CLIMATE CHANGE, SEA LEVEL RISING AND INCREASE OF TEMPERATURE THREAT TO GROUNDWATER AT COASTAL LOW LAND AND AYEYARWADY DELTA MYANMAR

Writer: Myint Thein (*)

1-Introduction

The greenhouse is present for two centuries. Greenhouse gases are necessary because without it the earth would be too cold to hold liquid water but limited. From those years the greenhouse gases called Carbon dioxide effect has increased in concentration by about 50%. That is boosting to change climate “Climate Changes”. Climate change has profound impacts on the earth’s resources and the environment in onshore as well as offshore. Here one of the earth’s resources is Groundwater that is threading by climate change. In Myanmar, Groundwater in coastal areas and delta area closed to the sea are starts facing that effect. Of that sea level rising by ice, glaciers melting are causing the greatest sign of seawater intrusion to Groundwater at Ayeyarwaddy delta area in Myanmar, mostly in the lower part of widening delta area. And impacts of climate change on Groundwater are slower than others such as surface water but permanently worsen the groundwater by depletion and degradation. Climate changes are linking with sea level rising, saltwater intrusion, increasing temperature, precipitation and recharge to groundwater. These points are threatening to Groundwater in the long-term. According to the Global Climate Risk Index, Myanmar is the second most vulnerable in the world to the impacts of climate change from 1993 to 2014 (Kreft et al., 2014).

2- Ayeyarwady Delta and Coastal Region

The Ayeyarwady Delta fans out from the limit of tidal influence at Myanmar to the Bay of Bengal and the Andaman Sea.

The low land (Alluvial plain) of Delta is as low as just 3 meters above sea level. Length of the coastal of the lower seaward third of the delta is completely flat with no local relief and stretches for 130 kilometers from east to west. The sea is very shallow with depths less than 5.5 m across the coastline. Deforestation has changed the landscape. As a result of constant accretion into the sea, the delta is advancing year by year. One scientific study estimated that the Delta lost 1,685 km² (651 mi²) from 1978 to 2011.

The areas of the Ayeyarwady Delta region are low-level land (at or less than 7 m above mean sea level)[Shown in figure-below]. The 6.2 million populations live on farming and fishing communities could be affected by the flooding due to climate change and sea level rise. Myanmar is its 2,832 km coastline faces the Bay of Bengal in the west and the Andaman Sea in the south. Many sandy beaches along with the coastal areas of Myanmar already face problems of coastal erosion. The mangrove forests degradation due to climate change, sea level rising and seawater penetration. That is an indirectly
loss of the valuable fresh groundwater. On the other side, the Myeik Archipelago on the west coast, a beautiful island group comprising more than 800 islands that one fourth could be flooded and submerged after 2050.

The estimated 0.5-meter rise, which is predicted to occur by 2100, could result in the Ayeyarwady Delta shoreline advancing by 10 km.

3 - Groundwater in Ayeyarwady Delta

The Ayeyarwady Delta is part of the Tertiary Inner Burman Basin. The two major aquifer systems are available in the Ayeyarwady Delta are the Alluvium and Irrawaddy Formation with a shallow watertable. It contains some unconfined, semi-confined, and confined aquifers of different thickness in different areas. Shallow lenses of freshwater locally found above brackish groundwater. The salinity of groundwater is caused by seawater intrusion in the Ayeyarwady Delta. 60% of households just use groundwater for drinking and domestic water supplies in the Delta. Depend upon varies geography, groundwater use is high (more than 80%) in townships of the upper parts of the delta in Hinthada and Tharawaddy districts. And much lower (less than 20%) in the lower delta in townships of Pyapon and Labutta districts. Estimated numbers of tube wells within 5000 and 7500 are in the Ayeyarwady Region. In the south, close to the sea, variation in groundwater salinity is likely to impact the ecosystem. Mangrove forests are considered a very high-value ecosystem. Mangroves are closely related to groundwater systems (recharge and discharge). But now mangrove forests are deforesting and it could be more seawater intrusion into the groundwater without buffer. Deep tube well should be introduced reference to the oil exploration well’s logs to get potable groundwater for long life safely.

Author estimate the depth should be minimum 3000ft to maximum 5000ft.

4 - Climate Change relates to Groundwater

Myanmar climate is influenced by the tropical southwest and northeast monsoons receiving about 5,000 mm of annual rainfall. The frequency of cyclones and accompanying strong winds, storm surge, floods or inundation, intense rains, extreme temperatures, droughts, and sea-level rise are evidence of climate change-related impacts water resources in Delta, Myanmar.

During the last four decades, Myanmar had five major cyclones: Sittwe in 1968, Pathein in 1975, Gwa in 1982, Maungdaw in 1994, Cyclone in 2006 and Nargis in 2008. These effects are still suffering along with coastal and delta areas. Those severe climate changes have been affected not only surface water but the groundwater system also.

The most noticeable impacts of climate change could be not only fluctuations in surface water levels and quality but the pressure indirectly on groundwater. So, climate change is expected to modify the hydrological cycle and affect water resources. Groundwater is a critical source of fresh drinking water. Climate change effects on groundwater resources are, therefore, closely linked to population growth, urbanization and land-use change. Groundwater resources are related to climate change through the direct interaction with surface water resources, such as lakes and rivers, and indirectly through the groundwater system. Tube wells were abandoning.

Climate change affects groundwater is more complicated and less understood. The major long-term climate variables such as air temperature, precipitation, and evapotranspiration are threatening
groundwater process. Direct impacts of climate change on groundwater recharge, discharge (Increased groundwater abstraction), storage, saltwater intrusion.

5 - The effect of temperature change relate to Groundwater

Coastal and delta regions have an average maximum temperature of 32°C increased by 0.23°C per decade. A daily maximum temperature increased by 0.4°C per decade happened between 1981 and 2010 that the Department of Meteorology and Hydrology (DMH, 2016) of Myanmar describes. These rates are comparable to global averages for the same time frame (IPCC, 2014). Mean temperature from 26.6°C to 27.7°C between 1972 and 2014 in Myanmar and this is on track to increase by another 1 to 4 degrees by 2100.

The annual average temperature of Myanmar is predicted to increase by 1.3°C to 2.7°C above the historical level by the middle of the century. It could be dry seasons have become longer with shorter rainy seasons. In Ayeyarwady Delta, change in climatic variables can significantly alter groundwater recharge rates because groundwater aquifers are recharged mainly by rainfall but control by temperature through interaction with surface water bodies. Temperature affects groundwater systems by reducing the amount of water available for groundwater recharge. That means threat groundwater not only quantity but quality also. Temperature is higher the surface water that rainwater more evaporated so, the amount of recharge for Groundwater is lesser.

By the end of the century, Global mean surface temperature could increase by 1°C to 4.5°C and Myanmar also could be as same increase as same.

6 - The effect of Precipitation changes that relate to Groundwater

Annual rainfall in the delta region is approximately 2,500 mm (100 in). Precipitation patterns now are changing. There may be more intense rainfall on rainy days, resulting in floods and more dry days in a year, causing drought. The late onset and early withdrawal of the monsoon period will result in large quantities of rain falling over short periods. This will result in flooding, contamination of water resources, erosion and limited replenishment of waterways. Furthermore, changes in river flow and discharge will increase the risk of flash floods as well as decrease groundwater recharge. Nowadays the Ayeyarwady River and delta are facing this problem. Conversely, increases in drought events will increase the pressures on groundwater utilization.

The rate of snow and glacial melt is expected to increase, resulting in changing river flows and unpredictable flooding events. The groundwater system is affected.

7- Parched soil and vegetation that relate to Groundwater

This water may reach the aquifer slowly by infiltrating through soils and permeable fractured rocks overlying the aquifer. Encroaching seawater and increased salinity in groundwater is causing much of the water supply and soil to become too salty to grow crops. Surface water also enters the soil and groundwater more or less is depending upon soil type and aquifer type. Sandy soil and unconfined aquifer received more water than clayey soil and confined aquifer. But all of the surface water is not infiltrated. Some are evaporated and some are run off into the rivers and sea.

Subsurface waters in the vadose zone and groundwater might respond to the
soil and vegetation with climate change. It is complex interactions between soil condition, vegetation, and surface water but the net effect of vegetation loss and soil parching on groundwater recharge is unknown.

8- Sea water Level rising and seawater intrusion that relates to Groundwater

Sea level rising is because of thermal expansion, melting glaciers and melting ice sheets. The impact of sea level rising is (1) Low land along coastal and delta can be flooded and (2) Entire ecosystems, such as the mangroves can be wiped out. Ice and glacier in the northern region are melting have been increased since the 1970s. Global sea level rose about 17 centimeters during the 20th century.

Projections of sea level rise along with Myanmar’s coast range from 5cm to 13cm by 2020 and 20 to 41 centimeters by the 2050s concerning some sources. Projections for the 2080s, ranging from 37 to 83cm, and they could rise as high as 122 cm (Horton et al. 2016). Mean sea level has risen globally by 25 cm (1 - 2.5 mm/yr) on average over the last century (IPCC, 2001). Based on the International Panel on Climate Change’s (IPCC) estimates, sea level could rise by another 50 cm (5 mm/yr.) by 2100. Rising sea levels, however, will lead to saltwater intrusion into groundwater that particularly vulnerable to saline intrusion during the dry season as a result of low water volumes in river systems in Delta Myanmar.

Sea level rise is one of the most pressing concerns for the coastal area, particularly the Ayeyarwady Delta region. Freshwater resources in the coastal areas are mainly the impounded water in ponds and reservoirs and groundwater.

If sea level rises by 0.5 meters, the shoreline on the Ayeyarwady Delta would move inland by 10 kilometers, with significant impact on local communities, agriculture, and potable water resources.

9- Conclusion

Groundwater discharge, storage, saltwater intrusion, biogeochemical reactions, and chemical fate and transport may be modified by climate change, sea level rising and potential effects on the quantity and quality of groundwater. Coastal flooding is one of the most important impacts associated with rising sea levels. A major study shows the
avoided damage costs by investing in infrastructure adaptation, i.e. dikes and sea walls, to maintain present-day standards. Increase the dyke height is required to achieve an adaptation strategy. That is maintaining relative risk. Source: Hallegatte et al. For Ayeyarwady delta, dyke height should be more higher than seal level rise with periods such as years (2030), (2050) and (2070).

In the short term, the increased melting of glaciers can cause floods. In the long term, glaciers will disappear causing rivers to dry up and droughts to occur. Groundwater, a major component of the available water resources could be affected. Of these, the effects of rising sea level have some of the greatest potentials for causing widespread devastation in Ayeyarwady delta.

Other effects of global warmings may also worsen the impact of sea level rise. These are variable precipitation, more frequent droughts, and floods, and shrinking of the glaciers that supply freshwater to river deltas.

To control and reduce vulnerability to climate change, policies, legislation, and other supporting tools need to be developed by government agencies in a coordinated manner.

Myanmar continues to undergo a political and economic transformation that include the development of the energy and industry sectors, urban areas, and agricultural production. But the sustainability of its new enterprises has increasingly come into question, not to mention their environmental impact. Myanmar is combined with its geographical location sandwiched between two of the world's largest polluters, China and India. Myanmar was recently called the second most vulnerable in the world to the impacts of climate change. Myanmar continues to perform badly in the global Environmental Performance Index (EPI) with an overall ranking of 153 out of 180 countries in 2016.

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