

Greening urban area: innovative techniques for mitigating flood in Thailand

Végétaliser les toitures, les façades et les voiries: une stratégie intégrée pour la gestion des inondations dans les secteurs urbains

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RESUME

L'urbanisation rapide et mal planifiée augmente notablement les surfaces imperméables (béton, asphalte) qui ont un impact destructeur sur les bilans énergétiques et hydriques urbains. Ceci induit une gamme de problèmes dont les risques d'inondation, les effets d'îlots thermiques urbains, le recours excessif à la climatisation, et autres questions environnementales. Pour résoudre efficacement à ces problèmes il est nécessaire d'augmenter les espaces verts mais cette option est rendue difficile par le manque de surface au sol. En théorie, pour que les projets réussissent, il faut prévoir de grands espaces verts sur les zones à problèmes. Dans la réalité, aucune ville ne dispose de tels espaces à bas prix. Cet article décrit des méthodes innovantes de végétalisation basées sur la recherche et la pratique dans le monde entier. Les techniques insistent sur l'utilisation des toits, des façades et des trottoirs. Les avantages de la végétalisation dans les zones urbaines de Thaïlande sont décrits.

ABSTRACT

The rapidly and improperly plan of urban development contributes to a significantly increase in sealed surface area, i.e., concrete and asphalt. As compared with the green surface, concrete and asphalt have a destructive impact on the natural water and energy balances in the city, which results in an array of problems including a high potential of flooding, urban heat island effect, high usage of energy for air-conditioning as well as other environmental problems. In order to alleviate the problems logically and efficiently, green area must be increased. However, in practice it is difficult to realizable the green area due to the limit ground surface. The successful projects require that large green areas are applied to where the problems are located. In reality, such low developed-ground surfaces at minimum cost appear nowhere in the city. Therefore, innovative techniques for greening urban area from both researches and in-practices worldwide are illustrated herein this paper. The described greening techniques emphasize on the greening of roof, façade and the pavement systems. The incentive benefits of greening the urban area in Thailand are discussed.

KEYWORDS

Energy, greening roof, façade and pavement; stormwater runoff

1 GREENING URBAN AREA

Greening urban area by plants is increasing worldwide. Because of its characteristics, the greening of roofs, façade and pavement area can be used as passive methods for mitigating several problems related to an improperly developed urban area. These problems include flooding, urban heat island, high energy usage, air pollution, noise and water pollutions. Employing the greening technique, the areas increase the storage of rain within the layers of their structures, which would, otherwise, contribute to the urban runoff. The photosynthetic processes carried out by plants attribute a natural cooling effect to the surrounding environment. The green areas can also bind several pollutants diffusing in the urban air, reduce noise and also act as a filter for runoff water. In overall, the greening area is regarded an effective method for improving the environmental and ecological balance in the urban area.

Contemporary, the successful greening activities, both researches and business, are mostly carried out in the areas which pay more attention for urban environment, such as Europe, specifically in Germany, and the USA (Figure 1-4). These areas are characterized by a temperate climate. Researches conducted in tropical conditions such as Mexico and Brazil revealed more complex problems when the greening technique, e.g., on the roofs, are introduced. Examples include higher intense rainfalls and longer drought periods in a tropical climate. Such problems might contribute to a great significant impact on the plant survival and the greening structures. Under these conditions, green area may also act as a spreading and living place for mosquito and other dangerous animals. Therefore, an assessment at the particular site must be carried out to determine the successful promotion of greening activities in the regions.



Figure 1 Extensively greened roofs in combination with 53 kW photovoltaic production (Schmidt, 2004)

Due to numerous advantages of greening area especially by reducing the energy for urban usage, greening activities in sub-tropical climate will be substantially increasing in the near future. However, the gap of knowledge between the two climatic conditions (temperate and hot climates) still exist, in another mean, more and more researches have to be performed under the later conditions. In the present paper, the techniques of greening urban area used worldwide are demonstrated by

means of greening roof, façade and pavement area. The way to promote the greening activities in Thailand, as a case study, is also discussed. The focus of the work will be on the advantage of the technique for reducing flood in the urban area. However, in a hot climate country like Thailand, most of the works were attempted to implement greening area for reducing the energy within the building. Therefore, these research works will be discussed.



Figure 2 Research stations at Michigan State University (MSU), USA



Figure 3 Greening façade for reducing energy in the building as well as for promoting an efficient usage of roof runoff (Schmidt, 2006)



Figure 4 Research of the pavement area for active infiltration (Schmidt, 2004)

2 EXISTING RESEARCHS OF GREENING URBAN AREA IN THAILAND

In the urban area of Thailand, most of residential, office, street, and pavement sites are constructed with reinforced-concrete. Since rainwater can not be naturally infiltrated through this impervious layer, flooding is not uncommon. The buildings are also behaving as a heat accumulator which results in very high consumption of energy is used for air-conditioning in the capital, and other larger cities like Bangkok, Chiang Mai and Hatyai, respectively. It could be speculated that greening system is a valuable tool for future development of urban areas in Thailand. Several reasons demonstrate that there is a need for greening urban area in Thailand;

1. Flooding occurs frequently in urban areas
2. High groundwater extraction usage
3. High energy cost for air-conditioning due to hot climate
4. Urban heat islands

The above problems reveal incentives for greening the urban area in Thailand. Thai people are increasing awareness of their surrounding as they do search for a better quality of life. Greening roofs could be one of the best practices for improving the environmental and ecological status in the urban area. Green roof business in Thailand is regarded unexplored and is opening. Preliminary assessment shows that several possibilities of green roof implementation could be seen. As examples, Figure 5 shows an example of a roof and parking lots of one shopping mall in Bangkok.



Figure 5 A roof of a shopping mall and its parking lots in Bangkok

To the author knowledge based on study excursion and personal communication, only a few researches have been carried out. Summary of those research works are described here;

1st Research Group (see figure 6)

A green roof project was carried out at Ratchaphat Mahasarakarm University, located in a Northeast of Thailand. The researcher plants several local succulents, commonly found in Thailand, on a flat concrete building. The substrate layer is mainly gravel with little mineral. Totally, 4 plots have been constructed (approximately 4 m² (2x2m) each). Different plants are all grown in the same plot at various substrate depths (7, 12 and 15 cm). Hence, the measured runoff is the mixed results of different substrate depth and different plants. The reduction in runoff is evaluated by comparing a total volume of water draining out of each plot during a rain event in the connected tanks. The result demonstrated the succulent could survive with natural rain for over one year (up to the date of discussion). The quantity of runoff has not been fully collected and analyzed.



Figure 6 Green roof experimental plots at Mahasarakarm University, Thailand

2nd Research Group (see figure 6)

At the same catchment area as discussed in the first group. Another researcher carried out an extensive green roof project. It was constructed on the roof of university building, cultivating several local plants which are in fact better suite for intensive green roofs. The substrate was a local soil originate, containing high minerals. Consequently, irrigation must be maintained several times every day. Frequent maintenance of weed has to be performed, using pesticides. Several plants died during the period of study due to the improper drainage and bacteria. The measurement of temperature compared between conventional and green roofs was performed manually using temperature probes. The results might not be useful since the reduction of temperature in the building with green roof structure was probably impacted by the watering process. Although, this research gives more or less no benefit result, experience of improper research has been learnt.

3rd Research Group (see figure 7)

The third research was conducted as part of a MSc thesis in Architecture at the University. Modeled buildings (Approximately 30x30x120 cm³) were configured so that they compose of movable green roof plots on the top. They are located on the flat concrete roof of a 12th floor-dormitory in the middle of Bangkok. In the study, different types of local grass were cultivated with normal soil at three different depths. The temperature was measured at various positions continuously with temperature probes, which were then transferred to a data logger. The standard of research is much higher compared with the above researches. Knowledge could be obtained from this study such as a reduction in temperature of the building when green roof has been applied, the dependency of plant grow on substrate depth, as well as other important parameters. However, the work has been performed with little model buildings with very high height: roof ratio (e.g. like high-rise building), rather than with a high roof area: height ratio building (e.g. factory, shopping mall). The later type of building has much higher potential for green roof systems. In addition, no measurement for runoff reduction by installing green roofs is considered.

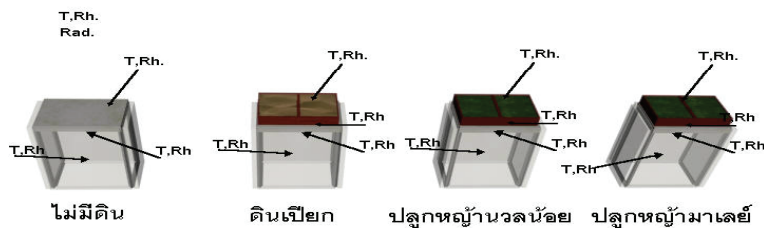
4th Research Group

Figure 7 Green roof stations for the 3rd research group (from right to left figure he compares different roof configuration; conventional flat-concrete roof, wet soil, and the last two ports with grasses)

At Chulalongkorn University, Miss Nuankakul carried out a research to evaluate the effectiveness of green roof to reduce the solar heat getting into the building. She studied the influence of the plant types, soil depth and humidity. The experimental plants include shub, groundcover and grass by comparing their effectiveness with a conventional insulate roof (model roof). It was found that green roofs can reduce the temperature up to 15 °C. The maximum value was obtained by shub plant. Soil depth show limit results in temperature reduction. The soil humidity is found to be most significant parameter determining the reduction in solar heat in the building. It was found that green roof has great benefit on the energy saving for air-conditioning.

In conclusion, experiences from previous researches in Thailand revealed that some local plant species such as sedum and succulents could be used for greening roofs because of their successful survival under extreme drought, heat and natural rainfall. Other kinds of plants need at least a frequent maintenance of watering. The reducing of temperature in the building has been investigated. Results show some positive benefit of 3 to 15°C degree in reducing temperature could be met. The measurement of reducing in runoff was overlooked and experimental setup was vague. Previous works have only few fundamental knowledge and most of the works have not been setup within the guidelines of FLL and standard criteria. It is recommended here that there is a potential need for researches of greening urban area in Thailand. The onsite experiment with the installation of several scientific measurements and a standard greening system must be performed. In addition, the benefit of greening area in terms of reducing flood must be taken into account.

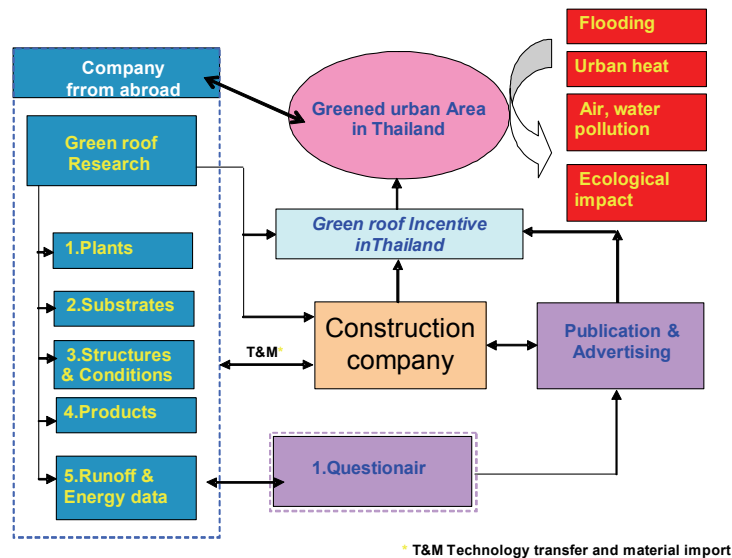


Figure 8 A schematic for introducing green area in Thailand

Summary

Unlike Europe and US, the availability of incentive and information on greening urban in tropical climates like Thailand is rare, resulting in quite a limit number of its activity being implemented. To expand and promote the greening activities - research and business - in Thailand or other countries having similar climatic conditions, a preliminary assessment is of essential. The information reported herein gives

introduction to greening research worldwide. The existing studies of greening roofs in Thailand are also summarized. Subsequently, a proposal for initiating greening activities in Thailand is present.

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