DAMOCLES - EVG1-1999-00027P

CNR- IRPI PERUGIA INTERIM REPORT

March – September 2000

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Summary of work carried out during the period March – September 2000

The DAMOCLES project began officially on March 1st, 2000. The start-up meeting was held in Milano on 4-5 April, 2000. This reports deals with the activities that the CNR-IRPI team completed within the period April-September 2000, from the actual project kick-off to the end of September. The CNR-IRPI is a sub-contractor of the team at the University of Milano Bicocca lead by Prof. Giovanni Crosta. The sub-contract activities focus on two main issues dealt with in WP2 and WP5. WP2 deals with the production of debris-flows and rock falls hazard and risk assessment procedures; whereas WP5 deals with data dissemination. Within WP2 the CNR-IRPI team has carried out a successful simulation aimed at testing the possibility of using GIS technology as an aid to the automatic evaluation of rock-fall hazard in an alpine environment. Within WP5 the CNR-IRPI team has set up the DAMOCLES project web page and has installed web-based GIS software for the distribution via Internet of landslide inventory and hazard maps prepared by the other DAMOCLES teams.

Main results obtained

The CNR-IRPI is a sub-contractor of the team at the University of Milano Bicocca lead by Prof. Giovanni Crosta. The sub-contract activities focus on two main issues dealt with in WP2 and WP5. Working package n. 2 deals with the production of debris-flows and rock falls hazard and risk assessment procedures. Working package n. 5 deals with data dissemination.

Working Package 2

The working package deals with the production of debris-flows and rock falls hazard and risk assessment procedures using GIS technology. Within this WP the CNR-IRPI team has successfully completed an experiment aimed at testing the possibility of using GIS technology

as an aid to the automatic evaluation of rock-fall hazard in an alpine environment. In particular, the test was aimed at preparing maps helpful for the regional assessment of the rock-fall hazard starting from information already available or that could be easily obtained from thematic maps. To evaluate the feasibility of the project, an experiment was set up with the aim of testing the procedure using Arc/Info? , a well known GIS software commonly used to store and analyse geographic information at various scales. In particular we tested the capabilities of the raster module GRID of Arc/Info? (release 8).

The area selected for the test extends for about 100 km^2 in the Upper Valcamonica, an alpine valley in the Lombardy Region. To describe the topographic surface a DTM with a ground resolution of 20 x 20 m was used. The DTM was originally prepared by interpolating the elevation values obtained form 30, 50, 80 and 100 m contour lines available on the 10,000 scale regional topographic maps (CTR) (Figure 1). The source areas of rock falls were obtained from a landslide inventory and surface geology map prepared by CNR-IRPI for the Lombardy Region within the framework of a previous research contract (Figure 2). To speed up the test, beside the source areas, stopping areas were also identified. These were defined as areas where a falling rock would stop, for whatever reason. For the test they were obtained from the higher order stream lines present on the topographic maps.

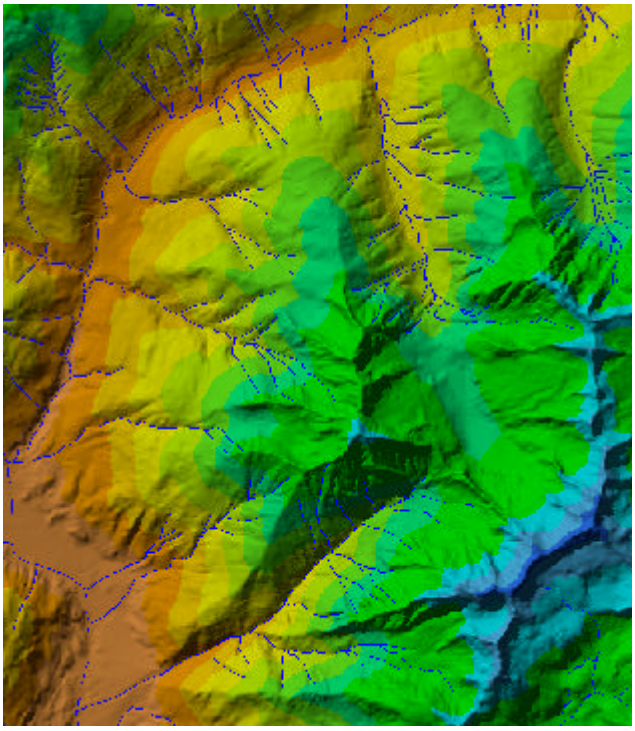

Figure 1. Digital terrain model (DTM) with a ground resolution of 20 x 20 m.

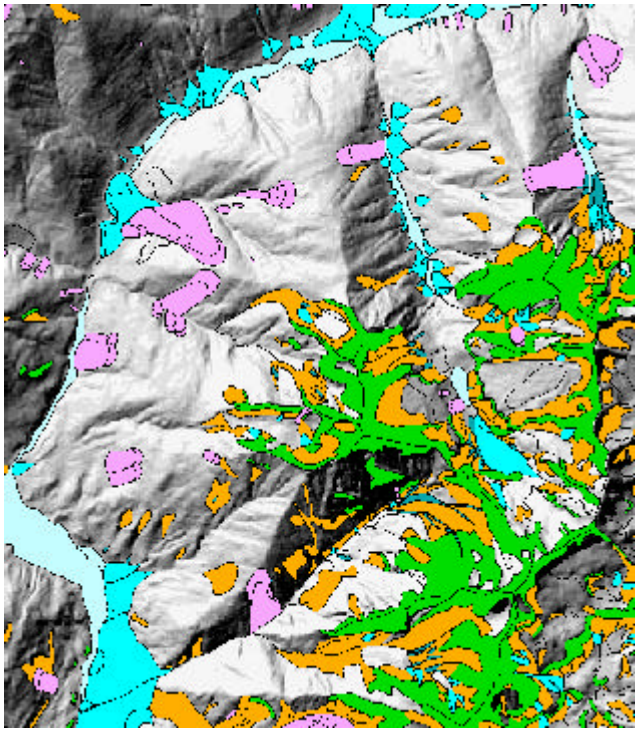

Figure 2. Landslide inventory and surface geology map. In green the areas that were classified as possible sources of rock falls.

Terrain (DTM) and geomorphological data were stored in Arc/Info? as grids, i.e., as raster matrixes with a resolution, scale and position coherent with the DTM. Simple computer programs written in the in Arc/Info? AML batch language were prepared to perform the test. Starting from the DTM and the definition of source and stop cells, various maps were prepared in raster format, namely:

? The map of the invasion zones (Figure 3), showing the areas where rock falls could travel going from a source cell to a stop cell.

? The map of the number of rock fall trajectories going through each cell of the DTM. The higher the number of trajectories the greater is the probability of rock fall occurrence and, as a first approximation, the higher the rock fall hazard (Figure 4).

? The map showing the highest velocity recorded within each cell of the DTM from the various trajectories going trough the cell (Figure 5). As a first approximation, the higher the velocity, the greater is the rock fall hazard.

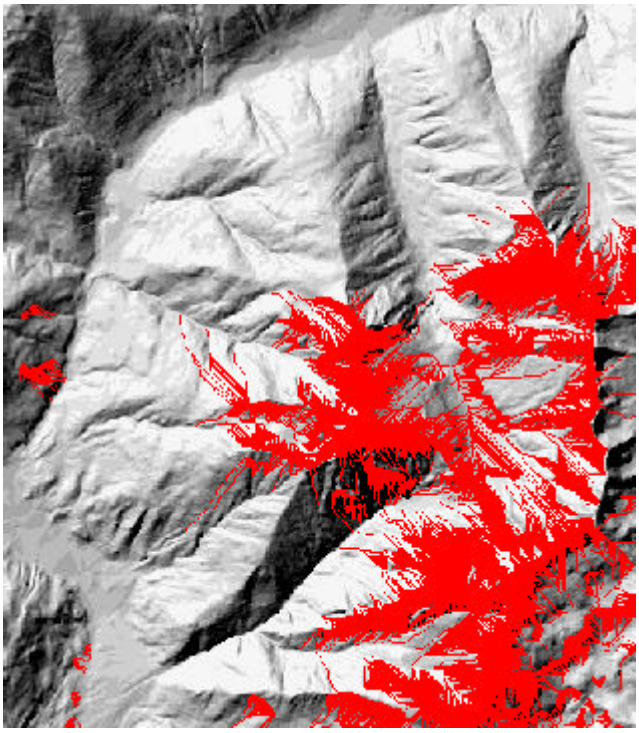

Figure 3. Red areas are the possible invasion areas of rock falls.

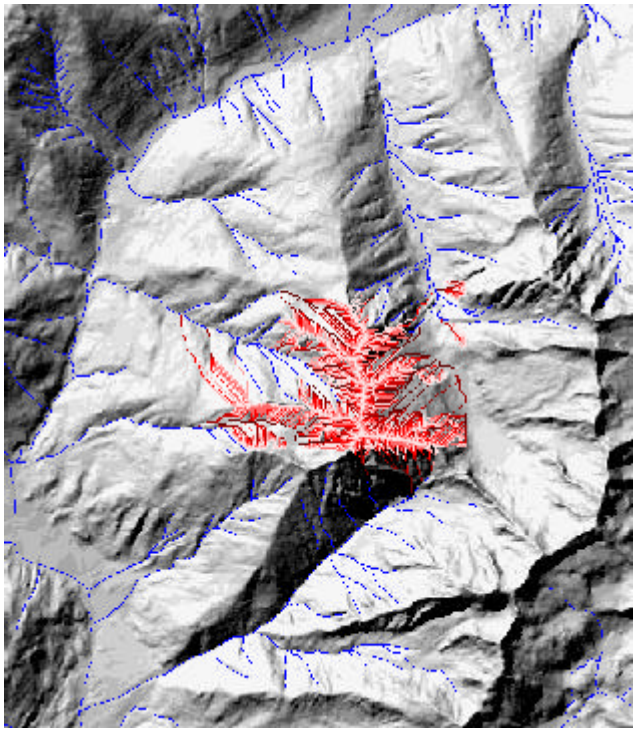

Figure 4. Number of rock fall trajectories within each grid cell. Light colours represent few trajectories, dark colours represent many trajectories.

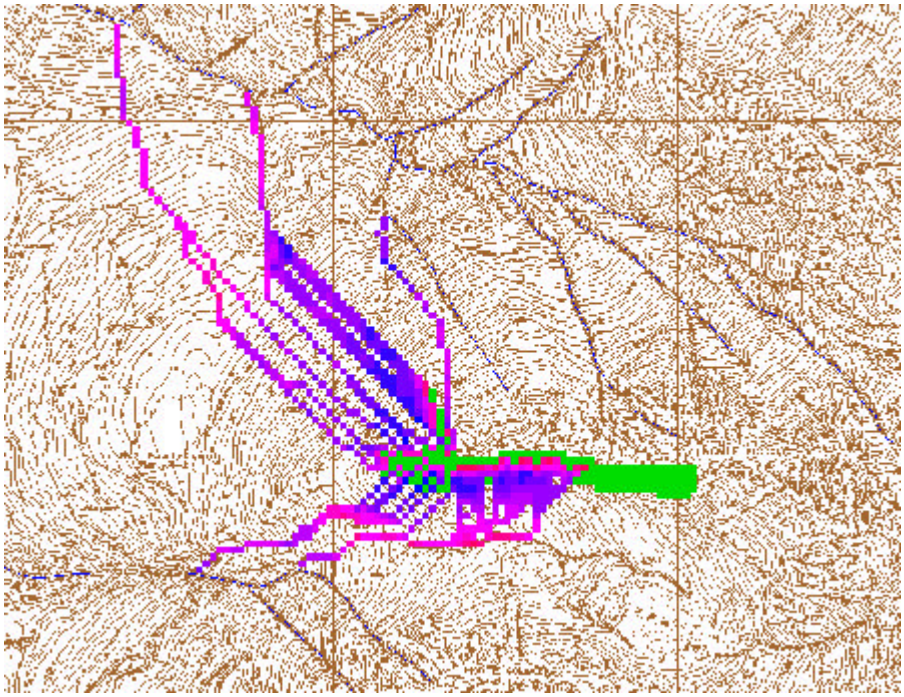

Figure 5. Maximum estimated velocity of rock fall trajectories within each grid cell.
In green the source cells.

Simulation of the rock fall process was kept very simple. Boulders were “rolled” from a source cell to a stop cell along the steepest path computed on the DTM. Friction was considered constant throughout the area. The loss of energy due to friction and impacts was simply computed as a fixed percentage (30 or 50 per cent) of the energy at each cell. Neither the sliding nor the flying motion of the boulder were modelled. Since most of the rock fall process occurs flying along parabolic trajectories, the latter is a major limitation of the model.

The simulation, albeit physically very simple, provided good results and proved that it is indeed possible to model rock fall trajectories using GIS technology and thematic data available for a basin or an entire Province, i.e., form some hundreds to few thousands square kilometres The test also showed the limits of the GIS software used for the experiment, and in particular:

- The extremely slow processing of the information. To complete the test over an area of 100 km^2 a few days of computer time were needed, making the calibration of the input parameters virtually impossible. This limitation is largely due to limits in the matrix algebra of the Arc/Info? software when used within an AML program.
- The practical impossibility of refining the physical model, and in particular the impossibility to perform a continuous 3-D simulation over a (discontinuous) DTM.
- The impossibility of modelling the flying motion of a boulder along a parabolic trajectory.

- The difficulty in modelling the friction and energy dissipation parameters is a realistic fashion.

Given the good results provided by the test and the limitations shown by the GIS software, we decided to prepare a computer program (in the C language) that staring from the same data sets used for the experiment (i.e, DTM, location of source cells, and information on the friction and energy release parameters along the topographic surface) could prepare maps useful to the preliminary assessment of rock fall hazard, namely: the count of rock fall trajectories within each cell; the highest computed and the highest flying height recorded within each cell. A computer program performing these tasks is currently being prepared and tested.

For the activities within the WP2 two team members were involved for about one month each to prepare the procedures with the Arc/Info® GIS and the data set for the test. A computer programmer financed with funds not coming from the DAMOCLES project, has worked for about two months preparing a prototype of the new computer program. The work was done according to the approved time-table.

Working Package 5

The working package deals with the dissemination of the most relevant project achievements. Activities within WPr are co-ordinated by Prof. James C. Bathurst, the project leader. Within the WP5 the CNR-IRPI activities were focused on setting up the DAMOCLES web site, to be maintained for 3 years after the completion of the project. At present there are two web sites for the project at the following Interned addresses:

- http://damocles.irpi.pg.cnr.it

- http://maps.irpi.pg.cnr.it/website/

The first address refers to the main project site, hosting the project home page and the other relevant information on the project (Figure 7). At present the home page contains information on:

- the project goals and the expected results;

- the project consortium, with information and addresses of each team;

- the study areas, and in particular the Benasque study area in Spain;

- the past and future meetings, including the agendas and the minutes of the meetings.

Pages for the progress and final reports have been prepared but are currently empty.

The DAMOCLES web site runs on a Sun Ultra workstation running Sun Solaris 7 and Netscape Enterprise Server, release 3.5. Both the hardware and software are provided to the project by the CNR-IRPI in Perugia.

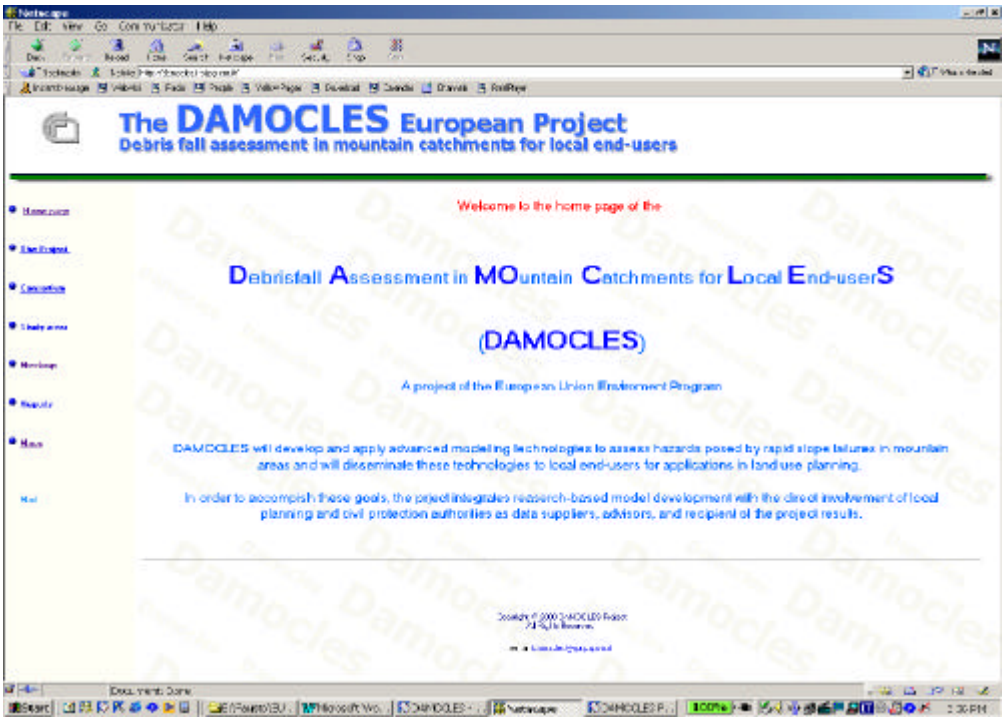

Figure 6. The home page of the DAMOCLES project, at the URL http://damocles.irpi.pg.cnr.it

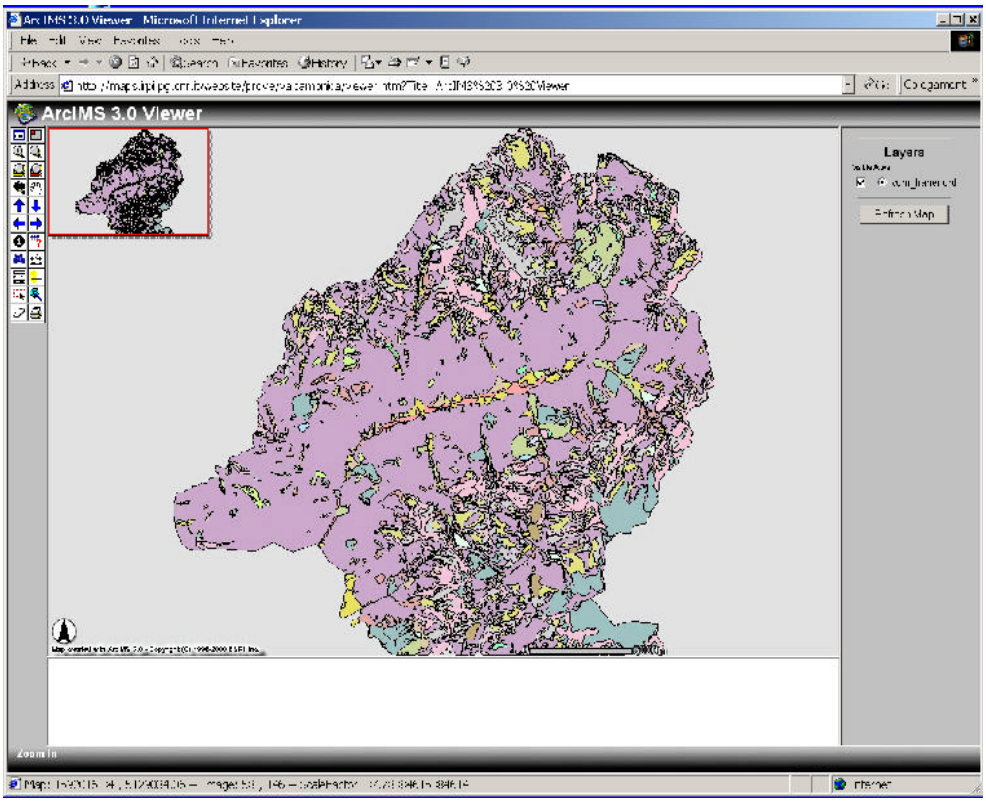

Figure 7. An example of landslides and surface geology maps published on the Web using the ARC-IMS 3.0 software.

The second address points to a different web server located on an personal computer running Microsoft Windows NT, release 4.0 and the public domain Apache web server software. The site hosts the web-based GIS software capable of publishing on the Internet geographical information. Contrary to what was originally planned, the new ARC-IMS (release 3.0) web-based GIS software was selected for this experiment. The choice was made because of the new and improved capabilities of the software, and its price, lower (at least for educational users) than that of similar competing products.

Installation of the web and GIS software was not straightforward and required several attempts, adjustments and quite a few days of work. This is largely due to the fact that we choose to use a set of public domain products (i.e., the Apache Web server and the Jserv servlet engine) and that the ARC-IMS software we used (release 3.0) was still a beta version. Despite these difficulties, when the entire software suite was installed and properly configured the publication of a prototype map was straightforward. It should be noted that this web site is still in its infancy and cannot be considered fully functional.

For the activities carried out within WP5 two team members were involved for about one month each, prepare the web site structure and to format the available documents. A computer expert paid with funds coming from the DAMOCLES project, has worked for about one month to study, install and configure the web-based GIS software. The work started late according to the approved time-table due to the unavailability of the web-based GIS software, but was then completed in time.

Summary of activities for the next reporting period

From October 2000 to February 2001 the CNR-IRPI will continue its activities on both WP2 and WP5. Within the working package 2 activities will focus mostly on continuing the development and testing of the computer code written to prepare maps useful for the evaluation of rock fall hazard at the basin scale. In particular the team plans to test the program on a very large mountain area, most probably the entire Val Camonica, extending for about 1400 km^2, and for witch the thematic information needed to run he program (DTM and thematic data) is already available. Within the working package 5 the CNR-IRPI team plans to keep the project web site updated, publishing the available project reports, and the information on the other study areas when it will be made available by the other groups. The team also plans to work on a better defined examples of the capabilities of the web-based GIS software.

References

1. Antonini G., Ardizzone F., Cardinali C., Carrara A., Galli M., Guzzetti F., Reichenbach P., Sotera M. & Tone G. (1999) – *II° Rapporto Semestrale*. *Novembre 1999*. Convenzione fra il CNR, IRPI di Perugia e CSITE Bologna, e la Regione Lombardia, Direzione Generale al Territorio ed Edilizia Residenziale, per lo svilupp di tecniche e metodologie idonee alla produzione di carte della pericolosità e del rischio da frana in are campione rappresentative del territorio della Regione Lombardia. 60 pp. (Unpublished, in Italian)

Publications

During the 5 months period between April and September 2000 the CNR-IRPI team has not published any paper or report concerning the activities carried out within the DAMOCLES framework.

Preliminary results of the activities carried out within the WP2 were presented at the INTERREG IIC "FALAISES MEETING" held at Varenna, Italy, on May 17th – 18th, 2000. The computer presentation is available on request to the DAMOCLES team members.

Keywords

Landslide, Hazard, Rock fall, Maps, GIS, Web site, Information dissemination