

Water as a Focus for Rural Research

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Inscribed in the fresh concrete of a self-help water supply scheme in Tanzania's Usambara Mountains are the Swahili words, *Uhuru na Maji*, which link freedom and water to paraphrase the national motto of freedom and unity. In this way the villagers have emphasized the critical role that water plays in a country where land is plentiful, but well-watered land is limited to a few montane districts and parts of the coast. The villagers' view is shared by the nation, for approximately six out of every hundred shillings of government expenditure is for water-supply development.¹ More significantly, these expenditures represent a fourth of all funds available for agricultural development.²

Water, therefore can serve as a focus for rural research in a program where national relevance weighs heavily along with scientific interest. The hydrologic cycle is a great natural system and a key to understanding the ecology and ecological changes in the land systems of rural Africa. The modified hydrological cycle that serves human needs is also a technological system of considerable complexity as well as a major social system. Technologically, in Tanzania there are probably over a thousand engineered structures, ranging from drilled wells to township distribution systems, all designed to divert water from the natural system for the use of human society. The social systems are equally diverse, ranging from the system of traditional rights and duties on the irrigation furrows of Kilimanjaro, to a recent requirement in one district that all able-bodied men respond to emergency calls for repairs of a critical water pipeline under penalty of a fine. Thus study of the water-use systems in all their dimensions serves as a bridge between natural and social scientist, academic and technician, university research fellow and civil servant.

Tanzania has a tradition of such research, embodied in the work of Clement Gillman, who arrived in German East Africa in 1905 to work on the railroad, eventually becoming its chief engineer. A self-taught geographer, he served after retirement in 1937 as water consultant to the colonial government. His many papers and published writings give testimony not only to his energy, but to the wisdom of a broad approach to water problems.³ Today, at Univer-

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1. United Republic of Tanzania, *Background to the Budget* (Dar es Salaam, 1968).

2. G. Helleiner, "The Composition of Agricultural Development Expenditures in Tanzania, 1963-64 to 1967-68," ERB Paper 68, II, (Dar es Salaam, 1968).

3. C. Gillman, *A Reconnaissance Survey of the Hydrology of Tanganyika Territory in its Geographical Settings*. Tanganyika Territory, Water Consultants Report. No. 6 (Dar Salaam, 1940).

sity College, Dar es Salaam, water resource research is a major component of the research program of the Bureau of Resource Assessment and Land Use Planning. One of the two research bureaus at the college (the other is the Economic Research Bureau), the bureau is a multidisciplinary institute related to the geography department and engaged in applied research on resource assessment, including population resources, regional planning and rural development. A distinctive feature of University College research is its close linkage with government and the joint selection of research topics directly related to development problems. Geographers and their co-workers appear well suited by temperament, training and tradition to organize the field-oriented studies required for most of this research. Their efforts are enhanced by the large-scale involvement of capable, interested students who move with ease in the countryside and contribute their own insight to these studies.

The bureau is but fifteen months old and its research program is still evolving, but presently it is working on the following water-oriented research topics: compilation of basic data and development of these data into more useful formats, evaluation of rural water supply projects, collection of irrigation statistics, assessments of smallholder irrigation projects, longitudinal study of soil erosion, and study of smallholder attitudes and adaptation to drought. Slated for the future are cooperative studies on the relationship between patterns and customs of water use and the transmission of water-borne disease.

Based on our experience to date, I would suggest four major areas of research which we have found relevant to the needs of Tanzania and which may have similar relevance to other areas of Subsaharan Africa. For each area, I will discuss this relevance, give further details on our current research, and suggest what seem to be the priorities for the future.

Analysis of Existing Data

By comparative international standards our knowledge of Tanzanian water resources is poor. Modern stream gauging is but 15 years old⁴ and the seventy-eight gauges of the network cover drainages of less than 50 per cent of the land surface. Nevertheless, the potential information content of existing data is substantial. Scattered records of stream flow and flood heights from railroad bridges, mission stations, and agricultural experiment stations can extend in time and space the information content on the modern gauging system.⁵ The

4. Water Development and Irrigation Division, *Hydrological Year Book 1950-1959* (Dar es Salaam, 1963); Water Development and Irrigation Division, *Hydrological Year Book 1960-1965* (Dar es Salaam, 1968).

5. L. Berry, "Notes on the Hydrology of some Tanzanian Rivers," paper presented to the International Geographical Union Commission on the International Hydrologic Decade (Delhi, 1968).

350 recorded well logs can be analysed to provide regional descriptions of underground water resources. Data exist for over 1,350 rainfall stations, and only a fraction of these have been subjected to limited study, usually in the context of East Africa as a whole and on highly generalized map scales of 1:2,000,000.⁶ Finally, the 166 papers and reports on water development problems including ten major basin or area studies in the Lake Victoria, Lake Tanganyika, Pangani, Wami, Ruvu, and Rufiji drainages, can be further utilized.

A great deal of our current effort is devoted to making those data accessible and a series of bibliographic-cartographic guides to the data are in various stages of publication. These include climatological stations with location and length of record, listing of drilled wells with locations and flow estimates, and listing of major and minor water resource studies with annotations of their contents. Woodhead⁷ and Porter (personal communication) provide new maps and data on evapotranspiration. Jackson has underway regional studies of montane rainfall. Berry is working on the characterization of the flood regimes of the major Indian Ocean drainages.⁸ Berry and Kates, building on work by Mascarenhas,⁹ are attempting to construct drought recurrence indices from the archival materials of colonial and postcolonial times.

High on the research agenda should be the derivation, on a regional basis, of the critical parameters required for rain-fed agriculture, irrigation and transportation planning. Desired relationships include rainfall-runoff coefficients, plant water requirements, soil moisture storage, growing season rainfall probabilities, expected peak flows from small drainages, ground water assessments, and basis for improved crop-planting strategies.

Evaluation of Existing Water Resource Development

Many of the development activities of a country such as Tanzania are frankly experimental. Even where the technology is well-developed such as the provision of a drilled well, the impact in terms of use is not well known. The benefits from a new water point may be in the form of improved health, new opportunities for increased agricultural or livestock development, or simply convenience, by the reduction of arduous and time-consuming portage of water and driving of cattle. Concentration of settlement may take place, as well as ecological change, in the area immediate to the new water point. Finally, the

6. East African Meteorological Department, *10-percent and 20-percent Probability Maps of Annual Rainfall of East Africa*, (Nairobi, 1961).

D. H. Johnson, "Rain in East Africa," *Quart. J. R. Met. Soc.*, 88 (1962), 1-19.

7. T. Woodhead, *Studies of Potential Evaporation in Tanzania* (Dar es Salaam, 1968).

8. Berry, *op. cit.*

9. Mascarenhas, "Aspects of Food Shortages in Tanganyika (1925-45)," *Geography Research Paper 6613* (Dar es Salaam, 1966).

point may be little used or over used, depending on its placement and its apparent utility to the inhabitants of the area.

Where the technologies are relatively new, such as in engineered irrigation schemes, the impacts are more speculative. Of course, the initiation of the new and untried is the essence of development but so is the process of learning. A great deal of useful experience is contained in the water resource development to date: the 300 dams and hafirs, the 350 drilled wells, the 15-20 small irrigation schemes, the many miles of rural water pipelines, the reservoir fishing industry, the improved traditional irrigations systems, and the Nyumba ya Mungu dam. Unfortunately the evaluation of development effort is seldom incorporated into the effort itself, little attention being given to the design of evaluation as part of the project. Thus the experience of the past, both failure and success, may never be learned in the absence of a formal mechanism for evaluating and recording experience. And informal methods of assessment, relying on the accumulated experience of the operating agency, are severely restricted by the high turnover and inexperience of staff typically found in developing countries.

In our current research, two water pipelines and four small irrigation projects are currently under study. With the development of large-scale irrigation and special extension services for traditional irrigators, it is hoped that evaluation of these projects can also be carried out. All these evaluations require technical knowledge of water use, understanding of social, economic and political impacts, sensitivity toward ecological change and willingness to work in remote areas. These would all seem to be requirements particularly challenging for geographic research.

Improved and Integrated Water Resource Planning

Multipurpose river basin development and its related planning process has been a feature of water development for thirty years. Integrated land and water surveys have been encouraged in developing countries for over a decade. Nevertheless the level of performance is discouraging. In Africa, implementation of widely heralded multipurpose development on four great rivers: Volta, Nile, Niger and Zambezi has been, to date, basically for power in three cases and, in one case, for irrigation and power. Among the four cases, serious failures in evaluating the correct human and biological impacts of the great man-made lakes have been recorded and steps taken to rectify them (in particular, the work of the Committee for the Development of Water Resources in Africa, Africa Science Board, National Academy of Sciences).

The so-called integrated survey is more often than not simply separate reports by expatriate specialists in soils, geology, hydrology and civil engineer-

ing bound together under common cover. On rare occasions a sociologist or an economist might be included on the team but this may merely make for more numerous reports with real integration still unrealized.

On another level of planning, single-purpose water-resource development requires integration with other activities, if the full benefit of this development is to be realized. For example, a careful medical survey of a village that installed an improved water supply showed no reduction, one year later, in the prevailing high rates of helminthic infestation. Medical treatment was clearly required along with water-supply improvement. In other examples, improvement in smallholder rice irrigation requires development and distribution of new, evenly-maturing strains as well as better water control. Present methods of allocating new cattle-watering supplies favor existing concentrations of herds, thus foregoing some of the development incentive for opening new areas of grazing potential. And when rural water supplies are used to help stabilize and thereby intensify what is now only seasonal production of cotton and maize, the full returns of these investments are unrealized in the absence of associated feeder-road development and orderly control of settlement.

The common thread to the foregoing examples is that even single-purpose water-resource projects require integration with other development or service activities. Obstacles to such integration are partly administrative and partly technical. Efforts currently underway to decentralize rural development activity hold hope that the administrative problems can be overcome, but further study is clearly needed before we can specify the exact requirements for technical integration. For example, while water supply improvement alone will not reduce disease rates, it is not clear either whether improved supply coupled with a one-time course of treatment will have a lasting effect. Smallholder paddy cultivation is widespread and it is not known whether evenly-maturing strains will flourish in the diversity of small areas where such cultivation is practised. Careful surveys of ground water availability and runoff need to be coupled with surveys of grazing area potential before the opportunities in rangeland development foregone by the present system are identified. Finally, we know more about the spacing of water points to serve a rural population than we do about the spacing of feeder roads to encourage cultivation of specific crops. Thus, while we can criticize the lack of integration on a *priori* grounds, we frankly cannot specify the associated inputs required even if called upon to do so. This is clearly a major research need, part of which we are beginning to meet.

Understanding the Human Use of Water

Underlying all the opportunities of useful applied research with a water focus is the need to understand the ways in which water is viewed, sought,

chosen and used in rural Africa. It is unlikely that we will know where to apply the new, more powerful, molluscicides for control of shistosoma carriers unless we understand why village women favor particular sources in areas of diverse habitants. Utilization of the potential in Tanzania of some 300,000 acres of floodplain or traditional furrow land for irrigation requires an understanding of the role irrigated crops now play in the agricultural systems where such land is presently utilized. An equitable and just allocation of scarce funds for water supply improvement requires more studies as recent ones suggest that the real cost of water is highest for the low-income, urban dweller in East Africa¹⁰ or that Bahaya women devote almost as much time fetching water as they do growing food crops.¹¹ Improved crop-planting strategies, capable in some cases of actually doubling yields, require an intimate knowledge of present agricultural systems, drought adaptations, and farmer attitudes towards risk.

Current studies that might be considered as fundamental research of this type include the study by White and Bradley of East African water use, to be published shortly, the bureau's pilot study of drought now centered on the examination of how drought adjustments vary with rainfall within a single cultural group, and the forthcoming volume by Porter on *Environment and Economies in East Africa*. On the research agenda, will be an attempt to support current medical and ecological research into bilharzia and other water-borne diseases with geographic studies of water use.

Conclusion

It has been estimated that to bring to all the people of Tanzania a dependable water supply is the work of at least four decades. Faced with such a commitment of time and resources, research that truly shows promise of reducing the time or diminishing the cost, should be consistently pursued.

10. G. White and D. Bradley, "Drawers of Water" (forthcoming).

11. J. Rald, "Land use in a Buhaya Village. A case study from Bukaba District, West Lake Region," (Bureau of Resource Assessment and Land Use Planning Research Paper No. 6, Dar es Salaam, now in press).