*Article*

# Research on Restorative Environment Characteristics through Urban Forest User Experience Focusing on Big Data of Dobongsan Mountain in Seoul, Korea

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**Abstract:** Since the COVID-19 pandemic, urban forest mountains have become important restorative environmental spaces, and demand-customized management based on users' experiences is needed. We collected 21,557 data points from blogs from January 2020 to December 2021. For data analysis, keyword frequency, term frequency-inverse document frequency, and sentiment analyses were conducted using TEXTOM 4.0, and a semantic linkage network was established and analyzed using Gephi 0.92. In the analyses, the restorative environment components of "being away" "fascination," "extent," and "compatibility" were derived from users' experiences. Fascination, which stems from natural objects such as rocks, valleys, and trails, was derived the most frequently, and being away and compatibility, representing leisure activities such as climbing and walking, formed the largest cluster in cluster analysis. Sentiment analysis revealed a high positive word rate of 91.6%, with favorable feelings accounting for 87.5%, whereas the proportions of joy and interest (12.5%) were relatively low. This study showed that leisure activities related to nature objects had a positive impact. However, joy and interest, which correspond to vitality, were relatively lacking in the restorative experience. To improve restorative experience quality, diversification of leisure activities should be promoted and customized management plans corresponding to restorative environment components developed.

**Keywords:** behavior; emotion; forest management; Gephi; landscape; perception; restorative space; TEXTOM

## 1. Introduction

In the post-COVID-19 era, the world has seen an increase in non-face-to-face activity with a corresponding decrease in outdoor activity, leading to mental and physical health issues such as depression and anxiety. Amidst these changes, the value and importance of green spaces is being reevaluated [1,2].

The United Nations [3] noted that new models of urban development, incorporating green space, are needed for urban resilience and sustainability, emphasizing the roles and responsibilities of local governments and practitioners. Scholars worldwide have been interested in the changes in urban space utilization patterns and value perceptions after COVID-19. They have found that urban space utilization has increased in green spaces that allow for outdoor activities [4–10], and the role of green space in health promotion is being valued more[2,8,11–14]. In addition, from a social equity perspective, the importance of accessibility has been emphasized to ensure that anyone, anywhere can easily reach green spaces [8,11,14,15]. The preference for and use of forests with dense vegetation, abundant shade, and trails has increased [4,6,10]. This is important not only for physical health, but also for mental health as it promotes stress reduction and psychological safety [11,14], and social health by allowing for social interactions and bonding [12,13]. Therefore, it is important for governments and managers to consider how to manage urban forest spaces to promote physical, mental, and social health in the post-COVID-19 era.

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As of April 13, 2020, Seoul (Korea) is the city with the highest increase in park visits worldwide since the COVID-19 outbreak, with an increase of approximately 51% [16]. Seoul has a high proportion of forests in the city, of approximately 22% [17], and the topography of the city in the form of lines and rings means that these forests are very close to residential areas, making them highly valued as urban green and leisure spaces [18]. Based on the unique Korean topographical characteristics and perceptions of nature, urban forest spaces have been used and valued pluralistically since the Joseon Dynasty [19]. Chae & Cho [20] analyzed big data on the public use of urban green spaces such as forests, watersides, parks, and walkways collected from blogs and found that people used them as a space for daily leisure activities, appreciating natural resources, and engaging in activities such as exercise and walking, expressing the emotional word happiness[20]. This research revealed that users of urban forest spaces directly or indirectly expressed their expectations and experiences of them as a restorative space.

Researchers are attempting to analyze semantic changes peoples' description of urban forest mountains between before and after the COVID-19 outbreak [20]. Forest management according to residents' perception [21], preferred motivation and companion characteristics [22], the need for addressing issues such as accessibility and management of paths [23] and ecological sensitivity [24], have been raised. In addition, Chae [25] proposed actions in changes of urban mountains of Korea after COVID-19. Lee & Yeon [26] collected data from 20–30-year-olds and analyzed 13 mountains, suggesting the need for customized services by age group. Rice & Pan [27] suggested that it is necessary to identify changes and impacts through a spatial application of big data collected after COVID-19. In the future, after COVID-19, urban forest mountains need to be managed as restorative spaces that reduce stress and positively affect mental health. However, there is a lack of studies on perceptions, behaviors, and emotions based on individual experiences of forest spaces as restorative spaces. In addition, although numerous recent studies have aimed to improve service quality based on perceptions by analyzing individual experiences, opinions, and evaluations [28,29], and other studies have revealed cultural context and place meaning [30], there is a lack of humanistic social scientific research on forest spaces. Therefore, this study aimed to identify the characteristics of urban forests as restorative spaces from the perspective of users through the collection and analysis of big data from blogs written by individuals about their experiences, and to seek management measures that consider these perspectives. The findings should contribute to the improvement of restorative experience quality and the promotion of diversification of leisure activities and the development of customized management plans for restorative environment components.

### *2.1. Research Model*

In addition to their social and personal environmental benefit value, urban forests have been recognized for their psychological and spiritual benefits as users experience them. In particular, urban forest mountains have been shown to be more effective in reducing stress than other natural environments, such as urban parks and green spaces [31]. This is because the intrinsic fascination for natural environments such as streams, green leaves, sunsets, and old forests are mentally consumed in daily life to restore and orientate attention. This is referred to as the attention restoration theory [32,33]. Therefore, it is necessary to examine urban forest mountains as a restorative environment. Kim [34] found that perceived stress among urban residents was negatively correlated with restorative environment use through leisure activities, while it showed a significant positive correlation with restorative experiences, which, in turn, affect quality of life. This suggests the impact of restorative environments and their negative correlation with stress. Many scholars have sought to understand the sense of a place based on the embedded memories and experiences of individuals in that particular place [35]. More recently, big data analysis of social media, where individuals' experiences are recorded, has been used to understand this. For example, Kim [30] sought to understand the cultural context and flow of local identity in Seochon. Researchers have attempted to analyze individual perceptions by collecting online data [29] as a measure of immediate service experience [28]. Chae & Cho [20] analyzed perceptions by clustering blog data and identified experiences such as usage behaviors, activities, time, and other behavior. They also extracted emotional language data

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during their analysis. Li et al. [36] categorized emotional words into positive and negative words. A review of studies related to the attention restoration theory [37–40] suggested four restorative environment components: "being away," "fascination," "extent," and "compatibility," and four restorative experiences: stress relief, attention recovery, energy revitalization, and health promotion, for attention restorative environments.

Urban forest mountains as a restorative environment are conveyed through the experience of four components of the restorative environment. Therefore, we derived positive and negative sentiments on how perception and behavior affect the components of the restorative environment, and established a model for how to apply these results to the management of urban forest mountains (Figure 1).

Studies on the recovery environment, environmental components, and recovery effects have been conducted by examining structured questionnaires. In this study, we attempted to structure and interpret the experiences recorded by individuals using big data. This model is different in that it uses blog big data to clarify the components of the recovery environment and to reveal that perception and behavior are related to emotion.

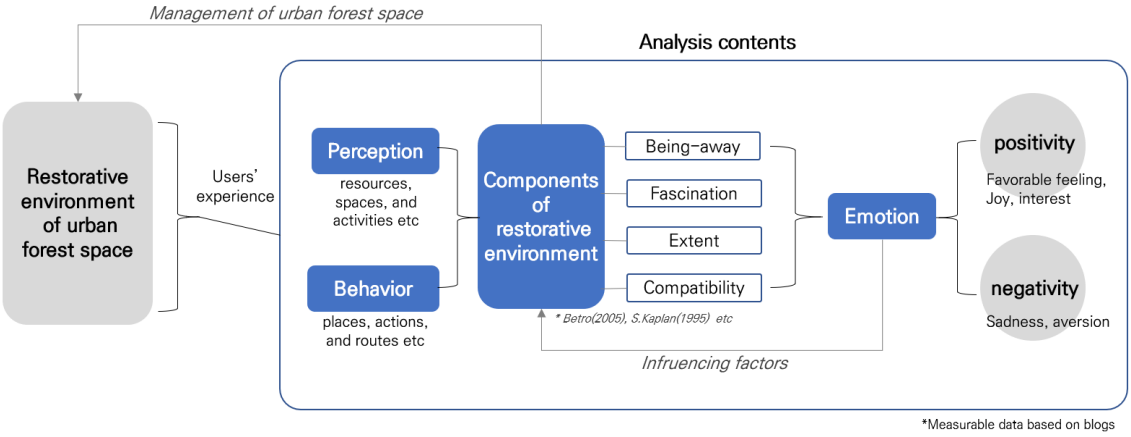


**Figure 1.** Study model.

## *2.2. Data Collection and Analysis*

### 2.2.1. Study Area for Data Collection

The study area is Dobongsan Mountain, located in Dobong-gu, Seoul, South Korea. Dobongsan Mountain has an altitude of 739.5 m above sea level and an area of approximately 24 km$^2$. It is located approximately 17 km from the center of Seoul (Jongno-gu). Dobongsan Mountain is designated as Bukhansan National Park and is one of Korea's 100 most famous mountains, as designated by the Korea Forest Service. It attracts approximately 10 million visitors per year and has outstanding ecological, historical, and cultural value. Its main resources include Dobong Valley, Obong Peak, and the National Mountain Museum. Dobongsan Station on the subway (Lines 1 and 7) is easily accessible from Seoul, Gyeonggi, Incheon, and other metropolitan areas (Figure 2). In addition, Dobongsan Mountain is one of the top three mountains in the metropolitan area with high numbers of visits for hiking purposes after COVID-19 [25].

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**Figure 2.** Map of the study area.

2.2.2. Data Collection

In this study, text mining was conducted using the keyword "Dobongsan Mountain." The data were collected using TEXTOM 4.0, a program specialized in web and social network analysis. The collection channels were Naver and Daum blogs. The data collection period was from January 1, 2020 to December 31, 2021, after the COVID-19 outbreak, for a total of 2 years, with a monthly collection rate of 1,000. The collected data were automatically cleaned, and terms such as "apartment," "comprehensive real estate holding tax," and "buying and selling," which are related to real estate advertisements, were deleted from the cleaned files. A total of 21,557 data points were collected as the final data (Figure 3).

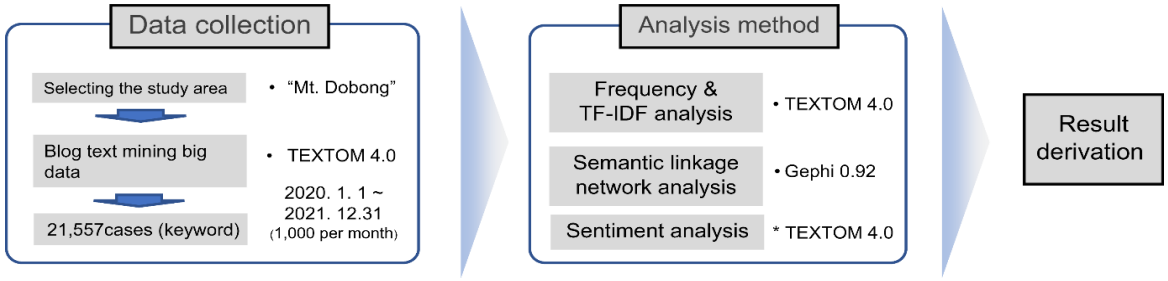


**Figure 3.** Data collection and analysis.

2.2.3. Data Analysis

For the data analysis in this study, frequency analysis, term frequency-inverse document frequency (TF-IDF) analysis, and sentiment analysis were conducted using Textom 4.0, and semantic network analysis was conducted using Gephi 0.92 (Figure 3). The results of the text mining analysis, frequency analysis, and TF-IDF analysis were compared. TF-IDF indicates how important a word is within a specific document. The higher the frequency of a word in a specific document and the fewer documents containing that word among all documents, the higher the TF-IDF value. Therefore, this value can be used to filter out words that are common in all documents and extract key words from documents. For sentiment analysis, words related to emotions in the original data were categorized as positive or negative in the emotion lexicon set by TEXTOM. Positive keywords are classified into three words: interest, favorable feelings, and joy, and negative keywords are classified into six words: pain, sadness, anger, fear, surprise, and rejection. Each keyword was measured on a 7-point scale and analyzed [41]. Gephi 0.92 is an open-source program developed for the exploration and manipulation of networks, which has strengths in visual mapping compared to other existing connectivity analysis programs [42]. In this study, centrality and modularity analyses were conducted. In general, connectivity networks consist of nodes (nodes and vertices) and connectivity relationships or arcs (links, arcs, and edges). Through network analysis, it is possible to interpret what constitutes an important symbolic place, and the relationships and nature of each symbol (place). Centrality

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analysis is mainly used to analyze the role and relationships of places, as it expresses how central a feature (place or actor) is in the network [43]. We used ForceAtlas 2 for visualization analysis; we set the tuning scale to 400 and Garavity to 1, and enabled overlap prevention. Average weighted degree was used because the degree value was high, including only the top 100 words. Node ranking was set to a minimum of 10 and a maximum of 100. For clustering analysis, we used modularity and set the parameter to 0.6, which is lower than the standard value of 1, because of the high clustering rate. The color of the nodes was based on the modularity to show clustering.

## 3. Results

### *3.1. Frequency and TF-IDF Analyses*

According to the frequency analysis, the top 100 keywords for "Dobongsan Mountain" are shown in Table 1. The 100 keywords can be categorized into the restorative environment components of fascination (F), being away (B), extent (E), and compatibility (C) based on the attention restoration theory as shown in Table 2. Specifically, the keywords representing fascination were natural resources, such as Sinseondae Observatory, valley, and Obong peaks. The keywords representing being away were non-daily routine-associated words, such as weekend and Saturday. For extent, keywords were derived to identify the size of the space, such as parking lots, hiking trails, and ridge walking. For compatibility, keywords were derived for leisure activities, such as hiking, climbing, ridge walking, and exploration, indicating that the environment is suitable for such purposes. In addition, COVID-19 was ranked 72th, indicating that this area has a relationship with healing and is perceived as a restorative environment during COVID-19.

**Table 1.** Frequency analysis results of the top 100 keywords.

| Rank | Word | Frequency | Rank | Word | Frequency | Rank | Word | Frequency | Rank | Word | Frequency |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Dobongsan Mountain | 33856 | 26 | Start | 1169 | 51 | Thought | 725 | 76 | Seoninbong Peak | 523 |
| 2 | Hiking | 7053 | 27 | Darak Ridge | 1158 | 52 | Weekend | 714 | 77 | Ui | 507 |
| 3 | Climbing | 6597 | 28 | Visitor Center | 1124 | 53 | Parks | 713 | 78 | Mangwolsa Station | 499 |
| 4 | Hiking trails | 6053 | 29 | Autumn leaves | 1108 | 54 | Observatory | 694 | 79 | Dobongsan Entrance | 489 |
| 5 | Dobongsan Station | 5414 | 30 | Mangwolsa Temple | 1080 | 55 | Arrival | 675 | 80 | Wontongsa Temple | 478 |
| 6 | Bukhansan Mountain | 5249 | 31 | Weather | 1063 | 56 | Explore | 652 | 81 | Peaks | 478 |
| 7 | Dobong | 5238 | 32 | Departure | 1016 | 57 | Bukhan | 647 | 82 | Tower | 463 |
| 8 | Seoul | 4279 | 33 | Uijeongbu | 991 | 58 | Dobon-gu | 644 | 83 | Down | 458 |
| 9 | Sinseondae | 3759 | 34 | Bulamsan Mountain | 941 | 59 | Sky | 629 | 84 | Winter | 451 |

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| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Observatory | | | | | | | | | | |
| 10 | Valley | 3238 | 35 | Landscpae | 934 | 60 | Exit | 629 | 85 | Connecting | 440 |
| 11 | Obong | 3077 | 36 | people | 924 | 61 | Distance | 606 | 86 | Clouds | 427 |
| 12 | Ridge | 2744 | 37 | Bus | 900 | 62 | Seoul Changpowon | 589 | 87 | Exercise | 422 |
| 13 | Suraksan Mountain | 2681 | 38 | Baekundae Peak | 883 | 63 | Location | 589 | 88 | Transportation | 422 |
| 14 | Summit | 2660 | 39 | Friends | 867 | 64 | Changpowon | 585 | 89 | Saturday | 421 |
| 15 | Sapaesan Mountain | 2540 | 40 | Gwanaksan Mountain | 837 | 65 | Daily routine | 583 | 90 | Wind | 412 |
| 16 | Trail | 2434 | 41 | Fall | 828 | 66 | Jubong | 579 | 91 | Cheonggyesan Mountain | 408 |
| 17 | Rocks | 2099 | 42 | Ridge walking | 822 | 67 | Amsan Mountain | 578 | 92 | Day | 401 |
| 18 | Fortress ridge | 1821 | 43 | Bukhansan National Park | 795 | 68 | Recommended | 573 | 93 | Manjangbong Peak | 398 |
| 19 | Today | 1725 | 44 | Center | 794 | 69 | Subway | 568 | 94 | Near | 398 |
| 20 | Songchu | 1468 | 45 | Climb down | 781 | 70 | Parking lots | 561 | 95 | Dobong-gu Seoul | 394 |
| 21 | Madang rock | 1455 | 46 | Morning | 761 | 71 | Beginner | 551 | 96 | Dobong-dong | 390 |
| 22 | Uiam Rock | 1446 | 47 | Famous mountain | 754 | 72 | COVID-19 | 540 | 97 | Insubong Peak | 389 |
| 23 | Section | 1422 | 48 | Entrance | 749 | 73 | Stroll | 538 | 98 | Next | 385 |
| 24 | Yeoseongbong Peak | 1386 | 49 | Landscapes | 738 | 74 | Namsan Mountain | 534 | 99 | Summer | 382 |
| 25 | Jaunbong Peak | 1348 | 50 | Cheonchuksa Temple | 733 | 75 | After a long time | 530 | 100 | Sunday | 382 |

**Table 2.** Components of the restorative environment of Dobongsan Mountain.

| Component | Keywords | Notes |
|---|---|---|
| Fascination (F) | Dobongsan Mountain, Bukhansan Mountain, Seoul, Dobongsan Station, Dobong, Sinseongdae Observatroy, Valley, Obong, Suraksan Mountain, Summit, Sapaesan Mountain, Trail, Rock, Fortress, Songchu, Madang Rock, Uiam Rock, Yeoseong, Jaun, Darak, Changpowon, National Park, Visitor Center, Mangwolsa Temple, Uijeongbu, Bulamsan Mountain, Baekundae Peak, Gwanaksan | Natural resources |

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| | | |
|---|---|---|
| | Mountain, Center, Cheonchuksa Temple, Observatory, Bukhan, Jubong, Namsan Mountain, Inbong Peak, Ui, Mangwolsa Station, Wontongsa Temple, Tower, Bomun, Cheonggyesan Mountain, Sapae, Sugol, Manjangbong Peak, Seondae, Dobondong, Insubong Peak, Park, Famous mountain, Autumn leaves, Weather, Landscape, Sky, Amsan Mountain, Clouds, Wind, Peaks | |
| Being away (B) | Today, Morning, Weekend, After a long time, Winter, Saturday, Day, Daily routine, Fall, Next, Bus, Subway, Transportation | Breaking out of the daily routine |
| Extent (E) | Connecting, View, Thoughts, Arrival, Start, Departure, Near, Hiking trail, Ridge, Section, Distance, Down, Exit, Location, Entrance, Parking lot, Dobong-gu Seoul | Sufficiency of space to use |
| Compatibility (C) | Hiking, Climbing, Ridge walking, Exploration, Recommended, Stroll, Exercise, Climb down, People, Friends, Beginner, COVID-19 | The environment matches my needs |

In addition, as shown in Table 3, the top 10 keywords identified by TF-IDF analysis were similar to those of the frequency analysis, but the top keywords were different. The top keywords were mainly related to the purpose and location of leisure activities, such as mountain climbing, hiking, ridge, Seoul, and hiking trail. This shows that the experience factor of leisure activities is important, with keywords corresponding to compatibility of the environment matching peoples' needs, highlighting it as a notable component of restorative environments.

**Table 3.** Comparison of the top 10 keywords identified by frequency and TF-IDF analyses.

| Rank | Keyword | Frequency analysis | Keyword | TF-IDF analysis |
|---|---|---|---|---|
| 1 | Dobongsan Mountain | 34345 | Climbing | 10974.9 |
| 2 | Hiking | 7053 | Hiking | 10951.3 |
| 3 | Bukhansan Mountain | 6822 | Ridge | 10668.4 |
| 4 | Climbing | 6597 | Seoul | 10022.3 |
| 5 | Hiking trails | 6053 | Hiking trails | 9994.79 |
| 6 | Seoul | 5913 | Bukhansan Mountain | 9788.31 |
| 7 | Ridge | 5826 | Dobongsan Station | 9197.08 |
| 8 | Dobongsan Station | 5414 | Dobong | 8850.96 |
| 9 | Dobong | 5354 | Sinseondae Observatroy | 7901.51 |
| 10 | Sinseondae Observatory | 3739 | Obong | 7707.33 |

*3.2. Analyzing Semantic Networks*

When the semantic linkage network was analyzed using cluster analysis (modularity), it was divided into seven clusters as shown in Table 4 and Figure 4. Cluster 1 was characterized by activity content and companion type, corresponding to leisure activities in Dobongsan Mountain, activity time, and activity period. This cluster was related to the C and B components presented earlier as restorative environment components, and accounted for the largest proportion of 32%. Cluster 2 involved mountains and landscapes in Seoul that are connected to Dobongsan Mountain as Seoul's landscape resources, such as Bukhansan Mountain, Bulamsan Mountain, Suraksan Mountain, and Gwanaksan Mountain, or mountains with views. It was related to scale and accounted for 20% of the restorative environment component. It appeared at a high frequency, including the surrounding mountains. Cluster 3 included surrounding connected resources, such as Dobongsan Station, trails,

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Changpowon, and parks, which were related to the scale presented in the restorative environment component and accounted for about 19%. Cluster 4 included scenic resources, such as Mangwolsa Temple and Wondongsa Temple, which corresponded to the attractiveness suggested by the restorative environment component, and accounted for approximately 13%. Clusters 5, 6, and 7 included natural resources, such as valleys, Manjangbong Peak, and Obong Peak, each of which corresponded to the attractiveness of the restorative environment component, and the total percentage was 16%, indicating that the same natural resources were perceived differently from different hiking trails. In summary, the proportions of the restorative environment components were 49% for F, 32% for C and B, and 19% for E, indicating that the proportions of the restorative environment components were appropriate in the perception clustering analysis.

**Table 4.** Cluster analysis of the semantic linkage network.

| Cluster | Keywords | Ratio | Nature of clusters | Notes |
|---|---|---|---|---|
| 1 | Dobongsan Mountain, hiking, climbing, hiking trails, Sinseondae Observatory, Summit, Today, Madang rock, Start, Autumn leaves, Weather, People, Friend, Fall, Morning, Famous mountain, Cheonchuksa Temple, Thought, Weekend, Arrival, Daily routine, Recommended, Beginner, After a long time, COVID-19, Winter, Exercise, Saturday, Wind, Day, Next, Summer | 32 | Recreation | Compatibility (C), being away (B) |
| 2 | Bukhansan Mountain, Suraksan Mountain, Rock, National park, Bulamsan Mountain, View, dae Peak, Gwanaksan Mountain, Landscape, Observatory, Bukhan, Sky, Amsan Mountain, Namsan Mountain, Peak, Tower, Down, Clouds, Cheonggyesan Mountain, Insubong | 20 | Seoul Landscape Resources | Fascination (F |
| 3 | Seoul, Dobongsan Station, Trail, Section, Changpowon, Departure, Uijeongbu, Bus, Center, Park, Dobong-gu | 19 | Neighboring Connected Resources | Extent (E) |
| 4 | Ridge, Sapaesan Mountain, Fortress, Uiam Rock, Darak, Mangwolsa Temple, Ridge walking, Ui, Mangwolsa Station, Wontongsa Temple, Connected, Bomun, Sapae | 13 | Scenic Resources | Fascination (F) |
| 5 | Dobong, Valley, Visitor center, Exploration, Sugol, Seondae | 6 | Natural Resources 1 | |
| 6 | Jaun, Entrance, Climb down, Jubong Peak, Inbong Peak, Manjangbong Peak | 6 | Natural Resources 2 | |
| 7 | Obong, Songchu, Yeoseong, Parking lot | 4 | Natural Resources 3 | |

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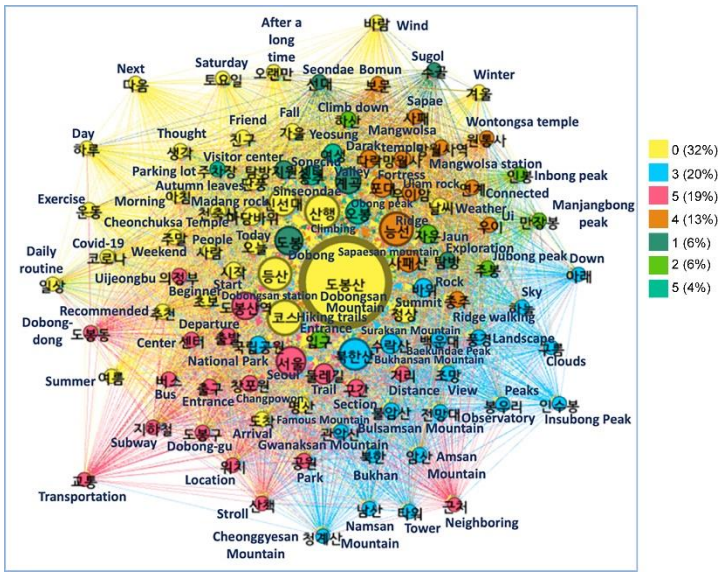


**Figure 4.** Semantic network analysis of key words (over three degrees).

### 3.3. Sentiment Analysis

The sentiment analysis showed an extremely high positive rate of 91.6% and a negative rate of 8.4%, as shown in Figure 5. Among the positive sentiments, 87.5% were favorable feelings, 8.6% were joy, and 3.9% were interesting. Among the favorable feelings were “Good,” “Awesome,” “Beautiful,” “Natural,” “Cool,” “Pretty,” and “Lovely.” Words of joy included “Best,” “Happy,” and “Enjoyable,” whereas expressions of interest included “New,” “Looking forward to,” and “Special.” Negative words included “Hard,” “Cry,” and “Regrettable” for sadness, and “Difficult” for rejection. Based on the user experience, Dobongsan Mountain is perceived as an exceptionally positive place, but relatively few words for favorable feelings and joy were derived, and negative feelings regarding physical activity in leisure activities were expressed. Kim [34] suggested that stressed people experience restoration in the form of relaxation, tranquility, mental stability, and vitality in a nature-based healing restorative environment. He also suggested that this restorative experience affects health-related quality of life. It is interpreted that users who experienced urban forest mountains experienced a positive restorative experience. When divided into specific restorative experiences, rest, calmness, and mental stability corresponding to favorable feelings (87.5%) accounted for the majority, whereas the proportion of vitality-related keywords corresponding to joy and interest (12.5%) was relatively low.

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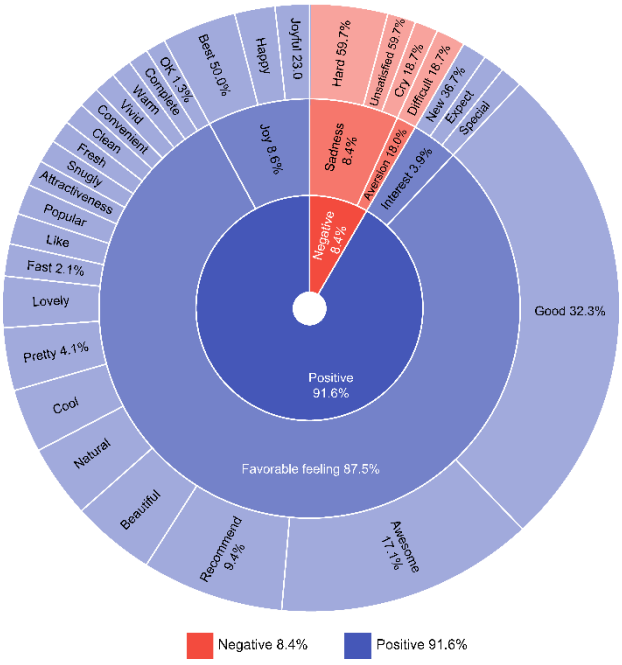


**Figure 5.** Sentiment analysis of Dobongsan Mountain.

## 4. Discussion

The characteristics of urban forest mountains as a restorative environment, which we examined through big data from blog posts related to Dobongsan Mountain after the COVID-19 outbreak, are as follows.

First, the frequency analysis showed that the forest space as a restorative environment component consists of fascination, being away, extent, and compatibility. In particular, it was found to have a very high fascination value as a natural area. In particular, according to the TF-IDF analysis, the restorative environment components, including purposeful leisure activities such as hiking and walking, which correspond to compatibility, are a major factor. This suggests that compatibility as a place for leisure activities is an important factor for the restorative environment component.

Second, in the cluster analysis, the keywords were categorized into leisure activities, Seoul landscape resources, scenic resources, and natural resources 1, 2, and 3. This analysis showed that leisure activities were related to compatibility and being away, neighboring connected resources were related to extent, and Seoul landscape resources, scenic resources, and natural resources were related to fascination. In particular, COVID-19 was included in the leisure activity cluster, and leisure activities owing to COVID-19 were connected to compatibility and being away, and were interpreted as playing a very important role. In addition, previous studies on place memories [35,43] suggested that clusters are formed around specific places. However, in this study, clusters were formed not only around places but also around specific activities, suggesting that leisure activities corresponding to compatibility, which are a component of restorative environments in urban forest mountains, are important and necessary to provide various experiences.

Third, the sentiment analysis showed that the restorative experience was positive, and the results were similar to those of Lupp et al. [44] in their study of small spaces affecting positive perceptions of forests. Therefore, we can confirm that urban forest mountains are highly positive restorative environments. In addition, keywords corresponding to favorable feelings, such as “Good,” “Nice,” and “Beautiful,” which are related to fascination and the extent of the restorative environment components, expressed the aesthetic experience of the resource. However, sentiments such as joy and interest were relatively lacking in the restorative experience, which corresponds to the vitality caused by compatibility and being away.

## 5. Conclusions

In this study, we attempted to find a management plan to optimize urban forest mountains in Korea as restorative environments after COVID-19. In terms of the four components of restorative environments, we analyzed the forest management plan by dividing it into spatial resource-related factors such as attractiveness and scale, and activity resource-related factors such as being away and compatibility. Fascination and extent, which are spatial resource factors, were important forest space resource factors perceived by people as scenic resources, natural resources, and landscape resources. It was found that these were classified into different resource clusters; therefore, conservation measures that consider their characteristics are necessary. In addition, after COVID-19, compatibility based on leisure activities was the most important restorative environment component. Therefore, it is necessary to diversify leisure activities and increase the range of restorative experiences as an important step to strengthen the positive factors of forests and minimize their negative factors. The significance of this study is that it identified factors in the recovery environment based on consumer perception. To improve the physical environment in the future, it is necessary to study the spatial environment based on actual user mobility data.

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**Conflicts of Interest:** The authors declare no conflicts of interest.

## References

1. Slater, S.J.; Christiana, R.W.; Gustat, J. Recommendations for keeping parks and green space accessible for mental and physical health during COVID-19 and other pandemics. *Prev. Chronic Dis.* **2020**, *17*, E59. DOI:10.5888/pcd17.200204.
2. McCunn, L.J. The importance of nature to city living during the COVID-19 pandemic: Considerations and goals from environmental psychology. *Cities Health* **2021**, *5*, sup1, S223–S226. DOI:10.1080/23748834.2020.1795385.
3. UN. *Policy Brief: COVID in an Urban World*, 2020.
4. Derks, J.; Giessen, L.; Winkel, G. COVID-19-induced visitor boom reveals the importance of forests as critical infrastructure. *For. Policy Econ.* **2020**, *118*, 102253. DOI:10.1016/j.forpol.2020.102253.
5. Morita, H.; Nakamura, S.; Hayashi, Y. Changes of urban activities and behaviors due to COVID-19 in Japan. *SSRN Journal* **2020**. DOI:10.2139/ssrn.3594054.
6. Venter, Z.S.; Barton, D.N.; Gundersen, V.; Figari, H.; Nowell, M. Urban nature in a time of crisis: Recreational use of green space increases during the COVID-19 outbreak in Oslo, Norway. *Environ. Res. Lett.* **2020**, *15*, 104075. DOI:10.1088/1748-9326/abb396.
7. Qian, K.; Yahara, T. Mentality and behavior in COVID-19 emergency status in Japan: Influence of personality, morality and ideology. *PLoS One* **2020**, *15*, e0235883. DOI:10.1371/journal.pone.0235883.
8. Lai, K.Y.; Webster, C.; Kumari, S.; Sarkar, C. The nature of cities and the COVID-19 pandemic. *Curr. Opin. Environ. Sustain.* **2020**, *46*, 27–31. DOI:10.1016/j.cosust.2020.08.008.
9. Kumar, L.; Kahlon, N.; Jain, A.; Kaur, J.; Singh, M.; Pandey, A.K. Loss of smell and taste in COVID-19 infection in adolescents. *Int. J. Pediatr. Otorhinolaryngol.* **2021**, *142*, 110626. DOI:10.1016/j.ijporl.2021.110626.
10. Chen, Y.-C.; Tsai, F.C.; Tsai, M.-J.; Liu, W.-Y. Recreational visit to suburban forests during the COVID-19 pandemic: a case study of Taiwan. Forests **2022**, *13*, 1181. https://doi.org/10.3390/f1308118111.
11. Lopez, B.; Kennedy, C.; McPhearson, T. Parks are critical urban infrastructure: perception and use of urban green space in NYC during COVID-19, 2020 [Preprint].

12. Xie, J.; Luo, S.; Furuya, K.; Sun, D. Urban parks as green buffers during the COVID-19 pandemic. *Sustainability.* **2020**, *12*, 6751. DOI:10.3390/su12176751.
13. Samuelsson, K.; Barthel, S.; Colding, J.; Macassa, G.; Giusti, M. Urban nature as a source of resilience during social distancing amidst the coronavirus pandemic. *Landsc. Urban Plan.* **2020** *[Preprint].*
14. Grima, N.; Corcoran, W.; Hill-James, C.; Langton, B.; Sommer, H.; Fisher, B. The importance of urban natural areas and urban ecosystem services during the COVID-19 pandemic. *PLoS One* **2020**, *15*, e0243344. DOI:10.1371/journal.pone.0243344.
15. Rice, W.L.; Mateer, T.J.; Reigner, N.; Newman, P.; Lawhon, B.; Taff, B.D. Changes in recreational behaviors of outdoor enthusiasts during the COVID-19 pandemic: Analysis across urban and rural communities. *J. Urban Ecol.* **2020**, *6*, juaa020. DOI:10.1093/jue/juaa020.
16. Park, H. I. 2020, April 03. "Distance in Korea, shopping and theaters for a month 19%↓ Visiting parks 51% ↑"... Google announces analysis of population movement in Korea ChosunBiz. Retrieved from https://biz.chosun.com/site/data/html_dir/2020/04/03/2020040303053.html17. Seoul Metropolitan Government. *Seoul Land Status (by Lot) Statistics* > Datasets > Open Government Data | Seoul Open Data Plaza. Available online: seoul.go.kr, 2022.
17. Chae, J.H.; Heo, Y.K.; Kim, S.H. Seoul and Berlin according to historical changes. Comparison of characteristics of suburban green spaces. *J. Seoul Studies* **2021**, *85*, 33-82.
18. 채진해. 코로나 시대, 근교산의 변화. 도시정보, 2021, 466: 29-33./
19. Chae, J.H. Change of Pluralistic Value in MT. *Gwanak Suburban* [Doctoral Dissertation]; Mountain Press; Seoul National University: Seoul, Korea, 2016.
20. Chae, J.H.; Cho, M.J. Changes in the cultural trend of use by type of green infrastructure before and after COVID-19 using blog text mining in Seoul. *J. People Plants Environ.* **2021**, *24*, 415–427. DOI:10.11628/ksppe.2021.24.4.415.
21. Chae, J.H.; Lee, I.J. Residents' perceptions and behaviors toward neighboring mountains region as green infrastructure in Gwanak-gu, Seoul. *J. Urban Des.* **2020**, *2*, 26–35. https://www.dbpia.co.kr/journal/articleDetail?nodeId=NODE10590675
22. Zhai, Y.; Baran, P.K.; Wu, C. Spatial distributions and use patterns of user groups in urban forest parks: An examination utilizing GPS tracker. *Urban For. Urban Greening* **2018**, *35*, 32–44. DOI:10.1016/j.ufug.2018.07.014.
23. Sergiacomi, C.; Vuletić, D.; Paletto, A.; Barbierato, E.; Fagarazzi, C. Exploring national park visitors' judgements from social media: The case study of Plitvice Lakes national park. *Forests* **2022**, *13*, 717. DOI:10.3390/f13050717
24. Zheng, Y.; Lan, S.; Chen, W.Y.; Chen, X.; Xu, X.; Chen, Y.; Dong, J. Visual sensitivity versus ecological sensitivity: an application of GIS in urban forest park ^lanning. *Urban For. Urban Greening* **2019**, *41*, 139–149. DOI:10.1016/j.ufug.2019.03.010.
25. Lee, B.; Yeon, P. An EDA analysis of Seoul metropolitan area's mountain usage patterns of users in their 20~30s after COVID-19 occurrence. *J. People Plants Environ.* **2021,** *24*, 229–244. DOI:10.11628/ksppe.2021.24.2.229.
26. Chae, J.H. Corona era, change in urban mountain, *Urban Policy* **2021**, 466, 29–33.
27. Rice, W.L.; Pan, B. *Understanding Drivers of Change in Park Visitation during the COVID-19 Pandemic: A Spatial Application of Big Data*, 2020.
28. Litvin, S.W.; Goldsmith, R.E.; Pan, B. Electronic word-of-mouth in hospitality and tourism management. *Tourism Manag.* **2008**, *29*, 458–468. DOI:10.1016/j.tourman.2007.05.011.
29. Kang, J.M.; Lee, B.J. Comparing service quality perceptions of airline before and after COVID-19 pandemic: Focused on topic modeling and semantic association analysis. *J. Tourism Leis. Res.* **2021**, *33*, 257–276. DOI:10.31336/JTLR.2021.9.33.9.257.
30. Kim, S.B. Blog text analysis about visitors' experience change of Seochon. *J. Archit. Inst. Korea Planning & Design* **2015**, *31*, 93–102. DOI:10.5659/JAIK_PD.2015.31.6.93.
31. Beil, K.; Hanes, D. The influence of urban natural and built environments on physiological and psychological measures of stress: a pilot study. *Int. J. Environ. Res. Public Health*. **2013**, *10*, 1250–1267. DOI:10.3390/ijerph10041250.
32. Kaplan, R.; Kaplan, S. The experience of nature: a psychological perspective. *CUP Arch.* **1989**.
33. Kaplan, S. The restorative benefits of nature: toward an integrative framework. *J. Environ. Psychol.* **1995**, *15*, 169–182. DOI:10.1016/0272-4944(95)90001-2.

34. Kim, J.O. The effect of perceived stress of urban residents on health-related quality of life by recovery experience through natural-based healing restoration environments: focusing on the attention restoration theory. *JTS* **2018**, *42*, 51–70. DOI:10.17086/JTS.2018.42.7.51.70.
35. Park, J.M.; Hong, Y.S. Analyzing places of memory and sense of place in the Taereung National sports center. *J. Urban Des. Inst. Korea* **2016**, *17*, 147–162.
36. Li, H.; Peng, J.; Jiao, Y.; Ai, S. Experiencing urban green and blue spaces in urban wetlands as a nature-based solution to promote positive emotions. *Forests* **2022**, *13*, 473. DOI:10.3390/f13030473.
37. Hartig, T.; Korpela, K.; Evans, G.W.; Gärling, T. A measure of restorative quality in environments. *Scand. Hous. Plan. Res.* **1997**, *14*, 175–194. DOI:10.1080/02815739708730435.
38. Herzog, T. R., Maguire, P., & Nebel, M. B. Assessing the restorative components of environments. *J. Environ. Psychol*. **2003**, *23*, 159–170. https://doi.org/10.1016/S0272-4944(02)00113-5
39. Berto, R. Exposure to restorative environments helps restore attentional capacity. *J. Environ. Psychol.* **2005**, *25*, 249–259. DOI:10.1016/j.jenvp.2005.07.001.
40. Ouellette, P.; Kaplan, R.; Kaplan, S. The monastery as a restorative environment. *J. Environ. Psychol.* **2005**, *25*, 175–188. DOI:10.1016/j.jenvp.2005.06.001.
41. TEXTOM, Big data analysis solution TEXTOM manual from big data collection to visualization! V6.0, 2022.
42. Bastian, M.; Heymann, S.; Jacomy, M. Gephi: an open source software for exploring and manipulating networks. International AAAI Conference on Weblogs and Social Media, 2009.
43. Park, J.M. Modern industrial landscape interpreted through place memory: Janghang, a modern industrial city, as an example. *Environ. Stud.* **2013**, *52*, 104–104.
44. Lupp, G.; Kantelberg, V.; Fäth, J.; Hirschbeck, T.; Käsbauer, C.; Ritter, A.; Schisslbauer, J.; Pauleit, S. Through the eyes of forest visitors–perception and scenic preferences of Munich's urban proximate woodlands. *Forests* **2022**, *13*, 1584. DOI:10.3390/f13101584.