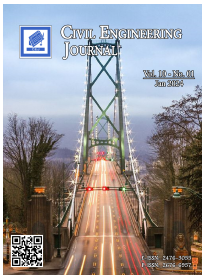
Available online at www.CivileJournal.org

Civil Engineering Journal

(E-ISSN: 2476-3055; ISSN: 2676-6957)

Vol. 10, No. 01, January, 2024



Evaluating the Importance of Ecosystem Services in University Campus

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Received 21 June 2023; Revised 30 November 2023; Accepted 14 December 2023; Published 01 January 2024

Abstract

University campuses provide a variety of ecosystem services (ES) that play an important role in both physical and mental benefits for students. However, the importance and actual service performance of ES in universities were not clearly perceived in Vietnam. This study was conducted to fill these gaps with the objectives of (1) assessing students' perceptions of the importance of ecosystem services on their university campus and (2) assessing students' satisfaction with these ecosystem services. Using the interview method, the study collected research data from 210 students at Can Tho University (CTU), a large university in Vietnam. The results of the study have confirmed the importance of ecosystem services such as trees, lawns, water bodies, and buildings on CTU's campus. With modern design, buildings play an important role in creating space to organize formal classes, self-study, and group work for students. Green spaces not only improve air temperature and bring high aesthetic value, but they are also habitats for many species of animals and plants. Most students were very satisfied with the ES provided by the CTU's campus. However, the functions of the grass and water bodies ecosystem need to be improved, as the student satisfaction with these ES was significantly lower than the value they expected. The results of analyzing the importance and satisfaction of ES will be a useful basis for making decisions on planning and developing ecosystems. This is a new research direction in Vietnam that needs continued research and application.

Keywords: Ecosystem Services; Importance; Satisfaction; University Campus.

1. Introduction

Ecosystem services (ES) are benefits that humans can receive from ecosystems, including both direct and indirect benefits [1, 2]. The value of ecosystem services has a strong impact on human health and well-being [3–5]. Natural ecosystems play an important role in regulating air temperature, regulating soil erosion, regulating floods, regulating water, and retaining water [6–8]. Forest and river basin ecosystems were sources of food and provided water for domestic and irrigation purposes [6, 7]. These natural ecosystems also help preserve biodiversity. At the same time, it brings high aesthetic value, helping to develop ecotourism as well as maintain traditional cultural values.

In recent years, the values of natural ecosystem services have also been researched and applied in urban spaces, where the priority for green spaces is less than for buildings such as houses, shops, roads, etc. [9, 10]. A typical example was the planning of urban greenery systems and urban parks [10–12]. In addition, research ideas on ecosystem services have also been implemented on university campuses [13, 14]. This research area not only had educational value but also provided a variety of ecosystem services (for example, water regulation, CO_2 storage, climate regulation, aesthetic value, etc.) [13–15]. University campus management can bring material benefits to the environment and mental health to students, as well as raise students' awareness of environmental and ecological protection [15]. According to Sedlacek (2013), universities are considered a particularly important socio-cultural context with the mission of training and educating people who will participate in the governance system in the future [16]. Therefore, universities were also

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http://dx.doi.org/10.28991/CEJ-2024-010-01-015

suitable places to implement effective environmental education initiatives based on students' awareness of the landscape and its ecological functions [17]. Analyzing human perceptions of the importance of landscapes and the satisfaction of ecosystem services was essential to evaluating the relationship between ecology and society [7, 18]. This was the basis for planning and developing the landscape [19].

Although ecosystem services in Vietnam have been commonly studied with natural ecosystems such as forests [20], wetland [21, 22], and rivers [23], there were almost no studies evaluating the importance of landscapes and human satisfaction with ES. Therefore, planning and developing ecosystems has faced many difficulties due to a lack of basis to identify ecosystem services that need to be prioritized for improvement. Also, to the knowledge of this study, previous studies for ecosystem services in Vietnam have not evaluated any university campuses. To fill this gap, this study was carried out with the goals of (1) assessing students' awareness of the importance of ES and (2) assessing their satisfaction with ES on the Can Tho University campus. Can Tho University (CTU) be one of the major universities in Vietnam. The CTU campus has a diverse landscape that can meet the learning, entertainment, and health needs of students. By using field survey methods, document reviews, and interviews with students' perceptions, the research was able to identify the ecosystem services provided by the landscape of CTU. From there, evaluate its importance and service performance. Based on that basis, plan and design appropriate environmental education programs as well as solutions to enhance the value of these ecosystem services.

2. Research Methodology

2.1. Research Area

Can Tho University be an institution that trains highly qualified human resources to serve the socio-economic development of the Mekong Delta in particular and Vietnam in general. The university has 8 subdivisions with a total land area of 224.98 hectares [24]. The area where this study was carried out was in subdivision II. This is the headquarters and main school building of CTU, with an area of 71.42 hectares. This research area is located in Can Tho city, which is the center of the economic, cultural, and social life of the Mekong Delta (Figure 1).

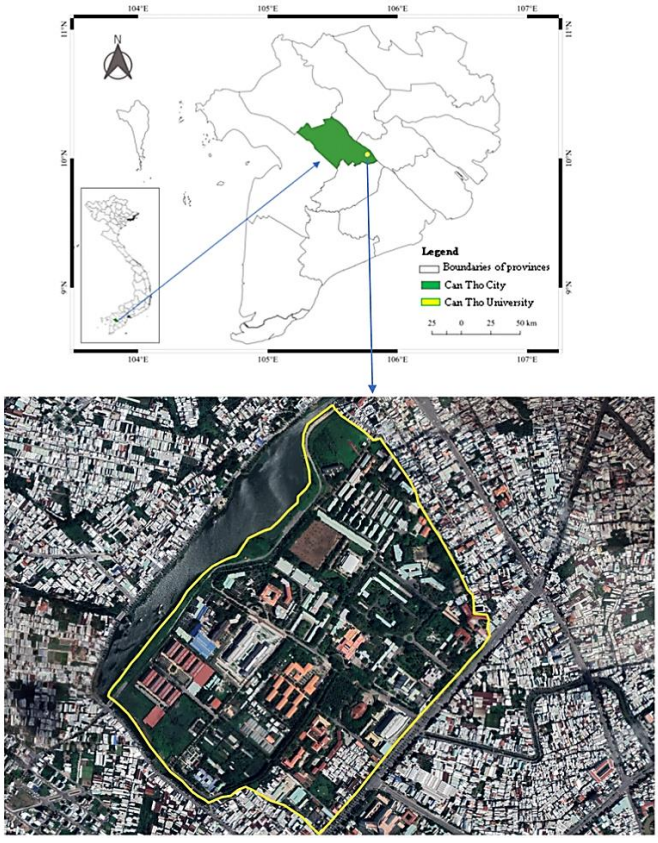

Figure 1. Location of the study area

CTU's campus is modernly designed with many lectures, halls, classrooms, libraries, laboratories, dormitories, sports fields, and green spaces such as trees, lawns, lakes, etc. According to Gonzalez-Garcia et al. (2023), the university campus not only brings value to education but is also a place for cultural activities such as festivals and sports, giving students the opportunity to exercise physically and engage together [13]. In particular, systems of trees and lakes can help store carbon, regulate microclimate, and regulate and store water [13, 25].

2.2. Collect and Process Data

Workflow of this study is presented in Figure 2.

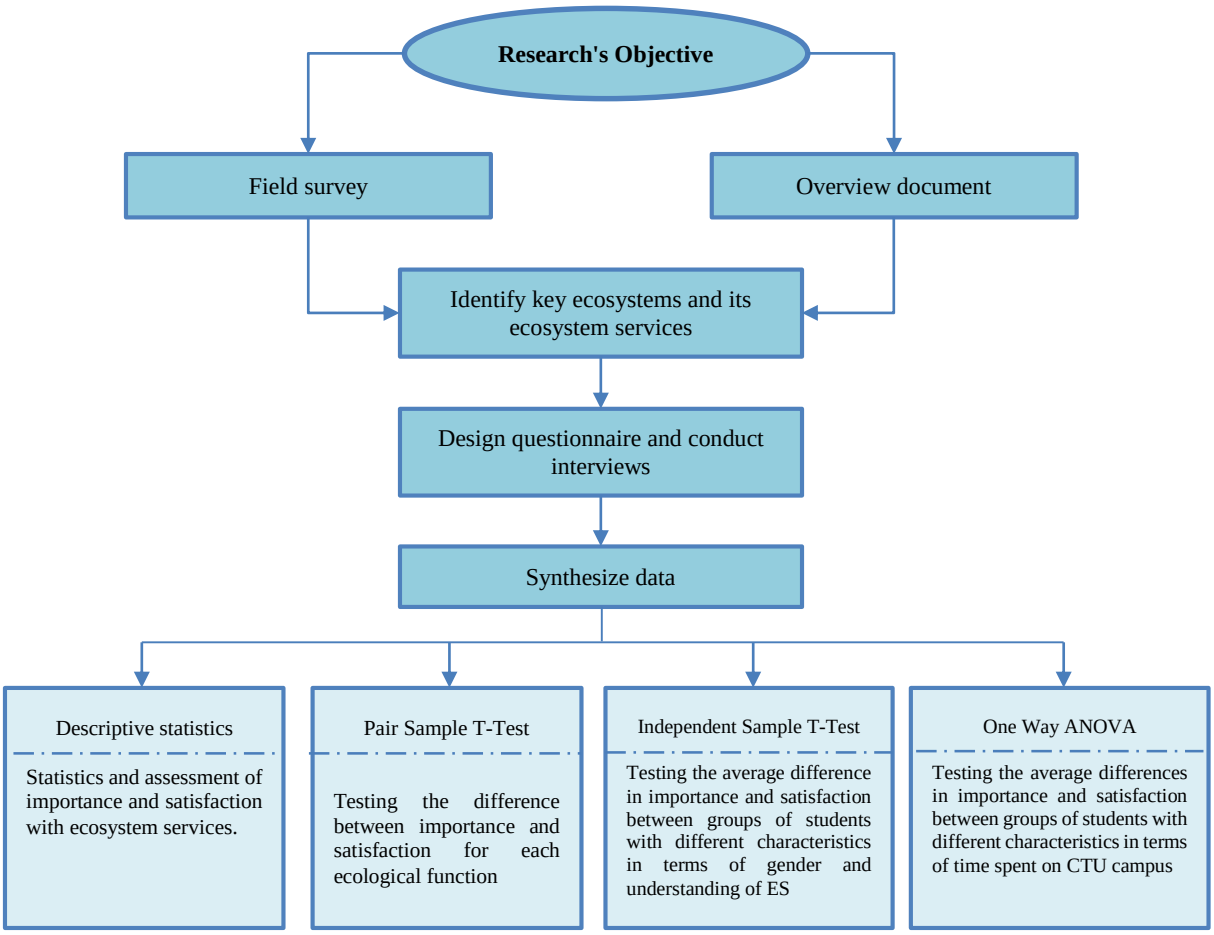

Figure 2. The process of the methodology

Based on the research objectives, a field survey was conducted to identify the main landscapes present on CTU's campus. As a result, the study has identified four main types of landscapes on the campus of Can Tho University, including (1) trees, (2) lawns, (3) water bodies, and (4) buildings. At the same time, the study conducts a literature review to determine the ecosystem services of each landscape. A total of 23 ecosystem services were identified (Figure 3), including provisioning services (n = 3), regulating services (n = 12), cultural services (n = 5), and supporting services (n = 3).

An interview with CTU students was conducted using a pre-designed questionnaire to collect information for an assessment of awareness about the importance of ecosystem services and student satisfaction with these ES. The questionnaire was designed with four main parts, including (i) the importance of ecosystem services, (ii) satisfaction with ecosystem services, (iii) understanding of ecosystem services, and (iv) general information about students. In particular, importance and satisfaction were assessed based on a Likert scale (1= totally unimportant/completely unsatisfied, 2= less important/less satisfied, 3= moderately important/normal, 4 = important/satisfied, and 5= very important/very satisfied). The results of the survey collected information from 210 students, including 37.1% male students and 62.9% female students. The majority of these students were freshmen, sophomores, and juniors, with 32.4%, 31.0%, and 33.3%, respectively. The remaining 2.4% were seniors, and 1.0% had graduated. The study used IBM SPSS Statistic 26 software to calculate and test the differences in awareness of the importance and satisfaction of ES. The testing methods used were pair sample t-tests, independent sample t-tests, and one-way ANOVA. The characteristics of student groups are presented in Table 1.

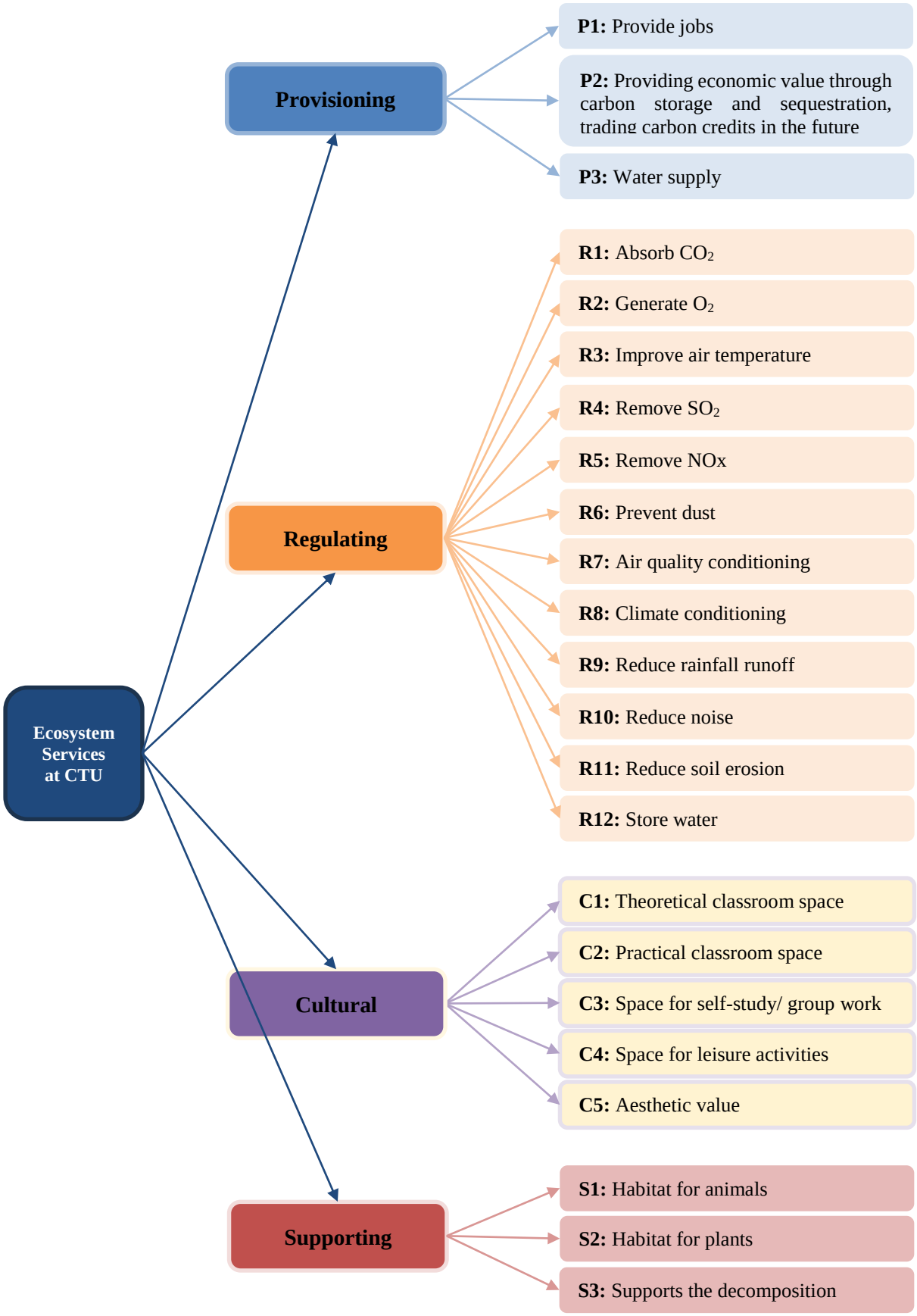

Figure 3. Ecosystem services on CTU's campus

Table 1. Characteristics of the sample (N = 210)

	Group	Sample (n)	Percentage (%)
Gender	Male	78	37.1
	Female	132	62.9
Course	Freshman	68	32.4
	Sophomore	65	31.0
	Junior	70	33.3
	Senior	5	2.4
	Graduate student	2	1.0
Time spent on CTU	<2 hours/day	5	2.4
	2-5 hours/day	120	57.1
	5-8 hours/day	69	32.9
	>8 hours/day	16	7.6
Time spent on green space	<0.5 hours/day	73	34.8
	0.5-1 hours/day	94	44.8
	1-2 hours/day	35	16.7
	>2 hours/day	8	3.8
Awareness of ES	Known	113	53.8
	Unknown	97	46.2

3. Results and Discussion

3.1. Perception of Importance and Satisfaction with Ecosystem Services

The importance and satisfaction of the ecosystem services on CTU's campus are presented in Figure 4. The results of the study show that while the importance of trees and lawn ecosystems was rated the same, the values of ES decreased in the order of supporting > regulating > cultural > provisioning. Similar to green tree and lawn ecosystems, water bodies also had high importance in supporting and regulating functions, but their cultural value was considered less important than provisioning services. For building ecosystems, cultural services were considered more important than provisioning services, with average values of 4.16 and 4.09, respectively. Generally, CTU students rated supporting services as the most important function of green spaces such as trees, lawns, and water bodies, with average values of 4.13, 4.01, and 3.95, respectively. This was consistent with the previous study on ecosystems of parks [8], where provisioning services (food) were considered less of a priority than other ecosystem services such as regulating (maintaining air quality and water regulation), cultural (health, aesthetics, physical, and mental), and supporting (habitats). In contrast, some other studies have shown that supporting services have been rated lower than provisioning, regulating, and cultural services [26, 27].

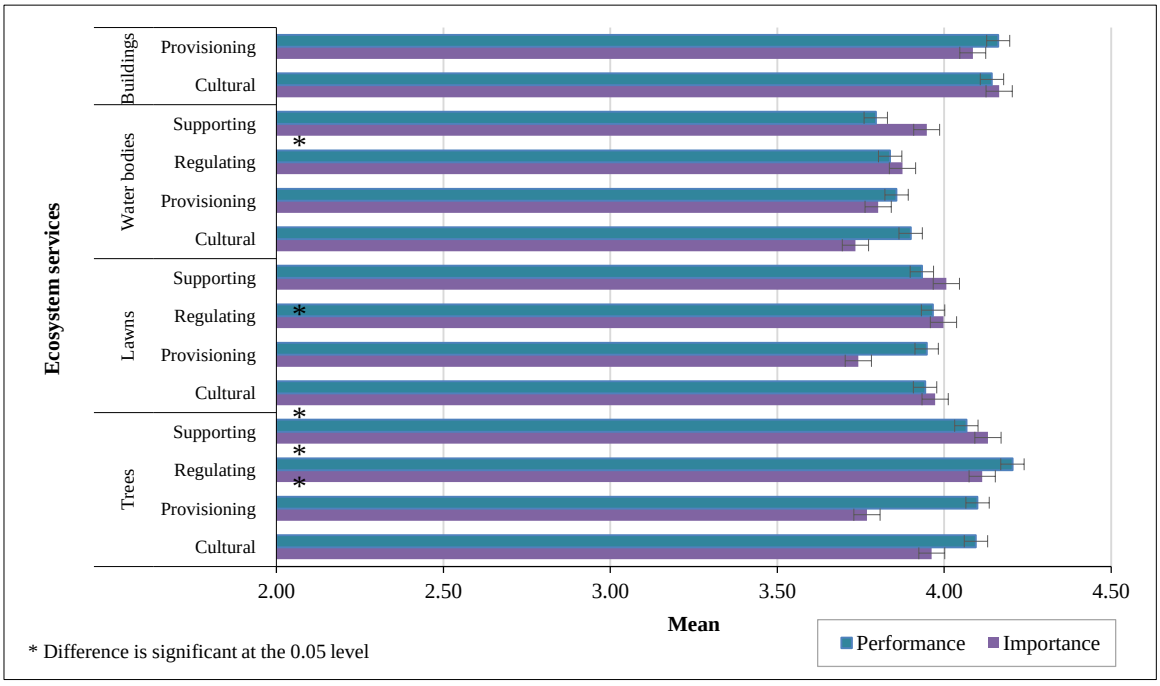

Figure 4. Importance and satisfaction for Ess

The results of this study also show that most of the ecosystem services were evaluated with a high level of satisfaction (Figure 4). This proves that these services have good service performance and meet the needs of students. Satisfaction was higher than the importance recorded for the regulating services of the green tree ecosystem, the cultural services of the green tree and lawn ecosystem, and the provisioning services of all four ecosystems. The regulating, provisioning, and cultural services of green ecosystems have good service performance, as satisfaction was significantly higher than the expected value of importance. Meanwhile, the remaining ecosystem services need to be prioritized for improvement, as satisfaction was recorded to be lower than perceived importance. Specifically, the lawn ecosystem (provisioning, regulating, and supporting services), the water body ecosystem (regulating and supporting services), and the cultural services of buildings. The significant difference between the importance and performance of ESs was also found in the study of Gai et al. (2022). A higher importance score than the performance score indicates that the level of citizen satisfaction was lower than the expected value of that ecosystem service [28].

Of the four ecosystems assessed, buildings had the highest importance (Figure 4). Some previous studies suggest that people often appreciate the importance of an ecosystem service when they directly benefit from or strongly depend on it [27, 29]. The results of a previous study have shown that mountain communities perceive the value of provisioning and cultural services (fresh water supply, food, fodder, and ecotourism) more easily than regulating and supporting services (climate control, disease regulation, soil formation, and nutrient cycling). For them, regulating and supporting services only bring indirect benefits and are less familiar [7]. Another study conducted with rural parks also showed that the distance from residence to the park had a great influence on people's perception of its importance for the park's ecosystem services [8]. The results of this study were completely consistent with previous studies. Evidence was that CTU students rated buildings as most important as they spent more time in buildings than other green spaces. Specifically, students often spend 2–5 hours/day (57.1%) or even 5–8 hours/day (32.9%) at CTU. However, they only spend about 0.5–1 hour/day (44.8%) or less than 0.5 hours/day (34.8%) on green spaces such as trees, lawns, and water bodies.

3.1.1.The Green Tree Ecosystem

Green space at universities is an important part of urban green space [14]. Many studies have appreciated the importance of regulating service in the tree system. Typically, it has the functions of CO_2 sequestration, O_2 generation, air temperature amelioration, removing SO_2 and NO_x, dust interception, regulating air quality, regulating climate, reducing rainfall overflow, noise reduction, etc. [10, 14, 26]. In this study, the majority of CTU students also confirmed that the green tree system on campus plays an important and very important role in forming O_2, improving air temperature, absorbing CO_2, and preventing dust (57.1–85.2%). In which, the functions of O_2 generation (R2) and air temperature amelioration (R3) were evaluated as the most important (Figure 5).

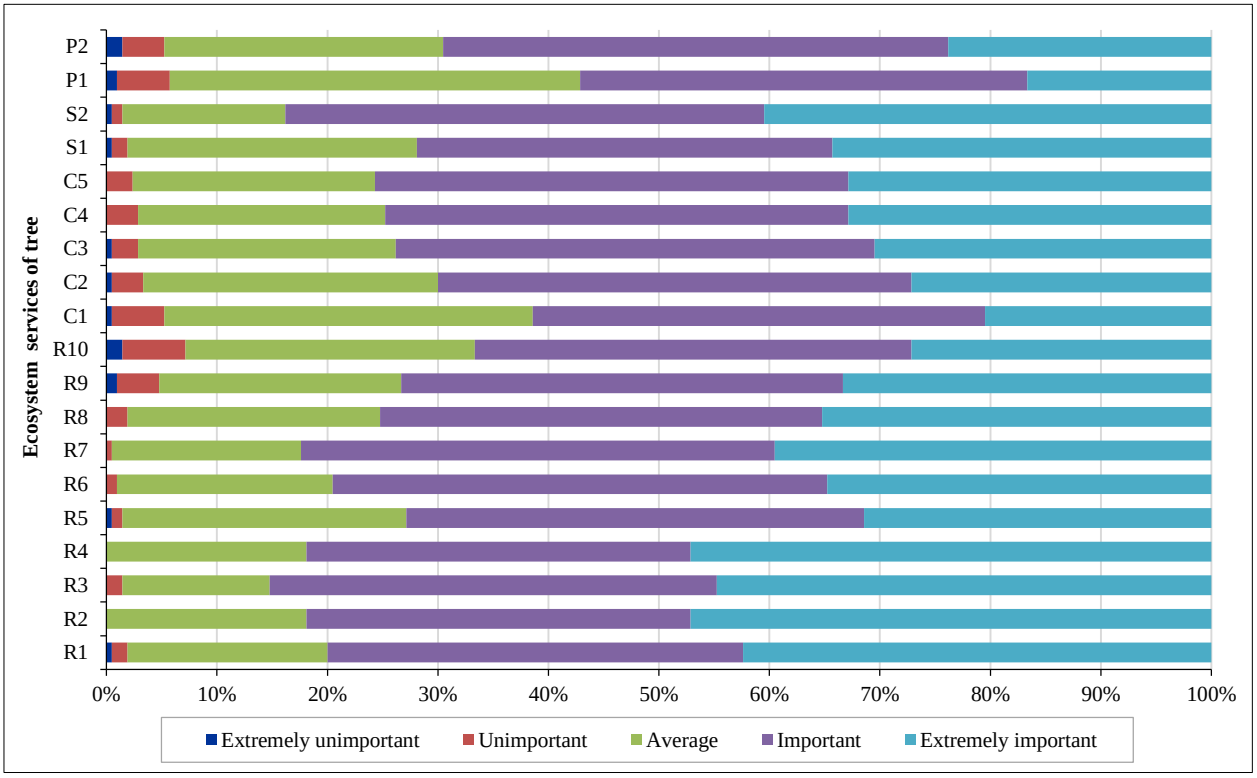

Figure 5. The importance of the tree ecosystem

Regulating runoff and reducing noise were considered less important than other regulating functions. The services provided by green ecosystems were highly valued for their function of providing jobs (P1) and providing economic value through carbon storage and sequestration (P2). This was not only a favorite self-study and group work space for students but also a space to relax with high aesthetic value. Previous studies have also shown that green ecosystems are suitable spaces for recreational activities such as playing sports, meeting friends, and relaxing [10, 26]. Another study also confirmed that green ecosystems help create jobs for people by taking care of trees [30]. Supporting services were often less recognized than provisioning, regulating, and cultural services [26, 27], as these services were less familiar and only brought indirect benefits to society [7]. However, CTU students said that the green ecosystem was an important habitat for plants and animals. This result was consistent with previous studies in Africa, where the supporting services of green ecosystems were also assessed as suitable habitats for biological species [31–33].

In general, green tree ecosystems had high value in all services, including provisioning, regulating, cultural, and supporting. However, the importance of ecological functions was assessed differently in each research context. In this study, the most important assessed functions of the green tree ecosystem were air temperature regulation and O_2 generation. This result was consistent with a previous study in Africa, as students and staff of universities assumed that air quality, temperature improvement, and creating shade were the most important aspects of green tree ecosystem services [31]. Meanwhile, another study has shown that the most important function of the green tree ecosystem on a university campus in Turkey was carbon storage and sequestration [14].

3.1.2. The Lawn Ecosystem

Besides the green tree system, lawns were also a common element in urban green space. This was a special type of ground cover that brings many benefits to humans and the surrounding environment [34]. On the campus of Can Tho University, all 15 services provided by the lawns were rated as mainly important (42.4–51.9%). Perceptions of the importance of lawn ecosystem services are presented in Figure 6. For the regulating services, regulating stormwater runoff (R9) and reducing soil erosion (R11) were considered more important than absorbing CO_2 (R1) and SO_2 (R4). Another study has also suggested that CO_2 absorption is a very important function of urban lawns [35]. The lawn on CTU's campus also placed a high value on cultural services. The lawn was considered a suitable space for recreation activities (C4), with the percentage of students rating it as important or very important as 51.9% and 27.1%, respectively. Aesthetic value was also considered important, with a total of 76.6% of students considering it important and very important. Similar results were also observed for an urban lawn, where recreational and aesthetic functions play a very important role [34]. Regarding supporting services, all functions surveyed, including animal and plant habitat and supporting the decomposition process, were rated as important or very important by more than 74% of students. Besides these functions, the research by Yang et al. [34] also suggests that lawns in parks were shelters in emergencies such as earthquakes.

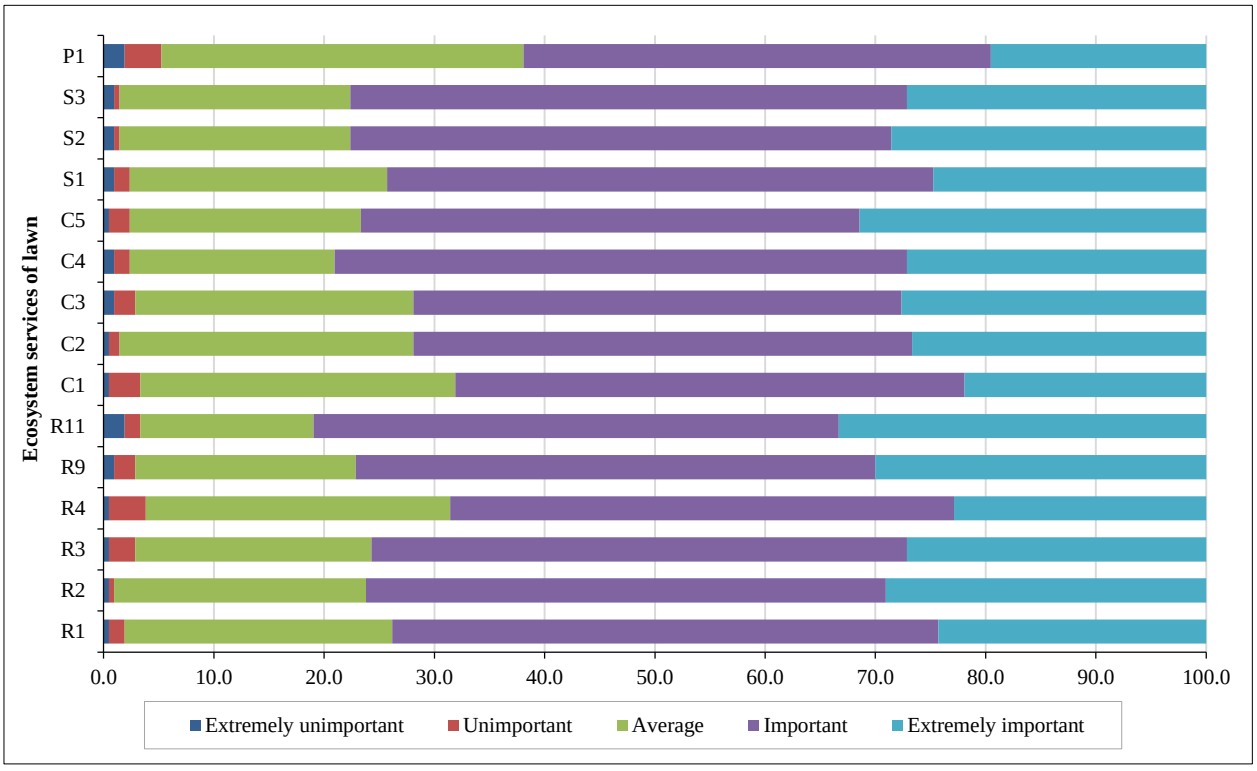

Figure 6. The importance of lawn ecosystems

3.1.3. Water Bodies Ecosystem

The functions of water body ecosystems were found to be less than those of tree and lawn ecosystems. Students' perceptions of the importance of water bodies ecosystem services are presented in Figure 7. Water storage was rated as the most important function, with the percentage of students rating it as important or very important being 45.71% and 34.76%, respectively. It is considered more important than improving air temperature, forming O_2, and absorbing CO_2. In aquatic ecosystems, the amount of CO_2 absorbed and O_2 produced was estimated based on the photosynthesis process of aquatic plants. The value of the regulating service of an urban lake was confirmed by absorbing 0.22 tons of CO_2/hm^2 and generating 0.17 tons of O_2/hm^2 [36]. In addition, water bodies also help regulate the air temperature. A previous study showed that air temperature in areas with lakes was significantly improved compared to places without lakes [11]. River basins, ponds, and lakes also play an important role in regulating floods [25] and providing water for daily life and irrigation [6]. The water bodies on CTU's campus were also considered important habitats for biological species. Similar to tree and lawn ecosystems, aesthetic value (C5) was also assessed as very important in cultural services. However, it was not highly appreciated for its suitable space to organize classes (C1).

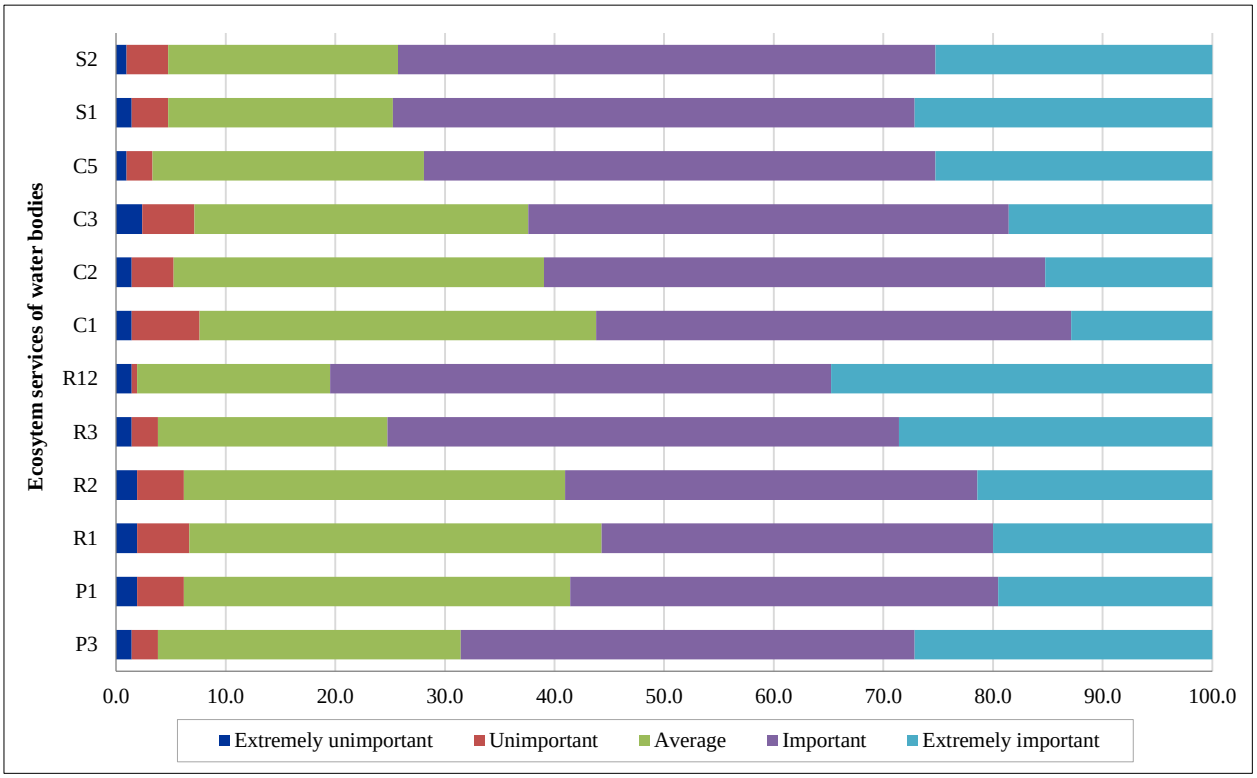

Figure 7. The importance of the water bodies ecosystem

3.1.4. Building Ecosystem

Building ecosystems have been identified as not providing the same regulating and supporting functions as tree, lawn, and water body ecosystems [11]. In this study, the building ecosystem was evaluated by providing jobs and cultural services such as learning spaces, entertainment spaces, and aesthetic value. The research results show that space for organizing classes, self-study, and group homework (C1, C2, C3) was considered the most important (Figure 8). The cumulative percentage of students rating these functions as important or very important was 82.9–84.8%. CTU's facilities have been increasingly upgraded; the study halls and laboratory complexes not only meet the learning and research needs of students but are also attractive places for students because of their modern beauty. Therefore, students highly appreciate the aesthetic value (C5) of buildings on CTU's campus. Compared to the ecosystems of trees, lawns, and lakes, the job-providing function of the building ecosystem was considered more important. At CTU, each building has a facilities manager, classroom manager, cleaning staff, etc.

3.2. Differences in Perceived Importance and Satisfaction of Students

The results of analyzing differences in perceptions of importance and satisfaction between student groups are presented in Tables 2 and 3. Analysis results show that gender significantly affects perceptions of the importance of ES rather than satisfaction with ES. Females rated the importance of cultural and supporting services in green tree and water body ecosystems higher than males. Besides, female students' satisfaction with the cultural services of the lawn ecosystem was significantly higher than that of male students (Table A-1). The findings of this study contrast with previous research, which found that male satisfaction was higher than female satisfaction in recreation services [8]. The

results of the study also showed that knowledge about ES also made a difference in assessing the importance of ES. Students with an understanding of ES rated the importance of regulating, cultural, and supporting services more highly than students who did not know about ES (Table A-2). Previous studies suggested that education level was an important factor influencing ES awareness [7, 8, 18]. The importance and performance of ES were more appreciated among highly educated people, especially in regulating services such as soil erosion, water regulation, climate control, etc. [7].

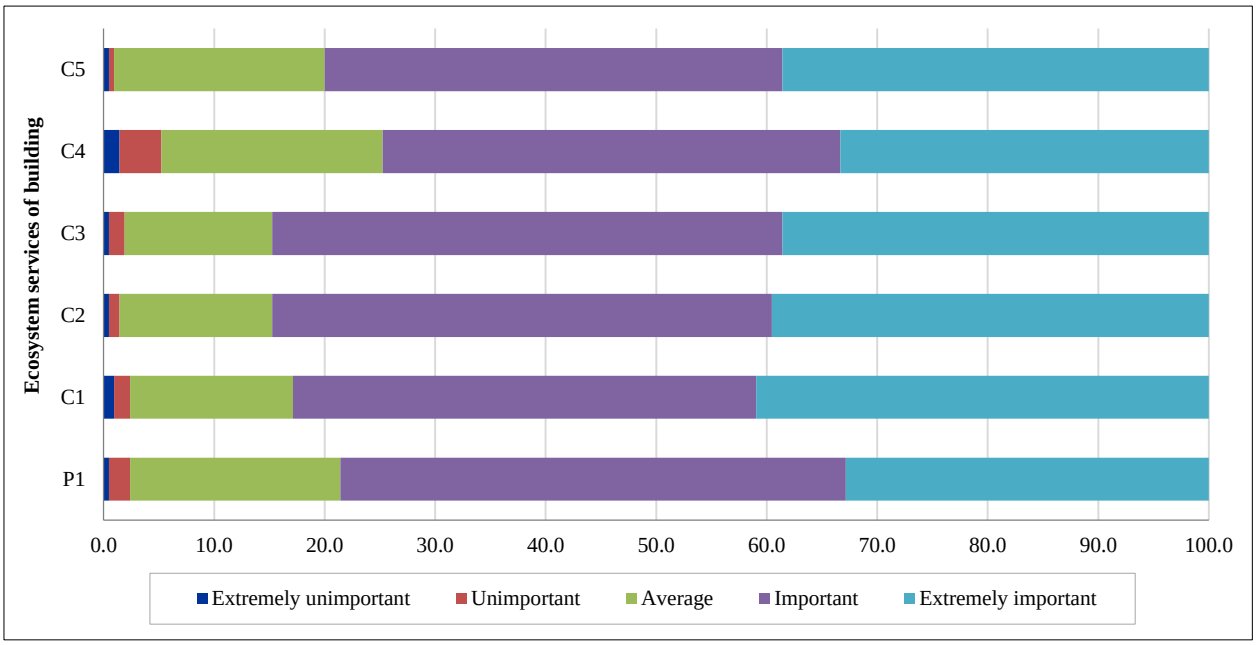

Figure 8. Importance of the building ecosystem

Table 2. Statistical significance level of mean difference in ecosystem service importance between classify group

The importance of ecosystem services	Independent Samples T-Test (sig)		One-way ANOVA (sig)		
	Gender	Knowledge	Course	Time spent on CTU (hours per day)	Time spent on green space (hours per day)
The green tree ecosystem					
Provisioning	0.120	0.367	0.860	0.568	0.189
Regulating	0.342	**0.002**	0.336	0.659	0.861
Cultural	**0.002**	**0.008**	0.753	0.389	**0.021**
Supporting	**0.006**	**0.010**	0.727	0.296	**0.021**
The lawn ecosystem					
Provisioning	0.258	0.425	0.833	0.981	0.171
Regulating	0.224	**0.002**	0.674	0.715	0.505
Cultural	0.087	0.102	0.891	0.271	0.124
Supporting	0.807	**0.046**	0.940	0.793	**0.012**
The water bodies ecosystem					
Provisioning	0.380	0.100	0.892	0.502	0.063
Regulating	0.245	0.095	0.143	0.966	**0.039**
Cultural	**0.038**	0.169	0.962	0.637	**0.021**
Supporting	**0.040**	**0.008**	0.334	0.821	0.222
The built-up ecosystem					
Provisioning	0.763	0.566	0.422	0.446	0.706
Cultural	0.131	0.291	0.051	0.954	**0.036**

Table 3. Statistical significance level of mean difference in ecosystem service satisfaction between classifying group

The satisfaction of ecosystem services	Independent Samples T-Test (sig)		One-way ANOVA (sig)		
	Gender	Knowledge	Course	Time spent on CTU (hours per day)	Time spent on green space (hours per day)
The green tree ecosystem					
Provisioning	0.300	0.416	0.097	0.170	0.209
Regulating	0.094	0.486	0.103	0.886	0.203
Cultural	0.081	0.194	0.161	0.588	0.037
Supporting	0.137	0.136	0.070	0.860	**0.015**
The lawn ecosystem					
Provisioning	0.209	0.223	0.290	0.918	0.115
Regulating	0.052	0.299	0.328	0.735	**0.018**
Cultural	**0.039**	0.345	0.300	0.772	0.067
Supporting	0.217	0.331	0.129	0.751	**0.015**
The water bodies ecosystem					
Provisioning	0.311	0.303	0.419	0.320	0.103
Regulating	0.208	0.250	0.602	0.735	0.160
Cultural	0.208	0.235	0.379	0.435	0.056
Supporting	0.208	0.308	0.409	0.497	**0.042**
The built-up ecosystem					
Provisioning	0.306	0.514	0.308	0.855	0.374
Cultural	0.213	0.981	**0.017**	0.975	0.293

The results of the study did not find differences in the perception of the importance of ES and satisfaction between students of different courses, except for the cultural services of the building ecosystem. The service performance of this service was better for senior students than for junior students. The difference in time that students spent on CTU also did not affect their perception of ES (Table A-3). An important finding of this study was that students' awareness of the importance and satisfaction of green trees, lawns, and water bodies ecosystems increased proportionally to the time they spent in the green spaces, especially regulating, cultural, and supporting services (Table A-4). For example, students who spend less than 0.5 hours/day in green spaces have a perception of importance and satisfaction with support services of 3.87±0.76 and 3.86±0.89, respectively, which are significantly lower compared to the values of 4.41±0.57 and 4.63±0.52 assessed by students who spend more than 02 hours/day in green spaces. It shows that students' perceptions of importance and satisfaction depend largely on their attachment to the ecosystem. The results of this study were completely consistent with the previous studies [7, 28]. In a study of parks' ecosystems, it was shown that people who regularly experience parks have high satisfaction with the services provided, especially cultural services [28]. The distance from the accommodation to the ecosystem space was also a factor that affected their perception of ES [8]. While local people prioritize provisioning and cultural services, out-of-town visitors give higher priority to educational value.

4. Conclusion

The ecosystem services provided by CTU's campus play an important role for students. Although green spaces (trees, lawns, and water bodies) were less important than buildings, their roles were undeniable. The green spaces in CTU were not only a suitable habitat for many animals and plants but also played an important role in regulating the environment. Each ecosystem has different priority regulatory functions. For example, the most important function of the greenery ecosystem was air conditioning and O_2 formation, while the lawn ecosystem was regulating the amount of rainwater runoff and reducing soil erosion. Overall, the functions of the greenery ecosystem have good performance, as most students were satisfied with these ecological functions. Meanwhile, the services of the remaining ecosystems need to be improved, as they did not meet the expected value for students. Assessing the relationship between importance and satisfaction for ecosystem services was a fresh finding in the field of research on ecosystems in Vietnam. This result allows the identification of ecosystem services that need to be given priority to improve the value of the ecosystem service and meet the expectations of people about the function of the ecosystem. For the scope of this study, the enhancement of information dissemination to improve understanding for students about ecosystem services is the most practical solution, as the results of the study have shown that the perceptions about the importance of ecosystem services of students who had knowledge about ecosystems were significantly higher than those of students who did not know about them.

5. Declarations

5.1. Author Contributions

Conceptualization, N.T.G. and T.H.D.; methodology, N.T.G. and T.H.D.; software, N.T.G. and T.H.D.; validation, N.T.G.; formal analysis, N.T.G. and T.H.D.; investigation, N.T.G.; data curation, N.T.G. and T.H.D.; writing—original draft preparation, N.T.G.; writing—review and editing, N.T.G. and T.H.D.; visualization, N.T.G. and T.H.D.; supervision, N.T.G. and T.H.D.; project administration, N.T.G. and T.H.D.; funding acquisition, N.T.G. and T.H.D. All authors have read and agreed to the published version of the manuscript.

5.2. Data Availability Statement

The data presented in this study are available in the article.

5.3. Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

5.4. Acknowledgments

The authors would like to thank Can Tho University's students who actively participated and answered the study's questionnaires. The authors also would like to thank ODA project for providing computer lab during preparation of this manuscript. The assistance of L.T.K.T and H.T.H.N in this manuscript is highly appreciated.

5.5. Conflicts of Interest

The authors declare no conflict of interest.

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Appendix I

Table A-1. Average difference of importance and satisfaction with ecosystem services by gender

ES	Gender						Understanding of ecosystem services					
	Male (n=78)		Female (n=132)		sig		Don't know (n=97)		Known (n=113)		sig	
	Importance	Satisfaction	Importance	Satisfaction	Importance	Satisfaction	Importance	Satisfaction	Importance	Satisfaction	Importance	Satisfaction
Trees												
Provisioning	3.66 ± 0.84	4.03 ± 0.81	3.83 ± 0.74	4.14 ± 0.79	0.120	0.300	3.71 ± 0.79	4.05 ± 0.82	3.81 ± 0.77	4.14 ± 0.78	0.367	0.416
Regulating	4.06 ± 0.71	4.09 ± 0.81	4.15 ± 0.65	4.27 ± 0.73	0.342	0.094	3.96 ± 0.71	4.17 ± 0.83	4.25 ± 0.61	4.24 ± 0.71	**0.002**	0.486
Cultural	3.77 ± 0.72	3.97 ± 0.83	4.08 ± 0.68	4.17 ± 0.72	**0.002**	0.081	3.82 ± 0.75	4.02 ± 0.82	4.08 ± 0.65	4.16 ± 0.73	**0.008**	0.194
Supporting	3.88 ± 0.75	3.96 ± 0.85	4.14 ± 0.61	4.13 ± 0.74	**0.006**	0.137	3.92 ± 0.75	3.98 ± 0.84	4.16 ± 0.58	4.14 ± 0.73	**0.010**	0.136
Lawns												
Provisioning	3.65 ± 0.92	3.86 ± 0.85	3.79 ± 0.85	4.00 ± 0.74	0.258	0.209	3.69 ± 0.92	3.86 ± 0.85	3.79 ± 0.84	4.00 ± 0.74	0.425	0.223
Regulating	3.91 ± 0.82	3.83 ± 0.84	4.04 ± 0.63	4.05 ± 0.71	0.224	0.052	3.83 ± 0.76	3.83 ± 0.84	4.13 ± 0.63	4.05 ± 0.71	**0.002**	0.299
Cultural	3.87 ± 0.77	3.80 ± 0.84	4.04 ± 0.64	4.03 ± 0.76	0.087	**0.039**	3.89 ± 0.76	3.80 ± 0.84	4.05 ± 0.63	4.03 ± 0.76	0.102	0.345
Supporting	3.89 ± 0.79	3.85 ± 0.87	4.07 ± 0.69	3.99 ± 0.73	0.807	0.217	3.90 ± 0.83	3.85 ± 0.87	4.10 ± 0.60	3.99 ± 0.73	**0.046**	0.331
Water bodies												
Provisioning	3.74 ± 0.91	3.78 ± 086	3.84 ± 0.77	3.90 ± 0.80	0.380	0.311	3.70 ± 0.86	3.79 ± 0.82	3.89 ± 0.79	3.91 ± 0.83	0.100	0.303
Regulating	3.79 ± 0.85	3.82 ± 0.88	3.92 ± 0.71	3.85 ± 0.78	0.245	0.208	3.78 ± 0.83	3.76 ± 0.86	3.96 ± 0.71	3.90 ± 0.88	0.095	0.250
Cultural	3.58 ± 0.88	3.82 ± 0.89	3.82 ± 0.66	3.95 ± 0.82	**0.038**	0.208	3.65 ± 0.76	3.82 ± 0.85	3.80 ± 0.75	3.97 ± 0.84	0.169	0.235
Supporting	3.79 ± 0.91	3.79 ± 0.87	4.03 ± 0.76	3.81 ± 0.81	**0.040**	0.208	3.78 ± 0.87	3.73 ± 0.82	4.09 ± 0.77	3.84 ± 0.84	**0.008**	0.308
Buildings												
Provisioning	4.06 ± 0.81	4.09 ± 0.86	4.10 ± 0.79	4.21 ± 0.74	0.763	0.306	4.05 ± 0.85	4.12 ± 0.81	4.12 ± 0.75	4.19 ± 0.77	0.566	0.514
Cultural	4.07 ± 0.76	4.05 ± 0.91	4.22 ± 0.66	4.20 ± 0.76	0.131	0.213	4.11 ± 0.76	4.14 ± 0.83	4.21 ± 0.65	4.14 ± 0.81	0.291	0.981

Table A-2. Average difference of importance and satisfaction level for ecosystem services by course

ES	Freshman (n=68)		Sophomore (n=65)		Junior (n=70)		Senior (n=5)		Graduate (n=2)		sig	
	Importance	Satisfaction	Importance	Satisfaction	Importance	Satisfaction	Importance	Satisfaction	Importance	Satisfaction	Importance	Satisfaction
Trees												
Provisioning	3.69 ± 0.82	4.07± 0.70	3.84± 0.68	4.2± 0.74	3.77± 0.83	4.03± 0.90	3.80± 0.76	3.80± 0.84	3.75± 1.06	3.00± 1.41	0.860	0.097
Regulating	3.99± 0.66	4.21± 0.68	4.24± 0.59	4.31± 0.73	4.12± 0.75	4.17± 0.85	4.2± 0.63	3.80± 0.47	3.7± 0.42	3.00± 1.41	0.336	0.103
Cultural	3.92± 0.61	4.13± 0.64	3.92± 0.77	4.20± 0.73	4.04± 0.75	4.00± 0.89	4.16± 0.56	4.00± 0.71	3.7±0.99	3.00± 1.41	0.753	0.161
Supporting	3.96± 0.63	4.09± 0.69	4.09± 0.69	4.12± 0.74	4.07± 0.70	4.03± 0.88	4.23± 0.63	3.40± 0.88	3.85± 1.20	3.00± 1.41	0.727	0.070
Lawns												
Provisioning	3.71± 0.81	3.94± 0.71	3.84± 0.79	4.07± 0.77	3.70± 1.03	3.87± 0.85	3.60± 0.55	4.00± 0.71	3.5± 0.71	3.00± 1.41	0.833	0.290
Regulating	4.00± 0.67	3.99± 0.72	4.03± 0.69	4.01± 0.74	4.00± 0.79	3.96± 0.82	3.70± 0.42	3.60± 0.55	3.42± 0.59	3.00± 1.41	0.674	0.328
Cultural	3.93± 0.66	3.99± 0.74	4.03± 0.66	4.03± 0.79	3.98± 0.76	3.84± 0.85	3.84± 0.71	4.00± 0.71	3.70± 0.99	3.00± 1.41	0.891	0.300
Supporting	3.96± 0.71	3.93± 0.74	4.06± 0.69	4.06± 0.77	3.99± 0.82	3.89± 0.83	4.13± 0.61	3.40± 0.55	4.00± 1.41	3.00± 1.41	0.940	0.129
Water bodies												
Provisioning	3.80± 0.75	3.85± 0.80	3.85± 0.75	3.97± 0.81	3.79 ± 0.98	3.79± 0.85	3.50± 0.71	3.80± 0.84	3.50± 0.71	3.00± 1.41	0.892	0.419
Regulating	3.90± 0.72	3.85± 0.87	3.85± 0.67	3.91± 0.88	3.94± 0.88	3.80± 0.89	3.05± 0.62	3.60± 0.55	3.50± 0.71	3.00± 1.41	0.143	0.602
Cultural	3.75± 0.72	3.96± 0.87	3.70± 0.84	3.98± 0.82	3.75± 0.73	3.80± 0.85	3.90± 0.58	3.80± 0.84	3.50± 0.71	3.00± 1.41	0.962	0.379
Supporting	3.97± 0.81	3.79± 0.87	4.07± 0.75	3.89± 0.77	3.86± 0.90	3.75± 0.84	3.60± 1.08	3.40± 0.55	3.25± 0.35	3.00± 1.41	0.334	0.409
Buildings												
Provisioning	4.03± 0.73	4.16± 0.68	4.20± 0.77	4.26± 0.76	4.03± 0.87	4.09± 0.90	4.40± 0.89	4.40± 0.55	3.50± 0.71	3.00± 0.00	0.422	0.160
Cultural	4.17± 0.59	4.19± 0.68	4.28± 0.64	4.28± 0.76	4.08± 0.82	4..01± 0.94	4.24± 0.72	4.20± 0.84	2.9± 0.99	2.50± 0.71	0.051	**0.017**

Table A-3. Average difference of importance and satisfaction level for ecosystem services by time spent on CTU

ES	<2 hours/day (n=5)		2-5 hours/day (n=120)		5-8 hours/day (n=69)		> 8 hours/day (n=16)		sig	
	Importance	Satisfaction	Importance	Satisfaction	Importance	Satisfaction	Importance	Satisfaction	Importance	Satisfaction
Trees										
Provisioning	3.70 ± 0.67	4.20 ± 0.84	3,82 ± 0.71	4.00 ± 0.85	3.75 ± 0.81	4.20 ± 0.72	3.53 ± 1.16	4.38 ± 0.62	0.568	0.170
Regulating	4.00 ± 0.71	4.40 ± 0.89	4.12 ± 0.67	4.18 ± 0.80	4.14 ± 0.69	4.23 ± 0.73	3.93 ± 0.66	4.25 ± 0.68	0.659	0.886
Cultural	3.44 ± 0.71	3.80 ± 0.84	3.96 ± 0.72	4.06 ± 0.77	4.01 ± 0.68	4.15 ± 0.79	3.96 ± 0.71	4.25 ± 0.68	0.389	0.588
Supporting	3.52 ± 0.58	4.00 ± 0.71	4.08 ± 0.67	4.03 ± 0.82	4.14 ± 0.60	4.10 ± 0.77	4.05 ± 0.67	4.19 ± 0.66	0.296	0.860
Lawns										
Provisioning	3.80 ± 1.30	3.80 ± 0.84	3.73 ±0.87	3.93 ± 0.76	3.76 ± 0.85	3.99 ± 0.80	3.81 ± 0.98	4.00 ± 0.97	0.981	0.918
Regulating	3.83 ± 0.85	3.80 ± 0.84	3.98 ± 0.69	3.94 ± 0.77	4.07 ± 0.72	4.04 ± 0.74	3.88 ± 0.77	3.88 ± 0.89	0.715	0.735
Cultural	3.48 ± 1.12	3.60 ± 0.89	3.94 ± 0.68	3.95 ± 0.80	4.04 ± 0.72	3.97 ± 0.77	4.10 ± 0.47	3.88 ± 0.96	0.271	0.772
Supporting	3.73 ± 0.83	3.80 ± 0.84	4.04 ± 0.76	3.89 ± 0.79	3.99 ± 0.72	4.01 ± 0.76	3.94 ± 0.67	3.94 ± 0.93	0.793	0.751

Water bodies									
Provisioning	3.90 ± 0.74	4.00 ± 0.71	3.86 ± 0.79	3.81 ± 0.83	3.75 ± 0.84	3.99 ± 0.76	3.56± 1.01	3.63 ± 1.09	0.502	0.320
Regulating	3.80 ± 0.78	3.80 ± 0.89	3.87 ± 0.76	3.83 ± 0.89	3.91 ± 0.76	3.90 ± 0.81	3.83 ± 0.89	3.63 ± 1.09	0.966	0.735
Cultural	3.50 ± 1.00	3.80 ± 0.84	3.74 ± 0.74	3.89 ± 0.86	3.69 ± 0.80	4.00 ± 0.77	3.92 ± 0.62	3.63 ± 1.09	0.637	0.435
Supporting	4.10 ± 0.74	4.00 ± 0.71	3.99 ± 0.77	3.75 ± 0.84	3.88 ± 0.81	3.90 ± 0.77	3.88 ± 1.27	3.63 ± 1.09	0.821	0.497
Buildings										
Provisioning	4.40 ± 0.89	4.20 ± 0.84	4.13 ± 0.80	4.18 ± 0.78	3.97 ± 0.79	4.16 ± 0.78	4.13 ± 0.81	4.00 ± 0.89	0.446	0.855
Cultural	4.00 ± 0.71	4.00 ± 1.00	4.18 ± 0.73	4.16 ± 0.80	4.15 ± 0.69	4.13 ± 0.78	4.19 ± 0.63	4.13 ± 1.09	0.954	0.975

Table A-4- Average difference of importance and satisfaction for ecosystem services by time spent on green space in CTU

ES	< 0.5 hours/day (n=73)		0.5 - 1 hours/day (n=94)		1 - 2 hours/day (n=35)		> 2 hours/day (n=8)		sig	
	Importance	**Satisfaction**	**Importance**	**Satisfaction**	**Importance**	**Satisfaction**	**Importance**	**Satisfaction**	**Importance**	**Satisfaction**
Trees										
Provisioning	3.62 ± 0.90	3.97 ± 0.88	3.87 ± 0.70	4.12 ± 0.78	3.70 ± 0.73	4.20 ± 0.8	4.06 ± 0.68	4.50 ± 0.54	0.189	0.209
Regulating	4.10 ± 0.73	4.07 ±0.89	4.15 ± 0.64	4.29 ± 0.67	4.05 ± 0.63	4.20 ± 0.72	4.19 ± 0.67	4.50 ± 0.76	0.861	0.203
Cultural	3.79 ± 0.78	3.89 ± 0.88	4.04 ±0.63	4.18 ± 0.69	4.02 ± 0.71	4.23 ± 0.69	4.45 ±0.54	4.38 ± 0.74	**0.021**	0.037
Supporting	3.87 ± 0.76	3.86 ± 0.89	4.15 ± 0.59	4.15 ± 0.70	4.06 ± 0.65	4.14 ± 0.73	4.41 ± 0.57	4.63 ± 0.52	**0.021**	**0.015**
Lawn										
Provisioning	3.56 ± 0.96	3.79 ± 0.87	3.86 ± 0.81	4.01 ± 0.71	3.80 ± 0.87	4.00 ± 0.77	3.75 ± 0.71	4.38 ± 0.78	0.171	0.115
Regulating	3.91 ± 0.83	3.82 ± 0.84	4.07 ± 0.60	4.05 ± 0.71	3.96 ± 0.70	3.97 ± 0.75	4.13 ± 0.80	4.25 ± 0.71	0.505	**0.018**
Cultural	3.83 ± 0.85	3.75 ± 0.89	4.01 ± 0.59	4.05 ± 0.69	4.10 ± 0.58	3.97 ± 0.79	4.25 ±0.69	4.25 ± 0.89	0.124	0.067
Supporting	3.80 ±0.85	3.71 ± 0.84	4.18 ± 0.63	4.02 ± 0.72	3.95 ±0.63	4.05 ± 0.76	4.08 ±0.90	4.38 ± 0.74	**0.012**	**0.015**
Water bodies										
Provisioning	3.60 ± 0.93	3.69 ± 0.86	3.97 ± 0.68	3.95 ± 0.77	3.79 ± 0.84	3.89 ±0.87	3.81 ± 0.99	4.25 ± 0.71	0.063	0.103
Regulating	3.66 ± 0.87	3.66 ± 0.92	4.03 ± 0.62	3.93 ± 0.81	3.88 ± 0.83	3.91 ± 0.89	4.00 ± 0.72	4.13 ± 1.12	**0.039**	0.160
Cultural	3.47 ± 0.90	3.67 ± 0.91	3.88 ± 0.62	4.05 ± 0.75	3.85 ± 0.63	3.91 ± 0.89	3.91 ± 0.76	4.13 ± 0.83	**0.021**	0.056
Supporting	3.82 ±0.86	3.61 ± 0.89	4.07 ± 0.73	3.87 ± 0.78	3.84 ± 0.88	3.83 ± 0.79	4.06 ± 1.27	4.38 ± 0.74	0.222	**0.042**
Buildings										
Provisioning	4.05 ± 0.90	4.06 ± 0.89	4.11 ± 0.74	4.25 ± 0.68	4.03 ± 0.75	4.11 ± 0.80	4.38 ± 0.74	4.38 ± 0.74	0.706	0.374
Cultural	3.90 ± 0.84	4.00 ± 0.93	4.25 ± 0.60	4.25 ± 0.70	4.22 ± 0.63	4.17 ± 0.82	4.55 ± 0.48	4.13 ± 0.99	**0.036**	0.293