

Article

Impact of Changes in Forest Use Caused by the COVID-19 Pandemic on the Perception of Forest Ecosystem Services in the Republic of Korea

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Abstract: Ecosystem services (ESs) play an important role in improving human well-being. This study identified the changes in people's perceived importance of forest ecosystem services (FESs) due to changes in forest use caused by the coronavirus disease-19 (COVID-19) pandemic. We measured the changes in people's perceived importance of FESs during the pandemic compared to before its outbreak. We analyzed how the decrease in frequency of visits to urban greenspaces and forests and the purchasing of wood products and non-timber forest products (NTFPs) during the pandemic affected changes in the perceived importance of FESs using a multiple linear regression model. Data were collected from 1000 participants through an online survey conducted in the Republic of Korea. Results showed that respondents commonly perceived that all types of FES, particularly regulating and cultural services, were more important during the COVID-19 outbreak than before its onset. Results suggest that people who had decreased their frequency of visits to urban greenspaces and forests had a perception of higher importance for regulating and cultural services than those who maintained it. This study proposes that it is necessary to change urban greenspace and forest management policies reflecting the public's changed importance of FESs.

Keywords: COVID-19; forest use; forest ecosystem service; perception; human well-being; human health



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1. Introduction

The concept of ESs was introduced in the 1970s to enable social functions and values of nature and ecosystems. Westman [1] debated the importance of measuring social benefits from nature's services and discussed methods to measure their values. An ecosystem function is defined as the capacity of natural processes and components to provide goods and services that satisfy human needs directly or indirectly [2,3]. Daily [4] defined ESs as the conditions and processes through which natural ecosystems and the species that make them up, sustain and fulfill human life. Costanza et al. [5] described that ecosystem goods and services represent the benefits that human populations derive directly or indirectly from ecosystem functions and valued them for 17 types of functions. Commonly cited definitions of ESs include the benefits people obtain from ecosystems [6]. ESs are generally classified into four categories: provisioning services (e.g., food, water, timber, fiber, and genetic materials), regulating services (e.g., air quality regulation, climate regulation, natural hazard mitigation, and water regulation), cultural services (e.g., recreational, aesthetic, spiritual benefits, and heritage), and supporting services (e.g., soil formation, nutrient cycling, habitat, and genetic pool protection) [6,7].

In the 2000s, frameworks for analyzing the relationship between ESs and their supply processes were developed. In the conceptual framework proposed by MA [6], dynamic interactions exist between ecosystems, ESs, direct drivers (e.g., land use change, climate change, and biological drivers), indirect drivers (e.g., demographic, economic and sociopolitical drivers), and human well-being. In addition, in the Intergovernmental Plat-

form on Biodiversity and Ecosystem Services (IPBES) conceptual framework proposed by Díaz et al. [8], the main elements are nature, nature's benefits to people, anthropogenic assets, direct drivers (e.g., natural and anthropogenic drivers), indirect drivers (e.g., institutions and governance), and a good quality of life. According to these two frameworks, indirect drivers significantly influence people's perceptions of ESs, which can affect their behavior and decisions about the interaction with nature. Consequently, this can lead to changes in ecosystems (or nature), the supply and demand of ESs (or nature's benefits to people), and even human well-being (or quality of life).

Forests represent an important ecosystem to provide urban residents with recreational services, fresh air, and clean water for their physical and mental health, and rural residents with timber and NTFPs for their livelihoods. Therefore, the perceived importance of forests to the public, urban residents, and rural communities in terms of ESs was surveyed in previous studies. In Lin et al. [9], Taiwanese people perceived that soil conservation, climate regulation, and carbon sequestration services were the most important among the 14 FESs. In Gouwakinnou et al. [10], forest communities in Northern Benin recognized crops, fuel, and plant-derived medicines as the most important provisioning services, and regulation of air quality as the most important regulating service. In Ahammad et al. [11], most forest villagers recognized the importance of fuel and food for provisioning services and water purification for indirect FESs in Bangladesh. In Mikusiński and Niedziałkowski [12], forest communities in Poland perceived the importance of provisioning services (e.g., timber and wood, and mushrooms) and cultural services (e.g., recreation). In Cuni-Sanchez et al. [13], local communities in north-western Cameroon also perceived the importance of forest provisioning services (e.g., water, medicine, honey, and firewood). In Lee [14], local communities in Laos selected food, raw material and timber as the top three priorities of ecosystem services in bamboo forests among the 15 FESs.

Recently, the outbreak of the COVID-19 pandemic, declared by the World Health Organization (WHO) on 11 March 2020, changed people's daily life. In the early stages of the COVID-19 outbreak, governments worldwide implemented strong restrictions on activities of daily life (e.g., social distancing, home confinement, and quarantine) as an indirect driver affecting human well-being. These measures have resulted in decreased physical activities and changes in eating behavior, such as reduced eating out [15,16]. The frequency of participation in outdoor recreational activities and the travel distance to participate in activities has declined, especially in urban areas [17]. In addition, the COVID-19 pandemic has led to negative impacts on income-generating activities, including reduced business activity, reduced pay, job losses, business closure, delays in receiving income, and stoppage of remittances [18]. Furthermore, activities pertaining to arts, entertainment, recreation, accommodation, and food services have declined, and the rate of poverty has increased in the absence of social support [19].

In line with the changes in daily life caused by the pandemic, people changed their forest use, including the visits to urban forests and greenspaces, and the consumption of timber and NTFPs products. In terms of visits to forests, outdoor recreational activities in greenspaces including peri-urban forests, protected areas and city parks increased after the COVID-19 lockdown [20,21]. Some studies have shown that the frequency of visits or the number of visitors to urban forests and greenspaces was higher during the COVID-19 pandemic than before the pandemic [22–27]. Yamazaki et al. [28] showed new visits were made by telecommuters to urban greenspaces and forests during the pandemic. However, other studies [29–31] found that urban residents' visits to greenspaces were decreased during the COVID-19 lockdown in some countries. In terms of the consumption of forest products, the pandemic increased the consumption of lumber because expenditures shifted from indoor or outdoor activities to housing in USA [32]. On the contrary, the COVID-19 pandemic reduced consumers' preferences for wood furniture in China because it was difficult for them to go to stores to buy furniture due to the COVID-19 measures [33].

The COVID-19 pandemic also changed the importance of forests. Previous studies highlight that the perceived importance of urban forests and greenspaces increased during

the pandemic. In Grima et al. [34], urban residents in Germany said that the personal importance of urban and peri-urban forests either increased or greatly increased during the pandemic. Lopez et al. [35] state that urban residents in New York City, USA, considered the role of urban greenspaces in mental and physical health to be more important during the pandemic than before. In Noszczyk et al. [36], most respondents believed that visits to greenspaces had a very big impact on improving general well-being in southern Poland during the COVID-19 pandemic. In da Schio et al. [23], the proportion of people in Belgium who prioritized urban forests and greenspaces as the local government's services was higher during the COVID-19 lockdown than before the lockdown.

Therefore, the pandemic can have an impact on the perceived importance of FESs. In Beckmann-Wübbelt et al. [22], urban residents in Burlington, USA, perceived a high value of cultural services of urban forests during the pandemic, especially for recreation services in peri-urban forests. However, there was no evidence that the perceived importance of diverse FESs changed during the COVID-19 pandemic.

This study aimed to identify changes in the public's perceived importance of FESs during the COVID-19 pandemic and its determinants in the Republic of Korea as a case study. The changes and its determinants were analyzed by addressing the following specific research questions:

1. How did the public's perceived importance of FES change during the COVID-19 pandemic in the Republic of Korea?
2. Why did the perceived importance of FES change during the COVID-19 pandemic?

2. Materials and Methods

2.1. Case Study

The Republic of Korea was among the countries that took preemptive action against the COVID-19 pandemic, where the first case of COVID-19 was confirmed on 20 January 2020, and a total of 630,835 cases had been confirmed as at 31 December 2021 [37].

During the COVID-19 pandemic, strong measures were enforced in the Republic of Korea. After the occurrence of super-spreader events in Daegu metropolitan city on 20 February 2020, the Korean government implemented measures to prevent the spread of COVID-19, such as wearing masks and staying at home, by raising the national alert level to the highest level. Following the declaration of COVID-19 as a pandemic by the WHO, the government strengthened restrictions on daily life by imposing 'social distancing' on 22 March 2020. They loosened the restrictions from the end of April to the middle of August 2020 due to a decrease in confirmed cases of COVID-19 but strengthened them again in the middle of August 2020 because of a rapid increase in cases.

To implement social distancing, the Korean government controlled the number of participants in social activities and meetings, ordered stores such as restaurants and coffee shops to reduce opening hours, and regulated the use of public facilities such as gyms and sports clubs. They also ordered schools and companies to switch to online learning and working. During social distancing, people reduced their face-to-face interaction activities and declined their participation in social activities to prevent the spread of the disease and infection. These measures were highly effective in preventing the transmission of the disease [38]. However, the decline in offline consumption and eating out led to the closure of small businesses, and some employees experienced a reduction in their income or were made unemployed.

In the early stages of the COVID-19 outbreak in the Republic of Korea, people mostly desisted from travel and tourism [39]. Moreover, the public's participation in forest recreational activities, such as visits to urban greenspaces, outdoor activities in forests and mountains, and travel to mountain villages, decreased, especially among elderly groups [40]. According to the statistics of the Korea National Park Service [41], the total number of visitors to national parks decreased during 2020.

In this study, a survey was conducted in the early stages of the COVID-19 outbreak (from 27 August to 4 September 2020) during a period of strengthened social distancing.

2.2. Conceptual Framework and Research Model

This study focused on the changes in people's perceived importance of FESs during the COVID-19 pandemic. Previous studies [23,34,35] found that the perceived importance of urban forests and greenspaces increased during the pandemic. In particular, in Beckmann-Wübbelt et al. [22], urban residents perceived a high value of recreation services in peri-urban forests during the pandemic. Thus, the first hypothesis of this study is proposed below:

Hypothesis 1 (H1). *The perceived importance of FESs increased during the pandemic as compared to before the pandemic.*

To assess the changes in the perceived importance of FESs, this study determined the types of FES that reflect the status of forests and the need for forests in the Republic of Korea, and then identified changes in the perceptions of the importance of each FES during the COVID-19 pandemic as compared to before the pandemic. This study selected 14 types of FES based on previous studies. It included 12 types of service in the FES category of the Korea Forest Service (KFS) [42,43], such as watershed enhancement, water purification, soil erosion prevention, landslide prevention, greenhouse gas (GHG) absorption, oxygen generation, air quality improvement, mitigation of urban heat islands, forest recreation, forest therapy, forest landscape, and biodiversity conservation. It also added two sub-provisioning services, namely, timber and NTFP production, from Jo et al. [44], and provision of biomass energy from Ahn et al. [45]. Table 1 shows the categories of FES used in this study.

Table 1. Category of FES used in this study.

First Category	Sub-Category	Description of FESs
Provisioning services	Timber and NTFP production	Production of timber for materials and NTFPs for food from forests
	Biomass energy supply	Production of woody biomass-based fuels
	Watershed enhancement	Sustainable provision and flow regulation of groundwater for drinking, irrigation, and hydropower
Regulating services	Water purification	Filtration of particles, pollutants, and chemicals by forest floor
	Soil erosion prevention	Prevention of soil erosion by vegetation cover
	Landslide prevention	Prevention of landslide by vegetation cover
	GHG absorption and storage	Reduction in greenhouse gas emissions through carbon sequestration and storage
	Oxygen generation	Emission of oxygen through photosynthesis
	Air quality improvement	Regulation of levels of CO ₂ , O ₃ , SO _x , and NO _x , and filtration or fixation of pollutants and fine dust
	Urban heat island mitigation	Reduction in air temperature by regulating albedo and evapotranspiration from vegetation cover
Cultural services	Forest landscape	Provision of aesthetic enjoyment by forest landscape
	Forest recreation	Provision of opportunities for healing, leisure, and recreational activities in forests
	Forest therapy	Provision of relaxation by emissions of an anion and phytoncide from trees
Supporting services	Biodiversity conservation	Formation of ecological conditions and habitat necessary for organisms such as animals (e.g., mammals, birds, and insects) and plants

These changes in the perceived importance of FESs can be influenced by changes in daily life caused by the COVID-19 pandemic. Lee et al. [46] identified that increased stress caused by economic shock, reduced work and business income, and freedom violations such as restricted activities and changed indoor-oriented lifestyle (e.g., watching TV, monitors and smartphones at home) in the COVID-19 period had a significantly positive impact on the preference for natures. In Howlett and Turner [47], urban residents decreased the time

spent outside by their children during the COVID-19 lockdown than before lockdown, but mostly changed their thinking on the importance of greenspaces.

In particular, in the early stages of the COVID-19 outbreak, worldwide restrictions on social gathering and movement, public event cancellation, and workplace closures were negatively correlated with the number of visitors to urban parks [48]. In some countries (e.g., Croatia, Israel, Italy, Lithuania, Slovenia, Spain, UK, and the Republic of Korea), visits to urban forests and greenspaces far from home decreased during the pandemic as compared to before the pandemic [29–31,40].

However, in Turkey, urban greenspaces were closed to maintain social distancing in the early stages of the pandemic, but half of the residents did not change the frequency of visiting urban greenspaces [49]. In Italy, residents who could not physically access greenspaces in towns located in red zones with hundreds of infections and increasing deaths were more likely to miss greenspaces [31].

FESs are an experience good that consumers must use before their quality is known. People who have consumed FESs (e.g., fresh air and recreation) through visits to urban greenspaces and forests, and have good experiences of them before the COVID-19 pandemic, already perceived the importance of FESs and their value. Therefore, they increased their perceived importance of FESs when their access to such services was restricted during the pandemic. The second hypothesis of this study is proposed below:

Hypothesis 2 (H2). *The decrease in forest use caused by the COVID-19 pandemic affected the increase in the perceived importance of FESs.*

Hypothesis 2-1 (H2-1). *People who decreased their visits to urban greenspaces increased their perceived importance of FESs more than those who did not decrease their visits.*

Hypothesis 2-2 (H2-2). *People who decreased their visits to forests increased their perceived importance of FESs more than those who did not decrease their visits.*

In this study, visits to urban greenspaces is defined as visits to nearby tree-lined streets, city parks, and urban gardens. Moreover, visits to forests means the visits to forests for outdoor activities such as camping, hiking, and forest therapy.

During the COVID-19 pandemic, some consumers in Croatia changed their purchasing behavior by switching from offline shopping to online shopping [50]. Moreover, in the Republic of Korea, there was an increase in the online consumption of crops and home-furnishing products such as furniture and interior products during the pandemic [51]. However, many consumers who prefer to purchase wood products and NTFPs in offline stores, in contrast to common industrial products, reduced their purchase of wood products and NTFPs during the pandemic.

Moreover, the pandemic restrictions affected the production and trade of forest products. Tao et al. [52] found that the imbalance between supply and demand for wood products during the pandemic led to an increase in log prices. This can lead to an increase in the price of wood products and a decrease in their consumption.

Similar to visits to urban greenspaces and forests, people who consumed FESs (e.g., ornaments and fresh foods) through the purchase of wood products and NTFPs, and had good experiences from them, improved their perceived importance of FESs when their access to such services was restricted during the COVID-19 pandemic. Therefore, sub-hypotheses of the second hypothesis are proposed below:

Hypothesis 2-3 (H2-3). *People who decreased their purchases of wood products increased their perceived importance of FESs more than those who did not decrease their purchases.*

Hypothesis 2-4 (H2-4). *People who decreased their purchases of NTFPs increased their perceived importance of FESs more than those who did not decrease their purchases.*

Finally, this study considered demographic and socioeconomic characteristics, and the perceptions of forests before the COVID-19 pandemic at the individual level as baseline factors, to establish the changes in the perceived importance of FESs.

In previous studies, the characteristics of individuals or households were found to affect the perception of FESs. In Mensah et al. [53], personal attributes, such as household income, gender, and age, affected the forest communities' perceived importance of ESs, especially in provisioning, regulating, and supporting services. Ahammad et al. [11] found differences in the perceived importance of FESs across wealth groups (e.g., low, middle, and high), particularly for pest and disease control, and soil protection. In Cuni-Sanchez et al. [13] and Lee [14], the type of stakeholder group (e.g., farmer and pastoralist, and community and expert) affected the perceived importance and priority of FESs. According to Gouwakinnou et al. [10], village characteristics (e.g., education rate, poverty index, distance from village to forest, and socio-cultural group) influenced the forest villagers' perception of ESs. Moreover, Mikusiński and Niedziałkowski [12] identified that there was a difference in the villagers' perceived importance of ESs across the location of forest villages.

This study selected age, gender, education level, household income level, number of family members, having children or not, and location of residential area as demographic and socioeconomic characteristics, and the level of importance of forests as the perception of forests before the COVID-19 outbreak.

Figure 1 shows the applied research model based on this conceptual framework.

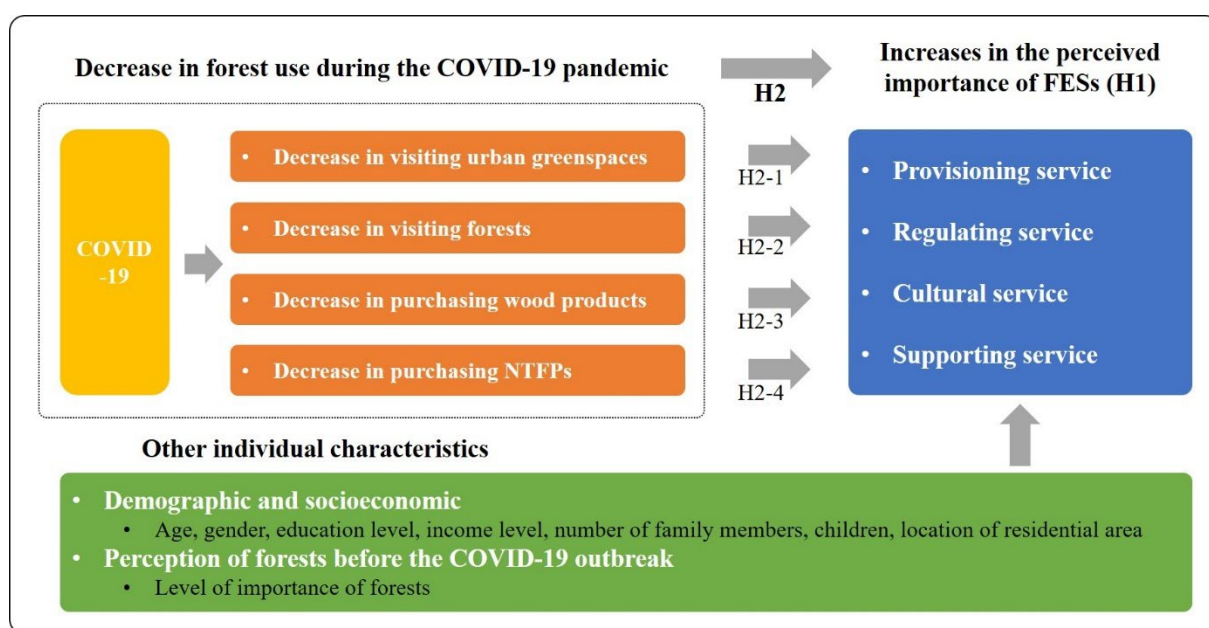


Figure 1. Research model of this study.

2.3. Empirical Model

To analyze the causal relationship between the variables in the conceptual research model, four econometric models were designed as follows:

$$\text{Change of Perception}_{\text{provisioning}} = \alpha_0 + \alpha_1 \text{Change}_{\text{forest use}} + \alpha_2 \text{Others} + \varepsilon_p \quad (1)$$

$$\text{Change of Perception}_{\text{regulating}} = \beta_0 + \beta_1 \text{Change}_{\text{forest use}} + \beta_2 \text{Others} + \varepsilon_r \quad (2)$$

$$\text{Change of Perception}_{\text{regulating}} = \beta_0 + \beta_1 \text{Change}_{\text{forest use}} + \beta_2 \text{Others} + \varepsilon_r \quad (3)$$

$$\text{Change of Perception}_{\text{supporting}} = \delta_0 + \delta_1 \text{Change}_{\text{forest use}} + \delta_2 \text{Others} + \varepsilon_s \quad (4)$$

For each dependent variable in each formula, variables were defined as the changes in the perception of the importance of FESs at the first category level, including provisioning, regulating, cultural, and supporting services. First, these variables were measured using a 7-point Likert scale from “considerably less important during the COVID-19 pandemic than before the COVID-19 pandemic” to “considerably more important during the COVID-19 pandemic than before the COVID-19 pandemic” for 14 services in each of the subcategories described in Table 1. We then calculated the average scale of the changes in the importance of FESs at the first category level. Biodiversity conservation represents the average scale of supporting services. In this study, “before the COVID-19 pandemic” was defined as the period from the beginning of August 2019 to the middle of February 2020, while “during the COVID-19 pandemic” was defined as the period from the middle of February 2020 to the end of August 2020, and the definitions of the periods were also explained to survey respondents.

Considering that the average scale is a continuous variable from the minimum of 1 point to the maximum of 7 points for provisioning, regulating, and cultural services as dependent variables, we established four multiple linear regression models for each service.

The variable $\text{Change}_{\text{forest use}}$ means the changes in forest use caused by the COVID-19 pandemic as an explanatory variable and is classified into four variables in terms of visits to urban greenspaces; visits to forests for camping, hiking, and forest therapy; consumption of wood products; and consumption of NTFPs. These were measured using a categorical variable coded 1 if it was “no change”, 2 if it was “decrease”, and 3 if it was “increase” for forest use before and during the COVID-19 pandemic. “No change”, “decrease”, and “increase” were calculated based on the frequency of forest uses “before the COVID-19 pandemic” minus their frequency “during the COVID-19 pandemic”.

The variable Others means individual characteristics, including demographic and socioeconomic characteristics, and the use and perception of forests as control variables, and ε is the error due to unobservable variables. In the case of demographic and socioeconomic variables, gender, having children or not, and residential area were measured using a dummy variable, and age, education level, household income level, and number of family members were measured using an ordered categorical variable. In the case of the perception of forests, the level of importance of forests was measured using an ordered categorical variable. Respondent’s demographic and socioeconomic characteristics were measured at the end of August 2020 and the perceptions of forests were measured based on “before the COVID-19 pandemic”.

Table 2 shows definitions and coding values of all variables including dependent, explanatory, and control variables in this study.

Table 2. Definitions and coding values of variables.

Variable	Definition	Coding Value
Dependent variable	CP _{provisioning} Change in respondent's perception of the importance of provisioning service during the COVID-19 pandemic compared to before the COVID-19 pandemic *	Average scale in the first category of FESs from scales evaluated in the subcategory as follows: Considerably less important = 1 Less important = 2 Slightly less important = 3 Similar important = 4 Slightly more important = 5 More important = 6 Considerably more important = 7
	CP _{regulating} Change in respondent's perception of the importance of regulating service during the COVID-19 pandemic compared to before the COVID-19 pandemic	
	CP _{cultural} Change in respondent's perception of the importance of cultural service during the COVID-19 pandemic compared to before the COVID-19 pandemic	
	CP _{supporting} Change in respondent's perception of the importance of supporting service during the COVID-19 pandemic compared to before the COVID-19 pandemic	
Explanatory variable	C _{green} Change in respondent's visits to urban greenspaces before and during the COVID-19 pandemic	No change = 1 Decrease = 2 Increase = 3
	C _{forest} Change in respondent's visits to forests before and during the COVID-19 pandemic	
	C _{wood} Change in respondent's consumption of wood products before and during the COVID-19 pandemic	
	C _{NTPF} Change in respondent's consumption of NTFPs before and during the COVID-19 pandemic	
Control variable	Age	Age of respondent
	Gender	Gender of respondent
	Education	Education level of respondent
	Income	Average monthly income level of respondent's household
	Family	Number of respondent's family member
	Children	Having children or not as respondent's family member
	Residence	Location of respondent's residential area
	Importance	Level of importance of forests perceived by the respondent before the COVID-19 pandemic
		20 s = 1, 30 s = 2, 40 s = 3, 50 s = 4, 60 s = 5
		Male = 1, Female = 0
		Not enrolled in university = 1 Enrolled in or graduated from university = 2 Enrolled in or graduated from graduate school = 3
		Under 2 million KRW = 1 2 to 4 million KRW = 2 4 to 6 million KRW = 3 6 to 8 million KRW = 4 More than 8 million KRW = 5
		Single person = 1 2 people = 2 3 people = 3 4 people = 4 More than 5 people = 5
		With children = 1 No children = 0
		Metropolitan city = 1 Medium or small city = 0
		Not important = 1 Slightly important = 2 Important = 3 Very important = 4

* In our survey, "before the COVID-19 pandemic" was defined as the period from the beginning of August 2020 to the middle of February 2020, and "during the COVID-19 pandemic" was defined as the period from the middle of February 2020 to the end of August 2020.

2.4. Data Collection and Analysis

This study collected data from 1000 sample participants using a quota sampling method for adults aged between 20 and 69 years among those living in the Republic of Korea. After allocating the number of samples considering the population of each province and the proportion of their age group and gender, samples were randomly selected according to the allocation ratio. An online survey was conducted by Mega Research, which is a professional research firm, from 27 August to 4 September 2020.

For the online survey, this study designed a structured questionnaire that could collect raw data for all variables, as shown in Table 2. In the questionnaire, we asked questions about not only the variables used in our econometric models, but also about the experience and perception of travel to mountain villages, and the consumption of daily necessities and non-forest products during and before the COVID-19 pandemic. However, those variables that were highly correlated with the other explanatory and control variables were excluded from our model.

We analyzed the data for all variables using a multiple linear regression with ordinary least squares (OLS) in Stata IC 14.2 to test the hypotheses of this study.

3. Results

3.1. Characteristics of Respondents

Table 3 shows the characteristics of the respondents.

In terms of demographic and socioeconomic characteristics, 1000 samples were allocated according to the proportion of the age group in the total population targeted in the survey. As shown in Table 3, 50.7% of the respondents were male and 49.3% were female. Two-thirds of the respondents enrolled in or graduated from university and had monthly household incomes in the range of KRW 2 to 6 million. Households of two, three, and four people constituted most respondents' households, and most of them did not have young children. In addition, 43.3% of the respondents resided in metropolitan cities such as Seoul, Busan, Incheon, Daejeon, Daegu, Gwangju, and Ulsan.

Before the COVID-19 pandemic, 44.2% of respondents perceived that forests are very important in people's daily life, while 10.5% of them perceived that they are not important.

Table 3. Characteristics of respondents ($n = 1000$).

Variable	Category of Measurement	Frequency	Percentage
Age	20 s	183	18.3
	30 s	191	19.1
	40 s	223	22.3
	50 s	230	23.0
	60 s	173	17.3
Gender	Male	507	50.7
	Female	493	49.3
Education	Not enrolled in university	221	22.1
	Enrolled in or graduated from university	676	67.6
	Enrolled in or graduated from graduate school	103	10.3
Income	Under 2 million KRW	121	12.1
	2 to 4 million KRW	320	32.0
	4 to 6 million KRW	304	30.4
	6 to 8 million KRW	150	15.0
	More than 8 million KRW	105	10.5
Family	Single person	55	5.5
	2 people	238	23.8
	3 people	290	29.0
	4 people	339	33.9
	More than 5 people	78	7.8
Children	With children	241	24.1
	No children	759	75.9
Residence	Metropolitan city	433	43.3
	Medium or small city	567	56.7
Importance	Not important	105	10.5
	Slightly important	154	15.4
	Important	299	29.9
	Very important	442	44.2

3.2. Changes in Forest Uses during the COVID-19 Pandemic

Figure 2 shows differences in the frequency of forest use before and during the COVID-19 pandemic. The number of respondents visiting urban greenspaces and forests, and purchasing wood products and NTFPs, was smaller during the COVID-19 pandemic

than before the COVID-19 pandemic. Specifically, the number of respondents who did not visit urban greenspaces and forests during the pandemic was far bigger than before the pandemic (Figure 2a,b). However, the number who did not purchase NTFPs during the pandemic was similar to that before the pandemic (Figure 2d).

Table 4 shows changes in forest use during the COVID-19 pandemic as compared to before the COVID-19 pandemic at the individual level. Respondents who decreased their visits to urban greenspaces accounted for 59.5% of the total respondents and those who decreased the visits to forests for camping, hiking, and forest therapy accounted for 45.0% of total respondents. Moreover, respondents who reduced their purchase of wood products and NTFPs accounted for 26.5% and 26.2%, respectively.

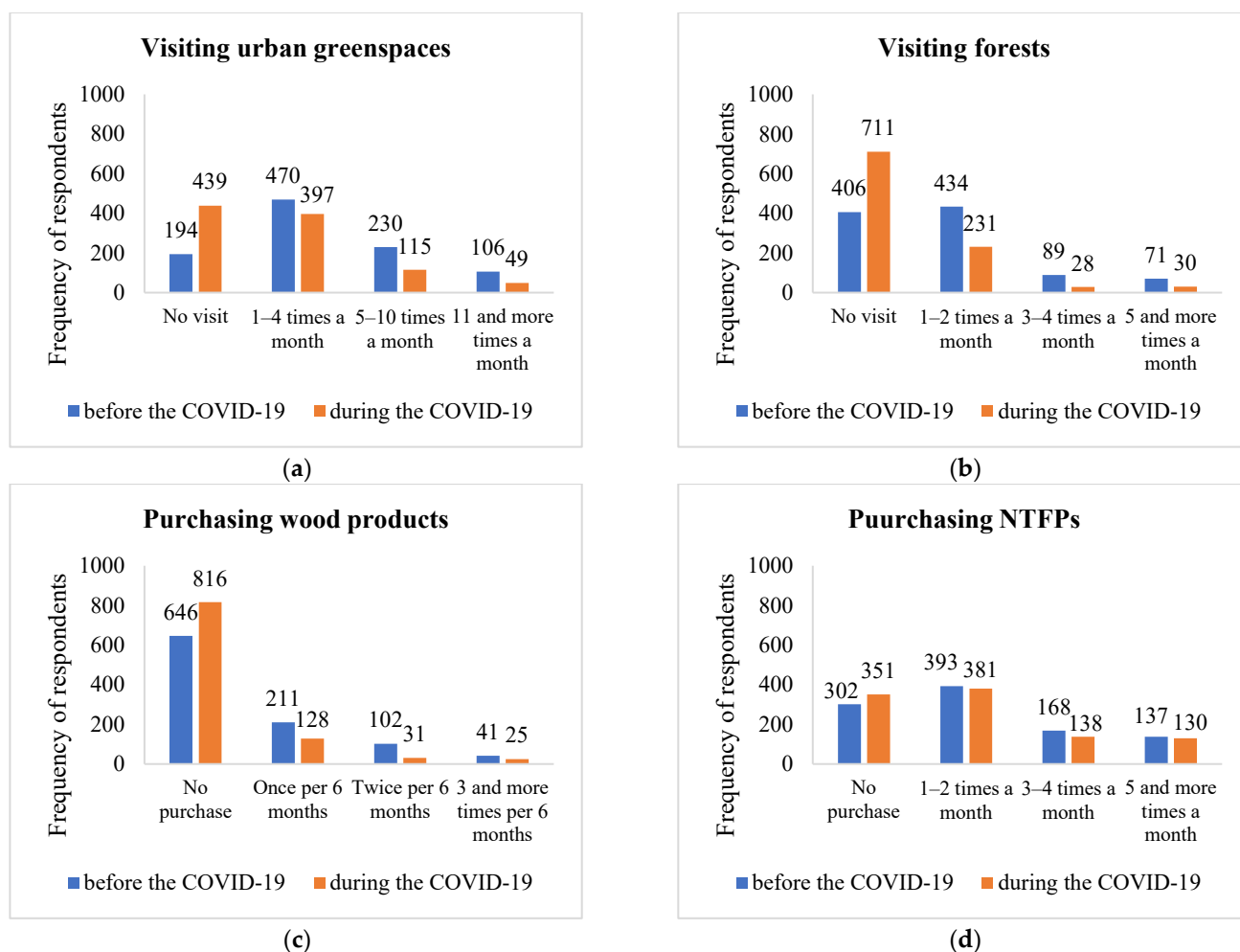


Figure 2. The number of respondents by the frequency of forest uses before and during the COVID-19 pandemic in terms of (a) visiting urban greenspaces; (b) visiting forests for camping, hiking, and forest therapy; (c) purchasing wood products; and (d) purchasing NTFPs ($n = 1000$).

Table 4. Changes in forest use during the COVID-19 pandemic as compared to before the pandemic.

	No Change	Decrease	Increase	Total
Change in visiting urban greenspaces (C_{green})	328 (32.8%)	595 (59.5%)	77 (7.7%)	1000 (100%)
Change in visiting forests (C_{forest})	488 (48.8%)	450 (45.0%)	62 (6.2%)	1000 (100%)
Change in purchasing wood products (C_{wood})	654 (65.4%)	265 (26.5%)	81 (8.1%)	1000 (100%)
Change in purchasing NTFPs (C_{NTFP})	568 (56.8%)	262 (26.2%)	170 (17.0%)	1000 (100%)

3.3. Changes in the Perceived Importance of FESs

Changes in the perceived importance of FESs during the COVID-19 pandemic are shown in Figure 3.

As the average scale of their change is a continuous value, this study created a histogram for each FES, which provides the frequency of respondents by the intervals of the changes in the perceived importance of FESs. The changes in the perceived importance of the 14 FESs are shown in the Supplementary Material. Most respondents perceived that the FESs were more important during the COVID-19 pandemic than before the COVID-19 pandemic, including responses such as “slightly more important,” “more important,” and “considerably more important”.

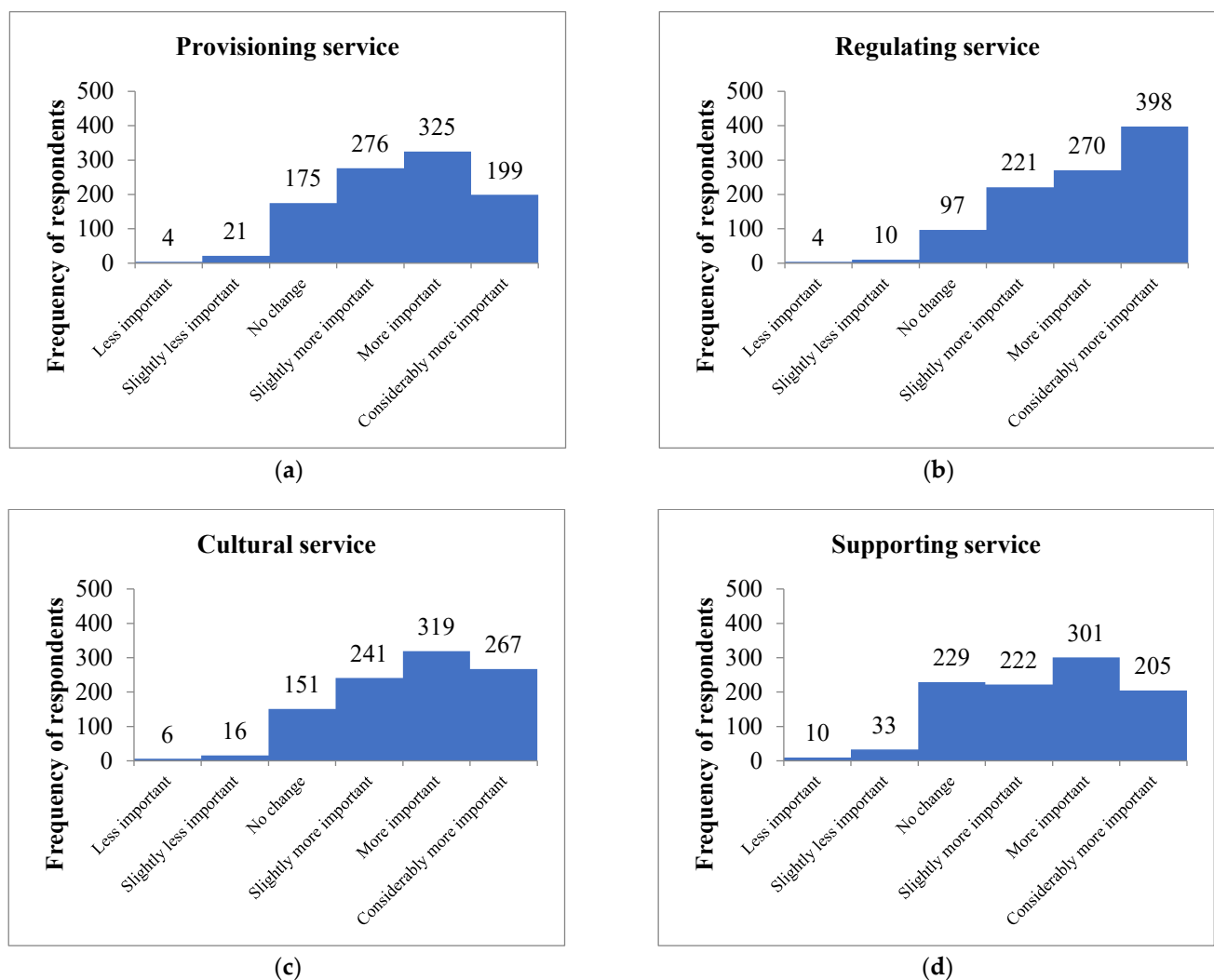


Figure 3. Change in the perceived importance of FESs including (a) provisioning; (b) regulating; (c) cultural; and (d) supporting services ($n = 1000$).

More than one-third of the respondents perceived that regulating services, including GHG absorption and storage, air quality improvement, oxygen generation, and urban heat island mitigation, were “considerably more important” during the COVID-19 pandemic (Figure 3b). The second largest number of respondents considered cultural services such as forest landscape, recreation, and therapy to be considerably more important during the COVID-19 pandemic (Figure 3c). However, the number of respondents who perceived supporting services such as biodiversity conservation (Figure 3d) or provisioning services

such as timber and NTFP production, biomass energy supply, and watershed enhancement (Figure 3a) as “considerably more important” were relatively small.

This study raises the question of why the perception of the importance of FESs changed during the COVID-19 pandemic. In the next section, this study identifies whether the change in forest use affected the change in the perceived importance of FESs.

3.4. Impact of Forest Use Changes on Changes in the Perceived Importance of FESs

Table 5 shows that the impact of the decline in the purchase of NTFPs on the change in the perceived importance of provisioning services was significant in model (1), with $p = 0.001$. The result indicates that the respondents who experienced a decrease in the purchase of NTFPs during the COVID-19 pandemic improved their perceived importance of provisioning services by more than those who did not change. However, the impact of the decline in the purchase of wood products on the change in the perceived importance of provisioning services was not significant in model (1), with $p = 0.247$.

Table 5. Results of multiple linear regression models for analyzing the impact of changes in forest use on the change in perceived importance of FESs.

	Model (1) Provisioning	Model (2) Regulating	Model (3) Cultural	Model (4) Supporting
C_{green} (base = no change)				
Decrease		0.133 *	0.126	0.055
Increase		0.323 **	0.267 *	−0.048
C_{forest} (base = no change)				
Decrease		0.195 ***	0.171 **	0.196 **
Increase		0.176	0.231	0.224
C_{wood} (base = no change)				
Decrease	0.081			−0.044
Increase	0.102			0.147
C_{NTFP} (base = no change)				
Decrease	0.242 ***			0.112
Increase	0.261 ***			0.284 ***
Age (base = 20 s)				
30 s	0.152	0.125	0.211 **	0.324 ***
40 s	0.139	0.109	0.147	0.134
50 s	0.281 ***	0.373 ***	0.505 ***	0.379 ***
60 s	0.050	0.175 *	0.278 **	0.297 **
Gender (male = 1)	−0.045	−0.002	−0.063	−0.078
Education (base = not enrolled in university)				
University	0.121	0.151 *	0.099	0.061
Graduate school	0.033	0.126	0.007	0.112
Income (base = under 2 million KRW)				
2 to 4 million KRW	0.054	0.042	−0.077	−0.124
4 to 6 million KRW	0.095	0.066	0.037	−0.087
6 to 8 million KRW	0.103	0.066	0.061	−0.036
More than 8 million KRW	0.077	−0.012	−0.094	−0.151
Family (base = single person)				
2 people	−0.192	−0.149	−0.104	−0.206
3 people	−0.230	−0.183	−0.103	−0.106
4 people	−0.242	−0.165	−0.187	−0.086
More than 5 people	−0.205	−0.176	−0.216	−0.144
Children (with children = 1)	−0.091	−0.117	−0.122	−0.070
Residence (metropolitan city = 1)	0.026	0.002	−0.015	−0.056
Importance (base = not important)				
Slightly important	0.354 ***	0.324 ***	0.413 ***	0.280 **
Important	0.833 ***	0.799 ***	0.747 ***	0.721 ***
Very important	1.337 ***	1.345 ***	1.234 ***	1.288 ***
Constant	4.134 ***	4.352 ***	4.274 ***	4.351 ***
Observations	1000	1000	1000	1000
R²	0.251	0.278	0.219	0.217
Adjusted R²	0.232	0.260	0.199	0.194
VIF	2.37	2.43	2.43	2.27

* $p < 0.1$, ** $p < 0.05$ and *** $p < 0.01$. The dependent variable was CP_{provisioning} in model (1), CP_{regulating} in model (2), CP_{cultural} in model (3), and CP_{supporting} in model (4).

Second, the impact of the decrease in visits to both urban greenspaces and forests on the change in the perceived importance of the regulating services was also significant in model (2) presented in Table 5, with $p = 0.069$ and $p = 0.004$, respectively. The results show that a decline in visits to urban greenspaces and forests during the COVID-19 pandemic affected the increase in the perceived importance of regulating services. This was attributed to the increase in the need for a safe outdoor environment (e.g., fresh air, clean water, and cool temperature) to enjoy outdoor activities due to restrictions on indoor social activities.

Third, the decline in visits to forests for camping, hiking, and forest therapy significantly influenced the change in the perceived importance of cultural services in model (3), with $p = 0.021$. This result indicates that the respondents who experienced a decrease in the recreational activities in forests during the pandemic improved their perceived importance of provisioning services more than those who did not change. However, the impact of the decline in the visits to urban greenspaces on the change in the perceived importance of cultural services was not significant in model (1), with $p = 0.110$.

Finally, the impact of decrease in visits to forests on the change in the perceived importance of the supporting services was also significant in model (4), with $p = 0.016$. However, the decrease in the visits to urban greenspaces, and the purchase of wood products and NTFPs, did not significantly affect the changes in the perceived importance of supporting services in model (4), with $p = 0.533$, $p = 0.601$, and $p = 0.188$, respectively.

3.5. Other Factors Affecting Changes in the Perceived Importance of FESs

Besides changes in forest use during the pandemic, respondents' demographic characteristics and perception of forests before the COVID-19 pandemic also affected the changes in the perceived importance of FESs (Table 5).

The perception of the importance of forests before the COVID-19 pandemic positively affected the improvement in the perceived importance of all services in models (1)–(4). This result was associated with high perceived values of FESs of people who considered forests as a very important element in their daily lives.

The age of respondents also significantly affected the increase in the perceived importance of all services in models (1)–(4). The perception of the importance of FESs improved more in the elderly group (e.g., those aged in the 50s and 60s) than in the younger group (e.g., those aged in their 20s). This is similar to the result that elderly local residents perceived provisioning, regulating, and supporting services as being more important than younger residents, as reported by Mensah et al. [53].

In model (2), education level also positively influenced the improvement in the perceived importance of regulating services. This was attributed to high awareness of regulating services through environmental education, such as education regarding climate change. In Lee [14], an expert group had a higher perception of regulating services in bamboo forests such as carbon sequestration, soil erosion, and fresh air regulation than a local community group.

4. Discussion

4.1. Improvement in the Perceived Importance of FESs during the COVID-19 Pandemic

The first hypothesis (H1) of this study was accepted. In Figure 3, results show that the respondents mostly improved their perception of the importance of FESs during the COVID-19 pandemic. In particular, the perceived importance of regulating and cultural services increased the most (Figure 3b,c).

Because people were aware that forest regulating and cultural services benefit physical and mental health by creating a pleasant outdoor environment and a place for meditation and physical activities, the people's perceived importance of these services increased during the pandemic. Remme et al. [54] suggested a conceptual framework for assessing the relationships among urban nature, physical activity, and health with an ES approach. In this framework, physical activities in urban nature (e.g., street trees, urban parks, and peri-urban forests) increase human health through health-centric services such as stress

relief and urban heat mitigation. Van den Bosch and Sang [55] found evidence of the impact of urban green regulation and cultural services on human health using a systematic literature review. There is strong evidence that urban heat reduction as a regulating service and improved affect as a cultural service positively affects the mediation of mortality (e.g., cardiovascular mortality) and mental disorders.

The second hypothesis (H2) of this study was partially accepted.

The results of this study indicated that forest regulating services were more important during the COVID-19 pandemic than before the pandemic due to a decline in visits to both urban greenspaces and forests during the pandemic (Table 5, model 2). People who decreased their visits to urban greenspaces and forests have feelings of missing outdoor activities in urban greenspaces and forests because time staying at home increased during the COVID-19 pandemic. Therefore, they increased the perceived importance of regulating services (e.g., air quality improvement and urban heat mitigation) providing pleasant outdoor conditions more than those who did not change (H2-1 and H2-2 were accepted). In a previous study [49], most respondents who increased the frequency of visiting urban greenspaces after a wave of the COVID-19 pandemic selected ‘getting fresh air’ as a usage purpose of urban greenspaces. In other study [24], 55% of respondents perceived ‘provision of clean air’ as more important, while 2% of them perceived it as less important, as a reason for using urban greenspaces during the period of COVID-19 restrictions.

The results also showed that forest cultural services were more important during the COVID-19 pandemic than before due to a decline in visits to forests for camping, hiking, and forest therapy during the pandemic (Table 5, model 3). People who decreased camping, hiking, and forest therapy in forests have feelings of missing forest recreational activities. They also experience more socio-psychological stress due to decreased recreational activities than before the pandemic. In terms of forest therapy, forest visitors who experienced a socio-psychological stress during the pandemic could increase their mental well-being by perceiving the ‘restorativeness’ through visiting forests [56]. Thus, people who decreased their visits to forests increased the perceived importance of cultural services including forest recreation and therapy more than those who did not change (H2-2 was accepted).

Moreover, the results of this study indicated that supporting services were more important during the COVID-19 pandemic than before due to a decline in visits to forests for camping, hiking, and forest therapy during the pandemic (Table 5, model 4). People who decreased their visits to forests increased the perceived importance of supporting services more than those who did not change (H2-2 was accepted). This was associated with the result of Park and Yeo-Chang [57], which showed that visitors to forests, especially to forest protected areas (e.g., national parks), considered the economic value of biodiversity conservation as being very high. Existing visitors who reduced their visits to forests during the pandemic increased not only the perceived importance of cultural services, but also that of supporting services such as biodiversity conservation.

Lastly, this study showed that forest provisioning services were more important due to the decline in the purchase of NTFPs during the COVID-19 pandemic (Table 5, model 1). People who decreased their consumption of NTFPs increased the perceived importance of provisioning services more than those who did not change (H2-4 was accepted). The decrease in the purchase of NTFPs was directly attributed to restricted access to markets and the decreased expenditure on foods due to income reductions during the pandemic. It was also attributed to rising prices caused by the decrease in the production and import of NTFPs, such as mushrooms, jujubes, and walnuts, in China and Korea during the COVID-19 pandemic [58]. Thus, people who decreased their purchase of NTFPs expect a stable supply of NTFPs in domestic markets.

4.2. Implications for Forest Policy in the Post-COVID-19 Era

Based on the conceptual framework for people’s interactions with nature by MA [6] and Díaz et al. [8], restrictions on daily life (e.g., restrictions on social gathering and movement, public event cancellation, and workplace closures) during the COVID-19

pandemic acted as an indirect driver. It decreased urban and rural residents' participation in outdoor recreational activities [17]. Moreover, people's interactions with forests, such as visits to urban greenspaces and forests, and the purchase of wood products and NTFPs, decreased in the early stages of the COVID-19 outbreak (Figure 2).

However, strong and long-term restrictions negatively affected the quality of their lives, including mental and physical well-being and social relations [16,59–62]. It led to an increase in outdoor leisure activities as a replacement for indoor leisure activities [63], and people perceived that outdoor activities such as visiting urban parks allowed them to participate in social interactions [64]. Therefore, the perceived importance of forests increased during the pandemic [34]. Moreover, people increased the visits to urban forests and greenspaces near their home [24–27] to counter the decrease in their human well-being.

During the COVID-19 pandemic, people's interactions with forests enhanced their well-being. Xie et al. [64] demonstrated that visiting urban parks improved self-assessed physical health levels and allowed them to meet their social interaction needs. Poortinga et al. [65] also revealed that access to public (e.g., park and woodland) and private greenspaces (e.g., private garden) was associated with better subjective well-being and self-rated health. Lopez et al. [35] reported a higher percentage of urban residents who thought that urban greenspaces were very important for mental and physical health during the pandemic than before the pandemic.

The Korean government started vaccination on 26 February 2021 and the second dose vaccination rate was 82.2% on 31 December 2021. As the vaccination rate rapidly increased, people were expected to return to normal daily life by taking off their masks, and the government considered 'living with COVID-19' was an option. Coronavirus variants (e.g., delta and omicron) spread rapidly because vaccines may not be effective against them, and the government strengthened social distancing again in the middle of December 2021. However, the government recently loosened the restrictions on daily life, including taking off masks in the open air and relaxing the regulation of social meetings due to decreased confirmed cases and low fatality rate.

As a result of loosening the restrictions on daily life, outdoor activities in forests have become increasingly popular in the Republic of Korea. Young people who could not participate in social meetings and indoor leisure activities because of social distancing started going to the mountains for hiking. The total number of visitors to national parks increased in 2021 [66] while it decreased during 2020 [41].

Consequently, when people return to normal daily life, the perceived importance of FESs can return to the importance level that prevailed before the COVID-19 pandemic. However, the great increase in the perceived importance of forest regulating and cultural services allows short-term policy implications for the post-COVID-19 era to be presented.

First, it is necessary to manage urban greenspaces to strengthen the function of regulating services. Previous studies [22,34] have focused on the importance of cultural services of urban greenspaces during the COVID-19 pandemic. However, this study identified the increased importance of regulating services, which was affected by the decline in visits to urban greenspaces during the COVID-19 pandemic. Before the COVID-19 pandemic, urban residents perceived the enhancement of biodiversity, and experts selected the recreation services, as the highest priorities of ESs in urban greenspaces in the Republic of Korea [67]. However, the Korean people improved their perceived importance of forest regulating services during the pandemic. This study proposes that urban greenspaces need to be designed and managed for increasing the function of regulating services (e.g., fresh air and heat island mitigation) and cultural services. The design of urban greenspaces, in terms of factors such as vegetation structures, species richness, density, and size, can affect the provision of air quality [68] and climate regulation services [69].

Second, it is necessary to manage forests to strengthen the function of forest therapy. In previous studies [16,59–62], the public's mental and physical well-being and social relations were worse during the pandemic. This study found that people who experienced socio-psychological stress due to decreased forest recreational activities increased their

perceived importance of cultural services including forest therapy. The term ‘forest therapy’ was searched for on an Internet portal very frequently during the COVID-19 pandemic in the Republic of Korea [70]. Therefore, this study suggests that policy makers manage ‘forest for therapy’ actively to meet increased demands for forest therapy during the pandemic and develop therapy programs appropriate to reducing depression associated with the coronavirus.

4.3. Limitations

This study focused on identifying the factors affecting changes in the perceived importance of FESs using an econometric model. To better understand individual experiences of forest use and perception processes of FESs, it is necessary to address the reasons why the public’s perception of the importance of FESs changed during the COVID-19 pandemic by conducting qualitative or mixed method research including exploratory questions. Further research is needed to find out the reasons by interviewing urban residents, rural communities, and stakeholders in forestry and the forest industry. This research will support individual experiences of forest use and perception processes of FESs, as presented in the discussion of the findings of this study.

We conducted a survey to collect data during the COVID-19 pandemic, but “during the COVID-19 pandemic” was defined as the period from the middle of February 2020 to the end of August 2020. The period of our survey represents only the early stages of the COVID-19 outbreak and the time in which social distancing was most strengthened and the perception of infection risk was the highest. However, the public’s perception can change as the COVID-19 pandemic is prolonged and the vaccination rate increases. In the post-COVID-19 era, daily life will return to that prevailing before the COVID-19 pandemic, in terms of social gathering, indoor leisure activities without wearing a mask, and business activities. This also may change the public’s perception of FESs again. Thus, further research to analyze the recent perception of FESs and use of forests is required.

Moreover, this study has limitations regarding sampling. The numbers in the samples were allocated to reflect the actual ratios of residential regions, age groups, and gender of the general population. However, the proportion of respondents in the samples who enrolled in or graduated from university and graduate school (78%) was higher than that of the general population (51%) in 2020, and the proportion of single-person households in the samples (6%) was lower than that in the general population (30%) in 2020. To ensure representativeness of samples, the study needs to consider education level, income level, and the number of family members as the characteristics of general population for quota sampling.

5. Conclusions

This study found that the respondents improved their perception of the importance of FESs during the COVID-19 pandemic. Specifically, the public’s perceived importance of regulating and cultural services increased more due to decreases in their visits to urban greenspaces and forests during the pandemic. Thus, demands for regulating and cultural services increased, and visits to urban greenspaces and forests will increase in the future if restrictions on social gathering and movement are loosened. Considering the public’s need for health-related ESs (e.g., air quality regulation, urban heat mitigation, recreation, and therapy) to improve their well-being in the post-COVID-19 era, we need to change urban greenspace and forest management policies to reflect the changed preference and importance of FESs. To enhance the resilience of human well-being in the post-COVID-19 era, we suggest that it is necessary to strengthen the function of regulating services in urban greenspaces near residences, and to provide the public with more forest therapy programs designed to relieve socio-psychological stress caused by the COVID-19. Consequently, the increased importance of FESs during the COVID-19 pandemic can provide opportunities to manage urban greenspaces and forest areas based on the ES approach.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/su141710914/s1>, Figure S1: The changes in the perceived importance of 14 FESs.

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