

Green Roof Systems: How buildings Reduce Heat and Stormwater

Myesha Tasnim

“Urban areas can be up to 5-7°F hotter than surrounding regions due to the urban heat island effect. Green roofs convert unused rooftop space into functional ecological systems that reduce heat, manage water, and improve building performance.”(Getter & Rowe, 2006)

What Is a Green Roof

A green roof is a roof covered with vegetation planted over a waterproof membrane. It has a series of layers worked together to support plant growth, manage water, and improve the urban environment. Green roofs are a form of green infrastructure that brings nature into our cities. (Oberndorfer et al., 2007)

Origin and Development

- Early examples of rooftop gardens can be seen in the Hanging Gardens of Babylon during 600. BCE. (Source: Encyclopedia Britannica, 2023)
- Studied by researchers like Kristin L. Getter and D. Bradley Rowe.
- Modern green roof systems were developed in Germany during the 1960s-1970s to improve urban sustainability and building performance.
- (Source: Research Gate)



Fig. 1: Hanging Gardens of Babylon



Fig.2: Modern Green roof in Germany

Key Terms

- **Stormwater Runoff** - Water from rain or melting snow that flows over surfaces instead of soaking into the ground.
- **Urban Heat Island** - Urban areas become much warmer than nearby rural areas due to buildings and pavement absorbing heat.
- **Evapotranspiration** - The process where plants release water vapor into the air, cooling their surroundings.

Performance Data

- Green roofs keep the surface temperature cooler.
- Peak temperatures are significantly reduced compared to regular roofs.
- This contributes to reduced urban heat island effect and energy savings
- Cost range: \$10-\$25 per square foot (Getter & Rowe, 2006; Oberndorfer et al., 2007)

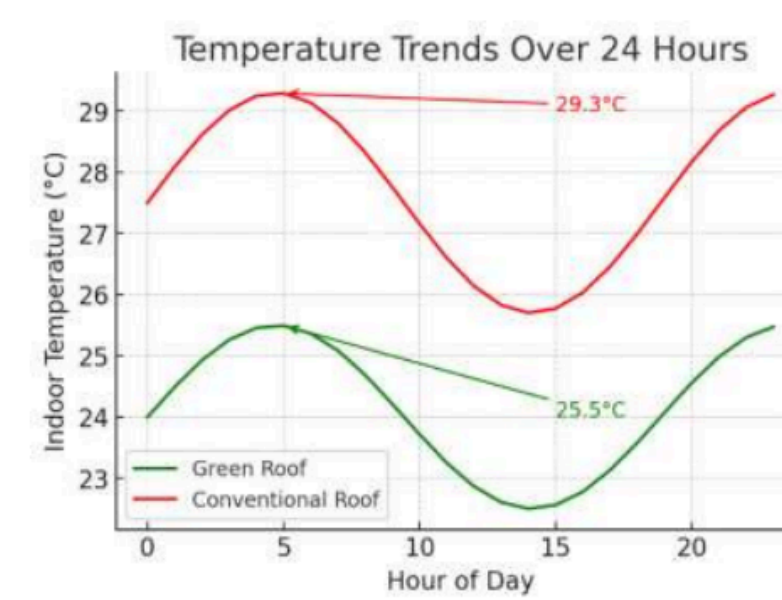
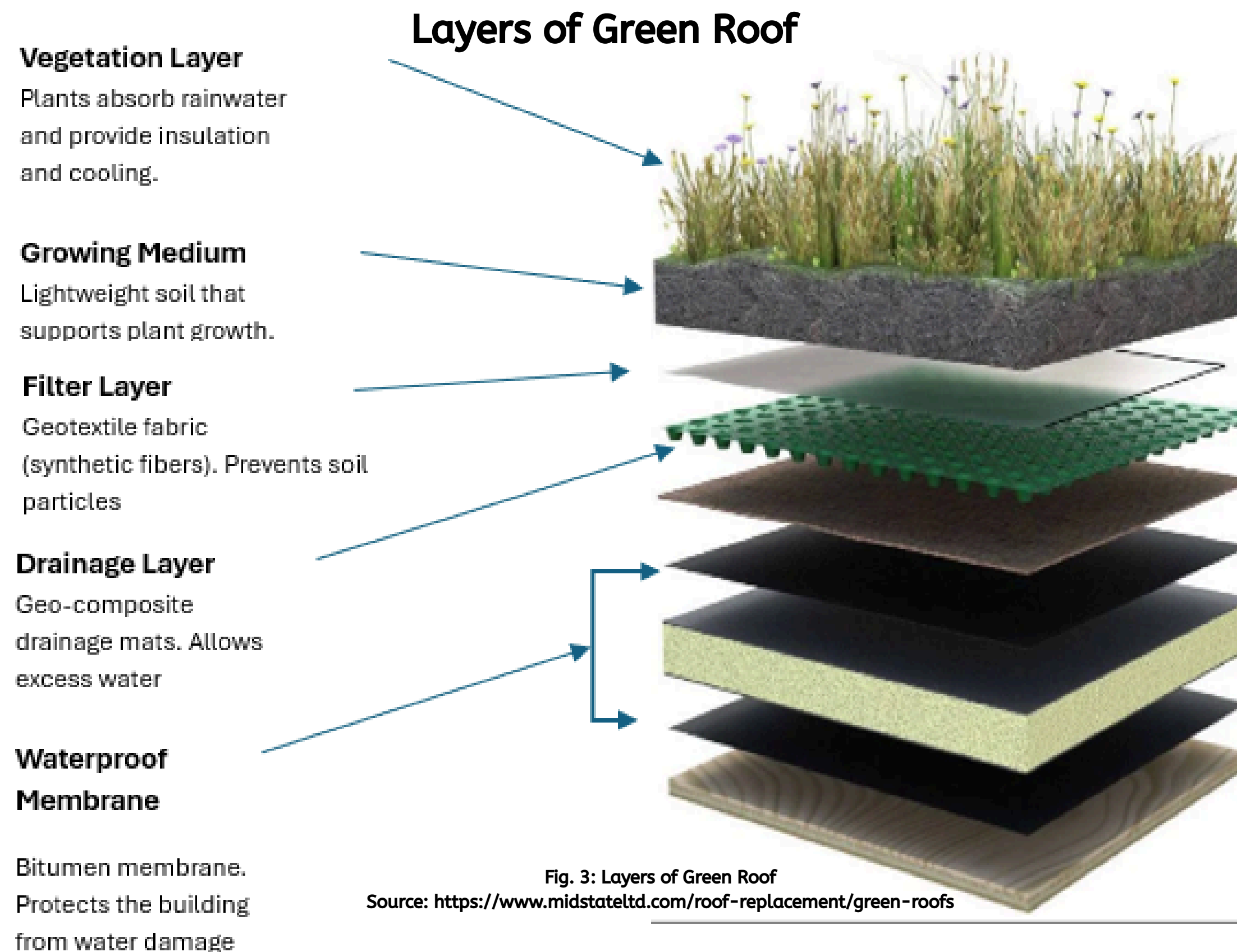
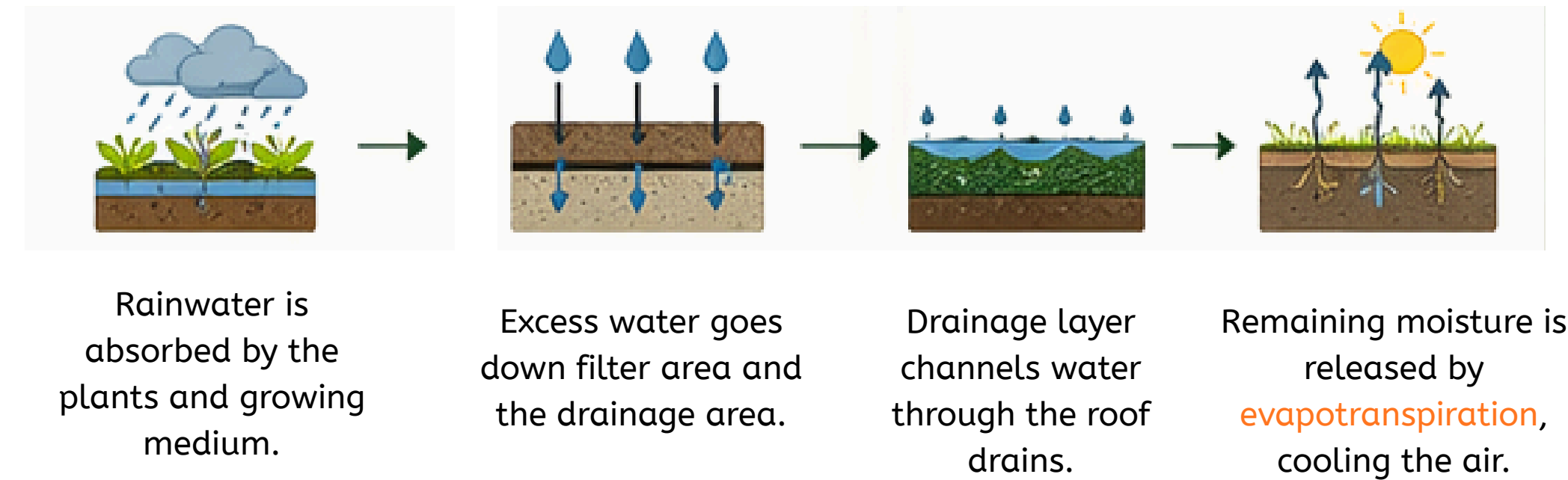


Figure 6 - Temperature trends over 24 hours comparing green roofs and conventional roofs. (Source: IJERD, n.d.)



How It Works



(Oberndorfer et al., 2007; Getter & Rowe, 2006)

Real-Life Example

- Acros Fukuoka, Japan:**
- Iconic stepped green roof building.
 - with public access.
 - Reduces heat and stormwater runoff.
- Source: Green Roofs.com



Fig.4: Acros Fukuoka, Japan

- Nanyang Technological University, Singapore**
- Completed in 2006.
 - Features a large sloping green roof.
- Source: Green Roofs.com



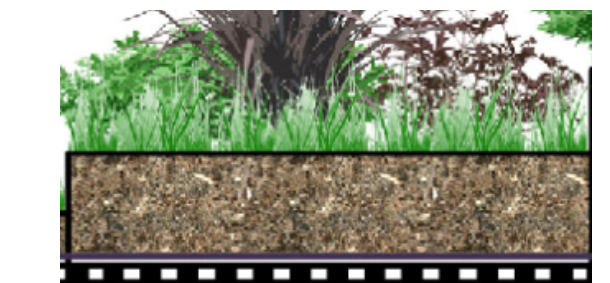
Fig.5: Nanyang Technological University, Singapore

Types of Green Roof



EXTENSIVE

- Shallow soil (5-15 cm).
- Lightweight.
- Low maintenance.
- Common on large buildings.



INTENSIVE

- Deep soil (15 cm or more)
- Supports a wide variety of plants, including trees
- Requires regular maintenance
- Used for rooftop gardens

Benefits

- Reduces **Urban Heat Island Effect**.
- Controls **Stormwater Runoff**.
- Improves air Quality.
- Adds Green Space in Urban Areas.

Limitation

- Structural load: 15-50 lbs per sq ft (or more).
- Requires waterproofing integrity.
- Maintenance needed to prevent plant failure.
- Higher installation cost than traditional roofing.

FAQ

- Can all buildings support green roofs?**
No. Buildings must be structurally strong enough to support the extra weight of soil, water, and plants.

Future of Green Roof

- Integration with smart water management systems.
- It can be combined with solar panels (biosolar roofs)
- Use in climate adaptation strategies
- Policy-driven expansion in major cities

Green Roofs In NYC

- Several green roofs in NYC are open to the public or visible from streets.
- Consider visiting:
- Brooklyn Grange.
- Rooftop at the Javits Center
- The High Line (elevated green park)

Video Resources Recommended

How green roofs can help cities- NPR- <https://youtu.be/FLJoBhLnqko?si=eeQ9PeRKmn1uixo0>
Different Types of Green Roofs - Green roof organisation https://youtu.be/qb___7hGW2M?si=suf1AtgbpGa0ufLT
What Are Green Roofs and How are They Beneficial <https://youtu.be/BnEFqiO6EcE?si=VitBOhFErm4F0nqb>

Work Cited

- Getter, K. L., & Rowe, D. B. (2006). The role of extensive green roofs in sustainable development. *HortScience*, 41(5), 1276-1285.
- Oberndorfer, E., Lundholm, J., Bass, B., Coffman, R., Doshi, H., Dunnett, N., Gaffin, S., Köhler, M., Liu, K. K. Y., & Rowe, B. (2007). Green roofs as urban ecosystems: Ecological structures, functions, and services. *BioScience*, 57(10), 823-833.
- International Journal of Engineering Research and Development (IJERD). (n.d.). Temperature trends over 24 hours. <https://ijerd.com/paper/vol21-issue5/2105161167.pdf>

- Greenroofs.com. (n.d.). ACROS Fukuoka Prefectural International Hall. <https://www.greenroofs.com/projects/acros-fukuoka-prefectural-international-hall/>
- Greenroofs.com. (n.d.). Nanyang Technological University School of Art, Design and Media. <https://www.greenroofs.com/projects/nanyang-technological-university-ntu-school-of-art-design-and-media-adm/>
- Midstate Ltd. (n.d.). Green roofs. <https://www.midstateltd.com/roof-replacement/green-roofs>
- ResearchGate. (n.d.). View of green roofs in Stuttgart, Germany. https://www.researchgate.net/figure/ew-of-green-roofs-in-Stuttgart-Germany-Internet_fig16_301357116
- Wikipedia contributors. (n.d.). Hanging Gardens of Babylon. https://en.wikipedia.org/wiki/File:Hanging_Gardens_of_Babylon.jpg