interpretation and field survey, is in progress. Geomorphological maps (scale 1:10,000, figure 5) reporting landslides and quaternary covers for Valcamonica and Valseriana was created by CNR-IRPI, Perugia (associate partner **AC3**); these maps have been mainly produced through air photo interpretation. A revision from the Geological Survey of Lombardy Region (end-user and subcontractor **SC/EU8**) is in progress.

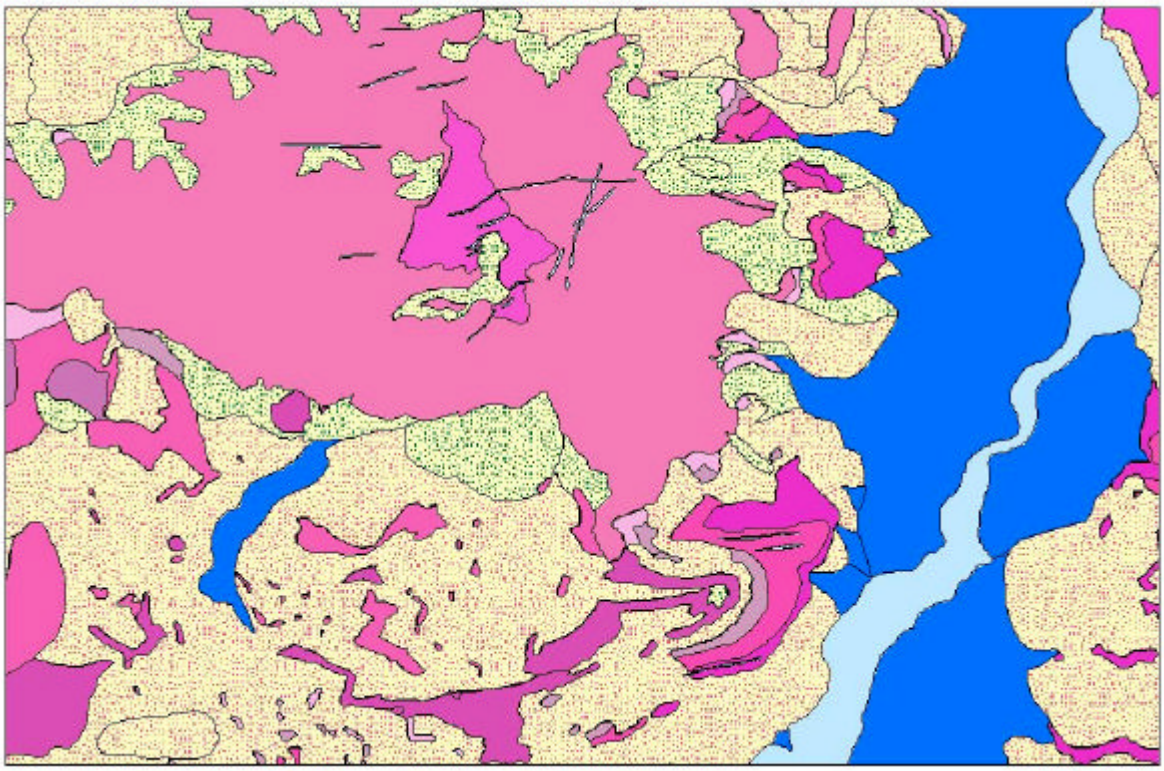

Figure 4: example from the Valcamonica geological map.

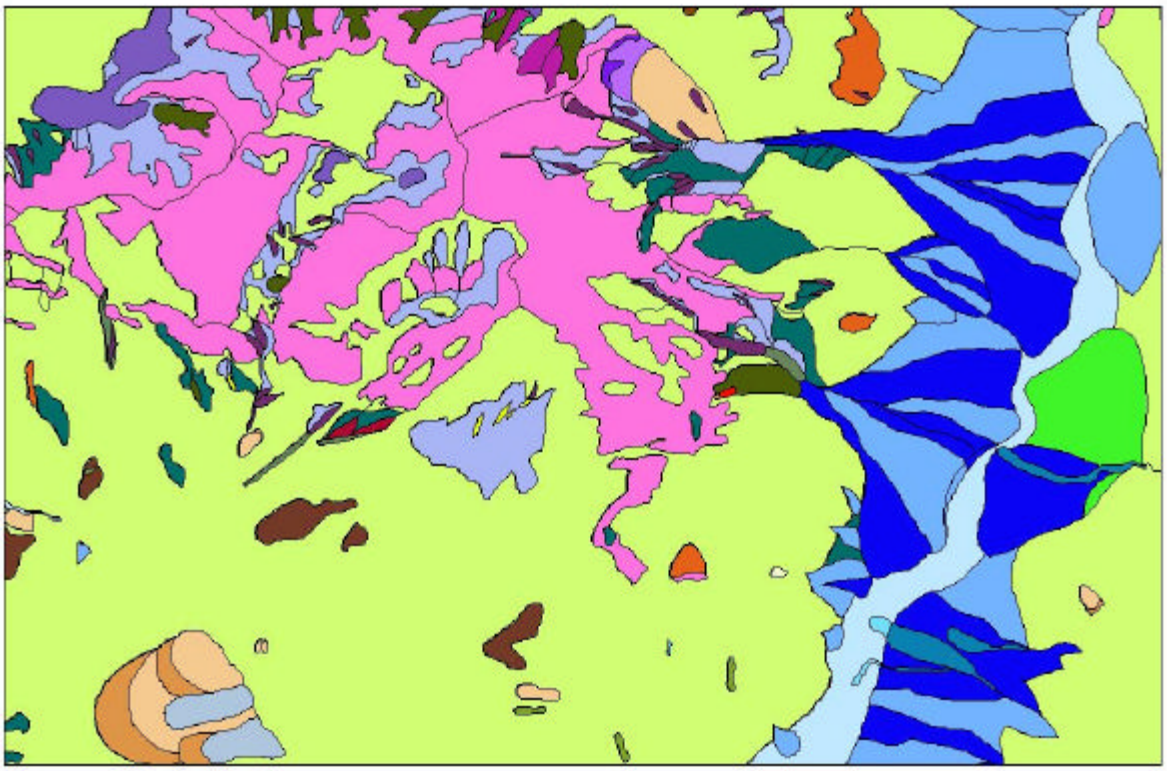

Figure 5: part of Valcamonica Inventory map

Digital Terrain Models have been created for the three areas in cooperation with CNR-CSITE Bologna (subcontractor). The DTM was obtained by interpolating contour lines derived from regional cartography (scale 1:10,000; Regione Lombardia, 1980), with an average elevation interval of 25 meters. DTMs have been realized with 20 m pixel size (figure 6).

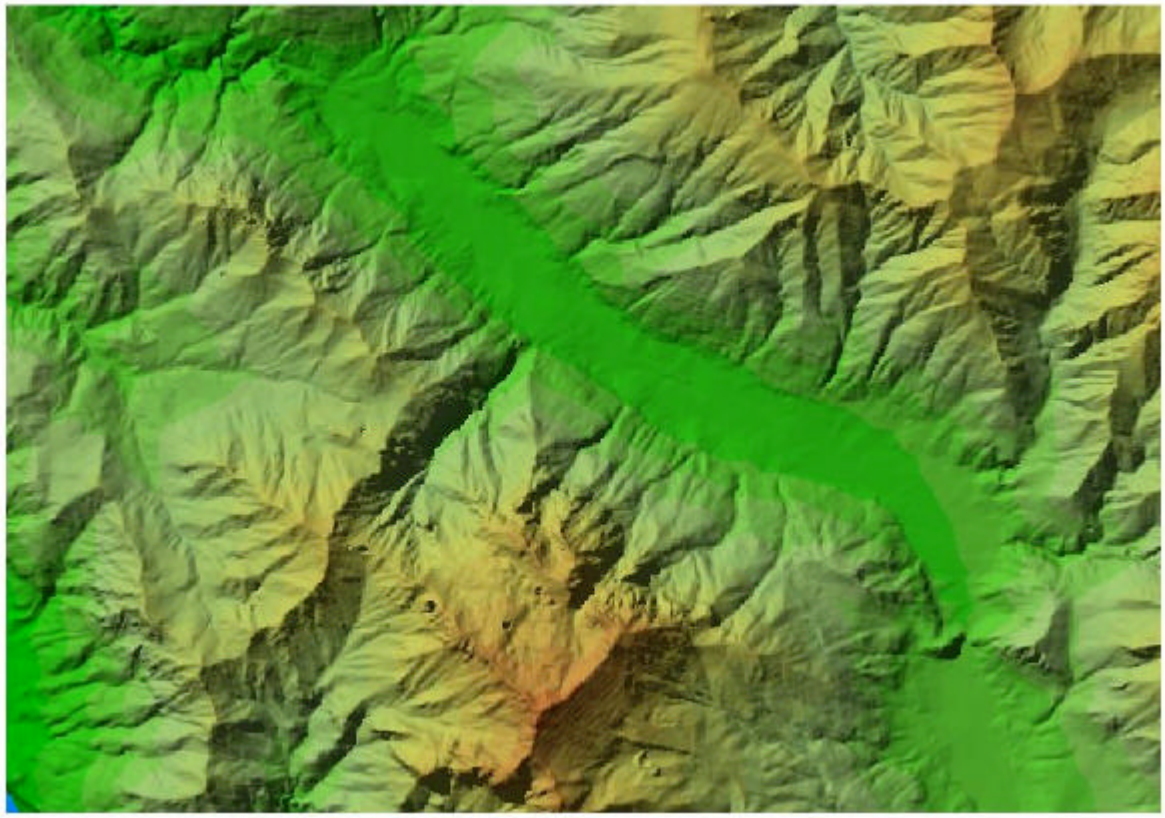

Figure 6: part of Valsassina DTM

2.1.2 Review of rockfall models

A document with a comprehensive review of existing methods for rockfall modeling has been compiled. It has been written in Italian and will be translated in English during the next 6 months of project. The document is a theoretical basis for the rockfall distributed model (see below) that will be realized in cooperation with CNR-IRPI Perugia (associate partner - **AC3**) and CNR-CSITE Bologna (Subcontractor **SC7**).

2.1.3 Rockfall model

A preliminary version of a distributed rockfall simulation model has been developed by CNR-IRPI Perugia (partner **AC3**). The model works on a raster DTM and use AML Arc/Info Macro Language. The model simulate the rolling of single block, calculating velocities on the basis of topographic and lithological characteristics. So far, the model has been tested at few sites, and it will be developed with our department to simulate the complete physical behavior of rockfalls (i.e. free fall, bouncing, rolling, rock explosion) also by introducing a probabilistic approach.

2.2 Activity for other workpackages

2.2.1 Basin and fan data collection

A database of 106 alluvial fans has been created collecting different kind of information (figure 7). Morphometric parameters have been collected through aerial photo interpretation and the use of topographic maps and Digital Terrain Models (table 1).

Historical data, geological characteristics and geomorphological features have been collected from bibliographic sources in collaboration with the Geological Survey of the Lombardy Region (**SC/EU8**). An estimation of the kind of depositional typology (stream flow, debris flow, mixed) and the magnitude of the maximum expected event (maximum

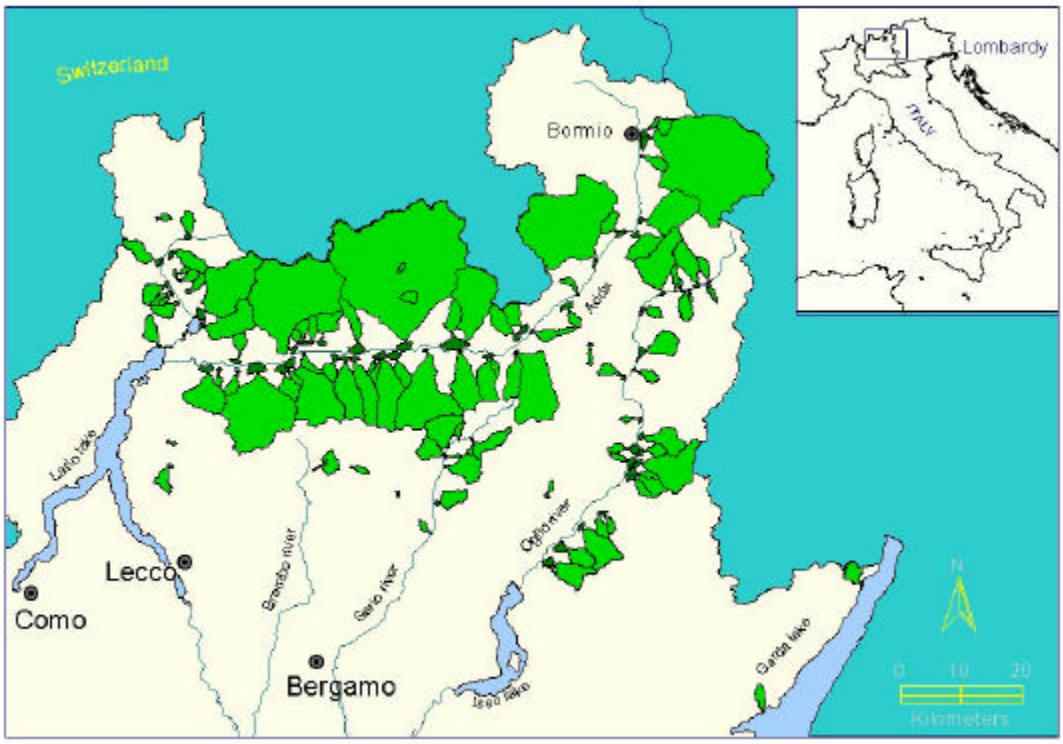

Figure 7: studied alluvil fans within Lombardy region area

deposition) on different alluvial fans has been performed using all available information (historical data, landslide maps, erosion features, experts knowledge, etc.).

Table 1: morphometric parameters

Symbol	*Units*	*Parameter*	*Description*
Ab	km^2	Drainage basin area	Area of the horizontal projection of basin surface
DT	m	Total drainage length	Length of horizontal projection of main and minor channels in the basin
DD	m^{-1}	Drainage density	DD = DT / Ab
Hmaxb	m	Max basin elevation	Elevation of the the basin higher point
Hb		Medium basin elevation	Hb= (Hmaxb + Hapex)/2
DHb	m	Relief energy	DHb = Hmaxb – Hapex
Mb	-	Melton's number	Mb = (Hmaxb – Hapex) / $Ab^{0,5}$
Qb	-	Area/length ratio	Qd = Ab / Lcl^2
Cb	m^{-1}	Melton * drainage density	Cb = Mb * DD
Lcl	m	Main stem length	Length of the horizontal projection of the main stem.
Hmaxcl	m	Maximum stem elevation	Elevation of the the stem higher point
DHcl	m	Relief energy of the stem	DHcl = Hmaxcl – Hapex
Scl	%	Mean slope of the main stem	Scl = DHcl / Lcl
Af	km^2	Fan area	Area of the horizontal projection of the fan
Vf	m^3	Fan volume	Vf =1/3 Ac 1000000 DHf cos (Sf p/ 180)
Vf/Af	m	Fan volume/fan area	
Af/Af	-	Basin area/fan area	
Hapex	m	Maximum fan elevation	Elevation of the fan apex
Hminf	m	Min fan elevation	Elevation of the fan toe
Hf		Medium fan elevation	Hf= (Hapex + Hminf)/2
DHf	m	Fan relief energy	DHf = Hapex – Hminf
Lf	m	Fan length	Length of the horizontal projection of the fan bisector
Lcl_f	m	Stem length along fan	Length of the horizontal projection of the main stem along the fan
Sf	%	Mean fan slope	Sf = DHf / Lf
Scl_f	%	Mean stem slope along fan	Scl_f = DHf / Lcl_f
Qf	-	Area/length ratio of the fan	Qf = Af / Lcl_ f^2
Mf	-	Melton fan number	Mf = (Hapex– Hminf) / $Af^{0,5}$

The dataset has been used to perform a series of statistical analysis in order to:

- investigate any significant statistical relationship among the parameters;
- discriminate the type of depositional processes;
- assess the maximum expected magnitude for an event able to reach the alluvial fan.

Results of these analysis are supposed to be useful for WP1 for the development of procedures for automatic identification of active basins likely to generate debris flows. We will encourage the discussion of this dataset with all the other partners involved in similar data collection activities (University of Padova (UNIPD), Italy; Instituto Pirenaico de Ecologia (CSIC), Spain; Instituto Tecnològico y Geominero de Espagna, Spain).

Analysis of these data is also underway with AC3 and SC7.

2.2.2 Description of debris flow characteristics

A field survey has been performed along the Grigna creek (Valcamonica) in order to describe the characteristics of a large debris flow occurred in 1993. The debris flow was originated by a large complex slide in glacial deposits (see fig. 8) and the total runout amount to about 7 km. Velocity and flow regime have been described and analysed starting from field data and compared with numerical models. This study could be of interests to WP1 and WP3 to evaluate the maximum possible runout for debris flows.

Figure 8 - The 1993 Sesa Landslide, source area for a large debris flow

2.3 Deviation from work plan and difficulties encountered

No deviation from the 6-months work plan has occurred. An updated time table is not necessary at this time.

Some difficulties has arisen about contract definition with the Geological Survey of the Lombardy Region and the subcontractor dr. Alberto Carrara. The second problem is due to a delay of our central administration and will be solved in few weeks. As above mentioned, the subcontractor is already working for the project.

A delay in acquisition of laboratory utilities occurred; again, the problem is due to the central administration of Milano Bicocca University and it has been solved so far.

2.4 Resource employed

- 3 months for team leader;
- 5 months for technician;
- 2 months for subcontractor.

3. Future activity

The activity programmed for the next 6 months period are:

- production of a digital database of historical events for Valcamonica;
- collection of historical data for Valseriana (with SC/EU8);
- complete the revision of Valsassina landslide inventory (with SC/EU8);
- statistical hazard assessment for Valsassina and Valcamonica (with SC7);
- translation of rockfall methods review;
- implementation of rockfall simulation model (with AC3);
- collection of other fan/basin morphometric and geological parameters, with a field description of alluvial fans located in the Focus Area.

4. References

Regione Lombardia (1980). *Carta Tecnica Regionale*, Milano.

Regione Lombardia (from 1987). *Carta Geoambientale*, Milano.

Regione Lombardia (1999). *Carta delle frane della provincia di Lecco*, Milano

5. Publications

Ceriani M., Crosta G. and Frattini P. “On Hydrological Hazard Assessment of Alluvial Fans”. Proc. Int. Symp. WARREDOC “10 years of IDNDR”, Perugia, July 17-21, 2000. (in press)

Crosta G. (2000) Failure and flow development of a complex slide; the 1993 Sesa landslide. Eng. Geology, (submitted)

6. Keywords

historical data, rainfall data, geological maps, landslide inventory, DTM, rockfall, alluvial fans, debris flow