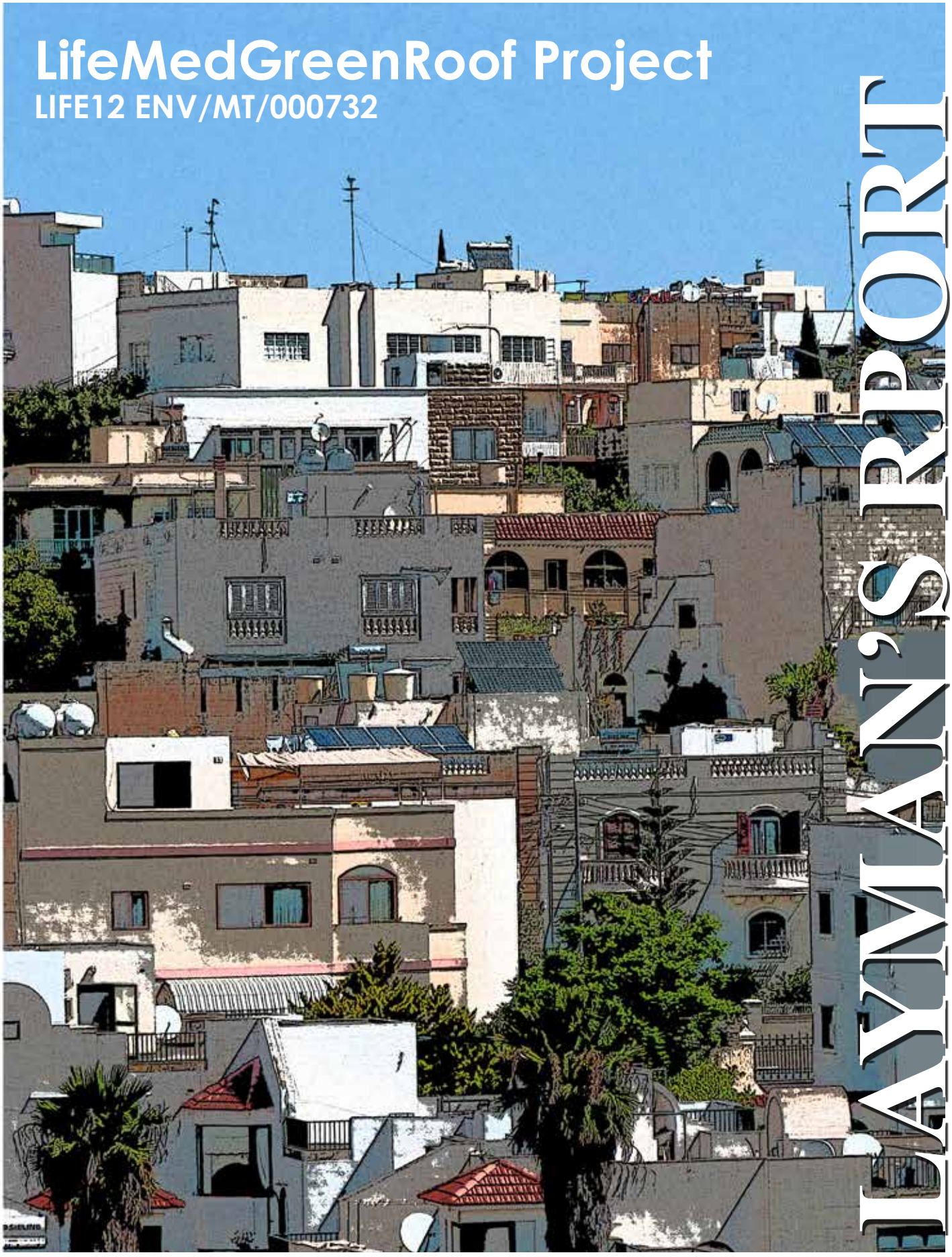
LifeMedGreenRoof Project

LIFE12 ENV/MT/000732



LAYMAN'S REPORT

UNIVERSITY OF MALTA
L-Università ta' Malta

MAC
Minoprio Analisi e Certificazioni s.r.l.

Fondazione Minoprio

MCCAA

LIFE+ Project "LifeMedGreenRoof Project; Constructing two demonstration green roofs to illustrate the potential of meeting environmental and energy targets"

LIFE12/ ENV/MT/000732

www.lifemedgreenroof.org

Coordinating Beneficiary:	University of Malta (UoM)
Associated Beneficiary:	Malta Competition and Consumer Affairs Authority (MCCAA) Fondazione Minoprio (FM) Minoprio Analisi e Certificazioni (MAC)
Total budget:	837,647.00 € (EU contribution 414,072.00 €)
Project location:	Malta, Italy
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Project Duration:	01-JUL-2013 to 31-JUL -2017
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Green roofs and the urban environment

Introduction

According to the World Health Organisation, in 2014 the urban population accounted for 54% of the total global population (WHO, 2017). Over the years there has been a sustained drive towards urbanisation, resulting in large tracts of fertile land being lost. This urban sprawl necessitated planning policies aimed at restricting the horizontal expansion of urban areas. Such policies have brought about a significant change in the urban fabric - terraced houses are being predominantly replaced by medium rise apartment blocks, resulting in high density urban areas. (MEPA, 2015)

High land prices and financial gain has led to building intensification and garden grabbing. This practice has unfortunately resulted in the reduction of gardens within towns and cities. This has led to the reduction of urban wildlife and associated benefits to humans. Urbanisation is also having a negative impact on the quality of life and well-being of the public.

Urban related problems

Towns and cities are becoming increasingly inhospitable places to live in because of high building densities, modern construction practices and lifestyle. These are creating problems such as an increase in air temperature (heat island phenomenon), increase in air pollution and localised flooding. Such problems cause unnecessary discomfort to urban dwellers. The resulting lifestyle imposes high energy demands, which then contribute to climate change.

Lack of urban vegetation - such as trees, private gardens and parks - is further intensifying these ill effects. Vegetation has the potential to reduce or mitigate these issues. They can reduce flooding, lower ambient temperature, and purify and replenish air. They also provide habitats for wildlife whose benefits are often overlooked.

Green infrastructure

Green infrastructure refers to urban vegetation as mentioned above. This vegetation can deliver a variety of environmental benefits including:

- Reduction in air pollution.
- Reduction in localised flooding
- Increase in aesthetic quality
- Reduction in ambient temperatures and in the use of air conditioners
- Creation wildlife habitats.

Unlike grey infrastructure, green infrastructure can deliver multiple benefits at the same time. However lack of appreciation of the benefits of green infrastructure results in the underuse of this technology.

Green roofs

Green roofs are considered a component of green infrastructure. They have an important role to play in rendering urban areas sustainable. There are many stuwdies which show that they can mitigate and compensate for problems within urban areas. They have become very popular in many countries throughout the world because of their advantages.

What are green roofs?

Green roofs are roofs over buildings or other structures which are covered in part or in full with a growing medium. In the growing medium vegetation is cultivated. Green roofs are constructed as a series of layers which are important for the proper efficient functioning of the system and for minimising damage to the underlying structure.

Green roof benefits

Green roofs provide a range of benefits to both the owner/occupant of individual buildings, and the community. These benefits vary between individual roofs and are dictated by factors such as design and microclimate.

Green roof benefits include:

- Increasing aesthetic value
- Increasing amenity spaces
- Insulating buildings
- Reducing the urban heat island effect
- Buffering of noise
- Mitigating flooding
- Filtering airborne pollutants
- Creating a feeling of well-being
- Creating habitats for wildlife
- Increasing property value
- Decreasing building maintenance
- Increasing efficiency of photovoltaic panels
- Job creation and increased economic activity
- Creating environmental awareness and education

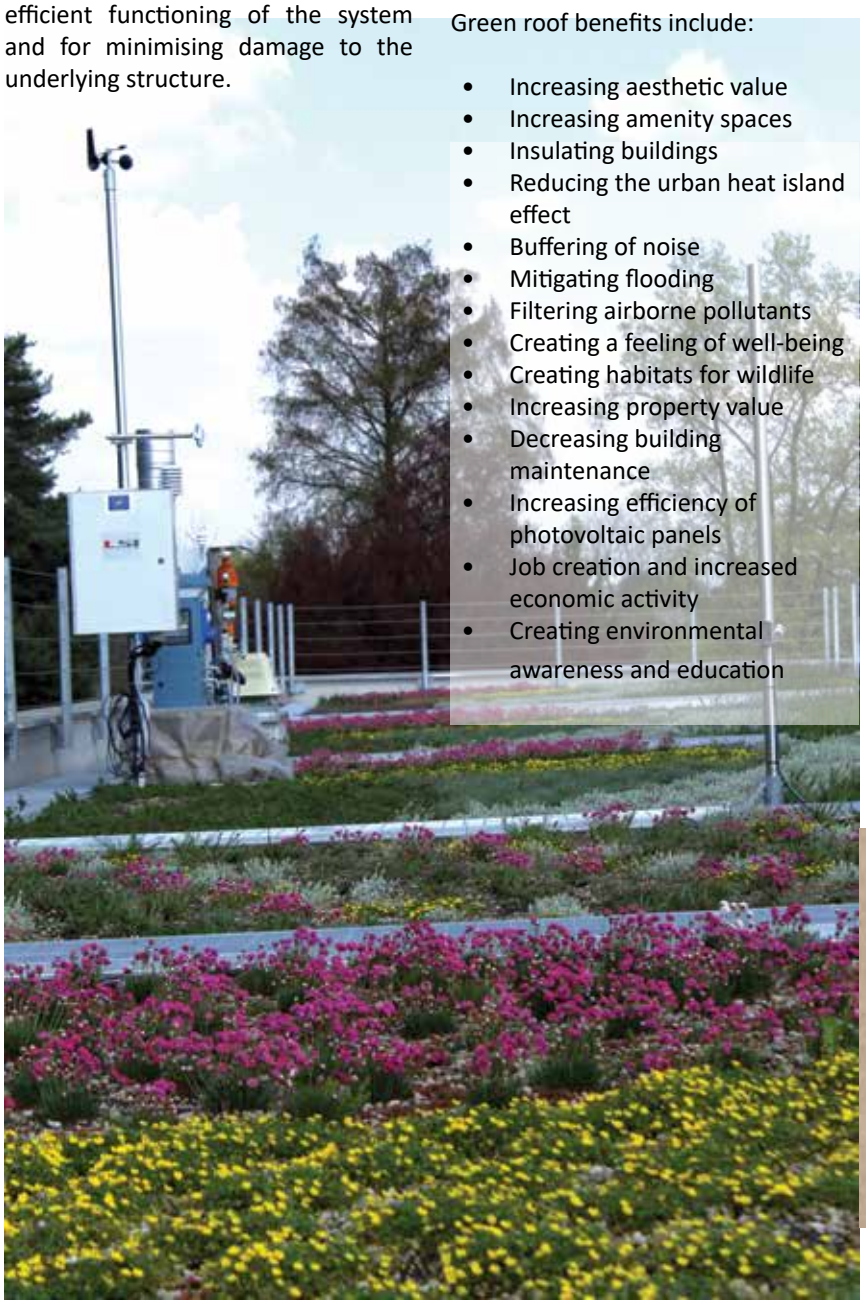


Figure 1: The basic components of a green roof.

1. **Roofing slab**
2. **Damp proof membrane**
3. **Root barrier**
4. **Drainage module**
5. **Filter fabric**
6. **Substrate (growing medium)**
7. **Planting**

Green roofs benefits

Increasing aesthetic value

Green enclaves in our towns and villages are very hard to come by. Consequently, the role green roofs play as a means of introducing greenery in urban areas should not be underestimated. Vegetation is known to visually soften the harshness of buildings and reduce glare. Greened roofs also brighten up dull rooftops creating seasonal interest with the potential of masking unsightly features such as mechanical plants.

Increasing amenity space

With the decrease in private gardens and more families living in apartment blocks, open spaces are even more important. Green roofs provide amenity space for recreational purposes and even food production.

On office blocks, green roofs provide space for the employees to socialise just like in an urban park. Public green roofs can be utilised for community functions and organising special events.

Buffering of noise

Green roofs are also able to reduce noise levels within buildings by as much as 40-60 decibels (Tolderlund, 2010). This buffering effect is influenced not only by the depth of a growing medium, but also by the type of plants cultivated, the percentage coverage and humidity levels within the substrate. (Tolderlund, 2010) (T. Van Renterghem, 2014)

Insulating buildings

During the hot summer months, the uppermost floors within buildings suffer from elevated temperatures causing discomfort to the occupier.

Studies (Zhao, et al., 2014) have proven that green roofs can be effective in reducing temperatures within buildings. Green roofs can shade the roof from the sun's energy contributing to the creation of a more comfortable internal environment with the advantage of a reduction in the use of air conditioners. (Austin, 2014). The properties of insulation vary depending on the area of green roof cover, the depth of growing media, the plants used and micro-climate.

Mitigating flooding

Most of the ground within an urban area is covered by impervious material (be it asphalt, concrete or a building) which prohibits the absorption of water into the underlying rock. Instead, the water runs over the paved surface which could lead to local flooding.

Green roofs absorb and retain precipitation. Both the growing medium and the vegetation can absorb rain, therefore reducing run-off. The volume of water retained by the substrate depends on the frequency and intensity of rain events (Berndtsson, 2010) (Stovin, 2012). Other aspects which effect the extent of flood mitigation include the depth of the substrate, the make-up of the substrate, the type of drainage layer, roof slope and vegetation type and density (Tolderlund, 2010) (Bursztа-Adamiak, 2012).

Filtering airborne pollutants

"Across Europe, people are exposed to levels of air pollution that exceed air quality standards set by the EU and the World Health Organization (WHO)" (European Environment Agency, 2009). Air pollution is a justified public concern. According to the Eurostat report, deaths related to respiratory disease in Malta are substantial (Eurostat, 2013). Children and the elderly are mostly effected (European Environment Agency, 2009). Good air quality is important for an increased quality of life.

Plants are known to remove pollutants from the atmosphere. Roof greening also improves air quality by reducing ambient temperatures and the generation of smog (European Environment Agency, 2009). Green roof systems are also known to trap contaminants found in the air we breathe. (Vijayaraghavan & Joshi, 2014)

Creating habitats for wildlife

Green roofs benefit urban wildlife which in turn provide benefits to humans. These benefits include pollination and air purification (European Commission, 2016). Green roofs provide feeding grounds and shelter to important creatures such as bees and butterflies. They also provide habitats for wild plants, providing an opportunity for native vegetation to once again colonise urban environments (Madre, et al., 2014) (Oberndorfer, et al., 2007).

Increasing property value

More attractive properties fetch better prices, in terms of lease and sales. A study in New York has found that properties rented out with a green roof were, on average, more expensive than in buildings without green roofs (Ichihara, 2011). A study in Canada estimated that properties with green roofs were valued higher than conventional buildings, whereas buildings with views onto greened roofs were also higher in value (Tomalty & Komorowski, 2010).

Creating a feeling of well-being

Nature provides a "multiple benefits to humanity, from food, clean water and flood protection to cultural heritage and a sense of place, to name but a few. However, many of these benefits, known as 'ecosystem services', are under severe threat from man-made pressures". (Brickhill, 2015)

Studies have demonstrated that the presence of green open spaces and less high rise buildings contribute to a healthier lifestyle, whereas people living in areas with ample green open spaces are more active (Ellaway et al., 2005). School children with access to, or in sight of, the natural environment show higher levels of attention than those children without (Velarde et al., 2007).

Humans feel more at ease when surrounded by what is perceived as natural (Kaplan & Kaplan, 1989).

Green roofs provide more pleasant views from the conventional black roof tops and can provide visual respite and amenity to the onlookers. Such enhanced views provide a sense of well-being, increasing ones' quality of life.

Reducing building maintenance

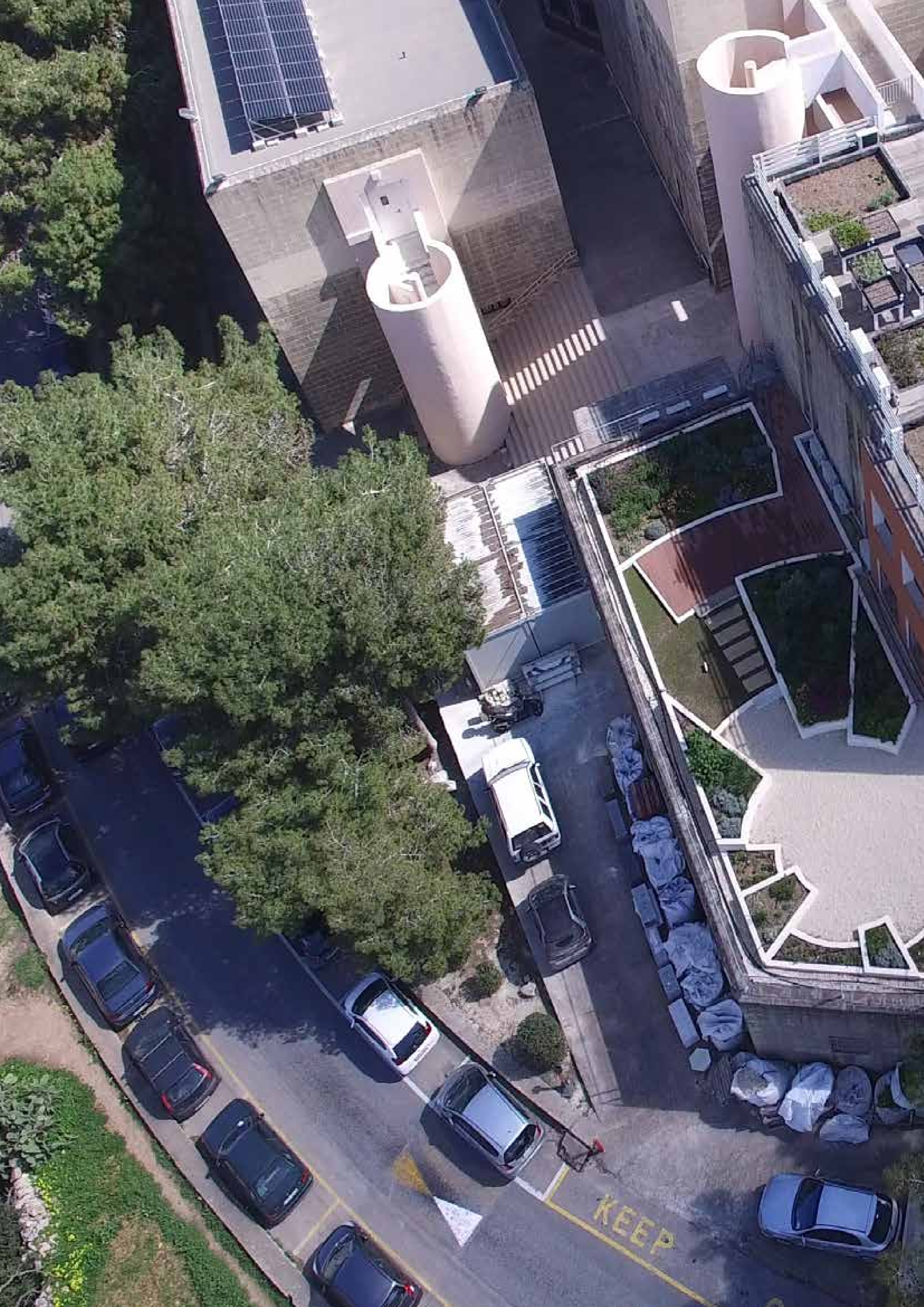
Green roofs create a permanent insulation cover on the roof and damp proof membrane. On a conventional roof, both the slab and the membrane suffer damage due to the constant expansion and contraction related to temperature fluctuation. This results in the degradation of the membrane and the creation of hairline cracks in the concrete. This condition is particularly relevant to Malta given the hot summers season. The protection given by green roofs results in the extended lifetime of the roof, resulting in less maintenance and associated costs for the owner. Green roofs maintain relatively constant temperatures especially on a daily cycle.

Solar panel efficiency

Solar panels work efficiently up to 24°C and 25°C. When ambient temperatures escalate beyond these levels, PV panels lose efficiency. Green roofs, through evapotranspiration, are able to lower the ambient temperatures, which means that solar panels work more efficiently, generating more energy. Experiments carried out in Hong Kong found that a combined green roof–PV system produced 4% more power (Nagengast, et al., 2013).

Job creation

With the increase in popularity in green roof technology, new job opportunities are created in all sectors of the market benefitting the local economy (Rowe, 2006) - from importers of raw material to manufactures, transportation to retail, and from design to construction. They also provide an opportunity for research and innovation.


KEEP

The LifeMedGreenRoof Project

Although local building practices allow for the installation of green roofs with limited structural intervention, green roofs have never been popular due to misconceptions related to plant survival and issues of water leaks. Given that there is little information on local green roof performance, it was only natural to propose a project which would test basic concepts on green roofs, paving the way for further studies but at the same time providing the opportunity and know-how for the technology to be replicated by others.

The LifeMedGreenRoof Project started in November 2013 and is planned to extend until July 2017.

Aims and objectives

The aims and objectives of the project are:

- Sourcing locally available materials for use as a growing medium. Such materials could include industrial waste
- Creating substrates adequate for the local climatic conditions
- Studying the adequacy of native plants on a green roof environment
- Analysing the insulation properties of green roofs
- Quantifying the flood mitigation of green roofs
- Disseminating the above findings to the public and to policy makers
- Constructing a green roof for demonstration purposes
- Developing guidelines for the construction of green roofs
- Proposing the need for policies to integrate green roofs into the construction industry

Expected results

The project's expected results include:

- The creation of a growing medium adapted to the local climatic conditions and vegetation type
- Identification of plant species which are suited to growing in a green roof environment
- The construction of a demonstration green roof
- The change in people's perception of green roofs
- The publication of data on the insulation properties of green roofs
- The publication of data on the storm-water management characteristics of green roofs
- The drafting of a National standard on green roofs
- The drafting of document on green roofs policies and their presentation to the relevant authorities

Methodology

Plant selection

Initial efforts were focused on identifying species which were able to survive on a green roof environment.
In both Italy and Malta, the plant selection was carried out following a desk study on the local native habitats. Native plants are important on a green roof because they are adapted to the local climatic conditions, they are able to provide both food and shelter to local fauna and they generally require less maintenance. The plants selected were propagated and tested in green roof simulation beds to verify their compatibility with the exposed roof environment and with the green roof substrate. Over 15 species of plants were identified in both Italy and Malta. Most of these plants were eventually used within the demonstration green roofs. Other non-native species were also identified for their visual appeal and resilience.

Substrate creation

Soil is not ideal as a growing medium on green roofs. Soil tends to have a considerable amount of very fine particles which, in time, would clog the filter fabric. It can become waterlogged and heavy. Soils tend to lose bulk and become compacted. These characteristics would have a negative influence on the plants and could even increase maintenance cost.

MAC carried out studies on various components to create two engineered growing media for Malta and four for Italy. Unfortunately, locally available components identified in Malta were deemed unsuitable, mainly because of the high carbonate content. It is thought that this could lead to problems of sintering in the short/medium term. A high pH would also impede the absorption of certain nutrients by plants, leading to plant failure.
All substrates were created to satisfy local climatic conditions. Biochar, an innovative material, was also used in the makeup of some of the substrates.

Dissemination of information

Many people have visited the green roof throughout the course of the project. The intention has been to create awareness amongst stake holders on the need to adopt green roofs within the urban areas.

Various articles and press releases have been published in local newspapers and magazines. Radio interviews and TV news articles have also been conducted. Talks were given on various occasions. Most of these presentations were requested by organisations and NGOs. Exhibitions were also set up at various venues and public areas.

The website and a Facebook page have been regularly updated with information and images pertaining to activities carried out by the project.

Testing plants and compatibility with growing media

Green roof simulation trays were constructed in both Italy and Malta and filled with the proposed growing media. Test trays were planted with the selected species so as to confirm whether plants were able to survive in an exposed micro-climate. The tests also verified the compatibility of the plants with the substrate, and whether the substrates perform satisfactorily in terms of porosity and storm water management.
Following successful trials, two demonstration green roofs were constructed (one at FM and another at the UoM). These green roofs were open to the public and allow for further research on green roof technology.

Green roof performance

The LifeMedGreenRoof Project was required to verify and quantify the potential benefits of green roofs in a Mediterranean environment. For this reason, both FM and the UoM set up equipment to monitor 1) the insulation properties of green roofs and 2) the storm water retention of green roofs. This was done to compare the performance of green roofs with that of a conventional roof.

Policy document and socio-economic document

A document aimed at policy makers has been drafted to encourage the implementation of policies, incentives and directives to have green roofs implemented on a wider scale in Malta. Such policies already exist in Italy. The document, highlights the need to introduce such policies and gives recommendations on the type of policies, incentives and directives appropriate to the Maltese scenario.

To better understand the broad benefits of green roofs, a document on the socio-economic benefits of green roofs has been drafted. The document looks at how green roofs can benefit the socio-economic scene in Malta.

Both documents can be found on the LifeMedGreenRoof project website, www.lifemedgreenroof.org

Standard document (SM3700:2017)

A Maltese standard for green roof construction has been published. This Standard (Criteria for the planning, construction, control and maintenance of Green Roofs - SM3700:2017) provides professionals with information to ensure that green roof systems are planned, constructed and maintained in accordance to best practices and within the Maltese legal framework. It has been developed following the need to identify best practices to plan, construct and maintained green roofs on new and existing roofs taking into account the Maltese Islands' environment and construction practices. Such a document already exists in Italy.
The document can be found on the LifeMedGreenRoof project website, www.lifemedgreenroof.org

Results

Following the tests carried out during the course of the project, it resulted that:

- Native plants can be successfully grown on a green roof even when exposed to direct sunlight and wind.
- The growing media is able to retain between 60% to 90% of the annual precipitation depending on the depth, the frequency and intensity of rain events.
- Green roofs are able to reduce the use of air-conditioners to cool the underlying rooms due to the insulation effect of the substrate and plants.
- Green roofs maintain the temperature of the roof slab and damp proof membrane stable especially during the hot summer season.
- In winter most plants can go without irrigation. In the dry season irrigation need not be intensive.
- Green roofs create important wildlife refuge for pollinator insects and other beneficial creatures including birds and butterflies.
- Green roofs help create pleasant environments especially to those with windows or views overlooking the roofs.

The LifeMedGreenRoof projects represents the first real effort in Malta to prove that green roofs can be successfully implemented. It provided a better understanding of the potential green roofs have in reducing local flooding and reducing the carbon footprint of buildings in a local context. The results achieved were promising and encouraging. Through the project it has become clear that action has to be carried out by local authorities to integrate the technology into the planning system and construction industry.

The project has also identified that further research should be encouraged within this sphere and the sphere of green infrastructure, so as to better understand their potential and create more pleasant urban areas.

Key priority areas

Key priority areas for future action include:

- *Community involvement* is very important in making the technology acceptable to society. This can be achieved through community workshops, meetings and information sessions. Community leaders, professionals, NGOs and policy makers should engage in the support of green roofs.

- An *action plan* is needed to introduce green roofs into local policies and create awareness about such technology. Green roof technology should not be seen as a benefit to society. The action plan should be complete and clear, so that all players are made aware of the aims and objectives and the direction to be taken during its implementation.

- *Technical research* is important to substantiate the theory of green roof performance. Green roofs are undeniably efficient in mitigating urban related problems; however, awareness of their performance locally would provide a stronger tool to encourage its dissemination.

- The establishment of *policies and incentives* is required to encourage the dissemination of green roof technology. The use of both policies and incentives is important as they target different stakeholders.

- Both central government and local governments could *lead by example* and commit themselves to developing green buildings. By introducing green roofs on public buildings, an example is set. Public entities such as educational institutions and government offices could support demonstration green roofs.

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LifeMedGreenRoof Project

MEETING ENVIRONMENTAL TARGETS

Partially funded through LIFE+ the EU's financial instrumentsupporting environmental and nature conservation projects throughout the EU.

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