PREPARING FOR THE NEXT GENERATION OF WATERSHED MANAGEMENT PROGRAMMES AND PROJECTS

EUROPE

Proceedings of the European Regional Workshop

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PREFACE

On the occasion of the International Year of Mountains, and in response to the clear consensus reached by the international community regarding the need to ensure harmonious and sustainable development of mountainous areas and watersheds, the Food and Agriculture Organization of the United Nations (FAO) and its partners undertook a large-scale assessment and global review of the current status and future trends regarding knowledge about and techniques for integrated watershed management.

The objectives were to promote the exchange and dissemination of experiences of integrated watershed management techniques, identify constraints to the implementation and development of those techniques during the decade from 1990 to 2000 and capture relevant new paradigms and approaches. The lessons learned from diverse experiences are being used to define a new generation of integrated watershed management projects.

Experts from four continents contributed to the assessment, which yielded four main outputs: 1) a review of experiences in watershed management, based on questionnaires that were sent to active partners in the field; 2) substantive reports from four regional workshops held in Nairobi (Kenya), Kathmandu (Nepal), Arequipa (Peru) and Megève (France); 3) four case studies from the Mediterranean basin, Nepal, Bolivia and Burundi; and 4) an international conference in Porto Cervo, Sassari Province, Sardinia, Italy.

Watershed management concepts and approaches were reviewed, and different experiences assessed. The results of this exercise are presented in several documents, including the proceedings of workshops and reports on the four case studies.

The conservation, use and sustainable management of watershed resources in order to meet the demands of growing populations have been a high priority for many countries over the past several decades. In this respect, integrated watershed management through people's participation has become widely accepted as the approach that ensures sound sustainable natural resources management and a better economy for upland inhabitants, as well as people living in downstream areas.

The European Regional Workshop was hosted on 4 September 2002 by the Ville de Megève, France. Megève, meaning "the place of waters" in Celtic, is a renowned international tourist resort and is indeed at the centre of water and watershed management challenges, its concern being to sustain the balance between mountain ecological and economic interests.

The regional workshop was held in the framework of the first international conference on Water in Mountains: Integrated Management of High Watersheds (5 to 6 September 2002), which brought together some 400 individuals and institutions from 25 countries and 15 international organizations.

The regional workshop at Megève allowed the sharing of achievements, gaps and lessons learned in watershed management in Europe. It provided ideas and suggestions to improve and refocus watershed management in the region, while acknowledging Europe's highly valuable technical, scientific, legal and policy achievements in this field. It highlighted raising the awareness of all parties and authorities concerned as to the urgency and importance of applying integrated and participatory practices in watershed management, particularly in view of the recent dramatic flood events of Eastern Europe.

The workshop also drew attention to the European Union's processes and reforms, and the paramount importance of a Water Framework Directive to implement preventive, long-term and scale-adapted approaches to watershed management by the year 2015.

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On behalf of the Food and Agriculture Organization of the United Nations (FAO), we would like to extend our gratitude and sincere thanks to the organizers of the international conference on Water in Mountains: Integrated Management of High Watersheds for hosting and sponsoring the European regional workshop on watershed management Review and Assessment of Watershed Management Approaches and Strategies – Preparing the Next Generation of Watershed Management Programmes.

We would also like to extend our thanks and gratitude to the Megève local authorities and all parties involved in the preparation and organization of the workshop, and especially to the organizing secretariat for providing the support and kind assistance that make this workshop a reality. Particular thanks to Pierre Lachenal, Director of Société d'Economie Alpestre de Haute Savoie.

Special thanks are extended to the European Observatory of Mountain Forests (EOMF), with whom the workshop was co-organized, and particular thanks to Mr P.C. Zingari, Director of EOMF for his kind support and assistance.

Most important is to mention the participation in the workshop of 29 professionals from 19 countries and 11 international organizations to whom we would like to extend our thanks for their participation and contribution to the success of the workshop.

Finally, we also wish to thank the FAO officers who attended the workshop and contributed directly to the results it achieved: Larry Tennyson, FORC Consultant; Jean Bonnal, SDAR; and Luca Fe d'Ostiani, SDAR.

ACRONYMS

ASSM	Azienda Speciale Sistemazione Montagna (Trento, Italy)
CDB	Community Development Board
CDCC	Community Development Conservation Committee
BERG	Berlin Environmental Research Group (Germany)
EAPI	Environment and Policy Institute (East–West Centre)
EFC	European Forestry Commission
EOMF	European Observatory of Mountain Forest
EPA	Environmental Protection Agency (United States)
EU	European Union
EU JRC	European Union Joint Research Centre
FAO	Food and Agriculture Organization of the United Nations
FORC	Forest Conservation Service (FAO)
GDP	Gross Domestic Product
GIS	Geographic Information System
GPS	Global Positioning System
GTZ	German Agency for Technical Cooperation
ICIMOD	International Centre for Integrated Mountain Development
IHP	International Hydrological Programme (UNESCO)
INRM	Italian National Institute for Mountain Research
IUFRO	International Union of Forest Research Organizations
IYM	International Year of Mountains
MRI	Mountain Research Initiative
NGO	Non-Governmental Organization
NWR	Norwegian Water Resources
SEA	Société d'Economie Alpestre (France)
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
VDC	Village Development Committee
WCMC	World Conservation Monitoring Centre
WMO	World Meteorological Organization
WSM	Watershed Management
WWF	World Wide Fund for Nature

INTRODUCTION

The European Regional Workshop on Preparing the Next Generation of Watershed Management Programmes, held on 4 September 2002, was the first of a series of regional workshops that were convened as part of an FAO initiative to review watershed management strategies and approaches and produce subsequent guidelines for the future. The workshop was an integral part of the international conference Water in Mountains: Integrated Management of High Watershed, held from 4 to 6 September in Megève, France.

The proceedings of the Megève workshop are presented in this volume, which provides a summary of workshop objectives, the programme and list of workshop participants, results and conclusions of the working groups, the workshop introductory and closing presentations, and text of the technical papers presented.

The conservation, use and sustainable management of watershed resources to meet the demands of growing populations have been high priorities of many countries in the world for the past several decades.

In this respect, integrated watershed management through people's participation has become widely accepted as the approach that ensures sound sustainable management of water and other natural resources and a better agricultural economy for upland inhabitants, as well as benefits for people living in downstream areas.

In addition, integrated watershed management was recognized as a suitable approach to addressing poverty and the need for food security of upland populations, as well as people living downstream. Watershed management integrates various aspects of forestry, agriculture, hydrology, ecology, soils, physical climatology and other sciences to provide guidelines for choosing acceptable management alternatives within the social and economic context.

Chapter 13 of UNCED Agenda 21, for which FAO is the United Nations Task Manager, stresses that "Promoting integrated watershed development programmes through effective participation of local people is a key to preventing further ecological imbalance. An integrated approach is needed for conserving, upgrading and using the natural resource base of land, water, plant, animal and human resources".

Although much progress has been achieved in watershed management, no clear picture has emerged of what has been successful and what needs to be done to improve future watershed management programmes. Therefore, an in-depth analysis of watershed management achievements and existing gaps was identified by FAO as a prerequisite to further development of watershed management programmes.

In this respect, FAO initiated a review and assessment of watershed management development strategies and approaches with the goal of providing reliable information to concerned stakeholders regarding lessons learned, existing gaps, and guidelines for the next generation of watershed management programmes. The following major steps are being taken:

- stocktaking exercise;
- case studies analysis;
- regional workshops;
- dissemination of results.

Additional regional workshops were scheduled for 2002 and 2003. These workshops are seen as an important step of the review in providing an opportunity, on the global scale, for watershed management interest groups and stakeholders to exchange information, discuss achievements, identify existing gaps in watershed management, and formulate innovative approaches and strategies for future watershed management programmes.

OBJECTIVES

The objectives of the workshop were to:

- provide a forum for regional input from various stakeholders in upland watersheds;
- identify achievements and gaps in watershed management projects and programmes;
- identify lessons learned and major issues emerging from past watershed management experiences in the region;
- identify guidelines for the formulation and implementation of the next generation of watershed management projects and programmes, with special focus on the role of effective watershed management in the conservation and sustainable use of water resources.

WORKSHOP PROGRAMME

The workshop programme, including the major discussion topics and a list of authors and titles of papers, is presented in Annex B.

WORKSHOP PARTICIPANTS

A total of 29 participants, representing 19 countries and 11 international organizations attended the workshop. A list of the participants is presented in Annex C.

WELCOME ADDRESS AND OVERVIEW PRESENTATION

Mr Moujahed Achouri of FAO opened the session with a welcome address that included a vote of thanks to the organizers and participants of the workshop and an overview of the objectives and expected outcome of the workshop. The welcome address is presented in Annex A.

Mr Moujahed Achouri also presented an overview of the FAO initiative. His presentation is given in Chapter 2 of these proceedings.

GROUP DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

Chair: Jean François Donzier; *rapporteur:* Jeff Sayer

Three working groups were convened for discussion of major topics relevant to the next generation of watershed management programmes. The group themes are presented in the following. A list of participants by working group is provided in Annex D. During the plenary session the results of the working groups were presented.

Group 1

Theme: Innovative approaches and methodologies to effective watershed management, with special focus on the conservation and sustainable use of water resources. Topics to include use of new ideas and technologies (e.g. new electronic technology) for watershed management (WM) planning, monitoring and evaluation, project/programme implementation and other technical elements relevant to project design and implementation.

Facilitators: Einar Beheim and Moujahed Achouri; *rapporteur:* Pier Carlo Zingari

Working group 1, summary of findings

- Awareness raising was discussed with emphasis on the need for everyone to get involved ("learn about my watershed" Environmental Protection Agency [EPA] Office for Water approach), for non-governmental organizations (NGOs) and group responsibilities (sharing responsibilities, sharing benefits), and for policies ("think and talk prevention").

- Information should be wider than the usual press agencies' reporting on killer floods, i.e. additional data (e.g. the memory of people, historical evidence of the events, and all the other aspects that are generally neglected) should be included in the reporting. In addition, the data sets should not be purely technical and local, but global (e.g. forests cannot do miracles).

- Planning should be with local people before technicians (e.g. by the Swiss Risk Prevention Office: dialogue with and involvement of local people are cost-effective tools for risk evaluation and prevention).

- Policies and legislation should be consistent and supported by funds (a policy decision = a set of objectives + a juridical act + money to achieve the objectives). Policies should go beyond governments. There are innovative, replicable and diversified financing tools (especially in mountain areas worldwide).

- The impact of watershed management is greater than commonly viewed. The scale of measures must equal the scale of the impacts.

- The watershed management concept can be restricted to water or opened to people, food, rural development, rehabilitation and nature conservation.

- In order for watershed management programmes to be effective, the following major elements should be considered: 1) financing (payment for watershed services and government commitment); 2) water conservation and sustainable use as a major objective; 3) different levels of scale (local, national and regional): and, 4) identification and use of appropriate technologies that ensure sustainability and replication in accordance with the desired results (including prevention of resource degradation).

- There is a need for complete and relevant information, mainly on neglected aspects such as sedimentation, forest hydrology and extended information resources, including historical, traditional and new technologies.

- There is a need for better planning based on improved collaboration and cooperation among all stakeholders, the availability of required information, technical capacities and operational monitoring and evaluation.

- There is a need to develop appropriate policies and legislation arrangements, with adequate institutional settings and clear objectives and priorities with regard to water resources management (water quality, quantity and timing).

Discussion group 1

- Jean-Francois Donzier: Made a point about the importance of a basin-level approach in management of water resources.

Group 2

Theme: Appropriate strategies for meaningful research and linkages between research and implementers; and strategies and approaches for technology transfer and dissemination (e.g. global networking).

Facilitators: Lalji Mandalia and Larry Tennyson; *rapporteur:* Philip Bubb

Working group 2, summary of findings

- There is an imbalance of data on mountain environments in the EU, i.e. most of the data are for the Alps.
- Mountain environments are highly variable, but these areas have fewer hydrological and meteorological monitoring stations than lowland areas have.
- There is a lack of data across biophysical scales; often only lowland data exist. (Scales should be local, catchment, basin, national and regional.)
- There is a need for research decision-making with links among researchers, land managers and users.
- There is a need for process-based concepts and models across temporal and spatial scales.
- There is a need for methodology to determine the carrying capacity of mountain watersheds (e.g. the impacts of human activities such as tourism, rural development, road density, etc.).

- There is a need for a global network for watershed management with inter-active capability for sharing information and databases.
- There is a need for Internet discussion groups on watershed management in mountains.
- There is a need for research output that is designed to be interpreted, understood and used by trainers, watershed managers and others.
- The FAO/European Forestry Commission (EFC) Working Party on the Management of Mountain Watersheds is a forum that could be utilized for information and technology exchange.

Discussion group 2

- General discussion about watershed-scale problems with respect to extrapolation of data.
- Josef Krecek stressed the importance of experimental watersheds and the extrapolation of information.
- Michaela Leitgeb stated that the lack and incompatibility of mountain databases are major problems.
- Carmen de Jong: The is a need to develop the concept of the carrying capacity of mountain watersheds.
- Sten Folving: There is a need to build on existing forest information systems with metadata information system approaches. There is also a need to set up an EU catchments information system.

Group 3

Theme: Innovative approaches and methodologies for effective watershed management, with special focus on economic and social considerations: the participatory process, policy and legislation, environmental services, onsite and offsite benefits, and other elements relevant to the conservation and sustainable use of water resources.

Facilitators: Luca Fe d'Ostiani and Carmen de Jong; *rapporteur:* Jean Bonnal

Working group 3, summary of findings

- Because of socio-economic complexity, WM programmes should be designed with multi-functional criteria.
- Collaborative design and management involving all stakeholders are prerequisites for effective WM.
- A dynamic monitoring process is needed as a decision support tool.
- There is a need for more focus on upstream–downstream linkages and related impacts, including flows of resources and environmental services.
- There is a need to identify and promote flexible incentive schemes that can be adjusted according to changes in environmental, socio-economic and institutional components.
- There is a need for careful consideration of local expectations in combination with cost–benefit and risk analysis at different levels (e.g., the household, the community, etc.).

Discussion group 3

Phillip Bubb: Regarding environmental impact procedures, are there any gaps? Some discussion by several participants on this topic. General agreement that this subject needs further investigation.

Josef Krecek added that environmental assessment should be part of the process.

TECHNICAL PAPERS

During the workshop several papers were given on topics relevant to the workshop theme. The papers are presented in their original in the following chapters of these proceedings

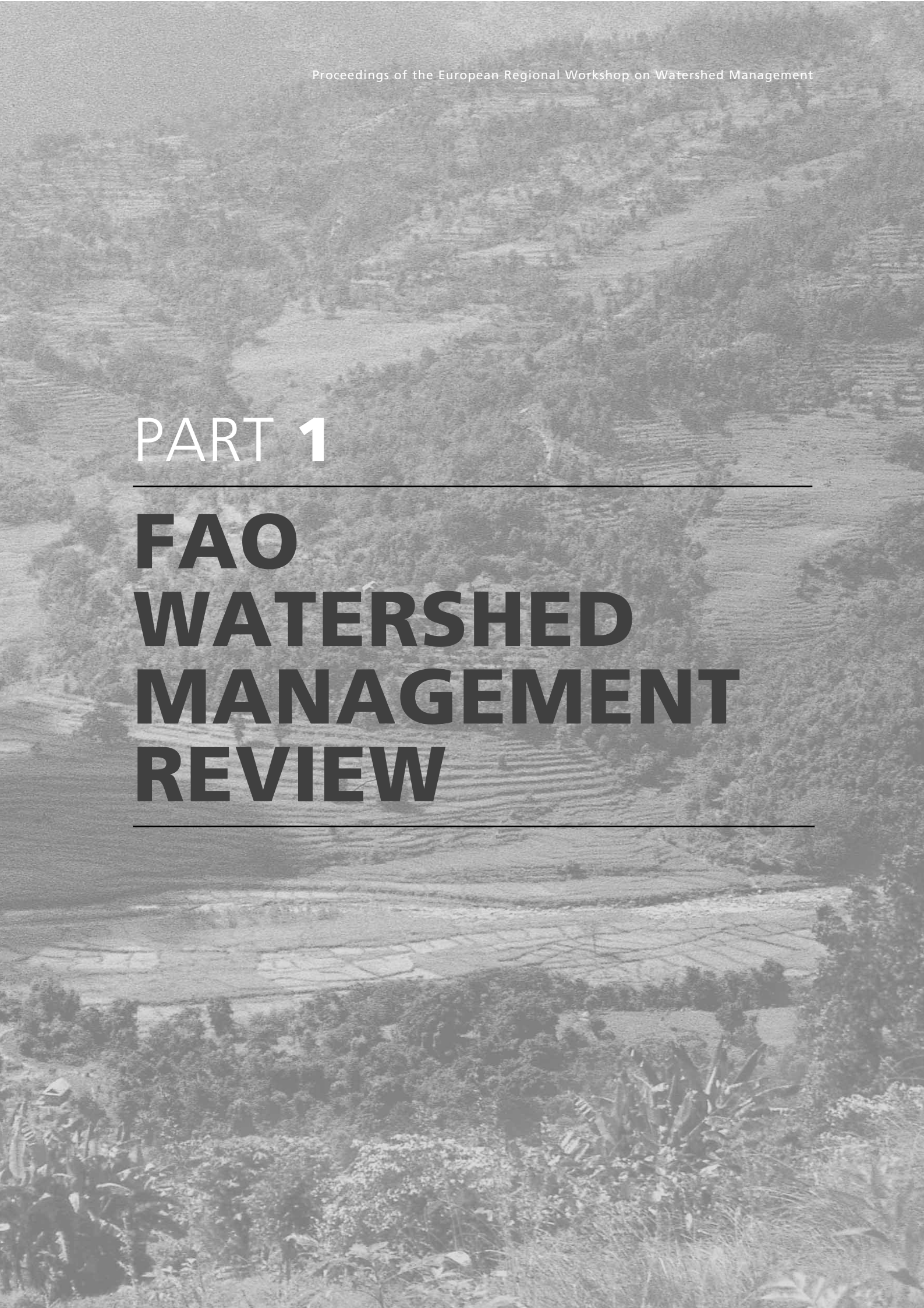
CONCLUSIONS OF THE WORKSHOP

A summary of workshop findings was prepared by the working group leaders and presented at the conference by Mr Moujahed Achouri.

WORKSHOP PROPOSAL

During the plenary session, the following proposal was presented and unanimously approved:

> The workshop brings forward a proposal made by the representative of Bosnia and Herzegovina and agreed upon by the participants. The tragic flood events of summer 2002 in central Europe have heightened the awareness of all concerned parties and high-level authorities of the urgent need to consider the importance of the integrated and participative movement in watershed management in a way that considers preventive, long-term and scale-adapted approaches in the perspective of the EU enlargement, subsidies and policies reform.



PART 1

FAO WATERSHED MANAGEMENT REVIEW

CHAPTER 1
PREPARING THE NEXT GENERATION OF WATERSHED MANAGEMENT PROGRAMMES

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It is clear that much progress has been achieved in watershed management, especially during the 1990 to 2000 period when new approaches and methodologies were developed to promote participatory integrated watershed management. However, no clear picture has been drawn as to what has really been working and what can be done to improve future watershed management programmes. In fact, there has been no systematic effort to review and assess watershed management strategies and approaches at a global scale since FAO did so at the expert meeting held in Kathmandu, Nepal from 25 February to 1 March 1985. Hence, in-depth analysis of watershed management achievements and existing gaps, with particular emphasis on the experiences of 1990 to 2002, is a prerequisite to further development of watershed management programmes.

This paper has been prepared in response to the raising of key issues of major concern to the development of watershed management. It reviews and assesses watershed management activities and provides reliable information on lessons learned and existing gaps. Such information is needed to justify investment in watershed management activities and to focus such activities on the areas where they are most needed. The assessment concept and approaches were designed to respond to the needs and characteristics of different audiences involved in watershed management.

BACKGROUND

Interest in and awareness of the multiple environmental, economic and social benefits provided by watershed management and development have greatly increased in recent decades. This may be particularly true in developing countries where the economy depends predominately on agriculture, but there are also fast-growing urban populations that depend on water and food supplies on an unprecedented scale.

Degradation of natural resources is considered to be the greatest constraint to sustainable agricultural development in most developing countries. It is generally accepted that sustainable use and management of land resources will only be achieved by adopting a system of improved land, water and vegetation management and use based on an integrated approach to land resources development with the direct involvement and participation of the different actors.

Given that watershed management is the implementation of management systems that ensure the preservation, conservation and sustainable use of all land resources, the development of watershed management is recognized as a prerequisite for the sustainable management of land resources and the improvement of upland inhabitants' living conditions. In fact, watershed management integrates various aspects of forestry, agriculture, hydrology, ecology, soils, physical climatology and other sciences to provide guidelines for choosing acceptable management alternatives within the specific social and economic context.

Integrated watershed management through people's participation has become widely accepted as the approach that ensures sound sustainable natural resources management and a better agriculture economy for upland inhabitants as well as the people living in downstream areas.

As a consequence of the attention paid to and the important investments secured for the development of watershed management, much progress has been achieved in this field. However, several issues of major concern, which were raised many years ago, still require in-depth analysis and consultation among all concerned parties for better understanding and implementation of effective watershed management.

The expert meeting on strategies, approaches and systems for integrated watershed management held in Kathmandu, Nepal in 1985 highlighted the threats that represent for the livelihood of millions of people, and the related constraints to the development of a healthy agricultural and natural resources base. This meeting, which was organized jointly by FAO, the International Centre for Integrated Mountain Development (ICIMOD) and the East-West Centre, Environment and Policy Institute (EAPI), also identified and recommended relevant action for urgent implementation.

The main actions it recommended can be summarized as follows:
- develop significant policy and programme responses;
- develop national conservation strategies and frameworks to achieve appropriate and comprehensive management of mountain watersheds;
- develop relevant training, efficient applied research and demonstration projects required to achieve effective watershed management.

In spite of the progress achieved in developing watershed management approaches and application, most of the actions identified 17 years ago are still in urgent need of implementation, even though some of them were proposed with time deadlines; for example, the development of relevant policies and programme responses was projected to be achieved by 2000.

In addition, issues such as people's participation, in which watershed management scientists and practitioners feel that major progress has been achieved, are now being raised by many as requiring further analysis and clarification. Questions that still require satisfactory responses include: What kind of participation are we using? Are we achieving what was expected? and What is missing for the institutionalization of participatory approaches?

Another important issue that many consider to be a major gap in the evolving watershed management concept is the still very limited dissemination and exchange of information on achievements and lessons learned. Owing to various reasons – mainly a lack of adequate

institutional and organizational arrangements – project experiences and lessons learned are sometimes not even shared among concerned institutions of the same country.

In this connection, the World Bank carried out a review of its own watershed management projects in May 2000. The findings of this review of 42 projects, which had a total budget of US$2.37 billion and were implemented between 1990 and 1999, also call for in-depth analysis to identify what has been achieved and what can be done to improve future watershed management programmes.

In view of these issues, an assessment and review of results and lessons learned in watershed management are considered prerequisites not only for providing answers and clarifications of the issues raised but also, and mainly, as an important preparatory stage for the next generation of watershed management projects and development programmes.

ACHIEVEMENTS AND EXISTING GAPS

During the last few decades, watershed degradation has been seen as a serious threat to environmental conditions and to the well-being and survival of millions of people living in watershed and downstream areas. Many countries recognize the importance of upper catchment conditions, and have made reversing watershed degradation a priority.

However, many watershed management programmes have failed to achieve their objectives, mainly owing to the following reasons:

- They focused too much on natural resources conservation.
- They were designed with little attention to human activities and the priorities and needs of people.
- They neglected beneficiaries' involvement and contribution to the planning and implementation of watershed management interventions.
- They were frequently limited in span and scope, and lacked the long-term commitments needed to address underlying causes and long-term management issues in a satisfactory way.

Consequently, new concepts and approaches were developed to reverse watershed degradation and establish an improved agricultural and rural economy. In order to achieve such objectives, social and economic aspects were given particular attention in watershed management programme/project formulation and implementation. In addition, *people's participation* was recognized as being key to the success of watershed management programmes.

Recognizing that the management and conservation of land resources through physical structures, reforestation and other conservation measures would not be sustainable and replicable unless people's concerns were taken into account, the *integrated concept* was developed as a process in which community problems and needs can be considered as an important component of development programmes. People's participation was also recognized as a principal component in all phases of the development of watershed management programmes.

The *participatory integrated watershed management* approach introduced and developed over the last decade includes, in addition to the technical aspects, the economic, social, political and cultural dimensions of natural resources conservation and management. Watershed management has become a multi-disciplinary activity in which appropriate institutional and organizational mechanisms are required for the coordination/implementation of watershed management activities.

The development of concepts and approaches, and the watershed management experiences from many parts of the world now call for further investigation, analysis and consultation among watershed management stakeholders for greater consensus on what has been achieved and on how things could be done better. Stakeholders are stressing the need for a clearer overview of several key issues of major concern to watershed management development.

Although it is generally agreed that integrated watershed management can play an important role in natural resources conservation and improvement of the conditions of upland people, conflicting views on the approaches and methods of watershed management continue to be the subject of concern and controversy.

A quick overview of the last decade's findings and recommendations on watershed management activities outlines a number of key questions.

Are we sharing experiences and lessons learned? It is recognized that significant progress on watershed management approaches and methodologies has been achieved in different parts of the world. However, sharing these results and identifying appropriate mechanisms for disseminating such information are important issues that require urgent action in order to benefit watershed management users/new projects from experiences learned and to avoid the duplication of efforts.

Are we using the appropriate participatory processes? The experience of participatory approaches during the last decade has raised several issues: What kind of participation is taking place? To what extent can participatory approaches be used? Are we overestimating what can be achieved through participatory approaches?

Participatory processes are recognized as primordial in watershed management at all stages, from project identification to the appraisal and implementation of activities. Experiences have shown that one-sided bottom-up or top-down approaches do not work. This leads to the conclusion that no single approach or method can be considered as the most appropriate one, but rather a variety of approaches and methods should be pragmatically used and adjusted according to specific circumstances.

Are the technologies developed producing the desired results? Greater emphasis is being put on the services and benefits that watershed management can provide. Watershed management is increasingly seen as an appropriate vehicle not only for environmental conservation but also for the improvement of rural livelihoods . In this regard, there is demand for the development of appropriate technologies that can ensure sustainable development and natural resources management. Specific issues are also raised regarding watershed management scale problems, upstream–downstream relationships and the technologies and methodologies needed.

Are project activities sustainable and replicable? There is uncertainty about the sustainability and replicability of the technologies that projects implement. The World Bank (2000) review of watershed management projects raised this concern, stating that "many Bank projects, while able to achieve considerable gains in the short term as a result of an intensive injection of funds and expertise, are neither replicable nor sustainable following project completion".

To what extent have the institutional/organizational and legislative arrangements been developed? Institution building for watershed management has been mentioned as one of the most neglected parts of watershed projects. It is recognized that there is a need for improved understanding and identification of the institutional and organizational arrangements required for effective watershed management. An appropriate legislative framework to support watershed management policies is an important tool that needs particular attention.

Are the expected policies/strategies in place? Recent assessments have shown that although broad environmental policies are in place in many countries, generally no attention has been given to the development of watershed management policies. Lacking or inadequate national policies, strategies and action plans are recognized as principal constraints to implementing sustainable watershed management programmes.

These are some of the relevant controversies and watershed management issues that have emerged from watershed management experiences all over the world, especially those carried out during the 1990 to 2000 period.

In order to achieve effective watershed management, it is necessary to examine state-of-the-art watershed management programmes and concepts. In this context, the review and assessment intends to address the key watershed management issues raised, in preparation for future watershed management projects/programmes.

ASSESSMENT: LESSONS LEARNED AND FUTURE PROGRAMME DEVELOPMENT

The assessment and review of watershed management activities is being conducted with the broad objective of promoting, disseminating and exchanging information on watershed management achievements and existing gaps and providing support for the development of effective watershed management through relevant projects and programmes. It aims to provide an adequate opportunity for all concerned parties to share information and contribute to a better understanding of the current status of watershed management, and to provide awareness raising and the required advocacy and support for the implementation of effective watershed management at the local, national and regional levels.

Based on the in-depth analysis of watershed management activities carried out over the last few decades, with emphasis on the last decade (1990 to 2000), and in view of important events such as the International Year of Mountains (IYM), the assessment/review initiative was developed with the main objectives of:

- assessing and identifying the nature and extent of achievements and existing gaps in state-of-the-art watershed management programmes and concepts;
- identifying lessons learned and principal issues emerging from the experiences of FAO and other relevant organizations, with particular focus on the 1990 to 2000 period;

- identifying guidelines for the formulation and implementation of the next generation of watershed management projects/programmes;
- contributing to implementation of Agenda 21, Chapter 13 (Sustainable Mountain Development) and to the outcome and follow-up of the IYM and the International Year of Freshwater.

The assessment's approach was carefully developed in order to respond to several needs while considering the characteristics of the different audiences involved in watershed management at the global, regional and national levels. It includes:
- stakeholder identification, participation and contribution;
- steps in the assessment development process that allow relevant parties to contribute;
- output that responds to the issues raised by stakeholders.

The following steps were identified as necessary for the proposed watershed management review and assessment.

Consultation: The review/assessment concepts and approaches were discussed in-house. Comments and suggestions were sought from technical divisions involved in watershed management activities.

Investigation: In-depth investigation was conducted to identify whether FAO and/or others had conducted other reviews and assessments on issues related to watershed management activities.

Stocktaking: FAO experiences of watershed management were emphasized, with particular attention on the period 1990 to 2000. Project formulation documents, evaluations and findings, recommendation reports and the outcomes of watershed management events such as seminars, conferences and workshops represent a principal source of information for the assessment. To be in line with the assessment objectives, experiences and information from other relevant organizations were taken into account during this phase of the assessment.

Case studies: Selected case studies treating watershed management issues were identified for in-depth analysis to provide reliable information on state-of-the-art watershed management. By highlighting what does or does not work, the case study analysis can also orient the formulation and implementation of the next generation of watershed management projects. Ongoing work on sustainable mountain development case studies could be a good source of information for the watershed management activities assessment.

Workshops: In order to learn from regional experiences, regional workshops were conducted. Watershed management experts who had been involved in watershed management shared experiences and lessons learned. Workshop participants commented on the outcome of the assessment steps, and contributed to the exercise's findings and recommendations.

International conference: An international conference was planned where key partners in watershed management could discuss the findings/recommendations of the review and guidelines for the next generation of watershed management programmes for dissemination at the global scale.

Dissemination of results: The review and assessment results will be disseminated through reports and relevant Web sites. An FAO Conservation Guide on future watershed management programmes is an outcome of this exercise.

The potential users of the watershed management activities review and assessment include FAO and other relevant international organizations, national institutions/decision-makers dealing with watershed management activities, and watershed management specialists, including researchers involved in watershed management development activities.

Potential uses include: sharing/promoting lessons learned from past experiences; greater streamlining and consensus on the issues raised; raised awareness on the role of watershed management in rural development/poverty alleviation programmes; development of future watershed management plans and strategies; guidance for policy development and formulation of relevant projects/programmes; and orienting research action to identified key issues for the development of watershed management programmes.

The findings and recommendations of the watershed management activities review and assessment will be presented in an FAO Conservation Guide. The results are also available through relevant Web sites.

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CHAPTER 2
REVIEW AND ASSESSMENT OF WATERSHED MANAGEMENT STRATEGIES AND APPROACHES

Larry Tennyson
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The importance of multiple economic, social and environmental benefits derived from land-based resources has increased in recent years. Sound management of these resources is therefore prerequisite to sustainable resource-based production systems. Watershed management, which in essence is the application of land resource management systems, is considered by many to be the most appropriate approach to ensuring the preservation, conservation and sustainability of all land-based resources and improving the living conditions of people in the uplands and lowlands. Integrated watershed management with participation of all the relevant key actors has become widely accepted as the approach best suited for sustainable management of renewable and non-renewable natural resources in upland areas.

WATERSHED MANAGEMENT – A HISTORIC VIEW

Large-scale removal of forest lands by humans in the nineteenth and early part of the twentieth centuries created significant changes in the hydrologic function of watersheds. Downstream flooding occurred more frequently, with subsequent increases in loss of life and damage to infrastructure. Accelerated erosion, produced by changes in the biotic and hydrologic components of natural drainages (watersheds), created unprecedented large-scale siltation of developed lowlands. At the time, the general consensus was that the removal of forest was causing these undesirable impacts. However, the mechanisms for reversing the process through sound scientific management had not been developed.

During the second quarter of the twentieth century, the discipline of forest hydrology evolved from the need for scientific management of the soil and water resources of headwater catchments in order to minimize the flooding and siltation of productive lands and infrastructure in the valleys and plains inhabited by humans. As the importance of rangelands and cultivated lands in the hydrologic cycle and the erosion–sedimentation processes of catchments became known, forest hydrology gave way to the more comprehensive, present-day watershed management.

Over time and in response to changing needs, the scope of watershed management has broadened from the initial concept of technical management of the water resource to an integrated discipline that applies biological, technical, social and economic principles to maintain the productivity of headwater and lowland areas through the scientific management of soil, plant and water resources.

Watershed management in its truest form is the conservation management of the soil, plant and water resources of a catchment to benefit humanity. It involves managing the land and human resources of the drainage in a manner that sustains adequate levels of water, soil, food and fibre production. This form of management requires a participatory integrated approach that includes the various physical, vegetative and human components of areas that range from a few hectares to large river basins.

The watershed part of watershed management implies management of these resources, to the extent possible, within a defined physiographic boundary. From a conceptual perspective, when the boundaries of a management system are defined it is easier to identify and monitor the components (e.g. inputs, storage and outflows) of that system – e.g. the hydrologic cycle. However, from a land management perspective, these physical boundaries are considered to be simply topographic demarcations within political and administrative boundaries that usually overlay a series of watersheds.

The theoretical concept of participatory integrated management of natural resources is difficult to apply. The myriad uses, ownerships, political and social constraints and biophysical systems in large watersheds limit application of the idealistic integrated approach. In practice, large catchments are usually managed according to economic, social and political considerations.

Management of the natural resources in headwater watersheds has the greatest potential for application of the participatory integrated concept. Agricultural, forest and rangelands often represent a potentially significant production resource for local inhabitants. However, the natural physical and biological constraints of uplands often limit productivity compared with lower elevations where major production and population centres are located.

WATERSHED MANAGEMENT REVIEW AND ASSESSMENT OF STRATEGIES AND APPROACHES

Degradation of the natural resources of upland areas has been occurring on the global scale for several decades. In an attempt to reverse this trend, concerned governments and development assistance organizations have been employing watershed management principles since the 1960s. Through these years of development, strategies and approaches for implementing watershed management interventions have changed as the discipline moves forward along the learning curve. By responding to research results, lessons learned, failures and successes, periodic reviews and evaluations, the discipline continues to be dynamic, with adjustment and modification as required to meet changing needs.

During the past decade, the social and economic aspects of watershed management have been given high priority. In addition, people's participation has been recognized as one of the keys to successful management of natural resources (Bendtsen and Sthapit, 1999; Petersen, 1999). The integrated concept has expanded to include community needs and problems as part of a holistic watershed management development scheme.

The last review and assessment of watershed management development strategies and approaches by FAO was held in 1985–1986 (FAO, 1986b). In view of the development changes that have occurred during the past decade, and the period of 17 years since this review, it was

decided to conduct a stocktaking exercise to determine the present status of watershed management development, identify any gaps and formulate guidelines for future development projects/programmes.

Objectives

The overall aim of the assessment was to promote, on the global scale, the dissemination and exchange of information regarding achievements and gaps in watershed management, and to provide future support for effective watershed management projects and programmes. Specific objectives include:

- to conduct a study, on the global scale, of the nature and extent of accomplishments in watershed management;
- to identify major gaps in watershed management strategies and approaches, with focus on the 1990 to 2000 period;
- to formulate guidelines for the next generation of watershed management development projects and programmes.

Procedures

A five-pronged approach was followed to collect information. The first step was to identify key actors) involved in watershed management development during the study period. A set of questions designed to provide information relevant to the study was prepared and sent to the key actors. The responses were reviewed and summarized.

The second step was to conduct stocktaking of FAO experience of watershed management development projects/programmes during the 1990 to 2000 period. This process included reviewing project terminal and evaluation reports, proceedings of seminars, conferences and workshops, personal and group consultations, and other information sources.

The third step was selection and review of case studies on completed watershed management projects or programmes. The selected case studies are summarized in this paper.

The fourth step was to convene a series of regional workshops to provide a forum for regional, national and local actors in watershed management.

The fifth and final step was to prepare a summary of the results of the first four steps and to formulate guidelines and strategies for future watershed management development programmes, with subsequent distribution on the global scale.

RESULTS

Initial findings of the watershed management review are presented in the following sections.

Key actors survey

The survey questionnaire was sent to 30 key actors (organizations, agencies and institutions). A total of 18 responses were received: 14 of these provided answers to the questions, and four provided information on contacts and publications (see Table 1).

TABLE 1

Key actor survey: organizations and names of respondents to FAO review questionnaire

CGIAR, Consultative Group on International Agricultural Research.
Ruth Meinzen-Dick, Senior Research Fellow, International Food Policy Research Institute.

CIAT, International Center for Tropical Agriculture.
Joachim Voss, Director-General.

CIFOR, Center for International Forestry Research.
Mike Spilsbury.

CONDESAN, Consortium for the Sustainable Development of the Andean Ecoregion.
Roberto Quiroz.

DANIDA, Danish International Development Agency.
Poul Richardt Jensen, TSA.

DFID, Department for International Development, United Kingdom.
Professor Ian R. Calder, Director, Centre for Land Use and Water Resources Research.

EU, European Union.
Helmut Bloch, M.Sc., Ph.D., Director-General Environment.

FAO, Food and Agriculture Organization of the United Nations.
Kumar Upadhyay, CTA, and Prem N. Sharma, Consultant.

IADB, Inter-American Development Bank.
Roberto E. Quiroga, Senior Economist.

ICIMOD, International Centre for Integrated Mountain Development.
Roger White.

IWMI, International Water Management Institute.
Frits Penning de Vries.

NUS, National University Singapore.
Professor Roy E. Sidle, Department of Geography.

PROMIC, Programa Manejo Integral de Cuencas.
Roberto Mendez and **Ana V. Heredia**.

TMI, The Mountain Institute.
D. Jane Pratt, President.

UNESCO, United Nations Educational, Scientific and Cultural Organization.
Dr Mike Bonell, Chief of Section, Division of Water Sciences.

UNU, United Nations University.
Libor Jansky, Ph.D., Senior Academic Programme Officer, Environment and Sustainable Development.

World Bank.
Norman B. Piccioni, Sr. Agric. Economist LCSES.

The results of the survey were summarized according to three main topics: 1) major issues that require further investigation and in-depth analysis; 2) major constraints – past and future; and 3) challenges, needs and opportunities for future effective watershed management. A summary of the responses is presented in the following.

Major issues that require further investigation and in-depth analysis include: pathways of water, sediment and nutrients in response to land management; appropriate sustainable natural resources management options; cross-scale biophysical and socio-economic issues; the dynamics of natural resource use intensification; multi-institutional approaches to acting together in watershed management projects.

The above suggests that there is a need to establish linkages among central governments, local governments and civil organizations, together with a more coordinated and effective international aid effort. It is also necessary to find ways of: appraising the ecosystem services of catchments and the damage to on- and off-site environments from the viewpoints of farmers and society; creating options for catchment development in which all stakeholders gain (including through intersectoral or downstream–upstream transfers); and dealing with trade-offs and conflict. Staff require careful on-the-job training, particularly in dealing with people, and the role of youth in watershed management should be investigated in greater depth.

In its response, the World Bank stresses that "….finding the right way to address the policy framework and the sets of incentives that affect natural resources in watersheds (water, land, forests, etc.) is key. Also, issues of governance (local vs. central; upstream users vs. downstream users; community organization; mechanisms for water allocation and property rights) are central themes. The challenge is not a conceptual investigation of these issues, but rather the political will to move in the right direction."

Major constraints for the present include reconciling the needs of resource-based planning with "people-first" objectives, the weak national research systems in developing countries, and the need to develop central and/or local government/community commitment and the political will to allocate appropriate staff. Watershed management is about managing conflicts. Thus, lack of governance is a major constraint.

In addition, process-based concepts and models are lacking across many spatial scales. There is insufficient understanding of the reasons why some major catchment development programmes are working well while others are not – in other words there is an inability to replicate successes. Lack of sustainable financial and institutional mechanisms was identified as an additional "Achilles heel" of watershed management projects.

Major constraints for the future include the present-day constraints continuing. Additional constraints for the future are related to limited access to freshwater, with worsening of the environmental situation as water quality and flooding become more important in highly settled areas; upstream–downstream issues are most important where water supply limits productive land use.

There is also a need to improve project design and management in order to increase the participation and commitment of key actors. A major constraint for catchment development is often the willingness/capacity of national governments to act, e.g. with respect to land tenure and payments for ecological services of catchments, including that of water supply.

Challenges include adapting decision support tools for different biophysical and socio-economic conditions, and documenting experiences and lessons learned in order to become the leading organization in this field.

Needs include a specific focus on water and sustainability as they apply to protection of human health and the environment, capacity building of youth through training and rural school curricula appropriate to their environments, and demonstrations of the usefulness of methodologies for science-based project design and monitoring and evaluation.

Opportunities include recognition of watershed management's important role as one of the most important mechanisms to address global climate change and the high negative impact of desertification in a sustainable way. There is also increasing public understanding of the importance of managing watersheds. Information collected during the 1990s will make it possible to assess performance more effectively and compare methodologies and approaches based on actual results.

FAO experiences

The second step of the study was to conduct stocktaking of FAO experiences with watershed management development projects/programmes during the 1990 to 2000 period. The process included review of project terminal and evaluation reports, proceedings of seminars, conferences and workshops, personal and group consultations, and other information sources. The results of the stocktaking exercise are presented in the following according to major topics.

Evolution of watershed management methodologies/approaches over the past decade, 1990 to 2000

The top-down approach, which was prevalent during the 1970s and 1980s, has given way to the grassroots, bottom-up approach. However, it appears that neither of the extremes is the recipe for success. The correct, sustainable approach is somewhere in between. The proper mix would include factors such as biophysical, social, cultural, financial and political considerations for all concerned stakeholders.

The emphasis of watershed management has changed from development of upland water and soil resources to all-encompassing management of upland natural resources, communities and associated infrastructure, with diffusion of the focus and prioritization of objectives. Community development has become a part of many integrated watershed management projects, with subsequent lower priority being set for management of soil and water resources. Technology for soil and water conservation on sloping lands has changed from mostly physical methods to emphasis on biological and biophysical treatments.

To some extent, the transfer of technology has shifted from a major emphasis on training professionals to training the local inhabitants who are directly involved in implementing development activities. Some of the more recently developed technologies are being used for planning and decision-making; e.g., Geographic Information Systems (GIS), global positioning systems (GPS), satellite imagery, management decision-making tools, advanced monitoring and evaluation, and participatory models.

FAO's role in sharing experiences and lessons learned in watershed management

Owing to the significant decrease in FAO field projects and the associated decrease in FAO field personnel, national meetings and technical backstopping, the sharing of technology and experiences at the national and local levels has decreased. At present, the sharing of experiences and lessons learned consists primarily of attendance, and sometimes presentations, at high-level conferences.

There is a need for networking of watershed management technology on the global scale. FAO is lagging behind as other organizations set up their own systems. This is an excellent opportunity and time for FAO to take the lead role in fulfilling this gap.

The International Year of Mountains, 2002 provided FAO with a forum to share its experiences in upland watershed development. Regional and national conferences and workshops have also provided fora for information exchange between FAO and national-level professionals. The regional participatory watershed management training project in Asia (1996 to 1999) provided a forum for information exchange between FAO and participating countries. Implementation of the second phase of this project could provide the mechanisms for a sustainable network in Asia, with links on the global scale.

The existing FAO conservation guides are being formatted on CD-ROM for distribution. However, some of these documents were prepared several years ago and may need revision to reflect the current trends and status of technology development and transfer in watershed management. The most recent FAO conservation guide that specifically addressed watershed management was prepared in 1996. Periodic articles on state-of-the-art watershed management topics in journals such as *Unasylva* have provided a mechanism for disseminating information on the global scale.

Decentralization seems to have created a technology transfer gap between FAO headquarters and regional offices. With respect to forestry and watershed management, the flow of technical information between the regions and the relevant central office is lacking. This particular initiative has shed some light on this issue. The causes are most likely multiple and the solutions complex. A detailed problem analysis with subsequent solutions is warranted.

Participatory processes in the planning and implementation of watershed management activities

Global experience has shown that there is no universal model for participatory planning and implementation of watershed management activities. There is a process that would, in most cases, have similar steps. However, this process – which should include all levels and steps of

the participatory process, e.g. planning, design and implementation with all concerned stakeholders – has not been well defined. Bits and pieces of the process have been identified by various projects. The complete participatory process for watershed management needs to be mapped out in a logical manner, tested and refined.

Experience has shown that empowerment of the main stakeholders in watershed management projects/programmes to plan and implement appropriate activities is essential if the project/programme is to have any chance of sustainability. For example, regardless of good intentions, it is not enough for a project to form a community conservation committee at the grassroots level – in isolation from local governments – plan and start interventions, provide technical, financial and other required inputs to the end of the project and then expect the government to make the project sustainable by providing the required inputs into the future. This is a recipe for failure.

Participatory research methods such as participatory rural appraisal, which have been developed and employed on a wide scale in watershed management projects, have sometimes been a good instrument for initiating the participatory process. However, owing in part to the inherent nature of rapid data collection, subjective questions and answers and limitations on statistical analyses and the subsequent extrapolation of findings, the data generated by these rapid survey methods have limitations for use as baseline data for future assessment of project success. In addition, these participatory appraisal methods are only one part of the participatory process. Participatory appraisal methods, if used, should be conducted in proper sequence as part of the overall participatory process.

Participatory approaches and institutional considerations

The pendulum is swinging in support of empowering people with regards to the conservation of natural resources. There are several reasons for this, one being that past endeavours by governments to solve natural resources degradation problems on their own have for the most part been unsuccessful in terms of sustainability. Second, most national governments do not have the human or financial resources for the countrywide mitigation of natural resource degradation. Throughout the world there are examples of successful, sustainable resource conservation being carried out by local communities that have been empowered to manage their land-based resources.

Change is also occurring, albeit slowly, in governments. New policies are being implemented that permit and encourage people's management of their natural resources; e.g. land tenure, user rights, water rights, crop tenure, formal recognition of community groups and committees, privatization of communal lands, rights to the income generated from these conservation activities, etc.

The participatory process requires an active, well-trained field-level extension service in sufficient numbers to carry out watershed management activities on a large scale. The extension component is usually a weak link in the development process.

Gender issues

Review of past FAO projects revealed that gender issues have been a part of watershed management projects. However, the extent to which these issues were addressed has varied and the recommended changes have not always been made. FAO has promoted the involvement of men and women in implementing watershed management activities since the early 1970s. Through time, the importance of directly involving women in these activities has grown. The degree of success of women's involvement has varied for many reasons, including the following:

- *Inadequate project design:* All of the projects reviewed from the 1990 to 2000 period included component(s) for women. However, most of the inputs provided for these activities were minimal compared with other interventions. In addition, the designs addressed only parts of the gender issues in rural environments. Consequently, most of these activities were inadequate in terms of addressing key gender issues.

- *Cultural and social constraints:* Experience has shown that cultural and social constraints are limiting factors regarding rural women's involvement in project activities. Regardless of the level of inputs, these issues have to be considered and project activities designed to fit the norms for a particular rural setting.

- *Policy and legal constraints:* If there is no supporting policy and legislation, the involvement of women in watershed management projects will continue to be limited.

As the empowerment of people movement moves forward, the inclusion of women in the decision-making process is a prerequisite to sustainable development in rural environments.

Impacts of watershed management technologies

Watershed management technologies have proven to be effective for mitigating erosion on sloping land, stabilizing landscapes, providing clean water, and stabilizing – and in some instances improving – agrarian production systems on the small to medium scale. With modification, these existing technologies can be used successfully in most terrestrial environments inhabited by humans. The degree of success of watershed management interventions is primarily a matter of the will of the people and the scale of the activities.

Regarding the *upstream* effects, examples exist throughout the world where upland resource conservation activities have been successful on the micro and macro scales; e.g. micro- to meso-scale activities in Honduras, the Philippines, China, Thailand, Burundi, Nepal, Pakistan, Sri Lanka, India, Bolivia, Peru and other countries, and the macro-project in Santa Catarina, Brazil.

Regarding the effects *downstream*, the impact of upland watershed management activities on downstream water quantity, quality and siltation remains a controversial issue, partly because of economies of scale, and partly because of difficulties in predicting with reasonable accuracy the results of these activities. Until the magnitudes of natural and human-induced erosion and subsequent sedimentation can be quantified with reliability in a watershed, the controversy will remain regarding upstream effects on downstream infrastructures. The same applies to the quantifiable affects of land use on the hydrologic cycle and water supply and quality.

In the meantime, downstream infrastructures such as hydroelectric and/or irrigation dams are being constructed for hundreds of millions of dollars. However, in the past, when watershed management activities were to be carried out to mitigate downstream siltation of these structures, at best a few million dollars were provided to treat all of the contributing upland areas. In many catchments, the upland areas are in degraded condition before the dam is constructed, so implementing small-scale watershed management interventions is like putting a band aid on gangrene; furthermore, the results of poverty level inputs are poverty level outputs.

Sustainability and replicability of watershed management technology

The interpretation of *sustainable* in the context of watershed management interventions is a matter of perspective. Many interventions at the community, household and farm levels have continued after the project terminated. For example, woodlots were still being managed years after projects ended in Pakistan, Nepal, Myanmar, Thailand, India and the Philippines. The same applies to terracing works that have stabilized hillsides and improved agriculture production in China, Nepal, Thailand and Honduras; biophysical gully erosion control treatments that have stabilized gully cutting on sloping lands – structures that were built 15 to 20 years ago are in place and functioning as an energy modifier on the landscape, which was the original intention; and simple low-tech water supply interventions that continue after projects finish. The development process has provided many examples of low-tech and low-cost upland interventions being more sustainable than high-tech, high-cost ones.

Two key factors regarding the sustainability of watershed management interventions are financial and institutional stability/instability. As stated by some of the contributors to this assessment exercise, the "tragedy of the commons" continues to be a problem. Experience has shown that the political, social and user rights issues must be solved on common lands before interventions are sustainable.

The technical solutions available for managing soil and water resources are *replicable*, with modification to fit most landscapes inhabited by humans. These techniques are being used throughout the world. The degree of replication depends to some extent on the degree of technical skills and investment required to implement a technique. For example, high-tech, high-cost torrent/landslide control is replicable to most sites. However, the scale of these interventions is limited by the technical and financial resources available. Whereas, low-tech, low-cost interventions at the community and farm levels have potential for replication on the large scale if local technical skills are available and people are willing to implement the activities.

Important scale factors for upscaling from site, to watershed, to basin, to region include institutions, finances, and cooperation and coordination of all concerned parties. Important factors for out-scaling from plot or demonstration site to local farms and communities include biophysical considerations, finances, and the capacity of local institutions.

Development status of institutional/organizational arrangements, policy and legislative mechanisms

Watershed management is an integral part of natural resources management in many countries; more so today than ten years ago. Some countries give it more attention than others. In Asia and the Pacific and in Latin America it has been institutionalized into existing forestry and agriculture line agencies. The degree of institutionalization varies, from one or more professionals in watershed management such as in Bhutan or the Lao People's Democratic Republic, to watershed management units or divisions such as in Myanmar, Nepal, Honduras and the Philippines. Institutionalization of watershed management in Africa has been slow to develop. The reasons for this lag are beyond the scope of this exercise.

Policy and legislation that support participatory watershed management remain major issues. Governments have been slow to respond to the need for changes in existing and new policies and legislation that enhance upland inhabitants' opportunities for sustainable participation in natural resource conservation interventions. However, some progress has been made, for example: 1) the granting of user rights for communities and households on government lands in Asia, Africa and the Americas; 2) many countries' enactment of tree crop tenure rights that permit individuals or groups to harvest and market products from trees that they themselves have planted (Nepal, Bhutan, Pakistan and other countries); and 3) formal recognition of local watershed resource conservation development groups/committees.

Training and education

Watershed management training and education programmes have progressed significantly during the past decade. The results of a study by Brooks (FAO, 1992) of the Asia and Pacific region indicate that there are many talented professionals. The study also pointed out that there are excellent education institutions in the region. None of the respondents to the global survey stated that there was a dearth of well-trained professionals. The Brooks study pointed out the need for training/education of all the key actors, from policy- and decision-makers to field-level technicians and villagers who are implementing watershed management activities.

The regional FAO watershed management training in Asia project (FAO, 2000) indicated the need for training in participatory methods and interpersonal skills at all administrative, professional and technician levels.

The major training constraint that surfaces in all the study reviews is the need for more emphasis on well-designed training programmes for local government staff and for the villagers who are directly involved in implementing field-level activities (FAO, 1996; Dent, 1996; FAO, 1999).

Evaluation of FAO projects

Eight FAO projects with a watershed management theme that were implemented during the 1990 to 2000 study period were evaluated in the context of the stocktaking part of this study. Terminal and evaluation reports were reviewed and evaluated according to the following criteria:

- scale of operation;
- participatory approach;
- project design;
- major constraints;
- sustainability indicators;
- training;
- technology;
- government capacity.

A summary of the project evaluation is presented in the FAO project evaluation matrix, Appendix 3.3. The results indicate that all of the projects had a community- or group-level participatory component. Project design was unsatisfactory in two projects, with satisfactory performance for the others. None of the projects were rated highly satisfactory. The major constraints varied, but were common to the constraints that have been identified in this overall assessment exercise. Evaluation of project training components indicated a trend towards more emphasis on the training of local-level technicians and villagers. All of the projects had social and biophysical technical components. However, indicators of the performance of these technologies were insufficient for evaluation. Government capacity ranged from unsatisfactory to satisfactory. In some projects, government performance was not clearly defined. Sustainability indicators were not clearly defined in most of the projects. In addition, these indicators were not of sufficient scope and detail in any of the projects to provide clear evidence of sustainability.

Analysis of the results of the FAO project evaluation identified some points that may need attention for the improvement of future projects. These points are the following:

- Project design is lacking: e.g., overdesign in terms of expected outputs; unclear objectives; less than comprehensive design (i.e. a design that includes the required inputs for all of the key actors in the project [FAO, 1991]).
- Performance indicators need to be comprehensive and clearly defined.
- There is a need for monitoring and evaluation procedures at the project and agency levels that clearly link performance with objectives.
- There is a need for sustainability indicators that are clearly defined and linked to project objectives.

Comparison of major watershed management development issues: 1986 and 2002

During 1985–1986, FAO conducted a study on the problems of watershed management in Asia and the Pacific (FAO, 1986a). One of the outputs of this study was identification of major issues and constraints with respect to implementing watershed management development projects and programmes. These major issues and constraints were used as a baseline for comparison with the major issues and constraints that were identified in the current study. The results of the comparison are presented in Table 2.

TABLE 2

Comparison of major issues and constraints, 1986/2002

	1986	2002
Policy, legislation and regulations	The concept of watershed management (WM) had not been introduced into upland strategies or national development policies	WM has become an integral part of upland strategies in many countries
	Coherent policies to promote good WM were inadequate	Some improvements in policy, but it remains a major issue
	Inadequate coordination policies	Coordination remains a key issue
	Legislative and regulatory measures emphasized policing for enforcement	In some countries, enforcement is now being given less importance than empowerment
Institutions and organizations	WM activities were implemented through forest and agriculture departments promoting the formation of separate WM units within government technical sectors	Experience indicates that this approach is preferable to multi-agency responsibility; separate WM departments are not necessary to achieve success; and well-trained WM staff are needed at all levels
Problem identification, programme planning and project implementation	Diagnostic methods were needed for rapid assessment of biophysical and social parameters	Rapid rural appraisal method developed and used globally
	Scope of WM activities was often not clearly defined	Failure to define scope of WM activities remains an issue although further diffusion of objectives and activities has occurred, with inclusion of integrated rural development
	WM planning methods overemphasized biophysical elements and inadequately considered social and cultural issues	Social and cultural issues have become an integral part of WM planning
	Inadequate economic analysis of WM programmes	Economic analysis models remain inadequate
	Absence of operational guidelines to overcome conflicts between project objectives and administrative organizations	Little progress on making operational guidelines
Monitoring and evaluation	Monitoring often started after, rather than before, projects started	Pre-project monitoring is still rarely carried out
	Monitoring was often inadequate to evaluate achievements and outputs	The advent of verifiable indicators in project design has improved monitoring and evaluation
	Social and cultural factors not covered	Project design considers social and cultural factors
Training and education	Professionals and technicians in WM lacked broad perspective	Good progress, but they still lack people skills
	Curricula copied from external sources, with limited application to local conditions	Many institutions have modified curricula to fit local conditions
	Emphasis on university training, with lack of training for field workers	Emphasis now on training field workers, But training of local people is lacking
	WM is mostly ignored in primary and secondary education	Conservation of natural resources is taught in many elementary and secondary schools throughout the world
	Hardly any planning for development of technical personnel in most countries	Still inadequate technical personnel planning

TABLE 2 - continued

	1986	2002
Research and demonstration	Relationships between technical and social benefits of WM were not clearly understood	Remains an issue
	Causes and effects of watershed degradation in highly populated watersheds were not fully understood	Remains an important issue
	Scarcity of well-designed demonstration watersheds	Demonstration watersheds established, but of little use because of unreplicable levels of inputs and other factors
	Need for linkages among research, demonstration, extension and educational organizations	Remains an important issue
Awareness raising	Inadequate public awareness campaigns	Public awareness campaigns are an integral part of conservation education worldwide
	NGOs are not being used effectively for awareness raising	NGOs are involved in all aspects of WM
Extension	Extension networks were one of the weakest links in WM	Still an issue, although there is more resource conservation and WM extension in many countries
	Majority of extension workers had inadequate training in conservation extension	Training of extension workers is common in many countries
	Weak linkages among extension, research and training	Remains an issue
People's participation	Large deficiencies in methods used to ensure participation	Participatory processes widely used. However, the total process, including all stakeholders, has yet to be well defined
	Unsatisfactory legal, institutional and organizational approaches to involving local residents in project planning and implementation	Remains an issue, and is a key topic being considered by development practitioners
	Land tenure was a major constraint to community and farmer participation	Significant progress, as rural people have gained more user rights, land tenure and crop rights
	Community-owned land was rarely well managed	Remains a key issue in most of Asia. Reasons for poor management of community land have been documented, but little implementation progress
Investments	WM is a long-term process needing long term investments	Donors and governments are aware of the need for long-term commitments
	It was seen as unfair to expect upland communities to bear costs of WM when most benefits were enjoyed by lowland people	Remains controversial, but note recent movement towards payment to upland dwellers for environmental services provided to lowlanders

Source: 1986 issues paraphrased from FAO, 1986b, Chapter 6 – Issues and constraints

Some of the issues and constraints identified in 1986 remain important today. Some of the institutional, administrative, project planning and research issues listed in the 1986 study have been identified in this current study (Table 1). Progress has been made on several issues and constraints. For example, policy and legislative reform is occurring. Improvements have been made in training and education, awareness, extension, people's participation, and monitoring and evaluation (Table 1).

CASE STUDIES

A literature search was conducted for case studies that had been prepared for projects with watershed management as a major component. Several case studies were reviewed (Dachanee, Lakhaviwattanakul and Kalyawongso, 1996; Hoang and Nguyen, 1996; Lim Suan and Rosaria, 1996; Rice, 2000; and Warren, 1998). The following two case studies were selected for presentation in this paper: the Begnas Tal and Rupas Tal Watershed Management Project (BTRT), Nepal (Bogati, 1996) and the Project Land Management II in Santa Catarina, Brazil.

BTRT, Nepal

The Begnas Tal (lake) and Rupa Tal (BTRT) watershed management project was funded and implemented over from 1985 to 1994 by the international NGO, CARE. A case study of the project was conducted as part of the FAO regional project on participatory watershed management training in Asia.

The BTRT watershed area comprises about 173 km^2 of land area that includes two main lakes and three minor lakes. The area is about 10 km east of Pokhara in western Nepal. The population is about 31 000. The terrain is hilly with gentle to steep slopes. The area is rural with an agrarian economy. The nearby town of Pokhara is the major population centre of the area.

In the project area, seven village development committees (VDCs) were established and used as the primary mechanism for implementing participatory methods. The local people were involved in planning, implementation, follow-up and maintenance of individual and community watershed resource activities. Watershed management technicians who were part of the external support served as technical facilitators. Community development conservation committees (CDCCs) were organized to ensure people's participation in interventions that were relevant to their particular needs. Every household in the community was represented on the CDCC. The participatory process began with formation of a CDCC, which in turn identified its problems, prioritized its conservation needs and presented these to the VDC and the project office for consideration. At the end of 1994, 100 CDCCs were in operational status. As the project progressed, the need was recognized for a third level of communication and decision-making at the community level. Consequently, a community development board (CDB) was formed at the village level to facilitate communication between the VDC and the CDCC. All members of the VDC and the chairperson of the CDCC are members of the CDB. The end result of this process was a participatory communication pathway of CDCC to CDB to VDC to facilitating agency.

Agricultural diversification interventions have minimized the risk of crop failure and enabled farmers to earn income throughout the year. The average farmer now grows about six kinds of fruits, five different fodder crops, and cereal crops.

Following initial education and implementation by the project, with people's participation, management of natural forests was handed over to the local users. The end result is denser forest lands.

Several conservation farmers adopted improved agriculture practices, which they share with their neighbours. They have set up demonstrations on their farms, and have converted many followers. Homestead agroforestry plots and kitchen gardens provide source of income. Cash crops such as coffee, pineapples, oranges, cardamom, broom grass, vegetables and other fruits are sold at local markets.

Local women are active in forest management and conservation farming activities, and are fully involved in the decision-making process. Three major factors that facilitated active participation of women were: a clear prospect of benefit sharing; support from their families; and the small size of the CDCC.

Overall, the project was considered a success. The participatory model developed in the BTRT area was used by other development projects in Nepal; e.g., the FAO Shivapuri watershed management and fuelwood project. According to Bogati, the participatory model and many of the activities that were implemented during the life of the project have continued after the end of international assistance.

The major reasons for success of the project included:
- clear and transparent decision-making procedures by project management;
- clear and simple guidelines and flexible operational procedures to facilitate people's participation in watershed management;
- well-defined programmes, budgets, plans, implementation procedures and benefit sharing mechanisms;
- integration of a wide range of diversified watershed management activities, and guarantee of benefits;
- strong motivation among project staff.

The main lesson learned by the project are as follows:
- Interest groups for women should be formed for income-generating activities.
- Indigenous technology for the conservation of watershed resources should be evaluated before external technology is imposed.
- Training of leadership skills for local users is needed.
- Training of local users on maintenance of activities is needed.
- Mid-level field technicians should be oriented in project goals, and receive refresher training in watershed management subjects.

Santa Catarina, Brazil

The Land Management project in Santa Catarina was implemented from 1995 to 1999 with World Bank funding. The project objective was to safeguard farmers' incomes and natural resources by increasing agricultural production and income for about 81 000 mostly small-scale farmers, by promoting the adoption of sustainable, modern forms of land management and soil and water conservation, and mitigating existing upland land degradation.

Project interventions centred on the introduction of land management methods that would improve soil and water conservation and the disposal of animal, human and pesticide wastes in 520 of Santa Catarina's 1 700 micro-catchments. The major components included agriculture

extension, research, incentives to share the costs for implementing new methods with farmers, support for reforestation of critical parts of the landscape, rural access road improvement, land-use planning and mapping, environmental monitoring, training assistance to state parks and biological reserves, and project administration.

The overall project performance was rated as successful. Owing to the good performance of the project and the apparent sustainability of activities, a second project is being considered, which incorporates the successful components and lessons learned from the original project.

A case study was conducted on the Lajeada Sao Jose micro-watershed (FAO, 2002), which was one of 520 micro-catchments included in the project. This micro-watershed was chosen for study to illustrate the positive effects of improved land management on land degradation, agricultural production, water quality, and upstream and downstream beneficiaries. The watershed is about 7 744 ha in size, with elevation of about 659 m and slopes ranging from 0 to 20 percent. Total population of the watershed is estimated at 28 375, with a distribution of about 1 057 people in the upland rural area and 27 300 in the downstream urban area.

Improved land use and management (zero and minimum tillage, crop rotation, cover crops, green and organic manure, level terracing and forestation) produced on-site benefits such as reduced soil erosion. Crop production increased (maize by 40 percent, soybean by 21 percent, beans by 3 percent and tobacco by 32 percent) with subsequent increases in farm income. Owing to the downstream environmental monitoring of stream flow, the project was able to determine some of the offsite benefits of the land management interventions. One important benefit was the reduction in suspended sediment levels by 69 percent. This reduction represented a savings in water treatment costs for domestic supply of about US$2 445 per month. This study illustrates that investment in upland watershed management-related interventions can produce downstream economic return.

Some of the important lessons learned during implementation of the project at the study watershed are as follows:

- Active participation and organization of land users are essential factors for success.
- Participatory methods need to be promoted at the micro-watershed level.
- Formal extension to and education of farmers is necessary.
- Existing farmers' organizations need to be strengthened.
- Farmers are most interested in activities that improve farm-level production.
- Environmental education of upstream and downstream inhabitants is essential.
- Decentralization of research and extension is needed.

CONCLUSIONS

Watershed management projects and programmes are being implemented throughout the world. It is considered by many to be one of the important development sectors now, and will continue to be so in the future.

As the trend continues towards empowerment of rural people to manage their natural resources, the integrated, multiple use concepts of watershed management at the community and farm levels with linkages to local and State governments will become more viable.

The watershed management development approach is not perfect in any sense. It continues to evolve with time, with ever-changing development needs. As described here, some of the major constraints that were identified in 1986 are still prevalent today. However, some of those earlier constraints have been removed, or are being given attention by the key actors in development. New approaches such as payment for environmental services are being implemented and tested. The role of national and local NGOs is becoming more important as the participatory approach is being expanded at the community and farm levels. However, the effectiveness of NGOs in implementing sustainable watershed management activities has yet to be determined.

According to Sayer and Campbell(2001), the integrated management of natural resources requires three key elements:

- Management needs to be adaptive.
- Movement along the research–management continuum is essential.
- There must be provision for negotiation among all stakeholders, with interventions that are based on (an outcome) of this process.

Sustained improvement of the well-being of poor people in developing countries, such as farmers, will require natural resource management research that gives more emphasis to: 1) management risks; 2) reduction of dependence on external inputs; 3) avoidance of long-term depletion of production potential; and 4) more careful control of environmental externalities (Sayer and Campbell, 2001).

In the 1990s, the watershed management development sector, to some extent, became ambiguous in context. The basic principles of multiple use management of renewable and non-renewable natural resources, with emphasis on soil and water resources, gave way in some projects to a more holistic, integrated rural development and agriculture production systems approach, with less importance to upland conservation of soil and water resources.

RECOMMENDATIONS

Analysis of the results of this review and assessment study suggests that a paradigm shift is warranted to refocus the watershed management development sector and improve the performance of future projects and programmes. Some of the important paradigm components and recommended changes are listed in Table 3.

TABLE 3

Preliminary recommendations of the FAO stocktaking exercise

Present scenario	Future scenario
1. Treating the symptoms of watershed degradation (i.e. deforestation, soil erosion, siltation, decreasing production) (WRDP-WMIC, 1998).	Identifying and treating the underlying causes of watershed degradation (i.e. lack of knowledge, poverty, population increase, demand for resources, improper land use). More focus on prevention rather than cure.
2. Priority focus on off-site/downstream costs and benefits of watershed management (i.e. downstream infrastructure risk, decrease in floods and sedimentation, increase in water quantity and quality for downstream users).	At minimum, equal priority to on-site costs and benefits of watershed management (i.e. improving and maintaining upland agriculture, forest, and rangeland productivity, water quantity and quality).
3. Inadequate project designs that often overestimate government capacity and assume policy changes will occur.	Project design that provides for adequate government capacity and assures policy changes.
4. Top-down research and development, and transfer of technology to local stakeholders that is driven by donors and education and research institutions.	Emphasis on stakeholder participatory learning and technology development process that builds on indigenous technologies and addresses local research needs.
5. Diffuse focus of watershed management, which often maximizes production of resources/commodities other than water and soil.	Sustainable multiple-use management of watersheds that combines water resources development with compatible economic land-based production systems (i.e. trees, crops, livestock, fish, recreation).
6. Encroachment of integrated rural development approach with multisectoral steering committees and line agencies (which, for the most part, has been a failure) into the integrated watershed management concept.	Multiple-use management of natural resources (renewable and non-renewable), with emphasis on water and soil resources in upland watersheds and with development responsibility given to the relevant line agency.

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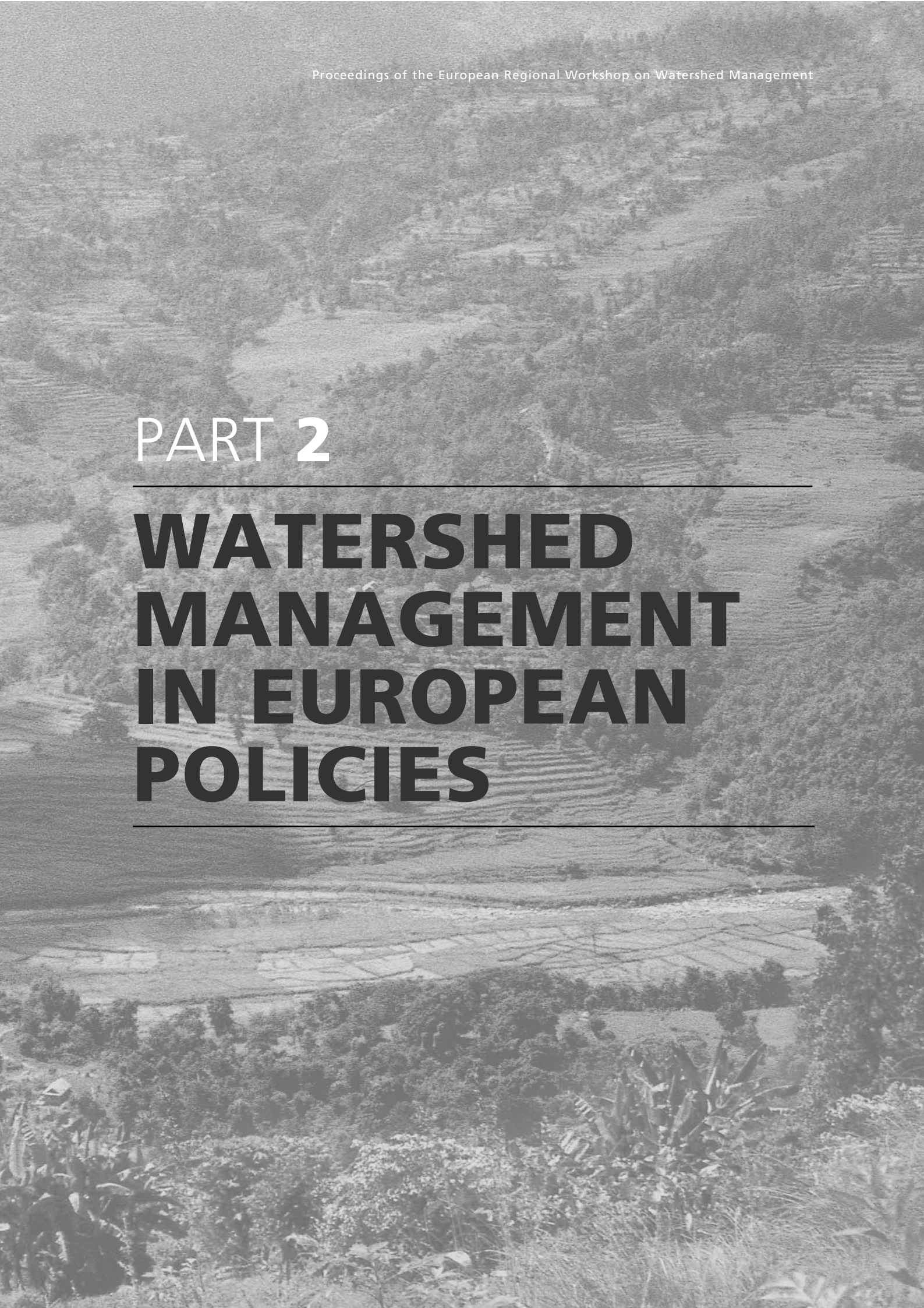

PART 2

WATERSHED MANAGEMENT IN EUROPEAN POLICIES

CHAPTER 3
OVERVIEW ON ACHIEVEMENTS AND PERSPECTIVES OF THE EUROPEAN FORESTRY COMMISSION/FAO WORKING PARTY

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HISTORICAL FACTS

In 1952, the EFC/FAO Working Party on Torrent Control and Protection from Avalanches held its first session in Nice, France. This group originated at the European Forestry Commission (EFC) of FAO, and its main task was to solve the technical aspects of natural disasters (control of torrent floods, landslides and avalanches) using both civil engineering and forestry practices.

In the 1960s, the tasks of the working party were extended to mountain agriculture, tourism, and social and economic problems in mountain areas. To reflect a new situation, the official name of the group was changed to the Working Party on Torrent Control, Protection from Avalanches and Watershed Management.

In the 1970s, environmental problems and their impact on society became the highlighted item of the group, changing its title to the present Working Party on the Management of Mountain Watersheds. The group started to be more open to an interdisciplinary approach.

In the 1980s and 1990s, the working party also addressed the transfer of knowledge to developing countries in Africa, Asia and Latin America.

In 1998, the theme of the twenty-first session of the working party, held in Marienbad, Czech Republic, was integrated management of mountain watersheds, discussing a modern watershed concept using procedure of both the environmental impact assessment (EIA) and strategic environmental assessment (SEA).

The fiftieth anniversary of the working party was celebrated at the twenty-third session, held in Davos, Switzerland from 16 to 19 September 2002.

THE CHANGING MANDATE

The working party's main aim is to support sustainable sound development in European mountain regions through interdisciplinary networking of government representatives (EFC member countries) and observers (representatives of NGOs, developing countries or the individuals involved). However, the mandate of the working party has changed over the period of its existence, reflecting the actual needs of society in Europe.

At the beginning, the working party was established to support the reconstruction of European countries after the Second World War. At that time, the main target was to protect mountain valleys from natural disasters (floods, landslides, rock falls and avalanches), with both technical constructions (civil engineering works) and watershed rehabilitation (mainly reforestation). The foundation of international organizations (namely the United Nations and FAO), gave European countries an opportunity for better cooperation and optimizing of investments.

Since the 1960s, the socio-economic problems of mountain regions (particularly in southern and eastern Europe) started to become the important task of the working party, while in the 1970s, one of the highlighted topics was to address broader environmental aspects. Thus, the watershed concept became to be a crucial approach of the working party.

Recently, the socio-economic changes in mountain regions in Europe (losing local farmers and growing mass tourism) with new safety demands focused on prediction and prevention, global climate change or global pollution problems (air pollution, toxic rain impacts, degradation of natural resources) moved the working party to the integrated concept of watershed control, based on integrated ecological monitoring, environmental impact assessment and broad participatory processes.

The transfer of knowledge to Eastern European countries in economic transition or to developing countries is a very important contribution of the working party to a stable common future.

SESSIONS AND INTER-SESSION ACTIVITIES

The traditional session of the Working Party is held, in principle, every two years, organized by both the host country and FAO. The member countries of EFC participate in sessions through national delegations represented by decision-makers, researchers and university teachers. However, the sessions are open to all interested bodies and to observers from developing countries in order to support wide knowledge exchange.

During a session, the recent progress of EFC country members is presented in national reports. Every session of the working party is oriented to a special theme related to any of the highlighted topics of the host country.

In inter-session periods, the activities of the working party are led by the Executive Committee (three elected officers of the working party), supported by the FAO Secretariat. Inter-session activities are mainly concerned with implementation of results, organizing the next session and supporting networking among individual members or observers.

THE WATERSHED CONCEPT

Dealing with both natural hazards and technical interventions, the working party soon recognized the watershed concept to be the effective tool to control mountain landscape.

The regime of runoff (quantity, quality and timing) in the lower reaches of a river basin reflects the natural landscape conditions, its stability, sensitivity to natural hazards, and disturbance

caused by the exploitation of natural resources. Research into the patterns of runoff genesis in a watershed testify to a basin's sensitivity to future disturbance and can also contribute to the assessment of sustainable practices.

The watershed is a system. It is a structured set of interactions that is defined for the purposes of understanding. It is a functioning natural unit. It is also a system that integrates the tightly coupled interactions among physical, ecological and social processes. It is overtly a system that is best examined as a nested hierarchy or wholeness. Its management requires the application of hydrophysical, ecological and socio-economic logic and the interaction of environmental management disciplines that too often operate in mutual isolation. These include hydrology, climatology, biochemistry, forestry, agronomy, soil, water and nature conservation, rural, landscape and resource planning, anthropology and economics. The watershed concept encourages interpretation of the unit of landscape as a dynamic series of mass balances and fluxes.

FACING NEW PROBLEMS

In general, more effective watershed management requires better information, better technologies, better management structures, change in land husbandry and direct engineering interventions. However, scientific uncertainties, the human impact on the natural environment, the changing global climate (including acid rain impacts and changing periodicity of extreme events) and the lack of interdisciplinary studies are still main problems in the effective and integrated management of mountain watersheds.

On the other hand, the effective management of mountain watershed in Europe should reflect the contemporary changes in European society: increasing decentralization, and increasing roles of the public and NGOs.

The management of mountain landscape deals more and more with processes of environmental assessment (EIA, SEA). But both EIA and SEA procedures require the exact prediction of responses in mountain watersheds to reflect several scenarios of land use or technical projects. However, uncertainties in exact prediction are rising with recent dramatic changes of the environment.

ENVIRONMENTALLY SOUND ORIENTATION

In 1966 to 1972, a spectre of "environmental disaster" heightened public sensitivity to environmental problems. However, the first high tide of environmentalism as a social movement was, probably, the period 1974 to 1980. By this time, the environment had become an established item of the mainstreams of society. In the 1990s, the United Nations began to take the lead role in promoting environmental issues. Simultaneously, the movement began to influence UN organizations, with members gaining influence in the fora of UN agencies, notably FAO.

In 1992, the UN Conference on Environment and Development (UNCED) in Rio de Janeiro confirmed the widespread consensus that the management of natural resources needed to be reformed. It also formulated an integrated approach to watershed management, which is based on the perception of water as an integral part of the ecosystem, a natural resource and a social

and economic good. The urgent call for a new approach in the assessment, development and management of freshwater resources, including watershed management, was formulated by the International Conference on Water and the Environment held in Dublin (1992). Within this context, the Second and Third International Conferences on Headwater Control (Sec, 1992 and Delhi, 1995) stressed the crucial role of mountain catchments in the recharge mechanism of water resources, as well as the need for land use and water management linkages across catchment areas or groundwater aquifers.

Meanwhile, the environmental movement, including the microcosm of mountain watersheds, has become acutely conscious that given the current status of our knowledge, more effective action on environmental problems is being constrained by lack of scientific certainty. Practical application is still thwarted by the lack of interdisciplinary studies that link natural ecosystems and socio-economic processes. Unfortunately, the world conservation strategy has not yet succeeded in integrating economics within the environment. It cannot demonstrate how better economic policies may act as a major force to improve the environment. Sustainable development is feasible, but it requires a shift in the balance of the way economic progress is pursued. During its history, the working party has systematically supported interdisciplinary and cross-sectoral communication at the regional, national and European scales.

COOPERATION

Traditionally, the working party has been linked to the International Union of Forest Research Organizations (IUFRO) Working Group on Torrent Control, Avalanches and Natural Disasters. The working party has been also active in co-organizing periodical scientific events (interpraevent or conferences on headwater control).

To support the more effective implementation of research results, the working party is active in stimulating the European research networks (for example the research programme on monitoring distant mountain lakes, MOLAR) and the North Atlantic Treaty Organization (NATO) Environmental Security Programme (Environmental Reconstruction in Headwater Areas).

The link with the European Observatory of Mountain Forests (OEFM) extended a horizon of the working party mainly to the socio-economic constraints, finding a more effective tool for promoting better participation in mountain regions, as well as upstream–downstream solidarity.

BENEFITS AND LIMITS OF THE WORKING PARTY

The benefit of the working party was recognized mainly in better communications among different sectors (decision-makers, researchers, teachers and NGO representatives) within European society. During the last 50 years, such communication led to improving the design of technical interventions in the Alpine regions of Europe, through serving technically more effective subjects, and showing an environment-friendly face. Significant progress in bioengineering, protective forestry and special oriented silviculture to reduce natural hazards in mountain areas has been reported, particularly from Austria, Italy, France, Norway, Spain and Switzerland.

On the other hand, the working party still concentrates on the traditional problems of natural hazards in the Alpine regions of Central Europe. This fact corresponds also to organizing the sessions (both themes and places): a total of 14 sessions of the working party have been hosted by Austria (two sessions), France (four sessions), Germany (two sessions), Italy (four sessions), and Switzerland (two session), only two have been held in Scandinavia (Norway), and two in Eastern Europe (one each in the Czech Republic and Romania).

In a near future, it might be adequate to change the rather formal (and expensive) procedure of the working party sessions (born in the 1950s) to reflect the needs of the modern European society, and thus to keep higher credibility and even more effective communications across society.

CHAPTER 4
EFFECTIVE WATERSHED MANAGEMENT: A EUROPEAN PERSPECTIVE

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Mountain forests mean
more than forests in mountains

The views expressed in this paper come from three main sources: the policies of the European Union (EU), the process of the Ministerial Conference on the Protection of Forests in Europe (MCPFE), and the activities of the European Observatory of Mountain Forests (EOMF). Some facts, figures, factors and trends are reported with special, but not exclusive, reference to forests. After a short review of main issues raised and initiatives taken within the three sources, two examples are given, one of a project (France) and one of a programme (Italy). Finally, linking the demand of local communities to national, European and international forest strategies, some lessons learned and perspectives on effective watershed management are outlined from the field, policies, economy, planning, research and cooperation in Europe and beyond.

SOME FACTS AND FIGURES ABOUT WATERSHEDS ACROSS EUROPE

If almost all lands can be considered under the watershed concept and influences, mountain areas play a central role in the hydrology of large territories. EU statistics consider that 38.8 percent of the total EU-15 is mountain areas, with a population attaining 54 million people, of which two-thirds show a gross domestic product (GDP) lower than the EU-15 average (European Commission, 2001a).

Figures clearly indicate that *mountain watersheds* have a relevant geographic place, *mountain people* a strategic role and *mountain economy* a widespread disparity. Concerning the ecosystems in mountain watersheds, forests cover 36 percent of the whole areas, while mountain forests as a whole represent 27 percent (28.1 million ha) of the total EU-15 forest area. The mountain forest cover in Central and Eastern European countries (CEECs) is evaluated to some 23 million ha, excluding the Russian Federation, where forests are found over 75 million ha (EOMF, 2000).

Given the fact that forests are necessary, but not exclusive nor sufficient, for effective watershed management, these ecosystems dominate, or have been dominating, most mountain areas, and consequently affect the water balance of more than half of the European lands.

A statement from Netherlands scientists at the Freshwater Conference in Bonn, Germany, quoted by Messerli (2001), provides an astonishing figure: in the dry summer of 1976, 95 percent of the Rhine water flowing into the North Sea came from the Alps, from melting snow and ice at high altitude, and crossed forest in its downstream flow.

If this is simply a quantitative figure, other questions rise: e.g. what are the situations and trends of mountain watersheds in Europe? What are the main influencing factors, including forests, affecting them? What are the main risks or the opportunities?

This paper stresses the place and role of forest ecosystems in relation to these questions, considering that forests are never isolated castles in any environmental, social, economic and cultural living land. Nevertheless, forests contribute significantly to effective watershed balances, and much remains to be known on how and at what level.

CONDITIONS, SITUATIONS AND TRENDS

The EU has institutionally recognized mountain agriculture as having the condition of permanent natural handicaps in a way that mountains are so-called less-favoured areas "characterized by a considerable limitation of the possibilities for using the land and an appreciable increase in the cost of working due either to difficult climatic conditions shortening the growing season or to slopes too steep for the use of machinery or requiring the use of very expensive special equipment, or a combination of these two factors" (European Council, 1999).

On the environmental side, the European Commission has worked on the high natural value sites that are so frequent in altitude and imply restrictions in the use of land and resources. These factors, added to market, infrastructure and social limitations can be seen as the causes of a most serious trend in the abandonment of mountain areas by resident people.

BOX 1

MOUNTAIN FORESTS IN EUROPE

Concerning mountain forests, an impressive list of negative trends should – unfortunately – be mentioned when considering watershed management in Europe (EOMF, 2000). These are:

- growing instability of stands in the last decades;
- damages by pollutants, game, logging, fires, tourism and recreation activities;
- ageing of stands and overstocking of living and deadwood;
- lack of natural regeneration;
- biomass density;
- reduction of biodiversity;
- reduction in management practices;
- decrease in forest revenues;
- loss of local adapted knowledge and practices.

It is common to hear local inhabitants, owners or communities in mountain forest areas declaring these resources are paradoxically becoming a liability, a danger, a problem, while before they represented an asset, a security and the solution of many different problems. One must add that, along with the abandonment of mountain areas, urban society is claiming far more environmental services, losing conceptually the necessary link between natural and human resources.

We do not know exactly the range of ecological, technical and socio-economic consequences of the abandonment of resource-related practices in uplands and lowlands. P. Piussi (personal communication, 2002) considers this issue as a current scientific and social challenge.

The recent tragic flood events in Central Europe during summer 2002 seem to confirm this challenge: Beside the variability and intensity of climatic events, the increase of infrastructures and settlements, what is the influence of the abandonment of active and productive practices on watershed functioning?

The question can be turned the other way round: At what level can effective watershed management prevent or mitigate events such as those of last summer, or other serious events such as the storms Lothar (1999) and Vivian (1991) or the melting of permafrost and glaciers across the mountains of Europe?

PROGRESS ACHIEVED THROUGH PROCESSES, POLICIES AND INSTITUTIONS

Although many initiatives related to watersheds should be mentioned, this paper refers mainly to three sources:
- the policies of the EU;
- the process of the Ministerial Conference on the Protection of Forests in Europe (MCPFE);
- the activities of EOMF.

The paper presented by the Joint Research Centre of the European Commission will review further achievements in Europe (e.g. the Water Framework Directive).

Referring to some of the policies of the EU that may be affecting the new orientations in the management of watersheds, the last decade has been characterized by key political questions, such as the territorial cohesion expressed by "how to achieve a solidarity of peoples and equitably share the costs and the benefits in a diversity of territories?" (European Commission, 2001b).

The orientations of European structural policies are turning towards the working concept of territorial cohesion which refers to "policies aiming at strengthening relations between areas with marked differences in terms of their economic and social characteristics, rather than taking isolated measures specific to individual types of areas" (European Commission, 2001b).

In other words, the concept can be expressed as "keep people on the land". It has a clear importance in watershed management as, at least in most of Europe, there cannot be any effective watershed management without balancing human resources, economic activities and natural resources. Another key policy carried by the EU that we refer to is rural development, also called the second pillar of the Common Agricultural Policy (CAP).

Although neither forests nor mountains appear in the treaties of the Union, the regulation on Rural Development (European Council, 1999) is a milestone for both. European countries recognized, since the Conference of Cork (1996), the diversity of situations, functions and interests of resources, such as forests and remote rural areas (i.e. mountains) in the context of rural development (see, for example, EOMF, 2000).

These resources in Europe share at least one main complex problem: their environmental and socio-economic fragility. Such a fragility and the diversity of situations imply a harmonization among actors at all levels with the aim of "maintaining and improving the ecological stability of forests where the protective and ecological role are of public interest and where the costs of maintenance and improvement measures exceed the income from forestry" (European Council, 1999).

Although actors can be a large number, we can identify here the two main groups of private (private or community owners, individually or associated) and public actors (public administration and management bodies).

One key instrument identified and implemented by the stakeholders is the *land contract*. Groups have to agree, on a local basis that fits into national criteria, on a long-term project to be implemented over an identified forest land. The principle of subsidiarity is fully included in the agreement, and all parties contribute "on the basis of the real costs of the measures to be carried out". The parties are therefore committed jointly to participate and provide means (human and financial) for the implementation of actions.

Besides land tenure, private and community-based rights and responsibilities are given the highest importance as the central condition of sustainability, possibly supported by communication and capacity building.

The contract is a mechanism of agreement and commitment linking local and national actors, individuals and institutions in a common responsibility of effective governance. In particular:

> It is a way, by written or spoken agreement, of expressing the will to manage common concerns by common means, public money for public interests.
> It recognizes the need of maintaining and improving the "ecological stability" of forests, i.e. their capacity of providing values, goods and services.
> It sets forth the "public interest" of a specific set of resources subordinating the private rights and the market forces to the responsibilities and values of a larger portion of society.
> It implies a participation and a harmonization that help to manage and reduce conflicts of interest in the name of a recognized "public interest".
> It asks for a negotiated and long-term commitment by the involved parties (the contract), which identifies together where, what, how and to what extent each one is responsible.
> It links the local mountain situation to the diversity of situations that all benefit from one another.
> The concept and practice of the contract includes understanding, responsibility, agreement and obligation by parties. They are all necessary steps, under many cultural and social perspectives, in sustainable management of resources. They are also a contribution to solidarity between people and territories (Zingari, 2001).

The Ministerial Process started in 1990 in Strasbourg. The Ministerial Conference on the Protection of Forests in Europe (MCPFE) is today of highest importance for the cooperation of more than 40 countries and some 30 organizations on key aspects of forests in Europe. From the very beginning, and two years before the Rio UNCED, mountain forests have been identified as a crucial issue by means of a specific resolution called S4 "Adapting the management of mountain forests to new environmental conditions".

This resolution, which is the only territorial one out of the 12 adopted so far, highlights the role of mountain forests in the regulation of hydrological cycles and in the fight against risks.

The S4 is a political commitment signed by 25 countries and the European Commission; in 1998, ministers gave its coordination, formerly provided by Portugal, to EOMF in shared responsibility with FAO and IUFRO.

Reviewing its achievements in terms of outputs, this resolution developed cooperation among countries through wide participation of actors in the exchange of experiences, methods and practices. It also contributed to raising awareness on the integration of the different roles of these forests in a larger territorial and rural development dimension.

The S4, on the basis of an action plan and close collaboration with FAO and IUFRO, has been acting as a political, technical and scientific instrument in the identification, formulation and implementation of actions.

The White Book 2000 on Mountain Forests, supported by the European Commission, assesses the situation and proposes five main actions:
- involvement of all actors in sustainable management;
- establishment of territorial contracts identifying objectives, measures, means and also responsibilities of different parties;
- development of wide economic approaches, including human and financial investments, payment for services of public interest, viability of small and medium-sized enterprises;
- promotion of quality of products and services;
- definition of integrated management plans.

These actions are relevant to watershed management considering the steps taken by European policies.

EOMF started its activities in 1996 on the initiative of the European Federation of Local Communities (FECOF) and the Government of French (Ministère de l'Agriculture, 1995). FECOF brings together municipalities, their associations and local communities, and represents 23 million ha of forests in Europe. In its European Charter of 1992, FECOF identified its strategy to include as a priority mountain forests because of their roles of public interest, protection of the environment and human activities, and agriculture of valleys. The activities of EOMF are threefold:

- to bring together governments and the EU (through the mandate of resolution S4), local forest communities (through FECOF) and all actors involved in mountain forest and forestry by thematic and systematic political, technical and scientific meetings and exchange of experiences;
- to follow-up local, national, European and international initiatives that may be of relevance for the actors;
- to propose tools, measures and guidelines that promote better management, capacity building and sustainability of natural and human resources.

Concerning watershed management, EOMF provides a platform for cooperation (e.g. with the FAO/EFC Working Party on the Management of Mountain Watersheds, with signatory parties of S4, with technical and scientific bodies) and exchange of experiences.

In concrete terms, EOMF produced the White Book assessing the situation in each European country and proposing a follow-up process on the five actions mentioned above (i.e. participation, partnership, integrated economic approach, promotion of quality of products and services, and integrated field planning). Today, all of these actions are implemented at different degrees through European legislation and policies, and – of course – by countries (e.g. the new French forest law).

The Scientific Committee of EOMF worked out and published in scientific journals the outputs of two events: an international symposium in 2000 on the concepts, methods and practices of multifunctionality; and a research course in 2002 on multifunctional management plans.

Since 1999, EOFM has worked in sessions and groups on the rural development aspects of mountain forests and forestry. In May 2002, a specific workshop was co-organized by EOMF in Scotland with the Forestry Commission and Euromontana (see Box 2).

BOX 2

EUROMONTANA, EUROPEAN OBSERVATORY OF MOUNTAIN FORESTS, FORESTRY COMMISSION, EUROPEAN WORKSHOP ON FORESTS, FORESTRY AND RURAL DEVELOPMENT, INVERNESS, UNITED KINGDOM, 18 MAY 2002

There was a strong consensus on the following points, among others:

- Local communities are key actors and stakeholders in conservation and development.
- There is a need to engage and genuinely involve them in decision-making, including issues of control. This will inevitably happen at different stages, in different parts of Europe.
- We must avoid gaps between local action and wider strategic decisions by ensuring that decisions are communicated effectively to all stakeholders.
- Public money is for public benefits.
- In mountain forestry and rural development, some concepts and practices are central: resource diversification, human capital, rights, responsibilities, consultation, devolution, governance, community support and involvement, co-management, sustainability, solidarity and subsidiarity.
- There is a very important role for rural development plans, along with national or sub-national forest plans. These are key supportive tools for achieving integrated environmental, economic, social and cultural goals for rural areas. They require genuine commitment and a real means of implementation.

During the last International Consultation on Mountain Forests, held in Navarra, Spain and Région Aquitaine, France in June 2002, four main actions were recommended that are closely related to effective watershed management:

- *Widening perspectives.* Mountain forest resources and mountain forest-related communities are part of larger ecosystems and processes. Their influences go beyond mountain forest ecosystems and include: a) the mountain massifs; b) the conservation of their natural and cultural assets; c) rural development patterns; d) water and watershed management processes; and e) the improvement of economic, social and territorial cohesion (i.e. keep people on the land).

- *Reinforcing locally adaptive management.* A sustainable future for the complex, unique, fragile and interrelated ecological and socio-economic systems represented by mountain forest resources and mountain forest-related communities, including activities and practices, requires an approach to management forms adapted to local conditions and situations. Such an approach takes into account both traditional knowledge (i.e. knowledge and experiences developed by local populations) and interdisciplinary research, in mutual reinforcement.

- *Sharing responsibilities.* The permanent natural conditions in mountain regions and the interrelationships between upland and lowland areas require efforts in sharing responsibilities, involving local communities, promoting governance (see note below) and collaborative management, and strengthening solidarity at different levels. Bringing together a diverse set of actors in the definition and implementation of policies and good practices is a sustainable way to achieve these requirements.

- *Sharing benefits.* Mountain ecosystems, under appropriate management, provide a large set of benefits to lowland regions. Many socio-economic sectors are both benefiting from and influencing these resources. Alliances, coalitions, partnerships, agreements and contracts on forest conservation and management between local and non-local actors help in sharing benefits at all levels.

An example of a project from France: the Management Plan of Natural Areas and Heritage of the Plateau de la Leysse, Savoy (France)

The objective of this plan is "to manage the whole of the land sustainably, keeping it living and visited, allowing to develop its local economy and its own heritage" (Syndicat Intercommunal du Plateau de la Leysse, 2000).

Six municipalities within the Natural Regional Park de Bauges in Savoy, France experienced the abandonment of practices and resources (cultural, economic, natural and landscape) and decided to form a permanent partnership (a co-management syndicate) aiming at the objective of the plan. The area is totally mountainous.

With the support of the park, a debate involving the participation of all actors – specifically local communities and inhabitants – has been carried out on the identification of the different elements providing quality of life in the area (10 149 ha of total area, 4 653 ha of forests – of which 2 090 ha privately and 2 563 ha communally owned – 4 000 ha of agricultural land, 115 ha of dry prairies, and 600 ha abandoned, water sources, rivers, lakes, etc.).

Once the preparatory work had been done, a legal association was established to manage the preparatory phase. The operational plan identifies the specific sectors, areas, measures, means and funding in an integrated way. Beside the technical aspects, the plan includes a quantitative chapter on the involvement of local populations, and the sensitization of young people.

The rough estimated annual costs, excluding the initial investment of €100 per hectare, are: planning, €50; field management, €75; total €125. The relatively low costs identified, compared with the cost of managing more individual areas or sectors, comes from an approach of scale in planning and management.

It is interesting to conclude with two elements: the area is part of a watershed with a trend towards abandonment; and this watershed is close to the urban settlement of Chambéry (population 120 000) classified as being under flood risk.

An example of a programme from Italy: the Territorial Pacts

At the end of the 1990s, Italy two-thirds mountain areas experienced the legally binding instrument of the Territorial Pacts.

With no intention of evaluating results, the experience has some relevant characteristics related to watershed management.

The first element is harmonization among different local actors with no external conditions: participation is voluntary and all sectors are invited (administration, enterprises, banking, research, trade, etc.).

The approach is horizontal on a given territory (from small- to medium-scale – one watershed, to large scale – the whole Apennines along 1 600 km). The objective is the cohesion of different current and new initiatives involving resources, people and economic activities. The overall orientation of the Territorial Pact is then organized into specific activities, for example, the management of natural resources including water resources.

While the Territorial Pact offers a wide and coherent framework for actions with advantages in terms of economy of scale it has been stressed how the human and cultural dimensions influence its implementation. A review of these instruments in the context of rural policies has recently been made by the Organisation for Economic Co-operation and Development (OECD, 2002).

LESSONS LEARNED AND PERSPECTIVES

Currently, 80 percent of European land is rural, and 20 percent urban. Considering the rural area, forests cover in Europe reaches some 40 percent of the land. Eighty percent of the European population lives in urban areas. Rural areas, forest areas and urban population have therefore a big "responsibility" in the future of integrated and participatory watershed management linking upstream to downstream areas. Mountains, as remote rural areas, are also water towers for the rest of land. Forests in mountain areas are progressing faster than in other areas. Some of the challenges of watershed management in Europe are:

- an overall territorial approach linking mountain unities to lowlands (massifs);
- combined agro-silvipastoral land use;
- involvement of local populations and urban people;
- sound cooperation and communication between local and national authorities.

The EU is strongly supporting a mountain territorial approach in its reform and enlargement policies. The conference organized by the European Commission in October 2002 in Brussels on European Policies and Mountains will be crucial in presenting watershed management as a key aspect of mountain sustainability and mountain–lowland relationships.

In this context, and with reference to a number of positions expressed on the issue (see, for example, Pezzini, 2001; Van Depoele, 2002) the exchange of experiences and good practices should be considered as a basis for building a new generation of watershed management programmes. Our European regional workshop is a good example of exchange.

The following Table 1 summarizes, as an overview of achievements, gaps, lessons learned and perspectives, the various aspects of a process leading to more effective watershed management. It refers to positions expressed by local communities, particularly forest local communities members of EOMF, and national, European and international entities, such as the EU or MCPFE.

TABLE 1

Features of past and future generations of watershed management plans

	Past generation	Next generation
Concepts, approaches and methods	Technical	Technical, ecological and socio-economic
	Limited communication	Active communication, transparency
	Planned management	Collaborative management
	Management of resource	Management of resource and conflicts
	Hydro-geological	Hydro-geo-ecological
	Tree cover and/or plant cover	Forest and/or vegetation
	Forestry practices	Agro-silvipastoral systems
	Use of soil- and climate-adapted species	Use of habitat-adapted and indigenous species
	Growth and stability	Ecology and stability
	Protective role	Multiple roles
Policies	Sectoral	Integrated (in) and intersectoral (out)
	Agricultural	Rural
	Forest	Rural
	Mountain	Upland–lowland
	Land, human-free	Territorial, human-influenced
	Centralized	Decentralized
	Planning	Frame working
	Directive	Participatory
	Quantitative	Quantitative and qualitative
	Linear	Non-linear
	Principle-oriented	Locally adaptive
	Regulatory	Precautionary
	Interventions	Preventive

TABLE 1 - continued

	Past generation	Next generation
Socio-economics	Public/private enterprise aims	Public benefits aims, public/private means
	Interests	Values
	Market	Externalities
	Individual responsibilities	Shared responsibilities
	Informing local communities	Involving local communities
	Defining plans	Promoting governance
	Providing subsidies	Strengthening subsidiarity and solidarity
Level	One	Multiple
	Local, national	Local, national and international
	Mountain watershed	Upland/lowland watersheds
Research	Scientific aims	Scientific means and methods
	Disciplinary	Multidisciplinary
	Objective scientific knowledge	Scientific and traditional knowledge
Cooperation	Technical groups	Interdisciplinary groups
	Individual initiatives	Permanent structured networks
	Bilateral	Multilateral (through the EU)
	EU members and Western Europe	Countries of Central and Eastern Europe
	Professional training	Multi-actor capacity building
	New instruments in "exponential growth"	Better use of existing instruments in a "common denominator" way

In the light of the views expressed, and from a forest perspective, the following key strategic elements are suggested for building the next generation of watershed programmes in Europe:

- active and accessible *communications on the place and role of watershed management* to involve the public and actors, with special attention to urban population (e.g. EPA, 2001);
- a *territorial and rural perspective*, urban–rural and upland–lowland links, with special attention to keeping people on the land, maintaining the viability of enterprises and balancing the quality of resources (water, soils, forests, air, ecosystems, agriculture) (European Commission, 2001a);
- the *participation, involvement and responsibility of all actors*, by means of territorial contracts or their equivalents securing the trade of products and the payment of public interest services (e.g. European Council, 1999);

- *links among existing policy and management instruments* (e.g. rural development, structural policies, water directives, national forest programmes) aiming at effectiveness (the right instrument at the right time) and coherence (integrate the instruments without multiply or opposing them; European Commission, 2001c);

- a *permanent effort of networking initiatives, exchanging experiences, increasing knowledge and providing capacity building* (e.g. FAO/EFC Working Party on the Management of Mountain Watersheds, MCPFE Resolution S4).

As a final suggestion and immediate step, a network of pilot sites, some of them already existing in Europe and providing different aspects of watershed management, could be established. Its objective would be to identify concrete cases where elements of different natures (conceptual, political, socio-economic, scientific, etc.) are presented, tested, discussed and further developed. Some of the existing institutions could contribute with their own capacity (e.g. EU, EC-JRC, FAO/EFC Working Party, EOMF, IUFRO, UNESCO-IHP, OIEAU, IGBP, etc.) and with the involvement of countries that will be the final beneficiaries of the initiative. EOMF is ready to act as a supportive network on mountain forest-related sites where improved orientations are under development at the local, national and transboundary levels.

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CHAPTER 5
CATCHMENT MANAGEMENT AT THE EUROPEAN LEVEL: CONTRIBUTION FROM THE JOINT RESEARCH CENTRE (JRC) OF THE EUROPEAN COMMISSION

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ABSTRACT

The mission of the Institute for Environment and Sustainability is to provide scientific and technical support to EU policies for the protection of the environment and to contribute to sustainable development in Europe. This also includes scientific and technical support for the conception, development, implementation and monitoring of EU policies, as stated in the mission of the Joint Research Centre (JRC). With the adoption of the Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy a new challenge has arisen for the catchment-related research and development being carried out at the JRC. Primarily, this concerns the catchment characterization and modelling (CCM) activities under the present EUROLANDSCAPE project, the natural hazards project and the European watershed observational network managed by the Soil and Waste Unit.

This paper introduces the Water Framework Directive and the various research projects carried out at the JRC to support this directive.

INTRODUCTION

Management of water resources has been important for most cultures throughout their history, especially in the densely populated, agricultural lowlands, where both flooding and lack of water for irrigation have caused catastrophes. The link between runoff in the lowlands and the conditions in the headwaters did not always have the necessary attention, whereby de-forestation and increasing bed load transport have caused problems to downstream management.

In Europe, transboundary river and catchment management is becoming more and more important – mirroring the growing awareness of the close link between impact on environment and impact on economy and society from misuse of land and water resources. The awareness is, of course, mainly caused by negative impacts such as major pollution and flooding events; but the general decline of river and water quality and loss in their biodiversity have also come into focus.

International cooperation has started in many catchments, and large transboundary catchment projects have been established, such as, the Danube Watch, the Conference of the Rhine Ministers, and the Rhine, Danube, Elbe, Oder, Mosel International Commissions. A positive development, which will continue, not least because of publication of the Water Framework Directive (WFD 2000/60/EC, europa.eu.int/comm/eurostat/) of the EU. The European Commission shall respect the principles of subsidiarity and governance, meaning that the Member States shall decide and manage all aspects of environment, society and economic issues that are not specifically of common interest and importance to the community. Catchments, being transboundary, cannot be regarded as only national entities; the planning and management have to be coordinated and a very high degree of harmonization in goals, means and monitoring standards must be established. The WFD is a very good example of what can be achieved when countries have to cooperate towards a common goal.

As described in this paper, collaboration within the frame of the WFD depends on common standards and evaluation methods that have requested international commissions of experts to be created. A close link between large area, small-scale normative research and local, representative primary case studies on both model and monitoring development must be established and maintained in support of the overall implementation of the directive. Indicators on state, development and environmental impact must be defined and developed for regular reporting and for the Member States to optimize their use of resources for achieving the common goals. Catchments and rivers are just one part of the cycle, other major impact areas such as lakes, coastal waters and the sea are also included. The composition of catchments in terms of physical and biological landscape elements, land cover/land use, etc. needs to be described and transferred into coherent data layers for monitoring and scenario modelling using GIS technology.

At the JRC, several projects related to catchments have been running during the Fifth Framework period (1998 to 2002). The objective of these projects is purely scientific, but in the future they will also be aimed at supporting the Water Framework Directive, and new issues may be specifically requested by the Commission and the Member States, in view of the harmonization of efforts in relation to other water-related and environmental regulations (e.g. Nitrates Directive, Habitats Directive, Drinking-Water Directive, Bathing Water Directive, Birds Directive).

THE WATER FRAMEWORK DIRECTIVE

The importance of the WFD lies in the fact that it establishes a wide and exhaustive framework for the sustainable management of water resources and the protection of water quality in all different types of water bodies (inland surface waters, transitional waters, coastal waters and groundwater), having the ambitious objective of achieving a *good water status* in all Member States by 2015.

The umbrella provided by the main concern of the directive – water quality – is wide and covers many different topics: protection of the status of aquatic ecosystems, promotion of sustainable water use based on long-term protection of available water resources, monitoring and progressive reduction of discharges, emissions and losses of priority substances, progressive reduction of pollution of groundwater, and mitigation of the effects of floods and droughts.

The influence that the WFD will have on the management of river basins is evident, as future river basin management plans will have to include the guidelines that drive implementation of the directive, which is structured in four activities (1. sharing information, 2. developing guidance, 3. information management, and 4. pilot basins) and 13 working groups. Under activities 2 and 3, ten working groups are regularly meeting in order to produce guidance documents (informal and non-legally binding) for each of the following specific topics:

- Analysis of pressures and impacts – lead: United Kingdom and Germany
- Heavily modified water bodies – lead: United Kingdom and Germany
- Reference conditions inland surface water – lead: Sweden
- Typology, classification of transitional, coastal waters – lead: United Kingdom, Spain and the European Environmental Agency
- Intercalibration – lead: the European Commission (JRC/IES)
- Economic analysis – lead: France and the European Commission
- Monitoring – lead: Italy and the European Environmental Agency
- Tools on assessment, classification of groundwater – lead: Austria
- Best practices in river basin planning – lead: Spain
- Geographic Information Systems (GIS) – lead: European Commission (JRC/IES)

Under activity 4, a list has been compiled of pilot river basins on which the different elements of guidance will be tested and integrated.

The key actions that Member States need to take are distributed over a period of 15 years:

- *by 2003*: identify the individual river basins lying within their national territory, assign them to individual river basin districts (RBDs) and identify competent authorities (Article 3, Article 24);
- *by 2004*: characterize river basin districts in terms of pressures, impacts and economics of water uses, including a register of protected areas lying within the river basin district (Article 5, Article 6, Annex II, Annex III);
- *by 2006*: make operational the monitoring of water status (Article 8);
- *by 2009*: based on sound monitoring and analysis of the characteristics of the river basin, identify a programme of measures for achieving the environmental objectives of the Water Framework Directive cost-effectively (Article 11, Annex III);
- *by 2009*: produce and publish river basin management plans (RBMPs) for each RBD, including the designation of heavily modified water bodies (Article 13, Article 4.3);
- *by 2010*: implement water pricing policies that enhance the sustainability of water resources (Article 9);
- *by 2012*: make the measures of the programme operational (Article 11);
- *by 2015*: implement the programmes of measures and achieve the environmental objectives (Article 4).

In case it is not possible for Member States to reach a good water status of all water bodies of a river basin district by 2015, for reasons of technical feasibility, disproportionate costs or natural conditions (floods and prolonged droughts), the possibility is given to extend for two further six-year cycles of planning and implementation of the new measures.

It is important to point out that all the steps need to be carried out in a transparent manner, involving decision-makers, local authorities, NGOs and scientists, and allowing public participation in all stages of the process.

Although responsibility for implementation of the Directive resides exclusively with individual Member States, an effort is being made in these preparatory years to allow a coherent and harmonious approach to implementation, particularly with respect to the high number of transboundary river basins. The services of the Commission will assist the Member States in the analysis and definition of implementation issues. The Commission will provide the financial basis for the strategic coordination group (which evaluates the outcome of the different working groups, prepares documents and reports for the water directors' meetings and gives guidance to the key activities), including the participation of candidate countries.

The JRC leads the activity of two of the working groups, the one on GIS and the one on Intercalibration, and ensures the technical secretariat of the working group on integrated testing in pilot river basins.

The primary objective of the GIS working group[1] is to elaborate the general specifications given in the WFD concerning the digital datasets (maps) that should be provided by Member States and to translate them into technical guidelines, so that a common and agreed standard is followed. This will be a first step towards a more integrated spatial data infrastructure for Europe.

Although the preparation of RBMPs also requires geographical data handling, the main focus of the GIS working group is on WFD reporting obligations. In this respect the guidance document will focus on the data layers to be reported.

In particular, the main issues covered are: layers content, representation of objects, background layers, reference system and projection, scale and positional accuracy, harmonization at boundaries, coding system, standards for data exchange and data access, content and structure of metadata.

In order to test the feasibility of the proposed structure, the working group is implementing a prototype GIS. Further testing is foreseen in the pilot river basins, coordinated by WG 4.1 (Integrated Testing in Pilot River Basins).

The purpose of the intercalibration exercise[2] is to ensure comparability of the ecological quality class boundaries and to obtain common understanding of the ecological status of surface waters all over the EU (i.e. good ecological quality should have the same ecological meaning all over the EU). The WFD requires that the boundaries between high and good and between good and moderate status be established through intercalibration (Annex V, 1.4.1, iii). Establishing comparable boundaries between good and moderate quality is particularly important in order to have an equal level of ambition in achieving good status of surface waters in different Member States. The intercalibration network will represent a common understanding of the normative definitions of surface water status (defined in WFD in Annex V, section 1.2) in relation to reference conditions.

The objective of the working group on integrated testing in pilot river basins[3] is to make operational the guidance documents developed under Action 2 of the Common Implementation Strategy and transform these into documents that should be taken into account by regional and local authorities by giving concrete examples of application in selected river basins in Europe.

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This approach is tackled through integrated testing of the guidance documents provided by the different working groups. The first step of the integrated testing has been the selection of the pilot river basins (PRBs). To this purpose, Member State authorities were invited to submit proposals for PRBs on which they wished to carry out integrated testing exercises in the context of the Common Implementation Strategy. Eleven proposals were sent from the countries, covering a wide range of conditions from both an institutional and an ecomorphological point of view. The EU water directors endorsed the PRB proposals at their meeting in Valencia in June 2002. The following step will be the development of a common understanding of the planning process for the preparation of RBMPs.

JRC STUDIES UNDER FIFTH FRAMEWORK PROGRAMME

The research activities at the JRC of the European Commission are regulated by multi-annual work programmes. A work programme is structured according to the priorities of the Directorates General (DGs) of the European Commission, and is revised annually to meet the evolving needs of customers in the DGs; it covers many different branches of research, including environmental research. The Fifth Framework Programme covered the years 1998 to 2002. During this period the Institute for Environment and Sustainability carried out several projects dealing with environmental analysis at the catchment scale.

Producing a pan-European river network and catchment database

Within the catchment characterization and modelling activity, a database of drainage networks and catchment boundaries for the pan-European territory is developed and version 1.0 will be completed by the end of 2002.

The area covered by the new layers ranges from Iberia to the Black Sea, and from Scandinavia to Malta. The project is carried out in a GIS environment, and the output mapping scale is approximately 1:500 000.

The objective of the project[4] is to derive river networks and catchment boundaries with an automated procedure, based on the analysis of digital elevation models and ancillary data.

For this purpose, a new methodology has been developed that takes into account the distribution of geophysical parameters that determine drainage density, and new algorithms have been written in order to optimize the channel extraction procedure, particularly in flat areas.

Among the problems that arise when deriving river networks at the continental scale, the variability of the landscape with respect to drainage density is certainly an important one. The proposed methodology therefore takes account of the natural variability in drainage density through a landscape classification that reflects the influence of climate, terrain morphology, soils, geology and vegetation on channel development. A different threshold for initializing drainage channels is then assigned to each landscape class, based on the analysis of the local slope to contributing area relationship.

4. CCM Leader: Juergen Vogt (Juergen.Vogt@jrc.it), JRC/IES Land Management Unit

In the procedures derived for the extraction of the channel network the following issues were taken into account: 1) handling of natural and spurious pits; 2) drainage enforcement in flat areas; 3) presence of lakes and coastal lagoons; and 4) connection to the coastline. During catchment mapping, a correction for sub-catchments draining into lakes was included.

The validation procedure is based on comparison of the extracted river network with existing data sets and comparison of the area of selected river basins with the corresponding value in the Eurowaternet database of the EEA. The latter represents a sample of some 3 000 catchments in Europe.

A coding system will be implemented, following the proposal made by the WFD GIS working group.

The new data layers will be included in the Eurostat GISCO database (Geographical Information System of the European Commission); the project also supports the technical work in the implementation of the WFD within the GIS Working Group.

Catchment information system (CIS) for agri-environment

The development of a catchment-based information system (CIS)[5] was initiated in 1998 to assess the impact of European Union policy on agriculture and environment and to support environmental protection. The final aim of the CIS is to provide a quantitative response to agri-environmental queries within the framework of an operational activity.

The principal methodological approach of the CIS is based on:
- arrangement of catchments and sub-catchments in a functional hierarchical system.
- design and implementation of an integrated data structure and management system.
- development of linked CIS applications.

The CIS catchments are derived from a pan-European flow network, which is derived from a specifically adapted river network of scale 1:1.000.000, using a stream burning method. The hierarchical system consists of ten layers. The highest layer consists of primary European catchments, i.e. those with an outlet into the sea. Sub-catchment layers were derived by continuous subdivision down to a nominal size of 1 000 km^2. The data set is distributed as part of the Eurostat GISCO database.

The integrated data structure integrates homogenized layers of very different types of data. The layers originate from other databases, e.g. land cover from Corine, or tabular statistics from Eurostat, which were adjusted to direct spatial analysis.

One of the applications of the CIS was the estimation of nitrogen in animal manure by sub-catchment as part of the Nitrogen Directive for DG Environment. The task required transferring statistics available in tabular format at NUTS units to spatial layers. The relatively coarse spatial resolution of the NUTS units was improved by using ancillary information derived from the Corine Land Cover data set.

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Natural hazards – flood monitoring

In order to address problems such as assessing the influence of historical land-use changes and land-use planning on flood risk, modelling the impact of climate change on flood risk, assessing flood damages, and setting up an alerting system for authorities and citizens by improving flood forecasting modelling, the floods group of the Natural Hazards Project has developed the hydrological model LISFLOOD[6]. Unlike most other hydrological models, it is capable of simulating large areas, while still maintaining high resolution, proper flood routing methods and physical process descriptions. As the physical process descriptions are universal, no or little additional calibration is needed when the model is applied in a new catchment. LISFLOOD is also especially designed to simulate the effects of change (land-use changes, modifications of river geometry, water reservoirs, retention areas and effects of climate change) in an easy and realistic way. LISFLOOD is embedded in a GIS and uses readily available European datasets, such as CORINE Land Cover, the European Soils Database, and the 1-km resolution European Flow Network. The output can be any variable calculated by the model. The format can be hydrographs of discharge at user-defined locations in the catchment – usually those locations where observations also exist – time-series of, for example, evapotranspiration, soil moisture content or snow depth at selected locations, and maps such as water source areas, discharge coefficient, total precipitation, total evapotranspiration, total groundwater recharge and soil moisture. Among the main applications of the model are collaboration with the Oder Commission IKSO for technical assistance in designing the Flood Action Plan for the Oder River, and setting up a European Flood Forecasting System (EFFS 2000–2003) whose aim is to issue a ten-day pre-warning of floods. The system is being developed in close collaboration with leading meteorological services (ECMWF, DMI, DWD), hydrological institutions (RIZA, SHMI, Delft Hydraulics, GRDC) and research institutes (JRC, University of Bologna, Bristol University, Lancaster University) across Europe.

European watershed observational network

This project[7] investigates impacts on water and soil quality induced by changes in land use, climate and EU policy and legislation, through an observational network of inland and coastal catchments representative of different land-use and climate conditions in Europe. The Network of European sites established by the JRC and DG Environment is a network of existing well-monitored small to medium-sized river basins across Europe. Research activities at each node of the river basins network contribute to removal of the uncertainties that still prevent an understanding of the links between pressures on water and soil quality resulting from emitted pollutants in the river drainage basin, their transfer in the soil–water continuum and the impact of different management decisions. Particular attention is given to the diffuse sources that are of agricultural origin, which is a re-emerging priority in Europe, in order to respond to the policy needs of future EU agri-environmental programmes. The network interrelates activities in the context of IES institutional projects and aims to develop modelling linkages between emissions from anthropogenic activities and environmental effects, as well as analysis of the propagation of uncertainties associated with possible climate and land-use

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scenarios; and assessment of the natural capacity of coastal ecosystems to assimilate nutrients and other selected materials and of long-term changes to the European coastal zone at the local and regional scales. This type of network addresses validation and the integration of knowledge, and interfacing with stakeholders and policy-makers in Member States, DG Env., DG Res., DG Agri., EEA and international conventions.

OUTLOOK AND CONCLUSIONS

Although this paper has dealt with catchment management in Europe, and mainly within the EU, it should be stressed that the Land Management Unit is also engaged in scientific collaboration with countries and authorities outside Europe. Within the frame of concerted action, collaboration in this issue is ongoing among most of the Mediterranean countries within the LandWaterMed network, which deals with most of the catchments that drain directly into the Mediterranean Sea (http://landwatermed.net). The objectives of the network are to examine the need of the participating Mediterranean partner countries for monitoring land and water resources, the institutions and tools currently in use and the potential role of remote sensing as a tool for ensuring a sustainable environment. The goal is to develop a cooperative process whereby institutions in participating countries will have better access to up-to-date tools for land and water management. The catchment is expected to be the basic unit for this management. A series of meetings will be held, involving experts in environmental monitoring techniques and water and land management.

At a far more formal level, in the Baltic, the Russian Federation is participating in the Helsinki Commission, which works to protect the marine environment of the Baltic Sea from all sources of pollution through intergovernmental cooperation, while in the Mediterranean the EuroMediterranean Ministerial Conference on Local Water Management covers a similar objective with the participation of countries in Northern Africa and the Middle East. This underpins the enormous importance that catchment management has in international collaboration and emphasizes the need for supporting research and monitoring, as well as pointing out that international networking and collaboration are to be considered important driving forces within research.

Furthermore, the Infrastructure for Spatial Information in Europe (INSPIRE) initiative (www.ec-gis.org/inspire) will become an important asset to international collaboration on catchment research and management by providing both a frame and the actual data layers required.

It should also be mentioned that the European Commission, through its Directorate General on Research, continues to support more that 130 projects and research networks dealing with problems that are or can support implementation of the WFD.

It is evident that the importance of proper and sustainable catchment management has become one of the most central themes in environmental policy and is a major driving force in research and development, not least at the European and international levels.

CHAPTER 6
THE UNESCO-IHP CONTRIBUTION

Lalji Mandalia
UNESCO-IHP

Considering the harsh environment of mountains, the hydrology of mountainous watershed areas is a challenging task for hydrologists and water resource planners. This task is vital as the availability of water resources is decreasing and their quality deteriorating. Despite this, mountains remain the most important source of global freshwater resources.

Because of rapidly increasing development in the last few years, there has been an increase in hydrologic, hydraulic and related studies in mountainous areas. These include studies of the availability, quantity (low mean and flood flows) and quality of stream flow, flood routing (including dam-break floods), sediment transport, the effects of acid rain, and precipitation – runoff modelling and geochemical studies are often unverified and in some instances inadequate. Conventional hydrologic and hydraulic procedures are inadequate for mountains because they were developed for lower gradients. As a result of these problems, research investigation is needed to improve our understanding of the underlying hydrologic process in mountains.

Hydrological measurements are very scarce. A database is needed covering the following factors:
- stream discharge measurements;
- meteorological measurements;
- glaciological measurements (including mass balance).

METEOROLOGICAL MEASUREMENTS

Glaciological measurements have been confined to work done on a random basis.

The water balance remains one of the basic tools available to a hydrologist for the assessment of water resources, their formation and behaviour in a region or watershed. Regarding the water balance, water management requires information about the availability of water in time and space, including water quality.

The subject requirements are determined by the water management tasks and objectives. The hydrologic approach to the water balance aims at assessing the water resources, and also considering the overall condition for their formation. Therefore, realization of the hydrologic water balance requires consideration of all determining characteristics of the region or watershed, and the necessary hydrometeorological data.

The amount of information required depends on the complexity of the hydrological water balance, and on both the time and space scales of water balance computation.

In the last few years, considerable advances have been made in our understanding of hydrological processes in high mountain areas. UNESCO's International Hydrological Programme (IHP) provides major incentives for worldwide hydrological process-oriented investigations. In many countries, IHP has been incorporated into already well established programmes of glaciological, hydrological and meteorological investigations. In other countries, the programme's impetus has been of fundamental importance to establishing high mountain investigative research, where little or no such research had previously existed. IHP has the added advantage that once a standard basic data collection programme has been established, many other shorter-term research projects on particular subjects can be undertaken, at little extra cost, and can benefit from the wealth of background information.

As a result of IHP, several very good integrated data sets are now available for further research analysis. Data on stream flow, sediment loads, meteorological and glaciological parameters have been collected in ever-increasing quantities. Recent innovations in aerial and satellite remote sensing have made a new database available. The compilation and dissemination of data have become much faster and more streamlined with advances in computer and communication technology.

IHP has basic research as its prime objective. In recent years interest has grown in applied hydrological programmes, technology transfer and education and training. Many programmes have the dual objectives of continued promotion of research and making the research results useful through practical application.

IHP constitutes an intergovernmental framework for applied research and education in the field of hydrology and water management. The general theme of the current phase, the sixth phase, covering the period 2002 to 2007, is Water Interactions: Systems at Risk and Social Challenges. It will examine the interactions "at the margins" – at the intersections of distinct components of water resources management Bridging gaps among these disparate components in an integrated fashion represents the major need to draw the IHP-VI phase in line with the above-mentioned comprehension of water interactions, technological developments of data acquisition and improved modelling of processes. IHP-VI has been formulated under five themes, with transition and interaction from the global to the watershed scale being the overall need regarding knowledge, information and technology transfer.

Two cross-cutting programme components – Flow Regimes from International Experimental and Network Data (FRIEND) and Hydrology for the Environment, Life and Policy (HELP) – through their operational concept, interact with all the five themes. The IHP-VI strategic plan includes many new initiatives, as described in the following paragraphs.

HELP is a joint UNESCO/World Meteorological Organization (WMO) programme that is designed to establish a global network of catchments to improve the links between hydrology and the needs of society. The vital importance of water in sustaining human and environmental health is the key driving force behind HELP. However, no international hydrological programme has addressed key water resource issues in the field and integrated them with policy and management needs. HELP is expected to create a new approach to integrated

catchment management by using real catchments, with real water-related problems, as the environment within which hydrological scientists, water resources managers and water law and policy experts can be brought together.

The purpose of HELP is to deliver social, economic and environmental benefits through sustainable and appropriate use of water by directing hydrological research towards improved integrated catchment management. It is user-driven so that water resource managers, through close partnerships with water users, will play a fundamental role in facilitating the application of research outputs from the experimental basis.

FRIEND is currently a well-established project of UNESCO's IHP. It is an international study in regional hydrology, which was launched in 1985. At present, the project involves research institutes, universities and operational agencies from more than 90 countries. FRIEND is structured for the mutual exchange of data, knowledge and techniques within several regions.

Watershed management in the mountain environment has become one of the most significant challenges to humankind in this century. To understand the mountain environment and organize environmentally friendly and sustainable development programmes oriented to people's needs are both complex and Herculean tasks, as these areas have their own unique features, known as mountain specificities. This means that we have to deal with mountain environments within the parameters of their uniqueness.

Over the years, UNESCO's programme has incorporated other elements and is currently looking at watersheds in a more integrated manner, including a strong focus on the participation of local people in planning and implementing upland conservation and development activities.

Mountainous upland watersheds constitute about 20 percent of the earth's surface, but there is hardly any area on earth that is not affected by their environmental characteristics. One of the unique niches of mountains is their ability to act as orographic barriers to the flow of moisture-bearing winds, resulting in rainfall in the mountains and the plains. Many upper mountain regions also contain large volumes of stored water in the form of ice, which provides the necessary melt-flows into the rivers during hot and dry seasons. Furthermore, the socio-cultural and ecological importance of mountain waters is vital, because they provide water to all living beings. Apart from being the home of mountain communities, the other economically important uses of mountainous watersheds include forestry, medicinal plants, ornamental plants, agrohorticulture, mineral extraction, livestock rearing, tourism and recreation.

The impact of human activities on mountain environments has increased considerably. Upland mountainous watershed areas are currently inhabited by more than one-tenth of the world's population. The environments and livelihoods of these people are threatened by an increasing imbalance between population and the available productive land. In many places, activities have exceeded the carrying capacity of the land, leading to ever-increasing demands for new agricultural and forest lands, and land-based products. Consequently, the forested upper slopes of these young mountain watersheds are being cleared for cultivation, grazing, fodder, fuelwood and timber. Removal of vegetation on steep slopes, in conjunction with intense monsoon rainfall, is triggering massive erosion and landslides, resulting in soil impoverishment, soil losses and a deteriorating biophysical environment. This is leading to

increasing poverty in mountain communities because the natural resource bases of forests, soil, water, plants and animal life, on which people depend for their continued survival, are decreasing at an alarming rate. Measures to control this degradation are required before the ecological balance is irreversibly damaged.

These recent human interventions have given rise to disturbing impacts on the mountain environment. The negative impact of such interventions is due to a low level of understanding of mountain specificities by the people who inhabit these mountains.

Large-scale changes occurring in the mountain environment have resulted in widespread human misery. The impact of such changes is not restricted to mountain areas, but has also had socio-economic repercussions on the plains. Few development interventions that have been designed are of a sectoral nature. They address the symptoms more than the causes of the problem, and largely ignore the opportunities for development that mountain watersheds provide. What is needed now is an integrated approach to sustainable development in which farmers are in the forefront, reconciling their socio-economic needs and aspirations with the requirements for enhancing environmentally friendly biological productivity.

OVERVIEW

The future security of the planet's growing human population rests in great measure on the mountain watersheds of the world. Yet no other part of the environment is as badly neglected by policy-makers.

In the deliberations of governments and organizations worldwide, the fate of mountains has been largely ignored. Unlike oceans or tropical rain forests, mountains have never had their own scientific discipline, or even a movement to broadcast the grave threats facing them and their populations.

In the surrounding lowlands, millennia of intensive human use have led to steadily increasing biological impoverishment and cultural homogenization. Mountain people, in their vertical archipelagos of human and natural variety, have become the guardians of irreplaceable global assets. All over the world, expanding economic pressures are degrading mountain ecosystems, while confronting mountain people with increasing cultural assimilation, debilitating poverty and political disempowerment.

Whether in cloud forests or alpine grasslands, on windswept promontories or along glacier-fed streams, what mountain ecosystems have in common is the combined effects of rapid changes in altitude, climate, soil and vegetation over short distances. Biologically, their high diversity – including prolific concentrations of species found nowhere else – leaves them vulnerable to losses of whole plant or animal communities. And culturally the fact that most mountain people are ethnic minorities, outside the dominant cultures of the plains, leaves their regions poorly represented in the centres of political or commercial power where much of their fate is determined.

Damaging policies

In many developing countries, development policies have actually undermined peasant agriculture rather than aiding it, and have left mountain farm communities enmeshed in interlocked webs of expanding population, declining resources and increasing poverty and environmental degradation.

This degradation has become visible in several trends over the last half century: landslides have become larger and more frequent; water flows in traditional irrigation systems have fallen; and yields of major crops have not kept pace with the gains typically achieved in the plains. The genetic diversity of crops and livestock has been diminished, as has the diversity of flora in forests and pastures. The regenerative capability of the land, based on intricate linkages among various land uses, has been weakened. The periods of hunger between harvests have lengthened; more time is spent collecting fodder and fuel; and the rates of poverty, unemployment and migration out of the hills have generally increased.

Local approaches

To elevate the status of mountain people and conserve their ecosystems, national governments and international development agencies will need to focus on policy reform in six areas: promoting efforts to secure land tenure or control over local resources; reducing the impacts of livestock, timber, hydropower and mineral production in mountains; creating regional networks of conservation areas; improving knowledge about mountains through integrated research, social and environmental monitoring, and public education; establishing institutions and cooperative agreements for each major range; and integrating mountains into the projects and policies of development agencies.

INTERNATIONAL YEAR OF MOUNTAINS 2002

Putting mountains on the global agenda

The focus during the International Year of Mountains (IYM) will be the well-being of mountain and lowland communities through promoting the conservation and sustainable development of mountain regions. FAO, the UN's lead agency for IYM, is working closely with other organizations to ensure that a wide range of expertise is focused on sustainable mountain development.

An international year dedicated to mountains is a unique opportunity to consolidate and capitalize on the many efforts carried out to date to protect and develop mountain regions. It also provides us with an opportunity to renew and intensify our commitment to our work in mountain areas, to celebrate the mountains and the communities that ensure their sound stewardship. But the real challenge lies in being able to focus on action-oriented activities aimed at long-term and sustained efforts to improve quality of life and environmental stability in the mountains. Concerted action is needed to build and strengthen the institutional and human capacity to continue with sustainable mountain development beyond 2002. Thus, IYM

is meant to be much more than just a series of events and activities confined to a one-year period, rather it is a springboard from which to launch or reinforce long-term mountain development and conservation efforts.

The following are some of the ideas for IYM 2002 celebrations and beyond.

UNESCO's involvement in activities during IYM

Thematic cluster - Natural Resources and Resource Use: UNESCO Mountain CD-ROM Atlas and Web site contain information on biosphere reserves and world heritage sites in the mountains, as well as information on projects of IHP and the International Geological Correlation Programme (IGCP). It is being constructed in collaboration with the World Conservation Monitoring Centre-United Nations Environment Programme (WCMC-UNEP) and the Mountain Research Initiative of the International Geosphere-Biosphere Programme (IGBP), the International Human Dimension Programme on Global Environmental Change (IHDP) and the Global Terrestrial Observing System (GTOS).

Collaborative links are currently being explored between the UNESCO Man and Biosphere Programme (MAB) and the Mountain Research Initiative. Duration: throughout IYM and beyond.

Thematic cluster - Integrated Themes:

- International meeting on World Heritage Cities in Mountains and Natural Disasters, in collaboration with the City of Chambéry (France), Chambéry, June 2002.
- International conference, World Meeting of Mountain People, in collaboration with ANEM, Quito (Ecuador), September/October 2002.
- Bishkek Global Mountain Summit, in collaboration with Kyrgyzstan, UN partners and other institutions (e.g. SDC, Aga Khan Development Network), Bishkek (Kyrgyzstan), October 2002.
- Cultural Ecotourism in the Mountains of Central Asia/Himalayas, in collaboration with Kazakhstan, Kyrgyzstan, Nepal, Pakistan, Tajikistan and, possibly, United Nations University (UNU), 2002 to 2003.
- International Mountain Expedition, in collaboration with Pakistan, ANEM, Chambéry, Reinhold Messner, dates and route to be determined.
- Environmental Education on Mountains (Mountain Calendar), in collaboration with the Swiss Agency for Development and Cooperation.

Thematic cluster - Socio-economic Themes:

- UNESCO Thematic Expert Meeting on Asia-Pacific Sacred Mountains, in collaboration with the Japanese Agency for Cultural Affairs, Wakayama City (Japan), September 2001.
- Culture-based Environmental Conservation Initiative on Natural Sacred Sites, in collaboration with IUCN/WCPA, WWF-International, and Rigoberta Menchú Tum Foundation.

IMPORTANCE OF ASSESSING THE WATER RESOURCES OF THE HINDU KHUSH HIMALAYAS (HKH)

The HKH are of central importance not only within their region, but also globally. They influence almost every facet of economic and social development, and effect weather and climate variability. Our ability to forecast weather and exploit water resources effectively is dependent on regional cooperation of hydrological and meteorological institutions both within and outside the region. They must provide the scientific and modelling foundations for the observing system. The routine provision of high-quality observations occupies a special place in this process. At the local level, the monitoring of water resources and an understanding of hydrological processes are needed for the protection and management of life, property and ecosystems.

By their very nature, water resources do not recognize geopolitical boundaries. Climate impacts and pollution that originate in one area are carried throughout the region by the rivers and streams. This leads to the growing recognition that it is impossible – politically, logistically and in terms of cost – for any one nation to gather all the information it needs for national prosperity and development. On the other hand, a nation would be negligent to ignore catchments beyond their own borders, because proper management and environmental sustainability will always be subject to forces beyond national jurisdiction.

It is therefore imperative for nations to seek appropriate regional cooperation in order to ensure that the information they require is gathered and accessible. A regional grouping of HKH countries should establish the necessary infrastructure and human resources to meet the growing demand for hydrological data and services from a wide spectrum of users, in an efficient and cost-effective fashion. This regional approach reflects a global trend to share obligations and co-sponsor sophisticated equipment, capacity building and product delivery. Another important new development is the recognition that the forecasting of weather, in particular, requires the transmission of critical regional information among adjacent countries in real time. Thus, it is not only accepted that cooperation is needed, but also that it must be virtually instantaneous, reflecting the speed of the phenomena that the data are used to track and forecast.

The importance of understanding, monitoring and predicting variations in the HKH is underscored by the human, environmental and economic factors cited previously. Sustained observing and monitoring, combined with modelling and analysis will produce hydrological data and services that people need for decision-making (e.g. where to locate dams, hydropower plants, etc.). Application of the data and provision of information and services to government and the public will result in improved management, quality of life and access to the resources contained within the Himalayas.

CHAPTER 7
NORWAY'S EXPERIENCE

Einar Beheim
Norwegian Water Resources

INTRODUCTION

As broadly defined, integrated watershed management comprises any use of land and water within a catchment, and involves a thorough and comprehensive assessment when planning future development activities. But the question remains whether all aspects of development are really being assessed and thoroughly considered when plans are made and constructions implemented.

In principle, everything should be assessed, but lessons learned show there is still a long way to go before the planning process is a truly thorough and comprehensive one. The reasons are that different types of planning activities are carried out based on different acts, and the decision-making authorities vary from one jurisdiction to another.

The most important laws governing the use of land and water resources in Norway are the Planning and Building Act, the Water Resources Act and the Forest Act. There are other laws, but they are less important. According to these main laws, the governing authority is placed at different levels, and public involvement varies considerably. For example, as far as land-use planning and development are concerned, authority is placed at the lowest level, the municipality. Forest authority is also placed at the municipal level, but the extent of public involvement in the planning of forestry activities is extremely limited. On the other hand, the use or exploitation of water, whether for hydropower generation or for drinking-water supplies, requires licensing at the highest level, which is the government and government agencies.

Watershed management comprises topics of varying importance, and is therefore a complex subject. Before starting a discussion of what can be improved, we need to define what we mean by watershed management. A broad definition of the term would include all elements in the catchment that affect the water from the time it meets the ground until it reaches the ocean. In short, this means that integrated watershed management should comprise such topics as:

- land-use planning and development;
- hydropower development;
- forestry and agricultural activities.

LAND-USE PLANNING AND DEVELOPMENT

Land-use planning is mainly a municipal task regulated by the Planning and Building Act (PBA). The act requires that the local planning authority and the national sector authorities cooperate in all local planning and development issues. A successful process is dependent on the parties being able to coordinate their interests in such a way that the land-use plan becomes a legal and useful tool in future local land-use and development issues.

According to the PBA, the municipality is recognized as the local planning authority within its own administrative borders. This is in line with the belief that local issues should be decided locally. Thus, it is up to the municipality, after a comprehensive assessment, to decide how its resources may best be used. Endangered or potentially endangered areas must be given special assessment in the land-use planning process. If an area might be vulnerable to a natural hazard, the municipality must ensure that a professional assessment of the potential danger has been carried out before a land-use plan is adopted or a construction permit is granted. An investigation must to be carried out if necessary. This authority was granted to the municipalities in 1985 when the PBA came into being. It implies that the local planning authority has the power to approve its own proposals, if objections have not been raised by a government agency on grounds of protecting national or regional interests.

The municipality is responsible for ensuring sound and safe use of land, as well as the promotion of other values within its borders. In addition, the municipality has a separate obligation to investigate potential hazards when formulating land-use proposals and granting construction permits. Municipalities with special topography or with records of natural hazards should be concerned with these issues when dealing with plans and permits for the use of land. Such an investigation might result in mapping the probability of rock or landslides, hazard zoning or the planning of protective measures to avoid future damage. The municipality is responsible for doing the necessary investigations and seeing to it that the knowledge gained from these investigations is employed in the planning process.

The municipality is also responsible for conducting the planning process in a formal and professional manner in accordance with the law and in keeping with national guidelines. A major premise for the municipality having authority to make legally binding decisions is that a statutory process ensuring public involvement and cooperation and information has been followed.

To help support the municipality, government agencies have worked out maps of hazardous areas, encompassing such hazards as landslides, quick-clay, rock falls and flooding. When such maps exist they must be used in land-use planning. Local knowledge or information must also be recorded and used in the planning process.

National sector authorities have a right and a duty to influence decisions made by local planning authorities regarding local land-use issues. This is a crucial part of the mandatory cooperation between government at the national and local levels to ensure that State policy is implemented locally. The PBA requires that government agencies, which have overriding responsibility for the development and sustainable use of resources as well as protective measures, supply the local planning authorities with the necessary support during the planning process. On the other hand, local government has a duty to involve national sector authorities on issues relevant to their field of work.

An early involvement of the national sector authorities is important to assure cooperation and influence from the start of the process. The relevant national authority has an obligation to follow up issues in its field of work and to ensure that national interest is sufficiently taken care of in the local planning process. If a controversy should arise on a particular issue, the local government's authority to make legally binding decisions is precluded. If a formal objection has been put forward, the plan will be submitted to the Ministry of Environment in order to decide whether the objection should be accepted or the land-use plan finally approved.

FORESTRY AND FOREST MANAGEMENT

Commercial forestry is a key Norwegian industry, and the Forest Act provides the main legal basis for work carried out by forest owners and supervised by the local forest service. The act aims to promote forest production, afforestation and forest protection. A basic principle is that forest owners should be free to manage their forests without interference from the authorities, as long as they observe the principle of sound forestry practice. The act provides the Forest Service with authority to intervene in cases of poor management. Public involvement and cooperation in the planning and operation of forest activities is insignificant.

The ongoing reversion of the Forest Act does not seem to have affected the basic principle of freedom for forest owners to manage their forests responsibly.

Certification of forestry through the forest owners' association constitutes the most important basis for forest activities today. For forest owners this means that they have to be members to be allowed to cut the forest and deliver timber. And owners have to comply with the rules of certification, which means managing the forest in a sustainable and environmentally sound way. To enable them to do so, owners have to make environmental investigations of their forests and comply with them in future forestry activities.

As forestry and watershed management are interrelated businesses, Norway is endeavouring to get the relevant national sector authorities to improve cooperation. An important reason for this is that forestry is a key commercial industry, which for a long time has been operating without much interference from others.

Consequences of land-use changes

After the floods in 1995, a report was written discussing the consequences of land-use changes on flooding of the Glomma–Lågen River in the southeastern part of Norway. The drainage basin covers approximately 42 000 km^2, of which 37 percent is forest and 6 percent cultivated land. The remainder is mainly mountainous land above the timberline. The greater part of this highland is situated in the Lågen drainage basin, which makes up the western branch of the drainage system.

For hundreds of years, the biomass of the conifer forests has been reduced owing to unfavourable climate conditions and excessive logging for the mining industry and timber export.

Since the turn of the last century, silviculture measures have been implemented to restore and increase forest production. These measures have resulted in increases in the volume of the standing timber mass of 70 percent in the Glomma watershed and 100 percent for Norway as a whole, since 1920. As the forest area has not increased significantly, the main change attributable is denser forest. This is expected to have reduced runoff, and thereby the risk of flooding, in the catchment area. On the other hand, the total length of forest roads has increased by a factor of 15 since 1940. In principle, this should have contributed to quicker runoff, thereby increasing the risk of flooding. However, only 2.5 percent of the forest area has been drained as a result of forest road construction, which implies that, in practice, forest roads do not contribute much to the flood situation.

As for the ditching of peat lands in forest areas, we expect contributions from both sides. The resulting effect, as only a small part of the area has been drained, is undoubtedly insignificant, that is, large floods in the river have not been altered by the drainage of forest areas.

HYDROPOWER DEVELOPMENT

Hydropower development in Norway has a long history. For more than 100 years we have exploited waterfalls for hydropower generation, and at present two-thirds of the potential hydropower has been developed. During the last decade, hydropower development gradually declined and is about to cease. New projects are rare, and those currently being implemented are restricted to the extension and renovation of existing facilities.

River protection plans

For decades, the Norwegian Water Resources Authority has worked out plans for the protection of watercourses against hydropower development. By 1993, four national river protection plans had been worked out and approved by Parliament. Today, the plans include 341 river systems throughout Norway, which represent a hydropower potential of 35 TWH, or about 20 percent of the potential. The protection plan is currently to be extended to include a new list of proposed protected rivers.

Licensing of projects and instream flows

Allocation of instream flows is paramount to the licensing procedure of watercourse encroachments. The determination of instream flows is an area in which management has to make decisions on a daily basis with respect to new licences, renewal of old licences and in response to the Water Resources Act.

This new law, brought into force on 1 January 2001, opens the way for a more flexible treatment of instream flows. However, the basis for making decisions on instream flows has frequently been inadequate, resulting in the granting of a trial period for the set instream flows. Even after the trial period, sufficient data have often not been available, resulting in an extension of the trial period, largely on biological grounds. For example, the Alta power station has had trial instream flow since its inception in 1987.

The European Union Water Framework Directive has been adopted by Norway. The Directive clearly defines environmental standards and requires that water quality must be defined according to ecological criteria. Discharge to a large extent determines the nature and development of the freshwater ecosystem, and thus is of importance in the field of instream flows.

Traditionally, the concept of minimum flows has been used to mean the flow that a regulator must not go below. However, this concept has been shown to be inadequate, at the international level. Environmentally based flexible instream flows are more in tune with modern sustainable watercourse management.

In order to meet the challenge of sustainable watercourse management and address the problems encountered in the licensing procedures, the Norwegian Water Resources and Energy Directorate (NVE) has initiated a five-year R&D programme on environmental instream flows. The objective of the programme is to increase knowledge of the effects of strongly reduced discharge, in order to form the basis for developing appropriate methods that will enable management to set ecologically sound instream flow.

Previous Norwegian research and development

The topic of reduced discharge and the setting of instream flows have been addressed in previous Norwegian R&D programmes. However, much of the work has been theoretical in nature, and is largely based on existing knowledge, rather than obtaining new knowledge concerning the ecological consequences of a particular instream flow. In particular, two programmes, the Environmental Effects of Hydropower Development (MVU, 1982–1988) and the Effective Energy System (EFFEN, 1992–1996), considered the question of minimum flows. In addition, two other programmes, the Weir Project (1973–1983) and the Biotope Adjustment Programme (1985–1995), increased the knowledge of remedial measures in regulated catchments.

The MVU programme had flexible regulation and requirements for minimum flows as one of its project areas. The aim was to develop methods to improve the basis for decisions regarding the setting of the regulation regime and the effects of different strategies. A number of interesting desk studies were completed (Ziegler, 1986), but practical demonstration projects were not carried out. The EFFEN programme had environment as one of its five programme areas. Here the aim was to increase knowledge of the environmental consequences of hydropower development. Attempts were made to develop an expert method for the setting of minimum flows. The method was tested in four watercourses (Faugli, 1997). However, it proved difficult to put forward specific flows as user interests were insufficiently documented. The Weir Project and the Biotope Adjustment Programme did not address the question of setting environmental flows, but did increase the knowledge of remedial measures, especially weirs, in regulated rivers in association with reduced flows (Eie, Brittain and Eie, 1997).

International practice

The setting of environmental flows has been the subject of considerable interest internationally, and several countries are addressing the problem. There has been a change in the concept, starting with minimum flows below large dams, which were developed in the 1950s and 1960s. These were followed by instream flows in the 1970s and hydrological- and habitat-based methods in the 1980s, before today's multidisciplinary catchment-based criteria were adopted. In Norway the idea of "minimum flows" is still prevalent, and there is a clear need to think more in terms of environmental flows. A certain degree of flexibility in setting different flows at different times of the year has been instigated in many instances, although there is a need to incorporate year-to-year variations. For example, it may be possible to allocate more water in wet years compared with dry ones.

The Norwegian Environmental Flows Programme

Several considerations must be evaluated when setting environmental flows. These include energy production, pollution, ice problems, sediment transport and erosion, aesthetics and biology/ecology. At present, in certain areas there is an urgent need for improving our practical knowledge of the consequences of reduced flows in regulated watercourses. These will form the focus of the Environmental Flows Programme. The programme will involve extensive cooperation within NVE and between NVE and those involved in hydropower regulation, including other government agencies, power companies, research institutes and universities. The programme started with limited funding in 2001, and has a preliminary five-year time frame, although the complexity of the topic and the necessity for long-term studies may necessitate an extension for a further five years.

ONGOING RESEARCH PROJECTS

In 2001, three projects were initiated in the fields of low flows hydrology, nuisance macrophytes and the use of long-term fisheries statistics. In setting instream flows in connection with hydropower schemes and other water uses, Norway has used the concept of "normal low flow" (Otnes and Ræstad, 1978). This is close to, but not the same as, the mean annual minimum flow, and is usually 5 to 15 percent of mean discharge. This concept is used as a distinction between those watercourses requiring a licensing procedure and those exempt. The use of this concept has been evaluated in relation to the new Water Resources Act. It has been concluded that to impose a specific discharge based on this concept is unsuitable in modern water resource management and that its removal should be considered in future revision of water resources legislation (Skaugen *et al.*, in press). An existing PC programme, LAVANTI (Krokli, 1988) has been extended using linear regression in order to estimate "normal low flow" for catchments lacking discharge data.

Increased growth of aquatic vegetation has taken place in several Norwegian watercourses regulated for hydropower. In certain rivers, mainly in the coastal areas of southern and western Norway, there have been severe nuisance problems with the excessive growth of *Juncus supinus* Moench, leading to the formation of thick vegetation mats, clogging waterways and rendering them unsuitable for recreational activities such as boating, fishing and bathing. In addition, such growth is unsightly, lowering the aesthetic value of the riverine landscape. Many of the affected rivers have suffered from acidification, but with extensive liming programmes, fish – including Atlantic salmon and sea trout – have returned to many of the rivers. There are several factors that may explain the increase in *J. supinus*, including river regulation, liming and climate change. River regulation for hydropower, resulting in reduced discharge and a lower frequency or even absence of major floods, appears to be one of the main causes (Johansen, Brandrud and Mjelde, 2000). However, the causal relationship is complicated, and studies have been started to clarify the role of discharge regime. Flushing trials have also been undertaken. In such trials, which are undertaken during winter, discharge is severely reduced in order to expose the macrophytes to sub-zero temperatures. This is followed by a rapid increase in discharge to flush the macrophyte growth out of the system. The programme is funding such a trial in early 2002. Removal and harvesting of *J. supinus* have also been employed.

In 2002, several more projects will be initiated. These include fields such as low flow hydrology, sedimentation and erosion processes in relation to remedial measures, interactions between groundwater and surface water and their role in river ecology, development of models for predicting the relationship between discharge and fish production, and flow requirements for salmonid migration. The setting of instream flows is an extremely complicated topic and, in addition to national research, it will be necessary to draw on international experience and expertise. By addressing the specific needs of management, it is hoped that the Norwegian Environmental Flows Programme will make a significant contribution towards a more environmentally appropriate allocation of instream flows in order to maintain the ecological quality of Norwegian watercourses.

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PART 3

WATERSHED RESEARCH IN EUROPE

CHAPTER 8
NEGLECTED ASPECTS OF WATERSHED MANAGEMENT

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INTRODUCTION

Integrated watershed management should not only deal with water balance or focus on the needs of stakeholders, land use and forestry but should also integrate aspects such as water and sediment sources, slope stability and sediment transport, especially in young, active mountain belts.

This paper will concentrate on:
- high alpine regions in the United States, Germany, Switzerland, Austria, France and Italy;
- stakeholders, mainly from forest services, small farms, alpine clubs, villages and small towns downstream;
- the treatment of watershed management as a comprehensive problem covering issues that range from precipitation to runoff, from ecology to evapotranspiration and from slope instability to sediment transport.

STATEMENT 1: WATER BUDGET AND EVAPOTRANSPIRATION

Water budget

In mountain watersheds, there is little sense in carrying out water balance studies in the traditional manner of calculating evaporation losses from the deficit between precipitation and discharge because precipitation is too inaccurate a factor to act as the main determinant. Instead, an alternative approach is suggested in which regional precipitation is back-calculated from the sum of the losses incurred by discharge and evaporation (Figure 1; de Jong, List and Ergenzinger, 2002; Schädler and Weingartner, 2002). This is more accurate than determining the regional precipitation with standard extrapolation procedures from few point stations. Because the losses by evapotranspiration in high mountains are relatively small, the relative error of accuracy of evapotranspiration models can also be kept minimal. Accordingly, integrated watershed management in high alpine regions should pay far more attention to the determination of evapotranspiration in forested zones and in those covered by alpine meadows and shrubs. Due to its ecological importance and potential for change in the near future as a consequence of climatic perturbations, the zone above the tree line, which interacts with alpine meadows, shrubs and the forest border, should no longer be neglected by hydrologists.

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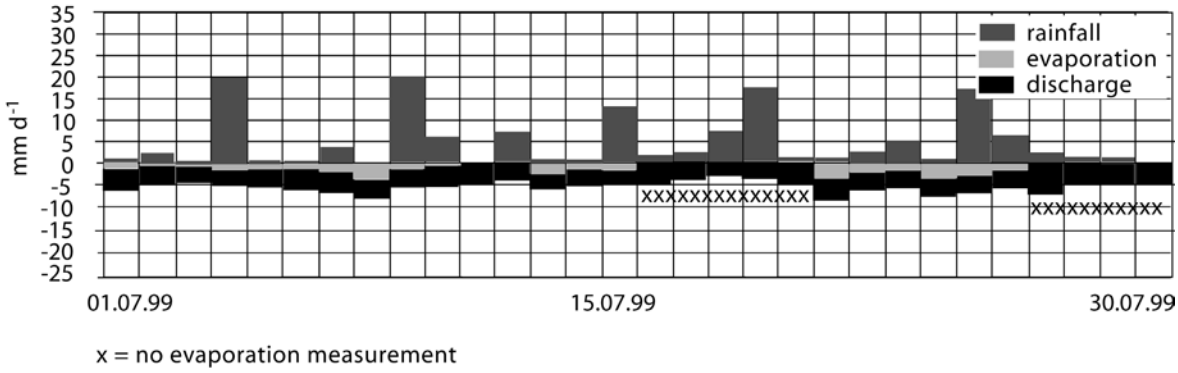
Another factor that is often neglected in watershed management in mountains is the hydrological role of avalanches within the water cycle. Avalanches are agents for the internal water movement within a basin and should therefore be investigated. Snow transfer into the lower valley zones near water route ways causes faster melt at different temporal and regional scales owing to higher temperatures. If snow melt occurs more rapidly and at an earlier stage seasonally, local soil moisture conditions can be influenced and water discharge into the streams is accelerated, so water can be transported away more quickly, and discharge increases. Any change in the frequency of avalanches through changes in climate or vegetation cover will be reflected in these hydrological processes.

FIGURE 1

Measured evaporation (from evaporation pans), discharge and rainfall in the Dischma valley for the wet month of August 1999.



Evapotranspiration

The regionalization of evapotranspiration requires a suitable description of the physical characteristics of the watershed. It is suggested that the regional differentiation of temperature as detected by remote sensing, e.g. from light aircraft or satellite, is the most appropriate approach for validating evapotranspiration model results in mountain terrain. Because there is no simple evapotranspiration approach that can be transferred from the lowlands to the alps, well-known meteorological functions that have been developed for flat terrain and non-turbulent conditions, such as the Penman or Bowen ratio, are not applicable (de Jong, Collins and Ranzi, 2005). On the other hand, the Priestley-Taylor function has proven to be a robust approach.

A profound knowledge of evapotranspiration processes of single trees and tree stands in alpine areas already exists from long-term experimental studies such as those carried out by the WSL Birmensdorf in Davos, Switzerland (Häsler, 1982). In contrast, little is known on evapotranspiration of the high alpine belt above the tree line, especially those areas covered by pasture and dwarf shrubs. The hydrological interactions between this zone and the lower-lying alpine meadow zone in relation to its role as meadow or pasture for milk production has been

largely neglected. In alpine catchments, the amount of evapotranspiration increases significantly from the colder, windier meadow on the valley floor to the sheltered, highly insulated shrub zone on the lower valley slopes (de Jong, Migala and Mundelius, 2005). It is these zones that are most highly frequented by grazing cattle. Should they undergo strong land-use change, this will not only have important impacts on the water balance in terms of ecology and biology; for example, once alpine meadow is abandoned, a rich and valuable deposit of fertilizer is developed locally (Körner, Hoflacher and Wieser, 1978). As a result of this extensive organic cover and the limited weathering capacity of the parent material, soil development is modified over many decades. No natural soil development will be possible for a long time, and any soil development that does occur will be strongly dependent on antecedent land-use conditions. Such modifications of the soil and vegetation cover influence the storage capacity of the soil and the amount of evapotranspiration.

STATEMENT 2: SEDIMENT BUDGETS AND RIVER BED STABILITY

During the International Year of Mountains 2002, the principal focus in natural sciences was narrowed down to problems of the hydrological cycle in mountains. However, in these extreme regions, watershed management has to be far more comprehensive and should include new focal points such as:

- river bed stability;
- general aspects of flooding;
- sediment transport.

River bed stability has an important causal relationship with the floodplain zones where land use and infrastructure are intensive. It is therefore important to understand and predict potential destructive changes in terms of erosion and deposition by flood flows in these zones (Dunne, 2000). During and after floods, large woody debris and coarse sediment play a dominant role in restructuring river beds, and this can have disastrous effects on areas with traditional land use. The stakeholders concerned include farmers with property in riparian river zones and administrators, especially of forest roads that are prone to erosion during floods. Locally, the hydraulic conditions and the river morphology are quite often altered by the impact of eroded trees and/or log jams (de Jong and Ergenzinger, 1995). Wood-induced river bed formations are common in mountain torrents and – apart from step-pool systems –are responsible for major habitat diversity. In contrast to hard check dam structures, these natural breaks in the longitudinal development of a stream enable far higher connectivity of the fluvial system (Figure 2).

It is commonly assumed that the probability of floods changes with land use, especially in relation to forested and agricultural land. However, during extreme thunderstorms with high intensity rainfall, the influence of land use on flood discharge rapidly loses significance. Forests, for example, can reduce average flood flows, but where extreme precipitation occurs during single precipitation events with magnitudes of 40 to 80 mm per day, extreme floods will develop independent of the vegetation cover. Liniger and Weingartner (1998) indicate that the influence of forest ceases as soon as soil is saturated, as was the case in the extreme rainfall–flood events in Switzerland in the last century. Naef, Sherrer and Weiler (2002) describe how storm runoff cannot be significantly reduced by land-use changes, unless they occur in the runoff generation areas where runoff is rapidly produced. Thus, for hazard

assessment of extreme floods the question of whether catchments are forested or not is not nearly as important as how much water can be stored and transmitted in rapid runoff production areas such as slopes, scree fields or river beds. Good geomorphological and hydrogeological maps that coherently describe the sub-surface conditions are therefore necessary, in addition to land-use maps. From a hydrological point of view, predictive tools will fail if prognoses rely only on forest cover maps.

It is often overlooked that the hazard potential of floods is not merely a function of the amount of peak flow but also of the amount of sediment mobilized (de Jong, 1997). Large-sized sediments are usually only set into motion during floods, and will then cause considerable river bed changes (de Jong, 1994). Such changes can have long-lasting effects on forests and other types of land use along the valley floor. This is especially true for Mediterranean mountain areas, where farmland and fruit orchards are closely tied to riparian areas. The danger of river bed change increases significantly in zones of slope instability. During extreme events, there is a high potential for slope degradation by mass movements; slope degradation, in turn, generates very large sediment point sources. Mass movements that block river courses can even create temporary lakes and act as source areas of coarse sediments for a considerable time after an event, thereby temporarily elevating the river bed (Ergenzinger, 1992). It can take decades for former valley conditions to be restored after disruption by fluvial erosion.

In order to obtain a comprehensive understanding of the dynamics of mountain torrent beds, appropriate observation systems should be applied. Apart from standard geodetic cross-sections or longitudinal surveys, remote sensing from tethered balloons or via helicopter using digital cameras or video systems is suggested for streams in the order of 5 to 10 m width

FIGURE 2

Damaged and sedimented check dams in the Bavarian Alps, Lainbach River after the 1990 extreme event.

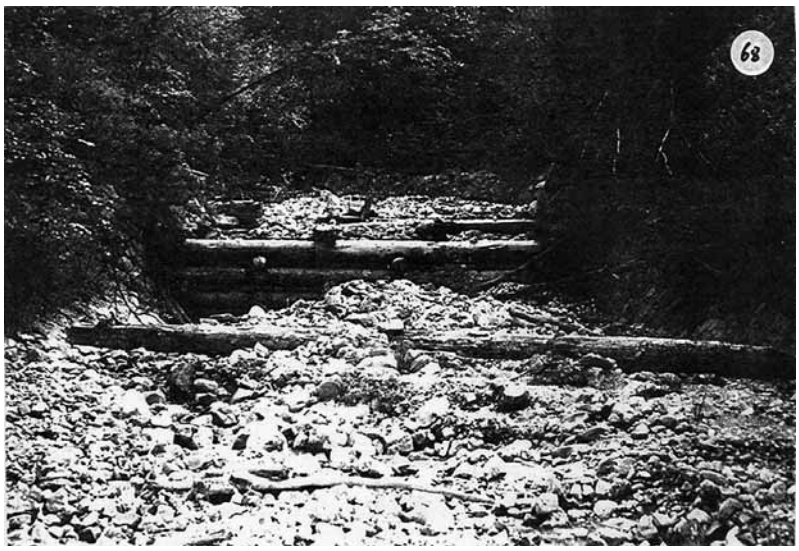


Photo: Thilo Schmalfeld.

(Ergenzinger and de Jong, 2003). For larger rivers (> 200 m in width), river bed changes can be determined with the help of drones or light aircraft and scanning stereo techniques (Figure 3), such as the HRSC system (Bucher and Lehmann, 2000). In addition, the velocity of representative bed particles during bedload transport can be measured with radio tracers (Figure 4) (Ergenzinger and Conrady, 1982) or magnetic tracers (Ergenzinger, de Jong and Christaller, 1994).

FIGURE 3

New possibilities of investigating morphological changes of river beds with HRSC scanner from light aircraft. Example of the Rissbach 400 m above its confluence with the Isar River, Upper Bavaria in 2000. The 3-D resolution of the river bed is 15 cm.

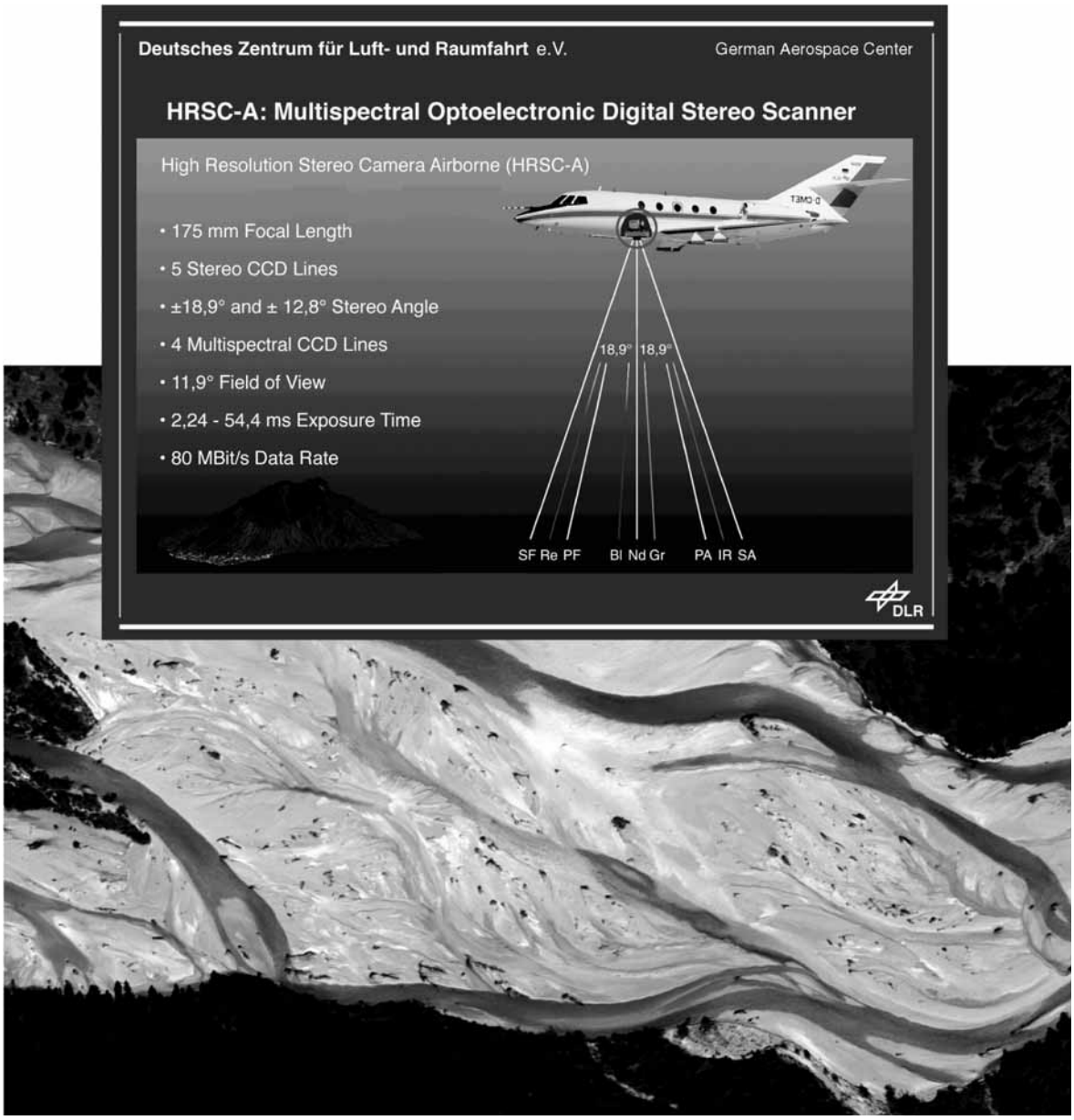
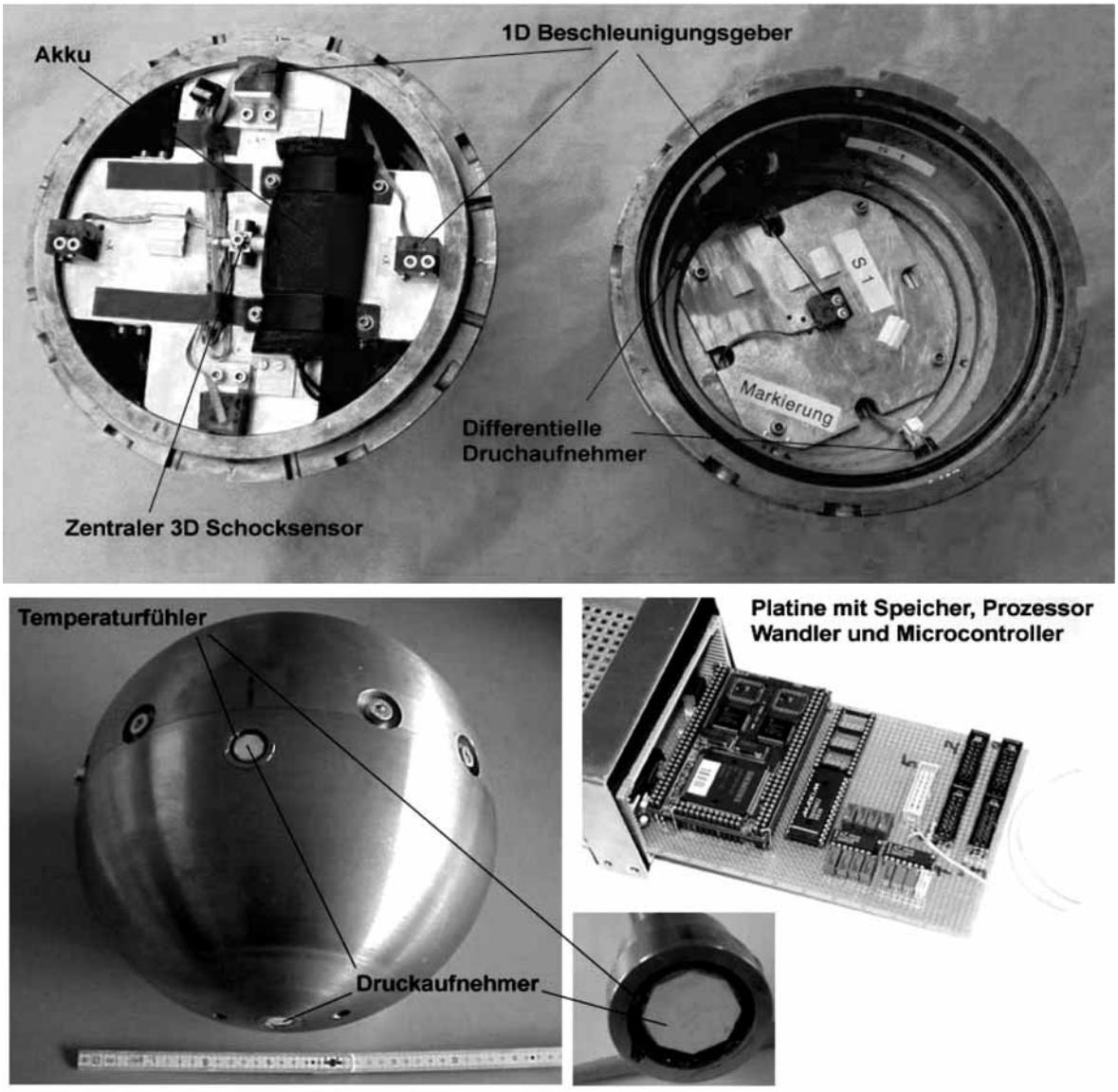


FIGURE 4

Instrumented mobile measuring probe for quantifiying pressure differences and velocity of sediment transport during natural debris flows and floods in high mountain streams. The probe is fitted with pressure transducers and memory module (developed by J. Hanisch, BGR Hannover and P. Ergenzinger, FU Berlin 2001)



STATEMENT 3: SEDIMENT RETENTION STRUCTURES AND SUSTAINABILITY

Over the past 150 years, special problems caused by human intervention have arisen in alpine catchments (Habersack and Piégay, in press). Modifications in the sediment source areas of catchments have had considerable impact on river channel dynamics. Considerable effort was undertaken to retain sediment in the source areas, on the one hand through slope stabilization (reforestation and technical measures) and on the other by torrent control work (Wildbachverbauung). As a result, sediment delivery was strongly altered, and new protective measures were required in the downstream areas, e.g. to counteract excessive channel incision resulting from sediment deficit further downstream (Liébault and Piégay, 2002).

One procedure for sediment retention in the nineteenth and early twentieth centuries was the construction of small check dams, mostly of wood, in high density along the upper river reaches (Bravard and Peiry, 1993; Habersack and Nachtnebel, 1995). The check dams store sediment until they are full, when the surplus is conveyed over the sill. Although the concept of check dams is to reduce the longitudinal river profile and associated sediment transport, the dams have proximal as well as distal effects. Small check dams in river channels are potentially dangerous nowadays because they have stored large quantities of sediment over long time periods and are weakening owing to a shortage of maintenance budgets (Figure 2). Disaster in terms of excessive sediment release and the consequent destruction of human-made structures downstream can result from the so-called "check-dam domino" effect (i.e. sudden failure of one check dam after the other resulting from the impact of sudden sediment release from the upper check dams). Whereas the sudden failure of check dams has strong local effects, long-term sediment retention in check dams alters the river dynamics over longer distances (hundreds of kilometres) by causing continual channel deepening. As a result of decreasing sediment supply over many years, it is possible that the active channel width decreases and the channel narrows. In the Rhone catchment, 70 percent of braided reaches have disappeared owing to the combination of torrent regulation, sediment trapping upstream and gravel mining (Bourdin, 2004). The financial costs of the effects of such measures are considerable (Bravard, Kondolf and Piégay, 1999).

The widespread claim that forests act as protectors against such sediment-dominated disasters is often a myth. The protective role of the forest is dependent on the soil porosity, slope gradient and rainfall intensity. Where flatter slopes dominate, runoff does not concentrate as much as it does on steep slopes, and in these zones the forest can reduce the impacts of sediment transport or the passage of debris flows. However, such conditions are rare in steep alpine areas, and forests cannot protect against the concentration of runoff during storm flow. In highly porous areas, such as steep debris flow cones within the forest, infiltration capacity is higher than rainfall intensity during storm events. Surface runoff does not occur except where the rapidly rising groundwater table reaches the surface and initiates small debris flows. Forests may dampen the effects of extreme events during the first 15 mm/hour of effective rainfall (without interception), but for rainfall exceeding 80 mm/hour, surface runoff dominates and sediment stored over decades on the forest floor is rapidly transported into the river. Thus, the capacity of the forest as a sediment trap is limited. This is also true for the occurrence of debris flows (Figure 5). Debris flows can either be generated above the tree-line or as a result of bank failure of streams within the forest, and their tracks can directly traverse the forest downslope. Again, the forest cannot help in protecting the passage of the debris flows. An example was the flood/debris flow disaster in the Lainbach valley in 1990 (de Jong, 1994) in which small, zero-order streams in the forest were rapidly enlarged to transport large debris flows. After this event small, turned-over grass patches provided evidence that groundwater had surfaced locally under high pressure in hollows, reactivating channels in the source areas. All these processes should have a significant impact on the way in which hazards are assessed in mountain catchments with major transport infrastructure and villages below forested slopes.

FIGURE 5
Multiple debris flows traversing dense forests at Piz Madlain in Prätigau (Lower Engadin) Switzerland.

Photo: Donatsch and Pult in Ikarus über Graubünden, 1995.

Other problems are the unwanted side-effects of sediment retention of large dams or dammed catchments (Kondolf and Swanson, 1993). Because the majority of sediment cannot be removed from the dam reservoir (Verstraeten and Poesen, 2000), sedimentation behind dams, whether minor or major, can be compared to a time bomb. However, the number of new dams being built in high mountain catchments is still increasing, and the sedimentary problems associated with them are largely ignored. By reducing flood magnitude, dams decrease or eliminate bedload transport and cause major ecological change downstream. Minimum discharge released from dams is not well regulated from an ecological viewpoint, and can completely extinguish ecosystems that depend on a certain flow velocity and river bed morphology. Not only is the limited life expectancy of all technical solutions to nature a challenge for us in the near future, we are already being confronted with the problem of how to react to large quantities of – at times, polluted – sediments that have been stored within dammed basins over many decades and centuries.

CONCLUSION

This paper has shown that there is no single solution that is suitable for mountain watershed management. It is therefore not advisable to discuss only the procedures of hydrological top-down or bottom-up strategies or of combinations of the two methodologies. Problems cannot be solved by applying single-discipline approaches, but require profound inputs from hydrology, meteorology, biology, geomorphology and related sciences. The neglected aspects of watershed management will remain neglected if there are no interdisciplinary means for controlling the success or failure of watershed programmes. In order to enable more sustainable solutions for the future, further technical developments, possibly from cross-cutting disciplines, are necessary to substantiate our understanding of the dynamics of high mountain basins.

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CHAPTER 9
INTEGRATED WATERSHED MANAGEMENT ON A LARGE-SCALE BASE

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INTRODUCTION

The control of natural hazards is part of watershed management and the main aim of the Forest Technical Service in Erosion, Torrent and Avalanche Control of Austria.

Natural hazards can only be controlled by integrated risk management. On the one hand, an interdisciplinary cooperation of authorities concerning management of the habitat and the basins of a region is essential, and on the other hand a proper control technique has to be implemented in each sub-catchment of a region. Naturally, the problems of watersheds vary from case to case and can only be answered individually. Therefore, again and again the question arises as to what kind of risk management should be applied to level down natural hazards to an incalculable risk.

First of all, risk has to be analysed and assessed by regional survey. Through the results of a regional survey, proper risk management has to be derived and implemented.

METHODOLOGY

Risk management can be derived by applying the risk concept method.

Risk is defined as: "Qualitative and quantitative characterization and analysis of a hazard due to its probability and consequences" (BUWAL, 1998: S.12).

Regional survey

A regional survey has to analyse the environmental situation of a region and its land use and contents, including:

- the boundaries of the area of survey;
- the communities, catchments and areas of natural risk concerned;
- data regarding the planning of measures;
- land use, forestry, settlements, infrastructure, etc.;
- basic investigations;
- geology, morphology, hydrology, etc.

A regional survey is a combination of risk analysis and risk assessment.

TABLE 1
Regional survey

Risk analysis Definition of risk Analysis of consequences Analysis of exposition Analysis of risk	Characterization and/or quantification of a disaster according to its probability and consequences
Risk assessment	Socio-political answering of the question: Which risk will be accepted by the claimants?

Results of the regional survey: The regional survey makes it possible to project hazard maps and hazard zone maps; the reach of risks from outside the dedicated area can also be selected. Furthermore, the results of the regional survey define the necessities of integrated watershed management.

Risk management – planning of measures

The control concept is a combination of measures that have to be integrated in a way reaches the target of control optimally and efficiently. Measures are hazard zone maps, regulations and rules, as well as structures and biological measures.

Measures are classified by their functions and divided into two categories, as shown in Table 2.

Planning of the measures depends on:
- the type of disaster: flood, bed load disaster, debris flow.
- the aim of control: settlement, infrastructure.

TABLE 2
Classification of functions

Damage causing area	Impacted area
Consolidation Drainage Biological measures	Bed load dosing and sizing Debris flow breaker Retention of floods Hazard zone maps

Control technique

A so-called "function chain" is applied as a control technique in Salzburg, Austria.

"A function chain is a unit of function carriers with interdependency. If one necessary function is not occupied, the whole control technique has to be questioned" (Kettl, 1994: S. 43).

The following are definitions of functions (Fiebiger, 1988):
- *Stabilization:* Fixation of debris flow channels at a desired level to stop and/or prevent depth erosion.
- *Consolidation:* Elevation of debris flow bed to support and/or prevent slides and slopes and lateral erosion.
- *Sorting and sizing:* Filtration and/or storage of undesirable debris flow components during debris flow.
- *Debris flow sizing:* Filtration and storage of large pieces of bed load during an event or debris flow.
- *Wood grading:* Filtration of undesirable wood during a debris flow.
- *Retaining:* Storage and deposition of debris flow until the retention capacity is increased.
- *Dosing:* Separation of a large mass of debris flow into small amounts.
- *Debris flow dosing:* Quantitatively dosing the transport of intermediate stored debris flow and bed load by decreasing flood and mean waters.
- *Breaking of debris flow:* Decreasing the high energy level of a debris flow to a lower level under particular energy change.

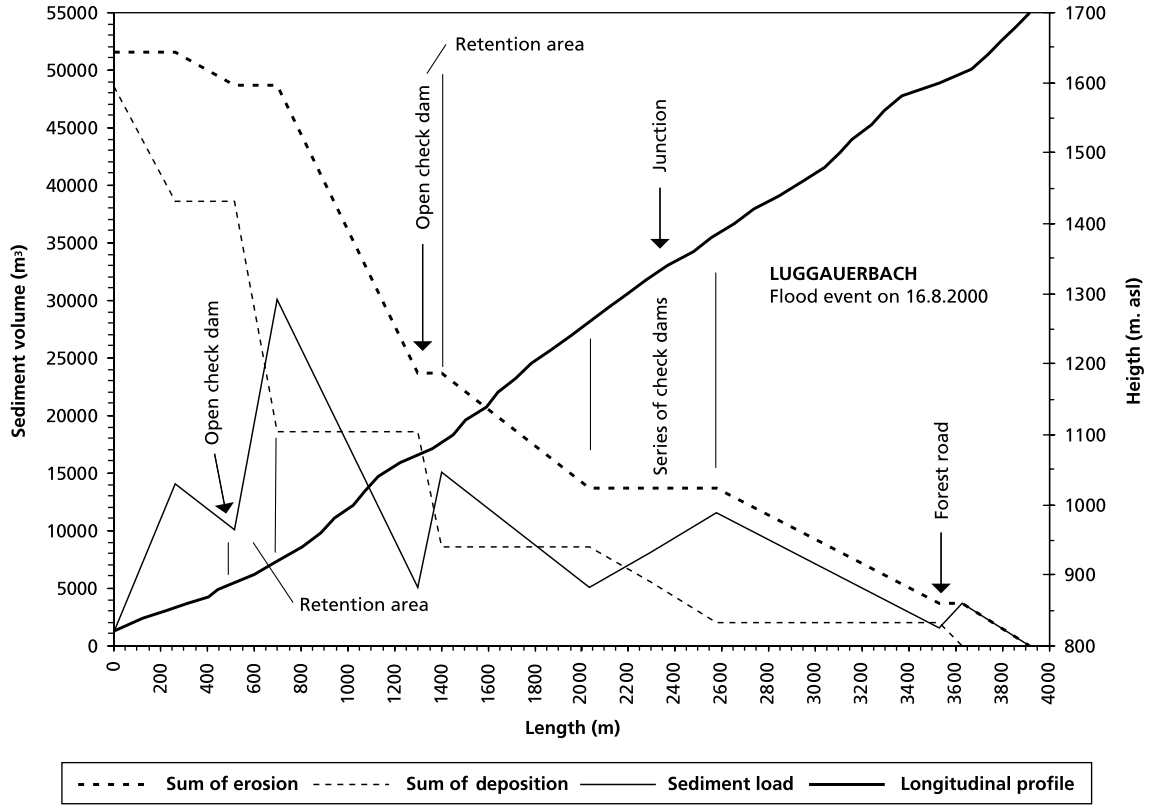
SYSTEMATIC CONTROL SYSTEM IN INTEGRATED WATERSHED MANAGEMENT

A method for deducing an effective control system is first to define the objectives of treatment and the necessary functions of the measures.

Hazard zone map

The technical method of preparing hazard zone maps is through aerial mapping of the level of danger at sites from torrents and avalanches – red and yellow hazard zones – as well as reference (brown) and reservation (blue) areas. The hazard zone map is the basis for projecting and implementing measures and surveying work. A method for hazard zone mapping is, for example, investigation of bed load balance from disaster documentation (Figure 1).

FIGURE 1
Bed load balance



TYPES OF STRUCTURE OF SALZBURG'S FOREST TECHNICAL SERVICE

Several structures with different functions combine to form the function chain and make it possible to treat torrent problems individually.

CONCLUSIONS

In managing natural hazards, an integrated view of the habitat and the basins is essential in order to be able to define the problem properly. Deducing an effective control system demands the interdisciplinary cooperation of authorities concerning the problems of a specific region.

The necessary measures derived from the regional survey have to be combined with local measures (each sub-catchment has to be treated individually). For example, the hazard zone maps should be taken into account in land-use planning.

Coordination of regional and local necessities in planning control systems would implement an integrated sustainable watershed management.

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CHAPTER 10
LAND USE AS LAND PROTECTION

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INTRODUCTION

The research project Land Use as Land Protection is being carried out by an interdisciplinary working team, under the supervision of Prof. Giuliano Cannata and in close cooperation with the technical staff of the Volturno Basin National Authority.

Started in July 2000, and now near to conclusion, it is focused on the most appropriate land uses for land protection against floods or landslides.

Giving priority to agriculture and wooded land, it aims to find the way to encourage those land management practices that are expected to be most effective in the prevention of such "natural" disasters, and to discourage those that are not.

In order to provide scientifically sound, as well as relevant to land planners, figures at the basin scale, three Italian case studies, which are well representative of a variety of land-use patterns, environmental concerns and human pressures, are analysed. A simulation model (Topkapi) has been set up to simulate the rainfall–runoff transformation process; a physically based grid cell scale modelling of the hydrological processes allows detailed understanding of the influence of land cover changes on stream flow, by depicting alternative land-use scenarios.

Existing policy tools, legal and institutional constraints and opportunities are analysed in depth at both the European and the national levels; special focus is reserved for those Regional Operative Programme measures that address EU Structural Funds in Objective 1 Regions for land protection, forest management and rural development.

THE PROJECT FRAMEWORK

Assuming the basin scale as the basic unit both for understanding the close connection between land use and water management and for implementing effective land management measures, the major topics addressed are:

- the influence of land-use changes on land protection, and the potential role of some vegetation covers in preventing/mitigating floods or landslides;
- the social and economic feasibility of such actions;
- the multifunctional perspectives of rural development in the framework of the EU Common Agricultural Policy (CAP) reform (Agenda 2000).

According to the last EU communication on Intermediate CAP Revision (COM 394/2002 def.), which aims to consolidate the decoupling processes of rural development by applying the

cross-compliance principle, rural and wooded areas' multifunctional role is expected to become increasingly important in meeting broader environmental targets.

In this context, land-use changes at the basin scale have to be taken into account as a "structural" environmental issue, and should be considered as a strategic tool of watershed integrated management and planning policies.

It is worth noticing that in order to pursue this objective, CAP cross-compliance measures will be reoriented in the framework of Agenda 2000 Intermediate Revision, in order to avoid current subsidy distortions, and the expected reform of Forestry Directive (EC)2158/92 will integrate the key concept of land use as land protection.

In risk-prone areas above all, productive needs and revenues from both forestry and agriculture have to be evaluated and compared with the social benefits arising from risk prevention improvements.

In a preventive, long-term approach, the quality of the vegetation coverage that is faced by erosion agents plays a crucial role. There is an increasing scientific awareness of the high performance of mixed and multi-layered forests in soil protection and surface runoff control. The favourable influence of permanent minimum vegetation coverage and riparian natural areas or parcels scattered among cultivated crops has also been broadly recorded.

Despite its limited, or rather difficult to quantify, role during extreme events, such as flash floods or mudflows, land-use management should address land protection, as it provides alternative solutions to more complex (and often more expensive) restoration measures. Furthermore, it can reduce the recurrence rate of moderate events, as well as prove beneficial to citizen warning systems, by delaying peak flow occurrences.

Disadvantaged rural areas show a clear economic feasibility for the implementation of reforestation and set-aside programmes. In these areas, a closer engagement of farmers in sustainable practices, specifically oriented to land protection, will not only reinforce the community's sense of the interrelations between upstream and downstream settlements, but can also provide alternative incomes, from both the higher environmental value of the landscape and the higher professional qualifications needed to look after renaturation processes.

In these terms, the EU rural development multifunctional perspective can lead to an innovative approach to social cohesion concerns.

THE CASE STUDIES

In order to consolidate and spread scientific knowledge on land-use management as land protection, and to demonstrate the socio-economic feasibility of changes in agricultural and forestry patterns, the following case studies have been selected:

- a flood-prone area, the Dora Baltea Basin, located in northern Italy, in the Piedmont and Valle d'Aosta regions;

- the Bussento Basin, located in southern Italy, and included in the Cilento National Park;
- the Vernotico Basin, located a few kilometres north in the same region of Campania, and affected by landslide phenomena specific to volcanic areas (mudflows).

The *Dora Baltea* valley is a flood-prone area, its headwaters encompassing the highest Alpine peaks of Italy, before flowing into the Po River. In this area, geomorphology, hydraulics and hydrogeology are seriously threatened by both heavy river training works and numerous water abstractions for minor hydropower generation.

In the last decade, two extreme flood events occurred, very heavily damaging settlements, crops and infrastructure and causing casualties. Subsequent structural restoration works have invariably proved inadequate to face the next flood.

We use the term "river training" to refer to all structural engineering works such as levees, weirs, channel straightening, lining, etc.

The alleged purpose is the protection of areas considered vulnerable owing to the human activities that take place on them. One major frequent drawback is the shifting of risk: where floodplains are withdrawn from the river's overflows, floods will become more destructive downstream, owing to the increase in water discharge, energy and speed.

The case study is focused on trying to demonstrate that the recent floods can partly be ascribed to river training, which has artificialized a good deal of the channels, bringing about a change in the basin's hydrologic response to rainfall.

Towards this goal, six major flooding events of the Dora Baltea have been studied relative to contexts both pre- and post-1980s river training works.

The analysis of frequency and examination of the available hydrologic parameters (peak discharge and corresponding rainfall) seem to show that the basin now reacts with a more severe runoff response to precipitation. Some confirmation of these findings has come through the use of a preliminary version of the distributed rainfall–runoff model.

In the framework of a watershed integrated management programme, embankment decommissioning should be better considered, together with the relocation of infrastructure and settlements on floodplains, in order to restore river divagation areas, wherever feasible.

The *Bussento Basin* is characterized by very low population density (a mean of 40 inhabitants per square kilometre) as a result of the emigration processes that occurred in the last century. Associated with a large extent of permanent set-aside crops, the last period of emigration, dated 1950 to 1960, was followed by a broad spontaneous landscape renaturation. Now, 80 percent of land is covered by forests either at, or in spontaneous evolution to, a natural stage, which achieves high performance in land protection.

In 1994, the area was included in the Cilento National Park, to protect and improve its increasing biodiversity. The Cilento Park plan specifically recognized forests' land protection functions as one of its major concerns. Residual wine and oil production must be submitted to sustainable good practice, in line with EU agriculture measures (Cilento olive oil has recently been certified).

Tourism and scientific research plans (a rich endemic entomofauna is present) are now the first source of income for the local population.

The *Vernotico Basin* represents the opposite of Bussento, as it is subject to heavy urban expansion and intensive agricultural production.

Although covering more than 50 percent of the area, forests appear damaged because of intensive forestry (especially logging at too short time spans of 12 to 15 years) and fires. Land protection capabilities are consequently poor. The area is widely affected by landslides, such as the well-known mudflows of Sarno.

The Vernotico Basin is located at the core of national chestnut and hazelnut production areas: owing to its volcanic soils, yields per hectare are ten times the national average values.

In wooded areas, any residual biodiversity is lost. Where current industrial systems of harvesting have taken place, brushes and spontaneous vegetation are continually eradicated. Where traditional harvesting practices are still in use, these are often associated with wood production, which implies abrupt drops in canopy coverage rates. The same occurs with fires: most are located in or close to productive parcels and they appear very frequently. Both phenomena can cause abnormal rises in soil moisture and speed up erosion processes, thus increasing local landslide hazards.

In spite of the national ranking in hazelnut production, the related incomes remain economically marginal for local farmers. A few figures summarize the economic dimension of the actual conflict between current productive practices and revenues, and risk prevention's potential benefits. Farms extend on average for about 1.2 ha each, 80 percent being less than 1 ha and only 1 percent more than 10 ha. Hazelnut production gives an annual income of about €2 500 per hectare. Local forestry incomes are evaluated at about €290/hectare/year: just the same as set-aside EU subsidies.

None of these practices, which spoil forests' and soil profiles' resistance to erosion, is subject to control. Only properties of more than 10 ha are including by the regional Forestry Act in Forestry Assessment Plans. National legislation does not include hazel trees among forest resources. Local planning tools do not consider specific crops the defining features of agricultural areas.

With the support of our project research team, the local basin authority, together with the region of Campania and the Volturno National Basin Authority (based in Naples), are now cooperating to identify the most effective legal and institutional framework to improve the conditions of the area's resistance to landslide hazards.

The aim is to reorient the Regional Operative Programme financial resources towards risk prevention instead of restoration, and to assess beneficial land-use changes on the basis of existing hazard maps.

At the local level, the so called "Consulta", an experimental committee on the model of the United States' Watershed Partnerships, has also been set up. It is formed by stakeholders, representatives of both public and private parties, that are potentially interested (inasmuch as they are present on the territory) in being involved in the new wide-scope and integrated approach to land management, as promoted by the project.

LESSONS LEARNED AND RECOMMENDATIONS

The following statements have been confirmed through the simulations performed so far with the rainfall-runoff model:

- Forests can play a crucial role in flood and landslide prevention (in the Vernotico, a 60 percent rise in annual peak flow is expected in the case of removal of forest coverage).
- Natural and abandoned agricultural areas disseminated in productive agricultural land can increase the risk mitigation capacity, especially when appropriate land management schemes are followed (e.g. buffer strips along watercourses).
- Diffuse non-structural measures such as appropriate land-use management should be preferred to point engineering works along river networks or on hill slopes.

Except for protected areas, all case studies show a very poor degree of integration among different existing policy tools suitable for risk prevention and land protection.

Despite a national Land Protection Act, dated 1989, which puts the integrated management of water and land use at the basin scale under the control of river basin authorities, land protection is still considered a sectoral goal.

There is a lack of integration at the spatial scale among land-use planning tools. There is a lack of coordination regarding the various land uses and sectoral policies implemented, namely agriculture, forestry and water resources management. There is a lack of data at the basin scale to provide geocoded maps of risk hazards, river networks and land use in order to support decision-making. There is also a broader lack of cooperation among institutional levels. Related policy targets often appear to be in conflict, and this must be seen as a reason for land protection policies' poor effectiveness, if not failure, in the face of increasingly frequent "natural" disasters.

Because of their influence on the evolution of national and local legislation, international agreements and EU directives should assume specific land protection targets, and strengthen risk prevention purposes at the basin scale. Watershed integrated management's key concept has to be put into practice as an effective interdisciplinary approach, sharing risk prevention and land protection concerns among different policy fields and encouraging land-use changes towards potential, innovative multifunctional roles.

CHAPTER 11
WATERSHED MANAGEMENT IN MOUNTAIN REGIONS IN BOSNIA AND HERZEGOVINA – A GENERAL OVERVIEW

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HISTORICAL REVIEW

Watershed management has not been completely defined and properly examined in Bosnia and Herzegovina. The greatest lack of information dates back to the Middle Ages period, but the Turkish administration period has not been described and studied attentively either. Some information about water management starts to emerge from the Austria-Hungary administration period. There is much evidence and documentation from this period up until the beginning of the war in Bosnia and Herzegovina in 1992.

Using the time interval development methodology for watershed management (of A. Trumic A. Mikulec), in which both technical praxis and scientific research are considered, watershed management development can be separated into three historical development periods:

- the period until the end of nineteenth century – development and formation based on empirical experience and tradition for each region separately;
- the period until the beginning of the Second World War – new technology application based on scientific approaches, especially from technical science;
- the period beginning at the end of the Second World War – multidisciplinary approaches to concrete technical problems considering the full cooperation of experts from different fields.

None of these periods has particular focus on mountain regions. For each historical development period there exist management elements from mountain regions, but these are part of general management and use concepts. User, organizational and management elements of watershed activities in mountain regions can be separated by detailed expertise.

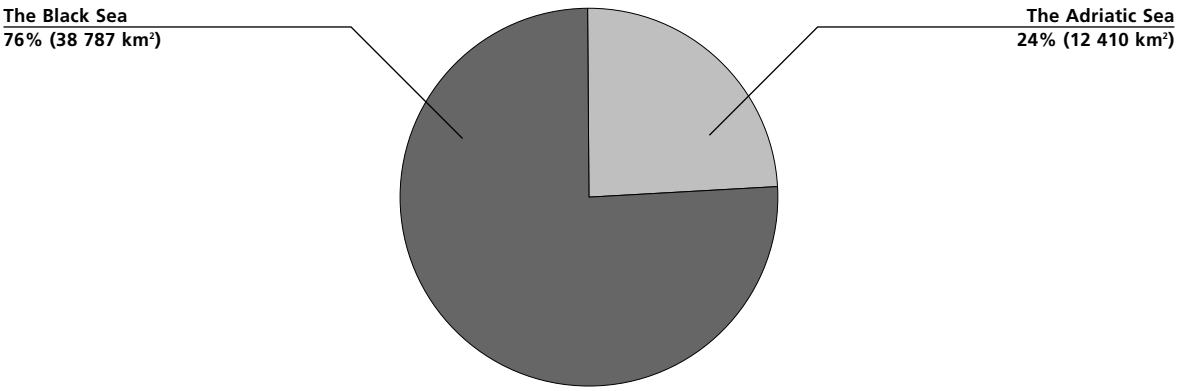
The first two historical development periods were characterized by intensive activities in a wide range of watershed problems related to multipurpose uses.

The last three decades have been characterized by scientific research with the main focus on a definition of wastewater and an evaluation of research carried out on rocky soil and karst. The water protection plan was completed in the last decade of the twentieth century.

GENERAL CHARACTERISTICS OF BOSNIA AND HERZEGOVINA

Bosnia and Herzegovina is located between 42° 26' and 45° 15' latitude north and 15° 45' and 19° 41' longitude east. Geomorphologically it is a complex of mountain and hilly areas with Perpanonic planes. It is a southeastern European country in the Mediterranean region and included in the Balkan Peninsula. Hydrological river basins (watersheds) in Bosnia and Herzegovina belong in the Black Sea and the Adriatic Sea watersheds.

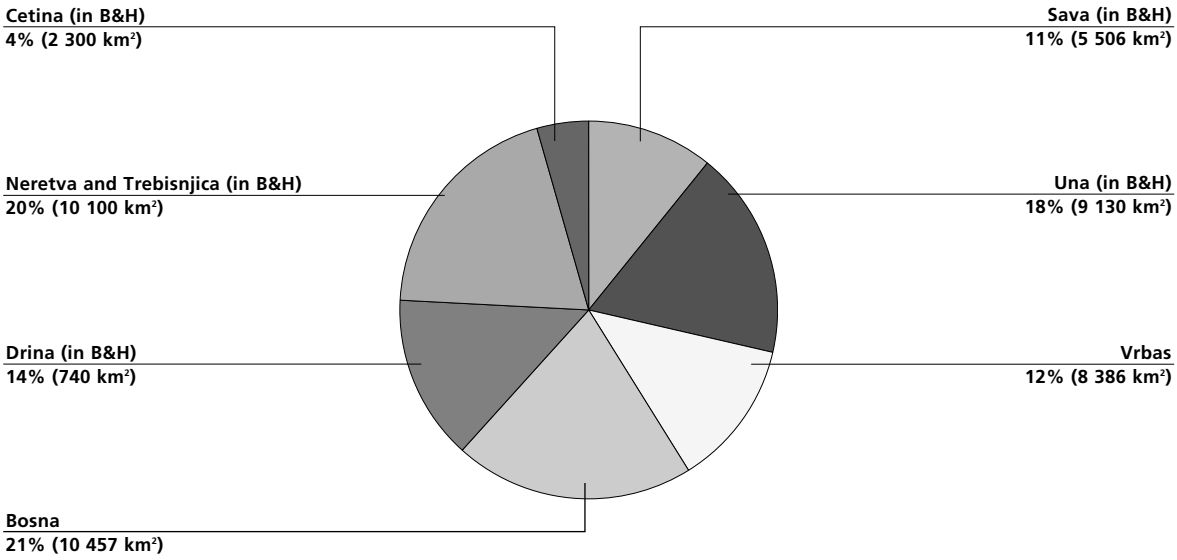
FIGURE 1
Bosnia and Herzegovina's watersheds



The total area of Bosnia and Herzegovina is 51 197 km², with 51 percent in mountain regions. The mountain regions range from 700 to 2 386 m in altitude. Of the total area of Bosnia and Herzegovina, about 38 790 km² (75.76 percent) belongs to the Black Sea watershed and about 12 410 km² (24.24 percent) to the Adriatic Sea watershed (Figure 1).

The total area of Bosnia and Herzegovina is separated into eight river basins (Figure 2):
the Sava river basin, the Una with the Korana and the Glina river basin, the Vrbas river basin, the Bosna river basin, the Drina river basin, the Neretva river basin, the Trebisnjica river basin, the Cetina river basin.

FIGURE 2
Bosnia and Herzegovina's main river basins



The Neretva and Trebisnjica river basins are usually considered and presented together.

The important characteristic of the water system in Bosnia and Herzegovina is that huge parts of watershed belong to the international watershed category. These parts mainly represent the country's borderlines. Only the Vrbas, the Bosna and the Ukrina river basins belong entirely to the Bosnia and Herzegovina area (43 percent of total area).

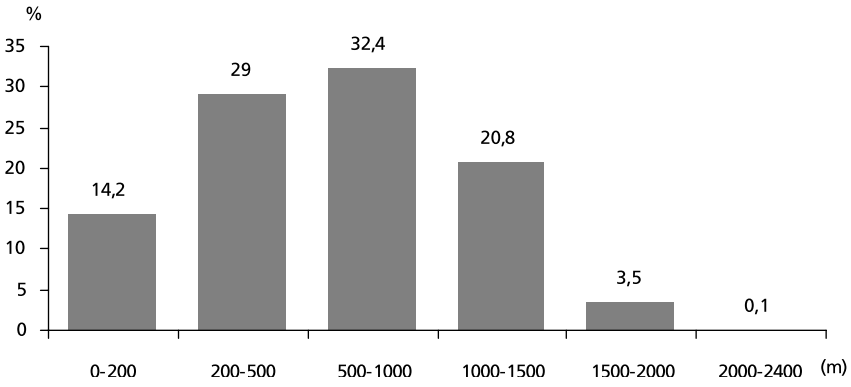
The hydrologic regime in Bosnia and Herzegovina is defined according to geological, topographical, orographic, climatic and other factors, such as water basin area, water basin shape and the type and conditions of vegetation. Some other factors are permanent, such as morphology and hydrogeology. Water basins are also influenced by some periodical events causing important deviation from expected hydrology regime characteristics. It could be concluded that in Bosnia and Herzegovina the hydrologic regime is influenced by complex factors expressing variety and differences in space and time.

The mountainous region, especially its specific form and character, evolved under morphological and hydrological conditions. The present form of this region is modelled mostly by erosion. The high mountain zones are almost exclusively of limestone-dolomite formation. The northern and internal parts of the Dynaride system consist of very split and different, low and medium-height mountain formations with upper altitudes of about 1 500 m. Upper belts of the middle mountains (1 000 to 1 500 m) present the most important forest resource zone with the most attractive landscape. The central and the Mediterranean parts, such as the southeastern external part of the Dynaride system, consists of high limestone-dolomite sediment mountains (1 500 to 2 386 m) modelled predominantly by tectonic movements and water erosion. They are closely connected, and mountains are separated only by river courses. Vertical differentiation in the mountain region is at its greatest around the

Black Sea and the Adriatic Sea watershed lines, while horizontal differentiation is least in limestone-dolomite massifs. The rocky mass character causes extreme inclination in crags and crossing between karst areas and high reefs. The mountain massifs' position and their entangled geological character are influenced by very diverse climate elements, which cause a wide spectrum of natural phenomena. This is the zone with the greatest natural diversity. In the south and Mediterranean parts of Bosnia and Herzegovina there are karst zones, which represent a specific zone in mountain regions of this part of southeastern Europe.

Bosnia and Herzegovina has altitudes ranging from sea level to more than 2 386 m. Most of the territory lies in areas of 500 to 1 000 m altitude. The height ranges are shown in Figure 3.

FIGURE 3
Height categories of mountains in Bosnia and Herzegovina



Relief development, geologic structure, pedologic structure, plant cover, land uses and climate conditions are a base for flood and erosion focuses. Extreme erosion processes appear on steep south and southwest expositions, where temperature differences are the greatest and kserotermical conditions lead to the weakest soil protection. In these conditions, especially in the summer, surface flow is about 60 percent of total precipitation. Erosion processes cover about 45 574 km^2 (89 percent) of the total area of Bosnia and Herzegovina. Erosion processes caused by water and wind are more intensive then those caused by geological erosion. Recently, 935 floods have been registered on a surface area of 12 969 km^2 (25.4 percent) of Bosnia and Herzegovina. The annual production of erosion alluvium is about 16 518 030 m^3 or 323 m^3/km^2.

Hydrological status in Bosnia and Herzegovina is based on geomorphologic and hydrogeologic elements. Position and altitude relations, the Dynaride system barrier (and the Alps' influence) influence wet air mass circulation from the Mediterranean and the Atlantic. The south and southwest part of the country is characterized by specific karst hydrology and huge underground retention hydrology potential. This zone is a major part of the high mountain massifs of Bosnia and Herzegovina.

Total forested area in Bosnia and Herzegovina is 2 708 507 ha, with a mountain forest area of about 70 percent (1 895 955 ha). The most important and most present species are native, mixed, uneven-aged high beech, fire and spruce forests. Forest category structure is given in Table 1.

TABLE 1
Forest category structure

Category	Area structure (%)
High forests	47. 4
Low forests and brushes	34.0
Forest terrain	14.6
Non productive	4.0
Total	**100. 0**

This situation, including border contacts with hydrogeologic insulators, is the most important source of rivers.

HYDROLOGIC CHARACTERISTICS

The Black Sea watershed

The Sava river basin. The whole Sava river basin is in the Black Sea watershed. Homogeneous drain out is identified on a large area of this river basin.

Exceptions are the karst areas belonging to the Una, the Sava, the Pliva, the Vrbas and some small river basins. The figures for surface areas and percentage of karst areas in the Black Sea watershed are presented in Table 2.

TABLE 2
The karst area distribution

River basin	Area (km^2)	Karst (%)
Una	9 368	24.4
Vrbas	6 386	17.4
Bosna	10 457	0.8
Drina	19 946	4.2

The Una River basin. The headwater of the Una River consists of many karst sources in mountain regions located in the Sator mountain and south of Martin Brod town. The Una has a characteristic snow–rainwater regime. It has high spring and autumn flows, with frequent high winter flows as well. The summer is characterized by low water flow.

The Vrbas river basin. The source of the Vrbas River is located in a mountain massif named the Vranica in the central part of Bosnia and Herzegovina. The Vrbas water basin is mainly in the west part of Bosnia (the central part of the Dynaride system). The river drains mountain

massifs up to Krupa town. South and west parts of the water basin are located in karst zones. The Vrbas River has a pluvial–snow water regime. It is characterized by high spring and autumn flows. Winter and summer water flows are low.

The Bosnia river basin. The headwater of the Bosna River is a strong karst source in the foothills of Igman mountain. The Bosna water basin includes central parts of Bosnia. The course of the Bosna River is directed northwards, following the decreasing altitude of medium-height Bosnian mountains. The Bosna River has a pluvial–winter water regime. It has high water flow levels in spring and lower water flow in autumn. It is characterized by low flow levels in summer and winter.

The Drina river basin. The Drina River consists of two smaller streams, the Piva and the Tara, appearing at the border with Montenegro. The Drina water basin surrounds central parts of the Dynaride system. It has a pluvial–snow regime. It has important high spring water flows caused by snow melting, and high autumn water flows caused by autumn rains. Summer and winter water flows are low.

The Adriatic Sea watershed

This is an area with strong karst character, but important surface watercourses originate here. Two water basins are dominant: the Neretva river, with the Trebisnjica river basin; and the Cetina river, with the Krka river karst water basin.

Underground water flows in karst zones differ from those in other geological substrata. It is difficult to define underground water flow principles precisely, but significant differences can be noticed in relation to some hydrologic parameters between karst and non-karst water basins.

The Neretva river basin. The Neretva River has its headwater in the Zelengora mountain. The Neretva River drains out a karst area of almost 250 km total length. This is the greatest water reach of any river in a karst zone in Bosnia and Herzegovina. It is connected to the Trebisnjica River by underground flows from a surrounding surface area of about 1 250 km^2.

The Trebisnjica river basin. A strong karst spring near Bileca town forms the source of the Trebisnjica River. This is a typical karst river, whose surface water disappears in karst underground gradually. West of the karst field Popovo polje, the Trebisnjica River sinks underground completely.

The Neretva and Trebisnjica river basins have the most important hydroenergy capacities in Bosnia and Herzegovina.

The Cetina and Krka river basins. Water basin parts of the Cetina and Krka rivers belonging to Bosnia and Herzegovina are located in west Bosnia karst fields (Kupresko, Glamocko, Duvanjsko and Livanjsko) positioned in a mountain region zone of between 700 and 1 300 m altitude.

CLIMATE CHARACTERISTICS

As part of southeastern Europe, Bosnia and Herzegovina has dynamic changes of climate elements in a geographically small area. The annual air temperature course is characterized by warm summer and cold winter periods. The annual precipitation course is characterized by a strong influence from the Azores and Atlantic cyclone fields.

According to geographical specifics, climate conditions are separated into three distinct types:
- south and southwest part – modified Mediterranean climate with maritime influences (Mediterranean part);
- central parts and mountain zones – continental and mountain climate with sub-alpine elements in the highest mountain parts (mountain and sub-Alps part);
- north Bosnia and Perpanonic plane – temperate zone and middle European climate, with cannoning climate influences (north Bosnia and the Perpanonic plane part).

The Mediterranean part

The Mediterranean part surrounds the south and southwest part of the karst and mountain zones. Mid-January temperatures reach up to 4.8 °C and mid-July temperatures exceed 24.0 °C. Annual precipitation is in the range of 1 000 to 1 500 l/m^2. The lowest level of precipitation is in August, with about 30 l/m^2, and the highest is in the periods September to December and February to April, with about 150 l/m^2. The main maximum is in December, with more then 160 l/m^2.

The mountain and sub-Alps part

The mountain and sub-Alps part includes the central part, with altitudes from 700 to more than 2 000 m. It is characterized by a modified continental climate, with strong influences of mountain and sub-Alps climates. The main characteristics of this climate type are sharp winters with January temperature of -3.4 °C and hot summers with maximum July temperature of 36 °C. The minimum average temperature in January is about -6.8 °C, and maximum average temperature in July is about 18.7 °C. The annual average precipitation is about 1 200 l/m^2, with an average maximum of 94 l/m^2 in November and an average minimum of 67 l/m^2 in February. Snow precipitation is very abundant in mountain regions of this climate zone.

The north Bosnia and Perpanonic plane part

The north Bosnia and Perpanonic part includes north and northeastern Bosnia and Herzegovina. Here there is a temperate continental climate with strong influence from the Pannonian climate. The main characteristics are warm summers and mild winters. Winter and summer temperatures rise from west to east. Average minimums in January are below zero, decreasing to -7.4 °C. The northeastern part is the warmest, with average maximum in July of about 21 7 °C. This area has the lowest average annual rainfall with a maximum of 800 l/m^2.

WATER DISTRIBUTION

The annual rainfall in Bosnia and Herzegovina is about 1 250 l/m^2. This is about 64 x 10^9 m^3 (2 030 l/s) water for the whole area. About 1 155 m^3/s, or on average 57 percent of total rainfall is delivered from Bosnia and Herzegovina. Water quantities are not distributed uniformly in time and space (Table 3).

TABLE 3
Rainfall distribution

Water area	Area (km^2)	Length of water flow longer than 10 km	Number of inhabitants (1991)	Average flow (m^3/s)	Biological minimum (m^3/s)
Sava river basin	5 574	1 693.2	635 353	63	1.5
Una river basin	9 130	1 480.7	620 373	240	41.9
Vrbas river basin	6 386	1 096.3	514 038	132	26.3
Bosna river basin	10 457	2 321.9	1 820 080	163	24.2
Drina river basin	7 240	1 355.6	422 422	124	24.1
Black Sea watershed	38 787	7 947.7	4 012 266	722	118.0
Neretva and Trebišnjica river basins	10 110	886.8	436 271	402	56.5
Cetina river basin	2 300	177.0	79 089	31	1.8
Adriatic Sea watershed	12 410	1 063.8	515 360	433	58.3
Bosnia and Herzegovina	**51 129**	**9 011.5**	**4 527 626**	**1 155**	**176.3**

Water from about 76 percent of the total area of Bosnia and Herzegovina flows off into the Black Sea watershed. The rest, about 24 percent, flows off into the Adriatic Sea watershed. The Sava river basin delivers about 62.5 percent (722 m^3/s) of total water, and 37.5 percent (or 433 m^3/s) of total water flows off in the Adriatic Sea watershed. The Neretva and Trebisnjica rivers have the highest water quantity. The lowest water quantity is from the Sava river basin.

Considering water supply and number of inhabitants, the most difficult situation is in the Bosna river basin. The Bosna river basin covers about 20.4 percent of the total area of Bosnia and Herzegovina, but about 40.2 percent of the country's total inhabitants live here. In this region, water flows are about 14.1 percent of total water quantity. Some small negative differences appear in the Sava direct river basin.

The situation is completely different in the Neretva and Trebisnjica river basin. The Neretva and Trebisnjica river basin covers about 19.8 percent of the total area of Bosnia and Herzegovina, but has only about 9.6 percent of total inhabitants. Water flows are about 34.8 percent of total water quantity.

In the other river basins, these relations are more or less equal, especially in the Vrbas river basin. The data regarding water supply are presented in Table 4.

As well as river basins there are also many natural lakes of different types and hydrological importance. These lakes can be categorized as permanent or temporary. Permanent lakes are river and mountain lakes. The temporary lake category contains hydroenergy and economic potential lakes.

TABLE 4
Relative water supply

Water area	Average specific flow		Biological specific minimum	
	From area Qaver./A (l/s/km2)	**From inhabitant Qaver/inhab.** (l/s/inhab.)	**From area Qbm/A** (l/s/km2)	**From inhabitant Qbm/inhab.** (l/s/inhab.)
Sava river basin	11.44	0.099	0.272	0.002
Una river basin	26.29	0.387	4.589	0.067
Vrbas river basin	20.67	0.257	4.118	0.051
Bosna river basin	15.59	0.089	2.314	0.013
Drina river basin	17.13	0.293	3.329	0.057
Black Sea watershed	18.65	0.180	3.048	0.029
Neretva and Trebišnjica river basin	39.76	0.921	5.588	0.129
Cetina river basin	13.48	0.392	0.782	0.023
Adriatic Sea watershed	34.89	0.840	4.698	0.113
Bosnia and Herzegovina	**22.59**	**0.255**	**3.448**	**0.039**

Water balance

Climate parameters of evaporation and evapotranspiration have been registered at a small number of meteorological stations in Bosnia and Herzegovina. Table 5 shows potential evapotranspiration (PET), real evapotranspiration (RET) and evaporation (E) figures from different meteorology stations.

TABLE 5
Climate parameters from different meteorology station

No.	Meteorology station	River	Rainfall (mm)	PET(T) (mm)	RET(T) (mm)	E from water surface (mm)
1	Sarajevo	Bosna	913	553	470	691
2	Zenica	Bosna	776	576	490	720
3	Doboj	Bosna	870	588	500	735
4	Tuzla	Bosna	895	571	485	714
5	Modrića	Bosna	795	585	497	731
6	Derventa	Sava	906	569	488	711
7	Orašje	Sava	720	615	523	769
8	Foča	Drina	938	572	486	715
9	Goražde	Drina	798	557	473	696
10	Višegrad	Drina	732	588	500	735
11	Zvornik	Drina	912	588	500	735
12	Bihač	Una-Sana	1 306	584	796	730
13	Prijedor	Una-Sana	913	591	502	739
14	Sanski most	Una-Sana	1 024	584	496	730
15	Ključ	Una-Sana	1 069	581	494	726
16	Bugojno	Vrbas	828	534	454	688
17	Jajce	Vrbas	914	570	485	713
18	Banja luka	Vrbas	1 026	582	495	728
19	Konjic	Neretva	1 509	611	519	764
20	Jablanica	Neretva	2 012	618	525	773
21	Mostar	Neretva	1 513	718	610	898
22	Livno	Cetina	1 143	536	456	670
23	Glamoč	Cetina	1 413	493	419	616
24	Kupres	Cetina	1 204	465	395	581
25	Čemerno	Trebišnjica	1 817	455	387	569
26	Gacko	Trebišnjica	1 720	516	439	645
27	Bileća	Trebišnjica	1 633	632	537	790
28	Trebinje	Trebišnjica	1 837	688	585	860

Owing to the low number of available data, these parameters are determined using the Thorntweith method. For climate conditions in Bosnia and Herzegovina the following relation between real evapotranspiration and potential evapotranspiration is used:

$$RET = 0.85 \times PET$$

Considering this relation, RET values are about 85 percent of PET. So, evaporation from free water surface is higher than PET by about 25 percent:

E = 1.25 x PET

PET ranges from 387 mm (the Cemerno meteorology station) to 610 mm (the Mostar meteorology station).

Water quality

In Bosnia and Herzegovina there are hard and very hard water types. Water quality decreases significantly during the summer period, with minimal water flows on one side and increasing water needs and quality on the other.

Water quality has been determined for 58 profiles. In the last five years, water quality has been in the expected range in almost all profiles. The worst results were registered in the Bosna river basin, the Vrbas river basin near cities Jajce and Banja Luka, the Sana empty, and downstream of the Sana empty. The Una has the highest hardness and alkalinity.

WATER REGIME EVALUATION LEVEL

Globally, the present status of the water regime evaluation could be considered as satisfactory. Serious problems were caused during the war in 1992 to 1995, which destroyed basic hydrological documentation and the results of basic hydrological analyses.

Now, one of the priorities is reconstructing the destroyed documentation and hydrological observations. In addition, more studies need to be conducted to determine:

- balance and water regimes for small and medium-sized river basins (watersheds);
- balance and water regimes in mountain regions and planes;
- extreme flows;
- in and out water quantity distribution for each year and periodically;
- underground water regimes, underground water zones, underground water communications (especially in karst);
- comparative analyses of hydrologic events in the most important river basins (watersheds) in the Black Sea and Adriatic Sea watersheds.

ANNEXES

ANNEX A
OPENING REMARKS: FAO STATEMENT

Moujahed Achouri
FAO

I am pleased and honoured to address you on behalf of the Food and Agriculture Organization of the United Nations (FAO) at the opening of this important workshop. Taking this opportunity, I would like to thank you all for your presence and participation in this major event dealing with watershed management's past, present and – mainly – future perspectives. I would like also to extend my thanks to the organizers of the International Conference Water In Mountains: Integrated Management of High Watersheds for their support and assistance for the organization of this workshop. Also, to extend special thanks to the organizing secretariat and to the Megève authorities concerned for their assistance and hospitality.

WHY A FOCUS ON WATERSHED MANAGEMENT?

The conservation, use and sustainable management of watershed resources to meet the demands of growing populations have been a high priority of many countries in the world for the past several decades.

In this respect, integrated watershed management through people's participation has become widely accepted as the approach that ensures sound sustainable natural resources management and a better agriculture economy for upland inhabitants, as well as for people living in downstream areas.

Integrated watershed management was also recognized as a suitable approach to address poverty and the need for food security of upland populations, as well as of people living downstream. Watershed management integrates various aspects of forestry, agriculture, hydrology, ecology, soils, physical climatology and other sciences to provide guidelines for choosing acceptable management alternatives within the social and economic context.

Chapter 13 of UNCED Agenda 21, for which FAO is the United Nations Task Manager, stresses that "Promoting integrated watershed development programmes through effective participation of local people is a key to preventing further ecological imbalance. An integrated approach is needed for conserving, upgrading and using the natural resource base of land, water, plant, animal and human resources".

WHY WE ARE HERE

Although much progress has been achieved in watershed management, no clear picture has been drawn of what has really been working and what can be done to improve future watershed management programmes. Therefore, an in-depth analysis of watershed

management achievements and existing gaps was identified at FAO as a prerequisite to further development of watershed management programmes.

In addition, a number of key issues of major concern to watershed management development are raised. Issues related to participatory processes, technologies and desired results, sustainability and replicability, institutional/organizational and legislative arrangements and required policies and strategies are raised as requiring in-depth analysis.

In this respect, it was proposed to review and assess watershed management activities, with the intention of providing reliable information on lessons learned and existing gaps. The following major steps were identified as necessary for the proposed review and assessment of watershed management activities: 1) stocktaking exercise; 2) case studies analysis; 3) regional workshops; and 4) dissemination of results.

The present workshop conducted as the European Regional Workshop Preparing the next generation of watershed management development programmes is the first one of a series of regional workshops scheduled to take place in the Arab Republic of Syria, Argentina and Kathmandu. These workshops are seen as an important step of the initiated review in providing an opportunity to watershed management interest groups all over the world to exchange and discuss achievements and existing gaps in watershed management and to identify innovative approaches and strategies for watershed management future programmes.

WHAT ARE THE EXPECTED RESULTS?

Involving many experts and institutions dealing with watershed management, it is expected that – in addition to outlining the state of the art of watershed management in Europe – the findings of the workshop will contribute in providing the required advocacy and support for the implementation of effective watershed management at the local, national and regional levels.

The workshop findings will also contribute to the follow up of the International Year of Mountains and in achieving the expected results of the International Year of Fresh Water.

Finally, I would like to thank all of you who have contributed to making this workshop a reality. Also, to underline that we look to you all for your ideas, experiences that will help in developing appropriate policies, and strategies for future watershed management programmes.

ANNEX B
WORKSHOP PROGRAMME

WEDNESDAY, 4 SEPTEMBER

09.00 - 10.00 **Session 1: Welcome address and overview presentation**
Chair: Pierre Lachenal; rapporteur: Josef Kreček

Pierre Lachenal, Director, Société d'Economie Alpestre (SEA), Haute Savoie
Pier Carlo Zingari, Director, European Observatory of Mountain Forests (EOMF)

Introduction and overview presentation: Moujahed Achouri, FAO/FORC, Forestry Department

10.00–10.15 *Coffee break*

10.15–13.00 **Session 2: Presentation/discussion of technical papers**
Chair: Maria Luisa Baracchini; rapporteur: Gernot Fiebeger

Larry Tennyson, *Findings of the stocktaking exercise*
Josef Kreček, *Overview of achievements and perspectives of the FAO/EFC/W.Party*
Pier Carlo Zingari *Effective watershed management: a European perspective*
Sten Folving and Maria Luisa Paracchini, *Catchment management at the European level: contribution from the Joint Research Centre (JRC) of the European Commission*
Lalit Mandalia, *The UNESCO-IHP contribution*
Einar Beheim, *The experience of Norway*
Carmen de Jong, *Neglected aspects of watershed management*
Michaela Leitgeb, *Integrated watershed management on a large-scale base*
Remo Tomasetti, Chief ASSM, Trento, Italy
Izet Čengić and Azra Cabaravdic, *Watershed management in mountain regions in Bosnia and Herzegovina – a general overview*

13.00–14.30 *Lunch (at the Congress Centre)*

14.30–15.00 Alessandra Valentinelli, *Land use as land protection*

15.00–16.00 **Session 3 : Group discussions, conclusions and recommendations**
Chair: Jean Francois Donzier; rapporteur: Jeff Sayer

Working Groups

Group 1 *- Innovative approaches/methodologies to effective watershed management, with special focus on the conservation and sustainable use of water resources*
Facilitators: Einar Beheim and Moujahed Achouri; rapporteur: Pier Carlo Zingari

Group 2 *- Appropriate strategies for meaningful research and linkages between research and implementers; and strategies/approaches for technology transfer and dissemination (e.g. global networking)*
Facilitators: Lalji Mandalia and Larry Tennyson; rapporteur: Philip Bubb

Group 3 *- Innovative approaches/methodologies to effective watershed management, with special focus on economic and social considerations*
The participatory process, policy and legislation, environmental services, onsite and offsite benefits and other elements relevant to conservation and sustainable use of water resources.
Facilitators: Luca Fe d'Ostiani and Carmen de Jong; rapporteur: Jean Bonnal

16.00–16.15 *Coffee break*

16.15–17.30 ***Group discussions (continued)***

17.30–19.00 ***Plenary***
Reports from working groups and discussion
Conclusions/wrap-up and closing remarks

ANNEX C
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