History
Surface water
Groundwater
Management
Utilization
Review

Yangon
2019
Acknowledgments

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I am much obliged to my daughter for food and shelter in CA. The last big thank to my lovely spouse, Daw May. She allows and supports me with her care to write this book because I am living with Heart-Mate III. The Heart-Mate III machine in my body is boosting my heart blood circulation to live. It is an electrical device. That is a special micro machine under Medicare by heart special cardiologists from California Pacific Medical Centre (CPMC), San Francisco for my life.

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WATER RESOURCES, MYANMAR

FOREWORD

Myanmar (Burma) covers an area of 678,500 Square Kilometer (261,969 Sq. miles) is an agrarian country endowed with abundant water resources and has over 51.48 million inhabitants (2014 Census). Location of Myanmar (Burma) is Degree Minute Second (DMS) Latitude 23° 21' 11.3364'' N and Longitude 93° 33' 37.1160'' E in South East Asia is bordered by the Bay of Bengal, the Andaman Sea and the countries of Bangladesh, India, China, Laos, and Thailand. Water resources (surface and groundwater) are a valuable source for agriculture, hydropower, industries, household, municipal water supply, waterway transportation, and forest & environmental purposes for Nation.

The history of water resources has been largely dependent on the hydrological and geographical background. Civilization in Burma (Myanmar), about 3,500 years ago its inhabitants were used surface water for agriculture and household use. The development of historical water resources started from King Anawrahta, the Pagan dynasty. Groundwater was started using from Pyu dynasty, 8th century. Water resources have developed through the British colony period out to the present.

Glaciers and ice caps are the fascinating freshwater resource of nature. Glaciers and ice caps can be guessed/denoted far most northern part from Hkakabo Razi (highest point, 5,881 meters / 19,295ft) in Myanmar from satellite imagery; glacier might cover 10 – 15 Square Kilometer (4~6 Sq. miles).

There are many crisscrossed rivers. The most important rivers are the Irrawaddy, the Sittaung, Chindwin, Mekong and the Thanlwin (Salween) and the (59) tributaries are flowing into those main rivers. The rivers generally flow from north to south. But Myittar River, the one only, is flowing from South to North in Myanmar. Lakes, tanks, ponds, springs & falls, and dams are also considerable water resources. The total length of the four major rivers is 4654Km. The annual Surface-water capacity of eight rivers is 1081.885Km³ and the total catchment area is 737800Km². Water quality of rivers water and dams are monitored by the Hydrology Division of Irrigation department and Directorate of Water Resources and Improvement of River system (DWIR).

There 581 irrigation structures (dams, weir and so on) that are constructed on the rivers and tributaries nationwide as well as countryside and border to the neighborhood including 36 large hydropower potential dams (36 are constructed and 49 are planned). Pumps irrigable plants 208 are pumping rivers water for agriculture. Surface water resources are guided advised and control by authorized Engineers especially in irrigation structures and hydropower sectors. And Indawgyi, Inlay, Meiktila, Kandawgyi, and Inyar are famous lakes as surface water sources including Falls and Springs are usable water sources for society in Myanmar.
The Navigable length of Ayeyarwady River is 1534 Kilometer, Chindwin River is 730 Kilometer length, Thanlwin River and rivers in Mon state are 380 Kilometer, the rivers in Ayeyarwady Delta are 2404 Kilometer and Rivers in Rakhine State are 1602 Kilometer. The total length of Navigable Water Ways is 6650 Kilometer in Myanmar Territory. Most of the rivers and tributaries in the Delta area are intruded by seawater during seasonal flooding and getting salty water. Mostly rivers and tributaries in the part of the lower delta are facing the high tide and sea-level rise. Water quality is brine. Groundwater resources are available whether less or huge amount occurs in various parts of the nation, depend upon regional geology and hydrogeology, mostly in central Myanmar and lower Myanmar to the delta. Alluvium, Irrawaddy Formation, and Pegu Group are major aquifers and except Pegu Formation are as high yield discharge. Fissured & fractured rocks and Fault-zone are reasonable sources of groundwater in Shan high lands and Lime-stones as such as Mawlamyein Limestone and its equivalent have occurred groundwater in the eastern part of the nation and Tenintharyi area. Estimated groundwater potential is 495 Cubic Kilometer in Myanmar territory.

Total numbers of tube wells for agriculture are (23824) Tube wells and (1161) artesian wells are distributing by the Groundwater Division of Irrigation Water Utilization Management Department (IWUMD) and total agricultural beneficiary acre is (275094). In Myanmar, more than 60% of the Population is using groundwater for domestic use and industrial use. Besides, Groundwater is required for agriculture. The total number of wells drilled by two Departments (IWUMD and Department of Rural Development /DRD) for drinking water is (54777) wells and the beneficiary population are 26090806 (26.09 million people). As a keynote, more than half a million tube wells are considered to use countrywide. There is no national statistic of Groundwater & Wells.

Groundwater resources should depend on professional Hydro-geologists based on reliable hydrogeological and geological data and information. In Myanmar, there are no groundwater law and legislation is a big issue to control groundwater management until early 2019. There should be formulated groundwater legislation and regulation to mandate monitoring and technical & administrative management of Groundwater Resource in Nationwide. Unrestricted use of groundwater has resulted in over-exploitation and bad results, excessive to water level drawdown, reduced long-term availability to the community and water quality deterioration. Nowadays, Myanmar Groundwater management is (44) years behind Bangkok Groundwater management. Groundwater law in Myanmar is essential.

On the other side, Environmental impacts such as pollution by wastewater disposal of mines and quarries and contaminated by acid wastewater drained by industries and mines. Rivers and groundwater are affected by those pollution and contamination; an example of LetPaTaungTaung, Monywa. Surface water and groundwater qualities are deterioration.

Saltwater intrusion is steadily worsening both surface water and groundwater. It is happening at the new satellite towns closed to the marine estuary in Greater Yangon Region and Delta area (mostly in the lower and middle part).
Southwest monsoon is key to get low to high rainfall. Higher 508 mm (200 inches) to lower 100 mm (40 inches) per annum in Myanmar. Rainfall is the natural recharge to surface water and groundwater.

The total water resources potential of Myanmar is (1577) Km³. Total estimated utilization is 89% for the Agricultural sector, 6% for domestic and 5% for the industry. Water is an important resource. It is essential for the survival of human beings, economic development and the proper ecosystem for the Nation.

Technical management, administration, and Laws for water resources are still weak for both surface water and groundwater (detail in review chapter). Especially, groundwater is out of control by technical management, professional management, and law & regulation. Environmental impact, contamination, pollution and saltwater intrusion is worse mostly by wastewater from mining, industries and agricultural waste. It is obligatory to concern and preserves water.
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10. BIOGRAPHY (Author)
7. REVIEW

This book is the outcome of filed and management experiences and expertise in water resources (both surface water and groundwater) by the author and professional association and Government Departments over 20 years. The eight chapters in this book seriously deal with origin, occurrences, topography, geomorphology, geology, hydrogeology, climate and benefit.

Water Resources: The total water (statistics of internal or external, surface water or groundwater, measured or calculated) flow-in or flow-out does not mean that these actions are fully exploitable and available is called "Water resources". Water is renewable and is stored in any of the following reservoirs: the atmosphere, oceans, lakes, rivers, soils, glaciers, snowfields, and groundwater in the hydrologic circle.

Myanmar (Burma) is an agrarian country endowed with abundant water resources. Water resources (surface water and groundwater) meet the Nation’s needs for crop production and aquaculture requirements, agriculture, industries, hydropower generation, and public use. The rivers, lakes, wetlands, and coastal areas also provide a major mode of transport, as well as providing the environment for a wide range of aquatic species.

The total amount of the nation’s water resources utilized is only about ten to twelve percent or 90 million acre-feet (1Acre-foot = 1233.5Cubic meter = 325851US Gallon). The potential for further development of water resources in Myanmar is quite substantial. Surface water is ample for increased irrigation coverage and Groundwater resources are abundant for multi-use. More than 60-65% of groundwater is untapped.

Environmental point of view is water resources face a host of serious threats, all of which are caused primarily by human activity including sedimentation, pollution, contamination, climate change, deforestation, landscape changes, and urban growth.

7.1 Surface-water: Four Major Rivers [(Ayeyarwady, Chindwin, Salween River (Thanlwin) and Sittaung) and Ayeyarwady delta with 59 tributaries (Rivers), 581 dams and 208 river water pumps for agriculture, 36 smalls to large stations (dam) for hydropower and 69 spring water sources & 38 lakes] are available water resources. Rivers are essential for the transportation and agricultural sector; three million Acre of irrigable lands are economic sources for Nation.

Chindwin River is facing the worse impact that the quality of the water in the Chindwin River is critical to sustaining livelihoods and ecosystem services. Rapid economic development such as logging and mining in Chindwin Basin has resulted in significant changes to surface water and groundwater qualities, sedimentation, and turbidity of the water, socioeconomic and landscape conditions. Heavy metals such as lead and mercury were detected at Homalin and Monywa towns located near mining activities changes and declining water quality.
Ayeyarwaddy River is the lifeline of Myanmar. The water quality of the Ayeyarwaddy River has been in decline for many years. High levels of arsenic 30 ppb and cyanide 0.14 mg/L can be traced seasonally in the river. Siltation with the rate of 360 million tons annually ranking the third highest in the world (Robinson, 2007) especially from mining operations, the result of deforestation, and lack of soil protection or overexploitation of land. These activities are a major threat the rivers have been facing. The points lead to failure urgently with various critical issues that could be "a point of no return".

Ayeyarwady Delta also already demonstrates the first signs of significant changes (exploitation of the mangroves, overfishing, riverbank erosion and deterioration of water quality because of seawater intrusion). Lower delta is permanently seawater instructed and deteriorate the shallow groundwater aquifers also. Rivers are active with bank erosion, the emergence of sandbars progressively high. The river flow pattern is changing by climate changes and results make worse the river deterioration.

Many government agencies are responsible for monitoring and protecting the river but lack of coordination, incapacity, and minimal support do not help those agencies to reach the better status of rivers engineering.

The development of irrigable structures should be reconsidered to get an enhancement of river flow and not to get a negative impact on the environment; More dam more danger.

The negative impact of river pumps irrigation: Pump irrigation is possible to negatively impact the environment-damaging, river-water pumping stations, and waterway. Waterways are seasonally changing and the depth of the river water becomes shallow and Water Level is dropping in the rivers. Large Sand Dune Occurred at the Upstream of Ayeyarwaddy River near the Nattmaw Pump Station near Pyay and the Downstream of Ayeyarwaddy River near the Na Wa Day Bridge, Pyay, Semi-arid Area. The decrease in Water Level in the Ayeyarwaddy River affected insufficient water head to the river water pump. The supply pipes from pumps on the pontoon to high-level intake are choking with muddy sediment whilst the pump water supply was stopped after seasonal work. Before starting for the next agricultural season, it needs to clear the muddy sediment inside the pipes. The design should be changed not to worsen the rivers and the environment. This design is still using since the first pump water irrigation design that started general Ne Win’s ruling the country time.

The author’s suggestion is to pump-out the river water through tube-wells that installed vertically riverside at a firm location. Tube-wells should be the large diameter and drilling depth have to reach river bed level there water-bearing layer has occurred. Another way is Infiltration Gallery wells where suitable water-bearing sand layers
receiving high recharge and storage capacity are suitable for river banks. The design for river water pump irrigation should refer to geology, topography, and hydrogeology.

Other side, Rivers, their tributaries are facing water quality deterioration because of mining, industrial's disposal and bank erosion by the flood. Sedimentation and sand bars are an obstruction to navigate and river morphology is changing as long-term impact. Environmental conservation is essential and needs to speed-up by law.

7.2 Groundwater: Large volume of groundwater is stored in the aquifers defined as Alluvial, Irrawaddian, and Peguan. Recharge is predominantly from direct rainfall. The assessment of groundwater resources defined nine Groundwater Zones by further subdividing from Ayeyarwady Basin but groundwater storage and recharge are highly variable between the basins.

Nowadays, groundwater is highly contaminated and polluted by mining and industries, public waste disposal and fertilized agricultural drain water. Groundwater quality is deterioration in some places were closed to the rivers and coastal areas; mostly unconfined water-bearing layers have occurred.

There are two critical gaps in the management of groundwater in the Ayeyarwady Basin. [(A river basin is the portion of land drained by a river and its tributaries. It encompasses the entire land surface dissected and drained by many streams and creeks that flow downhill into one another; the river flows wholly within the territory of Myanmar. Its total drainage area is about 158,700 square miles (411,000 square km)].

The first is the paucity of basic data on groundwater status and use, the absence of systematic documentation of wells or extractions, and measurements of water levels and water quality countrywide. These data would provide the basis for establishing, monitoring, managing, and enforcing sustainable limits to groundwater extraction for each aquifer region and national groundwater quality standards to ensure that water is fit for purpose.

The second critical gap is the lack of any legislative or regulatory framework for groundwater management. Establishing a suitable institution and legislation for groundwater management is a priority in the Government of Myanmar’s National Water Policy. Groundwater storage capacity, reasonable recharges & discharge and groundwater budget is a key point for the groundwater industry. With improved information and institutions, there will be opportunities to use groundwater to support the expansion of agriculture, public use for drinking and other economic activities.

Municipal waste, mining waste, and industrial waste are increasing rapidly and the recycling system is less to control waste disposal by law in Myanmar. The leak from disposal sources flow to the low land area and or flow-into the rivers and streams that deteriorate the surface water and groundwater by filtration.
Adaptation to Climate Change for water resources should be as follows:

(a) To enhance the capabilities of the community to adopt climate-resilient technological options. One option is to increase water storage in various forms namely ponds, small and large reservoirs, rainwater harvesting for household use.

(b) Drip or sprinkler irrigation could enhance water use efficiency. Similarly, industrial water use should be made water-efficient and recycle water should be introduced and treatment plants are available.

(c) The criteria concerning new and old water resource structures need to re-work in view of likely to climate change.

(d) Many reservoirs under the Irrigation Department should be upgraded to optimize water uses to attain more storage capacity in dams/reservoirs.

(e) It needs to ensure that industrial effluents and other chemical residues should not be allowed to reach the groundwater table.

(f) The availability of water resources and its use need to be assessed at every five years interval.

(g) Climate change gives the sea level rising and saline intrusion. There is a sea-level rise in the delta and increased saline intrusion adversely impacting water resources and habitations, agriculture, infrastructure, and industry in such regions should precautionary by construction the reasonable high barriers to protect seawater rise and flood the potable water and land in the coastal region and delta area.

(h) Groundwater management should be active as soon as possible by law to control groundwater discharge and recharge.

The country has now reached a turning point in the use of water resources for all-round development. It is necessary to provide innovative and integrated solutions for the sustainable management of water resources to meet the country’s development.

In Myanmar, land, and water are managed by many different ministries, agencies and departments, at different levels (national, regional, and township). Coordination and collaboration between the different institutions and governance levels have to be improved, including the sharing of data and administrative management.

Our country should have the top surface water Management & Institution under the Government leading by the Minister level.

There should be TWO Departments;

(1) Surface Water Resources Management & Institution and
(2) Groundwater Resource Management & Institution
Currently, the National Water Resources Committee (NWRC) is the ceiling for political and policy for international relation of the water sector but the relation between NWRC and Departmental/organization are weak.

Our Country vision is" By the year 2030, the country will have attained sustainability of water resources to ensure sufficient water quantity of acceptable quality to meet the needs of the people of the country in terms of health, food security, economy, and the environment."
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Myint Thein, October 15, 2019.
Water resources

Water resources are sources of—usually freshwater that is useful, or potentially useful, to society; for domestic, agricultural, industrial, recreational, and public use. Examples include groundwater, rivers, lakes, ponds, waterfalls, springs, and reservoirs. All living things require water to grow.