

A Transboundary Agenda for Nature-Based Solutions: Crossing the Urban-Rural Divide in Southeast Asia

Michelle Miller, Asia Research Institute,
National University of Singapore

Michelle.Miller@nus.edu.sg



CGSEA
CARBON GOVERNANCE IN
SOUTHEAST ASIA



What are Nature-based Solutions (NbS)?

- **NbS = solutions to societal challenges that involve working with nature** (Seddon et al., 2021: 1519)
- Provide **co-benefits** for both human well-being and biodiversity.
- NbS could provide ~ **37% of climate change mitigation** needed until 2030 to achieve Paris Agreement targets by storing carbon more effectively in nature-based ecosystems (World Bank, 2022).
- **> 50% 700 articles** on NbS published between **2008 – 2021** focused on urban environments, esp. flood management (Seddon et al., 2021).
- **Tremendous potential, but under-represented at scale**, with limited information about enabling factors for successful co-benefits and trade-offs in local contexts.



Why a transboundary agenda for NbS?

Needed to address complex, transboundary problems that cannot be resolved any any single government or jurisdiction (e.g., air pollution, global warming at regional scale).

Key transboundary dimensions:

- **Cross-Sector:** Sector-level NbS tend to priorities single challenge areas (e.g., biodiversity or food security) when whole-of-ecosystem approaches are needed to deliver multiple co-benefits and minimize trade-offs.
- **Multi-scalar:** Scale of NbS activities always extends beyond jurisdictional administrative boundaries (horizontal) and has nested vertical (hierarchical/ governance) dimensions.
- **Interdisciplinary:** Necessary for inclusive NbS approaches, but difficult to achieve in practice- time consuming, uncertain, & interdisciplinary collaborations often perpetuate exclusionary practices – e.g., by limiting social scientific knowledge to communicating information).

NbS can also contribute to transboundary problems

Need to better factor cross-border externalities into design of NbS activities.

- **Leakage** (displaced emissions to other areas)
- **Impermanence** (future carbon loss)
- Narrowly defined solutions may **displace local livelihoods** & traditional ways of life, triggering “nature-enabled dispossession” (Anguelovski & Corbera, 2023: 45).
- Can create **new resource conflicts** in “clear territories” (Ide, 2020: 6).
- **Displaced ecological knowledge** may lead to unsustainable NbS innovations elsewhere (e.g., introduction of plant species not suited to environmental conditions), triggering cascading leakage + displacement (Miller, 2025).



Addressing urban-rural divide offers one way of thinking about transboundary possibilities for NbS

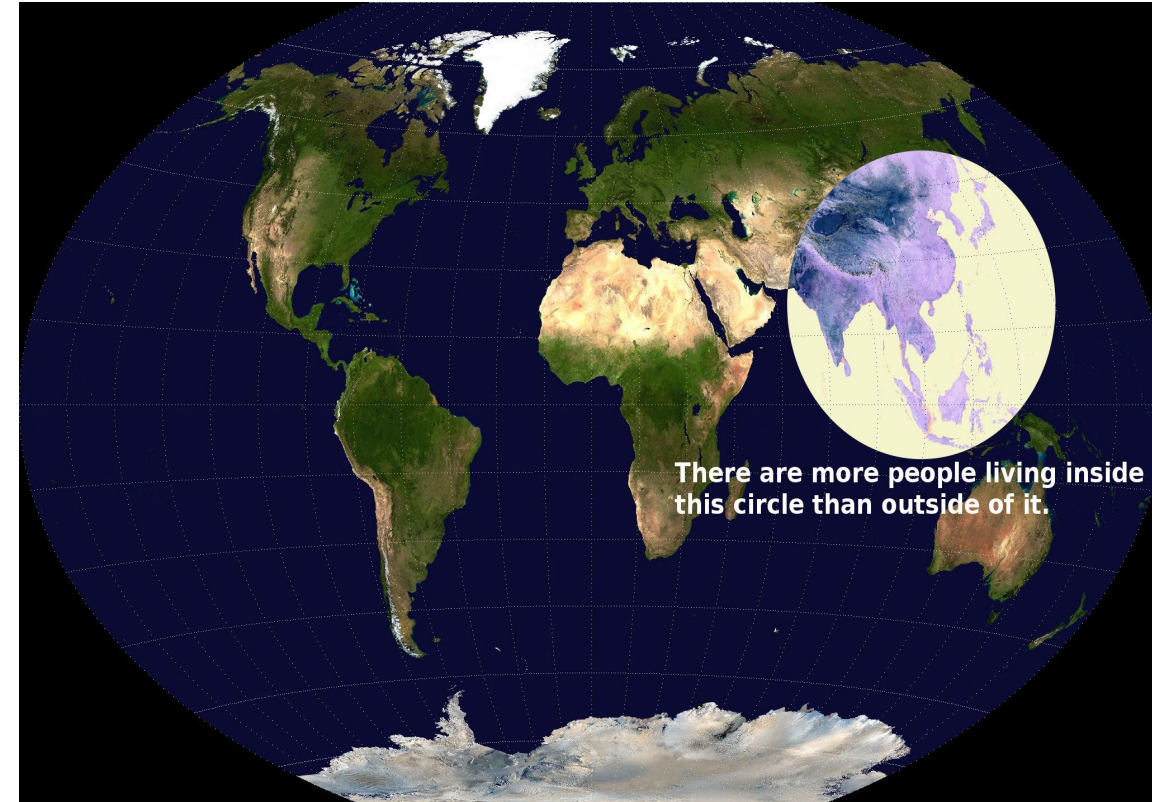
Urbanisation + climate change = two **intersecting megatrends of 21st century**.

By 2008, **over half world's human population** lived in urban areas, projected to increase to 70% by 2050.

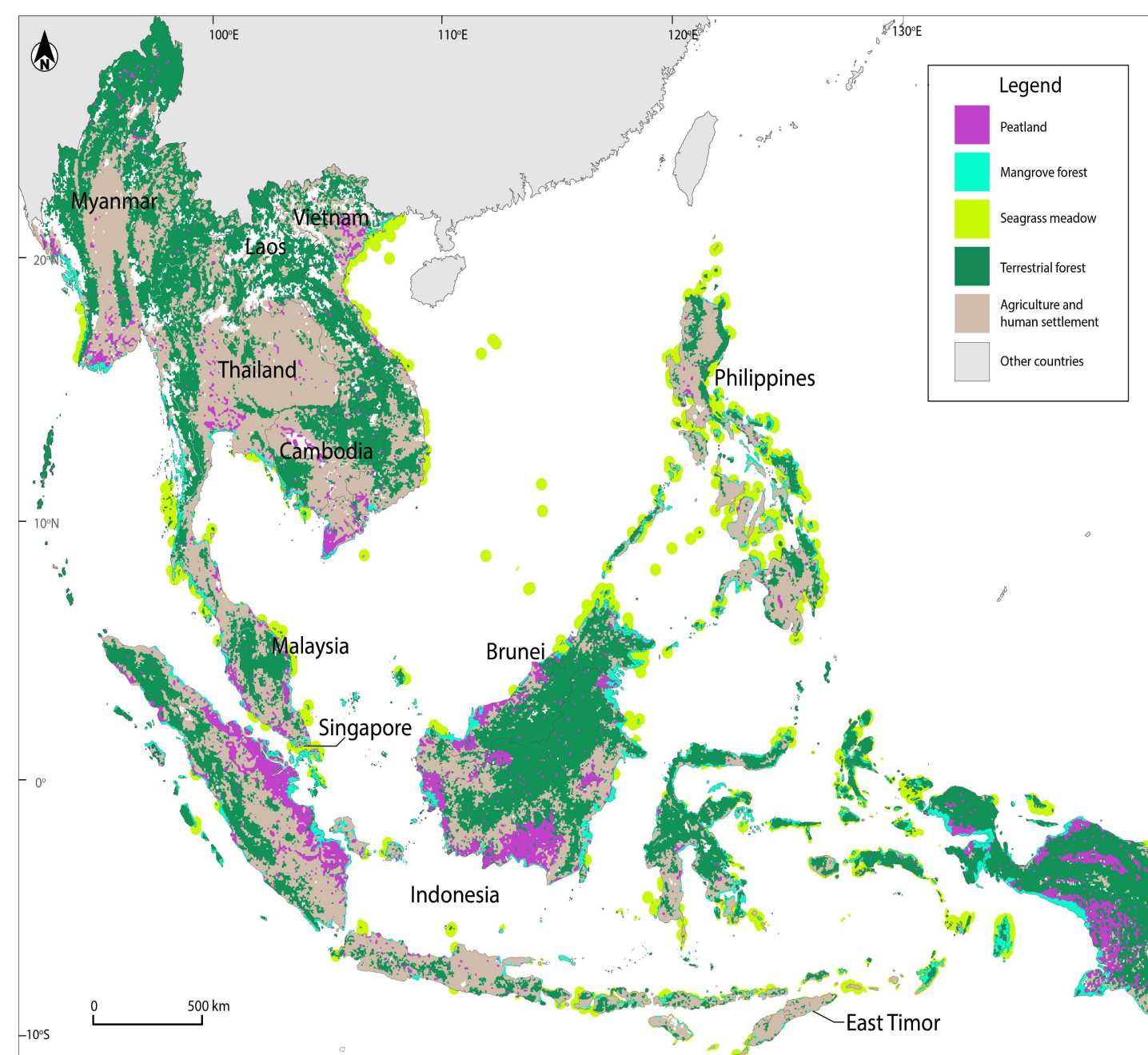
Cities are **first responders/ agents of climate change** mitigation in innovative climate stewardship (Fuhr, 2021)

But, urban century has **widened rural-urban inequalities** in income, emissions, food, water & energy security (Sethi & Oliveira, 2015)

Globally, urban populations contribute ~ **70% total emissions** (United Nations, 2019).



Cities will become increasingly vulnerable to climate risks & impacts as they consume natural resources in rural and remote areas at unsustainable rates.



Transboundary NbS governance requires framing of cities as extractive systems.

Previous work emphasises **urban consumer preferences** about forest carbon offsetting (Kuncoro et al., 2025).

ASEAN (2021) emphasises **growth-directed solutions/ risk mitigation**, downplaying pressures that urban populations place on rural ecosystems.

Financialised valuations of NbS often **neglect nonmaterial ecosystem services** important for climate stability & human well-being (e.g., pollution filtration, heat reduction, disaster protection, pollination) (Buenavista & Purnobasuki, 2023)

Urban drivers of rural ecosystem loss remain poorly understood.

Map showing distribution of main types of nature-based carbon sinks found in Southeast Asia (Source: Miller & Taylor, 2024).

Studies of urban-rural linkages need individual-level data on nature-based ecosystem service valuations among demographic subgroups.

Work on rural-urban differences in ecosystem service valuations varies by 3 main finding types:

- Urban residents **value ecosystem services more** than rural residents (e.g., Hassan et al., 2019);
- Urban residents **lack ecological knowledge/ awareness** compared to rural residents (e.g., Lapointe et al., 2019);
- Urban & rural populations **value different services**, even within same ecosystem (e.g., Yang et al., 2019).



Southeast Asia Case Study



Hypothesis

- Urban residents who receive repeat educational messaging are more likely to invest in NbS intervention in rural area (a reforestation carbon project) and individually adopt pro-environmental values & behaviours.

Key contributions

- Shows how urban households in Southeast Asia value rural, nature-based carbon sinks.
- Tracks both actual & self-reported behaviour over seven-months.
- Extends power of choice experiments to analyse connections between environmental values, motivations & pro-environmental behaviour.



Surveyed Urban Populations



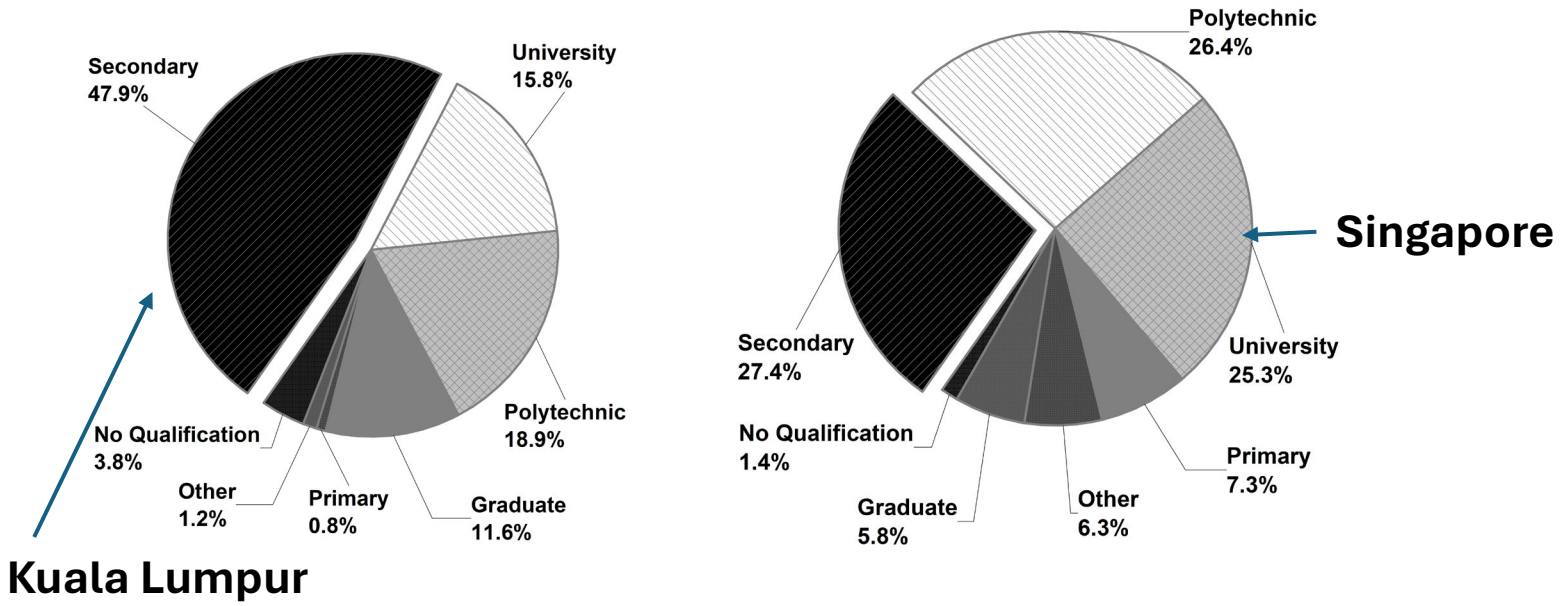
Category	Kuala Lumpur	Singapore
Urban Density (per km ²)	8,235	8,207
Land area (per km ²)	243	735.7
Individual carbon footprint annually	8 tonnes	9.5 tonnes
Green space/ forest cover	5.4%	21%
Urban design	Sprawling, car-centric layout, more terraced houses than apartments, few greenbelts.	80% households within 10-min walk to park, more apartments than houses.

Demographic snapshot

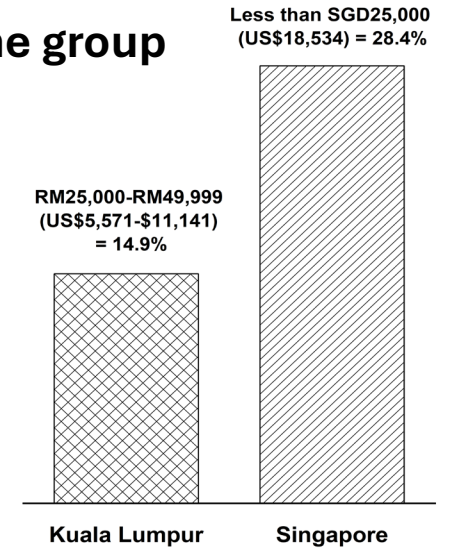
	Citizenship	Gender	Ethnicity	Religion
Kuala Lumpur	<p>Citizen 92.8% Permanent Resident 7.2%</p>	<p>Male 51.3% Female 48.7%</p>	<p>Malay 66.3% Chinese 22.9% Indian 7.2% Other 3.6%</p>	<p>Muslim 66.6% Buddhist 18.3% Hindu 7.2% Christian 6.2% Other 1.7%</p>
Singapore	<p>Citizen 87% Permanent Resident 13%</p>	<p>Male 48.8% Female 51.2%</p>	<p>Chinese 74.6% Malay 14.1% Indian 8.8% Other 2.5%</p>	<p>Buddhist 29.3% Freethinker 20.2% Christian 16.8% Muslim 16.2% Hindu 5.9% Taoist 7% Other 4.6%</p>

Demographic snapshot continued...

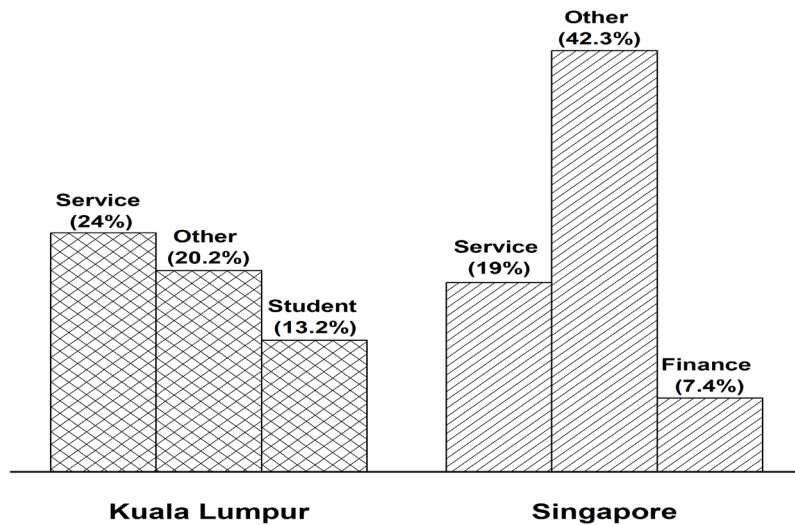
Education



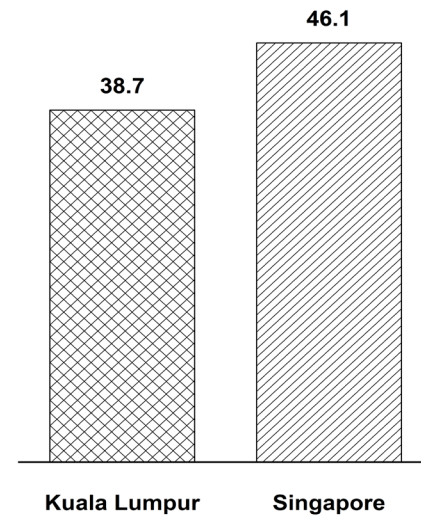
Largest reported annual income group



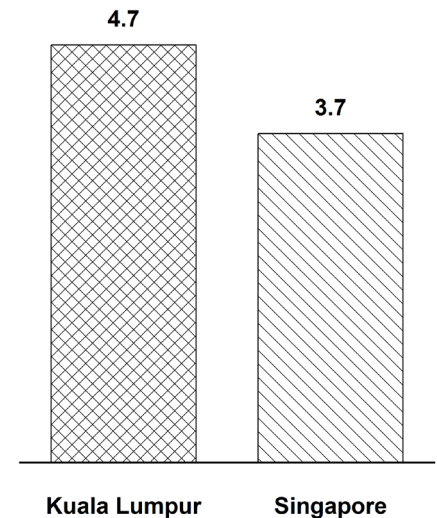
Three most common occupations



Median age



Average household size



Methods: Survey Component

Survey Coverage: 7-month survey (2024–2025), 600 households (300 in Kuala Lumpur, 300 in Singapore)

Data Collection: 3 waves (total 1,800 encounters)

- Wave 1: 26 Jul – 14 Oct 2024 (946 encounters)
- Wave 2: 25 Oct – 18 Dec 2024 (810 encounters)
- Wave 3: 20 Dec 2024 – 28 Feb 2025 (600 encounters)

Overall Attrition: 37%; unbalanced panel used in analysis

- **Survey Consistency:** Identical survey questions and video in respondent's preferred language (English + Malay/ Mandarin subtitles)
- **Mode of Delivery:**
 - Wave 1: In-person with interviewer
 - Waves 2 & 3: Web-based, self-administered
- **Rationale:** Mixed modes maximize response rate & minimize bias.



Methods: Video Component

Half households (150 respondents, 450 encounters total) participated in video intervention.

In both cities, video groups shown same 3-minute video, produced by our research team.

After video, respondents answered 2 extra questions, not asked of control group: (a) video motivated lifestyle change?; (b) If yes, what change?



Methods: Voucher Component

- Informed choice task at end of survey in each encounter.
- Respondents received voucher to spend on shopping or forest carbon donation.
- Sliding scale allowed flexible allocation.
- To eliminate national bias, unnamed 3rd country in Southeast Asia selected for donation to NbS intervention (forest carbon project).



Results

Results organised into four overlapping categories:

- **Material values:** Factors influencing purchasing choices and willingness to pay for NbS intervention;
- **Nonmaterial values:** Individual appreciation of ecosystem benefits that are difficult to monetise;
- **Motivations:** Reasons behind support for specific environmental issues;
- **Pro-environmental behaviours:** Actions taken to help the environment.

Together, offer a comprehensive view of values and actions relevant for designing **transboundary NbS interventions** to balance urban resource demands with rural ecosystem stewardship.

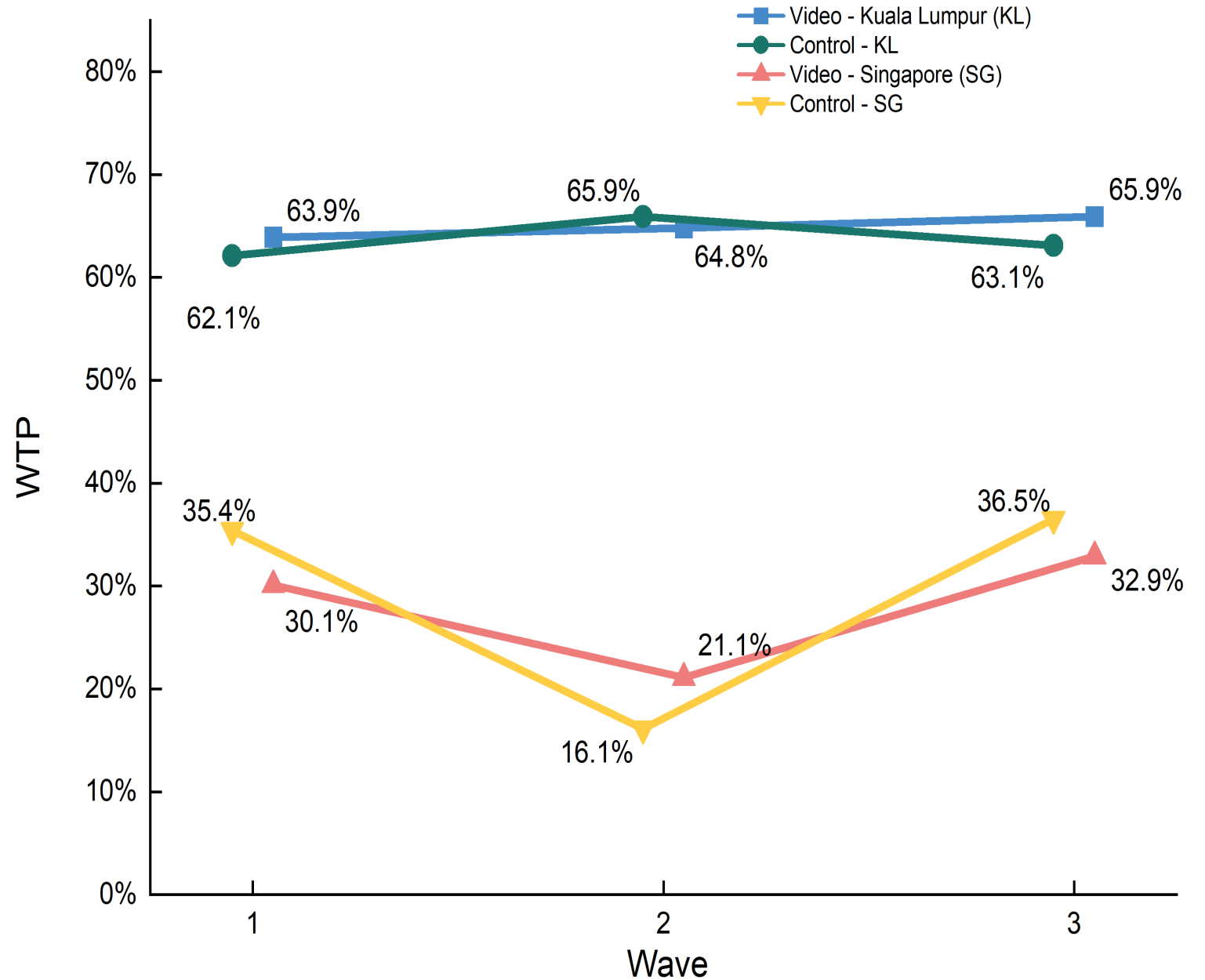
Material Values Results: Willingness-to-Pay (WTP) for NbS intervention in rural area

Variable	Kuala Lumpur	Singapore	Both Cities
Video	100% donated at least part of voucher twice; 98% donated each time.	8% donated consistently; 30% gave nothing.	Overall, slightly lower WTP among video respondents compared to control group.
Income & Education	Higher income households (84%) & graduate degree holders (83%) more WTP	University degree holders (45%) more WTP.	Higher household income & higher education = more WTP.
Other demographic predictors	Indians (80%), Hindus (80%) & large households (69%) more WTP.	No significant predictors	

Fig.1. Willingness To Pay (WTP) over time by group.

Respondents were allocated voucher worth 10 MYR (in Kuala Lumpur) or 10 SGD (in Singapore) per encounter.

Percentages represent average proportion of vouchers donated to NbS intervention.



Non-Material Values: Threats to Well-being & Environmental Concerns

Both cities, pollution affected health & wellbeing of 88% respondents, & 89% concerned about extreme climate events.

- Perceived **vulnerability more pronounced in Kuala Lumpur** (84%) than in Singapore (56%).
- **More Kuala Lumpur respondents experienced extreme climate event** in past 2 months (57% vs. 44% in Singapore) & **more motivated to change lifestyle + WTP.**



Over time, **Kuala Lumpur respondents became 7% less concerned** about environment; **Singapore grew 5% more concerned.**

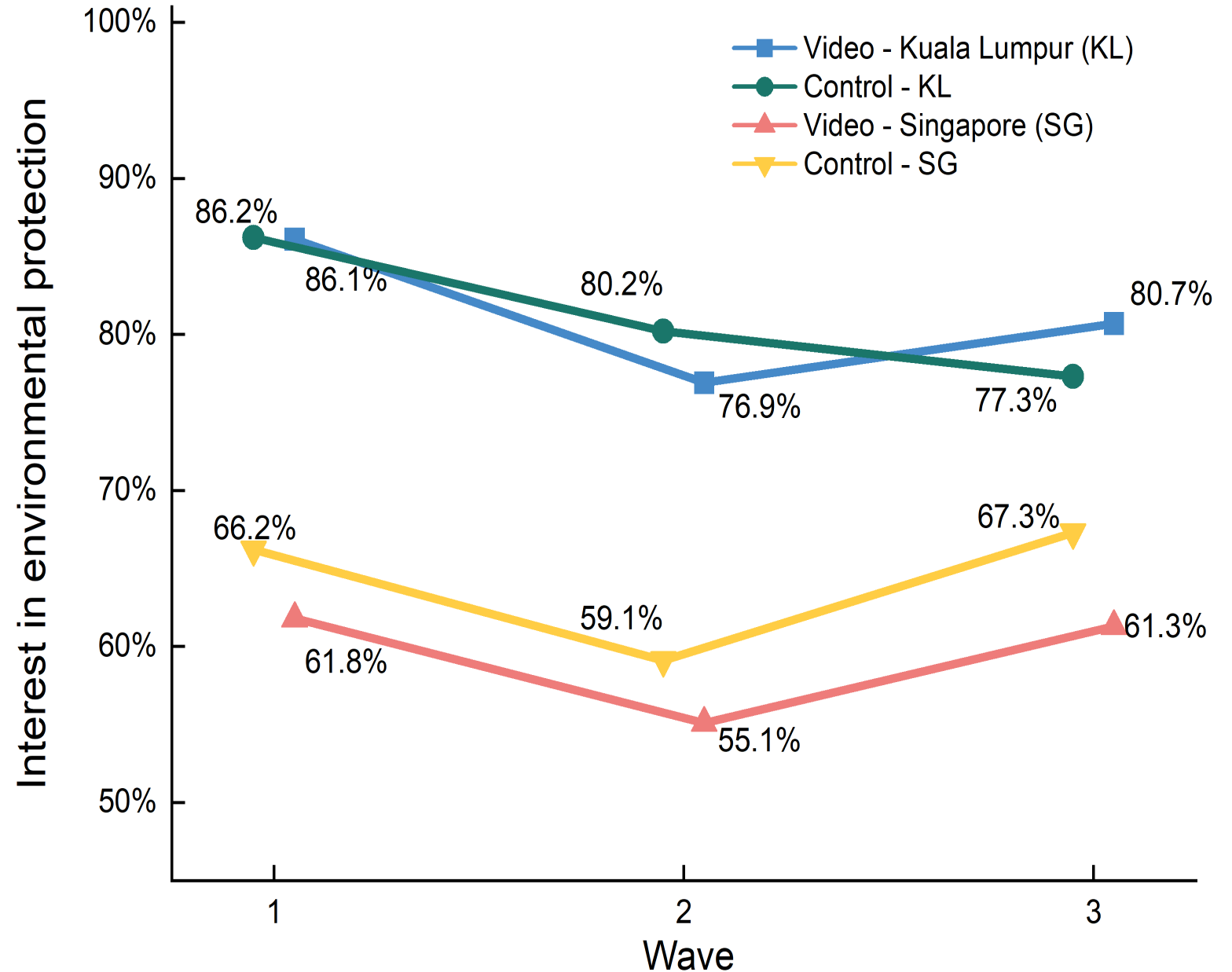
Kuala Lumpur greatest concerns: industrial waste pollution (66%) & deforestation (65%).

Singapore greatest concerns: rising temperatures (51%) & global warming (47%).

Lowest concerns in both cities were livestock production (27%) & overfishing (27%).

Fig. 2. Interest in environmental protection over time.

Percentages represent proportion of respondents in each group who selected "Very interested" or "Somewhat interested" in protecting environment.



Motivation Results

- Half video group respondents felt motivated to adopt pro-environmental behaviours.
- But, Kuala Lumpur respondents nearly twice as motivated (64%) as those in Singapore (36%).
- Motivation strongly associated with both **positive + negative outcomes**:
 - **Positively**, all Kuala Lumpur respondents perceived quality-of-life improvements from environmental conservation donations (72%).
 - **Negatively**, respondents in both cities with recent experience of extreme climate event more motivated than others to change lifestyle (Kuala Lumpur: 21%; Singapore: 19%).



Demographic profile of most motivated respondent in both cities: Indian Hindu from large household.

Reasons for Pro-Environmental Behaviour

NB: After counting fluctuations between encounters, these self-reported behaviours were much lower.

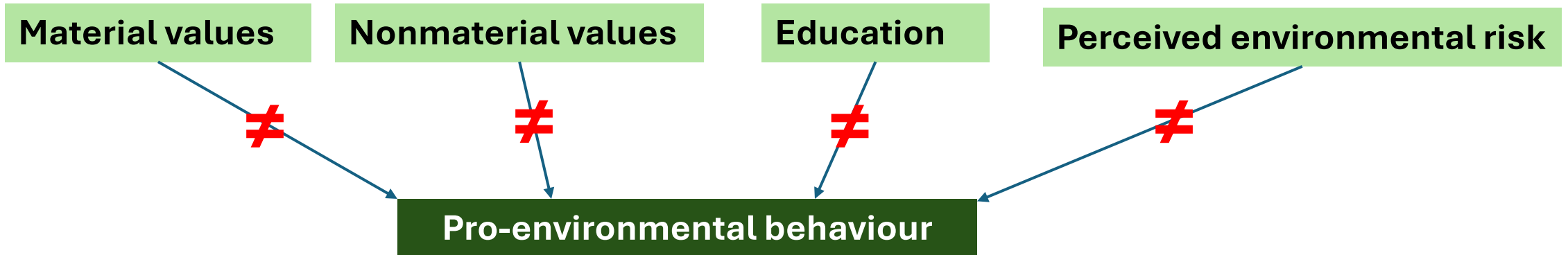
Pro-environmental behavior	Kuala Lumpur (%)	Singapore (%)	Main reason (KL, %)	Main reason (SG, %)
Recycling	10	37	–	–
Using reusable containers	68	64	Financial (44)	Environmental (45)
Reducing meat intake	71	57	Health (42)	Health (36)
Reducing car usage	57	57	Walking (38)	Public transport (38)
Reducing air travel	43	32	No vacation leave (28)	No vacation leave (17)
Reducing air conditioning	59	47	Health (35)	Cost-saving (27)
Reducing electricity use	54	47	Environmental (29)	Financial (30)

Constraints to Pro-environmental Behaviour

- In both cities, major constraints were **inadequate infrastructure** (Kuala Lumpur: 51%; Singapore: 30%) & **limited funds** for labelled purchases (Kuala Lumpur: 20%; Singapore 33%).
- Kuala Lumpur respondents **lacked time** to make sustainable choices (22%).
- Singapore respondents were challenged by **competing priorities** – e.g., eating meat as a core dietary component, despite knowing that livestock agriculture causes greenhouse gas emissions (29%).
- **Graduate degree holders** in both cities participated in climate activities **less frequently** (on average, once every 37 days) than those with lower educational attainment (every 20 days).



Discussion: Multiple Value-Action Gaps



- Value-action gap literature emphasizes **why good intentions do not result in action** (Hoffmann et al., 2024).
- Both our cities exhibited value-action gaps, in **opposing directions**.
- **High motivation doesn't ensure action, BUT low motivation doesn't rule it out!**



Value-action gap 1: Material values ≠ pro-environmental behaviour

- Overall, **high WTP** for NbS intervention, but **low pro-environmental behaviour**, esp. in Kuala Lumpur.
- **Financial valuations like WTP may be weak predictors of action.**
- Individuals more willing to **commit to easy changes** than significant behavioural shifts.
- Both cities- almost no investment in other carbon offset schemes between encounters.
- **Cultural norms** around giving may have inflated WTP.

Value-action gap 2: Nonmaterial values \neq pro-environmental behaviour



- **Kuala Lumpur** = more connected to nature but purchased fewer sustainably labeled products.
- **Singapore respondents** = less motivated/ connected to nature but purchased more labelled products.
- Positive cross-sectional correlation: **stronger environmental awareness + higher disposable income** in Singapore.
- **Successful Singapore government campaigns** to enforce industry compliance with, & consumer trust in, eco-labelling/ recycling, unlike Malaysia.

Government campaigns may nurture pro-environmental behaviour, even when sustainability burden is placed on citizens without providing sufficient enabling infrastructure.





Value-action gap 3: Education ≠ pro-environmental behaviour

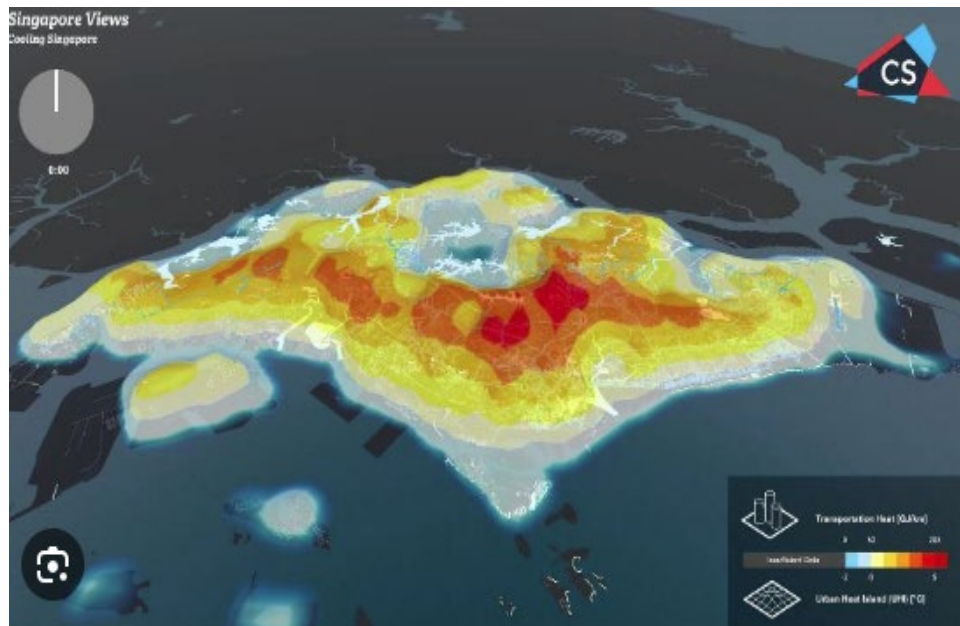
- Graduate degree holders more WTP for ecosystem services + higher awareness of sustainability labels in both cities.
- But, freshness still outranked environmentally-driven shopping, even among the informed.
- Graduates the least active in climate activities – time constraints? Skepticism about individual impact? Disconnect between knowledge & empowerment?

Education may not equate to informed choices or actions.

Value-action gap 4: Perceived environmental risk \neq pro-environmental behaviour

Respondents with recent experiences of extreme climate events more WTP for NbS intervention in both cities.

- May be connected to lived experiences of environmental threats like transboundary haze pollution/ urban flooding in both cities.



Overall environmental engagement remained low, despite strong awareness.

- Kuala Lumpur – same infrastructural constraints & unsustainable cultural habits that elevated risk likely impede action.
- Singapore’s centralized system – public trust in government & reliable infrastructure foster sense of risk insulation.
- Feelings of powerlessness & disengagement in both cities, eroding self-belief in individual impact.



Future transboundary NbS research implications

- **Contextualise urban systems** & human behaviours within wider societal-ecological systems;
- **Mobilise urban populations** as innovators & active participants in climate stewardship to bridge rural-urban divide;
- Addressing demographic complexity of urban behaviours can **create physical & discursive spaces** for operationalizing multiple valuations of ecosystem services across rural-urban boundaries;
- **Bridging Motivation-Value-Behaviour Gaps** in urban populations can strengthen linkages between discrete priorities in NbS interventions (e.g., projects that concurrently optimize sustainable livelihoods & biodiversity);
- Educating urban populations about wider resource dependencies can **foster knowledge exchanges & collaborative networks** between rural & urban institutions around nature-based projects.

References cited in presentation

- Anguelovski I & Corbera E (2023) Integrating justice in Nature-Based Solutions to avoid nature-enabled dispossession. *Ambio* 52: 45-53.
- ASEAN (2021). *Climate Change Report. Current Status and Outlook of the ASEAN region toward the ASEAN Climate Vision 2050*. Jakarta, Indonesia: ASEAN Secretariat.
- Buenavista, D. & Purnobasuki, H. (2023) People and mangroves: Biocultural utilization of mangrove forest ecosystem in Southeast Asia. *Journal of Marine and Island Cultures* 12(2): 95-115.
- Fuhr, H. (2021). The rise of the Global South and the rise in carbon emissions. *Third World Quarterly*. 42(11): 2724-2746.
- Hassan, S., Olsen, S. B. & Thorsen, J. (2019). Urban-rural divides in preferences for wetland conservation in Malaysia. *Land Use Policy* 84: 226-237.
- Hoffmann, R., Kanitsar, G. & Seifert, M. (2024). Behavioural barriers impede pro-environmental decision-making: Experimental evidence from incentivized laboratory and vignette studies. *Ecological Economics* 225, 108347.
- Ide, T., 2020. The dark side of environmental peacebuilding. *World Development* 127, 104777.
- Kuncoro, A. H., Dwijatmiko, A., Aida, N., Nurliyanti, V. et al. (2025). Mapping the landscape of carbon trading & carbon offset research: A global and Indonesian perspective. *AIMS Energy* 13(1): 86-124.

Continued...

- Lapointe, M., Cumming, G. S. & Gurney, G. G. (2019). Comparing ecosystem service preferences between urban and rural dwellers. *Bioscience* 69(2): 108-116.
- Seddon, N., Smith, A., Smith, P., Key, I. et al. (2021) Getting the message right on nature-based solutions to climate change. *Global Change Biology* 27: 1518-1546
- Sethi, M. & de Oliveira, J. P. (2015). From global 'North-South' to local 'Urban-Rural': A shifting paradigm in climate governance? *Urban Climate* 14: 529-543.
- Miller, M.A. (2025) Carbon territoriality at the land-water interface. *Global Environmental Change* 90, 102954.
- Miller, M.A. & Taylor, D. (2024) A transboundary agenda for nature-based solutions across sectors, scales and disciplines: Insights from carbon projects in Southeast Asia. *Ambio* 53(4): 534-551.
- United Nations. (2019). World Urbanization Prospects: The 2018 Revision n (ST/ESA/SER.A/420). New York: United Nations.
- Yang, S., Zhao, W., Pereira, P. & Liu, Y. (2019). Socio-cultural valuation of rural and urban perception on ecosystem services and human well-being in Yanhe watershed of China. *Journal of Environmental Management* 251, 109615.

Thank you

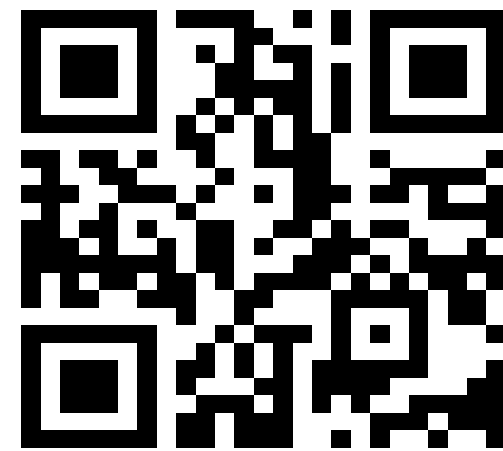


Photo: Mangrove carbon sink on Singapore shoreline
<http://www.wildsingapore.com/wildfacts/plants/mangrove/mangroves.htm>

