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DAMOCLES

DEBRISFALL ASSESSMENT IN MOUNTAIN CATCHMENTS FOR LOCAL END-USERS

Contract No EVG1 - CT-1999-00007

COORDINATOR'S MANAGEMENT REPORT FOR THE SECOND ANNUAL REPORT WITH ATTACHED CONTRACTOR AND ASSISTANT CONTRACTOR PROGRESS REPORTS FOR THE PERIOD 1 March 2001– 28 February 2002

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Project web site : **http://damocles.irpi.pg.cnr.it/**

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COORDINATOR'S MANAGEMENT REPORT

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1.1 OBJECTIVES OF THE REPORTING PERIOD

This report covers the period 1 March 2001– 28 February 2002. The main project objectives, by workpackage, were:

WP1 : Completion of fieldwork in Upper Aragón and Gallego river basins, preparation of a database on debris flow characteristics and analysis to establish statistical relationships for predicting these characteristics. Delivery of preliminary debris flow relationships. Delivery of a report on the factors explaining the spatial distribution of debris flows in the Flysch Sector of the Central Spanish Pyrenees. Fieldwork in the Benasque valley to support end-user application of project technologies.

WP2 : Development and testing of the STONE rockfall model. Development of simple physically-based hillslope stability models for comparison with the statistical multivariate model for debris flow probability. Application of the probabilistic modelling approach in the Benasque valley, Spanish Pyrenees. Delivery of a review on granular flows and numerical modelling of landslides.

WP3 : Improvement and preliminary validation of the one-dimensional channel routing component of the debris flow impact model, for the Rio Lenzi test site (Italy). Development of the two-dimensional model component for debris flow propagation and sedimentation in the fan area. Integration of the two model components within a GIS to create the debris flow impact model. Selection and mapping of a model test site in the Benasque valley. Delivery of a debris flow database for the impact model.

WP4 : Data assembly (including field and laboratory work) for the Valsassina (Italy) and Ijuez (Spain) focus basins. Creation of the SHETRAN model files. Preliminary simulations for both basins.

WP5 : Continued maintenance of the project website and testing the use of GIS-based web technology for publishing thematic and landslide hazard maps on the internet. Continued liaison with the project end-users. Preparation of Year 3 training programme.

1.2 SCIENTIFIC/TECHNICAL PROGRESS

1.2.1 Gantt Chart

The project Gantt Chart is attached. This has been updated to accommodate the problems described in Section 1.4.

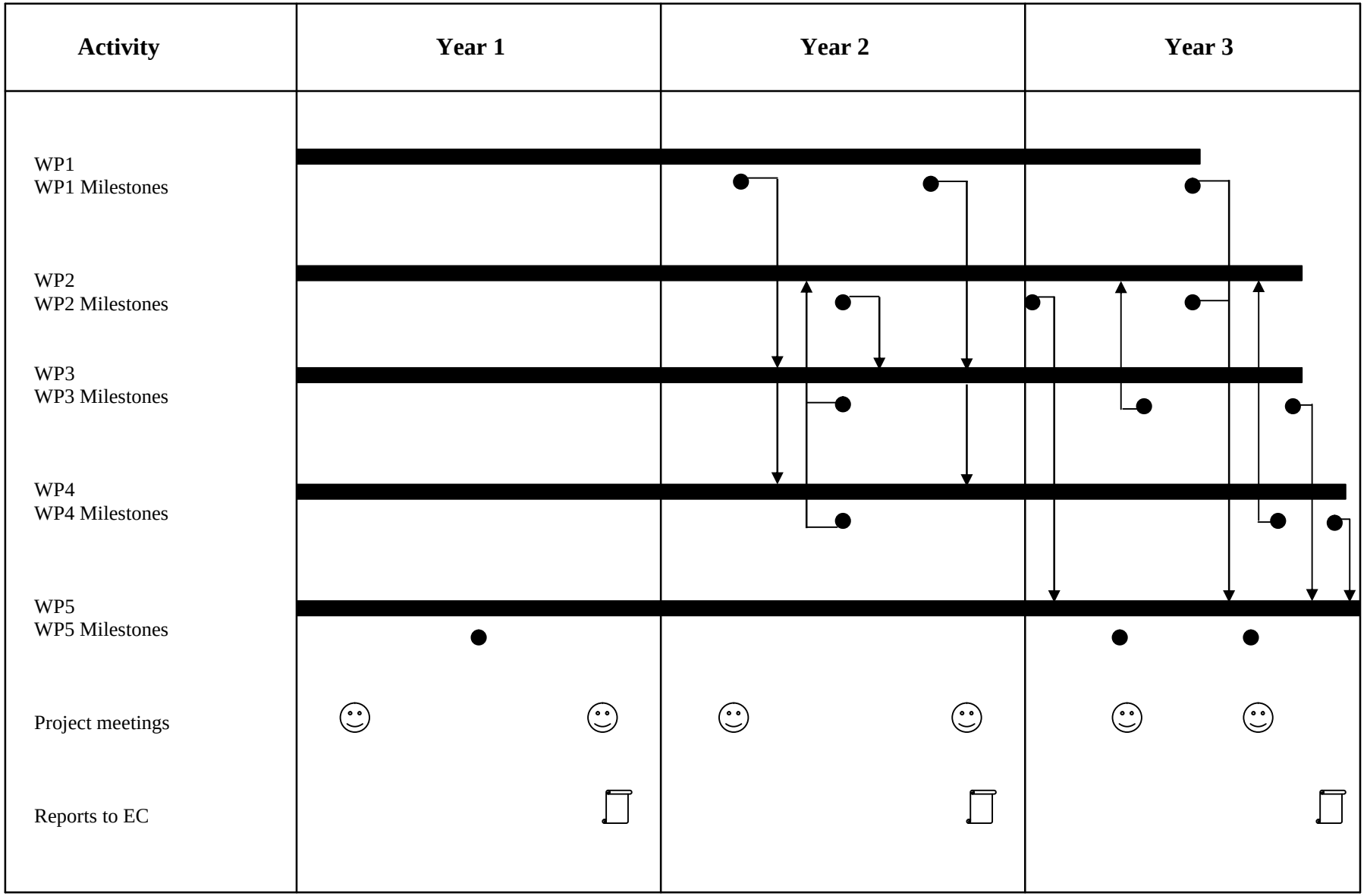
1.2.2 Resources Used

A comparison of the originally planned and actual use of manpower resources is shown in Table 1. Several partners are contributing more than originally envisaged (but without requiring additional EC funding).

A comparison of the originally planned and actual use of financial resources is shown in Table 2.

Low manpower use by the Universities of Newcastle and Padova is largely responsible for the underspend by those two partners. The cause of the low use is explained in Section 1.4. Plans are in place to compensate for the underspend in Year 3.

Gantt Chart for the DAMOCLES Project



Vertical arrows indicate exchanges between workpackages at the times indicated by the milestones.

Table 1 Manpower resources used during Years 1 and 2 and comparison with the originally planned use

WORK PACKAGE	RESOURCE USE IN PERSON-MONTHS FOR PARTNER									TOTAL
	1-UNEW		2-UNIBICO		3-CNR-IRPI	4-UNIPD		5-CSIC-IPE	6-IGME	
	Add*	Perm*	Add*	Perm*		Add*	Perm*			
Coordination	5	2								7
WP1	0	0	3	11.5	0	3	2.5	57.5	12.9	90.4
WP2	0	0	18.5	48.5	6.6	0	0	1	2.4	77
WP3	0	0	0	0	0	11	38	1	2.75	52.75
WP4	19.5	2.2	4	2.5	0	0	0	3.5	0	31.7
WP5	0.1	0.6	1.6	1	4.8	0	1.5	2	2.9	14.5
Total Use for Years 1 & 2	24.6	4.8	27.1	63.5	11.4	14	42	65	20.95	273.35
Original Planned Use for Years 1 & 2	34	6	16	14	5	35	38	52	4	204

*Add = additional personnel; Perm = permanent personnel

Table 2 Financial resources used during Years 1 and 2 and comparison with the originally planned use

EXPENDITURE TYPE	EXPENDITURE IN EUROS FOR PARTNER							TOTAL
	1-UNEW		2-UNIBICO	3-CNR-IRPI	4-UNIPD	5-CSIC-IPE	6-IGME	
	Coord*	Proj*						
Actual Total	12,153	103,760	129,484	61,327	116,117	275,195	50,128	748,164
Original Planned Total	15,486	178,756	171,280	57,828	141,387	267,623	43,268	875,628
Actual EC Claim	12,153	103,760	129,484	30,663	116,117	107,326	25,064	524,567
Original Planned EC Claim	15,486	178,756	171,280	28,914	141,387	104,373	21,635	661,831

* Coord = DAMOCLES coordination; Proj = Newcastle project

1.2.3 Highlights of Progress in Each Workpackage

Following the emphasis on data assembly in Year 1, there has been increasing work on model development and testing. Full details of the work are given in the attached partner reports. The main achievements for each workpackage are summarised as follows.

WP1 Development of functional relationships for debris flow behaviour derived from field data and existing databases.

(i) Detailed field measurements have been made of debris flow characteristics in the Upper Aragón and Gallego river basins and a summary table has been produced. Using statistical analysis, predictive relationships for these characteristics have been derived (e.g. debris flow runout distance) for use in refining the models of WP3 and WP4. A project report has been submitted to the Coordinator entitled "Debris Flow Relationships in the Central Spanish Pyrenees" and this is now on the project website. (Pyreneen Institute of Ecology)

(ii) A project report has been submitted to the Coordinator entitled "Distribution of Hillslope Debris Flows in the Flysch Sector of the Central Spanish Pyrenees", which presents a statistical description of the factors determining debris flow location. (Pyreneen Institute of Ecology)

(iii) An analysis has been carried out of the frequency of debris flow occurrence and its relationship to land use and rainfall in the Central Spanish Pyrenees. Rainfall is found to be the bigger influence. In the flysch sector, rainstorms with a return period of 10 years, or even less, are enough to trigger shallow landslides that evolve into debris flows. (Pyreneen Institute of Ecology)

(iv) 188 debris flows have been mapped in the 300-km^2 Benasque valley (Spanish Pyrenees) and a 1:25,000 scale geomorphological map has been completed which describes the processes and deposits in the area. These data will form the basis for application of a regional model (based on WP1 and WP2 technologies) for predicting the spatial distribution of debris flows. (Geological and Mining Institute of Spain)

WP2 Development of a GIS hazard assessment methodology using field data, available databases and model developments

(i) Additional data have been collected in support of the GIS debris flow and rockfall modelling activities in the Lecco Province of Lombardy. A 5-m resolution Digital Terrain Model has been compiled for the Valsassina focus area. A multi-temporal landslide inventory has also been produced for the area, from a sequence of aerial photographs covering the period 1954-1995. (University of Milan-Bicocca)

(ii) Further experience has been gained with the STONE rockfall model. A capability has been added for random evaluation of model parameters within a user-specified range, to allow for uncertainty in parameter values. Further capability for accounting for natural variability is provided by allowing more than one boulder to be launched from a site. Accurate calibration of the model parameters has been carried out using thematic maps and a database of observed rockfalls. Model performance has been investigated at different spatial scales and with different data availabilities within the

600-km^2 Lecco Province. Demonstration outputs include frequency of rockfall, three-dimensional display of rockfall trajectories (for free-fall, bouncing and rolling) and information such as velocity of fall and height of the trajectory above the ground. A revised rockfall hazard map has been produced for Lecco Province, which could be used in planning protection measures. Testing has also been extended to an area of the Apennines in Central Italy and to the Yosemite Valley, California. (University of Milan-Bicocca, CNR-IRPI Perugia)

(iii) Three simple physically-based, spatially-distributed models of shallow landslide occurrence at the basin scale have been developed and applied to the event of 28 June 1997 in the Valsassina area of Lombardy. The results are being compared with those of the statistical multivariate model. Comparison (and integration) of different modelling approaches is an important project task and the above comparison will eventually be extended to involve SHETRAN (WP4). (University of Milan-Bicocca, CNR-CSITE Bologna)

(iv) A project report (Project Deliverable 5) has been submitted to the Coordinator entitled "Granular Flows and Numerical Modelling of Landslides". (University of Milan-Bicocca)

(v) Debris flow, vegetation, geological and land use maps have been assembled for the application of the regional scale models of debris flow probability and rockfall hazard to the Benasque valley, Spanish Pyrenees. A Digital Terrain Model is in preparation. (Geological and Mining Institute of Spain)

WP3 Development of a small basin debris flow impact model using field data and a physically-based modelling approach

(i) The one-dimensional channel routing component (MODDS, Muskingum-Cunge One-Dimensional Debris-flow Simulation) has undergone further development, including routing an arbitrary shape of the debris flow wave, automatic control of the model stability condition, routing with bank overflow, determining superelevation at bends and accounting for potential bridge obstruction. Sensitivity analysis has defined the model response characteristics and a test comparison shows good agreement with the well-known DAMBRK model for the case of non-Newtonian fluids. A successful validation has been carried out for the Rio Lenzi (Autonomous Province of Trento). (University of Padova)

(ii) The two-dimensional model component for debris flow propagation and sedimentation on the fan area has been developed (DDPM, Debris Flow Distributed Propagation Model). The fan is represented by a grid of square cells: transfer of debris flow material from one cell to another occurs under conditions of either uniform flow as a function of gradient or flow over a broad-crested weir. A successful test of DDPM has been completed for the debris flow deposit of 4 November 1966 on the fan of the Rio Lazer, Eastern Trento Province. (University of Padova)

(iii) MODDS, DDPM and a Digital Terrain Model for the Rio Lenzi fan have been integrated to form the Debris Flow Impact Model, DEFLIMO. The integration is carried out using the ArcView GIS framework, which enables the one-dimensional

channel model (based on vector elements) to be linked with the two-dimensional fan model (based on raster cells). The component models can be run independently or integrated together. (University of Padova)

(iv) The 4-km^2 Sahún basin in the Benasque valley has been selected as a test site for the model in the Spanish Pyrenees. A detailed topographic survey of the main channel and fan area has been carried out at a 1:1000 scale and other relevant data have been assembled (including water discharge peaks for several return periods). (University of Padova, Geological and Mining Institute of Spain)

WP4 Application of a physically-based, basin scale, landslide erosion and sediment yield model to land use and climate scenario analysis for selected sites

(i) Field visits to the Valsassina (Italy) and Ijuez (Spain) focus areas were carried out to collect soil property data, to measure channel dimensions and sediment characteristics and to be familiarized with the areas. Soil samples were brought back to the University of Newcastle for laboratory analysis and soil property maps have been completed. (University of Newcastle, University of Milan-Bicocca, Pyreneen Institute of Ecology)

(ii) Catchment time series and property data have been assembled for both focus areas and used to create the necessary files for running and testing the SHETRAN landslide model. The data include precipitation and evaporation records, runoff records, topographic, soil and vegetation maps and landslide inventories. (University of Newcastle, University of Milan-Bicocca, Pyreneen Institute of Ecology)

(iii) Preliminary SHETRAN simulations have been carried out for the two focus areas. (University of Newcastle)

(iv) Validation of the SHETRAN landslide model for the Llobregat catchment has been completed. The results demonstrate an ability to bracket the observed occurrence of debris flows with simulated distributions and to determine catchment sediment yield within the range of regional observations. (University of Newcastle)

WP5 Dissemination of the project deliverables via training courses, workshops, implementation by end-users and placement of demonstration material on a web site

(i) The project website (http://damocles.irpi.pg.cnr.it) has been upgraded to improve its readability and speed of access. It is frequently updated and, in particular, contains all the progress reports and progress meeting minutes as well as the maps, databases and models produced by the project. The GIS-based web technology for publishing thematic and landslide hazard maps on the internet is provided by the ArcIMS^{TM} internet map server. This has already been used to publish maps for the Valsassina focus area and maps for other project sites are in preparation. However, the introduction of the latest version of ArcIMS^{TM} (release 3.1) forced a substantial redesign and revision of the GIS-based site, an unforeseen additional project task. (CNR-IRPI Perugia)

(ii) The partners remain in contact with their end-users. The Padova team meets once a month with its end-users, who want to use the debris flow model. The Milan-Bicocca

team is in continuous contact with its end-user, who would like to learn how to use its hazard analysis technique: the team and the end-user collaborated in organizing a two-day conference in Milan in September 2001 where the preliminary results of the DAMOCLES project were presented. The Pyreneen Institute of Ecology team is in contact with its Aragón end-users but with not very frequent meetings; the end-users prefer maps and results rather than models. The Geological and Mining Institute of Spain is both a partner and an end-user; they are energetically learning how to use the WP3 debris flow model and the Pyreneen Institute of Ecology mapping techniques. (University of Milan-Bicocca, University of Padova, Pyreneen Institute of Ecology, Geological and Mining Institute of Spain)

(iii) A joint programme for a training course on the WP3 debris flow model and the WP2 GIS-based statistical multivariate model has been prepared. Ten trainees will attend the course in Padova and Milan during 9-13 September 2002. (University of Padova, University of Milan-Bicocca)

(iv) Two workshops for publicising the project results will be held at Zaragoza in May 2002 and Milan at the end of 2002.

(v) Several DAMOCLES partners were invited to report their work at the EC High-level Scientific Conference "Link Geo and Water Research" held at Genova, Italy, during 7-9 February 2002. Most of the partners will also be making presentations at the 27th General Assembly of the European Geophysical Society in April 2002.

1.2.4 Workpackage Integration

Integration of modelling approaches

The Year 1 management report described the complementary characteristics of the WP2, WP3 and WP4 models. This complementarity is to be demonstrated as follows.

The local scale debris flow model of WP3 provides a means of investigating in detail the hazard (in terms of sediment deposition) at sites identified from the WP2 statistical multivariate model as requiring attention. A demonstration link is proposed for the website, in which the user will be able to select a site from a WP2 regional hazard assessment map, run the WP3 model for that site for different debris flow inputs and view the impacts.

The SHETRAN basin scale, landslide sediment yield model can investigate patterns of debris flow occurrence for possible scenarios of future climate and land use and thereby provide a basis for recalibrating the WP2 model for future altered conditions. It is proposed to demonstrate this process for the Valsassina focus area.

Integration of debris flow relationships with models

The WP1 data and process relationships form the basis of, or will improve, the model developments of WP2, WP3 and WP4. The WP2 hazard assessment model requires data on the spatial distribution of debris flows and the controlling factors for discriminant analysis. The WP3 local scale debris flow model needs information on debris flow characteristics as its input. The WP4 SHETRAN model will use the WP1 debris flow relationships to improve its current rule-based description of debris flows.

Integration of the end-users within the project

This is covered in Section 1.2.3, WP5.

1.2.5 Project Assessment by Outside Experts

Two independent experts (Dr Chris Kilburn, University College London, and Professor Tim Ward, University of New Mexico, USA) were invited to assess the project at its midpoint, through participation in the Third Progress Meeting at Newcastle in November 2001. They subsequently submitted a report to the EC which noted that the project had achieved its primary mid-term objectives and which contained the following recommendations for the remainder of the project:

(a) The linear and logistic models should be analyzed for the physical meaning of effects of the indicator (driving) variables;

(b) Data sets should not exclude observations that appear to be outliers when in fact they are end members of a wide range of values;

(c) The MODDS model should be tested against other types of inundation models developed for alluvial fans;

(d) The assumption in MODDS that a debris flow acts similarly to a water flow needs to be better demonstrated;

(e) The GIS hazard models need to be refined and compared with the results from the physical process models;

(f) More effort is needed to get SHETRAN applied to the focus catchments;

(g) The staffing problems at the Universities of Newcastle and Padova need to be addressed;

(h) The involvement of the end-users needs to be documented more explicitly;

(i) The training course and workshops should be preceded by a mock workshop to ensure that they are characterized by a smooth and efficient transfer of the project technologies;

(j) The project Gantt chart should be updated with sufficient information for tracking progress towards the milestones and deliverables.

Items (c) and (g) have already been addressed. Item (e) is being addressed within the integration of the WP2, WP3 and WP4 modelling approaches. Item (f) will be dealt with now that a new research associate has been appointed at the University of Newcastle. The involvement of the end-users (Item (h)) will become more explicit through the workshops and training course. The project Gantt chart has been updated and information is provided in Section 1.3 for tracking progress. Most of the remaining items will be addressed during the final year of the project.

1.3 MILESTONE AND DELIVERABLES

The project has successfully met most of its milestone (shown on the Gantt chart) and deliverable deadlines through the reporting period, as follows:

Month	Date	Workpackage	Milestone/ Deliverable	How Provided
6	August 2000	WP5	Website on line	Website
15	May 2001	WP1	Preliminary debris flow relationships	Report to Coordinator
18	August 2001	WP2	Granular flow modelling report (Deliverable 5)	Report to Coordinator and on Website
18	August 2001	WP3	Preliminary impact model	3rd progress report by University of Padova
18	August 2001	WP4	Preliminary simulation data	3rd progress report by University of Newcastle
21	November 2001	WP1	Final debris flow relationships (Deliverable 1)	Attached report by CSIC

As noted in the reports by the Universities of Newcastle and Padova, revised work programmes have had to be introduced as a result of staffing problems. The following deliverables are affected:

Deliverable 7: Debris flow impact model (WP3). This will be delayed from Month 24 (February 2002) to Month 28 (June 2002).

WP3 model applications (for WP5) will be completed in Month 34 (December 2002) instead of Month 30 (August 2002).

Deliverable 8: Debris flow impact scenario simulations (WP4). This will be delayed from Month 24 (February 2002) to Month 34 (December 2002).

Deliverable 9: Guidelines for basin land management (WP4, for WP5). This will be delayed from Month 30 (August 2002) to Month 36 (February 2003).

In addition, Deliverable 3 (Debris flow and rockfall database for GIS, WP2), originally due in Month 24 (February 2002), is partly complete (e.g. the multi-temporal landslide inventory) and is now due to be completed by Month 27 (May 2002).

1.4 DEVIATIONS FROM THE WORK PLAN AND/OR TIME SCHEDULE

Work has generally unfolded as planned. However, two partners encountered problems which will delay their work. The University of Newcastle's project research associate, Dr Ahmed El-Hames, left in November 2001 for a permanent position at the King Abdulazziz University in Saudi Arabia. He was replaced in March 2002 by Dr Greta Moretti. The University of Padova's end-user and subcontractor ARPAV (Arabba Avalanche Centre,

Veneto Region) could not sign its contract. A substitute contract was therefore negotiated with the Associazone Italiana di Idronomia to enable the required work to be carried out. There was also a four-month delay in appointing two of the Padova team's research assistants. The two partners have introduced revised work programmes to ensure that their deliverables are successfully provided by the end of the project.

1.5 COORDINATION BETWEEN PARTNERS AND COMMUNICATION ACTIVITIES

Progress meetings were held at Padova during 9-11 May 2001 and Newcastle during 1-2 November 2001. Copies of the minutes have been submitted to the EC.

Between the progress meetings partners circulate short "bullet-point" reviews of progress at two-month intervals, as a way of keeping each other informed of what is being achieved.

There has been excellent collaboration between the partners over data collection, model application and dissemination of project results. In particular:

- the University of Newcastle, University of Milan-Bicocca and Pyreneen Institute of Ecology have collaborated over data collection to support SHETRAN applications;

- the University of Padova and the Geological and Mining Institute of Spain have collaborated over the application of the debris flow impact model in the Spanish Pyrenees;

- the University of Milan-Bicocca and the Geological and Mining Institute of Spain have begun discussions about the application of the STONE rockfall model in the Spanish Pyrenees;

- the Pyreneen Institute of Ecology and CNR-CSITE Bologna are jointly investigating methodologies for deriving debris flow susceptibility maps;

- the Pyreneen Institute of Ecology, the University of Padova and the University of Milan-Bicocca are collaborating on the report on debris flow relationships;

- the Universities of Padova and Milan-Bicocca have prepared a joint programme for a training course on their respective models.

Several partners have been or will be involved in conferences and other meetings as described in the attached reports.

1.6 DIFFICULTIES IN MANAGEMENT AND COORDINATION

There are no difficulties to report.

APPENDICES

Progress reports by:

- University of Newcastle upon Tyne, UK
- University of Milan-Bicocca, Italy
- CNR-IRPI, Italy
- University of Padova, Italy
- Pyreneen Institute of Ecology, Spain
- Geological and Mining Institute of Spain