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A SUGGESTED METHOD FOR REPORTING A LANDSLIDE

PROPOSITION D'UNE MÉTHODE POUR RENDRE COMPTE D'UN GLISSEMENT DE TERRAIN

The International Geotechnical Societies' UNESCO Working Party on World Landslide Inventory *

Summary

The Landslide Report is a Suggested Method developed by the International Geotechnical Societies' UNESCO Working Party on World Landslide Inventory for reporting the position, date, type, geometry, volume and damage of significant landslides.

Résumé

Le « Compte-Rendu sur un glissement de terrain » est une méthode suggérée et développée par le « Comité de Travail pour l'Inventaire Mondial des glissements de terrain ». Il inclut l'emplacement, la date, le type, la géométrie, le volume des glissements de terrain importants, ainsi que les dégâts provoqués.

Introduction

A Working Party of the International Association for Engineering Geology Commission on Landslides and Other Mass Movements, the International Society for Rock Mechanics and the International Society for Soil Mechanics and Foundation Engineering Technical Committee on Landslides has been formed to assist the establishment of a World Inventory of Historic Landslides. The Inventory, a proposed contribution to the International Decade for Natural Disaster Reduction, would help the United Nations Education, Scientific and Cultural Organization and the United Nations Disaster Relief Organization in understanding the world distribution of landslides. The Working Party has prepared a Suggested Method for the compilation of the basic unit of the Inventory, the Landslide Report.

Structure of the world inventory

The Landslide Report is the building block of the World Landslide Inventory. The Suggested Method proposes standard measures to be used in reporting historic landslides. Numeric information from the Report can be compiled using a database management program into the Landslide Record which will be a summary of the information provided by the Report. A cumulative bibliography, compiled in a separate file, can be updated with additional references as they appear in the Landslide Reports. The information on landslides provided by these Reports can then be assembled and made available to local, regional, national and international authorities.

The conceptual information flow for the World Landslide Inventory illustrates the passage of landslide information from notification to its place in the World Landslide Inventory (Fig. 1). Once a significant landslide has occurred, the agency for local landslide inventory is notified and the Landslide Report is professionally completed. This Report is then numbered and translated into a Landslide Record at the national level. At the same time, any references to the landslide are added to a regional or national bibliography established in a separate database file. At this point the Landslide Record is added to the National Inventory. The Records in this inventory are compiled annually to produce a national Landslide Summary. This Summary is then sent in computer-processible form to the World Centre where landslide summaries from different countries are assembled to create and sustain the World Landslide Inventory. In addition to establishing an international summary of landslides, the World Centre will also maintain an international landslide bibliography. This information can then be made available to engineers, geologists, planners and other interested agencies.

To summarize, the Landslide Report leads to the Landslide Record, which leads to the Landslide Sum-

* *Secretary :* D.M. Cruden. Department of Civil Engineering Univrsity of Alberta Edmonton, Alberta, Canada T6G 2G7.

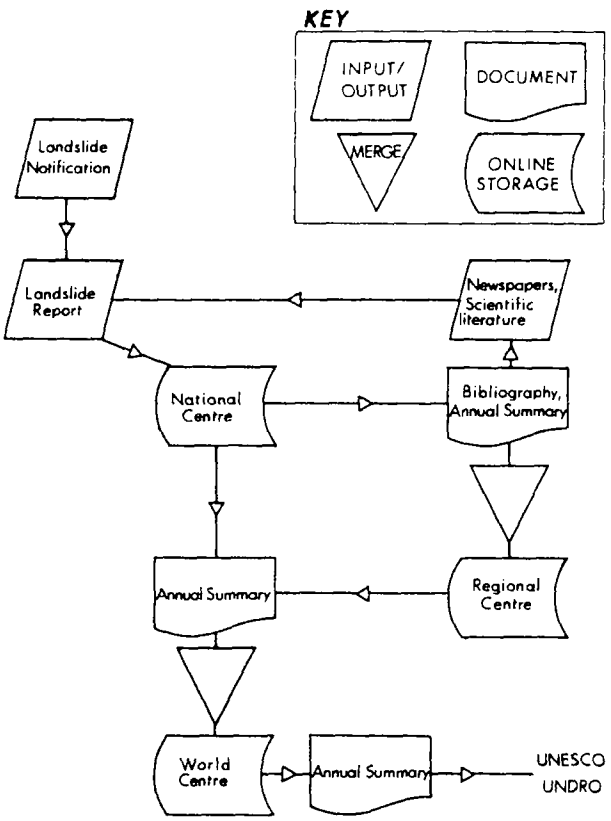

Fig. 1 : Conceptual information flow for world inventory.

mary, transferring information from the local to regional or national centres, and thence to the World Centre. All three components provide the foundation on which the World Landslide Inventory is based.

The Landslide Report

The Landslide Report, a suggested method of reporting landslides, provides a permanent record of details that cannot be coded in the database Record. Because of the need to code the data, complex, descriptive details which may face language barriers are avoided. The Report establishes minimum data requirements while permitting additional, detailed observations in the 'comments' (Fig. 2, 3).

Because it is not practical to report all landslides, it is necessary to create a working definition of a significant landslide. We propose that a significant landslide is one that satisfies at least one of the following criteria :

1) is over 1 million cubic metres in volume
2) causes casualties
3) causes considerable direct or indirect damage.

As this Inventory is concerned with historic landslides, only those that can be dated to, at least, the nearest year should be recorded.

The Report uses terminology from Varnes (1978) and the IAEG Commission on Landslides and Other Mass Movements (1990). This terminology is currently used in many regional and national inventories, including those in Canada, Czechoslovakia, Italy and the U.S.A. (Carrara and Merenda, 1976; Pasek, 1975; Thomson and Morgenstern, 1977; Varnes, 1984).

The Landslide Report is arranged to permit ready coding for computer processing. Consequently, observations are either numeric or, of mutually exclusive categories that can be classified numerically. Each category is represented by a number so that information is transcribable to the electronic database.

References in the Report and descriptive comments will not be transferred to the Landslide Record. A separate file of references will however be created and represented by numbers in the Record. The comments need not be transferred to the Record but should remain on file with the Landslide Report. Landslide Reports should be maintained in National Centres for public reference.

We now discuss specifications of the measurements of an individual landslide which can be included in the landslide Report (Fig. 4).

Position

The position of each landslide is to be mapped by its latitude and longitude to the nearest second. This provides a reference point for subsequent mapping and research. On landslides which extend over more than one second, the crown of the landslide should be taken as the reference point. The elevation of the tip of the landslide, the toe of the surface of rupture and the highest point of the crown above mean sea level should be recorded to the nearest 10 m.

Date

The date of occurrence should be recorded. Difficulties arise when the movement is not fast. When movement is progressive and takes place over an extended period of time, the 'date of occurrence' is when the most rapid displacement took place. If this is not known, the day when displacement last took place should be recorded.

Type

The most widely used classification is Varnes' (1978). It was based on Sharpe (1938) and augmented from other sources (Zischinsky, 1966; Zaruba and Mencl, 1969; Skempton and Hutchinson, 1969; Nemcok, *et al.*, 1972; and de Freitas and Watters, 1973).

Varnes' classification is based on two criteria : the type of movement and the material involved. Material is classified as either bedrock or engineering soil. Soils are divided into debris or earth. The latter is fine grained material in which at least 50 percent are sand, silt, and clay-sized particles. There are five main types of movement : falls, topples, slides, spreads and flows. A sixth group includes all complex failures in which one of the five main types of movement is followed by another main type of movement. Some movements may exhibit more than two types of movement in sequence. Most movements are complex Varnes (1978) suggested

LANDSLIDE REPORT

Date of Report day ____ / mo. ____ / yr. ____ /

Landslide Locality _____ National Inventory Number _____

Reporter: Name _____

Affiliation _____

Address _____

_____

_____

_____

Phone _____

Position: Latitude degrees _____ ° minutes _____ ' seconds _____ " hemisphere _____

Longitude _____ ° _____ ' _____ " hemisphere _____

Elevation: crown _____ m a.s.l.

rupture surface toe _____ m a.s.l.

tip _____ m a.s.l.

Date of occurrence: day ____ / mo. ____ / yr. ____ /

Type: First movement (circle the appropriate numbers and terms)

1. rock 2. debris 3. earth

1. fall 2. topple 3. slide 4. lateral spread 5. flow

Second movement (circle the appropriate numbers and terms)

1. rock 2. debris 3. earth

1. fall 2. topple 3. slide 4. lateral spread 5. flow

Fig. 2 : A Landslide Report — Side 1.

the construction of names for the movements which reflected their complexity.

Consider the Elm landslide in which the displaced rock mass fell, shattered and flowed as debris (Fig. 5a). This was a rock fall-debris flow (Varnes 1978 p. 21). The complex type of movement can be accommodated in the report by describing a second type of movement which follows the first.

To aid in the definition of movement type, a brief description is given of each, according to Varnes (1978).

In falls, a mass is detached from a steep slope along a surface on which little or no shear displacement takes place. Material descend mostly through air by either free fall, saltation or rolling (Fig. 5a, 5b).

Topples involve the forward rotation of the displaced mass about an axis at or near its base. Topples may precede or follow falls or slides and are sometimes evident as detached blocks perched precariously on a valley wall (Fig. 5b).

Slides are movements of a more or less coherent mass along one or more well-defined surfaces of rupture (Fig. 4).

In spreads, the dominant mode of movement is lateral extension accommodated by either shear or tensile fractures (Fig. 5c).

Geometry: Rupture Surface Displaced Mass

Length L_r = _____ m L_d = _____ m L = _____ m

Width W_r = _____ m W_d = _____ m

Depth D_r = _____ m D_d = _____ m

Volume: $V = \pi L_d D_d W_d/6$ or V = Swell factor =

V = _____ $m^3 \times 10^n$ n = _____

Damage: Value _____ Currency _____

Casualties _____

References:

1. _____

2. _____

3. _____

Comments: _____

Fig. 3 : A Landslide Report — Side 1.

Flows include a wide range of movements with significant variations in velocity and water content which exhibit spatially continuous deformations. Flows often begin as either slides, falls, or as topples on steep sloped which rapidly disintegrate with the loss of cohesion of the displaced materials (Fig. 5a).

Geometry

The length, width and depth of the rupture surface can often be estimated when parts of the surface of rupture are obscured. They are shown by a subscripted r. The length, width and thickness of the mass of displaced material are measured directly and are denoted with a subscripted d (Fig. 4).

The maximum length of the rupture surface, L_r, is measured from the toe of the surface of rupture to the crown. The other length measure, L_d, is taken from the tip of the displaced material to its top. The total length, L, is measured from the tip to the crown (Varnes, 1978). The maximum widths of the surface of rupture, W_r,

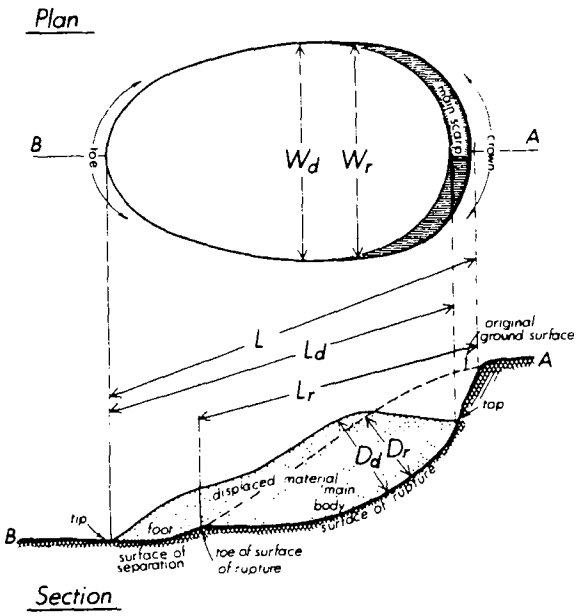

Fig. 4 : Landslide features and dimensions used for the Landslide Report.

and the displaced mass, W_d, are measured across the original ground surface in directions perpendicular to the lengths L_r and L_d. Depth is the most difficult dimension to estimate. The maximum depth of the surface of rupture, D_r, should be estimated from the original ground surface in a direction perpendicular to it. The thickness of the displaced material, D_d, is measured perpendicular to the surface of the displaced material.

Volume

The volume of the displaced mass in cubic metres should be given to three significant digits. In the Landslide Record, n represents the order of magnitude of the volume. When the displaced mass does not have regular dimensions, the volume can be estimated by fitting a geometric figure. For instance, considering the displaced mass as half an ellipsoid might be appropriate for a rotational slide. In this case, the volume is computed by using the major axes of half an ellipsoid :

$$V = \frac{1}{2} \cdot \frac{4}{3} \pi \frac{1}{2} L_d \cdot D_d \cdot \frac{1}{2} W_d = \frac{1}{6} \pi L_d D_d W_d \quad (1)$$

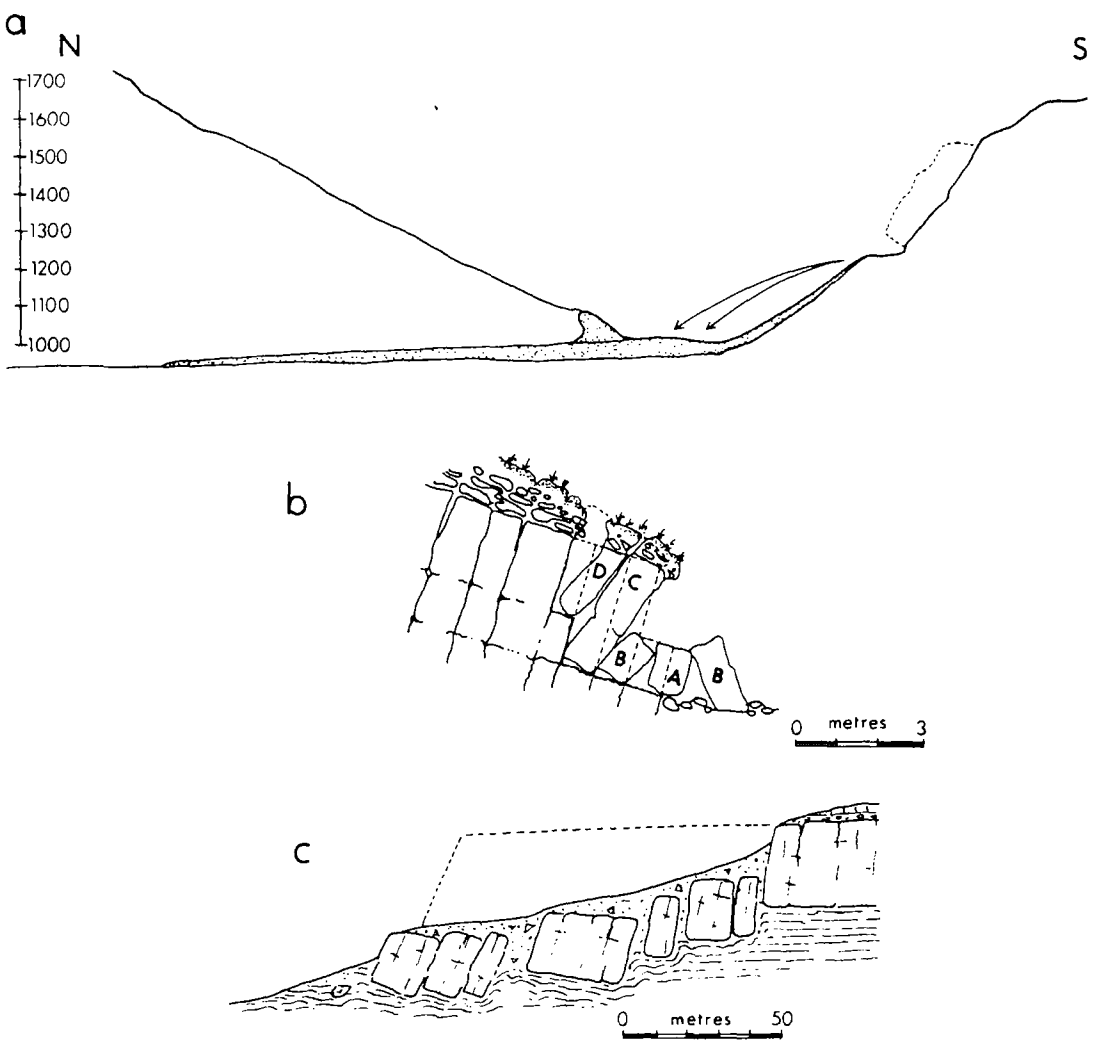

Fig. 5 : Sections through typical slope movements; 5a is based on Heim (1932, Fig. 19), 5b on de Freitas and Watters (1973, Fig. 1b) and 5c on Zaruba and Mencl (1982, Fig. 5-45).

If volume is estimated from the dimensions of the mass before displacement using the dimensions of the rupture surface, the volume of the displaced mass can then be estimated using a swell factor, perhaps based on experience excavating similar materials (Church, 1981, Appendix 1).

Damage

The damage estimate to be included in the Landslide Report should be given in the local currency and the number of deaths and substantial injuries by the direct or indirect effects of the landslide should be recorded. A substantial injury results in incapacitation for over a year. Direct effects take place on the landslide, indirect effects take place off the landslide (Fleming and Taylor, 1980).

References

Any reports on the landslide should be referenced in the Report. These and the reporter's name and address are made available should supplemental information be desired.

Comments

Additional comments can be added at the end of the report. This information will not be coded in the Landslide Record, but will instead be made available on the original Report.

Discussion

The need to establish a World Landslide Inventory is apparent. The world distribution of landslides has not yet been mapped. Landslide studies are isolated, limiting their interpretation to local factors. Looking at the occurrence of landslides on a much larger scale may reveal broad scale or interactive processes that contribute to movements. There is an obvious analogy to be drawn with the study of earthquakes.

The suggested method for reporting landslides, the Landslide Report, should simplify acquiring and accumulating information. Because the task of studying and reporting all significant landslides is immense, the Report requires a minimum of observations. These data, when transcribed to the Record and compiled at the World Centre, will provide the basis for subsequent analyses. Once the World Inventory is in place, the databank will provide information that will help to establish world patterns of landslide occurrence. This in turn will lead to a better understanding of the causes of landslides and to more accurate hazard assessments. Thus, the World Landslide Inventory will eventually lead to better predictive models, which can then be used to alleviate landslide risk.

The structure of the Inventory and the format of the Report are suggestions which can be modified by discussions from within and without the Joint Working Party. The Working Party (listed in Appendix A) welcomes carefully documented proposals for additions or amendments to the Suggested Method.

The Working Party has set up Working Groups to suggest methods of classifying the rates of movement of landslides, their causes, their geology, their activity and the distribution of movement within landslides. Another Working Group is studying the creation of Landslide Summaries. The recommendations of these Working Groups will be used to expand and modify the Suggested Method for Reporting a Landslide.

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Appendix A

International Geotechnical Societies' UNESCO
Working Party on World Landslide Inventory

Professor R. Fell
School of Civil Engineering
University of New South Wales
PO Box 1
Kensington NSW 2033
AUSTRALIA

Dr. W. Lacerda
Av. Rui Barbosa, 170 — Apt. 1405
Bloco B2
22250 Rio de Janeiro, RJ
BRAZIL

Dr. D.M. Cruden, Secretary
Dept. of Civil Engineering
University of Alberta
Edmonton, Alberta T6G 2G7
CANADA

Dr. S. Evans
Terrain Sciences Division
Geological Survey of Canada
601 Booth Street
Ottawa, Ontario K1A OE8
CANADA

Dr. P. LaRochelle
Department de Genie Civil
Université Laval
Cité Universitaire, Québec G1K 2P4
CANADA

Prof. Fernando Martinez
Av. Pedro de Valdivia 428
Santiago
CHILE

Mr. Lisandro Beltran
Associate Professor
National University of Colombia
Apartado Aereo 30420
Bogota, COLOMBIA

Prof. J. Jesenak
FSTAV SVST
Radlinskeho 11
CS-81368 Bratislava
CZECHOSLOVAKIA

Ing. S. Novosad
GEOtest np
Gottwaldova 287
70900 Ostrava, CZECHOSLOVAKIA

Dr. E. Krauter
Geol Landesamt Rheinland-Pfalz
Emmeransstr 36
D-6500 Mainz
FEDERAL REPUBLIC OF GERMANY

Mr. E. Slunga
Helsinki Univrsity of Technology
Dept. of Civil Engineering
Rakentajanaukio 4A
FINLAND

Dr. G. Pilot
Laboratoire Central des Ponts et Chaussées
58 boulevard Lefebvre
75732 Paris Cedex 15
FRANCE

Dr. E.W. Brand
Geotechnical Control Office
6/F, Empire Centre, Tsimshatsui
HONG KONG

Dr. J. Farkas
Technical University of Budapest
Muegyetem rkp. 3
H 1521 Budapest
HUNGARY

Dr. R.K. Bhandari
Director, Central Building
Research Institute
Roorkee-247667 (UP)
INDIA

Professor V. Cotecchia
Direttore, Instit. Geologia
Applicata and Geotecnica
University of Bari
Via Re David 200
I-70125 Bari, ITALY

Prof. Ing Franco Esu
Via Proba Petronia 69
00136 Rome
ITALY

Mr. H. Fujita
Japan Road Construction Bureau
Shin-Kasumigaseki Bldg. 15th flr.,
3-3-2 Kasumigaseki Chiyoda-ku
Tokyo 100
JAPAN

Dr. H. Nakamura
Public Works Research Institute
Ministry of Construction
Government of Japan
1, Ashahi, Tsukuba-shi
Ibaraki-ten, 305
JAPAN

Professor K. Sassa
Disaster Prevention Research Institute
Kyoto University
Gokasho, Uji
Kyoto 611
JAPAN

Dr. W.H. Ting
Managing Director
Dr. W.H. Ting Consultants Sdn. Bhd.
18 Jalan SS 20/10
Damansara Kim
Petaling Jaya
MALAYSIA

Mr. Graham Salt
Geotechnical Group
New Zealand Geological Survey
P.O. Box 64
Cromwell
NEW ZEALAND

Dr. Nilmar Janbu
Norwegian Institute of Technology
Hogskoleringen 7
7034 Trondheim-NTH
NORWAY

Mr. Mansoor Ahmed
Nespak
417, Wapda House;
Shahrah-e-Quaid-e-Azam
P.O. Box 1351, Lahore
PAKISTAN

Dr. Wang Gongxian
Northwest Institute
China Academy of Railway Sciences
Lanzhou, Gansu
PEOPLES REPUBLIC OF CHINA

Professor Zhang Zhuoyuan
President
Chengdu College of Geology
Chengdu, Sichuan, 610059
PEOPLES REPUBLIC OF CHINA

Mr. R. Michelena
Boccioni 279
Lima 41
PERU

Dr. Mihai Popescu
Civil Engineering Institute
P.O. Box 2-45
78172 Bucharest 2
ROMANIA

Mr. Leif Viberg
Swedish Geotechnical Institute
S-581 01 Linkoping
SWEDEN

M. CH. Bonnard
ISRF-EPFL Ecublens
CH-1015 Lausanne
SWITZERLAND

Professor J.N. Hutchinson
Dept. of Civil Engineering
Imperial College of Science & Technology
Imperial College Road
London SW7 2BU
UNITED KINGDOM

Dr. Herbert H. Einstein
Civil Engineering Dept.
MIT
Cambridge, MA 02139
USA

Dr. Robert L. Schuster
Branch of Geologic Risk Assessment
US Geological Survey
P.O. Box 25046 MS 966
Denver CO 80225
USA

Dr. D.J. Varnes
United States Geological Survey
MS 966, Box 25046
Denver, Colorado
U.S.A., 80225

Prof. Z.G. Ter-Martirosian
USSR National Committee for SMFE
103828 Moscow
Pushkinskaya Str
26 Gosstroy
USSR

Professor Dr. G.I. Ter-Stepanjan
9 avenue Lenin, apartment 11
Yerevan 375002
U.S.S.R.

Dr. P. Anagnosti
Energoprojekt Consulting and Engineering Co.,
Water Resources Dev. Dept.
11070 Belgrade, Bulevar Lenjina 12
P.O. Box 20
YUGOSLAVIA

Dr. M. Hashizume
Division of Earth Sciences
Science Sector, UNESCO
7, place de Fontenoy
75700 Paris
FRANCE

Dr. M. Watanabe
Coordination Officer
Office of the United Nations
Disaster Relief Coordinator
Palais des Nations
CH-1211 Geneve 10
SWITZERLAND