

FINAL REPORT OF THE

held in Rome
18-22 September 1978

**TWELFTH SESSION
OF THE WORKING PARTY
ON THE MANAGEMENT
OF MOUNTAIN WATERSHEDS**



FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

EUROPEAN FORESTRY COMMISSION

WORKING PARTY ON THE MANAGEMENT OF MOUNTAIN WATERSHEDS

Twelfth Session

Rome, Italy 18-22 September 1978

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ABSTRACT

The EFC Working Party on the Management of Mountain Watersheds held its twelfth session at the FAO Headquarters from 18-22 September 1978, followed by a study tour in Basilicata, Italy 23-26 September. 52 participants from 10 member countries of the EFC and from 16 non-member countries attended. The agenda included an overview of watershed management in developing countries, case studies, national reports, methods for the study of erosion and sedimentation, methodology for intergrated watershed management planning, hydrotechnical measures, influence of vegetation cover, results of research, socio-economic aspects and new dimensions of the Working Party on the management of mountain watersheds, the latter in view of the "internationalization" of the Working Party recommended by the Committee on Forestry. A short term programme of work was also prepared.

The individual reports summarized here are not available from FAO but should be requested directly from the individual authors.

I. INTRODUCTION

1. The Twelfth Session of the Working Party on the Management of Mountain Watersheds of the European Forestry Commission (EFC) was held at FAO Headquarters in Rome from 18 to 22 September 1978. The working meetings were followed by a study tour in the Southern Italian region of Basilicata from 23 to 27 September.
2. The 52 participants attending the meeting included 20 representatives from 10 member countries of the EFC, 22 observers from 16 countries, representatives from Unesco and the World Bank, 3 experts from FAO projects in the field and officers from various divisions of FAO Headquarters. The complete list of participants is given in Annex B.
3. The discussions were carried out under the chairmanship of Professor S. Munteanu (Romania), who was assisted by Mr. Puglisi (Italy) and Mr. Lichtenhahn (Switzerland). In the absence of Mr. Flores Rodas, Assistant Director-General of the Forestry Department, FAO was represented by Mr. L. Huguet, Director of the Forest Resources Division, and Mr. T. Eren, Chief of the Forest Conservation and Wildlife Branch. Mr. L.S. Botero (FAO) acted as Technical Secretary of the Session.
4. The Director of the Forest Resources Division of FAO welcomed the participants on behalf of the Director-General of FAO and the Assistant Director-General of the Forestry Department. He stressed the particular importance of this meeting and outlined the problems which lay ahead of the developed and developing countries with regard to the implementation of watershed management programmes. He emphasized socio-economic problems in particular, and the way in which these have evolved in the two groups of countries. He emphasized some priority aspects of watershed management which would deserve the attention of the Session: collaboration with specializations other than forestry, and the exchange of technical and scientific data on watershed management. He suggested that the goal to achieve would be to set up a basis for closer cooperation among countries having watershed problems and that the work of the Twelfth Session might follow along these lines.
5. The Chairman of the Working Party expressed his satisfaction that FAO had organized the Twelfth Session of the Working Party in Rome. He next stressed the fact that this session was of particular importance for the Working Party, which from now on would deal basically with problems of developing countries in order to promote a fruitful exchange of watershed management expertise between Europe's rich and now century-long experience and the new but significant experience of the developing countries of Asia, Africa and Latin America. The Chairman briefly described the background of the Working Party since 1952, the date of its first session, and remarked that the group had held eleven ordinary sessions during its 28 years of existence. During this period the problems appearing on the agenda had increased in scope and complexity, evolving from an original basic concern with technical problems to an increasing focus on the social and economic aspects arising out of the integral management of mountain watersheds. Lastly, the Chairman of the Working Party emphasized the multipurpose protective role of the forest for the environment in which man lives.
6. The Italian delegate, Mr. L. Boggia, extended a cordial welcome to the delegates on behalf of the Italian Forestry Administration and informed the participants on details of and arrangements for the study tour in the Basilicata region. Mr. Puglisi provided some details on the type of work which would be seen during the tour.
7. The observer from Unesco/MAB, Dr. H.L. Teller, gave a brief description of the MAB Programme, noting that it was essentially concerned with research, training, conservation and information exchange in several major "themes", generally related to man's interaction with a number of ecosystem types. Several national MAB projects are involved in watershed management research and closer cooperation should be sought, at a national level, between these projects and members of this group. In developing countries, links should

be established between these projects and operational FAO watershed schemes. Dr. Teller reported briefly on the Seminar on Erosion and Integrated Watershed Management, which was held recently in Rabat, Morocco. He expressed regret that the planned joint meeting with this FAO group could not be realized. The objective of the Morocco Seminar was to improve cooperation in watershed management research, training and information exchange between Mediterranean countries with severe erosion problems on steep terrain. Such cooperation is to be fostered through a network of national pilot projects, within which exchanges of specialists and information can take place. Small-scale training activities are also envisaged within the network.

8. The Chairman of the Working Party asked the Secretary to present the Provisional Agenda (Annex A) and the proposed Timetable (Annex D) which were then adopted.

II. WATERSHED MANAGEMENT IN DEVELOPING COUNTRIES

9. Mr. T. Eren, Chief of the Forest Conservation and Wildlife Branch of FAO, made the introduction to this topic. He said that, although watershed as a hydrologic unit has several similarities in its function both in developed and developing countries, when it becomes a social unit where man struggles for his subsistence under severe socio-economic constraints, then its behaviour and management totally change. This is almost always the case in most of the developing countries. Shifting cultivation, where the forest areas are under heavy pressure by scattered communities without any inputs other than human energy and ashes of destroyed forests, causes depletion of land and forest resources upstream and siltation of infrastructure and resources downstream. The causes and effects of these problems may be grouped as follows:

Unfavourable physical conditions: rough topography, degraded slopes, aggressive climatic conditions.

Socio-economic difficulties: most of the fertile croplands are owned by large land-owners, whereas poor villagers, small farmers or tribes, either of their own will or under economic and political pressure, have been pushed to live in remote places as scattered communities. They have no employment opportunities or very little as occasional labour. Unplanned and uncontrolled expansion of these scattered communities over less accessible areas hinders the development of infrastructures such as communications, marketing, schooling, health and transport, and inhibits their own development beyond the level of subsistence. The family is viewed as a labour producing unit. Social structure and behaviour are generally primitive and superstitious. Traditional and tribal rules are very strong; resistance to any innovation is obvious.

Institutional inefficiencies: top-heavy and centralized administrative set-up.

Lack of local research and training institutes: extrapolation of outside research results and imported curriculum do not provide the institutes with proper techniques and methodology.

Lack of incentives and extension, which keep the communities in isolation, particularly without any contact with government officials nor any financial support.

10. In view of all these difficulties there is an absolute need for using an integrated watershed management approach as an effective way of eliminating the conflicting demands as well as helping to close some of the production gaps. Natural and human resources should be developed through integrated forest and watershed management practices in

harmony with settled and market oriented agriculture leading to balanced economic growth and improved and secure living conditions for both upstream and downstream communities. In fact, integration helps to overcome scarcity. It tends to reduce or resolve conflicts of interests and competition for the resources. It promotes balanced use of resources. It brings various disciplines closer to each other and improves the relationship of the specialists with the communities concerned. It promotes appreciation of resources by all concerned and thus facilitates the implementation of proper management through cooperation and coordination. It reduces overhead and infrastructure costs and consequently increases efficiency. It provides diversification and creates employment opportunities.

11. During the discussions one participant asked, in the light of Mr. Eren's presentation, what priority issues were to be dealt with as part of the Working Party's activities, given the scope and magnitude of the problems to be solved. Mr. Eren pointed out that not everything could be solved at once and that the foremost task was to find answers to the social and economic questions, without losing sight of the technical aspects. Mr. Huguet added that the Working Party would have to decide about its own programme; there were, however, privileged sectors which were the direct concern of foresters but other factors such as the agricultural, sociological and economic aspects must be considered as well.

12. The Chairman of the Working Party emphasized that this is the only FAO working party dealing with watershed management questions. The Working Party's expansion to include the developing countries would allow a better definition of the particular priority areas for studies to be undertaken under various conditions, and would also bring about a better knowledge of the scientific, methodological and practical information needed for an integrated approach to watershed management.

13. Regarding specific areas of cooperation on watershed management questions, the Unesco representative, summarizing the principal conclusions and recommendations of the MAB Seminar in Morocco, reiterated the following points concerning possible areas of cooperation in favour of the developing countries:

hosting seminars or training courses as a means of making the necessary expertise and information available to the developing countries;

contributing to the teaching programmes of Unesco or of European universities;

sending relevant FAO and Unesco publications and reports to developing country watershed scientists;

making available equipment, or funds for the purchase of equipment, either bilaterally or through international channels.

III. PRESENTATION OF CASE STUDIES FROM DEVELOPING COUNTRIES

14. The author of the first case study, Mr. Niknam (Bureau of Soil Conservation and Watershed Management, Iran) being absent, Dr. Singh and Dr. Kowsar introduced the topic "Watershed management in Iran", followed by a slide projection. The soil and water resources are highly valuable to the economy of Iran. These resources are threatened by serious erosion problems. Overgrazing, improper farming and abuse of land, mainly due to socio-economic considerations, are the main causes of rapid degradation and soil loss. Watershed management is a new art and science introduced only recently in Iran. Studies on plots have been recorded since 1955. The close relationship between watershed management and the problems of siltation of reservoirs became obvious when the construction of large dams to produce power and supply water for irrigation started in 1960. Recognition of the serious nature of these problems resulted from studies of reservoir siltation that were conducted at the Mohammad Reza Shah Pahlavi Dam. At the same time soil conservation practices were established in Sirachal along one of the tributaries of the Karadj River. However, early 1970 was the real start for watershed management in Iran. More than

150 000 km² or approximately 10% of the country are already under watershed management to lower siltation rates for the 15 dams constructed or under construction. Comprehensive watershed management plans have been completed for eight dams and the study is in progress over 6.9 million ha in the watersheds of seven dams. The programme is expected to be completed by the end of 1980. More than 36 million dollars have been allocated for planning and operation of watershed management since 1969. To date, 10 813 km of contour trenches have been built, 5.3 million trees planted and 416 474 ha of watershed land brought under protection. A number of research studies have been conducted by the watershed research section of the Research Institute of Forests and Rangelands. A FAO Watershed Management and Coordination project, mainly for training, has been operative since 1972. The programme has helped to bring the BSCWM to a self-sufficient stage to carry on the job. As a result of the successful ongoing training programme, future activities appear quite clear and reliable.

15. The case study on "Watershed management in Honduras" followed, presented by Mr. H. Tschinkel (FAO), with slide projection. The principal objective of the project "Integrated Watershed Management" (HON/77/006) is to assist the Honduran Forest Development Corporation in the management of the watersheds of two mountainous regions (total area 1 000 km²) which are characterized by the destructive land use typical of Central America. The complex problem of improving land use can only be alleviated by means of a strategy which includes both the social and the technical aspects. The project has initiated the following four activities:

Forest protection - protection against shifting agriculture and wildlife, through programmes of forest extension

Soil conservation - construction of soil conservation works, primarily terraces, is carried out by the peasants themselves with supervision from the project staff and the use of food for work as an incentive. Motivation and participation of the people have been key aspects for the success of this effort

Agricultural extension - introduction of new cultivation techniques on the land treated by terracing

Reforestation - establishment of forest plantations for fuelwood and other forest products on marginal lands.

The advantages of integrating these activities have been demonstrated. The conditions necessary for the successful application of this type of strategy are analysed, including both the conditions of the rural environment and those of project design. The strategy utilized is an effective mechanism to reach the peasant directly, enabling him to use his own human resources to increase agricultural productivity, reduce deterioration of the watersheds and the environment, and open the door to other aspects of community development.

16. The third case study on "The Venezuelan experience in the organization of watershed management" was presented by Mr. Edgar A. Hernandez (Ministry of the Environment and Natural Resources, Venezuela), followed by slide projection. Mr. Hernandez pointed out that in Venezuela the hydro-forestry problems of the mountain watersheds can be grouped into three major geographic areas: the Andean mountain chain, with its complex patterns of erosion and torrents; the north-central, coastal and eastern regions where there is growing demand on the short water supply, creating water quality and shortage problems; and the Guyana region, with a mean annual rainfall of over 4 000 mm, an extraordinary hydro-power and forestry potential which must be conciliated with sound watershed conservation practices. In addition, there are the specific problems of international watersheds. Using the "conservation subsidies" technique, successful soil and water conservation treatments have been carried out over the past 20 years with proven success. A subsidy is granted to peasant families allowing conservation structures or work on their farms. They also become members of conservation committees with their own statutes and directives. In order to pay back the community for the construction of these conservation

works, the state underwrites works aimed at meeting priority needs, most frequently home improvement or the construction of roads or schools, irrigation facilities, fertilizers, or the construction of chicken coops, pigsties and rabbit hutches. In sub-watersheds dealt with in this fashion, there have been significant erosion control and socio-economic advances in comparison with untreated neighbouring areas. This methodology is now called socio-conservationist development. This experience, together with the creation in 1970 of the post-graduate course on watershed management at the University of the Andes, the national reforestation company and the Ministry of the Environment and Natural Renewable Resources, in 1977 provided a vigorous take-off for watershed activities in Venezuela which includes a ministerial board of directors and a staff of 70 engineers and 130 medium-level technical cadres, in addition to a basic government watershed conservation programme. The programme is being applied in 30 priority area watersheds with the following objectives:

to prevent the depletion of forest cover and the improper use of hillside slopes;

to incorporate the rural family into optimal, sustained, agricultural and forestry development practices;

to improve the hydrological function of the watersheds in terms of erosion control, torrential flooding and regularization of the water regime.

The following sub-programmes have been designed for this purpose:

identification of top priority watersheds, sub-watersheds and micro-watersheds;

physical, hydrological and socio-economic analyses;

drawing up the conservation management programme;

definition of the final projects and their execution in terms of land development, controlled leasing, environmental education, rural resettlement, torrent control, reforestation, forest range management, soil and water development;

personnel training;

research.

17. The practice in certain countries such as Honduras and Venezuela of using subsidies aroused the interest of several participants. Detailed explanations on the identification and granting of subsidies in these countries were presented. The use of these types of subsidies for restoration work was deemed of vital importance for the success of conservation actions. It was suggested that subsidies ought to be made an integral part of watershed management programmes so as to arouse the interest of the local communities and ensure their participation in the implementation of conservation activities and intensification of agricultural production.

IV. NATIONAL REPORTS

18. A number of national reports were presented during the session, several of them illustrated with slide and film projection. The following delegations of the member countries of the EFC submitted national reports:

- France, prepared by Mr. R. Blais

- Germany (Federal State of Bavaria), presented by Mr. M. Seyberth

- Italy, prepared by Mr. S. Puglisi and Mr. E. Giordano
- Norway, presented by Mr. B. Andersen
- Romania, presented by Prof. S. Munteanu
- Spain, prepared by Mr. F. Iópez Cadenas de Llano, and two films presented by Mr. N. de Benito : "The torrentiality of four rivers" and "Floods in S.E.Spain"
- Switzerland, presented by Mr. J.P. Graf and Mr. C. Lichtenhanh Riis.

19. National reports from several other participating countries, in addition to the case studies of Honduras, Iran and Venezuela, were submitted:

- Cape Verde, presented by Mr. A.Q.C. Semedo and Mr. M. de J. Gonçalves
- Iraq, presented by Mr. A.R.M. Anwar and Mr. R.H. Hassoun Obaidi
- New Zealand, presented by Mr. J. Morris
- Panama, prepared by Mr. A.A. Saenz P.
- Tunisia, presented by Mr. Saadallah Jamaledine.

V. METHODS FOR THE STUDY OF EROSION AND SEDIMENTATION IN VIEW OF THE IMPLEMENTATION OF WATERSHED MANAGEMENT ACTIVITIES

20. Mr. M. Djorovic (University of Belgrade, Yugoslavia), as rapporteur on this subject, made the introduction. He pointed out that in watershed management studies, the methods for quantitative determination of erosion and sedimentation are only one part of basic data collecting. Basic data collecting is a fundamental investigation and is necessary for getting the most detailed physico-geographical picture of the watershed, its general and potential capability. This fundamental study belongs to the watershed diagnosis and includes: climate, geology, soil, vegetation, morphology, hydrology, socio-economic problems and erosion. The number and precision of information on these general factors should depend on the importance of the objectives, i.e. on the importance of the objects that should be protected in the watershed. All methods for study of erosion and sedimentation belong to either the qualitative or the quantitative type, the latter being more precise and more useful. Surface erosion (soil degradation) is usually measured on the experimental plots and "universal soil erosion equation" is one of the best, representing methods that are based on the data collected by means of the plots. Surface, gully, bed and bank erosion, i.e. the total quantity of sediment and bed load transport, is best measured by sediment sampling and bed load traps on the most suitable profile of the watershed on structures specially designed for these purposes. Fournier's formula could be accepted as one of this type. Surface erosion is very important from the food production point of view, while stream bank and bed erosion and gully erosion usually play more significant roles in total discharged sediment out of the watershed. Both methods - experimental plots and measuring of total sediment production - should be carried out in pilot watersheds so that they may represent as large an area as possible. Erosion mapping is also one of the methods that are very often applied. There are two types of maps: quantitative and qualitative, depending on the kind of erosion data available. Apart from the methods that are essentially based on experimental or measured data, there are numerous methods and formulae for erosion evaluation that are purely empirical and they should be avoided when possible. Having in mind the international character of FAO, the Working Party on the Management of Mountain Watersheds is a very competent group and it should undertake the realization of the programme on the most adequate methods for determining sediment production and its discharge for various regions of Europe and other regions.

21. Dr. López Cadenas de Llano presented the paper, prepared jointly with Dr. Aguilo Bonnín (ICONA, Spain), on "Methodology for the study of erosion in a watershed in the Segura River Basin". The paper describes a methodology for determining the intensity

of erosion phenomena at the drainage basin level with a view to planning protective measures. On the one hand, the Fournier scale is used to calculate projections of eroded material at the mouth of the basin, a factor of great importance where sedimentation is concerned, especially for reservoirs. On the other hand, the Wischmeier short formula for calculating rainfall erosion indices, the Universal Equation for erosion forecasting, and the soil factor (by means of litho-faces and the slope/longitude factor) are utilized to assess potential erosion in the various areas. By adjusting these values to the type of vegetation in the area, we get maximum erosion forecasts for each of the established categories. From this we can deduce different types of protective measures which have to be taken and, taking the mean values for sub-basins as indicative, the danger factor or degree of urgent need for protection with relation to the total picture. Some concrete examples are given for the Segura River Basin. Lastly, the possibility of computerising the graphic and numerical determination of the different areas - the most tedious part of the application of the method - is examined.

22. Dr. T. Singh (FAO) presented his paper on 'Erosion studies in the Dez watershed of Iran.' The Mohammad Reza Shah Pahlavi Dam, completed in 1962, has the greatest reservoir capacity of all the existing dams in Iran. Its catchment area (17 365 km²) comprises over one percent of the total area of the country. The dam is an important source of hydro-electric power which is now being threatened due to the excessive mountain slopes and the consequent reduction of the storage capacity because of rapid silting. The accelerated erosion has been caused by overgrazing and an overall misuse of resources over many years. Sediment concentration and discharge are being monitored at a number of stations (Tireh, Marbareh, Sezar, Surkhab and the Dez River at Taleh Zang) to assess the patterns and trends of sedimentation over different parts of the watershed. Such assessments are an integral feature of any plan for the effective control of erosion from the mountain slopes. In addition to knowing the inherent erodibility of the soil-vegetation complexes present in the watershed, it is essential to determine the amount of soil that actually discharges into the streams, and thereby identify those segments of the watershed that may be of utmost concern in the rapid sedimentation of the reservoir. The analyses established the patterns of sedimentation from various sub-watersheds of the watershed and showed the seasonal trends, i.e. the time when the sedimentation rates attain peak values. For example, Surkhab, a tributary of the Dez River, showed maximum sediment discharge of 503 289 metric tons/day (mean concentration 48 054 mg/l) during the melt/rainy season. The Dez River at Taleh Zang was observed to have sediment concentration of 6 776 mg/l in a similar period. The analyses served the purpose of focusing attention on the more critical sub-drainages and the time of the year when extra vigilance is needed for protecting the catchment slopes. Such analyses are thus essential preliminaries to assessing the need and effectiveness of remedial measures inherent in a good land management programme.

23. The presentations under this topic concluded with Mr. Blanco Criado's (INIA, Spain) contribution on "Comments to various methodologies which are being used for the study of erosion in watershed management", the following indexes being examined: Middleton and Anderson's indexes on soil erosion susceptibility, the maximum admitted slope for crops proposed by J.M. Garcia Najera, the assessment of specific degradation in watersheds of F. Fournier, the universal soil loss equation and the measurement of solid discharge in waterways.

24. The application of the Wischmeier Universal Equation was the source of detailed discussion, especially with regard to the coefficient of soil susceptibility to erosion. It was pointed out that in order to obtain valid coefficients a great many measurements may be taken, which cannot easily be undertaken in arid zones. The utilization of rainfall simulators for this purpose was suggested. Other participants felt that the Wischmeier formula entails problems of a material nature in terms of laying out the necessary parameters before it can be used in the field.

VI. METHODOLOGY AND BASIC DATA FOR INTEGRATED WATERSHED MANAGEMENT PLANNING

25. Under this topic (item 4 of the agenda) three papers were presented. Mr. F. López Cadenas de Llano (ICONA, Spain), rapporteur on the subject, presented first his own paper "Methodology and basic data for integrated watershed management planning", pointing out that watershed planning and management - insofar as the conservation of water resources, optimization of the ecological productive capacity and prevention and control of desertification are concerned - require that the territory of the watershed be viewed as a complex and inter-disciplinary system. The only available instrument with which to integrate contributions from all disciplines and incorporate data and studies from different fields consists in mathematical models, where the mathematical process is the nexus between heterogeneous data in order to arrive at the solution of the problem. Two mathematical models are thought to be the most appropriate for the purposes of watershed planning. Although similar, they handle basic information differently. In the first place there is the system of Manual Superposition (Cail Steinitz 1976), suitable for watersheds which are either small or show a large degree of homogeneity, in which information focuses on cartographic transparencies. Once superimposed they will show, according to the degree of totality, the maximum optimization according to one's objectives with a minimization of impacts. The second system (IMGRID - 1975) handles information through a computer in which the data covering the three essential factors of the problem - present and future demand, management objectives and watershed characteristics - are automatically stored conforming to a square grid thus giving an inventory map for each case. Capacity and vulnerability models are established in a second phase by means of matrices which are compared with the data bank, thus automatically giving a reticular grid cartography which offers a first plan in which territorial characteristics are optimized and possible impacts minimized. This first plan can be automatically corrected if it should turn out that it is not the most appropriate because one of the resultant magnitudes, e.g. area destined to certain utilization, investments needed, etc., does not coincide with the objectives of interest, until one suited to these objectives is found. For example, in the case of Mediterranean watersheds, where the solution to the problem of erosion conditions the objective of the integrated survey, this system makes it possible to obtain thematic charts of the various elements which define this phenomenon by means of the automatic cartography of information obtained from aerial photography which offers a wide field of research into and development of this system.

26. The second contribution was from Mr. P. Dimanche (FAO) on "Methodology followed in Tunisia for watershed management studies". Soil and water conservation practices have been conducted in Tunisia for almost 20 years. The examination of their results shows that many disappointing effects originated from lack of participation of the population concerned and insufficient planning and preparation of the work. Efforts have been made for the last six years to improve both aspects including accurate sociological studies in a multidisciplinary approach at several levels of preparation. At the national level of planning three basic documents have been prepared and give elements for choice of priorities: identification of watersheds, erosion map and quantitative approach of erosion, assessment of soil and water conservation work already done. These elements give the possibility to choose priority watersheds. The check on their erosion map leads to the selection of sub-watersheds where erosion problems are more urgent. The level of this approach is at a scale of 1/200 000. The sub-watersheds study is the central phase of the general methodology. Generally conducted at a scale of 1/50 000, this phase collects information from several disciplines - hydrology, geomorphology, pedology - to propose technical processes of management in terms of forestry, pasture, agricultural and soil conservation practices. The study includes sociological inquiries of which the results are matched with technical aspects. During this phase, the sociologists must have the opportunity to be informed of the technical proposals and to discuss them with the population. Concrete and realistic proposals of management should come out of this matching of technical necessities and social realities. This level of

planning identifies implementable projects. A complete achievement of an implementable project study requires very detailed information directly applicable without complementary studies. Its scale is about 1/10 000 to 1/25 000. It includes precise location of works to be done, budget calculation, implementation planning. In conclusion, each level of study requires a multidisciplinary approach and the integration of social factors is underlined as a key element for success in the implementation of watershed management planning.

27. Professor N.W. Hudson (National College of Agricultural Engineering, England) presented the last contribution under this topic, "A research project on hydrology and soil erosion in mountain watersheds in Sri Lanka". Agricultural research in Sri Lanka has traditionally concentrated on plantation crops, tea, rubber and coconut. The increasing population and increasing need to reduce imports of food supplies now requires a new approach with more emphasis on food production. The objective has been defined as "to formulate improved land use patterns, and to increase productivity through better management, requiring a thorough knowledge of the inter-relationships of soil, landscape and hydrology in the higher rainfall zone". This research project, operated under FAO Project SRL/75/058, seeks to obtain this knowledge. Within selected catchments up to 5 000 hectares, the intention is to measure rainfall, run-off, consumptive use by crops, groundwater movement, changes in soil moisture, and hence to compute the water balance. At the same time to measure the soil erosion from the land, and sediment movement in the streams and rivers, to obtain a picture of soil movement. The run-off and soil loss data will be obtained for (a) the whole catchment, (b) smaller sub-catchments within the main catchment, and (c) small run-off plots. This will allow the various kinds of land use to be evaluated. Run-off will be gauged at the main outlet from each watershed and each main sub-catchment at rated stations, using existing structures where possible, e.g. railway and road bridges and culverts. One sub-catchment is selected for detailed measurements using Parshall flumes, H-Flumes, and rated stations, with automatic stage recorders. At a still smaller scale, run-off is measured from 1 hectare single crop plots, and very small run-off plots (0.002 hectare) will measure the effect of slope and land use. Soil movement will be measured by ad hoc sampling at all the run-off measuring points. At the 1 hectare and 0.002 hectare plots collecting tanks with divisors will provide daily measurement of soil loss. Changes in the water storage in the soil will be monitored by a network of water-table tubes, and regular sampling of the soil profile above the water table. The programme started in 1977 and the target is to instrument one watershed per year. The life of the Research programme will depend on the results obtained, but a minimum of 3 years operation of each catchment is expected.

VII. TECHNICAL ASPECTS: HYDROTECHNICAL MEASURES

28. Nine papers were introduced under this topic (item 5.1 of the agenda), the discussion having been coordinated by the rapporteur, Professor S. Munteanu (Academy of Sciences of Romania). The various contributions can be roughly grouped in three sub-topics:

- Calculation of flood discharges (Seyberth, Gaspar/Untaru, Munteanu/Gaspar/Cliniciu/Lazar)
- Effects and conception of torrent control systems (Perez-Soba/Camacho-Lopez, Rojo-Saiz, Parra-Ortun, Munteanu/Gaspar/Cliniciu)
- Particular techniques: terraces (Djorovic) and landslide stabilization (Kowsar/Abdi)

29. Professor M. Seyberth (Bavarian State Ministry of the Interior) in introducing his paper on "The designed discharge capacity of torrents", pointed out that when fixing the dimensions of water plants or buildings the designed discharge capacity Q_a chosen is of essential importance. It not only determines the success or failure of a building project but also considerably affects the building cost and thus the efficiency of a project. As in most cases there is a lack of reliable hydrological data referring to the catchment areas of torrents the discharge volume in times of floods must be calculated by using empirical formulae or by using graphs. The designed discharge capacity is computed according to the following formula:

$$Q = F \cdot q$$

The meaning of the individual symbols is:

- Q = discharge (cubic metres per second)
- F = the catchment area limited by the surface watersheds (square kilometres)
- q = discharge volume (cubic metres per second x square kilometres)

At first the catchment area F, i.e. the area limited by the appropriate watersheds, has to be laid down on a map. Where topographic maps of large scales (e.g. at a scale of $s = 1:25\ 000$) are missing, they must be produced as a matter of priority. If there are no informative precipitation-discharge relations for the torrent area to be examined, it is recommended that the graph constructed after Wundt be used for determining the designed discharge capacity.

30. The second contribution in this connection was prepared by Messrs. R. Gaspar and E. Untaru (Romania), "Contributions regarding run-off in small torrential watersheds". The authors present in this paper the results of research organized in seven small torrential watersheds mainly covered by forests and meadows. These results have led to the following conclusions:

- a) In watersheds situated in mountain zones and those of high hills, the lithological substratum has an important role in the formation of surface runoff. Average coefficients over a period of several years varied between 15 and 20 percent on marl formations and between 8 and 10 percent in catchments with crystalline schists and on sandstone-marl deposits on sand and gravel in the case of 30 to 40 mm rainfall, runoff was nil.
- b) Even where there are favourable runoff conditions only 30 to 40 percent of the total number of recorded rainfalls gave rise to important surface runoff.
- c) Maximum runoff coefficients for one rainfall have reached values of up to 50 percent in catchments covered by forests and meadows on marl and gravel formations, and up to 35 percent in the case of permeable deposits and high values for the precipitation layer.
- d) The forest has a complex influence on surface runoff.
- e) There is a close connection between flood hydrograms recorded in small research catchments and the rainfall hydrograms for precipitations causing the respective floods. Discharge variations are correlated with rainfall intensity variations, etc.

31. Professor Munteanu introduced next his paper, prepared in association with Messrs. R. Gaspar, I. Clinciu and N. Lazar (Romania), on "The calculation of maximum discharge of torrents". In the case of torrential watersheds there is no possibility of applying direct methods for the determination of maximum flood discharge due to the almost total lack of hydrometric data. Even in the case of experimental watersheds where these data exist, the periods recorded are too short to give useful statistical sets. In order to overcome these difficulties in part, it is customary in Romania to resort to so-called genetic methods which have as a feature the possibility of evaluating the maximum discharge of a flood as a function of the main genetic factor, that is, as a function of torrential rains and of the physico-geographic and phyto-edaphic (plant-soil) characteristics of the respective torrential catchments. Among genetic procedures several methods are applied in torrent management projects in Romania. One method which is often used is that of 'flow parallelograms' for the application of which, as for the application of any other genetic method, for that matter, two basic problems are taken into account, to wit: 'calculation' and 'verification' probabilities for maximum liquid discharges and the parameters of 'calculation rainfalls'. The determination of the probabilities of exceeding discharge maxima is based on the classification of hydrotechnical works into categories according to their economic and social value and the economically-based classification of objectives calling for flood protection. In a conventional manner, instead of maximum flood discharge probabilities - which, in the case of torrents, cannot be determined because of the absence of hydrometric data - an estimate of rainfall probabilities which give rise to the corresponding maximum discharges is made. In this case there are several torrential rainfall parameters which enter into the maximum discharge calculation: duration of rainfall, height of precipitation and average rain intensity. But, since direct observations on torrential rains are rare, in the case of torrents one has to rely on recordings of maximum yearly precipitation in 24 hours. Taking into account precipitation values recorded in 24 hours, various procedures may be used to establish the parameters of torrential rainfalls. In this case the procedure applied is that proposed by A. Apostol. The basic principle of the flow parallelograms lies in the fact that the method permits an analysis of the genesis of the flood formation from the quantitative, qualitative, temporal and spatial points of view, thus making it possible to measure the increase and decrease of the flow in time, within the calculation section under consideration.

32. During the discussion of the sub-topic of flood discharges, attention was drawn to a possible risk element in using the extrapolation of empirical formulae for calculating flood discharges. The recent example which occurred in the Tessin area was cited wherein the flood peak was three times over that calculated using empirical formulae.

33. Passing to the second sub-topic, the effects and conception of torrent control systems, Professor S. Munteanu introduced the paper which he had prepared in association with Messrs. R. Gaspar and I. Clinciu (Romania), "Considerations on certain basic aspects regarding the management of small torrential watersheds". The authors refer to the examination of certain basic aspects closely linked with the content of action on torrential watershed management. They analyze the fundamental notions of 'Torrential Watershed Management', 'Watershed', 'Torrent' and 'Torrential Process' (torrential flood, torrential erosion, torrential bedload transport and torrential sedimentation). They stress the fact that a watershed should be viewed as a physico-geographic 'organism' which presents itself as a whole; as a harmonious cybernetic system having well-defined natural limits and constituting at every moment a unitary body of components: lithology, relief, climate, soils, vegetation, water, etc., reciprocally conditioned and developing according to their own laws, independent from the will of man. Within such a system there are no independent structures but only groups and sub-groups placed in a hierarchical order according to natural laws and integrated from the functional point of view. As regards alluvial transport the authors hold that, although it is a characteristic element and one of the effects of inter-action between torrential flow (torrential floods) and torrential erosion, the latter (and, implicitly torrential transport) is not the primary determining factor which is decisive in the hydrological imbalance of the watershed but only one of the aggravating factors of imbalances in the torrential upset. In the second part of their report the authors suggest a methodology on the hydrological efficiency of measures and works for torrential watershed management. This methodology

has to do with the quantification of hydrological efficiency. Since, as a rule, a concrete management project must examine several alternative technical solutions, it turns out that the hydrological efficiency (including anti-erosion efficiency) of the corresponding measures and works evaluated starting with the project phase, may be the basic criterion for the corresponding solution in order to identify the optimum management alternative. In order to express hydrological and anti-erosion efficiency in the most objective manner, the authors propose very simple parametric expressions which permit a quantitative comparison of the state of the phenomenon before intervention, and the state of the same phenomenon after intervention. In this way the efficiency of intervention of measures and works may be expressed through two reciprocally complementary exponents: the effect of the intervention and the coefficient of intervention. Taking X_1 , as the initial value of the parameter being considered (therefore, the value expressing the state of the phenomenon before intervention) and X_2 as the value of the same parameter after intervention, the following is obtained:

- effect of intervention (E):

$$E = X_1 - X_2 = \Delta X$$

- efficacy of intervention (K):

$$K = \frac{\Delta X}{X_1}$$

One may speak of partial efficiency when the efficiency applies only to a certain area of the catchment or to a certain phase of the process of flow. But efficiency may be global when it applies to the entire watershed as well as to a single or several torrential floods.

34. The first of three contributions presented by the Spanish delegation was Mr. J.L. Parra Ortum's (ICONA, Spain) on "Problems and methodology applicable to the "ramblas" of S.E. Spain". The Mediterranean "ramblas"* consist of an extensive watershed usually lacking in vegetation, steeply sloped and with fine and abundant bedload discharge which brings about the uniform and constant rising of the bed over long distances as a characteristic symptom which gives the streams a propensity to overflowing and flooding. Torrential and unevenly distributed precipitation in this area, bringing about soil degradation and easy erosion due to their makeup, give rise to waves of high flows heavy with bedload which cause the sadly famous and catastrophic floods such as in the basin of the Segura. The dimensions of the catastrophe are dependent on the duration and volume of precipitation which give widely ranging figures which may vary from 30 to 200 l/m² in one hour. The only applicable procedure is the hydrological-forestry restoration of the watershed by means of reforestation at the headwaters and hydrological works along the streams and, in some specific cases, on the slopes themselves where reforestation is not feasible because of their craginess. These works are made up of hydraulic or gabion masonry, usually the latter, since it is difficult to find good sites for the foundation and embedding of hydraulic masonry works. Gabion masonry is much simpler and permits small movements of the masonry without appreciable damage. In the low regions some of these ramblas flow into the Guadalentín river or other streams while many of them end up in areas having excellent crops which have remained in place in their old alluvial fans. These crops have to be protected in

*A rambla is defined as a sandy or dry ravine, or as a natural bed of rainwater from abundant precipitation.

the lower area with the building of divergent groynes, the heads of which are joined by means of submerged dams. At the beginning the dam is short but increases in length farther on as the groynes become smaller, giving at the end a dam which is low and as long as the stream will allow, leaving a slanting sheet of water with almost no velocity and lying very flat, which will reach the crops with more benefit than damage. To these basic indispensable works are added auxiliary works, such as access roads and firebreaks cutting up the forest into parcels of 40 to 70 ha.

35. The paper prepared by Mr. F. Rojo Saiz (ICONA, Spain) "Influence of hydro-forestry work in flood peaks" was presented next. The paper summarizes the author's experience with hydrological forestry works carried out in the Province of Almerfa, Spain. The subject of infiltration capacity, which is fundamental for the calculation of maximum water levels, is treated from a practical point of view which is coherent with factual observation. Reforestation carried out in partial watersheds of the Almanzora river basin is seen as the only possibility of reducing maximum water levels from heavy rains. Another subject of great importance is that of stream control works, especially in those watersheds where reforestation is difficult or problematic.

36. The last contribution on this sub-topic was prepared by Mr. A. Perez-Soba Baro and Mr. N. Camacho-Lopez (ICONA, Spain), "Hydro-forestry restoration of watersheds for an integral hydro-power utilization". The authors pointed out in this note the growing relevance of the restoration of mountain watersheds with integrated hydroelectric exploitation as it is at present, and which will become more intense in the future, in view of the efforts that mankind must devote on a world-wide basis to the protection and utilization of sources of energy which, in relation to demand, are constantly becoming scarcer. For this reason, of universal scope, we believe that the experience of Spain may be a contribution of a more practical than theoretical nature with respect to restoration specifically aimed at that objective. The paper presents the various concepts and material achievements obtained in the watersheds of the headwaters of the adjacent Garona and Noguera Ribagorzana rivers, situated in the central area of the Spanish Pyrenees. The point of departure for that work was the control of a watershed with similar characteristics, that of the Flamisell river, where positive results were obtained with techniques and structures also applied to a large extent to the case in hand. These achievements are being developed according to a prior plan to which reference is made in this work, dealing with the particular characteristics of the hydroelectric works within the above mentioned watersheds, together with their repercussion on their torrential regime and the effect of existing torrentiality upon those installations. The whole of the control measures is to be deduced from this inter-relation between the environment and the installation. It is particularly important that these restoration works, which clearly protect direct interests of both private and public concessionaires, should be carried out by means of a collaboration and financing on a basis of agreements to ensure an equitable contribution to the investments required. This paper reports on existing agreements covering the restoration works, which are described in their various facets. Finally, some considerations are set forth as an analytic and critical synthesis of observations and experience in the specific handling of torrential watersheds with integrated hydroelectric exploitation.

37. During the discussion of the sub-topic on the effects and conception of torrent control systems, the quantification of torrentiality was mentioned as one of the major research topics which the Working Party ought to take up in the short term. With regard to this item, it was pointed out that the subject has not received the necessary attention. Since 1964 when Margaroupoulos' formula was discussed, the determination of erosion potential has been dealt with in a qualitative fashion.

38. The third sub-topic, particular techniques, was firstly introduced by Mr. M. Djorovic (Belgrade University, Yugoslavia) with his contribution "The erosion control and crop productive effects of bench terraces on sloped land in the Republic of Serbia, Yugoslavia". Mr. Djorovic pointed out that the problem of the use of sloped land for crop production is very important for the area of the central part of the Republic of Serbia. Nearly 87 percent of this area is on a slope of more than 5 degrees and 79 percent on a slope of more than 10 degrees. Though this natural condition does not suit crop production (due to the severe water erosion) the sloped land is in use for food production, and will be even more so in the future. Experimental plots for determination of erosion control and crop production effects on bench terraces were set up at 14 and 20 degrees. After six years of experimental observation of runoff, soil loss and crop production (corn and wheat) on bench terraces, the following conclusions could be stated:

- bench terraces nearly completely eliminate soil erosion because they eliminate slope and land use effects as the two most important factors of water erosion;
- construction of bench terraces excludes a certain area of arable land (risers) but total crop production is quite satisfactory, both in quantity and in stability;
- though construction of bench terraces is rather expensive work, when it is a question of protection of previous soil and stable food production, this price has its social and economic justifications.

39. The second contribution under this sub-topic was presented by Dr. A. Kowsar (Research Institute of Forests and Rangelands, Iran) who, jointly with Mr. M. Abdi, prepared the paper "Landslide stabilization by subsurface drainage and surface application of asphalt". Road construction across a potentially unstable zone on the left bank of the Farahnaz Pahlavi Dam and filling the reservoir with 95 million m³ of water resulted in a major landslide which clogged 150 m of a highway and threatened the dam and its adjacent buildings in April 1969. Removal from the slide zone of 120 thousand m³ of material to reduce the load and boring of drainage tunnels to decrease the pore-water pressure did not stop creep during the rainy season. Construction of a 4 m deep drainage canal on the upper edge of the slide zone along with spraying the soil surface with 5 litres/m² of hot, MC₂ asphalt has kept the soil mass dry and has effectively stopped the creep since the summer of 1973. Detailed clay mineral identification rules out the existence of swelling clay species in the slip zone and, therefore, their role in slide initiation.

40. During the discussion of the last two contributions, the construction of terraces for growing crops on mountain lands, as is practiced in several countries (Honduras, Thailand, Yugoslavia), was the subject of very lively exchanges. The participants exchanged experiences regarding the construction of these terraces (by hand or mechanized), their impact on agricultural production, the necessary maintenance and protection measures, cost of and return from such structures. Mentioned in this last context were economic analyses carried out in Honduras which showed a highly interesting rate of economic return. With regard to landslide control techniques, mention was made of the limitations of present techniques when used in the prevention of land slides on very steep slopes. This topic was thought to deserve the attention of the Working Party.

VIII. TECHNICAL ASPECTS: INFLUENCE OF VEGETATION COVER

41. Six papers were proposed on this topic (item 5.2 of the agenda). One of these, the paper prepared by Mr. J. Balek (Czechoslovakia) on "Forest transpiration as a mean of the water balance regulation" could not be introduced as the author was unable to attend the meeting. The rapporteur on this agenda item being unable to attend the session, the Chairman of the Working Party coordinated the presentation and discussion of the papers.

42. The first contribution which was introduced was Mr. G. Roger's (Forest Service, France) on "Forests and watersheds". Mr. Roger pointed out that the forest today has three recognized functions; social development, environmental protection and production. Without elaborating any of these functions to any great extent, we should nonetheless like to mention the interaction of forests and water. The forest plays a major role in producing and regulating water reserves:

- favouring rapid, deep penetration of rainwater;
- reducing surface run-off;
- diminishing risks of erosion and flooding.

At the same time the forest constantly distills pure water. "Forest/snow" interaction should also be stressed: avalanche control is often presented as a dynamic afforestation policy. But the forest cannot play its assigned part effectively unless it is managed correctly. Forestry management depends on the implementation of precise silvicultural practices and the careful planning of solid, clearly-defined "management". Forestry management must be global and must include both the cutting and management sectors. We too often tend to believe that the ultimate in watershed management would be to allow forests to grow old naturally with no thought for their present management or future regeneration. Forests require comprehensive care: such as carefully planned thinning cycles, cutting very young trees. The regeneration of certain kinds of forests can constitute a serious problem in mountain areas: as with larch, spruce, or Pinus austriaca larcio pine forests, or the future growth of certain deciduous stands. Indeed, regeneration will be attempted using either staggered cutting or the "strict regeneration groves", or "cutting in patches", a more refined method perfected over the past twenty years by French foresters. The thing to be avoided at all costs is to adopt a wait and see method and just let the forests grow without intervening in any way. This is the best way to turn our forests into "homes for old trees". At the same time the forest manager will be in a position to see that funding is spread to cover all projected operations. This is why the solution of the installations and equipment question will be top priority (designing a coherent network of logging roads and the like). The foresters' first duty will always be to guarantee the duration of the forests which he has created or which have been entrusted to his management.

43. Mr. Goujon presented next the paper prepared by his colleague, Mr. C. Bailly (C.T.F.T., France) on "Study of the influence of natural cover and its modifications; Experiences in oomparative watersheds made in the tropics". Mr. Goujon, after mentioning the various research activities conducted by the C.T.F.T., indicated that one of the most important research topics is to clarify the influence and modifications of plant cover on erosion. This is the subject of Mr. Bailly's report, in which two examples, Madagascar and French Guyana, were chosen. The research conducted had two kinds of objectives: first, to make the authorities in the countries involved aware of the problems which erosion and watershed management imply. Next, to test simple,

effective methods of erosion control which can be made rapidly available to farmers. The methods consist of setting up experimental schema which include either a system of basic plots which have already been used for a long time, or a system of experimental watersheds which vary in area from a few to a few hundred hectares. The principle is always the same, plant cover on the plot or on the watershed is varied and downstream run-off and soil losses are measured. The results are completely parallel: the best way to protect soil against erosion is to always maintain a sufficiently dense plant cover, but this cover does not necessarily have to be forest, it can be savannah or grass lands. The report is divided into two parts: the role of the forest on the one hand and, on the other, the role of savannah and grass lands. The data is given in the report in the form of tables. Regarding French Guyana, the particular problem here is tropical rain forests. French Guyana is an overseas department of France located in South America, in the tropics. Nine-tenths of its area is covered by dense forests. This forest is made up of a very complex ecosystem in terms of mechanical makeup and morphology. Among the numerous species of which it is composed, only a few can be utilized by the wood industry, and logging in this kind of forest is mostly a question of cutting here and there. Using this system a maximum of ten percent of the forest is logged. It seems that this kind of logging does not have any marked effect on the ecosystem, but if a higher proportion of the plant cover is removed, the ecosystem will in all likelihood be modified and the consequences of this modification are still unknown. Development in Guyana is included among the priorities of the Seventh Plan. This development will involve intensive logging, the objective of which is to create major wood consuming industries. This is why the National Forestry Bureau has asked CTFT to investigate the evolution of tropical forest ecosystems as a function of different levels of logging intensity. Experimental water basins were set up in 1976. One, which is to be used as a control watershed, will be left as it was and logging operations of steadily increasing intensity will be carried out in the others, up to the point where the forest is subjected to clear cutting. These logging operations will be followed by replanting under crops or used for livestock, according to the particular place. In other words, an initial, complex ecosystem, is transformed into a simplified ecosystem and the consequences of this modification are observed, which should lead to orientation of future development programmes.

44. Mr. H. Hadri (Forest Research Institute, Tunisia) presented next two contributions, illustrated by means of slide projection. The first one "Effects of soil use on watershed hydrology", dealt with research conducted in Djoggar (north eastern Tunisia) where for three minor watersheds drained by streams which are usually dry except after short, heavy rains, the major soil uses are:

- Catchment I (60 ha): Natural forest of young Aleppo pines
- Catchment II (100 ha): Mechanized traditional cereal cropping with fallow periods; no erosion control measures
- Catchment III (83 ha): Mechanized tree cropping (olives) in contour furrows in a system of banquettes.

Rainfall was virtually the same in all three adjoining catchments - mean annual rate 530 mm. The water regimes of Catchments I and III, forested and under tree cropping with treatments, are more or less the same, but contrast strongly with the regime of the catchment under wheat, where runoff was much heavier. During each of the years for which records were kept, it was observed that in the watershed under traditional cereal cropping, there was a fifty-fifty chance for floods exceeding 3 500 l/s/km² in any given year. High water in the other two catchments, in contrast, did not exceed flows of 200 l/s/km². 26 percent of the rainfall in the first catchment was recorded as runoff against only 3 percent in the other two. 40 to 80 percent of total runoff measured during the period for which records were kept was registered during the five largest floods. Variables most closely coordinated with runoff sheet water and peak flood flows are: total rainfall, intensity of rainfall in a 30 minute period and the index of the preceding rainfall.

The US Soil Conservation Service's method for predicting runoff seems promising. Curve numbers have been calculated for each watershed. The experimental schema drawn up for the study did not make it possible to separate the influence of land uses on the water regime from other influences due to soil characteristics and topographical conditions. In any case it is obvious that improper agricultural practices which completely disregard soil conservation are largely responsible for the poor hydrological behaviour of the catchment under wheat.

45. The second contribution from Mr. Hadri "Choice of species for gully erosion control in Tunisia" was based on research conducted in heavily eroded marly soil zones which are common in Tunisia. The only practical means of stabilizing these critical areas and checking the spread of gulying is by putting in plant cover. About 40 species of grasses, bushes and trees were produced in nurseries and tested in the field in 4 climatologically diverse sites in Central Tunisia. The best adapted species for this extremely harsh environment are: Atriplex halimus, Atriplex nummularia and Atriplex glauca. In certain areas, Lycium arabicum, Salsola vermiculata and Oryzopsis miliaceae also show promising results.

46. The last paper on this topic was prepared by Messrs. J.L. Montero de Burgos and J. Garcia Salmeron (ICONA, Spain), "Afforestation Techniques in the Mediterranean drainage basin". Because of low and badly distributed rainfall of the mediterranean climate, the number of satisfactory tree species is limited and it is necessary to make available to the plant the moisture needs for establishment and growth. Three types of action are undertaken to this end: increase in the soil's retention capacity, reduction of run-off losses and suppression of competition by the brush cover. The authors examine in this paper the particular techniques practiced in Spain for successful plant establishment.

47. During the discussion of this topic of the agenda, certain delegates felt that the silvicultural methods practiced in Europe for mountain watershed management would not be applicable under developing country conditions, in view of the magnitude of the social problems they entail and, in particular, human and livestock constraints. The stabilization of marly soil land using tradition erosion control structures was not considered an advisable practice, either in wet areas or in dry. The utilization of biological methods was recommended and recourse to grasses and shrubs in particular. Several countries have undertaken research on this (Iran, Tunisia). The Working Party strongly recommended that the stabilization of clay soils in arid and semi-arid zones, using biological techniques, ought to receive increasing attention in the years to come and, in particular, research on suitable species and the development of techniques to multiply them. The participants recommended that species to be selected should not only satisfy the purpose of protection but should also be productive on a multi-level basis (fodder, fruit, flowers).

IX. RESULTS OF RESEARCH AND NEW METHODS AND TECHNIQUES

48. Under item 6 of the agenda, both the results of research and the priority needs for cooperation between the countries engaged in research on watershed management and mountain land rehabilitation, were to be examined. The rapporteur on the subject, Mr. G. Kronfellner-Kraus (Federal Forest Research Station, Austria) presented firstly his paper "Newer contributions of research in order to achieve a successful watershed management". Mr. Kronfellner-Kraus pointed out that in order to achieve a successful watershed management, a thorough knowledge of the different erosion phenomena is a prerequisite. The spectrum of these phenomena ranges from normal geological erosion to accelerated or man-made erosion and, especially in steeper mountainous areas, to all kinds of torrent erosion, such as gulying and land slides up to deep reaching mass movements, as well as bed load transport, mud flows and sedimentation. Since it is

difficult to estimate quantitative data of floods and of combined forms of erosion and sediment transport from small mountain watersheds, it is often necessary to carry out special research and measurements in such cases. In order to explain the different research methods, their benefits and application in practice, some examples are described in detail in this paper. In the Trattenbach watershed, different methods of mapping were tested and led to an example of quantitative estimation of a torrent. In the experimental watershed Gradenbach, intensive nine-year investigations and measurements have now led to an equation for the functional dependence of the slope movement from precipitations. The results and the discovered relationship allow a better understanding of the mechanism of the deep reaching slope movements with valley narrowing by mass creep, facilitate the choice of control systems and enable forecasting and warning too. Due to the need for flexible control constructions, new elastic and prefabricated steel crib dams have been tested in the experimental watershed of the Dürnbach. The newer findings and research results are summarized and discussed in view of the application for other countries, particularly developing countries.

49. Next, Mr. Kronfellner-Kraus, being the leader of IUFRO's Subject Group S 1.04-00 "Torrents, Snow and Avalanches" took the opportunity to inform on several recent activities of IUFRO and, in particular, regarding various specialised meetings which took place on the occasion of the XVI IUFRO World Congress in Oslo. The joint meeting of Subject Groups S 1.03 (Environmental influences) and S. 1.04 (Torrent control) and the meetings of the Working Groups for Snow and Avalanches (S 1.04-02) and Torrents and Torrent Control (S 1.04-01) took place separately during that event. The following meetings will take place in the near future: Working Group S 1.04-02 in Davos/Switzerland; Working Group S 1.04-01 in Japan; Satellite meeting at the 8th World Forestry Congress in Jakarta.

X. SOCIO-ECONOMIC ASPECTS OF MOUNTAIN WATERSHED MANAGEMENT

50. Mr. M. Blais (Forest Service, France), Rapporteur on this subject (item 7 of the Agenda) in introducing the matter, pointed out that a number of presentations during this meeting had dealt with the subject. In his opinion the maintenance of life in mountain areas is conditioned by whether or not the mountain dweller is protected from water-caused erosion and destruction. The best possible protection is permanent plant growth and the forest is the best form of vegetation for protection. Watershed management should envisage a dual purpose:

- to protect rural spaces from abusive interventions by man and from the harmful effects of the exodus from the countryside;
- to keep mountain areas alive.

Rural mountain societies in Western Europe were unable to keep pace after the Industrial Revolution. The result, contrary to present patterns in many other countries, has been population decline. Economic activities in mountain areas are subject to constraints which for most of them constitute real stumbling blocks to development. Watershed management will have a negative impact in certain sectors which will undergo change in the short-term, whereas positive impacts will appear only in the medium or long-term. The downstream impact of watershed management will also have to be taken into consideration.

51. Continuing on this item, the report of Mr. Sanchez-Palomares (ICONA, Spain) "Socio-economic problems of watershed management projects", was introduced by the Spanish delegation, stating that the watershed is a physical and geographic area in which we find a population governed by certain economic and social relations established in a much earlier time. The management of this watershed presupposes a sizeable structural change and therefore an impact on the socio-economic complex of the area which will profoundly alter the above-mentioned web of socio-economic relations. In most cases, these changes lead to an unquestionable rise in living standards, but the

effects will be felt in the medium or long-term. This generates a series of negative effects which often turn into serious stumbling-blocks for the realization of the project. The most serious ones are those relating to land tenure and changing land ownership patterns. Of particular importance are watershed management activities in rural depressed areas since, although the prime purpose is protection, other purposes may also be considered - such as boosting the income as well as the quality of life of these rural populations. Furthermore, in the present economic crisis, which has caused heavy unemployment in these areas, watershed management activities can help to alleviate unemployment and thus contribute to effective employment policies. The medium and long-term impacts of watershed management have their repercussions not only on the people living in the watershed area but on the community as a whole through the social benefits generated. The relation of these benefits is great and its contribution to other economic sectors of the nation frequently decisive.

52. At the suggestion of the Secretariat, the participants were informed by Mr. J.E.M. Arnold (FAO) about the Forestry for Local Community Development Programme. During the discussion it was pointed out that the development of these rural communities through forestry, carried out in a context where the community is both the agent and the recipient of development, was a very valid approach to watershed degradation control. Stress was laid on the need for broader cooperation between developed and developing countries on exchanging expertise and information to develop and intensify forestry activities in favour of rural communities. Agri-silvicultural techniques and silvo-pastoral development of mountain lands were suggested as possible areas of cooperation. The Party's attention was drawn to the difficulties encountered by certain small forest industries in marketing their product internationally, and the impact of this on the income of the population involved. Any newly created small forest industries must take this factor into account, and it must be examined and programmed beforehand, in collaboration with the people living in the watershed.

53. Mr. A. Contreras (FAO) introduced next the secretariat note on the cost/benefit analysis of watershed management projects. He indicated that the FAO Forestry Department is preparing a paper entitled "Economic Analysis of Watershed Projects: Special Problems and Examples". The purpose of this paper is twofold. First, it is being developed to provide background and examples for illustrating principles in FAO's "Economic Analysis of Forestry Projects: Guidelines and Examples". Second, it is being prepared to provide a more detailed treatment of the special economic problems encountered in watershed projects which cannot adequately be covered in detail in EAFP. The first part of the paper presents a discussion of the problems associated with identifying and valuing costs and benefits for watershed projects. Some approaches are suggested, along with comments on "errors to avoid". This discussion is followed by a section dealing with comparisons of costs and benefits for watershed projects, which is illustrated with several examples based on FAO work in various parts of the world. The examples include a project where watershed considerations are treated as a constraint on project activities and a project where the major objective is watershed improvement and management. This first part of the paper demonstrates that economic analysis can only begin once appropriate physical input-output data have been assembled. In order to illustrate what is required, and what can be done, in this respect, the second part of the paper consists of a detailed discussion of the United States literature dealing with cost and benefit identification and valuation for watershed projects.^{2/} The paper ends with some conclusions and recommendations. A major conclusion is that it is difficult to carry out an economic analysis of a watershed project unless the economist works closely during all stages of project preparation and analysis with the other technical specialists involved - the hydrologist, forester, agronomist and engineer. Further, it is concluded that the main problem the project planner and economist faces in carrying out an analysis is the lack of properly

^{1/} Due to be published in late 1978, referred to as EAFP.

^{2/} Prepared by Professor Kenneth Brooks, University of Minnesota.

specified physical input-output data on which to base an identification and valuation of costs and benefits. The problems of comparing costs and benefits once they have been specified and valued appear to be the same ones encountered in appraisals of other types of projects. Finally, it is concluded that a lot more useful information exists than is generally known, or than is used in most project appraisals. There is a critical need to spend more time and effort on bringing together existing information from different sources and to develop some general guidelines which can be used in watershed project planning.

54. Mr. F. Lopez Cadenas (ICONA, Spain) presented his work on the same topic, pointing out that the study of watershed management-derived benefits for forestry projects is a complex and thorny task given the varied nature of such benefits and the fact that most of them are hard to quantify and evaluate. Analysis is based on two basic aspects of support to agriculture: soil conservation in terms of the soil itself and its water retention capacity, and the conservation of reservoir capacity. As for soil conservation, the benefits considered are those accruing from better land and water use resulting from the action taken. Production increases, however, are not necessarily analysed. The impacts of these inputs on land and water are considered and paralleled with the annual expenditure which would be necessary to achieve these impacts. The sum of the annual expenditure considered as benefits generated by these inputs would give the yield of these inputs. The factors analyzed in the overview as economic benefits are:

- those corresponding to benefits generated or damages avoided concerning the soil itself where the work is carried out;
- those corresponding to damages avoided from flood waters flowing normally from high to low areas.

As for the conservation of reservoir capacity, basically what is analyzed are the repercussions of hydro-forestry works aimed at eliminating or alleviating the process of erosion in the feeder basin. The effectiveness of these works (afforestation, control structures etc.) may not be total, i.e. it may not absolutely eliminate sediment transport into the reservoir. The criterion set, therefore, is partial defense, which will range from zero for unmodified watersheds, to 100 for those benefitting from integrated protection. There are other benefits which are not investigated but which may be more decisive for justifying inputs than the question of profit margins. These are: safety for people and towns; the prevention of damage to infrastructures; and the recharge of underground water reserves.

55. As regards the benefits from soil restoration activities on arid lands, particularly in the developing countries, the Working Party acknowledged the necessity for a better analysis of these benefits which should not, however, be too heavily weighed in terms of purely monetary considerations. The Working Party further acknowledged that cost/benefit analyses of integrated watershed management projects is a new area of concern for the Party and felt the need for organizing a special symposium to bring together technicians and economists with a view to improving coordination and making joint assessments of the technical and socio-economic aspects. Emphasis was also laid on the need for continuing analysis of the economic aspects of watershed management projects. In this light, it was suggested that the economists should work on a permanent basis throughout the life of projects of this kind. The intensified involvement of the rural mountain community in forestry actions calls for solid funding, especially for opening and maintaining access roads to reduce the isolation of the population and improve the rural milieu and this raises the problem of financial assistance. The question was discussed.

56. The representative of the World Bank, Mr. F. Heidhues, though he did emphasize the complexity of watershed management problems with regard to methods of financing, mentioned the existence of several projects financed by his organization and presented the details of a kind of integrated management project in Greece financed by the Bank which could serve as a financial model for mountain watershed management activities.

XI. INSTITUTIONAL ASPECTS

57. Mr. T. Eren (FAO) reported on the institutional aspects of watershed management. In his introduction of the subject, Mr. Eren underlined the importance of institutional aspects, which consist of administration, legislation, education and training, in achieving any watershed management activities. He referred to the previous compilation of legislation from member countries but expressed his doubts about the relevance of repeating such an exercise in the light of the enlarged activities of the Working Party and the intended expansion of its participants. Under administration, decentralization and coordination were singled out as prerequisites to efficient and timely operation of field work. Considering the multi-disciplinary nature of watershed activities, the importance of coordination and integration was strongly emphasized. Legislation must provide necessary incentives, broad and flexible policy, and provide participation and motivation of the population concerned. As regards education and training, it was clearly indicated that a multi-disciplinary background, appreciation of each profession, and a people-oriented resource manager type of education, can meet the requirements of future forest engineers and technicians in carrying out their watershed management activities. In view of the heterogeneity that exists in various countries from the point of view of social structure and behaviour, economic facilities and technical abilities, each country's own institutions must be developed accordingly within the above mentioned broad principles.

58. Mr. L. Boggia (Direzione per l'Economia Montana e delle Foreste, Italy) presented a paper on the recent reform introduced in the Italian Forest Service "Notes on the evolution of the Italian legislation concerning the management of mountain watersheds". In Italy the succession of calamities bringing destruction and bereavement to a large part of the national territory, having culminated in 1966 with the incalculable damage brought to the historic and artistic heritage of the town of Florence, has increasingly drawn attention to the need for an integrated management planning policy for mountain watersheds. The Inter-ministerial Study Commission on Water Management and Soil Conservation was thus set up (art. 14 of law No. 632 of 27 July 1967), and the final report of this commission led, after 1970, to a cognitive survey which was carried out by the Joint Senate Committees on Public Works and Agriculture and Forests. From this survey it was clear that it was necessary to promulgate a complete law on this subject and to set up a new organization to ensure close collaboration between the Central Government and the Regions. It was also deemed opportune to establish a unified national policy on a continuing and properly planned basis linked up with the more general policy for town and country planning and for the rational utilization of natural resources. Abandoning the informative criteria of the old and fragmentary legislation existing on the subject, the watershed was recognized as being the territorial unit on which organic operations were to be carried out, and at the same time it was decided to entrust one central administrative body with the coordination work, while the study of phenomena, research, experiments, teaching and training of specialized technical staff were entrusted to technical bodies. But it took quite a long time to achieve this administrative decentralization and to set up regional organizations. Only by the decree of the President of the Republic No. 616 of 24 July 1977 was mountain watershed management institutionalized and the draft bill concerning the first Ten Year Soil Conservation Programme was only presented to Parliament last January and is now taking its course. Moreover, the above bill adapted to the new institutions provides that for each watershed a "Watershed Plan" be studied and approved in support of the Ten Year Programme, for the implementation of which it is planned to earmark an amount totalling 1 996 000 million Italian lire for the ten years 1978-1987. Article 10 of the draft bill, which provides for the establishment of a National Soil Conservation Commission with vast coordinating and study tasks, and article 11, which delegates to the Government the task of an overall recasting of legislation on water resources are noteworthy.

59. Several delegates expressed the view that there is not much in the literature on the evolution of the institutional aspects of watershed management in developed and in developing countries. But discussions revealed the existence of a wealth of well classified literature available to members of Working Parties through the FAO Library and Legal Office.

XII. PUBLICATIONS, MANUALS AND TERMINOLOGY

60. The Secretary of the Working Party, Mr. L.S. Botero, reported firstly on the topic of the Torrent control handbook. He mentioned the way in which the preparation of the handbook was agreed upon at the Working Party's 10th Session (Norway 1972), and of the status of this effort, as follows:

- The avalanche control manual has been completed under the coordination of Mr. Graf and FAO will publish it shortly in French.
- The torrent control manual, for which the outline was discussed in Ankara in 1974, has not made progress.
- The part of the manual on the management of torrential catchments was undertaken by the FAO Secretariat. The series is called the FAO Conservation Guide and four volumes have been published in English up to the present time. The French and Spanish versions are expected to follow within the next few months.

61. Concerning the five language terminology of torrent control, the Secretary of the Working Party mentioned how the work had developed since 1960, when the first French Terminology was presented to the Working Party's session in Spain. The Secretariat has now edited, on the basis of the work of Messrs. Poncet (French), Kronfellner-Kraus (German), Kunkle (English), Benini (Italian) and Botero (Spanish), the text in five languages, the indices in four languages following the alphabetical order of the French terminology and the illustrations referring to the various terms. It is expected that the terminology will be in print during the coming months. Copies of the draft were circulated during the session.

62. As regards bibliography two delegations reported to the Twelfth Session on the latest publications as follows:

- Romania: "The Romanian bibliography on the topic of torrential watersheds management, 1974-1978", compiled by Messrs. S.A. Munteanu, C. Traci, R. Gaspar, P. Abagiu.
- Germany: Publications 1972-1977, compiled by Professor M. Seyberth.

XIII. NEW DIMENSIONS OF THE WORKING PARTY ON THE MANAGEMENT OF MOUNTAIN WATERSHEDS

63. Mr. L.S. Botero, Technical Secretary of the Working Party, presented the Secretariat Note on "International cooperation in the management of mountain watersheds: background, trends, prospects". He began with a brief history of watershed management, its origins and spread, the role of FAO at the pioneering stage and the activities and evolution of the Working Party on the Management of Mountain Watersheds. After an examination of some particular problems of developing countries in this area, the paper presented some proposals for cooperation among developing countries within the context of future activities of the Working Party.

64. One of the recent developments pointed out by the Secretariat note was the fact that the FAO Committee on Forestry (COFO), at its Fourth Session in Rome from 15 to 19 May 1978, in considering the EFC decision to expand the Working Party's composition to include developing countries, supported the decision and expressed satisfaction that countries outside Europe would be invited to the Working Party's Twelfth Session. COFO agreed with the "internationalization" of the Working Group and asked the Secretariat to consider the possibility of its transformation into a COFO Working Party, in accordance with the relevant rules governing the establishment of statutory and subsidiary bodies of FAO.

65. It was noted by the Secretariat that similar Working Parties had been created under Regional Forestry Commissions, but FAO was unable to provide the necessary secretarial support for their normal operation.

66. Whether a Working Party under COFO is set up or whether another method is adopted, it is desirable to find a machinery to promote cross-fertilization between countries where watershed management techniques have been perfected in the course of several decades and countries where efforts are being made to introduce such techniques. This exchange would be a two-way process. On the one hand, the experience of European countries, the United States, Canada, Japan, Australia, New Zealand and China, which are the most advanced countries in this field, would be examined by developing countries for its application. On the other hand, experts of the most advanced countries could examine with their colleagues in Asia, Africa and Latin America the problems of mountain areas in developing countries and the technological and socio-economic factors which have to be taken into account in innovating and adapting appropriate management systems and techniques.

67. Concerning the themes to be examined for a long-term programme of the expanded group, the following areas were suggested by the Secretariat:

- analysis of problems arising out of the improper use of mountain lands;
- ways and means of motivating and organizing the rural community with a view to its active participation in relevant activities;
- improvement of labour intensive techniques capable of alleviating unemployment;
- economic analysis of project benefits and methodological aspects of project formulation;
- policy, legislation, administration and large-scale implementation of watershed development activities;
- applied research on processes of erosion, hydrologic analysis and flood peak forecasting, blueprints for dams and other restoration measures, the influence of plant cover etc.

68. Considering the history of international cooperation in watershed management and the evolution of the EFC Working Party on the one hand and the need for extending the benefits of the developed countries' ample experience to other countries, as pointed out in the decision of the Eighteenth Session of EFC and confirmed by the recommendation of the Eighth COFO Session, the Working Party is requested to consider the prospects offered by extension to developing countries. In particular, it would be desirable to make proposals on:

- the structure of an "internationalized" Working Group;
- the subjects of work and cooperative efforts that should be undertaken;
- the frequency of ordinary sessions and of regional or specialized colloquia or symposia; and
- the possible role of the Working Party, as an advisory body to FAO, in technical assistance to developing countries.

69. Following the introduction of the topic made by the Working Party's Secretary, Professor Munteanu, Chairman of the Working Party, gave a brief retrospective description of the situation. He indicated that "internationalization" is a reflection of the changes occurred in the world since the establishment of the Working Party 28 years ago. He briefed the meeting on the circumstances which, at the time of the Eighteenth Session of the European Forestry Commission, made it possible for the Working Party to resume its activities and to convene the Twelfth Session. The Chairman pointed out that the Working Party finds itself today at a decisive turning point, because of the enlarged terms of reference under which the Working Party is now to concern itself with the problems of developing countries and because of the recommendation of COFO for the internationalization of the Working Party. He pointed out that internationalization is the only way to ensure the continuation of the activities of the Working Party but this internationalization should not imply neglecting the specific problems of European countries in the field of watershed management and avalanche control.

70. The Chairman presented a proposal to the Working Party which, with slight modifications proposed by the delegations of the Federal Republic of Germany and of Spain, was unanimously accepted. The text follows: " The Working Party noted the COFO recommendation that it should be "internationalised" by being transformed into a Working Party of COFO ^{1/}. It, therefore, recommended to the European Forestry Commission that it formally endorse, on the occasion of its next meeting, the above COFO recommendation. Notwithstanding the above the Working Party considered that there existed in the field of mountain watershed management important problems which were specific to European countries and which should be more adequately reviewed and studied on the occasion of meetings organized by these countries without duplicating with the activities of the newly created international working party".

71. During a lively debate on the future of the Working Party, several participants intervened. The Observers from Iran, Iraq, Mexico, Panama, Tunisia and the United States expressed their satisfaction with the internationalization of the Group and their gratitude for the opportunity which had been given to them to participate in the 12th Session of the Working Party. Questions were raised on the procedures connected with the internationalization of the Group. Mr. Huguet, explained that since the Working Party constitutes a subsidiary body of the Commission, the Commission should be requested to endorse the COFO recommendation that the Working Party be transformed into a subsidiary body of COFO. On the other hand, since COFO is a standing committee of the FAO Council, it should report in due time to the Council its recommendation for the "internationalization" of the Working Party as a COFO subsidiary body.

72. The Chairmain of the Working Party suggested that it would be desirable, between every two regular sessions of the Working Party to hold a colloque or a symposium on the specific watershed management problems of the European countries, with the moral and intellectual support of FAO, but at the expense of the participating countries. In this connection the Chairman kindly requested the delegations of Austria, Spain and France to explore the possibilities of organizing in 1979 and 1981 specialized meetings.

73. Mr. R. Blais, delegate from France, expressed his agreement with this proposal of the Working Party's Chairman and pointed out that, subject to the approval of the concerned authorities in his country, France would very much like to host a specialized symposium of the Working Party in Grenoble in 1980. The specific topic of the symposium would be defined later on, consulting the Executive Committee of the Working Party.

^{1/} See para 41 - CL 74/8 Report of the 4th Session of COFO (May 1976)

74. Following the discussion on the topic, Mr. J. Morris, observer from New Zealand, informed the participants that his country would be hosting an international symposium on soil erosion and the effect of man in mountain environments in January-February 1981. Contacts would have been made for this event with AIHS. The Working Party's specialists would be most welcome to attend.

75. Prof. Munteanu pointed out as well that he discussed with Mr. Kronfellner-Kraus on the topic of in-between meetings, and Mr. Kronfellner-Kraus had expressed his agreement for organizing a joint meeting with IUFRO's Subject-Group in September 1979 in Austria.

76. Regarding meetings to be addressed to the particular problems of Europe, Mr. Huguet, Director of the Forest Resources Division, stated that FAO's moral support was always possible, but that FAO could not commit budgetary resources for meetings other than those which are approved by the Conference in FAO's Programme of Work and Budget.

XIV. PROGRAMME OF WORK

77. The Working Party agreed to the outline of the long-term work programme proposed by the Secretariat (see para 66). It then examined the proposals for the short-term programme of work formulated by the four ad hoc committees which were set up by the Executive Committee as follows:

- i) Planning, coordinated by Mr. R. Blais (France)
- ii) Technical and scientific aspects, coordinated by Mr. S. Puglisi (Italy)
- iii) Socio-economic aspects, coordinated by M.H. Tschinkel (FAO)
- iv) Organization of research, coordinated by Dr. A. Kowsar (Iran)

In addition a fifth ad hoc Committee was established in order to proceed the work on manuals and terminology composed as follows: Messrs. Benini, López Cadenas, Munteanu, Lichtenhan, Fattorelli, Seyberth, Puglisi, Goujon and Botero. The four ad hoc committees presented their proposals to the Plenary Session and they were approved as stated in the following paragraphs.

78. Planning: The Working Party notes that the planning of watershed management operations is felt by the participants to be a priority issue and that no methodology in this field has been sufficiently tested to be universally recommended. It recommends that before any planning takes place, management objectives be clearly defined with the closest possible co-operation of all interested parties; that the Party investigate whether a single methodology is applicable to the objectives no matter how diverse natural and socio-economic conditions may be; and that planning be the responsibility of a multidisciplinary team including technical experts, economists and sociologists. It proposes that a detailed report be prepared on the points set forth in the recommendations and that Mr. Blais of the French Delegation together with Mr. Udhai Chanphaka (Thailand) be delegated to report on this subject.

Technical and scientific aspects

79. Calculation of maximum torrent flow: The Working Party being aware and convinced of the usefulness of a joint methodology for estimating maximum flows for the needs of torrential watershed management projects; and having been informed of the results of advanced studies in this field in Romania, recommends that Professor Munteanu have a detailed paper delivered to members of the Working Party on the methodology developed by Romanian specialists so that interested countries can investigate the possibility of testing it, with a view to its adaptation in practice. The Working Party proposes that Prof. Munteanu, R. Gaspar and I. Clinciu (Romania) as the major speakers on this subject prepare a detailed report on this subject in the light of data to be obtained from member countries.

80. Torrential erosion potential: The Working Party considering the importance of quantification of torrential erosion potential in view of the classification of torrential watersheds and for the planning of integrated watershed management actions, recommends that a study on torrential erosion potential be carried out in order to identify a formula for assessing this potential quantitatively. Prof. Puglisi (Italy) is proposed to head up the report on this study.

81. Methodology of Erosion Investigation in Watersheds: The Working Party considering that the quantification of erosion in watersheds constitutes a major basic datum for integrated management, recommends that an investigation of erosion studies methodology be undertaken with a view to harmonizing the findings on erosion quantification calculation. Prof. F. Lopez Cadenas (Spain) is proposed to head up the report on this study.

82. Influence of Plant Cover on the Coefficient of Flow of Torrential Watersheds: The Working Party considering the influence of plant cover on the coefficient of flow, considering the abundant literature in this subject, recommends that data on expertise in this field be collected and analyzed and a detailed report prepared for presentation at the next session of the Working Party. Prof. Sergio Fattorelli (Italy) is proposed to head up this report.

83. Hydro-engineering works: The Working Party considering that the exchange of information on hydro-engineering works constitutes a useful tool for progress and for improving the quality and effectiveness of gully erosion and torrent control activities; aware that such exchanges have not taken place in a systematic fashion, noting the existence of certain new data, recommends the preparation of a catalogue on recent techniques for the implementation of gully erosion and torrent control structures. Mr. E. Hernandez (Venezuela) is proposed to head up the report on this subject.

84. Replanting of degraded land in arid and semi-arid zones: The Working Party considering the existence in all countries of the Mediterranean Basin of vast zones of degraded land for which physical techniques of rehabilitation are ineffective, recommends that a detailed report be prepared on this subject and proposed Mr. H. Hadri (Tunisia) to head up this study.

85. On the basis of an additional proposal of the delegation from the Federal Republic of Germany, it was agreed that Prof. Seyberth (Germany) will contribute his research findings on the calculation of peak torrential flow. He will also make available to the coordinator of the "Erosion Studies Methodology" report his findings on the quantification of the influence of different erosion factors obtained by using rainfall simulators with intensities of 80 - 100 mm/h.

Social and economic aspects of watershed management

86. Until now, efforts of the Working Group have concentrated on the technical aspects of watershed management and torrent control as they apply in Europe. However, in developing countries such technical solutions are frequently blocked by social and economic constraints. As the Group opens its doors to the participation of developing countries, it is essential that greater emphasis be placed on the social and economic aspects affecting watershed management in these countries. Two main topics should be examined and developed as indicated in the next two paragraphs.

87. Basic socio-economic studies and project design: The Working Group recommends that under the coordination of FAO's Forestry Department Economics and Planning Unit, the following effort be undertaken:

- a) All agencies involved in watershed management projects give greater consideration to the social and economic aspects during the stages of project design, execution as well as evaluation. This will require the inclusion of the appropriate specialists on project teams.

- b) The exchange of practical experiences on the socio-economic aspects of watershed management be intensified through more frequent contacts and surveys by the Working Group. Documents demonstrating the socio-economic benefits of watershed management should be prepared and distributed by FAO.
- c) Since inappropriate land tenure is one of the most common constraints to proper land management, this aspect should be included in watershed studies and their application. FAO should carry out a study of land tenure legislation which encourages proper watershed management.
- d) National and international agencies which finance projects for the construction of infrastructures, especially for the construction of dams, should include, if appropriate, a component for the management of the watershed from the beginning.

88. Participation of the local population: In order to count on the support of the local population affected by the watershed management activities, they themselves should participate in the major management decisions which influence their lives. This implies the creation of formal organizational structures that permit horizontal communication among this population, as well as vertical two-way communication between the population and the relevant authorities. Appropriate communication and educational packages aimed at rural inhabitants should be developed by FAO and evaluated in selected developing countries. The Working Group and FAO should encourage and support strategy of Forestry for Local Community Development as an effective tool of watershed management. FAO should organize a study on the use of incentives for soil conservation and watershed management. The follow-up on this area will be coordinated by Mr. L.S. Botero, Secretary of the Working Party.

Recommendations on research priorities

89. The main emphasis of the Watershed Research Committee members was on the need of the developing countries for availability of information on applied research related to erosion of watersheds, according to assigned priorities within a country. Much of such information is already available in the developed countries who could contribute substantially in this context. In order to have this information locally available, the Committee recognizes the need for some basic data collection on the country watersheds. As such data collection is costly, the minimum data requirements have to be assessed. The attached Appendix deals with such requirements for the hydrometeorological and other data needed as inputs for a successful research programme. It was agreed that methodologies regarding the determination of soil degradation occurring on watersheds be evaluated; influence of various land uses, prevalent on watersheds, on such degradation be explored; and the benefits derived as a result of erosion preventing measures be assessed in relation to the costs involved.

90. The ad hoc Committee suggested that the research on evaluation of soil protection measures should include:

- a) Evaluation of the most suitable species for the particularly harsh environment existing on eroding sites.
- b) Experimentation on range improvement techniques as an integral part of preventive measures applied on critical watersheds, especially in the arid and semi-arid regions.
- c) Research on determining cheaper and effective methods of building soil conservation structures through mass production of component blocks.
- d) Experimentation on the assessment of alternative methods available for logging steep slopes on mountain watersheds, especially for the developing countries hitherto lacking in such information.

- e) Research in road layout and construction techniques required for hauling of forestry raw materials to satisfy the growing requirements of the modern industrial complexes that are being installed in some rapidly developing countries.
- f) Exploration of water harvesting and water conservation techniques for areas with limited precipitation.

91. The ad hoc Committee recommends that international organizations and the Working Party collaborate in establishing a pool of available information and finances, to assist the needy countries. The Working Party should also help the developing countries in selecting suitable experts for meeting the many challenges involved in doing research in these countries. The ad hoc Committee considers it noteworthy to mention that the suggestion by Mr. Kronfellner-Kraus to hold special joint meetings of FAO and IUFRO to solve some of these problems is a step in the right direction. The invitation and suggested topic of the next joint meeting in Austria, dealing with "Hydrological Research in Small Torrential Watersheds", are wholeheartedly endorsed by the Committee.

XV. ELECTIONS, VARIOUS MATTERS AND CLOSING OF THE SESSION

92. During the last day of the meeting, the place and date of the next session were chosen. The observer of Iran offered, subject to confirmation from the Iranian Government, his country to host the next session. Since Mr. L. Huguet, indicated that because of budgetary reasons it would not be possible to hold the next session before 1982, it was agreed to hold the session in Iran that year.

93. At this point, since the Executive Committee of the Working Party for the coming period was to be elected, the Chairman, Professor S. Munteanu (Romania) and the Vice-Chairmen, Messrs. S. Puglisi (Italy) and G. Lichtenhahn (Switzerland), presented their resignations. Mr. Lichtenhahn expressed the desire to be replaced on the Executive Committee. The session continued to be chaired temporarily by Mr. L. Huguet and the proposals of the delegations for the new Executive Committee were presented. Professor S. Munteanu was reelected as chairman and Professor S. Puglisi was also reelected as first vice-chairman. Professor F. López Cadenas de Llano (Spain) was unanimously elected as second vice-chairman.

94. In view of the preparations for the next session and in order to assist the Secretariat in securing the continuity of the work of the Working Party in its new "international" capacity, an ad hoc committee, called "Preparatory Committee of the International Working Party and of the 13th Session of the Working Party", was established. This committee will be composed of the Executive Committee of the Working Party plus the following participants, subject to confirmation from the relevant authorities in each country: Dr. A. Kowsar (Iran), Mr. H. Hadri (Tunisia), Mr. E. Hernandez (Venezuela), Mr. G.H. Nelson (U.S.A.), Mr. J. Morris (New Zealand), Mr. M. Harris (Indonesia).

95. The Secretary of the Working Party presented the draft final report of the 12th Session which was adopted.

96. At the closing ceremony, Mr. M.A. Flores Rodas, Assistant Director-General, Forestry Department of FAO, took the floor expressing the satisfaction of the Forestry Department of FAO with the work and the evolution of the activities of the Working Party, particularly from the 5th and the 9th sessions on, when the Working Party became more aware of the importance of socio-economic issues of mountain watershed management. He pointed out the significance of the 12th session in the light of the EFC recommendation for promoting a process of cross-fertilization between the rich experience 28 years of development of methods and techniques in the European countries and the challenging problems and innovative ideas of developing countries which are working in the area of mountain watershed management. Both developed and developing countries have a lot to win and there should be no fear that within an "internationalized" framework the working party may satisfy the needs and

expectations of all the countries interested in the subject. The FAO Secretariat will secure that the various activities and the flow of information will contribute to a very beneficial exchange between the specialists in the various countries.

97. The Chairman, in replying to Mr. Flores Rodas, expressed his hope that the reactivation of the Working Party's activities, in its expanded framework, will receive an effective support on behalf of FAO. He expressed at the same time his thanks to the FAO personnel who contributed to the satisfactory development of the 12th Session, including the secretaries, interpreters and translators. Finally he declared the 12th Session to be closed.

Annex A

AGENDA

1. Opening of the session - Reports of the Chairman and the Secretariat
2. Watershed management in developing countries: introduction and case studies
3. Methods for the study of erosion and sedimentation, in view of the implementation of watershed management activities
4. Methodology and basic data for integrated watershed management planning
5. Technical aspects: hydrotechnical measures and influence of vegetation cover in the hydrological behaviour of watersheds
6. Results of research; development of new techniques and new methods for watershed management and mountain land rehabilitation; priority needs in research and cooperation between countries
7. Socio-economic aspects of watershed management; environmental impacts of watershed management and rehabilitation work; cost/benefit analysis of watershed management projects
8. Institutional aspects: administration, legislation, education, training
9. Publication, manuals and terminology
10. New dimensions of the activities of the Working Party on the Management of Mountain Watersheds
11. Other matters
12. Approval of the report
13. Closing of the Session

ANNEX B
ANNEXE B
ANEXO B

LIST OF PARTICIPANTS
LISTE DES PARTICIPANTS
LISTA DE PARTICIPANTES

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Vice-Chairmen	S. Puglisi (Italy/Italie/Italia)
Vice-Présidents	C. Lichtenhahn (Switzerland/ Suisse/Suiza)
Vicepresidentes	
Secretary	L.S. Botero (FAO)
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Annex C

LIST OF DOCUMENTS

FO:EFC/MW/78/1	Provisional agenda
FO:EFC/MW/78/2	Provisional timetable
FO:EFC/MW/78/3	Economic analysis of watershed projects: special problems and examples - Secretariat Note
FO:EFC/MW/78/4	International cooperation in the management of mountain watersheds: background, trends, prospects - Secretariat Note
FO:EFC/MW/78/Inf. 1	Information note
FO:EFC/MW/78/Inf. 2	Annotated provisional agenda
FO:EFC/MW/78/Inf. 3	List of documents
AUSTRIA	
FO:EFC/MW/78/A.1	Newer contributions of research in order to achieve a successful watershed management, by G. Kronfellner-Kraus
FO:EFC/MW/78/A.2	Activities of the IUFRO Subject Group for torrents, snow and avalanches and proposals for closer cooperation with the Working Party, by G. Kronfellner-Kraus
CZECHOSLOVAKIA	
FO:EFC/MW/78/CZ.1	Forest transpiration as a means of the water balance regulation, by J. Balek
CAPE VERDE	
FO:EFC/MW/78/CV.1	National report, by A.Q.C. Semedo
FRANCE	
FO:EFC/MW/78/F.1	National report, by R. Blais
FO:EFC/MW/78/F.2	Study of the influence of natural vegetation cover and its modifications: experiences in comparative watersheds made in the tropics, by C. Bailly
FO:EFC/MW/78/F.3	Forests and watershed management, by G. Roger

GERMANY (FED. REP. OF)

FO:EFC/MW/78/D.1 Report on the Federal State of Bavaria, by M. Seyberth
FO:EFC/MW/78/D.2 Publications 1972-1977, by M. Seyberth
FO:EFC/MW/78/D.3 The designed discharge capacity of torrents, by M. Seyberth

HONDURAS

FO:EFC/MW/78/HON.1 Watershed management in Honduras, by H. Tschinkel

IRAN

FO:EFC/MW/78/IR.1 Watershed management in Iran, by F. Niknam
FO:EFC/MW/78/IR.2 Assessing erosion patterns in the Dez watershed of Iran,
by T. Singh
FO:EFC/MW/78/IR.3 Landslide stabilization by subsurface drainage and surface
application of asphalt, by A. Kowsar and M. Abdi

IRAQ

FO:EFC/MW/78/IQ.1 Watershed management in Iraq
by A.R.M. Anwar and R.H. Hassoun Obaidi

ITALY

FO:EFC/MW/78/I.1 National report, by S. Puglisi and E. Giordano
FO:EFC/MW/78/I.2 Notes on the evolution of the Italian legislation concerning
the management of mountain watersheds, by L. Boggia

NEW ZEALAND

FO:EFC/MW/78/NZ.1 National report, by J. Morris

NORWAY

FO:EFC/MW/78/N.1 National report, by B. Andersen
FO:EFC/MW/78/N.2 Water use and development in Norway, by the Norwegian Preparatory
Committee for the UN Water Conference

PANAMA

FO:EFC/MW/78/PAN.1 The watershed administration programme. MIDA-AID Agreement,
by A.A. Saenz

ROMANIA

- FO:EFC/MW/78/R.1 National report (1974-1978), by S. Munteanu
- FO:EFC/MW/78/R.2 Contributions regarding run-off in small torrential watersheds, by R. Gaspar and E. Untaru
- FO:EFC/MW/78/R.3 The calculation of maximum discharge of torrents, by R. Gaspar, I. Clinciu and N. Lazar
- FO:EFC/MW/78/R.4 Considerations on certain basic aspects regarding the management of small torrential watersheds, by S. Munteanu, R. Gaspar and I. Clinciu
- FO:EFC/MW/78/R.5 New orientation of the activities of the Working Party on the Management of Mountain Watersheds, by S. Munteanu
- FO:EFC/MW/78/R.6 The Romanian bibliography on the topic of torrential watershed management 1974-1978, by S.A. Munteanu, C. Traci, R. Gaspar and P. Abagiu

SPAIN

- FO:EFC/MW/78/E.1 National report by F. Lopez Cadenas de Llano
- FO:EFC/MW/78/E.2 Methodology for erosion studies in a watershed of the Segura River, by F. López Cadenas de Llano and J. Aguiló Bonnin
- FO:EFC/MW/78/E.3 Methodology and basic data for integrated watershed management planning, by F. López Cadenas de Llano
- FO:EFC/MW/78/E.4 Problems and applicable methodology for the "ramblas" of South Eastern Spain, by J.L. Parra Ortum
- FO:EFC/MW/78/E.5 Influence of hydro-forestry work in flood peaks, by F. Rojo Saiz
- FO:EFC/MW/78/E.6 Hydro-forestry restoration of watersheds for an integral hydro-power utilization, by A. Pérez-Soba and N. Camacho-López
- FO:EFC/MW/78/E.7 Socio-economic problems of watershed management projects, by P. Sánchez Palomares
- FO:EFC/MW/78/E.8 Cost/benefit analysis of watershed management projects, by F. López Cadenas and J. Aguiló Bonnin
- FO:EFC/MW/78/E.9 Afforestation techniques in the Mediterranean drainage basin, by J.L. Montero de Burgos and J. García Salmerón
- FO:EFC/MW/78/E.10 Comments on the various methodologies which are applied for erosion studies in watershed management, by M. Blanco-Criado

SRI LANKA

- FO:EFC/MW/78/SL.1 A research project on hydrology and soil erosion in mountain watersheds in Sri Lanka, by N.W. Hudson

SWITZERLAND

- FO:EFC/MW/78/CH.1 General report by the Federal Service of Roads and Dikes and the Federal Inspectorate of Forests
- FO:EFC/MW/78/CH.2 Overview of flood protection work in Switzerland, by C. Lichtenhahn

TUNISIA

- FO:EFC/MW/78/TN.1 National report, by Saadallah Jameleddine
- FO:EFC/MW/78/TN.2 Effects of soil use on watershed hydrology, by H. Hadri
- FO:EFC/MW/78/TN.3 Choice of species for gully erosion control in Tunisia, by H. Hadri
- FO:EFC/MW/78/TN.4 Methodology followed in Tunisia for watershed management surveys, by P. Dimanche

VENEZUELA

- FO:EFC/MW/78/V.1 The Venezuelan experience in the organization of watershed management, by E. Hernandez

YUGOSLAVIA

- FO:EFC/MW/78/Y.1 Methods for the study of erosion and sedimentation in view of the implementation of watershed management activities, by M. Djorovic
- FO:EFC/MW/78/Y.2 The erosion control and crop productive effects of bench terraces on sloped land in Republic of Serbia, Yugoslavia, by M. Djorovic.

TIMETABLE

Monday, 18 September

- 8.30 Registration
- 9.30 Opening of the 12th session of the Working Party. Reports by the Chairman and the Secretariat
- 11.00 Watershed management in developing countries. Introduction (T. Eren, FAO)
- 14.00 Case studies: The Karadj and Latian watershed management projects (F. Nilnam, Iran)
- 16.00 Audio-visual presentation of other experiences from developing countries

Tuesday, 19 September

- 8.30 Methods for the study of erosion and sedimentation, in view of the implementation of watershed management activities (Rapporteur: M. Djorovic)
- 11.00 Methodology and basic data for integrated watershed management planning (Rapporteur: F. Lopez Cadenas de Llano)
- 14.00 Hydrotechnical measures for watershed management and torrent control (Rapporteur: S. Munteanu)

Wednesday, 20 September

- 8.30 Influence of vegetation cover on the hydrological behaviour of watersheds (Rapporteur H.M. Brechtel)
- 14.00 Results of research; development of new techniques and new methods for watershed management and mountain land rehabilitation; priority needs in research and cooperation between countries (Rapporteur: G. Kronfellner-Kraus)
- 16.00 Audio-visual presentation of watershed management work in Switzerland, Spain and other countries

Thursday, 21 September

- 8.30 Socio-economic aspects of watershed management; environmental impacts of watershed management and rehabilitation work; cost/benefit analysis of watershed management projects (Rapporteur: R. Blais)
- 14.00 Institutional aspects: administration, legislation, education, training
- 15.00 Publications, manuals and terminology
- 16.00 Audio-visual presentation of work in the countries

Friday, 22 September

- 8.30 New dimensions of the activities of the Working Party on the Management of Mountain Watersheds
- 14.00 Any other business. Choice of place and date of the next session of the Working Party. Election of the Executive Committee of the Working Party
- 16.30 Approval of the Final Report. Closing of the 12th session of the Working Party on the Management of Mountain Watersheds.

Saturday, 23 September

- 14.00 Departure for study tour in Basilicata

Sunday, 24 September

- 8.00 Study tour

Monday, 25 September

- 8.00 Continuation of study tour

Tuesday, 25 September

- 8.00 Continuation of study tour

Wednesday, 26 September

- 18.00 Return to Rome

ITINERARY OF THE STUDY TOUR IN BASILICATA

(23 - 27 September 1978)

The study tour in the Basilicata Region, in Southern Italy was organized by the Direzione Generale per l'Economia Montana e per le Foreste, which kindly provided the transportation and made all the logistical and technical arrangements.

- Saturday 23: Departure at 14.00 and travel Rome-Potenza-Rifreddo.
- Sunday 24: In Trivigno, visit to landslide consolidation work consisting of remodelling, drainage, network for collecting the water in prefabricated concrete canals and retention dams, arch dams in gabions and protective planting of trees and other vegetation.
- In Castelmezzano, visit to works of landslide consolidation consisting of remodelling, drainage, network for collecting the water in prefabricated concrete canals and retention dams.
- In Laurenzana visit to managed mixed natural forest
- Monday 25: In Calciano visit to stabilization work of the landslide "Carbotta" by means of filtering sink holes, carried on by the Impresa Lodigiani.
- In Pisticci visit to watershed stabilization work through the correction of the river bed with earth dams and concrete spillway, drainage networks and afforestation. Visit to the landslide in the town.
- Visit to the Giuliano dam on the Bradano river
- In Montescaglioso visit to correction work in Fosso Perito by means of correction of the river bed with combined dams, consolidation of landslides and afforestation.
- Tuesday 26: In Metaponto visit to coastal afforestation and sand dune stabilization work.
- Visit to the Petusillo dam on the Agri river
- Visit in the Upper Agri valley to river channel stabilization work, torrent control structures and afforestation work conducted by the Consorzio di Bonifica dell'Alta Val d'Agri.
- Wednesday 27: Return trip Rifreddo-Rome.

