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A Study of Change in Rainfall by 24 Seasonal Terms

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Abstract. This study investigated rainfalls at meteorological observatories in Daegu, Daejeon, Mokpo, and Busan., analyzed the changing pattern of rainfalls at 24 seasonal division points with the use of moving average method, and looked into the changing pattern of 24 seasonal division points according to climate change. As the result of the comparison of rainfalls at 24 seasonal division points in four observatories, rainfalls at the start of summer and autumn increased a lot more than before, and rainfalls in summer, spring, and winter fell. Therefore, it was analyzed that temporal imbalance of rainfalls got worsened.

Keywords: Climate Change, Rainfall change, 24 seasonal terms.

1 Introduction

It has been said that Korean four seasons have distinct characteristics. In the country, people could feel the seasonal characteristics much in spring and autumn. With the rapid industrialization, the world has faced abnormal weather conditions which have caused the gradual changes in rainfalls and temperature. As a result, in the case of Korean four seasons which used to be distinct also, spring and summer terms are getting shorter. The hydrological climate change causes falling rainfalls and rising temperature on average, which influence the change in river flow, the use of water, a flow in dry season, and the change in flood flow.

In Korea, agricultural water accounts for a large percentage in terms of water use, and the water sources for agricultural water come from rivers and streams mostly. The use cycle of the agricultural water is influenced by Korean 24 seasonal days traditionally.

Regarding the change of 24 seasonal days, Korean seasons are changed by the alternate influences of continental climate and oceanic climate of the country located in the middle latitude. The seasons change into spring, summer, autumn, and winter, and are divided into 24 seasonal points which are closely related to our life. The 24

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seasonal points are divided according to the yearly location of the sun. Since long time ago, Korean people have farmed on the basis of 24 seasonal division points which have became the basis of our living change. So far, there has been research on the pattern of climate change on the basis of such time-based changes as monthly change and seasonal change. However, there is no study on the pattern of climate change on the basis of 24 seasonal division points.

This study investigated rainfalls at meteorological observatories in Daegu, Daejoen, Mokpo, and Busan, analyzed the changing pattern of rainfalls at 24 seasonal division points with the use of moving average method, and looked into the changing pattern of 24 seasonal division points according to climate change.

2 Analysis Method

This study analyzed the rainfalls which had been recorded from 1969 to 2013 at meterological observatories in Daegu, Daejeon, Mokpo, and Busan ,Korean representative inland and coastal cities, according to 24 seasonal division points by using moving average method.

3 Analysis Results

This study collected the data about daily rainfalls at the four observatories and categorized them according to 24 seasonal division points. It calculated the total and the mean of rainfalls that occurred before and after each seasonal division point, and analyzed the changes in rainfalls from 1960 to 2013 according to 24 seasonal division points. With the data of 24 seasonal division points, this study used moving average method to analyze the changes in rainfalls according to 24 seasonal division points. Table 1 presents the estimated average rainfall at each seasonal point, and a relevant date. Typically, Korean precipitation is distributed intensively in summer, and rainfalls in other seasons are relatively low.

Table 1. Average rainfall(1960~2013)

Season	Daegu	Daejeon	Mokpo	Busan	Average
Minor C.(1.5)	8.2	10.9	13.3	13.1	11.4
Major C.(1.20)	10.4	12.7	18.2	16.8	14.5
Start of S.(2.4)	12.3	14.2	21.2	21.1	17.2
RainWater(2.19)	21.1	22.9	27.7	31.9	25.9
Awakening(3.6)	22.5	20.6	28.9	40.1	28.0
Vernal Eq.(3.12)	24.5	23.5	29.1	43.3	30.1
Pure Br.(4.5)	37.6	38.5	40.2	73.6	47.5

Grain Rain(4.20)	40.1	40.1	50.6	84.5	53.8
Start of S.(5.6)	45.0	50.6	53.0	90.0	59.7
Grain Full(5.21)	36.0	33.3	40.4	62.3	43.0
Grain in Ear(6.6)	60.4	58.3	62.6	93.0	68.6
Summer S.(6.21)	110.1	116.5	127.7	155.5	127.5
Minor Heat(7.7)	137.0	157.8	133.9	163.1	147.9
Major Heat(7.23)	80.3	118.8	63.1	100.1	90.6
Start of Au.(8.8)	111.7	119.1	87.3	115.0	108.2
Limit of Heat(8.23)	98.3	106.4	114.5	126.0	111.3
White Dew(9.8)	74.8	70.5	70.6	91.4	76.8
Autumnal Eq.(9.23)	37.3	34.9	34.4	46.2	38.2
Cold Dew(10.8)	19.7	19.6	20.3	29.9	22.4
Frost De.(10.23)	18.2	19.1	22.6	29.6	22.4
Start of Win.(11.7)	18.7	20.6	25.8	31.5	24.2
Minor Snow(11.22)	13.1	19.8	23.5	21.0	19.3
Major Snow(12.7)	6.1	10.8	12.5	12.8	10.5
Winter Sol.(12.22)	6.5	8.9	13.3	10.3	9.8

As shown in Table 2, the moving average value of 24 seasonal days from 1969 to 1978 was compared with that from 2004 to 2013. In Daegu, rainfalls fell during the minor cold, the major cold, the start of autumn, the clear and bright, the grain rain, the grain in ear, the major heat, the white dew, the autumnal equinox, the frost descent, and the start of winter, and the winter solstice. In Daejeon, rainfalls dropped during the major cold, the start of autumn, the rain water, the awakening of insects, the clear and bright, the grain rain, the minor cold, the major heat, the limit of heat, the autumnal equinox, the frost descent, and the winter solstice. In Mokpo, rainfalls decreased during the minor cold, the major cold, the start of autumn, the clear and bright, the grain rain, the grain in ear, the major heat, the autumnal equinox, the cold dew, the frost descent, the start of winter, and the winter solstice. In Busan, rainfalls dropped during the minor cold, the major bold, the clear and bright, the grain rain, the grain in ear, the major heat, the limit of heat, the white dew, the start of winter, and the winter solstice. Overall, during the summer solstice and the minor heat, rainfalls increased around 111%-204%, and during the start of autumn rose to 178-266%. During the grain in ear, rainfalls at all observatory cities but Dajeon fell around 46-60%, and during the start of winter, rainfalls decreased to 39-82%.

Table 2. Comparison of 10 years moving avearge (1969～2013)

Season	Daegu		Daejeon		Mokpo		Busan	
	1969 ～1978	2004 ～2013	1969 ～1978	2004 ～2013	1969 ～1978	2004 ～2013	1969 ～1978	2004 ～2013
Minor C.(1.5)	5.9	4.4▼	8.4	9.1▲	10.6	10.3▼	8.8	7.4▼
Major C.(1.20)	15.5	8.5▼	22.5	16.3▼	24.6	16.6▼	25.9	13.5▼
Start of S.(2.4)	15.5	11.7▼	22.2	18.7▼	28.7	23.2▼	26.7	28.3▲
RainWater(2.19)	17.8	21.7▲	30.5	24.3▼	22.1	29.7▲	25.0	36.3▲
Awakening(3.6)	17.0	18.0▲	25.2	24.0▼	19.4	26.7▲	32.5	41.5▲
Vernal Eq.(3.12)	21.8	24.0▲	26.7	28.7▲	26.3	34.9▲	43.3	52.5▲
Pure Br.(4.5)	44.4	23.7▼	68.1	22.6▼	46.9	28.3▼	89.6	53.7▼
Grain Rain(4.20)	63.8	31.3▼	72.1	38.1▼	91.2	40.5▼	127.5	75.6▼
Start of S.(5.6)	42.4	52.9▲	49.6	70.5▲	44.2	74.3▲	87.2	93.4▲
Grain Full(5.21)	36.1	34.6▲	39.6	34.8▼	44.5	46.2▲	52.0	73.0▲
Grain in Ear(6.6)	82.7	49.9▼	41.4	75.8▲	94.3	53.3▼	134.0	62.3▼
Summer S.(6.21)	102.9	130.5▲	140.0	155.8▲	78.4	160.0▲	123.7	153.2▲
Minor Heat(7.7)	118.1	164.3▲	149.7	242.5▲	146.5	164.0▲	131.2	241.7▲
Major Heat(7.23)	100.3	61.8▼	183.4	110.6▼	55.8	44.7▼	111.8	76.3▼
Start of Au.(8.8)	58.3	154.8▲	95.5	191.4▲	62.6	111.6▲	54.8	109.2▲
Limit of Heat(8.23)	74.6	91.2▲	121.3	119.9▼	97.6	120.4▲	106.7	77.1▼
White Dew(9.8)	74.8	74.7▼	75.2	103.8▲	66.6	98.6▲	144.7	94.4▼
Autumnal Eq.(9.23)	28.5	16.9▼	48.6	22.9▼	30.4	20.2▼	30.1	31.7▲
Cold Dew(10.8)	15.7	28.0▲	16.4	17.0▲	16.3	12.9▼	26.9	31.6▲
Frost De.(10.23)	21.9	12.8▼	31.6	19.1▼	22.5	20.0▼	28.9	33.4▲
Start of Win.(11.7)	30.1	11.8▼	27.8	13.8▼	29.9	24.4▼	55.5	26.4▼
Minor Snow(11.22)	9.6	14.6▲	19.8	28.8▲	18.8	27.3▲	10.8	15.3▲
Major Snow(12.7)	6.4	9.0▲	12.1	16.5▲	12.1	16.3▲	11.5	18.8▲
Winter Sol.(12.22)	7.6	6.7▼	10.9	7.2▼	15.5	11.7▼	14.2	8.7▼
Sum	1,011.6	1,057.7▲	1,338.5	1,412.0▲	1,105.7	1,215.9▲	1,503.5	1,455.1▲

4 Conclusion

This study analyzed the changes in rainfalls according to 24 seasonal division points. Rainfalls at four representative observatories were compared according to 24 seasonal division points. As a result, rainfalls at the start of summer and autumn increased a lot more than before, and rainfalls in summer, spring, and winter fell. Therefore, it was analyzed that temporal imbalance of rainfalls got worsened.

According to the analysis by seasonal division points, during the summer solstice and the minor heat, rainfalls increased around 111%-204%, and during the start of autumn rose to 178-266%. During the grain in ear, rainfalls at all observatory cities but Dajeon fell around 46-60%, and during the start of winter, rainfalls decreased to 39-82%. According to this study, it is predicted that the changes in rainfalls at 24 seasonal division points will lead to the climate change tendency in Korea and the change of the uses of agricultural water and water resource. The study results are judged to be used for the application of water resource according to climate change.

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