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Environmentally Sustainable Library Buildings: Opportunities and Challenges for Asian Countries

Saima Qutab
Deanship of Library Affairs, University of Dammam, Dammam, Saudi Arabia
saimaqutab83@gmail.com

Zainab Faruqui Ali
College of Design, University of Dammam, Dammam, Saudi Arabia
shama037@yahoo.com

Farasat Shafi Ullah
Deanship of Library Affairs, University of Dammam, Dammam, Saudi Arabia
fsuallh@uod.edu.sa

Abstract:

Energy crisis and environmental challenges are becoming greater economic, health and social concerns of the day. Building design and construction processes, whether in the developing or developed world, have to address environmental issues. Library buildings, commonly known as intellectually stimulating and scholarly community places, have been, for some time dealing with this pressing need in quite a few countries. The Green Library Movement discussions in terms of building design and construction of libraries have been going on for a few decades, but only a handful of libraries with green or environmentally sustainable design have been built so far in the Asian context. In most cases, the budget allocation for library buildings is low making the case for sustainable and energy efficient buildings, stronger. This research tries to shed light on the opportunities and challenges of green or environmentally sustainable library buildings, focusing specifically on Asian countries with locally available resources, standards and climate assessments.

Keywords: green library, sustainable design and construction, standards and certification, Asian countries, climate, passive cooling and heating techniques

Introduction

The warming of the climate system is unambiguous due to increases in global temperatures, widespread melting of snow and ice, rising global average sea level, and carbon dioxide emissions, etc. This is resulting in heavier precipitation events, additional heat-waves, melting of Arctic snow, and uncertain weather changes (Meyer, 2008; Pacala & Socolow, 2004). There is a fast growing need for preserving the earth's environment largely affecting the world communities. Of the Millennium Development Goals (MDGs), the seventh, "to ensure environmental sustainability" is the base of worldwide recognition of the green movement in every walk of life. The Library, as a social and educational unit, remains no exception from

these goals of changes and challenges. The upcoming years will be crucial for the planet earth in terms of climate change, concerns over clean water and air, health and energy crisis due to built environment, and allied economic stability (Genovese & Albanese, 2011). The libraries need to provide sufficient information resources for supporting the overall green or sustainable movement and as well are required to embrace greening practices themselves. Although, there are various aspects of adopting green practices by libraries, this study focuses on the library building either as new construction or renovation and its energy and climate-related impacts.

Definitions, Terminologies and Green Movement in Built Environment

The built environment consists of manmade surroundings providing infrastructure and services for human habitat and activities. It also includes energy supply and construction systems, etc. for buildings and related processes. Global climate change and energy challenges calls for a green or sustainable built environment in every places of the world. The holistic goals of architecture defined by Vitruvius' *Firmitas, Utilitas, and Venustas*, are still essentially contemplative in buildings and maintaining its relation to the earth (Taylor & Enggass, 2009). McGraw-Hill Construction (2013) observes that about half of the global architects and designers are inclined towards creating sustainable built environments. Meyer (2008) stated that about *43% of* CO_2 emissions, only in the United States result from energy/electricity services such as heating, cooling, ventilation, and hot water. Oxford English (2008) defines *"sustainable"* as relating to *"forms of human economic activity and culture that do not lead to environmental degradation, especially avoiding the long-term depletion of natural resources"*. Genovese & Albanese (2011) suggested *"design elements and consideration including sustainable site selection and development, water conservation, energy efficiency, local resources, material conservation and waste reduction, indoor environmental quality, and innovation in design",* as sustainable/green buildings. Office of the Federal Environmental Executive (OFEE) defined green building as "the practice of (1) increasing the efficiency with which buildings and their sites use energy, water, and materials, and (2) reducing building impacts on human health and the environment, through better siting, design, construction, operation, maintenance, and removal—the complete building life cycle" (Kubba, 2013). There are also various terminologies, such as *ecological footprint, ecological rucksack, biomimicry, eco-friendly, ecological economics, biophilia, green/sustainable building, green/sustainability assessment, high-performance buildings, life-cycle assessment* etc. defining the ecological, social, economic, philosophical, scientific, technical, design and assessment aspects of the process (Kibert, 2013). However, the green building concept is not limited to the saving energy but is required to be responsive to the economic, social and environmental challenges and yet remaining functional. The transition of the economic growth-based model to the green growth-based model in the 21st century is sharpening the revolution to limit further damage to the climate regime and choices between action and delay to do so (Asia, Association of Academies of Sciences, 2012; Pacala & Socolow, 2004).

Green Library Movement

Generally, the green development concept dates back to 1960's, the green library movement emerged in 1990's and until 2003 it became well recognized among western library professionals. 2007 was marked as the *'tipping point'* for green/sustainable buildings, concepts and awareness, turning this unique concept common outside US and Europe (Asia, Association of Academies of Sciences, 2012; Genovese & Albanese, 2011; Antonelli, 2008; Walsh, 2007). Meyer (2008) laments that historically, the libraries remain unprepared for the disaster management and recovery processes due to environmental damages. Brown (2003) stated that the most libraries are considering green architecture essential to reduce the negative

environmental impact of conventional buildings and to save energy costs. In the developed world, more and more organizations are turning to green or sustainable building practices, to reduce the environmental impact of buildings and to improve the health and wellness of inhabitants. Importantly, buildings in the developing countries have a great need to be sustainable due to its shortage of supply of energy. The rather established green library movement in North America requires less awareness since there are acknowledged model practices, tangible, intangible and intellectual resources related to the green movement. On the other hand, environmentally challenged countries in Asia and Africa are still struggling to develop awareness towards sustainable practices both in the library affairs as well as in sustainable architecture. The library associations around the globe e.g. IFLA, ALA, Oregon Library Association, etc. are providing guidelines, blogs, frameworks, trainings and ideas for sustainable library building, practices, resources and services (Woodland, 2010; Antonelli, 2008). Experts observed several advantages, and disadvantages in sustainable energy sources which are stated below.

Benefits of the sustainable energies: According to an estimate a green building, on average, reduces energy use by 30%, carbon emissions by 35%, and water use by 30-50% (CEC, 2008). Most of sustainable energies ensure are cleaner-environment (especially the indoor-air quality), health and energy security (reliability and renewability) on domestically and locally available resources, lower greenhouse gas (GHG) emissions. It also contributes to the local economy and produced with the locally available resources and natural conditions. Reduce the usage of certain natural resources i.e. freshwater, natural fuels and thus overall preserving the global technical, economic, social, environmental, and institutional sustainability over their lifetime (ADB, 2015; Shrestha & Acharya, 2015; Kibert, 2013; CEC, 2008).

Disadvantages of the sustainable energies: Most of these are region, climate, time and weather depended thus often contribute little as alternative. Often costly at essential installment and later the cost per unit reduces, however, sometimes the cast remain higher, even 4times more than the cost of conventional built. They also required larger surface and land for installation to produce little energy. Wind energy becomes noisy and may cast potential danger to birds and living beings nearby. Sustainable energy generation technologies required high maintenance, skilled maintenance human resources and sometimes the legal issues.

Challenges & Barriers: There are numerous financial, administrative, research based challenges and barriers to plan and adopt green architecture techniques: Lack of financial and environmental audit for local sustainable resource; real and perceived higher first coats, operating costs, and inadequate funding for public organizations; inadequate research and knowledge on local environment, resources and productivity; rapid climate change of Asia region; is challenging to gain long run benefits.

Opportunities: Looking at the climate, economic and political scenario of Asian region, the challenges to green library construction are opportunities as well. There are opportunities for multi-disciplinary research ventures, self-endured energy supply, reuse and recycling, waste management, increasing the quality of indoor life and health, creates resilient and flexible structures to natural disaster, strengthen the local economies, business opportunities for manufacturers, utilities and new markets.

Asian Climate and Energy Status

Asia is the world's largest continent with about 4.4 billion inhabitants, residing in 48 countries. It has the world's most natural resources, extremely diverse climates and geographic landscapes, cultures, religions and dynamic economies. The varied Asian climates and geographical landscape, are mostly on both extremes of cold and hot (see figure 1), ranging from the hot desert in the Middle East, monsoon, tropical, cyclone zones, temperate areas in the east and the continental center to vast subarctic and polar areas in Siberia. The economies and political conditions are developed as China and Japan, stable as GCC countries and as developing in countries like Afghanistan, etc. In the past decade, various surveys on the global climate change, recognized about 17 Asian countries' environment to be extremely vulnerable (Salinger & et al, 2014; Adams, 2003). Human-induced factors both direct e.g. air pollution (indoor and outdoor), water crisis (water pollution and fresh water shortage), solid waste, greenhouse gas concentrations, and inter-regional heat transport etc.; and indirect e.g. population growth, urbanization, economic development model, technology change, social institutions and social-political frameworks, etc. by the new emerging economies of Asia are shouldering an increasingly greater share of regional and global environmental burdens (Asia, Association of Academies of Sciences, 2012). The climate of Asia is highly at steak, increasing changing, causing unexpected and fragile shifts with natural disasters.

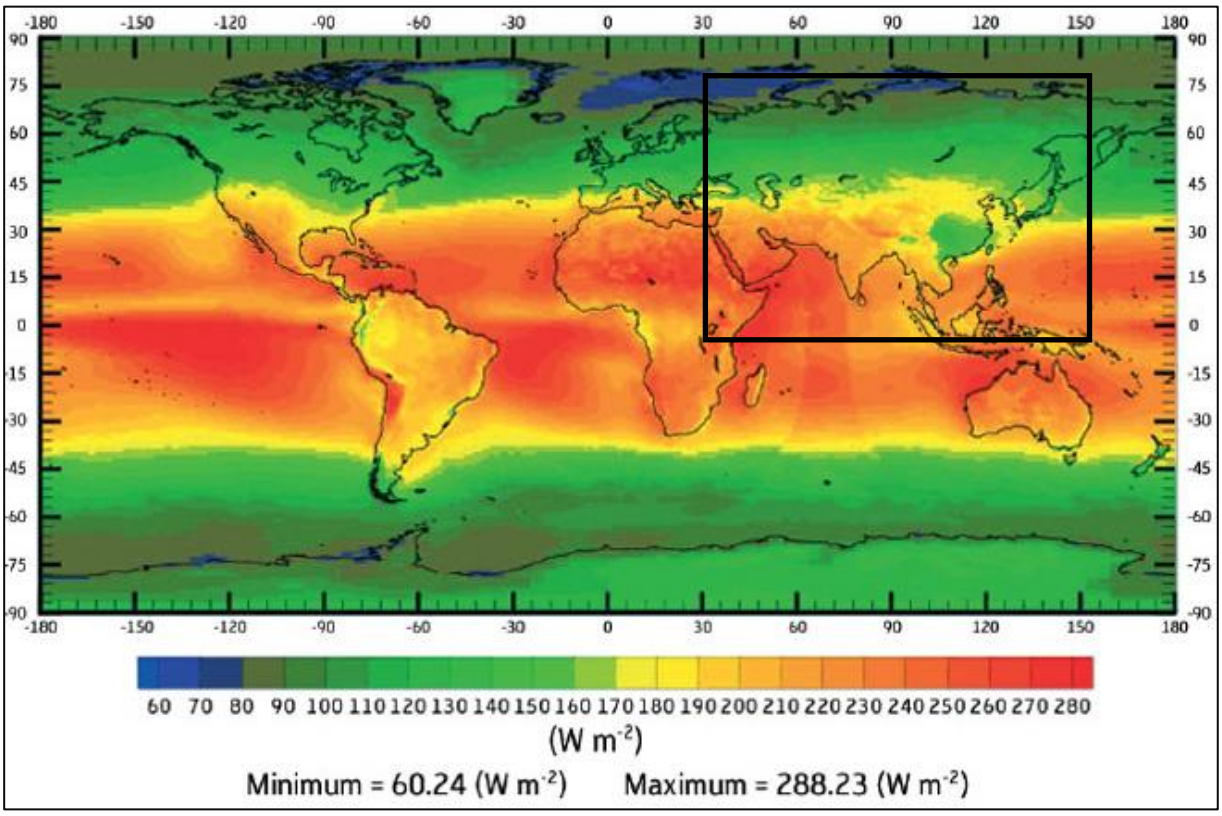


Figure 1: World Solar radiation map indicating Asia having a high solar radiation (SSE 22 - Year Average monthly Mean of All-Sky Surface Solar Insolation from 1983-07 to 2005-06; http://www.eohandbook.com/eohb2011/casestudy_energy.html)

The declining biodiversity due to clearing the forest for domestic use, industrialization and farming, acid deposit, etc. are also contributing challenges to the geophysical, meteorological, hydrological and climatological disasters (Association of Academies of Sciences in Asia, 2012). This results in extreme temperature trends such as the frequency of hot days, heat waves, desertification and sandstorm, Asian brown cloud and precipitation in several areas (Salinger & et al, 2014). Shrestha & Acharya (2015) stated that most Asian countries face

energy poverty and climate change with millions of habitants having no access to electricity or modern fuels. Almost all countries in Asia currently rely on outdated, inefficient power systems that fail to balance energy supply and demand as well as causing threats to the environment. ADB (2015) emphasizes the dire need for sustainable energy access planning to generate energy in a socially, economically, and environmentally sustainable manner. The Library buildings in Asia like all other types, should be considering adopting environmentally sustainable methods in their designs, construction and maintenance.

Research Objectives and Methodology:

This research is the first of its nature providing a framework for green/sustainable library building design guidelines for Asian countries with examples of practical applications in the specific climatic zone.

The paper thus aims to:

1. Identify the concepts, benefits and challenges of green/sustainable library building design,
2. Enlisting the standards and certifications for green/sustainable libraries of both international and Asian countries,
3. Identifying and analyzing the LEED and certified green library initiatives in various Asian countries.
4. Suggesting passive techniques for the construction design of sustainable library buildings in the Asian region.

The first step of this research was a thorough review of available literature. Next, a critical analysis of selected green library projects from Asia, USA, Canada and Europe was done to develop a conceptual framework for the green/sustainable library design. An important step was conducting the survey of forty-two Asian countries regarding the aspects that affect the designing of green libraries. This involved a comparison of climate profile, energy status, and use of sustainable materials and methods of construction. Importantly, next step involved the application of sustainable design strategies i.e. natural ventilation, green roof, earth cooling, evaporative cooling, diffused daylight, landscaping, wind tower, etc., and use of renewable energy such as solar, wind, geothermal, etc. Data were collected from various organizations i.e. LEED, GBC, DoE, and other related organizations and journals.

Standards and Certification

There are some established standards by national and international organizations for green/sustainable building developments. Brown (2003) stated that green library movement suffered a lack of allied standards and guidelines. McGraw-Hill Construction (2013) surveyed that in 2008, only 17 countries had official or emerging green councils. Although these standards are mainly about providing certification, they also provide guidelines, resources, case studies and standard filing system to anticipate and execute the green building projects. The most recognized and established standards are from international organizations e.g. World Green Building Council (WGBC), U.S. Green Building Council (USGBC), ASTM, American National Standards Institute (ANSI), International Green Construction Code (IGCC), The Energy and Resources Institute (TERI), United Nations Framework Convention on Climate Change (UNFCCC), American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE's standards): Standard 55, Thermal Environmental Conditions for Human Occupancy; Standard 62.1, Ventilation for Acceptable Indoor Air Quality; Standard 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings, etc. All of these cover the design and construction of a building, energy usages and passive techniques.

Five renowned international rating systems for the green /sustainable building are:

1. Building Research Establishment's Environmental Assessment Method (BREEAM)
2. Comprehensive Assessment System for Building Environmental Efficiency (CASBEE)
3. GBTool
4. Green Globes™ U.S.
5. Leadership in Energy and Environmental Design (LEED)

Asian countries are becoming collaborators by adopting and localizing the international green construction standards and certifications e.g. LEED and GBC (see Table 1). Some Asian countries have their national standards and policies.

Table 1 . Asian Countries Green Construction Standards and Certification

Country	Names	Country	Names
Bahrain	Bahrain Green Building Council (Prospective)	Lebanon	Lebanon Green Building Council
Bangladesh	Bangladesh Green Building Council (BGBC)	Malaysia	Malaysia Green Building Confederation, TERI
Bhutan	The Engineering Adaptation & Risk Reduction Division Department of Engineering Services Ministry of Works and Human Settlement	Maldives	Ministry of Environment and Energy
Brunei	Public works department (PWD)	Oman	Oman Green Building Centre (Prospective)
Cambodia	Cambodian General Secretariat of the National Council for Sustainable Development	Pakistan	Pakistan Green Building Council (Prospective)
China (PRC)	Green Building Evaluation Standard, Green Building Assessment System (GBAS), HKBEAM-Hong Kong, Hong Kong Green Building Council	Philippines	BERDA, Philippine Green Building Council (Emerging)
Egypt	Egypt Green Building Council (Prospective)	Qatar	Qatar Green Building Council (Emerging)
India	Green Building India, Indian Green Rating for Integrated Habitat Assessment, Indian Green Building Council (IGBC), The Indian Bureau of Energy Efficiency (BEE) launched the Energy Conservation Building Code (ECBC)	Saudi Arabia	Saudi Green Building Council (SGBC), Saudi Green Building Forum (SGBF)
Indonesia	Green Building Council Indonesia (GBCI), Greenship	Singapore	Singapore Building and Construction Authority (BCA), Green Mark
Iraq	Iraqi Green Building Council	South Korea	KGBC
Israel	Israel Green Building Counsil	Sri Lanka	Green Building Council of Sri Lanka (GBCSL)
Japan	Compherensive Assessment System for Building Enviornment Effciency, Japan Green Building Consortium	Syria	Syrian Green Building Council
Jordan	Jordan Green Building Council	Turkey	Turkish Green Building Council
Kazakhstan	Kazakhstan Green Building Council (Emerging)	United Arab Emirates	estidama, Emirates Green Building Council
Korea	Korea Green Building Council (Prospective)	Vietnam	Vietnam Green Building Council (Prospective)
Kuwait	Kuwait Green Building Council (Prospective)		

Green Library Construction Initiatives in Asia

Although, less in number than the developing countries, there are some very positive green library initiatives in Asian countries. Some of these projects use natural light, passive cooling and heating techniques and recycled construction materials along with traditional environmental techniques. ***The National Library of Singapore*** is an innovative and award winning 'green' building known as a "Library for the Tropics". This library uses bioclimatic and sustainable techniques e.g. vegetation and landscaping to improve the indoor thermal environment, lighting and air-conditioning control sensors, natural lighting and light shelves, extensive sun-shading design, rain water storage for irrigation and public toilets, roof gardens, and natural ventilation (Genovese, 2011). ***My Tree Library, Singapore*** uses recycled materials. ***Anna Centenary Library, Kotturpuram, India*** is considered as the largest green library and most sustainable in the Asia. This library uses natural light for most of its reading spaces, research and meeting halls (Malode, 2014). ***The Yogananda Library, Shoolini University, India,*** uses its large central courtyard that pours uniform indirect light into all parts of the built floors as well as help control temperatures and climate inside the building. ***Taipei Public Library*** and ***Beitou Public Library, Taiwan,*** (see image 7 & 8) is rated very high internationally in terms of sustainability with its rooftop solar cells and rain collection measures, waste reduction and storage systems. Its wood interior, deep balconies and vertical trellises also help reduce the energy consumption and warding off thermal radiation. ***Tainan public library, Taiwan*** uses natural light through double roof and skin to reduce the heat of direct sunlight and increase the indoor light. ***Kaohsiung Public Library in Taiwan,*** is a state of the art sustainable design library, with an indoor garden using potted plants, lined in 60 x 60 meter format, creating a microclimate to cool the interior. ***Bangkok's Green Library, Thailand,*** is wired with body-heat dedicating sensors that control lighting and air-conditioners. ***Shenzhen Art Museum and Library complex in China,*** (see image 5 & 6) is a cubic building with matte-glass facades to maximize natural light, but also include a solid inner layer to protect against solar heat gain. ***Ningbo Library in China*** uses passive design methods for utilizing daylight and ventilation. ***Liyuan Library, China,*** surrounded by a village, is a glass structure with local timber wood panels to protected from the direct daylight and ensuring solar gain. ***Kanazawa Public Library, Japan,*** (see image 11 & 12) provides a light-filled environment by keeping the main floor wide open to 6,000 small circular windows of 200 - 300 mm wide facades also being used for natural ventilation for smart cooling and heating system. The under-floor heating and cooling system moderates temperatures at floor level rather than conditioning the entire lofty space which saves energy and improves comfort. The design of the ***Bishan Public Library in Singapore,*** (see image 1 & 2) is inspired by tree houses and makes efficient use of atriums, natural daylighting, resource efficiencies and passive solar design. ***King Fahad National Library, Riyadh, Saudi Arabia,*** (see image 3 & 4) is an example of retrofitting old construction with sustainable design. Its exterior is covered by a geometric façade that doubles as a sunshade to avoid heavy desert heat; has steel and glass skylights to provide light penetration to reading areas; and is surrounded by gardens. ***Princess Nora bint AbdulRahman University Library, Saudi Arabia*** strongly expects receive a gold LEED rating for its water recycling and solar thermal plant (Nayar, 2014). ***King Abdullah University of Science and Technology (KAUST), Saudi Arabia,*** is a LEED NC-Platinum project to use minimum energy consumption with large roof spans used for natural daylight and ventilation. The roof is covered with photovoltaic panels for energy generation and large solar-powered wind towers harness energy from the sun and wind to passively create air flow in pedestrian walkways. Lastly, mashrabiya screens shade windows to reduce heat loads (Technical Review Middle East, 2015). ***Indonesia's University Library*** (see image 9 & 10)***,*** is under construction with the passive design, swirling green roofed concept to avoid

extra air-conditioning and light reflecting from nearby waterway and indoor flooring marks (LEED, 2016; ArchDaliy.com, 2016; inhabtant.com, 2016).

Image 1 & 2: *Bishan Public Library, Singapore* (ArchDaily, 2016; inhabtant.com, 2016)

Image 3 & 4: *The King Fahad National Library, Saudi Arabia* (ArchDaily, 2016; inhabtant.com, 2016)

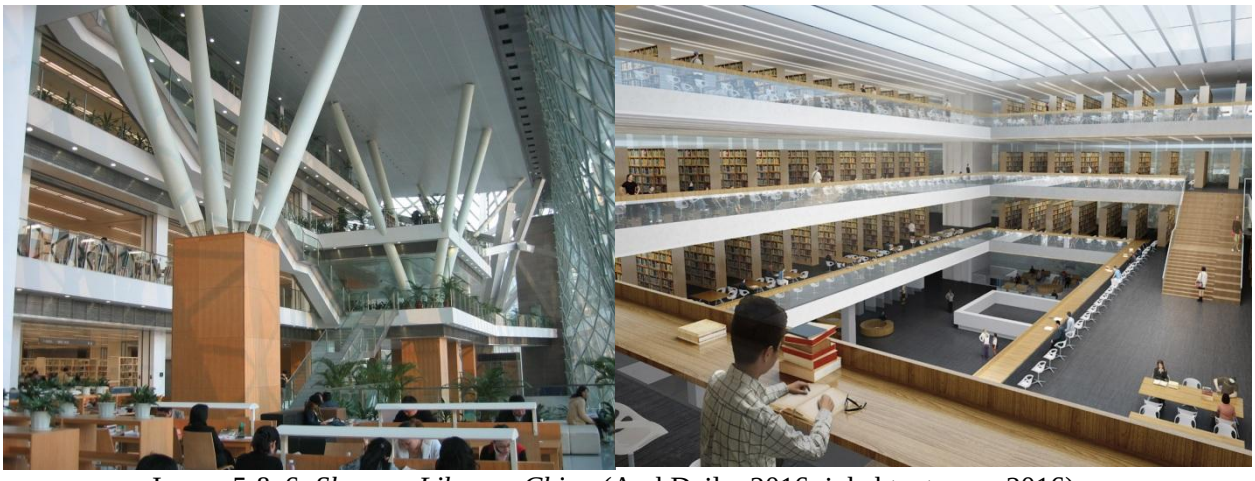
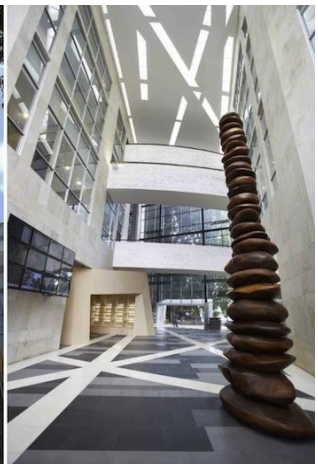


Image 5 & 6: *Shenzen Library, China* (ArchDaily, 2016; inhabtant.com, 2016)


Images 7 & 8: *Taipei Public Library Beitou Branch, Tawian* (ArchDaily, 2016; inhabtant.com, 2016)





Images 9 & 10: *University of Indonesia Central Library, Jakarta, Indonesia* (ArchDaily, 2016; inhabtant.com, 2016)


Images 11 & 12: Kanazawa Umimirai Library, Japan (ArchDaily, 2016; inhabtant.com, 2016)

Passive Techniques for Energy Saving

The green/sustainable architectural technologies include the concepts of architecture, use of technology and ecological performing methods and tools. Sustainable energy alternatives are bioenergy, solar energy, geothermal energy, wind energy, hydro energy, blue energy, fuel cell energy and hybrid systems energy. The energy alternatives are contingent to specific climate zone of a region (see figure 2 and table 2).

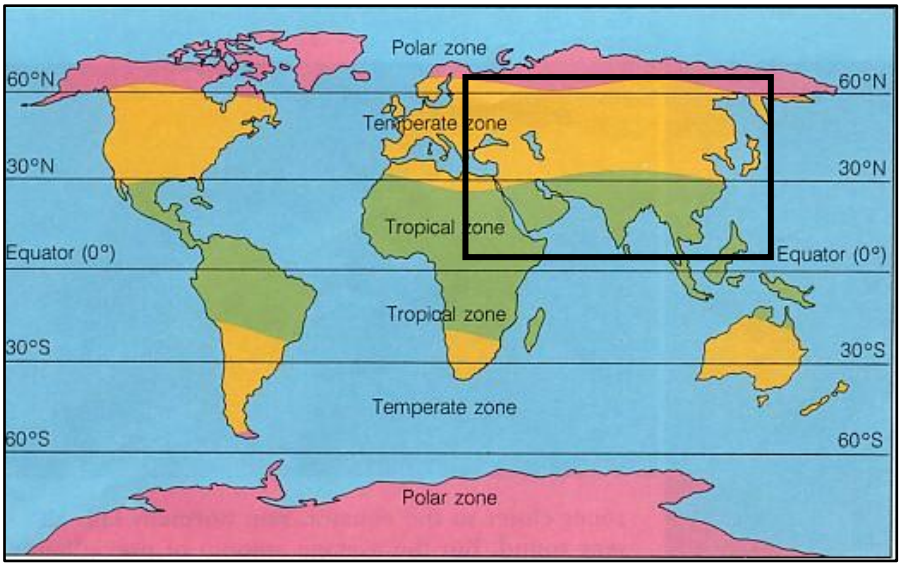


Figure 2: Map of world climate zones
(http://www.cgrove417.org/fry/Science/Climate/climatezones.html)

Green technologies for energy saving and indoor comfort:
The technologies are of two main kinds: first one is related to architectural design and construction and the other is related to the location, time and user preferences. The major technologies related to design includes, 1). *Insulation systems*: thick walls providing high thermal mass, bio-based, rigid panel, glass based, wood-cement forms, radiant barriers, natural fibers e.g. plants, animal and mineral sources; 2). *Heating/Cooling Systems*: furnaces, boilers, heat pumps, electric space heaters, radiant systems and green roof; 3). *Ventilation Systems*: natural and mechanical ventilation; 4). *Water and Waste Management Systems*.
Passive design methods involving direct and indirect energy saving rely less on the technology but on the design and construction styles and thus offer longer benefits with lower maintenance cost. To understand the various options of passive/sustainable techniques (see Table 2), designers and librarians of Asian countries are required to understand their respective climate zones. These techniques can be uses both for new construction or modifications/renovations in the library building. The climate zones and related basic design options are mentioned below (Attmann, 2010).

A. ***Cold/Polar Zones –*** Cold climates with permanent ice, tundra, snow, or permafrost. Buildings can be of minimum surface area to reduce exposure to low temperatures, maximize absorption of solar radiation, reduce radiant, conductive, and evaporative heat loss and provide wind protection.
B. ***Temperate Zones –*** Continental climates, with wide seasonal temperatures range. Architects elongate the form of a building along the east-west axis maximizing south-facing walls, minimizing east and west exposures, which are generally warmer in summer and cooler in winter than southern exposures, balancing the solar heat gain with shade protection on a seasonal basis and by encouraging the air movement in hot weather; protecting against wind in cold weather.
C. ***Hot-Dry Zones (Tropical) -*** Dry tropical climates, with little rains, hot in day and cold in night. Architects can design buildings surrounded by courtyard spaces, by reducing solar and conductive heat gain, promoting cooling by evaporation using water features and plantings, providing solar shading for windows and outdoor spaces. can build compact shapes and compact planning system of an area development, reduce glazed surfaces, provide plenty of shading, use thermal mass as a means for cooling, provide for night ventilation, use evaporative cooling

D. ***Hot-Humid or warm humid Zones (Tropical)* –** Moist or humid Tropical climates, where the temperature is mostly warm all year long. The building can be elongated along the east-west axis minimizing east and west exposures, reducing solar heat gain, utilizing wind to promote cooling by evaporation, providing solar shading for windows and outdoor spaces. A more elaborate environmental technologies and elements for sustainable design referring to specific climate zones are placed in Table 2.

Table 2: Climate Zones of Asia and Applicable Green/Sustainable techniques

Type of Cooling & Heating Methods	**Climate Zones**			
	Tropical		**Temperate**	**Cold**
	Warm-humid	**Hot-dry**		
Shading - windows	x	x	x	
Ventilation - windows	x		x	
Ventilation – Warm air exhaust				
Night ventilation	x	x		
Evaporative cooling – water body, roof pond, water wall, fountain (Water body has a moderating effect on the micro climate)	x	x		
Green wall, green roof	x	x	x	x
Earth cooling – partial or full		x		x
Thermal mass with heavy wall	x	x		
Insulation – wall, roof	x	x		x
Solar chimney – warm air exhaust & fresh air intake		x		
Solar power – electricity, hot water (roof ponds)	x	x		x
Wind power – electricity (near sea/ocean, depend on wind speed)	x	x	x	x
Geothermal			x	x
Recycled & recyclable material	x	x	x	x
Local material & technology	x	x	x	x
Skylight – diffused light (Northern/Southern direction latitudes)	x	x		
Skylight – direct light			x	x
Light shelves (Depends on cloud cover)			x	x
Sun rooms (For winter heating)			x	x
Courtyards - shaded	x	x		
Courtyards - sunny			x	x
Terrace/Verandah	x	x		
Screened openings – *Jaali, Rowashan, Mashrabiya*	x	x		
Special glass – heat reflecting, light admitting	x	x		
Landscaping - greenery	x	x	x	x
Wind tower (PDEC), Depends on wind speed	x	x	x	
Hybrid ventilation - natural ventilation & air-conditioning	x	x	x	
Mechanical heating with heat recycling for cold season		x	x	x
Double roof	x	x		x
Layering of spaces	x	x		x
Rainwater harvesting	x	x	x	x
Grey water recycling	x	x	x	x

Conclusion:

The green built environment offers opportunities to improve sustainable indoor environs as well chances of preserving global environment. Well-planned green buildings survive on their integrated built-in energy system, are lively, comfortable to the certain climate of its location and community, and capable of enduring on its own resources, unlike conventional buildings which in most cases could be termed as energy guzzlers. This innovation is often comprehensive, involving various dimensions such as technology, institution, organization,

and culture, covering both macro and micro levels, and even being revolutionary or radical. The core of the sustainable design and construction is the use available technologies, local resources, knowledge, and research. Library buildings as providers of knowledge should ideally showcase knowledge about green/sustainable building by their own designs. This shift is challenging and in some cases may be less rewarding at the end. There are only a few sustainable library building examples in Asia, mostly focusing on using natural light and shades as passive lighting and cooling techniques. On the other side, the rapidly changing Asian climate causes challenges for the sustainable built environment. There is much to be done to actively use the blessings of sustainable technology among Asian libraries especially in terms of standards and guidelines, national policy and frameworks, awareness of the local resources and its reliance with changing climate, research and professional support, library professional's education and training. The outcome of this study hopes to emerge an awareness about the benefits of green or environmentally sustainable libraries among the designers, users, managers and other stakeholders, as well as serve as the guidelines and inspiration for designing sustainable libraries in the Asian region.

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