

# Biological monitoring based on macroinvertebrates for decision support of water management in Ethiopia

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Public defence: 2 July 2009

Ethiopia is known for its high tableland waters and is often called 'the water tower of East Africa' because of the existence of many out-flowing rivers to the neighbouring countries. Because of different anthropogenic activities, many of the rivers in the different basins are facing serious river deterioration. Monitoring and management programmes for rivers hardly exist. The Gilgel Gibe river basin is a good example in this context. In order to fulfil the Millennium Development Goals and to ensure environmental sustainability in Ethiopia, ecological indicator systems can support river managers to analyse the status of watercourses and to select critical restoration actions. In order to use macroinvertebrates as river water quality monitoring and assessment tools, data from reference as well as impacted sites are needed from surface water ecosystems.

The Gilgel Gibe river basin, which is located in south-western Ethiopia, is impacted by different human activities. Major anthropogenic disturbances of rivers are caused by clearance of riparian vegetation, damming, irrigation, water pollution that arises from farmlands, grazing fields and domestic waste dumping. There are also some pristine river segments which are relatively less impacted with direct anthropogenic activities. Environmental and macroinvertebrate samples were collected from 42 sampling sites during the period from 2005 till 2008. During this period 162 samples were collected. The main variables are a combination of macroinvertebrates, water quality and structural variables, human activity and habitat condition. The data were analysed using multivariate methods and data mining techniques. Macroinvertebrate communities were calculated using 33 metrics to analyse their discriminatory power between pristine and impacted sites.

From the general analysis, one can conclude that water quality and structural variables, human activities and habitat condition were major variables influencing the distribution of macroinvertebrate communities. There was no significant difference observed between the dry and the wet seasons. Human impact and habitat condition have affected the river water quality and macroinvertebrates distribution in the Gilgel Gibe river basin. Specifically, vegetation clearance, waste dumping, grazing, tillage, sand dredging and stone collection were major anthropogenic activities that have caused river deterioration. Abundance, taxa richness, Margalef index, Berger-Parker index, Shannon index, Brillouin index, BMWP, BMWP-ASPT, % EPT, Ephemeroptera abundance, Trichoptera abundance, % scraper, FBI and McIntosh evenness were identified as sensitive macroinvertebrate metrics which are able to detect human impact and habitat change. However, % chironomids

% insect, % Oligochaeta, McIntosh diversity index, Brillouin evenness, Shannon evenness and Simpson evenness could not differentiate between the impacted and pristine sites.

Classification tree (CT) and support vector machine (SVM) methods were used to develop predictive models for macroinvertebrate metrics like % EPT, % scrapers, taxa richness and BMWP. Moreover, the models were optimized with genetic and greedy search algorithms. Optimized models gave a consistent result and indicated that riparian vegetation, embeddedness, river bank condition and pH were the major predictive variables. Improvements of the related river channel in the Gilgel Gibe basin probably will have a major contribution to the improvement of the ecological condition.

The Gilgel Gibe dam has affected the macroinvertebrate assemblages and river water quality in the river. The Gilgel Gibe contains poor macroinvertebrate communities in the parts upstream from the dam. Dominant taxa were Chironomidae and Oligochaeta. The reservoir is endangered by siltation and nutrient enrichment and the macroinvertebrate community is mainly affected by water level fluctuation.

Urgent restoration action of the degraded rivers and protection of remaining pristine sites are needed. Ethiopian government should have a clear policy and law enforcement to protect river degradation. The involvement of the general public and the higher education institutions can contribute to the conservation of the river ecosystems. Delimitation of riparian buffer zones could help the revival of the riparian vegetation and stability of river bank. This will increase the macroinvertebrate diversity. It will improve the habitat condition and filter the incoming runoff from farmland and grazing fields. Moreover, best agricultural practice and proper waste treatment and disposal could enhance the water quality and river ecosystem.