COMPARATIVE ANALYSIS OF ENVIRONMENTAL ASSESSMENT SYSTEMS OF UNIVERSITIES IN RUSSIA AND CHINA (USING THE EXAMPLE OF GREEN ZOOM "UNIVERSITIES AND CAMPUSES" AND GB/T51356-2019)

Dmitrii IAKIMOVICH
PhD candidate of Institute of Environmental Sciences, Kazan Federal University, Russia, e-mail: yakimovich11@yandex.ru

Elena SUKHININA
Assistant professor of department «Architecture», Yuri Gagarin State Technical University of Saratov, Russia, e-mail:arx-art-lena@yandex.ru

Vyacheslav SIROTKIN
Professor, Doctor of Geographical Sciences, Institute of Environmental Sciences, Kazan Federal University, Russia, e-mail: sirotkin067@gmail.com

Bulat USMANOV
Senior Lecturer, Institute of Environmental Sciences, Kazan Federal University, Russia, e-mail: batikandr@gmail.com

Alexey KULESHOV
Junior Researcher of Laboratory of hydrological instruments, State Hydrological Institute, Saint Petersburg, Russia, e-mail: alexeykuleshov1990@gmail.com

Abstract. This article provides a brief description of two modern systems for assessing the energy efficiency and environmental friendliness of university campuses in Russia and China: GREEN ZOOM "Universities and Campuses" (Russia) and GB/T51356-2019 (China). This issue is relevant due to the possible cooperation between Russia and China in the field of the use of green technologies on university campuses. This article uses the following methods: analysis, classification, analogy. Similar sections of the GB/T51356-2019 standard were defined and compared to the generated sections of the GREEN ZOOM system as a reference. Further, according to a similar principle, in the format of a large table, the key indicators of each section of the GREEN ZOOM assessment systems "Universities and Campuses" (Russia) and GB/T51356-2019 systems (China) were highlighted, showing the similarities of these systems, as well as the possible reasons for their differences. In the final part, conclusions are made reflecting the similarities of these systems, the possible reasons for their differences are analyzed.

Key words: university campus, environmental assessment, green construction, green university, green campus

1. Introduction

In recent years, sustainable development and environmental issues have received increasing attention worldwide. Nevertheless, the patterns of landscape-forming process evolution, as well as the internal relations of natural-territorial complexes, taking into account specific anthropogenic conditions, were not sufficiently studied (Jkimovich *et al.*, 2017). It is known that the construction of facilities has a great influence on landscape change, so environmental construction is a determining factor in the promotion of sustainable development. University buildings and university campuses are no exception. Across the world, students, academics and university networks have pioneered programs, tools and assessment systems to inspire, challenge and support universities to become test-beds and role-models of sustainability. The scale of university campus construction has become so high that they can also have a significant impact on urban areas (Ruoppila and Zhao, 2017). To understand what impact the university has on the environment, an environmental assessment is necessary.

Environmental assessment is a process of systematic analysis and determination of the environmental impacts of an intended activity, consultation with stakeholders, for planning, design, approval and implementation of that activity. Stability strategy of the university and the ability to apply the assessment system are influenced by methods such as sustainability assessment tools (SAT) (Berzosa *et al.*, 2017).

Some scientists identified the main features of the environmental assessment tool: a sustainability tool must identify important issues, be measurable and comparable, move beyond eco-efficiency, measure processes and motivations and be comprehensible to a broad range of stakeholders (Shriberg, 2002). Analysis of modern assessment tools indicated that some authors use mixed-method of both qualitative and quantitative measures in their study (Disterheft *et al.*, 2013; Fischer *et al.*, 2015) and apply different assessment tools simultaneously (Yarime *et al.*, 2012).

The comparison of systems of environmental assessment in China and in Russia is important due to the developing international cooperation between the two countries. The Research Institute for Sustainable Development in Construction (Russia) took the initiative in establishing cooperation with the Chinese side. In 2019, representatives of NIIURS entered into a strategic partnership agreement with the Association of Green Universities of China (China Green University Network, CGUN) represented by Professor of Tongji University, Mr. Tan Hongwei.

China has an ambitious goal of sustainable development and has developed strategic plans to achieve this goal, which are evident in the "energy efficient society" and the "harmonious society" oriented governmental policies (Yuan *et al.*, 2013). China and other emerging counties are playing expanding roles to solve global and local

environmental challenges, due to visionary academic leadership in some universities (Wang *et al.*, 2013). Natural factors have also a great influence on the formation of environmental assessment such us: wind environment evaluation has already been conducted by a number of scientists from North China University of Technology (Wang *et al.*, 2020), evaluation of carbon footprint (Liu *et al.*, 2017; Wang and Ge, 2020; Kulkarni, 2019), using food-water-energy nexus perspective (Gu *et al.*, 2018), using machine learning algorithms (Zheng *et al.*, 2021). To implement the concept of a green campus, an integrated model of a green university was created. Such a model aims to manage all the campus activities on a sustainable basis (Geng *et al.*, 2013). Evaluation system can be used to ensure the success of such a model. The importance of applying green building standards to all buildings is also emphasized by the fact that by the end of 2020, at least 50% of the new residential buildings should obtain the certificates of Estimation Standards for Green Building (ESGB) (Wu *et al.*, 2019).

Many authors presented evaluation systems. Initially, 6 categories were distinguished: the concept of sustainable development management, green scientific research, green practices, educational systems in green universities, campus construction, and the promotion of sustainable community development. The following key concepts are highlighted: connotation of green campus and the evaluation scope, structure design of green campus, evaluation indices, weighting of evaluation indices, Green Campus evaluation method.

It is noted two main categories for evaluation index system: green education and green culture and the inapplicability of international standards of energy efficiency and environmental friendliness for campuses (BREEAM, LEED, CASBEE). There is research that claims the active use of the LEED standard at universities in China, mentioning the receipt of LEED certificates from about 4,000 universities in China (Han *et al.*, 2015). On the contrary some researchers considered applicability of the STARS system for green campus in China (Zhu and Dewancker, 2021).

Some researchers highlighted that the correct scientific evaluation indexes are necessary for development of evaluation systems (Tan *et al.*, 2014). It is also noted that it is very important to develop evaluation system, as a long-term mechanism, revised and improved. 5 categories proposed: organization and management, energy and resource saving, friendly environment, campus culture, social outreach (Chen *et al.*, 2019).

Assessment Standard for Green Building scheme is implemented in a mandatory way. The first version of ASGB (GB/T 50378-2006) was released in 2006, followed by the revised version of GB/T 50378-2014 (Wang *et al.*, 2019). Some scientists also notes that GB/T51356-2019, based on the prior Green Campus Assessment Standard (CSUS/GBC04-2013) for green campus construction (Liu and Zhang, 2019). GB/T51356-2019 focused on energy, water, material, and land conservation (Na and Zhao, 2021).

Before the creation of a special standard for universities and campuses, there was the "Standard for Evaluating Green Buildings" (GB/T 50378-2014), common for all categories of buildings. It focused only on the assessment of green buildings, while some important items related to the green campus were

ignored, such as green procurement, green transportation, campus resource recycling (paper, electronic waste). In this regard, the creation of the "Green Campus Assessment Standard" has great importance. It was the first standard for green campus evaluation in China published by the Committee on Environmental Construction and Energy Conservation of the China Association for Urban Research, China Academy of Building Research and Tongji University. Tongji University not only takes a leading position in promoting this initiative in China, but also actively implements it on the territory of own university (Fig. 1).

Fig. 1. Tongji University (Siping campus).

The standard defines the green campus as a structure for maximum resource savings (energy saving, water saving, materials saving, land saving), environmental protection and pollution reduction throughout the life cycle, providing teachers and students with a healthy environment.

The structure of the Chinese GB/T51356-2019 system is represented by the following points:
1. General Rules;
2. Terminology;
3. Basic rules (basic rules, valuation methods and gradation).

The evaluation criteria of this standard consist of the 4th and 5th sections (university, college) and are represented by the following parts:
1. Planning and ecology;
2. Sources and resources;
3. Environment and construction;
4. Operation and management;
5. Education. Each category has maximum of 100 points. Key feature of the Chinese system is the division of the system into different criteria for colleges and higher education institutions, while the GREEN ZOOM system does not imply such a division.

Table 1 shows indicators including: 1. Figure reflects the number of evaluation criteria; 2. Figure in parentheses is the specific gravity of the indicators. From this table we can see that the high specific gravity section does not always include a large number of items (Ministry of Housing and Urban-Rural Development, 2019). Examples of indicators of other assessment systems in China represented in Table 2. Environmental certification system in China is voluntary as well as energy-saving and water-saving products certification.

Unfortunately, there is no established regulatory and reference framework for sustainable architectural and urban environment in Russia. So, the developers of Russian eco-standards very often refer to western standards, which greatly complicates the certification process. GREEN ZOOM "Universities and Campuses" was developed with the aim to introduce a universities and campuses certification system adapted to Russian realities.

GREEN ZOOM – is a voluntary certification system for improving the environmental friendliness and energy efficiency of industrial and civil construction facilities.

Table 1. Distribution of evaluation criteria of the GB/T51356-2019 system depending on the indicators

Criterion/type of educational institution	1. Planning and ecology	2. Sources and Resources	3. Environment and construction	4. Operation and management	5. Education
University	10 (0,20)	13 (0,25)	11 (0,25)	13 (0,15)	9 (0,15)
School	9 (0,25)	15 (0,25)	11 (0,20)	12 (0,15)	11(0,15)

Table 2. Indicators of various university and campus assessment systems in China

System Author or Organization	Name of the system or scientific work	Examples of indicators
CNWCESD (UNESCO National Working Committee on Education for Sustainable Development)	System of school quality indicators for sustainable environmental development	Organization of the school work plan, support and guarantees (teacher training and interaction with institutions), curriculum and instructions (introduction of sustainable development values), thematic educational activities (related to climate change, emissions reduction and energy conservation), technical solutions on campus (conservation of water, energy in the building), implementation of achievements (certain measures to change the behavior of students, teachers, society) (Shi, 2014).
Can XiaoXi	Research of green campus evaluation system	3 key concepts: green environment, green culture and green concept. These concepts include planting lawns, trees, campus landscaping, energy and water conservation, training courses on the concept of sustainable development.
Sun YingJie	System study of green university indicators based on CIS theory.	It consists of 3 first level, 12 second level and 45 third level indicators. First level Indicators: level of ideas (concept) - M (example: personnel management system, students, research, etc.); Level of activity - B (green habits, green research, number and scale of associations); Material level - V (maintenance of biological diversity, compliance with sanitary standards in the environment, etc.).
Chen Shuqin, Lu Minyan, Tan Hongwei, Luo Xiaoyu, Ge Jian	Assessing sustainability on Chinese university campuses: development of a campus sustainability evaluation system and its application with a case study	Organization and management (C1), energy and resource savings (C2), friendly environment (C3), campus culture (C4), and social support (C5) (Chen et al., 2019)

This system allows to reduce costs (investment and operational) and at the same time to improve the quality of construction facilities. This system was a response to the requirements of the Presidential Decrees to reduce the energy intensity of construction facilities by 2020 and reduce greenhouse gas emissions to the atmosphere. The first version of the GREEN ZOOM standard was born in 2014 on the initiative of the autonomous non-profit organization Research Institute for Sustainable Development in Construction (ANO "NIIURS"). It is worth noting that the 2014 standard contained a number of requirements and practical recommendations to reduce energy requirement only for newly erected civil engineering facilities, while today, the employees of the ANO NIIURS have developed 6 standards for construction projects of various functional purposes, including operable.

One of the family of standards is entirely devoted to innovative scientific and technological centers and university campuses. First version is called GREEN ZOOM "Universities and Campuses" (https://greenzoom.ru/books/15-prakticeskie-rekomendacii-po-snizeniu-energoemkosti-i-povyseniu-ekologicnosti-universitetov-i-kampusov-innovacionnyh-naucno-tehniceskih-centrov/).

This standard includes not only mandatory requirements on the territory of modern student campuses, but a number of practical recommendations for improving the energy efficiency and environmental friendliness of the territory adjacent to the university. The standard is a scoring system for the main sections under consideration (maximum number of points is presented in brackets):

1. Transportation and infrastructure, integrated security (15 points);
2. Ecology of the building site. No sources of contamination (10 points);
3. Ecosystem conservation (9 points);
4. Combating climate change (19 points);
5. Clean energy, energy efficiency (40 points);
6. Clean water, water efficiency (13 points);
7. Good health (27 points);
8. Development opportunities (12 points);
9. Responsible consumption (8 points);
10. Environmental Partnership (7 points).

Total: 160 points. Depending on the scored points, one of four levels is assigned to the certification object: Bronze certificate – from 85 points; Silver certificate – from 105 points; Gold certificate – from 125 points; Platinum certificate - from 140 points.

According to GREEN ZOOM standard Highpark, ITMO University campus, will be built in the Yuzhny satellite city (Pushkin district, St. Petersburg). The new campus will include educational buildings, innovative production sites and a business incubator covering an area about 400 km². The campus will have 50 international laboratories and at least 5 innovative productions that will specialize in such areas as IT, photonics and quantum technologies, robotics and cyber-physical systems, biomedical technologies and intelligent materials. The requirements of the Russian GREEN ZOOM standard have also been tested in a number of Russian scientific studies, including the proposal of a concept for determining the parameters of environmental reconstruction of Yuri Gagarin State Technical University of Saratov in 2019.

Even though certification of university campuses has not gained much popularity

at this moment, Russian universities take part in international and local rating of green universities increasingly. For example Ural Federal University and RUDN University, participate in the UI Green Metric (Ali and Anufriev, 2020). Chinese universities rarely participate in UI Green Metric, but the Peking University is a member of the International sustainable campus network (ISCN) (Marques, 2018). In Russia, it is possible to distinguish national green universities compiled with the participation in "Rating of Green Universities of Russia" of the environmental movement "ECA". Rating includes 6 categories, 42 universities took part in the 2019 ranking. The highest score was received by Bashkir State Agrarian University.

While both systems have evolved in their own countries, each system needs to be refined, this research will be able to better identify the strengths and weaknesses of each system and identify opportunities for development.

Research issue is relevant due to the possible cooperation between Russia and China in the field of the use of green technologies on university campuses. Implementation of environmental initiatives and improvement of their assessment methodology of Russia and China are also important for other countries because these countries (using the example of countries included in the Belt and Road initiative) are among the top three countries with the highest environmental footprint (Fang *et al.*, 2021).

According the topic under study, the following goal and objectives of the research were defined:

The goal of the study is to conduct a detailed comparative analysis of environmental assessment systems of universities in Russia and China using the example of two existing assessment systems.

Objectives:

- Provide brief information on the development of green campus assessment systems in Russia and China prior to implementation of existing assessment systems;
- Provide a detailed description of the GB/T51356-2019 assessment systems (China) and GREEN ZOOM "Universities and Campuses" (Russia);
- Conduct a comparative analysis of these systems according to the following criteria: highlighting key sections, the requirements of each system to create a comfortable environment, similarities and differences of all points of the assessment systems;
- Highlight the key differences in these systems, the benefits and lacks of each system.

2. Materials and methods

This article uses the following methods: analysis; classifications; analogies. To understand the similarity of scoring systems, a comparative analysis was conducted in Tables 3, 4. Tables 5, 6 provide separated information on the sections of the Russian and Chinese green campus assessment system. Scientific methodologies presented in various studies were used to construct Tables 7, 8. Table 3 identifies similar sections in the two systems. At the same time, in the second column, the corresponding sections of the systems are highlighted in the usual font, based on their names. In the Chinese system there are sections in which only some items correspond to the section of the Russian system.

Table 4 highlights the key characteristics of the standards under study.

Table 3. Benchmarking for GREEN ZOOM "Universities and Campuses" and GB/T51356-2019 System Sections

GREEN ZOOM	GB/T51356-2019
Transport and infrastructure, integrated security	4.1-5.1. *Planning and ecology*
Ecology of the building site. No sources of pollution	4.1-5.1.Planning and ecology
Conservation of ecosystems	*4.1-5.1. Planning and ecology* *6. Technology and innovation*
Combating climate change	*4.3-5.3. Environment and health* *6. Technology and Innovation*
Clean energy, energy efficiency	4.2-5.2. Energy and resources
Good health	4.3-5.3. Environment and health
Clean water, water efficiency	*4.1-5.1. Planning and ecology*
Opportunities for development	-
Responsible consumption	4.4.-5.4. Operation and Management
Environmental partnership	4.5-5.5. Educational activities

3. Results

Detailed analysis of the sections, criteria and their comparison among themselves made it possible to highlight the priority areas of GREEN ZOOM "Universities and Campuses" environmental assessment and GB/T51356-2019 "Standard of Assessment for Green Campus."

Table 5 shows the main sections of GREEN ZOOM containing the percentage of requirements, Table 5. Analyzing the number of activities proposed for environmental assessment in GREEN ZOOM, it is determined that the largest number of solutions belongs to the sections on creating a "High-quality environment and user health" - 21.00% of all the requirements of the document.

In the Chinese environmental standard for educational institutions, it was not possible to distinguish the number of requirements of each section in percentage terms according to the same principle as in GREEN ZOOM, since:
- Section 1 "General Information" and Section 2 "Basic Terms" include general provisions for a standard without evaluation criteria and requirements;
- concerning the Section 4 "Elementary and High Schools" and the Section 5 "Higher education" at assessment of a concrete object we involve only one of these two sections depending on category of objects, Table 6.

In analyzing the structure of the standards, it can be concluded that the sections of the environmental assessment of the systems under consideration take into account important aspects that allow creating comfortable microclimatic and safe conditions for training and work. We highlight the most significant measures in this direction from the entire structure of sections, dividing them into two groups - engineering, organizational and architectural, Table 7. The division of the requirements of the eco-standards under consideration into two sections (engineering, organizational and architectural) made it possible to distinguish a number of requirements for the control of air quality, water, ventilation, and material selection. Considerable attention is paid to thermal comfort, natural lighting and the organization of natural ventilation, which is especially important during the spread of acute viral infection. The comparison of standards in Table 7 reveals similar sections in the two systems. At the same time, in the second column the usual font is indicated - the correspondence of the sections of the systems, based on their names. In the Chinese system there are sections in which only some items correspond to the section of the Russian system - they are indicated in italics.

Table 4. GREEN ZOOM System Performance Comparison "Universities and Campuses" and GB/T51356-2019.

	Russia GREEN ZOOM «Universities and campuses»	**China System of evaluation of green campuses GB/T51356-2019**
Maximum point	160	500
Year of version	2020	2019
Certification Objects	University campuses	University campuses, colleges
Practical features	The system has criteria for only one type of educational institution - university campus The system is presented in Russian, also refers to Russian standards (GOST and others).	The system has different criteria for both universities and schools. The system is presented in Chinese, at the end of the standard sheet there is also a list of standards that were used in the development of the current standard.
Benefits	The system is multilevel graded with sections and subdivisions.	Developed quantitative gradation within the subsection (the ability to use several items within the system)
Lacks	Lack of items in the section "Responsible consumption"	Lack of university development items (non-environmental)

Table 5. Main sections of GREEN ZOOM "Universities and Campuses" (Russia)

Sections of the environmental standard	**Number of requirements in %**
1. Transportation and infrastructure, integrated security	11,9
2. Ecology of the building site	7,7
3. Ecosystem conservation	5,6
4. Combating climate change	7,7
5. Clean energy, energy efficiency	16,1
6. Clean water, water efficiency	10,4
7. Good health	**21,0**
8. Development opportunities	9,1
9. Responsible consumption	6,3
10. Environmental Partnership	4,2

In Table 8, the main sections of the GREEN ZOOM (Russia) system were selected as the benchmark for comparison (first column). In the second column the mandatory requirements (sign ®) and the measures allowing the highest number of points were highlighted in brackets (Russia), in the third column the most suitable points of the system were proposed GB/T51356-2019 (China) in brackets, Table 8.

4. Discussion

Analyzing Table 8, we see a great emphasis on the category of "Health" both in Russia and in China. Health is a key criterion for the existence of a human, therefore it has the greatest influence in both groups. In China, this standard includes a wide application-measurement of noise levels, air pollution. In Russia the main emphasis is on creating the most comfortable premises microclimate and organizing a healthy working environment.

Table 6. Main sections of GB/T51356-2019 Green Campus Assessment Standard (China)

1. General information
2. Basic terms
3. Basic regulations
- Specifications
- Evaluation methodology
4. Elementary and high schools
- Planning and ecology
- Energy resources
- Environment and health
- Operation and management
- Education and promotion
5. Higher education
- Planning and ecology
- Energy resources
- Environment and health
- Operation and management
- Education and promotion
6. Features and Innovations
- General terms
- Points criteria

Table 7. Requirements of environmental standards for creating comfortable conditions in general education institutions.

Engineering and Organizational	Architectural and technical
GB/T51356-2019 «Green Campus Assessment Standard» (China)	
Levels of pollutants such as organic substances and nitrogen	Content of hazardous substances in building materials
Campus Smoking Ban System	Reasonable use of green building materials
Indoor air quality monitoring system	Quality of the acoustic medium of the training area
Environmental quality of water	Work Surface Sun Factor
Quality medical equipment and services	Meet internal lighting quality and quantity requirements in classrooms
Strengthening "health education," health monitoring and control	Environmental assessment of indoor temperature and humidity
Campus management information technology and information network system	Innovative measures to save energy and resources, protect the environment and safety and health
Laboratories that detect harmful and toxic substances and conduct air monitoring	Measures to reduce the intensity of the campus heat island
GREEN ZOOM «Innovative Science and Technology Centers» (Russia)	
Compliance with the requirements of the regulatory framework of the Russian Federation for the level of indoor air quality	Prohibition of the use of asbestos and asbestos-containing materials in the construction of the facility
Tobacco Smoke Control	Prohibition of the use of mercury-containing lamps
Reducing colds from climate equipment	Prioritizing the use of local building materials to reduce SO2
Control of microclimate parameters	Simulating Natural Light
Improving indoor air quality	Low VOC materials
Control of microclimate by sensors	Protection of premises from street dirt and moisture
Healthy diet	Street sports infrastructure
Doctor's Office	Selection of environmentally friendly building materials
Sports competitions and events	Selection of certified wood
Clear water	Reduction of local roof overheating

Table 8. Comparative analysis of GREEN ZOOM "Universities and Campuses" system points and GB/T51356-2019 systems

Sections of Green Zoom «Universities and campuses»	Key points of GREEN ZOOM «Universities and campuses» (version 1.2)	Key points of GB/T51356-2019
Transport, infrastructure and safety	1.1.Organization barrier-free movement in the territory for cycling and low mobility groups ® 1.2.Bans the use of individual vehicles running on traditional fuels ® 1.4.Organization the cycling rental system (1)	4.1.12. Convenient distance from campus entrance to location of public transport stop ® 4.1.7. Comprehensive Security Plan (Safety Requirements) (11) Layout corresponds to emergency evacuation systems (3) Reasonable Emergency Evacuation System Planning (3) Campus road design complies with norms and national standards (3) The pedestrian crossing on campus is designed so as not to create obstacles (2) 5.1.7. Planning of a comprehensive safety program for disaster evacuation within the complex, with full compliance with all regulations (12)

Sections of Green Zoom «Universities and campuses»	Key points of GREEN ZOOM «Universities and campuses» (version 1.2)	Key points of GB/T51356-2019
		Emergency Evacuation Schedule Planning (3) Emergency housing evacuation system planning (3) 5.1.11 The place has a good connection between public transport and campus: the distance to the stop is no more than 1000 m, the pedestrian crossing is near the stop (up to 12)
Ecology of the building site	2.1. Qualification of accumulated environmental damage ®, 2.2. Prevention of environmental pollution during construction work ® 2.3. Comprehensive assessment of the land plot and its environmental value ®	4.1 / 5.1. The choice of the construction site should correspond to the city plan, in addition, measures should be taken to organize various types of reserves. Planning of the required ratio of green areas per person.
Conservation of ecosystems	3.1. Plan of landscaping territory (Area of landscaped territory shall be not less than 20%) ® 3.2. Ban on the use of agrochemicals ®	4.1.5/5.1.5. Rational landscaping of the territory, the level of landscaping is 35% (3) Correct location of buildings relative to wind direction (4.1.9/5.1.8), natural water (4.1.10/5.1.9), rain (4.1.11/5.1.10)
Climate change	4.3 Reduction of harmful emissions from cold supply/facility of conditioning systems ® 4.4. Prioritizing the use of local building materials to reduce CO2 emissions (3) 4.7.Energy efficient refrigerators (3) 4.9. Design solutions to reduce energy consumption and emissions CO2 the building (3)	4.3.9, 5.3.9. Installation of air quality monitoring system in rooms using ventilation systems (carbon dioxide, pollution) (11) 6.2.11. Computational analysis of greenhouse emissions during campus construction. Measures taken to reduce greenhouse emissions per capita on average.
Clean energy, energy efficiency	5.1.Power Supply Concept ® 5.3.Application of energy efficient LED luminaires in lighting systems ® 5.4.Create Building User Manual ® 5.5.Indoor Energy Audit ® 5.8. Complex energy supply of the territory (3) 5.9.Localization of thermal energy sources (4) 5.12 Use of secondary energy resources 5.19.Use of energy-efficient devices (3) 5.23.Energomodeling (maximum 12)	4.2.8/5.2.7. Use of residual heat in thermal systems (Use of secondary energy resources); Rational use of unspent heat, waste heat to solve issues of heating, hot water supply, steam on campus (6) 1. Energy provided by spent or residual heat makes up the total steam volume: not less than 40% (2), 60% (4), 80% (6) 2. Energy provided by spent or residual heat is not less than 30% of the total heating volume (2), 60% (4), 90% (6) 3. Non-consumed energy or residual heat provides the amount of hot water on campus of the total volume of at least 60% (2); 75% (4). 90% (6)
Clean water, water efficiency	Reduced drinking water consumption 6.1. Development of Water Conservation Company ® 6.2.About drinking water consumption for watering landscaping areas ®	4.1.11 Annual rainwater flow in campus infrastructure is at least 50% (11)

Sections of Green Zoom «Universities and campuses»	**Key points of GREEN ZOOM «Universities and campuses» (version 1.2)**	**Key points of GB/T51356-2019**
	6.3. Reduce drinking water consumption with major sanitation devices ®	
Good health	Very large section-30 points Required items: 7.1. Compliance with the requirements of the regulatory framework of the Russian Federation for the level of air quality inside the premises ® 7.2. Prohibition for smoking ® 7.3.Monitoring indoor air quality control during construction ® Many other criteria, scores of 1 point, such as having a medical center on campus, having a sports infrastructure, environmentally friendly cleaning, healthy eating, reducing local overheating of jobs, etc.	4.1.3. Urban planning shall take into account the distance of the building from landfills, mortuaries, geologically hazardous places ® 4.3.14/5.3.14. School carries out health education, monitoring and control (hygiene, control of infectious diseases) (9) 4.3.15, 5.3.15. During training, the average PM 2.5 level should not exceed 35 mg/m ^{3}, PM 10 should not exceed 70 mg/m ^{3} (9) 5.3.2.Soundproofing level in the class shall comply with modern state standards GB 50118 ® 5.3.13. Schools provide medical care and staff (7) 6.2.3. Concentration of different pollutants in different rooms corresponds to GB 50325 and does not exceed 70% (1) 6.2.4. Noise and soundproofing levels meet GB50118 requirements (1) 6.2.13.B Depending on the culture, resources, climate of the area, health is ensured (2)
Opportunities for development	8.1.Wi-Fi Campus Coverage ® Recommended: 8.3.Mobile application for campus (1) 8.5-8.6. Zones for coworking and for individual work (2), 8.12.Ecological measures (1), 8.13. Motivation to participate in university events (1)	No information about this criteria
Responsible consumption	9.1.-9.2.Rational waste management during recycling and construction ® 9.6. Extended service life of equipment and materials (2)	4.4.3. Waste management system, waste management planning (general requirements, no scoring) 4.2.16 Rational use of green building materials, use of local building materials (9) 1 Number of green materials used in green construction 8% - (3), 15% - (3) 2 Local materials in production 70%, (3) 3. On campus, the share of renewable energy sources is 10% (2), 15% (3) 4.4.16 Waste collection station does not pollute the environment (6) Urgent transportation and disposal of garbage (2)

Sections of Green Zoom «Universities and campuses»	Key points of GREEN ZOOM «Universities and campuses» (version 1.2)	Key points of GB/T51356-2019
		Regular disinfection of garbage stations (2) No unpleasant odors around the perimeter of the garbage truck (2) 5.4.8. School departments established and implemented management, energy, water, environment, landscaping (3) 6.2.9. Use of training materials and books that can be redesigned (2)
Partnership	10.1. Involvement of specialized specialists at the concept stage (1) 10.3. Increasing environmental literacy and social responsibility among students (3) 10.3. Student Initiative Incentive Program (1)	4.4.10 Regular evaluation and monitoring by external monitoring bodies to improve the management of green towns (6) Examination by external organizations. 4.5.7. Establishment of a unified network of interaction between school, family and society in interactive environmental education (15)

Standard GB/T51356-2019, unlike GREEN ZOOM system, added measures regarding the choice of "high-quality medical equipment and services", "strengthening" health education, "monitoring and control of health", "campus management information technologies and information network systems", the organization of "laboratories that detect harmful and toxic substances and conduct air monitoring."

"Education and Promotion" subsection deals with important aspects of promoting and developing the main goals of green building: the development of a medium and long-term education plan and the promotion of a green campus with the participation of the whole school; reliance on the existing system of subjects for penetration into green education; establishment of an environmental education and promotion network that interacts with schools, families and communities; regular training on operation and management of the green campus, etc.

Special attention is paid to the use of bicycles in the cities and campuses in both countries. In Russia, such events as "to classes on a bicycle" are regularly held, and attention is paid to the development of the bike sharing system. The bike sharing system is highly developed in China (Mobike, Hellobike and others). It can also be noted the construction of campuses near transport routes, for example Siping campus of Tongji University located close to the metro station which has the name of the university. In the Russian GREEN ZOOM system, an additional advantage is the presence of a comfortable transfer hub near the campus, which allows you to organize the transport system most optimally for passengers and provides access to all key infrastructure facilities. The emphasis on climate change in both systems is associated with a decrease in CO_2. In GREEN ZOOM system, measures can be found to reduce NO_x emissions from heating systems, as well as rewards for the use of human and environment friendly materials. A great emphasis in Russia is placed on reducing of energy requirement at all stages of the project, while in China the use of secondary

energy resources is more priority (for example, the use of residual heat generated in technological units. With regard to water efficiency, GREEN ZOOM's main approach is to reduce drinking water consumption by sanitary appliances and avoiding of plants watering. In the Chinese system, a larger number of items belonging to the category "Responsible Consumption" can be noted. In the Russian system this category is also represented, but with lower score as compared to other categories.

On the issue of environmental partnership, GREEN ZOOM system consider questions related to the involvement of third-party specialists whose professional consultations will help implement the project on the environmental principles, as well as internal educational activities and student initiatives reward. In China, the main solution is management system improvement and communication with environmental disciplines teachers. GREEN ZOOM also has points based on the formation of public spaces and a "friendly urban environment", and more emphasis on student health.

The key difference in assessment systems is the fact that in addition to the development of the environmental criterion, the possibility of total university development (section "opportunities for development") is highlighted in Russian and not presented in the Chinese system. The most pronounced in the Chinese system are sections devoted to the campus environmental friendliness, especially in terms of responsible consumption.

5. Conclusions

Based on information on the development of green campus assessment systems, different experiences in the organization of the assessment system in each country were highlighted.

Thanks to the detailed characteristics of the GB/T51356-2019 assessment systems and GREEN ZOOM "Universities and Campuses", general information about the assessment systems was clearly given: evaluation criteria, scores.

As a result of the comparative analysis, both assessment systems were compared with each other: the presence of similar criteria for each of the sections was determined, the requirements of each system for creating a comfortable environment were highlighted; for each section of the GREEN ZOOM "Universities and Campuses", similar points of GB/T51356-2019 were compared, which contributed to a more detailed analysis.

Key differences in systems were identified, the advantages and disadvantages of which could lead to more specific recommendations in future studies for the development of these evaluation systems.

For successful development of the campus environmental assessment system, the existing system must be constantly developed. The experience of other countries is especially valuable in solving this problem. Given the friendly relations between Russia and China, as well as different scientific approaches to the assessment system, each side will be able to help each other to improve their assessment system and make recommendations, in terms of energy efficiency and environmental friendliness of university buildings.

Acknowledgements

I want to express my great gratitude to Mr. Tan Hongwei (General Secretary of

China Green University Network, Professor of Tongji University) for great assistance in the process of studying materials on this topic and mentoring.

REFERENCES

Ali E. B., Anufriev V. P. (2020), *Towards environmental sustainability in Russia: evidence from green universities*, Heliyon **6(8)**: e04719.

Berzosa A., Bernaldo M. O., Fernandez-Sanchez G. (2017), *Sustainability assessment tools for higher education: An empirical comparative analysis,* Journal of Cleaner Production **161**: 817-820.

Chen S., Lu M., Tan H., Luo X., Ge J. (2019), *Assessing sustainability on Chinese university campuses: Development of a campus sustainability evaluation system and its application with a case study,* Journal of Building Engineering 24: 100747.

Disterheft A., Caeiro S., Azeiteiro U. M., Filho W. L. (2013), *Sustainability science and education for sustainable development in universities: a way for transition,* in: Caeiro S., Filho W. L, Jabbour C., Azeiteiro U. M. (Eds.), *Sustainability assessment tools in higher education. Mapping trends and good practices around the world,* Springer International Publishing, Switzerland, pp. 3-27.

Fang K., Wang S., He J., Song J., Fang C., Jia X. (2021), *Mapping the environmental footprints of nations partnering the Belt and Road Initiative,* Resources, Conservation and Recycling **164**: 105068.

Fischer D., Jenssen S., Tappeser V. (2015), *Getting an empirical hold of the sustainable university: a comparative analysis of evaluation frameworks across 12 contemporary sustainability assessment tools*, Assessment & Evaluation in Higher Education **40(6)**: 785-800.

Geng Y., Liu K., Xue B., Fujita T. (2013), *Creating a «green university» in China: a case of Shenyang University*, Journal of Cleaner Production **61**: 13-19.

Gu Y., Wang H., Robinson Z., Wang X., Wu J., Li X., Xu J. (2018), *Environmental footprint assessment of green campus from a food-water-energy nexus perspective,* Energy Procedia **152**: 240-246.

Han Y., Zhou X., Luo R. (2015), *Analysis on Campus Energy Consumption and Energy Saving Measures in Cold Region of China,* Procedia Engineering 121: 801-808.

Jkimovich D. N., Sirotkin V. V., Vasyukov S. V. (2017), *Experimental application of basic hydrophysical characteristic of soils in order to optimize their qualitative characteristics and agricultural soil quality evaluation criteria,* Revista Publicando 4 13(2): 214-226.

Kulkarni S. (2019), *A bottom up approach to evaluate the carbon footprints of a higher educational institute in India for sustainable existence,* Journal of Cleaner Production **231**: 633-641

Liu H., Wang X., Yang J., Zhou X., Liu Y. (2017), *The ecological footprint evaluation of low carbon campuses based on life cycle assessment: A case study of Tianjin, China*, Journal of Cleaner Production **144**: 266-278.

Marques E. L., Verona L. A., Tortao U. (2018), *Sustainable Brazilian Universities: Composition of Characteristics, Indicators and Performance Parameters* in: Filho W. L, Frankenberger F., Iglecias P, Mulfarth R. C. K. (Eds.), *Towards green campus operations. Energy, Climate and Sustainable Development Initiatives at Universities*, Springer International Publishing, Switzerland, pp. 57-72.

Ministry of Housing and Urban-Rural Development (2019), *Assessment standard for green campus GB/T 51356-2019* [in Chinese], China architecture industry press, Beijing, China.

Na W., Zhao Z. C. (2021), *The comprehensive evaluation method of low-carbon campus based on analytic hierarchy process and weights of entropy*, Environment, Development and Sustainability **23**: 9308–9319.

Ruoppila S., Zhao F. (2017), *The role of universities in developing China's university towns: The case of Songjiang university town in Shanghai*, Cities **69**: 56-63.

Shriberg M. (2002), *Institutional assessment tools for sustainability in higher education: Strengths, weaknesses, and implications for practice and theory*, International Journal of Sustainability in Higher Education **3(3)**: 254-270.

Shi G. (2014), *Education for Sustainable Development: Education toward Tomorrow,* Foreign Language Press, Beijing, China.

Tan H., Chen S., Shi Q., Wang L. (2014), *Development of green campus in China*, Journal of Cleaner Production **64**: 646-653.

Wang B., Sun S., Li Y., Xie Y. N., Hou Y. X., Jin Q. T., Ren Y. Y. (2020), *Campus wind environment evaluation in north China – A case study of NCUT,* Energy Reports **6**: 787-793.

Wang Y., Shi H., Sun M., Huisingh D., Hansson L., Wang R (2013), *Moving towards an ecologically sound society? Starting from green universities and environmental higher education,* Journal of Cleaner Production **61**: 1-5.

Wang J., He B., Wang H., Santamouris M. (2019), *Towards higher quality green building agenda – An overview of the application of green building techniques in China*, Solar Energy **193**: 473-493.

Wang Q., Ge S. (2020), *Carbon footprint and water footprint in China: Similarities and differences*, Science of the Total Environment **739**: 140070.

Wu Z., Li H., Feng Y., Luo X., Chen Q. (2019), *Developing a green building evaluation standard for interior decoration: A case study of China,* Building and Environment **152**: 50-58.

Yuan X., Zuo J., Huisingh D. (2013), *Green Universities in China – what matters?,* Journal of Cleaner Production **61**: 36-45.

Zheng N., Li S., Wang Y., Huang Y., Bartoccid F., Fantozzid F., Huang J., Xing L., Yang H., Chen H., Yang Q., Li J. (2021), *Research on low-carbon campus based on ecological footprint evaluation and machine learning: A case study in China*, Journal of Cleaner Production **323**: 129181.

Zhu B., Dewancker B. (2021), *A case study on the suitability of STARS for green campus in China*, Evaluation and Program Planning **84**: 101893.

Received: 4 November 2021 • **Revised**: 30 November 2021 • **Accepted**: 26 December 2021