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ENVIRONMENTAL EDUCATION POLICY FOR PURSUING SUSTAINABLE CAMPUS: EXPERIENCE FROM TAIWAN HIGHER EDUCATION

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Abstract

The education for sustainable development (ESD) in Taiwan's higher education institutions with 160 universities and colleges plays a leading role in promoting sustainable campus since the 1990s. This article was based on the documents of official and non-profit organizations attempting to review ESD policy and programs for pursuing environmental sustainability in these institutions. These mission-oriented programs include sustainability education curriculum, sustainable campus infrastructure, Green University Union and Environmental Education Regional Center. The article also tried to analyze the successful case study of National Pingtung University of Science and Technology, ranked No.1 in Taiwan as well as the third place in Asia according to the 2015 Universities Indonesia (UI) GreenMetric World University Ranking. It is thus prospective that the campus sustainability in Taiwan's higher education institutions has been on the way toward a low-carbon campus in line with the Environmental Education Act.

Key words: education for sustainable education (ESD), environmental education, higher education, sustainable campus, Taiwan

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1. Introduction

The concept of "Sustainable Development" was first revealed by the report "*Our Common Future*", which was issued by the World Commission on Environment and Development (WCED) in 1987 (WCED, 1987). Subsequently, its action plan (i.e., Agenda 21) was addressed by the United Nations Earth Summit in 1992 for the purpose of taking sustainable development as a core value in the 21th century. This action agenda has been reaffirmed and modified at several meetings, further forming the reference documents, like "World Summit on Sustainable Development", "Agenda 21 for Culture" and "United Nations Conference on Sustainable Development". According to these documents, education has been considered as an essential tool for achieving sustainable development. In recognition of the importance of education for sustainable development (ESD), the United Nations declared the UN Decade of Education for Sustainable Development (2005-2014) in 2002 (Van Wynsberghe and Moore, 2015). The United Nations Educational, Scientific, and Cultural Organization (UNESCO) led the Decade and participated in the implementation of the Decade. The goals of the decade are to provide an opportunity for refining and promoting sustainable development through all forms of education, public awareness and training. In this regard, higher education can play a leading role in the promotion of ESD because these universities and colleges have participated in their efforts to support this environmental issue in campus sustainability by infrastructures, relevant programs, curriculum renewal, and extension education to their communities (Disterheft et al., 2015; Lozano, 2010; Sterling and Maxey, 2013; UNESCO, 2014;). As pointed out by Little and Green (2009), the East Asian countries (e.g. Taiwan) have been uniquely successful in globalization, education and sustainable development.

Taiwan is a small island country, located in the southeastern rim of Asia. With the population of 23.5 million by the end of 2014, its average population density is about 650 capita/km^2 (1,680/miles^2), making it the 16th most densely populated country in the world. More noticeably, this country highly relies on the imported energy with over 98%. To be in accordance with the trend toward environmental sustainability, the Taiwan government established the National Council for Sustainable Development (NCSD) in August 1997. In Sep. 2009, the NCSD formally announced the "Sustainable Development Policy Guidelines" (NCSD, 2010). On the other hand, the central agencies, including the Ministry of Education (MOE) and the Environmental Protection Administration (EPA), have promoted the environmental education since 1992. To be in coordination with the UN Decade for ESD program, the Environmental Education Act (EEA) was passed by the Legislation Yuan (i.e. the Congress) of Taiwan in 2010, and will start to be implemented after one year.

Higher education for cultivating high-quality human resources is the key tool of moving society towards sustainability and of boosting industry for competitiveness. In order to meet the demand of university education in Taiwan, the number of higher education in university and college expanded very rapidly after the revision of the University Law in 1995 that deregulated the establishment of new universities and promoted the upgrading of junior colleges to technical universities or 4-year colleges. The number of universities and colleges significantly increased from 50 in 1991 to 161 in 2013, showing that the Taiwan government expanded the higher education system in the past two decade to enhance its competitiveness in the global society. In the study by Su and Chang (2010), they provided the rationale and the success of the Taiwan Sustainable Campus Program (TSCP) to support sustainable development in Taiwan's higher education institutions. However, there was no literature on addressing the updated programs related to ESD in Taiwan's higher education, particularly in the green university ranking and comprehensive sustainability education. In this study, the official documents were searched to provide a systemic and analytical description about the ESD and sustainable campus in Taiwan's higher education.

This case-study article has two purposes, which were sequentially presented as the structural subjects. One was to present the higher education policy for pursuing campus sustainability in Taiwan and the achievement situation of the updated ESD programs, including sustainability education curriculum, sustainable campus infrastructure, Green University Union and Environmental Education Regional Center. Another was to summarize the UI GreenMetric World University Ranking system for campus sustainability and to describe the case study in one technical university ranked No. 1 in Taiwan according to the overall ranking 2015.

2. Environmental education policy for pursuing sustainable campus in Taiwan

To take a step into the globally environmental issues (e.g., global warming, sustainable development, and biodiversity) prevailed on the 1990s, the Basic Environment Act was promulgated by the Congress (Legislative Yuan, Taiwan) in Dec. 2002. Subsequently, the central government established a national sustainable development commission under the authorization of the Act to be responsible for relevant strategies and policies on national sustainability matters. As a result, all levels of central and local governments has made great efforts to promote environmental sustainability education, which aimed to ensure biodiversity, to protect forests, estuaries and wetland environments, to maintain a diverse natural environment, and to also enhance water resource conservation, water and soil conservation, and plantation and green roofing work. For instance, the "Taiwan Sustainable Campus Program" (TSCP), officially launched by MOE in 2002, has been established to trigger the development of campus sustainability at all levels of schools, including college and university (Su and Chang, 2010). In this project, one of the core goals was to reform the existing facilities by green or eco-friendly measures, such as energy-saving appliances, rain recycling & reuse system, waste composting, artificial wetland, green roofing for greenhouse gas CO_2 reduction and biodiversity (Chen, 2013), and low impact development (LOD) for ground surface (Chen et al., 2014). On the other hand, the Taiwan Greenschool Partnership Program, initiated since 2005, has been designed to assist all schools to become Greenschools. Its focus is to provide green school concepts, examples of action plans, instructional material, and government and private resources.

To ensure the step of keeping up with environmental sustainability around the world and coordinating with the United Nations Decade of Education for Sustainable Development (2005-2014), the Legislative Yuan further passed the Environmental Education Act on May 2010, making Taiwan one of the few nations in the world to legislate on a sustainability education bill. According to one of the core missions in this Act, all levels of the education authorities shall supervise all public and private schools (including K-12 education, college, and higher education) to use course teaching and campus space, draft an environmental learning curriculum or teaching materials, while also implementing diverse teaching activities and conducting environmental education for school faculty, administrative employees, and students. In this regard, some programs, including sustainability education curriculum, sustainable campus infrastructure, Green University Union and Environmental Education Regional Center, are being underway under the funding support by the Department of Information & Technology Education of MOE.

3. Current status of campus sustainability programs in Taiwan's higher education

In Taiwan, with the promulgation of the Basic Environment Act in Dec. 2002 and the Environmental Education Act in Jun. 2011 (Tsai, 2012a), there have been a number of government-supporting projects or programs on sustainability education and green campus programs at the university level, which will be further summarized by the sequential order.

3.1. Taiwan sustainable campus program

The main goals of the Taiwan Sustainable Campus program (TSCP), launched in 2002 and officially sponsored by the MOE, were to redefine the harmonious relationships between students, faculties, community residents and the school's environment through such a government-supported project (Su and Chang, 2010). This hardware reform has called for the proposal from schools, including college and university, to renovate the campus from the following aspects, such as energy-saving appliance, water recycling and reuse system, permeable ground surface (one of low-impact designs), artificial wetland, multi-layer green roofing system for CO_2 reduction and biodiversity, green buildings, compost from foliage and kitchen waste, educational organic farm, or eco-pond.

During the period of 2002-2014, over 30 TSCP projects have been passed by Taiwan's higher education institutions. To review proposals and track the funded projects, the MOE established an advisory committee, which comprised 15 members from university faculties, responsible officials, and architectural & engineering experts. Over the past decade the TSCP showed some progressive features. For instance, most of the funded projects have demonstrated their opportunities in utilizing energy-saving appliances (e.g. LED lighting) and photovoltaic system for actual use and teaching purpose. More significantly, these funded sites at universities have been shared among the schools and the neighboring communities, indicating both the spirits of "green school" and "sustainability education".

3.2. Sustainability education program

The green technology/renewable energy education program under the funding support by the MOE was a four-year project starting from 2007 to 2010, and designing for undergraduates with interdisciplinary education in chemical, civil, energy, environmental, material, and mechanical engineering (Tsai, 2012b). It aims at developing core and professional courses by integrating interdepartmental knowledge for technology transfer and professional cultivation, which include green accounting (GA), green building (GB), green chemistry (GC), green design (GD), green energy (GE) and solar building technology. On the other hand, an initiative to promote ESD for higher education in Taiwan's university was sponsored by the MOE during the period of 2000-2010 to transfer the concepts of sustainable development and global warming in the undergraduate general education curriculum. A series of modules have been developed by renowned faculties from different disciplines across higher education institutions. The undergraduate students were required to take them as compulsory credits.

Furthermore, the MOE funded the curriculum project to transfer the mitigation & adaptation of climate change and the prevention & control of disaster from extreme climate events into the undergraduate general education since 2011. The curriculum platform has been built at the website entitled "E-learning Service Center for Adaptation to Climate Change" (http://safecampus.edu.tw:20001/). In brief, the cores of curriculum literacy included to

- inspire students to participate in various measures of adapting climate change and mitigating global warming as a result of greenhouse gas emissions.
- cultivate students to be a civic leadership, and to be willing to face to these environmental issues by applying the learned knowledge and take the initiative to find the demand in various regions.

3.3. Taiwan Green University Union program

As reviewed by Tilbury (2011), the milestones in higher education for sustainability began the Stockholm Conference on the Human Environment in 1972, identifying the leading role of higher education for sustainable development in every country, even in every region or city. Followed by the Stockholm Conference, the Belgrade Charter (1975) and the Tbilisi Declaration (1977) were documented to guide environmental education in schools and societies. Since then, there were international declarations signed by the university leaders, higher education associations and government ministers for committing to a global sustainability. The key Declaration/Charter included the Tallories Declaration (1990), the Halifax Declaration (1991), the Swansea Declaration (1993), the Kyoto Declaration (1993), the Copernicus University Character (1994), the Luneberg Declaration (2001), the Unbuntu Declaration (2002), the Graz Declaration (2005), the Sapporo Declaration (2008), the Turin Declaration (2009), and the Nagoya Declaration (2014). These documents from the Declaration and the Charter called for the signed universities and colleges to take the responsibility of higher education for pursuing sustainable development and also commit their supports through education for sustainable development.

The first declaration made by the Association of University Leaders for a Sustainable Future in

October 1990 may be the Talloires Declaration (Grindsted, 2011), which comprises a ten-point action plan for incorporating sustainability and environmental literacy into teaching, research, operations and outreach at colleges and universities. Up to January 2016, it has been signed by about 500 university presidents and chancellors in over 50 countries. About 50 universities in Taiwan have become a signatory to the Talloires Declaration, ranking No. 1 in Asia. On the other hand, the so-called Green University Union of Taiwan (GUUT), a non-profit organization, was initiated by the National Taiwan Normal University in May 2013 to enhance the concepts of sustainable development in Taiwan's higher education. At the beginning of its establishment, 51 university presidents, rectors and vice chancellors of universities agreed to join this Union.

The main objectives of the GUUT were to:

- connect each university to fulfill the "green university" in Taiwan.
- strive to exchange resources for promoting the "green university".
- share the information and enhance cooperation among the universities of the GUUT.
- incorporate the government, business and non-government organizations into the establishment of sustainable development at universities.

3.4. Environmental Education Regional Center program

Under the fund and mission-oriented support by the central competent authority (i.e., EPA), four (northern/central/southern/eastern) environmental education regional centers have been established in 2014 by the National Taiwan Normal University, National Taichung University of Education, National Kaohsiung First University of Science and Technology, and National Dong Hwa University, respectively. These Centers were to form the platforms for integrating human and social resources related to environmental education in each of the regions. As referred to the Guideline for Excellence developed by the North American Association for Environmental Education (NAAEE), the program areas of the Centers included leadership academy, the build-up of environmental education capacity, technology for supporting the field, research and evaluation, and dissemination partnerships, which aimed at the setup of environmental education courses and their certifications at universities, administrative organizations and civic parties.

4. GreenMetric World University Ranking system for campus sustainability

In recent years, several systems have been developed by magazines, newspapers, websites, governments, or academics to rank institutions in higher education around the world by various combinations of criteria measures (Millot, 2015). Among them, the Academic Ranking of World Universities, QS World University Rankings, Times Higher Education World University Rankings, Webometrics Ranking of World Universities may be the most famous for their global rankings. It should be noted that each ranking system adopted specific criteria indicators and their weighting percentages or composites. As a result, the academic database (e.g., Web of Science, Journal of Citation Reports) plays an important role in the comparative survey, which has been criticized for universities that do not use English as their primary language in the science-oriented publications.

In 2010, the Universitas Indonesia (UI) has creatively established an online 'green' ranking (i.e., UI GreenMetric World University Ranking) for world universities (Suwartha and Sari, 2013; Marrone et al., 2018). The ranking system was to measure the campus sustainability in the higher education based on the selected criteria that are relevant to be of importance for universities in the development of eco-friendly environment. In brief, the main objective of the UI Green Metric Ranking is to promote the efforts for sustainability by universities, to evaluate the commitment to mitigate climate change, to encourage the efficient use of energy and water, to enforce the use of environment-friendly transportation tools, as well as to reduce the carbon footprint.

As listed in Table 1, there are six main criteria of taking into consideration in 2016 (http://greenmetric.ui.ac.id/), including setting & infrastructure, energy & climate change, waste, water, transportation, and education. Just like other world university ranking systems, many criticisms are concerned about the misuse of ranking data as the result of methodological indicators quantitatively and objectively relevant to the survey's goal. As a result, UI has established an independent multi-disciplinary committee to critically review the methodology and provide suggestions to make the ranking more useful and comparative.

By the data and information of the university participated in the UI GreenMetric World University Ranking, they will be used to create a numerical "green campus" score for the institution that can be further used to compare it with other universities around the world or in the regional countries. More importantly, the results of the ranking scores for each indicator item will not only help inspect the situation regarding the conservative uses of energy, water, waste, and other resources, but also recognize the extent of campus sustainability at the university.

Due to the benefits for universities participated in this "green" system, there are more and more universities taking part in the ranking since 2010, indicating an increasing trend; that is, 95 universities from 35 countries in 2010, 178 universities from 42 countries in 2011, 215 universities from 49 countries in 2012, 301 universities from 61 countries in 2013, 360 universities from 62 countries in 2014, and 407 universities from 65 countries in 2015.

Table 1. The methodology of the GreenMetric Word University Ranking in 2016

Criteria	*Weighting percentage (%)*	*Indicator item*
Setting & Infrastructure	15	Campus Setting
		The ratio of open space area toward total area
		The ratio of open space area toward campus population
		Number of students
		Number of academic and administrative staff
		Area on campus covered in forested vegetation
		Area on campus covered in planted vegetation
		Retention: non-retentive surfaces on campus as percentage of total area for water absorption
		University budget for sustainability effort
Energy & Climate Change	21	Energy efficient appliances usage
		Renewable energy usage
		Smart building implementation
		The ratio of total electricity usage towards campus population
		Element of green building implementation
		The ratio of renewable energy production towards energy usage
		Greenhouse gas emission reductions program
		The ratio of total carbon footprint towards campus population
Waste	18	Recycling program for university waste
		Toxic waste handled
		Organic waste treatment
		Inorganic waste treatment
		Sewerage disposal
		Program to reduce the use of paper and plastic in campus
Water	10	Water conservation program
		Water recycling program
		The use of water efficient appliances
		Treated water consumed
Transportation	18	The ratio of vehicles towards campus population
		The ratio of campus bus services towards campus population
		The ratio of bicycles found towards campus population
		Parking area type
		Initiatives to decrease private vehicles on campus
		Parking area reduction for private vehicles within 3 years
		Campus bus services
		Bicycle and pedestrian policy on campus
Education	18	The ratio of sustainability courses towards total courses
		The ratio of sustainability research funding towards total research funding
		Sustainability publications
		Sustainability events
		Sustainability student organizations
		Sustainability website

Since the last 6 years, the GreenMetric Ranking System has become one of the flagship programs of UI that ranked universities throughout the world according to the methodological indicators of campus environmental issues. In brief, this ranking is one of the university's efforts in promoting campus sustainability and also creating a sustainable environment. In the first year (2010), only three universities in Taiwan took part in this ranking survey. With emphasis on promoting campus sustainability in higher education by the central competent authority (i.e., MOE) and the Environmental Education Act enacted in the middle of 2010, more and more universities participated in the GreenMetric Ranking.

The lists in Table 2 showed the number of Taiwan's universities participated in this survey on the increasing trend. Of the 21 universities in the latest data announced on 22 Jan 2016, 5 universities in 2015 were ranked in the top 100 universities around the world, showing a positive progress toward greener campus in higher education of Taiwan since 2010.

5. Case study at National Pingtung University of Science and Technology (NPUST)

NPUST, established in 1924, is a public technical university in Taiwan. The university has been reputed to be a "National Park University" because it occupies the largest unified campus (298 hectares) and features the advantage of her "tropical agriculture" research. In 2015, NPUST has about 400 full-time faculty members and over 11,000 students, which were distributed among six colleges, including the College of Agriculture, College of Engineering,

College of Management, College of Humanities & Social Sciences, International College, and College of Veterinary Medicine. More notably, the green sustainability has listed as one of six development goals at NPUST because it is the only technical university including the Colleges of Agriculture and Engineering in Taiwan.

Regarding the school-level research centers for environmental sustainability, they included the Biodiversity Research Center, the Disaster Prevention and Mitigation Technology Research Center, and the Wildlife Rescue Center. As described above, total 407 universities from 65 countries participated in the 2015 survey by the UI GreenMetric World University Ranking. Obviously, there is a significant rise of participant for the Ranking as compared to only 360 universities from 62 countries in 2014. Of the 21 universities in Taiwan took part in the survey (Table 3), NPUST still ranked No.1 in the nation, and was also the third place in all of Asian universities. This is the fourth year that NPUST has participated in the survey, showing that the university is dedicated to campus sustainability with reference to the best performance in 2015. For example, NPUST got the funding project from "Taiwan Sustainable Campus Program" supported by the MOE to reconstruct the abandoned fish pond as an ecological wetland.

Table 2. GreenMetric Word University Ranking in the past five years (1990-2009) in Taiwan's universities [a]

University (Abbrev./Website)	*Ranking*					
	2010 (95) [b]	*2011 (178)*	*2012 (215)*	*2013 (301)*	*2014 (360)*	*2015 (407)*
Asia University (AU/www.asia.edu.tw)		29	29	41	65	107
Chaoyang University of Technology (CYUT/www.cyut.edu.tw)					50	72
Chienkuo Technology University (CTU/www.ctu.edu.tw)		74	89	160	196	242
Da Yeh University (DYU/www.dyu.edu.tw)		16	43	69	45	47
Feng Chia University (FCU/www.fcu.edu.tw)			87	104	150	233
I-Shou University (ISU/www.isu.edu.tw)				93	55	100
Kainan University (KNU/www.knu.edu.tw)						151
National Cheng Kung University (NCKU/www.ncku.edu.tw)	28	100	64	89	132	155
National Chiao Tung University (NCTU/www.nctu.edu.tw)	38	33	33	71	83	127
National Chi Nan University (NCNU/www.nchu.edu.tw)					158	282
National Chung Hsing University (NCHU/www.nchu.edu.tw)				51	85	121
National Dong Hwa University (NDHU/ndhu.edu.tw)		25	34	83	102	139
National Pingtung University of Sci. & Technol. (NPUST/www.npust.edu.tw)			32	54	31	35
National Taipei University of Technology (NTUT/www.ntut.edu.tw)		18	24	23	58	59
National Taiwan University of Arts (NTUA/www.ntua.edu.tw					339	357
National Yunlin University of Sci. & Technol. (NYUST/www.yuntech.edu.tw)			49	67	87	279
Providence University (PU/pu.edu.tw)			47	99	152	252
Taiwan Hospitality & Tourism University (THTU/www.tht.edu.tw)			103	228	226	324
Tamkang University (TKU/www.tku.edu.tw)		37	56	81	112	157
Taipei Medical University (TMU/www.tmu.edu.tw)	47	115	140	204	146	147
Yuan Ze University (YZU/www.yzu.edu.tw)		32	28	111	75	104
No. of Taiwan's universities participated	**3**	**10**	**15**	**17**	**20**	**21**

[a] *Source: http://greenmetric.ui.ac.id/.*
[b] *Number in parenthesis denotes total universities participated in the current year.*

Table 3. 2015 GreenMetric Word University Ranking in Taiwan's universities and their scores [a]

Univ. Abbrev. (Ranking)	*Total score (10,000)*	*Setting & Infrastructure (1,500)*	*Energy & Climate Change (2,100)*	*Waste (1,800)*	*Water (1,000)*	*Transportation (1,800)*	*Education (1,800)*
NPUST (35)	6,134	897	1,250	1,200	900	834	1,053
DYU (47)	5,974	392	1,350	1,725	850	829	828
TNTU (59)	5,841	479	1,400	1,725	790	528	919
CYUT (72)	5,733	563	1,275	1,800	860	676	559
ISU (100)	5,412	514	1,150	1,650	604	977	517
YZU (104)	5,363	732	1,050	1,200	610	781	990
AU (107)	5,309	522	1,300	1,425	850	603	609
NCHU (121)	5,194	604	1,051	1,725	195	926	693
NCTU (127)	5,107	520	915	1,725	663	867	417
NDHU (139)	4,966	892	787	1,500	615	1,102	70
TMU (147)	4,872	264	1,006	1,725	750	682	445
KNU (151)	4,817	259	925	1,425	840	828	440
NCKU (155)	4,810	589	896	1,650	450	660	565
TKU (157)	4,794	630	697	1,425	550	826	666
FCU (233)	4,026	296	1,017	1,050	371	987	305
CTU (242)	3,938	413	927	1,650	277	527	144
PU (252)	3,848	737	75	825	310	600	626
NYUST (279)	3,611	534	725	1,050	424	526	352
NCNU (282)	3,584	920	514	975	370	529	276
THTU (324)	3,157	607	438	1,275	390	379	68
NTUA (357)	2,853	266	505	1,350	90	384	258

[a] *Source: http://greenmetric.ui.ac.id/.*
[b] *Number in parenthesis denotes maximal score for each criteria item.*

The project was also to enrich the biodiversity of plants and animals in the campus, and to establish the outdoor classroom as a basis for environmental and ecology education. On the other hand, the implementation of interdisciplinary bio-energy program at the university for undergraduates was described in the previous study (Tsai, 2012b). The campus at NPUST even uses solar power to supply electricity for some of their dormitories and test factories. Alongside the campus's general environmental friendliness, NPUST also includes many research departments that focus on green energy and sustainable research, such as Forestry, Wood Science, Environmental Science & Engineering, Soil & Water Conservation, Biomechatronics Engineering, and Wildlife Conservation. Due to the excellent achievement in campus sustainability, NPUST has been awarded by the official organizations as "2008 Best Water Conservation Award" and "2008 Best University for Promoting Environmental Protection".

From the scores of the overall ranking in 2015 (Table 3), however, it showed that the status of transportation system at NPUST is not so excellent because the university is situated quite far away from the city center, causing over ten thousand motorcycles and cars for running at the campus every day. As a result, NPUST is promoting to establish a green transportation system, including E-bus & IC card integration (electronic ticketing) and bicycle-renting service. On the other hand, large amounts of campus garbage generated from the trimmings of grass and trees have resulted in the pressure from the waste management at NPUST. In response to the sustainable campus, the school is seeking for its reuse as biomass fuels in the steam boiler and organic fertilizer in the husbandry field. Under the funding support by MOE in 2014, the school has also established green bio-industrial pilot plants for vegetable and fruit farming because NPUST is famous for its agricultural technology and solar energy research.

6. Conclusions and prospects

This article examines the ESD issue of how to progress the mission-oriented programs for pursuing campus sustainability in Taiwan's higher education institutions. Currently, a series of modules have been developed by renowned faculties from different disciplines across higher education institutions. The undergraduate students were required to take them as compulsory credits. Furthermore, the central agency (i.e., MOE) subsidized the funded project to transfer the knowledge and skills of climate change mitigation and adaptation into the undergraduate general education since 2011. More significantly, about 50 universities in Taiwan have become a signatory to the Talloires Declaration, ranking No. 1 in Asia. To enhance the concepts of sustainable development in Taiwan's higher education, the Green University Union of Taiwan (GUUT), a non-profit organization, was initiated by the National Taiwan Normal University in May 2013.

The prevailing approaches, however, still pose some challenges facing an increasing trend of carbon emissions at university level. Future research could investigate the performance benefits in the ESD programs by carbon and water footprint indicators (e.g., CO_2 emission, tap water and electricity

consumption per capita), as well as explore the comparative differences between K-12 schools and higher education institutions. In addition, the case study at NPUST reflected the results of 2015 UI GreenMetric World University Ranking, hence this technical university was ranked No.1 in Taiwan as well as the third place in Asia. In response to the sustainable campus, the University is upholding the ranking in its environment-friendly policies of green transportation and bioresource management.

As described above, the campus sustainability in Taiwan's higher education institutions has been on the way toward a low-carbon society and is also in line with the Environmental Education Act effective in June 2011. Also, the Legislative Yuan passed the Greenhouse Gas Emission Reduction and Management Act in June 2015, providing a legal basis for an array of response measures to climate change and GHG mitigation in Taiwan. It is thus prospective that ESD in Taiwan's higher education may have demonstrated in offering promotion strategies and providing a successful case for other "developing" countries such as Indonesia, Philippines, and Brazil.

References

Chen C.F., (2013), Performance evaluation and development strategies for green roofs in Taiwan: A review, *Ecological Engineering*, **52**, 51-58.

Chen C.F., Sheng M.Y., Chang C.L., Kang S.F., Lin J.Y., (2014), Application of the SUSTAIN model to a watershed-scale case for water quality management, *Water*, **6**, 3575-3589.

Disterheft A., Caeiro S., Azeiteiro U.M., Leal Filho W., (2015), Sustainable universities – a study of critical success factors for participatory approaches, *Journal of Cleaner Production*, **106**, 11-21.

Grindsted T.S., (2011), Sustainable universities – from declarations on sustainability in higher education on national law, *Environmental Economic*s, **2**, 29-36.

Little A.W., Green A., (2009), Successful globalisation, education and sustainable development, *International Journal of Educational Research*, **29**, 166-174.

Lozano R., (2010), Diffusion of sustainable development in universities curricula: an empirical example from Cardiff University, *Journal of Cleaner Production*, **18**, 637-644.

Marrone P., Orsini F., Asdrubali F., Guattari C., (2018), Environmental performance of universities: Proposal for implementing campus urban morphology as an evaluation parameter in Green Metric, *Sustainable Cities and Society*, **42**, 226-239.

Millot B., (2015), International rankings: Universities vs. higher education systems, *International Journal of Educational Development*, **40**, 156-165.

National Council for Sustainable Development (NCSD), (2010), *2009-Annual Report on National Sustainable Development*, NCSD, Taipei, Taiwan.

Sterling S., Maxey L., (2013), *The Sustainable University: Challenge and Response*. In: *The Sustainable University*, Sterling S., Maxey L., Larch L. (Eds.), Routledge, New York, 17-50.

Su H.J., Chang T.C., (2010), Sustainability of higher education institutions in Taiwan, *International Journal of Sustainability in Higher Education*, **11**, 163-172.

Suwartha N., Sari R.F., (2013), Evaluating UI GreenMetric as a tool to support green universities development: Assessment of the year 2011 ranking, *Journal of Cleaner Production*, **61**, 46-53.

Tilbury D., (2011), *Higher Education for Sustainability: A Global Overview of Commitment and Progress*, In: *Higher Education in the World 4. Higher Education's Commitment to Sustainability: from Understanding to Action*, GUNI (Ed.), GUNI, Barcelona, 1-21.

Tsai W.T., (2012a), An investigation of Taiwan's education regulations and policies for pursuing environmental sustainability, *International Journal of Educational Development*, **32**, 359-365.

Tsai W.T., (2012b), An Investigation on undergraduate's bio-energy engineering education program at the Taiwan technical university, *International Journal of Technology and Human Interaction*, **8**, 46-53.

United Nations Education Scientific and Cultural Organization (UNESCO), (2014), *Shaping the Future We Want: UN Decade of Education for Sustainable Development (2005-2015)*, UNESCO, Paris, France.

Van Wynsberghe R., Moore J.L., (2015), UN decade on education for sustainable development (UNDESD): Enabling sustainability in higher education, *Environment, Development & Sustainability*, **17**, 315-330.

World Commission on Environment and Development (WCED), (1987), *Our Common Future*, Oxford University Press, Oxford, UK.

Web site:

http://safecampus.edu.tw:20001/.

http://greenmetric.ui.ac.id/.