Meaning(s) of Water: Fish and the Human Ecology in Ethiopia's Upper Nile

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Abstract

Water is a media that sustains both belief and life. One of its powers is symbol of power and destiny. In the Upper Nile it carries meaning as a place (point of origin, a highland spring or montane rivers), a conduit for travel, and a source of food. This paper uses fish and waters as both a material, living part of nature and as part of the human imaginary. In this structured ecology human relationship with environment requires intervention of the supernatural that can be reached through mediation by holy men, who mediate between humanity and the environment (natural world). Hitherto, there has been no study looking at how local ecology of fish and the human settlement collide and interact. Drawing on a broad range of local historical sources, science studies, and field observations over several decades from Ethiopia's Blue Nile region, this article addresses human interaction with environment (and fish) in the Lake Tana region and sheds light on competing narratives that have resulted from this interaction. The article recognizes the centrality water as habitat in the relationship between people, water, and nature in this part of Ethiopia and addresses the impact of human movement on ways in which people make sense of their environment (past and present).

Keywords: Ethiopia, Ecology, Fisheries, waters, Nile, Africa, Tana

1. Introduction

The past five years have seen the birth of a vibrant interdisciplinary field, the environmental humanities. The expertise of the natural sciences by themselves have not in and of themselves have not yet translated fully into a coherent vision of sustainability of environmental resources, including water. Environmental issues are being addressed by many academic disciplines. Ecologists and environmental scientists try to understand the natural world and study the impacts of human activities on biodiversity. Climate scientist study the dynamics of the atmosphere and build models to predict future movements of air, water, and land/soils and suggest policy actions. Environmental social scientists, on the other hand, focus on the relations between policy and behavior, between economics, ecological "services" and human consumption of resources, and so forth. Yet, to achieve balance, environmental humanities studies address and describe the cultural dimensions of the environment, where interactions are expressed in Poetry, religion, plastic arts, and language. Fish as a part of that watery world are a nuanced part of water ecology and woven into a narrative over time.

Water is a media that sustains both belief and life. One of its powers is symbol of power and destiny. In the Upper Nile it carries meaning as a place (point of origin, the spring at Gish), a conduit for travel, a source of food and a link to spirituality. In Orthodox Christian allusion to magic revelation, and spirituality it is ubiquitous at its source and in its flow. A painting displayed in the church at the Blue Nile's point of origin tells part of that story. Another from a hagiographic text shows a fish belly filled with gold as a sign of spirituality to come, a daughter's sainthood. Still another aqueous allusion depicts waters of the lake ecology as a point of both danger and monastic spirituality....

Yet, this is a fish story as told through one aspect of the water of the Upper Nile (Abbay/Bue Nile) basin. It is also told through describing the ecologies of a species of *Cyprianid* fish (*labeobarbus*) and its co-evolutions with humans in the waters of the upper Blue Nile (Abbay) of Ethiopia across time. It includes the sequencing of that an endemic fish species to geological movement, and the efforts of human engineers to move, store, and redistribute Nile waters in the modern world. It is ostensibly a story about a fish, but one that narrates a deeper regional history of environmental change in one of the world's most storied watersheds. After all, he waters from the Ethiopian highlands annually make up over 84% of what nourished ancient and modern Egypt's civilization.

This article addresses the successions through time of ecological change and impending events. The *Labeobarbus* is our measure and its story illustrates a fine-grained harbinger of what is to come and a canary in the Nile's coal mine (to mix a metaphor). What of the Nile's future? That future begins at the Nile's true and perceived source in the highlands of Ethiopia and water is both substance and meaning.

The Upper Nile Water's Geology and Water's Longue Duree

Sitting at 1800 meters above sea level from where it frames much of the watershed. Lake Tana is at the Blue Nile's first major outflow and is the heartbeat of the entire Nile watershed, registering its seasonal pulse.[1] Lake Tana, The Blue Nile's hydrographic source sits in a basin of a mid-Tertiary flood basalt sequence and its surrounding ecologies are the various sources of the Blue Nile's waters. The lake's geological origins were a volcanic blockage of the river's stream about two million years ago by a 50 kilometer-long flow of basaltic molten rock that trapped water in the shallow lakebed. This was a dynamic, changing flow and there is also evidence that the lake dried up 15,100 and 16,700 years ago and became a papyrus swamp with shallow-water ecologies.

The Upper Nile waters also were not static over time, since about 14,000 BP the period of dessication ended and water flow that was to become the Nile was reestablished in the Late Pleistocene and the lake filled. In this dry phase historical geologists estimate that rainfall was less than 40% of what we expect has been the pattern in the last two centuries. A major change in lake ecology took place then.

When, about 14,750 years ago, water in the entire Nile system increased and the lake overflowed the volcanic blockage into the Blue Nile riverbed. The Nile system in its more recent geological history has regained its permanent flow, though still with the strong seasonal, pulsing rhythm that drives the Blue Nile watershed's ecology and gives us the Lake's fish endemism and the modern ecology of malaria.[2]

Water as Fish Media

Riverine fish over many short "fish" generations undergo a species radiation and adaptation to new lake habitat –an endemism that transformed fish feeding behaviors, mouth structure, and spawning habits across new sub-species that we now identify as *Labeobarbus*. Those species that vary in size from 32 mm (*L.brevicephalus*) to 82 mm (*L. megastoma*) and range from nutritional focus on vegetation to carnivorous, to omnivorous. The only known, intact species flock of cyprinid fishes, the 15 Labeobarbus species in Lake Tana (Ethiopia), includes eight piscivorous species. Piscivory is a rare specialisation among the highly successful (>2000 species) but mostly benthivorous (bottom-feeding) Cyprinidae. Lake Tana's fish over time are thus a canary in the coal mine that forms part of water's history.

The extent and mechanisms of diversification of this remarkable Labeobarbus species flock, particularly among the unexpected piscivorous species, are still largely unknown. All 15 Labeobarbus species are

[1] Tana, however, is not technically a pulse lake, like Cambodia's Tonle Sap on southwest Asia's Mekong river. The Blue Nile's waters rise and fall with the season, whereas the Tonle Sap has an annual backflow that sustains it distinctive aquatic ecology.

[2] Henry Lamb, et. al. "Late Pleistocene desiccation of Lake Tana, source of the Blue Nile, *Quaternary Science Reviews* 26 (2007), 287, 296.

segregated to a great extent along spatial, trophic and/or temporal dimensions. The spatial distribution, diet (prey species but not prey size), time of active feeding and predation techniques differed significantly among the eight piscivores. Lake Tana's Labeobarbus species displayed their retained potential for ecological diversification and speciation, including the uncommon specialisation of piscivore types that gets into the weeds of fish as a measure of long-term environmental change.. The latter is probably a result of the absence of common African specialist piscivores in Lake Tana. Lake Tana's endemic *labeobarbus* flock at this stage is predominantly structured by ecological selection models.[3]

Lake Tana and its tributary rivers have been the stage on which fish have played their own distinctive dramas of change. In it recent history, including the 20th century, the lake is shallow vessel, with a maximum depth of only 14 meters, and more recently nine meters, at its deepest point.[4] Four small rivers drain into the lake, and the Blue Nile is the lake's only historical outflow. The shoreline ecology of feathery papyrus and grasses and more recently of market gardens of lettuce and onions and mildly narcotic *chat* (*Catha edulis*) that are replacing rough peas (vetch) on floodplains. On the lake's northeast edge the black "cotton" cotton soils that support seasonal grazing have sustained distinctive Fogara cattle, though those seasonal flooded soils also are the favored habitat for larva of *An. funestus* mosquitos, a key local malaria vector. Overall, the lake water's oxygen level is unusually high. Though the flow of moves not only the river's water but also silt through the lake and into the great Nile flow towards Khartoum where it joins the full Nile. The lake's discharge at the outflow makes up a total of 8% of the annual total into the overall watershed, though the Blue Nile and Ethiopian highlands as a whole contribute over 80% of the water reaching the Nile delta in Egypt and its heretofore egress into the eastern Mediterranean. Now let's move to the modern era.

Human Ecology of the Upper Nile: The 19th Century

3 https://www.researchgate.net/publication/40792802_Adaptive_radiation_of_Labeobarbus_species_in_Lake_Tana [accessed Aug 31 2018]. Other observation of fish adaptive morphology suggests a much quicker change rate in, for example the Asian carp and possibility of such a fast evolution of the parent line for Labeobarbus from the parent L. Altianalis. Conversation with conservation biologist and liminologist Les Kaufman. 30 August 2018.

4 In April 1933 R. E. Cheesman measured the deepest point in off the shore of the bay Balas River at 21 feet 10 inches (less than 8 meters) and 43 feet at its deepest measurement near Gorgora in the north in the dry season. R.E. Cheesman, *Lake Tana and the Blue Nile* (London, 1936), 221.

As fish and their watery setting evolved, so did humans' limited settlements in contact with that ecology. In 1938 the Italian Tourist Agency published a detailed guidebook to their newly conquered East African colony. That guide remains one of the most revealing snapshots of Ethiopia's state of political development by the year 1938, after two years of Italy's 1935-41 colonial occupation. On page 383 of that guide is a description of the site of a church Bahirdar Giyorgis and what the Italians had built as the site of their Residenza del Tana Meridionale, a district (not a town) that encompassed the population of a rural district (c. 25,000). The *Guida* listed official buildings as a post office, a telegraph office, an infirmary, air strip, and a landing for the lake transport boat -and a "village" comprised of "Abyssinian and Wayto" (the latter are Islamic but Amharic-speaking lakeshore hippo hunters) whose thatched houses clustered near the southwestern shore and St. George (Giyorgis) church at the lake's southern edge. This was the early state of urbanization of the Tana region.

And the lake also sustained earlier signs of human habitation. Island monasteries and the Giyorgis church at Bahir Dar occupied sacred "frontier" refuge spaces isolating monks away from the temptations of human concentration and politics. When in 1635 the new Emperor Fasiladas founded a new capital at Gondar away from the lake that choice may have been founded as much for reasons of human health as for political reasons. At lakeside the former capital at Gorgora had long suffered the scourge of malaria that underlay patterns of thin human settlement.

The site of the Blue Nile's egress at Bahir Dar's malarial ecology did not encourage nor sustain dense human settlement. French visitors to the lake shore in the nineteenth century had called the endemic malarial site a "deadly zone". In the mid-twentieth century, sudden, and deadly, malaria epidemics had broken out in 1953 and 1958. Tens of thousands of rural folk died in those epidemics, leaving little doubt that the lakeshore never comprised an urbanshed that attracted a historical urban settlement, urban economy, or administrative core like that at higher elevations Gondar or, later at Addis Ababa. Yet, there is also early evidence of attempts to settle the lake front near the Bahir Dar shore for commercial and spiritual purposes.[5] The Giyorgis church compound contains a crumbling 17th-century staired stone tower with wooden doors, and a few steps away inside the town (and behind the more recent Jambo bar garden) is a building of the same vintage built of stone in the distinctive Gondarine (allegedly Portuguese) style.

[5] Seltene Seyoum, "Land Alienation and the Urban Growth of Bahir Dar 1935-74," in David Anderson and Richard Rathbone, eds. *Africa's Urban Past* (Oxford and Portsmouth, NH, 2000), pp. 235-45.

Malaria has long lived at the lake and its watery catchment area. The lakeside and periphery were habitat for *An funestus* and *An Pharoensus*, two malaria vector mosquitos, that carried both vivax and falciparum forms of the diease. The eastern and southern shores of the lake display its malarial ecology in swamps dominated by papyrus, water lilies, and wet “black cotton” soils. Large and sprawling fig trees (*Warqa*) overhang the water's edge, providing nesting spots for African fish eagles whose shrieks are among the first sounds of morning. The lake water itself offers few habitats for mosquitos, but the surrounding wetlands and puddles formed by receding lake water in the early dry season left habitat for *A. pharoensis* and *A. funestus* malaria vector mosquitos that may have been primary local vectors that made the lake area historically "a fatal zone".[6] That malaria established and sustained a separation of human settlement and restricted human predation of fish in the Upper Nile. That separation had set up a co-evolution of people and fish.

Through the millennia, the actions of Ethiopia’s people on the highlands did little to alter these slow rhythms, compared to other, deeper effects of climate fluctuations like the Little Ice Age or the seasonal pulse of rainfall, surface water flow and annual agriculture’s scratching out human livelihoods that differed from other highland area from what European visitors called Ethiopia’s "salubrious" highlands.[7] Instead, the watery lake ecology attracted island monasteries that sought isolation and cultures of fisherfolk, as well as fauna (e.g. hippos, crocs, monitor lizards and fish) that were able to escape human predation.

The Blue Nile basin, its geology and its geographies also eventually shaped the cultures of several distinctive peoples. The ethnographic landscape included Christian highland farmers and aristocrats, Cushitic-speaking Agaw farmers, Muslim traders (who spoke Amharic), and Omotic Shinasha. These cultures exchanged places and bodies of knowledge on the local ecologies over time. The wider Nile watershed is not a political boundary, but it has a political border, since an obscure 1902 treaty included an international border with Sudan, even though its waters and human ecology tend to ignore such political ideas. Within the change of seasons and human movements, malaria and other diseases danced in the ecologies of elevation, watery habitats, and human adaptations to them. Epidemic, unstable malaria is one of the deadly disease outcomes of the human/natural ecology, though so too were other enduring maladies of the watershed, exotic diseases of the sub-tropical world. We can count among these:

[6] Another mosquito species found in the puddles and pools, *An. arabiensis*, has another story (see below).
[7] W. Cornwallis Harris, *The Highlands of Ethiopia* (London, 1844), pp.

rinderpest, kalazar, yellow fever, tick and louse-based relapsing fever, and lower intestinal tract infections.

The Nile's biological endemism at the heart of its food production capacity, however, may soon be a thing of the past. Human and fish evolutions have collided quickly. The modern Nile as a whole has moved decidedly toward a endorheic (an inland drainage basin that does not drain into an ocean system). Its endemic fish e.g. *Labeobarbus*, *Garra*, Nile tilapia, (*Oreochromis niloticus tana)* – are historical icons of a diminishing watershed ecology that had long nurtured birds, human cultures, and domesticated plants. Yet, recent development actions are part of a phalanx of development forces changing the watery landscape across time in ways that have dramatically altered ecosystem services that may portend future world sub-tropical systems. Tracing the history of the Nile fishes' aquatic interactions over centuries, and now decades, merges histories of water(s) with human food and settlement outcomes and a growing urbanscape.

The Nile has moved from its natural setting to one of competing development states. In 2020 we can foresee nature's hand in terms of climate change that may diminish the south to north flow of waters from the Nile's watershed into the delta in Egypt to an endorheic future –i.e. a flow that no longer refreshes the Mediterranean nor serves as the lifeblood of irrigated grains and fish, i.e. food that nourishes growing modern human populations that seek grain, legumes like lentils, chickpeas, poisonous vetch (aka rough peas)-- as well as fish, that offered sustenance. In the world of nature, IPCC's model for rainfall change in the next decades projects a potential loss of 25-30% of moisture in historically productive agricultural zone. Water in each of its forms will be an actor in human responses

Water Ecology and the Water Column in the Development State

The river and lake's fish biodiversity results from the dramatic fall of 40 meters at the Tisisat ("Smoke of fire") 30 km downstream from the Blue Nile's outflow. Aquatic life –its fish species, plant life, and malarial habitat around the edges of the lake itself developed its own historical character (its endemism) isolated from the wider Nile system. Fish and other aquatic organisms did not ascend the river to inhabit the lake. Twenty-eight fish species inhabit the lake, twenty-one of which are endemic. Seventeen of those species are large barbs, types unique to this place and its ecological cocktail.[8] The lake's water column is shallow at between 9 and 16 meters, but fish feeding and spawning movements differentiate

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[8] Abebe Getahun and Eshete Dejen, *Fishes of Lake Tana: A Guide Book*. Addis Ababa, 2012.

over time fish mouth morphology, fish catch depth, and shoreline ecology with seasonal fluctuations of lake water.

The fish that appear for sale in morning markets along lake's edge indicate the complexity of lakebed ecology and the evolution of adaptation of species and sub-species. Those fish unloaded from the single-fisherman papyrus boats differ from those captured by gillnets from the few motorized boats that can reach more distant shores at Fogara and the boats' range allows them to set nets in the evening and collect them in the mornings. And the fish "captured" are of different ages of maturity and size. Labeobarbus (eg. *L. crassibarbis*, the largest, or *L. nedgia*) mature at 5 years, catfish at 18 months, and tilapia (*Oreochromis niloticus*) at only 6 months.

Their behaviors over time and place are an important part of fisher specialists' knowledge who brave the seasonality of the lake's waters and weathers. Labeobarbus, a ray-finned fish genus because of their tail structures, are the fastest swimmers among the lake's fish. They spawn upstream in particular tributary rivulets of the Tana watershed, a geographic ecological orientation seemingly retained in their fishy spawning behaviors.[9] Barbus mouth structures have evolved in response to foods: different sub-species feed in certain depths in the water column on small fish, plankton, molluscs, --barbus are omnivorous-- while tilapia subsist on a vegetable, plant-based diet near the shoreline. Populations shift fish spawning and feeding grounds in response to anthropogenic factors that affect habitat, spawning behavior, and spawning "memories."

Shoreline development settlements or dam construction thus affect fish behaviors. Like mosquitos they employ a R-strategy in producing numbers of young rather than parental protection. In fact, given the quick adaptions/genetic mutations seen elsewhere in the Nile system it seems that the divergent mouth structures in *Labeobarbus* sub-species in the lake show us their highly paraphyletic character (descent from a single line of ancestors sub-species.)[10]

Seasonality Matters.

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[9] Tilapia, by contrast, prefer a muddy, stable substrate rather than migration to their upstream "natal" stream sites.

[10] For the evolution of *Barbus* sub-species in the Lake Tana ecology see De Graf, et. al. Evolutionary origin of lake Tana's (Ethiopia) small Barbus species: indications of rapid ecological divergence and speciation." *Animal Biology*, 57, 1 (2007), 39-48.

Both fish and human settlement on the lakeshore near Bahir Dar have co-evolved in the growing urbanshed. Lake Tana fish also practice seasonally adjusted behaviors, responding both too ambient and water temperatures as well to increased rainfall in key (*keremt*) months. Fisherfolk know that since their catch is lowest in October-December (onset of the dry season) and highest during the July-September rains. In the coolest season November-February, when reduced nighttime cloud cover make for cooler temperatures. In that time the fish reduce their feeding and retreat into shore weeds that restrict the use of nets, though reed boats' use of chase and trap methods may be more effective in those seasons than gill nets from motorboats. Local fisherfolk know this and balance their livelihood calendar that fish season behavior to engage in handicrafts, and non-fish markets.

The overlap of agricultural and fishing calendars may have hardened the livelihood orientation of lakeside fisher/hippo hunting group (Waito Muslims) and the agrarian grain farming (Amhara) who did not historically mix settlement sites or economic profiles. August planting season for teff conflicts with the beginning of fish spawning and highest catch potential. Moreover, new dam site construction on the Rib tributary on the lake's northeast shore will likely disrupt the *Labeobarbus* spawning sites during the seasonal migrations that accompany the rains.[11] These issues need further research in limnology and and micro-economics.

Looking at two key sites on Lake Tana's ecology reveals a delicate balance of urbanization , lake hydrology, elevation and fish populations. Its all about water, political geography, and money. In 1933 British traveller R.E. Cheesman who did a full circumnavigation of the lake site recorded important evidence from lake geography and hydrology. First, he observed the Balas River, which flowed into the lake's western side, where the watershed of water flowing into the lake was at its narrowest and speculated about construction of a tunnel could drain water from the lake and into a catchment to the west and southwest. This idea had its full fruition when in 2005 Ethiopia and its Salini (Webuild) Italian construction partner opened the 460 MW power plant and irrigation project that drew lake waters toward the Nile Valley and the Sudanese border. http://www.ethiopian-news.com/ethiopia-tana-beles-a-multi-purpose-hydro-power-plant-inaugurated/) rather than into the lake.

In 2018 on the lake's opposite shore, the Rib River was the site of a new modern human intervention, an irrigation dam whose placement directly impeded the upstream spawning ground of labeobarbus. And in

[11] Interview at Tana Fish Corporation laboratory 19 May 2016 with Ato Belay Abdissa, Ph.D. candidate Bahir Dar University.

that year and at that reservoir site there was already evidence of vegetative invasion from water hyacinth and duckweed, both of which are part of the watery nitrogen cycle to impede fish propagation. The now complete GERD dam and its potential for water management and 5000 MW power generation is a story in the making for the region's future geopolitics.

Conclusion: *Labeobarbus as Coal Mine's Canary*

Can we use concepts about water and this behavioral information on Lake Tana's *barbus* sub-species as a factor of biological personality, or co-evolution with its human setting? Is this environmental humanities? At least part of the labeobarbus personality is the nature of their consumption/processing by humans. Unlike the Nile tilapia's white and lean flesh which invite use of fillets and frying of the whole fish, labeobarbus have a heavily oiled and boney flesh that requires meticulous and time-consuming labor to render it into an attractive food. Women separate the bones from the skeleton and then add the meat to the diced shallots and red peppered or turmeric colored stew. The deep red or yellow stew then ladled onto a base of spongy injera to be shared by individuals in a rustic lakeside thatched roof café or small groups in nearby homes. It is a delicious dish that attracts urban dwellers to new lakeside settlement created by ingenious women entrepreneurs.

Yes, this is a fish story, but the region's human ecology has transmographied as has the role and meaning of water. Is it possible for the Nile to face a future as a endorheic system, even partially or seasonally? Beginning in the late 1950s engineers and economic planners began a set of landscape/waterscape interventions changed the Blue Nile flow by building an 11 Megawatt hydroelectric dam completed in 1960. Since then a series of development actions stifled and redirected the water flow into and out of the lake. Hippo hunting from the lake became a livelihood of the past. Urban growth changed the littoral habitat, fish food supply, water chemistry (nitrogen algae blooms) and specific fish species spawning geography. The most visible recent effect is the plan to develop irrigation on the northeast lake vertisol shoreline, in what had been a key spawning ground for *Labeobarbus*. Nature or human perfidity in the Tana region's ecological history?

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