JSPS - VCC
ENVIRONMENTAL PLANNING GROUP

# PROCEEDING

**ENVIRONMENTAL PLANNING GROUP 2nd SEMINAR 2006**

**26TH – 27TH JUNE 2006**

**KAED BRIEFING ROOM,**

**LEVEL 4, KAED BUILDING**

# Innovative Approaches Towards Better Living Environment

Edited By:


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**Prof. Dr. Ryuici Kitamura**

**INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA**

**KYOTO UNIVERSITY JAPAN**


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# ENVIRONMENTAL EDUCATION AND SUSTAINABILITY SCHOOL DEVELOPMENT

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## ABSTRACT

This research offers way to upgrade human comfort in the school building in tropical climate and reducing cost for energy consumption in the buildings using landscape design and environmental education.

## INTRODUCTION

Generally, buildings are designed to protect humans and their belongings from extremes of climate and to provide a comfortable environment for temporary or permanent habitation. The other main purpose of buildings is the provision of safety and privacy at various required levels.

An effective building should also offer a cost effective spent on energy consumption.

## ISSUE

For example, the use of vegetations was seen as a cost-effective way to provide comfort, rather than using mechanically cooling systems. Nugroho's research (2002, p.346) also, indicated, "surrounding vegetation can help reduce temperature in buildings."

## BUILDINGS AND COMFORT

Satwiko (2002, p.84) calls attention to the importance of the roof in reflecting solar radiation. He recommends an extremely highly reflective material for roofs, which will reflect much of the solar radiation before it is absorbed and converted to heat. Although Satwiko's research is mostly aimed at the larger scale reduction of urban heat islands in hot climates, his work has some relevance to this research as it emphasises the importance of roofing material in open sided buildings.

Ariffin (1994, p.3) conducted a comparative measurement and thermal comfort survey in a suburban area of Kuala Lumpur in a double storey terrace house typical of contemporary design in Malaysia and in a traditional timber house found in a rural village. Whilst the sample (only 2 buildings) is limited and therefore requires the results to be considered with caution, the measurements were taken over a long time span and the buildings were in comparable settings of microclimate. The results showed that the traditional building enjoyed a mean indoor air temperature 2.5° C lower than the contemporary terrace house. Ariffin also found that measures for Predicted Percentage Dissatisfied (PPD) were higher for the terrace house, except during the night, whilst remaining comparatively low for the traditional house throughout the completely twenty four-hour period.

Her Climatically Sensitive house design research reflected the superiority of traditional planning and design details, with a mix of traditional and contemporary building materials. The resultant heat load simulations suggests that this hybrid solution has a mean indoor air temperature of about 1° C above outdoors air temperature, which represents a 1.5° C advantage over the contemporary terrace house. The cost of achieving this advantage is estimated at a (20%) increase in the cost of construction of the traditional house.

However, building materials and openings are not the only ways to achieve thermal comfort. Vegetation also plays a role in reducing heat, as described below.

## COOLING BUILT ENVIRONMENTS WITH THE USE OF VEGETATION

Purnomo (2002, p.460) studied the effects of vegetation on air temperatures on campus grounds. His work refers to earlier studies by Emmanuel (2002) who examined the impact of vegetation of microclimate on 'heat-islands', which showed that:

- Vegetation, especially trees, could shade certain areas from sun and reduce the air temperature (Sheffield and Westerling, 1997; Santamoris, 2001).
- Appropriate vegetation placement could reduce power loads by 30 percent (Ball, Erickson, Garbisch, 2002).
- Vegetation could reduce air temperature on asphalt surface by 2.2° C (CUFR, 2002).

The above findings demonstrate that vegetation has a positive influence on reducing air temperature.

Purnomo's study (2002) indicates that there is a significant relationship between vegetation and air temperature. His results show that there is also a significantly positive relationship between air temperature and certain surface types in both campuses studied at Trisakti University in West Jakarta and ISTN in South Jakarta. He found that asphalt surfaces increase air temperature significantly in comparison with grass and gravel surfaces. The study also indicates that there is a positive relationship between wind speed and vegetation, if trees are positioned in order to channel wind flow.

Mohyuddin and Yusuf (2002, p.494) in their examination of the characteristics of the traditional Malay cultural landscape found that traditional Malay society used to pay very careful attention to how a building site sustains the relationship between man and the natural environment. They also called attention to the traditionally close relationship between indoor and outdoor spaces and their visual environment.

Ariffin (1994) and Pramujadi (2002) found that a combination of vegetation and certain types of building materials could achieve a better indoor environment in buildings.

Pramujadi (2002, p.471) investigated the potential climatic effects of vegetation in both the urban and the micro climatic scale in the warm humid tropics. Pramujadi advocates the method of 'balanced cooling' for tropical urban areas, by which he means creating a balance between outside and inside temperature. This can be best achieved by cooling the surrounding area of the building through vegetation shading. Pramujadi emphasises the importance of roofs in tropical architecture. Current roofing materials, such as concrete or clay tiles, can both contribute heat to the interior of a building and add heat to the exterior environment. Air-conditioning can further increase the outside heat and this contributes to the urban heat island phenomenon. He advocates the use of both outside shading of the building surrounds by trees and the use of vegetation on the roof (living green roofs), as a means to create sustainable and low energy use architecture in tropical regions.

Other than vegetation and building materials, environmental factors such as wind and shade are another means to achieve thermal comfort as, described below.

## VEGETATION AND COMFORT

Ariffin and Rao (2002, p.100) emphasise the importance of both plants and traditional building types and materials in providing optimum levels of thermal comfort. According to the authors, in hot-humid climates, lightweight built forms with permeable walls and elevated permeable floors and large roofs are the most suitable building types to provide thermal comfort in the hot-humid tropics. Following Yeang's (1999), experiments with vegetation-screened vertical walls in the Mesiniaga Tower in Kuala Lumpur, Ariffin and Rao (2002) emphasise the importance of both plants and grasses to reduce the heat load on exposed surfaces by nothing that: "experiments showed that radiation can be reduced up to 63 percent under vegetation shaded surfaces on bare ground temperatures, which can be reduced by as much as 22° C in five minutes after the arrival of the shadow line".

## THE EFFECTIVENESS OF VEGETATION IN ABSORBING HEAT

Canadarma and Jusuf (2002, p.448) investigated the effectiveness of vegetation in creating an improved human environment in hot-humid climate urban areas in Indonesia. The authors examined Robinette's (1983a) recommendations regarding "sun absorption by shade trees, effect on air temperature by vegetation and effect on ground temperature by vegetation." Robinnete (1983b) edited and published a major work with McClemon for the Centre for Landscape Architecture Education and Research in the United States. This work was mostly based on his own research published in *Landscape Planning for Energy Conservation,* which has remained a key work to date on the effects of landscape on microclimatic conditions. According to Robinette (1983a, 1983b), shading by trees can prevent as much as (70%) of the sun's heat from being absorbed by the ground and 5.5° C to 11° C, due to shading when the general temperature is 32° C, can cool air temperature. The ground can receive less than (20%) of the incidental solar radiation in forested areas and grass covered surfaces are (33%) cooler than paving exposed to the same amount of solar heat. In addition, Canadarma and Jusof's (2002) work fully endorses Robinette's ideas and makes a number of recommendations for hot-humid climate landscapes (refer to Figures 1.1 to 1.4).

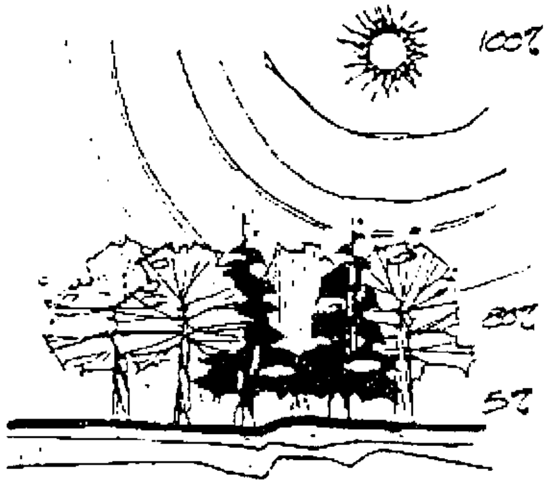


**Figure 1.1: Effect of vegetation on ground temperature in the forest (Robinette, 1983b, p.23)**

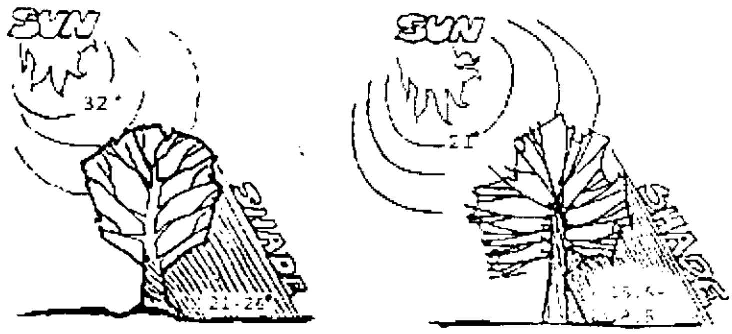


**Figure 1.2: Effect of vegetation on air temperature (Robinette,1983b, p.23)**

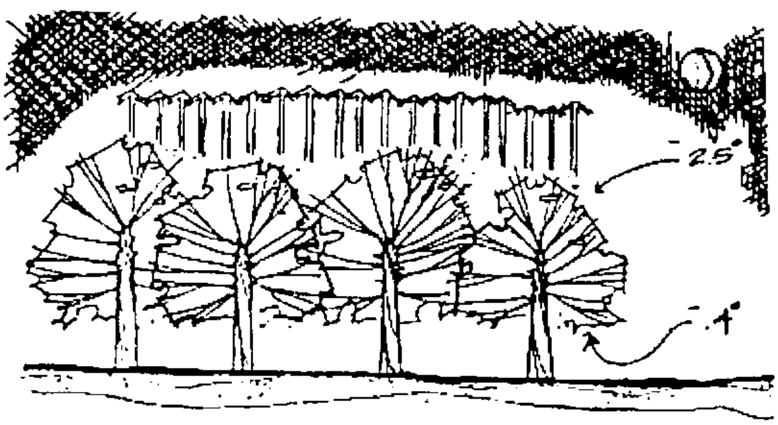


**Figure 1.3: Cooling effect of vegetation (Robinette, 1983b, p.24)**

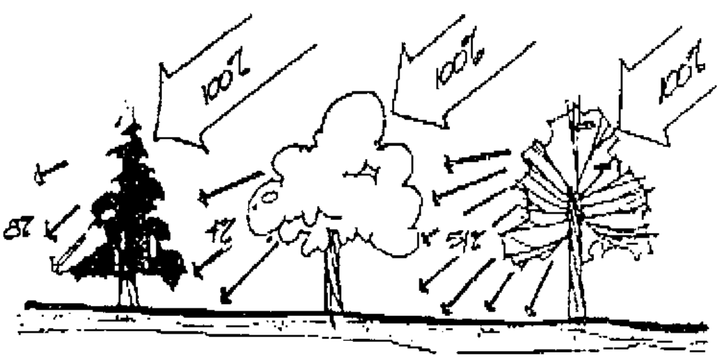


**Figure 1.4: Cooling effect of many types of vegetation (Robinette, 1983b, p.25)**

## SPECIES OF PLANTS, WHICH CAN BE USED TO REDUCE AIR POLLUTION

There are many species of plants, which can be used to modify air pollution. Mediastika's (2002, p.481) research on climbing vegetation for shade and spreading particulate matter in buildings to reduce air pollution, found that dispersion of particulate matter is mostly at lower atmospheric layers and that particulate matter could be deposited on certain types of vegetation. Low growing vegetation or climbing plants with particular leaf conditions that encourage deposition were predicted to be suitable for this function. Four species were examined; *Duranta repens, Polyscias fruticosa, Stephanotis floribunda* and *Scindapsus sp.* In the preliminary study, no valid conclusion could be drawn from this experiment. However, there are indications that *Duranta repens* and *Stephanotis floribunda* block and deposit slightly more particulate matter than the two others are. The fine hair on the surface of leaves with a rough surface, are better at absorbing fine particle matter, compared with smooth surface leaves.

Mediastika's (2002) finding is supported by a case study done by Kusmaningrum (1997) in housing estates on a main road at Jalan Padjadjaran (Bogor) and in Cinere (Jakarta). Her research concludes that the planting of vegetation, such as certain trees and shrubs, could reduce the presence of Nitrogen and Sulphur in the air.

Dockery and Schenker (1993) state that reducing the presence of pollutants in air is important, as pollution can cause chronic diseases such as bronchitis, asthma and pneumonia. The effort to reduce pollution by reducing gas emission levels is important in order to reduce the level of fine particulates.

## THE EFFECT OF SHADE ON HUMAN PERCEPTIONS OF THERMAL COMFORT

Majid, Safian and Denan (2002, p.171) have carried out research in Malaysia in relation to the microclimate of courtyards in tropical regions. The authors carried out field research in a number of shaded and non-shaded areas in the grounds of the International Islamic University of Malaysia in Kuala Lumpur. They found that there could be as much as 4.3° C difference in air temperature, reflecting the difference between shaded and non-shaded parts of the same courtyard. The relative humidity is, however, increased by as much as (15%) in the shaded areas. Fully enclosed courtyards (with open corners) were the most effective in temperature reduction as the open corners allowed air movement. Additionally, the authors suggest a wind velocity between one to two metres per second as the most favourable to offset body heat.

The effect of wind speed can help to achieve thermal comfort outside the building, as described earlier. Its effects on thermal comfort within the building are described below.

## THE EFFECT OF WIND SPEED ON THE ACHIEVEMENT OF THERMAL COMFORT

Hien and Tanamas (2002, p.192) describe a chamber experiment devised to determine the effect of wind speed on thermal comfort in a Singaporean naturally ventilated environment. The study found that air movement is a "common, most important parameter affecting thermal comfort and thermal sensation". The researchers also found that Predicted Mean Vote (PMV) model predictions closely followed the Thermal Sensation Vote (TSV) values in conditions without cross-ventilation. However, above two metres per second air movement, the PMV model could not predict the TSV accuracy. In these cases, the PMV considerably under-predicted the TSV values.

Hien and Tanamas (2002) describe the differences of opinion about the relationship between wind and thermal comfort in the building. The following authors describe the differences in the surroundings of the building to provide future design suggestions for buildings which can achieve better thermal comfort levels.

Rijal, Yoshida and Umemiya (2002, p.243) investigated thermal comfort in indoor and semi-open spaces in Nepal. The investigations concentrated on the establishment of neutral temperatures in a sub-tropical climate, using the method as described by Nicol *et al.* (1994). The authors obtained a neutral temperature of 33° C for sub-tropical climates, compared to 23° C to 29° C in temperate climates and 21° C in cool climates. They also found that the neutral temperature was higher in the semi-open spaces in the sub-tropical climate and the temperate climate, both in summer and in winter, than those in the indoor spaces. Semi-open spaces in the Nepalese context of this study were open verandah-like structures, usually attached to buildings. The elevated timber frame is constructed with a timber plank floor. The elevated deck is usually more than two metres above the ground to reduce humidity under the building. The walls are vertical teak boards and roofs are built with various materials, such as wood shingles, slates and clay tiles. Their research concluded that the buildings would perform well in the region of Kalimantan, where the constant sea breeze would aid the circulation of cooler air through the building. In inland central Java, these buildings do not perform as well. They represent a cultural heritage more than a climatically appropriate vernacular building.

## COST SAVING OF CLIMATE DESIGN IN BUILDING

Prescott (1998) summarises the thermal comfort needs of tropical schools. She refers to the Watson and Labs work (1983, p.26), which states, "the objective of the climatic design of buildings is to reduce the budget spent for energy used to achieve thermal comfort in the buildings." The maintenance costs and energy used to provide thermal comfort increases when there is no heat balance between a human body and its surroundings. The body produces heat by its activities and metabolism. Body heat is exchanged with the surrounding environment by conduction (contact), convection (air movement), evaporation (of moisture at skin surface) and radiation (Watson and Labs, 1983).

## CONCLUSION

Several authors such as Satwiko (2002) and Robinette (1983a, 1983b) agreed on the principles of design and construction for suitable, naturally ventilated buildings to provide thermal comfort in hot-humid climates. The factors include a reflective and insulated roof, an elevated and ventilated floor, large wall openings to allow cross ventilation, shading of the walls and roofs with trees and climbers, and landscaping to allow and aid on-site air movement. In addition, several authors suggested the importance of ground shading by low vegetation cover over the majority of the site. Lawns and low ground cover below the building deck level are recommended. Hard surfaces should also be shaded by trees. There are clear indications in the literature review of the importance of site design and building location and orientation on a site to achieve the maximum benefits of natural site air movement.

# APPENDIX

**Table A1: Activities Relating Language Subjects To The Physical Environment**

| | |
|---|---|
| Report writing | Oral reports |
| Poetry writing | Library researching |
| Discussions | Listening |
| Comprehension | Descriptive writing |
| Interpretive writing | Summarising |
| Creating encyclopaedias | Poetry readings and poetry writing |
| Speech making/ Oratory | List making or annotated lists |
| Presentations | Reporting sessions |
| Storytelling | Creating trails signs for information for nature trailing |
| Negotiation | Creating catalogues |
| Keeping written records | Creative writing |
| Letter writing | Brainstorming sessions |
| Diaries | Making journals and books |
| Survey and interviews | Creating dictionaries |
| Log books | Literature readings |
| Story writing | Conducting guided tours |
| Duty roster | Short walks |
| School newspaper or newsletter | Cue cards |
| Communications | Tick charts or word cards |

**Table A2: Activities Relating Music To The Physical Environment**

| | |
|---|---|
| Singing | |
| Writing songs | Recording sounds of wildlife–birds chirping, bees buzzing, insects humming. |
| Musical performance with echoes- | Recording sounds of nature- rainwater-falling, gushing, splashing, |
| Dubbing music | constructing and playing instruments from nature–leaves, trunks, coconut shells ,bamboo |

*Indoor spaces could be used for storing musical instruments and for classes during bad weather. The challenges from the environment (for example: the landform, vegetation, wind and rain) could be part of the play and produce learning ideas in the informal curriculum.

**Table A3: Activities Relating Drama To The Physical Environment**

| | |
|---|---|
| Role Play or pantomime | Video making |
| Script writing | Drama or theatre workshop |
| Creative dance workshop | Outdoor dramatic productions |

**Table A4: Activities Relating Mathematics To The Physical Environment**

| | |
|---|---|
| Percentages and proportions | Costs |
| Maths games | Sorting and grading |
| Calculating area | Direction and vector work |
| Measuring weights, lengths, angles, volumes, heights, rates (metric - imperial) velocities, depths, perimeter, and diameter. Tangent and perpendicular | Rates of currencies and time zones changes<br>Databases, data analysis, statistics, poll. |
| Shapes and geometry | Time and mass studies |
| Estimating and checking<br>Data analysis and statistics | Counting<br>Dimensions |
| Spatial and numerical relationship<br>Quantity surveys | Triangulation<br>Trigonometry and geometry |
| Graphs, pie charts and tables | Approximating |
| Skills of independence and survival negotiating | Commerce skills (bartering, trading: early monetary systems egg. using shells, leaves as currency) |

**Table A5: Activities Relating Economics To The Physical Environment**

| | |
|---|---|
| ***Fruit, flower, vegetable production***<br>***Processing products***<br>***Design of production areas***<br>***Accounting***<br>Harvesting processes<br>***Cooking harvested produce*** | Resource management projects<br>Conservation of resources<br>Book keeping<br>Home Economics- grocery budgets<br>Recycling projects |

**Table A6: Activities Relating Information Technology To The Physical Environment**

| | |
|---|---|
| Computer graphics | Spreadsheets |
| Inventories | Databases |
| Simulations | Simple CAD |

**Table A7: Activities Relating History To The Physical Environment**

| | |
|---|---|
| Coppicing | Brick-laying |
| Stone wall building | Hedge |
| Plants of historic value | Building ancient structures |
| Kilns | Primitive housing / shelter |
| Simple archaeology | |
| Reading Time : Sundials, hourglass, water clocks | |

**Traditional Power Sources**

| | |
|---|---|
| Wind<br>Lightning | Solar<br>flowing water |

**Table A8: Activities Relating Art, Craft And Design To The Physical Environment**

| | |
|---|---|
| Stencil and photo-stencil work<br>Collage and montage | Needlework based on patterns: eg. – dragonfly wings |
| Aesthetic appreciation exercises – like and dislike<br>Designing new spaces | Recording and interpreting nature using: drawing or painting, collage, |
| Making models of existing and imaginary objects<br>Natural dyes – textile art (making leaf, spore and seed prints) | Basic armoury (horns, blow pipe) |
| Display and exhibitions | Plaster casts |
| Designing symbols | Filming wildlife |
| Lifecycle drawings<br>Creating picture books | Quick sketching techniques:<br>Patterns and making natural objects |
| Photography courses | Pencil rubbings |
| Carving and sculpturing | Environment silhouettes |
| Life web mobiles<br>Making murals | Clay and plasticine modelling<br>Colour and shape studies |

**Table A9: Activities Relating The Sciences And Survival Skills To The Physical Environment**

| | |
|---|---|
| Presentation of findings | *Observing* |
| Recording | Raising questions |
| Writing reports | Planning investigations |
| Drawing conclusions | Graphs, pie charts and tables |
| Identification | Classification |
| Analysis techniques | Solving problems |
| Evaluating results and hypothesising | Seeking patterns |

**Table A10: Activities Relating Simple Physics To The Physical Environment**

| | |
|---|---|
| Flight (balloons, rockets, parachutes, plant material, birds, insects) | Movement, travel and propulsion |
| Sound | Structure and function studies |
| Experiments with Forces | Properties of fire |
| Density and mass tests | Properties of gases |
| Water properties | Velocity |

**Table A11: Activities Relating Physical Education To The Physical Environment**

| | |
|---|---|
| Fitness circuits and stations | jogging trails |
| Camping skills | Map and compass work |
| camp cooking | Weekend and overnight camps |
| Work on health and healthy environments | Dangerous and poisonous plants and animals |
| Plants for health | Balancing skills |
| Safe techniques for lifting | Fine motor skills |
| Orienteering | Nature- based sports |

**Table A12: Activities Relating Biological Sciences To The Physical Environment**

| | |
|---|---|
| Identification of plants and animals | Classification of plants and animals |
| Plant growth/ Seed searches | Diaries, journals and log books |
| Preserving and exhibiting plants<br>Basic environmental science– ecology studies/environmental sustainability) | Botanical study<br>Basic remedies from natural plant and medicinal properties<br>Plant succession studies |
| Vegetative reproduction | Growth experiments |
| Ecology and ecosystems<br>Soil 'micro-life' experiments | Natural flight in birds and insects<br>Insect trapping and counts |

| | |
|---|---|
| Animal tracks, casts<br>water colonisation studies<br>Plant group studies<br>'Ant safari'<br>Diversity studies | Nature hunts<br>Germination and Habitat studies<br>Death and diseases of plants and animals<br>Water plant studies |
| Botanical and biological drawing Quadrants and Transects | Colonisation<br>Energy and food chain studies |
| Fertility experiments | 'Adopt a seedling' type projects |
| Predator and prey relationships<br>Plant collection | Plant and animal relationship studies: Plant physiology tests |
| Feeding patterns | Life in the built environment |
| Case studies of plants and animals<br>Animal and plant counts | Feeding experiments with insects, birds and animals |
| Studies of animal movement and direction decisions | Decomposition studies of plants and animals<br>Soil and plant growth tests |
| Comparing animal life styles<br>Studies of species' adaptation | Life cycles<br>Bird watching |

**Table A13: Activities Relating Geography And The Physical Environment**

| | |
|---|---|
| Direction and distance studies | Using maps and plans |
| Rocks – types and composition | Soil pits |
| Mapping to scale and map making<br>Surveying | Using compasses and compass points<br>Basic nautical studies |
| Soil (structure, texture, composition, organic content tests, pH tests)<br>Basic agriculture and land practice- e.g. hilling rice fields, terracing rice fields and drainage systems | People and land use – human geography: Other ways of life.<br>Spatial organisation<br>Basic aeronautical studies |
| Weather studies, weather station and recording water and soil cycles | Design questionnaires<br>Basic tourism? |

**Table A14: Relationship between Religious Education and the physical environment**

| | |
|---|---|
| Vegetarianism<br>Veganism | Study of natural Lifecycles – birth, life and death, group work |
| Caring for and raising animals | Celebration of life |
| Exercises in : co-operation, sharing, negotiation and compromise | Conservation exercises |
| Caring for the world<br>Traditional sports and games using the environment<br>Outward Bound (trekking, nature studies)<br>Investigating plants from other lands | Elements of the natural environment used in celebrating: Christmas, Aidil fitri (end of Ramadan) and Aidiladha), Easter, Chinese New Year, Deepavali, Ramadan, Mothers' Day, Harvest festival. |

**Table A15: Uses Of English School Grounds In School Curricula, Applicable To The Malaysian Primary School Environment.**

| | |
|---|---|
| Club-house | Mats for working on |
| Drama studio or workshop and refreshment stand | Outdoor drama theatre or art display space |
| Sculpture display area or garden | Radio controlled vehicle-racing area |
| Dancing space | Working with wood |
| D.I.Y. area or exhibitions of work | Concert theatre or space |
| Craft fairs | Paved area |
| Garages- for work or storage | Meeting spaces with night lighting |
| Playing guitar | Miniature railway track |
| Seating | Rubbish bins |
| Painting space | Mural wall |
| Smaller games areas: such as walls or fences | Space for listening to radio or music |
| Modelling area (clay and plasticine) | Sailing model boats |
| Film-making | Working on cars |
| Tables for games, and work and self defence classes | Sheds or shelters |

**Table A16: Spaces For Hobbies, Or Arts And Craft Areas On School Grounds - Offering Opportunities For Informal And Hidden Curriculum Implementation In The Physical Environment**

| | |
|---|---|
| Orchard: fruit trees and soft fruits | Growing house-plants |
| Allotments: gardening plots: for: vegetables and medicinal plants | Walled or fenced enclosures:<br>Kitchen garden and Garden sheds (potting, storage) |

The following natural phenomena, if located in school grounds, would have multiple purposes in the curriculum. Table A17 shows possible activities in these spaces.

**Table A17: School Gardens/Nature Areas**

| Nature areas | Activities |
|---|---|
| Trees | Botanical studies |
| Tall grass | Wildlife habitat |
| Grassy patches | As above-seating and play areas |
| Nature trail | Plant identification/ Wild animal tracking |
| Wildlife garden (hedgehogs, birds, frogs, insects) | Nature walks/ Butterfly catching |
| Copse | Playing/observing animals, birds/insects |
| Biology corner | Observation of frogs insects and small animals |
| Farming corner (sheep) | Learning animal husbandry |
| Rockery | Looking under rocks |
| Bird watching hut<br>Birds nests and boxes<br>Aviary or pigeon loft<br>Butterfly garden/ bird bath<br>Bird tables | Studying flora and fauna -observing birdlife<br>Listening to birds<br>Walking<br>Vegetable plots<br>growing vegetables |
| Piles of cut grass | composting |
| Fallen tree | Observing insects/climbing |
| Specimen trees | Shade/observing birdlife |
| Over grown shrubs | Insect and wildlife habitat |
| Seating<br>Sand or rubble paths | Can be positioned in a variety of micro –environments –for observation of wildlife and socialising |
| Wildlife enclosure/ Underground camera for wildlife | Observation of animals |
| Conservation area (Wild area and untouched) | Rock, fossil collecting |
| Wildflowers | Botanical study |
| Weeds and mossy grass | Natural habitats for frogs and mosquitoes |
| Pets corner (mice, guinea pigs, rabbits) | Caring for and observing pets |

**Table A18: Natural Water Areas**

| | |
|---|---|
| Bird watching hide area | Trees |
| Islands | Fountain |
| Duck pond | Rockery with waterfall |
| Frogs, newts, toads | Fresh water shrimps |
| Fresh water fish | Shallow pools |
| Stream | Bridge |
| Fish pond | Water striders (water insects) |

**Table A19: Woodland**

| | |
|---|---|
| Trees | Log cabins |
| Shrubs | Flowers |
| Ponds and Meandering stream / creek | Mangroves |

**Table 20: Outdoor Function Areas**

| | |
|---|---|
| | Toilets |
| Snack area (tables with umbrellas) and benches | Plantscapes |
| Specimen trees with chairs around | Seats |
| Picnic tables/ Picnic area surrounded by trees | Shrubs |
| Pond | Line of trees |

**Table A21: Seating And Quiet Area**

| | |
|---|---|
| | Chairs |
| Lounging bank | Water to watch and listen to |
| Benches | Trees |
| Planted beds | Table and chair sets |
| Picnic tables | Tables for outdoor lessons |
| Sun deck for sunbathing (source of vitamin D) | Fence for privacy and shelter |
| Grassed area for outdoor lessons | Paved area |
| Outdoor eating area | Concrete walled enclosure |
| Pavilion | Tables |
| grassed areas for relaxing | stream |
| Bridge | Windmills/ water wheel |
| Litter bins | Veranda |
| Flower beds | Concrete shelter |

**Table A22: Obstacle Course**

| | |
|---|---|
| Rope ladder | Climbing wall |
| Death slide | Weaving poles |
| Vertical scramble net | Mud jump |
| Tarzan swing | Abseiling wall |
| Orienteering course | Jumping ditch |

| | |
|---|---|
| Rope swing | Sand pit |
| Water jump | Horizontal scramble net |
| Fitness trail :Running track and grassland | Krypton factor type course |

**Table A24: Courtyard Aarea**

| | |
|---|---|
| Pond | Seats |
| Concrete | Flower beds |
| Specimen tree | Tables |

**Table A25: Memorial Garden**

| | |
|---|---|
| Memorial cross | Trees |

**Table A 26: Garden And Ornamental Areas**

| | |
|---|---|
| Flowers | Plant beds |
| Benches | Shelter |
| Seating | Hedges |
| Specimen trees | Specimen shrubs |
| Fish ponds | Wishing well |
| Rockery with waterfall | Lower beds |
| Walls or fences | Walking/strolling/meandering path/ trails |
| Paved area | Fountain |
| Grass area | Water follies |
| Sand area | Grass lawns |
| Formal flower garden | Grade A wood trees |
| Sculptures | Grade B wood trees |
| Paving stones | Peace garden |
| Formal gardens | Courtyard area |
| Monuments | Clock tower |
| Floor art | Wall art |
| Park shelter | Rose gardens/ local flower gardens |

**Table A 27: Playground And Adventure Playground**

| | |
|---|---|
| Swings | Concrete playing area |
| Ball-only area | Slide |
| Tables | Steps |
| Specimen trees | Climbing ropes |
| Rope swings | Trampolines |
| Bridge | Underground caverns |
| exercise yard | Graffiti wall |
| Walls and fences for shelter | Climbing rocks |
| Outdoor cooking area | See-saw |
| Skipping areas | Ball rebound wall |
| Tobogganing slope | Climbing walls |
| Tarzan swing | Grass playing area |
| Bins | Chairs |
| Different age group areas | Seating around trees |
| Hollow tree | Arboretum |
| Ecology museum | Maze and grotto |
| Tunnels | Climbing frames |
| Skateboard run | Forts |
| Rubber matting surface | |
| Sitting and viewing slope | Steps |
| Pipes | Wading in water |
| Camping | Building tree houses |
| Mounds | Private / secret place |

**A28: Sports Grounds**

| | |
|---|---|
| Running track | Archery range (general) |
| Scrambling bike track | Skateboarding area |
| American football pitch | Racing bike track |
| Outdoor trampolines | Grass tennis courts |
| Weight-lifting | Long jump |
| Football fields | Bowling green |
| Clock golf | Cricket practice nets |
| Putting green | Tarmac practice area |
| 100m tracks with seating for spectators and Changing rooms | Cricket pitch, clay tennis courts and traditional games area |
| Pitch and putt | BMX jumps, ramps and bends |
| Bike sheds | Jogging track |

| | |
|---|---|
| Racquet ball | Outdoor table tennis |
| Hammer throw | Five-a-side football |
| Hurling | Micro korfball |
| Four-a-side football | Australian rules football |
| Hurdles | Target archery |
| Roller skating rink | General artificial sports pitch |
| Outdoor basketball pitch | BMX bike track |
| Outdoor badminton courts | Javelin |
| Rounders pitch | Croquet lawn |
| Touch football field | Crazy golf |
| Concrete practice area | 800m tracks |
| Rugby pitch | Netball courts |
| All-weather tennis courts | Mini golf course |
| Bike repair workshops | Skateboard jumps, pipes and bowls |
| Handball | Volleyball |
| Judo and karate | Rugby league |
| Grass skiing | Korfball |
| Roller hockey | Field archery |
| Fencing | Drinking water fountains |
| Wind shelter | Refreshment stands |
| Five-a-side football | |

**(Adapted from Beer and Sheat, 1992a, p.43-46; 1992b, Appendix 1)**

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