

Decay Hazard (Scheffer) Index Values in Korea for Exterior Aboveground Wood

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Abstract

This research was performed to evaluate the decay hazard for exterior aboveground wood in Korea. The decay hazard (Scheffer) index values were calculated for 56 locations in Korea using the 1972 to 2011 climate normal data available from the Korea Meteorological Administration, and the wood decay hazard maps were created on the basis of the determined values. Jeju Province, Korea's largest island lying in the Korea Strait, southwest of South Jeolla Province, has decay hazard ratings above 70, considered a severe decay hazard zone according to the generally accepted classifications. The index values of the other areas are in the range between 35 and 70, meaning that Korea could be considered a moderate decay zone. However, the annual Scheffer index values calculated from recent climate data tend to be higher than the average index values. The comparison of annual Scheffer index values showed that many moderate decay areas in Korea could be severe decay hazard areas due to directional or cyclical climate change. This suggests that proper wood protection is greatly needed and more critical in the future.

The Scheffer index, which was based on the idea of fast decay of wood under warm and moist conditions, has proved to be a reasonably useful tool to estimate microbiological deterioration of wood exposed aboveground to exterior conditions (Scheffer 1971, Larkin and Laks 2008, Morris and Wang 2008, Carll 2009). The index values can be simply calculated using the basic climate data on mean monthly temperature and mean number of days with precipitation over 0.25 mm and dividing a region into three zones. The region with values less than 35 is generally considered a low hazard zone. A moderate hazard zone has values between 35 and 70. The areas above 70 are generally accepted to be a high decay hazard zone (Degroot 1982, Degroot and Esenther 1982, Beesley et al. 1983, Setliff 1986, Foliente et al. 2002). The decay hazard map for aboveground wood structures can be created on the basis of the calculated values, which provides recommendations of the use of preservative-treated wood for both builders and building owners (Morris and Wang 2008, Carll 2009).

Decay hazard maps for aboveground wood structures have been presented in several countries (Scheffer 1971, Setliff 1986, Kiguchi et al. 2001, Wang et al. 2007, Morris and Wang 2008, Brischke et al. 2011). The maps of the United States, Canada, Japan, China, and Korea have been created on the basis of the Scheffer index or the index similar to the Scheffer index since Scheffer produced the first decay hazard map for the United States. Recently, the decay map for the United States was re-created on the basis

of the most recent climate normal data available from the National Climatic Data Center (Carll 2009). The index values for the United States calculated using recent climate data appeared to be moderately higher than the values listed by Scheffer, meaning that the decay hazard has increased because of climate change.

In Korea, a decay hazard map based on the Scheffer index has been created by Kim et al. (2011). They calculated the Scheffer index using 2001 to 2010 climate normal data. The index values of most areas of Korea were reported to be in the range between 35 and 70, considered a moderate decay hazard zone. There may be an advantage of the Scheffer index calculated by using 10-year climate data. In a situation where the climate tends to be changed due to the greenhouse effect, the Scheffer index may reflect the effect of the directional climate change. However, the index values are considered incomplete because the index values related to the climate were generally calculated based on 30 years

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Table 1.—Scheffer climate index values calculated from climate data for Korea.^a

Location	Mean annual temp. (°C)	Mean annual precipitation (mm)	Mean no. of days per year with precipitation ≥ 0.30 mm	Scheffer index
Busan	14.7 (14.6)	1,525.4 (1,478.6)	90.2 (85)	52.7 (52.7)
Changwon	14.1 (14.3)	1,467.7 (1,514.0)	95.8 (97)	54.8 (65.9)
Chongju	12.6 (12.8)	1,251.0 (1,805.6)	101.9 (107)	56.2 (80.7)
Chuncheon	11.2 (10.7)	1,360.8 (2,029.3)	95.8 (105)	50.8 (65.3)
Daegu	13.9 (13.8)	1,389.6 (1,300.3)	110.8 (111)	62.3 (71.6)
Daejeon	12.8 (12.6)	1,396.6 (1,943.4)	103.1 (100)	58.2 (71.1)
Gangneung	13.2 (12.7)	1,480.2 (1,810.5)	101.6 (115)	60.5 (77.5)
Gwangju	14.2 (14.3)	1,096.5 (1,430.4)	86.6 (95)	54.1 (69.1)
Incheon	12.2 (12.0)	1,252.6 (1,725.5)	91.5 (89)	48.3 (58.1)
Jeju	15.9 (15.6)	1,493.1 (1,478.6)	117.8 (113)	70.1 (68.3)
Jeonju	13.4 (13.2)	1,322.5 (1,621.8)	111.1 (107)	63.9 (74.0)
Mokpo	13.9 (13.0)	1,149.4 (9,82.1)	104.9 (99)	52.5 (53.4)
Pohang	14.3 (14.3)	1,159.9 (1,089.9)	90.7 (93)	53.9 (63.9)
Seoul	12.6 (12.1)	1,477.3 (2,039.3)	98.7 (101)	57.2 (70.0)
Seosan	12.0 (11.7)	1,301.5 (1,704.4)	100.7 (105)	48.9 (62.6)
Suwon	12.1 (11.9)	1,333.8 (1,975.9)	96.1 (100)	52.1 (66.6)
Uljin	12.7 (12.1)	1,136.4 (1,376.6)	91.5 (99)	47.7 (54.7)
Ulsan	14.2 (13.7)	1,283.2 (1,233.2)	89.4 (94)	53.1 (61.5)
Yeosu	14.4 (14.1)	1,140.4 (1,650.4)	86.4 (93)	50.2 (63.0)

^a Values are the Scheffer index calculated from the 1982 to 2011 climate data and the Scheffer index calculated from the 2011 climate data presented in parentheses.

to minimize the effect of abrupt and abnormal changes of climate in fewer years.

This article aims to develop a decay hazard map for exterior aboveground wood structures in Korea that can be used by researchers to explore the proper protection for different areas across the country and by designers and builders as a general guide for selecting wood materials based on their durability. The Scheffer index values were calculated on the basis of the 30-year climate data, and the decay hazard maps for wood and wood products in Korea were created. Changes in index values are discussed here.

Materials and Methods

Climate normal data for the period 1972 to 2011 were provided by the Korea Meteorological Administration (KMA) for 56 locations in Korea. Although the KMA currently measures climate data such as temperature and precipitation for 72 locations, the climate data accumulated for more than 40 years is available only in 19 locations, and the climate data for more than 30 years are available for 56 locations.

The calculation of a climate index was based on the Scheffer formula with a slightly different definition for precipitation:

$$\text{Scheffer climate index} = \sum_{\text{Jan}}^{\text{Dec}} \left[\frac{(T - 2)(D - 3)}{16.7} \right]$$

where T is mean monthly average temperature (expressed in °C), D is the mean number of days per month with 0.30 mm or more of precipitation, $(T - 2) \equiv 0$ if $T \leq 2$, and $(D - 3) \equiv 0$ if $D \leq 2$.

Because there are no data for days with rainfall ranging from 0.25 to 0.30 mm, the mean number of days in the month with precipitation of 0.30 mm or more was used for the calculation for all locations. The decay hazard maps were created on the basis of the calculated index values.

Results and Discussion

The Scheffer climate index is the summation of decay potentials across the year with both the temperature and the moisture conditions favorable for decay fungi to grow in wood. The months with an average temperature under 2°C and the mean number of days (<3) with 0.3 mm of rainfall are considered to be inappropriate for wood decay. Korea is located in the middle latitudes of the Northern Hemisphere, resulting in the temperature zone with four distinct seasons. The annual mean temperature ranges from 10°C to 16°C except in the high mountain areas. The mean temperature of August, the warmest month, ranges from 23°C to 27°C, whereas the mean temperature of January, the coldest one, ranges from -6°C to -7°C. The annual precipitation ranges from 1,000 to 1,800 mm in the southern part of Korea and from 1,100 to 1,400 mm in the central part. The summer precipitation is more than half of the annual precipitation, and the winter precipitation is less than 10 percent of the total annual precipitation. July shows the highest humidity, reaching 80 to 90 percent nationwide, whereas January shows the lowest monthly humidity ranging from 30 to 50 percent. Considerably more precipitation than that of the world average classifies Korea as a relatively wet region. Conclusively, December and January are the only months in Korea that are unfavorable for wood decay, and July and August are the months of most concern for wood decay.

The Scheffer climate index values for individual locations calculated from 1982 to 2011 climate normal data are given in Table 1. The index values of Korea except Jeju Province are in the range between 35 and 70, meaning that Korea could be considered a moderate decay zone. Jeju Province, Korea's largest island lying in the Korea Strait, has decay hazard ratings of 70 and is considered a severe decay hazard zone according to the generally accepted classifications.

Based on the revised Scheffer index values, Korea may be classified as a moderate decay hazard region. However, the Scheffer index values tended to increase slightly with time. Shown in Figure 1 is the change of Scheffer index values of

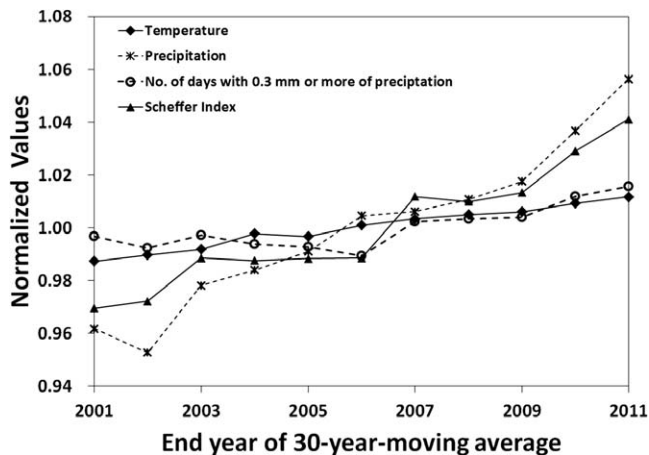


Figure 1.—Change of temperature, number of days with precipitation ≥ 0.30 mm, the amount of precipitation, and Scheffer index expressed by relative variables.

Seoul at 30-year intervals obtained from 1972 to 2011 climate normal data. Seoul is the capital city of Korea, which is located to the west of the central region of the Korean Peninsula. The x axis of Figure 1 represents the end year of the 30-year moving average. The y axis represents the values of the 30-year moving average divided by the average values calculated from the 1972 to 2011 data. Temperature, annual precipitation, number of days with 0.30 mm or more of precipitation, and the Scheffer index appeared to slightly increase with time, suggesting that the climate of Korea may be changing to be more favorable for wood decay.

The effect of climate becomes clearer when the Scheffer index values were examined year by year. The Scheffer index values calculated from 2011 climate data showed quite an interesting result. Compared with the values of Scheffer index determined from the 1982 to 2011 climate data, the values are increased by more than 10 in most areas of Korea (Table 1). Considering that index values of high decay hazard zones are more than 70, Chonju, Daegu, Daejeon, Gangneung, Jeonju, and Seoul would be classified as severe decay regions in 2011. In fact, Seoul had a Scheffer index value of over 70 three times during the past 10 years (Kim et al. 2011).

There may be two reasons for the wide variation in the Scheffer index of Korea. One is the complex climate characteristics of Korea that reveal both continental and oceanic features. It has a wide temperature difference between summer and winter and substantial precipitation compared with that of the Asian continent. The annual temperature generally shows a little variation, but the precipitation shows a wide variation year by year. The other is the recent climate changes in Korea. The average amount of precipitation for Seoul for 30 years was 1,477.3 mm, but the precipitation amount for Seoul in 2011 was 2,039 mm. The latter appears to be directly related to recent changes in climate, but more data in coming years will be needed to draw a firm conclusion regarding the influence of climate change on decay hazard. Recently, the number of days with precipitation above 0.3 mm tends to be increased especially in summer, resulting in the increase of Scheffer index (Fig. 1).

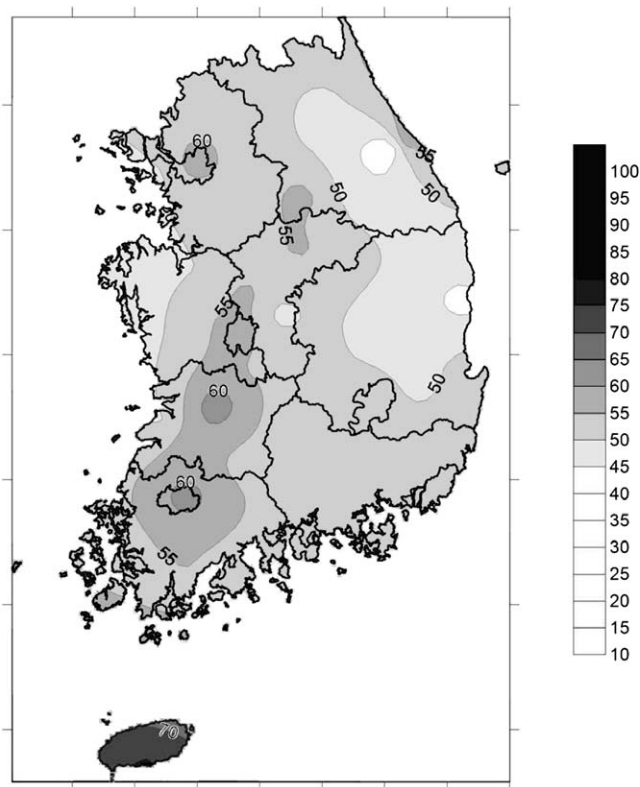


Figure 2.—Aboveground wood decay hazard map based on climate data for the period between 1982 and 2011.

The wood decay maps created using 30-year climate data (1982 to 2011) showed that Korea could be classified as a moderate decay zone (Fig. 2). However, recent changes, such as increased temperature and precipitation, suggest that changes in climate seem to be elevating the decay hazard higher than the decay hazard shown in the revised wood decay map. If that trend continues, the proper protection for wood and wood-based materials would be more important.

Conclusions

The Scheffer index values were calculated from the 1972 to 2011 climate normal data for 56 locations in Korea available from the KMA. The calculated index values showed that most of the areas in Korea except Jeju Province are in the range between 35 and 70, meaning that Korea could be considered a moderate decay zone. However, the annual Scheffer index values calculated from recent climate data showed a wide variation and tended to be higher than the average index values. Because several places in Korea could be turned into high decay hazard zones due to the climate change, proper wood protection is greatly needed and will be even more critical in the future.

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