Suppl. Geogr. Fis. Dinam. Quat.
III, T. 3 (1999), 163-165

FOURTH INTERNATIONAL CONFERENCE ON GEOMORPHOLOGY - Italy 1997
Symposium: Landslide Management

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LANDSLIDE MANAGEMENT

Landslide management is the complex of actions undertaken in order to solve problems posed by landsliding to the different aspects of human activity.

To this aim, the steps to be followed are a paramount standard: first the knowledge on the characters of the process, and on the spatial and temporal distribution of territorially dispersed processes; then the diagnosis on causes and trigger mechanisms. Based on them, countermeasures can be planned in order to reduce the impact of study phenomena, and/or to restore the stability of affected slopes, by increasing their resistance or decreasing the stress acting upon them. On the territorial approach, planning is required in order to avoid dangerous areas.

There is no room here to set a state-of-the-art on this wide range of topics. Literature is very extensive and exhaustive. We recommend the interested persons to refer to the several textbooks, among which we would suggest to read «Landslide Recognition», edited by R. Dikau and coworkers, and «Landslides - Investigation and Mitigation», edited by A.K. Turner and R.L. Schuster. The first book is devoted to non-specialists, though it gives a wide and exhaustive picture of diagnostic elements for landslide recognition; the second is a milestone in the literature on landslides.

The Symposium S2 has been organised in such a way that the aspects on the knowledge on the processes are stressed out: sub-sections are:

1 - Case histories
2 - Territorial zoning and land classification
3 - Geomorphology
4 - Modelling.

Not all papers fit precisely in one single section: some span over more than one, some others are out of this scheme. This notwithstanding, we tried to arrange the poster sections in such a way that papers on the same (sub-) topics are displayed together.

In the Case Histories sub-section we find the contributions:

1 - Les Glissement de Terrain de la Roumanie - Etude de cas; by Ielenicz M., Patru I. & Tudose C. This is a classical work of nation-wide zoning and some representative examples.

2 - Grands glissements de terrain dans l'espace montagneux de la Roumanie; by Surdeanu V. Large-scale landslides in Romania (volume > $1x10^6m^3$) are reported to have been active in 3-4 cycles in the XXth Century. Activity seems to be increasing; no effects of earthquakes are reported.

3 - Landslides from the February 3, 1996, Lijiang earthquake in China; by Chuang T. and Grunert J. Landsiding caused by the 7.0 magnitude Lijiang earthquakes are described. Most of landslides are in areas with intensity equal or greater than VI MM scale. Morphology appears as the controlling factor on landslide distribution. Incipient landslides are widespread.

4 - The great landslide of Mount Ciapa Liscia in the Aveto valley (Ligurian-Emilian Apennines); by R. Terranova. This descriptive paper presents a case study giving extraordinary precise figures for area and volume of the landslide.

5 - Landslides in the North of Lisbon Region (Portugal): conditions and triggering factors; by Zèsere J.L., Brum Perreira A. & Rodrigues M. L. A detailed study on spatial and temporal distribution of landslides in the study zone is given. Stress is conveyed to the possible causes, among which human activity appears to be as the most effective one, besides extreme rainfalls. This contribution actually contains more than case histories, as a territorial classification of the study zone, as regards landsliding and rainfall, is partially achieved.

6 - Mass-movement caused by rock block impact at the Soberbo slope, Rio de Janeiro, Brazil; by de Souza Avelar

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A. & Alvarenga Lacerda W. The impact of a rock block on the saturated soil downslope the Soberbo road is the topic of this paper that demonstrates, through undrained shock tests, that the dynamic load necessary to trigger the movement is lower than the static loads applied in triaxial tests.
7 - Geomorphic and environmental control of earth quake-induced landslides; by Okunishi K, Sonoda M. & Yokoama K. The 1995 Kobe earthquake triggered several landslides, the most of which were small in size - only one was a large slump that caused 34 casualties. Debris falls were concentrated in the area of maximum intensity, while debris slides were scattered throughout the macroseismic field. Landslides were more frequent on convex slopes, where normally rain-induced landslides are instead scarcer. As the earthquake occurred on weathered granite slope, during the dry season, and the preceding wet season was drier than average, the mode, number and distribution of landsliding was evidently controlled by the mechanical properties of the dry weathered granite mantle.

Zoning is the dominant topic of the sub-section containing the following papers:
8 - A constructive approach on landslides through susceptibility zoning & case study in the Rakti basin of Eastern Himalaya, by S. K. Bhattacharya. A territory in Darjeeling district has been zoned on the basis of a probably old-fashioned, but reliable procedure, based on the detailed direct and indirect classical methods for data collection. Beyond zoning, the paper presents a set of practical countermeasures prescribed for the study cases.
9 - Remote sensing, photogrammetric monitoring and digital cartography for regional management of landslides, by Biasini A., Campo V., Grangiè P.F. & Salvatore M.C. Remote sensing and G.I.S. philosophy is used to classify the Molise region (south Italy) on the basis of landslide incidence. The great advantage of periodical revision and updating of the G.I.S. is stressed out.
10 - Spatial and temporal occurrence of rainfall-triggered landslides in New Zealand, by Glade T. This was one of the two papers selected for extended oral presentation. It presents the results of a study carried out in three study zones of New Zealand, aimed at, among other things, establishing regional rainfall probabilistic thresholds for landslide-triggering rainfalls, and establishing a landslide hazard assessment for each region.
11 - Geomorphological mapping as a fundamental tool for Landslide management: the example of Cortina d'Ampezzo (Dolomites, Italy), by Panizza M., Pasuto A. & Soldati M. The paper presents some new proposals for the criteria to be adopted in distinguishing the various «landslide units» that characterise a given area.
12 - Landslides in Darjiling Himalaya, India; by S. Sarkar. The study is based on a long-lasting record of events starting since 1849, from which the great influence of human land(mis)use stems out clearly. Considering that «every landslide is an individual problem», this Author suggests that the solution for each problem needs to be treated as an individual case study, even though common characters are found in several cases.

In the Morphology sub-sections, the following papers were presented:
13 - Geomorfological investigations and management of the Corvara landslide (Dolomites, Italy); by Corsini A., Gandolfi M., Marchetti M., Panizza M., Pasuto A. & Soldati M. The paper reports the geomorphologic characters of large-scale landslides affecting one of the most valuable sky resorts in the Dolomites.
14 - Analysis of the evolution of landslides using geomorphologic criteria. Applicability to the Barranco de Tirajana basin (Gran Canaria, Spain); by Lomoschitz A. & Corominas J. The paper, in spite of former interpretations based on volcanic or tectonic origin, reveals that the shaping of the morphology of the study zone is due to large-scale landslides. Geomorphologic evidences, and absolute dating, are brought as support to this interpretation. Three stages in the evolution path of the landslides are described.

The Models sub-section is the richest in contributio ns. This indicates that the scientific community has developed experience and concepts enough to set general ideas on the landslide evolution and influence on the environment, and on the ways to their management.
15 - Slope stability in semi-arid mountainous terrain: modelling controlling factors; by Alcantara Ayala I. Three models are used to study the relationships between climatic, hydrologic, geologic, and geomorphologic elements, all contributing to slope instability. As a general result, failure is strongly controlled by morphodynamics, rather than by climatc events, except shallow landslides that are related to high-intensity rains.
16 - A predictive model of landslide occurrence, Upper Tiber Basin, Central Italy; by Cardinali M., Carrara A., Guzzetti F. & Reichembach P. A 1,100 km^2 study area has been accurately analysed in order to gather a variety of 40 environmental variables, used to implement a discriminant analysis based land classification model capable of distinguish the stable from the unstable zones. Slope morphology and attitude of bedding results as the most powerful variables in successfully discriminate the landslide-prone areas.
17 - Managing climate change impacts on landsliding - using a combined hydrology-stability model to assess the relative sensitivity of a landslide to climatic versus landuse change in South East England; by Collison A.J.C., Dehn M., Wade S.D. & Griffiths J. The results of this complex study suggest that climate changes may increase landslide activity. However, this effect is much less important than effects due to changes in available soil moisture due to land use practices, that appear as a potentially powerful tool for landslide management.
18 - Stability analyses and stabilisation works of the Montepiano Travertinuous Cliff (Central Italy); by D'Alessandro L., Genevois R., Berti M., Tecca P.R. & Urbani A. Modelling in this paper refers to slope stability analysis. For the peculiar geologic conditions represented by the travertinous bank overlying overconsolidated Plio--Pleistocene clays and silts, the control of ground water and the modification of the geometry of the slope result to be the only suitable methods for stabilising the slope.

19 - Assessment of climate change impact on landslide activity; Dehn M. & Buma J. The paper faces the important problem of downscaling from the global to the regional scale the climatic predictive models, and their impact on the study of geomorphic processes. Different methods of empirical downscaling techniques exist; some are used to show the influence of regional climatic changes on landsliding. The approach, however, is not easy, thus caution must be taken in the interpretation of the resulting scenarios.

20 - Temporal occurrence and forecasting of landsliding in the European Community; by Flageollet J.C. This work presents the results of an EC research project. Occurrence in space and time of landsliding has been studied in several study zones in seven European countries. In the past, landsliding was unevenly distributed in the different parts of Europe, and intensity was also different from place to place. A predictive model has to be set at a regional scale.

21 - The temporal stability and activity of landslides in Europe with respect to climatic change; by Dikau R. and Schrott L. This is one of the two papers selected for oral presentation. The paper presents the results of an EC project that represents the continuation of the project illustrated by Flageollet. The book «Landslide Recognition» is an easy reference text for planners and land managers; focus has been posed on the relationships between landslides and climatic conditions in different parts of Europe; the relationships between frequency of occurrence of landsliding and precipitation, have been studied by means of models that show that landslide type is determinant; coupling models for slope stability with down-scaled models for climatic change, the slope stability in future is evaluated in France, Italy and Great Britain.

22 - Les mouvement de terrain: un processus efficace qui explique le façonnement des grande vallèes des regions temperèes; by Marre A., Laurain M & Guèremy P. The paper illustrates a geomorphologic evolution model of the Marne River valley, according to which mass movement has been active during different periods of the Quaternary era. The large amount of debris mobilised by mass-movement has filled the valley. This situation still persists representing a noteworthy source of danger.

23 - Landslides hazard modelling using GIS and Logistic Multiple Regression; by Sadek T. K., Gippel C. J., Grayson R.B., McMahon T.A. and Wang Q.J. The papers presents some methodological improvements to the current procedures based on GIS and multivariate statistical analyses; however, as the study zone is actually monolithologic, there is no significant analysis of contribution of lithology in modelling for land classification.

24 - Identification of sites potential for large- scale mass-movement; by Gorshkov A. & Zhidkov M. The paper presents a method to identify sites in Lesser Caucasus where large-scale slope movements may occur. The method is based in the morphostructural analysis of the study zone, and on the principle that where the tectonically mobile crust blocks intersect, there are the most active neotectonic features, including large-scale landslides. The method proved efficient in the study zone and potentially useful for identification of such mass-movement prone zones in the orogenic belts of the world.

25 - Modelling susceptibility to landslide: an approach based on individual landslide type; by Massari R. & Atkinson P.M. The paper stresses out the necessity that in a landslide-prone modelling, situations before landslides are taken as independent variables, rather than situations after. A model based on logistic regression is used in a study area of Central Apennines, Italy. This model permits a better understanding of the occurring processes. In particular, it stems clear that significant variables change according to the landslide type. The system, however, is rather imprecise as a tool for mapping landslide susceptibility.

As general conclusions of this Symposium, it can be stated that:

a - the contributions extend over a large variety of themes

b - several papers stress the great influence of human activity on landsliding. Land use is still one of the most effective tools for reducing landsliding.

c - the use of statistical methods integrated into GIS may give a useful support in regional zoning of landslide susceptibility. However, such methods cannot replace yet, in terms of reliability, the traditional mapping.