Annex I
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Annex II
Glossary

Active (or live) storage. Volume or cubic capacity of a lake or reservoir between the maximum and minimum operating levels.

Adversely affected people. Populations who suffer negative effects during water and energy development interventions. In the case of dam projects, this includes people whose economic, social and cultural lives are negatively affected by construction works, impoundment, alteration of river flows and any ecological consequences. The term includes displaced people, host communities, and downstream and upstream populations. It may also include groups affected by the construction of transmission lines or the development of irrigation schemes, water transfer canals, sanctuaries, and so on.

Aquifer. An underground water-bearing layer of permeable rock, sand or gravel that is capable of yielding exploitable quantities of water.

Barrage (gate-structure dam). A structure built across a river consisting of a series of gates that when fully open allow the flood to pass without appreciably increasing the water level upstream of the barrage, and that when closed raise water levels upstream to facilitate diversion of water to a canal for irrigation or to a powerhouse for the generation of electricity.

Baseline assessment. The collection and analysis of data that describe prevailing social and environmental conditions and are used in the design of project activities and as a benchmark for future monitoring studies.

Benefit sharing. Transfer of a share of the benefits generated by a project, such as a dam, to local communities or authorities. Mechanisms for benefit sharing include preferential rates (for example, of electricity generated), revenue sharing or royalties, and equity sharing (through which local populations or authorities own all or part of the project).

Catchment. The area that drains into a river system; in relation to a dam, the area upstream from the dam from which the reservoir receives water. (The term 'watershed' has been used in this document to convey the same meaning.)

Civil society. Non-governmental organisations, community based organisations, professional associations from all disciplines and other sectors of society that are neither government bodies nor the private sector.

Compensation measures. Alternative resources (land, property or money) provided to displaced people or others adversely affected by a project as mitigation for losses suffered.

Conjunctive water use. The co-ordinated use of surface water and groundwater resources.

Cropping intensity. The extent of land use in a year, which reflects the degree of multiple cropping. It is the ratio of the total area cropped per year to the irrigation command area.

Cultural heritage. The cultural practices and resources of current populations (religions; languages; ideas; social; political and economic organisations) and their material expressions in the forms of sacred elements of natural sites or artefacts and buildings; landscapes resulting from cultural practices over historical and prehistoric times; and archaeological resources; including artefacts, plant and animal remains associated with human activities, burial sites and architectural elements.

Dead storage. Storage below the lowest outlet that cannot be released under normal conditions.

Decommissioning. Removing a dam from service and, where appropriate, physically dismantling it.

Demand-side management. Reducing use of water or electricity by improving the efficiency of use by the transmission system or the consumer, whether in the residential, industrial, commercial, agricultural or government sector.

Developer. The organisation (private or public sector) responsible for promoting and implementing a project, as distinct from the contractor who constructs the project.

Discounting. The process of applying a rate of interest to cost and benefit flows that is used to find the equivalent value today of sums receivable or payable in the future.

Displaced people. Communities required (often involuntarily) to abandon their settlements (homes, agricultural land, commons, forests and so on) or suffering loss of livelihood due to construction of a dam, submergence of the reservoir area, downstream impacts, building of dam-related infrastructure such as roads, and so on.

Ecosystem. An interacting system formed by living organisms and their abiotic environment regulating itself to a certain degree and explicitly includes the human social system.

Environmental flow. The specific release of water from a dam to ensure the maintenance of downstream aquatic ecosystems and key species. The flows may include seasonal or annual flows and/or regular or irregular pulses to meet ecosystem needs. They may also be linked to livelihood needs of downstream affected people.

Environmental management system. The processes by which an organisation identifies and assesses environmental problems, sets goals to address the problems, and measures and verifies progress in solving the problems.

Ethnic minorities. Social groups with a social and cultural identity distinct from the dominant society. They have been historically disadvantaged; come from non-dominant sectors of society; have low social, economic and political status; and are determined to preserve, develop and transmit to future generations their ethnic identity as the basis of their continued existence as people.

Export credit agency. A government agency that helps finance the overseas sales of a nation's goods and services, generally by providing guarantees of working capital loans for exporters, guaranteeing the repayment of loans, or making loans to foreign purchasers of the nation's goods and services. The agency may also provide credit insurance that protects exporters against the risks of non-payment by foreign buyers for political or commercial reasons.

Externalities or External Impacts. Costs and benefits that are external to the financial aspect of decision-making, and thus do not accrue to project developers and operators.

Flood control. In relation to dams, the intention to reduce flood peaks in the river and to minimise the impact of flood events on human activities, including loss of life, social disruption, health impacts, and property and economic losses.

Flood management. A broad concept that focuses on reducing flood hazards through a combination of policy, institutional, regulatory and project measures (such as replanting catchment areas), while recognising that they can never be fully controlled. This takes into account the beneficial uses of natural floods, which are more difficult to quantify in human and economic terms but which sustain natural systems that also have economic, social, cultural and ecosystem values and functions.

Greenhouse gases. Gases that accumulate in Earth's atmosphere and trap heat. Some are naturally occurring gases, like carbon dioxide and methane; others are made by humans, such as halocarbons.

Groundwater. Water that flows or seeps downward and saturates oil or rock, is stored underground and supplies springs and wells. The upper level of the saturated zone is called the water table. Generally, all subsurface water, as distinct from surface water.

Impoundment. Body of water formed by collecting water, as by dam.

Indigenous and tribal peoples. At its broadest, the adjective 'indigenous' is applied to any person, community or being that has inhabited a particular region or place prior to colonisation. However, the term 'indigenous peoples' has gained currency internationally to refer more specifically to long-resident peoples, with strong customary ties to their lands, who are dominated by other elements of the national society.

Integrity pacts. Voluntary undertakings related to the procurement of goods and services that are used to reduce corruption, and that are of particular use in situations where regulatory systems and institutional capacity are weak, although they have universal application. The concept was first developed by Transparency International.

Large dam. A dam with a height of 15m or more from the foundation. If dams are between 5-15m high and have a reservoir volume of more than 3 million m^3, they are also classified as large by the International Commission on Large Dams. In this report, everything else is considered a small dam.

Life-cycle assessment. An options assessment procedure at the front end of the planning cycle used in the energy sector to compare 'cradle-to-grave' performance, environmental impacts, and market barriers and incentives for different demand and supply options.

Main-stem. The main course of a river, characterised by its middle and lower reaches.

Major dams. The *World Atlas & Industry Guide* of the International Journal on Hydropower & Dams defines a 'major dam' as a project meeting one of the following criteria: dam height over 150 meters; dam volume over 15 million cubic meters; reservoir volume over 25 billion cubic meters; installed capacity over 1 000 megawatts.

Mitigation measures. The reduction of potentially significant adverse impacts.

Multi-criteria analysis. An analytical process that uses a mix of qualitative and quantitative criteria to assess and compare options, which may be policies, programmes or projects.

Multipliers. The amount by which equilibrium output of the economy changes when aggregate demand - as caused for example by the expenditure by a development project - increases by one unit. As those receiving the initial round of income generated are likely to consume a portion of the additional income, this subsequent expenditure will lead to additional ripple effects of rounds of income and consumption through the economy. The net effect of these increases in output is the multiplier effect of the initial expenditure, measured as a proportion of the initial expenditure.

Multi-purpose dam. A dam that meets two or more objectives (such as irrigation, flood control, water supply, power generation, recreation, navigation or fish and wildlife enhancement).

Performance bonds. Bonds supported by financial guarantees to provide a secure way of ensuring compliance with commitments and obligations. The bond is called upon in part, or in full, to meet unfulfilled obligations and commitments or is repaid when commitments are met, either in whole or in part, depending upon the circumstances.

Precautionary approach. According to the Rio Declaration on Environment and Development, signed in 1992, where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

Political Economy. Political economy is the analysis and explanation of the ways in which governments affect the allocation of scarce resources in society through their laws and policies as well as the ways in which the nature of the economic system and the behaviour of people acting on their economic interests affects the form of government and the kinds of laws and policies that get made.

Recession agriculture. A system of agriculture that depends on the moisture of the soil as the flood recedes. Recession agriculture takes place in the floodplain, which is the area subject to seasonal flooding by the river.

Rehabilitation. The physical or social restoration of an ecosystem or a community after a dam construction project has been completed, or the process of renovating a facility or system that has deteriorated and whose performance is failing to meet the original criteria and needs of the project.

Reservoir. Any natural or artificial holding area used to store, regulate or control water.

Reservoir drawdown. The extent to which the water level in the reservoir changes on a daily or seasonal basis due to release of water from the reservoir for operations (such as irrigation or daily peaking for power generation). Emergency drawdown may be for safety reasons, or in anticipation of a major flood event.

Resettlement. Physical relocation of people whose homes, land or common property resources are affected by a development, such as dam building.

Retention. Temporary storage provided by a dam. Even when a reservoir is full, the outflow may be smaller than the inflow as a result of the retention effect.

Riparian. Lying on or adjacent to a river or lake. Used to denote people, plants or wildlife living along the water's edge.

Riparian State. Any State through which a transboundary river flows or forms part of its boundary, or that includes part of the catchment basin of a transboundary river.

River. Large stream that serves as the natural drainage channel for a drainage basin. In terms of transboundary rivers, the

term relates equally to all types of waters that are or might be affected by dams.

River basin. The area from which the river system under consideration naturally receives its drainage water; may encompass a series of tributary rivers and their sub-basins.

Riverine. Features or habitats relating to, formed by, or lying within a river; living along the banks of a river.

Run-of-river dams. Dams that create an hydraulic head in the river to divert some portion of the river flows. They have no storage reservoir or limited daily pondage. Included in this category are weirs and barrages.

Surface water. Water that flows or lies on the ground surface.

Tailwater. The water in the natural stream immediately downstream from a dam. Applied irrigation water that runs off the lower end of a field.

Water table. The level of groundwater; the boundary between ground that is saturated with water (the zone of saturation) and ground that is unsaturated or filled with water and air (the zone of aeration).

WCD Forum. A body with some 68 members affiliated to the broad range of stakeholders and interest groups involved in the dams debate. The Forum is partly composed of members of the Reference Group from the 1997 meeting in Gland that recommended the establishment of WCD. It also has new members subsequently invited to participate by WCD. The Forum is a consultative body.

WCD Global Review. An assessment of the performance and impacts of large dams and of alternatives for water resources and energy development, based on the WCD Knowledge Base.

WCD Knowledge Base. Materials commissioned, organised or accepted by the WCD to inform its work: in-depth Case Studies of eight large dams on four continents, together with two country review studies; a Cross-Check Survey of large dams located in 52 countries across the globe; 17 Thematic Reviews grouped along five dimensions of the debate; four regional consultations; and 947 submissions from interested individuals, groups and institutions. These materials are available at www.dams.org.

Weir. A structure built across an open channel to raise the upstream water level or to measure the flow of water. Weirs tend to be smaller than barrages and are not generally gated.

Annex III

The WCD Work Programme – Approach and Methodology

This annex provides additional details on the method used in the WCD's four main work programme tasks. In response to its mandate, the Commission began by assembling a consolidated knowledge base on the worldwide experience with large dams. To give its analysis and conclusions a solid foundation, it commissioned, organised or accepted:

- in-depth case studies of large dams in five continents, together with two country papers;
- a Cross-Check Survey targeted at 150 large dams in 56 countries;
- 17 thematic reviews grouped along five dimensions of the debate;
- four regional consultations; and
- inputs submitted by interested individuals, groups and institutions.

The work programme elements were mutually reinforcing. And there were different levels of

analysis and review. For example, different types and purposes for dams were assessed (at the basin, country and regional levels); different methods were employed to look at cross-cutting issues; different timeframes were used to assess issues, including retrospective and forward-looking perspectives; and, finally, different stakeholder groups and review processes were involved. In terms of participation, the case studies involved interested and affected stakeholder groups looking at dams as a whole from a historical perspective and in the context of a specific country or basin; the thematic studies engaged review groups from all disciplines, regions and constituencies to look at past, present and future trends; the regional consultations included all constituencies in a debate of cross-cutting issues at a regional level. Finally, the WCD Forum provided the Commission with a multi-stakeholder, international-level review of the knowledge base products as a whole, as they were finalised. The following sections describe the main work programme elements in more detail.

Case Studies

The case studies were used primarily in developing the global review presented in Part 1 and addressed the question of development effectiveness. In all, the WCD produced 11 sets of reports and papers in the case study programme:

- seven full case studies of selected large dams (five in developing countries – Brazil, Thailand, Pakistan, Turkey and Zambia-Zimbabwe, and two in industrial ones – the United States and Norway);
- country-level review papers on the experience with large dams in India and China;
- a pilot case study of two dams in South Africa; and
- a briefing paper on the Russian Federation and the Newly Independent States.

Each case study had its own stakeholder review process. A common framework was used to identify the stakeholders to:

- identify and set priorities for the study team's coverage of the issues;
- review the information and analysis provided by the study team on these issues; and
- consider the findings, conclusions and lessons drawn.

The Commission took a principled decision to employ national teams of experts rather than using international consultants for the case studies. While creating greater challenges in terms of independence and neutrality it provided the Commission with a deeper insight into the political, historical and cultural contexts for water and energy resources management.

Purpose and selection of the case studies

Given that there are nearly 45 000 large dams worldwide, the case studies were not meant to be statistically representative. Case studies set out to provide an independent and in-depth review of the performance and development effectiveness of a number of large dams around the world and to draw lessons from this review. For the WCD Case Studies, a focal dam was studied intensively in the context of its river basin. Other large dams in the basin were examined to assess and illustrate the interactive and cumulative effects of these dams with the focal dam in areas such as storage and river regulation, sediment impacts, fisheries impacts, operation practices and cumulative social impacts.The WCD took a broad approach to the concept of 'development effectiveness'. This included the relevance and appropriateness of the dam as a response to the needs that motivated its construction (such as irrigation, power, flood control, water supply, navigation or multi-purpose benefits) or other goals such as using public infrastructure for regional development. The studies also looked at projected versus actual benefits, at costs and impacts, at the distribution of gains and losses among groups, and at the general conditions under which the dam was built and is now operated. The latter aspect includes decision-making and consultative processes, and the

ex-post validity of the key assumptions upon which the project was originally developed. The stakeholder processes formed around the study were the basis for considering development effectiveness from different perspectives, as it is clear there is no one view on this issue.

Selection process and criteria

The selection process started with the Secretariat, under the Commission's direction, compiling an initial list of possible countries, river basins and specific dams. This list was presented and discussed at the Second Commission Meeting in Cape Town, in September 1998. A number of criteria guided the effort to refine the list of candidates. For example, because developing countries have the largest number of existing dams, and are currently most active in dam building, the selection of case studies in developing countries was emphasised.

The Secretariat contacted a number of governments and dam authorities to assess the degree of co-operation the WCD could expect in implementing the programme. This co-operation was considered essential to ensure adequate access for travel to the site, field visits, interviews with project-affected families and data collection from government authorities and other institutions – and more broadly to maximise stakeholder involvement throughout the process. In parallel with the identification of potential dams and river basins for the work programme, the Secretariat initiated a pilot case study of two dams on the Orange River in South Africa. The pilot study was done to develop, pre-test and obtain wider consensus among the WCD stakeholders on the approach and method for the full case study programme. Once the pilot methodology was agreed on, terms of reference for the case studies were developed in two stages: the first for the scoping phase, and the second for full implementation of the studies.

In December 1998, at its third meeting, the Commission discussed a further short list of candidate dams. The Secretariat then proceeded to make formal contacts with governments to enter into agreements to undertake the scoping phase of an initial group of case studies.

Diversity was the main criteria applied to select case studies from across the list of potential countries, basins and dams. These criteria generally included:

- regional diversity (with the intention of covering all continents);
- functional diversity (to cover as broadly as possible hydroelectric, irrigation, flood-control and multi-purpose dams);
- age diversity (to capture experience from different decades and long-term impacts);
- diversity in size and type (to differentiate between large and major dams, as well as between storage and run-of-river dams); and
- diversity of the catchment area (tropical, sub-tropical and temperate zones, covering a range of variables – climate, biodiversity, river morphology, sediment characteristics and so on).

The start of the case studies was also influenced by budget considerations. Because the WCD was continuously fundraising, the budget and consequently the number of case studies was not finalised until mid-1999.

After the initial contacts with dam operators and governments, there were a number of developments. The Governments of Brazil, Pakistan, Thailand, Zambia, Zimbabwe, United States and Norway agreed to fully participate in the case studies. In Brazil, the Commission decided to study the Tucuruí project. The Governments of India and China indicated initially that they were not prepared to participate in full case studies. Based on a meeting in Beijing in June 1999, China agreed to participate in a country-level review. After a change of institutional responsibilities within the Ministry of Water Resources in China, however, the government withdrew the agreement to participate actively in the country review (October 1999). The WCD then undertook an external review of dams in China (January 2000). The Government of

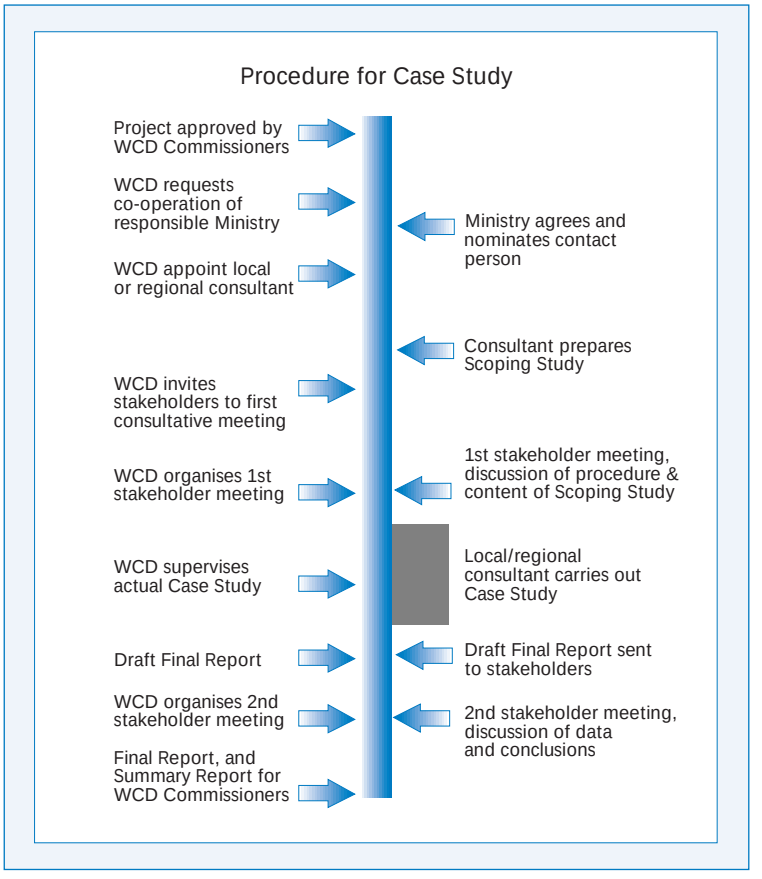
Table III.1 Basic data on WCD pilot and case studies

Focal dam	River basin	Basin country	Year commissioned
Grand Coulee	Columbia	United States	1941
Kariba	Zambezi	Zambia/Zimbabwe	1959
Tarbela	Indus	Pakistan	1968
Four Dams	Glomma-Laagen	Norway	1970, 1955, 1952 and 1910
Aslantas	Ceyhan	Turkey	1985
Tucurui	Tocantins	Brazil	1986
Pak Mun	Mun	Thailand	1994
Pilot study			
Gariep/Vanderkloof	Orange River	South Africa	1971

India, after meetings in New Delhi (June 1999), declined full participation; it subsequently agreed to co-operate fully with a country review paper on dams in India (February 2000).

Table III.1 lists the dams included in the pilot study and case studies, along with the year they were commissioned.

Figure III.1 Procedure for the WCD case studies



Case study method

The WCD established a stakeholder group and an inter-disciplinary study team for each case study and country study. This involved varying degrees of negotiation before the study teams and stakeholder groups were finalised. The selection of the study team and the identification of the stakeholders was an important aspect of the study to maximise participation and acceptance of the process and the study results. The standard method was then followed for each case study, based on the model developed by the WCD for the Orange River pilot. The main steps are represented in Figure III.1.

A scoping report and consultative meeting with stakeholders launched each study. The scoping phase required two to five months, depending on the study. The purpose of this phase was to identify and set priorities for the issues and to discuss with stakeholders how these would be covered within the study framework provided by the WCD. After a scoping phase meeting with the stakeholder group, the study team was revised and the terms of reference for the full study were finalised.

The study team then started parallel steps of data collection and verification, structured interviews, enquiries and invitation of submissions from interested parties.

After the data collection, field programmes, collection of inputs and analysis, the study team assembled a draft report. This was circulated and discussed by the stakeholders at a second meeting. The study team incorporated comments arising from the meeting and subsequent written follow-up, and then produced the final report. This captured the experience, lessons learned and the convergent and divergent views of the stakeholders. At times the process sparked considerable controversy and aspects of reports were contested in some countries.

At the core of the case studies were six questions:

- What were the projected versus actual benefits, costs and impacts?
- What were the unexpected benefits, costs and impacts?
- What was the distribution of costs and benefits – who gained and who lost?
- How were decisions made?
- Did the project comply with the criteria and guidelines of the day?
- How would this project be viewed in today's context in terms of lessons learned?

The study response to these particular questions, combined with additional views gathered through the questionnaires and discussions with stakeholders, were used to assess and illustrate the 'development effectiveness' of the dam, and to draw out and establish priorities on the lessons learned.

Media releases were provided for the stakeholder meetings, and at each stage the reports and results circulated to the stakeholder group were placed on the WCD website for international comment.

Each report presents the lessons learned from the case study that the stakeholders and study teams developed. These lessons were developed in one- or two-day meetings with stakeholders, with sometimes 60-70 participants. The Secretariat also undertook to brief stakeholders on the incorporation of their comments in the final report. Where full agreement with all stakeholders was not possible, divergent views were also captured in the report and written comments in the annex of the case study. The WCD website includes a list of lessons across the case studies along with the individual reports. The reader may also refer to the pilot study, which illustrates the procedures for verifying and collecting opinions from stakeholders at the meetings.

Cross-Check Survey

The WCD Cross-Check Survey provides a link between the topical issues emerging at a global and regional level as provided by the submissions, consultations and thematic reviews and the more in-depth insights derived from the WCD case studies. The survey does not provide assessments of individual dam projects nor does it aim to be statistically representative of the nearly 45 000 large dams. Rather it was designed to indicate broader patterns and trends.

A multi-stakeholder approach with inclusiveness and participation at all levels and with access to multiple information sources remained the key focus for the information-gathering process. As such, the Cross-Check represents an international collaborative survey in which legitimacy, transparency and integrity of data from contributors in more than 50 countries was the overriding objective.

Range of dams selected

The dams included in the Cross-Check Survey were drawn from a number of sources, including WCD Case Studies, existing databases and additional dams that contributed to the overall diversity of the total sample. The mix of large dams that make up the Cross-Check Survey sample includes dams:

- from different regional locations;
- of differing ages – dating from the 1930s through to the1990s;
- with a range of different heights and sizes; and
- with different purposes such as water supply, irrigation, flood management, power and recreation.

The survey sampling technique set out to construct a Cross-Check sample that would inform the dams debate and provide guidance for similar studies in the future, within the context of the WCD Work Programme. Given the emphasis on the Case Studies in the work programme, and the interest in 'cross-checking' the result of these in-depth studies against the wider experience in the selected river basins, the Case Study dams and a selection of other dams from the basin formed the first two strata in the sample. Inevitably, the selection of these two sub-samples involved some bias due to the criteria

used in choosing the Case Study dams and further sampling from specific basins.

The remainder of the sample aimed to eliminate many aspects of this selection bias – that is, to correct for the over-representation of specific attributes such as size, location, purpose and age. The third sub-sample aimed to build on dams from existing surveys by selecting a sub-sample of the dams examined in the 1996 World Bank study of large dams. Specifically, dams were chosen to represent regions, countries and purposes not reflected in the first two sub-samples. Representation of dams from additional countries was introduced by incorporating dams from WCD country studies of India, China and Russia into the fourth sub-sample.

The final step in the sampling process was an attempt to correct for remaining differences in representation of dams by location, age, size and purpose in the first four sub-samples as compared with the best available information on the global population of large dams. To meet this requirement, the WCD used the ICOLD *World Register* to select 73 complementary dams (this excludes Chinese dams, as noted elsewhere). The full details of the selection methodology and criteria are found in the Cross-Check Report.

Table III.2 shows the change from the original targeted sample to the final status of the dams received for each sub-sample in the Cross-Check Survey. Numerous challenges were faced in applying a global survey of this nature as part of a time-limited process. Due to many factors (either controversy, denial of permission or logistical difficulties), information for some large dams was inaccessible. At the end of the process, contributions were received for over 80% of the original sample. During the process, some dams were substituted to ensure compliance with the original criteria for the target sample. A number of additional contributions were received for dams not in the original targeted sample.

Table III.2 Cross-Check Survey Database

Strata (sub-samples)	Selected dams	Updated sample	Submissions received
Case Study Dams	13	13	13
Non-focal dams in Case Study basins	24	24	22
Dams from existing databases	24	23*	21
Country studies	19	9*	9
Complementary dams	73	73	60
Sub total	154	143	125
Incomplete questionnaires			2
Final total analysed			123
Additional submissions	–	–	

*number changes due to exclusion of the 11 Chinese dams from the sample

Of the total questionnaire submissions received (125 selected dams and 9 additional dams), only the 125 originally selected as part of the Cross-Check methodology were considered for final analysis. Two of these questionnaires were excluded due to incomplete information. The final analysis was therefore performed on 123 questionnaires about large dams.

Who provided the evidence?

The large dam projects analysed in the Cross-Check span 52 countries in six major regions of the world:

- Over 70 contributors were contracted, consisting of 40% government departments/utilities, 40% private consultants/companies and 20% NGO/academic/research institutions.
- An additional 30 contributors were commissioned to review a select sample of 17 randomly chosen and 18 controversial projects for data verification. The constituencies chosen for review were predominantly local NGOs, who provided a second opinion on the government and private contributions.

Safety nets and data confidence

To ensure credibility and confidence in the Cross-Check Survey, it was necessary to implement a series of iterative steps and

'safety nets' to enhance the quality and quantity of submitted data. They consisted of:

- *Range of Data Sources* used by contributors, including interviews.
- *Internal Review* of all questionnaires, requesting minimum threshold data and clarifications.
- *Review by WCD staff of in-house literature* on dams in the Survey.
- *External review* of controversial and randomly selected dams. Of the 50 targeted, 31 reviews were received and analysed, with the following insights:
  - Reviewers commented on approximately one third of the original data.
  - Most reviews corroborated the original data, with 20-40% contested figures (minimum 10% discrepancies).
  - Of the figures contested, the predominant focus covered discrepancies in number of actual displaced people and, in a few instances, actual capital costs.
- *Transparency* through sharing 'raw' data from submitted questionnaires on request. Around 50% of respondents gave permission for independent review of the questionnaires they submitted. A network of civil society organisations conducted a general review, supplementing and contesting information in this sub-sample.

The questionnaires

The main questionnaire for the Cross-Check Survey was developed, tested and revised by the Commission based on its experience with the Orange River Pilot Study in South Africa. Ten categories of questions covering a wide range of concerns – including questions about technical, economic, social, environmental and decision-making aspects – form the basis of the survey. It was necessary during the process to introduce a short supplementary questionnaire for completeness.

Data analysis

Information submitted in the original questionnaires was stored in a relational database.

The WCD derived 32 indicators from the analysis of the final dam sample to measure projected versus actual performance parameters. The graphs and statistics required to analyse these 32 indicators in the Cross-Check Survey were produced using the *Statistica* statistical software package. For most of the 32 indicators programs were written to draw the required graphs and calculate the appropriate statistics. This was automated to facilitate the smooth and fast production of the required results and to ensure that the analysis could be easily regenerated in the future.

The Cross-Check dams were classified according to the following 11 characteristics: region, sub-region, height, decade commissioned, reservoir area, purpose, subsamples, reach of river, climate, income and sub-income. (See Table III.3.) Each indicator was first analysed from a global perspective – ie all valid observations and the overall trend or pattern were identified. Then the observations were split between the categories of the chosen set of 11 specified characteristics, and the emerging trends or patterns were compared between the various categories of the particular characteristic (see list of cross-classifications).

The analysis of the survey questionnaires has been mostly graphical in conjunction with some simple statistics, regression modelling and clustering techniques used for hydropower energy output. For each of the 32 indicators, different types of graphs and corresponding statistics were prepared. All data was represented at the case level to ascertain the distribution and variance. Trends and patterns were inferred from the prepared graphs in the Cross-Check Report. Where possible, appropriate scientific or other explanations were given to justify emergence of particular trends or patterns. Key findings from 24 indicators were interpreted and integrated into the performance, impacts and decision-making aspects of Part One of this report.

All observations classified by *Statistica* as extremes or outliers were investigated. In

Table III.3 Cross-classification of dams in Cross-Check sample

Classification by	Category names	Number of dams
Region	United States and Canada	10
	Latin America	17
	Africa & Middle East	20
	Europe and Central Asia	34
	Rest of Asia	42
Sub-region	North America (United States & Canada only)	10
	Central America, Caribbean & Mexico	12
	South America	5
	Middle East & North Africa	5
	Sub-Saharan Africa	15
	Eastern Europe and Central Asia	9
	Rest of Europe	25
	East Asia & Pacific	26
	South Asia	16
Height of dam (m)	15–30 m	31
	31–100 m	63
	> 101 m	29
Reservoir area (km^2)	< 1 sqr km	19
	1–10 sqr km	25
	10–100 sqr km	40
	> 100 sqr km	39
Decade commissioned	< 1950	3
	1950–59	13
	1960–69	25
	1970–79	39
	1980–89	26
	>=1990	17
Purpose	Single Purpose: Water Supply Hydropower Irrigation Flood Control Other	 9 35 13 1 1
	Multipurpose	64
Sub-samples	OED	23
	Basin Study/ Non focal	21
	Basin Study/ Focal	12
	Country Study	
	Other	58
Reach of river	Upper	50
	Middle	32
	Lower	18
	Unknown	23
Climate	Temperate	77
	Tropical/Sub-Tropical	46
Income	High Income	46
	Middle Income	46
	Low Income	31
Sub-income	OECD	46
	Middle-Upper	22
	Middle-Lower	24
	Low	31

most circumstances these observations turned out to be valid in terms of the original questionnaire submissions and hence legitimate extremes. Any spurious data points were corrected where possible. Where the validity of the extremes or outliers was suspect and unsubstantiated, the observations were removed from the analyses. This was only necessary in a few isolated instances.

These are not the only analyses that the WCD has done on the fully verified Cross-Check sample, but they illustrate the final performance, impact and decision-making indicators that can be derived from the data. The WCD has also conducted bivariate and multivariate analyses to highlight trends and patterns for regional and other cross-classifications. They are reported in the WCD Cross-Check Report.

Thematic Reviews

The WCD commissioned 17 thematic reviews and some 130 papers addressing five major areas of concern identified in the strategy and objectives paper:

- social and distributional issues,
- environmental issues,
- economic and financial issues,
- options assessment and
- governance and institutional processes.

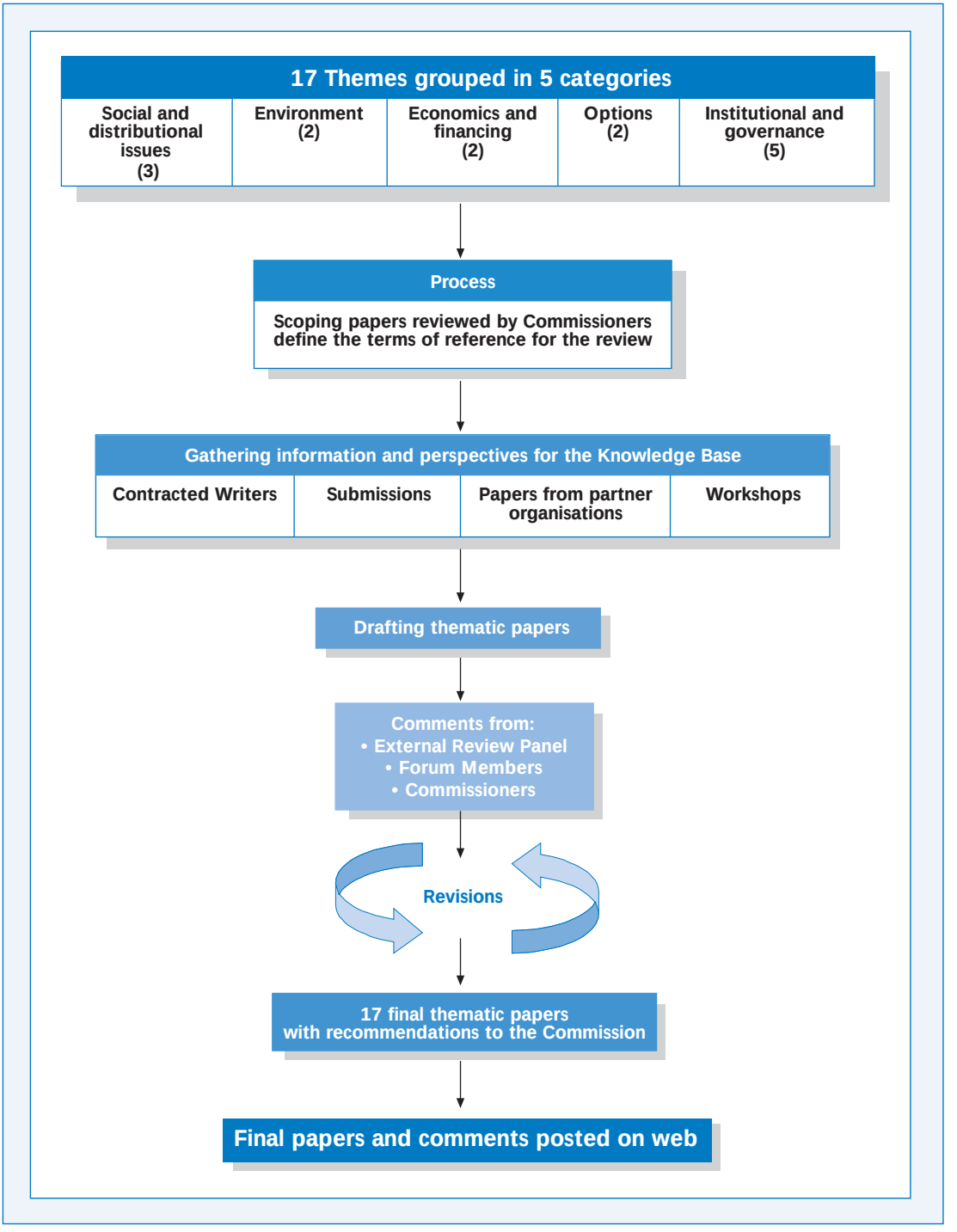
The thematic reviews provided the baseline information, analysis and recommendations on issues that cut across the central elements in the large dams debate. The reviews considered past and current experience, as well as the forward-looking context, by synthesising the state-of-the-art knowledge, practices and key viewpoints on each topic. Within limits set by available resources and the Commission's schedule, the level of effort involved in preparing these review papers varied according to the complexity of the issue and the level of controversy surrounding it. Preparation of the review papers included setting up panels and procedures for broader peer review. This

helped to bring together a wide spectrum of perspectives and approaches on the topic and to clarify the areas of potential agreement (and persistent disagreement) on highly controversial issues. The thematic review process is illustrated in Figure III.2.

Consultations and Submissions

For most of its two-year mandate the WCD followed the old adage of being 'quick to listen, and slow to speak'. Rather than plant-

Figure III.2: Thematic Review process



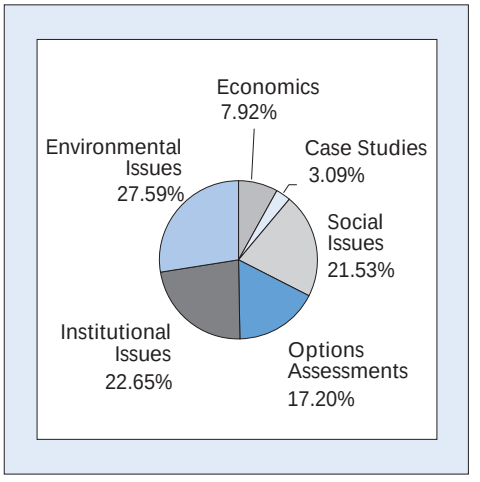
ing its opinions before it had harvested its research, the Commission canvassed views and knowledge on the costs and benefits of dams from a vast array of stakeholders. In addition to its work programme studies, the WCD established global listening posts through its submissions programme and its regional consultations. In addition to the submissions and the four regional consultations, the Commission consulted with numerous professional associations and provided input for many non-WCD stakeholder events.

A full list of submissions and reports on the regional consultations is available at www.dams.org.

Regional consultations

In total 1 400 individuals from 59 countries attended the WCD regional consultations held for South Asia, East and South-East Asia, Latin America, and Africa and the Middle East. The meetings were carefully organised to ensure broad-based participation by NGOs, governments, industries and utilities, irrigation interests, academics, financiers, and other interested parties. The WCD also participated in two hearings organised for its benefit by NGOs in Southern Africa and Europe.

Figure III.3 Topics in Submissions



The consultation process began with the choice of themes for each meeting. The themes were based on a broad range of submissions requested through a 'Call' announced and mailed out to a large list of dams' constituents some months before the regional consultation. After selecting the themes, the Secretariat invited presenters based on the relevance of their contribution to the WCD Knowledge Base and the effort to achieve balanced regional representation.

The key issues that emerged through the consultations were:

- participation and transparency in planning and decision-making on dams;
- displacement, resettlement and reparation for those negatively affected by dams;
- dams as a means to satisfy demands for food, energy, drinking water and flood control;
- assessing the costs and benefits of alternatives in providing irrigation, flood control, electricity and water supply;
- the importance of environmental sustainability;
- regional/transboundary approaches to sharing water resources, as well as conflict resolution; and
- methods of ensuring that those engaged in dam building comply with regulations, laws and policies.

Submissions

By September 2000, the WCD had received 947 submissions from 79 countries. Of those, 400 submissions were related to the regional consultations. All submissions were entered into a central database. They were catalogued by subject along the lines of the thematic reviews: social, environmental, economic and institutional issues, and options assessment. The cataloguing system allows sorting by issue, region and country. The submissions were reviewed by the Secretariat and, where relevant, were shared with lead writers and external reviewers involved in compiling the WCD Case Studies, Thematic Reviews and the Cross-Check Survey.

Annex IV
Reports in the WCD Knowledge Base

The WCD Knowledge Base served to inform the Commission on the main issues surrounding dams and their alternatives, and complemented the regional consultations, where Commissioners heard firsthand about relevant regional experience from governments, members of civil society and the private sector.

The reports listed in this Annex are available on the website at www.dams.org. They were used to synthesise and structure the wealth of knowledge that lies within the Knowledge Base, and to distill key issues, lessons learned and proposals for the future. They remain inputs to the Commission rather than products of its deliberations and thus do not represent expressions of the Commission's views and conclusions, which are contained solely in this final report.

The Case Studies and Thematic Reviews were contracted by WCD to lead authors, who were selected for their ability to respect

the Commission's guiding principles of professional expertise, independence, transparency and openness in synthesising information and perspectives from the contributing papers and the submissions. All terms of reference, and final draft reports, were peer-reviewed by local stakeholder groups (for the Case Studies) or by review panels (for the Thematic Reviews) composed of 8–10 people with varying backgrounds, regions of origin and perspectives. Working Papers were developed with partner organisations to include perspectives on particular issues.

In total, 201 people commented on the draft Thematic Reviews, and the lead writers were asked to address their comments, wherever possible, in the final report. Reviewers' comments have been included as annexes to enable the reader to better comprehend the debate. Draft and final reports for Case Studies and Thematic Reviews were available on the WCD website throughout the review process.

The Contributing Papers are listed for each Thematic Review, and the synthesis writers of the Reviews drew on them as appropriate. Some were solicited by WCD through key institutional partners; others were directly contracted to WCD terms of reference; and still others were the result of initiatives by partner organisations as direct contributions to the WCD process and knowledge base.

Case Studies

Case Study	Team Leaders
Grand Coulee Dam, Columbia River Basin, United States	Leonard Ortolano, Katherine Kao Cushing
Tarbela Dam, Indus River Basin, Pakistan	Amir Muhammed
Aslantas Dam, Ceyhan River Basin, Turkey	Refik Çölasan
Kariba Dam, Zambezi River, Zambia/Zimbabwe	Alois Hungwe
Tucurui Dam, Tocantins River, Brazil	Emilio Lèbre La Rovere, Francisco Eduardo Mendes
Pak Mun Dam, Mun-Mekong River Basin, Thailand	Songkram Grachangnetara et al.
Glomma and Laagen Basin, Norway	Jostein Skurdal
Orange River (Pilot Study), South Africa	WCD Secretariat

Country Studies

Country Study	Team of Writers
India	R. Rangachari, Nirmal Sengupta, Ramaswamy R. Iyer, Pranab Banerji, Shekhar Singh
China	Ismail Najjar, Bill Smith, Richard Fuggle, Habib Khoury, Sam Pillai, John Boyle

Briefing Paper

Briefing Paper	Team of Writers
Russia and Newly Independent States	Lilia K. Malik, Nikolai I. Koronkevich, Irina S. Zaitseva, Elena A. Barabanova

Thematic Reviews and Contributing Papers

I.1. Social impact of large dams: equity and distributional issues

Lead Writer	William Adams
Contributing Paper	**Writer**
Social Impacts of an African Dam: Equity and Distributional Issues in the Senegal River Valley.	Adrian Adams
Downstream Impact of Dams.	William Adams
Dams and Benefit Sharing. A Submission from Hydro-Quebec.	Dominique Egré, Joseph Milewski
Assessing the Project – Social Impacts and Large Dams.	Hugh Brody
Report on the Social Impact of Dams: Distributional and Equity Issues – Latin American Region.	Carmen Ferradas
Some Evidence on Overall Distributional and Equity Impacts.	Pablo Gutman
Balancing Pain and Gains – A Perspective Paper on Gender and Large Dams.	Lyla Mehta, Bina Srinivasan
Social Impacts of Large Dams: The China Case.	Lubiao Zhang

I.2. Dams, indigenous people and vulnerable ethnic minorities

Lead Writer	Marcus Colchester
Contributing Paper	**Writer**
Dams, Indigenous People and Vulnerable Ethnic Minorities: A Case Study on the Ibaloy People and the Agno River Basin, Province of Benguet, Philippines.	Jaqueline Carino
The Chixoy Dam in Guatemala: The Maya Achi Genocide. The Story of Forced Resettlement.	Jaroslave Colajacomo
A Case Study on the Proposed Epupa Hydro Power Dam in Namibia.	Andrew Corbett
The Resettlement of Indigenous People Affected by the Bakun Hydro-Electric Project, Sarawak, Malaysia.	Gabungan
Lake Winnipeg Regulation Churchill-Nelson River Diversion Project and the Crees of Northern Manitoba, Canada.	Luke Hertlein
Land Acquisition Act and Impact on Tribal Development in India.	Manisha Marwaha
Operationalisation of Free Prior Informed Consent.	Lyla Mehta, Maria Stankovitch
Dams and Tribal People in India.	Amrita Patwardhan
The Alta-Case in Norway. A Story about How Another Hydroelectric Dam-Project was Forced through in Norway.	Ande Somby

I.3. Displacement, resettlement, rehabilitation, reparation and development

Lead Writers: Leopoldo Bartolome, Chris de Wet, Harsh Mander, Vijay Nagaraj

Contributing Paper	Writer
The Experience with Dams and Resettlement in Argentina.	Leopoldo Bartolome, Christine Danklmaier
Displacement, Resettlement, Rehabilitation, Repatriation and Development. African Experience.	Chris de Wet
Displacement, Resettlement, Rehabilitation, Repatriation and Development – China Report.	Jun Jing
Displacement, Policy and Law in India.	Ravi Hemadre, Harsh Mander, Vijay Nagraj
Displacement, Resettlement, Rehabilitation, Repatriation and Development. The Mexican Case.	Scott Robinson

II.1. Dams, ecosystem functions and environmental restoration

Lead Writers: Mike Acreman, Ger Bergkamp, Patrick Dugan, Jeff McNeely

Contributing Paper	Writer
Dams and Biological Diversity – Establishing Strategic Linkages under the Conventions.	Asheline Appleton
Ecosystem Impacts of Large Dams.	Mike Acreman, Matthew McCartney, Caroline Sullivan
Managed Flood Releases from Reservoirs – Issues and Guidance.	Mike Acreman, Edward Barbier, Martin Birley, Kenneth Campbell, Frank Farquharson, Nicholas Hodgson, Jeremy Lazenby, Matthew McCartney, John Morton, David Smith, Caroline Sullivan
Capacity and Information Base Requirements for Effective Management of Fish Biodiversity, Fish Stocks and Fisheries Threatened or Affected by Dams during the Project Cycle.	Garry Bernacsek
International Mechanisms for Avoiding, Mitigating and Compensating the Impacts of Large Dams on Aquatic and Related Ecosystems and Species.	John Bizer
Definition and Implementation of Instream Flows.	Cate Brown, Jackie King, Rebecca Tharme
Information Needs for Appraisal and Monitoring of Ecosystem Impacts.	Cate Brown, Jackie King
Large Dams and Freshwater Fish Biodiversity.	John Craig
Biodiversity Impacts of Large Dams.	John Craig, Nick Davidson, Don McAllister, Dianne Murray, Mary Seddon
Biodiversity Impacts of Large Dams: Waterbirds.	Nick Davidson, Simon Delany
Fundamental Legal and Ethical Principles in Adjudging the Merits of Development Projects.	Charles DiLeva
The Influence of Dams on River Fisheries.	Donald Jackson, Gerd Marmulla

Dams and Fish Migration.	Michel Larinier
A Review of Guidance and Criteria for Managing Reservoirs and Associated Riverine Environments to Benefit Fish and Fisheries.	Steve Miranda
Molluscan Biodiversity and the Impact on Large Dams.	Mary Seddon
Report on the Conference on Hydrological and Geochemical Processes in Large Scale River Basins, 15–19 November, 1999, Manaus, Brazil.	Leonard Sklar

II.2. Dams and global change

Lead Writers	Nigel Arnell, Mike Hulme, Luiz Pinguelli Rosa, Marco Aurelio dos Santos

Contributing Paper	Writer
An Analysis of the Linkages between the UNFCCC Legal Regime and Dams.	Albert Mumma

III.1. Economic, financial and distributional analysis

Lead Writers	Alec Penman, Robert Unsworth

Contributing Paper	Writer
Methods for Valuation of Flood Control Benefits.	Colin Green
Resettlement Costs.	Pablo Gutman
Distributional Analysis.	Pablo Gutman
Survey of Multilateral Bank Practice on Financial and Economic Analysis of Large Dams.	Anneli Lagman
Methods for Valuation of Impact of Hydropower Projects.	Anil Markandya
Review Paper I - Review Paper on Financial, Economic, and Distributional Analysis .	Michelle Manion, Bruce McKenney, Robert Unsworth
Example of SAM Analysis in the Republic of South Africa.	David Mullins
Methodological Approach for the Distributional Effectiveness of Large Dams.	Kyra Naudascher-Jankowski
Review Paper II - Financial, Economic and Distributional Analysis.	Alec Penman
Methods for Valuation of Irrigation Benefits.	Douglas Southgate

III.2. International trends in project financing

Lead Writer	Per Ljung

Contributing Paper	Writer
Database Support.	Lily Donge
Hydropower Dams.	Chris Head
Multipurpose Dams.	Chris Head
Note on Financial Instruments and Incentives.	Michael Kelly
Financing Statistics, Trends and Policies of International Financial Institutions.	Hilary Sunman

IV.1. Electricity supply and demand management options

Lead Writers	Maritess Cabrera, Anton Eberhard, Michael Lazarus, Thierry Lefevre, Donal O'Leary, Chella Rajan

Contributing Paper	Writer
Renewable Options.	Glynn Morris
Major Trends in Energy Development.	Donal O'Leary
Demand Management.	Roger Peters
Life Cycle Analysis.	Bjorn Svenson
Rural and Appropriate Energy.	Rona Wilkinson
Submissions Contributing to the Thematic.	International Cogenereration Alliance, International Hydropower Association, International Atomic Energy Association, American Solar Energy Society, European Wind Energy Association, National Hydrogen Association, Gas Research Institute

IV.2. Irrigation options

Lead Writer	K. Sanmuganathan

Contributing Paper	Writer
Privatisation of Infrastructure Hydraulic Work – Chilean Experience.	Pablo Anguita Salas
Future Approaches towards Taking up Dam Projects.	S. Char
Developing Irrigation Options for Small Farmers.	Keith Frausto
Some Drainage Options.	Alfred Heuperman
Options Assessment and the Planning System in the IBIS, Pakistan.	Khalid Hussain
Biotechnology in Semi Arid Tropics.	ICRISAT
Contributions from the Latin American Experience.	Hector Maletta
Potential for Improvements of Water Harvesting.	Dieter Prinz, Anupam Singh
Irrigation and Agriculture Experience and Options in Israel.	Yehuda Shevah
Options in Agricultural Policy.	Laurence Smith
Assessment of Irrigation Options in India.	Himanshu Thakkar

IV.3. Water supply options

Lead Writers	Colin Fenn, David Sutherland

Contributing Paper	Writer
Water Efficiency Case Studies from California.	Mary Ann Dickinson
Contributions Relating to Rainwater Harvesting.	John Gould
Supporting Note.	Allan Lambert
Contributions on Community Based Systems.	Jon Lane
Example of Demand Management from South Africa.	Guy Preston
Supporting Note.	Philip Turner

IV.4. Flood control and management options

Lead Writer	Colin Green
Contributing Paper	**Writer**
Draft ICOLD Bulletin on Dams and Floods.	Luis Berga
A Review of the Role of Dams in Flood Management (draft).	Patrick Hawker
Why Multipurpose Dams Function in Japan.	Minoru Kuriki
Support to Lead Writer.	Dennis Parker
Support to Lead Writer.	Sylvia Tunstall
Assessment of Flood Management Options.	Johannes van Duivendijk
Flood Action Plan in Bangladesh.	Herb Wiebe

IV.5. Operation, monitoring and decommissioning of dams

Lead Writers	Peder Hjorth, Charles Howard, Kuniyoshi Takeuchi
Contributing Paper	**Writer**
Managing for Unforeseen Consequences of Large Dam Operations.	K. Betts, Michael Falter, Peter Goodwin
Dams in Spain.	Enrique Garcia
Hume and Dartmouth Dams, Murray Darling Basin, Australia.	Brian Haisman
Macquarie Marshes, Murray Darling Basin, Australia.	Brian Haisman
Operation, Monitoring and Rehabilitation of Dams/ Reservoirs in Japan.	Joji Harada, Kuniyoshi Takeuchi
Operation, Monitoring and Decommissioning of Dams.	Peder Hjorth
A Report on Large Dams in India.	V. Jauhari
US Federal Energy Regulatory Commission.	Thomas Russo
Operation, Monitoring and Decommissioning of Dams.	Geoffrey Simms
Ex Post Evaluation of Dams and Related Water Projects.	James Wescoat
Flushing of Sediments from Reservoirs.	Rodney White

V.1. Planning approaches

Lead Writers	David Nichols, Theo Stewart, David von Hippel
Contributing Paper	**Writer**
Planning Survey.	Daud Beg
Regional Integrated Resource Planning.	Catherine Fedorsky
Planning Survey.	Matthias Finger
Planning Survey.	J. Karmacharya
Planning Survey.	Don Moore
First Draft of Planning Approaches Thematic.	David Nichols, Theo Stewart, David von Hippel
Planning Survey.	Miguel Nucete
Planning Survey.	Girish Sant
Multiple Criteria Decision Analysis.	Theo Stewart

V.2. Environmental and social assessment for large dams

Lead Writer	Barry Sadler

Contributing Paper	Writer
Social Impact Assessment.	Frank Vanclay
Environmental and Social Impact Assessment for Large Dams – Thematic Review from the Point of View of Developing Countries.	Iara Verocai

V.3. River basins – institutional frameworks and management options

Lead Writer	Peter Millington

Contributing Paper	Writer
Dams in the Context of Transboundary/International Waters.	Len Abrams
Los Consejos de Cuenca en el Desarrollo de las Presas en México.	Enrique Castelan Crespo
Transboundary Impacts of Dams: Conflict Prevention Strategies.	Fiona Curtin
Review of the Role of River Basin Organizations in Latin America.	Luis Garcia
Water Resources National Policy in Brazil.	Raymundo Garrido
Large Dams, Transboundary Waters, Conflicts.	Ramaswamy Iyer
Dams on Transboundary Rivers.	Erik Mostert
River Basins: Institutional Framework and Management Options for Latin America.	Cecilia Tortajada
Possible Approach to the Management of Dams on International and Inter-Provincial Rivers.	Anthony Turton
Development and Transboundary Waters: Obstacles and Opportunities.	Aaron Wolf

V.4. Regulation, compliance and implementation

Lead Writers	Angela Cropper, Mark Halle, Danny Bradlow, John Scanlon

Contributing Paper	Writer
Report on International and Comparative Water Law Applicable to Large Dam Construction.	Daniel Bradlow, Gabriel Eckstein
Human Rights and Development.	Balakrishnan Rajagopal
Implementing World Commission on Dams Guidelines within an International Certification System.	Tom Rotherham
Export Credit Agencies.	Lori Udall
World Bank Inspection Panel.	Lori Udall
Transparency and Corruption Prevention when Building Large Dams.	Michael Wiehen

V.5. Participation, negotiation and conflict management

Lead Writer	Bruce Stedman

Contributing Paper

	Writer
Support to Lead Writer.	Tisha Greyling
Support to Lead Writer.	Anne Randmer
Support to Lead Writer.	Vanchai Vatanasapt
Support to Lead Writer.	Arch Isabel Viana

Working Papers

Dams and human health

Writers	Robert Bos, William Jobin, Martin H. Birley, P.V. Unnikrishnan, M'barack Diop

Dams and cultural heritage management

Writers	Steven Brandt, Fekri Hassan

Cross-Check Survey

The Cross-Check Survey – Methodology, Findings and Lessons Learned.	WCD Secretariat

Submissions

The WCD received 947 submissions from 79 countries that were reflected in the Case Study, Thematic Reviews and Regional Consultations. The full list of submissions is available on the WCD website at www.dams.org.

Annex V

Dams, Water and Energy –

A Statistical Profile

This Annex has two main sections: data on the world population of dams and regional profiles of large dams. The regional profiles present largely the statistical data that are available; social and environmental data are limited. Readers interested in further details on regional and national trends and on the issues under debate should refer to the reports on the WCD Regional Consultations, which are available at www.dams.org.

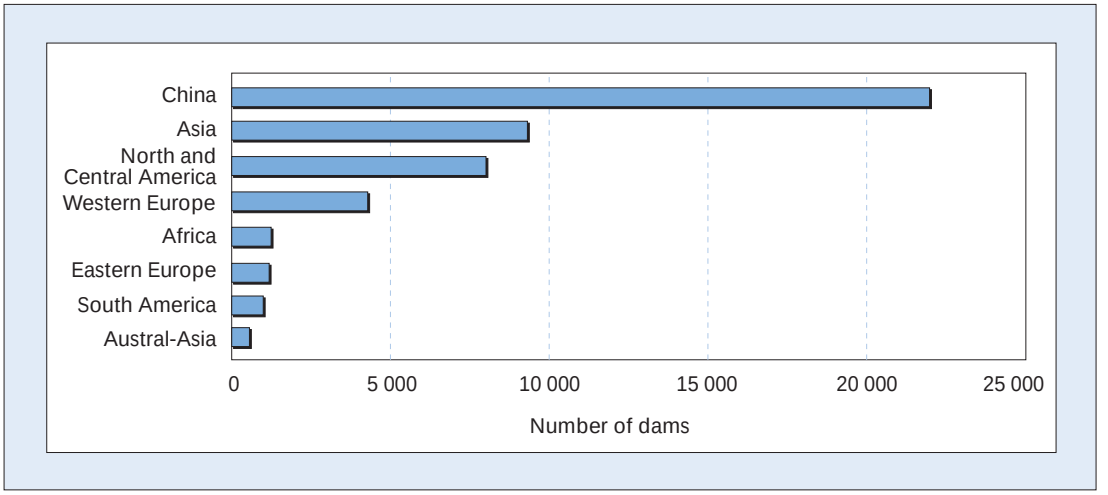
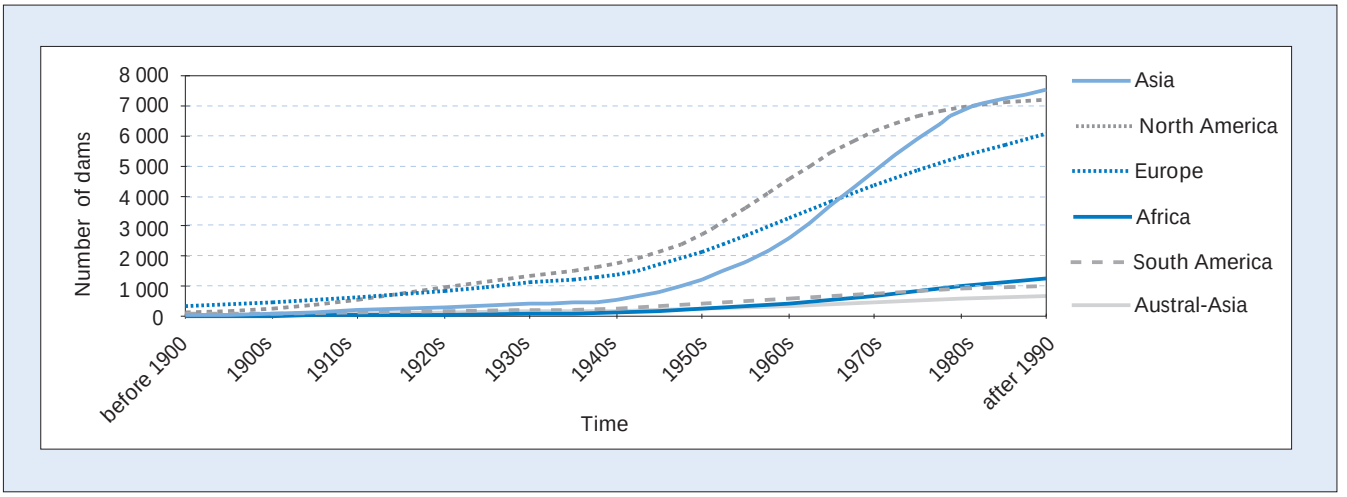


Figure V.1
Regional distribution of large dams in 2000

Source: WCD compilation of various sources and ICOLD, 1998.

Figure V.2 Cumulative commissioning of large dams in the 20th century



Source: ICOLD 1998, excluding over 90% of large dams in China.

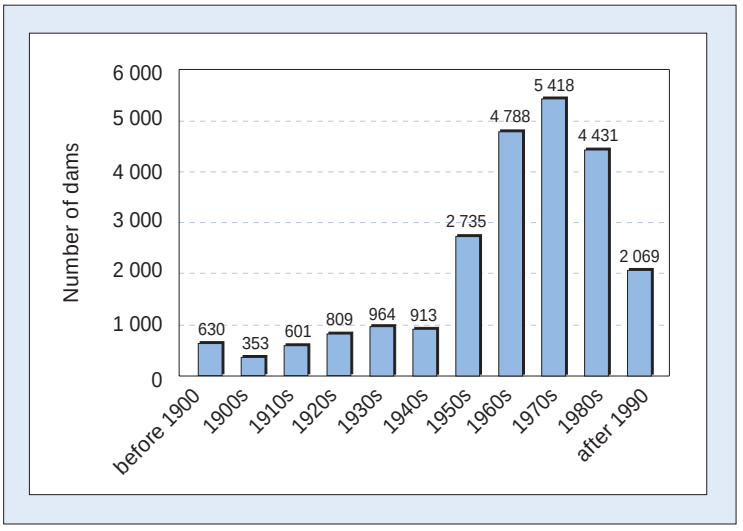


Figure V.3
Commissioning of large dams globally, by decade in the 20th century

Source: ICOLD, 1998, excluding over 90% of large dams in China.

World Population of Dams

This section is based primarily on the ICOLD *World Register of Dams* (ICOLD 1998). This voluntary register contains information on 25 420 large dams, which is a partial list, since member countries reported 41 413 dams in 1996. The register is constrained by the following: (1) it provides information on a limited set of parameters for each large dam such as location, commissioning date, purpose, height, reservoir size, spillway capacity, etc.; (2) it is incomplete for certain countries, the most significant being China with only 1 855 of the estimated 22 000 large dams registered; (3) gaps for other countries such as the Russian Federation are likely to bias the sample in similar ways; (4) data for the 1990s are underreported to an unknown extent and also contain dams that have not been completed; and (5) entries are for a dam and not a reservoir – therefore, care must be taken in finding average reservoir volume capacities and surface areas where more than one dam is associated with a particular reservoir.

Table V.1 Top 20 countries by number of large dams

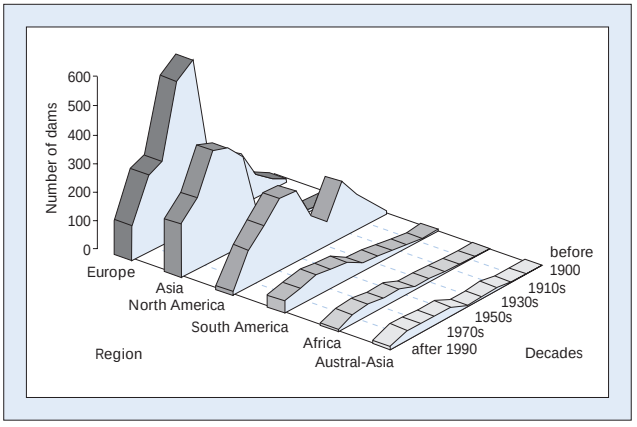
	Country	ICOLD **World Register of Dams 1998**	Other **sources**	Percent **of total dams**	Cumulative **percent**
1	China	1 855	22 000	46.2	46.2
2	United States	6 375	6 575	13.8	60.0
3	India	4 011	4 291	9.0	69.0
4	Japan	1 077	2 675	5.6	74.6
5	Spain	1 187	1 196	2.5	77.1
6	Canada	793	793	1.7	78.8
7	South Korea	765	765	1.6	80.4
8	Turkey	625	625	1.3	81.7
9	Brazil	594	594	1.2	82.9
10	France	569	569	1.2	84.1
11	South Africa	539	539	1.1	85.2
12	Mexico	537	537	1.1	86.3
13	Italy	524	524	1.1	87.4
14	United Kingdom	517	517	1.1	88.5
15	Australia	486	486	1.0	89.5
16	Norway	335	335	0.7	90.2
17	Germany	311	311	0.7	90.9
18	Albania	306	306	0.6	91.5
19	Romania	246	246	0.5	92.0
20	Zimbabwe	213	213	0.4	92.4
	Others	3 558	3 558	7.0	100.0
	Total	25 423	47 655	100.0	

Notes: There are different estimates for the number of large dams in each country. The World Register of Dams maintained by ICOLD is voluntary. By updating information on the top five countries, the WCD estimates there may be up to 48 000 large dams worldwide. As the higher estimate cannot be confirmed by more than one source, however, the WCD uses the figure of ' over 45 000' . The sources used are noted below. China is the major factor in the estimate.

China:	■ ICOLD (1998) has 1 855 dams. It notes the actual number of large dams in China may be over 20 000. ICOLD (2000) has 4 434 dams. ■ WCD China country study indicates there are over 84 000 human-made lakes, of which an estimated 22 000 have large dams by ICOLD' s definition, as reported in the WCD China Country Review. According to the Institute for Agricultural Economics (Zhang, 2000), by the end of 1999 there were 22 104 dams higher than 15m; of these, 17 526 dams were 15–30m high and 4 578 dams were over 30m (including 32 higher than 100m). There were also 320 dams under construction, 23 of which were more than 100m high. Approximately 45% of all dams were for irrigation. ■ IJHD (2000) indicates 26 094.
United States	■ ICOLD (1998) has 6 375 dams. ■ IJHD (2000) quotes an updated number of 6 575 large dams above 15 m and 75 000 dams in operation. ■ The National Inventory of Dams (USACE, 2000) indicates there were 6 390 large dams in 1996.
India	■ ICOLD (1998) has 4 011 large dams. ■ WCD India Country Review quotes 4 291 according to the National Register for Large Dams (CWC, 1994).
Japan	■ ICOLD (1998) has 1 077 large dams registered, noting that only those above 30 m in height were reported. ■ Japan Dam Almanac (Ministry of Construction, Japan, 1994), updated annually, estimates 2 675 large dams. ■ IJHD (2000) estimates 2 560 dams.
Spain	■ ICOLD (1998) has 1 187. ICOLD (Berga et al, 2000) quotes updated number of 1 196 dams. ■ IJHD (2000) estimates there are 906 large dams (above 30 m).
Russian Federation	■ ICOLD (1998) has 91; mostly hydropower dams were reported. ■ Russia has 400 human-made reservoirs larger than 3 million m^3 (a large dam, using ICOLD' s definition), according to the Hydroproject Institute, cited in the WCD Briefing Paper on the Russian Federation and NIS.

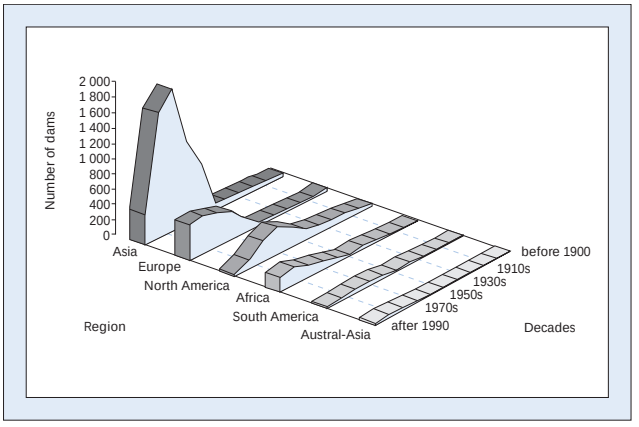
Functions of large dams, by region

Figure V.4 Hydropower dams, by region



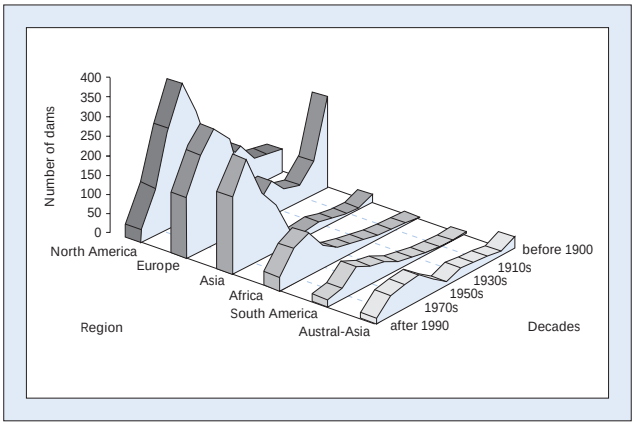
Source: ICOLD, 1998.

Figure V.5 Irrigation dams, by region



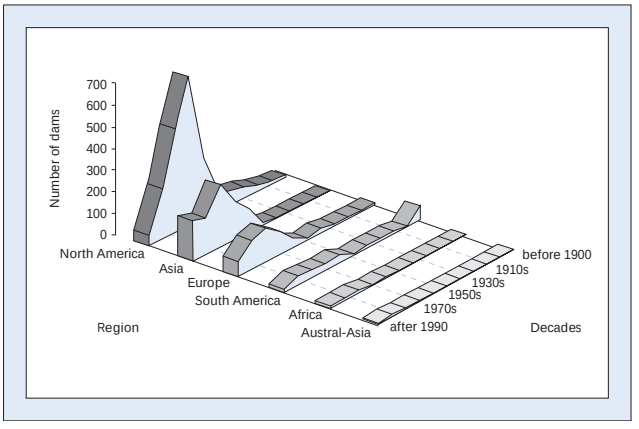
Source: ICOLD, 1998.

Figure V.6 Water supply dams, by region



Source: ICOLD, 1998.

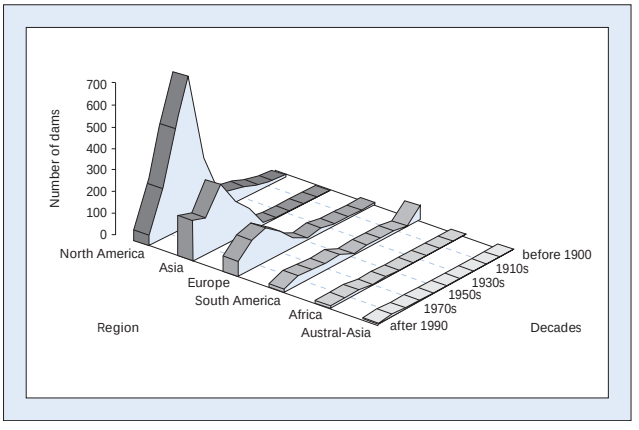
Figure V.7 Flood control dams, by region



Source: ICOLD, 1998.

Note: Over 90% of dams in China are excluded as time series data are not available. Categorisation of 140 countries of the six regions as used in ICOLD (1998) is as follows:
Africa: Algeria, Angola, Benin, Botswana, Burkina Faso, Cameroon, Congo, Côte d'Ivoire, Dem. Rep. of Congo, Egypt, Ethiopia, Gabon, Ghana, Guinea, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritius, Morocco, Mozambique, Namibia, Nigeria, Senegal, Seychelles, Sierra Leone, South Africa, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zambia, and Zimbabwe;
Asia: Afghanistan, Bangladesh, Brunei, Cambodia, China, India, Iran, Iraq, Japan, Jordan, Kazakhstan, Kyrgyzstan, Laos, Latvia, Lebanon, Malaysia, Myanmar, Nepal, North Korea, Pakistan, Philippines, Saudi Arabia, Singapore, South Korea, Sri Lanka, Syria, Taiwan/China, Tajikistan, Thailand, Uzbekistan, and Viet Nam;
Austral-Asia: Australia, Fiji, Indonesia, New Zealand, and Papua-New Guinea;
Europe: Albania, Armenia, Austria, Azerbaijan, Belgium, Bosnia-Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark,

Figure V.8 Multipurpose dams, by region



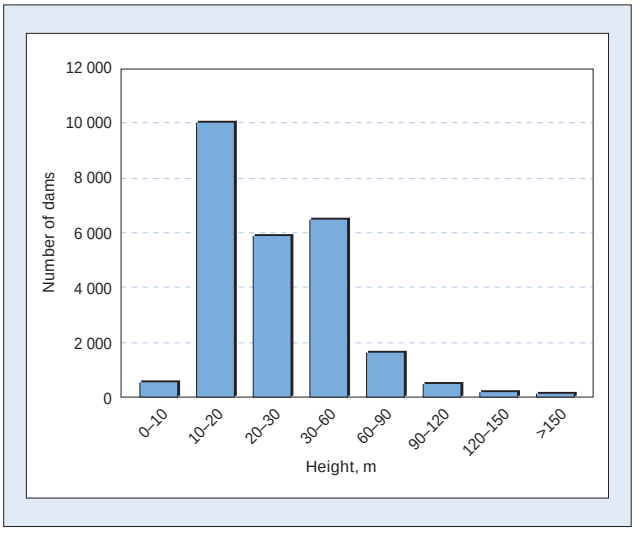
Source: ICOLD, 1998.

Finland, France, Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Lithuania, Luxembourg, Macedonia, Moldova, Netherlands, Norway, Poland, Portugal, Romania, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom, and Yugoslavia;
North America: Antigua, Canada, Cuba, El Salvador, Haiti, Honduras, Jamaica, Mexico, Nicaragua, Trinidad & Tobago, and United States; and
South America: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Guatemala, Guyana, Panama, Paraguay, Peru, Suriname, Uruguay, and Venezuela.

Physical attributes of large dams

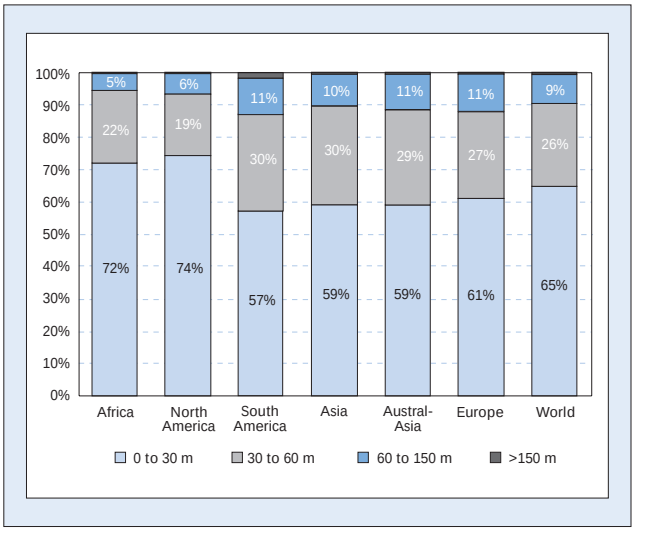
These figures show the distribution of dams by height, reservoir surface area (km^2) and reservoir volume (million m^3) globally and across the regions. These parameters have an influence on the use and operation of dams and on the nature and scope of the impacts.

Figure V.9 Global distribution of dam heights (m)



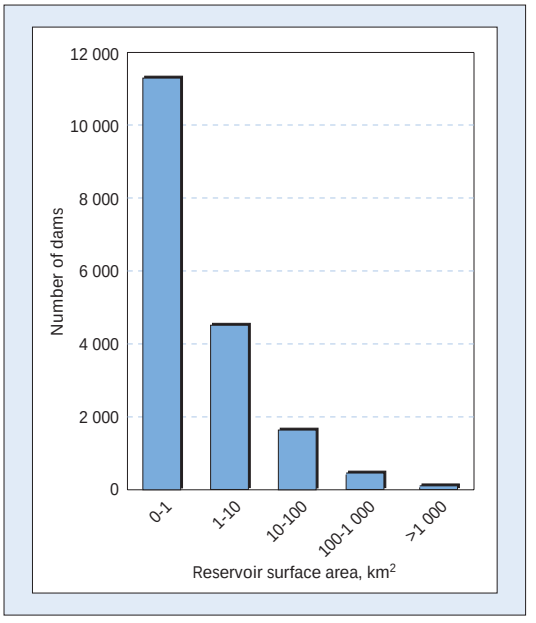
Source: ICOLD, 1998.

Figure V.10 Regional distribution of dam heights (m)



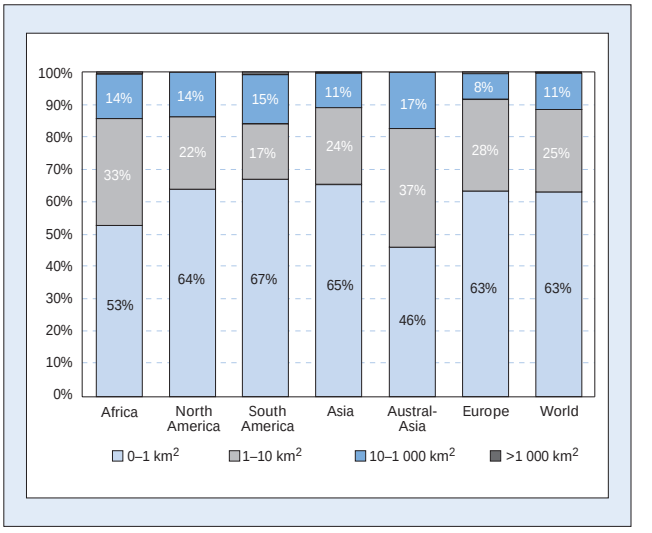
Source: ICOLD, 1998.

Figure V.11 Global distribution of reservoir surface area (km^2)



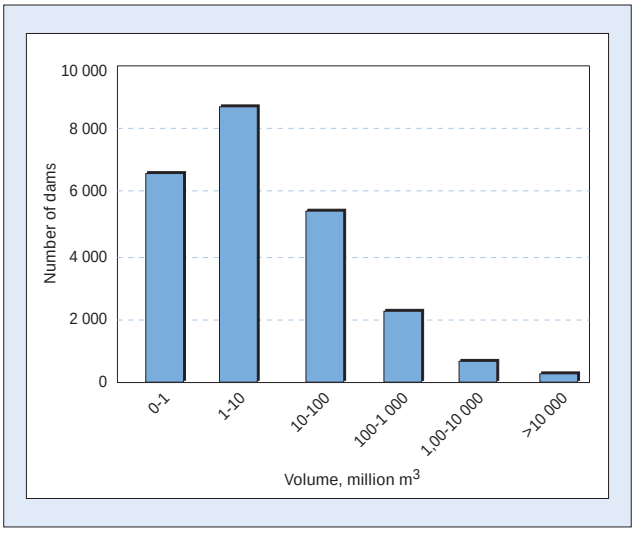
Source: ICOLD, 1998.

Figure V.12 Regional distribution of reservoir surface area (km^2)



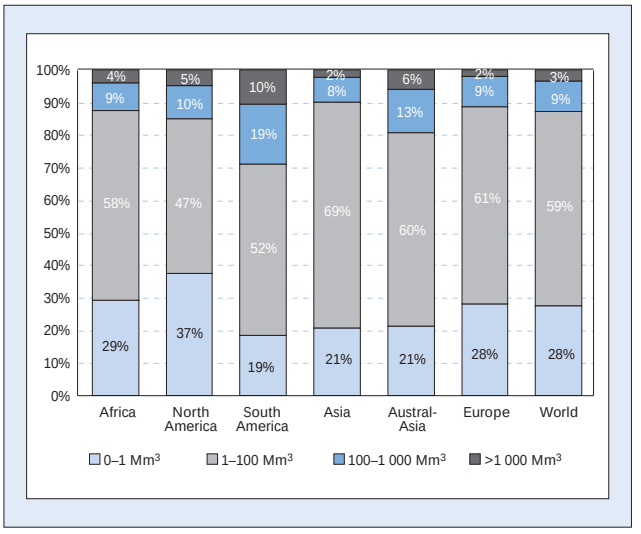
Source: ICOLD, 1998.

Figure V.13 Global distribution of reservoir volume (million m³)



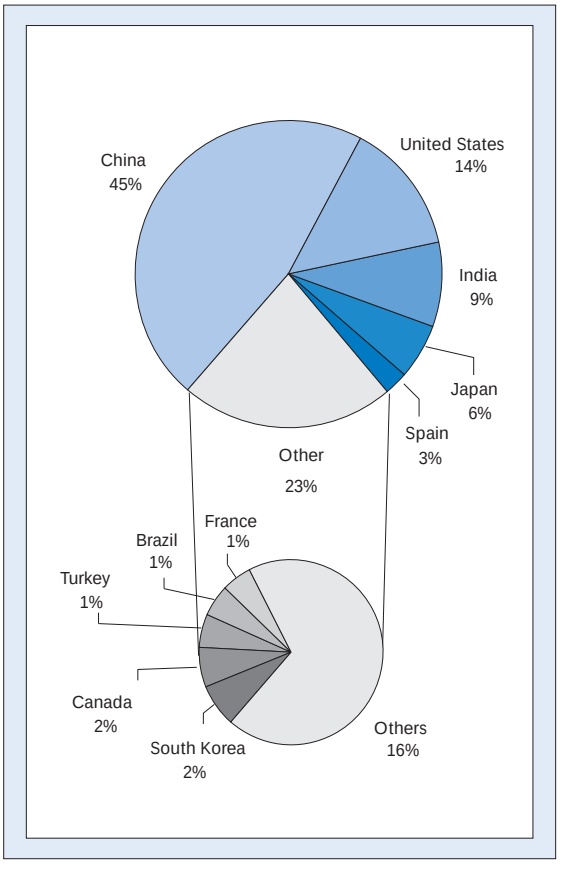
Source: ICOLD, 1998.

Figure V.14 Regional distribution of reservoir volume (million m³)



Source: ICOLD, 1998.

Figure V.15 Share of world population of dams, by country



Source: See Table V.1.

Table V.2 The 10 countries with the most large dams

By number of **large dams**		By function			
		Irrigation	Water supply	Flood control	Hydropower
1	China	China	United States	China	China
2	United States	India	United Kingdom	United States	United States
3	India	United States	Spain	Japan	Canada
4	Spain	Korea	Japan	Brazil	Japan
5	Japan	Spain	Australia	Germany	Spain
6	Canada	Turkey	Thailand	Romania	Italy
7	Korea	Japan	South Africa	Mexico	France
8	Turkey	Mexico	Brazil	Korea	Norway
9	Brazil	South Africa	France	Canada	Brazil
10	France	Albania	Germany	Turkey	Sweden

Note: This table shows that China, India and the United States have outpaced the world in building large dams, based on ICOLD 1998 and WCD correction for China.

Table V.3 Dams in 140 countries

Regions and countries	Number of dams
Africa	
South Africa	539
Zimbabwe	213
Algeria	107
Morocco	92
Tunisia	72
Nigeria	45
Côte d'Ivoire	22
Angola	15
Dem. Rep. of Congo	14
Kenya	14
Namibia	13
Libya	12
Madagascar	10
Cameroon	9
Mauritius	9
Burkina Faso	8
Ethiopia	8
Mozambique	8
Lesotho	7
Egypt	6
Swaziland	6
Ghana	5
Sudan	4
Zambia	4
Botswana	3
Malawi	3
Benin	2
Congo	2
Guinea	2
Mali	2
Senegal	2
Seychelles	2
Sierra Leone	2
Tanzania	2
Togo	2
Gabon	1
Liberia	1
Uganda	1
Total	1 269
Western Europe	
Spain	1 196
France	569
Italy	524
United Kingdom	517
Norway	335
Germany	311
Sweden	190
Switzerland	156
Austria	149
Portugal	103
Finland	55
Cyprus	52
Greece	46
Iceland	20
Ireland	16
Belgium	15
Denmark	10
Netherlands	10
Luxembourg	3
Total	4 277
South America	
Brazil	594
Argentina	101
Chile	88
Venezuela	74
Colombia	49
Peru	43
Ecuador	11
Bolivia	6
Uruguay	6
Paraguay	4
Guyana	2
Suriname	1
Total	979
Eastern Europe	
Albania	306
Romania	246
Bulgaria	180
Czech Republic	118
Poland	69
Yugoslavia	69
Slovakia	50
Slovenia	30
Croatia	29
Bosnia-Herzegovina	25
Ukraine	21
Lithuania	20
Macedonia	18
Hungary	15
Latvia	5
Moldova	2
Total	1 203
North and Central America	
United States	6 575
Canada	793
Mexico	537
Cuba	49
Dominican Republic	11
Costa Rica	9
Honduras	9
Panama	6
El Salvador	5
Guatemala	4
Nicaragua	4
Trinidad & Tobago	4
Jamaica	2
Antigua	1
Haiti	1
Total	8 010
Asia	
China	22 000
India	4 291
Japan	2 675
South Korea	765
Turkey	625
Thailand	204
Indonesia	96
Russia	91
Pakistan	71
North Korea	70
Iran	66
Malaysia	59
Taipei, China	51
Sri Lanka	46
Syria	41
Saudi Arabia	38
Azerbaijan	17
Armenia	16
Philippines	15
Georgia	14
Uzbekistan	14
Iraq	13
Kazakhstan	12
Kyrgyzstan	11
Tajikistan	7
Jordan	5
Lebanon	5
Myanmar	5
Nepal	3
Viet Nam	3
Singapore	3
Afghanistan	2
Brunei	2
Cambodia	2
Bangladesh	1
Laos	1
Total	31 340
Austral-Asia	
Australia	486
New Zealand	86
Papua New Guinea	3
Fiji	2
Total	577

Source: Based on ICOLD, 1998, IJHD, 2000 and other sources. Regional categories do not match the ICOLD classification given for Figures V.4 – V.8.

Table V.4 Number of dams under construction, selected countries		
By number of large dams		By function
India	960[a] 695[b] 16[c] – above 60 meters	Irrigation
China	280[a] 90[c] – above 60 meters	Flood control Hydropower, including pumped storage
Turkey	193[a] 209[c] – more the 60 meters	Irrigation, hydropower and water supply
South Korea	132[a] 4[c] – more the 60 meters	Multi-purpose: hydropower, flood management Water supply
Japan	463[d] 90[a] 51[c] – more than 60 meters 13[c] – more the 100 meters	Multi-purpose flood control with hydropower and water supply
Iran	48[c] – above 60 meters	Irrigation, single and multi-purpose
Note: Other countries currently building dams over 60 meters include Spain (10), Algeria (7), Italy (9), Romania (8), Brazil (6), Venezuela (5) and the Russian Federation (5).[c]		
[a] ICOLD, 1997 [b] WCD India Country Study [c] IJHD, 2000 [d] Ministry of Construction, Japan, 1999		

Regional Profiles of Large Dams

Table V.5 Summary of regional statistics on large dams							
	World[a]	Europe	Asia	North and **Central America**	South **America**	Africa	Austral-**Asia**
Total number of large dams with China	25 420[a] ~48 000[a]	5 480	31 340	8 010	979	1 269	577
Average height[b](m)	31	33	33	28	37	28	33
Average reservoir[b] area (km^2)	23	7	44	13	30	43	17
Avg. reservoir capacity[b] (million m^3)	269	70	268	998	1 011	883	205
Technically feasible hydroelectric potential[c] (TWh/year)	14 370	1 225	6 800	1 660	2 665	1 750	270
Annual Hydroelectric Production[c] (TWh/year)	2 643	552	753	700	534	62	42
Exploited technically feasible hydroelectric potential[c] (%)	>18%	>45%	>11%	>42%	>20%	>3.5%	
[a] *The primary source of data is ICOLD 1998, but the regional divisions in this Table and in Figures V.16 through V.27 follow those described in Table V.3. The 1998 ICOLD Register has 25 420 dams registered. Reporting depends on the member countries. Table V.1 indicates how the global estimate of nearly 48 000 large dams is arrived at, with the main issue being the number of dams in China.*							
[b] *The ICOLD 1998 database was used to calculate the average dam height, reservoir capacity and surface area by region.*							
[c] *IJHD 2000. Technical Feasibility is based on the conversion of all river head and flow in the major rivers in region into energy.*							

Western and Eastern Europe: hydropower in the North and irrigation in the South led dam development in Europe

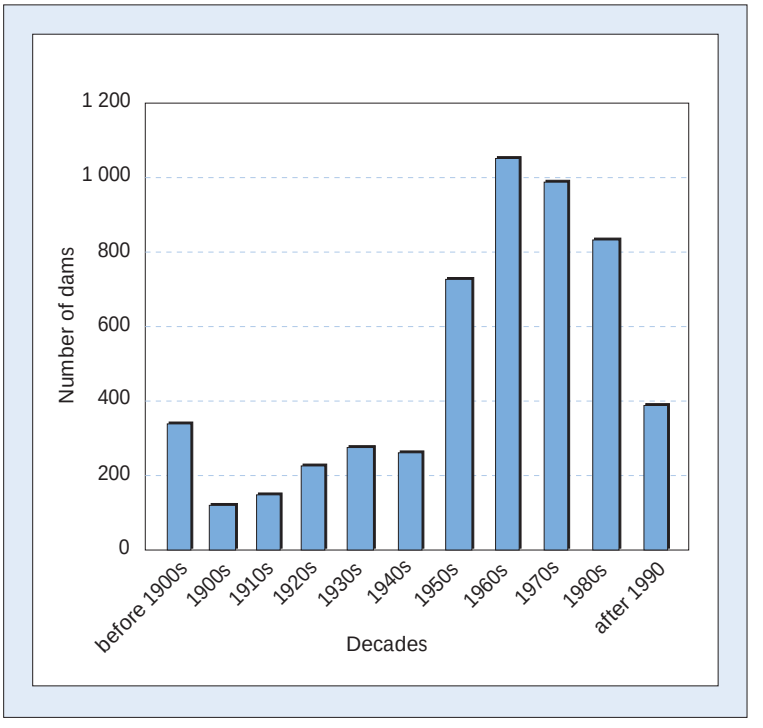
At the turn of the twentieth century, most large dams in Europe were found in the United Kingdom (220 dams).[1] By 2000, more than 4 277 large dams were registered in Western Europe; Spain built the most (about 1 200), followed by France, Italy and the United Kingdom, each with more than 500 large dams. Until 1960, France and Italy were building dams at the same rate as

Spain. East European countries have about 1 200 large dams; Albania (306 dams, almost all for irrigation) and Romania (246 dams, for all purposes) have built the most in the region.

As shown in Figure V.17, hydropower and then irrigation and water supply have been the main purposes of dams in Europe. There is marked contrast in reservoir use (and importance) across Europe, which reflects topography, rainfall and national polices, particularly on hydropower. Numerous hydropower reservoirs – often located in mountainous regions and in Nordic countries – are distinguished from the generally smaller irrigation and water supply reservoirs located in lowland and southern regions of Europe.[2] Approximately one-quarter of dams in Europe are multi-purpose. Hydropower provides more than half of the electricity supply in several European countries (86% in Albania and 90% in Iceland, for example) and more than 99% in Norway.[3]

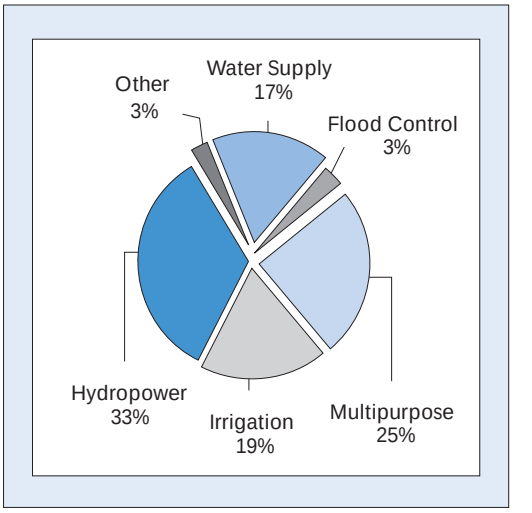
Dam construction and hydropower development passed its peak in the 1960s in many parts of Europe. At present there is a focus on refurbishment and upgrading dams and adapting to new regulations. In 2000, some 2 460 MW of additional hydroelectric generating capacity was under construction in 22 countries, with the most significant new dam development under way in Bosnia and Bulgaria. According to industry sources, other active hydropower developers are Germany (in the eastern part), Greece, Iceland, Italy, Macedonia, Portugal, Slovenia and the Ukraine.[4] Refurbishment is the main focus in many East European countries, and plans for additional dams for power and flood control have also been made. Spain is most active in dam building overall for other purposes and is now implementing a number of multi-purpose schemes. Spain has plans for further dam construction for drought management, though there is debate on these plans.

Figure V.16 Large dams commissioned per decade in Europe



Source: ICOLD, 1998.

Figure V.17 Breakdown by purpose of dams in Europe



Source: ICOLD, 1998.
Note: Rates of dam commissioning in the 1990s are underreported.

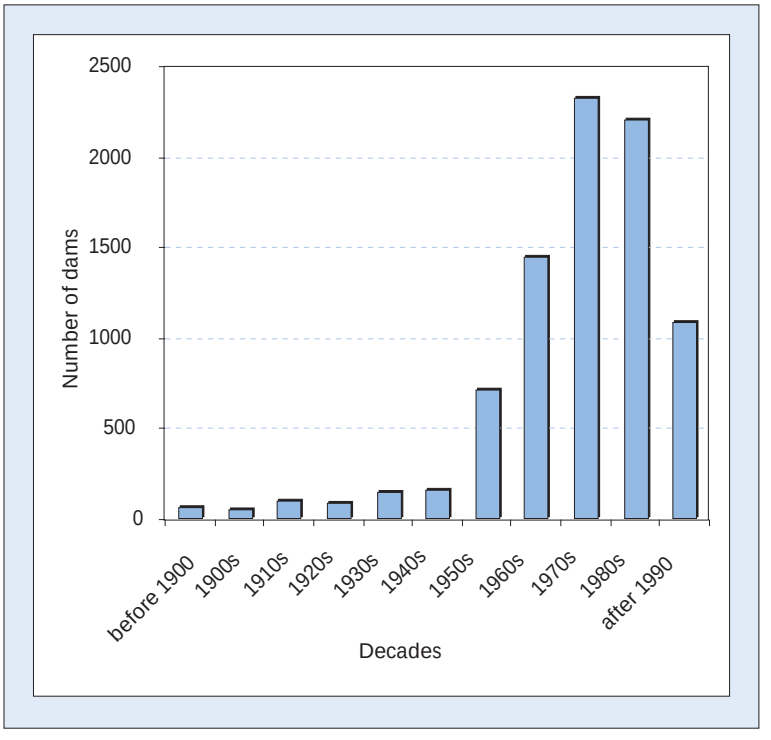
Asia: the most active region today for dam development – and historically for irrigation

Asia as a region, and particularly China and India, is one of the most active in the world in terms of the number of dams in operation, under construction and planned. China, with half the world's large dams and an active construction programme, dominates the picture. ICOLD (1998) has 8 500 large dams listed in the Asian region, but WCD estimates there are more than 30 000.

Most large dams in Asia were built for irrigation, followed by hydropower, flood control and water supply functions. A quarter are multi-purpose. These tend to be the larger projects. There are nevertheless large differences across Asia in the purpose and type of dams. The primary purposes for dams built today include irrigation in India and Turkey; flood control and power, including pumped storage, in China; flood management and hydro-pumped storage in Japan; and irrigation and power supply in Iran. Hydropower provides more than 50% of the national electricity supply in nine Asian countries. It represents 19% of the total power generation in China, 25% in India, and 19% in the Russian Federation. The balance is largely based on coal-fired generation.

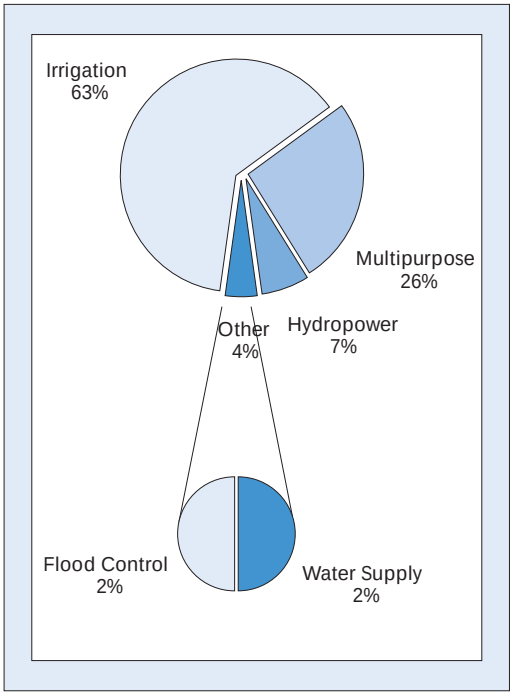
India, China, Turkey, Japan and Iran are among the most active dam-building countries overall. The overall rate of large dam building peaked in Asia in the 1970s–1980s at over 200 dams per year. Statistics (excluding China) show the pace of construction slowed in the 1990s, reflecting multiple trends, including a focus on improving existing surface irrigation infrastructure. Still, in 2000 more than 83 000 MW of additional hydroelectric generating capacity was under construction in 23 countries. The

Figure V.18 Large dams commissioned per decade in Asia



Source: ICOLD, 1998.

Figure V.19 Breakdown by purpose of dams in Asia



Source: ICOLD 1998. Note: Rates of dam commissioning in the 1990s are underreported. Figures above exclude China

majority of the development is in China, followed by India, Indonesia and Iran.

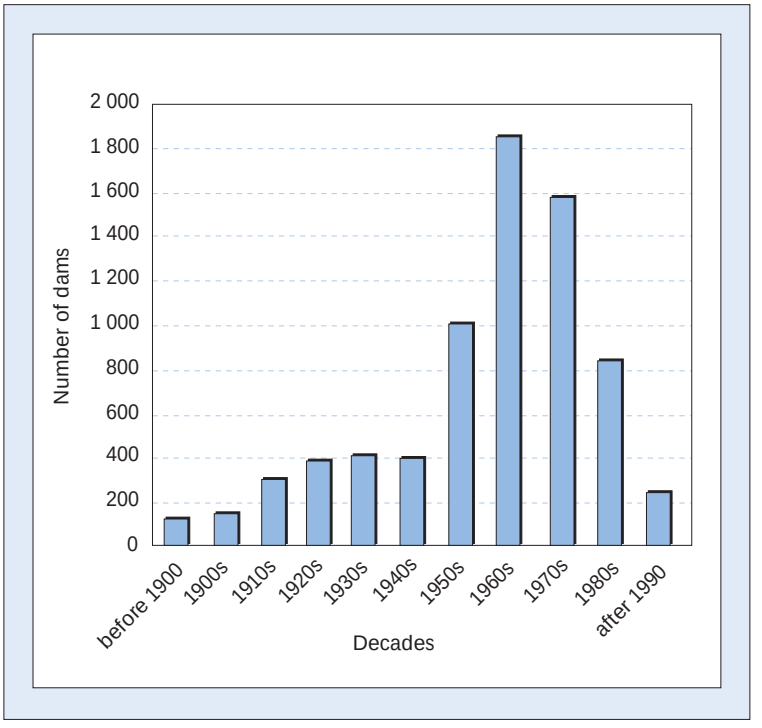
The Russian Federation, where economic and institutional restructuring are under way, has focused on completing large projects started under the former political systems but abandoned in the 1990s. Other priorities include the rehabilitation of large dams in operation. Russia is planning to construct five new large dams. Democratisation and the emergence of NGOs have led to greater involvement and public debate on water and energy, though active participation of non-governmental interests in decision-making is limited as yet.

A discussion of the issues around the development of dams in the Asian region may be found on the WCD website in the report on the South Asia Consultation held in Colombo, Sri Lanka, in December 1998 and the East and Southeast Asia Consultation in Hanoi, Vietnam, in February 2000.

North and Central America: 80% of the region's dams are in the United States

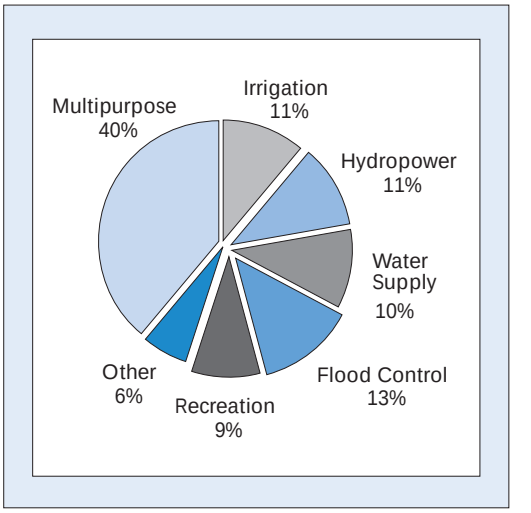
Of more than 8 000 large dams in North and Central America, about four-fifths (6 575) are in the United States. About 40% of these are multi-purpose. Hydropower provides over 50% of the electricity supply in 7 of the 15 countries in the region, including Canada, Guatemala and Honduras. Canada has the highest hydropower generation in the world; combined with the U.S., North America produces over a quarter of the world's hydropower.[5] Flood management and recreation have become principal uses of large dams in the United States, and operations are increasingly determined by those seasonal requirements. There are large variations in climate in the region, which determine the predominant use of dams locally. In southern and arid areas of the region, irrigation and water supply are more important.

Figure V.20 Large dams commissioned per decade in North and Central America



Source: ICOLD, 1998. Note: Rates of dam commissioning in the 1990s are underreported.

Figure V.21 Breakdown by purpose of dams in North and Central America



Source: ICOLD, 1998.

Dam commissioning in the region increased dramatically after the Second World War and peaked in the late 1960s at about 180 dams per year. Commissioning rates have recently decreased to about 40 dams per year (in 1990–95). In the United States, the rate of decommissioning has now exceeded the rate of construction of newly licensed large dams.

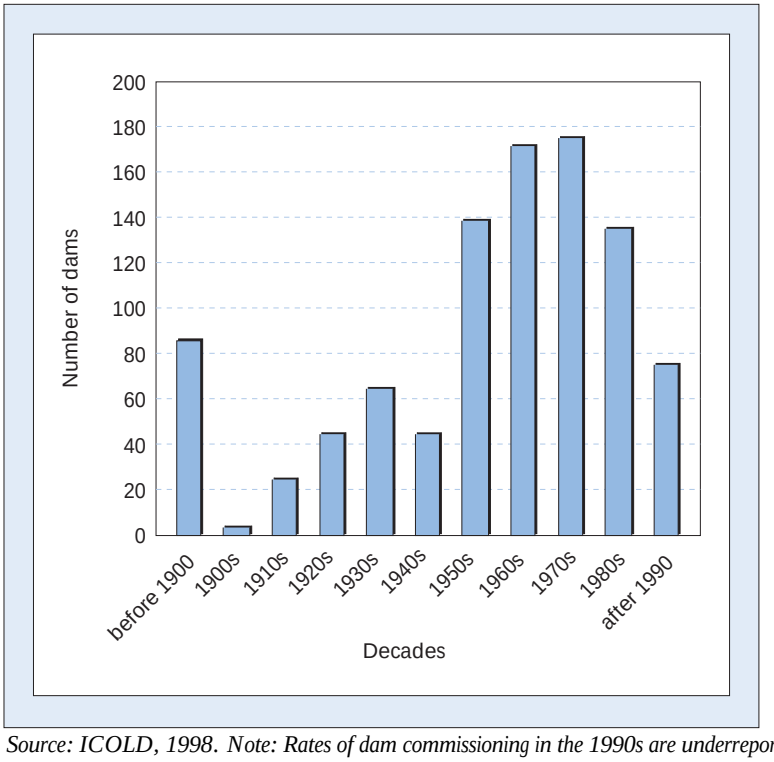
No new hydropower development is currently planned in the United States, and some 30 000 MW of existing hydropower is due to be relicensed in the next 20 years. The major activities in the United States and Canada occur around refurbishment, upgrading, optimisation of the operation of dams and, in the United States, decommissioning. Most notably, over 400 dams of all sizes, though mostly small, have been decommissioned in the United States. The only major dam reported under construction in the United States is in Puerto Rico (multi-purpose); a dam for a new water supply reservoir in California (Diamond Valley Lake) was completed in 1999. Canada has a large hydropower potential – and while more dams are proposed, especially in Quebec, Labrador and Newfoundland, there is uncertainty over such developments.

Central America has more active dam-building programmes or plans. In 2000, some 2 124 MW of hydroelectric generating capacity was under construction in five countries. High-head small hydropower is actively pursued. Among those active in the region are Guatemala, El Salvador, Costa Rica and Honduras. Mexico has 540 dams in operation and no major dams currently under construction. While more dams are planned, industry considers the outlook uncertain, given the restructuring of the power sector.[6]

South America: hydropower has driven dam building in the region, with Brazil leading

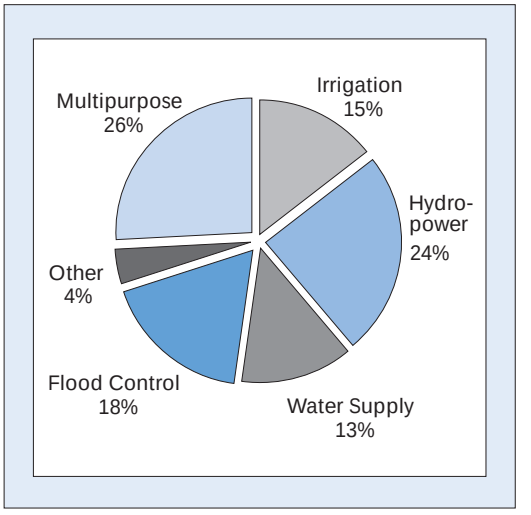
Almost two-thirds of the 979 large dams in South America are in Brazil (594 in 1998). The primary purposes for building large dams

Figure V.22 Large dams commissioned per decade in South America



Source: ICOLD, 1998. Note: Rates of dam commissioning in the 1990s are underreported.

Figure V.23 Breakdown by purpose of dams in South America



Source: ICOLD, 1998.

have been hydropower generation and flood control. Among multi-purpose dams, irrigation, flood control and water supply functions are important. The peak of the dam building in South America took place in 1960-79, when an average of 17 dams per year were commissioned.

The region's most active hydropower developers have been Brazil – which generates over 93% of its electricity from hydropower – Venezuela (73%), Ecuador (68%), Chile (57%) and Colombia (68%).[7] Hydropower supplies more than half of electricity generation in 10 of the 12 countries in the region that have dams, including Paraguay (nearly 100%) and Peru (74%).

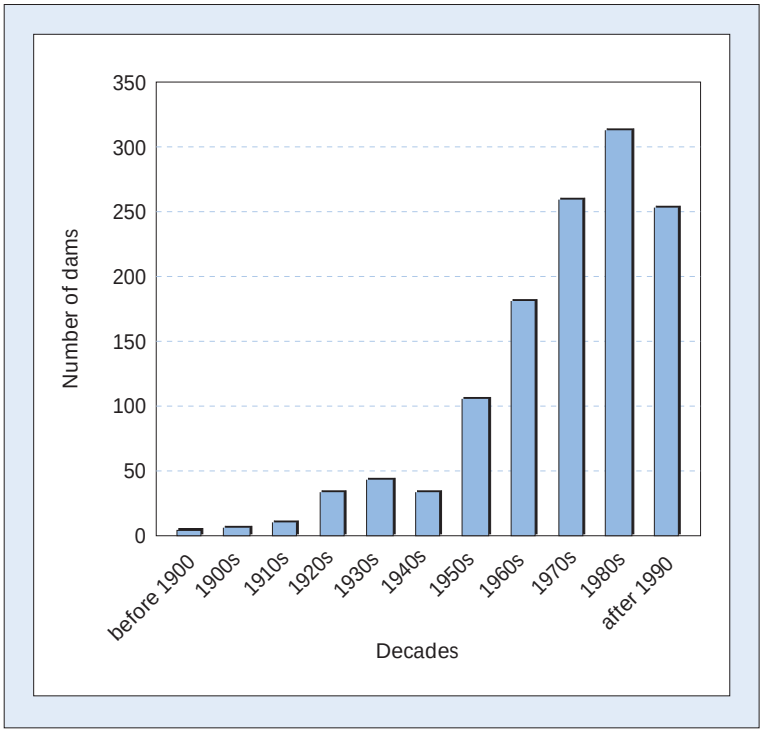
As of 2000, some 18 000 MW of additional hydropower capacity were under construction in 10 countries in Latin America.[8] Despite the large hydropower potential of the region, the expansion of natural gas networks, regional interconnection of power grids and the restructuring and privatisation of the power industry have made the prospects for large hydropower dams more uncertain. Industry projections indicate that further development in the short to medium term is likely to occur around medium and small hydropower dams.[9]

A discussion of the issues around the development of dams in the region may be found on the WCD website in the report on the Latin America Consultation held in São Paulo, Brazil, in August 1999.

Africa: irrigation and hydropower have been the main drivers for dam building

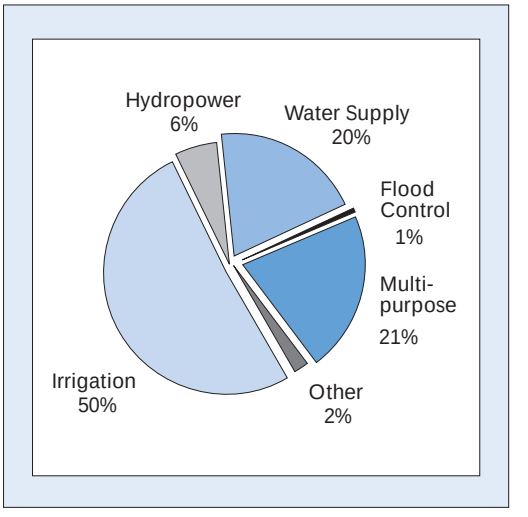
Of the over 1 269 large dams in Africa, South Africa (with between 539 and 791) and Zimbabwe (with between 213 and 233) together account for over 60% of the dams on the continent.[10] Irrigation is the single largest purpose for building large dams in Africa, especially in the northern and southern regions that have large arid or semi-arid zones. In central and other parts of

Figure V.24 Large dams commissioned per decade in Africa



Source: ICOLD, 1998. Note: Rates of dam commissioning in the 1990s are underreported.

Figure V.25 Breakdown by purpose of dams in Africa



Source: ICOLD, 1998.

Africa, which are less arid, hydropower is the primary reason for dam building.

In South Africa, large dams have a capacity equivalent to 50% of mean annual river flow. Most dams have irrigation and water supply as their main uses (just 1.9% of electricity generation is hydropower). In Zimbabwe, 87% of the large dams are embankment dams and hydropower accounts for 17% of electrical supply, mainly from the Kariba dam jointly operated with Zambia. The Southern African Power Pool Arrangement will have a major impact on the region and its investment in power supply infrastructure in the future. In Africa hydropower contributes more than 80% of electricity production in 18 countries, and over 50% in 25 countries. Droughts in East Africa in the 1990s affected power generation significantly in those regions where reservoirs were drawn down.

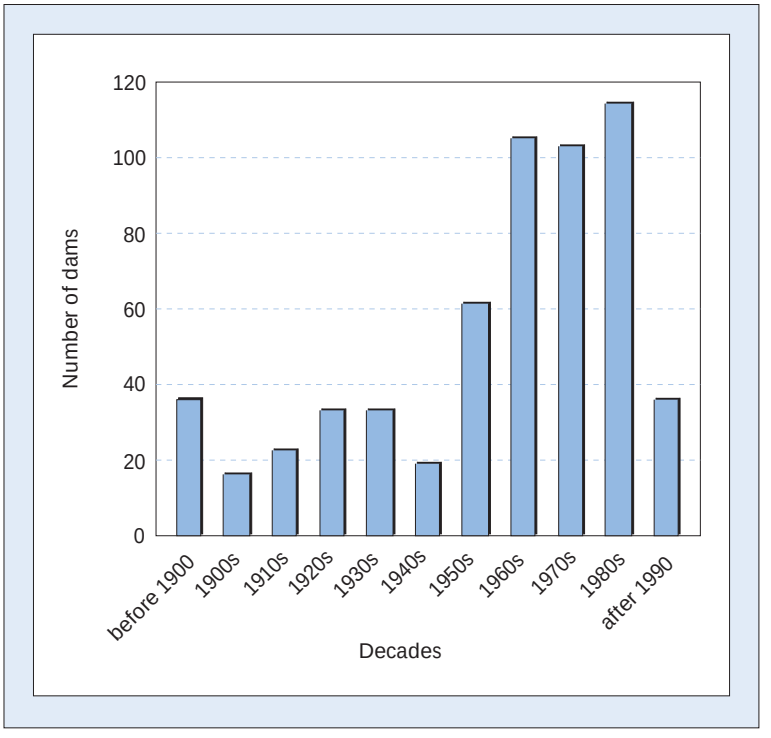
Irrigation and water resources development projects are under way in northern Africa, especially in Tunisia, Morocco (where 7 large dams are under construction) and Algeria (with 13 dams being built). As of 2000, more than 2 000 MW of additional hydroelectric generating capacity was under construction in 17 countries. Zimbabwe and South Africa have a number of irrigation and water supply large dams under construction.

A discussion of the issues around the development of dams on the African continent may be found on the WCD website in the report on the Africa and Middle East Consultations held in Cairo, Egypt, in December 1999.

Austral-Asia: close to half the dams were built for water supply

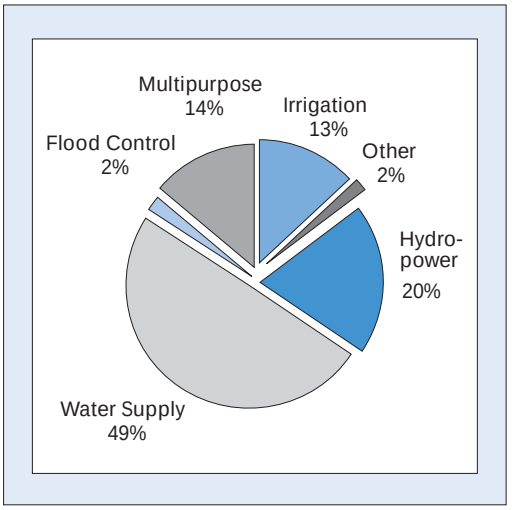
Of the nearly 577 dams in the region, the majority (486) are located in Australia. New Zealand has 86. Almost 50% of the large dams in the region were built as single-purpose water supply dams. Hydropower and irrigation were the next most important reasons for dam

Figure V.26 Large dams commissioned per decade in Austral-Asia



Source: ICOLD, 1998. Note: Rates of dam commissioning in the 1990s are underreported.

Figure V.27 Breakdown by purpose of dams in Austral-Asia



Source: ICOLD, 1998.

building. Hydropower accounts for more than 50% of electricity supply in four countries in the region (Fiji, New Zealand, Papua New Guinea and New Caledonia).

Dam building peaked in Australia and New Zealand in the 1980s (at about 10 large dams per year) and slowed dramatically in the 1990s. At present no new major dams or large hydropower projects are under way in Australia and New Zealand, though New Zealand recently completed a water supply dam. Both Australia and New Zealand have reformed the water and power sector regulatory framework, and restructured or privatised water management and power sector institutions. While there are several new dams being carried as options in longer-term planning, it appears unlikely they will go ahead in the foreseeable future.[11]

Australia and New Zealand do have several projects under way to heighten and refurbish existing dams and are generally focusing on improvement, safety and optimising the operation of existing dams. Current trends in Austral-Asia are towards small-scale hydropower development within the region's island states and towards water supply projects as demand grows.

Endnotes

1 This classification of Europe includes Western and Eastern Europe but excludes the Russian Federation and Turkey, which are reported under the Asia Region.

2 EEA, 1999.

3 Albania and Iceland from IJHD 2000; Norway from UNDP et al, 2000.

4 IJHD, 2000.

5 UNDP et al, 2000.

6 IJHD, 2000.

7 Brazil from IEA, 2000.

8 IJHD, 2000.

9 Ibid.

10 Lower figures from ICOLD, 1998; higher figures from IJHD, 2000.

11 IJHD, 2000.

Annex VI
United Nations Declarations

The Right to Development

The General Assembly,

Having considered the question of the right to development decides to adopt the Declaration on the Right to Development on December 4, 1986, the text of which is annexed to the present resolution.

ANNEX

Declaration on the Right to Development

The General Assembly,

Bearing in mind the purposes and principles of the Charter of the United Nations relating to the achievement of international co-operation in solving international problems of an economic, social, cultural or humanitarian nature, and in promoting and encouraging respect for human rights and fundamental freedoms for all without distinction as to race, sex, language or religion,

Recognising that development is a comprehensive economic, social, cultural and political process, which aims at the constant improvement of the well-being of the entire population and of all individuals on the basis of their active, free and meaningful participation in development and in the fair distribution of benefits resulting therefrom,

Considering that under the provisions of the Universal Declaration of Human Rights everyone is entitled to a social and international order in which the rights and freedoms set forth in that Declaration can be fully realised,

Recalling the provisions of the International Covenant on Economic, Social and Cultural Rights and of the International Covenant on Civil and Political Rights,

Recalling further the relevant agreements, conventions, resolutions, recommendations

and other instruments of the United Nations and its specialised agencies concerning the integral development of the human being, economic and social progress and development of all peoples, including those instruments concerning decolonisation, the prevention of discrimination, respect for and observance of, human rights and fundamental freedoms, the maintenance of international peace and security and the further promotion of friendly relations and co-operation among States in accordance with the Charter,

Recalling the right of peoples to self-determination, by virtue of which they have the right freely to determine their political status and to pursue their economic, social and cultural development,

Recalling also the right of peoples to exercise, subject to the relevant provisions of both International Covenants on Human Rights, full and complete sovereignty over all their natural wealth and resources,

Mindful of the obligation of States under the Charter to promote universal respect for and observance of human rights and fundamental freedoms for all without distinction of any kind such as race, colour, sex, language, religion, political or other opinion, national or social origin, property, birth or other status,

Considering that the elimination of the massive and flagrant violations of the human rights of the peoples and individuals affected by situations such as those resulting from colonialism, neo-colonialism, apartheid, all forms of racism and racial discrimination, foreign domination and occupation, aggression and threats against national sovereignty, national unity and territorial integrity and threats of war would contribute to the establishment of circumstances propitious to the development of a great part of mankind,

Concerned at the existence of serious obstacles to development, as well as to the complete fulfilment of human beings and of peoples, constituted, inter alia, by the denial of civil, political, economic, social and cultural rights, and considering that all human rights and fundamental freedoms are indivisible and interdependent and that, in order to promote development, equal attention and urgent consideration should be given to the implementation, promotion and protection of civil, political, economic, social and cultural rights and that, accordingly, the promotion of, respect for and enjoyment of certain human rights and fundamental freedoms cannot justify the denial of other human rights and fundamental freedoms,

Considering that international peace and security are essential elements for the realisation of the right to development,

Reaffirming that there is a close relationship between disarmament and development and that progress in the field of disarmament would considerably promote progress in the field of development and that resources released through disarmament measures should be devoted to the economic and social development and well-being of all peoples and, in particular, those of the developing countries,

Recognising that the human person is the central subject of the development process and that development policy should therefore make the human being the main participant and beneficiary of development,

Recognising that the creation of conditions favourable to the development of peoples and individuals is the primary responsibility of their States,

Aware that efforts at the international level to promote and protect human rights should be accompanied by efforts to establish a new international economic order,

Confirming that the right to development is an inalienable human right and that equality of opportunity for development is a prerogative both of nations and of individuals who make up nations,

Proclaims the following Declaration on the Right to Development:

Article 1

1. The right to development is an inalienable human right by virtue of which every human person and all peoples are entitled to participate in, contribute to, and enjoy economic, social, cultural and political development, in which all human rights and fundamental freedoms can be fully realised.
2. The human right to development also implies the full realisation of the right of peoples to self-determination, which includes, subject to the relevant provisions of both International Covenants on Human Rights, the exercise of their inalienable right to full sovereignty over all their natural wealth and resources.

Article 2

1. The human person is the central subject of development and should be the active participant and beneficiary of the right to development.
2. All human beings have a responsibility for development, individually and collectively, taking into account the need for full respect for their human rights and fundamental freedoms as well as their duties to the community, which alone can ensure the free and complete fulfilment of the human being, and they should therefore promote and protect an appropriate political, social and economic order for development.
3. States have the right and the duty to formulate appropriate national development policies that aim at the constant improvement of the well-being of the entire population and of all individuals, on the basis of their active, free and meaningful participation in development and in the fair distribution of the benefits resulting therefrom.

Article 3

1. States have the primary responsibility for the creation of national and international conditions favourable to the realisation of the right to development.
2. The realisation of the right to development requires full respect for the principles of international law concerning friendly relations and co-operation among States in accordance with the Charter of the United Nations.
3. States have the duty to co-operate with each other in ensuring development and eliminating obstacles to development. States should realise their rights and fulfil their duties in such a manner as to promote a new international economic order based on sovereign equality, interdependence, mutual interest and co-operation among all States, as well as to encourage the observance and realisation of human rights.

Article 4

1. States have the duty to take steps, individually and collectively, to formulate international development policies with a view to facilitating the full realisation of the right to development.
2. Sustained action is required to promote more rapid development of developing countries. As a complement to the efforts of developing countries, effective international co-operation is essential in providing these countries with appropriate means and facilities to foster their comprehensive development.

Article 5

States shall take resolute steps to eliminate the massive and flagrant violations of the human rights of peoples and human beings

affected by situations such as those resulting from apartheid, all forms of racism and racial discrimination, colonialism, foreign domination and occupation, aggression, foreign interference and threats against national sovereignty, national unity and territorial integrity, threats of war and refusal to recognise the fundamental right of peoples to self-determination.

Article 6

1. All States should co-operate with a view to promoting, encouraging and strengthening universal respect for and observance of all human rights and fundamental freedoms for all without any distinction as to race, sex, language or religion.
2. All human rights and fundamental freedoms are indivisible and interdependent; equal attention and urgent consideration should be given to the implementation, promotion and protection of civil, political, economic, social and cultural rights.
3. States should take steps to eliminate obstacles to development resulting from failure to observe civil and political rights, as well as economic, social and cultural rights.

Article 7

All States should promote the establishment, maintenance and strengthening of international peace and security and, to that end, should do their utmost to achieve general and complete disarmament under effective international control, as well as to ensure that the resources released by effective disarmament measures are used for comprehensive development, in particular that of the developing countries.

Article 8

1. States should undertake, at the national level, all necessary measures for the realisation of the right to development and shall ensure, inter alia, equality of opportunity for all in their access to basic resources, education, health services, food, housing, employment and the fair distribution of income. Effective measures should be undertaken to ensure that women have an active role in the development process. Appropriate economic and social reforms should be carried out with a view to eradicating all social injustices.
2. States should encourage popular participation in all spheres as an important factor in development and in the full realisation of all human rights.

Article 9

1. All the aspects of the right to development set forth in the present Declaration are indivisible and interdependent and each of them should be considered in the context of the whole.
2. Nothing in the present Declaration shall be construed as being contrary to the purposes and principles of the United Nations, or as implying that any State, group or person has a right to engage in any activity or to perform any act aimed at the violation of the rights set forth in the Universal Declaration of Human Rights and in the International Covenants on Human Rights.

Article 10

Steps should be taken to ensure the full exercise and progressive enhancement of the right to development, including the formulation, adoption and implementation of policy, legislative and other measures at the national and international levels.

Universal Declaration of Human Rights

Adopted and proclaimed by General Assembly resolution 217 A (III) of 10 December 1948

On December 10, 1948 the General Assembly of the United Nations adopted and proclaimed the Universal Declaration of Human Rights the full text of which appears in the following pages. Following this historic act the Assembly called upon all Member countries to publicise the text of the Declaration and "to cause it to be disseminated, displayed, read and expounded principally in schools and other educational institutions, without distinction based on the political status of countries or territories."

PREAMBLE

Whereas recognition of the inherent dignity and of the equal and inalienable rights of all members of the human family is the foundation of freedom, justice and peace in the world,

Whereas disregard and contempt for human rights have resulted in barbarous acts which have outraged the conscience of mankind, and the advent of a world in which human beings shall enjoy freedom of speech and belief and freedom from fear and want has been proclaimed as the highest aspiration of the common people,

Whereas it is essential, if man is not to be compelled to have recourse, as a last resort, to rebellion against tyranny and oppression, that human rights should be protected by the rule of law,

Whereas it is essential to promote the development of friendly relations between nations,

Whereas the peoples of the United Nations have in the Charter reaffirmed their faith in fundamental human rights, in the dignity and worth of the human person and in the equal rights of men and women and have determined to promote social progress and better standards of life in larger freedom,

Whereas Member States have pledged themselves to achieve, in co-operation with the United Nations, the promotion of universal respect for and observance of human rights and fundamental freedoms,

Whereas a common understanding of these rights and freedoms is of the greatest importance for the full realisation of this pledge,

Now, Therefore THE GENERAL ASSEMBLY proclaims THIS UNIVERSAL DECLARATION OF HUMAN RIGHTS as a common standard of achievement for all peoples and all nations, to the end that every individual and every organ of society, keeping this Declaration constantly in mind, shall strive by teaching and education to promote respect for these rights and freedoms and by progressive measures, national and international, to secure their universal and effective recognition and observance, both among the peoples of Member States themselves and among the peoples of territories under their jurisdiction.

Article 1

All human beings are born free and equal in dignity and rights. They are endowed with reason and conscience and should act towards one another in a spirit of brotherhood.

Article 2

Everyone is entitled to all the rights and freedoms set forth in this Declaration, without distinction of any kind, such as race, colour, sex, language, religion, political

or other opinion, national or social origin, property, birth or other status. Furthermore, no distinction shall be made on the basis of the political, jurisdictional or international status of the country or territory to which a person belongs, whether it be independent, trust, non-self-governing or under any other limitation of sovereignty.

Article 3

Everyone has the right to life, liberty and security of person.

Article 4

No one shall be held in slavery or servitude; slavery and the slave trade shall be prohibited in all their forms.

Article 5

No one shall be subjected to torture or to cruel, inhuman or degrading treatment or punishment.

Article 6

Everyone has the right to recognition everywhere as a person before the law.

Article 7

All are equal before the law and are entitled without any discrimination to equal protection of the law. All are entitled to equal protection against any discrimination in violation of this Declaration and against any incitement to such discrimination.

Article 8

Everyone has the right to an effective remedy by the competent national tribunals for acts violating the fundamental rights granted him by the constitution or by law.

Article 9

No one shall be subjected to arbitrary arrest, detention or exile.

Article 10

Everyone is entitled in full equality to a fair and public hearing by an independent and impartial tribunal, in the determination of his rights and obligations and of any criminal charge against him.

Article 11

(1) Everyone charged with a penal offence has the right to be presumed innocent until proved guilty according to law in a public trial at which he has had all the guarantees necessary for his defence.

(2) No one shall be held guilty of any penal offence on account of any act or omission, which did not constitute a penal offence, under national or international law, at the time when it was committed. Nor shall a heavier penalty be imposed than the one that was applicable at the time the penal offence was committed.

Article 12

No one shall be subjected to arbitrary interference with his privacy, family, home or correspondence, nor to attacks upon his honour and reputation. Everyone has the right to the protection of the law against such interference or attacks.

Article 13

(1) Everyone has the right to freedom of movement and residence within the borders of each state.

(2) Everyone has the right to leave any country, including his own, and to return to his country.

Article 14

(1) Everyone has the right to seek and to enjoy in other countries asylum from persecution.

(2) This right may not be invoked in the case of prosecutions genuinely arising from non-political crimes or from acts contrary to the purposes and principles of the United Nations.

Article 15

(1) Everyone has the right to a nationality.

(2) No one shall be arbitrarily deprived of his nationality nor denied the right to change his nationality.

Article 16

(1) Men and women of full age, without any limitation due to race, nationality or religion, have the right to marry and to found a family. They are entitled to equal rights as to marriage, during marriage and at its dissolution.

(2) Marriage shall be entered into only with the free and full consent of the intending spouses.

(3) The family is the natural and fundamental group unit of society and is entitled to protection by society and the State.

Article 17

(1) Everyone has the right to own property alone as well as in association with others.

(2) No one shall be arbitrarily deprived of his property.

Article 18

Everyone has the right to freedom of thought, conscience and religion; this right includes freedom to change his religion or belief, and freedom, either alone or in community with others and in public or private, to manifest his religion or belief in teaching, practice, worship and observance.

Article 19

Everyone has the right to freedom of opinion and expression; this right includes freedom to hold opinions without interference and to seek, receive and impart information and ideas through any media and regardless of frontiers.

Article 20

(1) Everyone has the right to freedom of peaceful assembly and association.

(2) No one may be compelled to belong to an association.

Article 21

(1) Everyone has the right to take part in the government of his country, directly or through freely chosen representatives.

(2) Everyone has the right of equal access to public service in his country.

(3) The will of the people shall be the basis of the authority of government; this will shall be expressed in periodic and genuine elections which shall be by universal and equal suffrage and shall be held by secret vote or by equivalent free voting procedures.

Article 22

Everyone, as a member of society, has the right to social security and is entitled to realisation, through national effort and international co-operation and in accordance with the organisation and resources of each State, of the economic, social and cultural rights indispensable for his dignity and the free development of his personality.

Article 23

(1) Everyone has the right to work, to free choice of employment, to just and favourable conditions of work and to protection against unemployment.

(2) Everyone, without any discrimination, has the right to equal pay for equal work.

(3) Everyone who works has the right to just and favourable remuneration ensuring for himself and his family an existence worthy of human dignity, and supplemented, if necessary, by other means of social protection.

(4) Everyone has the right to form and to join trade unions for the protection of his interests.

Article 24:

Everyone has the right to rest and leisure, including reasonable limitation of working hours and periodic holidays with pay.

Article 25

(1) Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control.

(2) Motherhood and childhood are entitled to special care and assistance. All children, whether born in or out of wedlock, shall enjoy the same social protection.

Article 26

(1) Everyone has the right to education. Education shall be free, at least in the elementary and fundamental stages. Elementary education shall be compulsory. Technical and professional education shall be made generally available and higher education shall be equally accessible to all on the basis of merit.

(2) Education shall be directed to the full development of the human personality and to the strengthening of respect for human rights and fundamental freedoms. It shall promote understanding, tolerance and friendship among all nations, racial or religious groups, and shall further the activities of the United Nations for the maintenance of peace.

(3) Parents have a prior right to choose the kind of education that shall be given to their children.

Article 27

(1) Everyone has the right freely to participate in the cultural life of the community, to enjoy the arts and to share in scientific advancement and its benefits.

(2) Everyone has the right to the protection of the moral and material interests resulting from any scientific, literary or artistic production of which he is the author.

Article 28

Everyone is entitled to a social and international order in which the rights and freedoms set forth in this Declaration can be fully realised.

Article 29

(1) Everyone has duties to the community in which alone the free and full development of his personality is possible.

(2) In the exercise of his rights and freedoms, everyone shall be subject only to such limitations as are determined by law solely for the purpose of securing due recognition and respect for the rights and freedoms of others and of meeting the just requirements of morality, public order and the general welfare in a democratic society.

(3) These rights and freedoms may in no case be exercised contrary to the purposes and principles of the United Nations.

Article 30

Nothing in this Declaration may be interpreted as implying for any State, group or person any right to engage in any activity or to perform any act aimed at the destruction of any of the rights and freedoms set forth herein.

The Rio Declaration

Rio Declaration on Environment and Development

The United Nations Conference on Environment and Development,

Having met at Rio de Janeiro from 3 to 14 June 1992,

Reaffirming the Declaration of the United Nations Conference on the Human Environment, adopted at Stockholm on 16 June 1972, a/ and seeking to build upon it,

With the goal of establishing a new and equitable global partnership through the creation of new levels of co-operation among States, key sectors of societies and people,

Working towards international agreements which respect the interests of all and protect the integrity of the global environmental and developmental system,

Recognising the integral and interdependent nature of the Earth, our home,

Proclaims that:

Principle 1

Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature.

Principle 2

States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental and developmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.

Principle 3

The right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations.

Principle 4

In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it.

Principle 5

All States and all people shall co-operate in the essential task of eradicating poverty as an indispensable requirement for sustainable development, in order to decrease the disparities in standards of living and better meet the needs of the majority of the people of the world.

Principle 6

The special situation and needs of developing countries, particularly the least developed and those most environmentally vulnerable, shall be given special priority. International actions in the field of environment and development should also address the interests and needs of all countries.

Principle 7

States shall cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth's ecosystem. In view of the different contributions to global environmental degradation, States have

common but differentiated responsibilities. The developed countries acknowledge the responsibility that they bear in the international pursuit to sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command.

Principle 8

To achieve sustainable development and a higher quality of life for all people, States should reduce and eliminate unsustainable patterns of production and consumption and promote appropriate demographic policies.

Principle 9

States should cooperate to strengthen endogenous capacity-building for sustainable development by improving scientific understanding through exchanges of scientific and technological knowledge, and by enhancing the development, adaptation, diffusion and transfer of technologies, including new and innovative technologies.

Principle 10

Environmental issues are best handled with participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes. States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided.

Principle 11

States shall enact effective environmental legislation. Environmental standards, management objectives and priorities should reflect the environmental and development context to which they apply. Standards applied by some countries may be inappropriate and of unwarranted economic and social cost to other countries, in particular developing countries.

Principle 12

States should cooperate to promote a supportive and open international economic system that would lead to economic growth and sustainable development in all countries, to better address the problems of environmental degradation. Trade policy measures for environmental purposes should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international trade. Unilateral actions to deal with environmental challenges outside the jurisdiction of the importing country should be avoided. Environmental measures addressing transboundary or global environmental problems should, as far as possible, be based on an international consensus.

Principle 13

States shall develop national law regarding liability and compensation for the victims of pollution and other environmental damage. States shall also cooperate in an expeditious and more determined manner to develop further international law regarding liability and compensation for adverse effects of environmental damage caused by activities within their jurisdiction or control to areas beyond their jurisdiction.

Principle 14

States should effectively cooperate to discourage or prevent the relocation and transfer to other States of any activities and substances that cause severe environmental degradation or are found to be harmful to human health.

Principle 15

In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for

postponing cost-effective measures to prevent environmental degradation.

Principle 16

National authorities should endeavour to promote the internalisation of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment.

Principle 17

Environmental impact assessment, as a national instrument, shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority.

Principle 18

States shall immediately notify other States of any natural disasters or other emergencies that are likely to produce sudden harmful effects on the environment of those States. Every effort shall be made by the international community to help States so afflicted.

Principle 19

States shall provide prior and timely notification and relevant information to potentially affected States on activities that may have a significant adverse transboundary environmental effect and shall consult with those States at an early stage and in good faith.

Principle 20

Women have a vital role in environmental management and development. Their full participation is therefore essential to achieve sustainable development.

Principle 21

The creativity, ideals and courage of the youth of the world should be mobilised to forge a global partnership in order to achieve sustainable development and ensure a better future for all.

Principle 22

Indigenous people and their communities and other local communities have a vital role in environmental management and development because of their knowledge and traditional practices. States should recognise and duly support their identity, culture and interests and enable their effective participation in the achievement of sustainable development.

Principle 23

The environment and natural resources of people under oppression, domination and occupation shall be protected.

Principle 24

Warfare is inherently destructive of sustainable development. States shall therefore respect international law providing protection for the environment in times of armed conflict and cooperate in its further development, as necessary.

Principle 25

Peace, development and environmental protection are interdependent and indivisible.

Principle 26

States shall resolve all their environmental disputes peacefully and by appropriate means in accordance with the Charter of the United Nations.

Principle 27

States and people shall cooperate in good faith and in a spirit of partnership in the fulfilment of the principles embodied in this Declaration and in the further development of international law in the field of sustainable development.

Annex VII

Members of the World Commission on Dams

Professor Kader Asmal, Chair, is a prominent member of President Thabo Mbeki's Cabinet as Minister of Education of the Republic of South Africa. Under Nelson Mandela, he was the Minister of Water Affairs and Forestry and led the fundamental review and reform of South Africa's water resource management policy. Prior to his return from exile in 1990, Professor Asmal was a law professor at Trinity College Dublin for 27 years, specialising in human rights, labour and international law. From 1980 to 1986 he was Dean of the Faculty of Arts (Humanities). He was also founder of the British Anti-Apartheid Movement as well as the Irish Anti-Apartheid Movement in 1963, and its chairperson until 1991.

In 1983, Professor Asmal received the Prix UNESCO for the advancement of human rights. In 1993, he became a member of the negotiating team of the African National Congress at the Multi-Party Negotiating Forum, and in May 1994 was elected to the National Assembly. In 1996, he was awarded the Gold Medal Award for conservation from the World Wide Fund for Nature–South Africa. He is also a patron of the Global Water Partnership. On 22 March 2000 – *World Water Day* – Professor Asmal was awarded the 10th Stockholm Water Prize by the Stockholm Water Foundation. His selection to chair the World Commission on Dams was the result of a comprehensive global search process and consultation with participants at the Gland workshop.

Lakshmi Chand Jain, Vice Chair, has served on India's National Planning Commission and Planning Boards of several states and was appointed High Commissioner for India to South Africa for 1997–99. He was a member of the Government of India's Independent Committee to report on selected aspects of the Sardar Sarovar Project. He has also served as the Chairperson of the Industrial Development Services, a techno-economic consultancy organisation in India, for 30 years. L.C. Jain received the prestigious Ramon Magsaysay Award for Public Service in 1989.

Donald J. Blackmore is the Chief Executive of the Murray-Darling Basin Commission, in Canberra, Australia. He has brought principles of environmentally sustainable water management to a major river basin initially focused on irrigation and hydroelectric power generation. Since 1990 he has served as Director and Deputy Chairperson of Australia's Land & Water Resources Research & Development Corporation. He also was a member of the International Advisory Panel for the Aral Sea.

Joji Carino's work began as an activist and analyst of indigenous peoples' issues in her native Philippines, particularly in relation to dam projects in the Cordillera region. Over 25 years she has worked as an active campaigner and advocate of indigenous peoples' human rights. She now works for the Tebtebba Foundation (Indigenous Centre for International Policy, Research, and Education). Well known for defending the interests of tribal and other indigenous peoples and minorities, she has effectively carried her agenda into global fora.

José Goldemberg is a professor at the University of São Paulo, Brazil, and has been recognized for his work on the future of energy globally. He was the chairman and CEO of the Energy Company of the State of São Paulo. He has served as Rector of his University, and as Secretary of Science and Technology for the Federal Government of Brazil and as Minister of Education. He currently serves in senior capacities with the International Energy Initiative and the Intergovernmental Panel on Climate Change. His most recent work has been as Chairperson of the World Energy Assessment.

Judy Henderson trained professionally as a medical doctor. She served as Chair of Oxfam International, was a board member of the Environmental Protection Agency of New South Wales, Australia, and a former board member of Greenpeace International. She has a distinguished record of involvement in social and environmental issues internationally. She is currently a board member of the Ethical Investment Agency.

Göran Lindahl is the President and CEO of ABB Ltd., a global technology group with headquarters in Zurich. He is a member of the Advisory Board for the Alliance for Global Sustainability, deputy chairman of the Prince of Wales Business Leaders Forum and on the advisory board of the World Childhood Foundation. He is also a frequent speaker at the World Economic Forum. An electrical engineer by profession, he has been involved in many major electricity infrastructure projects, including large hydroelectric schemes. As the head of ABB, Göran Lindahl leads one of the world's largest industrial companies. The ABB Group employs about 160,000 people in more than 100 countries.

Deborah Moore was until recently Senior Scientist at Environmental Defense, a US-based NGO, where she continues as Consulting Scientist working to protect living rivers worldwide. In the western United States, Moore has worked with Native American communities and the U.S. Congress to design and promote innovative water rights and river restoration arrangements. Internationally, she has contributed to many global water policy fora, including the Dublin Conference on Water and the Environment, and analysed the performance of large-scale river development projects and alternatives in Asia and Latin America.

Medha Patkar graduated in physical sciences and did postgraduate research in social sciences. She was a member of the faculty at the Tata Institute of Social Sciences before founding the Narmada Bachao Andolan (Struggle to Save the Narmada River) in India, a people's movement against the construction of large dams on the Narmada River and for alternatives in water, power and development. She is a founding member and National Convenor of the National Alliance of People's Movements. She is internationally recognised as a campaigner for human and political rights.

Thayer Scudder is an emeritus professor of anthropology at the California Institute of Technology. His work over 40 years on socioeconomic issues associated with river basin development has been definitive in the field. His work in Africa is best known, but he has undertaken studies of sustainable resource use in all parts of the world with a focus on resettlement and socioeconomic issues related to infrastructure development. He has also served on a number of independent review panels for dam projects in Africa and Asia.

Jan Veltrop worked with the Harza Engineering Company from 1954 to 1994 except for a three-year period when he served as Dean of the Faculty of Engineering at the University of Nigeria. He was Chairman of the U.S. Committee on Large Dams (1981-82) and President of the International Commission on Large Dams (1988-91). At Harza he was Chief Engineer, member of the Board of Directors, and retired as Senior Vice President. He worked on many world-class hydroprojects such as Mangla, Tarbela, Guri, Yacyreta, Karun-I, Ertan and Bath County pumped-storage; received ASCE's Rickey Medal in 1997 for his contributions in the field of hydroelectric engineering; and was elected a member of the National Academy of Engineering in 1998.

Achim Steiner (WCD Secretary-General, ex-officio Commissioner) has served as an advisor on international development policy as well as economic planning and natural resources management. During his career he has worked for both governmental and non-governmental organisations, with extended assignments in India, Pakistan, Germany, Zimbabwe/Southern Africa, the United States, and Vietnam. Most recently, he served as Senior Policy Advisor for Global Policy with IUCN in Washington and Chief Technical Advisor with the Mekong River Commission/GTZ, based in Hanoi, Viet Nam.

Annex VIII

A Profile of the WCD Secretariat

Programme Staff

(on September 1, 2000)
Secretary-General
Achim Steiner – Germany

Bruce Aylward – United States
Jeremy Bird* – United Kingdom
Christopher Clarke – South Africa
Lawrence Haas* – Canada
Saneeya Hussain* – Pakistan
Madiodio Niasse – Senegal
S. Parasuraman* – India
Corli Pretorius – South Africa
Jamie Skinner – United Kingdom
James Workman – United States

* Team Leader

Finance & Administration Staff

(on September 1, 2000)

Solly Fazel – South Africa
Jacques Coetzee – South Africa
Lucia Hickman – South Africa
Noluthando Magadla – South Africa
Yumna McCann – South Africa
Pamela Morris – South Africa
Nadia Richards – South Africa
Phumla Yeki – South Africa

Research Fellows

The WCD Secretariat was fortunate to have a large number of research fellows contributing to the work programme during the life of the Commission. The time they spent at the Commission ranged from one month to nine months.

Mark Cassidy – Australia
Sophia Chan – Canada
Luis Paulo Ferraz – Brazil
Nicolas Gutman – Argentina
Laurence Haller – Switzerland
Huynh Thuba – Viet Nam
Anneli Lagman – Philippines
Khutso Madubanya – South Africa
Sandi Nielsen – Zimbabwe
Pumeza Nodada – South Africa
Alice Ojwang – Kenya
Saule Ospanova – Kazakhstan
Sarah Porter – United States
Chaminda Rajapakse – Sri Lanka
Manrique Rojas – Costa Rica
Sohini Sengupta – India
Jason Switzer – Canada
Pamela Wallace – Malawi
Webster Whande – Zimbabwe

Temporary Staff

The Commission would like to recognise the contribution of the following individuals who joined the Secretariat for various periods of time:

Programme Staff

Kate Dunn – Canada
Pat Govender – South Africa
Sanjeev Khagram – United States
Elisabeth Monosowski* – Brazil
Eric Noel – Australia
Engelbertus Oud – The Netherlands

Finance & Administration Staff

Nikki Boltman – South Africa
Kathy Bova – South Africa
Michel Cozien – South Africa
Salih Hendricks – South Africa
Ian Fennell – United Kingdom
Marshay Mackay – South Africa
Ashleigh Meier – Zimbabwe

Consultants and Advisors

The WCD also wishes to acknowledge the contribution of the following individuals for their special inputs as consultants and advisors to the Secretariat and the Commissioners:

Jeremy Berkoff – United Kingdom
Maggie Black – United Kingdom
Dick Cloete – South Africa
Tim Cullen – United Kingdom
Robert Goodland – United States
Pablo Gutman – Argentina
Mark Halle – Switzerland
Minoru Kuriki – Japan
Donal O'Leary – Ireland
Katarzyna Ronda – South Africa
John Scanlon – Australia
Mark Svendson – United States
Linda Starke – United States
Allan Taylor – South Africa
Martin ter Woort – Canada

Index

The index does not cover the Executive Summary (pages xxvi-xxxvii) or the glossary (Annex II). Page numbers given in italics indicate illustrations, figures or tables.

D

E

F

G