A COMPREHENSIVE ACTION PLAN TO PROTECT SURFACE WATER IN BANGLADESH

Md. Khalequzzaman
Department of Geology & Physics, Lock Haven University of Pennsylvania, Lock Haven, PA 17745, USA. http://www.lhup.edu/~mkhalequ

Abstract
Water is one of the most abundant resources in Bangladesh. If managed properly, water resources can transform Bangladesh into a very resourceful nation. Unfortunately, the state of water quality in Bangladesh is extremely poor. Because of the lack of integrated water resources management plan, policies, active involvement by all stakeholders in decision making process, both the quality and quantity of water in Bangladesh have reached a very critical situation. The quality of surface water is critically degraded by untreated run-off, uncontrolled development, land-use practices, industrial wastes, untreated sewage, and agrochemicals. The government of Bangladesh needs a comprehensive water resources management plan to delineate the extent of degradation, as well as to improve the quality of surface water. In light of the surface water management plan that has been developed and practiced successfully in the US during the last three decades, the author proposes an action plan that is practical and beneficial for Bangladesh. The following is a list of activities that the government and the people of Bangladesh need to undertake in order to ensure the quality of surface water: (a) establishing a national surface water quality assessment program, (b) establishing a nationwide program to delineate the watershed boundaries, (c) implementation of a GIS-based inventory of point sources of pollution, (d) enforcement of a chemical discharge permit system for all industries that discharge their effluents into water bodies, (e) creating partnerships among stakeholders and the government, (f) promoting education on environmental issues at primary and secondary levels, and (g) implementation of stricter environmental laws.

Water is Life

Anyone who lives in Bangladesh must have heard the phrase "*panir opor nam jibon*", i.e. water is life. Other popular nationalistic slogans and songs that illustrate the importance of water and the inseparable link of our culture to water include "*tomar amar thikana - Padma-Meghna-Jamuna*", i.e. our address is the Padma-Meghna-Jamuna Rivers; and "*Ganga amar ma, Padma amar ma*", i.e. the Ganges is my mother, the Padma is my mother. Water is one of the most valuable and essential resources that humans need to sustain their livelihood. It is needless to say that without enough good water our survival will be threatened. Fortunately, we have plenty of both surface water and groundwater supply to support the entire population in Bangladesh. In fact, after human

resources, water is the most abundant resource in Bangladesh. If managed properly, water resources can transform Bangladesh into a very resourceful nation. Unfortunately, the state of water quality in Bangladesh is extremely poor. Because of the lack of water resources management plan, policies, and mechanism by which all stakeholders living in a (sub)watershed can participate in decision making processes, both the quality and quantity of water in Bangladesh have reached a very critical situation. According to a recent study, Bangladesh ranks 86th out of 142 countries in terms of Environmental Sustainability Index (Samuel-Johnson and Esty, 2002). The study is partly based on the quality of water in those countries. A great deal of information is now available about the arsenic and other sources of groundwater contamination. Now more than ever before we need to protect the quality of surface water as an alternative source of water for drinking, irrigation, industrial, and other beneficial uses. Moreover, surface water and groundwater are inter-related. The quality of groundwater can only be ensured through a better protection of surface water and recharge areas on the ground.

Surface Water and Watersheds

Surface water is a part of the hydrologic cycle, which illustrates the pathways of water movement through atmosphere, hydrosphere, and lithosphere. Major components of the hydrologic cycle include evapotranspiration, precipitation, run-off (part of precipitation that moves on land surface and flows into surface water bodies), and infiltration (groundwater). Land areas on both sides of a stream or river across which run-off gathers water before entering a common point is called watershed of that river or stream (Figure 1). Watersheds come in all sizes and shapes. Small watersheds (also called sub-watershed) are parts of a large watershed (also called drainage basin). Watersheds are like branches of a tree – small branches come together to form a big branch, and big branches meet with the stem. Delineation of watershed boundaries for streams and rivers of all hierarchical levels is an integral part of surface water quality study vis-à-vis land-use practices in a watershed.

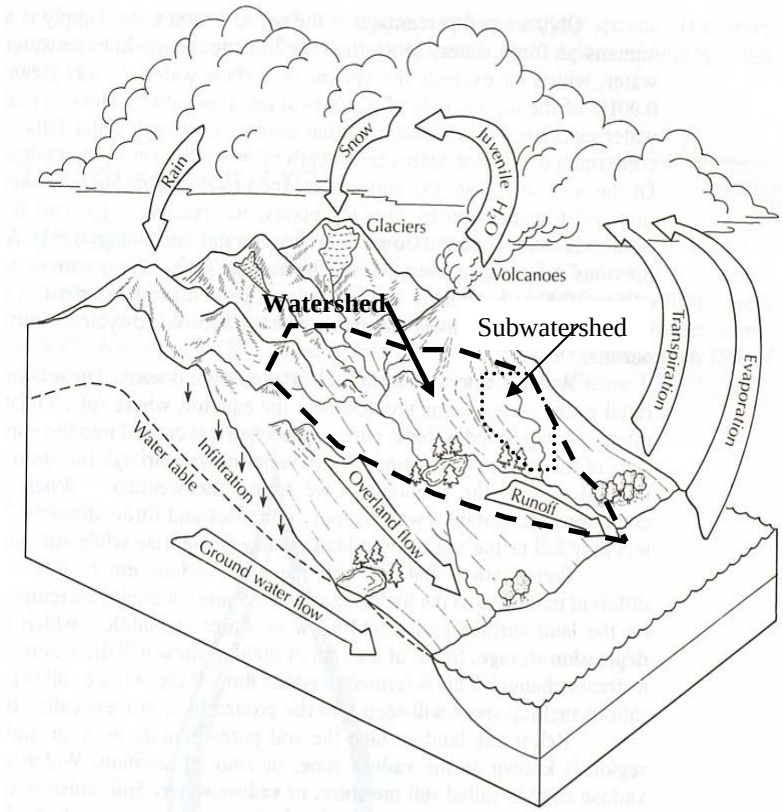

Figure 1: Diagram showing the hydrologic cycle, watershed, and subwatershed delineated by dashed lines (modified from Fetter, 2001).

Land-use and Quality of Water

Water quality in rivers and streams is controlled by land-use practices in watersheds. There is a common saying among environmental communities, "we all live downstream." For example, any land-disturbing activities (e.g. agriculture, forestry, and urbanization) in a watershed can generate loose sediments, part of which will be washed down in neighboring streams, increasing turbidity of water downstream. Similarly, part of fertilizers and pesticides used in a watershed will end up in a stream with run-off (termed as non-point sources of pollution). Also, industrial, sewage, medical, and household wastes are directly discharged in a river at a given point (termed as point sources of pollution), which degrade the quality of water downstream. Both point and non-point sources of pollution need to be identified, contained, and treated properly

in watersheds to maintain water quality in rivers and streams. At the present time, very limited data are available for surface water quality on watershed scale in Bangladesh (Anwar, 1993).

Water Quality Assessment Program

A National Surface Water Quality Assessment Program (NSWQAP) should be formed. One of the tasks of this program will be to delineate watershed boundaries of all creeks, streams, and rivers in the country. The NSWQAP will have to be multi-disciplinary in nature (Lindsey, Loper, and Hainly, 1997). For example, the Geological Survey of Bangladesh under the Ministry of Mineral Resources, Ministry of Agriculture and the Ministry of Water Resources, and the Ministry of Environment can jointly form such an entity. All point and non-point sources of pollution need to be identified and located on watershed maps. Depending on the hierarchical level (e.g. first order stream, second order stream, and major river, etc.), hydrological unit codes (like postal codes) or names can be assigned to those watersheds. Once named, the people living in a watershed will be able to identify themselves with a common natural boundary in their neighborhood. When the people can identify themselves with a watershed in which they live, through proper education, they will develop a sense of belonging. In turn, they will feel encouraged to protect the quality of water through Best Management Practices (BMPs) designed for various land-use activities (Ridge and Seif, 1997). The BMPs are series of activities and programs designed to maximize land-use by certain sectors (e.g. agriculture, forestry, urban planning, etc.) while safe guarding the environment. Since most of the watershed areas of major rivers lie outside the political boundary of Bangladesh, it will be necessary to reach agreement with upper riparian nations in order to successfully implement water quality improvement plans on a large drainage basin scale.

Beneficial Uses of Surface Water

The concerned authorities of the government (e.g. the Ministries of Environment, Water Resources, Agriculture, Mineral Resources, etc.) need to assign certain beneficial use(s) for each water body. Designated beneficial uses will include drinking (e.g. as an alternative source of drinking water in areas where groundwater is contaminated by arsenic), fishing, irrigation, swimming, navigation, etc. The designation process will have to ensure participation of the general public. Depending on the designated use, maximum contaminant levels (MCLs) for various water quality parameters (e.g. amount of chemicals and mircrobes present) will have to be established (Elder, Killman, and Koberstein, 1999). For example, if water from a given river is used for drinking then the number of coliform bacteria present in water will have to be zero, whereas the same water used for fishing can have up to 200 counts of bacteria per 100 milliliters of water (Georgia DNR, 1999). The government will have to

guarantee the quality of water for beneficial uses. Community-based watershed monitoring groups or other NGOs should have the provision to act as legal watchdogs. The citizen groups and other voluntary organizations will have the entitlement to notify the government authorities of any failure to compliance. Upon notification, the concerned authorities will have up to several months to fix the water quality problem, or else face lawsuits against them in the court. If found guilty of negligence, the government authorities will have to pay the people who experienced any damage due to the use of polluted water. The environmental courts can be in charge of such undertakings against polluters, or against the concerned government authorities that failed to enforce environmental laws. Only through such strong commitments the quality of surface water can be guaranteed. A similar framework exists in the United States.

Point Sources of Pollution

With proper policies, laws, acts, and stricter enforcement of laws, the point sources of pollution in a watershed can be controlled. An inventory of all toxic and hazardous chemicals that are produced, used, and discharged by every facility (industry, factory, workshop, laboratory, etc.) will have to be prepared for all watersheds in Bangladesh. The inventory will also include fact sheets explaining the health and environmental hazards associated with these chemicals. This information will have to be disseminated to the general public through public meetings, newspapers, education, Internet, and other mass media. Each facility that uses any chemical which has potentials for health and environmental hazards when introduced into water bodies, land, and/or air will need to have written permission to discharge a Total Maximum Daily Load (TMDL) of such substances after proper treatment. The amount permitted for discharge by each facility will be determined and controlled by concerned authorities based on research data on river flow characteristics, accumulated impacts of such chemicals on ecology and human health. A similar action plan was implemented by the United States of America through a program called National Pollution Discharge Elimination System (NPDES), which was an outgrowth of the Clean Water Act of 1972 and Safe Drinking Water Act of 1974 (Elder, Killman, and Koberstein, 1999). The amount of point sources of pollution in water is now very much under control in the US.

Non-point Sources of Pollution

Non-point sources of pollution include (but are not limited to): agricultural run-off, urban run-off, fertilizers, pesticides, acid rain, animal waste, raw sewage, septic tank leakage, household waste, etc. Since the sources of pollution is not known or identified, it becomes problematic to control their discharge into rivers and streams in a watershed. Proper sampling techniques and long-term monitoring of water quality at carefully selected locations can

help to delineate “the sources” of such diffuse pollution. The best way to control non-point sources of pollution, however, is through education, awareness building among citizens about possible sources of such pollution, and implementation of BMPs. In addition, forming alliances among all stakeholder groups in a watershed can help identify and reduce such pollutions. Financial incentive programs offered by government to stakeholders to offset the loss incurred by adopting BMPs in order to reduce sources of pollution. For example, reducing the amount of fertilizers and pesticides use may result in reduction of crop productions for farmers, which can be compensated by the government. However, if farmers are taught to apply the right amount of fertilizers and environmentally friendly pesticides in the crop fields, no loss in productions should take place.

Immediate Plans

The proposed National Surface Water Quality Assessment Program (NSWQAP) needs to take up some immediate measures to protect and improve the quality of surface water. The following is a list of activities and proposed plans of actions that need to be carried out to ensure quality of surface water: (a) the NSWQAP needs to take a plan to delineate watershed boundaries of all streams and rivers. Base maps showing drainage networks and roads that can be used to access various points along those rivers and streams need to be prepared at different scales. Various maps showing soil type, geology, land-use and land covers (agricultural lands, forestry, wetlands, urban areas, etc.), flood propensity and depth, and ecologically sensitive areas need to be prepared for each watershed; (b) the NSWQAP needs to identify all potential sources of pollution (e.g. landfills, tanneries, pulp industries, fertilizer industries, pharmaceuticals, electroplating workshop, soap industries, chemical industries, ceramic industries, textile industries, paint and dye shops, furniture manufacturing, underground storage tanks for petroleum, etc.), and geo-referenced them on base maps. The Geographic Information System (GIS) can be of great help in preparing various types of maps for each watershed; (c) the NSWQAP needs to establish baseline data on basic water quality in the entire country. Science teachers in high schools/colleges and students in science departments at universities (as well as any other groups of qualified people) can be trained within a very short amount of time about sampling procedures and analysis of water quality. The teachers can then act as coordinators or trainers to train others participants in the program. The university science teachers, scientific and research officers with NGOs, and other qualified persons can play a pivotal role in the water quality assessment program for nominal financial benefits or as volunteers. Once the volunteers or participants are prepared and equipped with basic sampling instruments, all major rivers and streams can be sampled on pre-determined days of certain times of the year to establish a “snapshot” of water quality nationwide (Pavine Watershed Alliance, 2000). Such information, when published, will have

tremendous value to researchers and/or planners in assessing impacts of point sources and non-point sources of pollution. If sampled several times a year over a long period of time, the trends in water quality parameters can be assessed in the context of seasonal, climatic, and land-use changes in different watersheds. The government will have to allocate budget on a priority basis to implement all phases of this project; (d) the government needs to establish mutually beneficial partnerships with various stakeholders (e.g. farmers, industrialists, fishermen, and any other groups of people who live in a watershed) and research institutions (e.g. colleges, universities, etc.) to facilitate understanding about water quality problems and to device plans of actions to solve those problems; (e) the government authorities need to develop manuals of Best Management Practices (BMPs) that are appropriate for agriculture, industry, poultry farms, urban development, forestry, and other sectors to reduce pollution generated by those sectors (Allen, 1999; Georgia SS&WCC, 1994); (f) the NSWQAP needs to determine TMDLs for various contaminants that should be permitted to discharge in the water bodies by both point sources and non-point sources of polluters (Georgia DNR, 2001). The amount of discharge from point sources of pollution will have to be controlled by NPDES program; (g) several locations along streams and rivers in each watershed need to be selected very carefully to collect and analyze water samples for the following parameters: pH (acidity), alkalinity, hardness, dissolved oxygen, biological oxygen demand, conductance, total dissolved solids, turbidity, total suspended solids, nitrate-nitrogen, ammonia, phosphate, chloride, sulfate, trace metals (lead, zinc, chromium, iron, copper, aluminum, arsenic, etc.), and coliform bacteria. The list of parameters to be studied should be modified depending on the specific situation and needs in a watershed and available resources.

Save the Water - Save the Nation:

No civilization can survive and thrive without clean water. We as a nation are fortunate to have plenty of this vital resource. However, the quality of this valuable resource is deteriorating very fast before our eyes. It is only through a better understanding of the sources of pollution and processes that affect the quality of water that we can save this precious resource for us and for our future generations. Understanding of a problem, however, is only half of the solution. Other half of the solution lies in communal actions. All of us can play a role in preserving the quality of water. We all need to join hands to protect this invaluable resource, as well as our very existence as a nation.

REFERENCES

Allen, J.F. (1999), *Georgia's Best Management Practices for Forestry*, Georgia Forestry Commission, 68 pages.

Anwar, J., (1993), *Bangladesh: The State of the Environment*, Coastal Area Resource Development and Management Association, 188 pages.

Association of State Drinking Water Administrators (1990), *The Regulation of Drinking Water under the Safe Drinking Water Act – Consumer Education Guide*, Arlington, Virginia, 12 pages.

Elder, D., Killman, G., and Koberstein, P. (1999), *The Clean Water Act: An Owner's Manual*, River Network, Portland, Oregon, 157 pages.

Fetter, C.W. (2001), *Applied Hydrogeology, 4th edition*, Prentice Hall, Upper Saddle River, NJ, 598 pages.

Georgia Department of Natural Resources (2002), *Total Maximum Daily Load Evaluation for Forty-one Stream Segments in the Ocmulgee River Basin for Sediment*, 25 pages.

Georgia Department of Natural Resources (1999), *Rules and Regulations for Water Quality Control*, Environmental Protection Division, Atlanta, Georgia, 110 pages.

Georgia State Soil & Water Conservation Commission, (1994), *Agricultural Best Management Practices for Protecting Water Quality in Georgia*, 35 pages.

Georgia State Soil & Water Conservation Commission, (1994), *Planning Consideration for Animal Waste System for protecting Water Quality in Georgia*, 12 pages.

Lindsey, B.D., Loper, C.A., and Hainly, R.A., (1997), *Nitrate in Groundwater and Stream Base Flow in the Lower Susquehanna River Basin, Pennsylvania and Maryland*, National Water-Quality assessment Program, Lemoyne, Pennsylvania, 78 pages.

Pavine Watershed Alliance (2000), *Building a Watershed Alliance, Decatur, Georgia*, 8 pages.

Ridge, T. and Seif, J.M., (1997), *Local Solutions to Pennsylvania's Pollution: Pennsylvania's Non-point Source Management Program,* Pennsylvania Department of Environmental Protection, Bureau of Watershed Conservation, 15 pages.

Samuel-Johnson, K. and Esty, D.C., (2002), *2002 Environmental Sustainability Index – An Initiatives of the Global Leaders of Tomorrow Environment Task Force*, World Economic Forum, Annual Meeting 2002, Yale Center for Environmental Law and Policy, and Center for International Earth Science Information Network, 86 pages.