

PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON DAMS IN THE SOCIETIES OF  
THE 21<sup>ST</sup> CENTURY, ICOLD-SPANCOLD, 18 JUNE 2006, BARCELONA, SPAIN

# Dams and Reservoirs, Societies and Environment in the 21<sup>st</sup> Century

*Edited by*

L. Berga, J.M. Buil, E. Bofill, J.C. De Cea, J.A. Garcia Perez,  
G. Mañueco, J. Polimon, A. Soriano & J. Yagüe  
*Spanish National Committee on Large Dams, SPANCOLD*

Volume 2



**Taylor & Francis**  
Taylor & Francis Group

LONDON/LEIDEN/NEW YORK/PHILADELPHIA/SINGAPORE

Flow resistance and design guidelines for embankment stepped chutes <i>C.A. Gonzalez &amp; H. Chanson (Australia)</i>	1015
Study on hydraulics of the overtopped cofferdam used for flood diversion in hydropower engineering <i>C. Qingsheng, Zhou Chuntian, Li Jing &amp; Teng Libing (China)</i>	1023
Control of alkali silica reaction at Tala Hydroelectric Project in Bhutan <i>Rajbal Singh, A.K. Sthapak, Phuntso Norbu &amp; R.N. Khazanchi (Bhutan)</i>	1029
The potential of a ground based transceivers network for water dam deformation monitoring <i>J.B Barnes &amp; J. Van Cranenbroeck (Australia, Switzerland)</i>	1037
Works for improving the safety conditions of the Roman dam of Cornalbo <i>F. Aranda Gutiérrez, J.L. Sánchez Carcaboso, J.M. Balsa Bretón &amp; A. Bernal Couchoud (Spain)</i>	1047
Author index	1055
 <i>Volume II</i>	
 <i>Theme 4. Social and environmental aspects</i>	
General Report – Session IV <i>A.H. Walz (USA)</i>	1061
The role of dams in the XXI Century to achieve a sustainable development target <i>F. Lempèrière &amp; R. Lafitte (France, Switzerland)</i>	1065
Dams and the Millennium Development Goals <i>H. Brühl (Germany)</i>	1073
Kyoto Protocol and hydraulic policy <i>F.J. Baztán Moreno, D. Cristóbal Dolado &amp; R. Ricord (Spain, Panama)</i>	1077
Assessment of the sustainability of dams <i>A. Burgueño Muñoz (Spain)</i>	1085
The dam: a fair judgment <i>F. Vázquez Brea (Spain)</i>	1091
Some issues over dams in the 21st century <i>F. Salinas &amp; C. Salinas (Spain)</i>	1097
Viability of dams and their alternatives in a century of globalization <i>G. Visentini (Italy)</i>	1101
Integrated schemes for social and environmental impact management of large dams <i>M. Amato, L. Doria, L. Fantacci, G. Mazzà &amp; M. Meghella (Italy)</i>	1103
Three Gorges Project and the environment <i>C. Guangjing &amp; D. Huichao (China)</i>	1109
Study on eco-environmental monitoring and protection of the Three Gorges Project <i>D. Huichao &amp; Tian Bin (China)</i>	1115
Sustainability management of the Three Gorges Project <i>S. Zhiyu &amp; L. Jian (China)</i>	1123
Environmental protection and development in Xiaolangdi project <i>Dezhong Dong (China)</i>	1131

Analysis of impacts of dams on ecological environment for river ecosystem <i>Chun-mei Mao &amp; Rui-qiang Zheng (China)</i>	1135
Mitigation's observed impacts on the downstream's fish populations, on Yacyretá Hydropower <i>H. Aguadé de Latorre (Paraguay)</i>	1143
Discuss about the need of adopting temperature control device for reservoir to protect the downstream fish growth environment <i>Chen Guanfu &amp; Zhou Jianping (China)</i>	1151
Coordinated development of reservoir resettlement and regional society, economy, environment <i>C. Shaojun &amp; L. Zhen (China)</i>	1155
Support program of dam surrounding areas in Korea <i>L. Gwangman, K. Woogu &amp; P. Yangsoo (Korea)</i>	1161
Dam construction and sustainable livelihood support for displaced people <i>P. Dooho, Y. Yangsoo &amp; S. Youngdu (Korea)</i>	1169
Santa Helena city of waters <i>P. Fernández Carrasco &amp; S. Dellenburger (Spain, Brazil)</i>	1175
The experience of environmental impact assessment of large dams in Spain. 1988–2004. Case analysis <i>R.M. Arce &amp; A. Castro (Spain)</i>	1179
Advances in integrative approaches for dams' viability in Mexico <i>M.A. Gómez B., P. Saldaña F., C. Lecanda T. &amp; E. Gutiérrez L. (Mexico)</i>	1187
Identification of the environmental impacts caused by the expansion of Zimapan power plant <i>O. Calahorra, L. Vázquez, H. Rodríguez, E. Hernández, C. Delfin-Alfonso &amp; G. Benitez (Mexico)</i>	1195
Changes in hydropower exploitation planning due to modern environmental constraints <i>D.A.V. Krüger, E.H. Gomes Jr. &amp; C.E.N.L. Michaud (Brazil)</i>	1201
Hydropower Project, La Parota, Guerrero <i>R.D. Llerandi (Mexico)</i>	1207
The role of environmental studies in the dam construction projects in Iran <i>M. Mivehchi, B.R. Khamsi &amp; A.R. Khamsi (Iran)</i>	1213
Environmental Impact Assessment of the Badovli Reservoir Dam Plan <i>F. Sabzevari &amp; R. Khalili (Iran)</i>	1219
Lessons learned from the water diversion in the hydropower projects in Indonesia <i>M. Marsam (Indonesia)</i>	1223
Social and environment aspect on Musi Hydroelectric Power Project Indonesia <i>K.S. Sugeng (Indonesia)</i>	1229
A dams-targeted environmental enhancement: hydroelectric stations driven by ecological flows <i>I. Guerra Larrabeiti, N. Rodríguez Nieto &amp; R. del Hoyo Fernández-Gago (Spain)</i>	1235
Managing sedimentation in the Swiss Rhone and Génissiat reservoir <i>L. Thareau, Y. Giuliani, C. Jimenez &amp; E. Doutriaux (France)</i>	1243
The production of sediments on Brazil and the management of the hydropower reservoirs <i>F. Campagnoli &amp; N.C. Diniz (Brazil)</i>	1251

Influence of climate change on Halslon reservoir sediment filling <i>S.M. Gardarsson &amp; J. Eliasson (Iceland)</i>	1255
Dams and environment: Effect on soils <i>V.M. Starodubtsev, T.G. Badira &amp; S. Krupelnitskiy (Ukraine)</i>	1261
Dredging the Canfranc reservoir <i>J. Espinós Solís (Spain)</i>	1269
Complex response and geomorphologic thresholds in Large Dams <i>E. Moghimi (Iran)</i>	1275
Corumbá reservoir and Caldas Novas thermal aquifer – GO – Brazil <i>E.J. Gil, E.A. Vargas Jr. &amp; S.K. Ono (Brazil)</i>	1279
Hydrogeological model of Caldas Novas thermal aquifer – GO – Brazil <i>E.J. Gil, E.A. Vargas Jr. &amp; S.K. Ono (Brazil)</i>	1285
Preliminary results of Carbon Budget in two hydroelectric reservoirs in Brazil <i>M.A. dos Santos, B. Matvienko, L. Pinguelli Rosa, E. Oliveira dos Santos, E. Sikar, C.H. Eça D'Almeida Rocha, M. Bento Silva, S. Rao Patchineelam, A.M. Portilho Bentes Junior &amp; R. Santos Costa (Brazil)</i>	1289
Fluxes of greenhouse gases from hydropower dams reservoirs in Brazil <i>M.A. dos Santos, B. Matvienko, L. Pinguelli Rosa, E. Oliveira dos Santos, E. Sikar &amp; M. Bento Silva (Brazil)</i>	1293
Effects of environmental acoustic in hydropower project <i>C.M. Yorg Rojas &amp; P.H. Trombetta Zannin (Brazil)</i>	1297
Ganges water scarcity in the transboundary catchment due to Farakka Barrage and threats to mangrove wetlands ecosystems in the Sundarbans <i>S.N. Islam &amp; A. Gnauck (Germany)</i>	1303
Problems of the surface water source in the Czech Republic <i>P. Novakova &amp; M. Stasna (Czech Republic)</i>	1311
Turbid water management for reservoirs in Korea (focusing on the Imha multipurpose dam in the Nakdong River) <i>K. Deukkoo, N. Joonwoo &amp; K. Jeongkon (Korea)</i>	1317
Social acceptability of dams. Lessons learnt by a builder and manager of reservoirs in France <i>D. Boubée (France)</i>	1321
Social acceptability of dams: Facts and arguments. Public awareness concerning dams <i>T.A. Sancho Marco (Spain)</i>	1327
Bujagali dam – socio-impact on people <i>J. Mwami (Uganda)</i>	1333
Analysis of social impact on water conservancy and hydropower development <i>S. Guoqing &amp; Fu Weiqun (China)</i>	1337
Social demand for dam construction in Spain: Forest fires, rural tourism and environment <i>S. Garcia Wolfrum, P. García Cerezo &amp; G. Garcia Hernández (Spain)</i>	1345
Dam safety criteria: A “paradigm” to be reviewed <i>C.H. de A.C. Medeiros &amp; O. de S. Tórrres (Brazil)</i>	1351
Author index	1355

## Preface

These volumes contain the Proceedings of the International Symposium on Dams in Societies of the 21st Century, held in Barcelona (Spain) on 18th June, 2006, as part of the 22nd ICOLD International Congress. The proceedings comprise 203 papers, from 50 countries, together with General Reports from Symposium sessions. Together, this constitutes an in-depth analysis of the potential role to be played by dams and reservoirs in water development, and management challenges in the 21st Century. The papers are presented under the following headings:

1. Role of dams and reservoirs
2. Benefits of dams
3. Dam Engineering and analysis of alternatives
4. Social and environmental aspects

Water is an essential resource for life and the environment. During the second half of the twentieth century, an increase in the world's population and the economic and social progress of the developed countries, has put serious pressures on water. Numerous countries across the planet are now affected by a water crisis. Statistics emphasise the urgency of the situation:

- 18% of the world population do not have access to safe drinking water
- 40% of the world population lack access to adequate sanitation
- 50% of the world population is subject to water stress, and by 2025 it is estimated that the figure will be 65%

There is increasing stress on water ecosystems as the natural environment continues to be impacted. The incidence and extent of flooding has increased, and water can be seen in many situations as a hazard rather than a resource.

Over the last years, numerous international organizations have promoted a variety of initiatives and proposals, with a view to mitigating the water problem. The United Nations has designated the period between 2005 and 2015 as the International Decade for Action: *Water for Life*. During this period, the focus will be on undertaking real and effective measures, in an effort to meet the Millennium's targets: including reducing by half the population that is currently completely lacking in the essential water supply and sanitation services.

The renewable water resources in the world, which emanate from the hydrological cycle, are constitute approximately 40,000 km<sup>3</sup>/year. However, these resources are distributed extremely irregularly, not only in time but also geographically and only about 9,000 km<sup>3</sup>/year are available as natural accessible resources. Over the past 5000 years, more than 50,000 large dams have been constructed and these large dams and reservoirs regulate some 3,500 km<sup>3</sup> per year. This represents 30% of the world's available water resources which reaches the end users after having been regulated by dams and reservoirs. The water that is stored and regulated by dams and reservoirs produces irreplaceable water resources and brings benefits to water supply, irrigation, hydropower, flood mitigation, river navigation, recreation, tourism and the environment. Of the world's arable land, 17% is irrigated in this manner, producing 40% of the total world crop. Reservoirs regulate around 40% of the water for irrigation, which supports 15% of the total food production. Furthermore, hydropower, which is a clean and environmentally-friendly source of energy, yields 20% of the world's generated electricity supply, while 20% of the world's reservoirs account for a reduction in the major socio-economic impact of flooding. The data mentioned here illustrates the extent to which dams and reservoirs contribute to the availability of water resources, and to the economic and social development of many countries.

All studies, research work and surveys indicate that the stock of dams, and the reservoir volume per capita, is closely linked to a country's stage of socio-economic development (Gross National Income per capita and Human Development Index). Developed countries have an ample stock of dams and reservoirs, and in general terms, the greater the stock in volume of reservoirs is, the greater its contribution to development will be. However, experience has shown us that dams and reservoirs can, in some cases, have other major social and environmental impacts, so it is necessary to consider them within the framework of Integrated Water Resource Management and sustainable development. All feasible alternatives should be considered as part of this holistic approach.