

DROUGHT RISK ASSESSMENT FOR EACH COMMUNE OF KON TUM CITY IN CENTRAL HIGHLANDS OF VIETNAM

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1. INTRODUCTION

Vietnam is considered as one of the countries that is severely affected by climate change (Change, 2001), therefore response to climate change is crucially important to Vietnam. Increase in temperature and change in precipitation have observed in Vietnam during the past century. According to a report by the Central Steering Committee on Disaster Prevention in 2016, the consequences of climate change in Vietnam were evident with serious drought in the Central Highlands region. At the end of April and the beginning of May 2016, the Central Highlands region was in serious drought, causing great socio-economic losses. As of April 2016, there were more than 80,000 hectares of crops suffering from water shortages in Dak Lak province, of which nearly 15,000 hectares were lost and 26,247 households have lack of clean water. In Kon Tum, there are about 32,500 people without food, 2,800 households with 11,520 people who are lack of drinking water. The situation in Dak Nong and Gia Lai provinces is similar to Kon Tum province.

Drought is a natural disaster that affects the earth each year. Effects of drought range from water shortage, ecological degradation, losses of agricultural production, to human health impacts, famine, and food crisis. One can categorize the effects of droughts and water shortages into three groups: environmental, economic and social. Drought can also reduce water quality because lower water-flows reduce dilution of pollutants and increase contamination of remaining water-sources. Drought is subdivided into different types, including meteorological drought, agricultural drought and hydrological drought. This study use drought indexes to assess drought risk.

2. STUDY AREA

Kon Tum's terrain is a large valley with a common height of 515m - 535m. The city is surrounded by mountains which have ranges height of 600 to 800 m, Dak Bla river flows through the city from east to west. The city area is 432.98 km², of which land used for production is 13,736 ha. Kon Tum has 21 communes with a population of 138,011 and a population density of 319 people / km². In the past decade, the drought in Kon Tum city caused severe damage to crops and lack

of water for people demand. Drought-prone areas in Kon Tum city: Doan Ket commune belongs to Dak Tia, Tan Dien and Ca Tien irrigation system; Chu Reng commune belongs to Dak Ly Irrigation system, Dak Ho; Kroong commune and Dak Cam commune. There is only one meteorological station in Kon Tum City while the area is very large. In order to have a scientific basis for the planning of socio-economic sectors in Kon Tum city, drought zoning, risk assessment due to drought in Kon Tum city is very necessary.

3. METHODOLOGY

3.1. Data collection

In this paper, a 30-year meteorological data was collected from 1987 to 2016. This data includes: average air temperature, highest air temperature, lowest air temperature, average air humidity, rainfall, number of rainy day, evaporation amount, number of sunny hours.

3.2. Formula to determine the drought

There are nearly 100 formulas to determine the drought in the world, but Vietnam Institute of Meteorology, Hydrology and Climate change has selected a number of formulas for determining the drought that is appropriate to the conditions in Vietnam such as: K drought index, The Standardized Precipitation Index (SPI).

3.2.1 K drought index

$$K_i = \frac{E_i}{R_i} \quad (1)$$

Where, E_i is the amount of evaporation (mm); R_i is the rainfall at the same period (mm)

Table 1: Definition of states of drought with K

Description	Criterion
Period i is called dry period	$K_i \geq 1$
Period i is called wet period	$K_i < 1$

3.2.2. The Standardized Precipitation Index (SPI)

$$SPI = \frac{R - \bar{R}}{\delta} \quad (2)$$

Where, R is the actual total rainfall (mm) (week, month, crop, year ...); $\bar{R}$ is the average annual rainfall of the corresponding period (mm); δ is the standard deviation of rainfall in the corresponding period (mm).

Keywords: Drought, Drought index, Kon Tum City, Vietnam

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Table 2: SPI Classification

Category SPI values	SPI values
Extremely wet	+2 and above
Very wet	+1,5 to +1,99
Moderately wet	+1,0 to +1,49
Near normal	-0,99 to +0,99
Moderately dry	- 1,0 to -1,49
Severely dry	- 1,50 to -1,99
Extremely dry	- 2 and less

3.2.3. SI drought index

FAO has given an index to determine the extreme level of drought as follows:

$$SI = (Y - X_{tb}) / X_{tb} \quad (3)$$

Where, Y- monthly rainfall (mm); X_{tb} - average monthly rainfall (mm)

Table 3: SI Classification

Category SI values	SI values
Extremely drought	$\geq 0,75$
Severely drought	+0,5 to +0,74
Moderately drought	+0,25 to +0,49
No drought	$\leq 0,24$

- Formulas to determine Agricultural drought

3.2.4. Moisture index MI

$$MI = \frac{R}{PET} \quad (4)$$

Where, R: Rainfall (mm); PET: the potential evaporation (mm)

Table 4: MI Classification

Category MI values	MI values
Normal moisture	+0,8 to +1,2
Moderately moisture deficiency	+0,4 to +0,79
Severely moisture deficiency	< 0,4

3.2.5. Prescot Index

$$K_n = \frac{0,38P}{E^{0,7}} \quad (5)$$

Where: P is the rainfall or irrigation water (mm); E is the evaporation of the calculation period (mm)

Table 5: K_n Classification

Category K_n values	K_n values
Normal moisture without irrigation	≥ 0.54
Moisture deficiency, Irrigation needed	<0.54

4. RESULTS AND CONCLUSION

In December, the drought index of the city is $13.9 < K < 18.8$; therefore whole area in Kon Tum City is severely drought in December.

We divided the area of TP Kon Tum into 2 zones which are: **Zone 1**: Drought index $15,0 < K < 18,8$ is the more severely drought area; including Kroong, Ngoc Bay, Vinh Quang commune, 1/2 area Dak Cam commune, Ngo May, Duy Tan Ward, a small part of Chu Ho Reng commune, a small part of Tran Hung Dao Ward, most

area of Doan Ket commune. Area of Zone 1 covers about 2/5 area of the city. **Zone 2**: The drought level is less severely than Zone 1. Drought index $13,9 < K < 15,0$, including LaChim, Dak Nang, Hoa Binh commune, most area of Tran Hung Dao ward, most area of Chu Ho Reng commune, 1/2 area Dak Cam commune, 4/5 area DakBla commune, 3/4 area Dak Ro Wa commune. Area of Zone 2 covers about 3/5 area of the city.

Table 6: Drought index of Kon Tum city in December average 30 years 1987-2016

Small zone	R	E	Utb	K	MI	Kn
TV1	8,5	160,2	73	18,847	0,053	0,092
TV2	8,7	128,2	74	14,736	0,068	0,111
TV3	8,6	133,5	74	15,523	0,064	0,106
TV4	9	128,7	74	14,3	0,07	0,114
TV5	9,1	126,6	75	13,912	0,072	0,117
TV6	8,9	145	75	16,292	0,061	0,104
TV7	8,9	143,3	75	16,101	0,062	0,105
TV8	9	143,2	74	15,911	0,063	0,106
TV9	8,9	146,7	74	16,483	0,061	0,103
TV10	9	144,3	75	16,033	0,062	0,105

R: Total rainfall (mm); E: Total evaporation (mm); U: Air humidity (%). TV1: Quang Trung, Quyet Thang, Thong Nhat, Thang Loi, Duy Tan, Truong Chinh; TV2: LaChim, Dak Nang; TV3: Nguyen Trai, Tran Hung Dao, Doan Ket; TV4: Hoa Binh; TV5: Chu Ho Reng; TV6: Dak Ro Wa; TV7: Dak Cam; TV8: DakBLa; TV9: Ngo May, Vinh Quang; TV10: Ngoc Bay, Kroong

Conclusion

Drought in Kon Tum has evolved to a complex matter encompassing collectively the political, social and scientific facets. Drought assessment for each commune supported by continuous scientific research has to be carried out with the full support from the government. Some solutions should be implemented in Kon Tum city as investing in plantation of bare land, bare hills and mountains, closely managing the remaining forest areas; agricultural production must be planned suitably with the capacity of irrigation works; banning deforestation and using saving water.

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