Preface

River basins are the focus of the conference topic "River Basins, Reservoir Sedimentation and Water Resources." A wide range of topics are covered, including hydrological processes at watershed scale, sediment supply and delivery to the fluvial system, debris flows, sediment and wood transport, fluvial dynamics, dam operation and hydropower generation, impacts of dams on flows and sediment transport, flood hazard, evaluation of water resources and their management, groundwater modeling and quality. Many of them are traditional subjects of Engineering Geology (e.g., groundwater and water resources), with the addition of several emerging topics at the interface with other disciplines (hydrology, hydraulics, geomorphology), which are gaining an increasing interest in the field of applications of geology to engineering and environmental problems. These topics have a great impact on the "society and territory," as they play an important role in contributing to a sustainable management of natural resources, as well as in predicting and mitigating risks associated to river systems. This is specifically the case of the analysis of fluvial processes, which is becoming a subject of central interest for the role that rivers have in the society and territory, and therefore for the increasing need to conciliate economic, societal, ecological objectives interests and needs. Scientific sessions included in the conference topic "River basins, reservoir sedimentation and water resources" comprise case studies for advancing field monitoring techniques, improving modeling and assessment of rivers, and studies contributing to better management plans and policies for the river environment and water resources. These sessions can be grouped in the four main topics that are summarized in the following sections.

Advances in Monitoring Techniques of Hydrological Processes and Debris Flows

This first topic is focused on the advancements of the techniques employed for monitoring, in particular, catchment-scale hydrological processes and mass movements (i.e., debris flows) having a direct impact on sediment supply and delivery and on the dynamics of the fluvial system.

The hydrological response of a catchment is the result of the several interconnected processes involving, on the one hand, the space-time variability of precipitation and soil moisture and, on the other hand, the overland flow and flood routing in natural channels. Therefore, the monitoring and the prediction of the spatial and temporal distribution of rainfall and soil moisture over a catchment as well as of the hillslope runoff and discharge along rivers are matters of paramount importance in hydrology.

Advances of the hydrological monitoring are discussed in terms of ground measurements and remote sensing for: (i) rainfall and soil moisture spatial variability assessment at catchment scale; (ii) flood events prediction at river sites; and (iii) improvement of hydrological and hydraulic models aimed at flooding risk analysis.

As mentioned earlier also the technological improvements are explored that took place over the last few years and that have led to significant advances in debris flow monitoring activities.

This subject is of particular relevance because a systematic collection of field data is strongly needed to address the difficult task of investigation, management and hazard mitigation of such destructive phenomena. Further refinements of the existing monitoring techniques are possible and should contribute to improve process understanding and provide high-quality data for testing, calibrating and improving the numerical codes that simulate inception, propagation and deposition of debris-flows. This would bring to more reliable design of mitigation measures, including warning systems, and the issue has been therefore addressed in a specific session.

River Processes and Management

This topic encompasses various aspects, such as investigation and monitoring of basic fluvial processes (e.g., sediment and wood transport), analysis of channel changes, effects of dams, flood risk, and integrated management.

Sediment dynamics in river systems from source to sink, including sediment production, transfer, storage, and sediment budgets, are becoming a central issue in management of fluvial resources and associated risks. Multiple interactions among hillslope, channel, and coastal processes in relation to climate change and resource exploitation represent a basic knowledge for any management measure aimed to environmental and ecological protection or natural hazards mitigation. Advanced techniques for monitoring fluvial processes (e.g., LiDAR, remote sensing, numerical modeling, GIS applications, etc.) are increasingly becoming part of studies and investigations in the field of Engineering Geology.

Sediment and morphodynamics influence flood risk through changes in channel dimensions, grain roughness (sediment calibre) and form roughness (planform style). Climate and land use change and river engineering can drive changes in sediment supply and river-floodplain morphology. Such interactions must be understood in order to provide effective flood risk assessment and appropriate management responses. In the context of flood risk, a particular case is represented by ephemeral streams typical of arid and semi-arid region and karst areas, which occasional drain runoff, in particular when generated by extraordinary or extreme rainfall events. Floods along ephemeral streams are relatively rare events however they can be really severe and disruptive, causing serious damages to people and infrastructures. For this reason, it is of paramount importance for urban and environmental planners to understand their dynamics of activation and to be able to simulate their activation and behavior.

A subject that is increasingly emerging during the last few years is the dynamics of large wood in river basins, for its conflicting implications in terms of ecosystem quality and fluvial hazards. Indeed, many recent events have shown the great relevance of LW-related processes for a reliable flood hazard prediction, but observations and modeling efforts on this topic are still very scarce. More effort is needed for working on LW dynamics at different spatial scales and with different methods, from headwaters to lowland river systems.

Dams and their multiple uses are a particular focus of many engineering and geological studies for their several impacts on river systems. Effects and consequences of dams on water resources are important issues, including changing hydrological regimes, conflicts and tradeoffs among multiple operational objectives for dams, adverse effects of dams and reservoirs on geomorphic, ecologic, and social systems, and potential mitigation and integrated management of water resources. Specific topics of increasing interest include effects of hydropeaking and thermopeaking, irrigation water abstraction, minimum flow requirements, reservoir operations, ecosystem losses, and efforts to mitigate or offset the effects of changing hydrologic regimes due to climate change and human activities. Furthermore, dams may have multiple effects on sediment dynamics, including upstream reservoir sedimentation, consequences of disruptions to sediment transport, and effects of dams on downstream geomorphic processes. As a consequence of these multiple effects, management practices to mitigate the impacts of dams, including geomorphic responses to and effects of dam removal, are a central issue in Engineering Geology.

Recent significant advances have occurred in river science that underlie and inform new initiatives toward integrated river management, with particular focus on conflicts among river quality, fluvial dynamics, and hazard mitigation objectives. A sound understanding of fluvial systems and geomorphic processes are needed for a sustainable management and river restoration from catchment to site scale. The European Directives on water quality and hazard mitigation (WFD 2000/60 and Flood Directive 2007/60) introduce new challenges and opportunities for integrated management. A main subject of interest is the discussion of the different strategies, which have been proposed by scientists and applied by practitioners and decision makers to cope with floods and to manage risks due to inundations by rivers and torrents. The subject is challenging as it involves different disciplines, in engineering and geology, ranging from hydrology, structural engineering, geomorphology, river morphodynamics.

Despite the diversity of studies, approaches, and geographical contexts of the case studies, a number of common themes emerged from this topic: (i) the importance of analysis, monitoring and quantification of processes; (ii) a continuous and constructive interchange among different disciplines (e.g., hydrology, hydraulics, fluvial geomorphology, ecology, etc.) is needed to identify the best approaches and solutions to the investigated problems; (iii) related to the previous point, the importance of an integrated management, accounting for different conflicting objectives related to EU directives or environmental policies in other non European countries.

Water Resources Assessment and Management

In semi-arid regions, the growing population pressure combined with climate changes and unsustainable land management is resulting in degradation of land and growth of irrigation-water demand. For these reasons, the development of appropriate technologies for land and water management is of primary importance, in particular in low-income countries. This need has stimulated the research into the relationships between water availability, land use, sediment transport, soil erosion, and reservoir design and management. Various aspects of water basins management in semi-arid regions are considered, including: (i) water resource and reservoir management; (ii) soil erosion and conservation; (iii) remote sensing for water resources; (iv) early warning of droughts; (v) monitoring and mitigation of desertification; and (vi) research into the economic and policy aspects.

Global changes shall affect water resources management throughout the World. Especially, the Mediterranean area will be impacted by rainfall decrease and temperature rise. The stress on water resource shall also increase in tropical regions due to population growth. Unconventional aquifers such as karst systems or fractured crystalline rocks constitute alternative water resources, which should be evaluated according to their specific hydrogeological context. Groundwater resources assessment (aquifer mapping, volume, safe yield, borehole siting) and water quality in unconventional aquifers are important topics that need to be addresses. In karst regions, studies on the characterization of the geometry and hydrodynamics of karst aquifers can provide advances on the knowledge of the potential of this kind of reservoir. In crystalline aquifers, studies on the geometry of the shallow weathered part of the aquifer allow to regionalize aquifer properties and properly locate pumping wells.

Groundwater Modeling and Remediation of Polluted Aquifers

Groundwater resources are the most important source of water for manifold purposes besides being an important factor for a lot of engineering geological problems. Groundwater needs of being protected and carefully managed also in a scenario of climate change that can severely affect groundwater supply. Therefore, the analysis and the modeling of the processes related to groundwater management are paramount problems for engineering geological study. The difficulties in modeling groundwater systems are related to their intrinsic complexity and to the potential high not linearity of their behavior in response to external input. There is a need to bring together the experiences in analysis and modeling of groundwater systems, with different approaches and in different hydrogeological environment.

Groundwater from alluvial basins is widely used for drinking water and irrigation purposes and aggregates are extracted for concrete production. Flow in the alluvium is often not measured at the hydrometric stations, introducing bias in the water budget and flood prediction. Groundwater flow models of alluvial systems are difficult to calibrate and building roads and bridges on river banks is hazardous, likely because of a lack of characterization of the sediments. Hydrostratigraphic units can be delineated by using lithologic well logs, water quality and water level data, and interpreted facies models may compare well to resistivity and geologic map data. It is needed to take into consideration the tectonic and geomorphological history in relation with climatic change. The revised hydrogeologic framework will enable useful analyses of quantity/quality issues such as land subsidence, effects of ground-water withdrawals on habitats, and sustainability of alluvial resources.

Another important topic is the role of Geology within the selection procedures and design of the modern systems for remediation of polluted aquifers and subsoils. There are today a lot of new technologies for containment, degradation, extraction, and inerting of subsoil and aquifer pollutants but the main issue is the correct choice of the best system or combination of systems taking into account beyond contaminant types and species, the hydrogeological scenario, and the subsoil profile at the small and large scale. Within this context, the role of the engineering geology is fundamental and must indicate the initial direction of the path toward the optimized solutions for an effective treatment of polluted subsoils and aquifers.

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