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THE CREATION OF BIOCLIMATIC VEGETATION MAP TO DEVELOP SUSTAINABLE AGRO FORESTRY IN BA AND KONE RIVER BASIN, VIETNAM*

Bioclimate and natural vegetation have a long - term relationship that identify the potential vegetation distribution at different areas. For that reason, bioclimatic classification system was applied to the territory of Ba and Kone river basin, Vietnam. The precipitation and temperature dataset of Ba and Kone river basin was collected from 17 climate, hydrology, rain gauge stations which allowed to create a bioclimatic map at a scale of 1:250.000. Three bioclimatic factors of thermal-moisture basic conditions such as annual temperature (TN), annual rainfall (RN), length of dry season (n) are selected as criteria system of Ba and Kone river basin's bioclimate. In order to describe the relationships between bioclimatic variables and zonal vegetation units, the resulting map presented 12 bioclimatic units corresponding distribution of vegetation from low to high altitudes. By building bioclimatology map in Ba and Kone river basin, the government can develop sustainable agro forestry in Central Highlands and South Central Coast of Vietnam.

Keywords: *natural vegetation; bioclimatic classification; bioclimatic map; dry season; Ba and Kone river basin.*

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ПОБУДОВА БІОКЛІМАТИЧНОЇ КАРТИ РОСЛИННОСТІ ДЛЯ РОЗВИТКУ СТАЛОГО ЛІСОВОГО ГОСПОДАРСТВА В БАСЕЙНІ РІЧОК БА І КОН, В'ЄТНАМ

Біоклімат і природна рослинність мають довготривалі взаємозв'язки, які визначають потенційний розподіл рослинності на різних територіях. З цієї причини система біокліматичної класифікації була застосована до території басейну річок Ба і Коне, В'єтнам. Масив даних щодо опадів і температури басейну річок Ба і Коне було зібрано на 17 кліматичних, гідрологічних, дощомірних станціях, що дало можливість укласти біокліматичну карту в масштабі 1:250 000. В якості критеріальної системи біоклімату басейну річок Ба та Коне обрано три біокліматичні фактори базових умов тепла і вологи, такі як річна температура (TN), річна кількість опадів (RN), тривалість посушливого сезону (n). Для того, щоб описати взаємозв'язок між біокліматичними змінними та зональними одиницями рослинності, на отриманій карті було представлено 12 біокліматичних одиниць, що відповідають розподілу рослинності від малих до великих висот. Створення біокліматичної карти рослинності в басейні річок Ба і Коне надасть можливість уряду країни розвивати стале лісове господарство на Центральному нагір'ї та на південному узбережжі В'єтнаму.

Ключові слова: *природна рослинність; біокліматична класифікація; біокліматична карта; посушливий сезон; басейн річок Ба та Коне.*

Introduction

Climate plays an important role in plants distribution and their diversified communities, so the study of this relationship were developed to get the new science of bioclimatology. There are numerous bioclimatology research projects of in different parts of the world, ranging from global to local application.

Typical research of worldwide bioclimatic classification is mentioned as "Worldwide Bioclimatic Classification System" of Rivas-Matínez et al, 1982 which was applied in some research Bioclimate-Vegetation Interrelations along the Pacific Rim of North America [1] or Bioclimatic classification of US vegetation along a coast-to-coast macrotransect

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crossing central United States [2]. On the global scale, bioclimatic zones from Mediterranean Arid/ Dry/ Humid/ Semiarid zones to Temperate Humid/ Dry/ Cold zones and to Boreal Oceanic/ Continental zones have shown close relationship of climate and natural vegetation's divisions of Central United States or along the Pacific Rim of North America. To do these classifications, the authors have used a great number of climatic data collected from hundreds of hydrology stations, dozens of parameters and indices. To portray the connection between climate and rulable classification of natural plants, some important parameters are used such as annual temperature, mean temperature of the hottest month, mean temperature of the coldest month, annual precipitation, total precipitation of rainy season, total precipitation of dry season, etc, while indices are Continentality Index, HEV Holdrige yearly evapotranspiration, Thornthwaite yearly evapotranspiration, Thermicity Index, Holdrige evapotranspiration, etc.

On a national scale, some specific countries are mentioned such as Palestine [3], Iran [4], Libya [5], Portugal [6]. Some of these research mentioned the limits between bioclimatic zones in relation to rainfall, temperature and other bioclimatic factors such as Libya, or divided the studied territory into groups reflected by the ombrothermic indices of the driest months of the year, while others revealed macrobioclimates or bioclimate variants for vegetation map such as Iran, Portugal, Palestine. They all have highlighted the influence of bioclimatology on vegetation and almost used climate factors or bioclimatic parameters (independent variables) to classify bioclimatic units for each specific plant.

Other studies are also concerned with some mountainous regions as Eastern Alps [7], Venezuelan Andes [8] or the territories bordered the ocean as Yucatan Peninsula (Mexico) [9], Canary Island (Spanish archipelago)[10], Iberian Peninsula [11], etc. AThese research projects clearly show that the authors have focused on the interrelation between climate and the distribution of living organisms, in particular, plants and plant communities. These authors have defined many bioclimatic units with different classification methods and numerical criteria. Several authors have related the thermal regime and humidity with sets of woodlands [3] – studied thermicity index, annual ombrotherme index [5] have combined rainfall and evapotranspiration through mean annual thermal amplitude to bioclimagram and Pluviothermic climagram. Bioclimate is the factor to understand vegetation's performance habitant modeling and their dynamics. Nowadays, by using bioclimatic variants, scientists can predict response of living organisms in case of climate change [12] with the use of growth model sibyla [13], computed bioclimatic indices and their spatial expression with Geographic Information System reflecting the monthly and annual averages for precipitation and temperature of Mexico from 1902 through 2011.

A number of presently available bioclimatic classification systems define bioclimatic units based on different types of methods and criteria. The most widely used bioclimatic classification of natural vegetation is the "Worldwide Bioclimatic Classification System" of Rivas-Matínez et al since 1982, being the last version having been published by Rivas-Martínez et al. [14] (WBCS) with 12 parameters and 6 bioclimatic indices to find the various floristic features. Following the formula proposed by Rivas-Matínez, the study of M.Djamali have used the set of 3 bio macrobioclimates, 10 bioclmates and 3 bioclimate variants applied in Iran that provide the most appropriate zonation for potential natural vegetation [4].In addition, many recently published bioclimatic maps were produced at different scale or were the result of local analysis, lacking reference to a WBCS. In Canary Island [10] the data from 85 meteorological stations was used to differentiate 26 bioclimatic belts and correlate them with vegetation series of this island. With 140 meteorological stations in Yucatan Peninsula (Mexico), the authors have built a bioclimatic map at scale 1:1.000.000 of two typical forest in this island as Xeric Tropical and Pluvistational Tropical [9]. Other research [2] uused a geographical information system bases on 987 weather stations located along a longitudinal macrotransect from the shores of the Atlantic to Pacific to identify 28 isobiclimates. Overall, bioclimatic approach can be applied to a range of woodlands and due to advantage of taking the different spatial density between temperature and precipitation stations, we can see that two climatic parameters have a distinctly different spatial variability and behavior of natural vegetation. It also confirms that shift climate variation can alter the quality of microhabitats and the types of vegetation that have adapted to these characteristic climate fluctuations.

In Vietnam, some noticeable research of Vietnam's bioclimatology classification can be referred as follows: Vu Tu Lap's bioclimatic classification

systems [15] used total annual temperature and Xelianhinov hydrothermal coefficient as heat – moisture indicator to classify landscape. Besides, Thai Van Trung's Vietnam forest classification [16] applied annual rainfall and drought index [17] X = S.A.D (S is the duration of dry season, A stands for the number of arid months and D means the number of drought months) to classify Vietnam's natural vegetation into 14 types According to Gaussen, the number of dry months S is identified when r <2t; the number of arid months A is determined when r <t and the number of drought months D is determined when r ≈0 or 5mm/month (r means monthly rainfall (mm) and t – monthly temperature in °C). Lam Cong Dinh's forestry applications of temperature and rainfall that contributes to creation of the bioclimatic criteria systems[18] with the 78 forms of formula "Temperature – Moisture – Lights" and he has combined them into 10 units of bioclimate. The ways to classify bioclimate of Vietnamese authors show that they mostly paid attention to the basic elements of climate: temperature and rainfall or humidity. For each of the factors, they have considered not only annual average values but also the highest values or the lowest values or maintenance time (the duration of dry season, duration of rainy season, etc).

Study area

Climates of Ba and Kone river basin hydrographic systems are combined by three factors as tropical radiation regime, tropical monsoon atmospheric conditions and topographic of South Truong Son Cordillera. Here, monsoon tropical climate is typically formed.

As a results of Phan Tat Dac, Pham Ngoc Toan's [19] and Nguyen Khanh Van's [20] research on climatic characteristics; Nguyen Duc Ngu, Nguyen Trong Hieu's [21], cclimatic zoning study show that climate of Ba and Kone river basin especially its humidity–rainfall regime is the combination of Centre Highlands' climate and South Central Coast climate. The summer season of Western Truong Son Cordillera starts from May to October upon the mainly impact of South–West monsoon while Eastern Truong Son Cordillera namely Binh Dinh, Phu Yen provinces has its rainy season which arrives in May but is interrupted by foehn Western wind in the period of June to July. It is not until The Intertropical Convergence Zone with its turbulence (storms and tropical low pressure) that normally occurs and Northeast monsoon appears from August to December that rainy season of Eastern Cordillera comes frequently in East of Truong Son Cordillera.

Data and methods

Database of classification and bioclimatic Ba and Kone river basin map is a standard data of bioclimatic features such as: annual temperature, annual rainfall and monthly rainfall which are collected from 17 meteorological, hydrological stations and rain gauge.

This study used following methods mentioned: statistical processing of climatic data, bioclimatic classification of vegetation and map method – Geographic Information Systems (GIS).

Based on regular division of natural vegetation in accordance with bioclimatic conditions, classification of bioclimatic Ba and Kone river basin collected important heat – moisture criteria to forest such as: temperature, rainfall, duration of dry season which were divided into suitable levels of ecosystems to create different units of bioclimate.

The results of bioclimatic classification for assessment of Vietnam climatic resources [22], Vietnam forest vegetation [16], Geographic landscape of Northern Vietnam [15] or Landscape classification for the purpose of reasonable use of natural resources [23] the criteria system of bioclimatic map of Ba and Kone river basin was created. Due to small area and its position, Ba and Kone river basin is located in typical monsoon tropical climate zone (without winter season compared to Northern Vietnam). Therefore, we find it unnecessary to use many parameters and indices, or detailed targets about monthly temperature, rainy season, dry season as abroad studies did. The specific characteristics of the Ba and Kone river basin's climate to be considered when selecting the system of bioclimatic criteria are: regular differentiation of climate, division of temperature according to elevation and the contrast between summer rainfall regime (South West monsoon) in Highlands and autumn- winter rainfall regime (North East monsoon) in South Central Coast of Ba and Kone river basin.

Moreover, to create scientific basis for organizational model of territorial regions of Central Highlands – South Central Coast for the purpose of sustainable agro forestry development in Ba and Kone river basin, bioclimatic studies show their effect on reasonable use of resources. Some typical bioclimatic variants that are normally used for classification in North East of Vietnam [24] such as: annual temperature (TN), total rainfall (RN), duration of cold season (N), duration of dry season (n). The

threshold of these criteria is chosen depending on ecological characteristics of vegetation types (on the basis of origin). In this study, the presence of basic types of natural vegetation such as evergreen, semi–evergreen, deciduous, tropical forest on mountains, etc.) points out the distinct of climatic features in the studying area.

To create criteria system of Ba and Kone river basin bioclimate, some specific characteristics of studied territory such as climate and ecosystem can be considered. Firstly, Ba and Kone river basin is typically tropical monsoon climate of Central Highlands with alterable temperatures according to large plateau and the rule of elevation, different humidity conditions between rainy season and dry season. Secondly, this climatic conditions connect to the presence of various types of vegetation from low to high altitudes such as:

1) *The tropical evergreen closed forest;*

2) *The tropical broad-leaved deciduous semiarid woodland forest* (lowland of Ba and Kone river basin, Central Highland);

3) *The tropical woodland, shrub, savann*a (Cheo reo, Daklak);

4) *The tropical evergreen closed forest at low mountain*.

There are some requirements to select criteria system of Ba and Kone river basin bioclimate:

- The nature and distribution characteristics of studied territory's thermal and moisture through space, time and altitude must be chosen for selected criteria;

- The law of distribution, the growth and development of the vegetation types existing in the studied area must be shown.

To assess the bioclimatic conditions of Ba and Kone river basin, factors reflecting thermal-moisture basic conditions are selected as mean annual temperature and total annual rainfall.

Mean annual temperature criteria

By analyzing the differentiation of temperature characteristics, to assess the thermal conditions in relation to distributed characteristics of vegetation, we have used mean annual temperature because it affects the rhythm of seasonal states of plants and their growth. Mean annual is also a valuable quantity in agriculture science and is often used widely in planning for agriculture production. Accordingly, thermal resource in the territory evaluated mean annual temperature named TN which is very valuable for agro-climatology research and widely used in Production Planning of Agriculture and Forestry. There are some thermal differences between space, latitude and elevation of studied territory that fluctuate from 26°C to 20°C. Temperature TN is classified into the following levels *(Table 1)*: (I). Very hot, TN ≥ 26ºC, equivalent to the total operating temperature more than 9,500ºC. As under 20m height, the coastal sections of Ba and Kone outfalls has very hot temperature conditions which are favorable for tropical plants to flourish. (II). Hot, 26°C > TN ≥24ºC, similar to the total annual temperature from 9,500 – 8,700ºC. This thermal level appears in the areas of 20 to 300m elevations and very favorable for vegetation and tropical plants to grow year – round. (III). Warm, 24°C > TN ≥22ºC, corresponding to the total annual temperature: 8,700-8,000ºC at 300 -700m height. This warmth level is still available for tropical plants. (IV). Cool, TN < 22ºC, equal to < 8000ºC at over 700m elevation. Tropical plants are still present and some kinds of sub- tropical plants are found here.

Humidity and rainfall criteria

"While the thermal regime has affected the distribution of plants and crops, the rainfall – moisture condition including dry – moisture regime has influenced appearance, shape and state of them" [22]. Besides, according to [16], dry –wet regime is the factor that

Table 1.

Classification of mean annual temperature

Criteria	Levels		Elevations	Characteristics of vegetation and plants
	T_N	Radiant energy	(m)	
I – Very hot	$T_N \geq 26^{\circ}C$	$\geq 9.500^{\circ}C$	<20 m	Typical tropical vegetation and plant with adequate heat
II - Hot	$26°C > T_N \geq 24^{\circ}C$	9.500-8700°C	20 - 300 m	Tropical vegetation and plant with adequate heat
III - Warm	$24°C > T_N \geq 22^{\circ}C$	8700- 8000°C	300 - 700 m	
IV - Cool	$T_N < 22^{\circ}C$	<8.000°C	>700 m	Tropical plants and some types of sub – tropical plants

control and choose types of climate for big tropical monsoon bioms, for example Vietnam. It is suggested that the complex combination of dry-wet regime compose of annual rainfall and the number of dry months.

Annual rainfall criteria

As an indicator of the humid potential supply for plants, humidity rainfall criteria is chosen as an indicator of the total annual rainfall (RN). By studying the rainfall regime throughout the territory in relation to natural genetic vegetation [16, 25], the following levels of the annual rainfall in Ba and Kone river basin are shown:

A. *Abundant rain, RN > 2,000mm,* indicating excess moisture conditions, to ensure dense evergreen forests with broadleaf trees existing in any circumstances.

B. *Moderate rain, 1,500mm <RN ≤ 2,000 mm,* corresponding to evergreen or semi-deciduous forests (depending on dry season).

C. *Little rain, 1200mm <RN ≤ 1500 mm,* corresponding to the type of dry deciduous forests or semi-deciduous forests.

D. *Very little rain, RN ≤ 1,200 mm,* corresponding to dry deciduous forest and scrub.

Because there are two rainy regimes in Ba and Kone river basin, Summer rainy season in West and Autumn – Winter rainy season in East, so the last one is indicated with asterisk (*). West and East of Central Highlands have the same amount of precipitation but differences in rainy schedule so that it makes a certain impact on natural vegetation, especially crops of agro forestry.

The duration of dry season

Beside the total annual rainfall, the number of dry months is also added as an indicator of climate limitation for plants in particular and tropical vegetation in general. The length of dry season is calculated by the month of dry season. Therefore, areas with short dry season are places with less than 2 months of dry season. Average dry season is from 3 to 4 months of dry season. Period of 5-6 months of dry season means long dry season. Over 7 months of dry season stands for very long dry season. Because the dry – moist regime of a territory is closely related to plant evaporation which depends on radiation conditions or temperature, the dry month index is determined in accordance with the relationship between rainfall and temperature r = 2t [17]. Thus, based on the distribution of annual rainfall, the number of dry months with rain ≤ 50 mm/month [17, 18, 20, 23], has a great influence on the structure and external appearance of the vegetation. The classification of dry season levels on Ba and Kone river basin relies on the results of these above studies.

Criteria system of bioclimatic division in study area is shown in the matrix of ***fig 1***. Based on analysis, overlaying the information of selected bioclimatic factors (TN, RN, n), the bioclimatic map of Ba and Kone river basin was created**.**

Results

The bioclimate map was established on the basis of overlapping analysis of annual average temperature data (TN), annual rainfall (RN) and the length of dry season (n). As the result, 12 units of bioclimate for natural vegetation in Ba and Kone river basin are shown in ***fig. 1*** and ***2.***

There are 12 bioclimate units in bioclimatology map of Ba and Kone river basin at scale 1: 250,000. Among them, IVBb has the most appearances with 4 areas, after that IIB*b bioclimate unit occurs 3 times in different areas; other 10 units: IB*c, IB*b, IIDc, IICb, IIICb, IIIBb, IIIB*b, IIIA*b, IVBb và IVA*b appear only one time.

From the above mentioned bioclimatic units, the unit of IIIBb occupies the largest area of 611.000 ha, equivalent to 33.8% of the whole region *(Table 3)*; the second largest area equivalent to unit of II*Bb – 247,414 ha (accounting for 13,7%); the third largerst

Table 2.

Classification of duration of dry season

Criteria	Levels	The number of dry months (n)	Characteristics of vegetation and plants
b	Average dry season	n = 3 – 4 months	Seasonal closed evergreen forests or Mid-decidous forests upon annual rainfall and groundwater
c	Long dry season	N ≥ 5 months	Mid-deciduous broad leaves sparse forests or deciduous broad leaves sparse forest in dry season

Note: The duration of dry season level a - n ≤ 2 months (insignificant dry season) which is equivalent to evergreen rainy forests, isn't found in Ba and Kone river basin.

is IICb with 215,600 ha (equivalent to 12%), the fourth one is IVAb – 207,500 ha (around 11.5%). Finally, the unit that has the smallest area is IIIB*b – 8,710 ha (equal to only 0.5%).

Description of the differentiation of bioclimatic units in Ba and Kone river basin territory was conducted from low lands to hills and mountains; from unit of drier bio-climate to the wetter bio-climate, in the following order below:

1. *IB*c. Type of bioclimatic unit: very hot, moderate rain, Autumn – winter rainy season, long dry season,* occurs only once in the bottom of Da Rang (Ba) river's estuary – Phu Yen province with its total area of 78,300 ha accounting for 4.3% of researched region.

2. *IB*b. Type of bioclimatic unit: very hot, moderate rain, Autumn – winter rainy season, average dry season.* This type of bioclimatic unit appears only once concentrating in low area, near Kone river - Binh Dinh province and has 109,700 ha equal to 6.1%.

3. *IIDc. Type of bioclimatic unit: hot, very little rain, Summer rainy season, long dry season.* Appeared only one times at the driest region of Ba and Kone river basin – Krong Pa (Gia Lai province) which has an elevation of under 300m, this kind extends 52,580 ha equivalent to 2.9% area.

4. *IICb. Type of bioclimatic unit: hot, little rain, Summer rainy season, average dry season.* It is also available once in center and spreads along Ba and Kone river basin to the South of under 300m height, including some district of Gia Lai Provices as Ayun Pa, Krong Pa and a part of Kong Chro và Chu Se. Therefore, this IICb has the third largest area 215,600 ha.

5. *IIB*b. Type of bioclimatic unit: hot, moderate rain, Autumn – winter rainy season, average dry season.* Getting the frequency of 3 at the elevation of under 300m, this IIB*b bioclimate unit occupies the second largest area as 13.7% territory. Obviously, it has an extensive extension from Binh Dinh province (Vinh Thanh, Tay Son, Phu Cat) to Phu Yen province (Son Hoa, Song Hinh, Tuy Hoa).

6. *IIICb. Type of bioclimatic unit: warm, little rain, Summer rainy season, average dry season.* Appears only once at 300 - 700m, this kind of bioclimate unit is seen in the East of Ayun Pa, Krong Pa (Gia Lai province) with 5% studied area – 89,360 ha.

7. *IIIBb. Type of bioclimatic unit: warm, moderate rain, Summer rainy season, average dry season.* IIIBb gets *the largest area up to 34.4% Ba and Kone river basin.* This type *can be found across the West at 300 – 700 elevation such as* Kbang, An Khe, Kong Chro, Chu Se (Gia Lai province), Ea Hleo, Krong Nang (Dak Lak province).

8. *IIIB*b. Type of bioclimatic unit: warm, moderate rain, Autumn – winter rainy season, average dry season.* Ea Kar, M Drak (Dak Lak province), Song Hinh, Son Hoa (Phu Yen province) have this bioclimatic unit with smallest density of 0.5% and only once appearance at 300 -700m height.

9. *IIIA*b. Type of bioclimatic unit: warm, abundant rain, Autumn – winter rainy season, average dry season.* With small area of 48,600 ha, accounting for 2.7% of studied region, IIIA*b appears only one times at M Drak (Dak Lak Province) and Song Hinh, Tuy Hoa (Phu Yen province) which have the eleavation of 300 -700m.

10. *IVBb. Type of bioclimatic unit: cool, moderate rain, Summer rainy season, average dry season.* With its widespread appearance of 4 times, IVBb bioclimatic unit can be seen in some places at the height of above 700m Mang Yang, An Khê, Kong Chro (Gia Lai province), Van Canh (Binh Dinh province), Ea Hleo, Krong Pa, Krong Nang (Dak Lak province). Contrary to its high frequency, this type of bioclimatic unit has an inconsiderable area of 112,972 ha - equivalent to 6.3%.

11. *IVAb. Type of bioclimatic unit: cool, abundant rain, Summer rainy season, average dry season.* It

Table 3.

Statistic area and times of appearance of bioclimatic types in Ba and Kone river basin

No.	Bioclimatic units	Area		Times of appearance
		Ha	%	
1	IB*c	78300	4.3	1
2	IB*b	109700	6.1	1
3	IIDc	52580	2.9	1
4	IICb	215600	12.0	1
5	IIB*b	247414	13.7	3
6	IIICb	89360	5.0	1
7	IIIBb	340200	18.9	1
8	IIIB*b	279510	15.5	2
9	IIIA*b	48600	2.7	1
10	IVBb	112972	6.3	4
11	IVAb	207500	11.5	1
12	IVA*b	21040	1.2	1
Sum	12 units	1802776	100.0	18

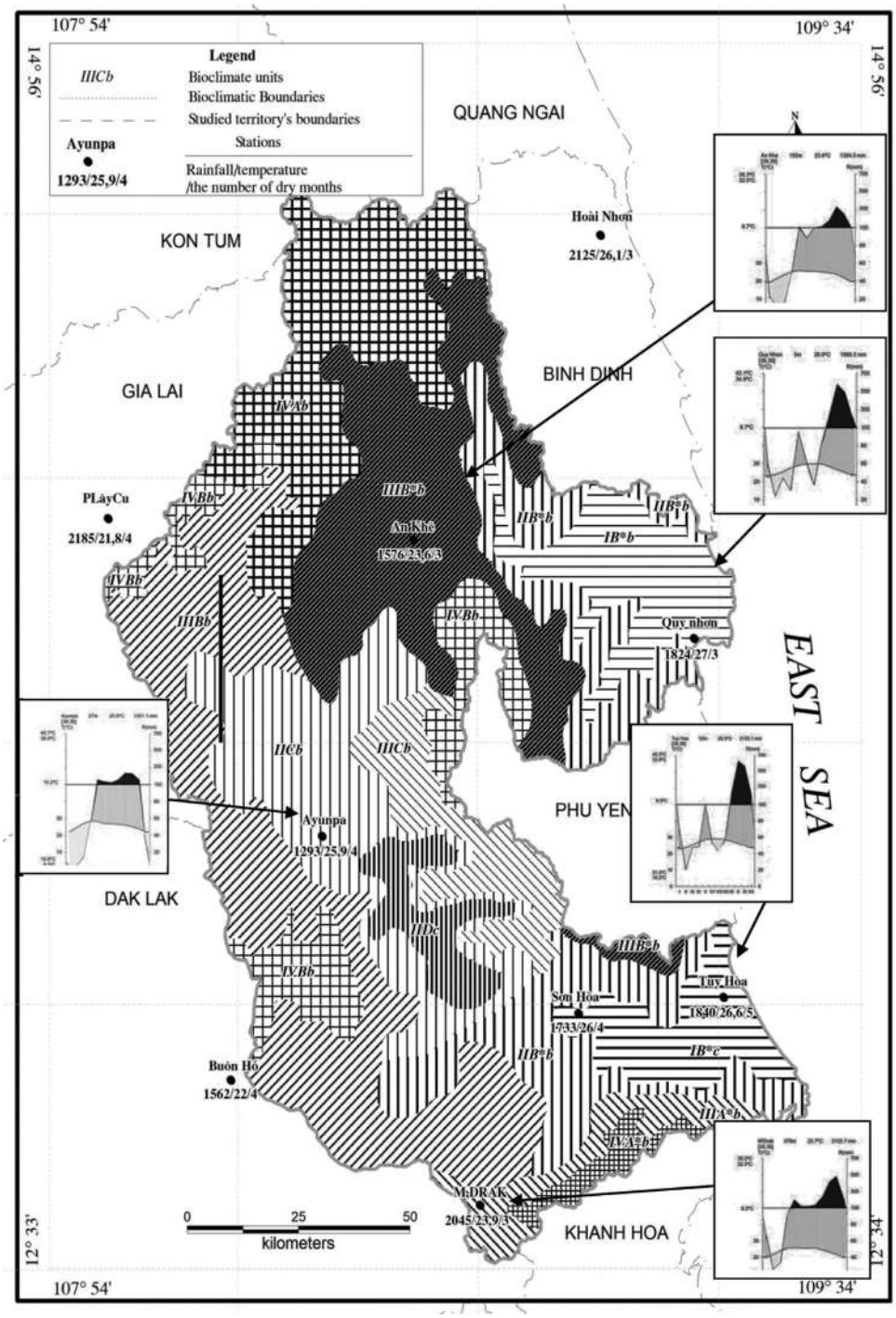

Fig. 1. Bioclimatic map (scale 1: 250,000) and bioclimatic diagrams in Ba and Kone river basin

*There are 12 bioclimate units in bioclimatology map of in Ba and Kone river basin at scale 1: 250,000. Among them, IVBb has the most appearances with 4 areas, after that IIB*b bioclimate unit occurs 3 times in different areas; other 10 units: IB*c, IB*b, IIDc, IICb, IIICb, IIIBb, IIIB*b, IIIA*b, IVBb và IVA*b appear only one times*

is shown one times at the elevation of above 700m in the North of Ba and Kone river basin which are Kbang, Mang Yang (Gia Lai province). This IVAb has the fourth largest area as 207,500 ha, equal to 11.5% researched territory.

12. *IVA*b. Type of bioclimatic unit: cool, abundant rain, Autumn – winter rainy season, average dry season.* It can be found once in the South of studied ara such as M Drak (Dak Lak province), Tuy Hoa, Song Hinh (Phu Yen province) which have the height of above 700m.

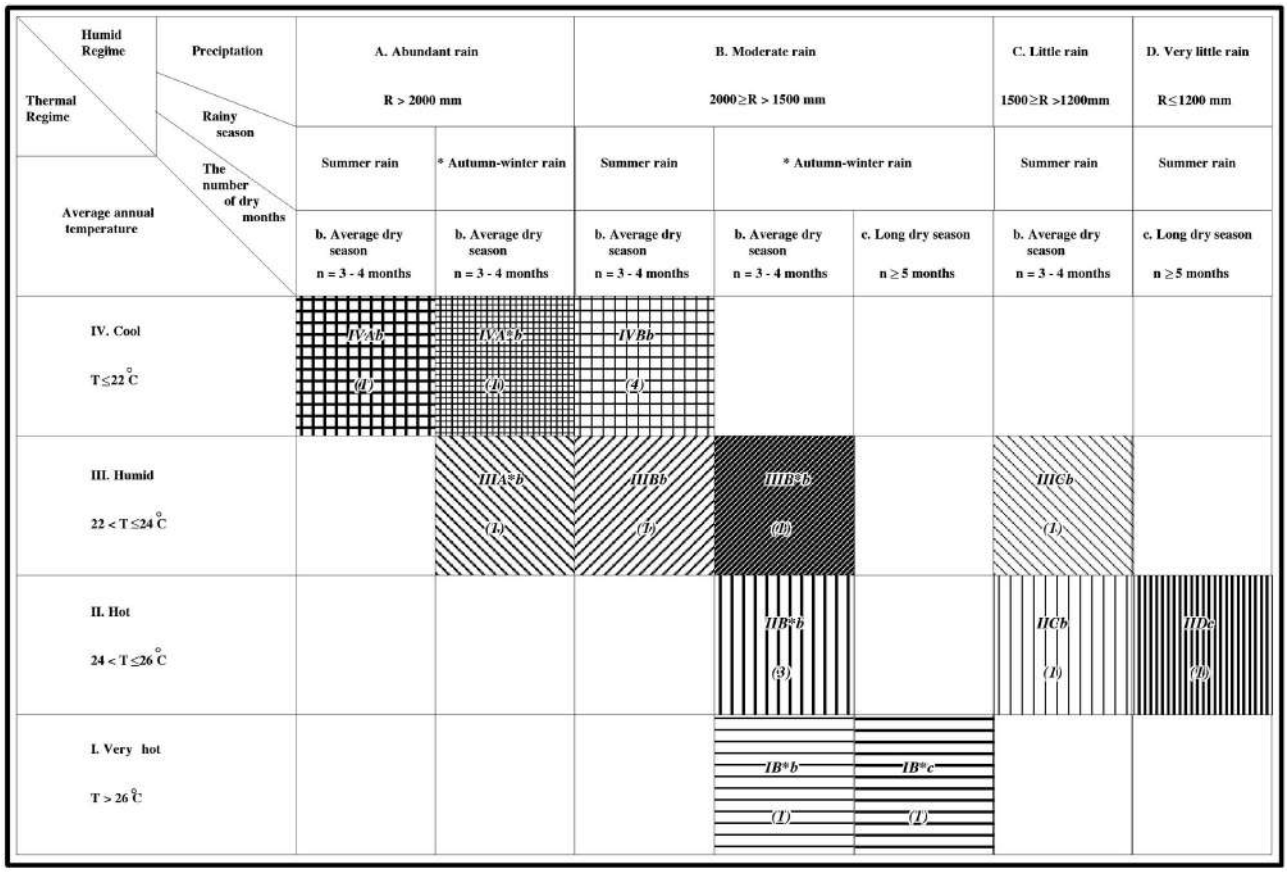

Fig. 2. Legend of bioclimatic system in Ba and Kone river basin

Conclusions

Ba and Kone river basin has a complex humidity and precipitation regime: The Western – Central Highlands has summer rainy regime, while Eastern coastline gets Autumn – winter rainy season, while the boundaries between Central Highlands and Eastern coastline including An Khe, M' Drak and other places receive mixable regime of rainfall. Special rainfall regime will provide water for agro forestry in Ba and Kone river basin giving the industry much more advantage in dry season. The bottom of Ba and Kone river basin can get enough water in dry season for manufacture and economy thanks to rainy season in the source of Ba and Kone river basin.

The result of bioclimatic classification in Ba and Kone river basin proves that bioclimatic resources in this territory are rather plentiful and comfortable for various floristics such as: tropical forest, sub- tropical vegetation and tropical evergreen closed forest; tropical broad-leaved deciduous semiarid forest and deciduous arid forest in dry season in Cheo Reo.

The variety of bioclimatic units in Ba and Kone river basin give many valuable indicators for probable existence of many natural vegeatation based on their origin; moreover, it is also a major premise for diversified landscape in Ba and Kone river basin to develop sustainable agro forestry.

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