Shrinkage of Lake: 
An Impact of Global Warming 

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ABSTRACT

Lake is an important element to sustain ecological balance. The present trend of global warming speeds up shrinkage of water area over the land, specially the lake and the environment of it undergoes certain changes which have brought degradation as direct impact on the inhabitants and their economic activities. Many lakes of the world are facing the threat of shrinkages.

The present study attempts to explore the evidences that prove increase of temperature in the Manipur Valley during the last few decades and degradation of Loktak Lake environment with changes of its area covered.

Keywords: Degraded Environment, Shrunken Lake, Glaciation, Sedimentation and Loktak Lake

INTRODUCTION

Lake is an important element to sustain ecological balance. Apart from the geographical location, altitude and topography, the prevailing type of climate influences a lot to the lake’s environment. Lake may cover a small area but in the catchment, there may be a number of complementary components such as hills, hillocks, settlements, agricultural fields and water bodies which successfully create the essential micro habitats for a vast diversity of life forms. On global perspective, one can look into the nature and overall characteristics of lake and the existing ecosystem.

The present paper attempts to examine the shrinkage of lake’s water body and degradation of lake to global warming and man-made pressures taking into account the condition of Loktak Lake of Manipur based on primary information and personal observation.

In case of fresh water lake, everyone gets water for domestic use, agriculture, production of fishes and the habitats of aquatic fauna and flora. With the pace of global warming and climate change, there has been a gradual loss of lake natural configuration and the ecosystems, in turn it has given drastic changes on the habitats of flora and fauna and people whose economy depend on the lake resources. The present trend of global warming speeds up actual vaporization process and simultaneously the environment of lake undergoes certain changes. Shrinkage of water area, water pollution and degradation of ecological functions threat the lake and have brought direct impact on the inhabitants and their economic activities. The warming trend of the globe is one of the main factors for shrinkage of lakes and changing the lake environment. So, many lakes of the world are on the brink of disappearance.
Since the industrial revolution, human activities have resulted in steadily increasing concentration of green house gases in the atmosphere. The IPCC in its third assessment report has shown that the increase of average surface temperature of the world (0.67 °C) over the past hundred years will bring a more severe situation in the coming years. The anthropogenic causes speed up the warming trend of planet during this inter glacial period. There might be various natural process responsible for periodical global warming but they are beyond man’s control. On the other hand, all efforts to check industrialization, burning of fossil fuels, deforestation etc., though discussed seriously at national and international levels for minimizing the emission of CO₂ and other greenhouse gases, seem to be a far cry (Bandyopadhyay, 2000). Because, it is difficult to say precisely the causes of climate change as multiplicity of possible explanations exist. There has been circular relation between land change and climate variability, though the scales of interactions, feedbacks and consequences are at an embryonic stage (Gerard MacMahon, Susan P. Benjmin, Keith Clarke and Others, 2005).

LAKE FORMATION

Lake on different topographical features manifest with their typical geologic background having original formation related to structural depression, riverine, glacier erosion, cater of volcanic eruption etc. The body of lake may be fresh or salt water of considerable size and surrounded by land, but for some cases connected with sea. Most of the inland lakes have at least one natural flow that maintains always the average level of lakes’ water. The balance of inflow and outflow mechanism exhibits possibly longer life span of the lake. By nature, there are glacier water or rainfall onto the lake and runoff carried by streams and channels from the lakes’ catchment areas. The outflow is fulfilled due to evaporation from the lake, surface flow through river or channel and extraction of water of lake by human. A huge economic significance to communities and resources from lakes is expected, thus hydroelectric power generation, aesthetic and recreational purposes, agricultural use and domestic water supply are launched by the inhabited people. Due to sediments deposit and accumulation of wastes mostly biological origin from the catchment through the rivers and streams, the limnology i.e., littoral, photic and benthic zones of lake, is disturbed to the extent that the inland body of water and related ecosystem get change and alternately good plant growth and possible algal blooms develop gradually. So, many of the inland lakes of the world are temporary over geologic time scales and reducing the lake configuration in which the particular environment is degraded by sediment deposits, siltation, eutrophication, extensive weed growth etc. Global warming is the key factor to change the ecosystem of lake and bring decrease of its size.

WORLD SCENARIO

In the beginning of 20th century, the discussion of climatic fluctuations related with global wind circulation, atmospheric-ocean anomalies with occurrence of
ENSO events, fluctuation of solar constant in relation to the position of sun and earth, changes in atmospheric composition relating to volcanic activity etc. Later, having given emphasis on anthropogenic factors, there has been growing influence of human activities that concern with the potential global warming. Explosive growth of world population, industry and technology have led to dramatic increase in the concentration of GH gases, which ultimately have the tendency to increase radiative forcing and global temperatures from the preindustrial era (Roger G. Barry and Richard J. Chorley, 2003).

Lakes and reservoirs are, in fact, important sources of water in large amounts. Because of water present, the ecology of lakes is the most attractive to human beings, where a combination of land and water is the best area for habitation. Unfortunately, lakes of the world face shrinkage and degraded environment. Globally, there are an estimated 5,000 major natural and 7,500 artificial lakes of considerable size, of which 40 to 60 Per cent is lost to seepage and evaporation. The positive relationship of lake shrinkage with the surrounding forests and rainfall of the area was recorded by Alexander Von Humboldt in about 1793 in the case of Valencia lake of Venezuela. He found out that the lake had shrunk and the flat banks were used for cultivation of crops and deforestation the neighbouring lands (Majid Hussain, 1990). It is a fact that the earth has experienced several periods of glacializations and de glacializations in the past geologic period, even in the Pleistocene age many advance and retreat of the glaciers took place. Lake Agassiz was a great glacial lake in North America; its size decreased drastically over geologic time and now is a shrunken lake (www:waterdatabase.com/Lakes/Lake-Agassiz). The condition of inland water has been changing slowly; it is in alarming condition everywhere in the world. Reduction of water cover area of lake is a natural phenomenon; however it is the result of cumulative effect of the degradation of lake environment under the tendency of global warming. In fact, the warming trend of the globe is one of the main factors for shrinkage of lakes and changes of lake environment. As observed by Prof. Paul R. Baumann, the shrinkage of lake Powell, USA is mainly due to draught in the Coloredo river basin, that has dropped water level from 21,385,072 acre-feet to 16,427,414 acre-feet between 2000 and 2002 (www: oneote.edu accessed on 10.08.2010). It is true that the water level of Lake Victoria has been dropped about a meter over the last 10 years and about 1,50,000 sq. km land of it is affected by soil degradation. At present, Keenijhar, the largest freshwater lake in Pakistan faces serious environmental degradation (Ali Raza, 2009). Aral lake of Central Asia was one of the largest lakes with an area of 68,000 sq.km and has changed its ecosystem now by reducing the lake water. Global warming alarms over Lake Balaton, Hungary as a result of four consecutives hot summers and low annual rainfall since 1865. Lake Biwa, the largest fresh water lake in Japan (670 sq. km.) and one of the world’s oldest twenty lakes is getting pollution due to industry, household and synthetic detergents, nitrogen and phosphorous from agriculture (www:en.wikipedia.org/wiki/lake_biwa). Shrinkage and fragmentation of littoral zone vegetation in the lake Kasumigaura, Japan is also
reported (Nakamura Keigo, Nishihiro Jun and Shimatani Yukihiro, 2000). In China, there was drastic shrinkage of lakes mainly due to lingering of drought in the lake regions. The precipitation is dropped by about 50 Per cent to 90 Per cent. Dongting lake, the second largest fresh water in China, located in the drainage basin of central Yangtze river decreased from 4,955 sq. km to 2, 518 sq . km. between 1930 and 1998 in the past seven decades. The lake is fragmented and the degradation has resulted in negative ecological consequences (Shuging Zhou and Others,2005). It is also reported that Anguli lake in Hebei province in China experienced shrinkage and draying up since the autumn of 2004 (Qiao Yanziao, Hao Yueesheng and LV Fengjum,...). As such, China has been getting disappearance of natural lakes.

It is an established fact that the global temperature keeps on rise during nearly one hundred years which has combined with the human made pressures on the available topography to dry up lakes, for examples lake Songor of Ghana as a result of intensive salt production and the extraordinary changes in the Zambezi river system; Lake Nakuru of Kenya due to extensive deforestation; Lake Djoudy of Senegal since the building of Diana Dam in 1986 and Owens lake in Carifornia, USA

The Inle lake of Myanmar (www:myanmars.net) has similar character with Loktak lake of Manipur as floating weed and water hyacinth are commonly found. It is reported that the lake decreases from 69.10 sq.km. to 47.69 sq . km, a loss of 32.4 Per cent between 1935 and 2000 and faces sedimentation, eutrophication and pollution (www:myanmars.net accessed on 12.08.2010). However, the Tonle Sap lake of Combodia, the largest fresh water lake in South East Asia (2,700 to 16,000 sq.km.) is less threaten to its environment since the lake water is regulated by the connecting river (Tonle Sap). The Malaysia’s first Ramsar site, Tasik Bera, a fresh water wetland has fluctuation of water level 2 m to 5 m. according to seasonal rhythm. As reported by the United Nation, the lake Chad of Africa has shrunk 95 Per cent from 1963 to 1998. A number of natural species is stressed and threatened (www: en.wikipedia.org). Dry climate throughout the year with occasional rains between June and October could not sustain the life of the lake. According to the United Nations Food and Agriculture Organization (UNFAO), if the pace of shrinkage of lake Chad continues at the current rate and nothing is done, the lake will possibly vanish in the next 20–25 years. So, the shrinkage of lakes found all over the world is related to climate change. The Sambhar salt lake in Rajasthan, a Ramsar site, is threaten by desertification and low availability of water with seasonal fluctuation of 190 to 230 sq.km of lake area. The flood plain lakes in the Kashmir valley have reduced rapidly their water areas (Raina, HS and Reter, T–www:fa.org.). Wular lake is drying with the result of deep sediments, less inflow of water from Vitasta, Madumati and Erin Nallah, vanishing aquatic life, weeds cover an area of three fourth of the total and tree plantation along the bank (html:Chinar Shade: Wular, Another Dying Lake of Kashmir, 16 September, 2009). Similarly, Dal lake has also shrunk from 22 sq . km to 18 sq . km. The fluctuated dimension of lakes in the North West Himalaya due to
compression in the continental regime and climatic fluctuations has also been found out by researchers (Philip and John Methew, 2005). In the face of accelerating global warming, glaciers retreat and rapid accumulation of water lead to sudden breaching of artificial lakes and reservoirs and discharge huge amounts of water and debris known as Glacial Lake Outburst Floods (GLOF). Nepal has recorded twenty one GLOF so far (Samjwal R. Bajracharya, Pradeep K. Mool and Basanta R. Shrestha, 2006). The rapid shrinkage of glaciers does not affect the scenic beauty of landscape but brings economic dislocation and political instability to some of the world’s most volatile regions. In response to a warming climate there is no doubt of shrinkage of most mountain glaciers world wide (http://climate progress.org).

In the north east India, there are reports of lake shrinkage as a result of man-made pressures and climatic condition. The pristine Beel ecosystem pushes to the brink of disappearance; an example is the Deepar Beel of Assam which has reduced from about 40 sq. km to around 4.1 sq. km over the past few decades (Planning Commission.org.in/reports/E&F/Deepar Beel). Rudrasagar, 55 km from Agartala, one of the India’s national lakes has now shrunk due to encroachment and misuse of land including setting of brick kilns with a water area of 364 acres from its original expansion of 816 hectares (The Hueiyen Lanpao, Imphal, 5th Nov. 2013).

LOKTAK LAKE

Loktak, a fresh water lake of Manipur and lacustrine in origin (GSI,2011), has been considered as one of the Ramsar sites of International importance, with an area of about 300 sq. km spread over 24°25'–24°42'N latitudes and 93°46'–93°55'E. longitudes. The size of the lake varies in response to the rhythm of monsoon rains. At one stage the maximum length is 32 km. and the width is 13 km. and its average depth is 2.7 m. and at some portion the deepest goes up to 4.6 m. It has a vast catchment areas, direct as well as indirect, of about 5038 sq. km. and the land elevation, in case of direct catchment, varies between 780 m and 2068 m wherein numerous streams flow in to the lake. During the rainy season, the streams discharge a huge quantum of water and silt load to the lake. There is multiplicity of land uses due to agriculture, forest, human settlements etc. in its catchment areas.

TEMPERATURE AND RAINFALL CONDITION OF MANIPUR VALLEY

The climatic regime of Manipur is largely controlled by the topography and seasonal-monsoon winds. Being located near the Tropic of Cancer, both hills and plain of the state experience sub-tropical humid monsoon climate in which the inhabitants enjoy moderate temperature and rainfall (21.6 °C and 1860 mm respectively) annually (Deva and Ibochouba, 2001). While observing from 1959 to 2010, recorded annual average temperature in the state is found increase. There is also increase of average temperature almost in all the months from 1992 to 2010 as shown in Table 1.
The Manipur valley where Loktak lake is situated experiences about 20 °C average temperature and 1,432 mm of average annual rainfall. The seasonal rhythm of South West Monsoon covering from May/June to September/October and is followed with winter season touching the mercury about 3 °C on a day or a few days in December or January month. The short spells of the North East Monsoon and the Western disturbance rains give interruption usually the cool weather in the month of January and February. Seasonal variation is clearly noticed as evidenced by the foggy weather that fills up the Loktak lake and its surrounding areas even upto 11 am during winter. The summer heat, however is becoming intense recording above 33 °C, on a day or a few days during pre-monsoon. But the observed trend of climate and the experiences of inhabitants are that days of pre-monsoon, summer and rainy days have a little variation in temperature condition whereas winter cold is reduced considerably in the Valley. Common man in the Valley has been sensing less variation of temperature between day and night and the nocturnal weather in all seasons is getting warm.

Table 1: Manipur Valley: Average Temperature and Rainfall

<table>
<thead>
<tr>
<th>Months</th>
<th>Temperature in °C</th>
<th>Rainfall in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>14.46</td>
<td>13.5</td>
</tr>
<tr>
<td>February</td>
<td>16.68</td>
<td>15.8</td>
</tr>
<tr>
<td>March</td>
<td>21.80</td>
<td>19.6</td>
</tr>
<tr>
<td>April</td>
<td>23.96</td>
<td>22.6</td>
</tr>
<tr>
<td>May</td>
<td>24.22</td>
<td>24.2</td>
</tr>
<tr>
<td>June</td>
<td>24.98</td>
<td>25.5</td>
</tr>
<tr>
<td>July</td>
<td>25.83</td>
<td>25.7</td>
</tr>
<tr>
<td>August</td>
<td>25.90</td>
<td>25.7</td>
</tr>
<tr>
<td>September</td>
<td>25.18</td>
<td>25.2</td>
</tr>
<tr>
<td>October</td>
<td>22.78</td>
<td>23.0</td>
</tr>
<tr>
<td>November</td>
<td>18.58</td>
<td>18.0</td>
</tr>
<tr>
<td>December</td>
<td>13.72</td>
<td>14.9</td>
</tr>
<tr>
<td>Annual Average</td>
<td>21.57</td>
<td>21.2</td>
</tr>
</tbody>
</table>

* Computed from the recorded data of Automatic Weather Recording Station, Department of Geography, Manipur University, Imphal
** Data from Loktak Catchment Geomorphology by Meghajit, 2010, p.53
*** Data from Deva and Ibochouba, 2001, P. 304

Another set of weather data of 21 months from October, 2009 to June 2011 recorded by the Automatic Weather Recording Station, Department of Geography, Manipur University reveals average temperature, 20.66 °C in and around of Canchipur, north eastern part of the Valley. In a year, November to February are getting the average temperature between 12 °C and 18.58 °C and the rest eight months are relatively warmer getting above 20 °C. It is also found that the hottest moment of a day was recorded 33.86 °C on the 21st March, 2010 at 13 hr. 39 minute and 45 second whereas the coldest moment was with 3.39 °C on the 13th January, 2010 at 06 hr. 09 minute and 39 second.

Rainfall in the Manipur Valley shows a little change over the last 50 years being the annual average amount of rainfall 1,404.1 mm, though there might be cases of droughts for short spell. But local people observe well the micro
variation of rains in the valley as well as hills, largely due to change of surface conditions by deforestation and different types of land uses that will create the suitable condition for the approaching moisture laden wind or rain bearing cloud. However in the last 21 months a good rainfall occurs with minimum flood hazard in the valley. Perhaps, rainfall pattern is unpredictable in global warming.

It is understood that the seasonal weather condition influenced by the monsoon in Manipur valley is the single most important natural phenomenon that gives the source of water for Loktak lake. Inter annual variability in the timing of onset and withdrawal of monsoon in Manipur is observed. The temperature of the valley since 1959 has been increasing slowly with the pace of global warming, which has given tremendous influence on the lake ecosystem.

**DEGRADATION OF LAKE**

Every year, deposition of sediments to lake takes place. More than a dozen of streams bring down materials as the upper catchment area faces deforestation due to shifting cultivation. The inflow of Imphal river through Khordak and Ungamel channels during the rainy season also transports silt to the lake. The most important is the Nambol river which passes Imphal city carries a heavy load of suspended materials and urban wastes directly to the lake. It is found out more than half of sediments input from direct agents is contributed by Nambul stream. Nearly 6,50,000 metric tones of sediments deposit to lake (Trisal and Manihar, 2004) annually which causes the lake becoming more shallow. The increased sediments will allow fast growth of weeds and wild vegetation. The fluctuation of water level between rainy season and winter season, slow shrinkage of lake and nutrients enriched water bring the advantage of widespread of vegetation, locally called “Phumdis”. Phumdis are on the rise in the lake and gradually cover more and more area, if not removed, the lake is speeding its shrinkage. Before construction of the Ithai Barrage the sediments flew down along with the Phumdis but now the situation is different, moreover, the presence of nitrogen (2.21 mg/L) and phosphorus (1.17 mg/L) in polluted and warm water (17.2 °C and 29.1 °C) during summer provide a good condition for faster growth of vegetation (ENVIS, 2007 and Kosygin et al., 2007).

Loktak lake of Manipur faces decrease of its water spread and extension of aquatic vegetation and marshy and swampy lands gradually. It is reported that because of shrinkage of the lake water, levels of anthropogenic pressures (Trishal and Manihar, 2004) such as fishery and farming along the lake shore is increasing. The post monsoon water coverage is the maximum limit and the pre-monsoon the minimum for the lake as found about 8000 hectares in the month of March. There is growing evidence of the circular relation between land use change and climate variability, though difficult to know different scales of interaction. Changes in the configuration of lake in respect of invasion of exotic species and growth of wild vegetation, siltation, hydrological regime
and diminishes and displacement of flora and fauna are evidences of decaying lake, which have been reported by many studies (Gajananda and Sundari C hanu, 2008).

CONCLUSION

The question is how long Loktak Lake will survive when lakes all over the world are getting shrinkage and many of them have become dry. In the decaying process, drastic changes have been witnessed in Aral lake of Central Asia, Chad lake of Africa, Wular lake of Kashmir, India and many others due to the warming trend and man made pressures. There has been climate change in the Earth planet right from the beginning and global warming trend is a spectacular phenomenon at present. Many small lakes even in the Manipur Valley itself have become dry and vanished. Though small in size, Hein gang pat, Lamphel pat (near Taorem and Tangkham Villages), Pats at Luwangsangbam, Kameng. Mongjam villages and other low-lying pocket areas located in the northern part of the Valley have dried during the last 30 years. Even the Lamphel pat (near the Langol hill) under the care of state government, is gradually becoming a preserve water body area of Imphal city. Those Pats (lakes) located in the south of the Valley, including Kharung pat and Ekok pat, have also gradually lost their natural ecosystems and have been changing their major areas to agricultural land and fish firms. It is true that sedimentation, eutrophication and wild growth of vegetation in Loktak lake areas are continuing with the advance of global warming. The Ithai barrage constructed for the Loktak Hydro Electric Project is also not responding to the expectation of guarding the fresh water lake and its ecosystem. Except that rainfall is abundant in the Valley, others are detrimental. The natural law is so strong to determine the lifespan of a lake that Loktak lake will die one day, if global warming continues further, having lost its natural characteristics and the entire area of lake will be available for agriculture, pisciculture, fishery etc. That will be the cultural land surface feature but not the natural land and water surface what we see today. So, it is the matter of keeping the lake for a longer life but not for saving and keeping intact the life of lake forever. If people of Manipur who are getting the lake resources are not serious about the sustenance of lake, it will be hazardous and the lake will meet fast decaying step. Thinking for the personal benefits and self interest activities in the name of guarding and saving the ecosystem and environment of lake either through the government or non–government performances may simply mean a sort of eyewash and may not give the real strength to the inherent characters of Loktak lake for a longer life span. Now the most important is, instead of 200 years of life of the lake, let us have 500 years life span of Loktak.

REFERENCES


[25] www: oneota.edu accessed on 10.08.2010