REPORT

EUROPEAN FORESTRY COMMISSION

Lillehammer,
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1-9 July
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Working Party on the Management of Mountain Watersheds

Twentieth session

Food
and
Agriculture
Organization
of
the
United
Nations

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WORKING PARTY ON THE MANAGEMENT OF MOUNTAIN WATERSHEDS

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FINAL REPORT

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I. INTRODUCTION

1. The Twentieth Session of the European Forestry Commission's Working Party on the Management of Mountain Watersheds was held in Lillehammer, Norway, from 1 to 5 July 1996 at the kind invitation of the Government of Norway. The meeting took place at the Lillehammer Hotel, and was followed by a study tour organized by the Host Government, illustrating sustainable watershed management, torrent and avalanche control, forestry and hydrology in south-central and southwestern Norway from 6 to 9 July. The agenda, timetable and study tour programme are given in Annexes A, B and D.

2. The Session was attended by 64 delegates and observers from 14 EFC member countries: Austria, the Czech Republic, Finland, France, Germany, Israel, Italy, Latvia, Norway, Poland, Romania, Spain, Sweden and Switzerland, and from 11 non-European countries: Chile, China, India, Japan, Laos, Morocco, Nepal, South Korea, Tunisia, the United States of America and Venezuela. One representative of the International Union for Forestry Research Organizations participated. The list of participants is given in Annex (C).

3. The Chairman of the Working Party, Mr L. Rojo Serrano, Spain, chaired the discussions together with the two Vice-Chairmen, Mr A. Göttle, Germany and Mr J.Krecek, the Czech Republic. Mr S. Kunkle, Secretary of the Working Party for the Twentieth Session and Mr. S. Borelli, Associate Professional Officer, from FAO's Forest Conservation, Research and Education Service coordinated the meeting with the precious collaboration of Mr H. Haga and E. Beheim of the Norwegian Water Resources and Energy Administration and of Ms Bente Bjorkoy of Lillehammer Arrangement AS. Thestudy tour was organized and conducted by NVE and was coordinated by B. Wold, Director of the Water Resources Department, NVE and A. Tvede, Section Manager of the Hydrology Department, NVE.

4. Mr L. Rojo Serrano welcomed the participants from EFC member countries and overseas observers. He expressed his satifaction for the opportunity to chair the session, especially for such a large number of participants. He complimented the Norwegians for the excellent arrangements and underlined the importance of the theme they had selected, "Restoration of Mountain Watersheds". He pointed out that the Working Party has the distinction of viewing the protection of natural resources from an integrated and holistic perspective. This distinct perspective should be valued, especially within the concept of sustainable mountain development. Another important value of the Working Party is its role of promoting information exchanges and interactions among technicians and academics from the various countries. Mr. Rojo underscored the value of having observers present, which further extends the Working Party's insight into watershed management around the world.

5. Mr. Knut Korsaeth, County Governor, Oppland County welcomed the participants to Norway, noting that Lillehammer's recent experience in hosting the Olympics make it a natural site for a meeting of many countries. He pointed out that the goal of Norwegians is also to "take care of mountains in the best possible way" and that in Norway the counties work closely with various national agencies to accomplish this goal.

6. Deputy Mayor of Lillehammer, H. Larsen, appreciated the importance of the meeting, and pointed out that in the municipality they include the spirit of Agenda 21 in all aspects of general planning. She gave an

overview of the town, its culture, history and people. She described the challenges of hosting the Oympics in such a small town with only four years to make all the preparations, explaining how the effort was both positive and ecologically sound. A number of lasting values resulted to Lillehammer, for example, an outstanding water treatment facility was created. Special attention was focused on environmental protection throughout the endeavour.

7. Mr. J.P. Lanly, Director, Forest Resources Division, welcomed both the delegates and observers on behalf of the Director-General of FAO and the Head of the Forestry Department, and thanked the Government of Norway and the General Directorate for Water Resources and Energy for all the excellent efforts they had made to prepare and host the session. He personally thanked the two key logistics persons, Mr. Haga and Ms. Bjorkoy, and expressed appreciation to the town and county for their hospitality and to the Norwegian Agency for Development for their support of observers. He noted that the Working Party first met 44 years ago, and compared to past sessions that the Twentieth Session has an exceptionally large number of countries represented. He gave an overview of five key goals for the Twentieth Session: (i) to summarize accomplishments in the various aspects of mountain development that have taken place in the individual European countries during the past two years; (ii) to present and discuss some "special reports," such as work on Chapter 13; (iii) to offer technical reports --the basic material of the meeting; (iv) to conduct the special IUFRO session on research; and (v) to develop a "Mission Statement and Credo" for the Working Party.

8. Mr. B. Wold, Director, Water Resources Department of the Norwegian Water Resources and Energy Administration (NVE) welcomed the participants on behalf of NVE and its Director General Mr. E. Diesen, expressing their pleasure with the opportunity to host the Twentieth Session. He described his Administration's overall roles and functions in watershed and water management within the country of Norway, noting the importance of hydroelectric power production as well as watershed management. He noted how their efforts tie well to the theme, "the Restoration of Mountain Watersheds."

Mr. Wold then declared the work of the Twentieth Session officially open.

9. The Working Party adopted the proposed agenda and timetable given in Annexes A and B.

II. NATIONAL REPORTS

10. Delegations of the following countries presented national reports: Austria, Czech Republic, Finland, France, Germany, Israel, Italy, Latvia, Norway, Poland, Romania, Spain, Sweden and Switzerland. Observers from the following countries presented general overview reports of their respective countries: Chile, India, Morocco, Nepal and Tunisia.

11. Mr. G. Fiebiger presented the national report of Austria. About 62 percent of the national territory is torrent or avalanche prone, and in high mountain areas the percentage may be 90 percent, so mountains play a big role. The Forest Technical Service for Torrent and Avalanche Control has 1720 employees, and this Service has 1200 protection type projects under construction in hazard zones. Some major objectives: improve protective forests; conduct reforestation in high areas; and provide for seed and propagation materials. Land use planning

provides for an evaluation system for the multi-functional performance of forests and for protection of water supplies.

12. Mr. J. Krecek presented the Czech Republic's national report. Sixteen percent of the country is covered by mountain forests, which play a key protective function. Emphasis is currently on "ecological forestry," and since 1989 more emphasis has been given to environmental protection; still, 75 percent of mountain forests have been damaged by air pollution or other impacts, and 25 percent have been "devastated." Some improvements in acid rain impacts are now occurring, and work is under way to rehabilitate forests. The country is now moving toward sustainable management of watersheds and, following the Strasbourg Resolution 4, a number of projects is under way, mostly in conjunction with Earthwatch, the World Bank and UNESCO.

13. Mr. E. Kubin presented the national report of Finland. In the utilization of forests, special attention has been given to the effects on watercourses and the protection of water ecosystems. Objectives are to protect water and biodiversity, and environmental issues are becoming an integral part of silvicultural practices. Regional ecological planning is the basis for preserving habitats and stressing "environmentally friendly silviculture." Forestry industries have been provided with a guide on "Forestry and Protection of Watercourses," and forest policy in the last few years has been evolving towards the protection of ecosystems, especially water.

14. Mr. J. Charry presented the national report of France. During 1994-95 several significant floods and landslides occurred, resulting in deaths and the destruction of communication channels and infrastructures, including a storm near Nice causing over a billion francs damage. The 1882 law Restoration of Mountain Lands and new 1995 legislation on prevention and planning provide for financing of restoration work in areas of catastrophe and for financing prevention measures and, in some cases, for expropriation. Universities, CEMAGREF and technical schools continue their research in avalanches, torrents, reforestation, modelling, hydraulics and other mountain topics. CEMAGREF's research funding for natural hazards is 6 million francs per year. The National Forest Office has a Service for Restoration of Mountain Lands (RTM), funded at about 130.5 million francs per year. Activities include land purchase, torrent correction, avalanche control, with emphasis at the community level. The technical work by RTM is about: 8% avalanches, 14% landslides, 8% rockfalls, and 70% torrential or surface erosion.

15. Mr. A. Göttle presented the national report of Germany. Torrent control, avalanche control, afforestation and forest improvements in Bavarian alpine areas cost about DM 70 million during the last two years. This work brought additional areas of mountain watersheds under protection against erosion, mudflows and other dangers. Research on torrential processes helped to expand the knowledge base for torrents, runoff, erosion, hazard mapping and avalanche analysis. This work is being conducted by the Bavarian Water Resources and Forestry Administration, in cooperation with universities. An expert meeting in Munich 14-15 November,1996 will discuss these studies.

16. Mr. M. Cohen presented the national report of Israel. The Land Development Authority (LDA) uses integrated watershed management as its basis for sustainable development. A Geographic Information System (GIS) has been found most valuable for handling watershed databases. In 1995, the National Master Plan for Forests and Afforestation became the legal mandate to protect Israel's forests. The River Rehabilitation Authority and LDA recognize river and water protection and development as an essential element for lasting peace in the

Middle East and also realizes that peace would mean more demands for water supplies. Their projects include plantings along rivers and pollution mitigation. The Jewish National Fund is a major partner in developing tourism near forests and watercourses, and tourism development is expanding.

17. Ms G. Trisorio-Liuzzi presented the national report of Italy. New concepts have been taking root in Italy, namely: a unitary view of the environment; the principle of sustainable development; the concept of globalization; international directives; and joint action programmes. These new concepts are yielding effects and should become operational nationally in the coming years. Interdisciplinary efforts are now underway, and new environmental and resource laws provide an essential point of reference for the watershed management sector. The Mediterranean Agronomic Institute of Bari --part of the International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM), is an active site in the watershed management area.

18. Ms D. Hadonina presented the national report of Latvia. Future environmental protection will be based on the National Environmental Action Programme, which is planned for approval in late 1996. Environmental policy goals include: practice pollution control at source; use principle of individual responsibility; adopt polluter-pays system; improve environmental quality where it poses risks to health and ecosystems; retain biodiversity; aim for sustainability; work in a principle of openness; and integrate environmental protection policy into all aspects of the country. Latvia has 3,000 lakes and 777 rivers over 10 km long. Polluted water originating in other countries, then flowing into Latvia in the major rivers, is a major concern.

19. Mr. B. Wold presented the national report of Norway. The main elements in the country's landscape are mountains, fjords, valleys and rivers, and water is essential for energy, transport, and recreation as well as water supply. Forestry is based on the Forest Act, allowing freedom for individuals to manage forests, within the guidelines of the Act. Mountain forests and protective forests also are defined by the Act. The major economic role of the rivers is hydro-power production; hydro power provides 99.4 percent of all electricity in Norway. Most large lakes and waterfalls are already used for power production. Guidelines of watercourse management have been worked out to mitigate impacts on water, linking also to the country's "National River Protection Plans" for protecting waters. In recent years, with high snowfalls and rain-on-snow conditions, there has been a higher number of disastrous floods. The 1995 Glomma River flood, which displaced 7,000 people from their homes, was the most extreme there since 1789, with a 200 year return period in parts of the river. A better use of regulation reservoirs is recommended for the restraint of flood waters. In general in the country, downstream peaks around cities have been moderated by river engineering and flow management. Municipalities are increasingly involved in the planning for floods and in the mapping of flood plains. Flood forecasting is important, especially in flood-prone areas, and work on better warning systems is continuing.

20. Mr. E. Lenart presented the national report of Poland. Montane forests are significantly affected by atmospheric pollution, with degradation and die-off of spruce in the Sudeten mountain ranges of southwest Poland especially severe. Reforestation work is underway, testing species that are resistant to air pollution, including native provenances of spruce, larch and dwarf pine. Polluted soils show high acidification and excessive lead and aluminum levels. Spruce needles have a high sulfur content. Secondary pest infestations have been evident in spruce stands weakened by pollution impacts. Reforestation work also has evaluated the benefits of liming, fertilization, weeding and wildlife controls in regenerating stands. Cooperation with Germany and Scandinavia is under way in some of these research programmes.

21. Mr. N. Lazar presented the national report of Romania. In 1975 a major, long-term reforestation programme was established (1975-2010), which continues. During 1994-95, another 650 ha of hydrotechnical work was completed along 120 km of torrential streams, and from the beginning of this programme until 1993 95,000 ha were rehabilitated and 1,550 km of torrential streams were corrected. Research has been carried out on investment, forest management, hydrotechniques and modelling, carried out by the Institute of Forest Management Research in collaboration with torrent control scientists at the Forestry and Forest Utilization of the University of Brasov. During the last two years over 100 such studies have been conducted.

22. Mr. L. Rojo Serrano presented the national report of Spain. As of June of 1996, the main agencies for mountain watershed management in Spain are the Dirección General de Conservación de la Naturaleza (Agency for Nature Conservation), formerly ICONA, and the regional forestry services. The national agency contributes about 50 percent to these collaborative projects. Local participation is important in these projects, as is development of an integrated management plan. During 1995 about 15,000 ha were reforested, and some 90,000 cubic metres of concrete, rip-rapping and gabion works were completed for torrent control. Protective revegetation was carried out on some 21,000 ha. Forest fires were a particularly severe problem in 1995, due to a heatwave. Most investments in watershed projects are based on support of the European Union, with efforts directed at erosion control and the regeneration of ecosystems degraded by fires.

23. Mr. P. Kjellin presented the national report of Sweden. The National Board of Forestry and the County Forestry Boards are conducting a project to identify forest habitats containing endangered flora and fauna and important for biodiversity, including those in mountain areas, with the goal to protect representative sites of these habitats. Forest policy has been changed to provide for protection. Logging is limited to 20 hectares, and some trees are left behind. Native species are required in regeneration work. During logging a protective strip where no cutting is allowed must be left along streams. County Forestry Boards approve logging to assure that regeneration can be secured.

24. Mr. P. Greminger presented the national report of Switzerland. A new law from 1992 focuses on assuring the maintenance of forest ecosystems and the need to preserve their protective, social and environmental benefits. The law helps maintain biodiversity and also encourages creation of forest reserves within the cantons. Defoliation of mountain forests, for reasons still not clear, has been a problem in up to 26 percent of these forests since 1995. The delineation of areas of protective forests is determined by the individual cantons. The Federal Forestry Service has developed detailed guidelines for managing protective forests, to assure stable forests with a range of age classes. Planning is carried out for protection against natural disasters by providing specific techniques and criteria for mapping hazard areas and for assigning probabilities of floods, landslides, avalanches, rockfalls and other events to each of these areas. Management and planning are supported by and coordinated with a programme of applied research.

III. NATIONAL OR OVERVIEW REPORTS BY OBSERVERS

25. Mr. Francke presented an overview report for Chile. The policy-administrative breakdown in the country is exceptionally complex, with 12 administrative regions stretched over nearly 40 degrees of longitude, from deserts and tropics to the sub-arctic. In high mountain areas the watersheds are characterized by a high risk of

natural disasters, which also relates to erosion and desertification problems. The productivity of natural resources is low in these areas, and land capability is limited. A general programme exists for an integrated approach to watershed management, which includes legal, socio-economic and technical components. The socio-economic part of this effort provides mainly for works in reforestation, soil conservation and for forest management at the watershed level. The technical effort includes projects of restoration in critical watersheds and provides for projects of soil rehabilitation in degraded areas. These projects emphasize technology transfer at the rural community level.

26. Ms. Upadhyay presented an overview report for India. The country is of continental dimensions, with 127 agro-climatic zones, from tropics to tundra, a population of nearly 920 million and 33 million hectares of mountain land. Awareness is growing of the importance of ecosystem preservation as a pre-condition for macro-economic stability. Watershed problems include over-grazing, cultivation of steep slopes, slash-and-burn agriculture and mining exploitation. Many forest lands are abused. A number of laws exist to protect forests, and "preserved forests" in some cases are in fact protected. International aid for watershed work at present includes that from the World Bank, EEC, Denmark's DANIDA, United Nations Development Programme, the German Bank and the Swiss Development Corporation. These programmes consider women's participation in development and small-scale hydro electric projects as well.

27. Mr. Askarn presented an overview report for Morocco. Erosion rates are high in many areas, and 50-60 million cubic metres of sediment are trapped in the retention pools of reservoirs each year. Therefore a national action plan for watershed management has been established to: analyze watershed management experience; establish geographic priorities for 20 years for projects --showing proposals, costs and estimated benefits; propose a mechanism for financing the work; and identify a project for the first phase of the National Plan. Some 22 watersheds with dams, covering 15 million hectares of land, have been prioritized. Cost estimates have been made for the needed watershed restoration and management projects. The United Nations Development Programme (UNDP) funds projects emphasizing local participation. The institutional as well as technical aspects are considered, including geographic information systems and remote sensing.

28. Mr. Dhital and Mr. Shrestha submitted an overview report for Nepal. In Nepal mountains dominate the landscape; forests comprise about 37 percent of the land and provide 90 percent of the country's fuel. Six major forestry programmes are planned: community forestry (the largest effort); forest leasing; promotion of wood-based industries; use of minor (non-wood) forest products; soil and water conservation; and conservation of ecosystems and genetic pools. Natural erosion is quite high, for geologic reasons, but accelerated erosion occurs as a result of deforestation, population pressures, overgrazing, cultivation of marginal lands and fires. In some cases 100 tons/ha/yr or more losses of soil are found, resulting in high sediment loads in rivers. Watersheds generally show between 1 and 3 mm/yr of degradation (soil loss). Floods impact villages, hydropower facilities and irrigation structures and kill many people. The Government has a flood warning system in the Bagmati Basin. Generally little work has been completed on flood forecasting in Nepal.

29. Mr. Bouzid presented an overview report for Tunisia. Intense rains, high annual climatic variation, cultivation of marginal lands, poor vegetative cover and other factors cause high runoff and extreme erosion rates in the country. Many techniques exist for soil and water conservation, some traditional These include: terracing, diversions for harvesting rainfall, dikes along hillsides for catching runoff or for recharging ground water;

vegetative bands; various shapes of hillside runoff catchers; and bands of rocks across slopes. Better techniques for pasture and rangeland management are essential. Biological techniques include use of fruit trees and plants such as acacia, atriplex and cactus, and research has been done to determine the best planting densities and species mixes. Generally a combination of techniques is best, with biological and physical actions applied at the watershed level.

IV. SPECIAL REPORTS

30. Chapter 13 Mr. S. Kunkle, representing the FAO Forestry Department, presented the document "A Brief Overview of FAO's Sustainable Mountain Development and Watershed Management Activities During 1994-96." The United Nations Conference on Environment and Development (UNCED) agreed on a global action programme on sustainable development, called Agenda 21. FAO's Forestry Department has the role of Task Manager on Chapter 13 of Agenda 21, "Managing fragile ecosystems: sustainable mountain development." The activities of this mountain effort also are referred to collectively as the "Mountain Agenda."

FAO is assisting with regional inter-governmental consultations on mountains, which in Europe include one in Scotland and one in Italy during 1996. As task manager, FAO works closely with other international organizations and governments to help implement Chapter 13 and strengthen partnerships in the process. FAO also works closely with non-governmental organizations (NGOs) on the Mountain Agenda, coordinating with them in organizing meetings and in developing communication and information sharing.

Work is progressing on a set of "Indicators of sustainable mountain development" at FAO. FAO continues its normal activities, including field projects and technical publications, and the Working Party members continue to have opportunity for involvement in these activities facilitated by FAO.

31. FAO Guidelines: Mr. S. Borelli of the FAO Forestry Department presented an overview of a project under way with The Mountain Institute (TMI) in USA to develop a set of "Guidelines for sustainable mountain development." This is a cooperative effort between FAO and a large network of organizations linked to work together and share information on mountain activities; this network is known as the "Mountain Forum." The "Guidelines" will build on existing planning methodologies and will therefore complement available guides and manuals and also focus primarily on best management practices for mountain areas. In summer 1996 TMI is conducting an "e-mail conference," to gather impressions and suggestions for the "Guidelines," especially from developing countries. Completion of the "Guideline" effort is scheduled for late 1996.

32. Strasbourg Resolution 4: Discussions and presentations covered progress on the implementation of Resolution 4 of the Strasbourg Ministerial Conference on Forest Protection in Europe, "Adapting the Management of Mountain Forests to New Environmental Conditions," for which the Working Party is serving as a facilitating forum. Three sub-groups had been formed in 1994 on Resolution 4 activities, for: (i) Mediterranean zones, (ii) Alpine zones and (iii) eastern and northern European zones. The overall coordinator is Mr. L. Silva, of Portugal. These sub-groups had been requested in 1994 to report on their activities at the 20th Session of the Working Party in 1996. The active and productive eastern/northern and the Alpine sub-groups made their presentations at the 20th Session, as noted below, by Mr Stephan and Krecek respectively. The Mediterranean Sub-group (Mr. G. Montero was assigned the role in 1994) and the overall coordination (Mr. L. Silva) were not present at the 20th

Session for presentations and their particular activities are not well documented at this time (note under Programme of Work for 1996-98 that it was recommended as very desirable to activate these two).

Mr. J-M. Stephan summarized the Resolution 4 activities for European countries, which includes the goals to (i) establish sampling sites to monitor forest ecosystems, (ii) conservation of forestry genetic resources, (iii) study of the feasibility of a decentralized databank on forest fires, (iv) adoption of mountain forest management adjusted to new environmental conditions, (v) enlargement of the EUROSILVA network on timber research, and (vi) creation of a European research network on forest ecosystems.

Mr. J-M. Stephan also reported on behalf of Mr. C. Chauvin, France, on the Resolution 4 activities of the Alpine Sub-group. The group organized study tour to Slovenia as well as tours along the French, Italian and Swiss borders. An international network of reserves has just been launched, and a French-Italian project with Swiss collaboration on forest roads also has been initiated at six test sites. France and Germany are working together on mixed reforestation modelling. A project on mountain policy issues is concerned with the broad scale of the entire Alps. An exchange of graduate students and interns is underway, also with sponsorship of some students.

Mr. J. Krecek reported on the Resolution 4 activites of the east European and Baltic countries. The group is composed of a network of individuals in many countries: Bulgaria, Slovenia, Hungary, Czech Republic, Finland, Russia, Slovakia, Albania, Belarus, Poland and Lithuania, and they have been able to meet twice duirng 1994-96, for the "National Debate on Management of Mountain Watersheds in the Jizera Mountains" and at a workshop "Reclamation of Soil and Groundwater: Opportunities in Eastern Europe." Under the active leadership of Mr. Krecek, the group regularly shares information on projects on many topics: degradation of forests and soils; air pollution/acid rain impacts on mountain forests; nuclear contamination of forests; long-term climate changes and climate modelling; reforestation and reclamation of damaged forests and soils; and the concepts of "ecological forestry" and new policies evolving.

33. European International Agreement on Mountains: Mr. J-M. Stephan reported on international agreements on mountain land and resources in Europe. The Alpine Convention was signed in 1991 by the ministries of the environment in seven Alpine countries and the European Community. The Convention's objective is environmental protection and covers six main points: regional planning and sustainable development, nature and landscape protection, agriculture, mountain forests, tourism and transport. Counterbalancing the European Union's Alpine Convention's more environmental thrust is the European Charter of Mountain Regions, currently being considered for adoption by the Council of Europe, which emphasizes the importance of economic development, especially at the important local and regional levels. It is too soon to evaluate the consequences of these two agreements economically or otherwise; however, such agreements have stimulated interest in sustainable mountain development and already led to greater transboundary cooperation.

34. ICIMOD's Role in Chapter 13: Mr. Li Tianchi gave an overview of the activities and organization of the International Centre for Integrated Mountain Development (ICIMOD), in terms of its work in the Hindu Kush-Himalayan Region. The Centre has three main thrusts in its mountain work: farming systems; natural resources; and enterprises and infrastructure. ICIMOD also is a database and information centre. Workshops conducted by ICIMOD have facilitated professional exchanges of knowledge and experience in applied watershed management. More work is needed on: questions of population pressures; better pasture/fodder management; training needs;

institutional strengthening; appropriate technology in energy; and the need to share experiences better. Focus also has gone into the topic of landslide mitigation and risk engineering, with studies and training conducted.

35. IUFRO Task Force: The International Union of Forestry Rsearch Organisations (IUFRO) created a Task Force on Forest in Mountain Development. Mr. H. Schaffhauser reported on this for M. Price, the Task Force Coordinator. The Task Force's roles include preparation of "state of the art" reports and research agendas, contributing to work on Chapter 13 of Agenda 21. IUFRO has members in 717 institutions in 115 countries worldwide. A number of IUFRO's Working Parties focus on mountain forests, including work on harvesting, ecosystems, torrents, avalanches and watershed management. The Task Force also is involved in updating the book "The State of the World's Mountains".

36. Interpraevent 96: Several participants had attended the meeting Interpraevent, 24-28 June in Germany. Mr. Göttle, Germany, noted that this international meeting attracted 450 experts from university, planning offices and water or forestry agencies. Discussions covered research and applications in the technical areas related to natural resources in mountains, as well as the planning aspects. Proceedings are currently in preparation.

V. MANAGEMENT OF MOUNTAIN FORESTS

37. Mr. D. Claudius presented his report on National park management in the Gudbrandsdalen region. The parks in this region are some of Norway's most valuable protected land. Management concerns include: trampling, construction impacts; human effects on wildlife; and pollution. An important future topic in park management will be the control of visitors to minimize their impact on wild mountain reindeer. In 1992 the Government proposed 20 new national parks and the expansion of nine existing parks, and also proposed 17 protected areas --mostly for landscape protection. These expansions would double the percentage of Norway's protected lands, to 13 percent of the country's total area. Reinheimen, in northern Gudbrandsdalen, is one of the biggest parks proposed, and Rondane and Dovrefjell National Parks will be substantially expanded. Many new visitor centers have been established, such as the Norwegian Mountain Museum in Lom. Others will be created.

38. Mr. K. Solbraa presented his report on Sustainable forestry in Norway, with special reference to mountain forests. Forests cover 37 percent of the country. The Forestry and Forest Protection Act intends to provide profitability and a steady supply of raw material for the forest industry and at the same time provide for recreation, hunting, fishing, wildlife protection and nature conservation. Productive forests contain about 48 Percent spruce, 33 percent pine and 19 percent deciduous species. A network of small key biotopes (very small preserves) within productive forests has been proposed. Research has expanded the knowledge about "sustainable forestry" and about habitat requirements of endangered species. Mountain forest problems include: cold weather impact on regeneration; fungus infections; and wildlife impact on regeneration. Special regulations have been developed to protect forest ecosystems and to assure sustainable management of forests.

39. Mr. J-D. Spaak made a slide presentation on watershed management activities in the Tessaout area of the in the High Atlas Mountains of Morocco, west of Marrakech. Weather conditions in these mountains include violent winds, ice, snow, dry periods and other difficult conditions. Over-grazing, fuel cutting and poor land use lead to accelerated erosion. The FAO/UNDP watershed management project has the following objectives: protect

the dam downstream; re-establish a social-ecologic balance; reduce emigration; and preserve local culture. Efforts are made to conduct a participatory project in this isolated area. Pines, cactus and fruit trees all have been tested for re-vegetation work in the eroded areas.

40. Mr. O. Haveraaen presented his report on Management of mountain forests in view of ecological, sociological and economic conditions. The objective of the *Norwegian Forestry Act* is to promote multi-purpose forestry, considering not just wood production, but also recreation, aesthetics, biodiversity protection and other aspects. The principal trees of concern in "mountain forests" are birch (Betula pubescens var. tortuosa), aspen (Populus tremula), gray alder (Alnus incana), mountain ash (Sorbus aucuparia), bird cherry (Prunus padus), pine (Pinus sylvestris) and spruce (Picea abies). Their reproductive characteristics, problems and limitations have been the subject of research. The research has considered logging, types of cutting, soils, temperatures, snow and other factors as they affect regeneration. "Selective cutting" is now popular for assuring mountain forest reproduction; this also provides environmental benefits and recognizes that recreation and ecosystem protection are important.

VI. FAO/IUFRO SYMPOSIUM

41. Mr. G. Fiebiger, as Representative for IUFRO at the Session, opened the day's FAO/IUFRO Symposium, Applied research in mountain watersheds, welcoming presenters and describing the role of cooperation between the Working Party and IUFRO.

42. Mr. G. Fiebiger, on behalf of Austria, offered to print the presentations from the 20th Session, and with overhead projection summarized the editing guidelines that authors should follow when submitting their manuscripts to him.

43. Mr. A. Göttle presented his paper Alpine erosion and climate change --new challenges and solutions. Erosion includes rock fall, land slides and other forms, and is influenced by various factors, such as precipitation or wind. Site factors influencing erosion include geology, soils, vegetation and morphology. Human presence determines "erosion danger." Climate change will potentially change erosion and "erosion danger." The likelihood of warmer temperatures, stronger storms, different rainfall patterns, more rain/less snow, faster thaw and freeze fluctuations, quicker snowmelt conditions, or other changes are considered, and the Bavarian State Office of Water Management has researched these relevant factors. They simulate run-off at plot studies on a range of sites, for various simulations of climate. A geographic information systems (GIS) helps compare the climate factors to erosion and to hydrologic processes. Simulation of various potential climatic conditions with sprinklers allow observation of the processes occurring at a range of sites, and testing of the impacts on erosion processes.

44. Mr. R. Kattelmann presented his paper Floods following wildfire in the Sierra Nevada, California, USA. Peak flows in small streams of the Sierra Nevada are sometimes enhanced by the effects of forest fires and post-fire treatments. Following fires soil moisture conditions, infiltration and snowmelt patterns are changed. Impacts of tractor and road construction during fires increase runoff. Rehabilitation after fires has been counter-productive. Channel-scouring flows transport high sediment loads from burned areas, compared to non-burned control areas. Unnaturally high fuel loads resulting from decades of successful fire suppression have increased the

risks of intense fires and have augmented peak flows. Efforts to reduce the fuel loads mechanically or with prescribed burning must be considered, as a way to avoid the even larger hydrologic impacts of catastropic fires.

45. Mr. R. Kattelmann presented his paper, co-authored with T. Watanabe, Opportunities to limit a glacier lake outburst flood in the Khumbu Himal, Nepal. Severe floods have occurred in the Himalaya when a dam of moraine and/or ice failed suddenly and released massive amounts of water stored in a glacial lake. The Imja Glacier Lake is such a case, and presents a serious hazard to villages downstream, with risk that its ice-cored moraine could fail. There is risk of seismic events, ice calving, rapid incision of the outlet channel and piping through the terminal moraine. Site investigations in 1994 evaluated the feasibility of reducing the hazard of an outburst flood by using a siphoning technique. The approach appears to be relatively effective, practical, inexpensive, and safe.

46. Mr. J. Krecek presented his paper, with co-author Z. Horicka, Restoration of air-pollution-damaged watersheds in the Jizera Mountains, Czech Republic. Watersheds in the Jizera Mountains were significantly damaged in the last 20 years by air pollution, acid deposition, logging, insects and poor forestry. Water quality in streams and reservoirs deteriorated, as revealed in low pH levels, higher aluminum and acid levels, in reduced aquatic flora and fauna abundance, and in the extinction of fish. Careless logging caused erosion and sedimentation. Rehabilitation is now underway via liming and other efforts. Air pollution is also decreasing. So pH levels are rising, aluminum pollution is dropping, and trout are being introduced successfully into reservoirs. "Sustainable watershed management" or "ecological forestry" planned includes native tree planting, improved forestry practices, development of stream protection strategies and better management of reservoirs.

47. Mr. D. Richard presented his paper An overview of CEMAGREF's research on torrential bedload. A mode of sediment transport is observed in torrents and torrential rivers in the mountains that is called bedload (torrential); likewise lowland rivers refer to a mode of sediment transport called bedload (fluvial). These two modes of solid transport have analogies, but the nature of torrential bedload is different, for example, steep torrential streams can carry "hyper-concentrated bedload." Therefore specific and independent studies at CEMAGREF are underway. Many non-torrential bedload formulae and models exist from the past half century, and the research is testing their applicability to torrential conditions and comparing the various models. The research shows the need for some more basic research on torrential bedload transport itself.

48. Mr. J. Mintegui Aguirre presented a paper by R. Serrada, J. Mintegui Aguirre and J. Robredo Sánchez, Analysis of the runoff generated on experimental plots with different degrees of vegetative cover and various types of soil preparation for reforestation, given simulated torrential rains. A method is presented for the simulation of torrential rainfall to analyze the hydrological effects of plant cover, and to evaluate how best to prepare soil for reforestation. Sixteen plots were prepared, including: a control plot with brush cover; five plots where vegetation was cleared or cut down in different ways; and ten plots where soil was prepared for reforestation by four different methods of ripping, two types of hoeing, and four types of terracing. These plots were subjected to simulated rainfall. The treatments affected soil moisture, with the "terraced" plots being wetter (hence better for reforestation) and the cleared plots being drier.

49. Mr. E. Hernandez presented his paper Torrent control in Venezuela. Venezuelan mountains exhibit hydrologic and sediment characteristics quite similar to conditions found in the Alps. Torrent impacts cause loss

of lives, damage to infrastructures and other negative effects. Reservoirs' effective lives are shortened by sedimentation. For example, the Guaremal Dam underestimated sediment in its design, mainly because the high erosivity and the sediment delivery in this tropical area are now known to be much higher than in other mountain ranges around the world. The population explosion has created demand for water supply, but new aquaducts also are endangered by torrential conditions. Techniques are needed to deal with these problems, and attempts are made to adapt Alpine experience. More collaboration with Europe is needed on a wide range of techniques suitable to confront these mountain watershed problems.

50. Mr. J. Bogen presented his paper Erosion and sediment transport in Norwegian rivers. Sediment yield and erosion has been studied around the country for a number of years, including data for rivers in mountain and forest areas. In the mountain areas, above timberline, sediment delivery is generally higher than found in forested lowlands, for example the 26 tonnes/km2/yr for the Dovre Mountains. Near glaciers, sediment yields will be even higher, ranging from about 100 to 1313 tonnes/km2/yr. This is nonetheless smaller yields than found in comparable terrain in Iceland or Alaska. In forest areas the main sediment sources are Pleistocene moraines and glacifluvial deposits, and only about 2 tonnes/km2/yr are typical. Very extreme storms may cause high yields however.

51. Mr. Li Tianchi presented a slide show on torrent control and watershed management as seen in the Himalayas.

52. Mr. G. Volk presented a paper Spatially distributed hydrological modelling of torrents for risk assessment using GIS. Flashfloods, mudflows and landslides cause heavy damage in the Austrian Alps every year, with human and economic losses. Environmental conditions are changing, but also more marginal sites are being used for construction, causing the problems. For mapping hazards, a model called ACURAT was developed, which is able to estimate discharges and sediment yields and to predict effects of land-use changes in watersheds. The simulations and modelling tested well, and discharges and stormflows were accurately predicted.

53. Mr. G. Volk of Austria described a model called ELBA, which is an energy-line based model for avalanches combining statistical and physical components. The physical processes in an avalanche cannot be well described, but the energy losses of an avalanche can be calculated stochastically. The effects of the terrain on the flowpath of an avalanche can be modelled in a deterministic way. This model has been tested on three major avalanches in Austria.

54. Chairman Fiebiger showed four videos from Austria and Italy on avalanches, torrents, flood events and sediment yields. The Norwegians presented a video on the Town of Lillehammer's environmental considerations and planning before, during and after the Winter Olympics of 1994.

VII. PREDICTION AND EVALUATION OF DISCHARGE AND SEDIMENT LOADS

55. Mr. N. Lazar presented the paper by Lazar and Clinciu, Factors concerning the influence of the forest on the maximum discharge in the torrential watershed of Bistra-Sebes in Romania. Different values of runoff coefficients were determined for forest areas to calculate the maximum stormflow discharges, using the Rationale Formula. These runoff coefficient values were differentiated by taking into account the structural

factors of the forest, such as age, as well as the variation of rainfall intensity. Four hydrologic categories were then developed, and a regression equation to determine runoff coefficients for times of concentration, from 10 to 200 minutes, was developed for each category. To use the procedure, runoff coefficients were determined for 16 small torrential watersheds having an area of less than 1.2 km2 and having forest cover. Finally, maximum discharges were calculated with the Rationale Formula, to quantify the forest structural effects on maximum discharges.

56. Mr. H. Marui presented a paper Sediment disasters along the great techtonic line in summer 1995. The Himekawa River, which flows along the great techtonic line called "Fossa Magna," experienced severe flooding and sediment problems following an intense rainfall in 1995. In places the river bed was raised over 10 metres because of the heavy sediment loads. Rainfall up to 569 mm in 24 hours was measured, with up to 59 mm in an hour. Debris flows and slope failures occurred. Urakawa Torrent, with a catchment of 22 km2, length of 12 km and gradient of 1/10 had constant slope failures and produced one landslide of 2 million m3. Fortunately two large check dams on the Urakawa worked well as sediment catches. The mass movements were related to geological characteristics, specifically to quaternary volcanic materials.

57. Mr. N. Lazar presented a paper by Clinciu and Lazar Prediction of maximum stream discharges in torrential watersheds -- a quick procedure. The diagrametric procedure presented in this paper is based on the well-known Rationale Formula and on the use of Clinciu's diagram from 1983. His diagram is based on the simplyfying concept of "morpho-standard torrential basins," producing a series of runoff curves. By using this "morpho-standard diagram" one can quickly predict the maximum discharge with reasonable accuracy. The parameters involved are: the area of the watershed; the hydrographical order (based on the "Strahler" method); and the runoff coefficient.

VIII. PLANNING, MAPPING AND GIS

58. Mr. A. Hurand presented a paper by Hurand, Chauchadis, Gay and Brochot entitled Mapping of the sediment production in torrential watersheds by a geographic information system (GIS): an example from Gourron, Pyrénées-Centrales. Sediment production is a function of (i) a basin's capacity to furnish materials and (ii) the capacity of discharge for sediment delivery. A torrential basin was used for testing these two capacities. Watershed erosion was essentially based on the basic factors of the Universal Soil Loss Equation: soil, slopes; cover; and rainfall intensity. Streambed characteristics allow derivation of an index of bed erosion. An average index of torrentiality was then developed, considering mainly bed slope and watershed area above a given point. Available data were then tested in a GIS-based analysis with reference to historic aerial photographs. Preliminary results indicate that this tool will be a good technique for predicting torrential erosion.

59. Mr. A. Göttle presented a paper GIS in the Bavarian Water Management Administration. Geographic information system (GIS) management in Bavaria ties into an enormous range of activities, including: research, water management, project development, planning, supervision, cartography, modelling, evaluation, data management, information dissemination and the monitoring of torrents and avalanches. So GIS work is at the heart of nearly all operations. Various levels of hardware and software are utilized in GIS, depending on objectives. ArcVIEW is the common software employed at this time.

60. Mr. H. Lee presented a paper Soil erosion on the cut slopes of forest roads in Korea. Road construction for the forest road system in Korea is undergoing major expansion at this time, with the goal to attain a forest road density of 10 m/ha. Erosion is a serious problem on the new roads. Research was conducted on road cuts, using 300 plot studies, to reveal the average erosion volume and to relate it to the slopes. Average erosion along these road cuts was 3,103 m3 per km over a 4-year period, with the upper parts of the road cuts found to be the major sources of the erosion.

IX. RESTORATION IN MOUNTAIN WATERSHEDS

61. Mr. L. Rojo presented the paper Non-impacting designs and techniques for hydrologic restoration in the high mountains, by Mr. G. Aranda y Antón. Restoration was tested in a study area in the high Pyrenees, at 2050 m
elevation, in a glaciated zone. The ravines of the area contain moraine materials of sands and clays, with calcareous cementation. An "ecological wall" that was evaluated in the ravine at the erosion site was made of a design of plants supported by a battery of drainage pipes. The vegetation used included pines, poplars and other trees. Fluorescent and other dyes were used for sub-surface water tracing work, and old aerial photographs for different years provided historical evidence. Environmental and economic analyses for the project were completed.

X. SLOPE STABILITY ANALYSIS

62. Mr. G. Dalla Fontana presented the paper Distributed slope stability analysis using a physically-based model and digital elevation data. A model for the analysis of topographic influence on shallow landslide initiation was tested in a catchment in northeastern Italy. The model contains two parts: a steady-state model for shallow sub-surface runoff and an infinite-slope, "Coulomb" failure model. The principle is that sub-surface runoff increases pore pressures in the soil, eventually reducing soil strength against sliding. Applying a geographic information system, the model can show areas most prone to shallow landsliding, which is based on the surface topographic effects on hydrology. An inventory of landslide scars was used to document unstable sites and to test the model's performance.

XI. PROGRAMME OF WORK OF THE WORKING PARTY

63. The Working Party agreed on the following activities to be carried out in preparation of the 21st session in 1998:

a. A recommendation was made that the delegates should, in addition to comments given in the Lillehammer session, discuss the "Mission statement and Credo" with concerned parties in their respective countries and forward detailed suggestions to the Secretariat for incorporation in a new draft. The Secretariat will then prepare a revised draft taking into account comments received.

b. The work related to the follow-up to Resolution 4 of the Strasbourg Ministerial Conference on Forest Protection in Europe should be continued. The Group recommended that the work of the Mediterranean sub-group be reactivated in order not to lose information on these important ecological zones.

c. A special FAO/IUFRO Symposium, should be included in the Agenda for the 21st Session. Fifty percent of the time available to IUFRO should be dedicated to a special topic of (to be determined when host country of next session is known), and the remaining 50 percent should cover work of various Subject Groups of IUFRO related to the Programme of Work of the Working Party.

d. It was suggested that, in the period in between sessions, technical exchanges and 1-3 day field visits could be organized at the initiative of individual countries. These could also be extended to interested observer countries, if appropriate.

e. A questionnaire could be prepared to assess the role of each member of the Working Party in his/her respective country and to establish possible cooperation mechanisms based on individual possibilities. A directory of members could be created (and kept up to date), possibly including e-mail addresses. It also would be useful to identify potential "official delegates" and "heads" from each countries between sessions.

f. The Working Party should seek ways to raise public awareness of the value of sustainable management of mountain ecosystems and also seek to disseminate more information about Working Party activities.

g. It was recommended that a standard format should be developed for the submission and presentation of National Reports, recognizing the good example of France this time.

h. A special report will be presented concerning progress on the implementation of agreements related to UNCED Agenda 21, Chapter 13 (Mountains) in the period 1996-98 (To be prepared by FAO).

The Working Party decided to retain the list of interest topics indicated in the previous meeting agenda, to be further refined when the host country of the 21st Session has been decided upon. The list of topics to be considered includes:

- New challenges related to technical solutions in view of environmental as well as social considerations,
- Restoration of degraded lands in mountain regions, involving technical, environmental and social aspects;
- Silviculture of mountain forests;
- The effect of decreasing budgets on mountain watershed management programmes;
- Indicators concerning sustainable mountain forest management, including indicators for the conservation of biological diversity;
- Impact of forest road construction in mountain areas;
- Restoration of eroded flysch landscapes;

- The effects of forest fires on soil degradation in watersheds;
- Evaluation of cost-effectiveness of torrent control works;
- Improve public information systems in order to ensure local support, including financial contributions to watershed restoration and torrent control works;
- The effects of acid rain and other aspects of forest protection and its influence on physical as well as socio-economic aspects of watershed management;
- Integration of torrent control structures in the landscape;
- Minimum requirements of mountain forest management;
- Technical analysis of the construction and management of sedimentation basins and open checkdams;
- Sustainable mountain development from the special point of view of watershed management, including social aspects;
- Technical improvements of torrent control works related to the aspects of environmental compatibility and landscape values.

The heads of delegations elected the following officers of the Working Party: as Chairman, Mr. Albert Göttle, Germany; as first Vice-Chairman, Mr. Einar Beheim, Norway; and as second Vice-Chairman, Ms. Giuliana Trisorio-Liuzzi, Italy.

It was suggested that the new officers function as a "steering committee" between sessions, to keep the Working Party alive. The also could help the host country decide on a theme and decide on topics of focus before the "First Information Note" goes out on the upcoming session.

The Working Party welcomed the offer in principle to host future meetings from the Czech Republic. The Working Party requested FAO to make further contacts with the country for the 21st Session in the near future. Italy and France expressed an interest in principle in the organization of the 22nd Session.

The Working Party recommended to coopt as Associate Vice-Chairman a delegate from the host country to be identified. The Working Party recommended that time management of the meeting should be reassessed in preparation for the 21st Session. Discussion could focus around a more limited number of issues (e.g. disasters, management issues, involvement of local populations, etc.), and possibly be held in the form of position papers, followed by a roundtable on each subject. It was mentioned that the length and scheduling of the study tour could be reviewed for modifications suitable for the next host country.

ANNEX A: AGENDA

1. Opening of the session
2. Adoption of the agenda
3. National and special reports

    a. National reports
    b. Special reports

4. Restoration of mountain watersheds:

    a. Restoration of degraded lands in mountain regions, involving technical, environmental and social aspects.
    b. Technical analysis of the construction and management of sedimentation basins and open checkdams
    c. Evaluation of the cost-effectiveness of torrent control works

5. Follow-up to Resolution 4 of the Strasbourg Conference on Forest Protection in Europe: "Adapting the management of mountain forests to new environmental conditions"

    a. Action taken by national Governments concerning legislation and financial support mechanisms for the protection of mountain forests
    b. Technical aspects of the management of mountain forests and their protective role
        - Silviculture of mountain forests
        - Indicators of sustainable mountain forest management, including indicators for biological diversity
        - Minimum requirements of mountain forest management
        - Impact of forest road construction in mountain areas
    c. Action taken by the Regional Coordinator and by sub-regional groups.

6. The role of the Working Party in the follow-up to UNCED Agenda 21 Chapter 13 "Managing fragile Ecosystems: sustainable mountain development".

7. FAO/IUFRO Symposium: Prevention of natural disasters, research and technical aspects

    Main topic: Flash floods in mountain areas, methods of calculation, management and mitigation of effects

Other topics:

a. Hydraulics and torrent hydrology
b. Landslides and large mass movements
c. Biological and hydrotechnical means of watershed restoration and torrent control
d. Snow and avalanche control

8. Programme of the Working Party
9. Election of officers of the Working Party
10. Date and place of the 21th session and special symposia
11. Other matters
12. Adoption of the report
13. Closing of the session

ANNEX B. TIMETABLE OF THE SESSION

20th Session of the Working Party on the Management of Mountain Watersheds
Lillehammer, Norway 1-5 July 1996

Theme: Restoration of Mountain Watersheds

Monday, 1 July

09:00 Registration

10:00 Opening of the 20th Session of the Working Party

Mr Leopoldo Rojo Serrano, Chairman of the Working Party
Mr Knut Korsaeth, County Governor, Oppland County
Mrs Hallgerd Larsen, Vice Mayor, Lillehammer
Mr Jean-Paul Lanly, Director, Forest Resources Division, FAO
Mr Bjørn Wold, Director, Water Resources Department, NVE

11:15 Working Party Business

Adoption of the agenda
Secretariat information

11:30 National Reports

13:00 Lunch break

15:00 National reports (continued)

17:00 Special Reports

A brief overview of FAO's sustainable mountain development and watershed management activities during 1994-96. (**S. Kunkle**)

A description of FAO's project to develop "Guidelines" for sustainable development in mountain lands (**S. Borelli**)

Progress on Resolution 4 of the Strasbourg Conference - Eastern Europe subgroup (**J. Krecek**)

Progress on Resolution 4 of the Strasbourg Conference - Alpine subgroup (**F.Stephan**)

Special report on the European international agreements: the Alpine Convention and the European Council's mountain charter Alpine Convention and Agreements (**F. Stephan**)

Monday, 1 July (continued)

18:30 End of day's session

19:00 Reception by Town of Lillehammer at Art Museum

Tuesday, 2 July

09:00 Norway National Report

09:15 ICIMOD's role in Chapter 13

09.30 National reports from Observer countries

10:00 Management of Mountain Forests

National park management in the Gudbrandsdalen region (**D. Claudius**)

Sustainable forestry in Norway, with special reference to mountain forests (**K. Solbraa**)

Participatory watershed management: example from the Tessaout Valley in the upper Atlas Mountains of Morocco management (**J.D.Spaak**)

Management of mountain forests in view of ecological, sociological and economical conditions (**O. Haveraaen**)

12:30 Lunch break and afternoon local field tour.

19:00 Busses return to hotel

Wednesday, 3 July

9:00 FAO IUFRO Symposium - Applied research in mountain watersheds

Opening (**G.Fiebiger**)

Climatic changes: new challenge in torrent and erosion control (**A. Göttle**)

Floods following wildfire in the Sierra Nevada, California, USA (**R. Kattlemann**)

Opportunities to limit a glacier lake outburst flood in the Khumbu Himal, Nepal (**R. Kattlemann**)

Restoration of air pollution damaged watersheds in the Jizera Mountains, Czech Republic (**J.Krecek & Z. Horická**)

Wednesday, 3 July (continued)

Research in France on torrential bedload: overview, recent findings and perspectives (**D. Richard**)

Analysis of the runoff generated on experimental plots with different degrees of vegetative cover and various types of soil preparation for reforestation, given simulated torrential rains (**J.Mintegui Aguirre**)

Torrent control in Venezuela (**E. Hernandez**)

Erosion and sediment transport in Norwegian rivers (**J. Bogen**)

12:30 Lunch break

15:00 FAO/IUFRO Symposium (continued)

Slides on Torrent Control and Watershed Management (**Li Tianchi**)

Spatially distributed hydrological modelling of torrents for risk assessment using GIS (**G. Volk**)

Avalanche control design studies by a powder avalanche simulation model (**H. Schaffhauser**)

Energy-line based avalanche model (**K. Kleemayr & G. Volk**).

Videos (i) Avalanche control in Austria and (ii) Torrent control in Austria iii) Rio Cordon (Italy) event, 1994 (iv) Types, model and functions of dams (v) Lillehammer's environmental protection before, during and after the Olympics.

18:30 End day's session

19:00 FAO reception at Maihaugen Museum

Thursday, 4 July

09:00 Prediction and evaluation of discharge and sediment loads

Factors concerning the influence of the forest on the maximum discharge in the torrential watershed of Bistra-Sebes in Romania (**N. Lazar & I. Clinciu**)

Sediment disasters along the Great Tectonic Line in 1995 (**H. Marui**)

Prediction of maximum stream discharges in torrential watersheds --a quick procedure (**I. Clinciu & N. Lazar**)

Thursday, 4 July (continued)

11:00 Planning, Mapping and GIS

Mapping of the sediment production in torrential watersheds by a geographic information system (GIS): an example from Gourron (Pyrénées-Centrales) (**A. Hurand**)

Application of geographic information systems (GIS) (**A. Göttle**)

Soil loss on the cut slopes of forest roads in Korea (**H. K. Lee**)

12:30 Lunch break

13:00 Study tour

18:00 Busses return to hotel

Friday, 5 July

09:00 Restoration in mountain watersheds

Non-impacting designs and techniques for hydrologic restauration in high mountains (**G. Aranda y Anton**)

09:30 Slope stability analysis

Distributed slope stability analysis using a physically-based model and digital elevation data (**G. Dalla Fontana**)

11:00 A mission statement for the EFC Working Party on the Management of Mountain Watersheds (**L.Rojo**)

11:30 Working Party Business

Programme of the Working Party
Election of Officers
Discussion of Date and Place 21st Session

13:00 Lunch break

15:30 Adoption of report

17:45 Closing of the 20th Session of the Working Party

19:30 Dinner hosted by NVE at Lillehammer Hotel

ANNEX C. LIST OF PARTICIPANTS/LISTE DES PARTICIPANTS/LISTA DE PARTICIPANTES

Chairman Président Presidente	L. Rojo Serrano (Spain)
Vice-Chairmen Vice-Présidents Vicepresidentes	A. Goettle (Germany) J. Krecek (Czech Republic)
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ANNEX D. PROGRAMME FOR THE FAO STUDY TOUR

6. July Departure from Lillehammer. Damages from the 1995-flood, several locations in the Gudbrandsdalen Valley.The Atna River is protected and is assigned as a national reference river. Rondane national park nearby. The Folldal and Dovrefjell mountains are locations with active flood and wind erosion. Old mining history. At Fokstua is a sediment station and location for follow-up studies from the Chernobyl accident. At Sel are old flood protection works and biotope adjustment test areas. Overnight at a mountain hotel near Otta.

7. July At Otta the river in the winter causes ice problems. At Lom visits to a mineral center and an old stave church. Gravel excavation from the river. The Jotunheimen mountains can be seen. At the Sognefjell mountains summer skiing activities on glaciers. Inner parts of the Sognefjord: hydropower developments, changes in river beds and deltaes, salmon rivers. Overnight at Mundal Hotel in Fjærland.

8. July Near Fjærland a visit to advancing glaciers and to the Glacier Museum. Boat tour on the Sognefjord to Gudvangen, classic fjord landscapes. Bus from Gudvangen. At Voss locations for flood and vegetation and forest studies. The management of protected rivers. Tourist development. Crossing the Hardanger fjord. Overnight in Eidfjord. (If time, an evening visit to the
Vøringsfoss waterfall.)

9. July Visit to the Sima power station. Along the Sørfjord, snow avalanche problems and protection works. Old hydro-based industry in Odda, the Folgefonna icecaps, Låtefossen waterfall, old and new mountain roads crossing Haukelifjell mountains. Old reservoir at Møsvatn with erosion problems. Mountain forest management. At Rjukan old hydro power development. Further on to Oslo via the old mining town of Kongsberg.