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Extent of area under shifting cultivation (Jhum) in North East India has been reduced: A case study at Aizwal district of Mizoram

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ABSTRACT: The term "shifting cultivation" refers to a broad range of crop producing techniques. After growing crops for two to three years, the land is left fallow for a number of years before being further cultivated. The locations under various jhum cycles are currently inadequate. Shifting cultivation often occurs in remote and difficult-to-reach regions, such as dense forests, hilly terrain, and remote valleys. This makes it challenging to physically access and survey these areas. Therefore, to locate moving farmed areas, IRS and LISS-III sensor data from many time periods were used in satellite imagery. While for the years 1988, 1991, 1993, 1994, 1996, 1997, 1999, and 2000, Land-sat TM satellite imagery was used. ERDAS IMAGINE 9.2 image processing has been used to digitally process the satellite data relevant to research region. A correct fallow cycle of shifting agriculture may help to increase watershed conservation while maximizing crop productivity. The jhum regions of the Aizawl district's overall geographic area declined by 5.08% to 3.04%. Jhum cycles covered more land in the order of 5 yrs> 10 yrs> 7 yrs>15 yrs. However, it was revealed that there was no place in the Aizawl district with a 20-year cycle. The estimated jhum cycle data may be useful for good strategic jhum farming management in the region.

Keywords: Shifting cultivation, Jhum, Fallow cycle, North East India.

INTRODUCTION

The Shifting Cultivation, its name varies in different parts of the world and generally known as “slash and burn” and “bush fallow” agriculture (Nath *et al.*, 2022). It is most prevalent form of agriculture in North East India (Upadhaya *et al.,* 2020) which is locally known a*s jhum farming* and the cultivators are known as *jhummias* (Deka and Sarmah 2010). Shifting cultivation is practiced widely in the tropical uplands, covering roughly 280 million hectares of land, probably support 200-300 million people (Nath *et al.*, 2022). In Northeast India, over 4,40,000 families of rural communities depend on jhum cultivation partially or wholly for their livelihoods (NEC, 2015). The system involves clearing of forest vegetation from a selected plot by slashing and burning, and cultivating the land for a period of one or two years followed by abandonment as fallow for recovery of soil fertility through natural vegetation regeneration (Tripathi *et al.*, 2017). Though this farming system is being considered to be major factor responsible for loss of biodiversity and causing imbalance in the ecosystem, but the fact remains that the majority of the world mega biodiversity area coincide with the area occupied by the indigenous people practicing similar system of agriculture (Kalita *et al.*, 2017). The role of jhum farming is being widely recognized for ecologically sustainable and economically viable form of agriculture (FAO, 2014). Shifting cultivation systems are ecologically viable as long as there is enough land for long (10–20 years) restorative fallow, and expectations of crop yield (Lal, 2005). The length of this fallow period varies considerably and 5-20 years is common (FAO, 1974). In North East India shifting cultivation cycle of 10–15 years over the years has shortened to about 2–3 years, thus leading to ecological imbalance (Ranjan and Upadhyay 1999). Fallow duration and cultivation periodicity may be influenced by multiple factors, including ecological factors such as precipitation, soil conditions and topography as well as socio-economic factors (Mertz, 2002). Under the pressure of increasing populations, fallow periods are drastically reduced and the system degrades, resulting in serious soil erosion and a decline in soil fertility and productivity (Van *et al.*, 2008). A reduction in the fallow cycle lowers the soil fertility and yield, increases soil erosion, and causes watershed siltation (Ziegler *et al.*, 2009). In North East India, the dynamics of crop-fallow rotation cycles in shifting cultivation fallows, however, are poorly understood (Thong *et al*., 2018). The most preferred jhum fallows in the region remains 7–11years (Thong *et al*., 2019) against most believed that jhum cycle has drastically reduced. The most critical factor that governs the sustainability of Jhum is the length of the fallow period (Abizaid and Coomes 2004). The intervening period between fallowing and returning to the same spot for cultivation (jhum cycle) is indeed a matter of concern. This is seriously impacting on environmental security of a region (Datta *et al*., 2014).

The vulnerability assessment could provide us an in-depth study on the status of ecological sustainability due to shifting cultivation at landscape level. The vulnerability assessment can be performed by basing the length of shifting cultivation cycles. The length of a shifting cultivation cycle is manifested in the form of alternating fallow and cultivation periods. This assumption is commonly accepted, however, empirical evidence of areas under different fallow cycles is scarce. Our study's main objective is to determine the areas under different fallow cycles in North East India. Thus, fallow length could be a strong predictor of crop yield and the best proxy for assessing sustainability of the system. Therefore, it is necessary to fill this gap by developing the fallow cycle map of this particular region to assist in its strategies and management.

The study is, thus, conducted with the following objectives:

1. To estimate the areas under different fallow cycles.
2. To generate the fallow cycle map of the particular region.

Study Area. Aizawl district is one of the eleven districts of Mizoram state in India. It is the most populous district of Mizoram. This district is bounded by Assam in the North, Manipur in the North East, Champhai district in the East, Serchhip district in the South, Lunglei district in the South West, Mamit district in the West and Kolasib district in the North West. According to the 2011 census Aizawl district has a population of 400,309 with a density of 113 inhabitants per square kilometer. The latitude of Aizawl, Mizoram, India is 23.727106, and the longitude is 92.717636**.** Aizawl, Mizoram, India is located at *India* country in the *Cities* place category with the GPS coordinates of 23° 43' 37.5816" N and 92° 43' 3.4896" E. The total geographical area of Aizwal district of Mizoram is 3576.31 sq km occupying 19.96% area of the state and falls under tropical monsoon type climate. The temperature varies from 21°C to 32°C in summer and 10°C to 17°C in winter. The entire Mizoram state comes under the direct influence of the south west monsoon receiving an annual average rainfall of 250 cm. Soils of the state are young, immature and sandy. Soil texture varies from sandy loam and clayey loam to clay. The soils are porous and poor water holding capacity, deficient in potassium, phosphorous, nitrogen and even humus content. The soil pH is normally in acidic range and sometimes approaching to neutral, this may be due to excessive leaching. The location of the study site is shown in Fig. 1 and 2. About 60% of the total workers are engaged in agriculture & allied sector in Mizoram. The State is deficient in food grain production and could meet only 31.60% of rice requirement. About 32% of the cultivated area is under jhum.

MATERIALS AND METHODS

Selection of *Jhum* Cycle. Three *jhum* cycle viz. 15 years, 10 years 7 years and 5 years were selected with some criteria which were formulated on the basis of using the number of time the plots were cultivated in the past, the number of year cultivated and in fallow during each cycle that is adopted from Young (1994). The cycle is referred to the sum of years in cultivation plus years in fallow. The mathematical equation followed as

$$\text{LU intensity} = t \times \frac{c}{(c+f)}$$

Where,
LU = Land Used
t = number of cycle
c = Years in cultivation in each year
f = years under fallow in each year

Integrating Remote Sensing, Ground Based Measurements and GIS for Calculating *Jhum* Cycle. Multi temporal satellite imagery of IRS (Indian Remote Sensing Satellite) LISS-III (Linear Imaging Self Scanning) sensor for the year 2003, 2006, 2009 and 2012 were used to identify shifting cultivated areas of Aizwal district of Mizoram and observed the changes occurred in those areas. Whereas, Land-sat TM satellite imagery were used for the year 1988, 1991, 1993, 1994, 1996, 1997, 1999 and 2000 for the district. Visual image interpretation technique has been used to identify the shifting cultivated areas and changes occurred during 20 years. The data (images) have been collected from NRSC, Hyderabad and the study area covering Aizawl district of Mizoram. Digital processing of the satellite data pertaining to study area during March-April has been done using ERDAS IMAGINE 9.2 image processing software. The standard false colour composite (FCC) was generated by assigning blue, green and red colors to visible green, visible red and near infrared bands on 1:50,000 scale, respectively. Visual interpretation of the imagery has been done and verified with field checking for deriving information on spatial extent of current shifting cultivation areas. All the input vector layers (current shifting cultivation layers) were overlaid in GIS environment and change analysis was done using analysis tools. Analysis tool option is used from Arc tool box window to overlay the layers for calculate the intersect area of *jhum*. The intersect areas are only considered by erasing repeated *jhum* areas within cycle. The area under different *jhum* cycle *viz.*, 15, 10, 7 and 5 years were calculated by ERDAS imagine and Arc GIS 10.0 software tool and developed the maps. The brief methodology is presented in the flow chart (Fig. 3).

RESULT AND DISCUSSION

The sum of years in cultivation plus years in fallow is called *jhum* cycle. The cycle may be short 3-5 years or long more than 20 years. In North East India, the *jhummias* follows different *jhum* cycle varying from 3 to more than 20 years. The data presented in Table 1 shows total current *jhum* area of Aizawl district is different in each year and a decreasing trend in areas is observed since 1988. The total area under *jhum* in Aizawl district of Mizoram decreased from 5.08 % to 3.04 % of the total geographical area of the district. Among the different *jhum* cycles followed by the *jhummias* of this district, the area under 5, 7, 10, 15 and 20 years cycle is decreased. The data presented in table 1 revealed that area of total current *jhum* under 5 years cycle is the highest and it followed by 7, 10 and 15 years cycle. However, no area under 20 year's cycle is recorded in Aizawl district of Mizoram. The available literature on the effect of Jhum cultivation includes general studies on areas with different intensities of Jhum. Still, the Jhum sites have significant topography and geography variations, making it difficult to evaluate the effects of Jhum cultivation accurately (Sharma and Yadav 2023). However, the reduction of *jhum* area and cycle was also reported by several workers like Toky and Ramakrishnan (1981); Roder *et al*. (1995); Silva-Forsberg and Fearnside (1997); Kato *et al*. (1999); Thong *et al.* (2019).

The reduction of *jhum* area may be due to several socio economic reasons. *Jhum* farming needs huge labour for cutting and burning of vegetation (Datta *et al*., 2014). This cultivation practices are entirely rainfed and risky to crop failure. Generally, the productivity of *jhum* land is very poor especially under shorter fallow cycle (Zonayet and Paul 2020). Moreover, there is a tendency of the young generation to migrate commercial places. Further, the government and non government organization also pressurized for settled cultivation to the *jhummias*. Vermeer (2005) reported that the shortening of fallow period under *jhum* farming is due to higher population where instantaneous carrying capacity has been reached in that ecosystem. Instantaneous carrying capacity can be defined as the maximum theoretical population that can be supported in a particular area with the given technological and ecological condition of production. But hill farmers are still depend on it either partly or fully for their livelihoods. It ensures staple food for most of the months with rice, vegetables, cash crops, fruits, spices etc. This might be the reason for consideration of *jhum* farming as one of the best livelihood options in hilly tracts. Therefore, a proper strategy is required to sustain and improvement of the jhum farmer. Many worker conclude that longer fallow cycle is important for balance ecosystem of this farming but we do not have the data on areas under different fallow cycle. Findings of total areas under different cycles may useful to the policy maker for sustainable development in such areas where jhum farming is continued.

Mapping of jhum fields over the years. The visual interpretation and on-screen digitization techniques were followed for classifying and delineating of jhum fields from the multi-temporal Landsat data, LISS-III and Land-sat TM Imagery of 1988 to 2012. The fallow age of jhum field was determined with time series analysis of satellite data and overlaying techniques (Fig. 4).

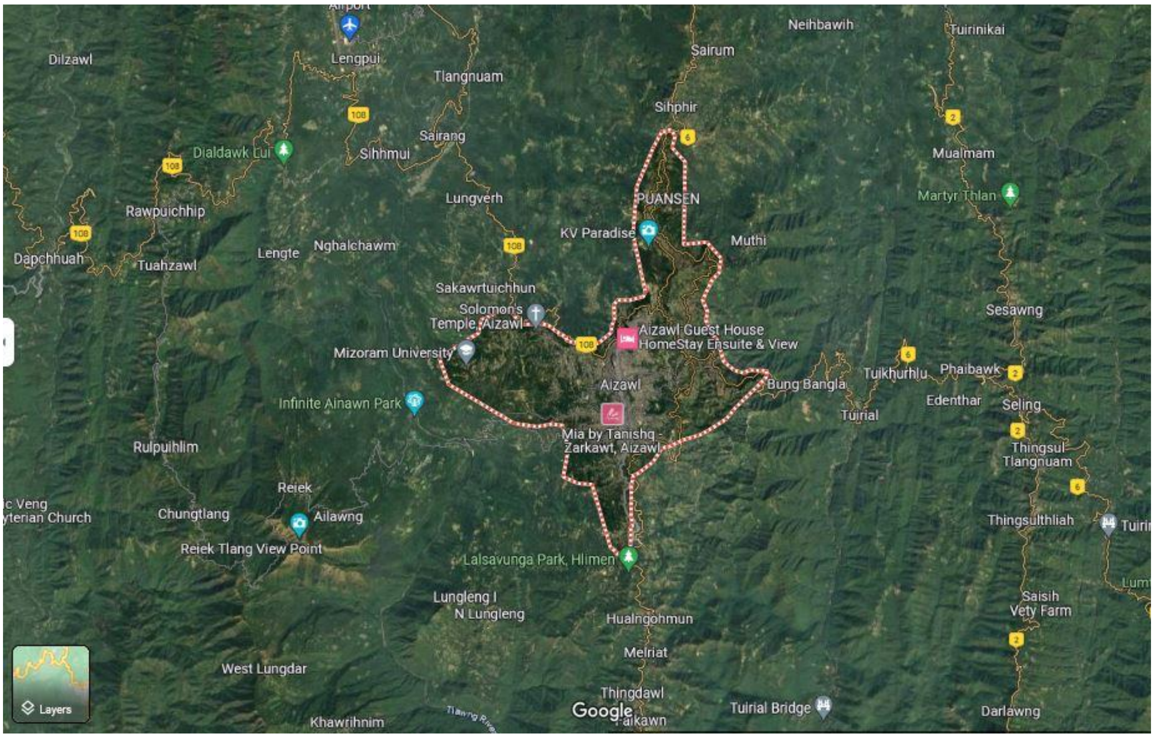

Fig. 1. Satellite Map of Aizawl district of Mizoram, India.

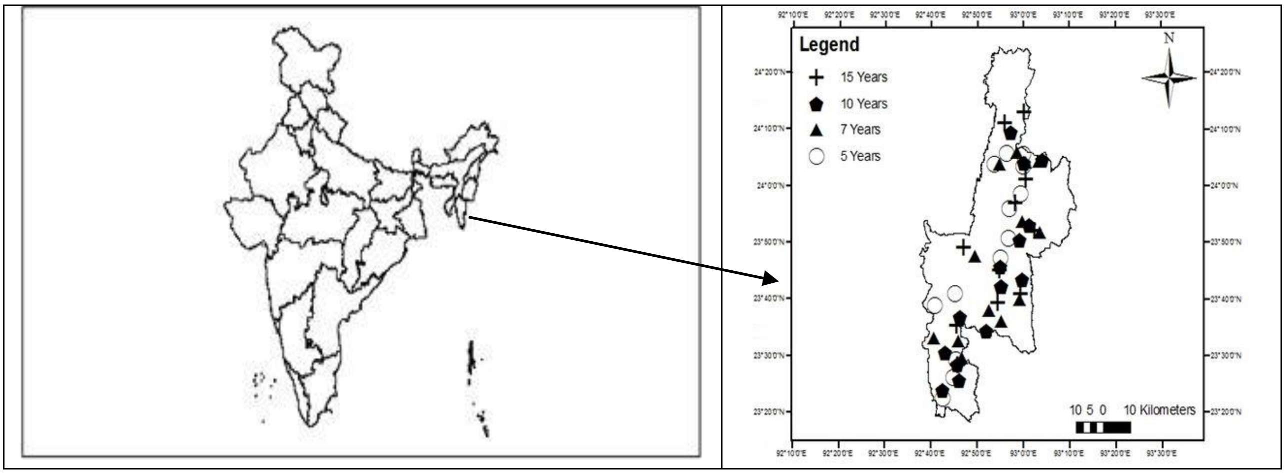

Fig. 2. Study Area Aizwal district of Mizoram, India.

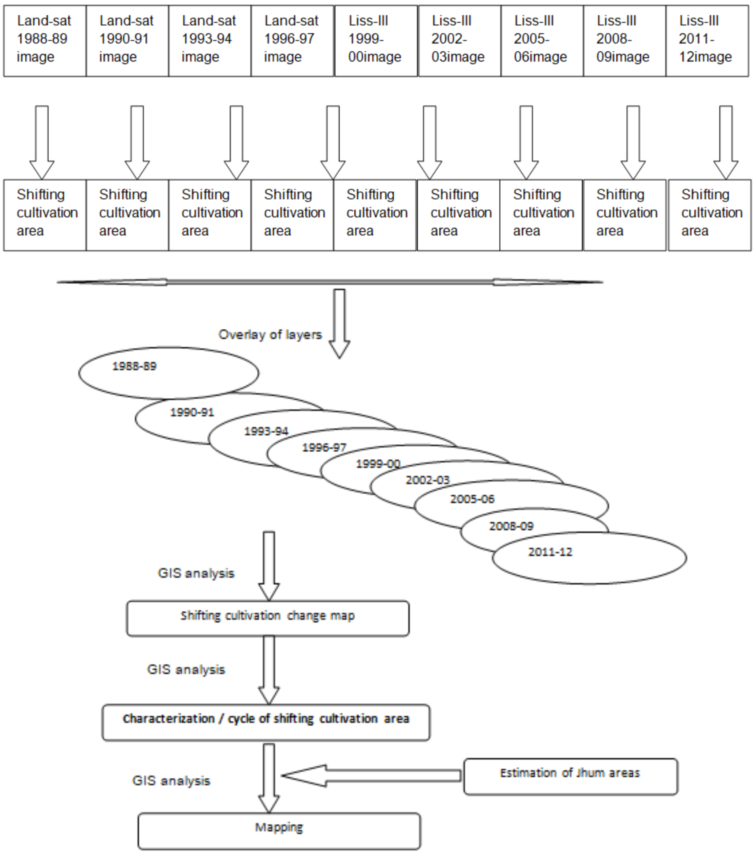

Fig. 3. Flow chart of Methodology for estimation of area under *jhum* cycle (Aizawl district).

Table 1: Total area under different *jhum* cycle in Aizawl district of Mizoram.

Year	Total *jhum* area (ha)	5 years cycle		7 years cycle		10 years cycle		15 years cycle		20 years cycle
		Year	Area (ha)	Year	Area (ha)	Year	Area (ha)	Year	Area (ha)	
1988	18193.83	1989-1993	741.34 (5.52)	1991-1997	814.45 (4.78)	1988-1997	2100.12 (12.34)	1988-2003	766.35 (6.56)	
1991	13412.98	1991-1996	324.02 (3.93)	1994-2000	723.86 (3.73)	1991-2000	804.29 (4.14)	1994- 2009	538.77 (4.69)	
1994	8242.61	1993-1997	551.75 (3.24)	1997-2003	1035.89 (8.86)	1994-2003	382.05 (3.27)	-	-	
1997	17017.11	1996-2000	922.7 (4.75)	2006-2012	1468.36 (13.48)	1997-2006	1761.73 (10.00)	-	-	
2000	19389.7	1999-2003	2204.2 (18.86)	-	-	-	-	-	-	
2003	11681.32	2008-2012	2524.3 (23.17)	-	-	-	-	-	-	
2006	17601.45	-	-	-	-	-	-	-	-	
2009	11486.22	-	-	-	-	-	-	-	-	0
2012	10892.25	-	-	-	-	-	-	-	-	0

Figures in parentheses indicates is % of total *jhum* area; - = Not calculated / no data.

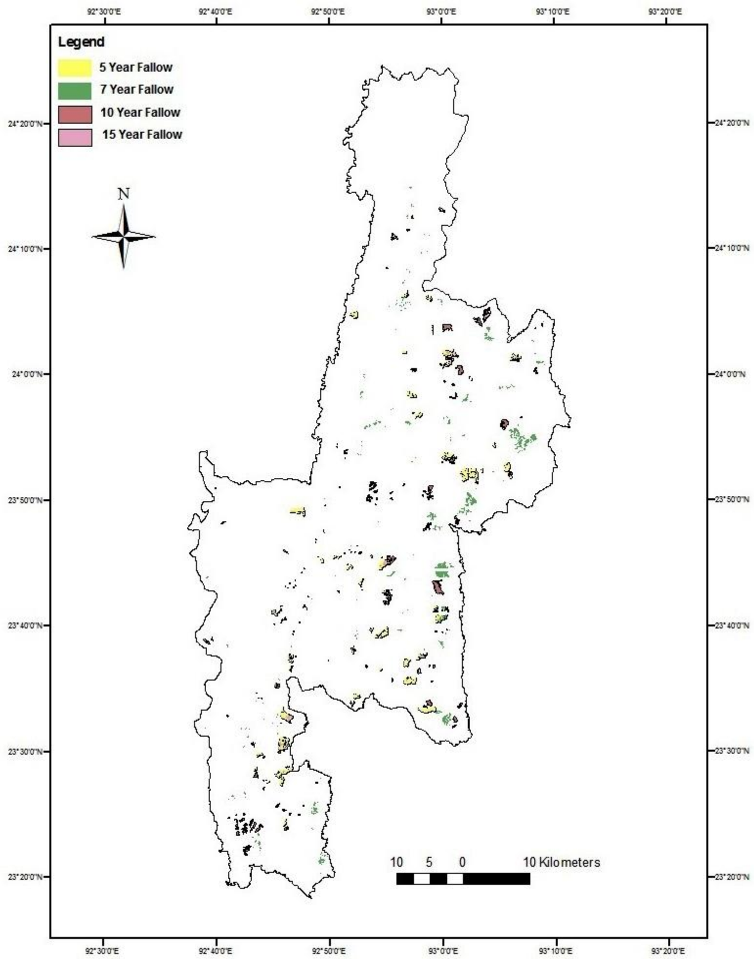

Fig. 4. Maps of areas under 5 years, 7 years, 10 years and 15 years Jhum cycle at Aizawl, Mizoram.

CONCLUSIONS

The *jhum* farming or shifting cultivation is the practice of cultivating crops by slashing and burning the vegetation in dry season and planting crops in wet season for 1-2 years. The total *jhum* area of study sites Aizawl of North East India is decreasing since 1988. The highest area of *jhum* cultivation in Aizawl is under 5 years cycle followed by 10 years cycle, 7 years cycle and 15 years cycle. Remote sensing with time series data and GIS techniques helped in accurate and precise analysis of jhum fallow cycles. These data could contribute to management of jhum farming and helps in proper strategies to the policy makers of a region.

FUTURE SCOPE

The findings might be utilized to quickly access and disseminate information to stakeholders as well as assist in the development of policies and plans for the area. Future research projects may be conducted in the designated area, particularly during specific fallow periods for environmental security and livelihood of jhummias.

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Conflict of Interest. None.

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