DESIGN FOR COMMUNITY GREENWAY – LOW MAINTENANCE TRAIL FOR RECREATIONAL AND EDUCATIONAL PURPOSES AT THE FACULTY OF SUSTAINABLE AGRICULTURE, UMS SANDAKAN

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DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF BACHELOR OF AGRICULTURAL SCIENCE WITH HONOURS

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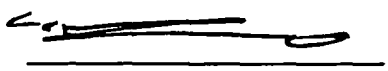

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ABSTRACT

This study was conducted from February 2015 to November 2015 (28 weeks) to explore greenway landscape planning at the Faculty of Sustainable Agriculture, Universiti Malaysia Sabah Sandakan Campus (geographical coordinates: 50° 55' 51.32" N, 118° 00' 39.92" E), Sandakan. This study aimed to promote a healthy campus life in Faculty of Sustainable Agriculture (FSA) as well as to improve the well-being of its community. The study site was located at the main lake of FSA, which is also the largest lake in FSA. The objectives of this research were to assess FSA's community's input on the idea of a multi-functional trail in the campus and their knowledge on sustainable landscape practices, conduct site inventory and analysis at the proposed site and recommend a low-maintenance trail design. This thesis employed a mixed-method approach which were qualitative method (site inventory and site analysis) and quantitative method (questionnaire survey and descriptive statistical analysis). The existing soil was extremely dry and the pH range from 6.2 to 8. Questionnaire were distributed to 50 respondents and the findings collected were analysed and utilized for the design recommendation at the proposed site. Based on the findings, there were 86% respondents who were unsatisfied with the existing site and 72% was not familiar with application of sustainable landscape practices. The proposed site was divided into four different zones: Zone A, Zone B, Zone C and Zone D. The final output of the landscape design recommendation were master plan, several perspectives from each zone and planting palette. To conclude, a low-maintenance landscape, which integrated with greenway concept and sustainable practices, was proposed to be implemented at the lakeside of FSA, which mainly included low-maintenance (concrete-based) trail and low–maintenance plants along the lakeside for recreational and educational purposes.

REKA BENTUK TAMAN KOMUNITI-LALUAN PENYELENGGARAAN RENDAH UNTUK TUJUAN REKREASI DAN PENDIDIKAN DI FAKULTI PERTANIAN LESTARI, UMS SANDAKAN

ABSTRAK

Kajian ini telah dijalankan dari Februari 2015 hingga November 2015 (28 minggu) untuk meneroka perancangan landskap 'Greenway' Fakulti Pertanian Lestari, Universiti Malaysia Sabah Kampus Sandakan (koordinat geografi: 50° 55' 51.32" N, 118° 00' 39.92" E, Sandakan. Kajian ini berupaya untuk menggalakan kehidupan sihat dalam kampus serta meningkatkan kesejahteraan komuntiti sejagat bagi tujuan reakreasi dan pendidikan. Lokasi untuk kajian ini ialah tasik utama dan terbear di sekitar FPL. Tujuan kajian ini dijalankan adalah untuk menilai input masyarakat FPL mengenai idea laluan pelbagai fungsi di dalam kampus dan pengetahuan mereka berkaitan dengan amalan lanskap mampan. Selain itu, inventori dan analisis tapak telah dijalankan dan reka bentuk laluan jenis penyelenggaraan rendah telah dicadangkan. Kajian ini telah dilakukan dengan menggunakan kaedah bercampuran iaitu kaedah kualitatif (inventori tapak dan analisis tapak) dan kaedah kuantitatif (kajian soal selidik dan analisis statistik deskriptif). Hasil kaedah kualitatif mendapati bahawa tanah yang sedia ada sangat kering dan mempunyai julat pH dari 6.2 hingga 8. Soal selidik telah diedarkan kepada 50 responden dan hasil kajian juga dikumpul untuk digunakan sebagai cadangan reka bentuk. Berdasarkan hasil kajian ini, terdapati 86% responden adalah tidak berpuas hati terhadap tapak sedia ada dan 72% responden tidak biasa dengan amalan landskap mampan. Tapak cadangan dibahagikan kepada empat zon yang berbeza iaitu Zon A, Zon B, Zon C dan Zon D. Hasil akhir cadangan reka bentuk landskap adalah pelan induk, beberapa perspektif daripada setiap zon dan penanaman palet. Kesimpulannya, landskap rendah penyelenggaraan yang bersepadu dengan konsep 'Greenway' dan amalan lestari dicadangkan untuk dilaksanakan di tepi tasik FSA, yang sebahagian besarnya termasuk jejak yang penyelenggaraan rendah (berasaskan konkrit) dan tumbuh-tumbuhan yang rendah penyelenggaraan di sepanjang tepi tasik untuk tujuan rekreasi dan pendidikan.

TABLES OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS, UNITS AND ABBREVIATIONS

%	Percentage
′	Minutes
″	Seconds
°	Degrees
am	Ante meridiem
E	East
e.g.	for example
et al.	*et alia*
etc.	*et cetera*
FPL	Fakulti Pertanian Lestari
FSA	Faculty of Sustainable Agriculture
i.e.	that is
JPP	Jabatan Pembangunan dan Penyelenggaran
lux	Illuminance
m	Metre
N	North
PhD	Doctor of Philosophy
pm	Post meridiem
PMR	Penilaian Menengah Rendah
PT3	Aplikasi Pentaksiran Tingkatan 3
STPM	Sijil Tinggi Persekolahan Malaysia
UMS	Universiti Malaysia Sabah
UPSR	Ujian Pencapaian Sekolah Rendah

CHAPTER 1

INTRODUCTION

1.1 Background

Provision of quality living and learning setting is important for both students and staffs in university campuses (Noraini and Ismail, 2014). Thus, greenway plays a crucial role in campus planning in order to create a healthy and responsive working and learning environment. It plays multiple roles such as for ecological protection, environmental protection, educational and recreational. It is believed to offer more benefits; physically, socially and emotionally (Nurhayati *et al.*, 2015).

Greenway allows movement of campus residents at the surrounding of lake under comfortable and safe conditions. It may also provide route for cyclist and pedestrian to boost health benefits through contact with nature when they utilize the greenway and promotes 'green' transportation mode. Greenway at lakeside may also become a communal space because it provides a chance to congregate and communicate through a simple greeting and smiling (Noraini and Ismail, 2014).

Past studies have confirmed that there is a link between health outcomes and green space, which is affected by the increasing levels of physical activity of individuals living in areas with more green space (Mytton *et al.*, 2012). Thus, this study is proposed to go beyond the creation of an infrastructure for recreation and education by developing a relaxing and learning platform for campus community.

The design of greenway includes the entire areas alongside of the lake in FSA, offering a chance for campus residents to carry out their daily activities such as biking,

jogging, walking, experiencing nature, displaying artworks, watching people, meeting friends and so on. A low maintenance trail, which is also considered as lakeside promenade, becomes an infrastructure for recreational and educational purposes.

It might be one such environmental influence promoting physical activity by offering a safe, accessible and attractive place for exercise, such as walking, jogging, running or cycling (Figure 1.1). It is hypothesized that those who have access to more green space including greenway in their surrounding environment might be expected to achieve higher levels of physical activity (Mytton *et al.*, 2012). In addition, the creation of such a greenway, where sustainable practices are involved, will help to improve environmental and visual quality in the campus.

Figure 1.1 A greenway design that runs alongside the lake in Aix les Bains, France
Source: Wheelchair Access Travel, 2012

According to Noraini and Ismail (2014), greenery that would provide a wide range of benefits to campus community, especially students. In this sense, they agreed that

students might prefer a campus with a large green area as comfortable places for study. Thus, campus greening at lakeside FSA is one of the approaches taken to achieve environmentally good campus by maintaining and improving all the landscape elements that exist alongside the lake as well as other recreational facilities. On the other hand, greenway at lakeside FSA may also give an opportunity to conserve the remnant green spaces, which nearly disappear from a campus scene due to continuously development pressure.

In short, this study is conducted to explore greenway landscape planning at the lakeside for recreational and educational purposes to promote a healthy campus life in FSA as well as to improve the well-being of its community.

1.2 Justification of Study

Furthermore, the existing landscape in FSA is considered as lacking aesthetically and functionally. FSA's landscape should be a testing grounds for innovative landscape practices and even acts as a demonstration area for the public. Referring to Figure 1.2, it can be clearly seen that there is only one type of groundcover and only a few trees planted on the surrounding of the lake. Currently, the area is used for only one type of recreation activity, which kayaking. The lack of landscape facilities has also discouraged the community from using the site for other outdoor activities. Obviously, it is not attractive enough for staff or students to do other recreational activities such as cycling and jogging. The lake has the potential to serve as focal point to attract users. This study will explore the ideas of multifunctional greenway planning for recreational and educational purposes such as group discussion, photographing, walking, kayaking, wildlife observation, fishing and jogging. The importance of aesthetic features in a landscape design is important is to integrate the trail into the landscape context. Besides, the landscape design planning will respond to the needs of a low-maintenance trail through the integration of sustainable landscape practices.

Figure 1.2 FSA's lakeside

1.3 Objectives

The objectives of this research are:

I. To assess Faculty of Sustainable Agriculture (FSA)'s community's input on the idea of a multi-functional trail in the campus and their knowledge on sustainable landscape practices.

II. To conduct site inventory and analysis at the proposed site.

III. To recommend a low-maintenance trail design for recreational activities and educational purposes.

CHAPTER 2

LITERATURE REVIEW

2.1 Greenway

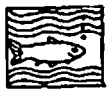
2.1.1 Greenway Concepts

According to Shafer *et al.* (2000), greenway is generally defined as a linear open space corridor that includes a natural or human-made feature either for travel or recreational activities. On the other hand, Ahern (2003) identified greenway as networks of land that are planned, managed and utilized for multiple purposes including cultural, recreational, ecological, aesthetic, or other congruous with sustainable land use concept.

Furthermore, Greenways Incorporated (2011) suggested that greenways are utilized as land corridors that are able to connect both places and people together. In this case, greenways can be considered as vegetated buffers to improve water quality, protect natural habitats, and reduce flooding impacts in areas of floodplain (Figure 2.1). Greenways mostly contain trails, which improve existing recreational opportunities, enhance the overall life quality, and provide routes for alternative transportation in that particular area (City of Boulder Greenways System, 2011).

Besides, greenways nowadays have been implemented to control flooding and enhance water quality (Figure 2.1). Shafer *et al.* (2000) found that greenway is able to protect floodplain areas from encroachment and thus indirectly benefit residents by keeping them out of harm's way. Therefore, greenways are usually designated along natural features such as streams and rivers for better storm-water management. They also mentioned that greenway corridors also help to purify water because it recharges aquifers or other sources for instance reservoir.

To protect and restore riparian, floodplain, and wetland habitat.



To enhance water quality.

To facilitate storm drainage and mitigate floods.

To provide alternative transportation routes or trails for pedestrians and bicyclists.

To provide recreation opportunities.

To protect cultural resources.

Figure 2.1 Objectives of greenway program
Source: City of Boulder Greenways System, 2011

Ribeiro and Barao (2005) stated that the widely use of greenway concept can be related to its effectiveness in achieving its aims to foster landscape conservation, protect heritage and provide opportunities for public recreation. In addition, they suggested that landscape conservation should be done as a group of methods aimed at safeguard cultural and natural resources. Mytton *et al.* (2012) realized that greenway is one of the environment influences promoting physical activity by offering an attractive safe, accessible and place for relaxing, exercise, and playing games.

According to Ahern (1995), the greenway movement builds on scientific theories such as the meta-population and island bio-geographic theories of ecology, which shows the need for ecological connectivity. He also mentioned that greenways are not only for the protection of nature, but also for other human uses of the landscape which are recognized and legitimized, so that there is a balance between resource use and protection. Sustainability should be regarded as a special globally accepted goal and paradigm for the future.

There are five ideas listed by Ahern (2003) regarding greenway concepts. He suggested that the spatial configuration of greenways is primarily linear. Linkage is a key greenway characteristic that defines the greenway and relates it to the larger landscape context, generally at multiple scale levels. For example, greenway is integrated systems

bid to realize a synergy based on the benefits of linkages across spatial scales. At times, it may be gain the synergistic properties of a network.

Furthermore, based on an assumed or negotiated spatial and functional compatibility of special uses, greenways are considered multifunctional. These trade-offs have important spatial and functional consequences, thus they are particularly important in greenway planning (Ahern, 2003). The decisions made on greenway goals like environmental protection should reflect cultural and social perceptions and values. Besides, he also mentioned that greenways strategy is consistent with the concept of sustainable development based on an assumed complementarity between nature protection and economic development. In addition, greenways indicate a distinct spatial strategy depending on the particular characteristics and advantages of integrated linear. He suggested that greenways should be considered as a complement to comprehensive landscape and physical planning but not a replacement. Efforts should be done in order to protect other important landscapes that are not linear and for those elements that may not benefit from linkage or multiple use.

Ahern (2003) also stated that focusing on linear greenway elements should not be causing less concern for other non-linear areas with equally important landscape planning issues. This can be just as a strategy or a plan, due to its much intrinsic merit. The definition and the five key ideas described above provide an overview of greenways as a complex and variable strategic approach to landscape planning.

2.1.2 Greenway Purposes

Trail development effect normally on the special qualities of a place is outweighed by the need to prevent wear and tear and to control the access to an area by visitors / users. Consideration should be given to the particular theme that it will be used to explore the objectives of its provision. Themes may be one or a combination such as relaxation and general exercise by anyone, with an emphasis on multi-accessibility; wildlife viewing; scenic viewing leading to a viewpoint; visiting archaeological sites or other cultural features; educational visits to explore geology, geography, natural or cultural history; physically demanding routes for exercise (Bell, 2008).

Greenways provide benefits that ultimately influence the sustainability of a region's environmental, economic, and social health. The process of establishing goals in greenway planning is critically important, since all the goals cannot be optimized, trade-offs and compromises must be done to reflect the cultural, ecological, aesthetic and social goals associated with greenways (Ahern, 2003). For example, the needs of recreation and wildlife habitat protection often conflict, and may require spatial segregation, elimination of one of the uses or specific management if compatibility cannot be achieved.

Tourism and recreation-related revenues from trails and greenways can be several forms. Trails and greenways create opportunities in construction and maintenance, recreation rentals (such as bicycles and kayaks), recreation services (such as shuttle buses and guided tours), historic preservation, restaurants and lodging (United State Forest Service, 2008).

2.1.3 Landscape as a Setting for Recreation and Education

According to Bell (2008), a landscape enfolding wildlife, habitats, cultural heritage and different land uses may have the potential to offer the opportunities to fulfil some or all of the demands, by way of the type of recreation, by its carrying capacity or land use (Figure 2.2).

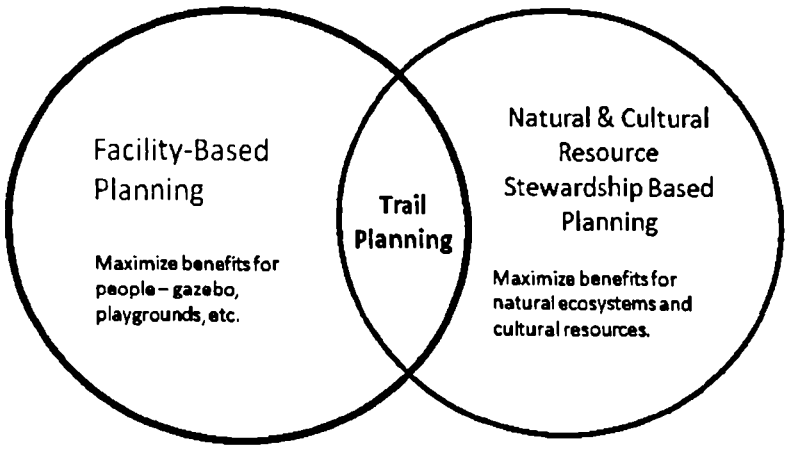


Figure 2.2 Combination principles when making trail planning
Source: Kines, 2015

There are some concepts related to greenway trail planning, design and management. Firstly, understanding the impact is very important. Greenways trails have

specific zones of influence, which need to be planned with nature and intensity of trail use, awareness of the timing, and with the natural of landscape through which the trail passes. Next, understand the trail users which are diverse and heterogeneous group, each of them with unique and important characteristics (Bell, 2008). The growing success of the greenway concept can be related to its effectiveness in achieving its aims to foster landscape conservation and supply opportunities for public recreation.

Since greenway planning has been linked to the identification and assessment of areas with special resources, thus most of the time the methods used are based on parametric approaches to landscape analysis and assessment. The methods of landscape assessment are often evolved from the work of pioneers in landscape planning. All of these methods include phase of site inventory, site analysis, planning proposals such as conceptual diagrams, schematic design, and evaluation (Lin, 1993).

Landscape analysis includes natural and cultural factors such as natural drainage network, geomorphology, physiography and historic sites (Ribeiro and Barao, 2005). The natural resources were assessed in terms of soil conservation, biodiversity, ecological functional, water conservation, and natural history potential for interpretation and research. Design of every trail requires consideration of four main goals: safety, connectivity, response to location, and diversity of users (Portland Park and Recreation Trail Guidelines Coordination Team, 2009). Safety is the top concern. Ideally, cars and trucks alongside or crossing a trail should be minimized. Visibility is particularly important at intersections with roads and in natural areas, but design principles for prevention of crime should be considered to all projects. Different trail users also travel at differing speeds, which can cause conflicts and accidents.

Then, connectivity is also important because trail length makes longer trips perhaps, increasing effectiveness for communicating and exercise. Trails also connect gaps in the on-street pedestrian network. Trails should be built to have multiple access points from the surrounding system of sidewalks, other trails, and bikeways to make short trips and loops perhaps (Portland Park and Recreation Trail Guidelines Coordination Team, 2009). Nevertheless, these access points will be less frequent than in a typical street network to minimize interruptions to the flow of users along the trail.

Next, response to location means that trail design responds to constraints, opportunities, and character of the surroundings (Portland Park and Recreation Trail Guidelines Coordination Team, 2009). For example, supplying periodic views of water may prevent from damaging user-made trails to reach the water. Trail width, slope, and material of trails may also need to be changed to fit neighboring development, drainage needs, vegetation, vehicle circulation patterns, and so on (Baughman and Serres, 2006). Impacts to private property should be avoided or minimized. Trails may be less consistent over their length, but the adaptations enliven the overall trail experience and fit wide range of neighborhoods and settings. Lastly, diversity of users refers to activity, ability, and age (Portland Park and Recreation Trail Guidelines Coordination Team, 2009). Although the overall recreational trail system includes challenging segments for the most fit and expert, the common aim is to provide challenge levels suitable for all abilities and ages.

2.1.4 Recreation Purposes Greenway

According to Bell (2008), 'recreation' is the term used mainly to refer to activities that are carried out not far from home and within the normal daily routines and a key function of greenway for people. On the other hand, recreation greenways involve trails and other means of access for human use, such as canoe / kayak launches. Normally these corridors are constructed for low-impact and non-motorized recreation activities such as hiking, horseback riding, nature watching, cycling and kayaking. This is depending on different location and size of the greenway (Portland Park and Recreation Trail Guidelines Coordination Team, 2009). As Bell emphasized in his book (2008), recreation corridors can include single use trails, such as those that allow only hiking, or multiple use trails, which accommodate a wide range of non-motorized uses.

Recreational trails enable users to get closer with the natural surroundings, to soothe their psyches and to challenge their bodies. Shafer *et al.* (2000) found that approximately 75% of greenway based trail use was exclusively for recreation purposes. They stated that people usually use greenway trail to walk, run, cycle, and skate for exercise, to interact with other people, and to experience nature. Besides, 'recreational trails' are defined in the Irish Trails Strategy as being 'a corridor, pathway or route, generally water or land based, primarily intended for recreational purposes, including

REFERENCES

Ahern, J. 1995. Greenways as a Planning Strategy. *Landscape and Urban Planning*. **33**: 131-155

Ahern, J. 2003. 3-Greenways in the USA: Theory, Trends and Prospects. In Jongman, R. and Pungetti, G. 2004. *Ecological Networks and Implementation*. Cambridge: Cambridge University Press

Arizona Cooperative Extensive. 1998. Environmental Factors that Affect Plant Growth. https://ag.arizona.edu/pubs/garden/mg/botany/environmental.html. Access on 15 November 2015. Verified on 25 November 2015

Autodesk Sustainability Workshop. 2011. Measuring Light Levels. http://sustainnability workshop.autodesk.com /buildings /measuring-light-levels# illuminance. Access on 15 November 2015. Verified on 25 November 2015

Backyard Gardener. 2015. *Bauhinia purpurea*. http://www.backyardgardener.com/plant name/pda_efa4.html. Access on 20 August 2015. Verified on 25 August 2015

Bareja, B. G. 2011. Climatic Factors Can Promote or Inhibit Plant Growth and Development. http://www.cropsreview.com/climatic-factors.html. Access on 15 November 2015. Verified on 25 November 2015

Baughman, M. and Serres, T. 2006. *Trail Design for Small Properties*. University of Minnesota: College of Food, Agricultural and Natural Resource Sciences

Bean, C. and Yang, C. H. 2008. *Standards in Sustainable Landscape Architecture*. Austin: The University of Texas

Bell, S. 2008. *Design for Outdoor Recreation*. Britain: The Cromwell Press

Boo, C. M., Omar-Hor, K., Ou-Yang, C. L and Ng, C. K. 2006. *1001 Garden Plants in Singapore*. Singapore: National Parks Publication. 2nd Edition, 7th Print

Bowe, A. 2011. *High- impact, Low-Carbon Gardening: 1001 Ways to Garden Sustainably*. London: Timber Press

British Columbia Ministry of Forests. 2001. *Chapter 10: Recreation Trail Management*. Recreation Manual

California Integrated Waste Management Board. 2005. Sustainable Landscaping. *Landscape Management Guidelines* **443(11)**: 1-2

Calkins, M. 2007. Cooling the Blacktop: Pavement Strategies can Reduce the Urban Heat Island Effect. *The Magazine of the American Society of Landscape Architects*. February

Chaney, W. R. 2001. How Wind Affects Trees. Purdue University. *Spring* **10(1)**

City of Boulder Greenways System. 2011. Greenways Master Plan. California: Boulder Creek

Cousins, C. 2015. The (Sometimes Hidden) Meaning of Shapes. http:// designshack. net /articles /layouts /the-sometimes-hidden-meaning-of-shapes/. Access on 15 November 2015. Verified on 30 November 2015

Cox, L. and Koening, R. 2010. Solution to Soil Problems II. High pH (Alkaline Soil). http:// extension.usu.edu/files/ publications/ publication /AG_Soils_2003-02.pdf. Access on 12 November 2015. Verified on 16 November 2015

Dave's Garden. 2000. Croton *Codiaeum variegatum*. http://davesgarden.com /guides/pf/go/715/#b. Access on 20 August 2015. Verified on 25 August 2015

Denny, G. C. and Hansen, G. 2003. *Right Plant, Right Place: The Art and Science of Landscape Design – Plant Selection and Siting*. University of Florida IFAS Extension: Institute of Food and Agricultural Sciences

Department of Conservation and Recreation. 2014. *DCR Trails Guidelines and Best Practices Manual*. Massachusetts

Diamond, L. 1992. Plaza Design Guidelines. *City of Vancouver Land Use and Development Policies and Guidelines*. http://vancouver.ca/docs/planning/plaza-design-guidelines-1992-november-17.pdf. Access on 15 November 2015. Verified on 30 November 2015

Giles, F. 1999. *Landscape Construction Procedures, Techniques, and Design*. Illinois: Stipes Publishing

Google Earth. 2015. FSA Sandakan Campus. 5° 55' 51.32"N, 118° 00' 39.92"E

Google Earth. 2015. Sandakan. 6° 00' 11.39" N, 117° 44' 38.01" E

Gordon, K. 2015. Getting Active Outdoors: A study of Demography, Motivation, Participation and Provision in Outdoor Sport and Recreation in England. https://www.sportengland.org/media/871842/outdoors-participation-report-v2-lr-spreads.pdf. Access on 15 November 2015. Verified on 25 November 2015

Greenways Incorporated. 2011. Benefits of Greenways. http://www.greenways.com/benefits-of-greenways. Access on 24 March 2015. Verified on 30 August 2015

Herz, M. 2002. *Campus Landscape Planning and Design*. Germany: Design Media Publishing Limited

Ingels, J. 2009. *Landscaping Principles and Practices*. New York: Delmar Cengage Learning

Janice, A. 2005. *Landscape Design with Plants: Creating Outdoor Rooms*. United Kingdom: United Kingdom Cooperative Extension Service

Kines, S. C. 2015. *Countywide Park Trails Plan Amendment*. Montgomery: Park Planning & Stewardship Division

Kothari, C. 2004. *Research Methodology: Methods and Techniques*. Second revised edition. India:New Age International Publishers

Lau, S. S. Y., Gou, Z. H. and Liu, Y. J. 2014. Healthy Campus by Open Space Design: Approaches and Guidelines. *Frontiers of Architectural Research* **(3):** 452-467

Lin, M. 1993. *Drawing and Designing with Confidence: A Step-by-Step Guide*. Canada: John Wiley and Sons Incorporated

Loehrlein, M. 2014. *Sustainable Landscaping Principles and Practices*. United States: CRC Press

Logan, J., Heimlich, J. E. and Barringer-Smith, L. 2002. Educational Use of Nature Trails. Environmental Education and Training Partnership. *EETAP Resource Library"Advancing Education & Environmental Literacy"* **105**:1-2

Macbeth Joseph. Staff of *Jabatan Pembangunan dan Penyelenggaran* (JPP) of Sustainable Agriculture Farm Administration, Universiti Malaysia Sabah. 14 May 2015. Personal communication

Marazita, E., Ac, L. and Spano, M. 2004. Excerpt from "Reflexology Paths of the World". http://www.7starsma.com/images/Article-ReflexologyPaths.pdf. Access on 12 November 2015. Verified on 16 November 2015

Missouri Botanical Garden. 2015. *Fittonia albivenis* (Verschaffeltii Group). http://www.missouribotanicalgarden.org/PlantFinder/PlantFinderDetails.aspx?kempercode. Access on 25 March 2015. Verified on 30 August 2015

Missouri Botanical Garden. 2015. *Pedilanthus tithymaloides*. http://www.missouribotanicalgarden.org/PlantFinder/PlantFinderDetails.aspx?kempercode=b607. Access on 25 March 2015. Verified on 30 August 2015

Mohamed, A. I. 2013. *KU-HU Graduate Partnership Program, Hargeisa-Somaliland, Garowe-Puntland & Mogadishu-Somalia Academic year 2013*. Masters Program of Hope University and Kampala University

Moore, T. 2001. *Pithecellobium flexicaule Ebenopsis ebano* Texas ebony. https://ag.arizona.edu/pima/gardening/aridplants/Pithecellobium_flexicaule.html. Access on 25 March 2015. Verified on 30 August 2015

Mytton, O. T., Townsend, N., Rutter, H. and Foster, C. 2012. Green Space and Physical Activity: An Observational Study Using Health Survey for England Data. *Health & Place* **18(5):** 1034-1041

National Trails Office. 2008. *Classification and Grading for Recreational Trails*. Dublin: An Initiative of the Irish Sports Council

Nik, H. N. M. 2012. Ecological Approaches in Designing Neighbourhood Green Spaces As Urban Wildlife Habitat in the Klang Valley, Peninsular Malaysia. *International Journal of Applied Science and Technology* **2(3)**: 192-213

Noraini, B. and Ismail, S. 2014. *A Greenway Network for University Campus*. Master of Science Dissertation. Universiti Teknologi Malaysia

Nurhayati, A. M., Manohar, M., and Nik, I. A. A. R. 2015. Community Participation in Quality Assessment for Green Open Spaces in Malaysia. *Procedia-Social and Behavioral Sciences* **168:** 219–228

Online Plant Guide. 2007. *Calathea loeseneri*. http://www.onlineplantguide.com/Plant-Details/4438/. Access on 25 March 2015. Verified on 30 August 2015

Online Plant Guide. 2007. *Plumbago indica*. http://www.onlineplantguide.com/Plant-Details/3222/. Access on 25 March 2015. Verified on 30 August 2015

Online Woodland Stewardship Resource Area. 2011. Recreational Trail Design. http://woodlandstewardship.org/?page_id=1226. Access on 1 April 2015. Verified on 30 August 2015

Open Space Program Staff. 2006. *Wake County Consolidated Open Space Plan*. Raleigh: Wake County Government

Paving and Hard-landscape Consultants. 1997. Block Paving-Choosing Block and Brick Pavers. http://www.pavingexpert.com/blocks03.htm. Access on 1 April 2015. Verified on 30 August 2015

Perry, A. 2003. *Low Maintenance Landscapes*. University of Vermont Extension: Department of Plant and Soil Science

Plant and Soil Sciences eLibrary. 2015. Transpiration - Water Movement through Plants. http://passel.unl.edu/pages/informationmodule.php?idinformationmodule=1092853841&topicorder=6. Access on 15 November 2015. Verified on 25 November 2015

Poincelot, R. P. 1980. *Horticulture: Principles and Practices*. Englewood Cliffs: Prentice-Hall Incorporated

Portland Park and Recreation Trail Guidelines Coordination Team. 2009. *Trail Design Guidelines for Portland's Park System*. Portland: Portland Parks & Recreation

Prairie Hills Resource Conservation and Development. 2015. Schuy-Rush Hike and Bike Trail Comprehensive Plan. http: / /www. prairiehillsrcd. org /uploads/3/2/4/2/ 342104/markup_final_master_plan_6-23-15.pdf. Access on 15 November 2015. Verified on 25 November 2015

Rails-to-Trails Conservancy. 2001. Surface. http://www.railstotrails.org/build-trails/trail-building-toolbox/trail-building-and-design/surfaces/. Access on 1 April 2015. Verified on 30 August 2015

Ribeiro, L. and Barao, T. 2005. Greenways for Recreation and Maintenance of landscape quality: Five case studies in Portugal. *Landscape and Urban Planning* **76**: 79-97

Royal Botanic Garden Edinburgh. 2015. Plant Label Information. http://www.rbge.org.uk/assets/files/Gardens/Plant%20Lable%20Information.pdf. Access on 12 November 2015. Verified on 16 November 2015

Schulman, A. 2015. *Beautiful, Low-Maintenance Plants*. Fine Gardening issue 139. The Taunton Pre Incorporated

Shafer, C. S., Scott, D., and Mixon, J. 2000. A Grenway Classification System Defining the Function and Character of Greenwaysin Urban Areas. *Journal of Park and Recreation Administration Summer 2000* **18(2)**: 88-106

South Australian Trails Coordinating Committee. 2007. Chapter 7: Trail Design and Construction. *Guidelines for the Planning, Design, Construction and Maintenance of Recreational Trails in South Australia.* Government of South Australia: Sustainable Recreational Trails Guidelines

Squamish Outdoor Recreation Capital of Canada. 2008. *District of Squamish Trails Standards*. Canada: District of Squamish Trails Standards

Starbuck, C. J. 2008. *Low-Maintenance Landscaping*. University of Missouri Extension: Department of Horticulture

State of New Hampshire. 2004. *Best Management Practices for Erosion Control during Trail Maintenance and Construction*. Bureau: Department of Resources and Economic Development

StatPac Incorporated. 2014. Questionnaire Design–Considerations. https://www.statpac.com/surveys/questionnaire-design.htm. Access on 5 August 2015. Verified on 30 August 2015

Sugasweets. 2012. Portrait Location Database: Taman Tasik Perdana (Lake Gardens). http://famecherry.com/photo/pld/malaysia/kuala-lumpur/lake-gardens/lake-gardens. Access on 5 August 2015. Verified on 30 August 2015

The Irish Sports Council. 2007. *Irish Trails Strategy Promoting and Developing Activity in the Irish Outdoors*. Dublin: An Initiative of the Irish Sports Council

Tnau Agritech Portal. 2013. Agrometeorology: Relative Humidity and Plant Growth. http://agritech.tnau.ac.in/agriculture/agri_agrometeorology_relativehumidity.html. Access on 15 November 2015. Verified on 25 November 2015

Tnau Agritech Portal. 2013. Agrometeorology: Wind and Plant Growth. http://agritech.tnau.ac.in/agriculture/agri_agrometeorology_wind.html. Access on 12 November 2015. Verified on 25 November 2015

United State Forest Service. 2008. The Economic Benefits of Recreational Trail. http://www.srs.fs.usda.gov/factsheet/pdf/rectrails.pdf. Access on 25 March 2015. Verified on 30 August 2015

United States Department of Agriculture. 1995. *Landscape Aesthetics a Handbook for Scenery Management*. California: Forest Service

Venhaus, H. 2012. *Designing the Sustainable Site Integrated Design Strategies for Small-scale Sites and Residential Landscapes*. Canada: John Wiley and Sons Incorporated

Watkins, J. and Wright, T. 2008. *The Management and Maintenance of Historic Parks, Gardens and Landscapes –The English Heritage Handbook*. London: Frances Lincoln Limited

Wheelchair Access Travel. 2012. Accessible Travel Lake Bourget and Aix les Bains. http://www.wheelchairaccesstravel.com/category/france/. Access on 5 August 2015. Verified on 30 August 2015

Whiting, D. 2014. Plant Growth Factors: Temperature. Colorado State University Extension. *CMG Garden Notes* **143**: 1-8

Wijaya, M. 2007. *Modern Tropical Garden Design*. London: Thames and Hudson

Wisker, G. 2007. *The Postgraduate Research Handbook*. 2nd edition. Brighton: Palgrave Macmillan Publishing

Yakandawala, K. and Adikari, A. M. 2014. *Lawsonia inermis* (Lythraceae): From the Wild to the Garden. *Journal of Environmental Professionals Sri Lanka* **3(2)**: 48-59