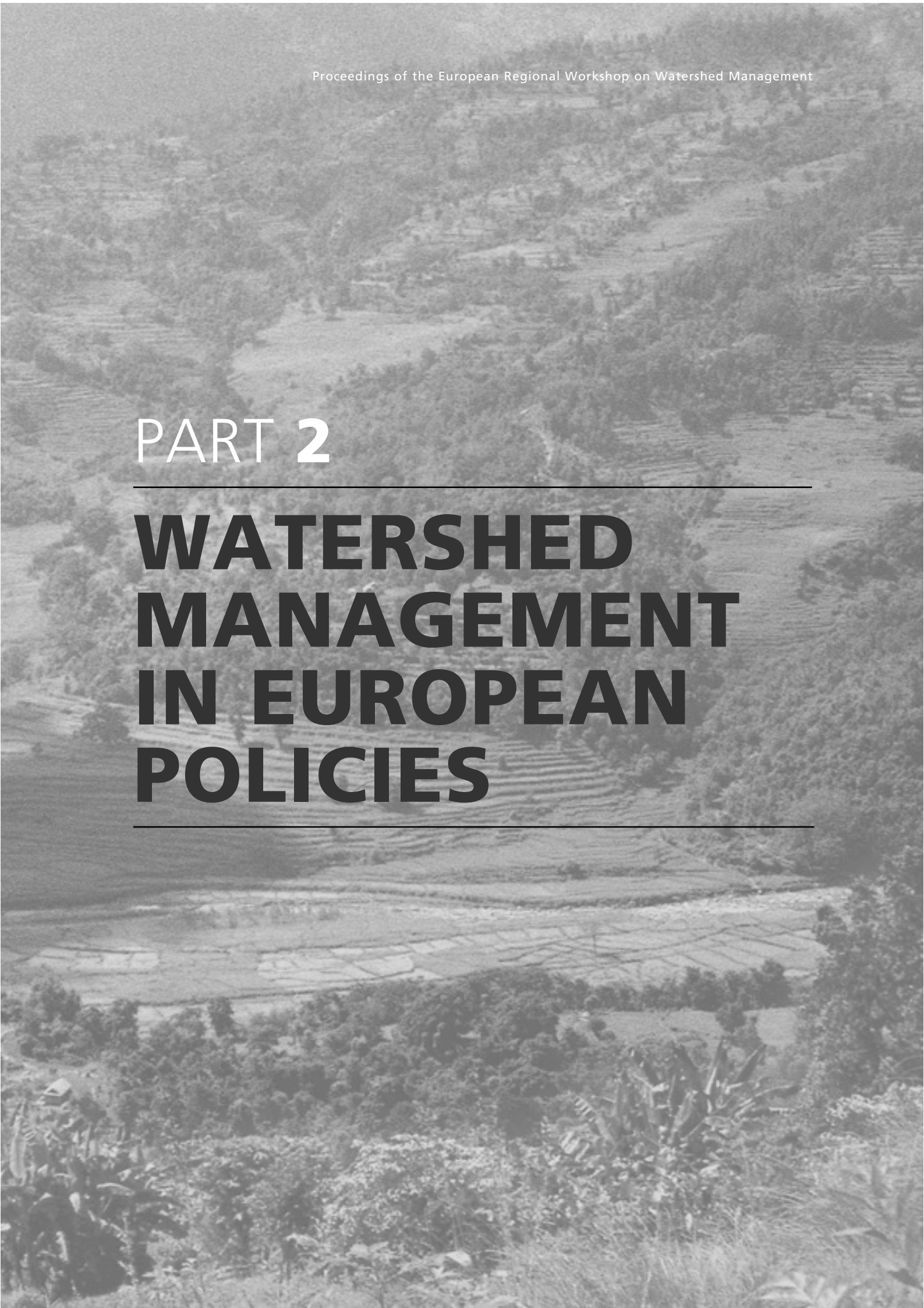

PART 2

WATERSHED MANAGEMENT IN EUROPEAN POLICIES

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

Josef Kreček
President, FAO/EFC Executive Committee
Working Party on the Management of Mountain Watersheds

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

Pier Carlo Zingari
Director, European Observatory of Mountain Forests

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

Maria Luisa Paracchini and **Sten Folving**
European Union Joint Research Centre

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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1. Working group leader: Jürgen Vogt (juergen.vogt@jrc.it), JRC/IES Land Management Unit
2. Working group leader: Anna-Stiina Heiskanen (anna-stiina.heiskanen@jrc.it), JRC/IES Inland and Marine Waters Unit
3. Contact person: Giovanni Bidoglio (giovanni.bidoglio@jrc.it), JRC/IES Soil and Waste Unit

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.

5. Workpackage Manager: Roland Hiederer (Roland.Hiederer@jrc.it), JRC/IES Land Management Unit

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

6. Floods Work Package Manager: Ad de Roo (Ad.de-Roo@jrc.it), JRC/IES Land Management Unit
7. JRC contact persons: G. Bidoglio (giovanni.bidoglio@jrc) and N. Murray (for the coastal part) (nicholas.murray@jrc.it)

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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