Green roof design techniques to improve urban water management under Mediterranean conditions

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LINKING LANDSCAPE, ENVIRONMENT, AGRICULTURE AND FOOD LEAF

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what? Green roof design techniques

why? to improve urban water management

where? under Mediterranean conditions

Green roof design techniques to improve urban water management under Mediterranean conditions

1. the problem

   green roofs in climates with hot dry summers

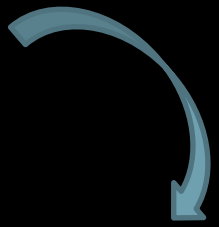
2. solutions

   ? solutions to optimize water management – minimum water requirements

3. take home messages

1. the problem

climates with hot and dry summers, Mediterranean regions, the need to irrigate



but costs might outrun the benefits

Why do we want GRs?

- help mitigate the urban heat island effect
- buildings thermal insulation
- cope with floods
- pollution
- wellness and aesthetics
- property value
- … …

1. the problem

- GRs help cool the environment and the buildings but irrigation has costs
  - careful analysis of the costs is required

- extreme drought events: priority uses, watering restrictions in landscape irrigation , privileging human, agriculture and industry uses
  - implementation of GRs in zones prone to such events should prevent the situation, low water demanding solutions should be used

innovative green roof design techniques that cope with water limited environments can provide adequate sustainable solutions

create solutions

2. solutions
    1. use of drought adapted species (native)
    2. use of construction materials with water retention capacity
    3. deficit irrigation maintaining aesthetic value
    4. mixtures of vascular plants and bryophytes
    5. moss-dominated biocrust roofs
    6. precultivated vegetation blankets for roofs
    7. wall plants transplanted to roofs

the green roof lab

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rooftop of the Herbarium

experimental set up created in 2014, in the frame of the *NativeScapeGR* project

NativeScapeGR

Green roofing with native species:

alternative urban landscape areas to enhance water use and sustainability in Mediterranean conditions

EXPL/ATP-ARP/0252/2013
www.isa.utl.pt/proj/NativeScapeGR/
https://www.facebook.com/nativescapegr

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Minimize *water requirements* without compromising *aesthetic value* enhancing *biodiversity* and *sustainability*, providing a tool for *climate change* adaptation

NEOTURF

SIGMETUM
PLANTAS AUTÓCTONES

Mediterranean Garden Society

MedMossRoofs

MedMossRoofs: Urban green covers based on mosses with no irrigation requirements under Mediterranean climate

PTDC/ATPARP/5826/2014

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apiWall - another plant in the wall 2018








1. solutions

    1. use of drought adapted species (native)

Brachypodium phoenicoides

Rosemary
(*Rosmarinus officinalis*)

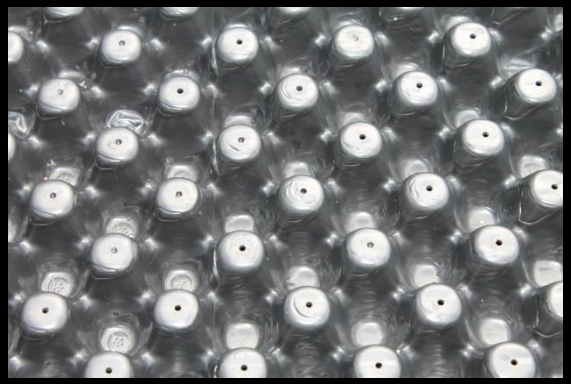
Rosmaninho
(*Lavandula luisieri*)

mosses

2. solutions

2. use of construction materials with water retention capacity

vegetation
lightweight substrate
filter
drainage layer
moisture retention layer
root-resistant waterproofing barrier



maximum water retention: 8 mm

approximately the double of the water lost by evapotranspiration in a typical summer day for deficit irrigation conditions, for example in a *Rosmarinus officinalis* test bed

2. solutions

3. deficit irrigation maintaining aesthetic value

- two irrigation levels (full irrigation, deficit irrigation)
- comparisons for identical species or identical substrates
- aesthetics evaluation method (Anico, 2015)

T8, S1, 100

T6, S1, 60

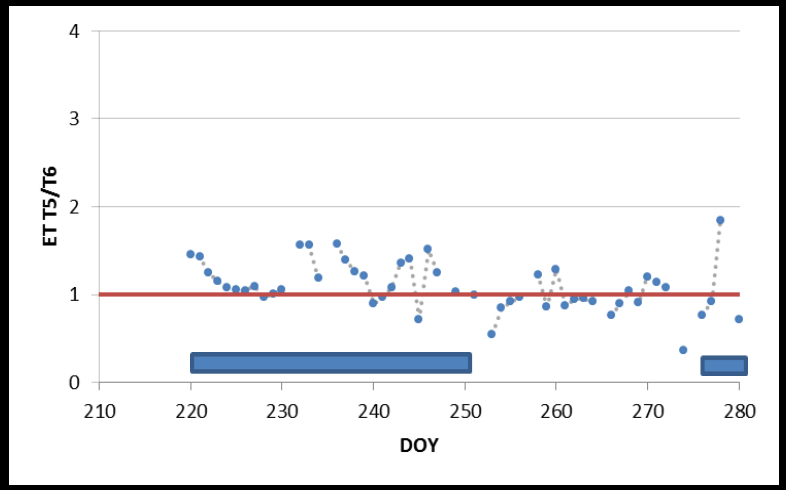
example with rosemary

differences were not significantly reflected in the aesthetic value that was in general maintained

2. solutions

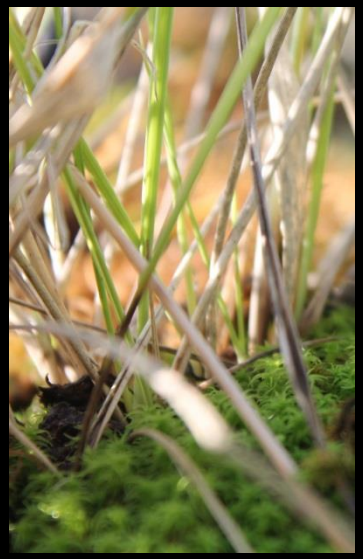
4. mixtures of vascular plants and bryophytes

Lavandula luisieri
Rosmarinus officinalis Brachypodium
phoenicoides Pleurochaete
squarrosa



Relative evapotranspiration (ET/ETo) of a test bed with all the vascular plants mixed with bryophytes (T5) and T6 (*Rosmarinus officinalis*).

- evapotranspiration was higher for the mix, indicating a higher water retention
- probably due to the presence of mosses, since irrigation levels and substrates were the same
- results from the high water retention of the mosses that can benefit the soil moisture content around the vascular plants
- nature-based solution, since it is a replication of what is observed in the natural environment



2. solutions

5. moss-dominated biocrust roofs

- non-irrigated (rainfed conditions)
- bryophyte-dominated biological soil crusts (biocrusts) - ability to lose almost all water from inside the cells and upon rehydration regain normal function

- dry and brown aspect during summer
- after the first rains in September they restarted activity

- possible to maintain the selected species without irrigation in such conditions

- can be grown in two months under controlled climatic conditions

solution for low-cost green roofs
- urban areas with dry, hot summers, no irrigation
- increase water use efficiency of other vascular plants if irrigation is required
- lightweight
- attenuate floods by the ability of some mosses to retain water up to eight times their dry weight

2. solutions

6. precultivated vegetation blankets for roofs

organic geotextile blanket, made with a coconut fiber matrix, reinforced with a fine photodegradable net (Ecosalix®, EROMAT 6s)

- tests for seed adhesion to the geotextile blanket: different combinations of water, flour and gelatine

  most suitable combinations were the mixture 4:1 of water and flour or just plain water

- tests with substrate

Centrathus ruber (10%), *Asphodelus fistulosus* (30%), *Sanguisorba verrucose* (30%), and *Papaver rhoeas* (20%), *Capsela bursa-pastoris* (10%)

Trifolium angustifolium (30%), *Brisa maxima* (30%), *Silene scabriflora* (10%), *Stachys germanica* (10%), *Teucrium scorodonia* (20%).

blankets act as mulches - interesting for green roofs in what concerns water conservation

1. solutions

7. wall plants transplanted to roofs

apiWall - another plant in the wall 2018

Centrathus ruber (L.) DC., *Asphodelus fistulosus* L., *Antirrhinum linkianum* Boiss. & Reut, *Sedum sediforme*

TAKE HOME MESSAGES

less water, no water, store water

native plants so far studied were adequate to sustain deficit irrigation without significant loss of aesthetic value

a non-irrigation solution was found – Biocrust roofs

the mixture of vascular plants and bryophytes, a nature-based solution, was the most interesting solution for plant selection

plants from walls and rocky environments were able to survive and develop in green roofs

THANK YOU!

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