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# Turning Water into Power: Debates over the Development of Tanzania's Rufiji River Basin, 1945–1985

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# Turning Water into Power

## Debates over the Development of Tanzania's Rufiji River Basin, 1945–1985

**HEATHER J. HOAG and MAY-BRITT ÖHMAN**

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In 1928, the irrigation engineer Alexander Telford set out to survey Tanganyika's Rufiji and Kilombero valleys, a region many believed held the territory's most promising sites for agricultural development (fig. 1).<sup>1</sup> Traveling via boat, motorized lorry, and most often by foot, Telford recorded the soils, waterways, and people he encountered. The region's "well-cultivated [and] carefully laid out and tended" farms, he argued, were evidence of residents' environmental knowledge and agricultural skills. The Rufiji River was more of a challenge, being "very irregular in places, of constantly varying width and depth [and] unstable."<sup>2</sup> He concluded that more geographical surveys were needed prior to spending large sums on irrigation or river-improvement projects. Following World War II, the colonial government turned to international development agencies for assistance in gathering this data. From 1954 to 1960, experts from the United Nations Food and Agriculture Organization (FAO) traversed the region's few passable roads in four-wheel-drive vehicles and made repeated flights over the basin, using

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1. In 1885, Tanzania became part of German East Africa. In 1919, Great Britain was granted a League of Nations mandate over the colony; at that time, the colony became the Territory of Tanganyika. On 23 April 1964, Tanganyika and Zanzibar joined to form the United Republic of Tanzania.

2. A. M. Telford, *Report on the Development of the Rufiji and Kilombero Valley* (London, 1929), 1–5, 35.



FIG. 1 Tanzania's main waterways and lakes. (Map by David Castro, reproduced with permission.)

JULY  
2008  
VOL. 49

the latest photogrammetric equipment available to photograph the area. The picture they constructed stands in sharp contrast to earlier surveys (1919–45). To the FAO experts, the basin's farming systems were "irregular" and in need of standardization.<sup>3</sup> Its waterways, however, offered more possibilities. Where colonial surveyors plodded through muddy fields and measured success in terms of bags of rice and bundles of cotton, the FAO experts viewed the region from above, conceptualizing the basin's snaking waterways as potential megawatts of electricity.

This article examines the forces that shaped both the collection and use of geographical data for hydropower projects in Tanzania's Rufiji Basin. Some scholars have argued that, in the rush to extract profits from African territories, colonial planners worked with inadequate data, creating projects that were inappropriate to African environments and agricultural systems.<sup>4</sup> The case considered here suggests a more complex story. In the basin, colonial engineers attempted to understand the region's ecology prior to the implementation of large-scale irrigation and hydropower projects. Their surveys included detailed discussions of local production systems and environments and, in some cases, accurately foresaw the challenges of damming in the basin. The priorities of development institutions and the Tanzanian government led to the dismissal of this information in favor of the later studies of international development consultants. As the actors changed so did the setting; increasingly, knowledge of the basin was formulated outside of the region, with little input from residents.

The history of development in the Rufiji Basin contributes to our understanding of the relationship between knowledge production and development in Africa. While colonial agents drew upon African environmental knowledge and agricultural practices in their attempts at economic and social transformation, postcolonial development experts have often devalued such knowledge.<sup>5</sup> Recent scholarship highlights the difference between Western knowledge and indigenous knowledge and the power relations between them. James Scott argues that it is faith in science and technology and a commitment to "high modernism" that make the state unwilling to recognize the value of indigenous knowledge, while Christophe Bonneuil con-

3. Food and Agriculture Organization, *The Rufiji Basin, Tanganyika: Report to the Government of Tanganyika on the Preliminary Reconnaissance Survey of the Rufiji Basin* (Rome, 1961), 45.

4. For example, see Alan Wood, *The Groundnut Affair* (London, 1950). For a post-colonial case study, see David C. Cole and Richard Huntington, *Between a Swamp and a Hard Place: Development Challenges in Remote Rural Africa* (Cambridge, Mass., 1997).

5. Richard H. Grove, *Green Imperialism: Colonial Expansion, Tropical Island Edens, and the Origins of Environmentalism, 1600s–1860* (Cambridge, 1995); Monica van Beusekom, *Negotiating Development: African Farmers and Colonial Experts at the Office du Niger, 1920–1960* (Oxford, 2002); and Joseph Morgan Hodge, *Triumph of the Expert: Agrarian Doctrines of Development and the Legacies of British Colonialism* (Athens, Ohio, 2007).

tends that in the late colonial and early postcolonial period in Africa, devaluing indigenous knowledge was “an intrinsic element in the affirmation of the state, its institutions, and its agents.”<sup>6</sup> Similarly, James Ferguson demonstrates that a shared language and attitude toward development led World Bank experts in Lesotho to define the country in ways that justified the intervention proposed, in a manner that often disregarded local knowledge.<sup>7</sup> Arun Agrawal has challenged the binary classification of Western versus indigenous knowledge, arguing that “it makes much more sense to talk about multiple domains and types of knowledge, with differing logics and epistemologies.”<sup>8</sup> This article further blurs the distinction between knowledge systems by showing how some “outsiders”—men working within a colonial model or later foreign and urban-based researchers and planners—produced a type of local environmental knowledge. Although paternalism often influenced their relationship with basin residents, long stays in the region and their surveying techniques had instilled in these men sensitivity to the interplay between the basin’s people and waterscape.

Studies of African rivers have focused on the centrality of water to the social, political, and agricultural development of the continent.<sup>9</sup> The process of transforming these rivers from free-flowing waterways into regulated, hydropower-producing systems—what the American historian Richard White refers to as “rationalizing the river”—has received little attention.<sup>10</sup>

6. James Scott, *Seeing Like a State: How Certain Schemes to Improve the Human Condition Have Failed* (New Haven, Conn., 1998); Christophe Bonneuil, “Development as Experiment: Science and State Building in Late Colonial and Postcolonial Africa, 1930–1970,” in *Nature and Empire: Science and the Colonial Enterprise*, ed. Roy MacLeod (Chicago, 2000), 258–81. For more on the character of indigenous knowledge, see Roy C. Dudgeon and Fikret Berkes, “Local Understandings of the Land: Traditional Ecological Knowledge and Indigenous Knowledge,” in *Nature across Cultures: Views of Nature and the Environment in Non-Western Cultures*, ed. Helaine Selin (Dordrecht, 2003), 75. For the relationship of indigenous knowledge to development, see David Brokensha, D. M. Warren, and Oswald Werner, eds., *Indigenous Knowledge Systems and Development* (Lanham, Md., 1980); Paul Sillitoe, “The Development of Indigenous Knowledge: A New Applied Anthropology,” *Current Anthropology* 39 (1998): 223–52; and Elisabeth Croll and David Parkin, eds., *Bush Base: Forest Farm Culture, Environment, and Development* (London, 1992).

7. James Ferguson, *The Anti-Politics Machine: “Development,” Depoliticization, and Bureaucratic Power in Lesotho* (Minneapolis, 1994).

8. Arun Agrawal, “Indigenous and Scientific Knowledge: Some Critical Comments,” *Indigenous Knowledge and Development Monitor* 3 (1995): 5.

9. See Robert Collins, *The Waters of the Nile: Hydropolitics and the Jonglei Canal, 1900–1988* (Oxford, 1990); Robert Harms, *Games against Nature: An Eco-cultural History of the Nunu of Equatorial Africa* (Cambridge, 1987); W. M. Adams, *Wasting the Rain: Rivers, People, and Planning in Africa* (Minneapolis, 1992); Elizabeth Colson, *The Social Consequences of Resettlement: The Impact of the Kariba Resettlement upon the Gwembe Tonga* (Manchester, 1971); David Gordon, *Nachituti’s Gift: Economy, Society, and Environment in Central Africa* (Madison, Wisc., 2006).

10. Richard White, *The Organic Machine* (New York, 1995), 76. On river develop-

JULY  
2008  
VOL. 49

With the exception of Moses Chikowero's recent work on colonial Zimbabwe, even less attention has been devoted to the development of Africa's electricity systems.<sup>11</sup> In Tanzania, where hydropower dams supply over 60 percent of electricity consumed, recurring droughts since the 1990s and biodiversity concerns have decreased the amount of water available for power production, leading to the need for electricity rationing and the renewed call for the construction of hydropower dams. An examination of development planning in the Rufiji Basin offers scholars, policy makers, and development practitioners a historical understanding of Tanzania's electricity system.<sup>12</sup>

Based on archival and fieldwork conducted in Tanzania and Sweden, this article uses colonial records, geographical surveys, development reports, and interviews to explore the different ways people have understood the basin's waterways and the factors that have led to the privileging of certain perspectives over others. To engineers, development consultants, and government planners, the Rufiji Basin's waterways offered the means for hydropower development in Tanzania. Between 1945 and 1985, international development experts conducted a series of geographical studies of the basin. While this data was detached in many ways from the realities of the basin's ecology and offered limited data on stream flow, the pressure to translate proposed dam plans into concrete structures led planners to deem it sufficient. The shifting of the setting of knowledge construction from the fields and riverbanks of the basin to distant planning offices did not lead to projects based on better scientific knowledge, but set the stage for Tanzania's current electricity problems.

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ment in the United States, see Donald Worster, *Rivers of Empire: Water, Aridity, and the Growth of the American West* (New York, 1985); Norris Hundley, *The Great Thirst: Californians and Water, 1770s–1990s* (Berkeley, Calif., 1992); Theodore Steinberg, *Nature Incorporated: Industrialization and the Waters of New England* (Cambridge, 1991); David E. Nye, "Remaking a 'Natural Menace': Engineering the Colorado River," in *Technologies of Landscape: From Reaping to Recycling*, ed. David E. Nye (Amherst, Mass., 1999); and Donald J. Pisani, *Water and American Government: The Reclamation Bureau, National Water Policy, and the West, 1902–1935* (Berkeley, Calif., 2002).

11. Moses Chikowero, "Subalternating Currents: Electrification and Power Politics in Bulawayo, Colonial Zimbabwe, 1894–1939," *Journal of Southern African Studies* 33, no. 2 (2007): 287–306.

12. Between 1991 and 1995, Swedish, Norwegian, and Finnish development assistance funded the construction of a 2x33 megawatt power plant on the Pangani River, downstream of the existing Pangani hydropower station. In 1995, work started on the 180 megawatt lower Kihansi hydropower project (with a future total potential of 300 megawatts); the plant went online in December 1999. Other energy sources under development include the Songo Songo, Mtwara Region, and Mnazi Bay gas projects. See Sten Löf, *Preparatory Desk-Study for the Evaluation of the Swedish Support to Tanzania's Power Sector* (Stockholm, 1996), 7f; and Björn Kjellström et al., *Rural Electrification in Tanzania: Past Experiences, New Approaches* (Stockholm, 1992).

## Development and Damming in Britain's African Colonies

The term *development* has taken on a wide range of meanings: it can refer to the process of economic growth, industrialization, improvement of the quality of life, or poverty reduction. During the colonial era in Africa (approximately from the 1880s through the 1970s), administrators believed that through the application of science, technology, and rational planning techniques, a “primitive” colonial economy could be managed to support both its own needs and those of the colonizing nation, benefiting both.<sup>13</sup> Britain began promoting colonial development during the 1890s, with its colonial secretary, Joseph Chamberlain, asserting in 1895 that it was “not enough to occupy certain great spaces of the world’s surface unless you can make the best of them, unless you are willing to develop them.” He called on Britain to use its capital and credit “to create an instrument of trade” in the colonies.<sup>14</sup> Under Chamberlain’s leadership, Britain issued loans for infrastructure development in its colonies, including, for example, the construction of roads, wharves, and railways in the West Indies, Cyprus, Uganda, and Sierra Leone. After World War I, these efforts increased. In 1929, the British Parliament passed the first Colonial Development Act, which provided £1 million annually to support development projects in Britain’s colonies. In 1940 and 1946, Parliament passed new acts that increased funding for colonial development to £5 million and then £12 million per year.<sup>15</sup>

With this mandate, colonial administrations assumed an interventionist attitude toward African agricultural production and social welfare. Fears of economic recession, soil erosion, overpopulation, and drought convinced administrators to discard the more hands-off approach they had practiced earlier.<sup>16</sup> Following World War II, administrators expanded their scope, worrying about increasing urbanization and the reintegration of former soldiers into rural life. In Tanganyika, colonial administrators at-

13. Ferguson (n. 7 above), 15. Many anthropologists have addressed the issue of development and modernization from a variety of perspectives. Examples include Norman Long, *An Introduction to the Sociology of Rural Development* (Boulder, Colo., 1977); Brokensha, Warren, and Werner (n. 6 above); Mark Hobart, ed., *An Anthropological Critique of Development: The Growth of Ignorance* (London, 1993); Alan Hoben, “Anthropologists and Development,” *Annual Review of Anthropology* 11 (1982): 349–75; and A. F. Robertson, *People and the State: An Anthropology of Planned Development* (Cambridge, 1984).

14. *Times* (London), 1 April 1895, as quoted in Robert V. Kubicek, *The Administration of Imperialism: Joseph Chamberlain at the Colonial Office* (Durham, N.C., 1969), 68, 71–74.

15. *Ibid.*, 71–74; J. D. Fage, *A History of Africa*, 3rd ed. (London, 1995), 422.

16. David Anderson, “Depression, Dust Bowl, Demography, and Drought: The Colonial State and Soil Conservation in East Africa during the 1930s,” *African Affairs* 83 (1984): 321–43. For a discussion of the spread of settlement schemes, see Bonneuil (n. 6 above), 258–81.

JULY  
2008  
VOL. 49

tempted to foster economic growth and stave off demands for independence by embarking on extensive programs to improve village life that included, among other projects, building water supplies, roads, and native administration buildings, implementing soil-conservation programs, and forming cooperative societies for marketing agricultural produce.<sup>17</sup>

Nations without formal colonies nevertheless shared an interest in developing the world's poorer regions. The economic instability and global conflicts of the 1930s and 1940s produced a renewed commitment on the part of Western nations to the pursuit of political stability through social and economic betterment. Political, cultural, and ideological differences gave way, in part, to an international coalition united by a belief in the ability of modern science and technology to improve livelihoods and maintain global peace. Norris Dodd, the director-general of the FAO from 1948 to 1953, wrote in 1955:

These people [FAO experts] are from all parts of the world. They have profoundly different ethnic, cultural, religious, social, political, and economic backgrounds. They speak many different languages. But also they all speak the same language of science and technology and share the same dream of human advancement. They are a gallant company, growing in numbers and influence.<sup>18</sup>

Agreement over the importance of development and the path to be taken led to the formation of numerous institutions, including the World Bank (1944), the International Monetary Fund (1944), the United Nations Educational, Scientific, and Cultural Organization (1945), and the FAO (1945). These institutions assumed the responsibility of channeling technical and financial resources from wealthier nations to their poorer counterparts.<sup>19</sup>

Economic growth was not a goal held only by colonial planners and foreign experts; African elites also shared the dream of development. Following political independence, many of Africa's leaders pursued developmentalist agendas similar to those of their colonial predecessors.<sup>20</sup> Both groups

17. Tanzania National Archives (hereafter TNA) 274/2/1/782, "Letter to Provincial Commissioners and District Commissioners from the Provincial Office," Dar es Salaam, 3 September 1943.

18. Norris Dodd, in "Preface" to Gove Hambidge, *Story of FAO* (New York, 1955), iii.

19. This belief in science was obviously not a new occurrence in the post-World War II era. For a discussion of how it affected interactions between Europeans and non-Western peoples in other periods, see Michael Adas, *Machines as the Measure of Men: Science, Technology, and Ideologies of Western Dominance* (Ithaca, N.Y., 1989); and MacLeod, *Nature and Empire* (n. 6 above). For a discussion of the resurgence of internationalism during the 1940s, see Amy L. S. Staples, *The Birth of Development: How the World Bank, Food and Agriculture Organization, and World Health Organization Changed the World, 1945-1965* (Kent, Ohio, 2004).

20. Frederick Cooper, "Modernizing Bureaucrats, Backward Africans, and the Development Concept," in *International Development and the Social Sciences: Essays on the*

viewed waterways as vital to the promotion of economic growth. While the commitment to river development did not falter, what did change was the definition of what that development should look like. Colonial administrators valued Africa's waterways for their ability to facilitate navigation and provide irrigation water.<sup>21</sup> With the ascendance of scientific development in the late 1940s, new ideals came into play; by the mid-1950s, Western and non-Western planners alike agreed that efficiently developed rivers could catalyze national economic development. From the 1960s on, harnessing rivers to support agricultural expansion and produce electricity to fuel industrial growth became a top priority for African planners.<sup>22</sup>

Throughout the twentieth century, North American and European nations had demonstrated how controlled rivers could form the foundation for a nation's economic transformation, making them symbols of "modernity." African leaders also recognized the value of dams to control floods, irrigate crops, facilitate navigation, and, most important in postwar Africa, produce hydropower. Beyond supplying concrete evidence of modern development, however, dams were also reflections of state power. Cold war politics heightened the importance of hydropower dams and other large, capital-intensive projects in Africa. Leaders such as Gamal Abdel Nasser in Egypt, Kwame Nkrumah in Ghana, and Julius Nyerere in Tanzania sought development assistance from all sides of the political divide to fund such projects. After the United States and Britain withdrew funding for the Aswan High Dam in 1956, Nasser turned to the Soviet government, which ended up funding a third of the construction costs.<sup>23</sup> Other African leaders took note. Nkrumah leveraged Soviet interest in the Volta River Project to solidify American and British financial commitments, warning that "either we shall modernize with your interests and support—or we shall be compelled to turn elsewhere."<sup>24</sup>

Tanzanian president Nyerere also recognized the symbolic and eco-

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*History and Politics of Knowledge*, ed. Frederick Cooper and Randall Packard (Berkeley, Calif., 1997), 64–92; and Bonneuil, 258–81.

21. In Britain's African colonies, the key example of this type of development was the Gezira Scheme and the Jonglei Canal in the Sudan; see Arthur Gaitskell, *Gezira: A Story of Development in the Sudan* (London, 1959), and Collins, *The Waters of the Nile* (n. 9 above).

22. By 1956, the United Nations designated river development as a key to economic development. See L. A. Teclaff, *The River Basin in History and Law* (The Hague, 1967), 123; Adams (n. 9 above), 100–154.

23. Jeremy Collins, "Ghana, the Congo Crisis, and the Volta River Project: Kwame Nkrumah and the Cold War in Africa" (M. Phil. thesis, Oxford University, 1995).

24. The desire for Western financing ultimately kept Ghana from accepting Soviet support for the Volta River Project; however, in 1961, the USSR agreed to finance a dam at Bui on the Black Volta River. See Kwame Nkrumah, quoted in Collins, "Ghana, the Congo Crisis, and the Volta River Project," 49; and the Ghana National Archives (hereafter GNA), SC/BAA/206, October 1962.

JULY  
2008  
VOL. 49

conomic importance of hydropower dams. At the commissioning of the Hale hydroelectric plant in 1965, he proclaimed: "Schemes such as this one are in fact the bricks and mortar evidence of the revolution which our country is deliberately and purposefully undergoing. It represents the application of science to the needs of the people."<sup>25</sup> Nyerere requested assistance from multiple international-aid organizations to fund hydropower dams on the waterways of the Rufiji Basin.

### The Rufiji Basin

To postwar planners, the Rufiji Basin held great promise for development.<sup>26</sup> Stretching over 600 kilometers from the Indian Ocean to the border with Malawi and Zambia, the basin covers 177,420 square kilometers, one-fifth of Tanzania's total area. In the upper basin, several rivers flowing from the southern highlands water the Usangu Plains, forming the Great Ruaha. Well suited for irrigated cultivation and pastoral activities, the area has long attracted immigrants from nearby regions, Europe, and Iran. Today, between thirty and forty different ethnic groups live in the region, including agriculturalists such as the Wasangu and pastoralists such as the Wasukuma and Maasai.<sup>27</sup> The Great Ruaha River flows through the Pawaga Plains and eventually meets the Rufiji River. The largest river in Tanzania, the Rufiji has an average annual flow of 900 cubic meters per second and gives rise to a large delta. Farmers take advantage of the alluvial soils to cultivate rice, maize, and cotton, and residents also fish the region's numerous waterways and lakes. The river, along with the widespread adherence to Islam, unifies the ethnic groups living within its sphere of influence. Many residents and outsiders refer to the population simply as the "Warufiji." As one resident explained, "The word *Rufiji* means all the people who live in areas affected by the river."<sup>28</sup>

Rufiji residents understand the Rufiji as a beneficial, potentially dangerous, and, above all, changing force of nature. In addition to serving as important water sources, transportation byways, and fisheries, the basin's waterways hold spiritual significance. To Utete resident Nyambonde Masafi, the rains and springs that provide the river "were probably caused by *mashetani* [spirits]."<sup>29</sup> Such *mashetani* affect people's daily lives; for exam-

25. "Mwalimu Opens Hydro-electric Plant," *News Review*, January 1965.

26. The U.S. Agency for International Development (USAID), "Rufiji Basin: Land and Water Resource Development Plan and Potential," paper prepared for USAID by the U.S. Bureau of Reclamation (Washington, D.C., 1967), p. 2, held in the private archive of Kjell Havnevik.

27. Susan Charnley, "Environmentally Displaced Peoples and the Cascade Effect: Lessons from Tanzania," *Human Ecology* 4 (1997): 593–618.

28. Interview with Salumu Likindi and Juma Bogobogo, Utete, Tanzania, 18 February 2001. Other informants echoed this sentiment.

29. Interview with Nyambonde Masafi, Utete, Tanzania, 17 February 2001.

ple, in the lower Rufiji, a person who disobeys local norms, such as going to the river with black objects or using obscene language near the river, can incur the wrath of these *mashetani*.<sup>30</sup>

In the Rufiji floodplain, agricultural success depends on rainfall and flooding, both of which are highly unpredictable. In a good year, the region experiences two wet seasons: the short rains that begin in October/November, and the long rains between February/March and May/June. The amount and duration of rain varies, with inland areas receiving substantially less than coastal areas. The failure of either rainy season can lead to crop failure. Floods likewise play a crucial role, because they deposit the alluvium that helps maintain soil fertility. If the preferred soil type (*mbaragilwa*) does not receive a flood at least once every three years, crop yields can decline by as much as 50 percent. High or ill-timed floods can destroy crops, livestock, property, and even occasionally kill people. Early floods disrupt the planting cycle, often arriving before farmers have finished preparing their fields.<sup>31</sup>

Floodplain residents respond by diversifying production. They have developed a system that uses both wet and dry seasons, as well as the fertile soils of the floodplain and the poorer soils of higher elevations, to provide security in years of high or insufficient flooding, low rainfall, or both. Farmers draw on their knowledge of the variable climate and soil conditions and planting times to choose from over thirty-two varieties of rice to suit local microenvironments.<sup>32</sup> Agriculture in the delta is similar, although here, tidal fluctuations rather than the annual floods regulate farming practices. The absorption of water into the upstream floodplain, lakes, and wetlands slows the floodwater, diminishing the harmful effects felt in the delta. Tides and annual floods constantly transform the delta waterscape. Ronald de la Barker, a New Zealand-born hippo hunter who lived in the region during the 1930s and 1940s, described the delta's dynamism: "Every spate [flood] season makes remarkable changes in both the river and delta. Little

30. Interview with Juma Bogobogo, Utete, Tanzania, 18 February 2001. Informants used the term *mashetani* to refer to spirits in general. For a discussion of the different types of spirits and deities in the region, see T. O. Beidelman, *The Matrilineal Peoples of Eastern Tanzania* (London, 1967), and C. G. K. Gwassa, "Kinjikitile and the Ideology of Maji Maji," in *The Historical Study of African Religion*, ed. T. O. Ranger and I. N. Kimambo (Berkeley, Calif., 1972), 202–17.

31. For a detailed discussion of Rufiji agriculture, see Han Bantje, "The Rufiji Agricultural System: Impact of Rainfall, Floods, and Settlement," Bureau of Resource Assessment and Land Use Planning (hereafter BRALUP) Research Paper No. 62 (Dar es Salaam, 1979); and David Jack, "The Agriculture of Rufiji District: A Review," TNA, 1957, 7.

32. Bantje, 3–4, 22; Audun Sandberg, "Socio-economic Survey of Lower Rufiji Flood Plain, Part I: Rufiji Delta Agricultural System," BRALUP Research Paper No. 34 (Dar es Salaam, 1974); and H. Marsland, "Mlau Cultivation in the Rufiji Valley," *Tanganyika Notes and Records* 5 (1938): 56. This information was confirmed through discussions with informants.

bays become sandbanks and are sometimes soon covered with vegetation, and deep channels are scoured out elsewhere. On each island of the delta the sea is encroaching at one place and receding at another.”<sup>33</sup> Delta farmers also utilize the region’s microenvironments: in the sandy soils of the mangrove forests and delta islands, they plant millet, maize, rice, cassava, cowpeas, and cotton; on the adjacent higher lands, they grow coconut trees for copra, coconut oil, and materials for mat-making; and along the banks of the rivers and in the valleys, they grow tomatoes, pumpkins, tobacco, and sugarcane and fish in the nearby streams and ocean.<sup>34</sup>

### Mapping the Rufiji Basin, 1879–1949

Beginning in the late nineteenth century, the agricultural potential of the Rufiji Basin drew the attention of European visitors. James Elton, British consul at Mozambique, described the river’s floodplain during the 1870s as “a land of plenty.”<sup>35</sup> Reaching the southern highlands, Elton and his co-traveler Henry Cotterill described the landscape as “the Garden of Africa.” “Cattle abound,” Elton wrote, “flats, hillsides, and mountain sides are under cultivation and serrated with hedgerows, and pathways to high elevations, the main valleys being appropriated for grazing.”<sup>36</sup> William Beardall’s 1880–81 exploration of the Rufiji River for the sultan of Zanzibar described the floodplain as “very fertile, and grows splendid crops of rice, which is the principal grain cultivated.”<sup>37</sup> Such reports piqued the interest of the German East African government, which undertook a series of technical investigations of the Rufiji and Kilombero rivers in 1904, 1907, 1909, and 1911. The German administration concerned itself with the navigational possibilities of the Rufiji River and an irrigation scheme in the Kilombero Valley. Ultimately, the Germans decided that a railroad was more economical and hence turned their attention away from river transport.<sup>38</sup>

33. Ronald de la Barker, “The Delta of the Rufiji River,” *Tanganyika Notes and Records* 2 (1936): 1.

34. For a description of the mangrove trade, see Erik Gilbert, *Dhows and the Colonial Economy of Zanzibar, 1860–1970* (Athens, Ohio, 2004).

35. J. F. Elton, *Travels and Researches among the Lakes and Mountains of Eastern and Central Africa* (London, 1879), 97. This was a common trope in tropical colonies as Europeans were often confronted with advanced indigenous production systems. For a discussion of how Europeans explained and presented non-Western achievements, see S. H. Alatas, *The Myth of the Lazy Native* (London, 1977), and Adas (n. 19 above).

36. Elton, 331. H. B. Cotterill was connected to the Scottish mission at Lake Nyasa. During their travels together, Elton fell ill and died. Cotterill returned to the coast with Elton’s journals from the journey, which he later edited and published. See Royal Geographical Society, “Obituary: H. B. Cotterill,” *Geographical Journal* (1925): 86–87.

37. William Beardall, “Exploration of the Rufiji River under the Orders of the Sultan of Zanzibar,” *Proceedings of the Royal Geographical Society and Monthly Record of Geography* (London, 1881), 642.

38. Clement Gillman, “A Reconnaissance of the Hydrology of Tanganyika Territory

The transfer of Tanganyika from German to British control following World War I halted investigations of the Rufiji Basin until the late 1920s, when the colonial administration contracted Alexander Telford, an irrigation engineer and chief of the Sudan Plantations Syndicate, to conduct a study of both the Rufiji and Kilombero valleys. Influenced by his experience in the Sudan, Telford included vivid descriptions of the basin's environment, agricultural systems, and inhabitants alongside soil classification and cross-sections of the river. He emphasized the relationship between land use and social practice. Where previous visitors often portrayed farmers as lazy, Telford found farmers' attitude toward labor justified: "It has been suggested that their [farmers'] laziness may be due to diseases such as hookworm," he wrote, "but one of the main reasons is undoubtedly the prodigality of nature, which renders a very prolific return for next to no work."<sup>39</sup>

Telford's study exemplifies the kind of knowledge colonial engineers obtained about basin landscapes through their survey methods. He described the environment in active terms, evoking images of the area and its people as agents in their own development. The Rufiji River, Telford described, "originally chose a depression to flow through," his anthropomorphism emphasizing the river's independent character.<sup>40</sup> Traveling over a thousand miles during the course of his study (500 miles by foot), he came into close contact with basin communities. His understanding of the capriciousness of the basin's waterways, based on observations and discussions with local inhabitants, led him to recommend that the colonial government postpone construction of bunds or embankments along the river. His knowledge of agricultural and social systems led him to argue that irrigation was unnecessary, as "in most years there is sufficient rainfall to produce at least one food crop or cotton crop successfully."<sup>41</sup>

Between 1938 and 1940, Clement Gillman, formerly the chief engineer of Tanganyika Railways and at the time the territorial water consultant, completed the next major survey of the basin.<sup>42</sup> Like Telford, he worked within the British colonial establishment, bringing with him over four

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in Its Geographical Settings," Water Consultant's Report No. 6 (Dar es Salaam, 1943), 97; Food and Agriculture Organization (n. 3 above), 5; and Kjell J. Havnevik, *Tanzania: The Limits to Development from Above* (Motala, Sweden, 1993), 263.

39. Telford (n. 2 above), 36. On European attitudes toward African labor patterns, see Valentin Mudimbe, *The Invention of Africa: Gnosis, Philosophy, and the Order of Knowledge* (Bloomington, Ind., 1988).

40. Telford, 20.

41. *Ibid.*, 18.

42. As the chief engineer of Tanganyika Railways, Gillman conducted an extensive reconnaissance survey of the southern highlands for a possible rail line. Because of failing health, Gillman curtailed many field visits for the water survey and relied on his extensive field notes collected during previous trips throughout the territory. This resulted in an abbreviated report. For a detailed discussion of Gillman's life, see B. S. Hoyle, *Gillman of Tanganyika, 1882–1946: The Life and Work of a Pioneer Geographer* (Hampshire, UK, 1987).

decades of experience in the territory. Gillman linked water and economic development directly in a 1943 report:

JULY  
2008  
VOL. 49

The Administrator and his scientific and technical advisors, singly or combined . . . will never find a solution for the thousand and one problems facing them, unless they base their deliberations on Water which is the fundamental and outstanding aspect of all attempts to develop a semi-arid country and to improve the physical, mental and moral life of its peoples!<sup>43</sup>

To Gillman, social development required that the colonial administration understand how to use the territory's natural resources. Although poor health and the outbreak of World War II prevented a visit to the region, Gillman offered cautious comment on its future development potential: "One is, therefore, forced to the conclusion that large-scale irrigation schemes should be left severely alone and that in the light of a recent fuller understanding of the complications of climate, soils, hydrography and markets the early optimism of the Germans regarding the possibilities of such schemes can no longer be upheld."<sup>44</sup>

Reclamation of the lower Rufiji, Gillman believed, hinged upon the construction of expensive works, similar to those initiated along the Nile River, and a program of river gauging for which the staff and financing were lacking. Although pessimistic about large-scale irrigation schemes, Gillman was optimistic about the basin's potential for hydropower production, provided that sedimentation levels and agricultural water use were taken into consideration. His report raised three issues that his successors would contend with. First, he suggested that the differences between high and low stream flow in the rivers was so great that power schemes would have to depend on the "meagre volumes of the latter [water in the low season] unless very costly and at present wholly unwarrantable projects for storing part of the high water are resorted to." Second, he noted that human "misuse" of the highland vegetation led to larger flood runoff, thus reducing the permanent discharge. Finally, Gillman believed that the large amount of silt and sand carried by the rivers necessitated the construction of sand traps to prevent damage to turbines.<sup>45</sup>

Telford and Gillman exemplify the wider efforts that colonial engineers and scientists made to understand the geography and hydrology of the Rufiji Basin.<sup>46</sup> Conducted with limited resources, Telford's and Gillman's

43. Gillman, 1.

44. *Ibid.*, 94.

45. *Ibid.*, 97–99. For a discussion of colonial science and Western views on indigenous people's "misuse" of land as a cause for soil degradation, see Christopher A. Conte, "Colonial Science and Ecological Change: Tanzania's Mlalo Basin, 1888–1946," *Environmental History* 4 (1999): 220–44.

46. Other studies on the basin were published in the journal *Tanganyika Notes and*

studies provided little quantifiable data on the basin; they do, however, offer insight into how colonial engineers interacted with the basin's environment and populations. Telford focused on the relationship between the basin's environment and people, analyzing future development in terms of the needs of the population. Gillman's vision included the entirety of Tanganyika's water resources, with the Rufiji Basin merely one element in the larger territorial picture.

As temporary visitors to the basin, Telford and Gillman relied heavily on the knowledge of district officials. Working closely with farmers, many officials had a detailed understanding of residents' relationship to their environments and the logic behind production systems. This knowledge positioned district officials as local experts. During the 1940s and 1950s, Rufiji district commissioner John Young interacted with residents on agricultural projects ranging from "Plant More Crops" campaigns to tractor mechanization programs.<sup>47</sup> Working within the variable waterscape, Young and other officials understood the river's volatility. Like the residents, they agreed that the yearly floods were blessings in disguise. However, while local residents devised strategies to cope with the variations in flooding, Young and his colleagues proposed to regulate the river by clearing, dredging, and straightening its main channel or building embankments to protect adjacent rice fields. Such projects would require an expensive "full investigation" of the area—an impossible endeavor for the cash-strapped territorial government.<sup>48</sup>

### Enter the External Experts: The Rufiji Basin Survey, 1952–1961

During the late colonial period, developing the hydrological resources of the Rufiji Basin became a key goal of planners in Tanganyika. Officials in Dar es Salaam and London discussed how best to capitalize on the basin's potential. In 1950, E. Smith, the director of Tanganyika's Depart-

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*Records*. Examples include Barker (n. 33 above), 1–6; Ronald de la Barker, "The Rufiji River," *Tanganyika Notes and Records* 4 (1936): 10–16; Marsland (n. 32 above), 55–59; and G. M. Stockley, "The Geology of the Rufiji District, Including a Small Portion of Northern Kilwa District (Matumbi Hills)," *Tanganyika Notes and Records* 16 (1943): 7–29.

47. Interview with Salumu Likindi, Utete, Tanzania, 18 February 2001. Residents nicknamed John Young "Yange," a term that also came to refer to the maize flour given to residents during food shortages by the colonial government. With the exception of periodic leaves, Young was stationed in the Rufiji district during the following years: January 1946 to March 1947, and November 1950 to July 1961.

48. TNA 274 11/8/230, "Letter to Provincial Commissioner for Eastern Province from Rufiji District Commissioner John Young," 1951. This correspondence continues throughout TNA 274 11/8, "Agriculture and Veterinary Crop Campaign," 1951; TNA 1/2/D, "Letter to All Provincial Commissioners, from the Member for Agriculture and Natural Resources A. E. Trotman," 18 June 1954.

ment of Water Development, sent the Natural Resources minister a proposal for a six-month exploratory survey of the basin. Such a survey, viewed by Smith as the first step in constructing a basin-wide development plan, would include contour mapping, an examination of potential dam sites, an aerial survey, and the establishment of hydrometric gauging stations throughout the basin.<sup>49</sup>

JULY  
2008  
VOL. 49

Because the colony lacked both the funds and the personnel to conduct a comprehensive survey, Tanganyika's governor, Edward Twining, approached the director-general of the FAO in 1952 with the survey proposal. The following year, the FAO contracted Nicholas Simansky, formerly of the Sudan irrigation department, to investigate the "possibilities for the development of irrigated cultivation, and what such development might involve in works and expenditure." This included documenting the basin's cadastral, topographical, and hydrological conditions, investigating potential sites for storage dams, and calculating construction costs.<sup>50</sup> Confronted with the enormity of the basin during his preliminary investigations, Simansky narrowed the survey's geographic focus to what he thought were the three most promising areas for irrigation development: the floodplain of the lower Rufiji, the Kilombero Valley, and the Usangu and Pawaga plains of the Great Ruaha River subcatchment basin.<sup>51</sup>

In August 1954, Governor Twining announced the start of the Rufiji Basin Survey (RBS) to over 10,000 residents in the Rufiji district capital of Utete. Following a performance of the Tanganyika police band, the governor explained the need for technical control of the Rufiji River. He predicted that the data gathered by the RBS team would allow the Rufiji floodplain to become the "veritable Eldorado" that colonial planners envisioned. Governor Twining concluded his comments by urging residents to offer their assistance to the "many experts and technicians" who would come to learn about their river.<sup>52</sup>

The RBS forged a partnership between the colonial administration and the FAO. From the beginning, the process of collaboration faced difficulties as actors struggled to keep their priorities and visions for the basin on the negotiating table. The government argued for the value of hydrometric and agronomic data; the FAO team prioritized topographical and geological investigations of potential dam sites. United by their commitment to using the basin's resources, they put aside their early differences and signed a formal agreement in 1955.<sup>53</sup>

49. TNA 274/15/30/111, "Preliminary Survey of Rufiji and Great Ruaha Basins," Department of Water Development to Member for Agriculture and Natural Resources, 19 December 1950.

50. Food and Agriculture Organization (n. 3 above), 2–4.

51. *Ibid.*, 7; and TNA 257/AN/19/06/A/92, "Extract from Tanganyika Unofficial Members' Organization," 27 July 1954.

52. "Utete Told of Plan to Harness the Rufiji," *Tanganyika Standard*, 7 August 1954.

53. TNA 257/AN/19/06A/204, "Letter to A. Trotman from Stuart Gillett (TAC)," 11

The Rufiji Basin Survey team included members of the FAO, government staff, and staff members of the parastatal, the Tanganyika Agricultural Corporation (TAC).<sup>54</sup> While the TAC coordinated the survey, the FAO provided the core of the technical team, with the colonial government recruiting African and European “assistants and subordinates” from within Tanganyika. Between 1953 and 1960, the FAO contributed from one to twelve members of a team that included, at its highest count, forty-two members (not including porters, guides, and hydrometric gauge readers hired throughout the basin). The team members came from diverse national backgrounds and had studied in some of the most prestigious technical colleges of the day; for example, the FAO’s hydrologist, Norwegian Jakob Otnes, had worked as the state hydrologist in Norway and had undertaken large basin surveys similar to the RBS before being recommended to the FAO by the World Meteorological Office.<sup>55</sup>

When the FAO team set out to map the Rufiji Basin and its many waterways, it needed to determine how much water flowed through the basin’s rivers. In order to answer this question, the team established sixty-five hydrometric stations throughout the basin, in addition to the sixteen set up during Simansky’s preliminary investigation in 1953.<sup>56</sup> Hydrologists then trained residents to record the daily fluctuations of the basin’s rivers, as the large size of the basin made it impossible for the team to collect the hydrological and climate data for itself. The FAO team understood that the members of the riverine community had an understanding of the basin’s waterways. After the high floods of 1956, Otnes wrote to the director of the water department that “I presume the people living by the Rufiji will be able to give maximum hight [*sic*] of thier [*sic*] villages.”<sup>57</sup> Yet the team did not ask residents about their past experiences of the basin’s waterways; rather, it asked only about daily changes in stream flow. Most residents did not

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May 1955; and TNA 532 15/30/546, “Letter to Provincial Commissioner of the Eastern Province,” 25 May 1955. The Department of Surveys agreed to include the Rufiji Basin on its priority list, hence decreasing work planned in other areas. In exchange, the FAO agreed to slow down the pace of the survey and reduce the number of staff from the colonial government. See TNA 532/22/32/1, “Letter to Member for Agriculture and Natural Resources Arthur Trotman from A. Smith,” 1 May 1954; and TNA 257/AN/19/06/A/85, “Record of Conference to Plan Rufiji Basin Survey 1954,” 26 July 1954.

54. Parastatals were state-owned enterprises set up to facilitate the economic development of specific sectors.

55. TNA 257 AN 19/02/A/204, “Letter to Chief Secretary of the Secretariat, Dar es Salaam, from Ralph Phillips, Acting Director Agricultural Division, FAO, Rome,” 28 July 1955. Other team members came from Australia, Austria, Britain, Canada, France, Holland, India, Italy, Lebanon, Norway, Poland, South Africa, and Switzerland; see Food and Agriculture Organization, 6.

56. Food and Agriculture Organization (n. 3 above), 27. The observations of each were presented in volume 2 of the survey.

57. TNA 532/15/30/676, “Letter to Director of Water Development and Irrigation Department from Jakob Otnes,” 17 May 1956.

understand what motivated this influx of *wazungu* (foreigners) into their villages. As one resident recalled: “The British were relentlessly measuring the Rufiji River. Why were they doing it? We do not know.”<sup>58</sup>

Between 1955 and 1960, the basin experienced what the team considered a low hydrological year (November 1958 to October 1959), as well as a high hydrological year (November 1955 to October 1956). This allowed the team to extrapolate the expected flows from the basin’s tributaries in both low and high flood years, in addition to dry and wet seasons. Presented in a series of tables, the data showed the wide variation in stream flow recorded for the basin’s waterways. Such tables and graphs gave planners a false confidence that they could predict the seasonal fluctuations of the basin’s rivers. Colonial administrators challenged this confidence as early as 1955, when they accused Simansky of “putting the cart before the horse” by starting trial farms based on only one year of stream-flow data. Stuart Gillett, TAC’s chairman, complained:

To be quite frank I cannot see how he [Simansky] is going to decide on a policy of water control until we have the information necessary from the hydrometric records . . . no positive recommendations regarding water control of the area could be framed until several years of readings have been recorded and studied.<sup>59</sup>

Gillett’s concern did not slow down the FAO team. By the end of 1955, it had established trial farms at Beta, Mtanza, and Ndundu in the Rufiji district, as well as at sites in the upper basin. In the end, high flooding in 1956 severely damaged the Mtanza farm, proving Gillett right and questioning the wisdom of using resources on irrigation projects without more data on the vacillations of the district’s waterways.<sup>60</sup>

The FAO team’s methods of collecting data enhanced the growing distance between planners and the Rufiji ecology. Airplanes made surveying easier for the team, since more ground could be covered in a day. Flying meant fewer firsthand encounters with mud, insects, wildlife, and other annoyances and dangers. It allowed the FAO team to view the Rufiji without wading through its many marshes or driving through saturated floodplains. The team surveyed the environment while being physically separated from it, and consequently perceived the river as passive and controllable. Working from a perspective that was inaccessible to most Rufiji residents, the team thus gained an understanding of the Rufiji ecology on entirely different kinds of experiences than those of the local people.

The aerial data, displayed on maps drawn in London and Rome (the headquarters of the FAO) from the survey data, proved remarkably influ-

58. Interview with Bibi Nyamtambo, Utete, Tanzania, 17 February 2001.

59. TNA 257 AN 19/06A/204, “Letter to Arthur Trotman, Member for Agriculture and Natural Resources, from Stuart Gillett, Tanganyika Agricultural Corporation,” 11 May 1955.

60. Tanganyika, *Annual Report of Provincial Commissioners* (Dar es Salaam, 1956), 21.

ential, codifying the Rufiji in the minds of planners. The FAO constructed a portrait of the basin with little detailed understanding of the many microenvironments present within it. Where colonial engineers and surveyors had focused on the circumstances of particular localities, the FAO sought a quantitative overview of the entire basin and neglected site-specific descriptions. It dismissed earlier nonquantified data and the observations of residents, British colonial officials, and surveyors; for example, the FAO rejected Clement Gillman's 1940 finding that no major rivers would lend themselves to large irrigation schemes, as the costs of gauging their highly variable flows would outweigh the benefits, explicitly noting that his conclusion was "clearly a mistaken one."<sup>61</sup>

In 1961, the FAO team presented a seven-volume study to the now-independent government of Tanganyika, providing information on hydrology, topography, and soil conditions in the basin and the first quantified presentation of the seasonal variation of stream flow for the basin's main rivers and tributaries.<sup>62</sup> The FAO's charts, graphs, and tables replaced colonial understandings of the basin's waterscape. Armed with a mere five years' worth of data, FAO planners believed themselves amply prepared to construct trial irrigation projects and plan hydropower dams.

### Tanzania's Boulder Dam: Stiegler's Gorge, 1961–1985

The Rufiji Basin Survey marked the beginning of the formal planning of hydropower dams in the basin (see table 1). Throughout the 1960s and 1970s, the Tanzanian government commissioned an additional series of surveys of the basin. Most of these studies concluded, as had the FAO, that the answer to the basin's underdevelopment was better utilization of its waterways. Although neither the preliminary inquiry nor the subsequent survey had mentioned the possibility of hydropower generation, a third of the RBS's available funds had been devoted to topographical surveys of potential dam sites. In addition to investigating the basin's most promising sites, those of Mtera and Stiegler's Gorge, the team turned its attention to eighteen additional sites (six on the Great Ruaha River and twelve on the upper Kilombero River).<sup>63</sup>

The FAO team believed that the yearly floods were the major hindrance

61. Food and Agriculture Organization, 5.

62. The Rufiji Basin Survey final report included volumes on the following topics: general report, hydrology and water resources, water control, irrigation development, Mbarali Irrigation Scheme, geology, and soils. The third section of the report included papers on the following topics: topographic reconnaissance surveys, meteorology, agriculture and trial farms, medical appraisal, forestry, and general compilation of land tenure, population, communications, and education.

63. The total cost of the survey was £727,000, with £520,000 from the Colonial Development and Welfare Fund and £207,000 from funds raised through the FAO (Food and Agriculture Organization [n. 3 above], 8).

**TABLE 1**  
HYDROPOWER PLANTS IN TANZANIA REFERENCED IN THIS ARTICLE

	<i>Plant</i>	<i>Available capacity (MW)</i>	<i>Date of completion</i>
JULY	Hale	21	1964
2008	Nyumba ya Mungu	8	1969
VOL. 49	Kidatu	200	1978
	Mtera	80	1988
	Pangani	68	1994
	Kihansi	180	1999
	Stiegler's Gorge	2001 (est.)	(not yet built)

*Source:* Tanesco, "The Power Sector in Tanzania," *ESI Africa* 2 (2006): 16.

to development in the lower Rufiji, and it recommended postponing further activities until a large dam at Stiegler's Gorge was completed to prevent flooding and permit systematic irrigation.<sup>64</sup> The director of water development, W. Steele, wrote in 1954 that Simansky "seems to think that there is great promise in the development of about one million acres under irrigation in the Rufiji Basin, in order to develop which Tanganyika will have to have its own Boulder Dam."<sup>65</sup> The RBS examination of the lower Rufiji consisted primarily of topographical and geological studies of Stiegler's Gorge. Planners estimated that a dam of 6.4 million acre-feet capacity would cost £10 million and provide 150 megawatts of power. Simansky imagined an even larger dam, one capable of holding 18.5 million acre-feet and producing 400 megawatts of "firm" power.<sup>66</sup> With the proper markets, selling power from Stiegler's Gorge could provide Tanzania with the revenue to implement other development plans. Stiegler's Gorge Dam would harness the waters of the Rufiji River and electrify East Africa.

By 1967, the optimism stemming from Tanzania's independence had begun to dissipate. Hoe-based subsistence agriculture, the foundation of the country's economy, was declining, resulting in falling agricultural income and increased reliance on foreign assistance.<sup>67</sup> Faced with the daunting challenge of Tanzania's deteriorating economy, the National Executive of the Tanganyika African National Union passed the Arusha Declaration on 29 January 1967. Hailed as the "blueprint for socialism," the declaration

64. *Ibid.*, 14.

65. TNA 532/15/30/368, "Letter to Lance from W. Steele," 5 August 1954.

66. Food and Agriculture Organization, 66. "Firm" power refers to electricity that is guaranteed to be available during a specified period.

67. Dean E. McHenry Jr., *Tanzania's Ujamaa Villages: The Implementation of a Rural Development Strategy* (Berkeley, Calif., 1979), 2–4.

laid out President Julius Nyerere's commitment to development through socialism.<sup>68</sup> The centerpiece of his program was *ujamaa villagization*. As defined by Nyerere, *ujamaa* was the traditional African way of living and working together for the good of the entire family. By providing technological knowledge and establishing communal farms he hoped to expand these familial values to the village level, thus creating productive, self-reliant agricultural settlements. Government officials urged (later ordered) rural residents to either move into existing villages or create new *ujamaa* villages. Due to prolonged, high flooding in 1968, the Rufiji floodplain became the first area to undergo government-mandated *villagization*.<sup>69</sup> The floods provided justification for both the FAO's recommendations and the government's resettlement program.

Socialist agriculture was only one aspect of Nyerere's economic-development strategy; industrial development was another. Tanzania's Second Five-Year Plan emphasized the importance of electricity for national development.<sup>70</sup> In 1964 and 1969, respectively, the Tanzanian national utility (Tanesco) completed the Hale hydroelectric plant on the Pangani River and the Nyumba ya Mungu Dam in the Kilimanjaro region. Both dams were small and gravity-driven, allowing water use downstream and requiring no large dams or reservoirs. Yet they produced little power: the Nyumba ya Mungu provided only 8 megawatts of installed capacity.<sup>71</sup>

Many planners believed that the Stiegler's Gorge Dam would provide electricity for the nation's industrial and urban development. To make it a reality, the Tanzanian government enlisted the aid of international funding agencies. In 1966, the U.S. Agency for International Development (USAID) brought two Tanzanian planners to visit American river-basin projects, including the Grand Coulee Dam and the Tennessee Valley Authority. Tanzania had both USAID and the Overseas Technical Cooperation Agency

68. United Republic of Tanzania, "The Arusha Declaration: Socialism and Self-Reliance," in Julius Nyerere, *Freedom and Socialism* (Oxford, 1969), 246.

69. A thorough description and critique of *ujamaa* is outside the scope of this article. See Andrew Coulson, ed., *African Socialism in Practice: The Tanzanian Experience* (Nottingham, UK, 1979); William Redman Duggan, *Tanzania and Nyerere: A Study of Ujamaa and Nationhood* (New York, 1976); J. H. Proctor, ed., *Building Ujamaa Villages in Tanzania* (Dar es Salaam, 1974); and Scott (n. 6 above), 223–61. For a discussion of villagization in the Rufiji district, see Ben Turok, "The Problem of Agency in Tanzania's Rural Development: The Rufiji Ujamaa Scheme," in *Rural Cooperation in Tanzania*, ed. Lionel Cliffe (Dar es Salaam, 1975).

70. United Republic of Tanzania, *Tanzania Second Five-Year Plan for Economic and Social Development, 1st July, 1969–30th June, 1974: Volume I: General Analysis* (Dar es Salaam, 1969), 121.

71. Swedish National Archives, SIDA Archive, Arninge (hereafter SNASA), F1AB 1387–1391 and Tanesco archive, *Tanesco: Reports and Accounts, 1964–1971*. The British company Tanesco was established in 1931; in 1964, it became the national utility company owned by the Tanzanian government. Run of the river dams are usually built on waterways with consistent stream flow; therefore they do not require adjacent large reservoirs to produce a steady supply of electricity.

JULY  
2008  
VOL. 49

of the Japanese Government (JETRO) study the hydropower potential of Stiegler's Gorge. Both agencies recommended the construction of the dam. The Tanzanian government found a willing funding partner in the Norwegian Agency for Development Cooperation.<sup>72</sup> In August 1971, the Tanzanian government assigned the engineering firm Norconsult to produce yet another feasibility study, one that would estimate costs and recommend power-consuming industries for the region. In 1976, after completing these studies, the Norwegian engineering firm Hafslund began work on the plans for the Stiegler's Gorge Dam.<sup>73</sup>

Concerned about the rapid pace of planning and the harm the dam could do to downstream production systems, foreign and Tanzanian researchers produced conflicting project reports and environmental-impact assessments for the proposed dam.<sup>74</sup> Between 1961 and 1984, over thirty major studies of the Rufiji River and the potential ecological impact of the Stiegler's Gorge Dam circulated within Tanzania. Foreign consultants undertook the bulk of these studies and recommended constructing the dam. An interdisciplinary group of researchers—foreign and Tanzanian alike—at the University of Dar es Salaam's Bureau of Resource Assessment and Land Use Planning (BRALUP) conducted numerous field studies of Rufiji agriculture, political economy, and natural-resource use that emphasized the negative effects of the dam.<sup>75</sup> These researchers employed techniques that were a combination of those used by their colonial and FAO predecessors: they conducted extensive fieldwork, interviewed farmers and district officials, and collected agronomic data using the most recent survey and scientific techniques.<sup>76</sup> They became, in a way, the voice of basin residents.

72. By the slowdown of planning efforts during the 1980s, Norway had given Tanzania over US\$24 million to support the planning of the Stiegler's Gorge project. For a discussion of Norway's aid industry, see Association for International Water and Foreign Studies, "When Norway Dams the World, or Power Conflicts Report" (Oslo, 1994); Michael Ngallapa, "Energy Development and Foreign Aid: The Case Study of Norway-Tanzania Cooperation in the Planning of the Stiegler's Gorge Hydropower Project, 1975-1985" (M.A. thesis, University of Dar es Salaam, 1985); and K. J. Havnevik et al., *Tanzania: Country Study and Norwegian Aid Review* (Bergen, 1988).

73. "Pact to be signed soon on Stiegler's Gorge Survey," *The Standard*, 20 August 1971; Hafslund, A/S, "Stiegler's Gorge Power and Flood Control Development, Project Planning Report, Volume 1" (Oslo, 1980).

74. Havnevik, *Tanzania: The Limits to Development from Above* (n. 38 above), 270-71.

75. TNA 640/A/COM/BRALUP/2, "Programme Committee Minutes," 16 November 1967.

76. The BRALUP reports include the most detailed discussion of the lower Rufiji political economy. Examples of this research include Han Bantje, F. Mrisho, and B. Ljungqvist, "A Nutritional Baseline Survey in Four Villages in the Lower Rufiji Valley," BRALUP Research Paper No. 55 (Dar es Salaam, 1979); Bantje (n. 31 above); Han Bantje, "Floods and Famines," BRALUP Research Paper No. 63 (Dar es Salaam, 1980); A. Cook, "Land-Use Recommendations for Rufiji District," BRALUP Research Paper No. 11 (Dar es Salaam, 1974); Kjell Havnevik, "Economy and Organization in Rufiji District: The Case of Crafts and Extractive Activities," BRALUP Research Paper No. 65 (Dar es Salaam,

By 1980, support for the Stiegler's Gorge Dam was waning. Researchers within Tanzania questioned the feasibility of the proposed design; others emphasized the damage the dam could do to downstream environments and production systems.<sup>77</sup> The global public increasingly viewed large dams as environmentally and socially destructive, and, as Ghana's Akosombo Dam had shown, economically and politically risky.<sup>78</sup> In 1984, based on the findings of a Norconsult study, the government halted planning for Stiegler's Gorge and refocused attention on smaller, less expensive hydro-power projects in the upper basin.<sup>79</sup>

### The Great Ruaha Power Project, 1966–1985

The story of the Great Ruaha Power Project allows us to see in greater detail the kinds of challenges faced by international consultants, and the ways that they created geographical knowledge in the face of those challenges. In 1970, at the height of enthusiasm for the Stiegler's Gorge project, representatives from Tanesco, the World Bank, and the Swedish International Development Cooperation Agency (SIDA) agreed to construct the Great Ruaha Power Project, which included the Kidatu hydropower plant (first phase completed in 1975) and Mtera Reservoir (completed in 1980). Like Stiegler's Gorge, the Great Ruaha Power Project originated in the Rufiji Basin Survey. M. Freimann, the project engineer of the RBS, had proposed a hydroelectric reservoir and power plant at the Mtera site with a capacity of 21 megawatts, and he identified the Kidatu site as a good location for a storage reservoir for future projects.<sup>80</sup>

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1980); Sandberg (n. 32 above); and Audun Sandberg, "The Impact of the Stiegler's Gorge Dam on Rufiji Flood Plain Agriculture," BRALUP Service Paper 74/2 (Dar es Salaam, 1974).

77. For example, see Euroconsult/Delft, "Identification Study on the Ecological Impacts of the Stiegler's Gorge Power and Flood Control Project," paper prepared for the Rufiji Basin Development Authority, United Republic of Tanzania, 1980; and Kjell Havnevik, "The Stiegler's Gorge Multipurpose Project, 1961–1978," DERAP Working Paper No. A71, Chr. Michelsen Institute (Bergen, 1978).

78. The Akosombo Dam had led to the resettlement of over 80,000 people, exacerbated Ghana's indebtedness, and weakened support for Nkrumah (who was ousted in a coup in 1966, the year of the dam's commissioning). For a discussion of the ecological, economic, and social impacts of the Volta River Project and Akosombo Dam, see David Hart, *The Volta River Project: A Case Study in Politics and Technology* (Edinburgh, 1980); Kwaku Obosu-Mensah, *Ghana's Volta Resettlement Scheme: The Long-term Consequences of Post-colonial State Planning* (San Francisco, 1996); and Dzodzi Tsikata, *Living in the Shadow of the Large Dams: Long-Term Responses of Downstream and Lakeside Communities of Ghana's Volta River Project* (Leiden, 2006).

79. Norconsult, "Rufiji Basin Hydropower Master Plan: Main Report," paper submitted to the Rufiji Basin Development Authority, Dar es Salaam, 1984.

80. Food and Agriculture Organization (n. 3 above), vol. 3, pt. 1, 137. A geological discussion of both dam sites was presented in the additional geology survey volume by

JULY  
2008  
VOL. 49

SIDA's involvement in the project stemmed from a 1966 investigation of a different project on the Wami River. During their investigations, SIDA consultants learned about the competing Great Ruaha Power Project, which had been proposed by Tanesco and a British consulting firm. In their report on the Wami project, the engineers included a calculation for the Ruaha project, basing their estimates on the data and interpretations of the Rufiji Basin Survey. Due to time and budget limitations, they did not visit the Great Ruaha River themselves.<sup>81</sup> The World Bank asked SIDA to finance a study of the Great Ruaha Power Project, and in 1967 it contracted with John Fletcher, a Swedish hydropower plant director, to research the upper basin's waterways and explore the feasibility of hydropower projects. With limited data available and no funds to conduct field studies in Tanzania, Fletcher opted to compare the Wami and the Great Ruaha to the regulated Klar River in central Sweden, which at the time had records extending back seventy-eight years.<sup>82</sup>

The task of predicting the flows of the Tanzanian rivers was complicated. For the Klar, records showed small variations in stream flow over long periods and between its lowest and highest monthly means. In comparison, Fletcher found that the available river-gauge readings for the Tanzanian rivers provided data that seemed either impossible or unlikely to occur again. Stream flow for both rivers varied dramatically throughout a single year (from no recorded flow to 1,000 cubic meters per second [cumecs]), and also between years. The highest floods came the year after the lowest mean was recorded. Fletcher's experience of flow variations in Swedish rivers, and the Klar in particular, simply did not compare to those of the Great Ruaha. To Fletcher, the variations seemed faulty or were evidence of extreme events that were unlikely to recur any time soon, and he referred to the river as a "problem child."<sup>83</sup> To translate the data into forms useful to engineers and planners, Fletcher chose to "smooth" the available figures for the Tanzanian rivers:

It will be noticed that the year 1961/62 was exceptionally rich. This fact leads to a distortion of the monthly means if calculated in the

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E. G. Haldemann. The geological investigation by Haldemann was planned as the sixth volume of the FAO report, but as his work was so extensive, it was published as a separate report. See Haldemann, *The Geology of the Rufiji Basin with Reference to Proposed Dam Sites* (Dar es Salaam, 1962), 36ff, 43ff.

81. Ingvar Jernelius and Lennart Samuelsson, "Tanzania Wami River Power Development, Study of the Lower Wami for the Swedish International Development Authority" (Stockholm, 1966), 1 (SWECO archive, Stockholm).

82. During November and December 1966, Fletcher had taken part in a World Bank mission to investigate the East African power sector; see John Fletcher, "Report on Study of Power Problems in Uganda, Kenya and Tanzania," in SNASA, FIAB 1387.

83. SNASA, FIAB 1388, John Fletcher, "Klarälven, Wami and Great Ruaha—a Comparative Study of Three Rivers" (Munkfors, 1967), 18.

ordinary way. As such means will be used later on, some “smoothing” has been done: the total amount of water in the average year . . . has been distributed over the year in proportion to the monthly medians, which can be more accurately assessed.<sup>84</sup>

The gauge readings of the two sites on the Great Ruaha River were so different that Fletcher chose to simplify by converting the two into a single mean that he dubbed the “Great Ruaha Substitute.”

Fletcher’s process was meant to supply adequate data on which to base his calculations, yet he was hesitant about its accuracy, noting that it was “perhaps not absolutely flawless, but it will serve.”<sup>85</sup> Without the data he needed and no funding for further investigation of the sites, he concluded that “accuracy and reliability are not what we should have liked them to be,” but he maintained that enough information existed to go ahead with planning for future dam construction on either the Great Ruaha or Wami river.<sup>86</sup>

Following Fletcher’s report, the Tanzanian government requested funding for the Wami project from SIDA, which agreed, provided that a comparative study of the Wami and Great Ruaha projects be conducted prior to committing more funds.<sup>87</sup> Heavy rains delayed and reduced the scope of the resultant work. Geological field studies to find suitable conditions for the construction of tunnels for the power plant were made during a two-week visit in 1968. Tanzania’s water department took extra water-flow measurements, but consultants conducted no further hydrological field studies. Consultants from the Swedish engineering firm SWECO noted that the data were incomplete and left many unanswered questions. Despite this, the SWECO representative favored the Great Ruaha Power Project, citing “further considerations.”<sup>88</sup> There is no evidence of what these considerations were, although the project’s main funder (World Bank) and planners (Balfour, Beatty, and Co. Ltd. and Tanesco) supported the project. This was enough. In 1968, SIDA commissioned a study of the technical and eco-

84. *Ibid.*, 5–6.

85. *Ibid.*

86. *Ibid.*, 6–7, 26.

87. Consequently, a joint study involving Balfour, Beatty, and Co. Ltd. and SWECO was set for late 1967. The comparative study dealt with three options: hydropower on the Wami or Great Ruaha rivers (as proposed by the Great Ruaha Power Project), as well as a thermal power plant in Dar es Salaam.

88. See the following correspondence and minutes in SNASA, F1AB 1389: John Fletcher, “Anteckningar om Tanzania,” 18 January 1968; copy of letter from SWECO to John Fletcher, 25 January 1968; telegram from the Swedish Embassy in Dar es Salaam, Rolf Beijer to SIDA Stockholm, K. H. Willén, 29 January 1968; letter from John Fletcher, Munkfors, to SIDA K. H. Willén, 7 February 1968; letter from John Fletcher, Munkfors, 17 February 1968, to SIDA, K. H. Willén; letter from WD & ID, Lwagarulila—Ministry of Lands, Settlement, and Water Development, Tanzania, 6 February 1968, to SIDA; John Fletcher, “Notes on Tanzania Power,” 28 February 1968.

JULY  
2008  
VOL. 49



FIG. 2 River gauge, probably by the Great Ruaha River, January 1969. (Photo by Erling Reinius, reproduced courtesy of Ulla Reinius.)

conomic feasibility of the Great Ruaha Power Project, to be produced within a year.<sup>89</sup>

Pressured by the short period allocated for the study, SWECO consultants relied heavily upon the FAO's Rufiji Basin Survey. Erling Reinius, a Swedish hydrologist and professor of hydraulics, was given only ten days for field studies of the Great Ruaha River.<sup>90</sup> During his stay at the Kidatu and Mtera sites, Reinius photographed the sites, measured water flows, and checked the previously installed gauging instruments (fig. 2), recognizing in the process the inadequacy of earlier records. After interviewing residents, he realized that measurements had been left out during some floods; in some cases, he could not ascertain where the measurements had been made. He also observed that some gauges were leaning. Despite these inadequacies, Reinius finalized the study. A year-and-a-half later, construction began on the Kidatu site.<sup>91</sup>

89. SNASA, F1AB 1389, "Letter from John Fletcher to SWECO—copy to SIDA, K. H. Willén," 22 March 1968 (this letter contained the minutes from a meeting with Balfour, Beatty, and Co. Ltd., 14 March 1968); SWECO archive, Stockholm, "Comparative Study of the Wami River and the Great Ruaha River Developments in Tanzania, Joint Report," July 1968, and "Copy of Agreement between SIDA and SWECO on Preinvestment Study," 14 November 1968 (terms of reference for the preinvestment study), 1.

90. Interview with Ulla Reinius (wife of Erling), Stockholm, 6 May 2005, and Ulla Reinius, private diary, 1969.

91. Interviews with Kristoffer Reinius (son of Erling), Stockholm, 23 May 2002, 5 and 9 March 2005, and 25 May 2005; interview with Ulla Reinius, Stockholm, 6 May 2005; SNASA, F1AB 1393, "IBRD Supervision Report, Kidatu Hydro Electric Project," 19 November 1971.

As the Great Ruaha Power Project moved forward, opposition to the reservoir at Mtera arose. SWECO engineers had raised the issue of the local population's land and water rights with Tanzanian planners. Planners at the central planning authority, DEVPLAN, dismissed these concerns, noting that regional authorities would handle the relocation of people as part of the ongoing *ujamaa* program.<sup>92</sup> In 1972, A. Buchanan, a senior executive engineer at the Tanzanian Ministry of Water Development and Power, wrote to DEVPLAN: "With its almost complete draw-down and consequent wide muddy shoreline, Mtera reservoir will be of little or no use for fisheries, for settlement or for watering animals, stock or game. Except very occasionally when full, the dam will not even be attractive to look at."<sup>93</sup>

Buchanan's objections had little effect. In 1974, he wrote to Tanesco's general manager to further emphasize the problems with the Mtera Reservoir, suggesting as an alternative that dams be built at both Utengule and Iringa, which in the case of Utengule would flood only permanent swamps and a "virtually uninhabited" area.<sup>94</sup> Despite this opposition and the shortage of adequate scientific data, the Tanzanian government approved the construction of the Mtera Dam. It took less than a decade after reaching the full supply level before the doubts regarding water flows proved correct. Beginning in 1993, the Great Ruaha River began to dry up completely during the dry season, resulting in the loss of water to the Mtera Dam, power shortages in the national electricity grid, and power rationing in Dar es Salaam.<sup>95</sup>

92. SNASA, F1AB 1391, "Letter from Anders Trydell, SIDA, Stockholm to SIDA, Dar es Salaam, Delegation for Negotiations with Tanzania and the World Bank Concerning Power Project," 9/10 (9 October) 1970. For a discussion of Tanzania's *ujamaa* program, see Idris S. Kikula, *Policy Implications on Environment: The Case of Villagisation in Tanzania* (Dar es Salaam, 1996); McHenry (n. 67 above); Goran Hyden, *Beyond Ujamaa: Underdevelopment and an Uncaptured Peasantry* (Berkeley, Calif., 1980).

93. SNASA, F1AB 1393, "Letter from Stig Regnell, SIDA (Dar es Salaam) to SIDA (Stockholm), including copy of confidential letter from A. Buchanan to DEVPLAN, 23 February 1972."

94. SWECO archive, 26757–120, GRPP Mtera Power Project and Kidatu Power Plant Stage II, film Oracle 238, copy of "letter from Mr Buchanan, Tanzania Ministry of Water Development and Power, to Tanesco General Manager," 20 March 1974.

95. Annex 1 of the "Final Report of the Sustainable Management of the Usangu Wetland and Its Catchment (SMUWC) Project, Phase 1, March 2001," in Geoffrey King and Julie Thomas, <http://www.usangu.org/reports/> (accessed 20 September 2004), i, 55, 65, 75, 89; Jannik Boesen et al., *Water Resources Management in the Great Ruaha Basin: A Study of Demand-Driven Management of Land and Water Resources with Local Level Participation*, Danida/World Bank Study (Washington, D.C., 1995), 1:6; D. K. Yawson, R. K. Kachroo, and J. J. Kashaigili, "Failure of the Mtera–Kidatu Reservoir System in the Early 1990s" (Arusha, Tanzania, 2003), [http://eng.suanet.ac.tz/swmrg/outputsdownloadable\\_files/Wordpapers/Failure\\_Mtera\\_Kidatu.pdf](http://eng.suanet.ac.tz/swmrg/outputsdownloadable_files/Wordpapers/Failure_Mtera_Kidatu.pdf) (accessed 5 May 2004); Elon Dahlström, Melinda Cuellar, and Hans Peterson, *Swedish Support to Tanzania's Power Sector Sida Evaluation 97/24* (Stockholm, 1997), 67ff.

## Conclusion

*“As systemic knowledge grows, so does the possibility of ignorance.”*

—Mark Hobart<sup>96</sup>

JULY  
2008  
VOL. 49

The waters of the Rufiji Basin have incited the imagination of foreign visitors since the late nineteenth century. During the colonial period, the desire to increase agricultural production brought colonial engineers to the region. The surveys they produced evidence their sensitivity to local resource use and their recognition of the expense and challenges of controlling the basin's rivers. Following World War II, the colonial and independent Tanzanian governments invited international agencies to conduct studies of the basin's largest rivers and recommend a course of development. Disconnected from the local experiences and having limited hydrological data, these studies replaced previous geographical knowledge of the basin. With the publication of each survey, certain assumptions about the basin's development remained constant: most of the technical experts involved viewed hydropower dams as the best use of the region's waterways. Throughout this process, residents were excluded from discussions of the region's development priorities and dam projects. Their voices were not entirely absent, however, as some researchers embraced the methods of the colonial engineers, completing detailed studies that promoted the interests of residents.

The case of the Rufiji Basin is not simply another example of inappropriate or failed development, but one that illustrates how the process of development planning has affected the creation of geographical knowledge in Africa. The new development science of the 1940s and the institutions it spawned were based on a faith that Western science and technology could transform less-developed nations into modern economies. As adherents of this doctrine, the many experts who entered the basin came with a wealth of expertise and the latest technology to assist them in their work. But they found themselves more constrained than their colonial predecessors. The pressure to produce quantitative data and concrete structures exposed the tensions between the priorities of development and state institutions and those of engineers and scientists. Political pressures and competition between funding agencies pushed engineers to complete their tasks quickly and hindered their efforts to collect data on the basin's waterways. They completed their assignments as best they could, dutifully presenting their findings in forms accessible to other technical experts. Even when engineers questioned the data contained in the many charts, tables, and graphs, decision makers tended to trust it more than the narrative surveys of colonial engineers. By illustrating the power of international institutions and gov-

96. Hobart (n. 13 above), 1.

ernments to choose what is accepted as knowledge, as well as how such knowledge is used, the case suggests the need to historicize studies of African environments. Understanding the context within which such information is created and passed on allows scholars and policy makers to interrogate assumptions about African environments and resource use, while assisting engineers in planning socially and environmentally appropriate projects.

In Tanzania, the assumptions of the FAO's Rufiji Basin Survey continue to affect the lives of millions of people. Influenced by bilateral and multilateral funders and the global trend toward large dams, Tanzania predicated its energy sector on the construction of hydropower dams, thus setting the stage for its recent electricity crisis. With drought, increased water use, and biodiversity concerns threatening the production of hydroelectricity, Tanzania has been forced to institute power-rationing schedules and seek ways to increase electricity production.<sup>97</sup> Within this context, dam boosters have reemerged. The website for the Rufiji Basin Development Authority prominently displays a drawing of the Stiegler's Gorge Dam, claiming the project "will supply abundant and reliable energy and will stimulated [*sic*] multiple developments in other sectors."<sup>98</sup> It also suggests that the project has been studied in detail, implying that all that is needed is the funding. Moreover, the focus on large-scale hydropower projects—another legacy of the FAO's study—has decreased funding of rural electrification projects, leaving most rural Tanzanians without reliable electricity.

Since the 1980s, international institutions like the World Bank have come under increasing criticism for the environmental and social impacts of their projects. This has led to a renewed interest in understanding and incorporating local knowledge and perspectives into development planning, implementation, and evaluation. But there remains a tendency to downplay the importance of a region's environmental history in the development-planning process. As the proposed hydropower projects would impact their livelihoods and environments, it is important that residents participate in discussions of future dams and development initiatives. Only by incorporating multiple types of knowledge, valuing past experience, and understanding the power dynamics within and between development institutions will planners avoid costly mistakes and better address local and national needs.

97. A number of natural gas projects are under development; for example, the Songo Songo and the Mtwara Region Gas-to-Power Project, and the Mnazi Bay gas projects.

98. Rufiji Basin Development Authority, <http://www.rubada.org> (accessed 30 March 2008).