

Preliminary Investigation of Water Level Fluctuation in Yemyet In

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Abstract

Wetlands are among the world's most productive environments. Meanwhile, they are also the most threatened ecosystems in the world. Yemyet In is located in Sagaing Township, also an important wetland and natural resource for its surrounding area in the Dry Zone area of Myanmar. There has an area of 28.5 square miles (18240 acres) in the period of flood and 23.15 square miles (14813 acres) in that of normal. Small changes in precipitation and stream inflows strongly affect the extent of the lake surface area. For times when there are no satellite images, it is difficult to determine the extent of the lake from observations. Water balance computations were performed to create a water-level series for Yemyet In extending back in time. The water-balance computations confirm the crude local people knowledge about historical lake status. It is found that if the average monthly precipitation is less than 2.45 feet during the wet season around Yemyet In, there is a risk that this shallow lake dries out in the dry season. This paper also conducts the fluctuation patterns of water level and processes of fluctuation from the perspective of physical condition and human activities.

Key words: Sagaing Township, Yemyet In, water balance computing, lake level

Introduction

Background

Generally, lake is a large body of inland water, to which streams and rivers are coming in or from which streams and rivers are going out (Hla Tun Aung, 2003). Lakes are highly valued for their recreational, aesthetic and

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scenic qualities, and the water they contain is one of the most treasured of our natural resources. Lakes constitute important habitats and food resources for a diverse array of fish, aquatic life, and wildlife, but lake ecosystems are fragile. Lake ecosystems can undergo rapid environmental changes, often leading to significant declines in their aesthetic, recreational, and aquatic ecosystem functions. Exposed to external effects from the atmosphere, their watersheds, and ground water, lakes are subject to change through time. Human activities can further accelerate the rates of change. If the causes of the changes are known, however, human intervention (lake-management practices) sometimes can control, or even reverse, detrimental changes. Wide fluctuations in stage (lake level) can create major hardships for lakeside residences, marinas, and businesses, and they also may impair the habitat suitability for nearshore biota. These changes most commonly are linked to weather anomalies (extended periods of abnormally high or low precipitation), but also may be associated with human activities such as withdrawals for water use.

There are several lakes in Myanmar and some of them take an important role in the processes of local and regional development. Yemyet In is situated in the Sagaing Township, within the Sagaing Division of the Union of Myanmar (Figure 1). It lies (9) miles north of Sagaing city. Yemyet In is a pan shaped depression between the Sagaing range and Shwetaunggon range. The longest length from north to south is about (9) miles and east to west is about (5) miles. During the highest flood period of the rainy season, the length of the lake from north to south is about (14) miles. It is one of the natural lakes which is moderately wide in Sagaing Division.

Fluctuations in water levels have occurred in the Yemyet In since that was formed. They are the result of several natural factors and in recent time have also been influenced by human activities. The primary natural factors affecting lake levels include precipitation on the lakes, run-off from the drainage basin, evaporation from the lake surface, inflow from upstream lakes, and outflow to downstream lakes. Human factors that also affect the water levels include diversions into or out of the drainage basin, consumption of water, dredging of outlet channels and the regulation of outflows.

There are three types of water level fluctuations on the Yemyet In: long-term (multi-year), seasonal (one-year) and short-period (less than an hour to several days). The long-term fluctuation in Yemyet In water levels result from persistent low or high water supplies. The seasonal fluctuation in In levels reflect the annual hydrologic cycle which is characterized by high water

supplies to the lakes during the rainy season and lower supplies during the remainder of the year. Short-period fluctuations, lasting from less than an hour to several days, are caused by meteorological conditions. The effect of wind and differences in barometric pressure over the lake surface create temporary imbalances in the water level at various locations.

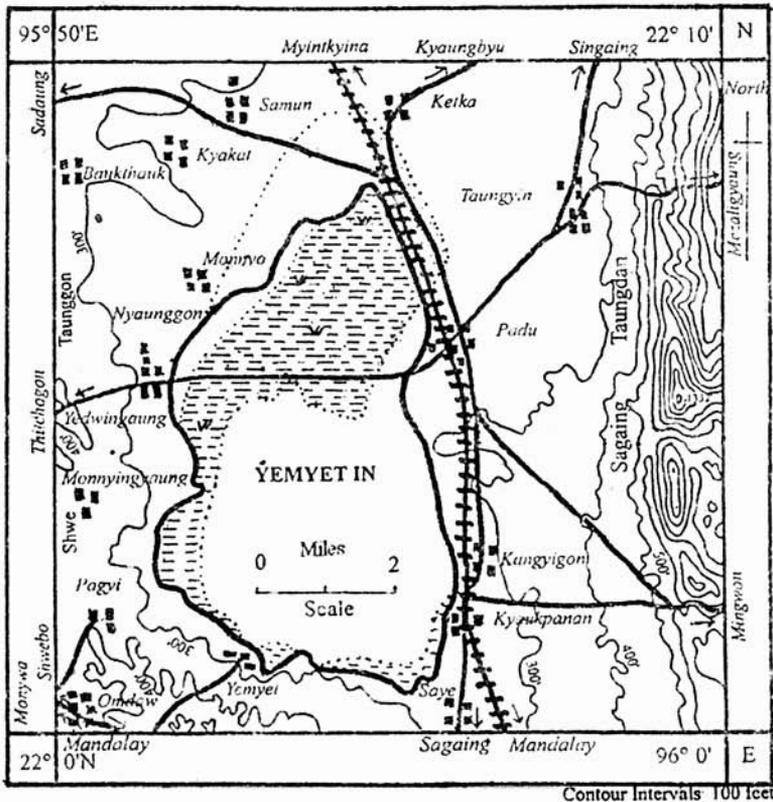


Figure 1. The location map of Yemyet In in Sagaing Township.

Source: U San Myint (2004)

The main objective of this study is to describe water level fluctuations of Yemyet In area in accordance with the amount of rainfall. There are seven streams of salty water from north, west and south direction and eleven streams of fresh water from west, north and east flow into Yemyet In. Most of the streams are narrow and shallow. In some years it is filled with water the whole year round. However some years experience low water level. But in least

rainfall or drought years, this lake is completely dried up. If the area receives heavy rainfall, it will be filled with water.

Previous Investigation

The preliminary investigations were based on local needs reference of Yemyet In in 2004 and other literature reviews. In that investigation there was no evidence about water level fluctuation. In this study work, investigation to water level fluctuation in Yemyet In was made on collected rainfall data of surrounding areas and on the questionnaires of villagers in Padu, Yemyet and Yedwinkaung Villages of Sagaing Township during field period.

Problem

Yemyet In is formed by the rift-valley fault and a pan shaped depression. So, it has water-level fluctuation in associated with yearly rainfall in this study area. Consequently there have water level changes and economic problems for fishermen, farmers and others who rely on it. In this research observed to determine:

- (1) How did the water level fluctuates over past years?
- (2) Are there any relationship between landform, climate and water level fluctuation?
- (3) Is there a relation between human activities and water level fluctuation?

Data and Methods

Primary data were entirely collected from structured interview record. Secondary data especially rainfall data were collected from Sagaing Township Peace and Development Council and another Departments as Myanmar Agriculture Enterprise. Especially, situation about water level changes, how to affect human activities and physical conditions on water level fluctuation areas were collected from the interview record. In this research work, data analysis were made on field observations collected from three villages, Padu, Yemyet and Yedwinkaung and on rainfall data from rainfall stations at study area. For Within the period of field observations, the data were collected from

fishermen, business men, some native people and the peasants, respectively. To become reliable facts and figures, rainfall data were compared with land reforms management years in Yemyet In area.

Origin of Lake

According to the local believes the origin of the lake derived from over-respective nature of local people upon national hero and spirits. With regard to origin of Yemyet In, the most possible reason is that was formed by the Earth's crust movement with subsidence and uplifting that occurred along an active Sagaing Fault. Subsidence is lowering of land surface and uplift is rising of land surface as Shwetaung Hill on the west and Phokaung Hill on the east. It also may be new land lake as the uplifting of marine sediments because its form is large and shallow. Change in land surface elevation can create lakes. Shwetaung Hill (West) and Phokaung Hill (South) are composed with young sand stone layer. However, it is important to emphasize that, geologically, lakes are temporary and form rapidly and decay quickly. Because most of the Earth's land surface is dominated by fluvial erosion, lakes that do occur are threatened with either capture and draining by expanding tributaries or infilling of sediment until the lake becomes extinct. The origin and some distinct characteristics of tectonic lake formation are comparable to that of the Yemyet In. In addition, the displacement of Sagaing Fault reveals the major tectonic movement in Myanmar and it can be traced from the research works of Myint Thein, 2004. He said "it is now know that the right-lateral displacement along Sagaing Fault is due to a spreading centre developed under the Andaman Sea from Middle Miocene (11 million years) onwards. Myint Thein et al 1991, based on their field work made during 1976 through 1981, estimated that the total displacement of the Sagaing Fault had been 126.14 miles (203 km) at an average of 0.79 inches (2 cm)/year."

Changes of Water Level

Water level fluctuation pattern of the study area, Yemyet In, is analysed from two types of data: primary and secondary. Primary data collected by structured interview method can give a clue to the cycle of fluctuation. According to the interview with local people, there are three types of water level fluctuations on the Yemyet In: long-term (multi-year), seasonal

(one-year) and short-period (less than an hour to several days). In those fluctuations, short-period is needed to calibrate to know more detail.

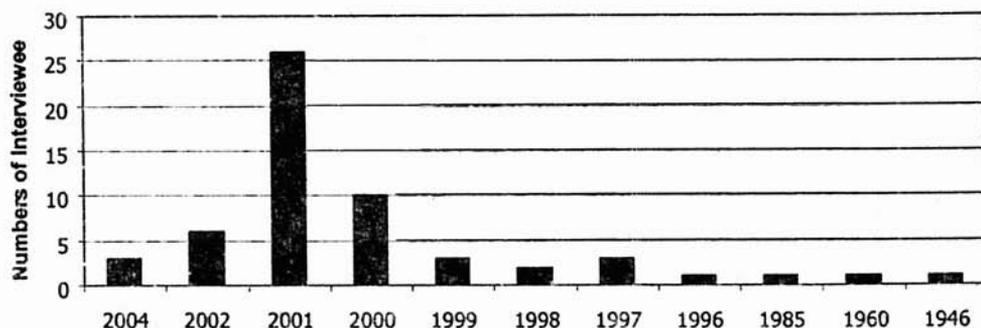


Figure 2. Experienced drought year in Yemyet In area based on local people.

Source: Interviewed data in 2006

Most of the local people experienced the drought year in 2001 as very recent event. Some people thought until beginning of the year 2002. In some area as Yedwingaug or most shallow lake area have experienced from end of 2000. So we can assumed year 2001 was almost drought and can be expected 2000 to 2002 was long-term (multi-year) fluctuation. In 1997, that was also shown there have experienced a period of drought (Figure 2).

Most people faced the lowest level in March. Some are in February and April. Similar as lowest level, most people faced high water level in September and some faced in July and August. There was also indicated the seasonal water level fluctuation in Yemyet In (Figure 3).

On the other hand, secondary data from three stations are useful to estimate the numbers of year which experience drought, flood, high water and low water respectively. The amount of rainfall is actually a major determinant for water fluctuation of the study area. Therefore, rainfall data from three stations Padu, Taeinte, and Ohntaw are firstly analysed.

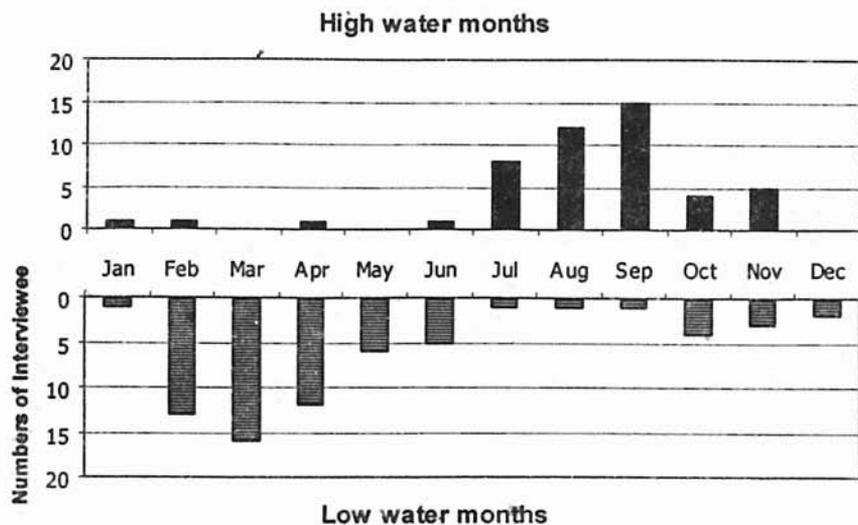


Figure 3. Local people experienced the water fluctuation as seasonal changes. (Source: Interviewed data in 2006.)

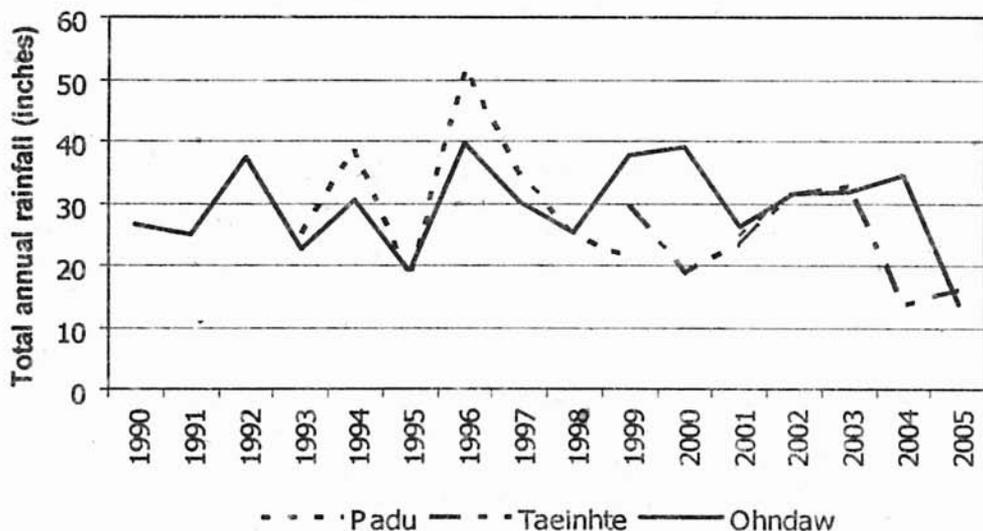


Figure 4. Spatial and temporal differences of rainfall around Yemyet In area.

Source: Padu, Taeinhte and Ohndaw rainfall stations of Myanma Agriculture Service

Water level of Yemyet In was fluctuated with the amount of rainfall from different years. From 1990 to 2005 in rainfall data, water level in Yemyet In can be observed as flooded years, the years of low water levels and completely dry years (Figure 4). In the years of 1990 and 1991, the amount of rainfall received 25.56 inches and 26.07 inches respectively and the water level had very low. In these years, most of the In areas were dried up and land reformations on agriculture were managed by government in the dry land areas. In the periods between 1992 and 1994, the rainfall had more higher than last years and water level increased. In 1995, the rainfall was 17.82 inches. In this year, the area experienced very low water and completely dried up. In the period between 1996 and 2004, the amount of rainfall had been changed and the water level had also fluctuated with three years cycle. During the years of 1996, 1997 and 1998, the rainfalls increased and the most areas of Yemyet In were submerged. During the years of 1999, 2000 and 2001, the rainfall decreased and it had very low water levels and nearly all areas gradually dried up. As a consequence, agricultural land reforms and ponds for fish breeding were managed by Mandalay City Development Committee (MCDC) in these years. During the years of 2002, 2003 and 2004, the rainfall had more higher than former years and the most areas were also submerged. At 2005, the amount of rainfall had 13.89 inches and it was a year of least rainfall. So, Yemyet In area had completely dried up in January of 2006, the period of field observation.

Relationship between Landform, Climate and Water Level Fluctuation

Nearly all of surface configurations, except man-made features, are originally controlled by geologic structure. At the same way general landscape of the study area is under control of its geologic setting.

Seeps and springs can only be seen on the western and south-western low hills of the study area especially near Yemyet, Yedwangaung and Bagyi villages. Due to its geologic structure, they flow its origin to Yemyet In all the year round forming as the small perennial streams. Although they are small in number, they can fulfill some amount of ground water all the year round. Ground water sources can be divided into two: one is under lake bed and the other is under its environment. Being an inland water drainage, ground water is mostly saturated and it can support to water storage capacity. If the other things being equal, ground water from close environment of the study area

will seepage into the lake and it will take a greater role in water saturation process and water storage capacity.

The form of Yemyet In is large and shallow. It is favour to fill water rapidly when the heavy rain in short time and evenly get around Yemyet In area. Then it can be dried rapidly when the dry season with high evaporation.

The amount of rainfall is the most important source of water. According to the topographic control, the area receives different amount of water from the same amount of rainfall. In general, the study area and its environ receives the average annual rainfall of about (30) inches. Although the area lies in Sagaing Township as an administrative unit, its topographic features that govern the flow of rain water are greatly. Therefore, to get more accurate data, the amount of rainfall should be calculated and estimated from that of inner concentric area and outer marginal area.

Due to its topographic favour, the northern area is more flatten and more open than the others and it receives the largest amount of rain water as the great surface runoff. If we compare the remaining three sides of the area, southern and western low hills expose more closely to the Yemyet In. Therefore, rain water on these low hills flows to the lake as a rapid runoff. On the other hand, the eastern low range of Minwun stands about (3) miles east of the lake. The land between the lake and the range is mainly utilized for intensive agriculture. In this way, after rain, water on maximum range can not flow directly towards the lake as the great runoff. Instead of runoff, much of water infiltrates to the ground and finally reaches the lake as the ground water. In fact, inflowing rain water is comparatively lesser in amount and they flow into the lake during short period of rain and after rain.

Streams by referring the previous investigation (San Myint, 2004), it is known that the area receives water from (18) small streams. Of these streams (11) streams are fresh water and the rest are of saline. Saline water streams originated from fresh water seeps and streams. When they flow across the alkalinized surface, due to chemical reaction, the water becomes salty and then enters the lake as the alkalinized water. Being taking its source from seeps and springs, the saline water streams are flow into the lake all the year round. In contrast, fresh water streams are of intermittent and they are usually filled with water during rain days.

With the exception of southern and western areas, drainage pattern of the remaining areas were somewhat altered by some man-made features such

as the establishment of settlement area, land reclamation to agriculture, and construction of roads, railway and irrigation canals. Water capacity of the area, apart from rainfall, is mainly controlled by the drainage pattern of northern area. At the present time the study area receives water from the northern parts with six distinct water courses and they are Letswutkya C., Kyakhat C., Segyi C. (saline), Chauklonpyon C., Yonpyon C. and Taungyin C. They are especially filled with water during rain days.

From the western lowhills for major streams flowing into the lake and they Shwetaung C., Thapye C., Alla C., and Shweku C. Of these streams Alla and Shweku are saline. On the southern low hill, four major streams also flowing into the lake and they are Ze C., Yemyet C., Phokaung C. and Ngalet C. They are all saline streams. On the eastern low range all are fresh water streams and those of prominent ones are Yinkwegyi C., Tada C., Kyikone C. and Paunglong C. In addition to above mentioned streams, the remaining ones are too small to be taken into account its capacity.

Rate of surface runoff is influenced by the extent of infiltration into the subsurface, is controlled by the soil type. Around the Yemyet In area, we found the soil types are Vertisols ('Sanei Myay'), Acrisols ('Myay Ni'), Nitosol (Mye Wa The` Wun), and Luvisols (Mye Ni The` Wun). Within the heavy rainfall, those soil type can infiltrate and runoff to the Yemyet In rapidly.

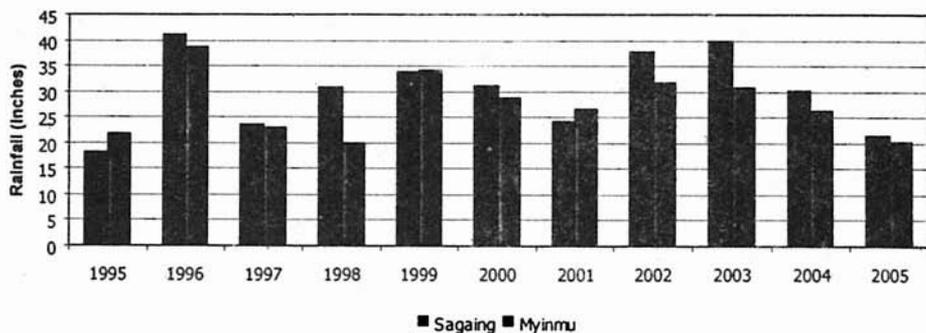


Figure 5. Annual rainfall of Sagaing and Myinmu Township in 1990-2005.

Source: Department of Meteorology and Hydrology of Sagaing

In annual rainfall of Sagaing and Myinmu Township in (1995-2005), according to Department of Meteorology and Hydrology of Sagaing, normal annual precipitation is 33.82 inches in Sagaing and 29.49 inches in Myinmu.

Here we can assume the year of under 25 inches may be drought as in the place is located in Dry Zone. So, in 1995, 1997, 2001 and 2005 were faced as drought year in those areas as meteorological fluctuation (Figure 5).

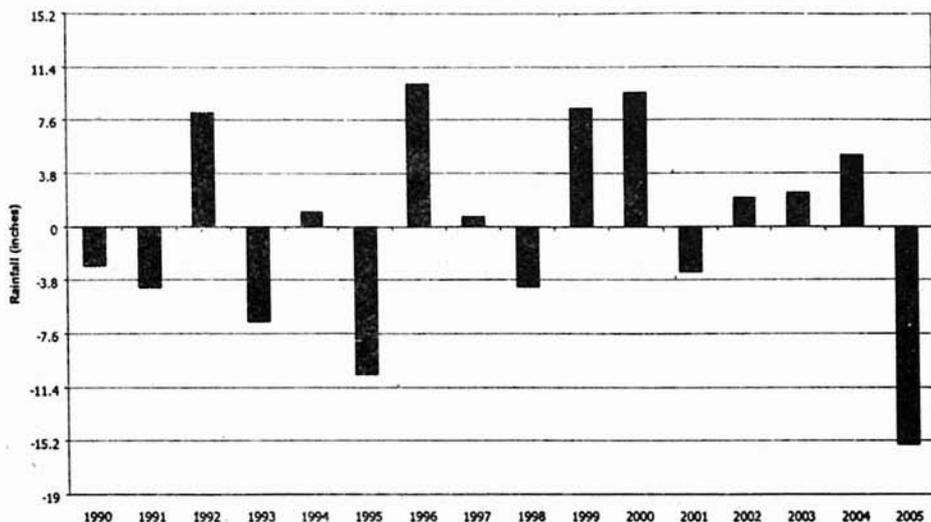


Figure 6. Departure of rainfall from normal at Ohndaw Village from 1990 to 2005.

Source: Myanma Agriculture Service, Ohndaw Village

The figure 6 shows the departure of rainfall from normal rainfall of 2.45 in inches in rainy season at Ohndaw village from 1990 to 2005. That is indicate the average monthly precipitation is less than 2.45 inches during the rainy season around Yemyet In, there is a risk that this shallow lake dries out in the dry season. Therefore, 1990-1991, 1997-1998, 2005 were drought years of Yemyet In. In 2005, there was extremely depart from normal rainfall and thus faced severely drought in that year to next dry season.

Based on the water balance data of Yemyet In area and local knowledge, a hypothetical water level fluctuation level for long term period from 1990 to 2005 can be drawn (Figure 7). According to that figure, some years were drought continuously as 2000-2002 and some year are only one year as 1995. 2005 also faced as severe drought in dry season.

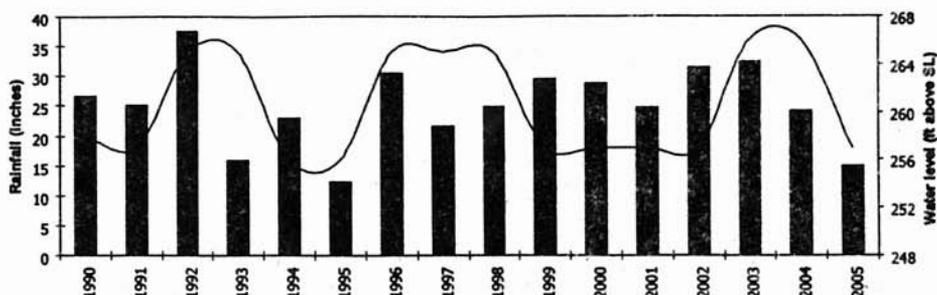


Figure 7. Annual rainfall and hypothetical water level fluctuation in Yemyet In (1990-2005).

Relationship between Human Activities and Water Level Fluctuation

Human impact on this study area is observed from the land use aspects. Land used on this area can be divided into two: land use in the lake area and land use in the catchment area.

In the In-area

Before 1988, agricultural land use was mostly conducted in north-east concern of the study area. At that time, two plots of land were permitted to grow paddy especially in dry season. With the exception of these two plots, the remaining areas were preserved naturally. There was few distinct impact of human activities upon this area before 1988.

After 1988, a project on land reclamation was launched by authority concerns. At the first phase of project, a new eastern road which is to be connected Padu and Yedwingaung was constructed for dual purposes of local development and land reclamation. At the second phase, the areas on both sides of the new road were designated to carry out fish breeding and wheat cultivation and these areas were shared to departmental concerns. Then areal extent of fishing pond was delimited on deep water site of the south and that of wheat cultivation was demarcated on shallow water site of the north. In this way, fishing ponds, road and agricultural lands took a place in this area from north to south successively. At the same time, land excavating, grading and embankment construction were conducted for fishing ponds and agricultural lands. Irrigation canals on northern fringe of the study area and diversion

ditch on southern fringe of that area were also constructed during this period. From that time on, the normal fluctuation pattern of the lake water had disturbed by these activities to a greater extent and it was largely due to the increase in rate of evaporation, infiltration and sedimentation. On the other hand, stubble from harvested crops and the fast growing area extent of Reed mace (Shin Mwelun) can disturb water level fluctuation pattern by making the rate of sedimentation higher. In addition, most of the fisherman usually takes abandonment to their fishing materials such as bamboo screen and bamboo fish-trap when the last fishing period is over. When water re-enters the lake in the next rainy season, these abandoned materials can catch the sediments.

In the catchment area

According to the previous investigation, the lake has a total catchment area of (161) sq-miles or (103040) acres. With the exception of the hilly region, the remaining areas are used for residential purposes and it contains several villages. Deforestation may be one of the backward improvements and this process has been developed from the period of the very first settlement to present successively. Due to the deforestation, ecosystem of the area has been changed and it takes a negative effect to water level fluctuation of the study area each and every year. In addition, farming technique has been transformed from single crop, double crop to mixed crop and then to hybrid of foreign origin. Due to the intensive farming, land degradation occurred and it in turn encourages to sedimentation process of the lake through surface runoff.

Mandalay-Myintkyina railway which had been opened in 1898 took an important role in modification of the drainage pattern. North-south running position of this railway made an effective barrier for surface runoff and inflows of the whole eastern area especially for all drains of Minwun Range.

Padu-Yedwingaung road is not only important for water level fluctuation of the area but for economic lives of the local people. It also becomes one of the major controlling factors of the water level fluctuation for its dam-like structure. Being connected with Padu and Yedwingaung villages, it can affectively block to the inflow of the northern part of the study area and also creates sedimentation process faster. By dividing the lake into two parts, it enhances the rate of evaporation with the separated swaying and waving processes. In addition, embankments of fish ponds and wheat field are greatly

affected to water level fluctuation of the study area in the same way mentioned above.

Past and present deforestation processes are dangerous to long term preservation effort of hill forests and the watershed area of the lake. Similarly, most of the vegetative covers in southern and western low hills have been cleared for agricultural purposes. It has now been occurred two related problems: the first one is rapid in land degradation process and the second is lesser in the amount of storage water for seeps and springs. Therefore, it can be assumed that land used for forests are increasingly important for the preservation of watershed area and for water level fluctuation of the lake.

Conclusions

Both physical and human factors are related to the process of water level fluctuation of Yemyet In. Among the physical factors, the amount of rainfall and its variation from one year to another and distribution pattern of rainfall directly control the fluctuation pattern. The water-balance computations confirm the crude local people knowledge about historical lake status. It is found that if the average monthly precipitation is less than 2.45 feet during the wet season around Yemyet In, there is a risk that this shallow lake dries out in the dry season. Here we have to investigate about evaporation rate that also an important factor to more understands the water fluctuation for large and shallow lake. Most of the human factors, irrigation canals and land reclamation for agriculture and fishing ponds are major controlling factors of water level fluctuation.

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