POTENTIALS OF CAMPUS RIVER RE-DEVELOPMENT TOWARDS A PERFORMANCE LANDSCAPE

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ABSTRACT
River forms the fundamental of human survival and is critical for socio-economic development, and healthy ecosystems. It is very imperative in linking the environment and its climate system, and the human society too. Once, river potentials were neglected in a development that it had been not strategically located and to some extent became a dumping area. However, it has been realized that river has high ecological value and can be vibrantly transformed through appropriate development approaches which enhance the physical environment of its surrounding that leads to a positive effect on the economic value, social value, as well as the quality of life. Therefore, this study aims to analyse the potentials of a campus river re-development in creating a performance landscape, whereby the ecological aspects and appropriate technology can be combined to create a great sense of place. Precedence studies of river development and campus development are conducted, followed by site analysis and synthesis which concentrates on the natural environment of the International Islamic University Malaysia (IIUM) river and its surrounding. Potentials of the performance landscape river re-development are analysed based on the four strands of the eco-infrastructures – green, grey, blue, and red; where they represent the ecological eco-infrastructure, engineering eco-infrastructure, water eco-infrastructure, and human eco-infrastructure respectively. The finding indicates that the IIUM river and its surroundings have positive potentials to become a performance landscape towards sustainable river re-development.

Keywords: river re-development, ecology, eco-infrastructures

INTRODUCTION
River plays important roles in the lives of many and nation building pursuits. Early community settlements were found along rivers. Commercial activities along with societal activities were also performed within the river corridor. The importance of a river in the various aspect of human activities remains. Until today, physical development such as the expansion of the commercial, industrial, and residential areas are still taking place along the river corridor. All these events have affected the river system. One of the major threat is the river pollution. Wastes from human activities such as domestic and industrial sewerage, effluents from livestock farms, manufacturing, and agro-based industries, suspended solids from mining, housing and road construction, logging and clearing of the forest, and heavy metals from factories have significantly affected the river (WWF - online). The worst situation would be the rivers are so polluted to the extent that they cannot be rehabilitated. This is something to be avoided. Deforestation also leads to increased sediment loading into the river systems, followed by flood and adverse effect on the river water quality and quantity, and eventually, the ability of the river to support the eco-system is risked greatly (Chan et al. - online). It was reported that the span of some of the clean water sections of rivers in Selangor is getting shorter due to development particularly housing (The Star, 12 October 2012 – online). Damaged river systems would disturb its primary functions that would lead to long-term environmental and economic crisis. The quality of life of the people would be at risk.

Hence, this research is intended to analyze the potentials of a campus river re-development with the aim to propose a landscape design that performs in sustaining its environmental condition. This is deemed important as landscape design is not simply about beautifying the outdoor environment, it is about creating design elements that function and support the environment and the people. Besides that, it is believed that by this approach, a great sense of place can be suggested. The river of the International Islamic University (IIUM) is selected as the case study. Currently, the river condition is threatened by the development particularly those that take place beyond the boundaries of the campus. It affects the depth of the river as certain parts get shallow, shrinking, and the water seems to be muddy from time to time particularly when it rains heavily. Part of the river was used for the co-curricular activity of the university such as kayaking. However, it has stopped. Not much active activities can be seen nowadays resulting the river, and its surrounding environment is mostly used for passive activities. Hence the real environmental and social potentials of this area may have been neglected.

SUSTAINABLE DEVELOPMENT

There are various terminologies used to reflect the sustainable development approaches, and in general, they give similar connotation. Green infrastructures, green design, eco-design, and eco-infrastructures are some of the examples. Green infrastructure is a concept introduced to upgrade urban green space systems as a general planning entity with a multifunctional role (Sandström, 2002). Green design is not just about addressing the rating and accreditation systems such as the Green Mark of Singapore, the Leadership in Energy and Environmental Design (LEED) of the United States of America, the Building Research Establishment Environmental Assessment Method (BREEAM) of the United Kingdom, and the Green Building Index (GBI) of Malaysia. The way forward from these systems should also be made clear as it is not only on the use of photovoltaic solar cell and wind generators to produce renewable energy. Several types of research mentioned that if the green infrastructure is planned, developed, and maintained proactively, it has the potential in guiding the economic growth and nature conservation of the urban development (Walmsley, 2006; Schrijnen, 2000; van der Ryn & Cowan, 1996). Yeang and Spector (2011) outlined four strands of eco-infrastructures that cover various factors are categorized as follows:

i. Grey: the engineering eco-infrastructure – renewable energy systems, eco-technology, carbon neutral systems, etc. It involves the urban engineering infrastructure such as roads, drains, sewerage, water reticulation, telecommunications, energy and electric power distributions system that should be designed sustainably;
ii. Blue: the water eco-infrastructure – such as sustainable drainage, rainwater harvesting, water efficient fixtures. The aim is to recover and reuse wherever possible the water used in the built environment;
iii. Green: the ecological eco-infrastructure is nature's infrastructure/utilities, biodiversity balancing, ecological connectivity, etc. It is parallel with the grey urban infrastructure of roads, drainage, and utilities with an interconnected network of natural areas and open spaces. It functions among others in providing cleaner water, enhancing water supplies, cleaner air, reducing the heat-island effect in urban areas, moderating the impact of climate change, and increasing energy efficiency.
iv. Red: human eco-infrastructures that include the human community, its built environment (such as buildings, houses, etc.), hardscape, and regulatory systems (such as laws, regulations, ethics, etc.) that represent the social and human dimension.

The Georgia Institute of Technology is an example of good campus planning and development. It produced its landscape master plan with the focus on the environmental performance while giving equal emphasis on the human regarding living, working and learning, and unifying the campus to give it a distinct sense of place and identity (http://www.space.gatech.edu/landscape-master-plan). Hence, technology and ecology are joined to achieve the goals.

METHODOLOGY

The International Islamic University Malaysia (IIUM) has two river tributaries from the northern part and eastern part of the campus which joint before flowing towards to west side of the main Gombak Campus (refer figure 1). These tributaries are surrounded by academic, residential, recreational, and green/natural areas. Tributary A becomes the case study for this research as it flows through the core area of the campus.

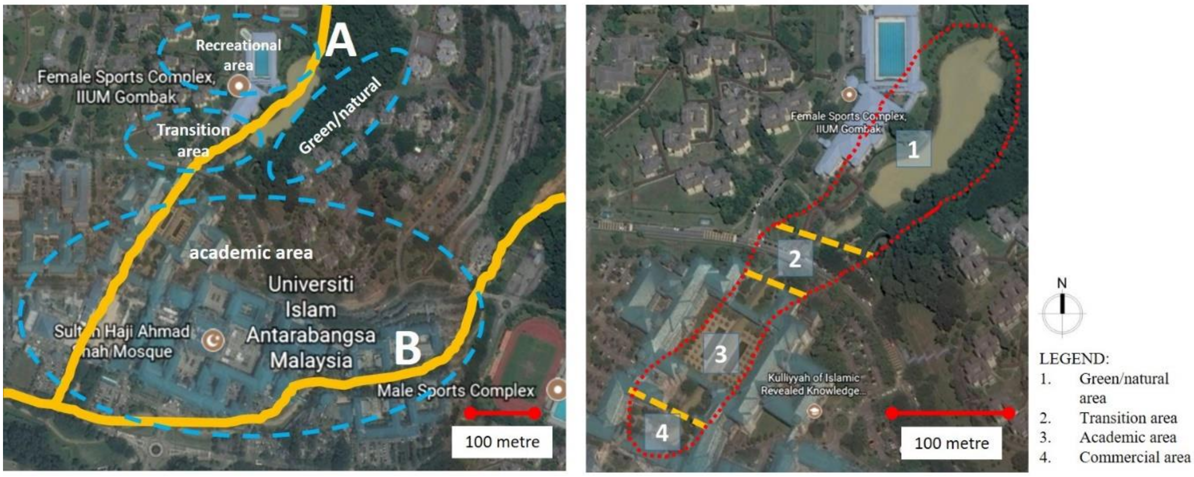

Fig. 1: The two river tributaries of IIUM – tributary A and B (left), and the case study site at tributary A (right)

The stretch of the river for the case study starts from the recreational area where the Female Sports Complex (FSC) is situated and part of the academic area. The case study site was segmented into four sections (refer figure 1 – right) for systematic data collection, analysis, and synthesis and named as the green area, transition area, academic area, and commercial area following the site characteristics. Site inventory was conducted where elements covered include vegetation, circulation, space for user activities, topography, hydrology, existing site features, and senses. A base-map which was obtained from the Development Division of IIUM was updated with the current physical features based on the inventory. Measuring tapes and staff (a tool to measure height) were used to measure the length and height of site elements. A digital camera was used to capture relevant images for analysis purposes. The following table 1 is a summary of the data collection and the techniques involved. The primary approach of the data collection is observation method.

Table 1: Data collection techniques

Elements of site inventory	**Technique of data collection**
Vegetation	Observation, measurement
Circulation	Observation
Topography	Topography map obtained from IIUM
Hydrology	Observation
Existing site features	Observation
Space for user activities	Observation and mapping
Senses (sound, smell, feeling)	Observation

On the land use and site context, visit to the adjacent areas was conducted, and the Google Earth application was used to study the areas beyond the case study boundaries where the river flows into the campus. As for the vegetation, trees, shrubs, and ground covers are observed regarding their quantity, size, and quality of shades as it is related to the microclimate and wildlife. On the circulation, the vehicular and pedestrian circulation were identified and indicated on the base map. As for the landform, the topography map was obtained from the IIUM, and further observation on site was conducted to double check the condition. The hydrology which includes the flow of the river, and other sources of water such as the drainage system which channel rainwater into the river was also identified. The hydrology and topography are closely related. On the existing site features, structures such as the gazebo, retaining wall, and covered walkway; and street furniture such as planter boxes, bollards, and benches are observed for their conditions and functions. Photos were captured to analyse the views inward and outward of the site. Use of spaces by the campus community is also observed. The data collected is screened for analysis and synthesis with the goal of improving the area with landscape elements that perform towards sustainable development.

DATA ANALYSIS AND SYNTHESIS

The focus of this research can be divided into two which are the physical environment and social environment. The data is analysed according to the four physical sub-areas to identify the site-specific issues first, followed by the potential solutions, guided by the four strands of eco-infrastructures identified towards performance landscape, and improving the social and nature interaction. The four sub-areas are further categorized into main spaces (the river itself), and the sub-spaces (the surrounding areas of the rivers) – refer figure 2.

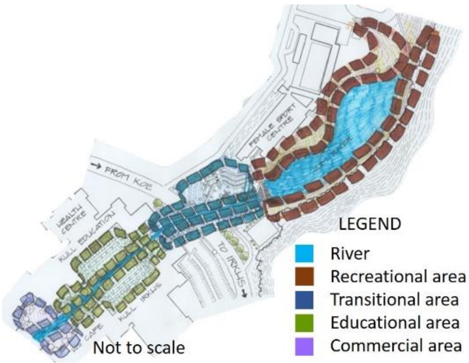

Fig. 2: The main space (river) and the sub-spaces (recreational area, transitional area, educational area, and commercial area) of the case study site

Based on the site inventory and analysis conducted, on top of the general issues of the river which are mentioned earlier, specifically it was found that the location has several problems that affect the quality of the space such as lack of shades, secluded area, steep slope, almost stagnant water, potholes, shallow river bed, and also maintenance issues such as ruined pavement and street furniture.

Table 2: Matrix of the data synthesis

		vegetation							circulation						space for user activity						topography					
		Increase vegetation/greeneries	Increase groundcover use	Provide shade/cover from weather	Nature protection/Habitat security	Add wide canopy trees	Vegetation arrangement for quality view	Maintain existing vegetation	Enhance walkway with appropriate furniture	Maintain existing walkway	Enhance accessibility & sense of welcoming	Decrease walkway steepness & sharp turn	Green pavement to be used	Improve accessibility	Increase visibility of space	Improve backdrop for viewing quality	Reselect trees that provide shades	Improve the structures and furniture	Propose design for new activities	Create sense of place/space character	Slope surface treatment	Redesign staircase with appropriate height	Design enhancement of space	Area to be preserved	Safety barrier needed	Decrease slope steepness
Commercial	Main space	■	■	■					■	■	■					■		■		■			■	■	■	
	Sub space				■		■	■		■			■			■		■			■					■
Academic	Main space		■	■		■		■	■	■						■	■	■	■	■	■		■	■	■	■
	Sub space				■		■		■	■			■			■				■	■		■	■	■	
Transition	Main space	■		■		■	■	■	■	■							■			■			■		■	
	Sub space		■		■	■	■	■			■	■	■	■	■			■	■		■	■			■	■
Natural	Main space	■		■	■	■			■		■	■		■	■	■	■	■	■	■		■	■		■	■
	Sub space				■			■	■				■			■		■	■	■	■		■			

		hydrology						existing site features				senses							quantity of suggested improvement		
		Water element as cooling feature	Implement water treatment mechanism	Minimise hard surfaces coverage	Enhance permeability of pavement	Implement proper drainage system	Deepening of river bed	Provide/enhance lighting	Increase space visibility	Add more shades	Add more seating	Add natural /design elements to create calming environment	Implement sound barrier	Preserve existing natural environment - trees	Add air filter mechanism/ dust screening	Add/increase fragrance vegetation	Add more texture to the surfaces	Preserve landform/undulating topography to evoke feelings through experience	Nos	Total nos	% - over each segment (commercial, academic, transition, natural)
Commercial	Main space	■		■	■			■						■	■	■	■		**20**	**34**	**40.5**
	Sub space		■			■		■				■						■	**14**		
Academic	Main space	■		■	■	■	■	■		■		■		■	■		■		**27**	**43**	**51.2**
	Sub space		■				■	■			■							■	**16**		
Transition	Main space	■			■			■					■	■		■	■		**18**	**45**	**53.6**
	Sub space		■	■	■			■	■		■		■		■	■	■	■	**27**		
Natural	Main space				■		■	■		■	■			■	■	■		■	**27**	**46**	**54.7**
	Sub space		■			■	■	■	■			■				■	■	■	**19**		

The observations made and data collected are analyzed with the matrix approach, leading towards a synthesis where potential improvements are suggested. The proposed revisions address the physical environment and also the community to ensure they have functional spaces for their well-being. The matrix approach is applied in the analysis following the complexity of the data obtained as it involves many factors considered. Hence, the following synthesis is produced (refer Table 2). There are 42 sub-factors listed for each main-space and sub-space for each sub-area, and when combined there are 84 sub-factors altogether. The transition and natural areas seem to require more improvement compared to the commercial and academic area, and the obvious factor is in circulation. This could be due to lack of opportunity for the user to make optimum use of the current areas. Lighting seems to be significantly needed by all spaces too as the river similar to a spine of the whole area which connects main areas of the campus such as the academic, recreational, and hostels/residential areas. It also shall enhance the visibility and safety of these areas.

FINDINGS AND DISCUSSIONS

The concept of performance landscape for the river re-development which are aligned based on the four strands of the eco-infrastructures is applied to address both the environment and the community/people. Hence the following eco-infrastructures are suggested accordingly (refer Table 3):

Table 3: The potential eco-infrastructures according to the four strands

strands	commercial	academic	transition	recreational
Grey: engineering-eco infrastructure	Vine façade Green roof Permeable paving	Permeable paving	Vine façade Green roof Solar photovoltaic cell roof Permeable paving Living walls/living tunnel	Permeable track
Blue: water-eco infrastructure	Green roof Bio-retention cell Permeable paving Bio-swale	Bio-retention cell Bio-swale Permeable paving	Green roof Permeable paving Weir Terraced planting	Rain garden Permeable track Water aeration
Green: ecological eco-infrastructure	Vine façade Bio-retention cell Permeable paving Bio-swale	Green bridge Bio-retention cell Permeable paving Green corridor Bio-swale Rain water harvesting	Living walls Terraced planting Vine façade Permeable paving weir	Permeable track Windbreak hedges Rain garden
Red: human-eco infrastructure	Vine façade Green roof Permeable paving Bio-swale	Green corridor Permeable paving Bio-swale Bio-retention cell	Vine façade Green roofs Living walls Terraced planting Weir	Rain garden Green corridor Windbreak hedges Permeable tracks

It is important to address the four strands to ensure various eco-infrastructures are proposed in providing reliable and optimum environmental and societal performance. The functions of these elements are briefly described in the following Table 4.

Table 4: Function(s) of proposed eco-infrastructures

Design elements	Function(s)
Vine façade, living wall	Shading, heat mitigation, improve energy performance, urban habitat for wildlife, reduction of urban heat island effect, aesthetics
Green roof	Biodiversity, aesthetics
Terraced planting	Soil erosion control, create space division
Green corridor	Storm water management, biological production, habitat creation, recreation, pedestrian paths
Solar photovoltaic cell	Generation of renewable electrical energy
Weir	Alter river flow characteristics, prevent flooding,
Permeable/semi permeable paving	Control stormwater at source, reduce runoff, improve water quality by filtering pollutants, reduce heat trap (reduce UHI effect), moisten the soil
Bio-retention cell	Captures and treats small stormwater events, often with higher design standard compared to rain garden or larger-scaled systems with designed outlets to control system hydraulics and media - designed for both healthy plant growth and storm water holding/filtration capacity
Bio-swale	Linear, vegetated ditches which allow for the collection, conveyance, filtration and infiltration of stormwater.
Rain garden	Holds and slowly let water to infiltrate back into the soil as the plants, mulch and soil naturally remove pollutants. It receives water from impervious (hard) surfaces such as rooftops, sidewalks, driveways and patios
Water aeration	Brings water and air in close contact in order to remove dissolved gases (such as carbon dioxide) and oxidizes dissolved metals such as iron, hydrogen sulfide, and volatile organic chemicals (VOCs)
Wind break planting	Reduce plant damage, protect soil, decrease evaporation from water, biodiversity and provide habitat, air filtration, microclimate control

As for the community of the campus, the spaces along the river are redefined for interaction among users and with nature (refer table 4). One of the examples is the cycle for life area proposed at the transition area. This area is rather abandoned and not seen as an important part as it is considered as a transition space. The 'cycle for life' is where modified bicycles are located where users can cycle while generating energy to light up the area as well as moving water turbines to oxygenate the water of the river.

Table 4: Space enhancement and creation for interaction among users and with nature

	Space/elements
Academic	Accessibility for the people with disabilities, stage for activities, enhance lighting – safety and night view, water cascades, riverside seating/decking
Commercial	Fish feeding, outdoor dining area, environmental awareness signage
Transition	Wall climbing, enhance lighting – safety and night view, skate board space, multifunction gabion (retaining wall and seating purposes), cycle for life area

Natural	Eco-trail (cycling and trekking), watching tower, fish feeding, bird watching, floating deck, water sports activity, environmental awareness signage, riverside seating/decking, space for water interaction.

CONCLUSION

Based on the study, it can be concluded that the proposed eco-infrastructures would help to create a performance landscape that supports the environmental sustainability of the site. The majority of the spaces except for the academic area can be further improved by over 50% concerning effort or strategies identified. In addressing the well-being of the community, the proposed space enhancement and creation with the activities are expected to attract the users to stay and use the space optimally. This is hoped to increase the interaction among users, as well as user-nature interaction. The overall approach would create a distinct space character to the site correctly and the IIUM campus specifically. This study has provided some insight on the potentials of river re-development of a campus to be transformed into a functional area – physically, environmentally, and socially. It is the role of the professionals in the Built Environment to carefully select the green design strategies to ensure the environment is well taken care of and the society benefits from the development.

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