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Status of biomass energy resource in Assam

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Abstract

Biomass has been one of the main energy sources for the mankind since the dawn of the civilization, although its importance dwindled after the expansion in the use of oil and coal in the late 19th century. There has been resurgence of interest in recent years in the biomass energy in many countries considering the benefits its offers. Estimates have indicated that 15-50% of the world's primary energy use could come from biomass by the year 2050. Currently about 11% of the world's primary energy is estimated to be met with the biomass. Like in most developing countries, Fuel wood occupies the pre-eminent position amongst the domestic consumption of fuel in India. Assam is no exceptional to the overall India's energy scenario. Around 80% of the households depends primarily fuelwood either as a single fuel or in combination with other fuels. The demand of domestic fuels is met by conventional biomass sources. Assessment of available bio resources is helpful in revealing its status and helps in planning a sustained supply to meet the energy demand.

Against this backdrop, an explorative analysis is been attempted with the objectives of estimating the availability of forest biomass and agricultural biomass for energy use. The whole study has been made b agro-climatic using satellite based secondary source of data . The status of biomass regarding its energy use in terms of its efficiency in respective zones are thereby calculated in which all the zones are found to be deficient depicting an alarming situation in the present energy scenario..

Keywords: *Biomass, Agro-climatic zones, Possible fuelwood, biomass status.*

Introduction

Assam situated in North-East India, is physiologically land of hills, valleys and mighty river Brahmaputra. The name Assam is derived from the Sanskrit term 'Asom' meaning unequal or unrivalled. It is the largest amongst the eight states of them, in terms of its population and geographical area. With a geographical location of 89.5 – 96.1 east longitude and 24.3- 27.58 north latitude, it covers an area of 78,438 km2, which is about 2.4% of the country's total geographical area.

According to 2011 census, Assam has a population of about 31 million, compared to all India total population of 1210 million. Population density of Assam is calculated to be 397 sq km which is higher than the national population density of 382 sq km. It is pre-dominantly a rural based state, almost 86 % of its population still living in rural. The economy of the state continues to be agrarian and the agricultural sector contributes 25% to the state domestic product (Dhar,2014)

In terms of fuel use Assam records a high percentage of households using fuel wood i.e. 72.1%, much higher than the national average of 49.0% on the other hand modern energy carriers like LPG, records ales percentage of user household i.e. 17.6, than the national average of 28.6%. Under this backdrop, the present study has been concentrated to assess the biomass status of the state, based on availability and consumption of biomass energy resource. Assessment of available bio resources is helpful in revealing its status and helps in planning a sustained supply to meet the energy demand. (Guta, 2012)

According to the Indian state of forest report 2011, as per assessment, the state has 18 forest types belonging to five forest type groups viz tropical wet evergreen, tropical semi-evergreen, tropical moist deciduous, tropical dry deciduous and sub tropical pine forest.

The word 'biomass' consists of 'bio+mass' and originally used in the field of ecology simply referring to amount of animal and plant. But after oil crisis, the meaning of the term has widened beyond ecological perspective and came to include the meaning 'biological resources as energy sources, since it was vigorously proposed that alternative and new energy sources should be promoted. Though there is no any strict definition of biomass, yet it is general term for 'animal and plant resources and the waste arising from them.' Biomass resources comprises of residues from agriculture, harvests from forest (in the form of firewood, charcoal, residues), crop residues, energy crops, animal manure, residues from agro-industrial and food processes, municipal solid wastes, and other biological resources. These resources could be directly utilised for basic energy needs (e.g. firewood, charcoal, dung cake etc) or transformed into invaluable renewable energies (e.g. biogas, bio-fuel, bioelectricity, hydrogen energy etc) for household as well as industrial and transportation sectors. (Asian handbook on biomass)

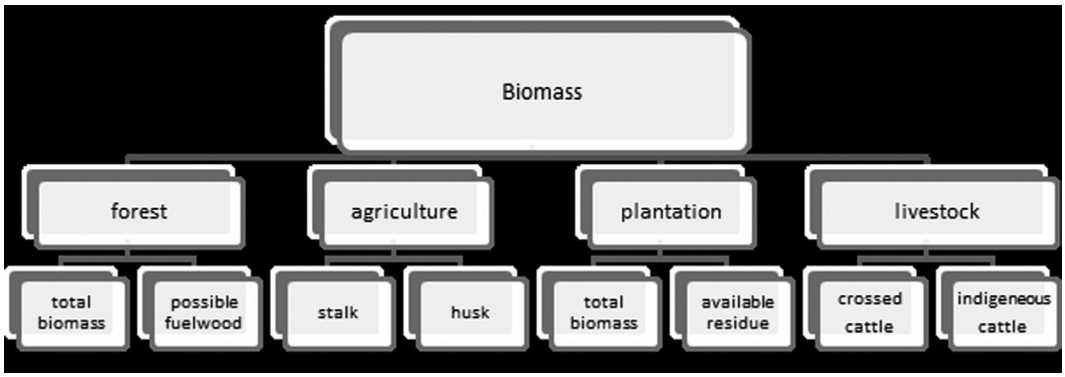

Fig 1 : categorization of biomass

Objectives:

The main objectives of the study are;

- a/ to estimate the availability of biomass in the agro-climatic zones of Assam
- b/ to estimate the status of energy with respect to its use.

Study area:

The present study has been done on the agro-climatic zones of Assam. On the basis of terrain, rainfall and soil characteristics, Assam is broadly classified into six agro-climatic zones.

1. **UBVZ(Upper Brahmaputra valley zone)** : This zone comprises of the districts of Sivsagar, Jorhat, Golaghat, Dibrugarh and Tinsukia , encompassing a total area of 16,192 km2, about 20.40% of the state area. The topography of the zone slides down gradually from the hills towards the Brahmaputra. The climate is characterized by high rainfall i.e more than 2000 mm per annum and high humidity of more than 80%. The maximum temperature records about 37C in July august and minimum falls to 10 C in January.

2. **NBPZ (North Brahmaputra plain zone**) : This zone comprises of districts of Lakhimpur, Dhemaji, Darrang and Sonitpur, with an area of 14421 km2. NBVZ covers about 18.37% of the total area of the state. This zone can be divided into three belts of distinct physiography (i) in the foothills of Himalayas, alluvial soils are found with dense forests. On the south of this belt, there are small tea plantations extending from Subansiri river to river Barnadi; (ii) the central belt comprises old alluviums which are acidic. Near the river banks there are new alluvials which are either neutral or less acidic ; and (iii) the low lying riverine belt lies by the side of Brahmaputra. (kataki, 2012). The average rainfall of this zones is recorded to be 1000mm.

3. **LBVZ (Lower Brahmaputra valley zone):** This zone covers about 25.75% of the total state area, comprising of the districts of Kamrup, Dhuburi, Bongaigaon, Nalbari, Barpeta, Kokhrajhar and Goalpara with an area of 20148 km2. On the northern side lies the folded ranges of the Himalayas while in the south lies the plateau of shillong. The flood plains of the Brahmaputra lies in the southern part of the zone. The average rainfall of this zone is about 1700 mm, which increases towards the north and western side of the zone. The maximum temperature records upto 37C in the month of july august while a minimum temperature of 10C in recorded in January. The soil of this zone is mostly sandy and sandy loam loam in texture.

4. **Hill zone** : The districts of Dima hasao and Karbi Anglong constitutes the Hill zone., covering about 19.4% of the total state area, with an area of 15322 sq.km Both the districts are characterized by undulating topography. The north cachar hills are high and steep. In karbi Anglong the hills have gentle slopes. (kataki, 2012).

5. **CBVZ(Central Brahmaputra valley Zone**) includes Morigaon and Nagaon, with an area of 5561 sq.km, covering about 7.08% of the total state area. The main crops are mustard, jute, rape, pulses. About 30% of the area falls in the rainshadow belt with a recorded temperature of about 600 mm. The temperature falls within the range of 8C-38C. Soil of this zone is lighter in texture.

6. **Barak valley** comprise of Cachar, Hailakandi and Karimganj, with an area of 6922 sq.km. covering about 8.9% of the state's area. The zone is characteristically bear an undulating plain. Karbi Anglong and North cachar are the two hilly states that separates the whole zone from rest of the Brahmaputra valley. The climate is characterized by high rainfall, temperature and humidity. The zone is typically swampy in nature, with low marshy lands.

Methodology :

Secondary data source pertains to census, statistical handbook, published literature, research journals etc. The satellite data has been assessed from the website of National Remote Sensing Agency (NRSA) www.bhuvan.nrsc.gov.in. The entire study has been done using 2011-12 data, depending on its availability. This secondary source has been used for north east states, Assam (agro-climatic zones and districts) and the study area. Biomass inventory, its availability and demand, both are assessed from secondary data source.

In both the cases of biomass assessment viz North-East and Assam, three main categories of biomass is chosen for assessment viz, forest, agricultural-plantation and agricultural-cropland. Assessment of the definite area under the mentioned categories is generated from the website.

The total forest area is divided into evergreen forest, deciduous forest and scrub forest as per availability of data. The total biomass from each category of forest is calculated accordingly. Total biomass= area* productivity. Mean annual increment (MAI), is calculated from each individual category of forest. It is a pre-calculated percentage adopted from a report of NRSA(1992). 50% of MAI is the possible fuel wood actually available. Productivity of evergreen ranges from 13.41-27 t/ha/yr, productivity of deciduous ranges from 3.90-13.50 t/ha/yr while the productivity of scrub ranges from 0.9-3.60 t/ha/yr.(Ramachandra, 2007). However it is not the total biomass but only the mean annual increment (MAI) which should be considered as the sources of fuel wood. Again of the mean annual increment 50% may be considered as the actual source of fuel wood as the trees have to meet demands other than fuel wood.

Adapted from a report of NRSA(1992), as already established, 10% of total biomass is the MAI in evergreen forest,10.21% of the total biomass is the MAI in deciduous forest,6.6% of the total biomass is the MAI in case of the scrub forest.

Similarly, from the area and the productivity of agri-plantation, the total biomass, MAI, possible fuel wood is thereby calculated. In case of agricultural plantation 9.26% of the total biomass in the MAI. Biomass production of plantations was calculated using an average productivity of 5t/ha/yr. Portion of the residues available are used as fuel while some is used as fodder and the rest is left behind in the

field for nutrient cycling. Apart from this, the actual availability of residues as energy supplements would also depend on other factors like efficiency of collection, mode of transportation and storage. Considering these, in the computation of bio residue from agriculture, only 50% is accounted for fuel. (Ramachandra, 2007)

In agro-cropland, production of cereals are considered in case of Assam, considering its mass production with respect to other food crops. The type and amount of residue generated is estimated from the residue production ratio (RPR).). In case of cereals two types of residues are produced viz, straw (RPR 1.4) and husk (RPR 0.2) and in pulses, residue produced is namely stalk(RPR 1.5) (Hiloidhari, 2014).

For calculating the demand of energy, the energy consumption rates have been considered. Estimation of consumption rates itself is a major challenge in energy studies, which varies from place to place, depending on many external factors. Estimation of the energy demand is based on the population of the states according to 2011 census. The population data of the states has been taken from 2011 census. The cultivated area and the biomass yield of each crop influence the biomass potential from agricultural residue. (Ramachandra, 2007).

Since energy consumption varies across different geographical regions, the per capita values used for cooking and water heating in hilly regions is taken to be 1.72 kg/person/day for water heating and 2.07 kg/person/day for cooking; and for plain region it is 1.02 kg/person/day for water heating and 1.85 kg/person/day for cooking. (Ramachandra,2007).

The status of the state in terms of bio-resource is determined by calculating the total availability and demand of fuel wood in the respective states and thereby calculated the efficiency and deficiency of energy. The ratio of the availability to the demand indicates the bio-resource status of the state. Ratio greater than one indicates bio-resource surplus zone while a ratio lesser than one indicates a bio-resource deficit zone.

Findings are displayed with the help of tables, maps and graphs.

Data have been analysed using proper statistical method.

Analysis :

Table 1: Availability of evergreen fuel wood in the agro-climatic zones

Agro-climatic zones	Evergreen forest area (ha)	Total biomass (ton)	MAI (ton)	Possible fuelwood (kg)	Energy Eqv (kcal)
UBVZ	152352	2132928	213292.8	96748014.38	386992057536
NBPZ	81418	1139852	1139852	51702831.83	206811327324
LBVZ	83248	1165472	116547.2	52864935.82	211459743264
HILL ZONE	164965	2309510	230951	104757641.5	419030565870
CBVZ	126	1764	176.6	80013.717	320054868
BARAK VALLEY	299341	4190774	419077.4	190090365.6	760361462238

Table 2; Availability of deciduous fuel wood in the agro-climatic zones

Agro-climatic zones	Deciduous forest area (ha)	Total biomass (ton)	MAI (ton)	Possible fuelwood (ton)	Energy Eqv (kcl)
UBVZ	353607	1414428	1414413	65504698	262018794070
NBPZ	287605	1150420	117457	53278014	213112057364
LBVZ	621062	2484248	253641	115049982	460199928968
HILL ZONE	803353	3213412	328089	148818875	59527550138
CBVZ	197325	789300	80587	36553899	14621559806
BARAK VALLEY	109266	437064	44624	20241218	80964872168

Table 3; Availability of scrub fuel wood in the agro-climatic zones

Agro-climatic zones	Scrub forest area (ha)	Total biomass (ton)	MAI (ton)	Possible fuelwood (ton)	Energy eqv (kcal)
UBVZ	16040	14436	952	432169	1469376864
NBPZ	8445	7600	501	227535	773621422
LBVZ	83401	75060	4954	2247093	7640118443
HILL ZONE	83268	74941	4946	2243510	7627934707
CBVZ	2174	1956	129	58574	199153697
BARAK VALLEY	25409	22868	1509	684600	2327643188

Tea is the most important plantation crop of Assam. Assam produces about 51% of the tea produced in India and about 1/6 th of the tea produced in the world. Tea is grown both in the Brahmaputra and Barak valleys. Tea gardens are mostly found in the districts of Dibrugarh, Jorhat, Sibsagar, Sonitpur, Golaghat and Darrang of Assam. There are more than 850 tea estates and 2500 tea gardens in Assam that covers thousands of acres of land.(Arya, 2013)

Table 4; Availability of plantation fuel wood in the agro-climatic zones

Agro-climatic zones	plantation forest area (ha)	Total biomass (ton)	MAI (ton)	Possible fuelwood (ton)	Energy Eqv (kcal)
UBVZ	224025	1120125	103723	47038641	134530514011
NBPZ	73080	365400	33836	15344644	43885682240
LBVZ	8578	42890	3971	180426	5151223074
HILL ZONE	6714	33570	3108	1409741	4031861940
CBVZ	13251	66255	6135	2782319	7957432613
BARAK VALLEY	56914	284570	26351	1195026	34177746566

Among the food crops, rice occupies about two-third of the total crop area of the state. Assam occupies aspecial place in the rainfed rice production system of the eastern India(being a major rain-fed rice production area, by covering about 9% of the total rice area and contributes 8% to the production. At national level, the state contributes over 5 % of the rice area and 4% of the rice production.(www.ncap.res.in)

Table 5 : Availability of crop residue in the Agro-Climatic Zones

Stalk		**Husk**			
Agro-climatic zones	Prod (ton)	Avail. Residue prod.(kg)	Energy eqv. (kcal)	Avail. Residue prod.(kg)	Energy eqv (kcal)
UBVZ	760.9	483095.41	1794216353	6549134	24323483790
NBPZ	663.8	421446.62	1565252747	5326714	19783419319
LBVZ	1190.8	756038.92	2807928549	11502652	42720849670
HILL ZONE	192.9	122472.81	454861787	14878852	55260058972
CBVZ	678.9	431033.61	1600858828	3654644	13573349619
BARAK VALLEY	373	236817	879540937	2023709	7516055338

Source: statistical handbook, 2011

Table 6 ; Availability of cattle dung in the agro-climatic zones

Crossed cattle			**Indigenous cattle**			
Agro-climatic zones	**Numbers**	**Available dung (kg) annually**	**Energy (kcal)**	**Numbers**	**Available dung(kg) annually**	**Energy (kcal)**
UBVZ	107338	391783700	66473156812	1748445	2393184094	406046758818
NBPZ	68295	249276750	42294287619	1628922	2229586988	378289564995
LBVZ	169903	620145950	77530922914	2319063	3174217481	538563131609
HILL ZONE	25397	92699050	15728062415	580498	794556637	134810835571
CBVZ	42029	153405850	26028063758	639061	87714743	148411101143
BARAK VALLEY	37376	136422400	23146515763	768161	1051420367	178392391125

Source; statistical handbook 2011

Considering the standard demand rate as mentioned above , the status of the agro-climatic zones as well as the respective districts under each zones are thereby calculated.

Table 7: biomass status of the agro-climatic zones : Fig 2: (refer page 55 for the figure)

Agro-climatic zones	Status
UBVZ	0.9
NBPZ	1.05
LBVZ	0.8
HILL ZONE	1.4
CBVZ	0.5
BARAK VALLEY	0.7

Shows the biomass status ratio in the six agro-climatic zones. It shows that only NBPZ and Hill zone are in the efficient state of biomass while other zones shows deficit state of biomass status.

Table 8 : biomass status in the districts of the agro-climatic zones. Fig 3: (refer page 56 for the figure)

Districts	Status
Dibrugarh	0.9
Golaghat	1.05
Jorhat	0.9
Sibsagar	0.8
Tinsukia	0.9
Darrang	1.1
Dhemaji	1.5
Lakhimpur	1.0
Sonitpur	0.8
Barpeta	0.7
Bongaigaon	1.3
Dhuburi	0.5
Goalpara	0.7
Kamrup	1.0
Kokrajhar	1.0
Nalbari	0.9
Karbi Anglong	1.3
N.cachar hills	1.7
Morigaon	0.6
Nagaon	0.4
Cachar	0.7
Hailakandi	0.5
Karimganj	0.7

The table shows the biomass status analysis of the districts. It shows that wide variation among the districts. Amongst the districts only 9 districts shows an efficient state of biomass viz Golaghat, Darrang, Dhemaji, Lakhimpur, Bongaigaon, Kokhrajar, Karbi Anglong, North cachar and Kamrup. Kamrup the district of the study area shows an efficient status ratio of biomass i.e 1.0

Conclusion:

Intensive, area specific research is required to overcome the present energy scenario. Local area based planning as well as technologies compatible to users' need can go a long way in introducing efficient ways of energy use. Adequate and serious dedicated research is of paramount importance. In this context, mentioned may be made of MNRE (Ministry of Non Renewable Energy), TERI (The Energy and Resource Institute), AEDA (Assam Energy Development Agency), Centre of energy studies, Tezpur University and Gauhati university in their initiatives in this regard.

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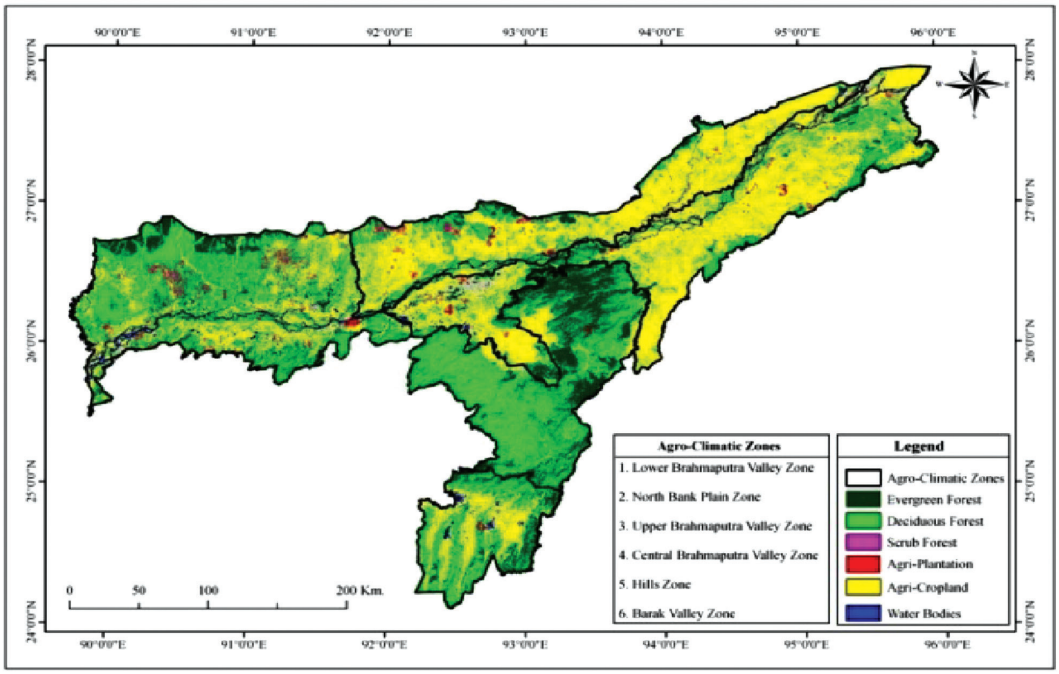

Figure 2: Distribution of biomass energy resource in the agro-climatic zones of Assam

(refer page 52 for the text)

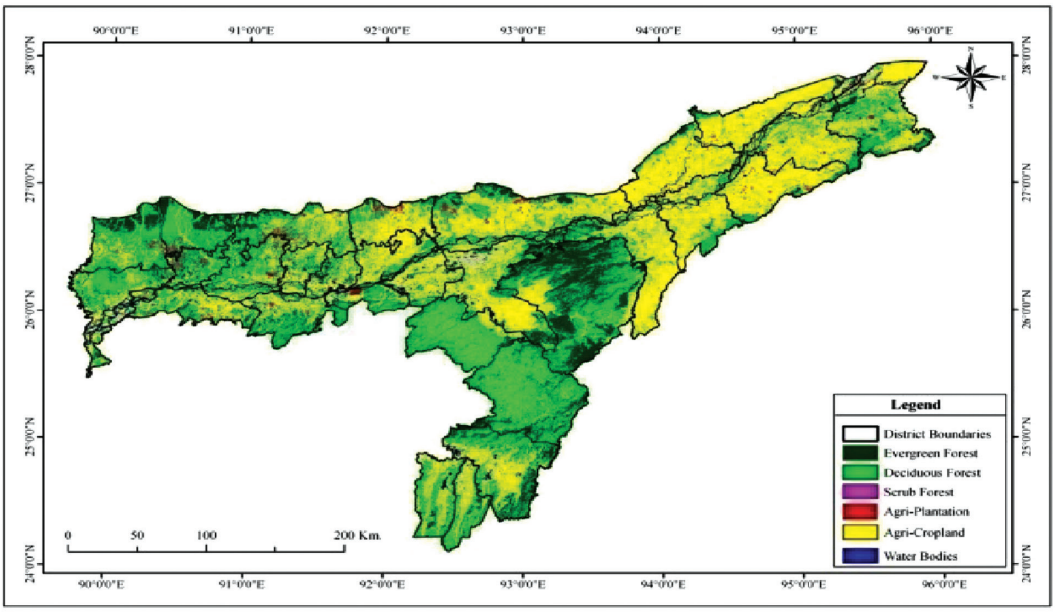

Figure 3 : Distribution of biomass energy resource in the districts of Assam

(refer page 52 for the text)