

## 4. DAMS AND THE ENVIRONMENT

### 4.1 THE TANA RIVER

Oomen, JMV. 1981

Monitoring health in African dams: the Kamburu Dam (Kenya) as a test case.

1981, x + 181pp. Thesis, Erasmus Universiteit Rotterdam, Netherlands. Noolseweg 2, 1251 GP Larsen (NH), The Netherlands

**Abstract:**

This pilot study attempts to demonstrate that it is possible to document the health effects of development without an elaborate research organization. In Part I, a framework is presented in which to fit the manifold aspects of health planning. Such a framework is necessary for selecting the components of health monitoring. In Part II, a factual account is given of the conditions encountered, methods employed, and results obtained during trials to monitor health in the development of the Kamburu Dam. The research was guided by the belief that health problems related to dams and irrigation are more of an especial chapter in intelligent rural development, than a mere problem of water-related diseases.

Hughes, FMR. 1984

A comment on the impact of development schemes on the floodplain forests of the Tana River in Kenya.

The Geographical Journal of the Royal Geographical Society, Vol.150, No.2, July 1984

**Abstract:**

The Tana, Kenya's largest river, with an average annual flow of 5 billion m<sup>3</sup>, is the object of hydroelectric development on its upper reaches and large-scale irrigation

schemes on its lower reaches. Hughes discusses how these developments may effect the floodplain forest that extends for about 1 km on either side of the river, and stretches from the delta, 400 km upstream. Four dams exist in the upper catchment, and several others are being considered.

Hughes writes:

"These dams will have a considerable effect on the discharge downstream, virtually suppressing the annual floods and substantially reducing the 5 to 10 year recurrence interval floods." One effect could be the "rapid degradation of the Hameye Swamp area ... (which) acts as a powerful attenuation barrage." This will result in the countering of the attenuation effects of the dams, and the increasing of the severity of the large floods that the dams will not be able to contain. In addition, writes Hughes: "The decreased flood levels and frequencies plus decreased sediment load must have major incalculable effects on the floodplain forests through changed river processes and morphology."

The Bura irrigation scheme to grow cash crops such as cotton, will cover 12,000 ha, on the West Bank and perhaps a further 25,000 ha, on the East Bank. The local population is expected to treble, and although forest plantations have been planned, these have yet to materialize. Meanwhile the floodplain forests are being destroyed for firewood and building materials.

Kimani, JK. 1984

Small holder irrigation schemes: the Kenyan experience.

African regional symposium on small holder irrigation. 5-7 September 1984. Zimbabwe, Harare, Zimbabwe. (Edited by M.J. Blackie). 1984, 259-271; OAE. Wallingford, UK; Overseas Development Unit of Hydraulics Research Limited. Tana and Athi Rivers Development Authority, Nairobi, Kenya

**Abstract:**

The history of irrigation in Kenya, from pre-colonial times to the present, is reviewed. Using the Kibirigwe scheme as an example, the problems inherent in irrigation development are illustrated and the necessary policy measures for successful irrigation implementation are outlined.

**Roggeri, H. 1985**

African Dams: Impacts in the Environment. The Social and Environmental Impact of Dams at the Local Level: A Case Study of five man-made lakes in Eastern Africa.

Environmental Liaison Centre, Nairobi, Kenya. 61 pages.

**Abstract:**

This booklet provides a general discussion of some major environmental and social impacts of five African dams; the Kamburu, the Kindaruma and the Masinga on the Tana River in Kenya, and the Kyle and Mc Ilwaine in Zimbabwe. The study does not go into great depth, yet there is some interesting information given. Roggeri focused on the dams' impact on the immediate surroundings and local populations. For these five dams he was able to conclude that: "The local population does not benefit in any way from the presence of the lakes, whether it is a matter of the availability of drinking water, sanitary installations and electricity or the increase of food resources and the improvement of housing."

None of the reservoirs studied were in densely populated areas, although the Masinga and Kamburu dams flooded the subsistence plots of an estimated 1,000 families. In the case of these 4,000 to 6,000 people, there was no adequate resettlement plan. Displaced families had to find new places to live and work, or were assigned plots and had to build new homes.

Regarding water quality, Roggeri noted that due to the high turbidity rates and

populations of coliform bacteria, " the water in lakes Masinga, Kamburu and Kindaruma is not fit for consumption unless it is treated." Increases in waterborne and water-related diseases were observed among population around the Kenya lakes, With few exceptions, medical dispensaries in the region reported annual average growth rates in malaria cases of between 15 and 40 per cent; for intestinal worms annual growth rates were between 19 and 71 per cent, and for diarrhoeal diseases, between 33 and 70 per cent.

Considering the impact on local food supply, Roggeri stated that the three Kenya dams are solely for hydroelectricity generation and provide no water for irrigation, either in the area surrounding the reservoirs or downstream, Fish production increased with the impounding of the Tana. However, fishing has been prohibited at Masinga since 1982, and the large variations in water level have resulted in a 3.7 per cent decline in the catch from lakes Kamburu and Gitaru (downstream), from 35,582 kilos to 21,237 kilos. Lake Mc Ilwaine has provided no irrigation water since it is reserved as a drinking water supply for Harare. Fishing on this lake is a leisure activity. Lake Kyle provides abundant fish for the local population. Irrigation from the lake, however, is limited to the Lowveld 100 km downstream, and to big local ranches that have the financial resources for irrigation development.

Finally, those dams built exclusively for hydroelectricity - Masinga, Kamburu and Kindaruma - provide no electricity to local populations. At the same time, sedimentation rates in the Tana River are so high that the 'useful lifespan' of Kamburu is estimated to be 30 years and Lake Masinga will lose 25 per cent of its capacity by 1990.

**Hughes, F. 1987**

Conflicting uses for forest resources in

the Lower Tana River basin of Kenya.

Conservation in Africa: people, policies and practice [edited by Anderson, D.; Grove, R.]. 1987, 211-228; Cambridge, UK; Cambridge University Press.

**Abstract:**

Results are presented from a study in the floodplain forest of this area in order to relate use of forest resources (particularly for fuelwood) to availability and to predict how long wood supplies can last in the area.

**Hughes, FMR. 1988**

The ecology of African floodplain forests in semi-arid and arid zones: a review.

Journal-of-Biogeography. 1988, 15: 1, 127-140. In Biogeography and development in the humid tropics. Proc. conference held at Reading, UK, Jan. 1986

**Abstract:**

Common features in their form and functioning are reviewed for these little studied but valuable natural resources. The distribution of vegetation within them is related to frequency of flooding, and their overall extent to depth of the water table. On most floodplains, mature trees can only exist on the highest parts, whilst grasslands dominate in more frequently flooded areas. On floodplains in areas of very low rainfall, forest vegetation is more dependent on groundwater and the outer forest edge tends to be more abrupt than in wetter areas. These general patterns are complicated by burning of floodplain grasslands by pastoralists to improve grazing for their stock and by browsing by wild animals. A study of some of these factors in the Tana River floodplain forests of Kenya is described, and results discussed in the context of general trends apparent from the literature.

**Hughes, FMR. 1988**

The environmental impact of river basin

development: whose responsibility? In: Environmental issues in African development planning (Edited by Seeley, J.A.; Adams, W.M.).

Cambridge-African-Monographs, African-Studies-Centre, University-of-Cambridge. 1988, No. 9, 15-25

**Abstract:**

The paper considers the environmental problems arising from both dam and irrigation scheme construction in the Tana River Basin in Kenya. In particular, the environmental problems of the Bura Scheme are assessed, with details of the effect of delay in implementing the planned fuelwood plantation. It is concluded that there was awareness of potential environmental problems for all the projects in the Tana Basin at some stage prior to project construction. In the case of the upstream dams, the potential problems were reluctantly faced, but at Bura there was early recognition of, and even planning for, the possibility of floodplain forest destruction. The dams were built for hydro-electric power, and an early appreciation of the possible impact of reduced floods on the forest downstream would probably not have altered decisions to build. However, it might be possible to arrange more sensitive water releases from dams so that they more nearly resemble natural conditions. The Bura Scheme was very expensive and recognized as not viable at an early stage. \$40,000/ha has been expended so far compared to an average of \$20,000 for most World Bank schemes. The shortage of fuelwood has been a major problem for the scheme and destruction of the floodplain forest is likely to occur long before any indirect effects of dam construction on forest regeneration might be felt. The only protected area of the floodplain forest is the Tana River Primate Reserve, downstream from Hola, and this needs better funding and protection to ensure its survival. Environmental problems in the

Tana Basin, especially in the floodplain-forest zone, might have been avoided if aid agencies had insisted on studies of forest ecology and importance as a condition of aid. Decisions regarding the priority of the forestry plantation were made within the Kenyan Government.

**Johansson, S. 1988**

Forestry research in the Bura Irrigation Settlement Project, Tana River District, Kenya.

Working-Paper-Bura-Forestry-Research-Project. 1988, No. 37, i + 15 pp. Joint publication with Department of Silviculture, University of Helsinki. Nairobi, Kenya; Kenya Forestry Research Institute (KEFRI).

**Abstract:**

A paper presented at the ASAL Forestry Research Seminar, 22-25 Feb. 1988, Embu, Kenya. The Bura Irrigation Settlement Project (BISP) aims to develop the irrigation potential of the Lower Tana River Basin, in which about 2000 tenant farmers have settled since the late 1970s. The scheme aims to cater for >13 000 people (the traditional Malakote and Orma population makes up 10-15 000 people). The forestry component of the scheme, the Bura Forestry Research Project (FORP) is a sub-component of the FINNIDA funded Bura Fuelwood Plantation Project (BFPP) which aims to establish 600 ha of irrigated fuelwood plantations. The research started in 1984 and is jointly implemented by KEFRI and the University of Helsinki Department of Silviculture. A list is given of field experiments included in the project and preliminary results are reported on species and provenance trials, stand establishment and management, and population-environment interaction. Prosopis species had the greatest potential, especially *P. juliflora*, with *Eucalyptus* spp. performing more poorly. Brief growth data are given for *P. juliflora* and *E. camaldulensis* planted by different methods (or direct sown for *P. juliflora*),

and for *P. juliflora* established under different irrigation regimes and spacings, and nodulated with *Rhizobium*. Data are also reported from permanent vegetation sample plots in the bush and riverine forest (which indicate severe depletion of woody biomass) and from a tree planting survey and an ethnobotanical study. It is concluded that although the potential yield from irrigated plantations is high, the unreliability of the water supply indicates the need for a broader afforestation strategy. The multi-ethnic nature of the settlement and the new type of production in a new environment has led to a labour shortage, although the level of technology is high.

**Verhaeghe, RJ; Krogt, Wvd; Most, Hvd. 1989**

Simulation and optimization analysis of the water resources of the Tana River Basin in Kenya.

Delft-Hydraulics. 1989, No. 413, 8 pp.; Paper presented at 6th IAHR Congress, Asian and Pacific Div., Kyoto, Japan, 1988.

**Abstract:**

The Tana River Basin contains almost half of Kenya's irrigation potential, and also provides most of the public water supply and electric power. A river basin modelling package for the Tana River Basin is described. The package comprises 5 simulation and optimization modules using the same data-base, and enables a number of water resource planning options to be analysed efficiently. A description is given of these modules in relation to some typical planning and operation problems in the basin. The characteristics of the computational framework and associated data-base are discussed.

**Rowntree, K. 1990**

Political and administrative constraints of integrated river basin development: an

evaluation of the Tana and Athi Rivers Development Authority, Kenya.

Applied-Geography-Sevenoaks. 1990, 10: 1, 21-41

**Abstract:**

The Tana River Development Authority in Kenya (later to become the Tana and Athi Rivers Development Authority) was set up in 1974 with the proclaimed function of promoting integrated basin planning. This paper examines the concept of integrated river basin development and evaluates the extent to which it has been achieved within the Tana and Athi river basins. The administrative and political constraints on truly integrated river basin development are discussed.

**Hughes, FMR. 1990**

The influence of flooding regimes on forest distribution and composition in the Tana river floodplain, Kenya.

Journal-of-Applied-Ecology. 1990, 27: 2, 475-491

**Abstract:**

Different forest types, related to frequency and duration of flooding on the Tana river floodplain, are described: active levee evergreen forest (*Ficus sycomorus*, *Sorindeia madagascariensis*, *Sterculia appendiculata* typical overstorey species); inactive levee forest (as above, with shrub species typical of areas further from river); *Acacia* forest, dominated by *A. elatior*; clay evergreen forest, dominated by *Diospyros mespiliformis* and *Garcinia livingstonei*; vegetation on low-lying point-bars, commonly *Populus ilicifolia* and *Pluchea dioscoridis*; and pioneer vegetation in ox-bow infills, such as *Terminalia brevipes* and/or *Spirostachys venenifera*. Flood tolerance appears to be a major determinant of forest distribution, and floodplain forest growth can only be sustained at or above heights which receive floods of critical maximum frequency and duration. Probable changes to the floodplain forest, resulting from

construction of a series of dams in the Tana headwaters, are discussed. It is suggested that while tolerance to maximum flood levels is important in all floodplain forests, floodplain forests in semi-arid zones also depend on minimum flooding frequencies and durations.

**Little, PD; Brokensha, DW. 1990**

Institutional dynamics and development in the Tana Basin, Kenya.

Social change and applied anthropology. Essays in honor of David W. Brokensha [edited by Chaiken, M.S.; Fleuret, A.K.]. 1990, 215-230; Westview Special Studies in Applied Anthropology, Boulder, Colorado, USA; Westview Press.

**Abstract:**

This chapter pays particular attention to relationships between the major institution in the Tana basin, the Tana and Athi Rivers Development Authority (TARDA), and smaller institutions (e.g., water user and herder associations) representing thousands of smallholders in the region. Although TARDA is a regional institution, with regional and local development mandates, its structure and policies are national in orientation. This orientation places most of TARDA's plans in conflict with local institutions and inhibits meaningful local development. Two recurrent themes highlight the discussion. The first is the importance of historical specificity in the analysis of Tana Basin institutions, since these institutions often arose and, consequently changed, in response to particular historical circumstances. The second theme is that Tana institutions promote the interests of their members, which may complement or conflict with other institutional interests in the Tana basin. The ability of certain segments of the population, whether they be planners, rainfed farmers, irrigated farmers, or herders, to defend and support their economic interests depends on the strengths of their representative

institutions. Thus, those sectors of the Tana basin (e.g., the livestock sector) that have the weakest institutions have received the smallest share of development resources.

**Ensminger, J; Rutten, A. 1991**

The political economy of changing property rights: dismantling a pastoral commons.

American-Ethnologist. 1991, 18: 4, 683-699.

**Abstract:**

Economic growth has brought dramatic changes to pastoral societies. One of the many indirect effects of economic growth is greater sedentarization. Sedentarization in turn increases the threat of overgrazing, rendering many common grazing systems no longer viable. Although in the past such systems were routinely changed to prevent overgrazing, pastoralists have recently had less success in restructuring their common systems. The roots of their failure lie in the economic and political changes brought on by economic growth. Economic growth has increased the gains to be had from dismantling the commons while also making it harder to reach agreement about how to distribute those gains. To illustrate the changing economics and politics of common property in pastoral societies, the article examines the case of the Galole Orma of northeastern Kenya who inhabit the middle portion of the Tana River district and are riverine pastoralists. In 1979, 39% of Galole households were settled in villages with shops and were strongly integrated into the market economy. The other 61% were less involved in the market economy and were to some extent nomadic. The case of the Orma illustrates the interaction of economics, ideology and politics in the evolution of property rights. The framework used to analyse these changes is derived from the new institutional economics (Eggertsson, 1990; North, 1981, 1990), a perspective

premised on the assumption that institutions influence choices, that people realize this, and that people try to structure institutions towards their own ends. The study analyses different possible institutions and determines how they distribute costs and benefits across society; assesses current ideologies concerning the legitimate distribution of costs and benefits; and considers the politics of the institutions.

**Hirji, R; Ortolano, L. 1991**

EIA effectiveness and mechanisms of control. Case studies of water resources development in Kenya.

International-Journal-of-Water-Resources-Development. 1991, 7: 3, 154-167

**Abstract:**

The Tana and Athi Rivers Development Authority (TARDA) in Kenya performed environmental impact assessments (EIAs) on four major water resources development projects between 1974 and 1988. These projects are analysed to evaluate relationships between EIA effectiveness and mechanisms of control (eg national EIA requirements). Procedural controls imposed by the National Environment Secretariat were consistently ignored by TARDA. The Authority responded to 'instrumental controls', ie EIA requirements imposed by foreign donors as a condition of support. However, because of a lack of donor supervision or the availability of funds from other donors, EIAs conducted in response to instrumental controls did not substantially influence TARDA's projects. The case studies also show that TARDA's EIA activity on some projects can be interpreted as a means of legitimizing previously held positions.

**Johansson, S. 1991**

Ecological implications for Tana River Basin forestry and irrigated agriculture.

When the grass is gone: development intervention in African arid lands [edited by Baxter, P.T.W.J. Seminar-Proceedings---Scandinavian-Institute-of-African-Studies. 1991, No. 25, 115-140. Uppsala, Sweden.

**Abstract:**

The need to support growing rural populations which are dependent on agriculture has increased the pressure to develop marginal areas in Africa by irrigation. This paper deals with some of the ecological and social implications of the development of the Tana River Basin in eastern Kenya, with special emphasis on forestry at the Bura Irrigation Settlement Project. Specifically, it discusses some of the causes and effects of environmental degradation which are often associated with irrigated agriculture in arid and semi-arid areas, including the effects of other catchment development efforts. The effects of this degradation on the management of the irrigation scheme, on the tenant farmers and on the surrounding pastoralist and traditional agricultural communities, are also discussed.

**Johansson, S. 1992**

Irrigation and development in the Tana River Basin.

African river basins and dryland crises [edited by Darkoh, M.B.K.]. 1992, 97-112; Uppsala, Sweden; Uppsala University.

**Abstract:**

The development of hydro-power and irrigation in the Tana River Basin, Kenya, are described, and their implications are discussed.

**Kinnaird, MF. 1992**

Competition for a forest palm: use of Phoenix reclinata by human and nonhuman primates.

Conservation-Biology. 1992, 6: 1, 101-107

**Abstract:**

The palm Phoenix reclinata is heavily exploited for food and beverage, construction, and other domestic and commercial purposes by people of the Tana River District of northeastern Kenya; it also provides an important food source for an endangered forest primate, the Tana River crested mangabey (Cercocebus galeritus galeritus). Humans use all parts of the palm; preferential harvesting of the reproductive size classes may affect the palm's population structure, and excessive leaf removal may influence reproduction. P. reclinata accounts for up to 62% of the monthly diet of the mangabey. Mangabeys rely heavily on the fruits and seeds of P. reclinata when other fruits are unavailable; therefore, the elimination of palms and the reduction of fruit production degrade the mangabey's habitat. Human exploitation of P. reclinata may not be sustainable. Regulated harvesting outside protected areas and cessation of harvesting within protected areas are necessary to provide benefits to both the humans and the endangered Tana River crested mangabey.

**Medley, KE. 1993**

Primate conservation along the Tana River, Kenya: an examination of the forest habitat.

Conservation-Biology. 1993, 7: 1, 109-121;

**Abstract:**

The Tana River National Primate Reserve, Kenya, was established in 1976 to preserve the endemic and endangered Tana River red colobus (Colobus badius rufomitatus) and crested mangabey (Cercocebus galeritus galeritus). Between 1975 and 1985, their populations declined by 80% and 45%, respectively. A study addressing primate-to-habitat relations was conducted in 12 forest areas to determine what attributes appear most important to the in situ preservation of both primates. Correlations among the

abundances and sizes of primate groups, and the structural, resource, disturbance and spatial attributes of the forest were used to distinguish the quality of forest patches. Intraforest habitat quality was examined using canonical variate analysis to discriminate primate ranging patterns based on canopy and subcanopy tree composition. The colobus and mangabey showed positive relations to interior-forest habitat and appeared susceptible to forest disturbances that reduce forest area or increase edge and intraforest disturbance. Forest loss, fragmentation, and consequent reduction in the area-to-perimeter ratio of the remaining forests measured from 1960 to 1975 provided a partial explanation for the decline in primate populations. The results suggest that a combination of primary food items and seasonal food resources in large, high-stature, closed-canopy forests is the best predictor of high-quality habitat for these monkeys. Stewardship should be directed at the preservation of these areas or the restoration of forests toward this habitat model.

Otsamo RL; Johansson SG; Luukkanen MO; Odera JA (ed.); Luukkanen MO (ed.); Johansson SG (ed.); Kaarakka V (ed.); Mugah JO, 1993

Dynamics of floodplain forests at Bura, Tana River, Kenya: results from a permanent sample plot study.

Forestry in irrigation schemes with special reference to Kenya. East-African-Agricultural-and-Forestry-Journal. 1993, publ. 1994, 58: Special Issue, 71-79.

**Abstract:**

Six permanent sample plots were established in 1984 in the riverine forest and 3 in the transitional zone between riverine forest and the Acacia/Commiphora bushland, and remeasured in 1987 and 1992. The aim was to study the the dynamic processes in

the floodplain forest and to monitor changes caused by the establishment of the Bura Irrigation Settlement Scheme. Details are given of stand structure. Changes between 1984 and 1992 were small.

**Mburugu, EK. 1994**

Dislocation of settled communities in the development process: the case of Kiambere Hydroelectric Project.

World-Bank-Technical-Paper, 1994, No. 227, 49-58; Washington, D.C., USA.

**Abstract:**

The paper describes the problems that are often associated with involuntary movements of people to allow for a project to be constructed. At the Kiambere Dam, in Kenya, an estimated 6500 people were displaced. The policy on resettlement in Kenya provides that when the government acquires privately owned land, the owners will be compensated in cash for all immovable assets on the land. The government provides services such as roads, water, schools, health centres, security, in the areas where displaced people are resettled. The paper examines the shortcomings of this policy in relation to the Kiambere Hydroelectric Project, and the lessons that can be learned from the project. These include reviewing the existing laws on resettlement, ensuring that land is made available for displaced persons, involving resettlers in decisions on resettlement issues and devising ways of handling the host population.

**4.2 WATER RESOURCES ELSEWHERE IN KENYA**

Krhoda GO; Ominde SH (ed.), 1988

Water supply in Kenya today and to the year 2000 AD.

Kenya's-population-growth-and-development-to-the-year-2000. 1988, 87-



99. Heinemann Kenya Limited; Nairobi; Kenya

**Abstract:**

The current adequacy of water supply in Kenya is analysed in order to project future demands and problems that are likely to occur by the year 2000. In discussing the physical background, it is noted that the climatic conditions are influenced by the equatorial location and the monsoonal system of the Indian Ocean. Water availability and quality as well as the drainage pattern depend on the geology of an area. Six major physiographic regions determine the distribution of surface water. Consideration of water supply includes contemplation of: types of water supply projects; expected benefits of piped water supply; and factors that control the level of water supply service. The distribution of surface and ground water resources is outlined. One of the main reasons that planners give for choosing a surface water project over groundwater is the cost; other advantages are identified. Following the assessment of future trends in water supply in Kenya it is concluded that the government's objectives of providing piped clean water to every household within a sensible distance and food security may be achieved by the year 2000. However, the population growth rate needs to decrease from 3.7% to less than 3.2% per annum. The rate of economic growth must be sustained at its present level of between 5%-6% per annum. Heavy public expenditure in water would result in less expenditure on health, famine relief and the social services.

**Odingo, RS. 1988**

Sustainable agricultural development in Kenya and competing needs for agricultural land to the year 2000 AD.

Kenya's population growth and development to the year 2000 [edited by Ominde, S.H.]. 1988, 66-86. Nairobi, Kenya; Heinemann Kenya Limited.

**Abstract:**

Recent years have seen genuine concern in Kenya as to the prospects for sustainable agricultural development. The potential for extending the cultivated area, using rain-fed agriculture exists, although this may mean moving into marginal districts which are fragile and liable to rapid deterioration, especially during the frequent periods of below average rainfall. Methods will have to found for utilizing the arid and semi-arid lands without destroying them. Rapid population growth poses a severe threat. It will be from 32-35 million by the year 2000. Even with the current population of some 19 million, food shortages have been experienced, but part of the problem has been the frequent droughts and the inability to purchase the required agricultural inputs to boost crop yields. To realize its recently adopted policy of self sufficiency in food, Kenya will have to bring large areas of land under cultivation by the year 2000. Efforts will be required to ensure that this implied agricultural expansion is not accompanied by massive environmental damage which would mean that the systems adopted are not sustainable. The expansion of wheat growing to the logical requirement of 500 000 ha to meet domestic requirements could lead to a clash with the aims of wildlife conservation, particularly in the Masai Mara Game Reserve. More effective methods of land use will have to be found. After the current idle lands in the Rift Valley and the coast provinces have been taken up, agricultural intensification will have to be resorted to. In the interest of sustainable development, studies should be carried out to map out the best directions for land use and agricultural production to the year 2000 and beyond.

**Thomas Slayter BP; Ford R, 1989**

Water, soils, food, and rural development: examining institutional frameworks in Katheka Sublocation.

Canadian-Journal-of-African-Studies.  
1989, 23: 2, 250-271

**Abstract:**

The nature of village resource management institutions in rural Kenya is investigated. The circumstances and needs are analysed of effective resource management in Katheka sublocation, using this case study to draw lessons about local institutional capacity as it has a bearing on resource degradation. Data were collected during July 1987 and include interviews with 60 households (about 16% of the total), leaders of 12 women's groups (about 30 interviews) and extended discussions with another 25 village residents including school, church, political, and government leaders. It is argued that the institutional conflict between local and external actors (in Katheka's case over water) is at the core of the sublocation's resource management dilemma. Where Katheka has succeeded, for example in soil control and food production, it has been because: (1) community leaders and local institutions have been involved with and support the resource management efforts; (2) the technologies have been manageable for the community's institutions; and (3) external variables, money, fertilizer, technologies, political ambitions, marketing agents, etc., have entered in ways that local institutions could maintain and direct. In contrast, in areas such as water provision, the sublocation is in a weaker position because some of the variables are beyond the control of the community. Reversing Africa's resource degradation will require: strengthened capacities of community institutions to cope with internal problems; understanding the political context within which these institutions function; and work at district and regional levels to help local institutions gain access to agencies and bodies that have the authority or funds to manage external resources.

Adams, WM. 1989

Dam construction and the degradation of floodplain forest on the Turkwell River, Kenya.

Land-Degradation-and-Rehabilitation.  
1989, 1: 3, 189-198

**Abstract:**

Riparian forest bordering the Turkwel River in northern Kenya is dominated by *Acacia tortilis* which depends upon river flooding. The river has a seasonal and highly 'flashy' flow regime, and floods are vital to recharge the floodplain aquifer. Flood regime, bruchid beetle infestation of *A. tortilis* pods, and the role of domestic herbivores in killing beetle larvae and grazing seedlings are important influences on *A. tortilis* regeneration. The riparian forest is a vital element in the grazing ecology of Turkana pastoralists, particularly in the dry season and in times of drought. Dam construction threatens to degrade the forest both through reduced survival of existing trees and reduced regeneration.

Anon. 1990.

African energy: issues in planning and practice. CA: African Energy Policy Research Network.

1990, xviii + 157pp. London, UK; Zed Books.

**Abstract:**

Over the last 20 years the countries of sub-Saharan Africa have been subjected to grave economic crises, including energy crisis in traditional and modern sectors. In 1989 researchers and policy makers from these countries co-operated to form the African Energy Policy Research Network, in order to overcome their common problems. This book presents a series of studies carried out to examine the current and prospective policy measures aimed at energy conservation and substitution and assesses their impact on the environment, households and the trade sectors of each country. Case studies include Tanzania,

Uganda, Rwanda, Botswana, Lesotho, Zambia, Burundi, Somalia, Ethiopia and Kenya. Following a brief introduction, chapter 2 deals with renewable energy technologies (RETs) such as biomass, wind and solar power and the research and economic viability pertaining to them in specific countries as well as in sub-Saharan Africa as a whole. Chapter 3 discusses bio-energy and its use in the household in Rwanda, Botswana and the Sudan, with special focus on fuelwood. In chapter 4, electricity and its sources in rural and industrial areas are outlined in terms of consumption patterns and the efficiency of particular projects. The analysis is extended to coal and gasification, looking at prospects for coal utilization (in Zimbabwe) as a substitute for traditional fuels. Oil and natural gas are also dealt with. Finally some policy implications are drawn from the studies, scrutinizing the role of foreign technical assistance, demand management and forecasting.

**Darkoh MBK, 1990**

Kenya's environment and environmental management.
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Journal-of-Eastern-African-Research-and-Development. 1990, 20: 1-40
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**Abstract:**

A Food and Agriculture Organization/United Nations Fund for Population Activities survey of Kenya's food producing potential points out that the population of Kenya's high potential areas has already exceeded the land's carrying capacity. Today arable land for subsistence farming in these areas is in short supply, and this shortage is resulting in the inevitable expansion of the cultivation boundary into the semi-arid and drought-prone marginal lands of the east and south. The government and people of Kenya, however, are manifesting an increasing awareness of the problems of land degradation and desertification. To contain them, emphasis

is being placed on strengthening public participation in afforestation and soil and water conservation projects. Restrictions have been placed on tree clearing and charcoal making and support given to the 'Green Belt' tree planting campaign organized by local non-governmental organizations. Considerable attention is being given to research and an attempt is being made to slow the rate of population growth through family planning. It is believed, however, that there is often little follow-up observation of the impact of rural development projects. Consequently well-meant development action on the part of the government and donor agencies is contributing to the worsening environmental and human condition. There are several legislative Acts related to natural resources and resource management, but their enforcement has remained poor. There is disjunction between political pronouncements and institutional responses. It is considered essential that any further initiatives in environmental management be backed by real expressions of political will and commitment matching the seriousness of the situation.

**Downing, TE; Lezberg, S; Williams, C; Berry, L. 1990**

Population change and environment in central and eastern Kenya.
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Environmental-Conservation. 1990, 17: 2, 123-133.
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**Abstract:**

This analysis of population growth and environmental change in Central and Eastern Kenya illustrates two models of the interactions of population and resources: (1) the classical neo-Malthusian model that relates population growth to conservation of natural resources but ultimate degradation, and (2) the proposition that population growth induces intensified agricultural production and environmental conservation. Rural and urban population changes taking place

in the six districts of the study area were assessed by agro-climatic zone (as an indicator of agricultural productivity, economic infrastructure, and social services). The average annual production growth rate between 1969-79 for the entire rural area was 3.98%. The highest growth rates were in the tea and coffee zones (respectively 3.5% and 4.2% per year) and the semi-arid zones (3.8%-5.5% per year). The ability to absorb and sustain dense populations varied by agroclimatic zone. In the highlands (zone I and II), high growth-rates have been accommodated by some expansion of the agricultural area, but, more importantly, by increased yields, application of commercial inputs and economic development in connection with expansion of urban areas and the availability of off-farm opportunities. This supports the induced model of agricultural intensification. The middle zone (III) has not been able to absorb even the population growth that was expected from natural increase, and so is a zone of out-migration to urban centres and zones IV and V. This supports neo-Malthusian interpretation. More recently, however, the greatest gains in soil conservation have been made in zones III and IV. Which appears to have made the transition towards induced agricultural intensification and conservation of resources. In the lowlands (zones IV, V, and VI) there has been little change in productivity, and the classical model describes the results of population pressure relieved by expansion of the cultivated area, along with immigration from the more densely-populated highlands. The prime agricultural lands (zones I and II) have already reached conditions of population near-saturation (for the available technology). The capability of these lands to absorb more people has been taxed to the limit; populations are now beginning to overflow into the other agroclimatic zones (III-VI). The high rate of population growth in zones IV and VI, despite low

densities, attests to this trend. Future agriculture development strategies and agronomic research should focus on crops, technologies, and policies, that are applicable to the semi-arid zones where population expansion is the greatest.

**Mu XM; Whittington D; Briscoe J, 1990**

Modeling village water demand behavior: a discrete choice approach.
Water-Resources-Research. 1990, 26: 4, 521-529

**Abstract:**

This study presents a discrete choice model of households' water source choice decisions in developing countries. This model is estimated with data collected by indepth personal interviews with 69 households in Ukunda, Kenya, a small town south of Mombasa. The results suggest that households' source choice decisions are influenced by the time it takes to collect water from different sources, the price of water, and the number of women in a household. Household income, however, did not have a statistically significant effect. Essentially the same data were used to estimate a traditional water demand model which attempts to explain the quantity of water demanded by a household as a function of collection time, income, and other socioeconomic variables. The results of the discrete choice and traditional water demand models are compared.

**Finkel M, 1991**

Sustaining the arid and semi-arid (ASAL) environment in Kenya through improved pastoralism and agriculture.
Journal-of-Eastern-African-Research-and-Development. 1991, 21: 1-20.

**Abstract:**

The paper argues for environmental conservation through resource development and environmentally

sustainable resource use in Kenya's arid and semiarid lands (ASAL). ASAL inhabitants have, over the centuries, evolved a complex pattern of survival in a region with extreme climatic conditions and erratic water supply. All their activities are linked to survival tactics rather than to long-term strategical planning. This pattern includes sophisticated risk-spreading priorities based on an intimate knowledge and understanding of the harsh environment and the human condition. Traditional pastoralism has always been less risky than traditional dry land farming. The economy of the ASAL has therefore evolved mainly towards livestock keeping, with some farming conducted only in good rain years and in selected sites where water accumulates. The paper argues that a strategy for sustainable development in the ASAL should not overlook traditional survival strategies. It should aim at understanding these risk avoidance strategies and reducing, through the introduction of broader knowledge and improved technologies, the risks involved in ASAL farming systems without attempting drastic changes. The main body of the paper deals with the two aspects of pastoralism and agriculture, and outlines the contours of such a strategy.

**Ottichilo, WK; Kinuthia, JH; Ratego, PO; Nasubo, G, 1991**

Weathering the storm: climate change and investment in Kenya.
1991, xiii + 90pp. Environmental Policy Series No. 3. Nairobi, Kenya; ACTS Press; Stockholm, Sweden; Stockholm Environment Institute.

**Abstract:**

Climatic change will have far-reaching impacts on existing and future development projects in the Third World by affecting the bio-productive systems on which most economic investments are based. Analysis of 86 years of climate data shows clear trends of increasing

atmospheric temperatures in Kenya since the mid-1960s. This book describes the anticipated effects of climatic change on agricultural production, infrastructure development, energy and water supply, and tourism in Kenya. It highlights the need to re-orient investment policies and strategies to take into account diminishing productive resources. Shifts on agro-ecological zones and changes in geophysical resources, such as increased erosion rates, must be taken into account in current development planning. Dry areas are expected to become drier according to climatic change models, with evapotranspiration rates increasing. This would have serious implications for current government plans to expand crop and livestock production in the vast arid and semi-arid areas through irrigation and dryland farming. The anticipated increase in rainfall in the highland sources of Kenya's rivers may improve hydropower and irrigation potential, but would increase flooding, erosion and siltation. Major dams designed to last for 50 years may be rendered useless after only 15 years. In coastal areas, the expected sea-level rise will erode beaches and destroy marine habitats, port facilities and water systems with devastating consequences for the tourism industry.

**Ominde, S-H; Juma, C (Editors), 1991**

A change in the weather: African perspectives on climatic change.
1991, xii + 210 pp.; ACTS Environmental Policy Series No. 1. Nairobi, Kenya; African Centre for Technology Studies.

**Abstract:**

This book outlines the likely effects of global climatic change on African ecosystems and economies and identifies policy and practical measures that can be adopted by governments, businesses, non-government organizations, international organizations and individuals to deal with the problems. There are 17 chapters

divided into five parts entitled: (1) a change in the weather (1 chapter); (2) causes of climatic change (4 chapters); (3) possible effects of climatic change on Africa (5 chapters); (4) policy options for Africa (5 chapters); and (5) the way ahead (2 chapters).

**Thompson J, 1992**

Combining local knowledge and expert assistance in natural resource management: small-scale irrigation in Kenya.

From-the-Ground-Up-Case-Study -World-Resources-Institute-and-African-Centre-for-Technology-Studies. 1992, No. 2, vii + 34 pp.

**Abstract:**

Landless peasant farmers from various regions and ethnic backgrounds in Kenya organized themselves into cooperatives to purchase land and founded three communities in the 1970s. In the early 1980s each community had formed a self-help organization to address water shortage problems. By the late 1980s these institutions had joined forces to design a common gravity-fed water supply and irrigation system, attract external support and construct the system. The communities' success is attributed to their actions being a response to the increased risks associated with practising rainfed agriculture in semiarid lands; the farmers holding title deeds to their land; the separate self-help associations organizing the water users; and external funding and technical assistance agencies providing help in a supportive rather than a controlling manner. Several policy and programme recommendations are intended to facilitate similar collaboration with other communities and village clusters in Kenya.

**English, J. 1993**

Does population growth inevitably lead to land degradation?

Agriculture and environmental challenges: proceedings of the Thirteenth Agricultural Sector Symposium [edited by Srivastava, J. P.; Alderman, H.]. 1993, 45-58. Washington, D.C., USA; World Bank. Policy and Research Division, Environment Department, World Bank, 1818 H Street, N.W. Washington, D.C. 20433, USA

**Abstract:**

This paper discusses the issue of whether population growth inevitably leads to land degradation drawing on the results of two studies undertaken in sub-Saharan Africa in the mid-1980s, one drawing on data from Ethiopia, and the second in Kenya. The paper argues that land degradation does not necessarily result from population growth, and that concern should focus on the steps that can be taken to ensure that this is the case. The paper briefly reviews the results of these two studies and discusses the general view on the links between population growth and environmental degradation, and the importance of human capital in avoiding degradation under conditions of population growth. It then discusses possible preconditions for successful adaptation to increased population, relates the two case studies to the model outlined, and finally discusses the implications of the findings for development policy.

**Turner, BL, II; Hyden, G; Kates, RW (Editors) 1993**

Population growth and agricultural change in Africa.

1993, xvii + 461pp.; Carter Lecture Series. Gainesville, Florida, USA; University of Florida Press.

**Abstract:**

The question behind the ten case studies of highland East Africa and Nigeria commissioned for this book is whether population growth in densely settled areas of rural Africa has led to the intensification of agriculture. Using a

"natural experiments" methodology, the papers explore changes in agricultural inputs and outputs, analyse the role that external productive forces have played in these changes, note the consequences of the changes (especially for the environment and the standard of living), and speculate on the changes' implications. The volume is framed by chapters on theory, one that presents traditional thought on the relationship between population and agriculture and one that offers a synthesis that, while controversial, holds out real hope for African agriculture. Case studies are drawn from Uganda, Kenya, Tanzania, Rwanda and Nigeria.

**Krhoda G, 1994**

The impact of water resources utilization on land use in a semi-arid environment of Amboseli Area in Kenya.
Eastern-and-Southern-Africa-Geographical-Journal. 1994, 5: 1, 62-67.

**Abstract:**

Conflict over land use, especially in arid and semi-arid areas, is becoming common, partly because of population pressure and partly due to sedentarization and consequent farming activities in areas where water resources exist. Such conflict of land use is evident in the Amboseli Area of Kenya which boasts abundant wildlife, concentrated mainly around springs and swamps, as well as group ranches, tourist activities and small-scale irrigation. The main sources of water are springs that originate from the slopes of Mount Kilimanjaro, swamps and boreholes, and these have attracted both wildlife and human activities that presently are causing desertification. The quality, quantity and demand for groundwater resources are assessed. The paper concludes that the demand is far higher than the supply, and is increasing. Livestock continue to come into the national park in search of water during the dry season when the vegetation cover is

dry, thus causing environmental degradation of the area. There is a need to carry out a water balance study of the swamps, assess the groundwater resources potential and evolve a water supply management strategy that will take into account the grazing habits of the wildlife and livestock in the area.

**Almedom A; Odhiambo C, 1994**

The rationality factor: choosing water sources according to water uses.
Waterlines. 1994, 13: 2, 28-31

**Abstract:**

Rural water-supply projects often seem to base their technological interventions on the belief that, once installed, the improved water sources will be used to the exclusion of all others. But users perceive their traditional water sources to be just as good, if not better. The article examines why this is likely to be, and how changes can be made to villagers' thinking in an area of Kenya. It describes the participatory rural appraisal methodology used at the village level by the water and sanitation educators to pass on knowledge of the importance of choosing the correct water source to village members. Having described the methods, techniques and tools, the article briefly examines the findings, reviews the results and discusses why different water sources are chosen for different jobs.

**Wood M; Pickford J (ed.); Barker P (ed.); Coad A (ed.); Ince M (ed.); Shaw R (ed.); Skinner B (ed.); Smith M, 1994**

Privatization of rural water supply.
Water, sanitation, environment and development: selected papers of the 19th WEDC conference, Accra, Ghana, 1993. 1994, 76-78.

**Abstract:**

Since Independence in the 1960s most governments of developing countries have been the main providers of improved rural

water supplies and sanitation facilities. The state provided for basic services, using the rationale that communities could not afford to develop water or sanitation systems themselves. At the time there were very few NGOs or private companies able to do such work. During the International Drinking Water Supply and Sanitation Decade (1980-90), of the total global funding for water supply and sanitation of \$10 million, 65% came from state sources. Over the last 30 years or so this approach has been only partially successful. Thousands of systems were constructed but at the start of the 1990s one in three people in developing countries still lacked access to a safe and reliable water supply. The paper examines the background to the present situation, the decline in government services, and the emergence of the private sector, before analysing a water society in Kenya. Seven small community groups in Kenya amalgamated and with the help of the Ministry of Water Development made contact with several NGOs to develop the extensive infrastructure required for piped water systems. The paper looks briefly at the membership, the gravity systems used, user fees, project management and problems faced by the project. It is concluded that for privatization to work in the provision of essential services like water and sanitation, governments and external agencies must adjust their role to become more like facilitators for community initiatives and less like providers of systems for communities.

**Adams WM; Leach M; Mearns R, 1996**

Irrigation, erosion and famine: visions of environmental change in Marakwet, Kenya.

The lie of the land: challenging received wisdom on the African environment. 1996, 155-167.

**Abstract:**

A description of the way in which change in received wisdom about indigenous irrigation on the Marakwet Escarpment in the Kerio Valley in Kenya influenced development interventions on the ground is presented. The views of colonial officers and development agents between the 1930s and the 1960s, as recorded in the files of the Kenyan National Archives are examined with regard to changes in attitude towards the Marakwet and their irrigation and farming systems. The imposition of programmes for agricultural development and their social and environmental impacts are described linking their outcomes to famine and erosion in the area.

**4.3 DAMS & RESERVOIRS ELSEWHERE: ENVIRONMENTAL IMPLICATIONS**

**Ecologist. 1984**

Briefing Document: The social and environmental effects of large dams.

Ecologist. 1984, 14: 5/6, 16pp

**Abstract:**

The extent to which dams actually fulfil the aims of supplying power for progress, increasing food production and reducing flood damage is discussed in detail. Some of the problems associated with dams include resettlement, loss of land, loss of wildlife, water losses, malaria and schistosomiasis, impact on fisheries, dam failures, dam induced earthquakes, deforestation and erosion, building on flood plains, salinization, waterlogging, and reservoir sedimentation. The schemes to combat salinization in the irrigated southwestern USA are critically examined.



**Drijver C.A. and M. Marchand, 1985**

**The Sudd Jonglei Canal Case (Sudan).**

In *Taming the Floods, Environmental Aspects of Floodplain Development in Africa*, C.A. Drijver and M. Marchand, Centre for Environmental Studies, State University of Leiden, December, 1985.

**Abstract:**

This article describes the water diversion scheme undertaken by the governments of Sudan and Egypt. Its objective is to redirect the waters of the Nile so as to prevent them from entering the Sudd - one of the largest swamps in the world - from which much of it evaporates and is thereby considered wasted. The canal is to be 360 km long and of an average width of 50 m and a depth of 4 m. It is designed to divert 20 million cubic metres per day of Nile water. It should be noted that this article was written in 1984 at which time 2/3rds of the length of the canal had been dug. Since then construction has come to an end, largely because with the now chronic drought there is little water left to divert. Nevertheless the project may well be revived, so it is important to know its exact nature and likely implications.

The authors describe the natural and human geography of the area, placing emphasis on the richness of wildlife that lives in the swamp. The region is inhabited by a number of tribal people, notably the Dinka, Nuer and Shilluk tribes. The lifestyles of these tribal people are described, and it is noted that, for all of them, fishing provides a vital part in their diet. The floodplains play a big part in their lives. Dry season fishing occurs along the edge of the swamp and is a "major seasonal food supply for the pastoralists." Long fish are speared and fishing parties are organised on the shallow lakes to catch large numbers of fish. The authors describe all the other means whereby the local tribesmen assure their livelihood. "There is strong evidence that the system has already persisted for

500-1000 years. Because of strong internal relations and relative isolation from the outside world the system can be regarded as highly coherent. Through the use of cattle and small livestock, the peoples of the Jonglei region manage to exist in a harsh environment with little or no additional input from the outside world." They have succeeded in developing a self-sufficient way of life in what is a very harsh environment.

This way of life would not survive the building of the canal. The exact effects on their life will depend on unpredictable hydrological factors - notably the extent of discharges from two Equatorial lakes - the Bahr el Jehel and Bahr el Zeraf. These discharges, after 1961, forced the Deraf Nuer to shift their way of life from pastoralism to fishing. They may be forced to resort to pastoralism or consider may be that neither fishing or pastoralism will be possible.

Floodplain losses would have a serious effect on cattle production, on fishing, and of course it would be disastrous for local wildlife, especially if you consider that the whole scheme will open up the area to other destructive activities such as oil exploration, modern hunting etc. The authors trace these and other effects, both positive and negative, in some detail and offer suggestions for mitigating the more obviously negative ones.

**Bolton, P. 1986.**

**Mozambique's Cabora Bassa Project: an environmental assessment.**

The social and environmental effects of large dams. Volume 2: case studies [edited by Goldsmith, E.; Hildyard, N.]. 1986, 156-167; Camelford, Cornwall, UK; Wadebridge Ecological Centre.

**Abstract:**

From experiences dating from its colonial origins to the present day, it is concluded that the Cabora Bassa Dam should not have been built. Both in the area flooded by the reservoir and in the region

downstream, there have been detrimental changes affecting the livelihood of the local people as well as the diversity and productivity of the natural environment. The far-reaching, multiple-purpose benefits from the project envisaged by the Portuguese planners have not materialized. Even viewed solely as an electrical power generating facility, the project has, so far, been a disaster. One important feature of the scheme, common to many other water projects, is the tendency throughout the history of the Cabora Bassa Dam for the authorities to underestimate both the constraints governing the regulation of a river of this size and the extent of the changes which the dam must introduce.

**Cox, BS. 1987**

Thailand's Nam Choan Dam: a disaster in the making.
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Ecologist. 1987, 17: 6, 212-219.
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**Abstract:**

The Electricity Generating Authority of Thailand (EGAT) proposed the construction of a hydroelectric scheme based on the Nam Chaon Dam, in Thailand's western province. It would harness the upper reaches of the River Kwai and inflict irreparable damage on the Thung Yai wildlife Sanctuary. The EGAT commissioned environmental impact assessment survey is considered in some detail and concluded to be unrepresentative of the area under threat and inadequate in its coverage. World Bank doubts about the proposal are echoed in the conclusion, which claims the dam would decimate the finest wildlife conservation area in mainland South East Asia for very little real economic gain.

**Goodland, R. 1987.**

Hydro and the environment: evaluating the tradeoffs.
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Water-Resources-Journal. 1987, No. 153, 25-31.
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**Abstract:**

Although the environmental impact of hydroelectric schemes is not minor, precautions are available, affordable, feasible and tested, and their implementation can prevent damage and mitigate environmental costs. Moreover tradeoffs, such as the establishment of a protected area or national park as part of the water project, can compensate for these costs. Four recent examples of hydroelectric projects are examined to illustrate the possibility of tradeoffs: the Dumoga project, Sulawesi, Indonesia; Franklin River project, Tasmania, Australia; Nam Choan project, Thailand; and the Silent Valley project, Kerala, India. The first two cases eventually achieved acceptable tradeoffs: efficiently in Indonesia, and with confrontation in Australia, although the two cases are not strictly comparable. The remaining two cases wasted an enormous amount of time and resources, although no tradeoff was reached. Environmental aspects of water projects are then examined: resettlement, health, wildland loss, water quality, fish and fisheries, cultural property, problems of economic analysis and systems modelling, and the need for correct institutional arrangements. Finally, the environmental impact of India's Narmada Programme is examined. The paper was reprinted from Water Power & Dam Construction (ISSN 0306-400x) 38 (11), 1986.

**Adam, KS. 1989**

Environmental impacts of the Nangbeto dam (Togo). OT: Les impacts environnementaux du barrage du Nangbeto (Togo). (French with English Summary)
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Geo-Eco-Trop. 1989, 13: 1-4, 103-112..
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**Abstract:**

The construction of the Nangbeto dam across the Mono River is a cooperative project between the governments of Benin and Togo. The dam, covering 180 km<sup>2</sup>, is

in a moderately densely settled savanna, where extensive agriculture was practised. The dam's building has flooded about a thousand hectares of cultivated land and palm plantations, displaced ten thousand people, disrupted roads, and encouraged the spread of parasitic diseases. Some positive aspects of the dam's building may include the development of fishing and tourism.

**Rao, RV. 1989.**

Large and small dams. International-Journal-of-Water-Resources-Development. 1989, 5: 2, 136-142.
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**Abstract:**

For some time there has been a controversy in India and abroad on the adverse effects of large dams. Environmentalists and water resource development planners have often opposed one another in this controversy, the former vehemently opposing the construction of large dams and the latter favouring them. Benefits of large dams comprise: hydroelectric power; flood control; water management; improved water quality; and the provision of recreation areas around reservoirs. The possible adverse impacts of large and small dams are listed: submergence; high cost; evaporation; groundwater use; and induced seismic activity. Next, the adverse impacts of large dams and their mitigation are discussed in terms of population displacement; water-logging and soil salinity; aquaculture; effects on downstream areas; and dam breaks. Modern-day project planning is exacting and comprehensive; all aspects of the impact on the environment are considered in detail at the planning and implementation stages. Most of the adverse impacts of large-scale water resource development can be minimized, compensated for or even eliminated. Large and small schemes both have their roles to

play in furthering the development of water resources.

**Goodland, RJA. 1990**

Environmental aspects of dam and reservoir projects - the World Bank's new policy.
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Waterlines. 1990, 8: 4, 7-10.
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**Abstract:**

In March 1989, the World Bank announced a new official policy related to dams and reservoirs, ensuring that environmental aspects are integrated into project design and operation. Benefits from dam and reservoir projects increase when they become regional development projects. Potential environmental effects must be identified and considered in project design. Broad intersectoral cooperation should be ensured between agricultural, fisheries, forestry, health, wildlife, tourism, municipal and industrial agencies. The Bank encourages consultation between the project executing agencies and the population affected by the project.

**Ahmed, A. 1991**

Irrigation hazards due to poor management: a case study of Kano River Project, Nigeria.
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Techniques for Environmentally Sound Water Resources Development; Proc. African Regional Symposium 1991, [Edited by Wooldridge, R.]. 1991, 21-33. London UK; Pentech Press.
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**Abstract:**

Nigeria's Kano River Project comprises about 16 000 hectares under surface irrigation. There was no involvement of local farmers at the initial design and construction stage, and subsequently system operation and management has been handled entirely by the government. Because of high overhead costs, the project has experienced poor management resulting in environmental deterioration. Prior to the project, there was no water

table within 1.5 m from the surface throughout the area. However, the water table during the irrigation season had risen to 40 cm from the surface after 12 years and was within 20 to 30 cm after 14 years. Both the water distribution and drainage systems are now suffering from siltation and aquatic weeds, and in some locations, weeds are in rice fields. Salinity is not yet high but with high water table it will soon be a problem. Wheat yield has reduced from an average of 3t/ha to less than 2t/ha and during the rainy season only rice and sugar-cane can be successfully grown. More involvement for farmers in managing the system is recommended by the paper.

**Ahmad, A; Singh, PP. 1991.**

Environmental impact assessment for sustainable development: Chittaurgarh irrigation project in outer Himalayas. *Ambio*. 1991, 20: 7, 228-302.

**Abstract:**

The construction of a dam in the outer Indian Himalayas had a serious impact on the flora and fauna and caused a considerable loss of forest land (405 ha) and cultivated land (212 ha). Other environmental disturbances expected are: rise in groundwater level, waterlogging, increased salinity due to the low permeability of clayey soils, fodder and fuelwood crisis following deforestation, crop pests and human diseases. After one decade siltation will increase 20 times due to the poor vegetation in the catchment area. However, positive impacts expected are: increased agricultural production (rice, sugarcane, fruit and vegetables), improved socioeconomic conditions and flood control. Guidelines to eliminate negative impacts at early stages are discussed.

**Ati, HAA. 1992.**

The damming of the River Atbara and its downstream impact.

African river basins and dryland crises [edited by Darkoh, M.B.K.]. 1992, 21-43. Uppsala, Sweden; Research Programme on Environment and International Security, Uppsala University.

**Abstract:**

This paper examines the major ecological changes that the Khasm el Girba Dam in Sudan has brought about in the area downstream over the last three decades and their social and economic implications. Prior to the construction of the dam, the lower Atbara economy was predominantly agricultural, largely dependent on irrigation from the Atbara river. Four types of cultivation were known in the area: Gerf cultivation on the river banks (flood irrigation), Karu cultivation which makes use of irrigation by means of water wheels and pumps, Magat cultivation of the river bed when the river dries up into pools, and Atmur rainfed cultivation in some parts of the Atbara basin. Agriculture was characteristically subsistence, depending on the seasonality of the river and the unreliable rainfall. Nomadic activity was concentrated in the south-eastern part of the area, with fishing and wood collecting being other subsidiary economic activities. The ecological changes caused by the dam under a steadily declining rainfall situation in the area since the 1950s include the following: severe drop in the amount of water passing downstream, erosion of the river channel, siltation, deforestation, disturbance of the breeding and feeding systems of the fish population and a sequential process of environmental degradation. Agriculture is the economic activity most affected by the changes that occurred as a result of the Khasm El Girba dam construction. The reduced water supply downstream has affected the acreage of cultivated land and brought tremendous changes in tenurial and production systems. The ecological and economic changes also had their

repercussions on other traditional livelihood systems and the population's income levels and distribution. The gap between the rich and the poor has widened.

Unemployment, underemployment and out-migration are occurring at a scale never known before in the area. The paper serves to illustrate the disastrous consequences of planning dams without considering their downstream impact.

**Mikesell, RF. 1992.**

Case studies on environmental and resource management problems in development projects and programs.
Economic development and the environment: a comparison of sustainable development with conventional development economics. 1992, 106-124;. London, UK; Mansell Publishing Ltd.

**Abstract:**

This chapter takes 7 case studies of development projects from around the world, to show how projects initiated by MDBs (Multilateral Development Banks) have violated sound environmental and resource management principles. These include: the Narmada River Irrigation projects in India; the Cameroon Forestry Project; the Brazilian Northwest Region Development Program; the resettlement of persons displaced by the Manantali Dam in Mali; the Indonesian transmigration programme; the ok Tedi Mine in Papua New Guinea; and the Carajas Iron One Project in Brazil. Many development projects that reveal serious environmental shortcomings may still however contribute to increased social welfare in excess of the social costs generated by their negative environmental impact. The shortcomings do suggest that the projects could have contributed more to sustainable development had the environmental and natural resource deficiencies been avoided or mitigated. MDB officials learn from past mistakes, and given the recent

adoption of EIAs (Environmental Impact Assessments) as a condition for supporting projects, responsible governments and external agencies should be sponsoring more successful projects in future.

**Nalini-Amarasekara; Khalid-Mohtadullah; Amarasekara, N; Mohtadullah, K. 1992**

Environmental consequences of major irrigation development - a case study from Sri Lanka.
Drainage and water table control. Proceedings of Sixth International Drainage Symposium 13-15 December 1992 Nashville, Tennessee. 1992, 145-152; St. Joseph, Michigan, USA; American Society of Agricultural Engineers.

**Abstract:**

The importance of environmental impacts of irrigation development has been increasingly recognized during the past three decades. Most of the irrigation development projects however, have come to attract criticism from environmentalists for a variety of reasons. Any large scale irrigation projects are bound to have environmental impacts. If these impacts are properly identified in the planning stage, it would help in minimizing the adverse effects and in maximizing the advantages of the projects. Recently major irrigation projects have been evaluated for their impacts on the environment. This paper discusses the environmental impacts of the most recent major irrigation project in Sri Lanka with particular reference to adverse effects of salinity, waterlogging, health hazards, loss of soil fertility, displacement of people, change in river regime and changes of ecological balance of flora and fauna. Measures to minimize such adverse effects of the project are outlined.

English, J. 1993

Does population growth inevitably lead to land degradation?

Agriculture and environmental challenges: proceedings of the Thirteenth Agricultural Sector Symposium [edited by Srivastava, J. P.; Alderman, H.]. 1993, 45-58. Washington, D.C., USA; World Bank.

**Abstract:**

This paper discusses the issue of whether population growth inevitably leads to land degradation drawing on the results of two studies undertaken in sub-Saharan Africa in the mid-1980s, one drawing on data from Ethiopia, and the second in Kenya. The paper argues that land degradation does not necessarily result from population growth, and that concern should focus on the steps that can be taken to ensure that this is the case. The paper briefly reviews the results of these two studies and discusses the general view on the links between population growth and environmental degradation, and the importance of human capital in avoiding degradation under conditions of population growth. It then discusses possible preconditions for successful adaptation to increased population, relates the two case studies to the model outlined, and finally discusses the implications of the findings for development policy.

Walker KF; Thoms MC, 1993

Environmental effects of flow regulation on the lower River Murray, Australia.

Regulated-Rivers. 1993, 8: 1-2, 103-119.

**Abstract:**

The effects of flow regulation on the lower River Murray in South Australia were investigated. The river had highly variable flows before regulation by the construction of 10 low-level weirs and dams in upstream areas. Flows remain variable but are much reduced in volume. Low flows (100-300 G1 per month) have decreased five-fold and moderate flows

(500-01500 G1 per month) have increased two-fold. The magnitude of peak seasonal flows has been diminished but the timing of flows is unaffected. Weir operations cause daily stage fluctuations that diminish downstream and the channel is developing a stepped gradient from active deposition and erosion. Flow regulation has limited exchanges between the river and its floodplain, changed the nature of the littoral zone, and adversely affected many native species.

Fair D 1995

Water and sanitation in sub-Saharan Africa. Serving the rural poor.

Africa-Insight. 1995, 25: 1, 48-54.

**Abstract:**

The article looks at factors surrounding the provision of safe drinking water and adequate sanitation in rural sub-Saharan Africa, basic needs essential to health and development generally and integral to rural programmes. Progress in water supply provision in Southern and Eastern Africa is reviewed. The article also examines the impact of the UN International Drinking Water Supply and Sanitation Decade, whose target was to provide clean water for all by 1990. By 1990 in 14 sub-Saharan African countries, more than 40% of the rural population had access to a safe supply, but the average for the region is nearer 33%. The main problem is that the improvements barely keep up with population growth. Some of the water-related diseases are discussed, the problems from contamination, and the benefits that community participation can bring. The provision of drinking water in Malawi, Ethiopia, Zimbabwe, Botswana, Kenya, Tanzania and South Africa is considered.

Lae R, 1995

Climatic and anthropogenic effects on fish diversity and fish yields in the central

delta of the Niger River.

Aquatic Living Resources 1995; 8(1):43-58

**Abstract:**

For last 20 years, the fish communities in the Central Delta of the Niger River have been subjected to: (i) two drought periods in 1973 and 1984, (ii) a dramatic increase of fishing and, (iii) the building of an electric-power dam in 1984. At different levels, these various factors modified the biological cycle of the fish which are adapted to the former hydrological cycles of the Niger and the Bani rivers. The Sahelian drought is responsible for a decrease in both flood duration and of the inundated area of floodplain which varies from 20000 km<sup>2</sup> to 5000 km<sup>2</sup>. From 1968 to 1989, fish landings declined from 90000 metric tons to 45000 metric tons. During the same period, as fish catches fell, yields per hectare increased from 40 kg in 1968 to 120 kg in 1989. This phenomenon is linked to the decrease of the average age of the fish (69% of fish catches are under one year old) in response to the increased fishing mortality and natural mortality which is higher during the drought period. The increase in fish productivity is characterized by a depletion of species such as *Gymnarchus niloticus*, *Polypterus senegalus*, *Gnathonemus niger*, whose reproduction are linked to the floodplains and of species like *Citharinus citharus* and *Clarotes laticeps* which visit frequently flooded areas. Concurrently, families such as the Cichlidae or Clariidae, which are resistant to low oxygen concentration, increase. Species which are under one year old at first reproduction and have several spawning periods per year, are the more abundant in fish communities.

Salewicz KA; Kaczmarek Z (ed.); Strzepek KM (ed.); Somlyódy L (ed.); Priazhinskaya V, 1996

Impact of climate change on the Lake

Kariba hydropower scheme.

Water-resources-management-in-the-face-of-climatic-hydrologic-uncertainties. 1996, 300-321.

**Abstract:**

The Lake Kariba hydropower schemes on the Zambezi River provides electricity for the interconnected energy systems of Zimbabwe and Zambia. The management objectives of the Kariba operation are to maximize hydropower output and to maintain a safe capacity at the beginning of the rainy season to store high flows and to avoid peak discharges through the flood gates. The optimization analysis of the operating policies conducted for the scheme in the existing climate and hydrological conditions is outlined. The effects of climate change on the management of the scheme were investigated using the general circulation models developed by the Geophysical Fluid Dynamic Laboratory (GFDL) and the Goddard Institute for Space Studies (GISS). The hydrological scenarios developed on the basis of climatic data obtained from GISS and GFDL yielded opposite results concerning guaranteed energy production level, minimum energy production level, and percentage of time the energy output was between the guaranteed energy production level and desired energy production target. The climate scenario from the GISS model predicted up to a 20% increase of the hydropower generation potential of the scheme. The climate scenario from the GFDL predicted a 5% decrease in performance.

Gichuki FN; Pereira LS (ed.); Feddes RA (ed.); Gilley JR (ed.); Lesaffre B, 1996

Sustainability concerns in African irrigation.

Sustainability of irrigated agriculture. Proceedings of the NATO Advanced Research Workshop, Vimeiro, Portugal,

21-26 March, 1994. 1996, 589-599.

**Abstract:**

The extent and distribution of irrigation in Africa are outlined. In 1987, the irrigated area was estimated as 9.5 million ha, with 61% of the irrigated area found in Egypt, Sudan, and Morocco. The contribution of irrigation to agriculture and rural development is considered. In 1986, potential irrigable area was estimated at 33 million ha and it was unlikely that the figure has risen. This is due to a decline in irrigated area as a result of salinization, institutional and financial problems, a decline in the annual rate of growth, and a low level of cropping intensity. The main sustainability concerns are environmental (water scarcity, fragile soils, environmental impacts of irrigation development), economic (high costs of irrigation development, low level of crop production, cost recovery and financing), and social (conflicts among water users, resource ownership, gender issues). The approaches applied to Kenya's smallholder irrigation sector to promote sustainability of irrigation are described: improving farmer's participation; improving the quality of designs; funding irrigation development; improving water delivery and collection of water fees; and reducing adverse environmental impacts.

#### 4.4 ENVIRONMENTAL ASSESSMENT BACKGROUND TEXTS

**Gardiner, JL (Editor). 1990**

River projects and conservation: a manual for holistic appraisal.

1990, xxxiii + 236 pp.; Chichester, UK; John Wiley and Sons Ltd.

**Abstract:**

The manual is aimed at providing an action check-list and a comprehensive introduction to the philosophy of holistic appraisal of river catchments. Part one

defines the types of projects likely to require detailed appraisal, such as urban flood protection, agricultural flood protection or land drainage, provision or improvement of structures, water resources, and environmental improvement schemes. In part two specific appraisal items are covered in 24 sections, including geomorphology; hydrological and hydraulic modelling; river engineering; cost estimation; risk, economics and public perception; urban and agricultural benefit evaluation; information technology; environmental assessment; legislation; groundwater quality; and recreation.

**Haslam, SM. 1990.**

River pollution: an ecological perspective.

1990, 253 pp. London, UK; Belhaven Press.

**Abstract:**

This book presents a systematic and thorough analysis of the impact of pollution on river ecosystems and discusses a few methods of measuring and monitoring pollution damage.

**Veltrop-JA. 1994**

Impact assessment of dams and reservoirs: the work of the International Commission on Large Dams.

Environmental-assessment-and-development. 1994, 75-83

**Abstract:**

Environmental impacts of dams and reservoirs are both direct and indirect. Direct impacts occur on soils, vegetation, wildlife, wetlands, fisheries, and climate in the watersheds upstream and downstream of the dam. Indirect impacts include migratory fish, waterlogging, spread of diseases, and saltwater intrusion. The work of the International Commission on Large Dams (ICOLD) is outlined. It provides members with a forum for discussion and exchange of knowledge



and experience. Its principal objective is to ensure that dams are built safely, economically and with respect for the environment. Management of environmental impacts is discussed with respect to the Mount Elbert Project (Twinlakes, Colorado, USA), the Delta Works Project, Netherlands, and the Three-Gorges Project, China. The application of regulations, control of water quality, and countermeasures to sedimentation are discussed with reference to examples worldwide. Two appendices list environmental topics discussed at ICOLD Congresses and ICOLD bulletins related to environmental effects.

#### 4.5 WATER USE, CONFLICTS & ENERGY ISSUES

**Underhill, AH; Xaba, AB; Borkan, RE. 1986**

The Wilderness Use Simulation Model applied to Colorado river boating in Grand Canyon National Park, USA.
Environmental-Management, USA. 1986, 10: 3, 367-374

**Abstract:**  
A modification of the Shechter-Lucas Wilderness Use Simulation Model (WUSM) for peak season boating on the Colorado River through Grand Canyon National Park, USA, is evaluated as a tool for making management decisions. A new microcomputer program to select trip itineraries for inclusion in the WUSM that was developed as part of this study is presented. This program simplifies user input and expands the WUSM's usefulness as a tool for management decisions by randomizing itinerary schedules based on probabilities developed from actual use of sites by canyon visitors. Model usefulness is demonstrated by simulating various management changes, and comparing use levels of attraction sites and camp sites as

well as numbers of encounters between parties. The WUSM is being used as part of an ongoing study, to reflect the impact of fluctuating flow regimes through the turbines at Glen Canyon Dam on river trips.

**Borkan, RE; Underhill, AH. 1989**

Simulating the effects of Grand Canyon dam releases on Grand Canyon river trips.
Environmental-Management. 1989, 13: 3, 347-354

**Abstract:**  
The Shechter-Lucas Wilderness Use Simulation Model (WUSM) has been modified to quantify the effects of fluctuating Glen Canyon dam releases on Grand Canyon river trips. The model now simulates changes in flow as predicted by the Streamflow Synthesis and Reservoir Regulation computer model for the Colorado river. This revised WUSM provides data on several flow-related effects, including delays at rapids, encounters with other parties, and the time available for visiting attractions. Nine flow alternatives are evaluated and compared. Analysis of these outputs provides useful information to the Bureau of Reclamation on how the operation of Glen Canyon dam affects river trips through Grand Canyon National Park.

**Bishop, R. 1991**

Economic methods to solve conflicts in the utilization of water resources.
Medit. 1991, 2: 3, 30-39

**Abstract:**  
Non-traditional uses of water, including river recreation and environmental protection, are increasingly challenging traditional uses for priority in water allocation. New tools in economic analysis are able to evaluate the trade-offs between traditional and non-traditional water uses. This paper presents the results of a study carried out at the Glen Canyon

Dam, Utah, USA, which affects the environment below it in many ways. Research to quantify the effects of dam releases on downstream recreation in monetary terms is also reported. On-going research aimed at modelling the economic effects of environmental constraints on power generation is described, and the paper concludes by summarizing how economic analysis can be used to understand the trade off between water use for energy production and for environmental protection.

**Omosa, M; Khasiani, SA. 1992**

Women and the management of domestic energy.

Groundwork: African women as environmental managers [edited by Khasiani, S. A.]. 1992, 41-54. Nairobi, Kenya; ACTS Press, African Centre for Technology Studies.

**Abstract:**

Firewood is the major source of domestic energy in Kenya, accounting for over 93% of domestic energy generation, used and collected mainly by women. It has been estimated that by the year 2000, if current demand levels remain unchanged, 65% of domestic energy demand will go unmet. This paper seeks to analyse those socioeconomic factors which have led to fuelwood shortages by considering the area in which the Bura Irrigation Settlement Scheme has been implemented in Tana River District. It was found that the residents in the scheme's area were reluctant to plant trees when they faced a shortage of fuelwood because they saw their position there as only temporary, and that they were confused with regards to property rights and land ownership. The chapter also notes the need for a degree of cultural reorientation, focusing not just on women, in order that dietary habits and thus fuel consumption may mirror fuel supply.

**4.6 HUMAN AND LIVESTOCK HEALTH**

**M.N. Hill, J.A. Chandler and R.B. Highton, 1977**

A comparison of Mosquito populations in irrigated and non-irrigated areas of the Kano Plains, Nyanza Province, Kenya.

In Arid Land Irrigation in Developing Countries; Environmental Problems and Effects, edited by E. Barton Worthington, Pergamon Press, Oxford, 1977

**Abstract:**

This short article is very much quoted in the literature. The authors set up traps to catch mosquitoes in irrigated and non-irrigated areas of the Kano Plains in Kenya in order to determine the effect of irrigation on the populations of different mosquito species. The results appear in a very valuable table. The most significant changes appear to have been a reduction in the number of different species from 20 to 16, and a radical increase in the population of the four species of malaria transmitting anopheles mosquito: from 37 to 122 in the case of *Anopheles ziemanni*, from 5 to 16 in the case of *Anopheles pharoensis*, from 210 to 1,309 in the case of *Anopheles funestus* and from 457 to 12,734 in the case of the particularly unpleasant *Anopheles gambiae*. The article goes on to explain these results in terms of the various ecological changes brought about by modern irrigation schemes.

**Odei, MA. 1983**

The effect of the Volta dams (at Akosombo and Kpong) on the ecology of schistosomiasis transmission in the lower Volta and its estuary in Ghana.

Bulletin-de-l'Institut-Fondamental-d'Afrique-Noire, A-Sciences-Naturelles. 1983, 45: 3-4, 195-207;

**Abstract:**

The construction of the Akosombo dam in 1964 and later the Kpong dam in 1981 across the River Volta in Ghana has created ecological conditions downstream and in the Volta estuary which have enhanced the invasion and proliferation of aquatic weeds, submerged, emergent and floating and the intermediate hosts of schistosomiasis, *Bulinus* and *Biomphalaria* and also of *Lymnaea*. The intensive water-contact activities of the riparian communities who are mainly fishermen and clam-diggers have resulted in the establishment and transmission of urinary and intestinal schistosomiasis, due to *Schistosoma haematobium* and *S. mansoni*, respectively, in the River Volta itself and in the Volta estuary almost at the sea coast.

**Sellin, B; Simonkovich, E. 1983**

Schistosomiasis and dams in Ivory Coast.

Travaux-et-Documents-de-Geographie-Tropicale. 1983, No.48, 209-214, In D'epidemiologie a la geographie humaine. Table ronde " Tropiques et Sante", Bordeaux, 4-6 Oct, 1982. France; ACCT/CEGET (CNRS).

**Abstract:**

The influence of the construction of 3 large hydroelectric dams on the epidemiology of schistosomiasis was studied in the Ivory Coast. In the region of the Buyo dam, *Schistosoma haematobium* was found in one of 25 autochthonous inhabitants and in 16 of 48 immigrants. *S. mansoni* was found in 4 immigrants. The intermediate host of *S. haematobium*, *Bulinus globosus*, was found at one of 41 sites studied before commission of the dam; *B. forskalii* was found at 2 sites. 2 years after commission, *B. forskalii* was found at 9 of 14 sites and *Biomphalaria pfeifferi* at one site. At the Taabo dam, *S. haematobium* was found in 2 autochthonous inhabitants and in 10 Mali fishermen. *S. mansoni* was found in 2

children in the village of Aoundo. Before commission of the dam, *B. pfeifferi* was found at 2 sites and *Bulinus forskalii* was also present; 2 years later, *B. truncatus* and *B. forskalii* were found respectively at one and 6 of 13 sites and *Biomphalaria pfeifferi* was present at 2 sites. The molluscan fauna at the Kossou dam studied was only 7 years after its commission. *B. pfeifferi* was present at 15 of 28 sites, *Bulinus globosus*, *B. truncatus rohlfsi* and *B. forskalii* were found at one, 2 and 3 sites respectively. No parasitological investigations have been carried out since 1976. The need for strict schistosomiasis surveillance near hydrological installations is stressed.

**Dzik, A.J. 1983**

Snails, schistosomiasis and irrigation in the tropics.

Public-Health, UK. 1983, 97: 4, 214-217.

**Abstract:**

The problem of schistosomiasis in endemic regions with new irrigation developments is discussed. Examples considered include the Aswan High Dam in Egypt, the Kano Plain of Kenya and the Awash Valley in Ethiopia. Methods of schistosomiasis and snail control are outlined. It is considered that schistosomiasis will continue to be a side effect of irrigation development in the tropical world unless concentrated efforts are made to formulate and enact comprehensive control measures.

**Schneider, CR. 1985**

Water-assisted diseases and Gambia River Basin development.

1985, xvii + 346pp.; Ann Arbor, USA; Center for Research on Economic Development, University of Michigan.

**Abstract:**

A survey of public health in five major dam construction project areas in the Gambia River Basin is presented. The projects include: the Balingho Barrage on

the Gambia River estuary; the Kekreti Dam in eastern Senegal; the Kogou Foulbe Dam on the Koulountou River; the Kouya Dam on the Gambia River; and the Kakakoure Dam on the Liti River. It is found that dam construction will alter many environmental parameters, leading to increased incidence of disease. 19 water-associated diseases that occur naturally in the Gambia River Basin, but are likely to become more widely transmitted under conditions imposed by water impoundment, are identified and include: cholera, typhoid, poliomyelitis, ringworm, malaria, yellow fever and hookworm disease. Mitigating measures are devised and involve: water supply improvements; mass chemotherapy; vector control of snails, mosquitoes, blackflies, tsetse and copepods; and health education.

**Brightmer, I. 1986**

Environmental and health issues of a river dam project: a study of Lake Kainji in Nigeria.
Science-Technology-and-Development. 1986, 4: 2, 8-13

**Abstract:**  
 The paper highlights the human impact, especially on health, of the creation of Lake Kainji, Nigeria's largest man-made lake. The principal water-related diseases throughout tropical Africa with a potential changed status after the creation of man-made lake are malaria, sleeping sickness (trypanosomiasis), river blindness (onchocerciasis) and bilharzia (schistosomiasis). The normal pattern is that river blindness may be reduced but that all the others may increase in prevalence. This has happened at Kainji. Criteria used in project planning have emphasized economic and technological considerations, at the expense of environmental and health issues. However, it is concluded that there are sound economic as well as humanitarian reasons for taking into account the health

of the people in the vicinity of a new project. There is the cost of loss of economic productivity from the debility caused by the increased disease burden, notably from malaria and bilharzia. Another economic reason for the control of disease in man-made lakes can be the potential they may offer for tourism and recreation.

**Morton, J. 1988**

The decline of Lahawin pastoralism (Kassala Province, Eastern Sudan). Pastoral Development Network, Overseas Development Institute, UK. 1988, No. 25c, 16pp.
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**Abstract:**  
 The paper discusses the Lahawin, one of the main pastoralist groups in the Sudan, whose dry-season camps lie on the river Atbara upstream of the New Halfa scheme, as an important example of the direct encroachment on pastoralist resources by extensive mechanized rainfed farming. It describes the threat to them of mechanized farming and other factors. The migratory patterns of Lahawin pastoralists, their own agricultural activity and the effects upon them of large-scale mechanized farming and the recent drought, all vary between different groups and are portrayed by case studies from three different areas. The encroachment on pastoralist grazing lands due to the expansion of mechanized farming has resulted in the forced settlement of Lahawin pastoralists in areas where the resources for subsistence agriculture do not exist, and in insecurity for those Lahawin who remain pastoralists. The most serious consequence of pastoralist dispossession in the area is the reduction of pastoralists into impoverished rural wage-labourers. The main cause of this long-term tendency is shown to be the drought, but extension of alluvial peasant cultivation and

insecurity on the Sudan-Ethiopian border are also contributing causes.

**Roundy, RW. 1989**

Problems of resettlement and vector-borne diseases associated with dams and other development schemes.

Demography and vector-borne diseases [edited by Service, M.W.]. 1989, 193-205; Boca Raton, Florida, USA; CRC Press, Inc.

**Abstract:**

The various forms which planned resettlement takes (associated with dam building, irrigation, transmigration programmes, deforestation and development of wilderness regions), the objectives served and the problems faced by the human populations displaced are first discussed in general terms, then with regard to general health risks. Special attention is given to vector-borne diseases including malaria, trypanosomiasis, onchocerciasis, filariasis, arboviral diseases, schistosomiasis and opisthorchiasis.

**Abu-Zeid, M. 1990**

Environmental upgrading of irrigation systems to control schistosomiasis.

Waterlines. 1990, 9: 2, 31-35.

**Abstract:**

In Egypt, the Ministry of Public Works and Water Resources has prepared short and long-term strategies to eliminate schistosomiasis resulting from irrigation systems fed by water from the High Aswan Dam. The introduction of perennial irrigation has intensified the problems of schistosomiasis. This article reviews the programme of measures for snail (*Bulinus truncatus*) control, including the control of aquatic weeds, the lining of irrigation channels with different materials, and the introduction of sub-surface drainage to minimize schistosomiasis by eliminating direct

contact (of farmers) with contaminated drainage water.

**Iarinasuta, C. 1990**

The role of dam construction in socio-economic development of the country on human health and nutrition.

TROPMED-Newsletter. 1990, 1: 2, 1-3.

**Abstract:**

The socio-economic status, health and nutrition of people residing in areas affected by water resource development programmes associated with construction of dams for hydroelectricity production and irrigation in Indonesia, Malaysia, Philippines and Thailand are briefly summarized. Particular attention is paid to primary health care, malaria, diarrhoea, intestinal helminth infections (hookworm, ascariasis, trichuriasis), filariasis (*Brugia malayi* or *Wuchereria bancrofti*), schistosomiasis (*Schistosoma japonicum*), dengue haemorrhagic fever, opisthorchiasis (*Opisthorchis viverrini*), leptospirosis, and malnutrition (vitamin B deficiency, anaemia).

**Talla, I; Kongs, A; Verle, P; Belot, J; Sarr, S; Coll, AM. 1990**

Outbreak of intestinal schistosomiasis in the Senegal river basin.

Annales-de-la-Societe-Belge-de-Medecine-Tropicale. 1990, 70: 3, 173-180

**Abstract:**

The first case of intestinal schistosomiasis in the Richard-Toll area, Senegal, was reported in 1988, 1.5 years after the Diama dam, which blocks the flow of salt water from the Atlantic Ocean into the Senegal river during the dry season, became operational. 3926 patients presenting with diarrhoea, dysentery or atypical abdominal pain at the Health Centre of Richard-Toll, Senegal, were tested for intestinal schistosomiasis in 1987-89; *Schistosoma mansoni* ova were found in 1935 (88%) of the samples,

increasing from 1.9% in 1988 to 71.5% in 1989. *Biomphalaria pfeifferi* was found at several sites in and around Richard-Toll and 44 (4.75%) of 926 snails examined were shedding schistosome cercariae.

**Carter, RC; Brook, JM; Jewsbury, JM. 1990**

Assessing the impact of small dams on vector borne disease.

Irrigation-and-Drainage-Systems. 1990, 4: 1, 1-16

**Abstract:**

There is concern that small dams may be worse than large structures in creating habitats for the spread of tropical diseases. The ecology of the mosquito vectors and the snail intermediate hosts of the major water related diseases, malaria and schistosomiasis, are reviewed. A reservoir surface area from the shore to a depth of 2 m was proposed as a measure of Vector Habitat Potential (VHP). It was then shown how a simple spreadsheet model can be used to quantify the VHP for a proposed reservoir site at any chosen water-level or as a time-series. This was demonstrated using data for a proposed dam in Burkina Faso, West Africa. The reservoir model must be combined with studies of vector biology and human behaviour in order to quantify the disease risk of any proposed dam site. The full model will enable various sites (large and small) to be compared, or, for a single site, the effect of different water management strategies to be evaluated.

**Harb, M; Faris, R; Gad, AM; Hafez, ON; Ramzy, R; Buck, RR. 1993**

The resurgence of lymphatic filariasis in the Nile Delta.

Bulletin-of-the-World-Health-Organization. 1993, 71: 1, 49-54

**Abstract:**

A study of 325 000 residents of 314 villages in 6 governorates of the Nile delta area of Egypt showed that the prevalence

of lymphatic filariasis increased from < 1% in 1965 to > 20% in 1991, especially in the governorates of Qalyubiya, Monufiya, Dakhaliya and Giza. Clusters of villages with high prevalences are surrounded by others in which the disease is absent, although their environmental, social, and agricultural features appear similar. Over the past 25 years significant environmental and demographic changes have taken place which have had a profound effect on the epidemiology of filariasis: a substantial increase in *Culex pipiens* breeding sites in most rural and urban areas (many related directly to the creation of the Aswan High Dam); large increases in the populations of rural and urban communities (which have had an impact on the quality of sanitation and water consumption, which in turn has increased vector breeding sites); the large number of residents in rural and periurban locations who commute to work from endemic areas (*C. pipiens* carrying *Wuchereria bancrofti* L3 has been caught on the outskirts of Cairo, suggesting that active transmission of urban filariasis has probably already occurred).

**Abdel-Wahab, MF; Yosery, A; Narooz, S; Esmat, G; El-Hak, S; Nasif, S; Strickland, GT. 1993**

Is *Schistosoma mansoni* replacing *Schistosoma haematobium* in the Fayoum?

American-Journal-of-Tropical-Medicine-and-Hygiene. 1993, 49: 6, 697-700

**Abstract:**

*Schistosoma mansoni* is progressively replacing *S. haematobium* along the Nile River in Egypt. This change has occurred in the past 15-20 years following construction of the Aswan High Dam in the 1960s. The cause is a shift in relative abundance of the snail vectors *Biomphalaria alexandrina* and *Bulinus truncatus*. *Biomphalaria* is increasing while the latter has disappeared from a village in the Fayoum where formerly

only schistosomiasis haematobia was endemic. A cross-sectional household survey in this village in 1991 showed the following prevalence values: *S. mansoni*, 22.3%; *S. haematobium* 3.4%; mixed infections, 2.8%. Only 2 children less than 10 years of age had *S. haematobium* infections. A review of the local Ministry of Health records showed that both species were parasitologically diagnosed during the past 7.5 years, *Biomphalaria* had been abundantly present in the local waterways for the past 10 years and has been found infected with *S. mansoni* since 1985, *Bulinus* has not been detected in the local canals and drains since 1986 and the few found between 1981 and 1985 were not infected, and *Biomphalaria* in this village and in 2 others in the Fayoum were believed infected by labourers from the Delta who helped build schools in 1984.

#### 4.7 DAMS, RESERVOIRS AND DEVELOPMENT

**Goldsmith, E; Hildyard, N. 1984**

The politics of damming.

Ecologist. 1984, 14: 5/6, 221-231

**Abstract:**

The political factors that exert enormous pressure for adoption of large-scale dam projects in both developing and developed countries are discussed, with particular attention paid to the Aswan scheme. These factors bear little or no relation to the actual benefits that accrue from such projects. Negative aspects such as soil salinization, need for drainage systems, and loss of soil fertility downstream are deliberately ignored.

**Goldsmith, E; Hildyard, N. 1984**

The myth of the benign superdam.

Ecologist. 1984, 14: 5/6, 217-220

**Abstract:**

The conditions put forward by critics of large dams under which it could be

beneficial to undertake dam projects include the following: prior assessment of environmental effects; benefits accruing to large sectors of the population; support of labour-intensive industries; production of food crops for local consumption; no damage to public health; non-destruction of heritage and wildlife areas; safeguards against siltation; avoidance of salinization; long-term resource enhancement; no harm to tribal peoples; impeccable design including avoidance of areas subject to seismic activity or landslides; no damage to fisheries; protection of downstream water quality. The authors conclude that if schemes were only built where they satisfied these conditions, then very few, if any, would be built.

**Drijver, CA; Marchand, M. 1985. (Eds.).**

Taming the floods: environmental aspects of floodplain development in Africa.

Commission of the European Communities - Centre for Environmental Studies, State University of Leiden, December 1985.

**Abstract:**

**Drijver, CA; Marchand, M. 1986**

Taming the floods: environmental aspects of floodplain development in Africa.

Nature-and-Resources. 1986, 22: 4, 13-22.

**Abstract:**

Africa's floodplains are key areas for the survival of millions of people. At present they are threatened with an irreversible loss of their natural resources, through the combined impacts of droughts, overexploitation of soils and vegetation and the mismanagement of the water regime. This study synthesizes experiences and knowledge of environmental aspects of water

management projects in seven African floodplains. Of the total African wetland acreage, approximately almost half is formed by floodplains bordering large rivers. These case-studies are representative of the full 300 000 km<sup>2</sup> of floodplains in Africa.

**Lavergne, M. 1986**

The seven deadly sins of Egypt's Aswan High Dam.

The social and environmental effects of large dams. Volume 2: case studies [edited by Goldsmith, E.; Hildyard, N.]. 1986, 181-183; OAE. Camelford, Cornwall, UK; Wadebridge Ecological Centre.

**Abstract:**

The secondary effects of the High Dam are presented as having been harmful: deterioration of the fertility of arable land; changes in the river's course; retreat of the Delta's coastline; water pollution; and removal of soil for brick making. It is concluded that the goal of using the reservoir for the long term storage of Nile water should consequently be abandoned.

**Goodland, R. 1987**

Hydro and the environment: evaluating the tradeoffs.

Water-Resources-Journal. 1987, No. 153, 25-31.

**Abstract:**

Although the environmental impact of hydroelectric schemes is not minor, precautions are available, affordable, feasible and tested, and their implementation can prevent damage and mitigate environmental costs. Moreover tradeoffs, such as the establishment of a protected area or national park as part of the water project, can compensate for these costs. Four recent examples of hydroelectric projects are examined to illustrate the possibility of tradeoffs: the Dumoga project, Sulawesi, Indonesia; Franklin River project, Tasmania,

Australia; Nam Choan project, Thailand; and the Silent Valley project, Kerala, India. The first two cases eventually achieved acceptable tradeoffs: efficiently in Indonesia, and with confrontation in Australia, although the two cases are not strictly comparable. The remaining two cases wasted an enormous amount of time and resources, although no tradeoff was reached. Environmental aspects of water projects are then examined: resettlement, health, wildland loss, water quality, fish and fisheries, cultural property, problems of economic analysis and systems modelling, and the need for correct institutional arrangements. Finally, the environmental impact of India's Narmada Programme is examined. The paper was reprinted from Water Power & Dam Construction (ISSN 0306-400x) 38 (11), 1986.

**Marchand, M. 1987**

The productivity of African floodplains.

International-Journal-of-Environmental-Studies. 1987, 29: 2/3, 201-211.

**Abstract:**

Wetlands are often considered as "economically unproductive". In this paper it is shown that for the African floodplains this unjustly denies the actual and potential benefits of the traditional land use systems. Both in terms of water use and financial costs traditional African floodplain exploitation compares very well with modern irrigation schemes. Gross earnings of irrigation systems must figure at least three times as much as traditional floodplain production in order to attain the same net margin of profit.

**Le-Moigne, G; Barghouti, S; Plusquellec, H (Editors). 1989**

Dam safety and the environment.

World-Bank-Technical-Paper. 1989, No. 115, 174 pp.



**Abstract:**

This volume contains 18 papers given at a World Bank-sponsored seminar on Dam Safety and the Environment, held in Washington, D. C., in April 1989. The first part of these proceedings presents a historical and geographical perspective on dam construction, a review of the need for and benefits derived from dams, and of the increased concern for their safety and environmental impact. The second part discusses past experience and the safety of existing dams and also design features for dam safety. The third part emphasizes environmental aspects with special reference to irrigation, water quality and public health. The need to express environmental and social aspects in financial terms when evaluating dam projects is stressed.

**Dixon, JA; Talbot, LM; Moigne, GJM-le; Le-Moigne, GJM. 1989**

Dams and the environment. Considerations in World Bank projects. World-Bank-Technical-Paper. 1989, No. 110, vii + 63pp.
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**Abstract:**

With growing environmental awareness worldwide during the 1970s and 1980s, increased attention has been focused on dams and their associated water resources projects. This paper explores the relation between dams and the environment, both the effect of dams on the environment, and the effect of the environment on dams, and the economic analysis of these effects. Dams are large social investments built to fulfill one or more of four primary purposes: domestic and industrial water supply, energy production, irrigation, and flood control. In addition to these direct benefits there are many associated environmental and social effects, some of which are benefits but more of which are likely to be costs. (Resettlement is a major social issue associated with most dam projects and is handled in detail in other Technical Papers). The economic analysis

of dams must include all associated benefits and costs, both direct and indirect, both in assessing the proposed project and in evaluating alternatives. This paper reviews the environmental factors associated with large storage dam projects and the economic analysis of environmental effects. Consideration is given to environmental effects that occur upstream, on-site, and downstream and techniques of economic analysis that can be used to value environmental effects in monetary terms. Samples of actual and proposed dam projects are examined to see what can be learned from completed projects and what are the environmental issues associated with several proposed dams. The examples selected include: the Tarbela Dam Project, Pakistan; the Aswan High Dam, Egypt; the Narmada Valley Development Programme, India (also featured in the appendix); the Three Gorges Project, China; and the Nam Choan Dam, Thailand. As expected with such major investments, there is a complex set of factors, some good, some bad, that have to be balanced. The paper concludes with the World Bank's response to this issue and some of the lessons that can be learned from analysis of past projects.

**Hancock, G. 1989.**

The Lords of Poverty London: Macmillan
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**Extract (p.140-142)**

In the last 40 years literally thousands of dams have been built in the Third World, absorbing colossal amounts of aid. The experience thus garnered, however, has not been correspondingly immense. On the contrary, with the commissioning of each new dam, it seems that the agencies are destined to reinvent the wheel: to be genuinely surprised by the human, ecological and economic damage that this kind of project can cause, and do nothing in advance to mitigate the harm.

An early lesson should have been learned in Ghana. Here in the 1950s and 1960s the World Bank took the lead amongst a group of aid agencies that planned, implemented and provided the soft loans to pay for the giant Akosombo dam on the Volta River. Certainly, very substantial benefits have since been extracted from this projects by foreign interests - notably the US-owned VALCO aluminium plant which, for more than twenty years, has been supplied with hydroelectric power at substantially below production cost. To the detriment of the local economy, however, VALCO's operations are based on the smelting of imported alumina which has previously been refined in Louisiana from Jamaican bauxite; Ghanaian bauxite is not used.

The dam has also benefited wealthy Ghanians: driving from Accra to Akosombo one can not help but notice how the transmission lines that run from the hydroelectric plant to the most prosperous districts of the capital simply pass over the many impoverished villages en route - as though they did not exist. It is, however, the inhabitants of these same poor villages still without electric light, who have paid the real price for the project:

- It is they who now suffer in the largest numbers from endemic onchocerciasis (river blindness) which affects 100,000 people, of whom 70,000 have been rendered totally sightless since the completion of the dam.;
- It is amongst their ranks that at least 80,000 more people have been permanently disabled as a result of schistosomiasis, a parasitic water-borne disease carried by two species of snail that are now the commonest molluscs in the Volta reservoir;
- And, almost needless to say, it was these poor rural people - not the inhabitants of Accra - who were amongst the 1 per cent of Ghana's population displaced (virtually without

compensation) when the Volta reservoir began to fill up in the 1960s.

For these reasons, and for some time - probably since at least the mid-1970s - one thing has been clearly understood by all the aid agencies which financed the Volta dam: while contributing little or nothing to the Ghanaian economy, this mega-project has infinitely worsened the predicament of the Ghanaian poor.

Detailed studies in other countries have, furthermore, made it quite clear that the Volta fiasco was not an isolated incident: the same kinds of problems crop up so frequently with large dams that they can now be regarded as inevitable by-products of the genre. These problems are typically long-term and in some cases are so severe as to counteract completely any economic benefits that dams may produce. As one authoritative paper from the Washington-based World Resources Institute puts it:

"Diseases have spread, whole communities have been displaced and valuable crop and forest lands have been flooded . . . . Tens of millions of hectares of agricultural land have been lost through waterlogging and salinisation, and 25 million hectares are threatened by salinisation. In Pakistan more than half of the Indus basin canal system command areas, some 12 million hectares, is waterlogged, and 40 percent is saline."

All in all, the mania for building large dams has meant that, today, half the world's irrigated land is salinised badly enough that yields are affected.

Worse still, the Damoclean sword of sedimentation hangs over all dams: sooner or later any reservoir, however large, will fill up with the silt and other detritus which the dam prevents from flowing downstream. When that happens, of course, the dam must be decommissioned: without its reservoir, it is no more than a useless slab of concrete. This is not mere speculation. To give just a few examples:

- In India the projected siltation rate of the Nizamsagar Dam in Andhra Pradesh was 530 acre-feet a year. The actual

rate has turned out to be 8,700 acre-feet a year. As a result the dams reservoir has already lost more than 60 percent of its storage capacity. Virtually every reservoir in India is currently suffering from similar problems.

- In Haiti, the Peligre Dam on the Artibonite River was completed in 1956. Built to last fifty years its reservoir has silted up so quickly that it was decommissioned in the mid-1980s.
- In China, the Sanmenxia Reservoir, which was completed in 1960, had to be decommissioned in 1964 owing to premature siltation. Another reservoir, Laoying, actually silted up before the dam was completed!

Although such cautionary data are available to the aid community, nothing much has changed. The World Bank and other donors consistently postpone serious investigation of alternatives to big dams and, in the mean time, continue gleefully to commit huge sums of money to ecologically and economically unsound water-development schemes - many of which bear strong family resemblances to old projects that have failed. Recent schemes which are either about to receive or have already received funding from the Bank and/or other Western aid donors include the Three Gorges Dam on China's Yangtze River, the Diama Dam and Manantali Dam in Sahelian West Africa, the Bakolori Dam in Nigeria, the Tucuruí Dam in Brazil, the Balbina Dam on the Parana River in Brazil/Paraguay, several major dams on the Mahaweli River in Sri Lanka, the Tarbela and Kalabagh Dams in Pakistan, the proposed Bardhere Dam in Somalia, and the proposed Chico Dams in the Philippines.

It is India, however, with its 10 million hectares already waterlogged, with its 25 million more threatened by salinisation - that continues to be the happiest hunting ground for aid agencies looking for super-dams to finance. The long-term and heavy emphasis placed by successive Indian

governments on the expansion of hydroelectric power and of large-scale irrigation has resulted in the construction of more than 1,000 dams in the past ten years. Amongst these, a recently launched project - the Sardar Sarovar Dam on the westward flowing Narmada River - looks set to repeat many of the best-known and most avoidable mistakes in water-development.

Sardar Sarovar received a loan commitment of \$450 million from the World Bank in 1985, despite the fact that India's Department of Environment and Forests had at that stage not granted environmental clearance for the project because major studies relating to environment and resettlement had not been completed. These studies were still not complete when then Indian government forced through the legislation in the spring of 1987 that gave the dam the needed environmental clearance.

Filling of the reservoir is displacing over 70,000 poor rural people from their homes, against their will and without adequate compensation: in most cases no provision has been made to resettle them and they must simply re-establish their lives wherever they can. Apart from the human rights abuse that this implies there is, according to the Washington-based Environmental Defense Fund, 'substantial risk of unsustainable ecological stress from the movement of these displaced people up into the hills surrounding the reservoir. These areas are already suffering from deforestation, sheet erosion and other environmental degradation'. In addition, included in the 900 square kilometres to be flooded by the dam are some 12,000 hectares of pristine rainforest. 'Along with the forest many rare species, flora and fauna, as well as an entire life rhythm - cultural and social - will be lost,' warn six of India's leading scientists and environmentalists in a letter to Prime Minister Rajiv Gandhi.

A study by the Indian Council of Science and Technology predicts that completion

of work at Sardar Sarovar will result in increased malaria, cholera, viral encephalitis, and other water-borne diseases for millions of local people. Meanwhile, there is no guarantee that the project will justify itself in the long term, even on purely economic grounds. Serious questions have been raised by non-governmental organisations, environmentalists and scientists regarding the cost-benefit analysis which the World Bank and the Indian government have relied on to validate the dam.

The Greater Narmada Programme, of which Sardar Sarovar is only a part, ultimately envisages the expenditure of billions more dollars on at least twenty-nine other major dams on the Narmada river; several of these are already being actively appraised for funding by the World Bank even though it is known that their construction will involve the displacement of more than 1.5 million people - mostly of tribal and minority origin. Alternatives such as energy-efficient improvements, and the building of smaller dams which would be environmentally, socially and economically less risky, have not even been considered by the global lender in its Gadarene rush to commit ever larger sums to India's most grandiose 'development' scheme.

Of course the Bank is in the business of lending money for development. If it stops doing that, then it ceases to have a role. Conversely, the more lending that it does the more important its role becomes. This creates a pressure within the institution to make loans big and to make them quickly and, frequently, leads to important little details being neglected - quality control, for example, attention to the usefulness of projects, efforts to establish whether they will do harm, and so on. What gets forgotten most often and most easily is the welfare of the poor: too much time spent worrying about peasants and paupers, too much effort spent carefully devising projects that take people into account,

would definitely slow down the flow of money.

**Rao, RV. 1989**

Large and small dams.
International-Journal-of-Water-Resources-Development. 1989, 5: 2, 136-142.

**Abstract:**

For some time there has been a controversy in India and abroad on the adverse effects of large dams. Environmentalists and water resource development planners have often opposed one another in this controversy, the former vehemently opposing the construction of large dams and the latter favouring them. Benefits of large dams comprise: hydroelectric power; flood control; water management; improved water quality; and the provision of recreation areas around reservoirs. The possible adverse impacts of large and small dams are listed: submergence; high cost; evaporation; groundwater use; and induced seismic activity. Next, the adverse impacts of large dams and their mitigation are discussed in terms of population displacement; water-logging and soil salinity; aquaculture; effects on downstream areas; and dam breaks. Modern-day project planning is exacting and comprehensive; all aspects of the impact on the environment are considered in detail at the planning and implementation stages. Most of the adverse impacts of large-scale water resource development can be minimized, compensated for or even eliminated. Large and small schemes both have their roles to play in furthering the development of water resources.

**Thanb, NC; Biswas, AK (Editors). 1990**

Environmentally sound water management.
1990, viii + 276 pp; New Delhi, 11001,

India; Oxford University Press.

**Abstract:**

The nine chapters in this book: (1) water systems and the environment; (2) objectives and concepts of environmentally-sound water management; (3) planning and decision making framework; (4) general management techniques; (5) monitoring and evaluation of irrigation projects; (6) management of water projects; (7) watershed management; (8) water quality management; and (9) environmental impacts of the high Aswan Dam: a case study, evaluate environmentally sound water management and issues related to water development in developing countries.

**Scudder, T. 1990**

Victims of development revisited: the political costs of river basin development.

Development-Anthropology-Network. 1990, 8: 1, 1-5

**Abstract:**

A number of recent IDA research activities dealing with river basins - the Juba (Somalia), Senegal, Mahaweli (Sri Lanka), and Nile (Sudan) have heightened awareness of the extent to which large scale development projects are used by national elites to achieve political and economic goals at the expense of local populations. Adverse impacts on people who are involuntarily relocated because of the construction of dams, irrigation canals and other infrastructure have been well researched. Although assessed costs invariably are underestimated, entirely omitted from cost-benefit analyses are social, economic and political impacts. The article focuses upon these costs. The political implications of large scale river basin development projects are so serious that they can lead to or intensify civil wars. The article presents four case studies of incidents where major projects are

implicated in the initiation of intensification of civil wars, or policies of genocide, or both. They are the proposed Baaraheere Dam on the Juba River in Somalia; river basin development in the Senegal River basin in Mauritania; the Accelerated Mahaweli programme in Sri Lanka and the Jonglei Canal Project in the Sudan. There is an urgent need for researchers and funding agencies to become more aware of, and take corrective action to counteract these impacts.

**Ponce, VM; Lindquist, DS. 1990**

Management of baseflow augmentation: a review.

Water-Resources-Bulletin. 1990, 26: 2, 259-268.

**Abstract:**

Baseflow augmentation refers to the temporary storage of subsurface water in floodplains, streambanks, and/or stream bottoms during the wet season, either by natural or artificial means, for later release during the dry season to increase the magnitude and performance of low flows. Management strategies for baseflow augmentation fall into the following categories: (1) range management; (2) upland vegetation management; (3) riparian vegetation management; (4) upland runoff detention and retention, and (5) the use of in-stream structures. The benefits of a management strategy focused on baseflow augmentation are many, including: (1) increased summer flows; (2) healthier riparian areas; (3) increased channel and bank stability; (4) decreased erosion and sediment transport; (5) improved water quality; (6) enhanced fish and wildlife habitat; (7) lower stream temperatures; and (8) improved stream aesthetics. This review showed that baseflow augmentation was successfully accomplished in a few documented cases.

**Horowitz MM, 1994**

The management of an African river basin: alternative scenarios for environmentally sustainable economic development and poverty alleviation.

Proceedings of International Conference on Water Resources Planning in a Changing World. 1994, IV73-IV82.

**Abstract:**

Based on field research in anthropology, agronomy, and hydrology, studies on the Senegal river indicate that under certain conditions there is no necessary incompatibility between the objectives of (i) flood-dependent diversified agrarian and natural production systems and (ii) flood-averse hydropower and irrigation. Designed to allow for expanded irrigation, barge transport, and hydropower, two dams have been built on the Senegal. While original plans favoured terminating the annual flood, this has now been modified by the discovery that sufficient water is stored in the reservoir to allow for both power and, via an artificial flood, food production on a minimum of 50 000 hectares of downstream floodplain. This artificial flood would enhance the environmental health of the basin, and provide for equitable access to land and water for thousands of smallholder farmers, fishers, and herders, without inconveniencing the municipal and industrial sectors who are the prime consumers of electricity.

**Brooks KN; Ffolliott PF; Gregersen HM; Easter KW, 1994**

Policies for sustainable development: the role of watershed management.

Policy-Brief -Environmental-and-Natural-Resources-Policy-and-Training-Project-EPAT-MUCIA. 1994, No. 6, 6 pp.

**Abstract:**

This policy brief reviews the role of watershed management in achieving sustainable land and water resource management. Poor management of natural

resources on watersheds is a major cause of land and water degradation. The main cause of mismanagement is lack of appropriate policies that encourage application of known watershed management principles and practices. Practices for maintaining or increasing land productivity, assuring adequate water quantities of usable water, reducing flooding and flood damage, and assuring water quality are listed. Watershed boundaries rarely coincide with political boundaries. The main policy challenge is to move towards greater harmonization of economic development and environmental protection. This involves establishing and implementing policies so that people become responsible for the impacts of their actions on others.

**Krhoda G. 1994**

Economic planning through drainage basins in Kenya.

Eastern-and-Southern-Africa-Geographical-Journal. 1994, 5: 1, 44-55.

**Abstract:**

In the last two decades the Government of Kenya has established regional planning authorities based on river and/or lake basins. The authorities have been given the mandate to coordinate regional development policies, ensure equitable development of water resources and to promote regional economic development. Because the basis of these units is defined as the parcel of land on which rain that falls is collected into rills, rivulets, streams and finally into a single river outlet that joins either a larger tributary or flows into a reservoir, these authorities vary in both their spatial extent and depth of coverage. This paper examines the basis of river/lake basin authorities in Kenya with the view of assessing resources, viability and challenges as planning and management units. The discussion revolves around whether the development authorities plan with the

view to achieve higher and sustained economic development and enhanced environmental benefits on the one hand, and reduced conflicts between economic and cultural development and conservation on the other. Some areas of further investigation include planning with limited data, conflicts with District Planning Strategy and utilization of international water resources. The need for a national sustainable development strategy is also discussed.

**Alam MK; Mirza MR; Maughan OE, 1995**

Constraints and opportunities in planning for the wise use of natural resources in developing countries: example of a hydropower project.
Environmental-Conservation. 1995, 22: 4, 352-358.

**Abstract:**

The impacts of hydropower developments on local environment, ecology, and socioeconomics, has influenced, and will continue to influence, the efficacy in decision-making and planning/design processes. Big dams have several disadvantages: (a) high costs, (b) possible collapse, (c) evaporation loss, (d) flooding of prime agricultural land, (e) siltation of reservoir, (f) salt-water intrusion in coastal areas, (g) deforestation and 'greenhouse' effect, and (h) destruction of habitat for rare species. This article suggests that it is necessary to develop a greater understanding of how hydropower development affects species, both individually and in their interactions with each other. It is argued that conservation objectives must be integrated with other objectives in formulating national and other policies, before they crystallize into projects and programmes. When ecological factors are considered only at the end of the process, they are liable to be viewed as obstructing development but if integrated at the basic level of decision-

making, they can positively guide development.

**Adams WM; Binns T; Binns T, 1995**

Wetlands and floodplain development in dryland Africa.
People-and-environment-in-Africa. 1995, 13-21; 1 fig.

**Abstract:**

The paper examines a type of environment in Africa which has a strategic importance for sustainable development that is out of all proportion to its size. The present utilization of wetlands and flood plains for agriculture, grazing and fishing is reviewed, and then the impact of various types of development on these areas is considered. The impact of dams has been particularly significant, it is argued, because knowledge on the part of engineers, economists and other planners about the ecology and human use of Africa's wetlands remains limited. There is an urgent need for better environmental appraisal of proposed projects to identify the likely costs and benefits.

**McMahon TA; Finlayson BL 1995**

Reservoir system management and environmental flows.
Lakes-and-Reservoirs. 1995, 1: 1, 65-76 .

**Abstract:**

Most large-scale dams were built before ecological concerns became prominent and with little understanding of the long-term consequences of alterations to flow volumes, flow patterns, and water quality. It is now clear that the maintenance of ecologically healthy rivers is not possible with most existing reservoir management systems and that changes are needed. Physical constraints to the provision of appropriate environmental flows from existing dams in Australia are reviewed. The regulation of rivers with variable flows, the patterns of flows released from reservoirs, and the release capabilities of dams are considered.

Soderbaum B, 1996

Revaluing wetlands.  
OECD-Observer. 1996, No. 198, 47-50.

**Abstract:**

Wetlands are among the richest and most productive ecosystems on the planet but they are threatened throughout the world. The article explains the range of useful functions which they perform such as water purification, flood control and food production. The increasing pressures in both developed and developing countries on wetlands are discussed. The dangers for wetlands in developing countries who follow models of development found in western economies are highlighted. The large scale development of irrigation systems and hydroelectric schemes contribute massively to the reduction in wetlands whose importance is not valued properly at the project planning stage. The need for environmental economics to take account of the value of wetlands in decision-making processes is highlighted and seen as a way of protecting wetlands in the future.

**4.8 REMOTE SENSING AND FLOOD MAPPING**

Afanas'eva, TV; Trifonova, TA. 1983

Typology of floodplain lands of the Ob River based on a complex interpretation of aerial and satellite photographs.  
Moscow-University-Soil-Science-Bulletin. 1983, 38: 4, 1-7; Translated from Vestnik Moskovskogo Universiteta, Pochvovedenie (1983) 38 (4) 3-

**Abstract:**

The suitability of using aerial methods for studying the typology of floodplain lands is discussed. A system of taxonomic units was developed based on characteristics of the structure of the soil cover. Groups of

land types were determined by morphographic interpretation of satellite photographs or small-scale aerial photographs. More detailed typologic studies involved instrumental interpretation of large-scale aerial photographs on the basis of soil catenas and quantitative characteristics of the relief of the floodplain surface.

Breyer, JIE. 1983

Supervised classification of Landsat MSS data for mapping flooding in the Lower Boteti Region, Central District, Republic of Botswana.  
Working-Paper, National-Institute-for-Development-and-Cultural-Research, University-College-of-Botswana. 1983, No. 45, iv + 56pp.

**Abstract:**

The study investigates the applicability of the Landsat system to the Lower Boteti Region in the Central District of Botswana. The report gives: a brief review of the Landsat system, the image processing system; a detailed account of the steps involved during the Landsat data processing and classification; an outline on the results on classification, geometric and aerial measurement accuracy of Landsat data for flooding; a summary of the input requirements for the classification with reference to time/costs spent on the field surveys, computer analysis, operator/interpreter's analysis, and the production of the hardcopies. It concludes with the feasibility of mapping flooding at regular intervals in the Lower Boteti Region and gives recommendations on improvement of the classification results.

Bhavsar, PD. 1985

Review of remote sensing applications in hydrology and water resources management in India.  
Advances-in-Space-Research. 1985, 4: 11, 193-200; Space Applications Centre,



Indian Space Research Organisation,  
Ahmedabad 380 053, India

**Abstract:**

The modern space technology of satellite remote sensing has been recognised in India as a useful tool for quick information gathering in many fields of resources management. Significant work has been carried out in hydrology and water resources management related problems using the remote sensing data from Landsat satellites, aircraft remote sensing and Indian experimental remote sensing satellites Bhaskara I and II. In particular it has been found useful in surface water resources and flood-plain mapping, monitoring of sediment and water pollution, water management in command areas and ground water targeting. Significant results of the work carried out are presented. A brief description of the proposed programme for the Indian Remote Sensing Satellite to be launched in 1986 is also described.

**Pilon, PG; Howarth, PJ; Bullock, RA. 1988**

An enhanced classification approach to change detection in semi-arid environments.

PEandRS, Photogrammetric-Engineering-and-Remote-Sensing. 1988, 54: 12, 1709-1716.

**Abstract:**

The use of Landsat digital classification or enhancements to monitor change in semi-arid environments has generally met with limited success. This can be partially attributed to unique physical and human factors which complicate change detection in these environments. An enhanced classification approach which combines image enhancement to isolate change with multispectral classification to identify change dynamics has been developed. The technique has been applied in northwestern Nigeria to dry season Landsat MSS images acquired for dates

before and after construction of the Bakolori dam and reservoir. These images span a nine-year period during which marked changes have occurred as a result of dam construction and stream regulation associated with the Bakolori project. The results show evidence of land degradation in flood plain areas downstream of the Bakolori dam where flood plain cultivation has been reduced by as much as 50 percent. Comparisons with ground survey data confirm that the enhanced classification approach provides more accurate information on change by minimizing errors associated with misregistration and misclassification and by allowing the suppression of environmental factors through the separation of natural and human-induced change.

**Neumann, P; Schultz, GA. 1989**

Hydrological effects of catchment characteristics and land use changes determined by satellite imagery and GIS.

IAHS-Publication. 1989, No. 186, 169-176.

**Abstract:**

A hydrological rainfall-runoff model is presented which uses satellite data combined with data from a Geographic Information System (GIS) for parameter estimation. It is based on the concept of source areas contributing to runoff. Infiltration is computed on the basis of the Green and Ampt concept. All computations are carried out for grid cells of Landsat TM pixel size (30 X 30 m). From GIS data the slope of each pixel is computed and direction and velocity of flow to the pixel below determined. Landsat data are used for land use classification and estimation of vegetation indices. This forms the basis for estimating infiltration and other hydrological parameters. The model is being applied to the Volme River catchment in northwest Germany. The influences of seasonal vegetation status on

flood flows and of land use changes on runoff will be studied.

**Nguyen-Thi, PT. 1990**

Application of remote sensing data to flood inundation studies and environmental monitoring of the Lower Mekong River basin.

Proceedings of the twenty-third international symposium on remote sensing of environment: Volume II 18-25 April 1990 Bangkok, Thailand. 1990, 793-803; Ann Arbor, USA; Environmental Research Michigan (ERIM).

**Abstract:**

Remote sensing techniques including LANDSAT, SPOT and SOUZ satellite images, were used successfully to study and map flooding over the Mekong river delta in Vietnam (4 million h). Direction of flood flow was monitored during its rising phase and receding stage for drained flow. Incorporating this information with relief maps, the depth and volume of water was determined. Together this information can be used to predict the extent of future floods, and as an aid for planning flood control and land use.

**Korolev-VM. 1991**

Flood mapping from satellite images using digital data processing methods.

Soviet-Meteorology-and-Hydrology. 1991, No. 8, 74-77; Translated from Meteorologiya i Gidrologiya, (1991), No. 8, 94-97.

**Abstract:**

A method of computerized mapping of floods, based on numerical digital processing of satellite imagery, using a Robotron system, is proposed. An equation was derived from mean brightness of the floodplain, water and land. The flooding map is presented as a binary image, where all the elements of the floodplain are classified as flooded or

nonflooded. The technique was tested on the Volga-Akhtuba floodplain near Volgograd.

**Usachev-VF. 1991**

Evaluation of the Volga-Akhtube floodplain inundation from aerospace surveys.

Soviet-Meteorology-and-Hydrology. 1991, No. 9, 42-49; Translated from Meteorologiya i Gidrologiya.

**Abstract:**

A variety of satellite images and aerial photographs were assessed in order to estimate flooding in the title area. Space imagery covers large areas, does not show geometrical distortion and, especially near infrared images, allows interpretation of water surfaces. Typical patterns of inundation and the dependence of flooding on water level are described. A method for calculating the amount of water necessary for inundation of the floodplain is suggested.

**Blasco, F; Bellan, MF; Chaudhury, MU. 1992**

Estimating the extent of floods in Bangladesh using SPOT data.

Remote-Sensing-of-Environment. 1992, 39: 3, 167-178.

**Abstract:**

Nine SPOT XS scenes recorded during the dry season (January, February) and after cyclonic storms were analysed to evaluate both the extent and consequences of floods in Bangladesh, in the delta of the Ganges. Digital and visual analysis showed the following results: (1) near the capital, Dhaka, within a SPOT scene (3600 km<sup>2</sup>), the extent of water varies from 324 km<sup>2</sup> during the dry season to 1303 km<sup>2</sup> after a destructive flood. This means that flood-prone areas in the overpopulated deltaic region are at least four times larger than the hydrographic network observed during the dry season. (2) The Sunderbans are the world's largest

area of mangrove (about 6000 km<sup>2</sup> in a single block); two-thirds of this forest (4050 km<sup>2</sup>) is in Bangladesh, and the rest is in India. These ecosystems seem to resist cyclones. No sign of any kind of mangrove alteration is seen on SPOT images recorded a few weeks after disastrous cyclonic storms (20 August 1987 and 6 September 1988). This is an important fact since the protective role of these coastal swamp forests is very important. (3) The islands located in the very exposed area at the mouth of the Meghna are densely populated (more than 1000 inhabitants/km<sup>2</sup>). Hathya island was carefully surveyed. According to the investigations carried out on SPOT images (25 February 1987 and 26 October 1988), the island seems to be at present satisfactorily protected against cyclones and tidal surges, behind newly planted mangroves (*Sonneratia apetala*) and sheltered by a complex network of embankments which are visible on the images. It was concluded that the spectral separability of classes (water, natural plant communities, land use units) and the geometric accuracy of SPOT are suitable for coastal monitoring in this part of Bangladesh.

**Ramamoorthi AS; Gupta NL (ed.); Gurjar-RK. 1993**

Remote sensing applications in hydrology.

Integrated-water-use-management. 1993, 63-66. PB: Rawat Publications; Jaipur; India National Remote Sensing Agency, Secunderabad, India

**Abstract:**

The applications of remote sensing technology in hydrology are reviewed: surface water mapping, watershed surveying, determining potential zones of groundwater, irrigation area planning, snow-cover mapping and runoff prediction, flood-plain mapping and flood damage assessment, and water quality assessment. Examples given include

assessing reservoir storage in Andhra Pradesh using LANDSAT, monitoring shifts in the land-water interface in the Kosi or Brahmaputra river, snow mapping in the Himalayas, and assessing river water quality on the basis of algal blooms and sediment concentrations.

**Schultz GA; Rango A (ed.); Ritchie JC. 1996**

Remote sensing applications to hydrology: runoff.

Special issue: remote sensing applications to hydrology. Hydrological-Sciences-Journal. 1996, 41: 4, 453-475.

**Abstract:**

Since no remote sensing (RS) devices have been developed allowing the measurement of river runoff directly, information from RS sources is used to compute runoff values indirectly. This is done with the aid of hydrological models, where RS data are used in two different ways: (1) in the form of model input data; and (2) for model parameter estimation. Three types of models are discussed, the parameters of which are estimated - at least partially - with the aid of RS information. A mathematical model is demonstrated, which reconstructs monthly river runoff volumes on the basis of IR data obtained by the Meteosat geostationary satellite. The second model computes flood hydrographs with the aid of a distributed system rainfall/runoff model. A major model parameter, the soil water storage capacity, which varies in space, was determined on the basis of Landsat imagery and digital soil maps. The third model discussed is a water balance model which computes all relevant variables of the water balance equation including runoff on a daily basis. Parameters used in the model components for interception, evapotranspiration and soil storage are estimated with the aid of RS information originating from Landsat and NOAA data. Examples of the performance of all three models are

presented. Input to hydrological models computing runoff is usually either rainfall or snowmelt or both. An example for model input estimation on the basis of satellite data is presented as well as the use of ground-based weather radar rainfall measurements for real time flood forecasting. An example of snowmelt runoff modelling is mentioned, followed by a brief discussion of future perspectives of runoff computations with the aid of RS data.