



IJSRM

INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH METHODOLOGY

An Official Publication of Human Journals




Human Journals

Research Article


October 2016 Vol.:4, Issue:4

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Agricultural Commodity Zoning Based on Agroecology Zone in Gopgopan Catchment Area, Tobasamosir North Sumatera



IJSRM
INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH METHODOLOGY
An Official Publication of Human Journals



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Submission: 3 October 2016
Accepted: 10 October 2016
Published: 25 October 2016

Keywords: commodity zoning, Agro-Ecology Zone, Gopgopan catchment area

ABSTRACT

This research aims: (1) to compile the agroecology zone in Gopgopan catchment area and identify the land resources for the sake of agricultural development; (2) to compile the information of the types of land uses for agriculture sustainability system; (3) to map the agricultural commodities based on AEZ. The method uses for this research is desk study, observation and survey. The homogeneous land unit (HLU) mapping done by overlaying topographic map, soil map, and ground elevation map. The result of this research shows that there are 9 HLU in Gopgopan catchment area. Geographically, it is between 99°0'30,409"E - 99°6'42,699"E East Longitude and 2°35'53,1"N - 2°24'24,244"N North Latitude. Gopgopan catchment area is in the regency of Toba Samosir that covers the districts of LumbanJulu, Bonatualunasi, Porsea and Uluan. Gopgopan catchment area consisted of 3 AEZ: Zone I (slope >40%), Zone III (slope 8 – 15%) and Zone IV (slope 0 – 8%). Agriculture system on AEZ I is dry land with forest plant, on AEZ III is dry land with cereal and nut crops, and AEZ IV is dry land with crops and one seasonal horticulture.



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INTRODUCTION

A. Background

The rapid growth of population will be followed by the growth of food demand and need. Fulfillment of the food need can be done by applying agricultural intensification and extensification system. Extensification will lead to the increasing of the land conversion into agricultural land. This activity will have a negative impact on the environment and hydrology. As the consequence, it can increase the critical land that symbolized by the increasing of the watershed number in the priority scale.

One of the efforts to increase the agricultural productivity is by growing the types of commodities according to land suitability. Land uses that do not fit can reduce productivity and quality benefits. Besides, it can cause disadvantage, not only economic and financial but also genetic and degradation of the land resources. Agricultural development must be based on the land potential, and its success depends on the choice of commodities as well as business systems in accordance with the characteristics of natural resources and the local socio-economic.

In order to optimally develop natural resources, there are various steps need to be taken, they are:

- (A) The identification of the quality and characteristics of the land;
- (B) Determine the suitability of land;
- (C) Establishes the level of management required for each land use;
- (D) Assessing the suitability of land for development of various agricultural commodities,
- (E) Determining the choice of commodities or certain types of land use that physically appropriate and profitable (Budianto, 2001).

The concept of agricultural zoning or agro-ecological zone mapping (AEZ) is simplification and grouping the diverse agroecosystem in the form of a more applicable classification (Las *et al.*, 1990). AEZ is also one of the methods to identify the land use for certain crops with high potential by observing the agroecosystem aspects or natural resources that consisted of soil, climate and vegetation.

Gopgopan catchment area is one of the catchment areas of Asahan watershed that is in the regency of Toba Samosir. Asahan Toba watershed is one of the watersheds that have been assigned as priority I watersheds (Decree of the Minister of Forestry and Plantation No: 284 / Kpts-II / 1999). Determination of the watershed priority is based on the criticality of the land and the rate of erosion in the watershed area.

B. Objective and Significance of The Research

This research aims:

- (1) to identify the potential of the land resources for agricultural development;
- (2) to compile the agroecology zone in Gopgopan catchment area;
- (3) to compile the information of the types of land uses for agriculture sustainability system.

The results of the research are expected to be useful, such as:

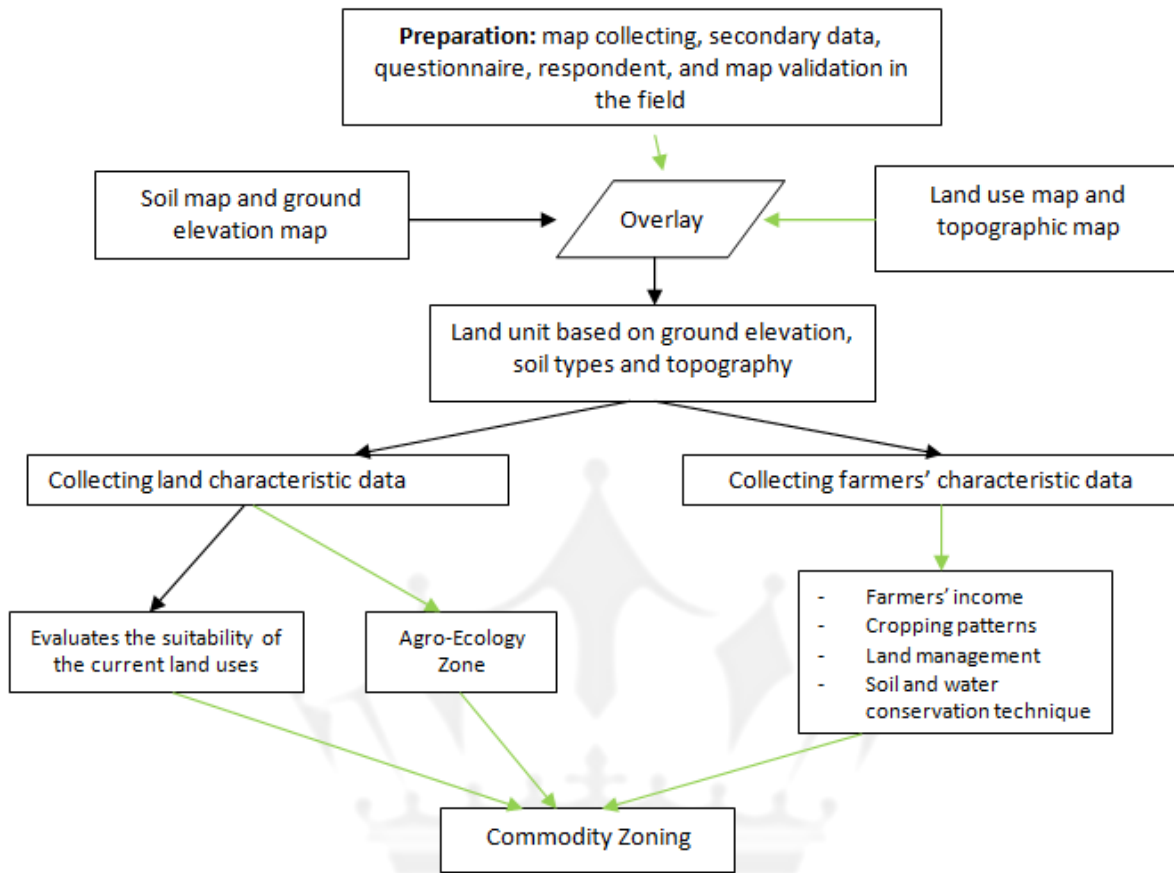
- (1) basic of the effective and sustainable agricultural development planning;
- (2) to facilitate in setting the areas of superior commodities;
- (3) to facilitate in selecting appropriate technology package for each specific area, or extrapolation proved technology, that has equal or nearly equal in the physical condition of the environmental and socio-economic.

RESEARCH AND METHODOLOGY

The research was conducted in February 2015 - July 2015. The location of the research is Gopgopan catchment area, Toba Samosir, North Sumatera. The tools used are one set of computer, GPS (Global Positioning System), digital camera, shovel, ground drill, hoes, knives, tape measure, camera, and a sample bag, and stationeries. Materials used in this research are the map of Gopgopan catchment area, soil type map, topographic map, land use map, rainfall data, farmers' socioeconomic data, materials for the survey and analysis of physical and chemical characteristics of the soil in the laboratory.

Research Method

This research uses survey method that divided into several steps, the steps can be seen below.



Pict. 1. Research Step

Data Collection

The data collection consisted of primary data and secondary data. The primary data are land biophysics, climate, farmers' characteristics and farmers' socio-economic that taken by direct field observation and measurement and respondent interviews through the questionnaire. The secondary data is the data of general overview of research areas from the villages and regency data and related reports from related institutions, maps and related agencies.

Table 1. Types, Source and Use of Data for Compiling Agro-Ecology Zone in Gopgopan Catchment Area.

Type of Data	Data Source	Use of Data
Secondary data		
Layout, geographical, soil properties, climate, topography, rainfall data	Base map, topographic map, a map of soil types, Bappeda Toba Samosir, BP DAS Asahan Barumun, BMKG data.	Describing the characteristics of the area and determining land units.
The type and extent of land use	Bapeda Toba Samosir Regency, BP DAS Asahan Barumun,	Describe the characteristics of land use.
Primary data		
Land biophysical (soil physical and chemical characteristics)	The soil survey and laboratory analysis.	Land suitability evaluation, determination of agro-ecological zone.
Plant Growing Terms	Survey and matching method.	Describing the land suitability.
Commodity zoning	Survey and matching method.	Getting appropriate commodity developed in gopgopan catchment area

RESULT AND DISCUSSION

A. Layout and Area

Geographically, Gopgopan catchment area is between 99°0'30,409"E - 99°6'42,699"E East Longitude and 2°35'53,1"N - 2°24'24,244"N North Latitude, with an area of 2.524,270Ha. Gopgopan catchment area is in the regency of Toba Samosir that covers the districts of LumbanJulu, Bonatualunasi, Porsea and Uluan (Table 2).

Table 2. Area of Gopgopan Catchment Area.

Regency	Districts	Villages	Area ha
Toba Samosir	LumbanJulu	JanggaDolok	16,404
		JanggaToruan	211,960
		Sibaruang	429,704
	Uluan	Sampuara	23,801
	Bonatolunasi	Sihiong	710,857
		SinarSabungan	532,694
		LumbanLobu	85,875
	Porsea	Amborgang	339,694
	Bandar PasirMandoge	Huta Padang	173,281
	Gopgopan Catchment Area		

B. Climate/Rainfall

Based on Oldeman climate classification (1972), climatic conditions in the Gopgopan catchment area, Toba Samosir included in zone B with the wet months between 7 – 11 Month and dry month in a row of less than 3 months. Rainfall in Gopgopan catchment area is between 1827,00 mm to 3166,41mm. Several important climate elements, such as: temperature, humidity, and precipitation are presented in Table 3. Based on the number of the wet and dry months, the types of rain in Gopgopan catchment area included into rather wet (Schmidt and Ferguson, 1951).

Table 3. The Average of Several Important Climate Clements in The Last 20 Years (1995–2014).

Year	Rainfall (mm)	Rainy day (day)	Number of Months		Temperature			Humidity
			Wet/ moist	Dry	Max	Min	Average	
2005	1954,98	163	2	10	26,00	14,55	22,71	75,10
2006	1907,80	195	2	10	24,26	22,98	23,55	78,44
2007	2341,60	198	1	11	26,19	22,66	23,75	79,67
2008	2568,70	206	3	9	30,13	17,35	26,29	72,75
2009	1981,85	161	2	10	31,97	28,30	29,95	62,80
2010	1827,00	163	3	9	31,71	28,17	29,79	63,15
2011	3166,41	178	2	10	30,77	27,63	29,2	59,2
2012	2796,90	172	3	9	30,33	28,32	29,4	59,3
2013	2348,00	183	4	8	30,74	28,55	29,5	59,4
2014	2423,77	165	5	7	33,64	28,29	30,5	66,2

Source: Station Climate Data, Rainfall Data SPAS Hatinggian Lumbanjulu 2014.

C.Aspects of Land Use

The percentage of land use in Gopgopan catchment area are dominated by lading / hills with an area of 1345.817 hectares or covers 53.31% of the area of Gopgopan catchment area. While the least land use is as residential with an area of about 1,056 Ha (Table 4).

Table 4. The Percentage of Land Use in Gopgopan Catchment Area.

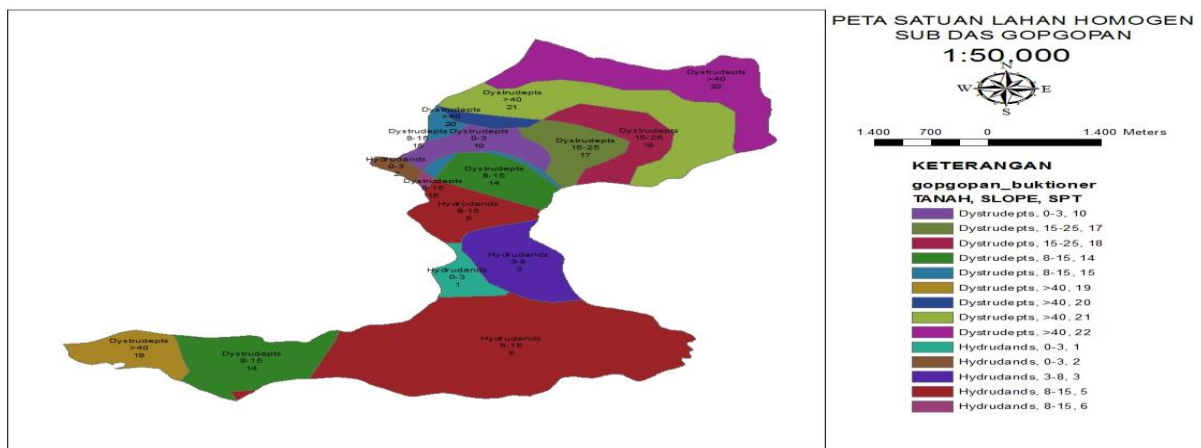
No	Type of Land use	Area(ha)	Percentage (%)
1.	Forest	815,969	32,324
3	Paddy field	335,824	13,303
3	Settlement	26,658	1,056
4	Field / grove	1345,817	53,315
	Total	2524,270	100,00

Source: Data Processing using SIG 2015.

D.Suitability Evaluation of Land Use

Evaluation of the suitability of current land use begins with a map of homogeneous land units (HLU), characterize the ground biophysical to determine the quality and characteristics of the soil in each HLU, evaluate the suitability of land (to match the quality and characteristics of the land with the plant growing terms), then overlaid with current HLU.

Soil map can be used as the base data that can be interpreted in accordance with the needs and goals of its development. In agriculture, soil maps used as basis for the assessment of land suitability for different types of commodities that will be developed and the level or management system that should be implemented. In this study, soil maps were overlaid with maps, topographic, and ground elevation into became the homogeneous land units map. The results obtained 9 HLU, presented in the form of a map as shown in Picture 2 and detailed descriptions are presented in Table 5.



Picture 2. Homogeneous Land Units Map Based on the Overlay Of Soil, Topographic And Ground Elevation Map.

Table 5. Homogeneous Land Units Based on The Overlay Of Soil, Topographic And Ground Elevation Map.

HLU	Soil Type	Topografi	Elevation (m asl)	Area (ha)
1	Dystrudepts	>40	900-1100	303,391
2	Dystrudepts	8-15	900-1100	920,416
3	Hydrudands	8-15	900-1100	1521,417
4	Hydrudands	0-3	900-1100	233,401
5	Hydrudands	3-8	900-1100	188,194
6	Dystrudepts	0-3	1100-1300	240,852
7	Dystrudepts	15-25	1100-1300	106,982
8	Dystrudepts	15-25	1500-1700	131,15
9	Dystrudepts	>40	1500-1700	828,42

E.Agro-Ecology Zone (AEZ)

Agroecology zone (AEZ) is a grouping of a region based on the physical state of the environment that almost equal in which the diversity of plants and animals can be expected not significantly different. The main component of agroecology is the climate, physiographic and soil. Climate is the most dominant variable in determining the growth of plants. The main components of the climate in determining AEZ are air temperature associated with altitude, humidity and rainfall. Agricultural business is also determined by the shape of the region and soil type. The shape of the region is easier to be determined by the magnitude of the slope. Soil properties that really determine in agricultural business are the acidity and/or texture and/or drainage (Research Centre for Soil and Agro-climate and Institutional Development Project Agricultural Research and Development, 1999).

The better the state of the land, there will be more alternative crops can be selected. In the selection of appropriate plants to cultivated on an area of land, the data input of a slope, drainage, texture, acidity is required, and is equipped with a data regime of humidity or rainfall and the regime of temperature or altitude, since AEZ is one of the way to organize the land use through clustering region on the basis of similarities in the characteristics and condition of the region. One of the purposes of grouping AEZ is to set the area or crop mapping and commodity development mapping in accordance with the carrying capacity of

the environment. The development of crops in accordance with AEZ will obtain optimal farming and sustainable.

The results of analysis of soil properties and biophysical Gopgopan catchment area (Table 6). Karakteristik CEC soils have low levels of acidity in the range of very sour, sour and slightly sour, organic C is low to very high, soil texture is argillaceous sand and sandy clay, and the drainage condition is Good.

Table.6 The Results of Analysis of Soil Properties in Gopgopan Catchment Area.

HL U	CEC	KB	pH-H ₂ O	C-org	Texture	Kdlmtn h (cm)	Topografi	Drainage	Soil Type
1	10,25	50	5,9	1,35	sandy loam	20-50	>40	good	Dystrudepts
2	14,21	44,41	5,66	3,38	sandy loam	>100	8-15	good	Dystrudepts
3	9,34	88,01	6,3	2,03	sandy loam	>100	8t-15	good	Hydrudands
4	7,89	54,25	5,95	1	sandy loam	>100	0-3	good	Hydrudands
5	8,68	74,51	6,21	1,93	sandy	>100	03-8	good	Hydrudands
6	7,74	43,45	5,45	1,44	sandy loam	20-50	0-3	good	Dystrudepts
7	9,5	28	5,1	1,4	sandy loam	>100	15-25	good	Dystrudepts
8	24,03	3,75	4,04	7,69	Sandy clay loam	20-50	15-25	good	Dystrudepts
9	9,33	40,74	5,74	2,92	sandy loam	>100	>40	good	Dystrudepts

Explanation: base saturation, cation exchange capacity, soil depth.

Agro-ecology zone of Gopgopan catchment area can be seen in Table 7. Table 7 shows that the Gopgopan catchment area, on the basis of physiographic land of diversity gradients, has several zones: I, II, III, IV wherein each zone has a form of management as well as the potential development of specific farming systems in accordance with the carrying capacity of the environment. Meanwhile, based on altitude, it has the regime of cool air temperatures, while on the basis of the characteristics of rainfall, it has the regime of moisture.

Table 7. Agro-Ecological Zone (AEZ) of Gopgopan Catchment Area.

SL H	Fisiografi	Iklim		Soil			Symbol AEZ
	Topograp hy(%)	Annual rainfall (mm)	Altitude (m)/Reji mSuhu	Kondi siDrai nase	pH	Texture	
1	>40 (I)	1900- 2700 (Moist- Y)	900- 1100 (cool- B)	Baik (1)	5,9 (neutral)	Sandy clay loam	IYB1, neutral Sandy clay loam
2	8-15 (III)	1900- 2700 (Moist- Y)	900- 1100 (cool B)	Baik(1)	5,1 (acid)	sandy loam	IIYB1, acidLoamy sand
3	8-15(III)	1900- 2700 (Moist- Y)	900- 1100 (cool B)	Baik(1)	6,3 (neutral)	Sandy clay loam	IIYB1, neutral Sandy clay loam
4	0-3 (IV)	1900- 2700 (Moist- Y)	900- 1100 (cool B)	Baik(1)	5,95 (acid)	Loamy sand	IVYB1, acidLoamy sand,
5	3-8 (IV)	1900- 2700 (Moist- Y)	900- 1100 (cool B)	Baik(1)	6,21 (neutral)	Loamy sand	IVYB1, neutral Loamy sand
6	0-3 (IV)	1900- 2700 (Moist- Y)	1100- 1300 (sejuk B)	Baik(1)	5,66 (neutral)	Sandy clay loam	IVYB1, neutral Sandy clay loam,
7	15-25(III)	1900- 2700 (Moist- Y)	1100- 1300 (cool B)	Baik(1)	6,25 (neutral)	sandy loam	IIYB1, neutral Sand loam
8	15-25(III)	1900- 2700 (Moist- Y)	1500- 1700 (cool B)	Baik(1)	5,45 (acid)	sandy loam	IIYB1, acidSandy loam,
9	>40 (I)	1900- 2700 (Moist- Y)	1500- 1700 (cool B)	Baik(1)	4,04 (acid)	sandy clay loam	IYB1, neutral sandy clay loam

Gopgopan catchment area has AEZ characteristics as the following:

1. Zone I is a land that has a slope of $> 40\%$ or a region which is very steep where the slope is not permitted for the cultivation of agricultural crops, the Zone I area ideal for forestry as productive forests or protected forests. There are several subzones which are in Zone I, namely: 1) Subzone Y is the areas with high rainfall or humidity Moist regime, with annual rainfall between 1700-2500 mm, 2) Subzone B with altitude area between 500-1000 m asl or Cool temperature regime, 3) Subzone 1 is a region that has a good drainage.

2. Zone II is the zone with the type of plantation / cultivation of annual crops / fruits land use. The utilization of the land is for crops plantation or perennial plants with conservation farming system. Planting without tillage, minimum tillage and the use of cover crops (cover crop) under the perennial plants helps to prevent erosion that can lead to degradation of land quality and environmental damage (Manik, 2007). Types of commodities suitable for plantations or perennial crops in this zone are cocoa, coffee, rubber and cotton. This zone can also be directed to the utilization of limited production forest, with the principles of environmentally friendly management. The silvicultural system (selective logging, planting) can be consistently and sustainably applied in forest management, given the soil conditions which are still relatively vulnerable to erosion. With that management principle, thus the forest sustainability and land can be maintained and the production of the wood as a source of sustainable income for the regional economy.

3. Zone III is a land with a slope of 8-15% or the land with choppy physiographic and pretty steep slope. The farming system used is a combination of agroforestry with annual crops and productive food crops, fodder crops and monoculture food crops by applying conservation technology. Subzone contained in Zone III is 1) Subzone Y, is areas with high rainfall or humidity Moist regime, with annual rainfall between 1500-3000 mm, 2) Subzone B with an altitude between 500-1000 meters above sea level where the temperature regime cool and, 3) Subzone 1 with Good drainage conditions.

4. Zone IV is a land with a slope of $< 8\%$ where the land can be used for planting include all kinds of commodities, intensively good for one seasonal or perennial crops, plant by using monoculture or intercropping. Land in this zone is flat land up to a bit flat. Subzone contained in Zone IV are: 1) Subzone Y, is the area with high rainfall or humidity Moist regime, annual

rainfall between 1500-3000 mm, 2) subzone B with an altitude between 500-1000 meters above sea level or temperature regime cool and 3) Subzone 1 with Good drainage conditions. The Commodities were developed based on land suitability evaluation in each zone are presented in Table 8 below.

Table 8. System pertaining dan alternative commodities unggulan.

Zona	HLU	Zone, farming system	Commodity	Land suitability	Area/ha
I /Dj	1,9	Zone I, dry land, forest	Pinus, Mahoni	S2	401,011
II /Dj	2,3	Zone II conservation areas	Hutanlahankering		1179,623
III /Df	7,8	Zone III, dry land, crops of cereals, and nuts	Paddy(<i>Oryza sativa</i>), corn (<i>Zea mays</i>), wheat (<i>Triticum aestivum</i>), soybeans (<i>Glycine max</i>), peanuts (<i>Arachishypogaea</i>), green beans (<i>Vigna radiate</i>), red beans (<i>Vigna umbellata</i>)	S1, S2,	562,299
IV /Df-h	4,5,6	Zone IV, dry land, crops and horticulture seasonal,	Potatoes (<i>Solanumtuberosum</i>), peppers (<i>Capsicum annum</i>) tomatoes (<i>Lycopersiconesculentum</i>) eggplant (<i>Solanummelongenae</i>) green beans (<i>Vigna Sinensis</i>) red onion (<i>Allium ascalonicum</i>) mango, banana, hazelnut,	S1, S2,	1179,623
Total					2524,27

CONCLUSION

1. The percentage of land use in Gopgopan catchment area are dominated by fields / hills with an area of 1345.817 hectares or covers 53.31% of the area of Gopgopan catchment area,

the least land use is for mix cropping farm with an area of approximately 2.525 hectares or approximately 0.10%.

2. Land cover index in Gopgopan catchment area is approximately 32.324% of the total area of the catchment area.

3. Agroecology zone in Gopgopan catchment area classified into four zones, namely Zone I, II, III and IV. Each zone is divided into sub-zones dominated by sub-Zone Y (humid), B (cool) and 1 (good drainage).

4. Farming system in Zone I (forest), Zone II (conservation area), Zone III (dryland crops of cereals, and nuts) and Zone IV (dry land, crops and annual horticulture).

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