

Preface

History preserves the name of George Kovacs as an outstanding international hydrologist who made a broad spectrum of scientific contributions in hydrology and was President of the International Association of Hydrological Sciences (IAHS) from 1983 to 1987. To commemorate his outstanding role in the international hydrological community, the UNESCO International Hydrology Programme (UNESCO/IHP) and IAHS have jointly organized a series of colloquia that are traditionally held at UNESCO's Paris headquarters, just before the IHP Intergovernmental Council. These colloquia are named after George Kovacs.

The IHP was initiated by UNESCO in 1975. One year later, in 1976, UNESCO in cooperation with the World Meteorological Organization (WMO) and the Bulgarian National Committee for the IHP organized a workshop on the water balance of Europe. In the general report of this workshop, George Kovacs underlined¹: *In our days water became one of the most important raw materials energy carrier and environmental factor in the society, the limited availability of which may considerably hinder the socio-economic development of many regions. The carefully planned management of the resources is, therefore, an indispensable requirement and this activity needs the complete knowledge of the characteristic parameters (quantity, quality and energy content) of water resources.*

This book contains the papers presented by the invited key-note speakers at the ninth Kovacs Colloquium: *River Basins – from Hydrological Science to Water Management* that, in part, returns to the fundamental questions highlighted by George Kovacs. The papers, in a way, also reflect the drift of the IHP's thematic foci during recent years. Initially they were devoted to a better understanding of hydrological phenomena across the full range of space–time scales, then moved to the questions of sustainability and vulnerability of water resources, and finally to societal issues and water management. The current IHP thematic focus is *Water Dependencies: Systems under Stress and Societal Responses*. Readers will realise that the significant theoretical developments and the emergence of information technology are competing with the increasing pressure on the availability and management of water resources, which have oscillated during recent decades, so there is a need to widen the scope of questions so as to embrace the human dimension and climate change.

All of us live in a river basin, even if we live far from a river. All our actions affect water quantity and quality far downstream. Whatever happens to surface water or groundwater on a given scale of the river basin influences its other scales. The majority of water that discharges from the basin outlet originated from precipitation over the basin, thus the river basin is a logical hydrological unit for studying water fluxes within the hydrological cycle. If water is diverted out of its downstream course in one part, its absence will be detected elsewhere, Pollutants are carried along water pathways down to the river basin outlet, affecting the ecological processes and disturbing the natural balances en route. Overall, this means that a river basin is coherent with the definition of an ecosystem in which all things, living and non-living, share a common water body and thus are interconnected and interdependent.

Historically, river basins have been important in determining boundaries, especially in those regions with important trade by water. Nowadays, being coherent entities in a hydrological sense, the individual river basins in many countries have become a basic territorial division of water resources management. Most countries have their own laws regarding river basin management. These environmental laws often impose the planning and actions that agencies

¹ *Water Balance of Europe*; General Report of Workshop on the Water Balance of Europe, Bulgaria, 27 September–2 October 1976; Publ. SC-76/CONF.807/COL.2, 1976.

have to take in managing the river basins. This book proposes to improve not only the understanding of river basin hydrological functioning, but also emphasizes the importance of public involvement for effective river basin protection and water resources management.

The first contribution in this book is written by Jean-Pierre Villeneuve, Sophie Duchesne, Jean-Pierre Fortin and Alain N. Rousseau and is entitled: *From watershed hydrology to integrated watershed management*. The authors present hydrology as currently practiced as a science essentially based on mathematical modelling. First they provide a detailed and well illustrated overview of the evolution of hydrological modelling over the past four decades, giving particular attention to the fact that water quality and decision-making tools are now included in watershed modelling. Then they emphasize that further development of Geographical Information Systems (GIS) and satellite data would allow the heterogeneity of watersheds to be better taken into account; this is of a particular interest for improved evaluation of development scenarios in the context of integrated watershed management. Finally, by using the example of the GIBSI model, the authors discuss the causes of the success obtained in applying integrated management concepts in Quebec (Canada) and argue the importance of such management philosophy implementation.

Giselher Kaule and Hans-Georg Schwarz-V. Raumer, in *Bridging the gap between knowledge and policy action: land use is the key – confidence is the condition* stress that, in spite of significant advances in numerical hydrological modelling, policy implementation in river basins is not a reflection of model results. It is mainly forced by natural hazards that make the influence of global changes visible on a local scale. Recalling their personal experience, the authors describe the process of confidence building between the policy administration and scientists as a long-term professional alliance based on the permanent confirmation of research results by reality. The authors emphasize that not only excellent scientific results, but also their coherent presentation is necessary to move from environmental knowledge to policy action. Land-use intensity can be modified over a relatively short period of time, thus Kaule & Raumer argue, and demonstrate with two projects, that the visualization of results would be most advantageous with the help of the integration of hydrological and land-use modelling in a scenario approach. They suggest future development of new types of projects and cooperation structures, whose duration would allow the time required for confidence building.

In *An overview of water resources systems modelling in South Africa*, Caryn Seago and Ronnie McKenzie present approaches, methodologies and new technologies successfully developed during recent decades for the planning and operation of water resources in the context of an arid to semi-arid country. The authors recall that the modelling system for water resources includes different steps, such as the generation of stochastic hydrological time series, in addition to the measured data or the determination of system response. The modelling system finally includes analytical decision-making tools that facilitate the planning of water resources to satisfy the increasing demand by an optimization of water use. The authors argue that, because of their integrative powers, predictive abilities and demonstration utilities, such decision-making tools could play a major role in the operations of all water management areas. This has a practical advantage in the context of the establishment of Catchment Management Agencies (CMAs) and the development of new catchment management strategies influencing the practice of water resources analysis. Seago & McKenzie conclude that the modelling of the Water Resources System in South Africa is comparable with the best practices worldwide, thus could be successfully implemented in other countries facing similar water resources problems.

In *Knowledge Management of water resources in El Salvador*, Ana Deisy López Ramos discusses a recent discipline devoted to improving the attitudes and practices at different levels of human society, in order to be more accurate in the decisions taken and the corresponding actions. The author explains a wide variety of concepts related to Knowledge Management, but

underlines that the common perception of Knowledge consists of a continuous process of space–time data acquisition, data transformation into information by data analysis, and the dissemination of this information. She applies this discipline to water resources in the context of El Salvador where the recent civil war has made the process of data acquisition and analysis a real challenge. The lack of complete historical data series makes it difficult to conduct studies predicting the behaviour of river basins and water availability. The important steps that have been taken in order to improve the knowledge about the national water resources are described; it includes not only the gathering of the information about the main components of the hydrological cycle and the influence on them of human activities, but also the measures to ensure that this information will be used by the decision makers. The author concludes that Knowledge Management would help to improve the sustainability of water resources in El Salvador.

Lucia Ana Varga, Daniela Radulescu and Radu Drobot in *Romanian national strategy for flood risk management* describe how, in accordance with the EC Directive on the assessment and management of flood risks and in order to reduce the risks of flooding impacts, the Romanian Government proposed a National Programme on Flood Prevention, Protection and Mitigation. They explain how this Programme provides the principal information for preliminary flood risk assessments and flood hazard mapping. They detail the main steps of the scientific approach and technical measures in setting up the National Programme at the river basin level. The projected outcome of this Programme is the integration of different protective measures in the Romanian River Basin Development and Management Master Plans. While the proposed measures will depend on regional development strategies and community interests, the authors give particular consideration to the incorporation of the requirements of the EC Directive to ensure harmonisation of the whole process during the planning phase.

The ability of “natural” (i.e. uninfluenced by humans) river basins to maintain the natural quantity and quality of water is discussed by Elena Asabina in *Sustainable water management by maintenance of the natural environment in river basins*. She proposes studying the quantity and quality of water by evaluating the natural conditions of the river basin environment. It is unusual to estimate the natural river basin environment’s role as a component of the whole biosphere, which is responsible for maintaining the global hydrological balance. The author emphasizes that the destruction of the natural environment of a river basin may lead to disruption in renewable water supply. For individual river basins all over the world, the author compares the estimates of water supply obtained for 1995 and those projected to 2025. She argues that a situation could arise in which disruptive water shortages may occur on some local scales. Asabina suggests use of the ratio between the populated and unpopulated areas of a river basin as a scientific indicator when determining the part of the territory that remains for sustainable economic development with a renewable water supply.

In *Water-quality monitoring and process understanding in support of environmental policy and management*, Norman E. Peters first discusses the evolution in understanding of environmental processes that have grown from single discipline studies into much more comprehensive integrated and interdisciplinary studies. The author designates hydrology as a central component of this evolution and the drainage basin as the most appropriate unit for addressing the complex environmental scientific issues. He emphasizes that aquatic systems have been continuously modified; human activities affect both water quantity and quality at all spatial scales and may have a disproportionate effect on entire drainage basins. Peters discusses how interdisciplinary integrated basin modelling may provide a comprehensive understanding of the linkages between air, land and water resources. But worries that those models, being only an extension of knowledge that introduces large uncertainties, will have considerable limitations until these uncertainties are explicitly evaluated. He argues that effective river basin resource management should integrate various scientific and engineering disciplines, economic sectors and governance.

In *Integrated and participative river basin management: a social sciences perspective*, Bernard Barraqué argues the necessity for stakeholders and modellers to share a common vision of the river as a policy issue. The author claims that once the involvement of stakeholders is accepted as a necessity for efficient water management, scientists have to accept that the traditional conception of physical modelling of river basin processes is of a top-down planning type, and thus can not be helpful for water management. The author takes examples of developed countries to illustrate the readiness of citizens to refuse some imposed decisions that they do not understand and do not trust, even if these decisions were based on knowledge. He highlights the building of a dual representation system as the first task in order that rivers may become a policy object. This system should define what is at stake in a given aquatic environment and who the stakeholders are, and it is within this structure that scientific analyses should be provided. The author concludes by suggesting a “house of the river” to be a potentially advantageous place for developing knowledge transfers between scientists, laymen, professional fishermen and environmental non-governmental organizations.

In *The changing Indian scenario: from river basin studies to water management studies and its scientific rational*, P. Rajendra Prasad discusses India’s freshwater resources and analyses the practices adopted by the Indian Government for their assessment and management. Despite the abundance of these resources, there is great heterogeneity of water availability in space and time relative to the rainfall and hydro-geological conditions of the country. The author explains that ineffectiveness of water resources management observed locally can be partially explained by climate changes and some government policies. But a major factor is the non-scientific exploitation of water resources, and in particular, some local over-exploitation of groundwater resources. The author promotes the concept of micro basins for handling water resources, so that the same practices as adopted by the Indian Government for the major and the medium river basins of the country can be carried out on smaller scales. He insists on the incorporation of the heterogeneities in terms of hydrological variables at small- and medium-scales allowing a more effective scientific evaluation and quantification of local water resources especially groundwater resources.

In *Measurements, models, management and uncertainty: the future of hydrological science*, Keith Beven reviews some fundamental problems of dealing with hydrological processes, starting from measurement uncertainties (including measurement cost limitations and indirect measurements), and scale mismatches between observation and modelling. He observes that there are two important issues to be addressed: how to estimate this uncertainty (in both gauged and ungauged catchments) and constrain it with the help of the most informative measurements; and, how to present and use the uncertainty in management decisions. The development of an adequate framework is required to span a wide range of scales, to assess the real information content of observations in testing models of hypotheses about system response; and to obtain robust decision making under uncertainty. He suggests that this framework will develop naturally as part of a learning process with the availability of “models of everywhere”, but it also requires thought as to how it should be implemented to address the range of questions required in catchment management.

The ninth Kovacs Colloquium: *River Basins – from Hydrological Science to Water Management* assesses the state of interdisciplinary integrated basin studies and identifies several new key priorities for the broader research community. Drawing from the contributions in this book, the final section recapitulates the main conclusions on the state of art and science priorities, measurement and data strategies, as well as management and knowledge-transfer needs. Recommendations for consideration in conjunction with the 2008 Session of the Intergovernmental Council of the International Hydrological Programme of UNESCO are included.

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