# Water Availability and Use Pattern in Upper Tuirial Watershed, Mizoram

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**Abstract:**
The present study was conducted with the objective of examining the water availability and use pattern in the Upper Tuirial Watershed Area. The study is based on primary and secondary data. Primary data was collected by employing a purposive random sampling method covering 48 % of villages in the watershed area. The sample size was 1194 households which is 25 percent households of the 13 selected villages.

**Keywords:** purposive, watershed, availability.

## 1. Introduction

The meaning of availability is the quantity of something that can be used. Water availability refers to the amount of water that can be used by humans without causing harm to the environment or other living organisms. The way we consume or utilize water has an impact on the water resource system. Water's unique properties pose a challenge in effectively conveying its qualities and practical applications. Some activities such as industrial processes may require a large quantity of moderately clean water, while household water supply may require a very small quantity of high-quality water. On the other hand, some activities such as water-based recreation may only use water without significantly altering the state of the resource.

Water availability, both surface water and groundwater, is crucial for various fields like agriculture, industry, energy generation, and most importantly, human consumption.Climate, local geological conditions, use of land, quality of water everything will affect the water availability. The analysis of precipitation patterns shows annual declining trends of rainfall at a rate of 3.94 mm/year (Mizoram State Water Policy, 2020). It should be kept in mind that the constant changes in rainfall will affect the availability of water in the future. As for this, the present study provides information on a region's capacity to offer clean water and the importance of managing and conserving water sources.

### 1.2 Study Area

Tuirial River originates from North Chawilung hills, near Chawilung village at the southern boundary of Aizawl District, and flows northward to enter Cachar District of Assam. The main river that flows from south to north direction divides the watershed area into the eastern part and western part with almost equal in terms of area. The trellised river system of the watershed can be classified as the rivers of the eastern area and the rivers of the western area. Among many small streams and rivulets, the important tributaries on the southern side of the river are Tuirivang, Tuinghaleng, Suanghuan lui, and Chite lui, they are perennial streams.

Upper Tuirial Watershed covers 535 square kilometres, out of which 88.7 percent falls under Aizawl District and 11.3 percent falls under Serchhip District. It extends between 23°51’12’’ North to 23°26’12’’North latitude and 92°41’51” East to 92°51’46” East longitude. According to the 2011 census, the total population of the study area is 32567. There are 27 villages within and on the catchment area and 6732 households (Census of India, 2011). The prominent physiographic character of the Upper Tuirial Watershed is the presence of medium structural hills ranging between 800m-1200m running north-south direction at the eastern and western watershed boundary. The forest cover type is mainly tropical wet evergreen forest mixed with semi-evergreen and tropical moist deciduous forests comprising mainly of bamboo.

### 1.3 Methodology

Primary data on water resources, water demand and supply, water conservation practices, and management processes are collected from 13 villages (48 % of the total villages). Using a purposive sampling method, a household-level survey was carried out on 20 – 25 percent of the total households.

Secondary data like rainfall, humidity, and climatic factors as well as population statistics are collected from records of the concerned department of the state government. A proper scientific method is used to analyze the data collected, pre-tested questionnaires, semi-structured questionnaires, and informal interviews with village authorities are also employed.

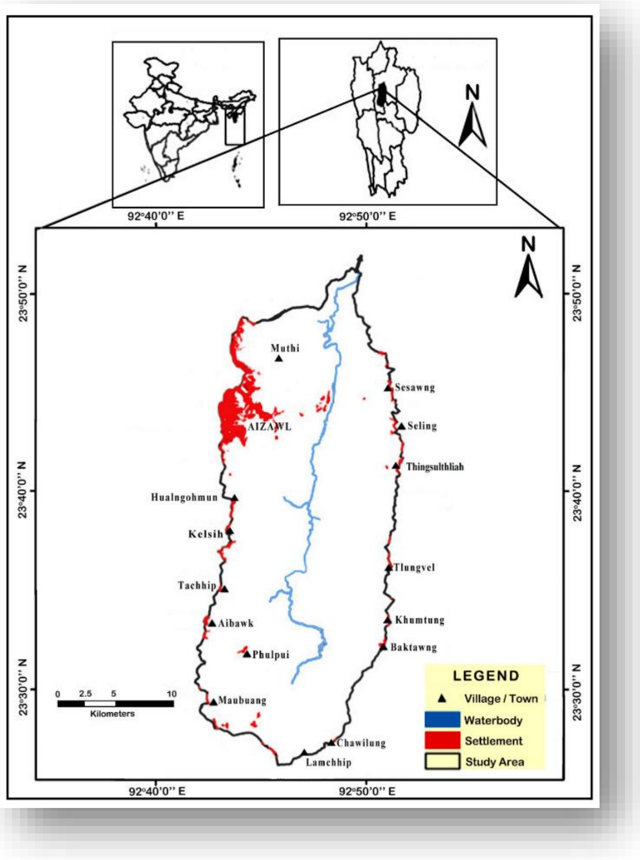


**Figure 1**: Study Area

**1.4 Objectives of the Study:**
**1.4.1.** To examine the availability of water and the level of their sustenance in the area.
**1.4.2.** To identified local area spring water availability and their importance in the study area.
**1.4.3**. To trace out the consumption pattern.
**1.4.4.** To suggest measures for the management of available water.

### 1.5. Availability of Water

The availability of water within the study area can be divided into underground water and surface water. Surface water includes water from rainfall, lakes, streams, and rivers. Underground water is the wells and springs that emerge on the surface from water below the surface. These are freshwater resources that are available for different uses.

#### 1.5.1. Rainwater

The study area experienced abundant rainfall under the direct influence of the South-West Monsoon. The rainy season (summer monsoon) generally starts from the month of April, it then rains heavily from May to September and lasts till late October. Thus, the dry months last for about 2- 3 months only. Generally, the settlements practice rainwater harvesting partially on one side of the roof with the help of a gutter. The annual rainfall for 23 years (2000-2022) is 2022.7 mm. While the annual rainfall in 2022 for Aizawl is 2015.1 mm. As a general rule in meteorology and weather forecasting, 1 mm (0.03 in) of precipitation equals one litre (0.21 gallons) of water per 1 square meter (10.7 sq foot) of area. The amount of precipitation is measured over a certain period, for example, per hour, day, a few days, a week, a month, or a year. The average rainfall in India is 118 cm / 1170 mm/ 46 inches according to annual data from the Meteorological Department.

**Table 1**: Annual Rainfall, Aizawl, 2000-2022. Source: State Meteorological Station, Directorate of Science and Technology, Aizawl, Mizoram

| **Year** | **Annual Rainfall in mm** | | **Year** | **Annual Rainfall in mm** |
|---|---|---|---|---|
| 2000 | 1785.5 | | 2012 | 2543.1 |
| 2001 | 2360.5 | | 2013 | 1920.8 |
| 2002 | 1885.5 | | 2014 | 1790.6 |
| 2003 | 2184.6 | | 2015 | 2412.3 |
| 2004 | 1797.5 | | 2016 | 2267.3 |
| 2005 | 1872.8 | | 2017 | 2686.7 |
| 2006 | 1598.4 | | 2018 | 1749 |
| 2007 | 2535.3 | | 2019 | 1709.8 |
| 2008 | 1547.7 | | 2020 | 1741.9 |
| 2009 | 1639.9 | | 2021 | 1917.6 |
| 2010 | 2650.8 | | 2022 | 2015.1 |
| 2011 | 1909.4 | | Total Average | 2022.7 |

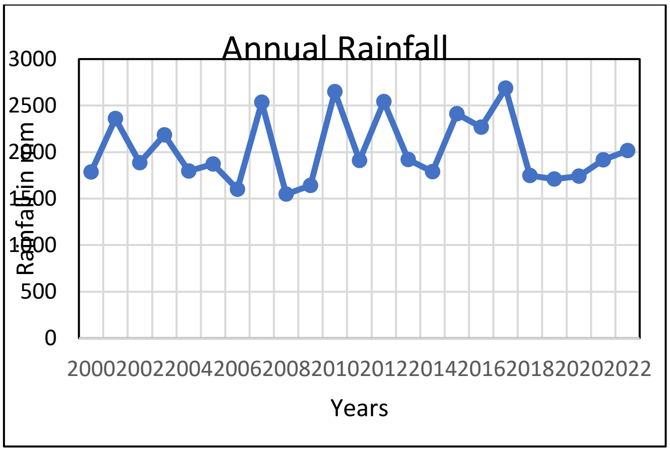


**Figure 2**: Average Monthly Annual Rainfall of Aizawl in mm. Source: State Meteorological Station, Directorate of Science and Technology, Aizawl, Mizoram

A rough measurement of rainfall depth at home: **Available annual rainfall = A x B x C.** A = Average annual rainfall of a region. B = Roof area of a building. C = Runoff coefficient (Runoff coefficient depends on roof surface material – generally taken as 0.8 to 0.9 for galvanized iron sheet and asbestos sheet). For Example, the study area with an average monthly rainfall of 168mm, a catchment area of $81m^2$ ($30ft^2$ approx.) will receive an average rainfall of 11566.8 liters per month (0.168x81x0.85 = 11566.8)

### 1.5.2. River water

Upper Turial Watershed is demarcated into eight mini-watersheds for studying potential availability of water in each small basin, namely; Ngharum Lui Watershed, Saibual Lui Watershed, Muthi Lui Watershed, Suanghuan Lui Watershed, Zilpui Lui Watershed, Chite Lui Watershed, Tuirivang Lui Watershed and Tuiritai Lui Watershed.

In general calculation, One cubic foot per second = 448.83 gallons per minute (450 for ordinary calculations) = 1 acre-inch in 1 hour and 30 seconds (1 hour for ordinary calculations) = 1 acre-foot in 12 hours and 6 minutes (12 hours for ordinary calculations) = 1.984 acre-feet per (24 hours) day (2 acre-feet for ordinary calculations. The average monthly discharge of the upper Tuirial River is estimated to be 2,75,925 liters/hour.

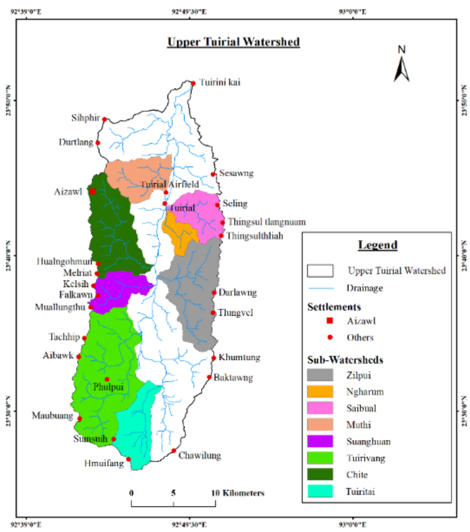


**Figure 3:** Sub-Watershed of Upper Tuirial Watershed.

**Table 2**: Annual water discharge of rivers. Source: Computed by author based on field survey.

| Sl. No. | Name of River | Length (in KM.) | Catchment area ($km^2$) | Water Quality | Average monthly Water Discharge (cfs) |
|---|---|---|---|---|---|
| 1 | Upper Tuirial | 60.5 | 534 | potable | 1216.6 |
| 2. | Ngharum Lui | 6.98 | 10.6 | potable | 166.21 |
| 3. | Saibual Lui | 6.66 | 24.4 | potable | 63.2 |
| 4. | Muthi Lui | 11.5 | 28.4 | potable | 149.7 |
| 5. | Suanghuan Lui | 8.5 | 21.9 | potable | 55.45 |
| 6. | Zilpui Lui | 10 | 54.4 | potable | 69.8 |
| 7. | Chite Lui | 18.2 | 48.3 | moderate | 251.7 |
| 8. | Tuirivang Lui | 18.1 | 84.9 | potable | 195.7 |
| 9. | Tuiritai Lui | 10.9 | 28.6 | potable | 143.5 |

**1.5.3. Springs**

The perennial source of water during the dry season in Mizoram is the village spring or tuikhur. The majority of the population in the village study area met their daily water requirement through this source. Springs (Tuikhur) play a vital role in the supply of water and have a higher potential for the supplement of water supply in the future, not only in the dry season but also during the monsoon season. They are one of the lifelines of water supply. Till today, one of the most important sources of water supply in rural areas can be considered as Tuikhur or village spring source (VSS). The average discharge of Tuikhur in the study area calculated from the field observation is 10 Liters/30 seconds. Thus, the average discharge of springs is estimated at 1200 liters/hour.

However, in recent years with rainfall variability and various anthropogenic reasons many of these sources either dried up or have reduced water quantity during the dry season or non-monsoonal season (Biswas et al, 2021). The reduction of water quantity of springs becomes a serious issue as the source of this water is related to the lithological structures below the surface and environmental degradation as well as waste pollution above the surface. The water resources from the springs are mainly used for drinking, cooking, cleaning, and washing purposes.

**Table 3**: Number of Springs in the selected village of the study area. Source: Author based on field survey.

| Sl.No | Village | Perennial Spring | Seasonal Spring | Total |
|---|---|---|---|---|
| 1 | Seling | 7 | 5 | 12 |
| 2. | Thingsulthliah | 8 | 6 | 14 |
| 3. | Phulmawi | 4 | 4 | 8 |
| 4. | Khumtung | 5 | 7 | 12 |
| 5. | Baktawng | 4 | 7 | 11 |
| 6. | Chawilung | 3 | 4 | 7 |
| 7. | Lamchhip | 5 | 3 | 8 |
| 8. | Kelsih | 5 | 4 | 9 |
| 9. | Aibawk | 4 | 5 | 9 |
| 10. | Thiak | 4 | 3 | 7 |
| 11. | Hualnghmun | 4 | 6 | 11 |
| 12. | Muthi | 5 | 7 | 11 |
| 13. | Sesawng | 6 | 6 | 12 |
| | TOTAL | 64 | 67 | 131 |

### 1.5.4. Ground Water

Geologically, the upper Tuirial is characterized by semi-consolidated structural hills belonging to Surma Formation of the Miocene age. In general, the terrain is tectonically young and immature. The moderate linear ridges are underlain by shale, sandstone, and siltstone alternations and are characterized by low permeability and infiltration capacity. Thus, resulting in low groundwater potential. In addition to this, steep slopes of the hill ranges do not allow computation of groundwater recharge potential in this area. The rainfall infiltration method is usually used to assess the groundwater recharge due to the unavailability of groundwater abstraction structures.

The groundwater development level is 3.94%. The natural discharge of water during the lean season is negligible. The available gross dynamic resources of groundwater are estimated to be 3.86 MCM, net annual draft is 0.14 MCM (Central Ground Water Board, 2013).

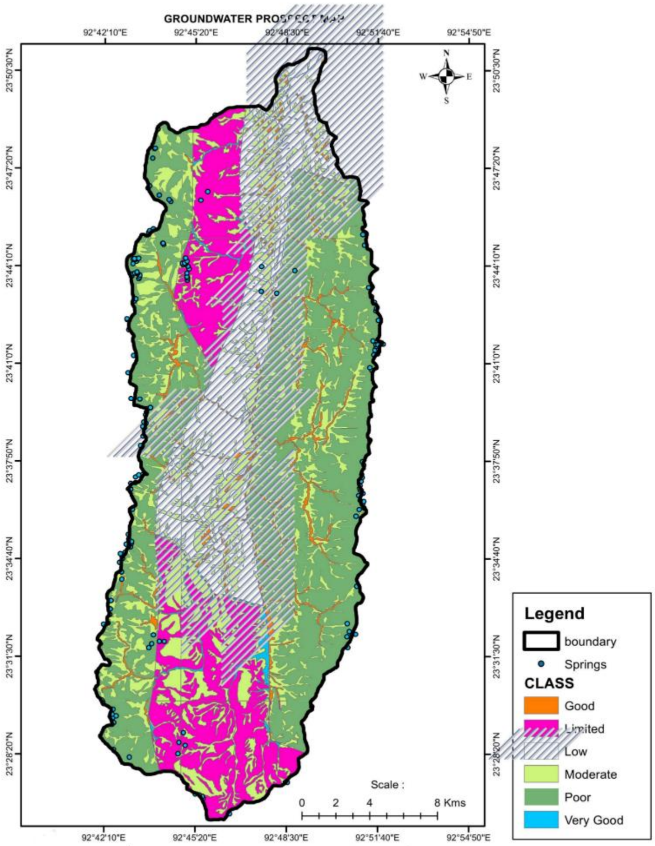


**Figure 4**: Ground Water Prospects of Upper Tuirial Watershed

## 1.6. Use Pattern of Water Resources

Further, uses of water can be distinguished between withdrawal use which includes consumptive and non-consumptive use of water resources from the source (groundwater or surface water), and non-withdrawal use, which are on-site uses like navigation, wildlife, etc. The terms "consumption" and "demand" may not be confused as only a portion of the water demand is actually consumed (Savenije.H.H.G., 1996). There are many uses of water ranging from daily domestic consumption to industrial uses.

### 1.6.1. Domestic Use

Generally, the household consumption of water depends on the personal habits of people, the social status of individuals, local climatic conditions, and customs of the local people. This made it difficult to calculate the exact amount of water demand as the indicators change from time to time. As per the Bureau of Indian Standards, IS:1172-1993, the minimum consumption rate per capita per day for villages and for communities with a population up to 20000 and without a flushing system, is calculated at 40 lpcd, as the villages within the surveyed fall under this category, this demand is taken into consideration. While, the Jal Jeevan Mission (2019) launched by Govt of India set a goal to provide adequate drinking water of prescribed quality, on a regular and long-term basis to every village household by 2024. The JJM then, upgrade the daily demand to 55 lpcd for every household. In continuation of this, The National Rural Drinking Water Programme (NRDWD) 2013 enhanced service level from 40 lpcd to 55 lpcd wherever possible (Ministry of Jal Shakti.2020).

The household survey and interviews with different persons reveal that the per capita per day demand ranges from 30 lpcd to 40 lpcd for a period of five days and an average of 50 lpcd – 60 lpcd for two days only. Thus, the average household consumption for one week is estimated to be 320 lpcd with an average of 45.7 lpcd without deduction in the transaction of water supply during the dry season (Table 5.1). The water demand of a household is met by government distribution, spring water, and from private vendors. The average distribution of water for 13 villages is 30.11 lpcd. This is taken for granted that the average for the whole area is also considered 30.11 lpcd as per distribution by the government for the dry season. The deficit level of water supply is met through Springwater and local water vendor. The distribution of water is normally fixed but only during winter season, when there is less rainfall, the fixed amount is strictly undertaken while during summer the community will take as much as they can store.

### 1.6.2. Agricultural Use

Irrigation is the major focus in agriculture water demand. Due to locational and topographical factors, agriculture is practiced along the hill slopes. There are no irrigational practices, crops rely on monsoon rains. Karif crops are mainly cultivated. Winter/Rabi crops like beans, mustard, tomatoes, and cabbage are generally grown along the main river in patches. The practice of growing Rabi crops in household gardens for domestic consumption is also common in the study area.

The practice of irrigation in the upper Tuirial watershed is minimal. A handful of farmers practices irrigation in pockets near the banks of Tuirial River in Small scale. Crops usually depend on the soil moisture and river soil nutrients. Thus, out of 60% population engaged in agriculture, less than 5% practice irrigation during dry season. Farmers usually manage farm water demand, even though assistance is taken from the government.

### 1.6.3. Livestock Water Use

The proper balance of water, carbohydrates, vitamins, protein, and minerals is required for the optimal performance of livestock. Out of these, the most critical is water, which also includes its quality. The important properties often considered in assessing the quality of water for livestock are physiochemical properties (pH, total dissolved solids, total dissolved oxygen, and hardness), presence of excess minerals or compounds (nitrates, sodium sulphates and iron), organoleptic properties (Odor and taste), presence of toxic compounds (heavy metals, toxic minerals, organophosphates, and hydrocarbons), and presence of bacteria (Faries, et al., 2007).

Livestock rearing goes hand in hand with village life. Almost every household in the village will domesticate pigs or poultry or even cows usually in small number. Poultry farming is very common in the study area. Cattle rearing is practice in Muthi Village, with more than 40 household engaged these activities. More than 600 cattle were domesticated, which is more than 57% of total cattle reared from the surveyed area. Hualngohmun, Melthum, Muallungthu, thiak and Aibawk village are concentrated in piggery and poultry farming. Demand of water for livestock is difficult to calculate, due to the fact that different region with different climatic conditions with different breed usually consume different quantities.

A separate water connection for farming or animal husbandry is not available, thus water supply for different livestock is dependent on rainwater. Normally, water demands for farms are managed by constructing a reservoir big enough to provide or store water for the livestock.

**1.7 Results and Conclusion**

From the above discussion, we can conclude the results in the following;

1.7.1. The study area is characterized by rugged structured topography ranging between 800m-1200m above MSL. Bamboo is the predominant vegetation.

1.7.2. Water is available in the form of rainfall, river, and groundwater.

1.7.3. The annual rainfall is 2022.7mm which is projected that an average 81m$^2$ catchment area or rooftop will receive an average rainfall of 11566.8 liters per month (0.168x81x0.85 = 11566.8) in total. But, according to field investigation, only 27.9% of rainwater is harvested.

1.7.4. The important tributaries of the Upper Tuirial River are Ngharum Lui, Saibual Lui, Muthi Lui, Suanghuan Lui, Zilpui Lui, Chite Lui, Tuirivang Lui and Tuiritai Lui. The average annual river discharge of the catchment area is estimated to be 2,75,925 liters/hour.

1.7.5. The groundwater potential is seen in the form of spring water. There are as many as 131 springs were located in the surveyed villages, out of that 64 springs were identified as perennial. The average discharge of a perennial spring is estimated at 1200 liters/hour.

1.7.6. Majority of the harvested water is consumed for domestic purposes. Due to absence of irrigation, the uses of water for agricultural is minimal. Livestock consumption of water is not possible to calculate due to insufficiency of data to be collected from the farmers.

**1.9 Acknowledgement**

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