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Possible Solutions of Water Pollution Control for hindwin River and Major Lakes in Monywa

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Abstract

This paper focuses on proposed possible solutions for water pollution control in Chindwin River and major lakes in Monywa. Field investigation and questionnaire survey were conducted to gather information about pollution sources in the previous study. The questionnaire set including eight questions being prepared according to five-point Likert rating scale, had been designed based on guidelines for Tanzania National Environmental Management Council (TNEMC). The responses from the survey were analysed by descriptive analysis, relative importance index (RII) and H statistic test. Water quality assessment on urban river water and lake water were performed. Municipal wastewater, industrial wastewater, illegal open dump of solid waste and agricultural waste were identified as major pollution sources of urban river and major lakes in previous study. Therefore, the possible solutions such as decentralized wastewater treatment (constructed wetlands, stabilization pond and bioretention), in-lake treatment techniques, soft engineering techniques and integrated solid waste management are proposed based on literature, secondary academic sources such papers, journals and other sources.

Keywords: Water pollution; possible solutions; Chindwin River and major lakes.

1. Introduction

Water is considered polluted if some substances or condition is present to such a degree that it cannot be used for a specific purpose. It is created by industrial and commercial waste water, agricultural practices and everyday human activities. Pollution poses a serious risk to life especially when the water is a source for domestic purposes and drinking since polluted waters are potent agents of diseases.

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Water pollution is the most serious form of environmental pollution. The rivers and lakes in the developing countries are always affected by industrial dumping which invariably make the water unsafe for drinking and other purposes. Rivers have some capacity to purify and cleanse themselves by diluting many of the pollutants. However, if the loads are too high, the rivers lose this capacity and they become polluted. Some pollutants are persistent in the water and accumulate downstream, causing great hazard.

At present, Chindwin River along urban reach of Monywa is adversely affected by human activities. The water quality changes due to municipal wastewater effluent. Releasing inadequately treated wastewater into natural water bodies can lead to degradation of aquatic ecosystem and public health problems for the people.

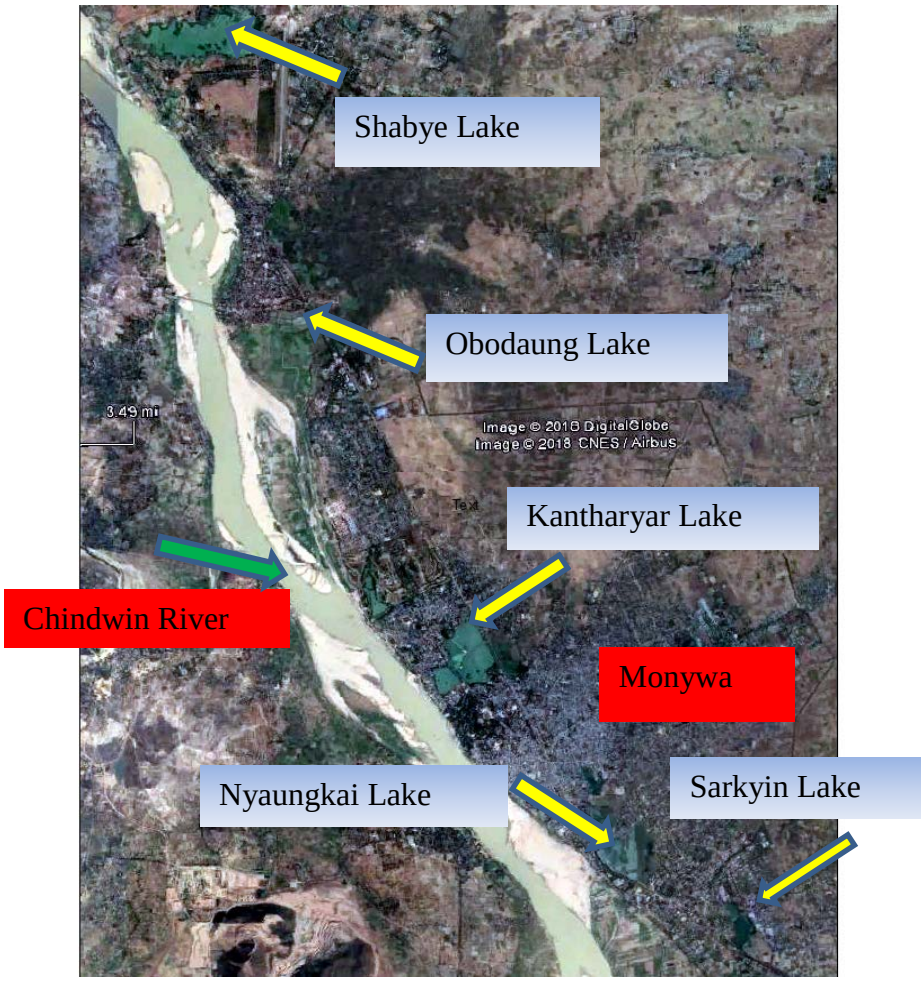

Figure 1: Location Map of Chindwin River and Major Lakes in Monywa

Monywa, a capital city of Sagaing Region, experiences negative effects of water pollution due to several pollution causes. In Monywa urban area, three drainage outlets are located along the Chindwin river bank. Domestic wastewater from the urban area is being discharged directly into the Chindwin River through the three drainage pumping stations. After heavy rainfall, flooding occurs along the riverfront due to insufficient capacity of the drainage size and blockage of solid waste. Moreover, illegal solid waste sites along the river bank are one

of the major causes of the Chindwin river water pollution. The Chindwin River and its river bank especially near three point source effluents have deteriorated due to municipal wastewater and solid waste.

Monywa city has some major surface water lakes being used for variety purposes such as flood absorption, fish production, sedimentation pond, ground water recharge and recreation. However, in present days, those lakes are experienced to impair flood absorption capacity, to reduce water quality for domestic purpose, to diminish fish production and to threaten biodiversity and the environment. Therefore, this study aims to propose on possible solutions of water pollution control for Chindwin River and major lakes in Monywa. The location map of Chindwin River and major lakes are shown in Figure 1.

2. Existing Chindwin River Water and Major Lakes Water Quality Status and Pollution Sources

The wastewater from some urban area in Monywa is also discharged directly into Chindwin River through three drainage pumping stations. Hence, the river water quality in the study area is significantly deteriorated. It is observed that sand mining activity is being carried out commercially in Chindwin River at northern part of urban area. The concentrations of Turbidity, DO, BOD and TSS from Chindwin River water near urban area are exceeded than the standards values. Solid wastes are illegally dumped along the urban river bank and municipal wastewater is flowing into the river through the municipal drain network. The values of BOD and TSS at drainage outlets are extremely greater than the standard values.

The major lakes (Shabye, Obodaung, Kantharyar, Nyaungkai and Sarkyin) are being used for variety purposes such as flood absorption, fish production, sedimentation pond, ground water recharge and recreation. It is observed that illegal waste dump sites and irrigation practices are present near the major lakes except Sarkyin Lake. The industrial zone is situated adjacent to Sarkyin Lake and the industrial waste from some factories is being discharged into the lake. The industrial waste water disposed into the lake with inadequate treatment results higher concentration of BOD, COD, Ammonia and pH. Kantharyar Lake is used for storm water storage to recharge groundwater and public recreation.

According to the informations from investigation of the lake side area by field survey, water quality analysis, secondary data and statistical analysis regarding the responses from the questionnaire survey, it can be identified that agricultural waste, open dump of solid waste and wastewater discharged from industrial plants are pollution sources of major lake water in Monywa.

3. Water Pollution Control Measures for Chindwin River and Major Lakes in Monywa

As for water pollution control measures in the study area, decentralized wastewater management, soft engineering technique, integrated solid waste management, lake restoration methods, waste stabilization pond and solid waste management strategy are proposed to adopt.

3.1. Pollution Control Measures for Domestic Wastewater

Pollution sources of urban river water (Chindwin River along urban area of Monywa) were found as discharging municipal wastewater directly into Chindwin River through the wastewater drainage outlets and the results from the wastewater analysis such as BOD being higher than the acceptable effluent standard. Therefore, to enhance river water quality, decentralized wastewater treatment system can be used for this study area.

Decentralized wastewater management is used to treat and dispose, at or near the source, relatively small volumes of wastewater, originating from single households or groups of dwellings located in relatively close proximity and not served by a central sewer system connecting them to a regional wastewater treatment plant (WWTP).

Decentralized wastewater treatment (DWT) still needs a local collection system; this will be much smaller and less expensive than those used for conventional centralized treatment. DWTs must be properly designed, maintained, and operated to provide optimal benefits. The simplest form of DWT consists of a simple underground septic tank (cesspool), which both settled suspended solids, and achieved some degree of anaerobic digestion.

Another common class of DWT systems such as waste stabilization ponds that include anaerobic ponds, facultative ponds (combining aerobic and anaerobic processes) and purely aerobic maturation ponds can also be used. But these ponds require relatively large land area. So, these ponds can be used if land availability is favorable in the study area. Otherwise, aerobic decentralized wastewater treatment (DWT) technologies can also be adopted in the study area for the enhancement of river water quality.

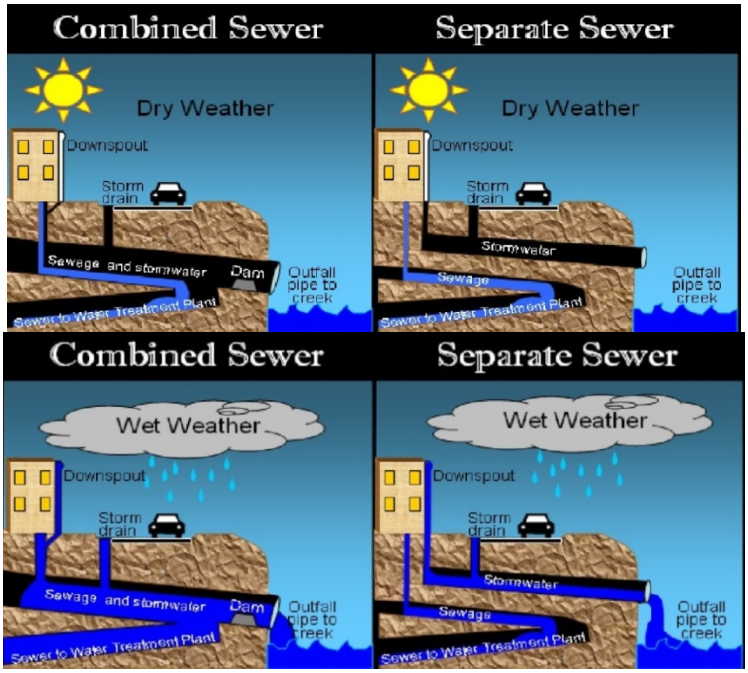

Figure 2: Typical Illustration of Combined Sewer Overflow and Separated System

By using decentralized techniques, combined sewer overflow can be minimized by separating the municipal wastewater and runoff from urban areas. Therefore, separated system for municipal wastewater should be

developed as an alternative solution for improvement of river water quality and the separated system is desirable to prevent the study area from the pollution and, maintain the public water clean.

For urban runoff, small storage and treatment facilities shall be installed. The quantity of sewage to be treated is small. The financial capability, water pollution level in the region, constructability and cost efficiency based on topographic condition shall be considered before determining the system. Figure 2 shows as a typical illustration for comparing between combined sewer overflow and separated system [4].

As other optional solutions, constructed wetlands, and biorentation can be used for water quality improvement and hydrological mitigation of urban runoff. A bioretention system is a multifunctional landscaped area that provides for the retention of a design storm and for water-quality improvement. They contain a soil aggregate of three feet depth and are drained underneath by a layer of crushed stone with an optional drainpipe.

If shallow landscaped depressions are available in the study area, bioretention can be used by enhancing vegetation and filtration to remove pollution and reduce runoff downstream. The surface is vegetated and improves water quality through infiltration and evapotranspiration. Engineered bioretention areas are 0.6 to 1.2 meters deep, about one to four square meters and constructed with successive layers of gravel, sand and mulch, under the top garden planting. The typical illustration for bioretention area is shown in Figure 3 [12].

Figure 3: Typical Illustration for Bioretention Area

3.2. Pollution Control Measures for Reducing Sediment Load

From the water analysis for lakes, TSS and turbidity are found as over the acceptable limits. To reduce sediment load in the studied lakes, the soft engineering approach can be applied for both environmental friendly use and cheaper use.

The revegetation of river banks can lead to reduce sediment load as healthy riparian vegetation is effective in reducing bank erosion. Riparian vegetation will also filter sediment being transported in surface water runoff. Therefore, riparian forests can play an important role as natural sediment trap for surface water before it enters the water bodies (river and lakes). Besides, existing riparian vegetation is needed to maintain for the study area.

Soft engineering is designed to work with the natural environment and it creates areas like wetlands which are important for wildlife habitats. Soft engineering is cheaper and requires less time and money to maintain. Therefore, soft engineering can be one possible solution as suitable management strategy for the study area because it has a lower economic cost and environment impact. Figure 4 describes the typical form of soft engineering technique [9].

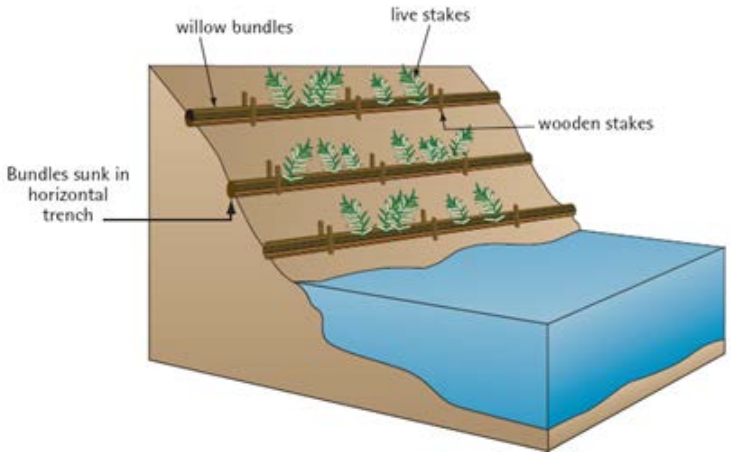

Figure 4: Typical Form of Soft Engineering Technique

3.3. Pollution Control Measures for Illegal Solid Wastes Site

The illegal solid waste open dump sites were found along the river bank of urban reach of Chindwin River and studied lakeside areas during the field investigation and questionnaire survey. The township development department is adopting systematic solid waste disposal system. This department is applying landfill through the processes of collecting such as door-to-door method by bell ringing and curbside collection and, transporting to final landfill site.

As long as people have been living in both illegal settlements and residential area, garbage or solid waste has been an issue as an illegal open dump along the urban river bank, lakeside and low lying areas. Also, business owners within the study area sometimes disposed their commercial waste unsystematically. Therefore, awareness and education program to those (households and business owners) should be done about how improper solid waste disposal can cause environmental and health hazards and, about how solid waste can be changed and used as a valuable resource. Solid waste management should be embraced by each and every household including the business owners in the study area.

For more effective waste management, integrated solid waste management can also be applied as a comprehensive waste prevention such as recycling, composting and, disposal programme that considers how to prevent, recycle, and manage waste in ways that most effectively protect human health and the environment.

3.4. Pollution Control Measures for Agricultural Waste

Crop farms according to season were present in some lakeside areas. Farmers used agricultural chemicals, pesticides and fertilizers to increase their yield production. As a result, water and soil pollution were caused due to leaving a lasting harmful chemicals. Based on water analysis from major lakes under the study, total phosphorus and total nitrogen were found considerable amount. So, long-term survivals of major ecosystems are threatened by the intensive use of pesticides.

For this pollution due to agricultural waste, the various lake restoration methods can be considered as possible solutions in two broad categories: (1) indirect methods, and (2) direct methods.

3.4.1. Indirect Methods

Essential guidelines for fertilization should be followed and, awareness, education and training program should be established to the peasants and farmers from the study area for water pollution control, healthy soil building and land management. The adoption of the "4R" approach (i.e., right time, right place, right rates and right source) should be used for fertilization management.

- Right Time: New fertilizer formulations may more closely tailor the timing of nutrient release to plant needs and potentially decrease phosphorus runoff. The loss of phosphorus in the runoff relates directly to the timing of applied phosphorus. Nitrogen and phosphorus can be reduced with an increase in the length of time between manure application and surface runoff.
- Right Place: Because of the relative immobility of phosphorus in soil, placement of phosphorus fertilizer is generally more critical for plant availability than that of nitrogen fertilizer. The incorporation of manure into soil profile, either by tillage or substance placement reduces the potential for phosphorus runoff.
- Right Rate: Fertilizer phosphorus rates are usually established by crop need and modified by the amount already in the soil, as determined by established soil "P" test methods. In the case of commercial phosphorus fertilizer, application can be tailored to match crop needs and minimize excessive soil phosphorus accumulation because of the economic incentive of advoiding applying too much costly fertilizers.
- Right Source: Fertilizer nutrients can be formulated to match crop needs; however, manures have more phosphorus than nitrogen compare to crop needs. As a result, applications of manure to meet crop nitrogen needs, apply three or four times more phosphorus than annual crop needs. Awareness of the range of nutrient formulations commercially available to farmers can help farmers tailor nitrogen, phosphorus and potassium additions to crop needs and to what is already in the soil and available for plant uptake.

3.4.2. Direct Methods

The direct methods involve either the treatment of the wastes before discharge into the lake (outside-lake methods) or direct intervention in the lake (in-lake methods). The following in-lake physical methods, in-lake chemical methods and in-lake biological method can be applied to improve lake water quality.

1. Mechanical Harvesting of Biomass: Harvesting of the biomass may be useful if the rate of removal by existing machinery can be improved, making it an economical alternative.

2. Lake Deepening or Dredging: Sediment removal for deepening shallow lakes may become necessary for restoring the lake to uses for which it was designed and built.

3. Admission of Unpolluted Waters (Dilution/Flushing): Admission of water or dilution results in lowering of nutrient concentration and a washout of algal cells, whereas flushing achieves only a washout of algal cells.

4. Lake Drawdown: Lake drawdown involves drainage of a lake through suitable outlet structures or through the use of high capacity pumps. Because the water content of the sediments is very high, about 90 percent on a volume basis for organic-rich sediments and a lesser value for the inorganic sediments, the drawdown considerably decrease sediment thickness.

5. Lake Bottom Sealing: Under anaerobic conditions, lake bottom sediments have been found to release nutrients to the lake water. To reduce or prevent this nutrient release, the sediment can be covered with plastic sheets, fly ash and iron-rich sand or clay.

6. Phosphorus Precipitation: This method involves successive applications of aluminum sulfate or alum to disrupt the internal phosphorus cycle.

7. Use of Algaecides and Herbicides: Chemical treatments can be used for control of nuisance algal blooms and dense growth of macrophytes. Copper sulfate has been widely used for control of blue-green algae. Use of herbicides is an effective method of controlling nuisance weed growths.

8. Species manipulation: Species manipulation is the main in-lake biological method for lake restoration. These biologic products can remove excess nutrients such as phosphorus and nitrogen. So, they can be used in studied lakes to manage and control the build-up of organic waste matter in lakes.

3.5. Pollution Control Measures for Industrial Waste

According to field investigation and questionnaire survey, most factories in Monywa industrial zone have been dumping their wastewater into nearby lake (Sarkyin Lake), causing health problems. A few factories have pre-treatment and primary treatment facilities. Especially, vermicelli factories are situated very near to the lake and these factories discharged their effluent directly into the lake without any treatment.

In the Monywa industrial zone, there are 68 factories which discharge wastewater. They are 22 numbers of vermicelli, 12 numbers of noodle mill, 20 numbers of tanneries, 10 numbers of textile mill and 4 numbers of

milk processing factories. According to secondary data which is collected from association of vermicelli, paper, leather and milk factory owners , the parameters such as TSS and COD of the waste water samples from all vermicelli, leather, paper and milk factories are significantly exceeded the acceptable limits. Therefore, on-site treatment plant should be developed as the best control measure. As for second alternative solution, the centralized wastewater treatment plant should be constructed to prevent pollution to the environment and soil pollution and, to improve lake water quality. Appropriate infrastructure and management plans are also required to protect water bodies. Thus, local authorities, factory owners and Monywa Industrial Zone Management Committee should cooperate.

The programmes which stimulate waste recycling and reuse should be developed and the appropriate technologies should be adopted. The public awareness programs should be done about how inadequate industrial wastewater disposal can cause environmental and health hazards. The factory owners should participate in training activities for industrial pollution control.

The government institution should promote voluntary environmental actions (such as environmental management and audit) by enterprises. Effluents from all factories and plants should be maintained wastewater standards based on the water pollution control law by such practices on the spot inspection. The legal, administrative and technical measures should be enforced. The actions for pollution control and environmental management should be developed in short term, middle term and long term. The regulation tools and activities on pollution control, such as EIA procedures and inspection should be utilized.

4. Conclusion

It is concluded that possible solutions for surface water pollution control in urban river and surface lakes in Monywa can be proposed for the improvement of water quality, aquatic ecosystems and, for prevention of public health problems to the people living downstream of urban Chindwin River.

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