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The use of nature friendly materials in urban public space

Georgi, Neratzia Julia

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The use of nature friendly materials in urban public spaces

N.J. GEORGI* & S. SARIKOU**

*Dr. Landscape Architect(MLA), Hellenic Open University, Spec. Scient. of the Ministry of Environment, Planning and Public works,
p.o.box. 13680, 10310 athens, GREECE, e-mail: jgeorgi@tee.gr
**Landscape Architect (MLA), Technological Institution of Kavala, Department of Landscape Architecture,
P.O.Box 50019, 54013 Thessalonica, GREECE, e-mail: ssarikou@tee.gr

Abstract: - The intensive building and construction development in cities and urban spaces causes a number of serious problems that constrain city life. The last decades Landscape Architects are trying to find alternative solutions to upgrade the quality of citizen's life. Aim of this study is to perform these problems and propose the use of nature friendly materials like gravels, crushed stones, creek rocks, cobble and sand in to the landscape design. These materials are friendly in environmental and economic terms and easy maintained with high aesthetic quality. The concept of this movement incorporates and integrates to a variety of strategies during the design, construction and operation of landscape projects.

Key-Words: - decorative aggregates, dry landscapes, gravel, hard landscaping, nature friendly materials, natural environments, natural formations, pebbles, sustainable materials, urban public spaces.

1 Introduction

The materials that are used in the constructions, in cities and urban spaces, should be evaluated by bioclimatic criteria. The urban temperature is affected significantly by the absorption of solar radiation of the building and over coating materials [1].

On the contrary, the use of nature friendly materials secures fulfilling comfort conditions to the city dwellers, whereas they contribute to the general reduction of the Energy consumption [2].

There is a wide and ever-expanding menu of aggregates that can be used as a surface dressing like: pebbles, decorative gravel, slates, crushed aggregate, rock or wood chippings can all be used and give a dry effect in the spaces. The nature friendly materials are of high aesthetic quality, cost less, to supply and maintain and are environmental friendly.

The aim of the following research is to promote the use of alternative environmental friendly materials instead of the hard paving materials which distress the urban microclimate.

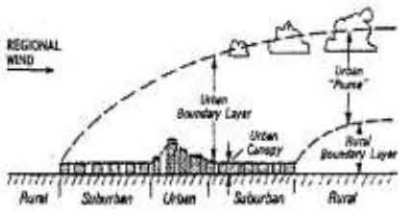
It's an obligation to protect and conserve the natural heritage for future generations of people and try to ensure, better quality urban conditions to the dwellers.

2 Literature review

The research of the microclimate is referred to the airy body that is expanded between the ground surface till the height that the underneath surface doesn't affect the climate of the place [3].

Oke express him self in the same way, when he describes the urban atmospheric marginal layer till the layer which exists upwards of the city and whose the microclimatic characteristics are changing accordingly with the buildings [4]. In the following fig.1 it's shown the planning of urban atmosphere where are represented the two airy bodies.

Fig. 1. The urban environment, where can be sown the two airy bodies [4]



Oke characterized the urban surface conditions as harsher and rougher because of the hard paved materials, warmer because of the absorption and the reflection of the materials, and tighter from those of the surrounding nature [4].
In the meanwhile the noise, the pollution and the dazzle layer are higher where there is less solar radiation [5].
Comparatively elements for the tense of the urban thermal zone in many different cities, all over the world, are performed by Oke [4] and Georgi and Zafeiriadis [6]. In particular they mention that the urban temperature is higher -2° till +15°C with max difference 5-8°C in large cities [4], [6].
Kartalis [3] mentioned that the air temperature in urban environments is 1-2°C higher than in nature environments, during the day time, whereas 6-8°C during the night in cases with windlessness. This phenomenon is called urban heat island and is observed in every urban site as coherence to the microclimatic conditions to the human influences [5].
Dafis conclude to the following verification: urban thermal climate consists of a mosaic of microclimates, with the appearance of thermal islands. Thus the urban temperature is not equable, but it depends on the special features of every small space like: building density, building height, width and orientation of streets, the existence of green or aquatic areas, etc [7].
Accordingly to these observations is obvious that human activity caused changes to the urban climates. Consequently getting improving the environmental elements in each sight, by adding vegetation or by replacing the building materials with green ones, can get enhanced the urban climatic conditions in the whole city [7].
The main reason to affect the microclimate is the creation of comfortable environmental conditions to the residents and the reduction of the building energy [8].

2.1 What is the meaning of nature friendly materials?

Nature friendly materials are divided in recycling, made of timber and wood chippings or none recycling made of pebbles, gravel and sand. Green materials (trees, shrubs and groundcover) are environmentally responsible because impacts are considered over the life of the product [9]. They are sustainable materials for creation. Landform, vegetation and water are the basic elements that comprise architect's palette, the matrix which delivers 'commodity, firmness and delight' [10].
The physical performance of materials more than perhaps any other single factor dictates whether over time a building, road or bridge becomes an asset or a liability in both environmental and economic terms [8].

2.2 The nature friendly materials

Gravel is rock that is of a certain size range. In geology, gravel is any loose rock that is at least two millimeters in its largest dimension (about 1/12 of an inch), and no more than 75 millimeters (about 3 inches). Sometimes gravel is restricted to rock in the 2-4 millimeter range, with pebble being reserved for rock 4-75 millimeters (some say 64 millimeters). Gravel is an important commercial product, used in many applications. Angular gravels are usually sourced from quarries, a by-product of the crushing processes, whereas rounded gravels are from a fluvial source, such as an old river bed, beaches, and channel dredging [11].

Fig 2. Ornamental gravels

Gravels can be of almost any colour, depending on the parent rock type, or even a multi-coloured blend.
Some important types of gravel include:
Crushed stone: This is generally limestone or dolomite that has been crushed and graded by screens to certain size classes. It is widely used in concrete and as a surfacing for roads and driveways, sometimes with tar applied over it. Crushed stone may also be made from granite and other rocks. A special type of limestone crushed stone is dense grade aggregate, or DGA, also known as crusher run. This is a mixed grade of mostly small crushed stone in a matrix of crushed limestone powder.
Creek rock: This is generally rounded stones, potentially of a wide range of types which are dredged or scooped from river beds and creek beds. It is also often used as concrete aggregate and less often as a paving surface.

Bank gravel: gravel intermixed with sand or clay.
Bench gravel: a bed of gravel located on the side of a valley above the present stream bottom, indicating the former location of the stream bed when it was at a higher level.
Fine gravel: gravel consisting of particles with a diameter of 1 to 2 mm.
Lag gravel: a surface accumulation of coarse gravel produced by the removal of finer particles.
Pea gravel refers to a well-rounded gravel, usually in the 5-10mm size range. It is a popular bedding material for laying drainage pipes.
Piedmont gravel: a coarse gravel carried down from high places by mountain streams and deposited on relatively flat ground, where the water runs more slowly.
Plateau gravel: a layer of gravel on a plateau or other region above the height at which stream-terrace gravel is usually found.
River run gravel: naturally deposited gravel found in and next to rivers and streams. [11]

A pebble is a rock with a size of 4 to 75 millimeters (some say 64 millimeters).
Pebble tools are among the earliest known man-made artefacts, dating from the Palaeolithic period of human history. Pebbles have many uses, such as floor coverings, edges covering, etc. [11].

Fig 3. Sample of White pebble

Cobble is a geologic term for a rock or rock fragment with a grain size with dimensions between 64–256 mm (2.5–10 inch). Rounded cobble sized rocks are known as cobblestone and are used as a construction material for road and street surfacing [11].
Sand is an example of a class of materials called granular matter. Sand is a naturally occurring, finely divided rock, comprising particles or granules ranging in size from $\frac{1}{16}$ to 2 millimeters. An individual particle in this range size is termed a sand grain. The composition of sand varies according to local rock sources and conditions. The bright white sands found in tropical and subtropical coastal settings are ground-up limestone. Arkose is a sand or sandstone with considerable feldspar content which is derived from the weathering and erosion of a usually nearby granite. Some locations have sands that contain magnetite, chlorite, glauconite, or gypsum. Sands rich in magnetite are dark to black in color, as are sands derived from volcanic basalts. The chlorite-glauconite bearing sands are typically green in color, as are sands derived from basalts (lavas) with a high olivine content. The gypsum sand dunes of the White Sands National Monument in New Mexico are famous for their bright, white color. Sand deposits in some areas contain garnets and other resistant minerals, including some small gemstones.
Sand is transported by wind or water and deposited in the form of beaches, dunes, sand spits, sand bars, and the like. In a desert, sand is a dominant constituent of the soil [11].

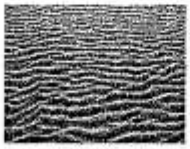


Fig 4. Sample of undulating sand

2.2 Historical elements
The ancient Greeks were popular (well-known) for their technological achievements, thus they couldn't stay behind in the transportation sector. The roads and paths in ancient Greece were made of native lapidarian rocks, in settled routes.
The compacted ground with limestone chippings is one material that recently has been used in the Olympic projects in Athens, around Acropolis. This material is a nature-friendly material with low percentage of compound energy, allowing the water absorption and is tightly connected with the Greek culture and civilization.

Fig 5. Compacted ground in the Unification of Archaeological sites in Athens

3 The Research questions

3.1 The environmental problems in the city-scape

The cities and urban spaces are suffering by the highly amounts of the compound energy. The materials that are used in the building and paving constructions like cement, concrete, zinc, bricks, plastic, polyethylene, etc. reflect the solar radiation, increasing the air temperature (see fig2) [2].

Fig. 2 Compound Energy in KWh per kg structurally materials Source: [2] Amourgis, Hellenic Open University

Type of material	Szokolay 1980	Wright 974	Chapman 1973	Several researchers	Stein 1977
Sand - gravel	0.01	-	-	-	-
Stone	-	0,85	-	-	-
Limestone	1,50	-	1,30	-	-
Cement	2,20	1,56	2,30	-	-
Concrete	0,20	-	-	300 kg* 0.305 200 kg* 0.199	0.26
Timber	0.10	-	-	0,40	-
[illegible]	-	12.90 kWh/m²	-	-	-
Brick	1.20	1,74/τούβλο	-	-	-
Iron	10,00	8,60	13,20	3.78	12.07
Copper	16,00	19,06	20,00	-	-
Aluminium	56,00	24,40	85,00	28.16	59.40
Zinc	15.00	10,60	-	16,20	-
Lead	14,00	7,14	-	-	-
Gypsum	-	-	-	0,30 MciKilep	-
Glass	6,00	-	7,20	-	-
Plastic	10,20	-	-	-	-
PVC	-	-	-	19,27 (Smith)	-
Polethylene	-	-	-	12.19 (Smith)	-
Glass fiber	3,90	-	-	-	-

The prises 200, 300 refer to the concistences of the concrete in cement

Also they perform little water absorption, causing high speed surface flow. Plants hardly manage to hold the water rainfall. Thus the paved materials perform[1]:

- Small absorption
- High Solar reflection
- High compound energy
- Low permeability
- High speed surface water flew

Fig. 8. The high solar reflection from the building materials in urban sites

3.2 What are the benefits of the nature friendly materials?

The nature friendly materials, contrary to the building materials, help reduce energy consumption in buildings and facilities. They perform:

- **Low energy reflection.**
  The solar radiation is absorbed by vegetation, for the procedure of photosynthesis or for breathing causing energy reduction, when the building materials reflect the solar radiation increasing the temperature [12].

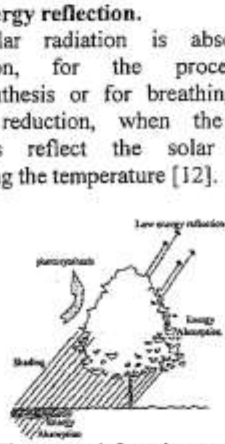


Fig. 9. The several functions of trees and natural friendly materials in urban environment

- **Low absorption and high water permeability.** The nature friendly materials because of its small size absorb less solar radiation instead of the building materials and perform high water permeability [9]. Also they are natural, plentiful and renewable. Nature friendly materials harvested from sustainable managed sources and preferably have an independent certification. Resource efficient manufacturing process: Products manufactured with resource-efficient processes including reducing energy consumption, minimizing waste (recycled, recyclable and or source reduced product

packaging), and reducing greenhouse gases [12]

- **Allowing the natural ventilation** of the ground, enhancing the air quality because they are low or non-toxic, with minimal chemical emissions [9].
- **Improve occupant health** and enhance their psychological mood [13].
- **Longer duration.** Are longer lasting materials comparable to conventional products [19].

4 Methodology

This research is a survey on the materials that are used in outdoor in modern houses and in modern city reformations in order to protect and promote nature in cities. Planning with materials that perform bioclimatic conditions is of great importance and as this survey concludes is also of high aesthetic value.

The research method was a combination of interviewing with personal visits to houses and in specific urban sites, discussing with the owners or with the designers, estimating the usage of nature friendly materials, comparing with the usage of buildings materials.

The aims of the consultation were:

- To identify the nature friendly materials that are usually used to urban sites
- The percentage of the nature friendly materials instead of building materials
- How people react to the use of nature - friendly material.

5 The Results

According to the research, in the private houses and in the urban sites, which participated in the survey, conclude to the following results: People like to use nature friendly materials in a percentage 70 - 30 %. They prefer the white pebbles 6-7cm long and the red gravel 1-1.5cm.

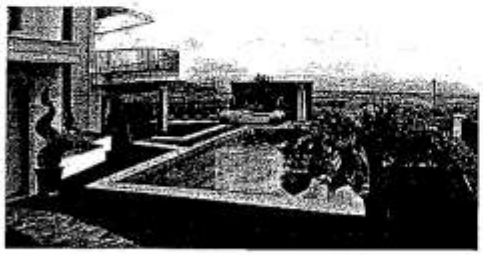


Fig. 10. A private garden design with natural friendly materials in Northern Greece [14]

They understand the environmental value but the 50% of them they seem to do it because of financial or maintenance reasons. In all the cases the sights were designed by Landscape Architects, who actually were responsible for the different materials that were used.

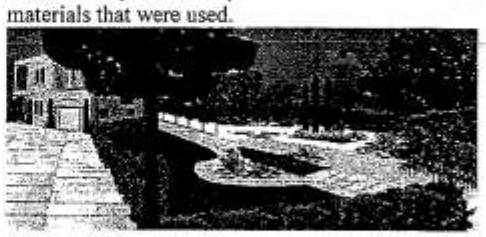


Fig. 11. A private garden with pebbles and gravel [14]

The research also concludes to the following results:

1. **The aesthetic value** of the nature-friendly materials in the garden and to the urban spaces is remarkable. Except of their natural beauty, they perform different colors and textures which can be combined with the constructions materials and act as a conventional stage from hard landscape to soft landscape. Another significant feature is the special effects that can add to the spaces. Some impressions like pond like, river like, lakes, etc.

Fig. 12. Formation of a dry river with gravel and pebbles in Malmo, Sweden.

2. **The Naturalistic value** – These materials are Environmental Friendly. They perform to the environment a meaningful character, cultural, environmental features, and create physical complexities.

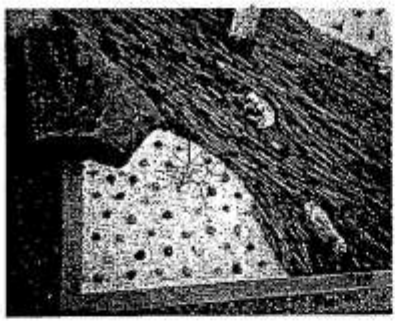


Fig 13. A dry formation with sand and slates in Malmo, Sweden

3. **Promote special solutions.** In Urban sites there are places that are difficult to get covered or to get planted. In these sites nature friendly materials are a unique solution. Except that they have different colors and textures they can be adjustable and modulate lighting, irrigation system, etc.
4. **Inexpensive practices.** The nature friendly materials are cheaper than any other material and demand less to maintain. They protect the ground surface, absorb the water, and create shade avoiding the weeds to generate.
5. **Duration** Most of these materials are sustainable. Perform lower costs associated with changing space configurations. Are moisture resistant. Products and systems that resist moisture or inhibit the growth of biological contaminants in buildings.

6. **Greater design flexibility.** Salvaged, refurbished, or remanufactured: Includes saving a material from disposal and renovating, repairing, restoring, or generally improving the appearance, performance, quality, functionality, or value of a product.

6 Conclusions

Gravels and other surface dressings provide a relatively simple path structure at a low cost. Highly decorative aggregates may be used just as well as cheap cinders or limestone chippings. Surface dressing aggregates are ideal for garden paths, and with a good sub-base, they can provide a large drive quickly and at minimal expense.

There is also some demand for gravel to be used as a surface for areas of gardens, such as in the currently popular 'Mediterranean-style' gardens to give a dry effect. In these circumstances, plants are often placed randomly within the area of gravel, and so it is essential that a reasonable top-soil exists beneath the gravel to provide nourishment and anchorage for the plants.

For driveways, paths and infill areas, colourscape products are ideal to add interest and colour around the garden. Easy to apply and maintenance free, the colourscape range offers a variety of natural colours and rock types. Using more than one colour in any area can significantly enhance the gardens appearance.

Used as mulches or in decorative areas, slate forms an attractive dressing, but when it's used for areas subject to vehicular traffic, its inherent brittleness means that it tends to get crushed down to a dust quite quickly. Now, this may not be a bad thing, as the dust generated acts as a binder and knits together the larger pieces, creating a sturdy, trafficable surface.

For decorative uses, the tumbled and washed slate is a better choice as it has had all sharp edges nullified and the claggy dust washed away, leaving an attractive, colourful, highly textured covering.

Thus there are many alternative ways to protect nature and enhance the city's appearance. That is needed is a wise management and handling of the natural resources and being innovative and flexible. Life in cities can be better as long as Landscape Architects act thoughtfully, wilfully and with responsibility. Additional survey by specialists, in other cities, can take place for more trustful results.

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