

Indoor plants, our environment and happiness

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HAPPINESS
& its causes



UTS

UNIVERSITY
OF TECHNOLOGY
SYDNEY

We function better with green plants

- Plants produce positive physical and psychological outcomes

Reductions in:

- Sick leave
- Coughing, fatigue ,
headaches, sore eyes,
nose or throat
- Poor Concentration
- Stress, depression

Improved:

- Work productivity
- Job satisfaction
compared to
window views

- Due to '*attention restoration theory*' through '*exposure to nature*'

Biophilia Hypothesis



- Humans 'preconditioned' to be in nature
- Current workplaces are designed to focus on efficiency rather than psychological wellbeing
- Biophilia promotes health, productivity and performance
- Indoor plants bring a surprising level of biophilia indoors



UTS Studies: Indoor plants cause changes in mood states



- Plant treatments in 60 university offices

Reductions in negative-feeling scores:

30% reduction in confusion

37% reduction in tension/anxiety

38% reduction in fatigue

58% reduction in depression/dejection

44% reduction in anger/hostility

4% increase in vigour

Plants directly reduce stress scores - Promoting productivity and performance

Biophilia has growing, international credentials

Productivity gains with biophilic workplace design

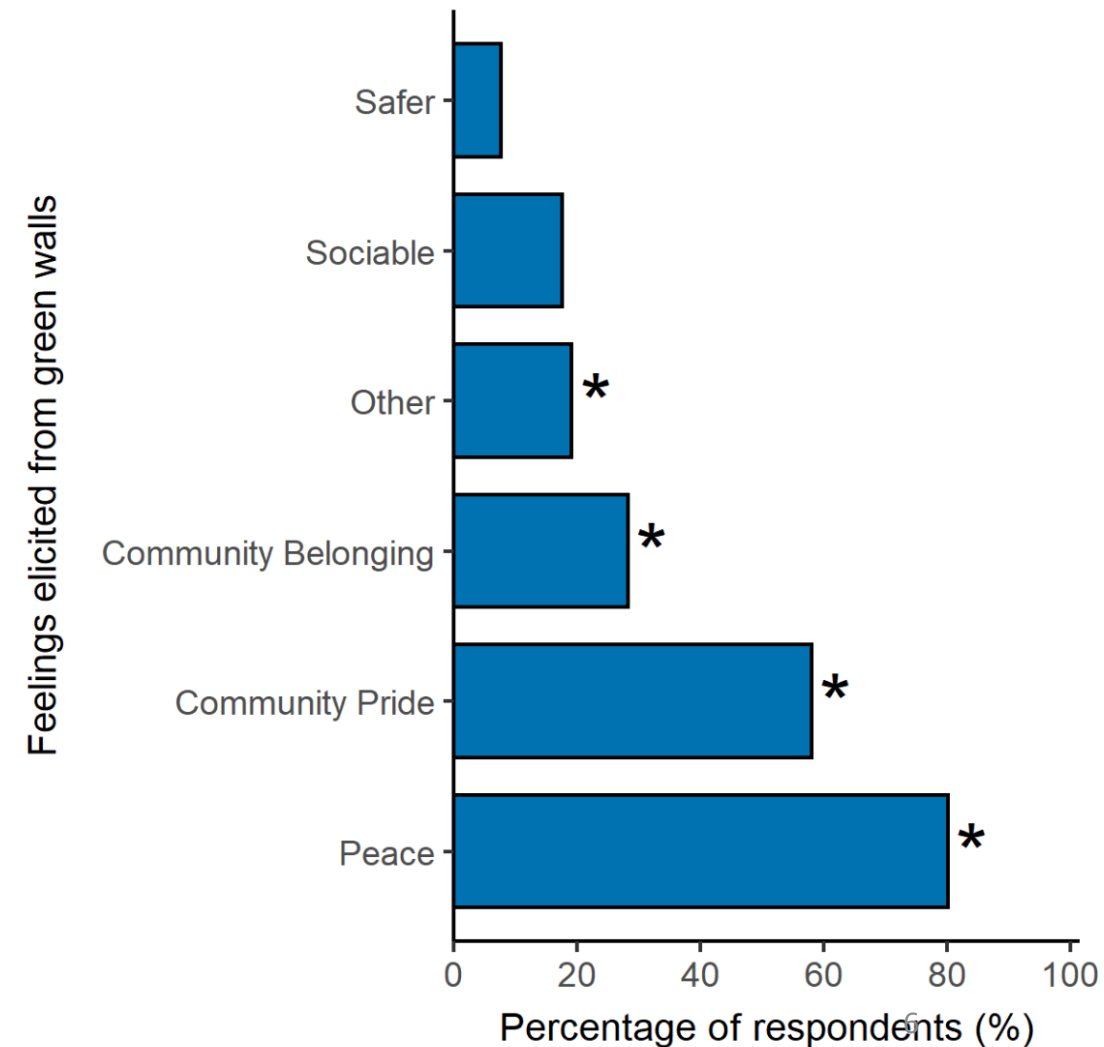
<i>Effect on productivity</i>	<i>Biophilic design strategy</i>	<i>Source</i>
+6% to 12%	Indoor plants	Lohr, Pearson-Mims, and Goodwin (1996)
+15%	Daylight	Romm & Browning (1998)
+13.2%	Daylight	Romm & Browning (1998)
+15% to 23%	Daylight	Heschong Mahone Group (1999)
Increase	Leafy indoor plants	Shibata & Suzuki (2002)
+7% to 13%	Daylight and window views	Heschong Mahone Group (2003)
+5%	Natural daylight	Painter & Goodman (2007)
Improved cognitive performance	Pictures of nature	Berman, Jonides, and Kaplan (2009)
+10% to 14%	Presence of plants	Daly, Burchett, and Torpy (2010)
Increase	Wooden surface	Fraser (2011)
Increase	Pleasant sounds from nature	Fitzgerald & Danner (2012)
+20% to 26%	Daylight	Terrapin Bright Green (2012)
+38%	Office plants	Knight (2013)
+15%	Enriched office with plants	Nieuwenhuis, Knight, Postmes, & Haslam (2014)
+6%	View of the outdoor environment	Cooper (2017)

Green Wall awareness, experience, and perception

Survey of 161 respondents, Australia wide

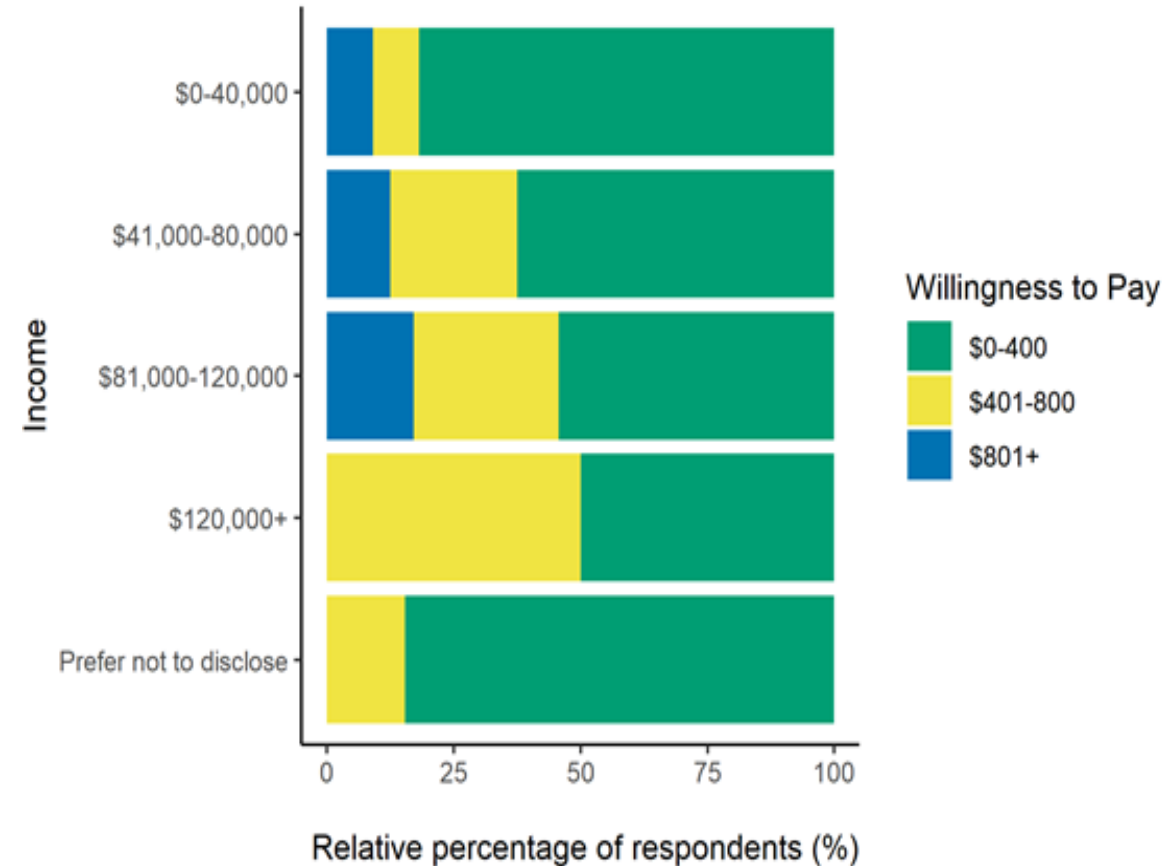
- Major *claimed* effects:
- more at peace (80%)
- stronger sense of community pride (58%)

(Douglas et al. 2022)



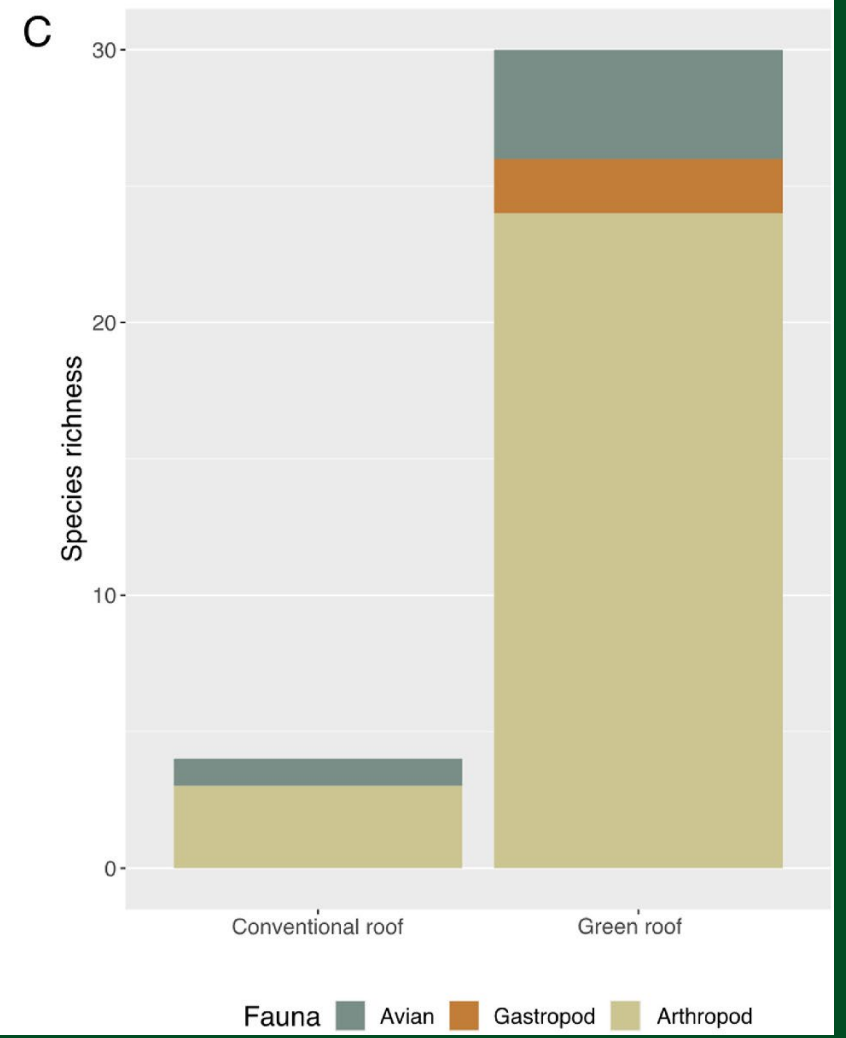
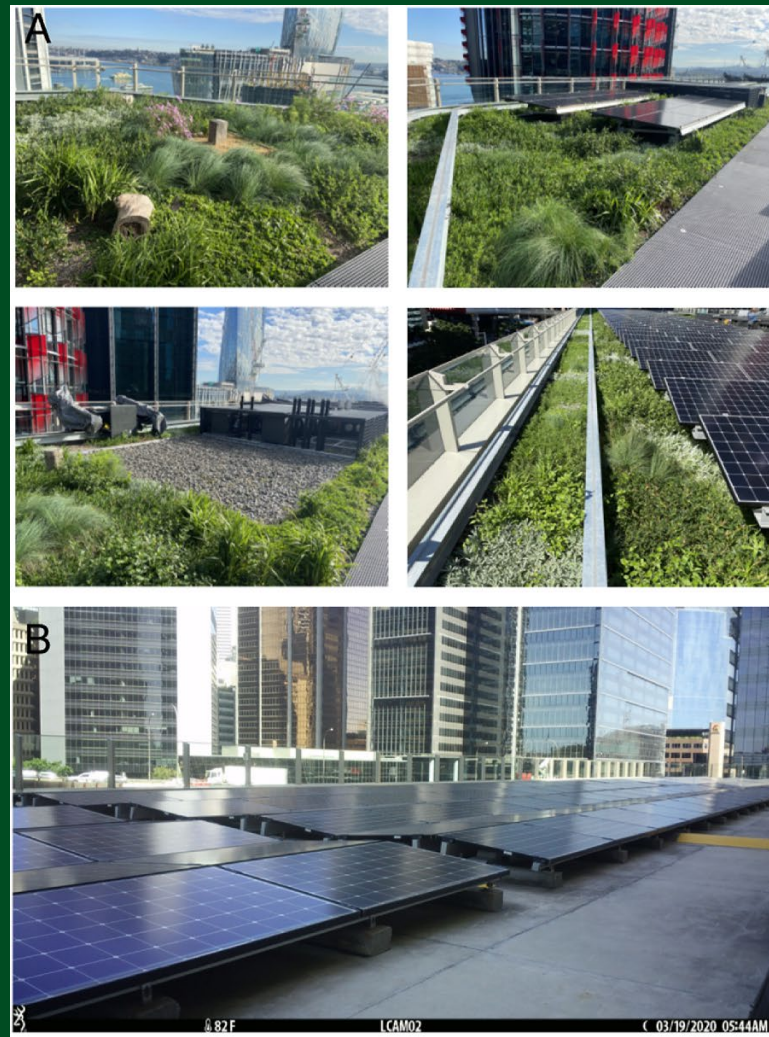
Willingness to pay for local green wall development

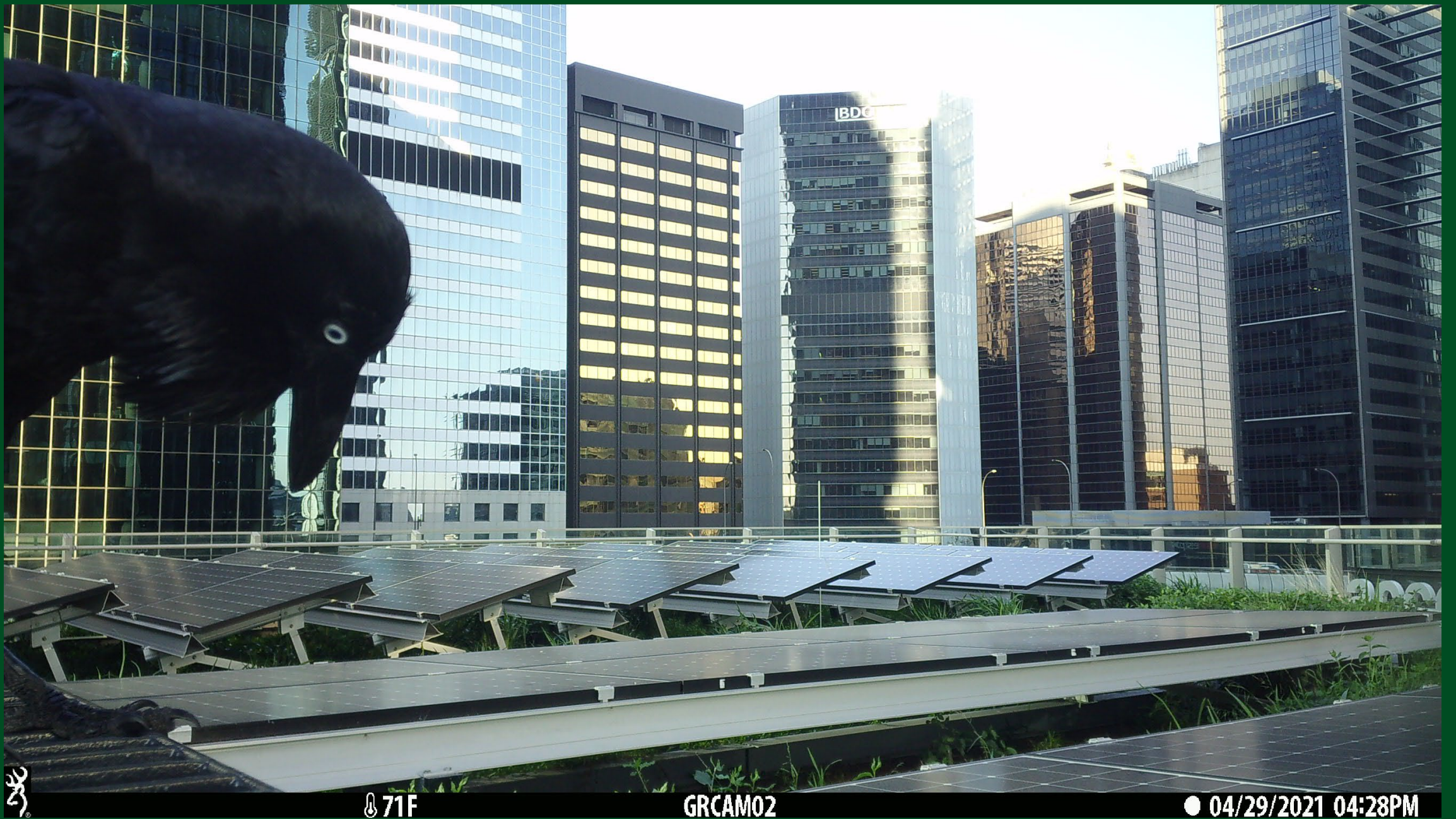
- 92% reported they were willing to pay for a GW construction
- WTP *mostly* proportional to income...



Willingness to pay for local green wall development of respondents belonging to various income brackets.

Biophilia includes more than plants...





71F

GRCAM02

● 04/29/2021 04:28PM

Wooster et al. 2022



91F

GRCAM02

02/19/2021 06:59PM



100 F

GRCAM01

02/22/2021 11:21AM



📍 93 F

GRCAM01

11/14/2020 03:40PM



Physical effects of plants on indoor environmental quality

Sick Building Syndrome and Building related Illness linked to time spent in a building, but a specific illness or cause cannot / can be identified (US EPA 1991)

Headache; eye, nose, or throat irritation; dry cough; dry or itchy skin; dizziness and nausea; difficulty in concentrating; fatigue; and sensitivity to odours

30% of new buildings (WHO)

Mainly attributed to *poor indoor air quality*, especially in contemporary, well-sealed buildings



Urban air pollution – an emerging epidemic

- Urbanization is increasing worldwide
- *Urban areas are polluted*: CO, NO_x, SO_x, Volatile Organic Compounds, particulate matter, ozone, bioparticles
- Indoor air is becoming 'the normal environment'
- Air pollution is *not* lower inside buildings

Plants improve indoor air quality



NASA studies (Wolverton *et al.* 1983–1997) showed that plants improved air quality in sealed spacecraft simulators



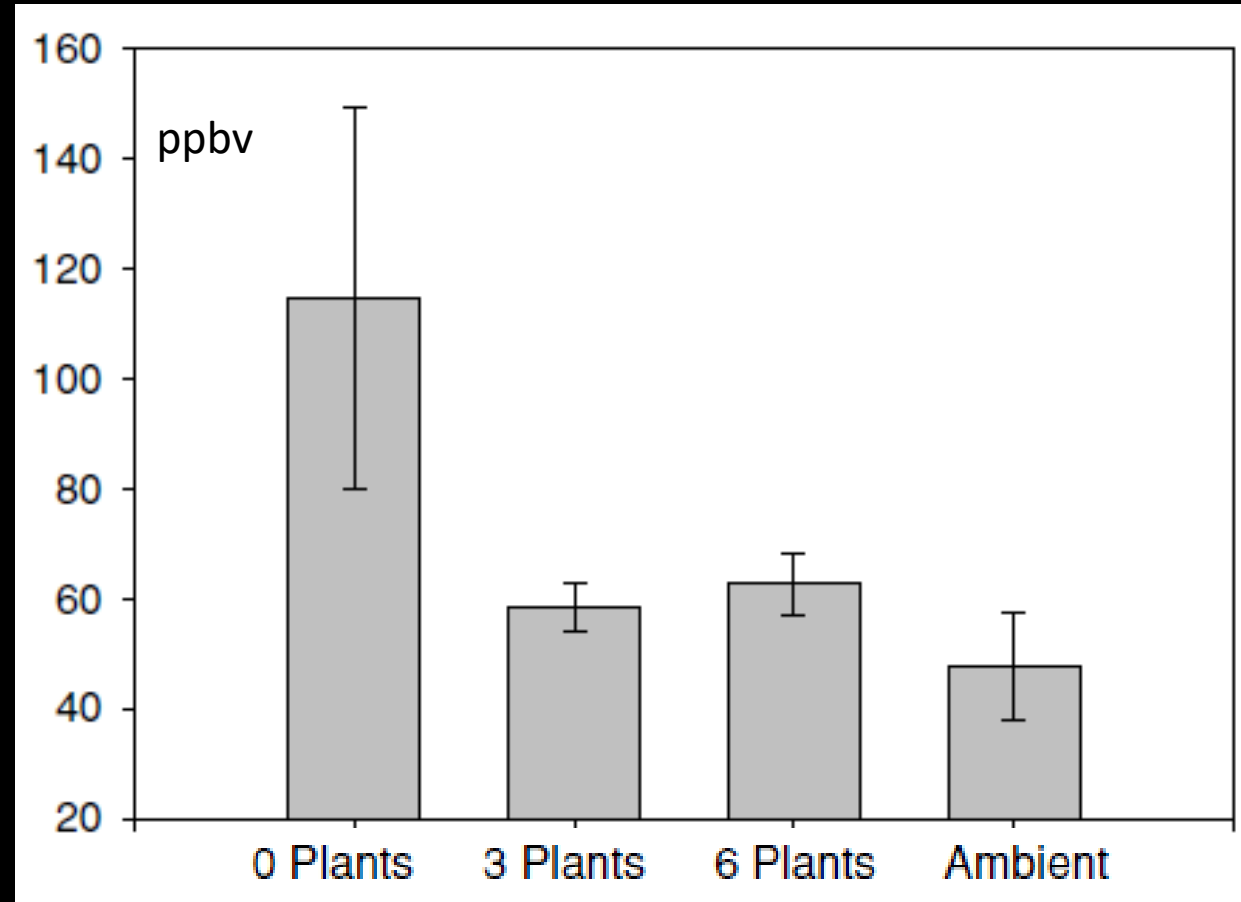
35 y of research:

All potted plants can
remove all VOCs

Mainly due to substrate
microbial metabolism

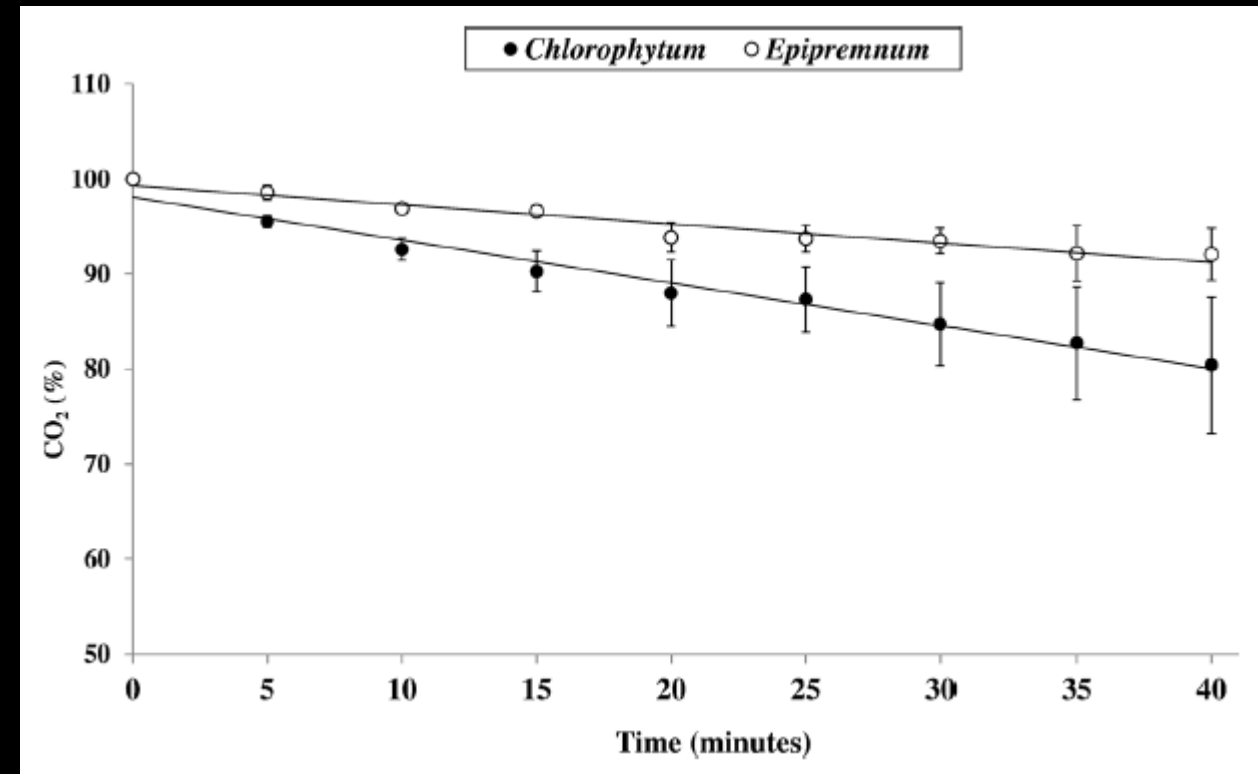
Consortial processes,
plant involvement

Total Volatile Organic Compounds in University offices



Phytoremediation of CO₂

- Major cause of indoor discomfort
- 40% of building energy use is for ventilation!

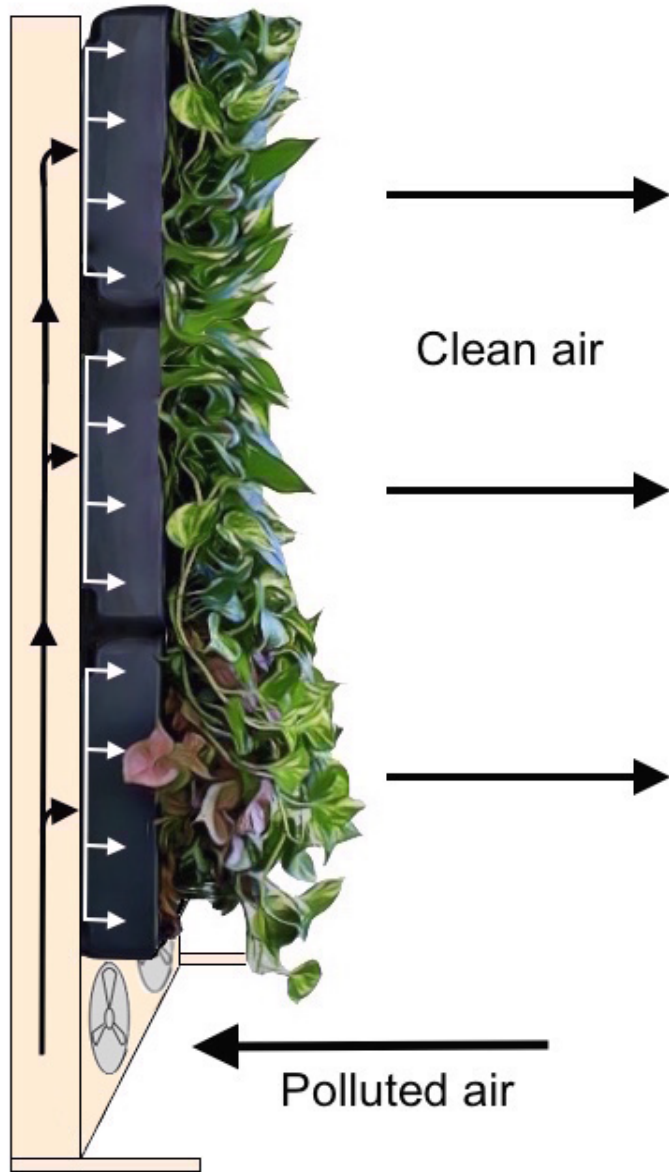


Draw down in test room from 1000 ppmv CO₂; 1 m² green wall, 100 μmol m⁻² s⁻¹ light

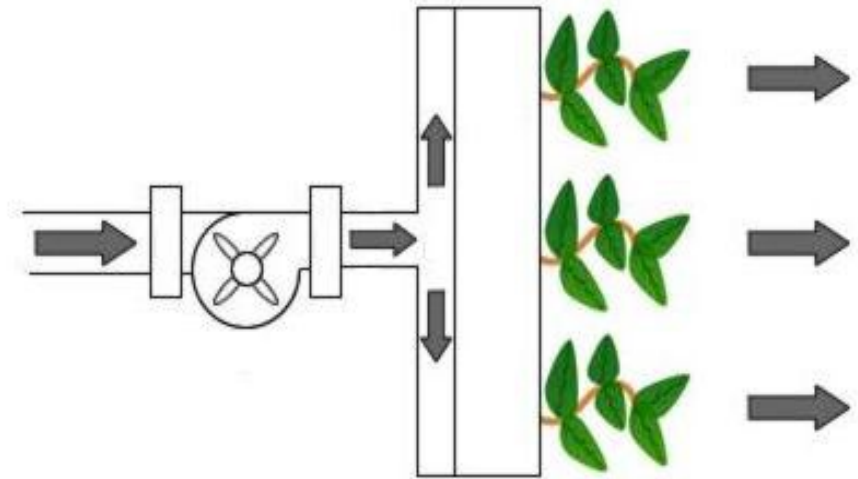
Problem: Pollution removal effect sizes by passive vegetation are low per unit of green space



- 
- Planting density increased
 - Improved substrate exposure
 - All pollutant removal rates increased

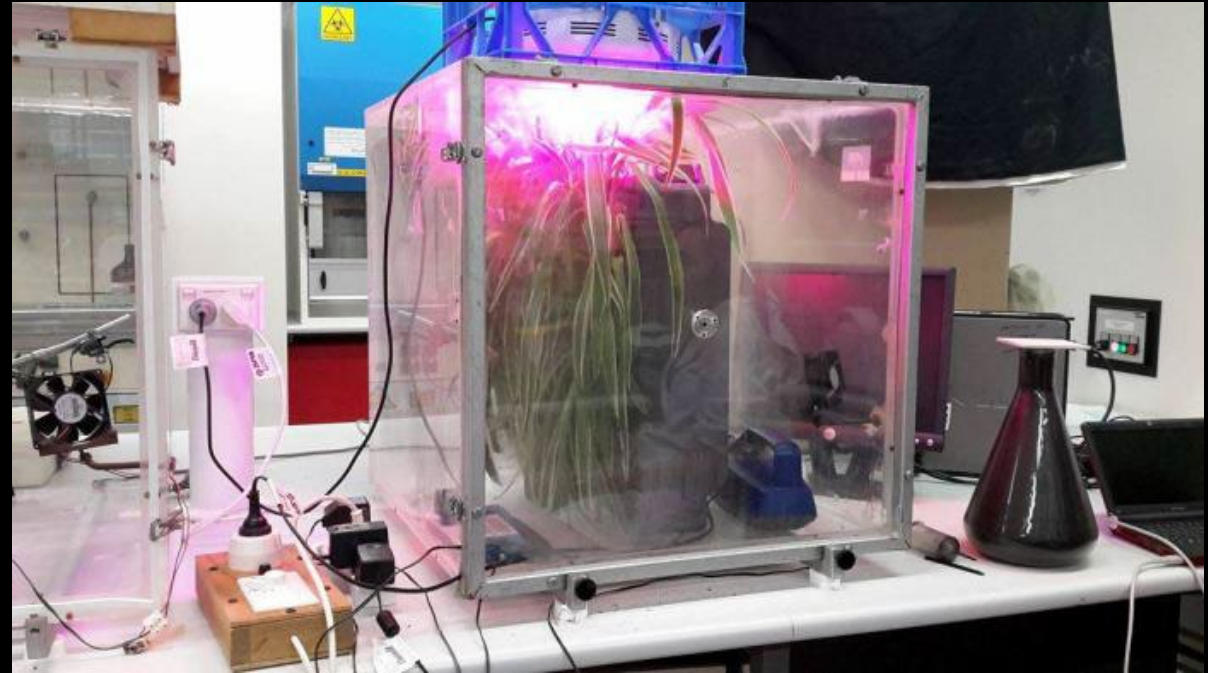


Indoor Plants Ver. 2: Active botanical biofiltration

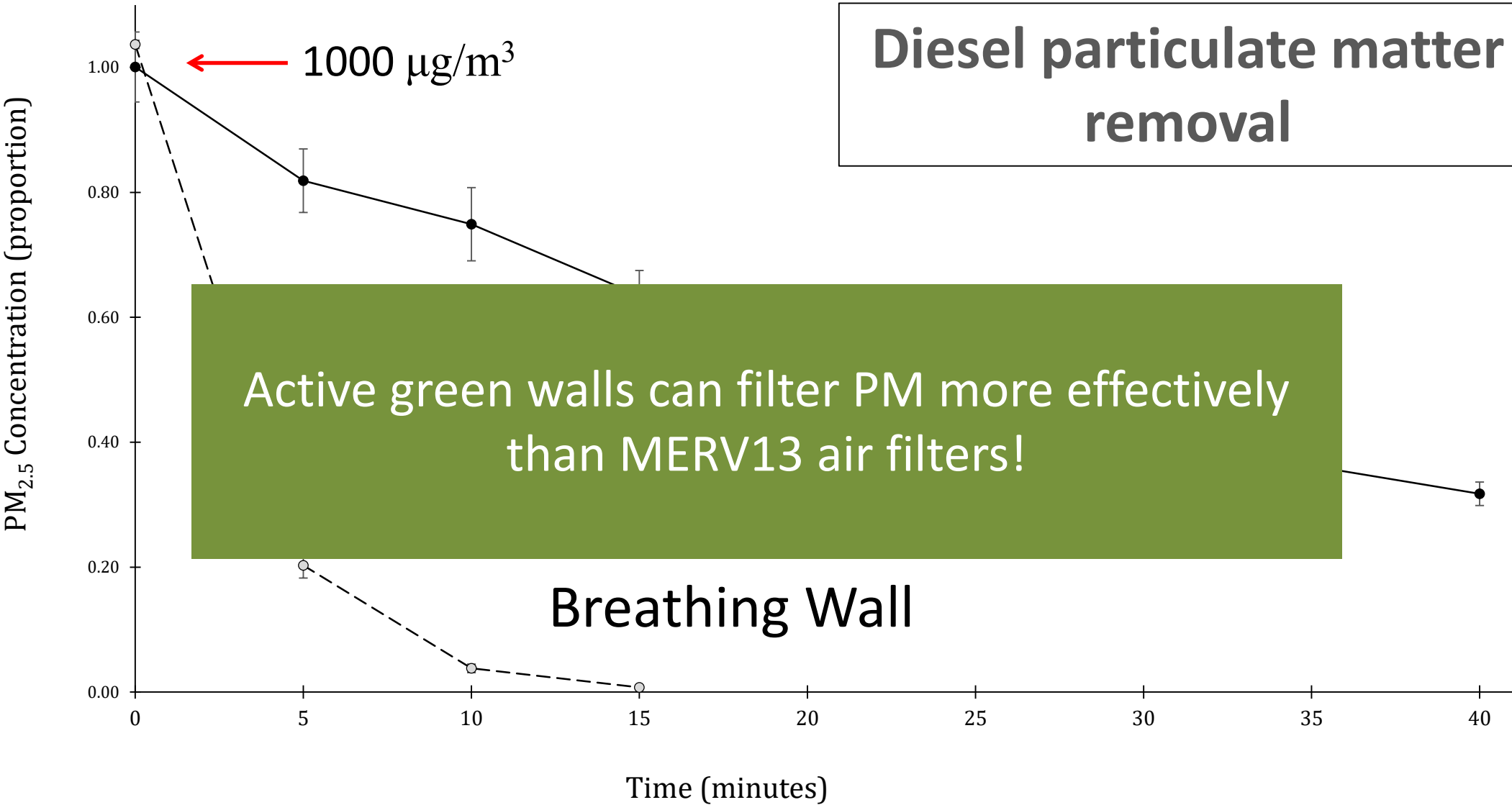


Active Green Walls

- Increased rate of removal of CO₂, *many* VOCs
- Low energy use
- No mould spores
- Temperature and humidity effects



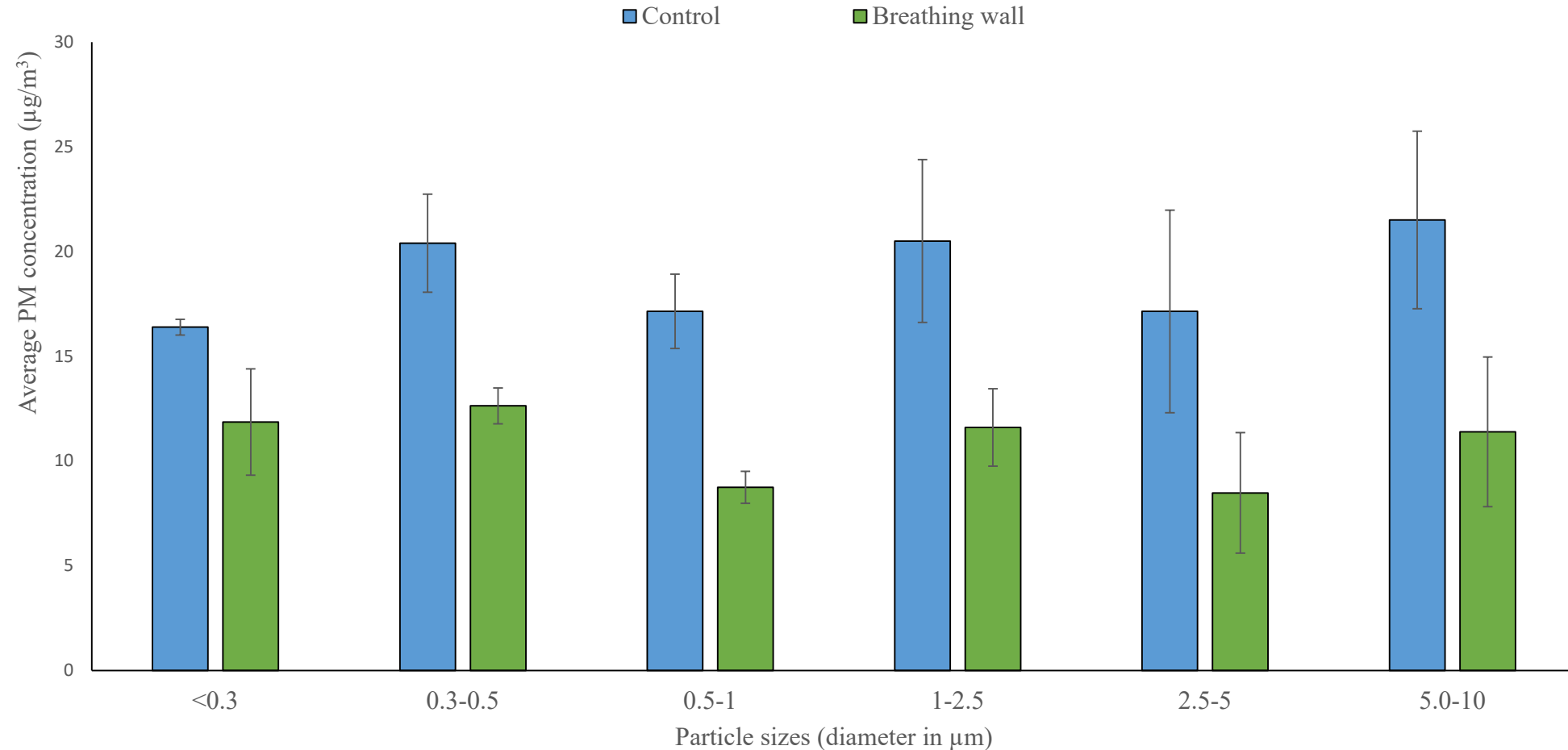
Diesel particulate matter removal



Dulwich College trial; Beijing China, March 2018



Ambient particulate matter



Manly Vale B-Line carpark
Opened 5/12/2018



Manly Vale B-Line carpark
Opened 5/12/2018

junglefy

Modelled CADR_s (m³/d)

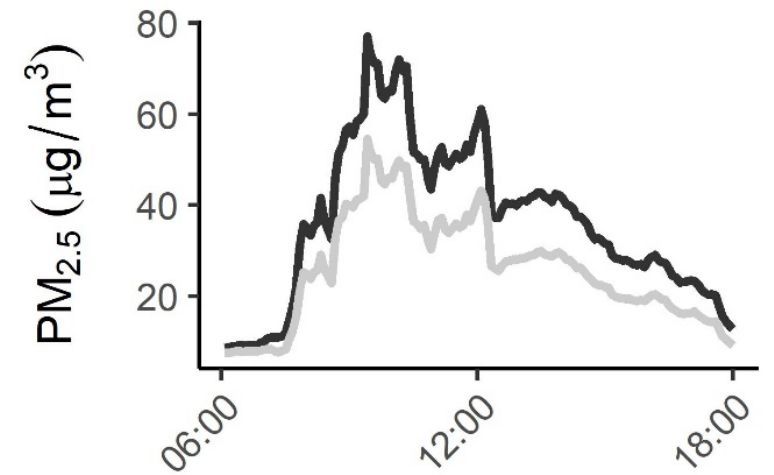
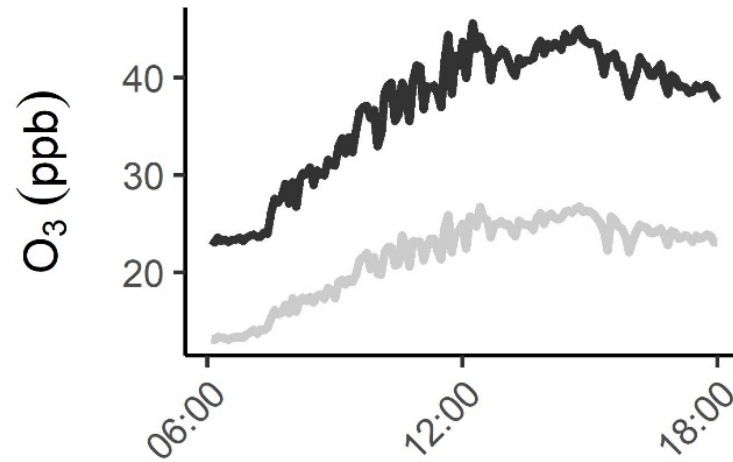
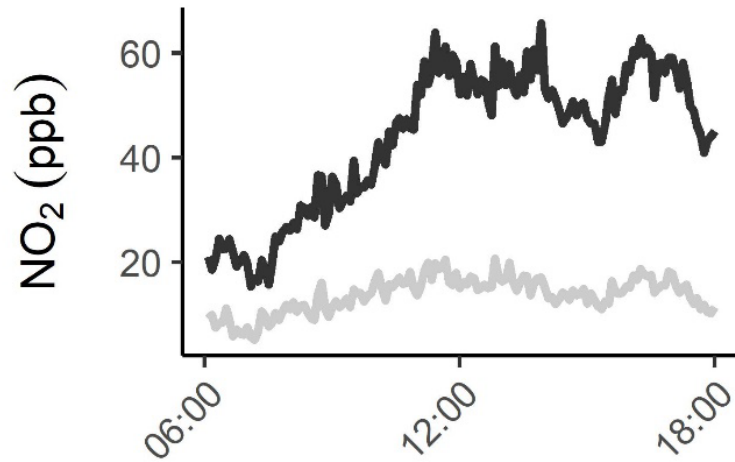
PM_{2.5}: 101,557

NO₂: 36,606

O₃: 100,340

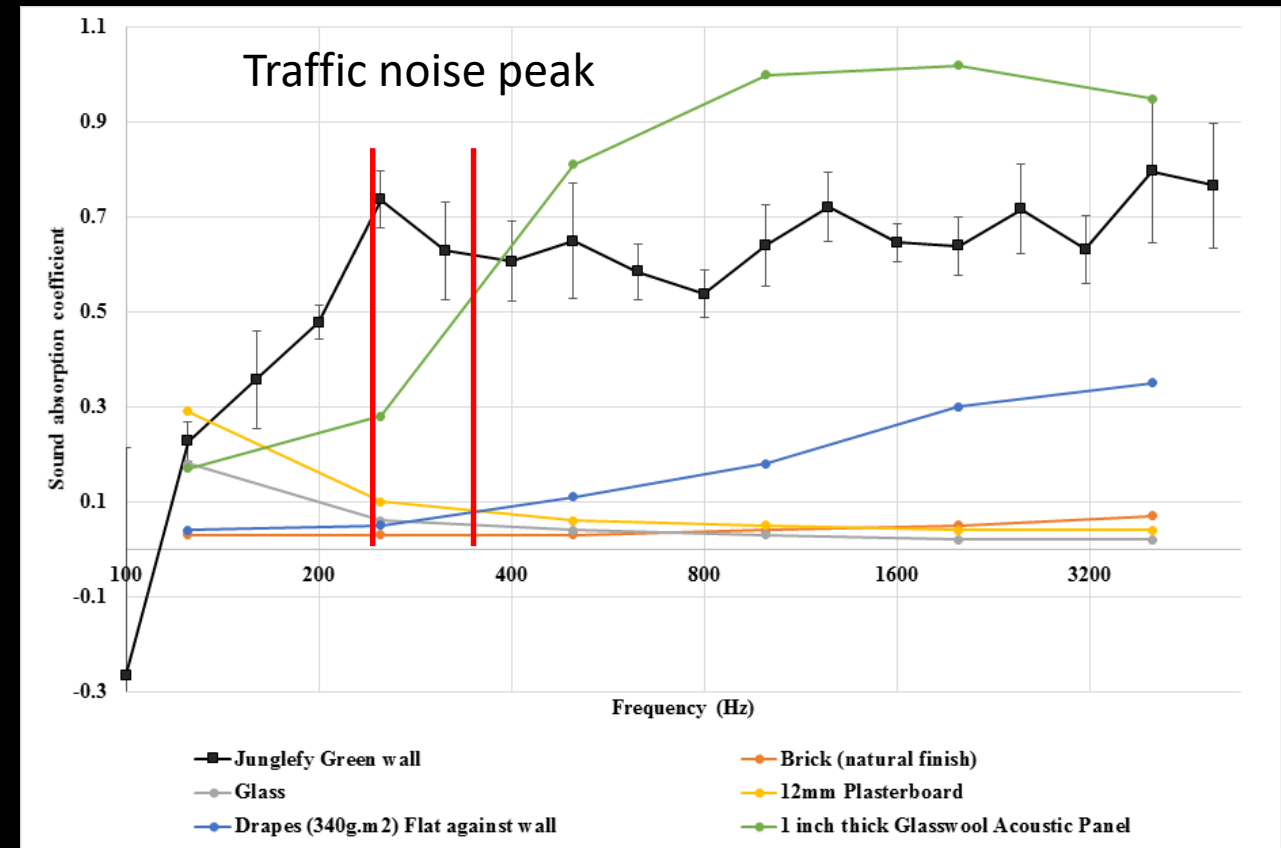
'Black Summer' bushfire smoke removal

08/01/2020

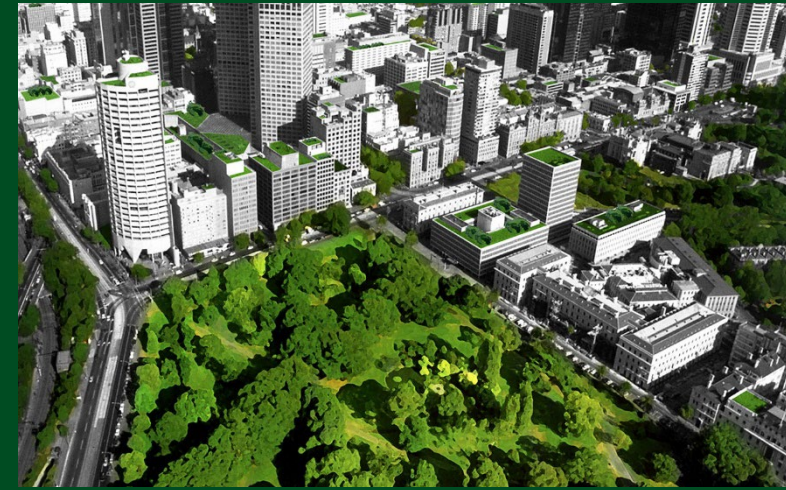


What else can plants do?

Sound absorption properties



Other services provided by the urban forest



- Sequestration of CO₂ (Nowak et al 2013)
- Health benefits have been recorded for populations adjacent to greenspaces (WHO 2021)
- *Many other services:*
- UHI, noise reduction, stormwater management, physical, mental, emotional, psychological benefits, biodiversity, aesthetics, property values, reduced crime rate etc. (Roeland et al 2019)
- *A universal core component of sustainable cities*

Expanding the Urban Forest

7,000 trees will be planted in London to improve air quality

The Mayor of London, Sadiq Khan has announced that in order to help reduce air pollution and carbon dioxide (CO₂), thousands of trees will be planted across 20 boroughs in London.

Paris plans to go green by planting "urban forest" around architectural landmarks



India Block | 26 June 2019 | 21 comments

4th September

Southend: 'Plant grass and plants on top of our town's bus stops to help the environment'



By Ellis Whitehouse | [@E_Whitehouse293](#)
Senior Reporter

Asia Pacific

Pakistan seeks to bring fresh air to polluted cities with 10 billion trees

By Umar Farooq

Experts identify 'super-plant' that absorbs roadside air pollution

Bushy variety of cotoneaster works best in areas of heavy traffic, say researchers, while other plants can cool buildings or reduce flooding

HOME » NEWS » INDIA » INDORE TO PLANT 2 LAKH PLANTS TO IMPROVE AIR QUALITY BY INDEPENDENCE DAY

🕒 1-MIN READ

Indore to Plant 2 Lakh Plants to Improve Air Quality by Independence Day

Problems

Gaps

- More research still required (BVOCs, O₃, SO_x)
- Effect sizes in *ventilated* buildings?
- COVID 19?
- Net zero contribution?

Barriers to implementation

- Space availability in highly urbanized environments
- Perception of 'Green washing'
- Perception of ROI: Environmental, social, and governance (ESG)





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