UNEP INTERNATIONAL WORKSHOP ON ECOSYSTEM IMPACTS OF LARGE DAMS

4-6 December 2000, Nairobi, Kenya

UNEP
United Nations Environment Programme

Published by the United Nations Environment Programme 2001

DISCLAIMER

The contents of this volume do not necessarily reflect the views and policies of UNEP or contributing organizations. The designations employed and the presentations do not imply the expressions of any opinion whatsoever on the part of UNEP or contributing organizations concerning the legal status of any country, territory, city or area or its authority, or concerning the delimitation of its frontiers or boundaries.

UNITED NATIONS ENVIRONMENT PROGRAMME
Division of Environmental Policy Implementation
P.O. Box 30552
Nairobi, Kenya
Tel: +254-2-623886
Fax: +254-2-624249
E-mail: takehiro.nakamura@unep.org

Report of the Workshop

I. Opening of the Workshop

1. Mr. Donald Kaniaru, Director, Division of Environmental Policy Implementation (DEPI), UNEP officially opened the session at 9:00 a.m. on 4 December 2000. In his opening statement, he outlined the UNEP/World Commission on Dams (WCD) project, supported by the United Nations Foundation (UNF) through United Nations Fund for International Partnerships (UNFIP). He discussed UNEP's substantive contribution to this project, among others, and gave an overview of ecosystem impacts of large dams sub-project (in cooperation with IUCN), and dams issues in the environmental conventions. Raising current and projected water problems on a global scale, he also emphasized a need for re-visiting dam issues from the water perspective.

2. Mr. Takehiro Nakamura Programme Officer, DEPI, UNEP, introduced the workshop, organization objectives, and results anticipated. He indicated that the World Commission on Dams had published the final report, and based on the report, and UNEP's input into the process, the workshop aimed to:

(i) Exchange of experiences in assessment, mitigation of and financing for ecosystem impacts of large dams within the context of developing countries and countries with economies in transition; and
(ii) Discuss and provide recommendations to the international community on possible follow-up to the WCD final report and UNEP's and other partner's contribution to the WCD process, particularly in the field of avoiding and mitigating ecosystem impacts of large dams within the context of developing countries and countries with economies in transition.

3. Technical experts from the following countries attended the workshop: Argentina, Brazil, China, Croatia, Ghana, India, Kenya, Republic of Korea, Mali, Poland, Romania, Senegal, South Africa, Syria and Zimbabwe. Representatives from World Conservation Union (IUCN), United nations Centre for Human Settlements (UNCHS-Habitat), UNEP-International Environmental Technology Centre (IETC), WCD, United Nations Educational, Scientific and Cultural Organization (UNESCO) and UNEP-Global Environment Facility Coordinating Office, as well as UNEP staff members were also present. The University of Nairobi attended as observers (Annex I for the list of participants).

4. The agenda for the meeting was adopted (Annex II).

5. Mr. Robert N'Daw (Mali) was appointed chair of the proceedings of the workshop. Mr. Rhee Deok-Gil was appointed rapporteur.

II Introduction of the work of UNEP, WCD and other partners

Introduction of the work of UNEP as a contribution to WCD

6. Mr. Nakamura briefly introduced UNEP's contribution to the WCD process. This contribution included UNEP/IUCN paper on ecosystem impacts of large dams, a UNEP paper on dam issues in relation to environmental conventions, support for Regional Consultation for Africa and Middle East in December 1999, substantive input to the WCD thematic review.

7. In direct relevance to the workshop, he outlined the three reports prepared by UNEP and IUCN on, respectively, ecosystem impacts of large dams, biodiversity impacts of large dams, and avoidance and mitigation of ecosystem impacts of large dams. Particular impacts he addressed were impacts on flow regime, thermal regime, stratification, water quality, sedimentation, organisms and biodiversity, including primary production. He indicted that a series of dams have cumulative effects and further outlined possible mitigation measures, and issues relevant to compensation and decommissioning of dams. Finally he mentioned the recommendations included in the three reports.

Dams issues in relation to biodiversity related conventions

8. Ms. Ashline Appleton briefly presented th3 strategic linkages between dam issues, the WCD process and the Conventions on Biological Diversity (CBD), the Ramsar Convention and the Convention on Migratory Species (CMS). She informed the participants that the linkages went beyond the Convention provisions and provided a basis for activities under the regimes.

9. Ms. Appleton discussed the following issues: sustainable use/wise use; environmental impact assessment; alien species, ecosystem approach/integrated management of river basin resources and the programme of work for inland waters biological diversity under the CBD. She explained why they were relevant to the planning, appraisal, design, construction, operation or decommissioning of large dams.

10. She concluded by stating that dams activities were an integral component of the development process and that the Conventions affirmed their legitimacy in as long as they incorporated biodiversity considerations. The challenge therefore lay in ensuring that adverse impacts attributed to dams were mitigated to enhance their contribution to sustainable development.

Planning and Management of Lakes and Reservoirs: An Integrated Approach to Eutrophication

11. Mr. Vicente Santiago gave an overview of UNEP-IETC's activities, particularly an UNEP-IETC publication "Planning and Management of Lakes and Reservoirs: An Integrated Approach to Eutrophication". He began by stating that the publication addressed the problem of eutrophication by discussing sources, consequences, solutions and prognosis using an integrated approach. He also explained that a comprehensive review of the most important issues relating to the planning, management, prevention and/or remediation of eutrophication of lakes and reservoirs were provided in the publication.

12. He noted that the publication outlined a new approach to water resources management, particularly eutrophication, emphasising the need to simultaneously address social, cultural, economic and other associated problems while also considering the lake ecosystem.

Global Environment Facility

13. Ms. Sheila Aggarwal-Khan provided information on the activities within the framework of the Global Environment Facility (GEF)in the four focal areas: biodiversity, climate change, international waters and protection of the ozone layer. She further explained the cycle of the project identification, establishment and operation, particularly the role of the Project Preparation Funding (PDF). She indicated that GEF's focus was moving from sector to sector approach to an integrated ecosystem management approach aiming at multiple environmental benefits.

Discussion

14. In response to a query regarding mechanisms for channeling GEF funding, Ms. Aggawal-Khan replied that funding was channeled through an institution e.g. University, NGO, or government. One had to develop a proposal and decide which implementing agency they wished to collaborate with, namely, UNDP, UNEP, or the World Bank. GEF would provide funding for drafting the project proposal (PDFA USD 25,000 PDEB-USD 350,000) to enable it to be eligible for GEF project funding. She also noted that each country has a GEF focal point that had to provide a written endorsement of proposed project.

The WCD final report.

15. Mr. Jamie Skinner of the World Commission on Dams made a presentation on the work of the World Commission on Dams and its final report "Dams and Development: A New Framework for Decision-Making".

16. Responding to a question on Environmental Impact Assessments (EIAs) Mr. Skinner noted that the WCD had made several recommendations regarding EIAs, which

included a scoping phase to determine the terms of reference. He added that the terms of reference should be determined through a consultative process and that it was necessary to make provision for a compliance plan to ensure that recommendations were implemented. Regarding licences Mr. Skinner observed that institutions were often auto regulatory because they owned the dam infrastructure and regulated their own activities. He called for a change in the regulatory structure in order to increase accountability.

17. One participant spoke at length on various issues emanating from Mr. Skinner's presentation. He began by highlighting the discrepancy of figures given for people displaced by dams, which he said ranged from, 40-80 million depending on the source of figures and called for accuracy. He went on to stress that the views of the vocal minority of dam opponents should not override those of the silent majority, who were enjoying the benefits that dams provided. He took exception to WCD stating that alternatives to dams had not been considered. The participant then proceeded to discuss the issue of corruption, claiming that dams projects did not per se perpetuate corruption but that corruption was intrinsic to the development process. He then objected to a statement made in the India Country study, which claimed that irrigation only provided 10% of the food crops in India. He questioned the credibility of the Country study in light of the authors disowning this statement. He concluded by observing that the media focused on such misleading statements and therefore sensationalised dam issues.

18. Mr. Skinner began by observing that the India Country study had been complicated, involving five authors who all wrote separate chapters; but had agreed on a joint executive summary. The Commission had looked at the agreed statement as opposed to the views of individual authors. He acknowledged that the Press did misquote and misrepresent dam issues and urged the participants to use the final report as a basis for determining the Commission's views.

19. Mr. Skinner also said that the WCD had established a common ground so that extreme views on both sides of the dam debate were marginalised. This middle ground was reflected in the decision-making process and criteria and guidelines outlined in the report.

20. Another participant sought to know whether the WCD envisaged conferring natural systems with a legal personality and if so who would represent them. Mr. Skinner replied that the WCD had not contemplated conferring natural systems with a legal personality but did recognise legitimate stakeholders of such systems. He added that there needed to be a change in the national and international regulatory framework, but that the Commission did not want to dictate the required process.

21. Responding to questions on the international water agenda, alternatives to dams and donors, Mr. Skinner observed that dams were being included in the international water agenda. He gave the example of the Third World Water Forum, which was going to incorporate the Commission's findings. On alternatives, Mr. Skinner stated that the Commission had avoided endorsing particular alternatives since their implementation depended on local conditions. He referred the participants to the comprehensive reviews

of alternatives, which has contributed to the WCD process. He also noted that the assessment of alternatives depended on the institution and that most entities had a very narrow focus, which often precluded comprehensive assessment of alternatives. He concluded by saying that the Commission was awaiting reaction from various donors regarding the final report.

III Presentation of experiences

Impacts of Proposed Dams on the Thukela Estuary and Inshore Marine Environment, Kwazulu Natal, South Africa
By Mr. A.T. Forbes and Ms. N.T. Demetriades

Presentation

22. Mr. Forbes explained that the Thukela was the largest river on the east coast of South Africa. The proposed dam would affect the runoff from 30% of the catchment, but were in the planning stage. He added that the study was part of a more extensive assessment process and was aimed at investigating the effects of these dams on the estuarine and the inshore marine environment with emphasis on the Thukela Banks and the adjoining coastal areas. The Banks had a maximum width of ca. 50 km and represented the only extensive shall (40-60 m) area off the east coast of South Africa.

23. Potential impacts were assessed on the basis of anticipated changes in flow levels and sediment transport and confidence levels were based on known historical changes associated with drought effects. Anticipated effects on the estuary centred on more frequent and longer mouth closure during winter low flow periods with the development of low salinity, non tidal, lagoon type conditions. These would favour certain animal and plant species.

24. Forecasted coastal changes included the stabilisation and likely retreat of beaches to the north of the mouth which were presently maintained and accreting due to longshore drift and deposition of terrigenous sediments. These beaches are backed by coastal forecast which could be at risk in the long term.

25. Mr. Forbes observed that anticipated changes on the shelf included the extension of muddy and reef areas and a reduction in the area of sandy sediments. He added that the effects on the biota of these areas were generally conjectural at present. Available information on riverine influences on population dynamics was limited to the commercially harvested penaeid prawns where a strong correlation had been found between early summer (September – November) rains and subsequent winter (April – August) catches. The mechanism of this apparent relation was uncertain but was suspected to involve the input of land derived plant nutrients into this generally oligotrophic coastal environment.

Discussion

26. In the discussion that followed one participant enquired about the correlation between river flows and the prawn/shrimp catches and whether peak river flows were followed by high catches. Mr. Forbes replied that high austral summer flows tended to be followed by subsequent good offshore winter catches.

27. Another participant asked about the parameters used to calculate flow requirements. Mr. Forbes replied that estimation of esturaine flow requirements involved an initial characterisation of the flora and fauna before the likely implications of flow variations could be assessed and acceptable limits of variability determined. He added that a method to determine the flow requirements of different components of the river including the coastal environment was being developed.

MR. REDDY

Presentation

28. Mr. Reddy made an oral presentation on the Indian experiences on dams and their impacts.

Discussion

29. A participant noted that dams were designed to be multipurpose and the trend was moving away from single purpose dams. He agreed that with proper environmental evaluation of impacts, dams could be more efficient. Using the Volta dam as an example he added that the Kpong hydro electricity scheme was more efficient in terms of water use. The real problem was the original design and variability of rainfall.

Assessment of Impacts of Large Dams on the Ecosystems and Aquatic Biodiversity.
Mr. Abd El-Fattah El-Miski

Presentation

30. Mr. Miski began explaining that hundreds of large dams had been built on the Nile, Euphrates and on smaller rivers and wadis in Arab countries. He stated that Syria was a pioneering Arab State in large dam construction. The volume of water impounded by the forty large dams in Syria was $18km^3$. The largest dam in Syria was the Thawrah Dam, which was situated on the Euphrates. This dam impounded Lake Assad with a storage capacity of $14km^3$ and had a surface area of $600km^2$.

31. Lake Assad had contributed towards mitigating the hot, dry climate of the area. Ath-Thwarah a modern city had been created at the dam site. The dam has improved the lives of the displaced people who were previously living in poor conditions. Lake Assad had also enhanced the fishing sector and produced 3,000 tonnes of fish in 1990 and eight hundred fishermen were employed in this sector. He concluded by stating that 60,000 hectares of inundated agricultural land was compensated by reclaiming 140,000 hectares of land downstream.

Discussion

32. One participant sought to know whether any of the large dams in Syria contributed to groundwater recharge either intentionally or unintentionally. Mr. Miski responded that dams contributed to groundwater recharge but some did not retain water because they were constructed for infiltration because the geological situation meant that water could not be retained for a long time.

33. Responding to the question on the sharing of the river Euphrates and whether there was international agreement regarding the use of the river, Mr. Miski replied that Euphrates passed through Turkey, Syria, and ended in Iraq. There was no formal agreement regarding minimum share of the river resources although a Memorandum of Understanding did exist.

34. Another participant enquired about the share of evaporation fluxes in relation to minimum discharge. Mr. Miski replied that evaporation was about 2,300 mm per year, which was 10 per cent of the average inflow total capacity of the dam.

35. Responding to a question on the water quality of the Euphrates, Mr. Miski stated that it was deteriorating possibly because of agricultural return water. He added that the water quality was still acceptable in spite of traces of pesticide having been detected, and that the issue of water quality needed to be formalised so that Syria could ascertain the minimum water quality that they should receive from the river Euphrates.

36. In response to a question from the floor Mr. Miski stated that the position of the dam outflow was in the middle part of the dam because the dam's waters were used for power generation and consequently water with the least amount of sediment was required.

Impacts of Water Resources Development in Zambezi Basin
Mr. Chris Magadza

Presentation

37. Mr. Magadza made a presentation on the impacts of the water resources development on the Zambezi basin. He noted that the most dramatic impacts inlcuded the obliteration of the riparina wetlands of the Gwembe valley nd the Lake Cabora Bassa original valley. Biodiversity in these man made ecosystems had been manipulated either through intended introduction of species from neighboring ecosystems or by accidental releases as in the case of the *Tilapia nilotica*. Impacts of the reservoirs on the remaining flood plains of the Zambezi were not well documented. The impact of the Kafue scheme derived not so much from the reservoir project, but rather from the inadequately planned Kafue industrial estate, which had caused eutrophication f the Kafue Gorge dam.

38. He attributed the most conspicuous impacts of the Zambezi Basin hydroelectric development programmes to anthropogenic activities. Primary impacts were those related to the forced migration of communities in the project areas. Secondary impacts arose from the facilitation of human migrations on to the wetland environs or vicinities. The provision of infrastructures had enabled the penetration and settlement of once remote areas at an unprecedented rate, without due regard to the ecological consequences of such human transmigrations. Tertiary impacts emanated from other forms of land degradation in the Zambezi valley. Persistent annual fires for example in the Charara safari area had degraded the woodland vegetation to an extent that the hydrology of the area had been altered.

39. Mr. Magadza concluded by observing that since Lake Kariba was the first of the big dams more effort could have gone into studying its impacts outside the immediate area. Additionally, 17 years of the Kariba experience should have informed the Cabora Bassa. He added that the Zambezi delta wetlands were probably the most severely directly impacted ecosystems from water resources development programme of the Zambezi basin. The management of the Zambezi Basin wetlands required close surveillance of trends of industrial development in the Basin.

Discussion

40. One participant noted that in addition to environment risk assessment, environmental technology assessment was also an important assessment tool. Mr. Magadza replied that the stage of the dam cycle when such assessments were initiated was important and such EIAs should be part of the design and process of dam construction. He added that low-pressure turbine systems these should be constructed where minimum flow to support the technology. He gave the example of Matoka dam, a run of the lake dam, which did not always have sufficient water.

41. In replying to the issue of side benefits of large dams Mr. Magadza questioned the purpose for which dams were built and stressed that they should be designed for their intended purpose with clear provisions for administration.

42. A participant asked whether creating a new environment like Lake Kariba and subsequently introducing fish species like *Limnothrissa miodan* from Lake Tanganyika to fill that niche in the new ecosystem (which provided a basis for a whole industry), constituted the introduction of an invasive species. Several other participants commented on the definition of invasive/exotic species.

43. Responding to a question Mr. Magadza stated that organochlorine levels were rising as a result of agricultural application and sewage contamination.

Transformation of the Fluvial System linked to the big dam of Diama.
Mr. Alioune Kane

Presentation

44. Mr. Kane discussed the socio-environmental impacts of the Diama dam in the Senegal River basin. This dam was built in 1986 in the lower valley, 100km upstream from the mouth. Its primary purpose was to prevent the extension of the salt wedge, which had previously reached 360 km upstream. It's secondary objective was to retain the flood water (from July to October) and to raise the water levels for irrigation in order to improve the agricultural development of the lower and middle valley.

45. Positive impacts attributed to the Diama Dam were highlighted. These impacts included considerable improvement o the regulated flow with a discharge guarantee and revitalisation of dead valleys. Agrarian landscape changes though, had been accompanied by social upheaval and Peuls breeders had subsequently lost out. Forcing induced by the estuarine behaviour of the lower stretch of the Senegal River, down current from the Diama dam had greatly disturbed the mouth topography and coastline equilibrium. Aquatic vegetation development was sighed as a problem in some stagnant water reaches. Macrophytes have colonised irrigation and drainage canals causing serious problems. The reduction of the river currents, resulting in stagnant water and eutrophication have favoured the development of mattresses composed essentially of *Pistisa stratiotes* and in the Djoudj National Park, *Salvina molesta*. The incidence of vector borne diseases had also increased.

46. Mr. Kane stressed that it was vital to address the drainage problems experienced in the delta. The delta received the totality of wastes from hydro-agricultural schemes, which affected water quality. The impacts attributed to Diama dam and subsequent development of the rice growing schemes could be mitigated, through the rationale management of resources.

Discussion

47. Responding to a question concerning the location of the dam in the river Mr. Kane replied that the dam was not built in a tidal section of the river. He added that it was an anti-salt dam intended to combat the invasion of the salt waters. He stated that no environmental impact studies were carried out in relation to the dam.

48. The chair intervened to provide the Senegal basin context. He explained that the dam was constructed to combat a seventeen-year drought in Senegal. He stressed that a comprehensive environmental study of the whole basin was conducted through funding from USAID. Some of the problems that resulted from constructing the dam could not have been foreseen but could be mitigated. He gave the example of irrigation, which was not implemented correctly since poor drainage was causing salinasation. Mr. N'Daw added that food imports were substantial and water recession agriculture had reduced

dramatically over the years due to the drought. He stressed that the dam's positive impacts should also be noted.

Assessment of Impacts of Large Dams on Ecosystems and Aquatic Biodiversity in Nigeria.
Mr. Lekan Oyebande

Presentation

49. Mr. Oyebande discussed the impact of large dams on ecosystems and aquatic biodiversity in Nigeria. He explained that some of the dams in Nigeria had been planed without careful analysis of the hydrological aspects meaning that the reservoirs were unable to recover their full water level at the end of the wet season. He went on to say that about 50% of irrigation schemes had stalled.

50. The Federal government had spent considerable sums of money constructing dams for irrigation mainly in the dry North during the oil boom era, but related downstream development had progressed slowly. Large quantities of water had been trapped in extensive reservoirs and was lost through evaporation. Traditional water users in the downstream fadamas had been adversely affected and the ecological balance had been disturbed.

51. The impacts on various dams were highlighted as follows:

Niger/Kaniji dam

- Lower peak flows downstream of the Kaniji dam;
- Increased dry season (low) flow
- The Niger River floodplain extent and the ecosystems it supported had shrunk drastically. 45 – 70% of the floodplain of fadama lands used for traditional recession farming were lost and not many modern farms replaced them; and
- Most of the sediment load was trapped in the Kaniji dam

Oyan Dam, Ogun River

- The saline water intrusion near the intake of Lagos water supply during the dry season had been checked by the all the year round high water level in the Ogun River regulated by the dam on the Oyan River tributary;
- Proliferation of disease vectors around the reservoir; and
- Water supply to Lagos and Abeokuta urban centres and irrigation along the Ogan River floodplain.

Komadugu Yobe River in the Lake Chad Basin

- Flow reduction promoted weed growth Typha reed beds) and futher siltation which blocks some rivers in the upstream segment of the Hadejia – Nguru wetlands;

- Reduction of fish biodiversity; and
- Reduction of plant biodiversity.

52. He stressed that appropriate plans for properly coordinated reservoir management of stored water should be established to avoid rapid and irreversible changes in the fadama ecosystem and to support the sustainability of small scale irrigation; groundwater recharge; wetland cultivation; pastoralism; and fisheries and wildlife conservation. This approach should be integrated to include engineering, ecological as well as socio-economic and cultural aspects of the people in the affected areas. Such approaches could only succeed if based on sound research of hydrological, ecological and socio-economic impacts of fadama rehabilitation on rights and access to wetland resources and on the nature of conflicts between the different users.

Discussion

53. A participant asked whether there was a scheme regarding water management for the river catchment areas in Nigeria. Mr. Oyebande replied that the policies existed but implementation was poor. The Federal government, he indicated, was responsible for planning water management and each State was responsible for its own water supply. Various river basin authorities managed the irrigation and the hydro-power dams. He observed that water was not efficiently used and irrigation schemes of many existing dams had not t been completed due to lack of funding although the dams had been in existence for a considerable period.

The Impact of large dams on ecosystem and aquatic biodiversity: the Volta experience

Mr. Chris Gordon and Ms. Selina K. Yawson

Presentation

54. Mr. Gordon began by stating that the Volta River had one of the largest drainage basins in Western Africa with a total area of about 390,000 km^2. He explained that there were two hydroelectric dams on the river, the larger Akosombo dam (8,400 km^2 of surface area) and the Kpong head pond. Since the formation of the Volta Lake in 1965, Ghana had benefited in several ways from the construction of the dam, e.g., hydroelectricity, navigation and fisheries. However this gain had been at the expense of 80,000 displaced people, lost of habitat and loss of ecological integrity. He outlined the upstream effects, which were related to loss of the riverine fish community, forest habitats, terrestrial biodiversity and changes in the thermal and chemical character of the water. The dams had a regulatory effect on the discharge of the river, which ranged between 470 and 980 $m^{3/}s$. Prior to dam formation, monthly average discharge ranged between 3,500 and 11,000 $m^{3/}s^{-1}$.

55. The reduction in variability flow has resulted in significant downstream impacts on the ecosystem as well as on aquatic biodiversity. These included changes in the soils of the former floodplain and reduction in the range and abundance of commercially important species, such as clams and prawns. These impacts had compromised the

livelihoods of the people downstream of the dam. The effects of change of flow had also impacted on the coastal and marine environment by altering the river and delta morphology, which had also led to loss of mangroves and other critical habitats. He concluded by suggesting that some of these negative impacts were unavoidable, but many could have been mitigated by changes in dam design and operation.

Discussion

56. A participant remarked that Mr. Gordon's presentation suggested the annual river flow had reduced after the dam was constructed and asked enquired whether this could be attributed to hydro operations. Mr. Gordon linked this phenomenon to the engineers who managed the water by holding it back. He added that the spillway had not been used for the last 15 years.

57. Responding to a question regarding the decline in inflow over the last few years Mr. Gordon replied sedimentation was affecting the upper reaches of the lake. The Chair provided background information by observing that the dam was designed in the 1960s using rainfall data that were no longer applicable since rainfall had significantly decreased in the Volta River basin. He also added that the dam's design had relied on calculations on the size of floods in the past and now periods of drought meant that water levels were reduced to such an extent that the spillway did not function.

58. One participant asked about the dam's benefits, which were not mentioned in the presentation. Dr. Gordon explained that the time constraints had prohibited him from expanding on the benefits. The dam was important for navigation, fisheries, water supply, and irrigation. He observed that hydropower production was vital because Ghana could not afford to import oil to meet total energy demands at the current prices. Volta's contribution was fundamental because thermal energy production was not significant.

59. Another participant remarked that dams were designed at a particular period without anticipating future changes in conditions.

Assessment of Impacts of Large Dams and Mitigation Measures in Maharashtra State.
Mr. V. Ranade

Presentation

60. Mr. Ranade gave an overview of the dam experience in Maharashtra State. He explained that Maharashtra State was located on the West Coast of the Indian Sub-Continent and received 85% of its annual precipitation in only three and half months from June to September by the Southwest monsoon. Irrigated agriculture was dependent mainly on reservoir-canal irrigation schemes. Maharashtra State also had nearly fifty percent of the dams constructed in India.

61. The appreciable reduction in reduction in floods downstream of the dam attributed to flood moderation resulting from the reservoir. This was sighted as a

favourable impact. The infrequent and occasional floods of a reduced magnitude resulting from the storage and moderation effect of the dam could however cause the river bed level downstream to rise, because the bedsilt would not be transported into the main river course through the downstream tributaries. The raised bed levels would reduce the outsell for natural drainage lines which could cause water logging, if soils in the command area were deep and nondrainable.

62. Maharashtra State was the first State in India to enact *The Maharashtra Resettlement Project Displaced Persons act (1976*). This act incorporated provisions for acquisition of surplus land (under *The Land Ceiling Act*) from command areas for allotment to affected people.

63. Mr. Ranade concluded by highlighting other favourable impacts such as enhanced land productivity, increased hydropower generation and fisheries development. He also mentioned other indirect benefits such as assured water for domestic/drinking purposes, industrial use, and employment generation.

Discussion

64. A participant commented that figures from the recently concluded Climate Change Conference in The Hague indicated that projected temperatures in 2050 for parts of India and Africa were likely to rise by 4 degrees centigrade. There was also likely to be a 2mm per day deficit in rainfall. He asked then asked about the minimum capacity of dams required to accommodate such a scenario and gave the example of Zimbabwe where small dams dried up under the slightest conditions of stress. Mr. Ranade gave the example of Northern India where the situation was likely to be different. Predictions for run-off were likely to be greater because rising temperatures were going to lead to snowmelt. Dams consequently had to be designed to anticipate these predictions although this was difficult.

65. Replying to a question concerning population demographics in relation to dams Mr. Ranade said that generally dam decreased migration into the cities so demand for water in those cities was also reduced.

The application of Ecohydrology Concept on Mitigation of Large Dam Impacts on the Environment.
Mr. Maciej Zalewski

Presentation

66. Mr. Zalewski presented the application of the Ecohydrology Concept for the mitigation of large dam impacts on the environment. He observed that a holistic approach was required to mitigate large-scale multidimensional human impacts generated by large dams. A new concept in integrated river basin management had been developed under the UNESCO IHP V programme on Ecohydrology. The essence of ecohydrology lay in using ecosystem properties as management tools for enhancing the absorbing capacity of freshwater ecosystems against human impact. Previously the emphasis in

freshwater management had been focused on the elimination of threats such as floods and droughts. The amplification of opportunities within environmental management had been neglected.

67. He stressed that it was important to integrate the dynamics of three components: catchment, water and biota in ecohydrology (EH); which was defined as the science of integrating hydrological processes with biota dynamics over varied spatial and temporal scales. This approach would create a holistic model for the river system in the basin scale, analogous to the "Platonian superorganism", thus implicitly indicating the management targets; the maintenace of sustainability; measurable of biodiversity, water quality and quantity.

68. Emphasis lay in using dams as positive tools in creating sustainable water management of the river basin. Ecological processes at the basin scale had to be understood and on the basis of this analysis dams could be sited to increase the resilience of the ecosystem. Dams could also compensate for negative modifications that occurred in the catchment areas due to population growth.

Assessment of Impacts of Large Dams on the Ecosystems and Aquatic Biodiversity: Integrated Coastal and River Basin Management Demonstration Project for Cetina River in Croatia.
Mr. Ivica Trumbic

Presentation

69. Mr. Trumbic, Director of the Priority Actions Programme (PAP/RAC) of MAP-UNEP, presented the Conceptual Framework and Planning Guidelines for Integrated Coastal Area and River Basin Management (ICARM) and the ICARM Demonstration Project for the Cetina River Watershed and the Adjacent Coastal Area, between Croatia and Bosnia and Herzegovina. He stressed the importance of that approach for assessing the impacts of dams and their potential contribution in the sustainable development of river basins and coastal areas. He explained that UNEP had initiated the preparation of ICARM guidelines and collaborated with PAP/RAC to undertake the task.

70. He went on to describe ICARM, its relevance and implementation methods and stressed that it was essential to understand that coastal areas and river basins were closely linked in terms of physical and socio-economic processes. Coastal ecosystems could suffer from serious consequences if sound management practices were not employed in the upstream river basins, thousands of kilometres away. Similarly, coastal areas (marine and terrestrial) contributed to the socio-economic development of river basins.

71. Mr. Trumbic then presented the Cetina River Project, which was supported by UNEP. He explained that the river was small (105km) but was very important to the Dalmatian coastal region in Croatia, in terms of water and energy supply. It was located in the karstic region, which had significant hydro-energy potential. This hydro-energy

potential was almost fully realised through the construction of a system of storage reservoirs and hydropower plants.

72. Dam construction on the river had a number of negative impacts in the river basin as well as in the coastal zone. These impacts ranged from reduced minimum flow, loss of natural habitats, landscape degradation, water pollution, to coastal erosion and sedimentation. He stated that the positive impacts should not be disregarded. He concluded by emphasising that poor management practices were often responsible for the negative environmental impacts, and that they should be regulated in order to avoid the negative consequences in the future.

Discussion

73. Responding to a question on the location of freshwater springs, Mr. Trumbic replied that most of the springs were found in coastal areas in the terrestrial parts and that these springs were not exploited. He also added that the construction of river structures had a positive effect.

A brief Overview on Eco-Environmental Impacts of the Tana River Dams, Kenya
Mr. Kenneth Mavuti

Presentation

74. Mr. Mavuti began by stating that the Tana River, at bout 1,000 km long was the largest river course in Kenya. The river and its watershed contained a catchment area of nearly 100,000 km^2. He added that, five dams and reservoirs Kindarum, Kamburu, Gitaru, Masinga and Kiambere had been built on the upper midcourse since 1964. The construction of these dams had contributed moderate to severe adverse environmental impacts on the Tana River ecosystem. The most pronounced impact of development upon the river system being attributed to the large (120 km^2) Masing dam, which gave absolute control over the Tana River flow regime. Mr. Mavuti went on to discuss a confirmed proposal to construct the Grand Falls dam, a relatively larger (more than 200 km^2) dam, in the near future to harness the Tana River waters from eastern Mount Kenya at the Tana/Kathita River confluence below Kiambere dam. Building this dam would reduce the sediment load to the alluvial floods from 6.35 m^3/sec to 5.3m^3/sec further reducing yearly rise of the riverbed by 40%.

75. He explained that potentially 91,000 ha could be irrigated on the Tana but only 18,841 ha were currently in use; 79% still had to be developed. He noted that financial and other implementation constraints had hindered the implementation of the schemes.

76. The reduced flooding of the Tana River basin was attributed to environmental impacts caused by the existing dams. These impacts had also impacted negatively on agricultural activities and pastrolist livelihoods. 1,310 households from the inundated area had been involuntarily resettled. Predictions indicated that an additional 3,140

households would be displaced within a 3 km buffer zone if the High Grand Falls was realised.

77. Community participation in the dam construction planning process, whether directly or through the active involvement of agencies and institutions had been insignificant. Existing planning procedures were also inadequate and based on limited information. Dam development in Kenya, as in other parts of Africa, had resulted in unequal distribution of benefits, ignoring the existing patterns of customary land tenure and riverine resource use. Downstream flood plain regimes and their farming systems had also been disrupted, resulting in increased social stratification, and the local improvised population had not benefited from the irrigation schemes.

78. Mr. Mavuti observed that constructing the Grand Falls dam without provision for regular sediment and water release would have major physical consequences on the ecosystem. Adverse impacts would include: decreased river flow; interruption of flood regime; hydrological changes in river flow and sedimentation; limited regeneration of riverine forests; reductions in biological productivity; loss of wetland habitat downstream; and reductions in downstream ecology; production of fish and changes in the total aquatic ecology.

Discussion

79. One participant raised the issue of migratory species and observed that in the river Matonga gorge eel had been caught in the last seven years which indicated that they were able to by-pass the Kariba dam by scaling the wall. Mr. Mavuti remarked that this scenario was not applicable in Kenya and wondered how eels were able to scale a 50-metre wall. The participant replied that as long as the wall was wet they were able to scale using their suckers. Mr. Mavuti added that in Sudan fish ladders were actually functioned as fish traps since local inhabitants were simply able to retrieve fish from these ladders.

80. Another participant noted that the Tana River was turbid and enquired whether there was a silt removal mechanism incorporated in the dam design. Mr. Mavuti replied that there was no efficient removal mechanism but there was no evidence of loss of dam depth. The proposed dams on the Tana River system had a bypass for silt incorporated in their design.

Environmental Impacts of Large Dams in Argentina, 'Lessons and Recommendations'
Mr. Alberto T Calcagno

Presentation

81. Mr. Calcagno began by explaining that large dams and reservoirs had contributed significantly towards meeting Argentina's water demands in addition to promoting economic development in different regions. He noted, however, that negative social and

environmental impacts had been experienced. Questions about the economic efficiency of dams combined with increasing public awareness of environmental issues were inhibiting the development of new dam projects.

82. He observed that the demand for irrigated, agricultural land and hydropower had not been satisfied in Argentina. Multipurpose dam/reservoir projects could therefore be instrumental in meeting these needs. He stressed that lessons learnt from past practice were useful in identifying key issues that should be taken into consideration for future initiatives.

83. He discussed how an integrated water resource management/an ecosystem approach; strategic planning and participatory mechanisms at the watershed level should provide the context for developing informed decision processes at project level. He gave the example of the strategic action plan for the Binational Bermejo River Basin which had been formulated to address these issues and establish an appropriate context for the assessment of three large dam projects designed for flow regulation.

Discussion

84. Responding to a question relating to the status of dams in relation to a river basin approach, Mr. Calagano explained that dams should be re-analysed in the context of a strategic framework for the whole basin. He added that the traditional cost/benefit analysis did not take externalities into account or cover a full basin analysis. The new procedure would involve a strategic programme for the whole basin including all riparian countries and dams would be re-analysed in this context.

The Sao Francisco River System, Brazil
Mr. Rolando Gaal-Vadas

Presentation

85. Mr. Gaal-Vadas presented the Sao Francisco River system in Brazil. He noted that it was one of the most important rivers in Brazil and was known as the "River of National Unity". The 740,000 km^2 basin, which drain across the North East Brazil to the South West Atlantic Ocean, was well endowed with a rich variety of natural resources, including minerals, fish, wildlife, and land suitable for agricultural development. He however added that the 3200km river and its watershed had been subjected to intense economic development pressures.

86. Historically the river was operated exclusively for energy production and for water supply for irrigation projects. Modifications of the natural hydrological regime of the river, which had contributed to the production of "clean" energy, had proven especially destructive. Organisms dependant on the quantity, quality, timing and rate of water flows for reproduction and survival, especially in the estuarine and coastal marine endpoints of the basin had been affected. This scenario also affected groundwater sources dependent on surface water flows for recharge.

87. The geomorphology of the river had been significantly modified by regulation (e.g. erosion of riverbanks, sedimentation, formation of islands in the delta, and erosion of the southern extreme of the delta). These modifications had not only affected the estuary by altering flooding cycles, but had also impacted the nearshore marine environment by modifying the nutrient and sediment content of the river water, affecting marine fauna and the sediment and turbidity dynamics of the estuary. Observed, although unquantified, changes in the aquatic fauna, flora and geomorphology of the river mouth had also been noted.

88. Actions required to reduce the impacts were then given: (i) sound engineering design; (ii) quantification of water use (quantity and quality) and integrated operational criteria; (iii) multi-sectoral and public participation in the process of basin management; (iv) creation of basin committees and water user associations, representing different users and interests; (v) application of modern water resources management principles such as tradable water rights, financial mechanisms (including polluter pays principle, water decision support systems; (vi) formulation of a watershed management programme (including information sharing and (vii) strengthening of Federal, State and local institutions.

89. Mr. Gaal-Vadas concluded by discussing one of the most important ongoing programmes in the basin; the GEF/UNEP/OAS/Federal Government of Brazil Programme called "Integrated Management of Land-based activities in the Sao Francisco Basin". This involved the implementation of pilot projects to address key problems, and development of a watershed management programme.

Discussion

90. Responding to a question concerning managing contamination, Mr. Gaal-Vadas observed that the programme involved building sewage treatment plants to reduce contamination, because the basin was the largest contaminator of the coastal systems.

A Balance between positive and negative effects of dams - The Romanian Experience
Ms. Liliana Mara

Presentation

91. Ms. Mara discussed the impacts of dams in Romania. She noted that Romania had relatively modest water resources and experienced high fluctuations in rainfall. The construction of dams and reservoirs played an important role in Romania's economic and social development, taking into account that the usable potential was just 5km^3/year and the total water demand at the national level was 19.4km^3/year in 1989 and about 10km^3/year in 1999.

92. Romanian legislation stipulated that reservoirs had to be designed for multipurpose usage. Owners of the hydraulic works were obliged to utilise the water

intakes of dams and reservoirs in accordance with dispatch graphs, on the basis of the monthly operating programmes. This provision was to ensure that flows necessary for water supply and flood control, correlated with the power generation activity. The evolution of dam construction and generally water resource development in the last 100 years was closely related to hydropower development and the need for water regulation for domestic and industrial water supply, land irrigation, flood control or navigation purposes.

93. Ms. Mara concluded by saying that since 1960 Romania had introduced the management of waters on hydrographic basins and had elaborated on the first plan for water development for the whole country. It had subsequently become a framework for the development and management of water resources and had been periodically updated.

Discussion

94. One participant asked whether there was a mechanism for dissipating hydraulic energy when it hit the bottom of the dam wall since the drop was 169 metres. The participant mentioned the problem of costly repairs to dam outlets after water discharge. Ms. Mara explained that there had only been a free discharge of water on one occasion and that compensation reservoirs in place to accommodate such situations. She went on to add that it was important to have agreement with all the reservoir users in the catchment area and to have in place licenses and policies regarding water management.

The Ecosystem impacts of the Mantali dam in the Senegal River Basin
Mr. Robert Tiebile N'Daw

Presentation

95. Mr. N'Daw gave a comprehensive overview of the Malian context: location, economy, natural resource potential and state of the environment. He presented the ecosystem impacts of the Mantali dam in the Senegal River basin as an example. He emphasised that in Mali the dam projects were initiated in an attempt to alleviate the economic, social and environmental degradation resulting from drought and desertification. He recalled that after the long drought in the Sahel, the past decades had witnessed a significant reduction of rainfall (100 to 150 km shift of the isohyetes southward, increase of the mean temperature). The River Niger's mean annual discharge had since reduced by more than 27%. Its middle course had even dried up in 1983 and the central delta's flooded area had reduced five fold. The Mantali dam presentation highlighted the dam's impacts on the upper Senegal basin. Measures taken before, during and after the construction of the dam were presented briefly.

96. In his conclusion Mr. N'Daw called for a better understanding of the potential role of water management and dams when implemented at the river basin scale, as one of the most important means available to combat the impacts of ongoing climate change and of local anthropogenic degradations. He stressed that dams could be instrumental in alleviating poverty and social degradation in this century. He also added that regional

cooperation between riparian States concerning the numerous shared river basins could play an important role in Africa. He called on the international community to place more emphasis on assessment and management of water resources. He mentioned demand side management and the domestication of plants of limited water needs. The freshwater balance of the continents could be improved through a basin and inter-basin scale approach, particularly in Africa.

Discussion

97. A participant asked whether there were any historical records of rainfall patterns that could indicate whether the present trend was cyclic or if this was a general trend in decline in rainfall was being experienced. Mr. N'Daw replied that records for the past 100 years had analysed using shifting averages of 5 years. The evidence was that rainfall had decreased, and planning of future projects had to consider this general reduction of water resources.

98. Another participant sought clarification about the effects of the Mantali dam, which was responsible for the reduction in water levels of the river downstream river and whether it accelerated the effects of the drought since the reservoir use was not correctly implemented. Mr. N'Daw clarified several issues explaining that the dam was completed in 1985 and slowly filled until 1987. The drought affected the dam operations because the floods were greatly reduced. The downstream effect was mainly caused by the reduction of rainfall in the basin and not because of the dam operations. He went on to clarify the location of the Mantali dam, which is not located in the Niger River basin.

Main Environmental Problems of Yuqiao Reservoir and its Comprehensive Treatment Plan
Mr. Jin Xiangcan

Presentation

99. Mr. Jin presented the Yuqiao Reservoir, an important water storage facility and a source provider of water for Tianjin City. He indicated that the reservoir provided water for domestic, agricultural and industrial use. In the last ten years, because of rapid economic development in Tianjin City the pollution load into the reservoir had increased and the water quality in the reservoir had deteriorated.

100. The reservoir was hypereutropic and was of between Grade IV-V water quality according to the Chinese standard with Grade I excellent and Grade V worst. He went on to present a comprehensive treatment plan for pollution by utilising the lake eutrophication control theory of integrating pollution sources control with ecological restoration.

Discussion

101. Commenting on non-source points of pollution one participant remarked that it would be difficult to clean up the reservoir where one could not identify the sources of pollution. Mr. Jin gave examples of several interesting technologies created by Chinese experts, such as reservoir shoreline pollution removal wetlands using soil/plant systems.

102. Mr. Nakamura confirmed that the illustration that Mr. Jin had given was typical of other Chinese reservoirs.

Water Resource Management, Dams and Environmental Impacts in Korea.
Mr. Deok- Gil Rhee Mr. Dong-Hwan Joeg

Presentation

103. Mr. Rhee began by stating that more than 18,000 dams and reservoirs had been constructed in the Republic of Korea because water resources were limited. The reservoirs retained the rainwater in the rainy season for use in the dry season. Most of the dams supplied drinking water and it was imperative to protect water resources and improve the water quality of major rivers and lakes through national plans and programmes.

104. It was becoming difficult to allocate optimum sites for dams in the Republic of Korea because of the environmental and social impacts attributed to dams. The lakes were characterised by large catchment areas per water surface, and large inflow of nutrients into the reservoirs, which resulted in water pollution and eutrophication. Because mot lakes were elongated, stream-shaped and had jagged shorelines with some dented parts, this sometimes resulted in retarded water flow or stagnated water bodies. Pollutants accumulated provided favourable conditions for algal formation.

105. Residents around the dam sites suffered from cold winters and hot summers. The number of foggy days had also increased affecting crop production and public health. Fish species were adversely affected and introduced species dominated native species.

106. The government had established comprehensive measures to improve the riverine ecosystemand water quality of the Han River in 1998, the Nakdong River in 1999 and the Keum and Yeongsan Rivers in 2000. These measures were based on a long-term perspective for restoring the resource including resolving current conflicts between up and downstream users. The Ministry of Environment was also in the process of transforming water supply policy to focus on demand management and implementation of comprehensive measures on water conservation to tackle future water scarcity problems.

107. In his conclusion Mr. Rhee stated that because the Republic of Korea had limited water resources, increasing demand for water had called for the construction of dams resulting in the destruction of natural ecosystems and loss of biodiversity. The prevailing

consensus suggested that wise use of existing water resources and demand management strategies were more national solutions to meeting water dams.

Discussion

108. A participant asked whether the environment impacts of large dams illustrated in a number of slides could be attributed to deterioration of water quality and intrusion of exotic species. He went on to ask whether these were impacts by the dams or impacts on the dams by humans through land use. Mr. Rhee said that impacts were on the dams and also caused by the dams. Referring to exotic species, he added that their impacts were not foreseen. He went on to say that the destruction of ecosystem was partly caused by human activities and that eutrophication attributed to non-point sources.

109. A participant remarked that since most reservoirs had very short retention periods (approximately ten days), considerable inputs of pollutants from the catchment must be received in the reservoirs resulting in them becoming so rapidly eutrophic. Mr. Rhee confirmed that the reservoirs were experiencing pollution from human activities especially agriculture.

110. Another participant sought to know the extent that dams in the Republic of Korea were used for the generation of hydropower and whether there were alternative sources of energy. Mr. Rhee explained that nuclear power and thermal power were the main sources of power generation.

IV. Discussion on recommended actions

111. Mr. Nakamura explained that the three documents: ecosystem impacts of dams, biodiversity impacts of dams and mitigating impacts of dams had been finalised. Input from the perspective of developing countries and countries with economies in transition were encouraged because the report was based on information mostly from developed temperate regions. The focus for future work was important especially in terms of implementing the recommendations contained in the report. He acknowledged that the recommendations could only be implemented in the context of the local socio-economic environmental conditions. He urged the participants to focus on the recommendations contained in the reports as opposed to merely criticising its substance and style.

112. The participants then presented their views of the UNEP/IUCN study.

V. Recommendations for future follow-up to the WCD report and UNEP/IUCN reports

113. In-depth discussions followed based on a working paper prepared based on the views of the participants. This comprehensive debate resulted in consensus reflected in the recommendations contained in Annex III.

114. Based on UNEP's mandate and the current work programme, UNEP would pursue the following activities as follow-up to the WCD process and UNEP's contribution to it:

(i) Development of a Dam Decision Support System;
(ii) Assessment of river ecosystems within a country for setting aside natural and pristine rivers for conservation;
(iii) Incorporation of ecosystem maintenance flow in national legislations and capacity building for it;
(iv) Demonstration project for Integrated Coastal Area and River Basin Management to address impacts of large dams;
(v) Application of options assessment methodologies for water and energy development for a river basin where large dams are planned;
(vi) Development of guidelines for Strategic Environmental Assessment that can be used for addressing cumulative effects of dams;
(vii) Demonstration project for dams in dryland management; and
(viii) Demonstration of ecohydrology approach and training courses.

VI. Agenda item 6: Any other business

115. No issues were raised under this agenda item.

VII. Closing of the Workshop

116. The Chair closed the workshop at 3:18 PM on 6 December 2000. He explained that some of the recommendations were already being implemented.

117. Mr. Nakamura added by thanking the chairman and rapporteur and the participants for their valuable contribution.

ANNEX I

List of Participants

1. Mr. Alberto T. Calcagno
Consultant – Professor UBA
Azcuénaga 1360 P7 "15"
1115 Capital Federal
Argentina
Tel/Fax: (54) 11-4826-8196
E-mail: atcalcagno@giga.com.ar

2. Mr. Rolando Gaal Vadas
Water Resources Engineer (Consultant)
Rua Padre Joao Manoel 1230 Ap. 63
Jardins – CEP 01411-000
São Paulo – SP
Brazil
Tel: 55-11-3064-2802, 55-11-9612-8798
Fax: 55-11-3849-3040
E-mail: gvadas.ops@terra.com.br

3. Dr. Xiangcan Jin
Director of Water Research Institute, Chinese Research Academy of Environmental Sciences (CRAES)
Beiyuan, Anwai
Beijing, 100012
People's Republic of China
Tel: (86-10) 8491-5185
Fax: (86-10) 8491-3896
E-mail: JinXing@public.bta.net.cn

4. Mr. Ivica Trumbic
Director
Priority Actions Programme
Regional Activity Centre (PAP/RAC)
Mediterranean Action Plan
Kraj Sv. Ivana 11
2100 Split
Croatia
Tel: (385-21) 343-499, 343-611, 591-171
Fax: (383-21) 361-677
E-mail: ivica.trumbic@ppa.tel.hr

5. Dr. Christopher Gordon
Interim Director
Centre for African Wetlands
University of Ghana
P.O. Box 67, Legon
Accra, Ghana
Tel: 233 21 5000880, 233 20 811 7200, 233 24 319 153
Fax: 233 21 500880
E-mail: afriwet@idngh.com/afriwet@ghana.com
E-mail: chrisgordon@ighmail.com

6. Dr. M.S. Reddy
Member, GWP - SASTAC
D-12, Swati Appartments
12 Patpar Gunj
Delhi – 110092
India
Tel: 91-11-272-1805, 247 9702
E-mail: sudpbanerji@netscape.net/wappower@ndb.vsnl.net.in

7. Mr. V. M. Ranade
Consultant to GWP-SASTAC
Retd. Secretary, I.D. Government of Maharastra
A 1/1, Rambaug Colony "Parijat"
Navi Peth, Pune 411030
India
Tel: 91-20-433-6076
Fax: 91-20-433-9701
E-mail: hketan@vsnl.net

8. Prof. Kenneth Muema Mavuti
Professor of Aquatic Ecology and
Director, International Programmes
University of Nairobi
P.O. Box 30197
Nairobi, Kenya
Tel/Fax: 254-2-446141
E-mail: kmavuti@uonbi.ac.ke

9. Mr. Deok-Gil Rhee
Director
Water Quality Research Department
National Institute of Environmental Research
Ministry of Environment
Environmental Research Complex
Kyungseo-dong Seo-gu
Incheon 404-170
Korea
Tel: 82-32-568-0767
Fax: 82-32-568-2041
E-mail: rhee111@me.go.kr

10. Mr. Dong-Hwan Jeong
Research Engineer
Water Quality Research Department
National Institute of Environmental Research
Ministry of Environment
Environmental Research Complex
Kyungseo-dong Seo-gu
Incheon 404-170
Korea
Tel: 82-32-560-7139
Fax: 82-32-568-2041
E-mail: dwacheong@me.go.kr

12. Mr. Robert N'Daw
C/o FAO
UNDP Resident Representative
Bamako, Mali
Tel: (223) 223-646
Fax: (223) 226298

13. Prof. Lekan Oyebande
University Professor
Chairman, National Sub-Committee
Hydrology & Hydrogeology
Faculty of Environmental Sciences
University of Lagos
P.O. Box 160, Akoka-Yaba
Lagos, Nigeria
Tel: 234-1-493-8637 ext. 1244/2382
Fax: 234-1-585-1139

14. Prof. Maciej Zalewski
Director
International Center for Ecology
Polish Academy of Sciences
PAS Warsaw-Dziekanow Lesny
St. Konoprickiġ 1
05-092 Lomenki
Poland
Tel: 48-22-751-4116
Fax: 48-22-751-4116
E-mail: mzal@biol.uni.lodz.ol

15. Ms. Liliana Mara
General Director
General Water Division
Ministry of Waters, Forests and Environmental
Protection B-dul Libertatii
Nr. 12 Sector 5, Bucharest
Romania
Tel: 401-410-0553
Fax: 401-410-2032
E-mail: mara@mappm.ro

16. Mr. Alioune Kane
Maître de Conferences
Universite Cheikh Anta Diop
BP 5005, Dakar-Fann
Senegal
Tel: 221-820-3624/221-864-01-04
Fax: 221-825-4977
E-mail: akane@ucad.sn

17. Mr. Abd Fattah Miski
ACSAD Expert in Hydrology
Director of Environment
Damascus Water Supply Authority
Water Resource Division
ACSAD, P.O. Box 2440
Damascus, Syria
Tel: 963-11-574-3087, 574-3039 or
Tel: 963-11-2392323
Fax: 963-575-3063
E-mail: acsad@net.sy

18. Prof. Anthony T. Forbes
Professor and Specialist Aquatic Consultant
Marine & Estuarine Research and
School of Life & Environmental Sciences
University of Natal
Durban 4041
South Africa
Tel/Fax: 27 (31) 260-3183
E-mail: forbesa@biology.und.ac.za

19. Prof. Chris Magadza
Professor
No. 6 Gatwick Close
Bluff Hill
P.O. Box Westgate
Harare
Zimbabwe
Tel/Fax: 263 4 331 748
E-mail: profmagadza@utande.co.zw

WORLD COMMISSION ON DAMS

1. Ms. Corli Pretorius
5th Floor, Hycastle House
58 Loop Street
P.O. Box 16002
Vlaeberg,
Cape Town 8018
South Africa
Tel: 27-21-426-4000
Fax: 27-21-426-0036
E-mail: cpretorius@dams.org

2. Mr. Jamie Skinner
5th Floor, Hycastle House
58 Loop Street
P.O. Box 16002
Vlaeberg,
Cape Town 8018
South Africa
Tel: 27-21-426-4000
Fax: 27-21-426-0036
E-mail: jskinner@dams.org

UNESCO

1. Mr. Emmanuel Naah
Specialist in Hydrology
UNESCO Regional Office
P.O. Box 30592
Nairobi, Kenya
Tel: 254-2-622351
Fax: 254-2-215991
E-mail: emmanuel.naah@unesco.org

UNCHS

1. Ms. Anne-Maj Lahdenpera
Programme Officer
UNCHS/Habitat
P.O. Box 30030
Nairobi, Kenya
Tel: 254-2-62318
E-mail: anne-maj.lahdenpera@unchs.org

IUCN:

1. Mr. Geoffrey Howard

UNITED NATIONS ENVIRONMENT PROGRAMME

1. Mr. Donald Kaniaru
Director
Division of Environmental Policy Implementation
P.O. Box 30552
Nairobi, Kenya
Tel: 254-2-623507
Fax: 254-2-624249
E-mail: donald.kaniaru@unep.org

2. Prof. Charles Okidi
Task Manager
Division of Environmental Policy Implementation
P.O. Box 30552
Nairobi, Kenya
Tel: 254-2-623923
Fax: 254-2-623859
E-mail: charles.okidi@unep.org

3. Mr. Halifa Drammeh
Deputy Director
Division of Environmental Policy Development & Law
P.O. Box 30552
Nairobi, Kenya
Tel: 254-2-624278
E-mail: halifa.drammeh@unep.org

4. Mr. Takehiro Nakamura
Programme Officer
Division of Environmental Policy Implementation
P.O. Box 30552
Nairobi, Kenya
Tel: 254-2-623886
Fax: 254-2-624249
E-mail: takehiro.nakamura@unep.org

5. Mr. Vicente Santiago
Programme Officer, Head of the Water Programme
International Environment Technology Centre
UNEP-DTIE-IETC
1091 Oroshimo-cho
Kusatsu-shi, Shiga 525-0001
Japan
Tel: 81-775-68-4585
Fax: 81-775-68-4587
E-mail: vicente.santiago@unep.or.jp

6. Mr. Cheik Omar Sow
Deputy Director and Regional Representative
Regional Office for Africa (ROA)
P.O. Box 30552
Nairobi, Kenya
Tel: 254-2-623812
Fax: 254-2-623928
E-mail: cheik.sow@unep.org

7. Mr. Salif Diop
Senior Environmental Affairs Officer
Division of Early Warning and Assessment
P.O. Box 30552
Nairobi, Kenya
Tel: 254-2-622015
Fax: 254-2-623943
E-mail: salif.diop@unep.org

8. Mr. Paul Akiwumi
Programme Officer
Policy Support and UNFID
Programme Co-ordination and Management Unit
P.O. Box 30552
Nairobi, Kenya
Tel: 254-2-623177
Fax: 254-2-623918
E-mail: paul.akiwumi@unep.org

9. Mr. Strike Mkandla
Programme Officer
Division of Environmental Policy Implementation
P.O. Box 30552
Nairobi, Kenya
Tel: 254-2-623507
Fax: 254-2-624249
E-mail: strike.mkandla@unep.org

10. Ms. Elizabeth Mrema
Programme Officer
Division of Environmental Policy Implementation
P.O. Box 30552
Nairobi, Kenya
Tel: 254-2-623507
Fax: 254-2-624249
E-mail: elizabeth.mrema@unep.org

11. Ms. Isabelle Vanderbeck
Programme Officer
Division of Early Warning and Assessment
P.O. Box 30552
Nairobi, Kenya
Tel: 254-2-624339
Fax: 254-2-623943
E-mail: isabelle.vanderbeck@unep.org

12. Ms. Asheline Appleton
Consultant
P.O. Box 40612
Nairobi, Kenya
Tel: 254-2-565665
Fax: 254-2-573119

13. Ms. Sheila Aggarwal-Khan
GEF Coordianting Office
P.O. Box 30552
Nairobi, Kenya
Tel: +254-2-62
Fax. +254-2-

OBSERVERS:

1. Mrs. Rafah Kousa
ACSAD, P.O. Box 2440
Damascus, Syria
Tel: 963-11-574-3087, 574-3039
Fax: 963-575-3063

2. Ms. Selina K. Yawson
Research Associate
Centre for African Wetlands
University of Ghana
P.O. Box 67, Legon
Accra, Ghana
Tel/Fax: 233 21 500880
E-mail: afriwet@idngh.com

3. Ms. Nicolette Tracy Demetriades
Research Scientist/Ecology Consultant
Marine and Estuarine Research
P.O. Box 417
Hyper by the Sea
South Africa
Tel/Fax: 27 (31) 260-3183
E-mail: mer@biolgy.und.ac.za

ANNEX II
Agenda and timetable

3 December 2000

Arrival of participants

4 December 2000

8:30 – 9:00 Registration of participants

Agenda item 1: Opening of the workshop

9:00 – 9:40 Opening of the workshop (Donald Kaniaru, UNEP)
Introduction of the workshop (Takehiro Nakamura, UNEP)
Introduction of participants
Adoption of agenda and introduction of timetable
Selection of officers (chairman and rapporteur)

Agenda item 2: Introduction of the work of UNEP, WCD and other partners

9:40 – 9:50 Introduction of the work of UNEP as contribution to WCD (Takehiro Nakamura, UNEP)
9:50 – 10:20 Introduction of the UNEP/IUCN study on ecosystem impacts of large dams (UNEP/ IUCN)
10:20 – 10:45 Dam issues in relation to biodiversity related conventions (Ashline Appleton, UNEP)

10:45 – 11:00 Coffee break

11:00 – 11:20 UNEP-IETC's work on reservoir management (Vicente Santiago, UNEP-IETC)

Agenda item 3: Presentation of experiences

11:20 – 12:20 Presentation (Chair: Mr. Mavuti)[1]
- Mr. Forbes
- Mr. Reddy

12:20 – 14:00 Lunch

14:00 – 16:00 Presentation (Chair: Mr. Calcagno)
- Mr. Miski
- Mr. Magadza
- Mr. Kane

[1] All the presentations are for 20 minutes, followed by 10-minute questions and answers.

- Mr. Oyebande

15:50 – 16:10 Coffee break

16:10 – 16:30 Presentation on UNEP-GEF programme (Sheila Agarwal-Khan, UNEP GEF Coordination Office)

16:30 – 18:00 Presentation (Chair: Mr. Rhee)
- Mr. Gordon
- Mr. Ranade
- Mr. Zalewski

18:00 – 20:00 Reception hosted by UNEP Division of Environmental Policy Implementation

5 December 2000

9:00 – 10:30 The recommendations from the World Commission on Dams (Mr. Jamie Skinner and Ms. Corli Pretorius, WCD)

10:30 – 10:50 Coffee break

10:50 – 12:20 Presentation (Chair: Mr. Zalewski)
- Mr. Mavuti
- Mr. Trumbic
- Mr. Calcagno
- Mr. Gaal Vadas

12:20 – 13:50 Lunch

13:50 – 15:50 Presentation (Chair: Mr. Gordon)
- Ms. Mara
- Mr. N'Dow
- Mr. Jin
- Mr. Rhee

15:50 – 16:10 Coffee break

Agenda item 4: Discussion on recommended actions

16:10 – 18:00 Discussion on the recommendations included in the UNEP/IUCN study and the WCD final report (facilitator: Dr. Robert N'Dow)

6 December 2000

9:00 – 10:30 Discussion on the recommendations

10:30-10:50 Coffee Break

10:50 – 12:00 Discussion on the recommendations

12:00 – 14:30 Lunch

Agenda item 5: Recommendations for future follow-up to the WCD report and UNEP/IUCN reports

14:30-16:00 Adoption of the workshop recommendations

16:00 – 16:20 Coffee break

Agenda item 6: Any other business
Agenda item 7: Closing of the workshop

16:20 –16:40 Concluding remarks

ANNEX III

Recommendations for follow-up actions to the World Commission on Dams and UNEP activities

UNEP organized an International Workshop on Ecosystem Impacts of Large Dams, 4-6 December 2000, in Nairobi, Kenya. The workshop was attended by 17 technical experts from China, India, Romania, Brazil, Kenya, South Africa, Nigeria, Ghana, Republic of Korea, Argentina, Mali, Senegal, Poland, Zimbabwe. Representatives from the United Nations Centre for Human Settlements, United National Educational, Scientific and Cultural Organization (UNESCO), World Conservation Union (IUCN), World Commission on Dams (WCD) as well as UNEP also attended.

In many parts of the world, dams are built for maintenance of human life, water resources and energy development, especially in the arid environment. Large dams have a wide range of ecosystem and biodiversity impacts, both positive and negative. The experts recognized that many of the negative impacts of large dams could be either avoided or mitigated by proper design, planning and operation of dams. National governments, NGOs, the United Nations Agencies, development banks, expert credit agencies, research institutes, and others, all have roles to play in addressing issues relating to ecosystem impacts of large dams.

The United Nations agencies and organizations can contribute to the follow-up to the work of the World Commission on Dams and to UNEP's and other partners' contribution to the work of the Commission.

The experts noted the conclusions contained in the UNEP/IUCN report on "Ecosystem Impacts of Large Dams", but expressed that not enough attention was given to positive ecosystem impacts of large dams.

The following are recommendations by the experts at the International Workshop on Ecosystem Impacts of Large Dams, held in Nairobi during 4-6 December 2000, based on the experiences in developing countries and countries with economies in transition. Some possible follow-up actions are also identified

Issues	Recommendations	Possible follow-up
Knowledge and information gaps	• Sufficient information on dam impacts on climate change and on climate change impacts on river basins and dams should be obtained and shared. • Sufficient knowledge should be obtained and shared on environmental requirements for rivers/estuaries/wadis/coastal areas.	Further studies on (i) dam impacts on climate change; and (ii) environmental requirements; (iii) genetic impacts of fragmentation of ecosystems.

Assessment	• Sufficient assessment on public health impacts of dams should be carried out. • There is a need for good tools for reliable rapid assessment and decision support system. • There is a need to base the policy decision on future projected conditions that can be obtained on the basis of reliable past data. • As much as possible, analysis of future conditions should take into consideration climate change trends. • Baseline ecosystem survey will be recommended particularly for planned dams. • Data acquisition system should be reinforced, and dams and water database should be appropriately established. • Economic valuation methods for ecosystem services and functions should be developed. • GIS system should be fully utilized.	• An overview of possible environmental and public health impacts of dams could be prepared. • Development of a Dam Decision Support System and Dams ecosystem database, particularly for dams in pipeline (through cooperation with UNEP-WCMC). • Projection of climatic and socio-economic changes for a basin where dams are planned. • Development of guidelines on evaluation of socio-environmental costing and costs of establishing equity post dam operation. • Development of guidelines for economic valuation of ecosystem services. • Assist in developing countries and countries with economies in transition in establishing GIS and databases.
Policy , legal and regulations aspects	• Environmental and social effects of large dams projects should be given enough weight in options assessment. • National water development policies should necessarily incorporate water environmental protection. • National regulations should incorporate ecosystem maintenance flow requirements. • Estuarine water quality standards should be	• Conducting a specific options analysis for water and energy development for a river basin where large dams are planned, as a demonstration case on applicability of the options assessment procedure, as set out in the WCD final report. • Development of guidelines for SEA

	appropriately defined and applied. • There is a need to reinforce application of EIA in the regulation and policy planning process. • There is a need to consider the policy and regulation within the framework of international and multilateral conventions (such as CBD) and transboundary river basin agreements. • The dams and climate change issues should be discussed at the UNFCCC forums. • There is a need to establish and reinforce licences for dam construction and operation. The license system should include: (a) Provision of licenses (b) Operational and legal framework of licenses; and (c) Inspectorate and enforcement mechanism and means. • Strategic Environmental Assessment should be carried out , *inter alia*, to address cumulative effects of dams. • Harmonized laws and regulations should be developed, at least at the basin level to address most important dam-related issues. • Appropriate financial tools should be used, such as Polluter Pays Principle and water pricing, fines and taxes, etc. • There is a need for setting aside natural, undammed river for conservation.	• Guidelines for ecosystem maintenance flow assessment and policy development, and training programme on this. • Survey of natural rivers for conservation of natural and undammed rivers.
Enforcement and compliance	• Compensation scheme for affected stakeholders should be established on an equitable basis, and enforced.	

Capacity building and strengthening	• It is recommended that performance evaluation of existing dams continue to be carried out to asses their effectiveness in achieving design objectives to acquire experiences to be applied to new dam projects. • Existing cooperation (such as UNEP-UNESCO on ecohydrology, and WMO regional training institute in Kenya) should be further strengthened and fully utilized.	• Improvement of capacity of planning objectives of future dams. • Training and production of materials for policy and decision making under the UNEP(IETC) and UNESCO joint programme on ecohydrology and phytotechnologies. • Development of training manuals on surveillance of dams; ecosystem modelling; and EIA.
Integrated and ecosystem management approach on a basin-scale, considering ecohydrogical principles	• When planned on a sound scientific basis, dams can enhance river basin ecosystem resilience and this has to be considered within river basins. • Dams can be positive tools for ecosystem rehabilitation and combatting drought and desertification at the scale of river basins. • Dam impacts on coastal areas should be given enough attention and coastal areas and river basins should be integrated in management schemes. • Potentials for positive environmental impacts of dams in dry areas and wadis should be given enough attention. • An integrated approach on a whole basin within one country or among riparian countries should be taken to address cumulative effects of a series of dams in a basin.	• Demonstration project on planning of dams based on ecosystem-based and ecohydrology approach. • Incorporation of impacts of large dams on coastal areas into integrated coastal area and river basin management schemes. • Demonstration project on ecohydrology approaches. • UNEP/GEF/other partners to assist dryland countries in assessment and planning of land and water resources and ecosystem rehabilitation through sound management of surface and groundwater.
Public participation and ownership	• Decisions should not be taken only by governments and donors. All concerned stakeholders should participate	

	fully in the decision making process. • Public participation should be formally implemented through various mechanisms (such as stakeholder committees, consultation meetings, discussion groups, etc.) as a continuous process accompanying dam project development, construction and operation. • Existing structure such as river basin organizations should be reinforced to ensure full stakeholder participation.	
Monitoring and evaluation	• Monitoring of environmental impacts of large dams should be reinforced and included systematically in the dam project and maintained after construction.	Assessment of impacts and effectiveness of environmental mitigation measures and developing future guidelines on this.
Safety of dams, early warning system and emergency response	• Monitoring of safety of dams should be organized to serve as early warning and prompt responses. This should also take into account effects of human activities in the catchment areas.	• Revised guidelines for design and operation of dams to be developed. • Guidelines on dam safety and their dissemination.
Institutional framework	• A multi-sectoral and multidisciplinary approach should be taken and identification of clear responsibilities will need to be made. • UN and donors should assist in reinforcing regional cooperation within shared river basins.	• Information on good practices on technical and institutional arrangements for avoidance, mitigation and compensation should be compiled and made available. • UN and donor communities to put more resources on shared water resources in developing countries and countries with economies in transition.
Constraints	• Assistance should be given to	

	remove constraints in addressing ecosystem impacts of large dams: scientific knowledge; governance; investment; and resources for capacity building. • There is a need to develop at the national level a sustainable economic system for the development and maintenance of the dams, and mitigation of their adverse effects.	