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Notes and Comments

THE CHALLENGE OF LAKE CHILWA[1]

Lake Chilwa and its environs present a unique challenge to science for two reasons:

1. The welfare of its people and the fish and crops on which they depend for income as well as subsistence are dominated by the vagaries of the periodic rise and fall of the lake. In years of high level the lake provides a relatively good living for the people of the plain and the fish is a major source of dietary protein for the densely populated Shire Highlands. Fish catches and fish consumption decline in years of low lake level. Could knowledge of the biology of the lake and the hydrology of the lake basin assist in stabilizing the fishing industry?
2. The area is underdeveloped, with the traditional matrilineal way of life, but it has considerable potential for a fishing industry, for agriculture, for livestock, for bird preservation and tourism and possibly, at some future date, for minerals. How can these interests be reconciled and in what order should developments take place?

The University of Malawi, recognizing that the new campus at Zomba would be less than 30 km from the lake, in 1966 established the Lake Chilwa Co-ordinated Research Project in which problems in biology, economics, geography and sociology would be investigated by the staff. It was realized that inter-disciplinary research would be more fruitful than individual efforts along separate lines. Fortunately, funds in support of the Project were granted by several organizations.

The following objectives were set out in 1966 for the Lake Chilwa Co-ordinated Research Project.

(i) To supplement research on fisheries by studying the biology of Lake Chilwa (with IBP collaboration).

(ii) To study the changing morphology of the lake and Chilwa Plain and the zonation of the vegetation in the landward areas with regard to future land use.

(iii) To study the people of the area in order to discover the relationship between fishing and farming and to analyse the economics of fishing, marketing and farming.

(iv) To measure the radioactivity in certain soils on Chisi Island, and its biological effects.

(v) To assist in a general ecological study of the north-west area of the Chilwa Plain, with a view to biological control of the red locust in the potential outbreak area.

1. Excerpted, in part, from Kalk, Margaret, ed. (1970). *Decline and recovery of a lake.* Research report 1966-1970 of the University of Malawi Lake Chilwa Co-ordinated Research Project. Government Printer, Zomba.

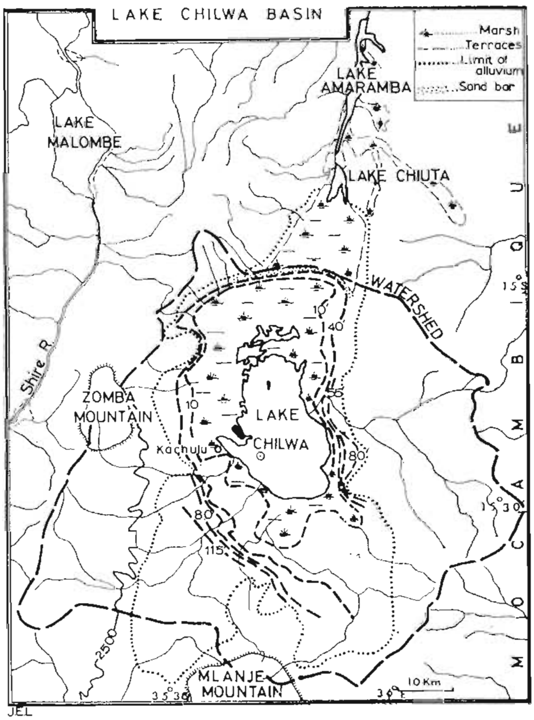

Fig. 1.—Map of the Chilwa Basin showing the catchment area. Reprinted by courtesy of Dr. W. Junk, N. V. Publishers from *Hydrobiologia* 36(1): 1970. A. Morgan and M. Kalk.

Lake Chilwa is situated on a plain which extends from longitude 35° 30′ to 36° east and from latitude 15° to 15° 30′ south, at an altitude of 620 m above sea level, adjoining the Malawi/Mozambique border on the east (Fig. 1). It is about 30 km due east of Zomba, the present capital of Malawi, and 88 km from Blantyre. The lake itself is 700 km^2 in area and is usually two to three metres deep. It is surrounded by an almost equal area of bulrush swamp. Approximately 500 km^2 of grasslands on the west and south are seasonally inundated up to the three metre contour line, above the present level of the lake, for short periods during the summer, the duration of the inundation depending on the climatic pattern of the year.

Many streams from the surrounding mountains, Chikala, Zomba, Chiradzulu and Mlanje in Malawi and the mountains in Mozambique to the east, all 30-60 km away, flow into the lake but only five of them, indicated on the map, run throughout the year. More water reaches the lake from the western mountains than from the south since it is in the rain shadow of the Mlanje massif (3,000 m high). Rain falls mainly in the months November-April when the mean air temperature is about 25°C. The dry season has three somewhat cooler months (mean air temperature 20°C), followed by hotter months before the rains when evaporation is very high. The lake has no outlet and the difference between its highest level during the inflow of water from rivers and surrounding grasslands in the wet season and its lowest level during the other months when evaporation is very high is less than one metre in a 'normal' year (Fig. 2).

Although full records are not available for long periods, it seems that the mean average rainfall over the catchment area varies from 80 cm on the plain to 125 cm a year on the mountains and that the evaporation over the lake is about 195 cm a year. Rainfall figures in different quadrants of the area not only differ markedly in any one year but vary independently in different years. If there happens to be a succession of two years when the total rainfall is low the lake will fall more than one metre before the next rains. This has happened at approximately six-yearly intervals since the gauge at Kachulu jetty was erected in 1949. In the dry season, it is then possible to walk to Chisi Island across the exposed mud of Kachulu Bay. When there is a succession of three or four years of lower than-average total rainfall, the lake level falls still more and the lake bed may dry over its whole surface as it did in 1968 for a few weeks. Twenty years of variations in lake level are indicated in Fig. 2. Recessions sufficient to interfere with fishing have been reported in 1879 and 1922. Kachulu Bay was dry in 1900, 1915 and 1934 as it was in the 1967 dry season.

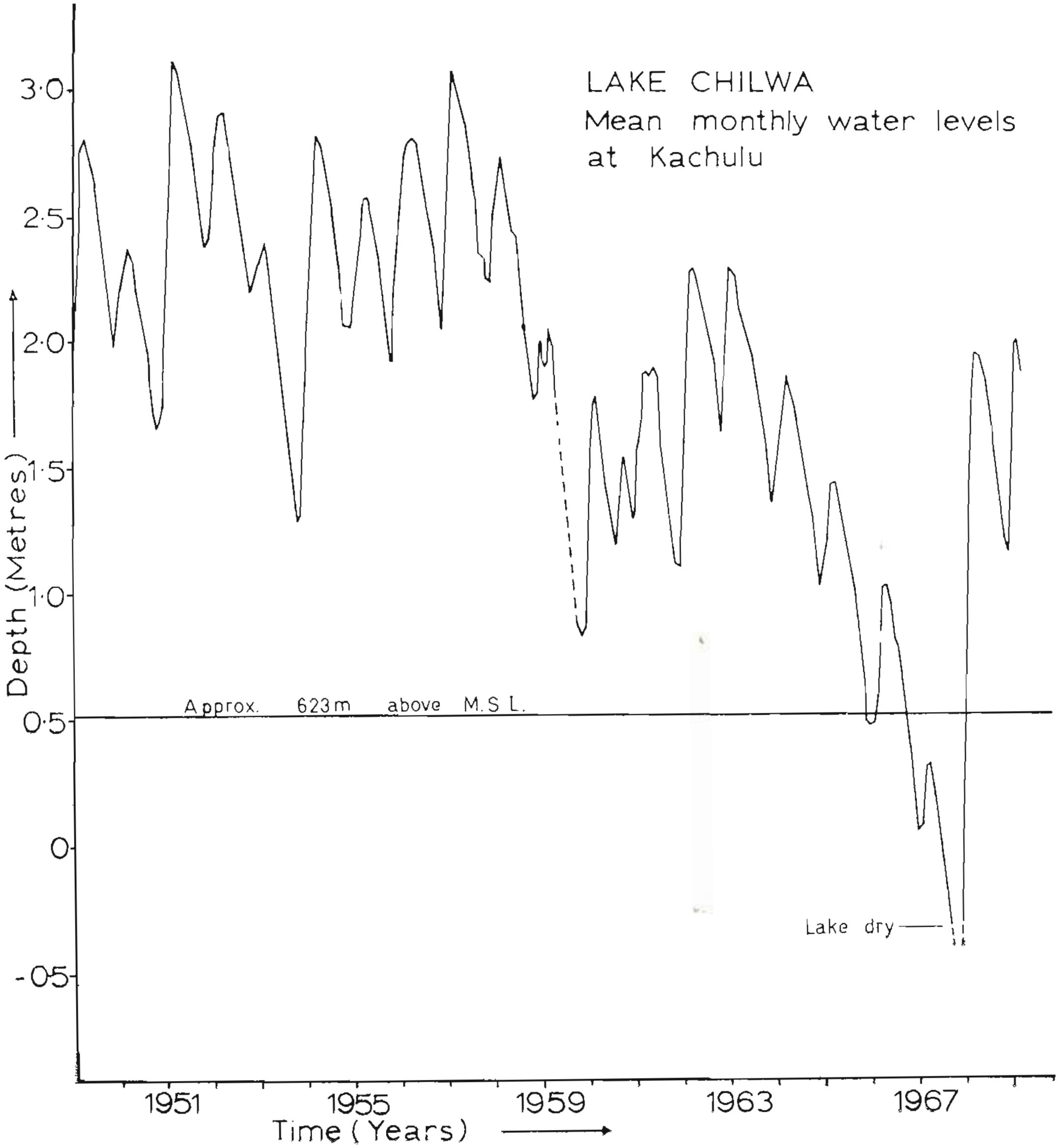

Fig. 2.—Mean monthly records of Lake levels at Kachulu jetty, Lake Chilwa, 1949—1970. (With acknowledgements to the Department of Hydrology, Ministry of Natural Resources.) Reprinted by courtesy of Government Printer, Zomba.

After the drying phase of 1966-8 the lake, quite remarkably, filled to a depth of two metres over the whole area in the five months of the 1968-9 rains; these began early in November 1968, were heavy over the lake itself and lasted a longer time than usual. The rainfall at Zomba was not significantly higher than the average over ten years, but was almost twice the average rainfall of the last three years. The timing of the Lake Chilwa Co-ordinated Research Project is therefore doubly interesting because work began immediately before the decline of the lake; it has continued through the unusual crisis of the complete recession of the lake to its rebirth and rapid recovery in every sphere. It also coincides with the beginning of economic development in the area after Independence.

Since the lake was formed in late or post-Tertiary times it has certainly been reduced to about one-third of its former size. The Lake Chilwa depression was formed in the mid-Tertiary plain by later downwarping and it tilted towards the east outside and away from the Rift Valley of the Shire River and Lake Malawi; it extended in a north-north-east direction and included Lake Chiuta and perhaps found outlet to the Indian Ocean via the Lujenda River (GARSON 1960). Whether Lake Chilwa also had an outlet at another time to the Ruo River southwards and thus to the Shire River is not yet clear. Fossil lacustrine beaches up to 33 m above the present level and borehole cores of alluvium down to 55 m testify to a much larger and deeper lake millions of years ago. There is clear evidence of a common shore-line with Lake Chiuta in the north, perhaps in Pluvial times; now the lakes are separated by a wind-blown sandbar about 16 m high. The geological history of the lake deposits is currently under investigation by the Geological Survey Department.

The Chilwa area has been surveyed for minerals by the Geological Survey Department which reported that on Chisi Island there are minerals of economic value: limestone from which lime for agriculture and cement might be obtained on a larger scale than hitherto; feldspathic rocks which would yield potash for fertilizer; niobium and thorium in the pyrochlore-rich dykes in carbonatite which may be too poor for exploitation; and sand on the lacustrine terraces which might be used for building (GARSON and SMITH 1958). The possibility of harmful radiation from the thorium deposits has been investigated and found to be probably minimal.

In the late nineteenth century explorers commented on the plentiful game (e.g. elephant, zebra, buffalo and antelope) on the Chilwa Plain. At the present time the human population is dense and game is almost absent. Duiker and reedbuck are sometimes seen and occasionally lion, jackal and hyena are reported. The place of game is taken, however, by cattle which are kept by many of the people. Monkeys occur on Chisi Island, hippopotami are seen in the river estuaries, and crocodiles are now rare. Bird life is exceptionally abundant in the marshes and snakes, such as python and adders, are numerous. A soft-shelled turtle (*Cycloderma* sp.) occurs in the lake. The marsh frogs *Ptychadaena mascareniensis mascareniensis* and *Phrynobatrachus acridoides* occur on the edges of the lake and in the marshes in the wet season, but the shrill musical trill of the tree frog *Hyperolius marmoratus albofasciatus* is the only sound heard at night in the summer.

Some river fishes enter the periphery of the lake in the wet season but only three species persist throughout the year and attain very large numbers, sufficient to support a successful fishing industry. Fishing declined in 1967 as the lake level fell until only the catfish *Clarias mossambicus* remained. During the recovery period of the lake only line fishing for this hardy fish was allowed, so as to protect the young *Tilapia shirana chilwae* and *Barbus paludinosus* recruited from the rivers, but after the second wet season prohibition of net fishing was rescinded because re-population of the lake had, quite remarkably, already taken place sufficiently to support the industry again.

The waters of the lake and neighbouring boreholes are more or less brackish, depending on the season and the year. The new lake is not as salty as the old lake was in 1966. The release of nutrients from the exposed mud is being investigated. The chemical features of lake and river water were studied in the drying phase and in the recovery phase a much wider programme of chemical study over the whole lake has been undertaken in order to document the conditions in which the biota of the lake live and change. The pattern of initial recovery is already known and it is intended that all phases of the next periodic cycle should be followed.

All trophic levels of the lake in open water as well as inshore are now under investigation. Photosynthetic activity is limited by intense discolouration of the water with humic acids in the drying phase (MOSS and MOSS 1969) and by excessive turbidity, except in the marshes, in the recovery phase. Significant changes in species composition, anomalous distribution of benthos, variations in population densities and in the utilization of algal standing crops are problematical.

The situation in the open water, however, is perhaps less complex than was expected for although the lake is fairly large it is of almost uniform shallowness and very turbid. It is surrounded, however, by an almost pure community of *Typha domingensis*, except for estuaries where the leguminous tree-like *Aeschonomyne pfundii* is dominant. The micro-niches in the marshes are numerous and important to the general ecology of the lake. Environmental hazards in the lake during its fluctuation in level, such as changes in salinity and alkalinity, have probably had a selective effect on the structure of communities, and few species remain at each trophic level. It may be possible, therefore, to estimate primary, secondary and tertiary productivity and the approximate utilization of energy at each level.

The extensive swamp vegetation is being intensively studied and the history of its colonization of the lake bed may shed light on recent changes in depth and area of the lake which are very pertinent to the problems of stabilization of the fishing industry and to agricultural plans.

The hydrobiological part of the Project had linked up with the International Biological Programme in the Section on Freshwater Productivity, from which assistance has been received.

Most of the land on the plains is cultivated manually and maize, beans, cassava, sorghum and millet, bananas and pawpaws are grown. Rice and cotton have been grown on the plain for many years. The density of the population varies and the movements of the people from the area since the critical dry period have been recorded. As the water receded in the drying phase land was reclaimed for agriculture in certain parts.

The north-west plain had been suspected of being a potential outbreak area for the red locust which did a great deal of damage in Central Africa up to 1930. Since the last intensive spraying with insecticide in 1962 by the International Red Locust Service only occasionally have numbers of locusts increased to the extent when it became profitable to sell them as food in Zomba market. Some observations on the ecology of the red locust are recorded but swarms have not been detected in the last few years.

Over one thousand fishermen make a permanent living on the lake and many fish traders smoke or dry fish (but do not salt it) and distribute it over a radius of 100 km at local markets. The main landing and trading site is at Kachulu jetty. Some of the characteristics of the traditional economy of both farmers and fishermen have been analysed. The efficiency of the growing entrepreneurial class of fish traders who distribute the fish on bicycles carried by lorries, and who drop off with their loaded baskets at local markets, has been described. During the time of crisis, when Lake Chilwa disappeared and fishing was impossible, many people adapted themselves to the new situation by migrating to Lake Malombe or the Lower Shire Valley, where the tonnage of fish caught in 1968 almost compensated for the loss of Lake Chilwa (RENSON 1969). The people who remained behind returned to farming and attempted to supplement their diet by snaring birds.

One factor for change in the traditional economy is the introduction of Rice Development Schemes in which the use of irrigation may allow the cultivation of two crops a year instead of the single annual crop. It will be necessary to study the activity of the stemborer in rice, whose depredations have lately been observed. The response of the people to planned change has been studied and an optimistic result noted.

In the Aquatic Environment the following areas of investigation are being conducted during both the drying and recovery phase of the lake: chemical and physical factors; algal, bacteriological and macrophyte ecology and productivity; distribution and composition of zooplankton and bottom fauna; food and ecology of commercial species of fish; and population dynamics of fish. Terrestrial and rural economy studies being undertaken include amongst others the study of plant communities, demographic study of the people, fish trade, rice schemes and radiation.

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REFERENCES

Garson, M. S. (1960). The geology of Lake Chilwa area. *Geol. Surv. Nyasaland. Bull.* 12.

Garson, M. S. and W. Smith, (1958). Chilwa Island. *Geol. Surv. Nyasaland. Mem.* I.

Moss, B. and J. Moss (1969). Aspects of limnology of an endorheic African Lake (Lake Chilwa, Malawi). *Ecology* 50(1):109-118.

Renson, H. G. (1969). *Fish Marketing in Malawi.* Ministry of Agriculture, Zomba.

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