EUROPEAN FORESTRY COMMISSION

FINAL REPORT OF THE

THIRTEENTH SESSION OF THE WORKING PARTY ON THE MANAGEMENT OF MOUNTAIN WATERSHEDS

Palermo, Italy
27 September to 9 October 1982

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

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Thirteenth Session

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

Rome, 1983

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I. INTRODUCTION

1. The Thirteenth Session of the Working Party on the Management of Mountain Watersheds of the European Forestry Commission (EFC) was held in Palermo, Sicily (Italy), from 27 September to 9 October 1982, thanks to the kindness of the Italian Government. The working meetings, which took place in the splendid Hotel La Torre in Mondello (Palermo), were followed by a study tour in Sicily, from 3 to 9 October.

2. The Session was attended by 76 participants from 11 Member Countries of the European Forestry Commission: Austria, France, Federal Republic of Germany, Greece, Israel, Italy, Norway, Romania, Spain, Switzerland and Yugoslavia. There were also observers from Tunisia, UNEP, IUFRO and CIHEAM. FAO was represented by two officers from the Forest Resources Division. The complete list of participants is given in Annex B.

3. The meetings were chaired by the First Vice-Chairman of the Working Party, Mr. S. Puglisi (Italy), together with the Second Vice-Chairman, Mr. F. López Cadenas (Spain). The Representative of the host country, His Excellency Mr. Mario d'Acquisto, President of the Sicilian Region, opened the Session and welcomed the participants. Mr. Talat Eren, Chief, Forest Conservation and Wildlife Branch, addressed the participants on behalf of FAO; and the Vice-Chairman of the Working Party, Mr. S. Puglisi, also gave a short speech, referring in particular to the thirtieth anniversary of the Working Party, one of FAO's oldest Working Parties. Mr. L.S. Botero, of FAO's Forest Conservation and Wildlife Branch, as Secretary of the Working Party ensured coordination of the meeting, with the help of a very efficient Secretariat and support service provided by the host institution, the Forestry Office of the Sicilian Region, coordinated by Mr. M. Arrigo.

4. In extending a warm welcome to the participants, His Excellency Mario d'Acquisto, President of the Sicilian Region, stated that it was an honour for Sicily to host an FAO Session dealing with a subject of such interest as the management of mountain watersheds. In the absence of action by the State and the European Community, the Sicilian Region has devoted considerable sums to soil protection, even though from an institutional point of view, the responsibility for such action lies mainly with the State. In wishing the meeting success, Mr. d'Acquisto expressed the hope that the European Community too would soon realise that the management of mountain watersheds is of prior importance in plans for the integrated development of depressed zones.

5. Mr. T. Eren, Chief, Forest Conservation and Wildlife Branch, also welcomed the participants on behalf of the Director-General of FAO and of the Assistant Director-General, Forestry Department. He expressed to the Italian authorities FAO's thanks for the hospitality provided by Italy, which was now hosting the Working Party for the third time. FAO was particularly grateful to the Forestry Office of the Sicilian Region, and especially Mr. Corrao, its Director, and his collaborators, Mr. Russo, Mr. Arrigo and the rest of the group which had prepared this event so carefully. Mr. Eren then reviewed the history of the Working Party during its thirty years of existence, underlining the effect that the work of the Working Party had had on policies and programmes for watershed management in Europe. He emphasized the importance of the Working Party redoubling its efforts in order to increase cooperation in this matter for the benefit of both developed and developing countries.

6. Mr. S. Puglisi, Vice-Chairman of the Working Party, then took the floor. He stated that it was an honour for him to welcome everyone to his birthplace. This Session of the Working Party was particularly important because this year the Working Party was celebrating its thirtieth anniversary.

The first Session, as the participants knew, had taken place in Nice. From this Session there had emerged a magnificent publication issued by the ENEF of Nancy, which had led to the circulation of new ideas and accelerated progress in torrent control techniques in Europe.

The activities of the Working Party had consisted essentially of an exchange of experience among technicians from Europe and other countries, the updating of problems and the improvement of methodologies. But the Working Party had had to keep up with the times as regards the economic and social problems of deprived areas, changing its title to the present one.

It was thanks to this remarkable activity, enriched by other events (the Symposia in Vienna and Grenoble, for example) that the Working Party had been able to survive: thirty years of activity, then, and many achievements. The Working Party had reached maturity, but Mr. Puglisi hoped it would never grow old.

7. The Vice-Chairman of the Working Party submitted for the approval of the participants the proposed Agenda and Timetable. The Agenda, adopted with slight changes, is given in Annex A, and the Timetable in Annex D.

II. NATIONAL REPORTS

8. Six delegations: France, The Federal Republic of Germany, Italy, Norway, Spain and Switzerland, submitted written national reports; and the representative of Israel made a brief verbal statement.

9. The national report of Spain, prepared by Messrs. F. López Cadenas de Llano and A. Pérez-Soba Baro, of ICONA, gave a detailed account of the situation in the country as regards watershed management, including the factors which condition the agrarian environment (abundantly illustrated by maps). It also described the problems concerning soil and water, and the action taken to resolve them, with particular reference to the institutional and legal aspects. As regards concrete measures, programmed on the basis of a study on erosion problems carried out in 1978, ICONA hoped to implement biological measures in 1 032 883 ha and to construct torrent control works for a total of 5 362 000 m^3 during the decade 1980-89; in 1982, a total of 74 600 ha and 143 400 m^3 had already been completed. The projects were concerned with protecting reservoirs, irrigated land, hydro-electric installations and rivers, restoring rivers and stabilizing and restoring soils.

10. The author of the French national report, Mr. L. de Crécy, "Delegé aux actions RTM", stated that:

France's mountain zone covers 116 000 km^2, or 21 percent of the national territory. Thirty percent of it is forested, and 32 percent of the area is used for agricultural purposes, mainly livestock raising. The inhabitants number 3 500 000.

It is divided into seven mountain formations, unequal in area and very different as regards climate, topography and ecological potentials. They are, in decreasing order of area covered: the Massif Central (50 000 km^2), the Southern Alps (21 000 km^2), the Pyrenees (14 500 km^2), the Northern Alps (13 000 km^2), Corsica (8 000 km^2), the Jura (6 500 km^2) and the Vosges (3 000 km^2).

The population, which is stationary, tends to concentrate in the towns in the valleys. The countryfolk are often "pluriactive", engaging in other activities in addition to farming.

Tourism continues to be the basis for the economic development of the mountain zone. The influx of tourists at all seasons into the most remote sectors poses new and serious problems in combating the natural risks.

A great deal of work on avalanche control had been done since 1970: identification of danger zones, forecasting, rescue, scientific research and extension work.

Torrent control and control of the other natural risks due to movements of the soil, begun 120 years ago, are continuing with increased collaboration by the local communities. Methodological studies are underway to identify the zones of natural risk and plan the necessary works.

Reforestation continues with the aid of the EEC in the Mediterranean zones and of the National Forestry Fund in productive zones. Upkeep and renewal of the forest stands resulting from previous reforestation work on steeply-sloping land pose formidable technical and economic problems.

As regards institutions, the local services for "restoration of mountain lands" have been placed under the dual authority of the Office National des Forêts and the Departmental Directors of Agriculture, with the task of assuming responsibility for the entire local policy for controlling natural risks.

A law of 13 July 1982 providing for compensation for the victims of natural disasters has engaged the State in a systematic policy of identifying zones of natural risks.

A "law on the mountain" is in preparation. It is following the principle of decentralizing responsibility for security to local communities and for management decisions to the "massif" regions listed above.

11. The national report for Italy was submitted by Mr. A. Angerilli of the Direzione Generale per l'Economia Montana e per le Foreste.

Hills and mountains occupy more than 70 percent of Italy's territory. Management of mountain watersheds therefore constitutes a permanent necessity in the country.

In 1972 management measures became the responsibility of the Regions. After the floods of the 1950's the "De Marchi Commission" was set up to study the technical, legal and financial aspects of soil protection in its entirety. The resulting document provides guidelines for programming and execution, even though the growing overall economic difficulties hinder implementation.

From the operational point of view, more cooperation between the State and the Regions is necessary, given that a comprehensive and unified approach is essential in soil protection work. Moreover, the traditional mountain watershed with its clear division of responsibilities between forestry, agriculture and water engineering, has now been replaced by the concept of a catchment area comprising the entire stretch of territory concerned, from the sources to the sea. The draft national laws for soil protection reflect this new trend, assigning responsibility for operations to public works services.

However, it is necessary to ensure adequate financing for measures in hilly and mountainous zones to continue the capillary water engineering and forestry activities in the upper reaches of the watersheds, as regards both new undertakings and the maintenance of existing ones.

In the five-year period 1977-1981, more than 1 250 thousand million lire a year were earmarked for these purposes. Recently about 1 000 thousand million lire have been ensured for the years 1982-1983.

12. The Norwegian national report shows that 10 people were killed by avalanches and landslides in 1980 and eight in 1981. Heavy floods in 1979 and 1980 in West Norway have necessitated security works at a cost of approximately 4 million dollars. Sills made by blasted stones have proved to be a good supplement in the struggle to secure bottom erosion in rivers and to raise the water level in order to improve the conditions for fishing, recreation and nature conservation. Important research work is being carried out regarding avalanches, river works, forest and agricultural problems. An official committee was appointed in 1978 with the main purpose of securing a better combination between the

departments involved in water use, pollution control, water power development, flood control, irrigation, etc. A film produced by the Norwegian Geotechnical Institute was presented during the Session. The film shows the Rissa landslide which took place on 29 April 1978 and is the biggest to have occurred in Norway this century.

13. The national report of the Federal Republic of Germany was submitted by Mr. E. Pröbstle, Ministerial Adviser, Senior Construction Authority of the Bavarian Ministry of the Interior. It stated that most of the torrent control work is concentrated along the northern edge of the Alps, in Bavaria. Main activities consist of: developing the irrigation system; reforesting the slopes denuded by erosion; excluding cattle from endangered land; reforestation for non-productive purposes; avalanche protection; rehabilitation of the Alpine pastures. During the last 25 years some 450 million DM have been invested for 415 Bavarian torrents, 15 percent of the cost being borne by the people concerned. A list is now being prepared of the actions desirable in order to prepare the 10-year programme 1983-92. The Bavarian Government has recruited 500-600 workers for maintenance work.

14. The national report for Switzerland was submitted by Mr. J.P. Graf on behalf of three institutions concerned: The Land Improvement Office of the Federal Bureau of Agriculture; The Federal Water Economy Office, and the Federal Forestry Office. The speaker stated that no catastrophic avalanches had occurred in Switzerland since the last Session of the Working Party. But there had been a few forest fires north of the Alps and some exceptional floods in various regions. The funds necessary for a national forest inventory had been obtained. A special project had been set up for cultural operations in mountain forests. A new, much more federalist draft law on land-use management had been accepted.

15. The representative of Israel, Mr. Y. Kaplan, of the Land Development Authority, made a brief verbal statement:

There are three agencies in Israel dealing with the management of watersheds. The Water Authority, Land Conservation Department and the Forestry Department.

The Water Authority is dealing with the water law, rationing of water for agriculture, industry and urban consumption. Since water is scarce, it is a limiting factor in almost every development project and rationing is very important.

The majority of the population in Israel and a major part of the agricultural activities are confined to the coastal plain; therefore, water consumption there is very high. The Water Authority has the power to limit overuse of water in order to diminish the danger of salination of wells by infiltration of sea water. The agency is also controlling water pollution of streams and wells by pesticides, herbicides, fertilizers and urban or industrial affluence.

The Soil Conservation Department, in cooperation with the Water Authority, is constructing reservoirs and dams on the floodplains near the coast in order to slow down the rainwater runoff into the Mediterranean. When the reservoirs are filled, the water is pumped into the sand dunes and so the water table is enriched. The reservoirs may be filled several times during the winter. The Soil Conservation Department is investigating the water consumption of different vegetative covers, and their effect on water balance of the watershed, on runoff and on sedimentation.

The natural woody vegetation in the northern part of Israel (more than 400 mm rain), on Mt. Carmel, the Galilee and Yudean mountains, is composed of an oak scrub, a remnant of mediterranean maquis, degraded during many centuries by neglect, abuse by fires, overgrazing and illicit felling.

The main task of the Forest Department is the conservation of this scarce vegetation, and the afforestation of eroded slopes, so that the soil may be restored and the erosion stopped.

Soil moisture is an important limiting factor for tree growth in a country with a long and hot dry season. All afforestation techniques are therefore aimed at securing maximum rainwater infiltration during the short rainy season, and maximum conservation and availability of soil moisture to plants, during the prolonged dry summer. The main method, suitable for the shallow soils and rocky sites in the hills is pit planting. On steep slopes, in danger of erosion, clear cultivation of strips along the contours combined with uncultivated parallel strips is used.

On higher-grade land, when labour is available, all the area is cultivated by hoeing. Whenever possible, site preparation is done by ploughing with small wheel tractors. These methods are applied in the autumn before the rainy season begins. They provide loose soil for the saplings and prevent moisture losses from run-off.

Planting on terraces was abandoned due to increased scarcity of labour and high wages.

Afforestation of bad lands in the south (Negev) is carried out after levelling and filling up open gullies by heavy bulldozers, thus completely changing the topography of the site. This method checks run-off and soil erosion and improves infiltration of rainwater.

Recently the method of liman planting of trees has been used on loess soil, where there is danger of erosion. This is an application of the ancient desert agriculture technique used by the Nabateans. In favourable topography, locations where flood water from small catchments can easily be retained, small earth dams are built to enclose a site for planting. After wetting of the soil by the first rain or flood, trees such as eucalypts, tamarisks or acacias are planted. The ratio of liman to watershed is at least 1:30. The liman method makes possible successful planting of small groves without artificial irrigation in areas where rainfall is about 100-200 mm.

The main tree species used in the north are southern conifers: Pinus halepensis, Pinus brutia, Pinus pinea and cypresses. Recently there has been a trend to plant more Pinus canariensis and Tetraclinis articulata, because of their ability to regenerate after fire.

There is still a controversy over land use and watershed management between forestry and grazing, although recently steps have been undertaken to combine both.

III. WATERSHED MANAGEMENT PLANNING

16. Three documents had been entered under this item of the Agenda:

- Soil protection in territory planning in the Trento Province (G. Castelli, L. Ferrari, P. Mazzalai, D. Nardin, R. Tomasetti, Italy).
- Testing a method for programming actions for the restoration of mountain lands in the French Alps (H. Huchon, CEMAGREF, Grenoble, France).
- Use of satellite images to obtain vegetation maps in watershed management planning (Hydrology and Soil Conservation Sections - ICONA, Spain).

17. The first part of the document on land use planning in Trentino illustrates the problems posed in Trentino, a mountainous region, by the need to protect the soil and to plan and control the use of the land, as a finite resource to be safeguarded and utilized.

It then describes the problems of meeting the demands for more space caused by the growth in population while protecting and conserving these areas from flooding:

A historical summary is given of the problems that have continually faced, and continue to face, those working in this sector, and a description is given of the administrative organization of the actions taken, based on three structures with clearly defined responsibilities.

The Forestry Services deal with the conservation and productive and hydrological improvement of the forests; the Azienda Speciale di Sistemazione Montana with the hydraulic and forestry management of water courses in the mountain watersheds, through direct administration; and the Servizio Acque Pubbliche handles the construction and upkeep of hydraulic works in water courses in the valleys bottoms.

In one hundred years of activity, about 8 000 dams have been constructed, distributed throughout the province.

The second part gives two significant examples of the management of mountain watersheds: those of the Brusago and Bianco rivers, which both form part of the main drainage basin of the Avisio torrent.

A series of examples is then given of correction and maintenance work carried out to improve the flow of water-courses in valleys.

Once the problem of sediment has been resolved, there remains the problem of preventing overflow by building reservoirs as part of an overall land use programme which should estimate the weight of each component of the programme in terms of cause and effect.

18. The methodology proposed by Mr. Huchon, of CEMAGREF, France, for planning mountain land restoration actions, attracted particular attention. The report stated that between 1860 and 1910 the French Forestry Service implemented measures in half the 2 000 dangerous torrents listed in the Alps and the Pyrenees, with the aim of regularizing the hydrologic regime by means of reforestation and torrent control works.

The importance of this work and the improvements it produced must obviously be taken into account in drawing up present erosion control programmes.

But our approach also has to be modified by new risks and problems. The decrease in the permanent population means that upkeep of the pastures, arable land and forests is being abandoned. The scarcity of local labour makes the surveillance and upkeep of the control works and protective reforestation stands difficult. The development of tourist resorts and hydro-electric plants makes it necessary to introduce security measures, but also leads to the appearance of new risks. Recent examples have demonstrated how serious these are.

In programming mountain land restoration actions account must, of course, be taken of the old objectives of regulating the water flow, but it is also necessary to be aware of the natural risks and to determine the objectives and priorities for protecting inhabitants and torrents from these risks.

The Ministry of Agriculture should no longer have sole responsibility for financing the necessary actions; therefore, individuals, promoters and local communities should contribute, together with the regional services and the State. It is therefore necessary to work out a methodology for coordinating programmes for preventive action with projects for management of the mountain areas.

The example described constitutes a first trial in the upper watershed of the Drac, a tributary of the Isère south of Grenoble.

Starting from an analysis in the field and from documents, the procedure consists of progressing towards a cartographic synthesis of objectives and priorities:

- A first series of documents deals with the factors brought into play by the natural risks in mountain areas, delimits the areas concerned and specifies the intensity of the phenomena. The foreseeable effects of these data are corrected by superimposing the factors liable to either aggravate or lessen them, such as slope, torrential hydrology, landslips and the effectiveness of the vegetative cover.

After three partial cartographic syntheses, an outline is thus obtained of the actual or potential erosion foci, constituting a picture of the initial state of the sites.

- A second series of documents must then be prepared to show on one or more maps the present (initial) situation regarding human influence, and also the social and economic trends, both evident and anticipated.

It is true that the social and economic dynamics of the watershed of the upper Drac are relatively simple and above all not very diversified: this was one of the reasons why it was selected for our first trial.

- Finally, by superimposing this map of the present and foreseeable situation on the map showing erosion foci, it is possible to prepare a map showing where action is most urgently needed (emergency actions).

This document is of direct use in deciding where and when to take action with regard to existing works. But to go further than this, the decisions will be those made by the communities or whoever else is responsible for management projects, duly informed of the existing risks and of those likely to be incurred.

A second trial is now being conducted in Maurienne, where the social and economic structure is particularly complex and has a particularly heavy impact.

19. ICONA, Spain, presented a methodology for the use of satellite imagery to obtain vegetation maps in watershed management planning:

In the study "Paisajes erosivos en el Sureste español" (Erosion-prone landscapes in Southeastern Spain), prepared by the National Nature Conservation Institute for the project on control of desertification in the Mediterranean, possibilities were tested of obtaining basic information on erosion parameters in large areas of at least one million hectares as a necessary data bank for the correct programming of priorities in watershed management and organized distribution of resources and activities for erosion control.

Maps showing land use and vegetative cover constitute part of the basic data for any study of this kind. Since the way in which the land is used for agricultural grazing and forestry purposes in continually evolving and changing, it is desirable that these maps be kept continuously up to date. In view of the great extent of the territory covered and the level of basic information provided by these maps, it has been thought to use the images provided by satellite for this updating.

On the basis of the information supports of this type, for five different dates and on the bands 4, 5, 6, 7, a territorial classification of soil uses into six different strata has been prepared: unproductive, irrigated farm land, dry-farming land, shrub land, forests, snow.

This cartographic information on a scale of 1: 500 000 compared with that used in the study based on conventional thematic mapping (map of crop lands and land utilization, scale 1: 50 000) has given as a result in the 150 plots of 400 ha sampled an approximation in the attribution of these strata of about 58 percent, the biggest differences having been encountered in defining the strata of shrub land and dry-farming areas, the best approximation being obtained for forests and irrigated farm land.

IV. HYDROLOGICAL STUDIES, CALCULATION OF MAXIMUM DISCHARGE AND SEDIMENT TRANSPORT IN TORRENTS

20. Eight papers were registered under Item 5 of the Agenda which was enlarged in order to cover the entire subject of hydrological and sedimentation studies. The following papers were examined:

(a) Calculation of the maximum discharge by the SOCOSE method (J.P. Cambon, CEMAGREF, France).

(b) Watershed management: water and sediment budgets (R.J. Prins, Faculty of Agricultural Engineering, Silsoe, U.K.).

(c) Sediment concentration in a discharge hydrograph in small watersheds (M. Djorović, Forestry Faculty, Belgrade University, Yugoslavia).

(d) Computer procedures for computing potential evapotranspiration on mountain areas (S. Fattorelli, S. Scarpa, University of Padua, Italy).

(e) Hydrological simulation experiences in Alpine watersheds (S. Fattorelli, G. dalla Fontana, University of Padua, Italy).

(f) A new and fast method for the calculation of maximum discharge of torrents (S. Munteanu, I. Clinciu, R. Gaspar, Romania).

(g) Hydrological investigations on three small watersheds in the Giudicarie Valleys (S. Fattorelli, University of Padua, Italy).

(h) Estimation of extreme sediment transport from torrential drainage basins in the East Alps (G. Kronfellner-Kraus, Federal Forest Research Station, Vienna, Austria).

21. Mr. J.P. Cambon of CEMAGREF (France) giving examples of the application of the SOCOSE method in calculating high flows, stated that in 1980 the Hydrological Division of the Centre d'Etudes du Machinisme Agricole, du Génie Rural, des Eaux et Forêts (CEMAGREF) worked out for the whole area of metropolitan France a formula for rapid calculation of the discharge over ten years.

This formula was prepared on the basis of a sample of 200 watersheds (area between 1 - 200 km^2). It has the advantage of not having to rely on any subjective parameters, which always have to be viewed with caution. The characteristics selected were:

- rainfall:

  Pa = mean annual rainfall (in mm)

  P = maximum daily rainfall over a period of 10 years (in mm)

  b = exponent of Montana's law $I = \frac{a}{t^b}$

- topography:

  S = area of watershed (in km^2)

  L = length of the thalweg

  Δ = uneven

It appeared necessary to check the validity of such a "national" formula by comparing its results with the data from observations in a region like Provence-Alps-Côte d'Azur that presents many contrasts.

One hundred hydrometre stations in this region were therefore studied. For three stations, the ten-year discharge was calculated on the basis of observations - by extrapolation of Gumbel's Law - and using the formulas proposed.

This comparison made it possible to verify that the formula produced satisfactorily accurate results.

It must be pointed out that formulation of the value J = potential interception must differ according to the aim pursued. If the formula J_2 (established in December 1977) is used, a more accurate estimate of the discharge is obtained (50 percent over-estimate, 50 percent under-estimate); the formula J_2, on the other hand (established in July 1979) provides a generally over-estimated figure (75 percent over-estimate, 25 percent under-estimate). It is therefore preferable to use this formula in making calculations for works, because over-estimates are less prejudicial than under-estimates.

22. At the last moment Mr. R.J. Prins, of the Faculty of Agricultural Engineering, Silsoe, England, was not able to attend the Session.

Two papers by this author address the topic of runoff-sediment-land use (RUSELA) relations. In the first paper some of the contents associated with establishing such relations from a programme of field measurements are discussed. Hydrological experiments carried out in small, more or less single land use watersheds may in a short time (several years) indicate the effects of land use treatments on watershed yield (run-off) and erosion (sediment or soil movement). Such quantitative information is of wide interest. Sediment transport in streams is of great concern to those operating or planning reservoirs of whatever size. Erosion, sediment movement across the land surface, particularly that from cultivated land is of great concern to those concerned with soil conservation works, extension work related to increasing crop yield and improving agricultural practices, and non-point source pollution. The two are connected in that soil loss from the land is one source for sediment transport in the streams.

The second paper with the same title presents a case study of RUSELA studies in Sri Lanka.

23. The paper prepared by Mr. M. Djorović of Belgrade University was then submitted.

The relationship between sediment yields and water discharge volumes in experimental watershed "Ralja" was studied in the period 1970-1975. The main aim was to find a certain quantitative relation between these two phenomena, that would enable the determination and prediction of the total sediment discharge during a flood.

This information is very significant especially in the event of a flood causing the discharge of more sediment in a few hours than during the whole year.

Water discharge was measured by standard equipment: water level recorder of the Valdai type with 24 hour rotation mounted on a broad crest weir.

Sediment concentration was measured by sampling 1-31 volumes in 20 minute intervals during the flood flow, followed by filtering, drying and weighing it.

While the water discharge hydrograph is completely explained by characteristics of the hydrograph, the sediment hydrograph is much more difficult to define.

By studying more than 60 events during the experimental period in watershed "Ralja", it is possible to point out the following facts:

- Sediment discharge hydrograph follows water discharge hydrograph more or less constantly during the whole flood event (the beginning, the peak and the end).

- The precise definition of these three main points on the sediment discharge hydrograph was up to now impossible due to the manual sampling procedure we have used in our investigation.

- Automatic registration of sediment concentration during the flood certainly would be much more useful for the determination of these main inflection points on sediment discharge hydrographs.

The quantity of sediment depends on the volume of discharged water; hence the expression:

$$Y = 0.0742\ X^{1.492}$$

where Y = total quantity of sediment in "tons"

X = total water discharge volume in "m^3"

The plotting of sediment volume versus water discharge during a flood flow, shows considerable dispersion but the given mathematical expression could be used especially in the lower portion of the curve.

With planned investigation that should be continued next year, this relationship will certainly be improved.

The given mathematical expression enables the approximate evaluation and prediction of the expected sediment volume for a given flood in experimental watershed "Ralja", but also in other watersheds with similar physical characteristics.

24. Mr. S. Fattorelli of the University of Padua (Italy), submitted three papers. The first, prepared jointly with Mr. S. Scarpa, also of the University of Padua, on computer procedures for computing potential evapotranspiration in mountain areas, pointed out that the knowledge of potential evapotranspiration and its link with actual evapotranspiration proves to be important also in forest hydrology investigations where an exact hydrologic balance has to be defined. The increasingly widespread use of mathematical watershed models has once again posed this problem.

The comparative investigation between the values calculated with the seven methods (Thornthwaite, Hamon, Jensen-Haise, Turc, Makkink, Van Bavel and Penman), and the values recorded in the principal meteorological stations along the Alpine range, have pointed out that these methods are equivalent for evaluating potential evapotranspiration in the Alpine environment, with the exception of the equation by Thornthwaite.

From a practical point of view, conclusions reached are undoubtedly rather significant, as they allow the use of methods requiring a limited amount of climatic data, which are easily available, without altering the approximation degree of results.

25. Mr. Fattorelli's second paper, parepared jointly with Mr. Dalla Fontana, was on hydrological research with experimental watersheds and simulation models.

The two basic approaches of the watershed management research are:

- the experimental watersheds
- the simulation models

The author illustrates the advantages and the disadvantages of the two types of approach.

The experimental watersheds allow the continuing increase of knowledge of hydrological processes. The simulation models have the advantage of requiring restricted observation periods, and of permitting reliable extrapolations. However, they are not an alternative to the watershed approach, but are an integrative means for studying and testing proposed solutions of complex natural resources problems in mountain watersheds.

On both these techniques of investigation, the author describes the experiences conducted in the Alpine watersheds.

26. Mr. Fattorelli's third paper dealt with hydrological investigations in three small watersheds in the Giudicarie Valleys.

The contribution illustrates a ten-year research in three small watersheds of the Giudicarie Valleys. These watersheds differ chiefly because of the forest cover:

- forest cover is very dense on one watershed (Arteson);
- forest cover is averagely dense on the second watershed (Busna);
- forest cover is missing and only grass is found on the third watershed.

A comparison between the data recorded in the three watersheds, is possible through the peak discharge values per unit-area of the principal storm events.

A second more recent approach to the watershed management research is represented by hydrological simulation models. These models can simulate the great number of hydrologic processes which take place within a watershed and reproduce their behaviour as watershed characteristics change.

When compared with the first type of investigation, they offer a twofold advantage: first, they require restricted observation periods and secondly, they allow to effect extrapolations of reliable results.

In this field, the group of forest hydrology of Padua University have started a long-term research programme in order to identify the models able to simulate the hydrologic processes of mountain watersheds.

At Padova University, the following models are presently applied:

- Stanford Watershed Model;
- Hydrocomp Simulation Programme;
- National Weather Service Model;
- Stanford Watershed Model, University of Strathclyde Version;
- USDAHL Model, University of Maryland Version;
- BROOK Model.

Excepting the last two models, oriented to agricultural and forest watersheds respectively, the remaining models are all derived from the Stanford Watershed Model, that is the first and most important model.

Practical design applications of these models used at the University of Padua include:

1. Land use planning to assess the effect on water and sediment response to changes in land surface and river channels, such as deforestation, afforestation, agriculture, tourism development, reservoir construction and river regulation.

2. Water yield assessment in watersheds.

3. Flood forecasting, both long term and real time.

4. Reservoir sedimentation.

The most up-to-date version of these models is presently the one of Strathclyde University, including also sub-models for snow melting and the erosion-transport-deposition phases.

The Strathclyde Model consists of three basic modules:

- watershed model;

- sediment erosion model;

- water and sediment routing model.

27. In the absence of the authors, Mr. S. Fattorelli presented the paper prepared by Messrs S. Munteanu, I. Clinciu and R. Gaspar, with which they had been entrusted as Rapporteurs at the Twelfth Session of the Working Party, under the title: "A new, fast method of calculating maximum torrent discharge".

The authors, having developed some general considerations on the evolution of methods for the calculation of the waterflow in the watersheds, describe the principal methods adopted in Romania.

Among these, particular importance is given to the rational formula which is the variation used by the Institut de Recherches et Aménagement Sylvicole de Bucarest. As the size of the surface of the watershed increases, this method becomes more complicated and the authors have developed a simple procedure of utilizing data collected in 67 small wathersheds, a procedure based on the relationship between the watershed area and the specific maximum contribution referred to as "q max".

Introducing two coefficients for correction: the first K1 as a function of the vegetation cover and soil texture, and the second K2 as a function of the amount of water falling in the watersheds. In this way it is possible to determine in an easy way the maximum flow of the watershed.

28. The last paper under Item 4 of the Agenda was presented by Mr. G. Kronfellner-Kraus from the Austrian delegation. It concerns estimation of extreme sediment transport from torrential drainage basins in the East Alps. The author states that a knowledge of the dangers and possible damage caused by torrents is one of the most important preconditions of sensible land use planning. Torrent erosion and sediment yield here include the whole process of excessive erosion (soil erosion, landslides, gully erosion) as well as bed load transport and deposition of bed load on debris cones or on valley floors. Whilst our understanding of soil erosion has reached a high level, the quantitative estimation of torrent erosion and torrential sediment yields is much more difficult. Based on both special investigations in experimental drainage basins and the systematic sampling of data relating to all extreme events associated with torrent in the East Alps, general formulae for calculating extreme sediment yields from torrential drainage basins during floods and mud flows have been developed. These are discussed and compared with other procedures.

29. Mr. S. Fattorelli having been requested to act as Rapporteur for this Item of the Agenda, summarized the main aspects covered in the various papers.

It is necessary to distinguish between methods of calculating maximum discharge in torrent control works, and methods for assessing the effects of changes in soil use on the hydrological processes of a watershed.

The formulae for the first set of methods must be very simple, such as, for example, the rational formula; in this connection interesting possibilities are offered by the correlative methods, such as those proposed in France (SOCOSE method) and Romania (Munteanu, Clinciu and Gaspar methods).

For the second class of problems the methods must necessarily be more articulated and complex, as the hydrological simulation models in fact are.

Mr. Fattorelli demonstrated how these techniques lend themselves very well for the study of the complex problems involved in management of the water resources in mountain watersheds.

He also emphasized, however, that a realistic solution to these problems can be achieved only with simulation models based on parameters with a physical significance.

These do not constitute an alternative to experimental research in small watersheds, but rather an additional means for extrapolating and integrating the results of this research. Experimental watersheds continue to play an essential role in helping to increase our knowledge of hydrological processes.

30. The Vice-Chairman having opened the discussion on this Item, Mr. Blanco Criado of the Spanish delegation took the floor. He stated that great attention should be given to methods of collecting data on torrential hydrology processes. He had questions to ask to three of the authors:

- to Mr. Djorović and Mr. Kronfellner-Kraus concerning the methods used in sampling sediments;

- to Mr. Fattorelli concerning the advantages and disadvantages of the two methods he had used: the use of experimental and representative watersheds and the use of models.

Replying to the question, Mr. Djorović stated that in the experimental watershed concerned the simplest method had been used - manual sampling - because the observer lives very near the section, so it is possible to take samples whenever required, day or night. Automatic sampling is too expensive, therefore the section used is small and the variations are not too big.

Mr. Kronfellner-Kraus stated that samples are taken from debris basins. The instruments used are described in the papers prepared by him for the meetings in Grenoble and Kyoto.

Mr. Fattorelli stated that the representative and experimental watersheds were, in fact, subject to strong criticism as regards representativeness, duration, cost and other constraints. But the advantages outweighed the drawbacks, because these watersheds make it possible to know the mechanisms of the various hydrological processes, of which our knowledge remains very limited. For example, the results obtained in these watersheds have made it possible to go beyond the theory of partial zones consequent on the work of Hewlett and other scientists. It is possible to obtain more reliable information at the same time as testing the new technique of simulation models.

Mr. Blanco Criado recommended that, because of the importance of ensuring reliability in obtaining data on hydrological processes, more exchange of experiences on this matter between experts was desirable. The subject deserved in-depth discussion on a future occasion.

The Vice-Chairman and the Secretary of the Working Party agreed that this proposal should be considered in the programme of work, in order to organize a special session on this subject.

V. STUDY OF THE EROSION PROCESS AND DETERMINATION OF THE CURRENT EROSION POTENTIAL

31. Three papers and the support documentation for the film presented by the Norwegian delegation were registered under this Item of the Agenda:

- The main report prepared by the Working Party's Rapporteur on this topic entitled: "Regarding the Evaluation of Potential Erosion in Torrential Watersheds" (S. Puglisi, University of Bari, Italy).
- Impact of rainfall in studies of erosion by water in the Sicilian territory (Messrs Santoro and F. D'Asaro, University of Palermo, Italy).
- Evolution of the drainage network in quantifying erosion processes for watershed management planning (Hydrology Section, ICONA, Spain).
- The quick clay landslide in Rissa, Norway (by Mr. O. Gregersen of the Norwegian Geotechnical Institute).

32. Mr. S. Puglisi explained his approach to an equation for torrent erosion potential:

I do not think it is possible to give a strict definition of torrent erosion potential (TEP), because erosion is not a physical unit or a mathematical object. However, erosion is the effect of forces which act in nature and which belong to fields that are already equipped with potential. Therefore, if instead of the erosion phenomenon itself, we consider the object affected by erosion, i.e. the soil, we obtain a potential that consists of the work done by field forces that act on the soil, modifying its composition, volume and position in space.

We may, therefore, define torrent erosion potential in watersheds as the potential of the soil likely to be eroded by the processes in the watershed that model the relief, starting from a time t and with reference to a base level Z. We can agree to call this quantity the TEP.

The soil is a multiphase system, often not isolated, in which exchanges of matter and energy occur with the surroundings. The forces which oblige the components of each phase to remain united are of an electromagnetic nature. Each component of each phase has a partial potential comprising the one due to the gravitational field in which it is situated.

The problem cannot be resolved directly. To resolve it indirectly, we can consider the watershed as a system and assume that the TEP is the amount of work necessary to extract from this system and move to outside the watershed all the components that form the portion likely to be eroded on the surface of the watershed.

For this purpose it is necessary to analyze the erosion process from the energy point of view in order to produce a formula that gives:

$$TEP = E_i + M + U$$

in which

E_i = internal energy of the components that has to be removed before sediment transport;

M = energy necessary to move the solid materials from the watershed to its outlet;

U = potential energy of the components of the system in the gravitational field.

E_i cannot be evaluated, but assuming that the kinetic energy of the rainfall is equivalent to the internal energy of the components that has to be extracted from the system, one can state that:

$$E_i = \alpha E_p$$

in which α is the fraction of kinetic energy of the rainfall used to soil components before sediment transport.

To calculate the second and third terms on the right-hand side of the equation given, another equivalency must be introduced, this time of a geometric nature, between the relief of the watershed and on rectangular parallel piped with the same volume and force coefficient as the watershed.

The prism then has three properties:

1) the bases are equipotential areas in the gravitational field;

2) the degree susceptibility to erosion is constant at each layer of the portion of average height $\bar{h}_p$;

3) the classical theory of soil transport established in the 19th century for the construction of roads can be applied to the upper basin OABA.

This theory makes it possible to determine the total average distance for transport, which is effected partly horizontally and partly vertically.

$$\bar{D} = D_o + D_z$$

One then obtains, w being the volume of soil eroded and γ the weight per unit of volume:

$$M = \gamma w \bar{D}$$

But the volume w eroded on the slopes may remain within the watershed, i.e. within the system.

It is then necessary to consider the weight of the solid materials definitely lost by the watershed, i.e. the solid load at the outlet of the watershed.

If this quantity per unit of area of the watershed is T, one may state that:

$$\gamma w = \beta T A$$

in which β is the ratio between the soil eroded from the slopes and the soil carried out of the watershed.

After having calculated the work done by the water to remove and transport the solid materials from the slopes to the outlet of the watershed, it is necessary to calculate the position energy of the materials before they are transported by the water:

$$U = \beta T A \bar{h}$$

because this energy contributes to the movement, and finally write the relationship required:

$$TEP = \alpha E_i + \beta T A \quad (D + h)$$

If we refer the first term to the area of the watershed we shall have the unit potential that will make it possible to effect a quantitative comparison between watersheds.

33. Mr. F. D'Asaro, of the Institute of Hydrology, Engineering Faculty of the University of Palermo, presented the paper he prepared jointly with his colleague, Mr. M. Santoro, on the impact of rainfall in studies on water erosion in Sicily.

Study of the problem of soil conservation, directed mainly at the process of degradation of the surface layer, received a considerable impulse when Wischemeier and Smith, on the basis of an important field experiment study, proposed the by now well-known universal equation for soil loss:

$$A = R K L S C P$$

Apart from the difficulty of evaluating certain factors, the need was immediately felt for a map showing the distribution of the erosive action attributable to the "active" factor in the process, i.e. rainfall, so as to obtain a first important source of reference in programming actions.

It was then recognized that the climatic factor in the soil loss equation, i.e. the so-called rainfall impact index R, could constitute a valid parameter representative of the erosion risk conditions in a given area.

The main objective of the work, carried out under the auspices of, and with funds from, the CNR project on "Soil Conservation", was to prepare a map showing erosion risks in Sicily analogous to those already available in certain countries.

For Sicily, which covers an area of 25 700 km^2, it has been possible to trace a network consisting of 42 "main" stations for which, thanks to the collaboration of the Sicilian Hydrographic Service, it has been possible to obtain rainfall charts for the period 1951-1970. These, in turn, have made possible direct calculation of the index R, expressed in Anglo-Saxon units of measurements, according to the procedure indicated by Wischemeier.

The mean annual rainfall impact index for the 42 stations during the twenty year period, 1951-1970, having thus been calculated by direct methods, a regressive analysis was undertaken of the mean annual values R and a set of mainly climatic variables referring to the stations themselves.

The formula which finally showed the best correlation ($r = 0.91$) was:

$$R = -102 + 2.9\, I_{1.2} + 30.4\, I_{24.2}$$

in which $I_{1.2}$ and $I_{24.2}$ indicate rainfall intensity at 2 year intervals for a period of one hour and 24 hours respectively.

The network of interpolations could thus be enriched, making possible indirect calculation of 30 values of R relating to as many "auxiliary" rainfall stations.

The final erosion map was prepared on the basis of 72 values of R (Fig. 1) 1/.

As can be seen in Fig. 2 1/, the values of R vary from 20 to about 200 units, with a clear concentration in the eastern belt and the geographical centre of the region of the zones with the most marked tendency to erosion.

The zones with the lowest rainfall impact index lie mainly in the western central part and the southern belt of the island.

The second aspect that was investigated was that of forecasting the phenomenon. The R factor being considered as an independent variable and it being ascertained that all the time series available were clearly asymmetrical, Weibull's law was identified as being the law of theoretical probability valid for the entire region.

Finally, recalling that in order to calculate the cultivation factor C it is necessary to know the seasonal percentage distribution of the mean annual index R, the monthly distribution of the mean annual indices of the 42 Sicilian stations was also studied.

The analysis, carried out with the help of grouping techniques, resulted in dividing the island into three homogeneous areas (I, II and III in Figure 3) 1/, for which the relative diagrams of the monthly distribution of the annual index R were traced (Figures 4, 5 and 6) 1/.

34. The paper prepared by the Hydrology Section of ICONA, Spain, on the evolution of the drainage network in quantifying erosion processes in watershed management planning, was presented by Mr. A. Pérez-Soba.

In the study "Paisajes erosivos en el Sureste español" (Erosion-prone areas in Southeastern Spain), prepared by the National Nature Conservation Institute for the project on control of desertification in the Mediterranean, possibilities were tested of obtaining basic information on erosion parameters in large areas of at least one million hectares as a necessary data bank for the correct programming of priorities in watershed management and organized distribution of resources and activities for erosion control.

Among the various aspects of erosion problems tackled in this study, it was considered that quantification and analysis of the evolution of the secondary drainage network of the area could be a significant indicator of the speed with which the processes of channel degradation that characterize most torrential activities are developing.

For this, on the basis of eight territorial strata with a similar index of soil protection by vegetation (IFIE-1968), 150 plots of 400 ha were established by stratified random sampling with proportional fixing and a minimum of four samples per stratum.

The measurements necessary to determine and analyze trends in the drainage network in these plots were made by photogrammetric restitution on aerial photographs from the 1957 flight (scale 1: 30 000) and the 1977 flight (scale 1: 20 000).

On the basis of the numerical basis provided by the parameter: an increase of so much percent in the drainage density in the plot during the twenty years between the two flights - this information was extended to the whole territory by means of automatic cartographic approximation techniques using a SYMAP programme (SYNOPSIS MAP).

In this way information was obtained showing that in 55 percent of the territory studied, the hydrological network presents torrential characteristics making necessary varying degrees of corrective action.

1/ Of the original document.

35. Following the very striking film shown on a landslide at Rissa, Norway, the Norwegian delegation distributed a paper of great scientific interest prepared by Mr. O. Gregersen, of the Norwegian Geotechnical Institute.

This paper gives a detailed description of the Rissa landslide. This has been possible due to eyewitnesses and films taken of the actual sliding process. Attention is given to events of special importance to the understanding of quick clay failure modes. Failure mechanisms of the Rissa slide are discussed.

Ground conditions, determination of the soil strength parameters and results of stability calculations were described.

The Rissa landslide, which took place on 29 April 1978, is the biggest in Norway in this century. The slide area covers 330 000 m^2 and the slide debris is of the order of 5-6 million m^3. The slide area was a typical Norwegian farming community, made up of small farms and single family homes. All together, seven farms and five single family homes, were taken by the slide or had to be abandoned for safety reasons. Of about 40 people who were within the slide area when the sliding started, only one was killed. The others escaped, many under extremely dramatic circumstances.

The first phase was retrogressive; going on for about 40 minutes and made up 6-8 percent of the final total slide area.

Retrogressive sliding took place where the sliding itself changed the stability condition from good to unstable. This occurred behind the slide edge, resulting in relatively small slides, each taking a certain time to develop. The remaining 92-94 percent of the sliding took five minutes or less, and was made up of large flake-type slides.

Flake-type slides occurred where the factor of safety was low prior to the sliding process. A stress increase, even small, led to instant structural collapse in the quick clay and subsequently to failure of the area.

VI. REHABILITATION OF WATERSHEDS

36. Six papers were registered under this Item of the Agenda:

- Erosion control methods in the Tunisian arid zones (H.B. Missaoui, Forestry Directorate, Tunisia).
- Recent development in torrent control and watershed management techniques in the southern slopes of the Alps (G. Benini, University of Padua, Italy).
- Management and restoration of torrential watersheds in the southeast of the Iberian Peninsula and the Lanjarón Research Station (Messrs Blanco Criado and F. Estirado, INIA, Spain).
- Afforestation systems in areas with semi-arid climate (E. de Simon, ICONA, Spain).
- Studies on the relationship between hydro-forestry work in the Gador Sierra and aquifer recharge in the Dalías fields, Almería (F. López de Vera, M. de Miguel Tejedor, Spain).
- Project LUCDEME: Control of desertification in the Mediterranean (J.A. Carreras, ICONA, Spain).

37. Mr. Habib Ben Aissa Missaoui, Chief of the Soil and Water Conservation Service of the Tunisian Forestry Service, presented the paper on the erosion control methods being used in Tunisia's arid zones.

Tunisia's arid zones, which cover the central and southern parts of the country, are very degraded and erosion has reached a critical stage. They are characterized by a dry climate, very hot in summer, cold in winter, and by very low precipitation which is not well distributed (150 to 200 mm).

The geographical situation of the country, the climate, the topography of the soil, land ownership problems, irrational land use programmes and the high intensity rainfall have increased the erosion process in these zones.

All these factors make Tunisia one of the Mediterranean countries most exposed to wind and water erosion phenomena.

Among the serious consequences of these phenomena are reduction of soil fertility, carrying away of good soils, annual loss of agricultural land, sedimentation of dams, movement of sand dunes towards cities and agglomerations, etc.

In view of these imminent dangers, the Tunisian Government included a large-scale programme of erosion and desertification control in arid and semi-arid zones as a top priority in its 6th Economic and Social Development Plan (1982-1986).

The practical erosion control methods used are many, but the main ones used at present in the arid zones are the jessours (drop structure) for water erosion control and the tabias (embankment) with raised palisade made of palm leaves for wind erosion control and dune stabilization.

The jessours are a kind of drop structure built with stones in the middle of the gully or talweg to reduce water speed, evacuate surplus runoff and create sediment retention zones which will later be cultivated.

The calculation of the dimensions of these structures will take into consideration the hydrological factors, the rate of runoff to be evacuated from the spillway and the amount of sediment to be retained.

As far as wind erosion is concerned, the tabias will be built perpendicularly to the direction of the prevailing winds or at a 120° angle to the direction of the winds if the danger of dune movement is imminent. In order to stabilize the dunes it is recommended to establish a plant cover around the zone to be protected. This could be done by planting certain fodder or wood species suited to arid zones, such as: Acacia cyanophylla, Parkinsonia prosopis, Tamarix, Eucalyptus occidentalis, Microtheca, Sergentis, Retema retam, Atriplex halimus and Casuarina.

This kind of work had made it possible to protect towns in the south of the country against floods and sand dunes and to increase the length of use of dams by reducing the sediment to be carried down to the lower part of the watershed.

38. The paper prepared by Prof. Giuseppe Benini, of the University of Padua (Italy), gives information on recent developments in torrent control and watershed management techniques in the southern slopes of the Alps.

A type of dam used increasingly frequently in the Italian Alps is that known as self-stabilizing (or right-angled), made of reinforced concrete.

To determine the geometrical characteristics of the dam and of the reinforcement, the Province of Bolzano has prepared tables giving all the elements of the project, while in the provinces of Trento and Veneto computer programmes have been prepared.

Prefabrication has often been tried, but the results have not always been satisfactory, particularly from the economic point of view. Partial prefabrication may be useful for building practically isostatic works where the foundations are not very sure.

A somewhat special structure, built in Piedmont, consists of a concave steel sheet, anchored to the dam, which can be useful for forming a subsidiary dam.

In order to respect the landscape and the environment, the dams and spillways have been built in dry masonry and, therefore, have a natural look.

Dams in concrete and reinforced concrete are advisable, however, in earthquake areas.

In order to obtain better knowledge of the territory, some Alpine regions have carried out fairly detailed surveys which make it possible to have an up-to-date and exact picture of the state of the watersheds. Watershed management trials are also under way almost everywhere.

There has been a remarkable development in avalanche control in almost all parts of the Italian Alps, a very well-equipped experimental centre having been set up in Arabba.

39. Mr. P. Estirado, Director of the Research Station of Lanjarón, presented the paper prepared jointly with his colleague in INIA, Spain, Mr. M. Blanco Criado.

In 1980 the Station for Research and Experimentation on the Management of Torrential Watersheds was set up under the INIA, Ministry of Agriculture, Fisheries and Food. Its essential purpose is to conduct research into the many complex problems presented by torrents in the watersheds in the Southeast of the Iberian Peninsula and which can be briefly classified into two types: a) present land use systems are leading to progressive desertification; b) the adverse factors relating to the environment and these desertified lands are creating a torrential phenomenon with serious consequences for the region's social and economic structure.

At the moment the Station is carrying out a research project concerned with the essential points involved in these problems. This project is being implemented jointly with the Departamento de Agrohidrología del Duero, also dependent on INIA, and in collaboration with ICONA.

40. Mr. E. de Simón, of ICONA, Spain, presented his paper on afforestation systems in areas with a semi-arid climate.

Southeastern Spain is the area of the Peninsula in which all the varieties of Mediterranean climate are to be found.

Its varied topography and its geographical situation produce a wide range of ecosystems, which have one common denominator: all are suffering from intensive erosion, reinforced by the lack of an adequate vegetative cover. This is the result of the traditional land use systems. The nature of the climate is such that periodically there are violent storms, which cause irreparable damage, with a progressive decrease in the land's biological potentials.

These special characteristics of the ecosystems, particularly those in the semi-arid zones, have led to the usual afforestation techniques being specifically adapted to the needs of each ecological system as regards preparation of the soil, which is done so as to cause the least possible disturbance. Considerable use is made of mechanized preparation, with different types of terraces according to the characteristics of the soil and the topography of each site, and in particular of mixed preparation, with terraces of varying width separated by banks and linear bands, and of linear and localized preparation, where it is necessary to plant trees without altering the existing shrub cover.

The restoration of climatic ecosystems by improving the existing shrubland, clearing certain spots and planting Quercus ilex rotundifolia in the clearings, is of special ecological interest.

41. The study on the relationship between afforestation work in the Sierra of Gador and replenishment of the aquifers in Campo de Dalias, Almería, a doctorate thesis by Mr. F. López de Vega and Mr. M. de Miguel Tejedor, was presented by Mr. A. Pérez-Soba.

The Sierra of Gador and Campo de Dalías are two different, but contiguous physiographical units, closely linked in many aspects. Campo de Dalías occupies a triangular area south of the Sierra de Gador, which, in turn, is bounded to east and west by the Mediterranean. Campo de Dalías is a foothill region dating from the Quaternary period that constitutes a plain sloping gently towards the sea.

In 1950 crops started to be grown on the sandy soil of Campo de Dalías, irrigated by underground water, and during the last decade new techniques for growing crops under plastic in winter have been developed, so that these vegetable crops now account for a third of the exports of these commodities.

But this encouraging picture is clouded by the fact that Campo de Dalías is traversed by the drainage system of the Sierra of Gador, of pronounced torrential nature. Another problem existing in this zone is over-use of the underground waters for irrigation during the winter period, resulting in a risk of salinization of the aquifers through the intrusion of sea water.

This has led to a study being made of the possible influence of the afforestation work being conducted in the Sierra of Gador for the purposes of torrent control, in increasing percolation and hence replenishment of the aquifers.

The preliminary results of the study of the relationship between the aquifers in the Sierra of Gador and those in Campo de Dalías, together with what is known of the dynamics of underground waters, lead to the conclusion that it will be a long time before the afforestation works can have any effect on the aquifers in Campo de Dalías. There are other possibilities however, such as replenishment of the upper aquifer through torrent control works, and microclimatic improvements brought about by reforestation.

42. The last paper under this Item was that on the LUCDEME Project (Control of desertification in the Mediterranean area). This was presented by Mr. J.A. Carreras of ICONA, Spain.

The United Nations Conference on Desertification, held in Nairobi in 1977, drew up a Plan of Action for halting and reversing the process of desertification throughout the world and for promoting and conserving the productivity of the arid and semi-arid regions and those suffering from serious erosion.

Following the directives of this Plan of Action, the Spanish Government, through ICONA (the National Nature Conservation Institute), has launched a unified project for erosion control in the Mediterranean (LUCDEME - "Lucha contra la desertificatión en el Mediterráneo"), which combines all the activities necessary to improve the country's capacity to deal with the scientific and technical aspects of controlling desertification.

This Project covers 30 000 km^2 of arid and semi-arid land in southeastern Spain, and its objectives are: to analyze the various factors and resources involved in desertification processes; to determine the systems and techniques that can be used in controlling desertification; to provide training and information on the subjects covered by the Project.

There is a clear decision by the Spanish, within this Project, to concentrate considerable efforts on the southeastern part of the country in order to obtain better knowledge of the complete phenomenon of desertification and of the technical, economic and social measures most suitable for combating it, applying the solutions as they emerge.

Given the characteristics of the area covered by the Project, which are common to many other regions and countries, not only in the Mediterranean basin, and in accordance with the spirit of the Nairobi Conference, which encourages regional cooperation among countries in order to discover the best ways of combating desertification, the Project is open to participation by other countries and international agencies interested in the subject.

VII. INFLUENCE OF THE VEGETATION COVER

43. Five papers were registered under Item 8 of the Agenda:

- Influence of afforestation with conifers on water quality in a small watershed. Impact on soil (C. Dupraz, Office National des Forêts, France).
- Influence of afforestation in the watershed of El Vado reservoir in the control of process of eutrophication (F. López Cadenas, A. Pérez-Soba, C. Mondejar, ICONA, Spain).
- Reforestation along the southern ramp of Berne-Loetschberg-Simplon (J.P. Graf, Office Fédéral des Forêts, Switzerland).
- Influence of agricultural land use zones on the risk of slope destabilization (H. Siegel, Institut für Wildbach-und Lawinenverbauung, Austria).
- Influence of forest cover on the hydrologic regime of mountain streams (new results of investigations in Central Europe) (H.M. Brechtel, Institut für Forsthydrologie der Hess. Forstl. Versuchsanstalt, Federal Republic of Germany).

44. In addition, two films were shown: the first, "The Fragile Mountain", on soil degradation and restoration in the Himalayas of Nepal; an the second, "Green Will", on the restoration of mountain lands in South Korea.

45. The first paper, entitled "Influence of reforestation with conifers on the quantity and quality of water in a small watershed: influence on the soil", presented by Mr. C. Dupraz of the French National Forestry Office, arose interest because it was the first time this subject had been brought to the attention of the Working Party.

Losses of nutritive elements through drainage are measured at the debris cone heads of three small mountain watersheds in the southern Massif Central in France which have very different types of vegetation:

- a beech coppice not logged for at least 80 years (54 ha);
- a 70-year-old reforestation stand of spruce (20 ha);
- a summer sheep pasture (75 ha).

These watersheds are identical as regards the other environmental aspects (altitude, exposure, geological substrata, soils meteorogical conditions).

Such an arrangement should make it possible to ascertain and, if confirmed, quantify the loss of fertility due to leaching accelerated by the organic derivatives of the pine needle litter. Traditional soil science tests (lysimetric measurements, alteration balances) have indicated qualitative changes without being able to calculate the intensity and speed of the alterations owing to experimental biases inherent in these techniques.

For these three watersheds, income and outflow of water and mineral elements in solution (rainfall and discharge at the cone heads) have been monitored since July 1981. Calculation of the aqueous solution balances has necessitated a very careful procedure, involving calculating separately for each flood the total elements in solution evacuated by the river.

The first hydrological results confirm the role of forests in reducing flood peaks (conifers have a more marked effect), but indicate that under forest cover there is greater and more delayed underground infiltration, as shown by the fact that after heavy rainfall the head in the springs rises 24 to 48 hours later than in the springs on the pasture land.

For the first seven months of the trial (August 1981-February 1982), losses in major nutrients (N P K) did not show any significant differences. But accelerated leaching of calcium and magnesium occurred in the reforestation stand of conifers.

If the results of the future periodic balances confirm these first indications (which seems probable, because the monthly balances show each month similar relative differences between the watersheds), this trial might lead us to modify the practice of reforesting granitic mountains with conifers, by providing for compensatory liming, choosing species with a less acid litter, or establishing stands in which conifers and deciduous species are mixed.

46. The paper "Influence of reforestation in the watershed of El Vado reservoir in the control of the process of eutrophication" prepared by Mr. F. López Cadenas, who presented it, jointly with Messrs A. Pérez-Soba and C. Mondejar Reyna, summarizes the effect of the reforestation work done by ICONA.

The El Vado reservoir (57.7 Hm^3) is one of the new reservoirs supplying water for the inhabitants of Madrid. With a watershed of 426 km^2 and a mean annual water yield of about 200 Hm^3, it provides about 18 percent of the capital's requirements. The reservoir has no eutrophication problems owing to strict conservation and adequate management of its basin. Other near reservoirs have serious eutrophication problems (Urbistondo 1980).

There are no industries or towns with drains and other sources of nutrient inflows in the reservoir's watershed. Twenty percent of the area is forested, 66 percent consists of treeless forest land, 8 percent is oultivated and 6 percent unproductive.

During 1979-80 a number of analytical determinations were effected regarding the daily discharge into the reservoir, in order to calculate the annual load of N and P, as well as other elements. The total load received by the reservoir from the watershed proved to be 29 859 kg and 2 594 kg of N and P respectively.

Using the formula proposed by the EEC in 1978, it was proved that the P value was within the required limits, but approaches a dangerous level.

A simple mathematical model, derived from that proposed by Cluis in 1980, was used to correlate the use made of the watershed's land with the exportation of nutrients. From this it was possible to deduce the most advisable measures to be taken. The simulations showed that a small increase in the number of livestock would result in a serious risk of eutrophication of the reservoir, and that the most suitable action would be to reforest part of the existing shrubland.

47. Mr. J.P. Graf, Federal Inspector of the Federal Forestry Office, Switzerland, presented his paper on the reforestation work done along the southern bank of the Berne-Loetschberg-Simplon raiway line. He pointed out that nowadays one might think that the choice of Loetschberg was made in ignorance of the dangers of the mountain on both sides of the main tunnel.

The initial reforestation project gives the list of the main districts in which stabilization, protection and reforestation works are planned and is the subject of a precise analysis. They consist, above all, of a whole series of avalanche tracks, unstable rock formations, zones threatened by rockfalls, forest plots ruined by overgrazing.

It is on the south-facing slopes that the situation is worst. The intensity of grazing by sheep and goats is so great that the soil is practically bare under stunted pines. Elsewhere nothing remains of the forest but a few thin bushes. Here and there erosion has even begun.

It is planned to carry out various technical stabilization works aimed at containing the small outcrops of rocks and above all at clearing the surfaces of the insecurely balanced materials scattered over the slope and bringing into the open the sub-soil in which planting can be effected.

Grazing will be forbidden on the areas to be reforested.

The position of the Valais between two big mountain ranges which rise to between 3 000 and 4 000 m results in there being an island of drought in the central valley and the bottom of the side valleys. The effect of the foehn (a hot, dry wind) makes itself felt in both of its aspects, and the dryest period is in April.

The southern bank of the Berne-Loetschberg-Simplon railway line is partly on steeply sloping limestone slabs plastered onto the old "massif" of the Aar, consisting of granitic or metamorphic rocks.

Sixty-three years have elapsed since the first project was drawn up.

Since there are experts here who have much more experience than the Swiss with reforestation in arid zones, I will pass over the problems connected with the plantations, choice of species, etc., that cannot be transposed to a different region, and will mention only the interesting factors.

In 1930, following a number of failures, the Valais foresters conceived the idea of using sprinkler irrigation over 3 ha, laying pierced metal pipes along the line of the steepest slope.

In view of the results obtained, the use of sprinkler irrigation was gradually expanded, while the traditional type of irrigation by "bisse" was also introduced where it seemed possible.

Starting in 1957 the system was improved by laying a secondary, horizontal pipe system. Reservoirs (and flood gates) were then constructed in order to have water available at all times for irrigation and fire-fighting.

A number of accidents, one of them fatal, showed that only the pipe system was valid for the future: on several occasions, in fact, landslides were caused by the traditional irrigation system, which consists of causing the "bisse" (channel) to overflow for several hours in order to saturate a plot with water.

The most recent complementary project for this reforestation work, drawn up in 1981, provides for a further 24 km of pipes, which will bring the total length of the irrigation pipes up to some 30 km.

Under the harsh climatic conditions prevailing along the southern bank of the Berne-Loetschberg-Simplon railway line, reforestation has no chance of success without well-planned irrigation.

Of course, it would be unthinkable to invest large sums for the sake of the forest alone.

48. Mr. H. Siegel, of the Austrian Institute for Torrent and Avalanche Control, presented the next paper, on "The influence of agricultural land use on the risk of slope failures".

For agriculture in Alpine regions, as in Austria, the use of the highlands for pasture land is very important. Pastures have been established by deforestation. The result of this has been the extension of waste land due to slope failures in newly opened land and following waterlogging in lower adjacent forests. On a number of slope failures we can find the same general situation.

Extensive areas affected by soil compaction in pasture land, located above the forest areas, are contributing a substantial portion of precipitation as runoff. A strong infiltration in the slope debris lenses laying on slope parallel rock strata, causes the water to reach quickly the underground. The infiltrated water flows in the contact strata between rock and soil, as far as to the transition to thin soil layers, where the water slows down. Water accumulation and an increased moisture content, combined with an increase in weight results in a decrease of the internal friction.

When the critical point of moisture content in the soil is passed, it leads to a sudden slip of the slope debris lens. The released failure predominantly occurs below root depth.

In most cases the influence of stocking on the unstable slopes can be avoided, but in other cases, slope failures are mainly a geological erosion process, which can only be retarded by diminishing infiltration into the soil. Therefore, measures to modify the land use pattern in the watersheds are necessary; namely the reduction of the pasture land in order to diminish high runoff and avoiding woodland pasturing, which is very harmful for the forest stands, in order to increase the hydrological efficiency of these areas. The deficit in pasture land can be compensated by an intensification of pasturing through fencing and fertilizing.

Exclusion of grazing in the steep areas opened for agriculture only reaches a full effect if forestry activities also take preventive measures against erosion by means of runoff control.

49. Mr. H.M. Brechtel, of the Forest Hydrology Institute of the Forestry Research Station of Hessen, Federal Republic of Germany, presented the last paper under this item, supplemented by a wealth of documentation on the research activity conducted by the Institute he directs. The title of his paper was: "Influence of the forest cover on the water regime of mountain streams".

How land is used and managed has a very definite effect on total amount of flow, on stream flow timing and on water quality. This is due to the fact that vegetal cover and soil, which can be influenced by man, are factors, which intervene between the precipitation and runoff of a watershed. Especially in the management of mountain watersheds important processes of the water cycle can be modified, as for instance: interception storage and loss, accumulation and melting of snow, frequency and depth of soil frost, infiltration-, retention- and detention-capacity of the soil, frequency and amount of surface flow, soil erosion and stream sedimentation, temperature and bacterial content of stream runoff. This report reviews the European literature about research on this subject summarizing the present knowledge about the influences of vegetation differences upon water yield as well as methods used in the determination of these differences. It was found that most of the European watershed research has been done on

the traditional aspects of watershed management only, which are watershed conservation and restoration (soil erosion, torrential erosion, torrent control, avalanche protection, etc.). Much less information is available about the possibilities of water yield control, especially about opportunities to attack this problem by management of the vegetation growing in the mountain watersheds and not by structural works only. Since mountain watersheds are the main sources for man's supply of fresh water and they are already experiencing serious deficiencies in water yield in many regions of Europe, a real need exists to initiate much more investigations on water as it is affected by the treatment of vegetation, especially by forest management. More and more even in humid regions such as Central Europe usable water must be considered by land managers to be a product as important as timber and crops.

50. The Vice-Chairman of the Working Party then opened the discussions on the papers submitted under this item.

Mr. Debazac, CIHEAM Consultant, referring to the contribution of great scientific interest made by Mr. Dupraz, emphasized the importance of considering chemical aspects as well as the aspects concerning the transport of solids - aspects that had been the subject of attention by the Working Party for a long time in studies on the behaviour of mountain watersheds.

51. The discussion then centred around the influence of the vegetation cover on water balances. Mr. López Cadenas (Spain) pointing out that although 50 peroent of Spain's land area consisted of forest land, this had very limited production potential, stressed the importance that must be given to the protection and service aspects in land use management. The Spanish National Forestry School had therefore included forest hydrology in its programme of studies ever since 1965. He thought it difficult to extrapolate knowledge regarding forest hydrology obtained in the USA and the USSR. Mr. M. Blanco Criado (Spain) expressed his agreement with Mr. López Cadenas and pointed out the importance of undertaking research in Europe on the influence of the vegetation cover on water regime, quantity and quality. Mr. Fattorelli said that in Italy there was fortunately a long tradition of forest hydrology studies. He expressed his agreement with the previous two speakers regarding the impossibility of extrapolating results from one part of the world to another indiscriminately. Research on forest hydrology should not be limited to soil protection aspects, but should take into account all the aspects of production and services connected with mountain watersheds. Mr. S. Puglisi (Italy) suggested that this subject be included in the Working Party's programme of work in order to go a little more fully into the direction to be given to research on the influence of the vegetable cover during the next sessions.

VIII. HYDROTECHNICAL ASPECTS AND CALCULATION OF TORRENT CONTROL DAMS

52. Three papers were registered under Item 9 of the Agenda:

- On processes for forecasting in stream control (C. Agnese and G. Giordano, University of Palermo, Italy).
- Programme for reinforced concrete torrent dam designs (S. Fattorelli, P. Mazzalai, University of Padua, Italy).
- Calculation of gabion masonry dams with a regular staircase profile (López Cadenas and Pérez-Soba, Hydrology Section, ICONA, Spain).

53. Mr. G. Giordano (Palermo University) speaking on "Processes for Forecasting in Stream Control" said that the problem of forecasting in stream control can be connected with the study of incipient motion: the latter makes it possible, in fact, to interpret some aspects of the mobility of a stream-bed, using the result to try and determine a stable order for the bed.

This note first covers some aspects of the procedure for stream control based on the criterion of incipient motion; in particular it analyses the possibility of applying this criterion to mountain streams.

It then provides graphic analytical procedures, valid under predetermined hypotheses, for rapid application of the method to technical cases that recur in the conservation of hydrographic networks.

54. Mr. P. Mazzalai presented the paper prepared by him jointly with Prof. S. Fattorelli on "BRIGLIA: a structural code for the design of torrent check-dams".

The computer report and the user's manual of the structural analysis code named "BRIGLIA" is presented in the paper. The programme is intended for the analysis and the interactive design of reinforced concrete torrent check-dams, applying micro and desk computers. The procedure leads to a progressive optimization of the structure and its foundations, starting from a simple front face of the work, under different selected and combined loading conditions (hydrostatic pressure, earth loads, earthquake actions, riverbed pressures) and soil characteristics. As to the base assumption of the structural behaviour, a multi-degrees of freedom system of vertical cantilevers and horizontal beams is defined, with given lateral keying-in conditions. The general stability problem is firstly investigated, complying with the Italian norms; then the bending, axial and shear stresses are computed, to perform the elastic dimensioning of the reinforcement bars. The conclusive solution is checked according to limit design criteria. A draft plot of the structure and of its reinforcements can also be obtained. Examples and references are given to compare the proposed formulation with the results and findings of the recent research works in the field.

55. "Calculation of Gabion Masonry Dams with a Regular Staircase Profile" (Messrs López Cadenas and Pérez-Soba, ICONA, Spain):

The gabion masonry dam normally used for torrent channel control is designed with a regular staircase profile (steps of equal width) in the downstream face and a vertical upstream face, with a crest one metre thick.

With the values of the calculation parameters and load assumption usual in Spain, the calculation of this profile with the usual conditions of stability leads, for the different dam heights H, to the following step width d and volumes of the work V for the one-metre-wide band in the overflow section, once the profile has been adapted to the commercial dimensions of the gabion:

H	2	4	6	8
d	1.0	1.5	1.5	1.5
V	3.0	13.0	28.5	50.0

The width of the steps achieved with this profile means that the structure is subjected in some cases to the impact of the solid materials, sometimes very large, that the evacuated waters in free fall hurl against the face of the dam.

To avoid this, in the case of torrents with a bedload discharge of great size, an alternative dam profile has been studied, with a fixed step width of 0.50 m and a crest whose thickness varies according to the height of the dam: a design which avoids these damages to a large extent. Under the same conditions as for the previous type, the calculations give the following results, a being the resulting crest thickness:

H	2	4	6	8
a	1.5	2.0	3.0	3.5
V	3.8	11.0	25.5	42.0

As can be seen, similar volumes are achieved for the structure, with the added advantages of a more robust crest thickness which makes it possible to design some wings for the overflow section making it more resistent to any lava flows, avalanches of rocks or snow, etc., that may strike the structure.

IX. SOCIAL AND ECONOMIC ASPECTS OF THE MANAGEMENT OF MOUNTAIN WATERSHEDS

56. Three papers were presented under Item 10 of the Agenda:

- Some activities conducted by FAO in order to ensure the participation of mountain dwellers (L.S. Botero, FAO)
- Management of the mountain territory (V. Margiota, Regional Director of Forests, Basilicata, Italy).
- The management of hilly watersheds in relationship with the present economic and social evolving phase of the Italian hilly areas (U. Bagnaresi, Italy).

57. Mr. L.S. Botero, FAO Forest Resources Division, as rapporteur for this topic presented a paper "Some activities conducted by FAO in order to ensure the participation of mountain dwellers". He referred to the emphasis given to the socio-economic aspects by the FAO Regional Forestry Commissions and mentioned how the Forestry for Local Community Development Programme had contributed to the reorientation of FAO Regular Programme and Field Programme activities. A number of field projects in Thailand, India, Indonesia, Ethiopia, Haiti, Nepal and Morocco had been conceived according to the need to involve the local communities and to transfer to them the benefits of sound resource utilization. The study tour sponsored by SIDA in the Caribbean, on the topic of incentives for the involvement of the local communities in conservation programmes, was mentioned. Audio-visual aids prepared by FAO for motivation, training and extension had also been a major area of work during the two last years. In addition, two volumes of the FAO Conservation Guides are devoted to the topics of people's participation and conservation incentive schemes. Finally, the development of guidelines for the economic appraisal of watershed management projects, as a follow-up to a World Bank-FAO informal workshop, was also explained.

58. The resource inventory system of the Basilicata Region was next presented by Mr. Margiota, Regional Director of Forests and by the specialists of Italeco, S.p.A. The title of the report "Physical agro-forestry potential of the mountain communities: Marmo, Vulture and Melandro of the Basilicata Region". The methodology was explained and the minicomputer was used, with a video connection, to present a number of examples of the use of the data bank. Thematic synthetic maps were shown presenting elevation and slope classes, soil potential, present land use, morpho-dynamics and erosion, lithology, agricultural potential, forestry potential and land use changes maps.

59. Italy's hilly areas are heavily populated and show many marks of human activities: towns, villages and scattered houses, a network of roads and railways, large expanses of cultivated fields, etc.

In recent years the centuries-old relations between people and the environment in these areas have changed profoundly, resulting in many problems which affect, among other things, preservation of the existing historical, scenic and productive values.

Many proposals have already been put forward for a new and more satisfactory productive, economic and social organization of the hill areas able to safeguard and make the best possible use of the resources present within the framework of a human presence that differs from that of the past in activities, cultural requirements and number of inhabitants.

These problems of the agricultural and forestry sector are particularly serious as regards soil conservation.

The priority given to interventions will therefore depend on two main components: the first of a strictly hydro-geological nature (degree of physical disorder) and the second of an economic, social and infrastructural nature.

Studies are being conducted to assess the importance of these parameters in order to formulate effective and realistic plans that will also take into account the chronic shortage and inadequacy of financing for their implementation.

60. As the discussion was opened by the Vice-Chairman, Mr. Puglisi himself took the floor to express that he could not agree with the statement of Mr. Bagnaresi that the restoration of gullied areas and of badly eroded clay hills was not urgent. This is in fact a crucial aspect for southern Italy as it is in Spain and other countries of the Mediterranean region.

X. OTHER MATTERS

Mr. E.F. Debazac introduced a paper containing proposals for post-graduate training in watershed management. He stated that the discussions held so far during the meeting facilitated presentation of these proposals. The various papers submitted had again demonstrated, were this necessary, the variety of measures which could contribute to better erosion control: biological measures affecting the forest, grazing or agricultural vegetation; engineering works, in particular to control runoff. In addition, the agenda item dealing with watershed management planning had shown the variety of experts participating in the preliminary studies.

A pluridisciplinary approach to watershed management problems was bound to become increasingly frequent in the future.

This situation should lead us to think about the training of the people who have to work together in planning and implementing watershed management measures.

For historical reasons, basic training in watershed management was given as part of forestry training. But the time that could be devoted to it was undoubtedly limited. More thorough training could certainly be given nationally, but it might be of great benefit to organize complementary training in an international framework.

CIHEAM was an international body whose purpose was precisely to organize post-graduate training and which had acquired wide experience in this field, using three existing institutes in Zaragoza (Spain), Montpellier (France) and Bari (Italy). Its activities had, moreover, gone well beyond the Mediterranean region.

Should several countries consider it useful to organize post-graduate training in soil and water conservation and watershed management, CIHEAM could offer the advantages of its status and experience.

To implement such a project, a small committee would meet to decide on the characteristics of the training and draw up the programme. This programme should probably comprise, as indicated in the note distributed, a concrete project exercise.

The course could be open to member countries of the European Forestry Commission and also to other countries which needed this type of training in their development programme.

62. The Vice-Chairman of the Working Party having opened the discussion on this Item, Mr. López Cadenas (Spain) pointed out that it would be desirable to make the CIHEAM proposal compatible with the proposal already submitted by the Spanish delegation regarding the LUCDEME project, which provides precisely for strengthening activities for training in watershed management in the Mediterranean area. He expressed the hope that it would be possible to reach agreements on cooperation among all the institutions concerned in this matter.

63. The Director of Forests for the Sicilian Region, Mr. C. Corrao, made a general statement on forestry and the management of mountain watersheds in Sicily. Because of the importance of this statement as an introduction to the problems of the region and to the activities conducted by the Forestry Office for the Sicilian Region, the full text is attached as Annex E. Mr. Corrao drew attention in particular to the importance of a more integrated approach in the management of mountain lands, taking into account all the goods and services that forest lands could provide for the region's economy. It was, therefore, of the outmost importance to consider social and economic aspects.

64. Two films on Sicily were shown to illustrate some particular aspects of the management of forest lands. The film "Green Forest" covered the problems of forest grazing land and the precarious situation of the livestock owners, faced with the need to ensure both the productivity of the environment and its protective functions. The film "Trees for Le Madonie" concerned the endangered resources of a natural reserve, including relict Abies species.

65. Hydro-geological management of the slopes around Agrigento was the subject presented by Mr. G. Farina, of the Cassa per il Mezzogiorno. This concerns essentially work intended to control landslips caused mainly by the town's drains.

XI. FAO/IUFRO SYMPOSIUM "RELATIONSHIP BETWEEN TORRENTIAL PHENOMENA AND SEISMIC EVENTS"

66. Five papers were presented during the Symposium organized jointly by the Working Party and the IUFRO Subject Group on the Prevention and Control of Torrent Erosion, Floods and Mud Flows, Snow Damage and Avalanches (IUFRO-S1.04-00). The Symposium was chaired by Mr. G. Kronfellner-Kraus, Coordinator of the IUFRO Subject Group. The papers examined were the following:

- Relationship between torrential phenomena and seismic events: Introduction (G. Kronfellner-Kraus, IUFRO).
- Research activities on torrent erosion, floods and mud flows, snow damage and avalanches (G. Kronfellner-Kraus).
- Evaluation of the effects of the 1980 earthquake on erosion in Basilicata (G. Palmentola of the University of Bari, Italy).
- Seismicity in the Carniche and Giulie Alps: Results of watershed management activities (R. Querini, Director General of Forests, Friuli-Venezia Giulia, Italy).
- Some aspects of the management of the torrential watershed of Trivigno, Basilicata (G. Palmentola, S. Puglisi, G. Trisorio-Liuzzi, University of Bari, Italy).

67. Mr. Kronfellner-Kraus gave an introduction lavishly illustrated by slides of several parts of the world. The title of his paper was: Relationship between torrential and seismic events:

From the different seismic hazards (ground shaking, fault rupture, tsunamis) mainly the so-called secondary hazards are to be emphasized in connection with torrents and avalanches. Rockfalls, landslides and avalanches caused by earthquakes can be not only destructive by themselves; they can also create new additional sources of danger. They can block torrent or river beds causing debris flows or floods subsequently. Also floods from dam and levee failures represent secondary hazards.

The different relationships between torrential and seismic events as well as the effects on control measures are discussed by means of examples. Because there is a close connection between seismic and volcanic appearances also the control methods of volcanic torrents are mentioned in examples. The knowledge of the most hazardous zones enables their consideration for all planning purposes.

Other examples show that seismic methods can also be used in order to prospect the subsurface of landslides. The application of seismic prospecting for avalanche warning purposes is still in a testing stage.

68. Mr. R. Querini, Director of Forestry for the Autonomous Region of Friuli-Venezia Giulia, then presented his paper on earthquake risks in the watersheds of the Carniche and Giulie Alps: results of the watershed management activities.

The 1976 earthquake in Friuli (Italy) was of tectonic origin and affected in particular the Carniche Alps 1/, the Giulie Alps (western side) and Prealps. The epicentre, covering 34 km^2, reached an intensity of 10° on the MKS scale, and the surrounding areas (covering 2 560 km^2) an intensity between 8° and 10°, resulting in serious hydrological disorders in the watersheds of the Tagliamento, Fella, Meduna, Cellina, Torre and Natisone rivers.

In these watersheds the rock structure consisted mainly of limestone, dolomitic limestone, dolomite and conglomerate, but also contained considerable amounts of debris from moraine and old and recent floods. There were numerous E.W. and N.W.-S.E. faults.

The damage caused was both direct (falls, destruction of water courses, cracks in the coherent and semi-coherent rocky masses, incoherent, uneven settling) and indirect (disorderly deposition of enormous amounts of rubble on the slopes and in the water courses, exceptional aggravation of every new incidence of flooding, rockfalls, avalanches). Damage to the management works, although infrequent, consisted of cracking and crumbling of dams and of containing and supporting walls, the burying of various dams under a mass of debris several metres thick caused by falls, the subsidence of various service roads, etc.

Two hundred and twenty-four new falls were identified in an area estimated at 3,4 km^2. Some old falls were rendered more serious and more extensive. Their deposits, especially those from dolomitic rocks, sometimes immediately disintegrated into minute debris (the Serassignis and Resartico torrents, etc.), sometimes retained the enormous dimensions they had at the moment they broke away from the high mountain slopes (Vegliato, Braulins, Partis torrents, etc.)

The main criteria followed in watershed management work in the area affected by the earthquake were:

1/ (Southern side), Carniche Prealps.

(1) to rebuild or repair all the works destroyed or damaged;

(2) to mass produce groynes (of reinforced concrete) to contain the landslip materials;

(3) to install the groynes in land of an optimum geomechanical nature so that the wings and foundations can be securely inserted;

(4) to establish setting basins for the deposition of debris, and construction of the service roads necessary to facilitate emptying of these basins;

(5) to enlarge the notches to allow the large new violent masses of solid material to pass without damaging the structure;

(6) to consolidate low, unstable rocky zones by injecting bentonite and using anchor logs and nails, after prior detachment of loose rocks by mechanized means;

(7) to protect the high, unstable rocky zones by constructing large, dry-stone containing walls, if necessary, of a complex type, downhill;

(8) to effect frequent remeasurements and clearing of river beds after every high flow;

(9) to dispose of the whole enormous mass of rubble resulting from the demolition of towns and villages (moving, organizing, protecting, etc.)

Particularly noteworthy examples of the work done are:

(a) the management of Vegliato torrent (Gemona);

(b) consolidation of the landslide at Mazzanons (Pinzano);

(c) the organization of the enormous deposits of rubble alongside the Tagliamento, Fella and Torre rivers;

(d) the construction of a large buffer wall in the Partis (Venzone).

69. Prof. G. Palmentola of the University of Bari then presented his paper on evaluation of the effects of earthquakes on erosion in Basilicata:

The paper communicates the first results of research started after the 1980 earthquake in watersheds in Basilicata already under, or being brought under, management in order to ascertain the effect of the earthquake shocks on the works already completed and thereby check whether the management criteria adopted were valid, or whether a different approach was necessary.

These results refer to an area near Trivigno where, following landslides affecting the town, work to stabilize the slopes was undertaken in 1969. The work was also intended to protect the railway line and the motorway.

The area is typical of the Lucanian Appenines, and consists of arenaceous flysch over multicoloured clays. The improvements that affect the area are attributable to roto- translational landslides and canalized flows. The mechanisms and conditions of stability of the landslides were analyzed for the following years:

- 1954 (15 years before stabilization work)
- 1969 (date of the work)
- 1976 (seven years after the control work)
- 1982 (13 years after the control work and two years after the earthquake)

The stabilization work carried out in part of the watershed was aimed at active protection of the soil by acting on the causes and not the effects of the landslides. In particular interstitial pressure was controlled by installing both deep and shallow drainage systems and groynes, and through levelling and afforestation.

The work effected did not suffer any damage as a result of the earthquake and the landslide sites controlled were not reactivated. The geotechnical investigations and the stability analysis under both static and dynamic conditions, provided the explanation of this positive behaviour, and of the negative behaviour of the areas not managed, which constitute a serious threat to the overall equilibrium of the slope.

From this derives both a favourable verdict on the action criteria used, and a recommendation to the relevant authorities to provide the funds necessary for the upkeep and the completion of the works.

70. Ms. G. Trisorio-Liuzzi presented the paper prepared jointly by her and Mr. G. Palmentola and Mr. S. Puglisi of the University of Bari under the title "Analysis of the effects of the 1980 earthquake on the hydraulic forestry management of a landslide affected watershed in Trivigno (Basilicata)". The first results of research conducted by University of Bari team demonstrate:

(1) The suitability of the management criteria which have been adopted to stabilize the landslide, which consist in active defense measures, that is, measures which are oriented to check the causes and to control the effects as well. In particular the fact of lowering through drainage the levels of pressure in the porous media, have made possible the recovery of slope stability, even under conditions of seismic acceleration.

(2) The need to take measures to consolidate the areas of active landslide which can have undesirable effects on the whole slope area.

(3) The urgent requirement of maintenance of the hydraulic works, since their efficient operation is the only way to ensure that the potential landslide areas will maintain their consolidation and their stability.

71. Mr. G. Kronfellner-Kraus presented the paper written by Mr. E. Brükl (Austria) under the title "Report on seismic prospecting in the area of valley narrowing by mass creep in rock in Gradenbach", since Mr. Brükl was unable to attend the meeting. The valley narrowing by mass creep in rock on the Berchtoldslope in Gradenbach near Döllach, Möll-valley in Carinthia, is one of the greatest in Austria. The depth of the moving mass, i.e. of the more or less ruptured and loosened bed rock has been partly determined by two drill-holes. Based on these drill holes, through seismic prospecting over three refraction seismic profiles an additional three-dimensional view of the extent of the different layers of the underground could be obtained.

72. During the discussion on the subject of the Symposium, Mr. Djorović (Yugoslavia) asked whether earthquake risks are taken into account in calculating gravity dams for torrent control. Mr. Kronfellner-Kraus replied that in Austria they are not. Ms Trisorio-Liuzzi and Mr. Puglisi stated that studies have been made on critical acceleration following the 1980 earthquake. The works had held well, but it is not known whether they would stand up to a stronger tremor. The Trivigno landslide had remained stable. Mr. Benini stated that Italian regulations distinguish between works more than 10 m high measuring from the base, and a storage capacity of more than 100 000 m^3, and those of smaller dimensions. The latter do not have to take earthquake risks into account.

73. In winding up the FAO/IUFRO Symposium, Mr. G. Kronfellner-Kraus provided some information on the recent activities of the IUFRO Subject Group which are contained in the repor "Research activities on torrent erosion, floods and mud flows, snow damage and avalanches". He mentioned that during the five-year period 1976-81 the Subject Group S1.04-00 (former name: torrents, snow and avalanches) had two working parties:

01 - for torrent erosion and torrent control, and 02 - for snow and avalanches. The membership list contained approximately 280 scientists from 36 countries. The following meetings took place and during study tours the following Research Stations and places of field research were visited:

1976: At the 16th IUFRO World Congress in Oslo subject and working group meetings and a study tour in Norway took place with the main topics: torrent control and river training, avalanche zoning, avalanche research station in Grasdalen.

1978, September: An International Seminar on Mountain Forests and Avalanches at the Swiss Federal Institute for Snow and Avalanche Research took place in Davos, organized by the working party 01, with a study tour in Switzerland.

1978, October: The Subject Group S1-04-00 held a Satellite Meeting at the 8th World Forestry Congress in Jakarta, Indonesia, with a study tour through Java. Related Institutes engaged in forest hydrology and erosion control were visited in Bogor, Bandung and Yogjakarta and in places of field research near Garut (Waspada experimental watershed) and in the upper and lower Solo river basin (Mt. Lawu).

1980, September: Subject Group meeting at the IUFRO-Division I Congress in Thessaloniki and Athens, Greece. Study tour to forest hydrological field research and to torrent control works North-East and North-West of Thessaloniki.

1981, June: Joint IUFRO/FAO Meeting in Grenoble, France, on "Research in small torrential watersheds" with two study tours.

XII. PROGRAMME OF WORK OF THE WORKING PARTY. ELECTION OF OFFICERS. DATE AND PLACE OF NEXT SESSION

74. The heads of delegations met in order to elect the Officers of the Working Party. The Vice-Chairman requested the delegations to express their opinions concerning the election procedure and the management of the Working Party for the forthcoming period, once Mr. T. Eren had explained the provisions of the Rules of Procedure of the European Forestry Commission regarding the election of the Working Party's Officers.

75. The delegates unanimously elected Mr. S. Puglisi (Italy) Chairman, Mr. F. López Cadenas de Llano (Spain) First Vice-Chairman, and Mr. G. Kronfellner-Kraus (Austria) Second Vice-Chairman. The outgoing Chairman, Mr. S. Munteanu (Romania) was unanimously elected Honorary Chairman of the Working Party as an expression of the Working Party's appreciation of his dedication to its service during his long term of office. The participants also agreed to honour Mr. G. de Messines, the First Chairman of the Working Party, who led the activities of the Working Party for almost 20 years, designating him Honorary Chairman.

76. The Working Party then turned to a discussion of its programme of work. The subjects to be covered and the priorities to be assigned were debated at some length. Finally agreement was reached on covering all the Working Party's traditional subjects while concentrating in the short term on a few specific issues.

77. One of the first issues tackled in the discussion on the programme of work was that of the national reports. Several delegations urged standardization in order to make these reports even more useful and facilitate the exchange of information. In addition they should be presented using audiovisual material, to make them more attractive. Mr. Puglisi pointed out that at the early sessions of the Working Party there had been an outline which made it possible to standardize the reports. The Secretariat was requested to prepare an outline and instructions for compiling it for future sessions. The standardized outline should make it possible to orient exchanges, in accordance with the Agenda, on policy, legislatation, institutions, programmes and achievements, research, education, etc. The information requested should cover the whole range of subjects dealt with by the Working Party.

78. In additional to the national reports, the other aspects that should be considered in the Programme of Work and for the Agenda of the next session are:

- torrential erosion, study of processes and evaluation methods, as a basis for programming watershed management actions;

- hydrological questions, including studies on representative and experimental watersheds, the use of mathematical models, study of the influence of the vegetative cover, calculation of the discharge in order to establish the dimensions of control works, and application of results of scientific research in order to make them of practical use;

- hydrotechnical and calculation aspects of torrent control works;

- biological measures for watershed management;

- questions connected with snow and avalanches and their control;

- the economic, social and institutional aspects, including institutional changes, in mountain areas, including economic evaluation of watershed management activities.

79. The members of the Working Party were requested to communicate to the Secretariat the subject of the papers that would be submitted at the next session of the Working Party, so that the programme could be arranged according to the number of contributions. Several delegates expressed the wish to have more time in which to discuss the subjects and perhaps to set up sub-committees in order to go into some of them more thoroughly.

80. The Vice-Chairman of the Working Party opened the discussion on the date and place of the group's Fourteenth Session. Mr. F. López Cadenas took the floor in order to read a letter sent to him, as Vice-Chairman of the Working Party, by the Ministry of Agriculture, Fisheries and Food of the Kingdom of Spain, expressing the Spanish Government's agreement in principle to host the Fourteenth Session in Spain in September 1984. The Vice-Chairman and the Secretary thanked the delegation of Spain, on behalf of the Working Party and of FAO, for this generous invitation. The Secretary stated that, subject to approval of the session in FAO's Programme of Work and Budget for the biennium 1984-85, FAO could supply the resources necessary for the organization of the session. He pointed out that it would be desirable to interest experts from developing countries, particularly in the Mediterranean zone and Latin America, in this session, which could be combined with a seminar on a subject of interest to them.

81. As regards specialized meetings, several subjects were mentioned:

- a seminar on methods of restoring mountain lands, in Bulgaria, possible after the 14th Session, so that the Bulgarian experts could have a chance to participate in a session of the Working Party;

- a seminar on hydrological and sedimentological research in small watersheds and by means of models, for which the Secretariat was asked to explore possibilities with AIHS, IUFRO, Unesco, WHO and other agencies interested in this subject;

- a seminar on mountain economy systems, possibly as a way of rendering a service to a developing country - Morocco was mentioned in this connection.

82. The Vice-Chairman asked the Secretary to read the Draft Report, which was adopted by the members of the Working Party. The closing meeting of the 13th Session was then held.

83. In closing the meeting Mr. T. Eren of the FAO Forest Resources Division took the floor to thank the participants for their attendance and for the high quality of their technical contributions. He also expressed FAO's gratefulness with the Italian authorities for hosting the session and with the Forestry Office of the Sicilian Region for ensuring the success of the session by means of meticulous organization and a very efficient support. The President-elect of the Group, Mr. S. Puglisi, added to Mr. Eren's appreciation the participants' appreciation. He congratulated the interpreters, translators, hostesses, secretarial and support staff for the very satisfactory way in which the session developed. The Group's Secretary also expressed his thanks to Mr. Russo and Mr. Arrigo of the Forestry Office of the Sicilian Region for their effective support and asked them to convey to all their staff and to EGA staff his warm appreciation.

ANNEX A

Agenda

1. Opening of the Session
2. Adoption of the Agenda
3. National reports
4. Watershed management planning
5. Maximum discharge calculation in torrents
6. Study of erosion processes and determination of the potential for torrential erosion
7. Watershed rehabilitation in semi-arid and mediterranean environments
8. Influence of vegetation cover
9. Hydrotechnical aspects and calculation of torrent control dams
10. Social and economic aspects of the management of mountain watersheds
11. Programme of the Working Group
12. Election of Group officials
13. Data and place of the Fourteenth Session
14. FAO-IUFRO Symposium: "Relationship between Torrential Phenomena and Seismic Events"
15. Other matters
16. Adoption of the Report
17. Closing of the Session

ANNEX B
ANNEXE B
ANEXO B

List of Participants
Liste des Participants
Lista de Participantes

Chairman Président Presidente	S. Puglisi (Italy/Italie/Italia)
Vice-Chairmen Vice-Présidents Vicepresidentes	F. López Cadenas de Llano (Spain/Espagne/España) G. Kronfellner-Kraus (Austria/Autriche)
Secretary Secrétaire Secretario	L.S. Botero (FAO)

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ANNEX C

Timetable

Monday, 27 September

8.30 Registration - Document distribution

9.00 Opening of the 13th Session of the Working Party. Addresses by representatives of the host country, by representatives of FAO and by the Chairman of the Working Party. Adoption of the Agenda. Nomination of rapporteurs for the various Agenda items. Secretariat information.

10.45 Coffee break

11.00 National reports: Austria, Spain, Israel, Italy, Norway, Federal Republic of Germany, Romania, Switzerland, Yugoslavia

15.00 Registration for the study tour

16.00 Hydrological studies, calculation of the maximum discharge of torrents and sediment load:

- Calculation of the maximum discharge by the SOCOSE method (J.P. Cambon, CEMAGREF, France)
- Watershed management: water and sediment budgets (R.J. Prins, Faculty of Agricultural Engineering, Silsoe, U.K.)
- Sediment concentration in a discharge hydrograph in small watersheds (M. Djorović, Forestry Faculty, Belgrade University, Yugoslavia)

17.00 Coffee break

17.15 Continuation of the topic under Item 5:

- Computer procedures for computing potential evapotranspiration on mountain areas (S. Fattorelli, S. Scarpa, University of Padua, Italy)
- Hydrological simulation experiences in Alpine watersheds (S. Fattorelli, University of Padua, Italy)
- Hydrological investigations on three small watersheds in the Giudicarie Valleys (S. Fattorelli, University of Padua, Italy)
- A new and fast method for the calculation of maximum discharge of torrents (S. Munteanu, I. Clinciu, R. Gaspar, Romania)

18.30 End of first day's sessions.

Tuesday, 28 September

9.00 Watershed management planning:

- Soil protection in territory planning in the Trento Province (G. Castelli, L. Ferrari, P. Mazzalai, D. Nardin, R. Tomasetti)
- Research of a programming method for actions related to upland restoration (H. Huchon, CEMAGREF, France)
- Use of satellite imagery for the production of vegetation thematic maps for watershed management (Hydrology Section, ICONA, Spain)

10.00 Coffee break

10.15 Study of erosion and determination of the potential for torrent erosion:

- Main report by the Working Party's rapporteur (S. Puglisi, University of Bari, Italy)
- Impact of rainfall in studies of erosion by water in the Sicilian territory (F. D'Asaro, University of Palermo, Italy)
- Evolution of the drainage network in quantifying erosion processes for watershed management planning (Hydrology Section, ICONA, Spain)

11.15 Watershed rehabilitation

- Erosion control methods in the Tunisian arid zones (H.B. Missaoui, Forestry Directorate, Tunisia)
- Reoent development in torrent control and watershed management techniques in the southern slopes of the Alps (G. Benini, University of Padua, Italy)
- Management and restoration of torrential watersheds in the Southeast of the Iberian Peninsula and the Lanjarón research station (M. Blanco Criado, F. Estirado, INIA, Spain)
- Afforestation systems in areas with semi-arid climate (E. de Simon, ICONA, Spain)
- Studies on the relationship between hydro-forestry work in the Gador Sierra and aquifer recharge in the Dalías fields, Almería (F. López de Vera, M. de Miguel Tejedor)
- Project LUCDEME: Control of desertification in the Mediterranean (J.A. Carreras, ICONA, Spain)

16.00 Influence of vegetation cover:

- Influence of afforestation with conifers on water quality in a small watershed. Impact on soil (C. Dupraz, Office National des Forêts, France)
- Influence of afforestation in the watershed of El Vado reservoir in the control of the process of eutrophication (F. López Cadenas, A. Pérez-Soba, C. Mondejar, ICONA, Spain)
- Reforestation along the southern ramp of Berne-Loetschberg-Simplon (J.P. Graf, Office Fédéral des Forêts, Switzerland)

- Influence of agricultural land use zones on the risk of slope destabilization (H. Siegel, Inst. für Wildbach- und Lawinenverbauung, Austria)

- Influence of forest cover on the hydrologic regime on mountain streams (new results of investigations in Central Europe) (H. M. Brechtel, Institut für Forsthydrologie der Hess. Forstl. Versuchsanstalt, Federal Republic of Germany)

Wednesday, 29 September

9.00 Watershed rehabilitation (continued)

- Influence of afforestation in the watershed of El Vado reservoir in the control of the process of eutrophication (F. López Cadenas, A. Pérez Soba, C. Mondejar, ICONA, Spain)

- Reforestation along the southern ramp of Berne/Loetschberg/Simplon (J.P. Graf, Office Fédéral des Forêts, Switzerland)

- Influence of agrioultural land use zones on the risk of slope destabilization (H. Siegel, Inst. für Wildbach- und Lawinenverbauung, Austria)

- Influence of forest cover on the hydrologic regime of mountain streams (new results of investigations in Central Europe) (H.M. Brechtel, Institut für Forsthydrologie der Hess. Forstl. Versuchsanstalt, Federal Republic of Germany)

10.30 Coffee break

10.45 Economic and social aspects of the management of mountain areas:

- Some activities conducted by FAO in order to ensure the participation of mountain dwellers (L.S. Botero, FAO)

- Management of the mountain territory (V. Margiota, Regional Director of Forests of Basilicata, Italy)

- The management of hilly watersheds in relationship with the present economic and social evolving phase of the Italian hilly areas (U. Bagnaresi, Italy)

11.30 Film (in English): "Green will" (on the restoration of mountain areas in Southern Korea). Duration: 20 minutes

16.00 Various matters

- Hydrological management of the slopes underlying the city of Agrigento (G. Farina, Cassa per il Mezzogiorno, Italy)

17.00 Film (in English): "The quick clay slides in Rissa, Norway". Duration: 25 minutes

17.30 Film (in Italian): "Green forest - Trees for the Madonie"

Thursday, 30 September

9.00 FAO/IUFRO Symposium: "Relationship between torrential phenomena and seismic events":

- Relationship between torrential and seismic events; an introduction (G. Kronfellner-Kraus, IUFRO)
- Seismicity in the Carniche and Giulian Alps: Results of watershed management activities (R. Querini, Director General of Forests, Friuli-Venezia Giulia, Italy)
- Some aspects of the management of the torrential watershed of Trivigno, Basilicata (G. Palmentola, S. Puglisi, G. Trigorio-Liuzzi, University of Bari, Italy)
- Report on seismic prospecting in the area of valley narrowing by mass creep in rocks in Gradenbach (E. Brükl, Austria)
- Research activities on torrent erosion, floods and mud flows, snow damage and avalanches (G. Kronfellner-Kraus, Institut für Wildbach-und Lawinenverbauung, Austria)

11.00 Coffee break

11.15 Hydrotechnical aspects and calculation of torrent control dams:

- On the procedure for the prevision of river channel correction (G. Giordano, University of Palermo, Italy)
- Calculation of gabion masonry dams with a regular staircase profile (Hydrology Section, ICONA, Spain)
- Programme for reinforced concrete torrent dam designs (S. Fattorelli, University of Padua, Italy)
- Summary on recent developments in the calculation of structures by the rapporteur (S. Munteanu, University of Braşov, Romania)

16.00 Various matters

- Proposal for the education at the third cycle (post-graduate) level for staff responsible for watershed management (E.F. Debazac, CIHEAM, France)

16.30 General information on forestry and watershed management in Sicily (C. Corrao, Regional Director of Forests)

17.15 Methods of erosion control in the Tunisian arid zones (H.B. Missaoui, Forests Directorate, Tunisia)

17.45 Coffee break

18.00 Work programme of the Working Party: Preliminary discussion on the present activity and a possible reorientation.

18.30 Film (in English): "Green will" on the restoration of mountain lands in South Korea. Duration: 20 minutes.

Friday, 1st October

8.30	Election of Group Officials
9.30	Programme of the Working Group
10.30	Discussion on the date, venue and agenda for the 14th Session, and for specialized meetings
11.00	Break for the preparation of the final report
18.00	Approval of the report of the 13th Session of the Working Party
19.00	Closing of the 13th Session of the Working Party

ANNEX D

Study tour itinerary

Sunday, 3 October

16.00 - Departure by coaoh from "La Torre" hotel, Palermo, for Erice

- Accommodation in the "Moderno" hotel in Erice

Monday, 4 October

8.00 - Departure from Erice for Agrigento with visit to Selinunte

- Management of Mount Erice and Fastaia Torrent watersheds

13.00 - Picnic offered by the Sicilian Azienda Foreste Demaniali

- Visit to Selinunte

- Dinner and accommodation in Agrigento in the "Colle Verde" hotel

Tuesday, 5 October

8.30 - Management of the landslips in the archeological zone of Agrigento

11.00 - Visit to the Valley of the Temples

- Lunch at the "Colle Verde" hotel

- Afternoon free

- Dinner offered by ICORI

- Accommodation in Agrigento

Wednesday, 6 October

8.00 - Departure from Agrigento for Castronuovo di Sicilia, Caltanissetta and Nicolosi

- Management of the mountain watershed of Alto Platani, Castronuovo di Sicilia

- Picnic offered by the Sioilian Azienda Foreste Demaniali

- Dinner and accommodation at the "Gemmellaro" hotel in Nicolosi

Thursday, 7 October

7.00 - Departure from Nicolosi for Capo d'Orlando

- Visit to the south-western slopes of Mount Etna
- Management of the Flascio Torrent watershed
- Picnic offered by the Sicilian Azienda Foreste Demaniali
- Dinner and accommodation at the Villagio Nettuno, Capo d'Orlando

Friday, 8 October

7.30 - Departure from Capo d'Orlando for Messina

- Management of the catchment basins of some torrents of Nebrodi mountains
- Lunch offered by the Sicilian Azienda Foreste Demaniali
- Dinner and accommodation in Messina in the "Paradise" hotel

Saturday, 9 October

7.00 - Departure from Messina

- State Forest of Peloritani (Colle San Rizzo)
- Management of the Peloritani mountains watersheds
- Lunch offered in Messina by the Sicilian Azienda Foreste Demaniali

14.00 - Departure for Taormina and visit to the town

17.00 - Departure from Taormina for Fontanarossa Airport, Catania

19.00 - Departure for Palermo

Arrival in Palermo is scheduled for about 10.00 p.m.

ANNEX E

General information on forestry and watershed management in Sicily

(Mr. C. Corrao, Regional Director of Forestry, Sicilian Region, Italy)

In our country regional development, whether for physical protection or for ecological conservation purposes, has, I am sorry to say, been tackled in a sporadic and fragmentary fashion, often under the emotional impulse of reaction to calamities of various kinds.

In fact, owing to an age-old habit of ignoring problems that have always existed, awareness of the enormous problems involved in land-use management has arisen only in more recent times; and there still persists a sectorial view of the different aspects and a lack of continuity on which we think it necessary to lay particular emphasis.

Sicily, this land whose beauty you will be able to admire during the study tour, illuminated by this magnificent summer sun which may well accompany you throughout your stay, yet has orographical, geological, hydrological, pluviometric and climatic characteristics which make it particulary prone to hydrogeological disorders.

The situation has been aggravated by irrational use of the land, connected with historical events that have subjected this tormented land to the most varied outrages. It is enough just to think of the reputation as the "granary of Rome" Sicily acquired after the occupation of the Romans, who wildly deforested vast areas in order to grow cereals. Its strategic position at the centre of the Mediterranean has almost always resulted in a high population density, with consequent pressure on the land. The combination of these inter-acting factors has led to the present situation of degradation, which in many areas has reached dangerous proportions. The centuries-old exploitation and irrational use of the land has not been accompanied by the least organized effort to repair the damage caused.

Watershed management, and in particular the management of mountain watersheds, is very recent. Not until the beginning of this century were some isolated measures taken by the unified State to protect the town of Messina, by controlling the torrents which rush down from the summits of the Peloritani mountains and undertaking large-scale afforestation with coniferous species on the slopes of these mountains.

After the second world war we saw the start of more regular, but still sporadic and disorganized activity, with regard to both reforestation and real water management. The State began, through its own institutional bodies and through the Fund for the Development of Southern Italy. Greater organic unity was acquired with the financing supplied under Law No. 632 of 1967. The Region, for its part, started disorganized, piecemeal reforestation work, often under the pressure of local employment problems. By 1967 politicians had come to realize that soil protection could not be conducted solely on an emergency basis, but required programming. And so the De Marchi report came to be prepared.

But it was in Sicily, with regional law 36/74, that the problem of watershed management was first tackled adopting a criterion of unity with all the other disciplines. Regional programming guidelines were prepared under this law and law 78/75 and subsequently confirmed in law 84/80.

The first objective of the programme was to avoid disorganized interventions by making a clean break with the policy of piecemeal and sporadic action, in order not to annul or minimize the effectiveness of whatever action is proposed. Any measure must always be seen from an interdisciplinary point of view, from the standpoint, that is, of soil conservation, land stability, the most economic approach, wise use of resources, environmental protection and nature conservation, adapting the whole to the social and economic requirements of the populations concerned and hence looking at the entire ecosystem, but with people as the centre of the system.

The first step was therefore to acquire the greatest possible amount of data, because decisions regarding measures and priorities must be based on knowledge of all facets of a problem.

Taking the watershed as the basic territorial unit, detailed studies were made of sixty-four of the most important watersheds, already identified by the Forestry Administration in connection with the preliminary study prepared for the well-known De Marchi report.

Inventories were made of all Sicily's wooded areas, ascertaining total area covered, percentage of plant coverage, type of coverage, type of silvicultural treatment and type of ownership.

Emphasis was put on the relation between forest and pasture land, indicating the limits and the possibility of coexistence.

An increase in the region's State forest area was proposed in order to make it easier to carry out forestry measures, thus ending the practice of temporary occupation of land which is one of the main reasons for fragmentary and uneconomic actions.

It was explicitly stated that soil protection cannot be achieved solely by controlling torrents and carrying out other water and forest management works, but requires also the active presence of people.

This presence should be considered as a service rendered to the community by those who remain in the mountainous areas and who ensure and guarantee the stability of the surrounding areas; it is therefore only right that resources should be transferred for the benefit of those who live in mountainous and hilly areas.

It was clearly shown that part of the present disorder has been caused by the way in which the land is now being farmed, with the uncontrolled use of machines.

Watershed management and plantation work cannot stabilize the slopes, that is, unless they are accompanied by agricultural water management works and unless the use of machines and the kinds of crops grown are also regulated.

In addition, management, by starting from an analysis of the hydrographic and hydrogeologic situation, analyzing the characteristics of the existing wooded area and determining the degree of degradation, the economic function and the characteristics of the flora, produces a detailed inventory of the existing situation and makes it possible to check the validity of certain choices made and to perceive some of the causes for the failures that have occurred in certain cases.

When the main lines of the programme were being formulated, it was stressed that the actions taken should be organic and comprehensive if they were to achieve tangible and concrete results in resolving at least localized problems despite the limited funds available.

In this connection, I may mention that at that time (1976) financial requirements were estimated at three thousand milliards (do not be alarmed by the enormous figure) as against the barely one hundred milliards available. It was therefore necessary to select the watersheds where action was most urgent.

Measures to conserve the existing forest area and to bring under state control wooded areas held under temporary occupation were fully implemented by the Azienda Foreste Demaniali through the Departmental Forestry Inspectorates, which worked in conformity with the choices and priorities indicated. The area controlled by the State therefore expanded to about 100 000 ha, with an increase of 20 percent over the area recorded in 1976.

The Sicilian Azienda Foreste Demaniali thus saw its responsibilities greatly expanded as regards not only the nature of its functions but also the size of the area to be managed.

The territorial basis of the Azienda, now more consistent, should make it possible to take fully into account those public aspects of State forests (protective, productive, scenic, hygienic, recreational, etc.) which by their nature or because of the limited and irregular profits they provide do not receive sufficient consideration under private management.

In this connection particular mention should be made of the new direction the Region decided to give the management of the Azienda Foreste through remarkable democratic participation.

The Azienda Foreste Demaniali is therefore engaged in tackling changed and broader land management tasks, while at the same time interpreting the new requirements of the populations concerned.

Separate mention must be made of the watersheds in which artificial reservoirs had already been constructed or were being constructed, to which the Sicilian legislators devoted particular attention. Since it was recognized that the funds available for each watershed would only gradually be able to cover the respective objective requirements, a comprehensive preliminary study was made of the physical state of each watershed, and an estimate drawn up for the entire management operation, graded according to the priority and possibility for autonomous implementation of each component.

Projects were then drawn up on the basis of the study and estimate, respecting the priorities indicated.

These projects have been carried out. Others will be undertaken as permitted by the additional funds provided under the laws already promulgated and other funds made available under new laws. We concentrated first on torrent control and then on work to stabilize areas particularly prone to landslides. Torrent control sometimes entailed designing and building works for the planimetric stabilization of certain sections of the watercourses.

The hydrographic networks to which we devoted attention are usually cut in plastic formations: the watersheds are very degraded and headwater erosion is frequent.

The projects did not concentrate overmuch, therefore, on trying to achieve equilibrium profiles for the torrents. This would have been pointless, probably resulting only in conventional and fairly valueless results.

In the torrents that we might call "disintegrating" we concentrated on identifying, by careful local observations, the sections in which control works could be securely installed and be most effective, with a high capacity for storing solid material, to the direct advantage of the profiles and the indirect advantage of the slopes and for the relief of the reservoirs threatened by siltation. Study of the correct profiles of the torrents was often conducted by local observations and deductions from graphic-analytic tables, both patiently conducted for the purpose of bringing the watercourse naturally to a convincing planimetric equilibrium, potentially stable, compatible with an environment usually averse to accepting engineering works, and with a high capacity for retaining, in real silting tanks, the solid debris which constitute a constant worry in the management of our artificial reservoirs.

It was endeavoured to make the silting tanks as large as possible, by choosing as sites for the diversion weirs sections where the torrents were at their widest; all this bearing in mind the prevailing clay silt composition of the debris.

Adequate attention was paid to the hydrological aspects of management. The estimates were backed up by the ample information provided by our hydrographic service, helped by methodological advances made in recent years which have now been incorporated also in the procedures for the hydrological study of small watersheds.

In implementing the projects we kept constantly in mind the fact that although the importance of constant upkeep is universally recognized, in reality control works have to be prepared for long periods when there is no possibility of timely repair work.

Finally, the constructional aspect was supported by geotechnical calculations, as prescribed by current legislation. The works are usually built in concrete, for technical and economic reasons.

The recent regional law 84/80, whose three-year programme is now being implemented, has enabled the work initiated to be continued, thus ensuring, as far as possible, the desired continuity in management activities.

Now that some years have passed since these activities began, we can draw up a first summary balance of the results obtained and check the choices made.

Naturally not everything has gone well and we certainly have no intention of boasting about our work here.

It is clear that, given the enormous gap that exists between requirements and available finances, it could not be hoped to achieve definitive results.

It must be recognized, though, that the Sicilian Region, despite the economic difficulties due to the recession prevailing for some years, has made available to this sector enormous financial resources that have made it possible to launch a remarkable number of intensive management operations, and has devoted other resources to protection and improvement of the existing forested area.

The results obtained by the Forestry Administration in the last eight years may be summarized as identification within Sicily's vast hydrographic network of the watersheds requiring priority attention, and the start of work to manage these watersheds.

Considerable effort has also been made to conserve the existing forest estate, by implementing measures to improve the vegetation, strengthening forest fire control, and above all bringing under State ownership an additional 20 000 ha of forest land.

The effort to base management activities on an overall programme has demonstrated a fundamental problem which concerns programming as a whole and land use programming in particular. The studies made of individual watersheds may be regarded as preliminary studies that have made it possible to clarify things that are certain, but a whole set of information is lacking, as is a study of all those interconnections which largely frustrate the purposes of the interventions. I refer in particular to the difficulty of getting the social and economic implications of watershed management perceived.

There is no overall land development plan, indispensable, apart from other considerations, for cost-benefit calculations and hence for deciding the priority of an intervention. Nor are there complementary projects which would develop other capacities of the land in place of those repressed by the management intervention itself, so as to rekindle an economy that will bring the mountain areas alive and ensure that human protection without which the physical degradation of the land will worsen.

It must be remembered that in almost all cases public intervention is not accompanied by action undertaken by the private sector. Management action imposes burdens on the users of the land, entailing limitations and obligations. In an economy that is already depressed such burdens prove intolerable unless the community takes steps to compensate for the reduction in income.

This too is one of the reasons why the initial public intervention is not followed by the water management work in farming land and more generally all those maintenance activities which, as is known, are of great importance for the management operation as a whole.

It is well known that often public intervention is not only unaccompanied by private sector activity, but is even in conflict with it. Extensive management involving a reduction in grazing possibilities, for example, causes real conflicts with the shepherds. To these difficulties of a social and economic nature are added others of a technical nature, such as the lack of geological and hydrological maps. Last but not least, there are difficulties of an administrative and constitutional nature, at least recently, so that for some works, while the State is absent the Region is not competent, or vice-versa.

These difficulties and deficiencies do not make us renounce the fundamental points of the programming guidelines which the forestry sector is following in Sicily. But the interdisciplinary nature of the problems, to which we have alluded, shows that the issue is not exclusively an engineering one, but also has economic and social aspects. We therefore think it useful to emphasize that all land-use planning activities must be guided by a criterion of unitariness.

In conclusion, I should like to express my hope that from this meeting, already on the way to certain success, there will come new indications for resolving land development problems with ever greater success, paying maximum attention to safeguarding the environment and the natural resources.

I should like to request that in the final report of this meeting special emphasis be put on the social and economic problems with which mountain watershed management is always inevitably linked, with the hope that the indications and suggestions emerging from this meeting will be duly noted by the government authorities.

The latter should be reminded, in any case, that in land management one cannot adhere exclusively to the present industrial economy model, with interventions aimed at repairing the damage continually caused, but must rather adopt a new development model which, rediscovering the real values of life, will provide for rational ecological management and maintenance of the land, in order to ensure the survival of humanity and a quality of life consonant with human dignity.

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