MGBC WORKSHOP 2015

Reducing Heat Island Effect Through Design Principles

Presentation Title:

Putrajaya Initiative on Carbon Stocking & Sequestration Towards Putrajaya Sustainable Green City

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ABSTRACT

Putrajaya was designed and built, as the Federal Government Administrative Centre of Malaysia. It is located 25 km equidistant from Kuala Lumpur and Kuala Lumpur International Airport providing an easy access to the rest of the country and the world. The pre-development site comprised of oil palms and rubber with remnants of scattered secondary forests along small streams. The terrain was undulating generally sustaining small mammals and avian population. Earthwork commenced for the development of the new city in 1996. The Prime Minister's office was the first building commission in June 1999 along with Taman Wetland (Wetland Park), the first park opened to the public.

As a "Garden City – City In A Garden", one of the most critical components of the new township are the parks and surrounding landscapes. The multitude of specialized designated uses for open spaces within the city fabric has resulted in **a complex network of green spaces assigned for public uses**, thus creating green areas with intrinsic values. Approximately 660,000 trees were planted in Putrajaya between 1997 and 2014, making **management of trees and the emerging urban forests** in parks and surrounding building complexes, and public spaces including street trees, becomes more and more critical as the trees grow bigger and bigger.

In Putrajaya, the green infrastructure and almost 40% of its land use is dedicated to open space has become a hallmark exemplary effort by government as testament of Malaysia's seriousness towards green practices. Having open spaces and green spaces as the federal government administrative centre's development backbone requires more than planting of trees and providing landscape amenities. The benefits from this effort need to be quantitatively proven using acceptable methods to take into accounts local and global benefits it can generate. There exist great challenges in ensuring Putrajaya living assets are healthy, continue to grow, generate oxygen, and become effective carbon storage, sequestrate carbon, and reduce carbon in the atmosphere. Capacity of carbon storage in trees varies with species. Putrajaya has relatively about 1100 species of trees from indigenous, natives and ornamental species that has the capacity of storing various levels of carbon. Around 500 species comprised of indigenous and Dipterocarp species that could store up to above 90% carbon, compared to ornamental species with storage capacity from around 40 to 60%. Apart from carbon storage, the trees also storage water and the forests play an important role in moderating micro and macroclimate. The ecological balance of forest habitats determines the overall health of the trees within the ecosystem. Forest biodiversity is amongst important parameters that are crucial to be monitored and managed to ensure successful urban forest landscape ecosystem. On the other hand, trees could become risks to people when the risks are not mitigated and hazards reduced, if not eliminated. Trees that are not managed properly have been identified as one of the risk factors that compromise public safety, hazardous to people, cause damages to properties, and could cause in lost of economic benefits. Trees increase in size and appreciate in values over time; so do their hazard ratings. The corporate body tasked with the local government function of Putrajaya adopted the International Society of arboriculture and urban forestry best practices in 2009. While arboriculture deals with a singular tree, urban forestry deals with group or stand of trees. This paper discusses the Putrajaya initiaves and direction for green space management and methodology, taking into accounts various limitations such as manpower and resources.

Keywords: Urban Forestry, Arboriculture, Green Space, Green Infrastructure, Tree Inventory.

MALAYSIAN GREEN BUILDING CONFEREDARTION WORKSHOP 2015

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Climate change and global warming has impacted our daily lives one way or another. The big flood that hit the east coast of Peninsula Malaysia during the period of 15 December 2014 and 3 January 2015 was the latest and biggest since more than 50 years. More than 200,000 people were affected and 21 reported killed during that period nationwide with hardest hit on the east coast. Rebuilding damaged infrastructure was estimated in excess of RM I billion. Many attributed floods, storms, heavy torrential rains, droughts, extreme hot weather conditions and other uncertain climatic phenomena due to climate change. Climate change has been mentioned by many scientific studies as a global phenomena connected to excessive atmospheric carbon which caused elevated global temperature.

How does this global phenomenon cause floods with disastrous impacts, disrupt our lives and jeopardize our health and safety? What are our responsibilities as professionals who are involved directly with the development? Do we know how development or urbanization can change our environmental conditions and ecology that resulted such outcomes? Many more questions should be brought forth with regards to our current practices and take proactive actions to mitigate disasters, and lessen the impact.

To understand how global warming impact our lives at home, we need ask ourselves the question of the relationship between trees, polar ice melts and the recent floods? Simplifying the connection for our understanding, we can safely summarize that cutting down trees will result in liberating carbon into the atmosphere which has resulted in the increase in global temperature by 3^0C. This has resulted in a rise of ocean temperature by 1^0C. The increase of temperature of the ocean has resulted in the melting of the polar ice. The ice melts has resulted in the rise of the global sea level by almost 1 meter in the past 10 years or so. Where as on landside, the vast cutting of forest trees has diminished the capacity of water retention within the forest trees. The now excessive water from rainfall not retained by natural forests, has to flow down seawards. When extremely large volume of water flow from upstream was met with high sea level exacerbated by high tides, resulted in the backflow upstream and in landwards that caused a tsunami-like damages seen in the aftermath of the recent flood.

With recent knowledge and technology that is available to us now, collectively we have the capabilities to protect lives, property damages and hardship to people living in low-lying areas that are prone to floods. We can lessen the intensity of flooding and damages caused by flood by putting back trees into our urbanized landscapes. We have the technology to inventorize trees in forests areas as well as urbanized areas using state of the art equipment mounted on unmanned aerial vehicles (UAV), and necessary advanced knowledge to identify species, monitor their health status, give us carbon stock and carbon sequestration information, rate of transpiration, water retention capacity, volume of water retained in trees, pollution filtering capacity, and other pertinent information. These knowledge can be used in landscape design to tell us the amount of carbon we need to stock back into our urban environment and number of trees of trees we need to plant back for water retention purposes to mitigate excessive water flow downstream during heavy downpours. Knowledge of landscape architecture is necessary to define natural factors, designing the natural requirement of nature built environment to benefit the trees and well as the users while maintaining safety standards for people using the outdoor areas.

Planting trees in urban areas is key to lessen the impact of flood but planting trees without the knowledge of the tree (arboriculture) and the urban forest ecosystem (urban forestry) could spell dangers to the public and become spatial hazards especially during inclement weather conditions. Trees in urbanized areas are subjected to greater environmental challenges due to the nature of urban conditions. Trees are normally planted in rows or in singular manner along streets and tiny planting strips. In forests, trees grow naturally in stands, colonies and vast tract of land. The forested condition normally afford trees to grow close to each other which provides necessary support from wind loads. More of their roots normally grow downwards and in all direction as water infiltrate downwards because of less or no compaction subjected to ground condition in forested areas. Natural forest also takes care of their own food and nutrient source by recycling their leaf litter by affording various ecosystem mechanisms to occur naturally.

The urbanized conditions on the other hand, normally provide the exact opposite conditions. Singular and street trees do not have the luxury of forest stand for support, and therefore are subjected to greater wind load stresses. The urban conditions normally provide limited or very little soils, therefore limited nutrient cycle and almost always depended on human interference for nutrient provision. Without people to provide necessary nutrients, trees will face various deficiency issues as very much subjected to all kinds of diseases and pests infestations rendering weak wooded trees. Whereas, the limited soil condition is almost always do not provide the necessary root zone for anchor and structural support. All the non-conducive conditions will produce extremely hazardous tree condition that we are very accustomed to in most development in Malaysia and third world countries.

Putrajaya has provided us with the opportunity to explore landscape architecture from the on set of the development, site analysis, landscape planning, landscape design, construction and implementation, landscape control, and, operation and management of the total landscapes with the city boundary. The vision of Putrajaya as a Garden City, City in A Garden, has provided a bonus for Putrajaya to qualify as a sustainable green city. Almost 40% of its land use is dedicated to open space that translates to an area of 1,930 hectares on the ground. The other 60% land use is also afforded with around 30% green areas or landscape reserves for the purpose of water infiltration and canopy cover. Where urbanized condition does not allow landscape installation on ground, 20% of the green areas can be provided as roof top condition over basements or on roof levels.

A total of more than 1.6 million plants were planted between 1997 and 2014, with 660,000 trees recorded. One of the most critical components of the parks and landscape management is the **management of trees and the emerging urban forests** surrounding building complexes. The multitude of specialized designated uses for open spaces within the city fabric has resulted in **a complex network of green spaces assigned for public uses**, thus creating green areas with intrinsic values. Trees, shrubs, groundcovers and other vegetative matters increase in numbers and appreciate in values over time. However, proper and suitable management and maintenance would need to be performed in order to ensure that vegetation remain valuable asset. These living things are categorized as living asset Malaysian government circular Living Asset 2009 comprising plants, animal and fish (*Perkeliling Aset Hidup 2009 (Tumbuhan, Haiwan dan Ikan))*.

In line with the government's move to enhance delivery system, the Ministry of Finance (MOF) prepared a circular to guide the **reporting of its living assets** for: **(1) vegetation, (2) animals and (3) fish.** As part of the effort to enable the city to prepare live assets reports every 3 months as required under the circular, the Perbadanan Putrajaya as a body corporate performing the function as Putrajaya local government has embarked on urban forest management by engaging collaborative initiative with the Forest Research Institute of Malaysia (FRIM) to study and recommend **urban forest management strategies**. The memorandum of understanding between Perbadanan Putrajaya and

The goals of Putrajaya sustainable urban forest initiative are to **gather essential data and information** regarding its urban forests, and **implement an electronic management system** based on research and development on forestry which has been developed by FRIM using the Putrajaya site as a ground project to help the city achieve its objectives and come up with concrete evidence for its Green City initiatives. Among others, the project quests include its **carbon sink calculation for green areas** and forests that are expected to contribute **16% of carbon reduction** by means of **carbon sequestration** by vegetative matters. The rest comes from the proposed cut in carbon emission.

Planting of trees in Putrajaya was implemented through either **reforestation** or **re-afforestation**. The Putrajaya living asset is one of the biggest investments made by the Malaysian government in creating Putrajaya. Therefore, it become necessary for **tree management and reporting on tree values** as well as its management and maintenance to be done in accordance to the Ministry of Finance living asset circular - *Pekeliling Aset Hidup 2009 (Tumbuhan, Haiwan dan Ikan)*. A new automated electronic management system named SIPP an abbreviation for Sistem Inventori dan Pengurusan Pokok (Tree Inventory and Management System), was designed in accordance to the living, and the development of the SIPP Pilot Project consisting of tree inventory, document management, health monitoring,

maintenance monitoring, and contractor's claim processing modules would assist in **budgeting and appropriation of expenditure in areas of maximum impact and outcome**. The pilot sistem development project was approved by the Ministry of Federal Territory, MAMPU and Ministry of Finance to be carried out as collaborative efforts between Perbadanan Putrajaya and FRIM in 2012 and was completed in August 2014. A memorandum of understanding was signed between both parties to take effect from 2012 through 2017 to encompass development of the holistic system including knowledge and technology transfer, staffs training and public capacity building and empowerment program. When completed, the system would be operating on a push-pull data and information operation system and enventually capable of performing an almost real-time reporting of events on the ground to management and Ministry of Finance.

The **tree inventory and management system** was developed as part of a continuing effort to ensure management of urban forest and landscape of Putrajaya is strengthened. The system design was tailor-made by programming step by step of each tasks that was carry out by the tree maintenance team. The tasks mapping and programmed to include of the actual work flow and report formats from contract specifications, reporting, and verifications by an **electronic management process** for recording, retrieval and process automation of trees information, contractors information, contractors' work programs, Perbadanan Putrajaya supervisors and management dashboard. The **maintenance regime** including pruning, fertilization, pest and disease control, health monitoring, storm and drought effects mitigation is being planned to avoid tree loss. The system is also designed to **maximise tree benefit for the city and the public** to mitigate tree hazards to ensure public safety.

The effort undertaken by the Park and Recreation Division using limited skill manpower included seasonal data gathering in the field is accurate, efficient, and systematic. The implementation of the system would assist the city to keep track of the Putrajaya Green City parameters, and ensure sustainability of its forest. Perbadanan Putrajaya is the first local authority in the country to employ a web based system to manage its living asset, green spaces and urban forest resources.

Urban forest management is aimed at achieving the long-term goal of having a healthy forest ecosystem for a sustainable environment. **Forest conservation** of trees planted or those that grows naturally on their own, either specimen species, stands or clumps of trees and vegetation is planned to be carried out in the new future once the urban forests strategies are identified. **Urban forest policy** for Putrajaya for the ecosystem, would include the total quality management of vegetative and natural (biotic and abiotic) matters such as trees, shrubs, herbs, mammal, birds, microscopic organism, soil, water and other natural living components of the forests. This policy will form parts of the cultural values that in turn will support the policy direction for the development framework of the entire urban forest within the boundary.

Principle of Sustainable Urban Forest Management adopted are **Conservation of ecological process** to enable biospheres at Putrajaya to function and biodiversity is protected; **Conservation of urban forest area** by minimising risks to enable trees and plants to grow healthy, biologically diverse as well as locally and globally productive to the environment, economy, social and culture; **Forestry practice** including methods of tree management, maintenance and health care follows the forest natural growth requirements such as natural disturbances that are required in nature and its ecology and mature landscape pattern; **Urban forestry practice** is to minimise adverse effects to the forest natural components including soil, water, surrounding plants, fish, birds and wildlife and other valuable forest components; and **Forest ecosystem** protection from destructive harvesting of any forest components endangering the forest health and wellbeing.

Strategic Objective of Putrajaya Urban Forest Management are engagement **in smart investment and smart partnership** to ensure the implementation of sustainable forest management; development of **specialist manpower** in various environmental sectors such as ecotourism, landscape, forest and forestry education, urban landscape management and forest management; Income generation from forest research, ecotourism, education and forest recreation; **development and application of knowledge and understanding** regarding urban forest in the quest to develop a sustainable urban forest ecosystem; development of **forest recreation potential** involving quality ecotourism facilities while building the community capacity to deliver ecotourism hospitality services; development of **beneficial ecotourism and recreational facilities** to fulfil user needs and simultaneously fulfils the requirement of sustainable use of urban forest; development a **team of competent personnel and experts** to expedite the implementation of sustainable urban forest action plans; and development of a team of competent personnel and experts to expedite the implementation of sustainable urban forest action plans.

The **Sustainable Urban Forest Action Plan** seeks to:

(1) To **develop a data, information and knowledge repository** on vegetation and forest resources, urban forest planning, development, and management for the above purpose.
(2) To **identify competent forest managers and rangers** to carry out tree inventory, measurement, and area mapping for the purpose of planning and implementation.
(3) To **develop measurable key performance indicator** (KPI) for forest trees and ecosystem health.
(4) To **develop a forest management plan** this is adaptable and representative of the actual occurrence to achieve the objective and KPI targets.
(5) To **undertake monitoring works and documentation** analysis, and **identify the effectiveness** of planning and management approaches, information verification and certification.

Perbadanan Putrajaya embarked on developing a **geodatabase on electronic management system** using GIS (**web-based online updating system**) **in order** to inventorize and gather data and information; ensure accurate and timely reporting; report on living asset as required by government; and ensure efficient delivery system. The system would offer benefits in **managing a variety of information** on routine, scheduled and emergency works requirements for tree management; enabling accurate and effective decision making process; ensuring **reduce response time** taken for tree workers to remove fallen trees; and cut emergency response time to less than 1 hour in comparison to the current 2 hours as per service level agreement (SLA).

A parallel effort is undertaken simultaneously to:

(1) Upgrade landscape officers and workers **knowledge and capabilities** is being done.
(2) Adopted **best arboriculture practice** promoted by the International Society of Arboriculture since 2009
(3) Ensure trees in urban green spaces especially along public streets have **reduced risks of becoming hazards to the public**.

Putrajaya SIPP is integrated using GIS to **existing electronic plan submission system and financial system**. Usage of a number of equipment to complement the system are amongst others include the following:

(1) *Global Positioning System (GPS)*,
(2) *Computer Tomography (CT Scan),*
(3) *Light Detection and Ranging (LIDAR)*,
(4) *Remote Sensing (RS), and*
(5) *Geospatial Analysis*.

Data management software and devices in SIPP include:

(1) ***PutraGeoInfo*** Geographic Information System (GIS)*,
(2) Radio Frequency Identification Device (RFID)*,
(3) LIDAR Imagery and Street*
(4) High Resolution Multi spectral/Hyperspectral Imagery**,
(5) Web-based data management*, and
(6) Integrated Equipment Management Systems** (Decision Support System).
(7) Data Upload to USDA Forest Services' Urban Forest Effects Model (UFORE)*** system for outcome on Carbon Stock, Carbon Sequestration, pollution filter effect.

Note:

* Developed in the SIPP Pilot Project (2011 – 2013)
** Proposed in SIPP Continuous Project (2014 – 2016)
*** Proposed Data Upload to UFORE (2017)

Reports generated would be used for **management decision** in developing the direction of forestry operation management to:

(1) **Monitor forestry service compliance**,
(2) **Monitor effectiveness of forestry practices**,
(3) **Enable forest auditing**, and
(4) **Forest certification.**

Sustainable Urban Forest Action Plan proposed:

1. SET UP COLLABORATIVE EFFORT FOR SMART PARTNERSHIP
2. SECURE FUNDING
3. DEVELOP URBAN FOREST ACTION PLAN
4. INVENTORISE LIVING ASSETS
5. DEVELOP URBAN FOREST POLICY
6. DEVELOP STRATEGIC OBJECTIVES
7. ESTABLISH PRINCIPLE OF SUSTAINABLE FOREST MANAGEMENT FOR ADOPTION
8. UNDERTAKE CAPACITY BUILDING PROGRAM
9. DEVELOP TREE INVENTORY AND MANAGEMENT SYSTEM
10. APPLICATION OF PRECISION FORESTRY EQUIPMENT
11. MONITOR FORESTRY SERVICE COMPLIANCE
12. MONITOR EFFECTIVENESS OF FORESTRY PRACTICES
13. ENABLE FOREST AUDITING
14. SECURE FOREST CERTIFICATION
15. INTERNATIONAL BENCHMARKING AND COLLABORATIONS

SIPP Main features

MAIN OUTCOME Efficient and systematic management Efficient Operations Data for decision making Easy Access (Information at fingertips) Ensuring safer environment Sense of Ownership	**WAY FORWARD** Exercise/implement data collection Data based for carbon stock analysis Data based for urban heat island effect analysis Upgrade the system
TREE MAINTENANCE INFORMATION Numbers, species and Location Tree Health Tree History Tree Registration Tree Removal	**GENERAL MAINTENANCE INFORMATION** Contractor Info Contract Info Payment Status Current Maintenance Status Maintenance Zone
TREE TRACKER (Public access) QR code Public education Tourist attraction	**INNOVATION** Mobile application PDA, Smartphone, Tablet Biometric Information at Fingertips Anywhere Anytime

STRATEGIC ACTION CHECKLIST	(✓)	(✖)	INITIATIVES
1. SET UP COLLABORATIVE EFFORT FOR SMART PARTNERSHIP	✓		PPJ-FRIM MOU (2011) UPM-PPJ MOU (2011)
2. SECURE FUNDING	✓		2011
3. DEVELOP URBAN FOREST ACTION PLAN	✓		2012
4. INVENTORISE LIVING ASSETS	✓		Started in 2012
5. DEVELOP URBAN FOREST POLICY		✖	Pending
6. DEVELOP STRATEGIC OBJECTIVES	✓		2012
7. ESTABLISH PRINCIPLE OF SUSTAINABLE FOREST MANAGEMENT FOR ADOPTION	✓		Pending
8. UNDERTAKE CAPACITY BUILDING PROGRAM	✓		Since 2009
9. DEVELOP TREE INVENTORY AND MANAGEMENT SYSTEM	✓		2012
10. APPLICATION OF PRECISION FORESTRY EQUIPMENT		✖	Pending
11. MONITOR FORESTRY SERVICE COMPLIANCE		✖	Pending
12. MONITOR EFFECTIVENESS OF FORESTRY PRACTICES		✖	Pending
13. ENABLE FOREST AUDITING		✖	Pending
14. SECURE FOREST CERTIFICATION		✖	Pending
15. INTERNATIONAL BENCHMARKING AND COLLABORATIONS (London?)		✖	Pending
16. URBAN FOREST EFFECTS (UFORE) MODELLING		✖	2016-2017

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