Assessing Sustainable Development of Urban Systems

Examples from the Foodprint Melbourne and City of Port Phillip Eco Footprint projects

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Overview

My background

Previous work

Key themes

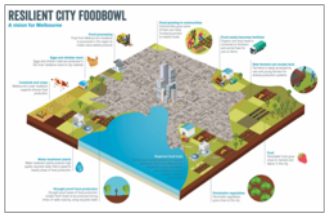
Key concepts

Sustainable Development
Socio-ecological systems
Resilience
Transformation
Transdisciplinarity

Methods

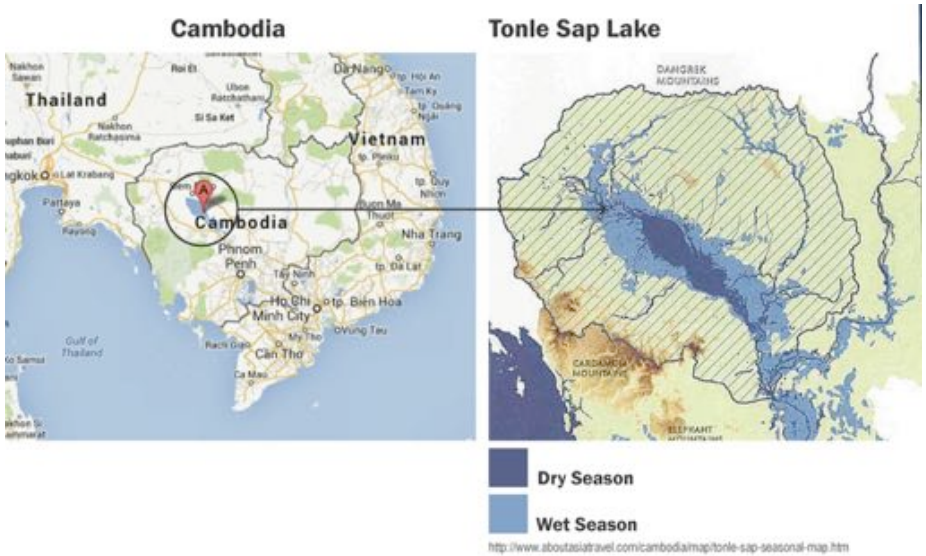
Scenario modelling

Foodprint Melbourne



CoPP Eco Footprint

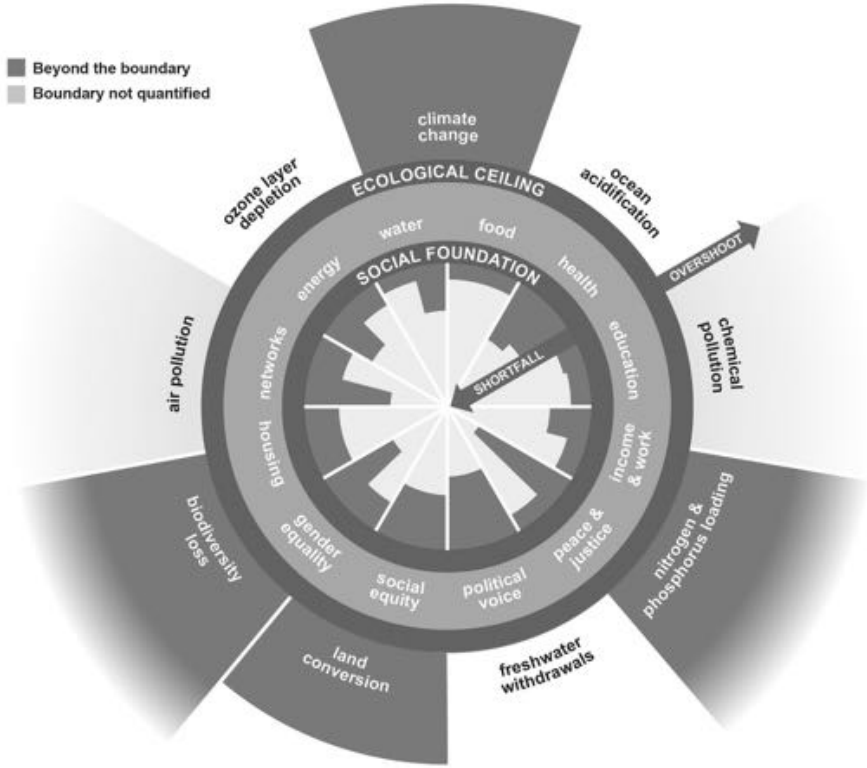

NEPAL
(Ecological Zone Map)
Far Western
Humla
Mid Western
Karnali
Western
Central
Eastern
Legend
Boundary
International boundary
Regional boundary
District boundary
Ecological Zone
Mountain
Hills
Terai


Cambodia
Tonle Sap Lake
Thailand
Vietnam
Cambodia
Phnom Penh
Ho Chi Minh City
Dry Season
Wet Season
http://www.aboutasiatravel.com/cambodia/map/tonle-sap-seasonal-map.htm


ROYA
BAKING P

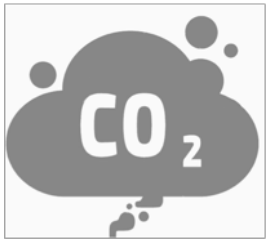
What is ‘Sustainable Development’?

Sustainable development is far broader than just the environment. It's also about ensuring a strong, healthy and just society. This means meeting the diverse needs of all people in existing and future communities, promoting personal wellbeing, social cohesion and inclusion, and creating equal opportunity.



Why cities?

*"The war on climate change will be won or lost in cities"**

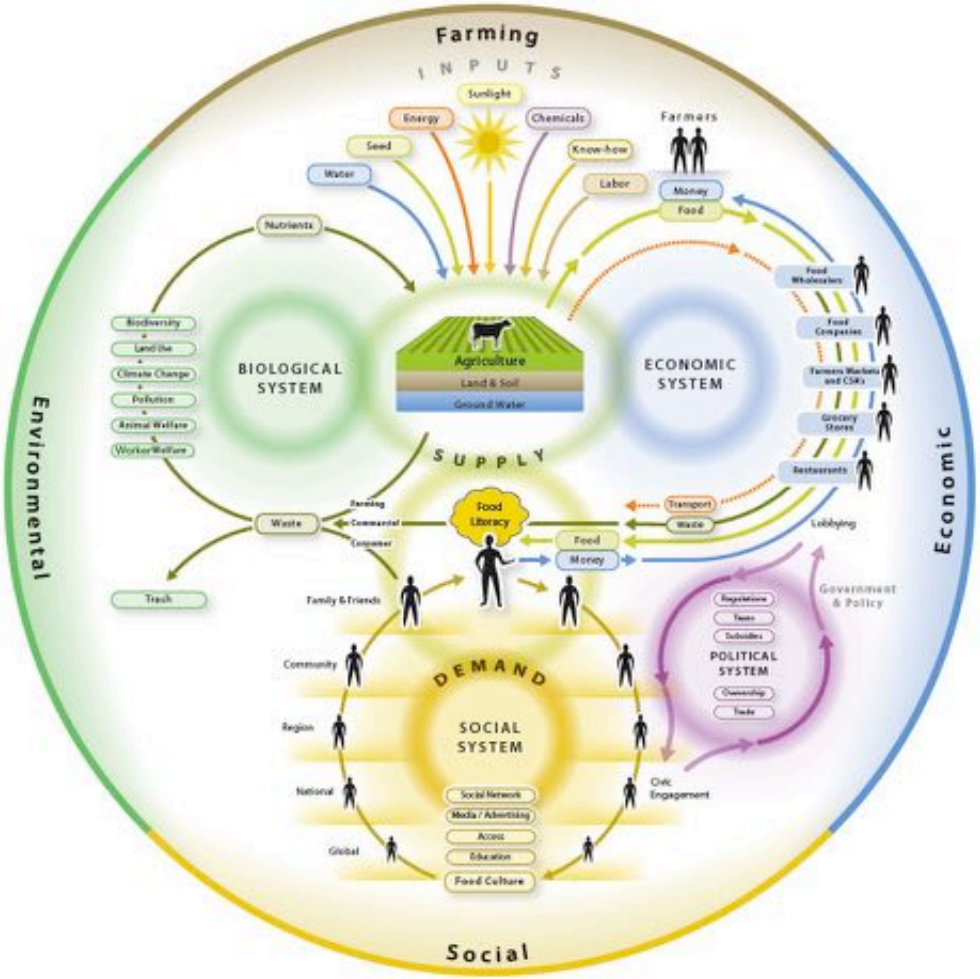


70%

* Rowe, M, 2017

Socio-ecological-(technological) systems

- Integrates
  - Social and equity issues
  - Environmental quality and protection
  - Technical / infrastructure engineering aspects

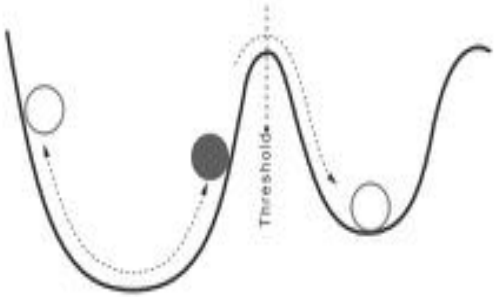


Source: http://www.nourishlife.org/teach/food-system-tools/

Resilience

Engineering Resilience

A measure of the rate at which a system approaches steady state after a perturbation (Folke, 2004) → ***Recovery***



Ecological resilience

The magnitude of disturbance that a system can experience before it shifts into a different state (Holling, 1973) → ***Robustness***

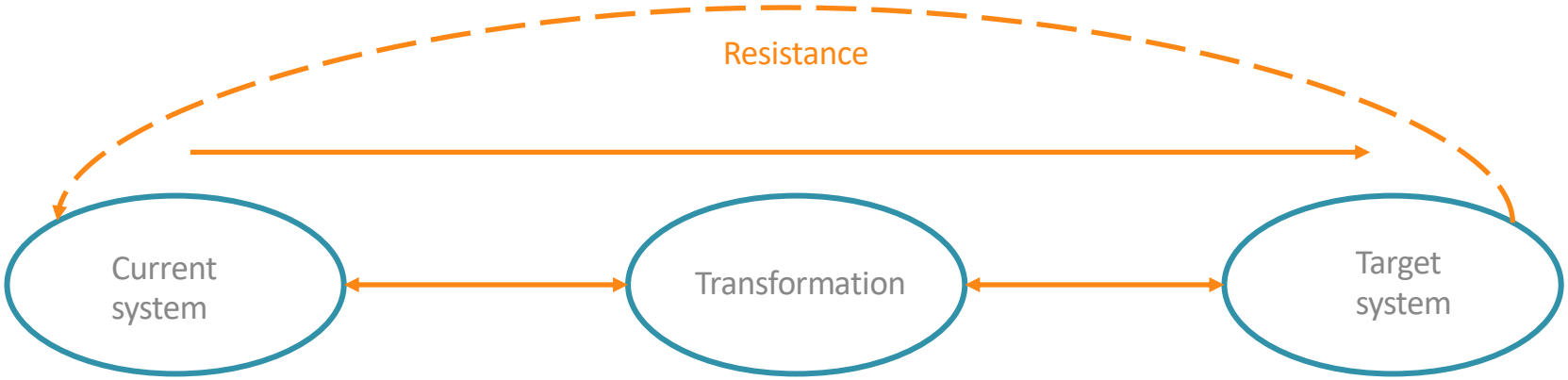
Socio-ecological resilience

- Amount of disturbance a system can absorb and still remain within the same state or domain of attraction
- Degree to which the system is capable of self organization
- Degree to which the system can build and increase the capacity for learning and adaptation. (Carpenter. 2001)

→ ***Adaptive capacity***

Source: Folke, Carl, Steve Carpenter, Brian Walker, Marten Scheffer, Thomas Elmqvist, Lance Gunderson, and C.S. Holling. 2004. "Regime Shifts, Resilience, and Biodiversity in Ecosystem Management."*Annual Review of Ecology, Evolution, and Systematics* 35

Transformation

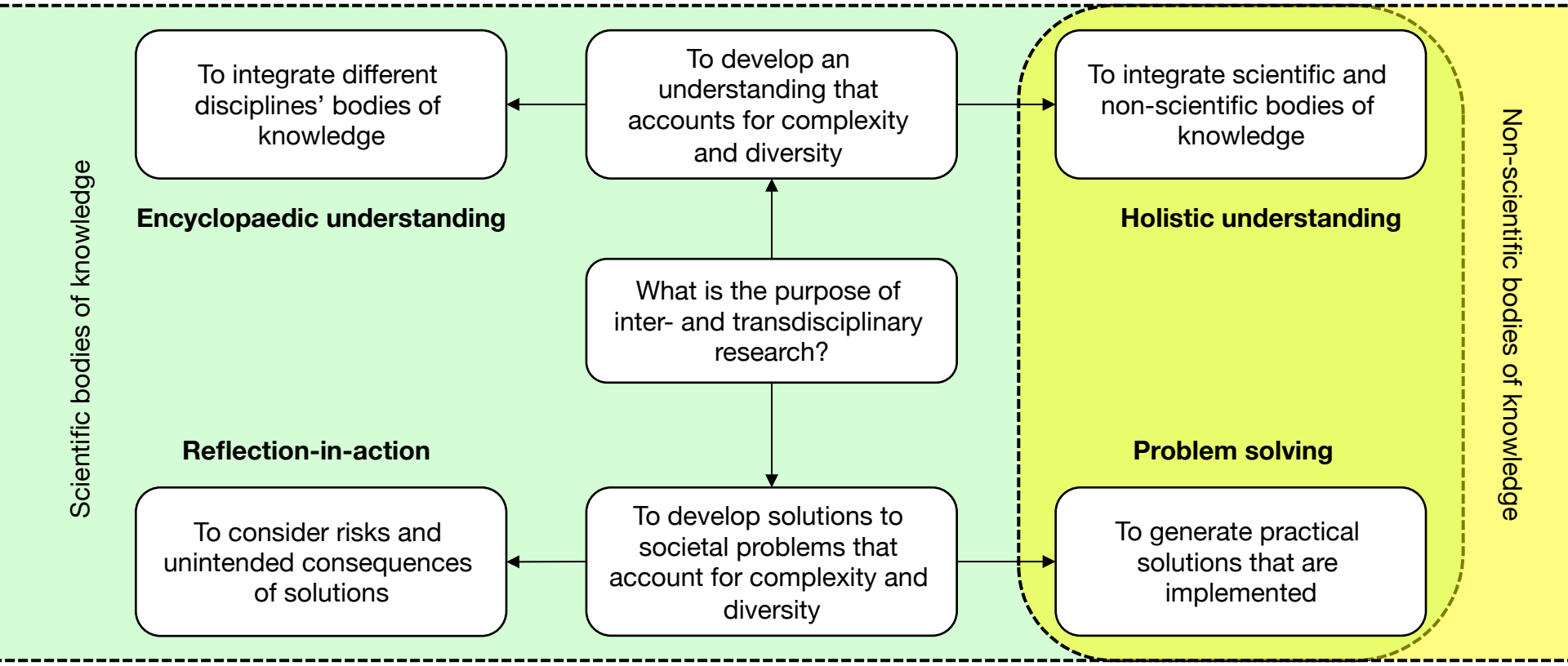


System status
Vulnerabilities
Connections /
Causal relations

Top down
Goals
Functions

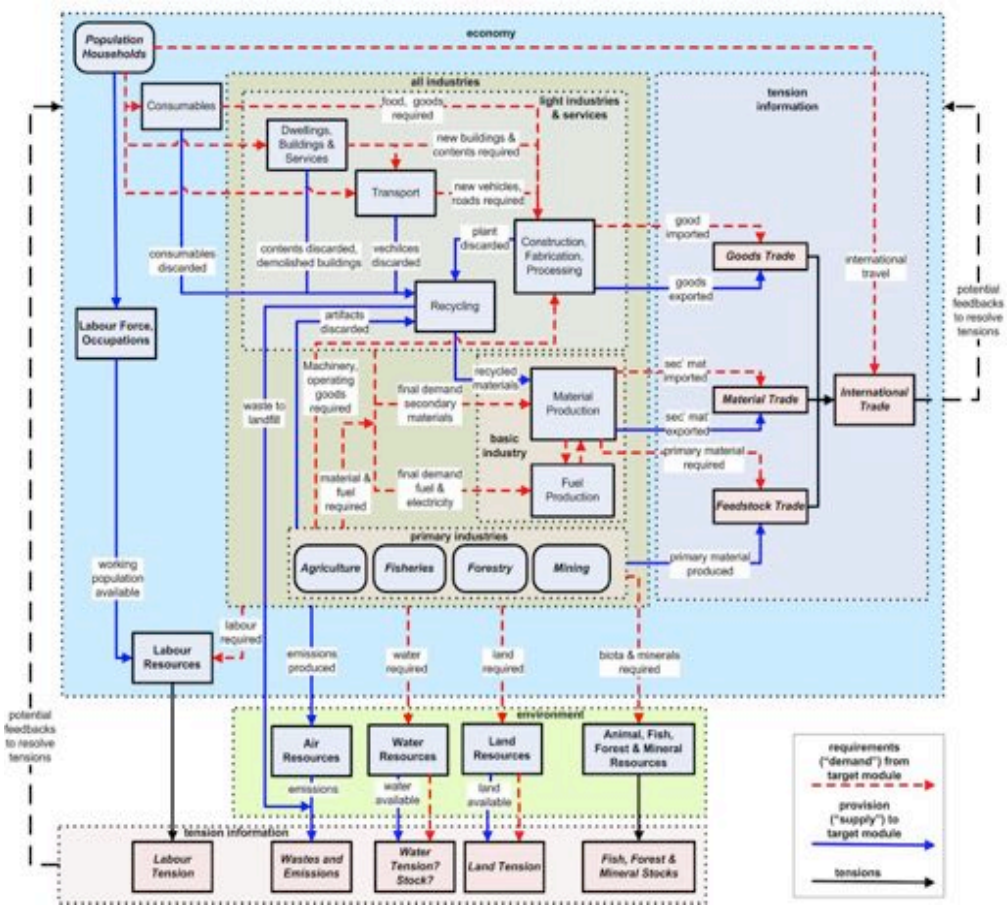
Values
Goals
Functions

Transdisciplinary approach



Scenario Modelling Method

- Australian Stocks & Flows Framework (ASFF)
- Links population needs with land and resource use
- Develop narratives or scenarios with stakeholders
- Translate to quantitative settings in ASFF
- Validate results with external data and expert consultation



Source: Turner G.M., Hoffman R.B., McInnis B.C., Poldy F., Foran B., (2011). A tool for strategic biophysical assessment of a national economy - The Australian stocks and flows framework. Environmental Modelling & Software 26(9): 1134-1149

Example: Foodprint Melbourne

- Investigated how Melbourne can feed itself sustainably as it grows to a population of over 7 million
- Transdisciplinary “knowledge to action” project
- Quantitative and qualitative methods
- Aim to put the protection of Melbourne’s foodbowl on the public and political agenda.

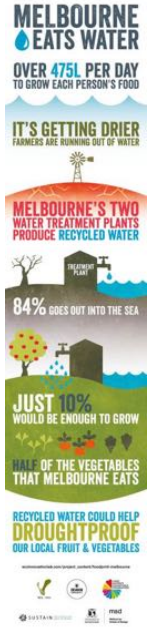
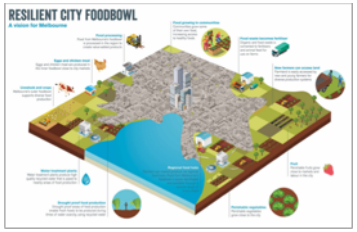
Cities and Food

- Currently over 50% of world population live in cities - by 2050, it will be 66%*
- Cities consume but typically do not produce food – vulnerable to food insecurity
- Competing needs for land use and resources
- Major contributor to environmental problems
- Progressive centres for change with cultural and economic influence

→ **Food Security is increasingly becoming an urban problem**

*UN, 2014. World urbanization prospects: the 2014 revision : Highlights. United Nations, Department of Economic and Social Affairs, Population Division.

Methodology & Methods

'The Natural Step' (TD project steps)	Methods	Research outputs	Public outreach
Awareness (problem formulation)	Co-development of research questions with stakeholders		
Baseline Mapping (system knowledge)	Scenario modelling (materials flow analysis and stakeholder consultation)	 	 
Creating a vision (target knowledge)	Background research and stakeholder workshops, used SES framework		
Down to business (transformation knowledge)	Development of policy guidelines		

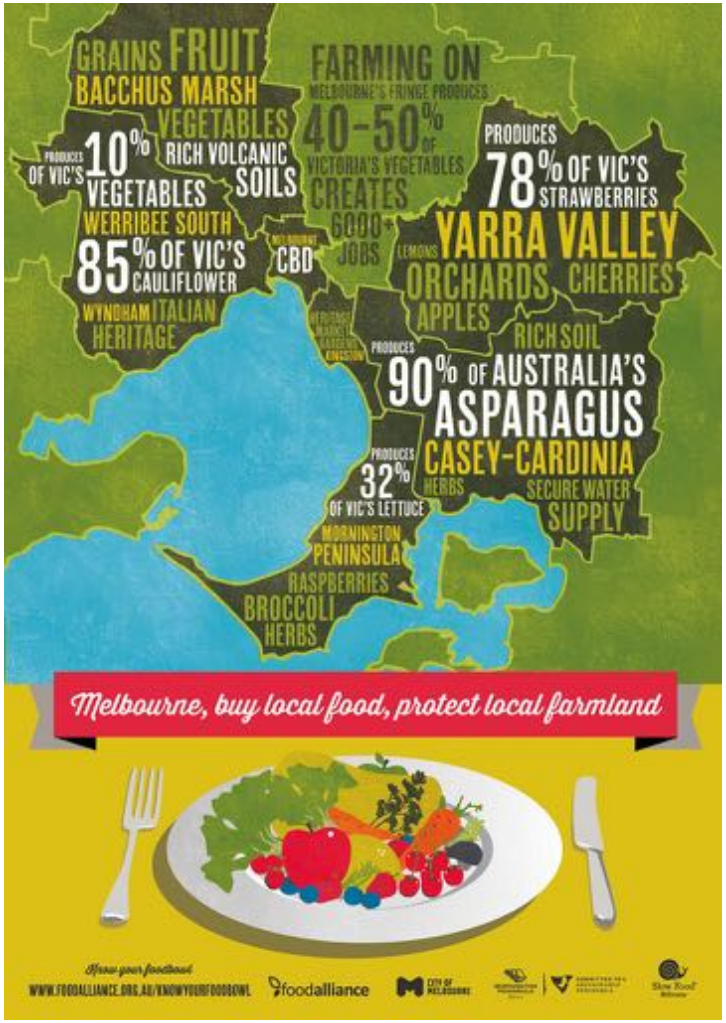
James, S., and T. Lathi. 2004. *The natural step for communities. How cities and towns can change to sustainable practice*. New Society Publishers, Gabriola Island, British Columbia, Canada.

Melbourne, Australia

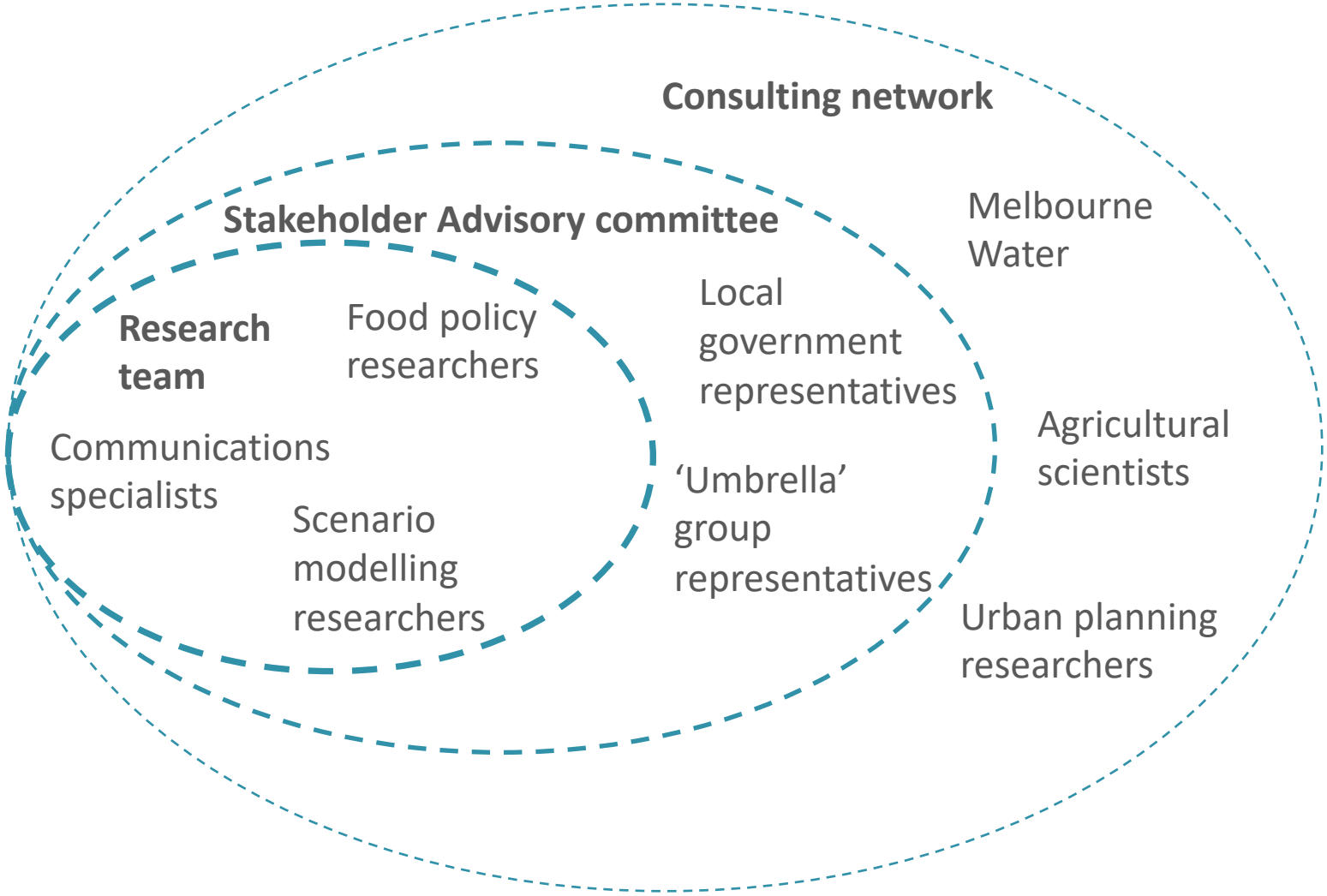
Australia's fastest growing city - population 4.37 million, 7 million in 2050

South east Australia, Temperate climate

Significant peri-urban agriculture around city



Project team and stakeholders +



Research questions

How Melbourne can feed itself sustainably as it grows to a population of over 7 million in 2050?

- What is the capacity of Melbourne's foodbowl to feed the city now and in 2050?
- What is the environmental impact of feeding the city now and in 2050?
- What does a sustainable and resilient city foodbowl look like and how do we get there?

Modelling

National scale

→

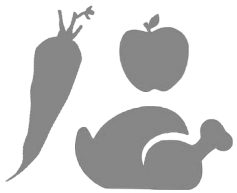
City scale

$$Domestic\ consumption\ factor\ (CF_D) = \frac{Domestic\ food\ consumption}{Total\ food\ production}$$

$$Melbourne\ consumption\ factor\ (CF_M) = CF_D \times \frac{Melbourne\ population}{National\ population}$$

$$Melbourne\ Foodprint = Resources\ used\ on\ national\ scale \times CF_M$$

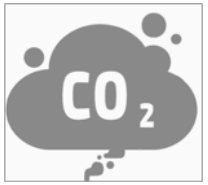
What does it take to feed the city?



15,080 tonnes food per day

475 litres per person per day

16.3 million hectares of land



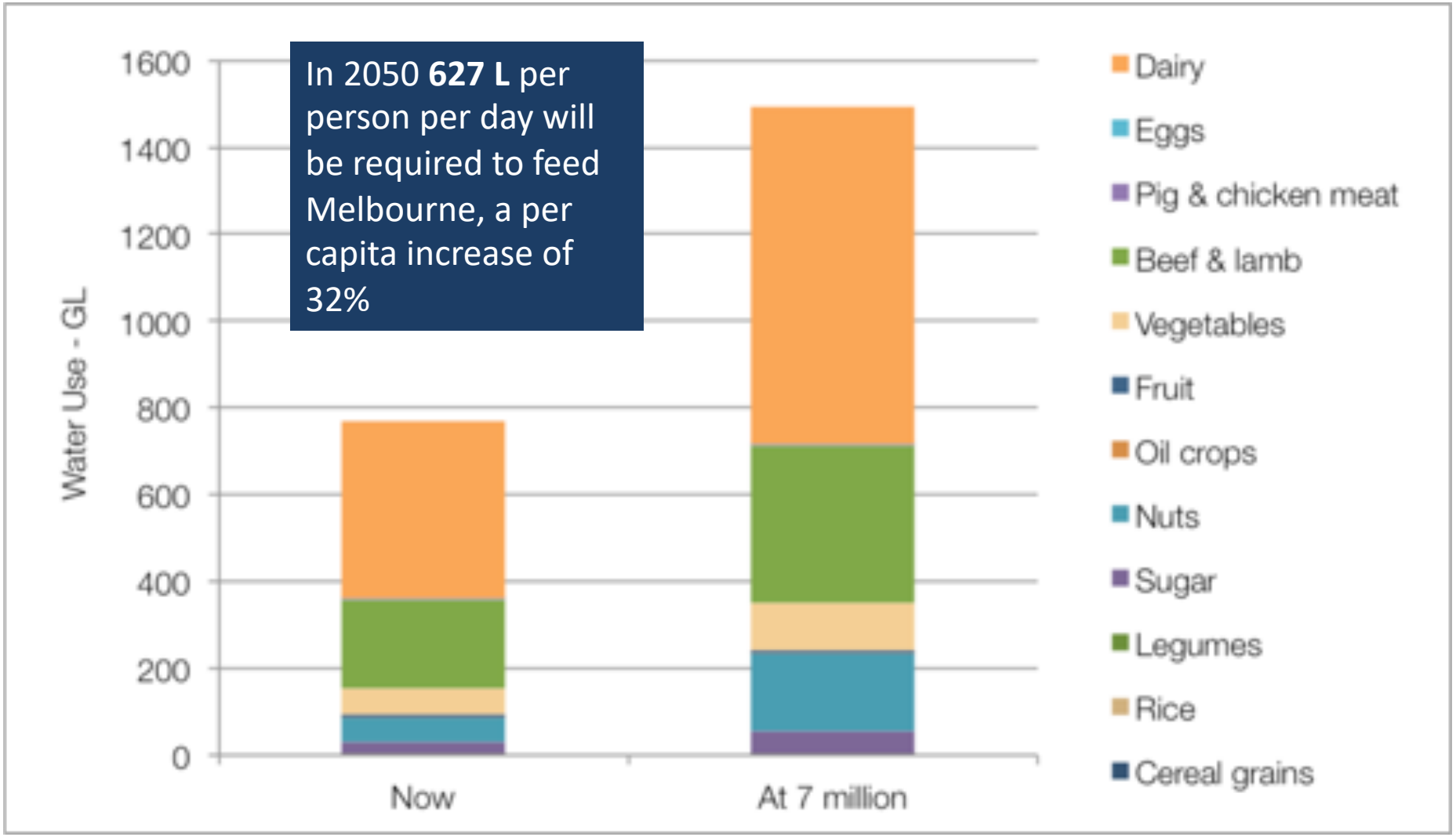
4.1 million tonnes GHG emissions per year

900,000 tonnes edible food waste per year

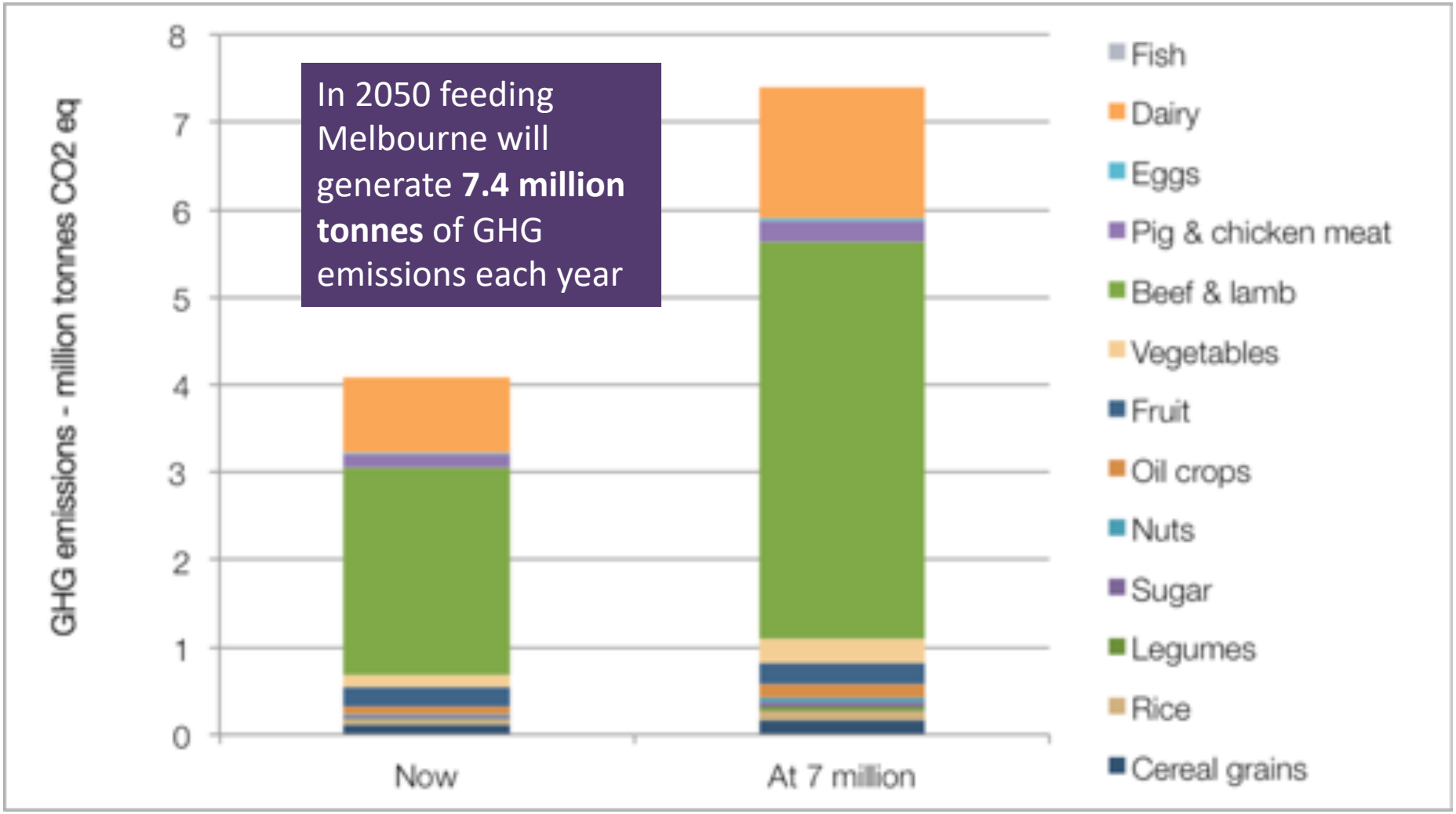
Land


When Melbourne has a population of 7 million, the land required to feed the city will have almost doubled to **32.3 million hectares**
Land Use - million Ha
35
30
25
20
15
10
5
0
Now
At 7 million
Dairy
Eggs
Pig & chicken meat
Beef & lamb
Vegetables
Fruit
Oil crops
Nuts
Sugar
Legumes
Rice
Cereal grains

Water

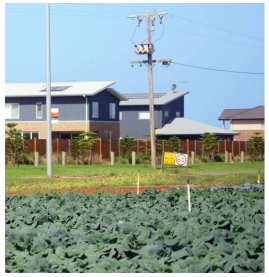

In 2050 **627 L** per person per day will be required to feed Melbourne, a per capita increase of 32%
Water Use - GL
1600
1400
1200
1000
800
600
400
200
0
Now
At 7 million
Dairy
Eggs
Pig & chicken meat
Beef & lamb
Vegetables
Fruit
Oil crops
Nuts
Sugar
Legumes
Rice
Cereal grains

Greenhouse Gas Emissions



Food system vulnerabilities

Predominantly road transport supply networks



Losing peri-urban agricultural land to housing

Conventional farming practices degrading land

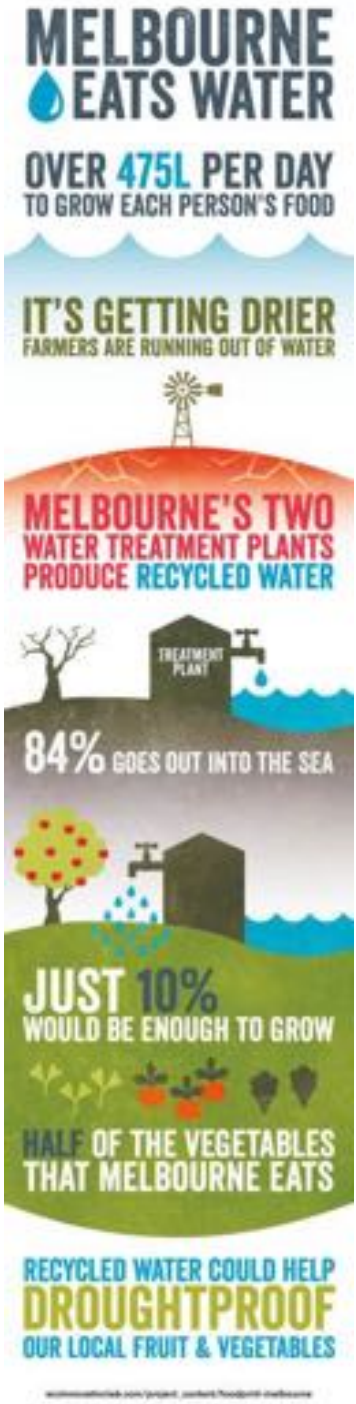
Production far from consumption

Reliant on diminishing water sources

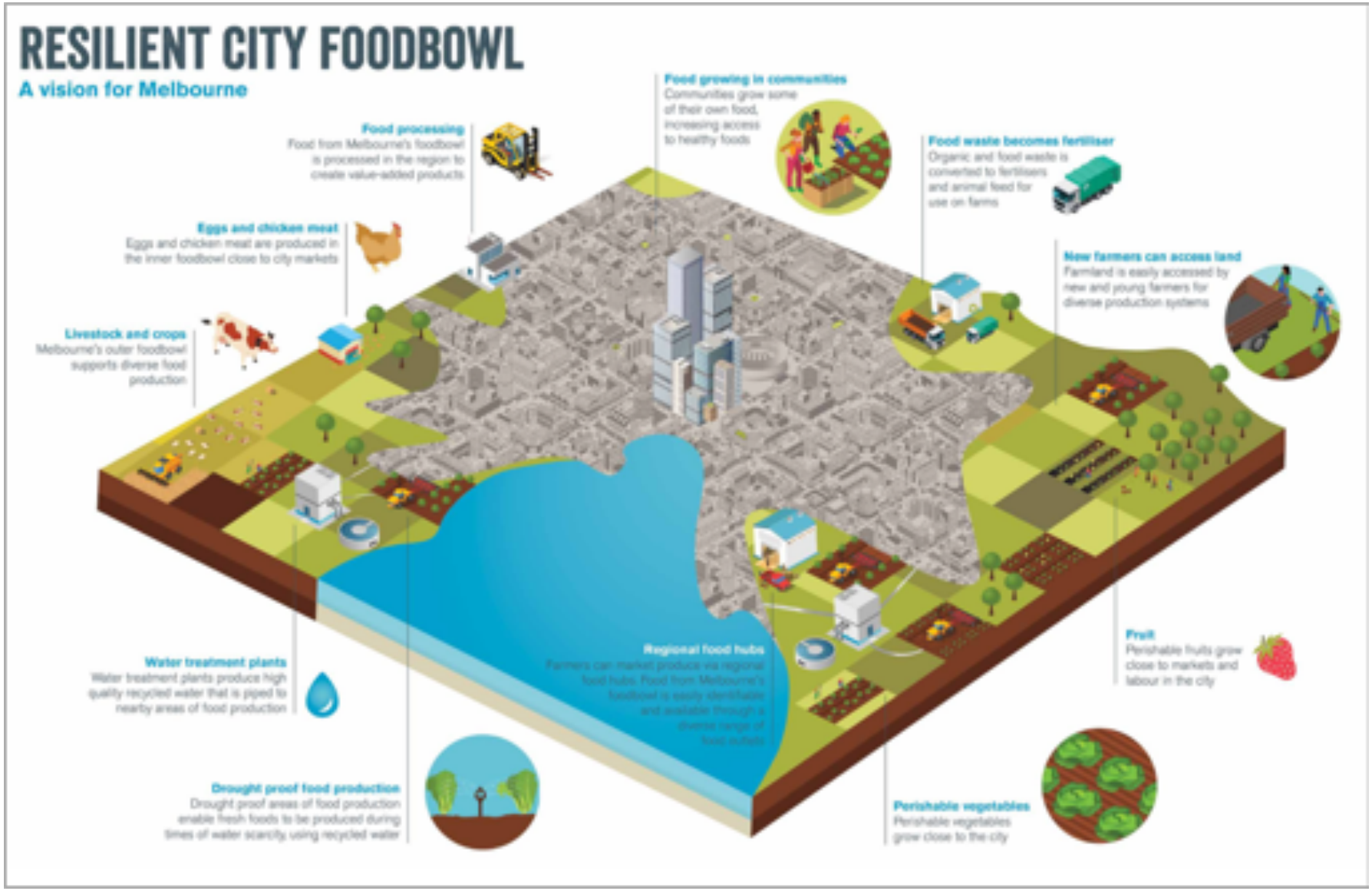
NPK

Reliant on fossil fuel based fertilisers

Skills shortage due to ageing farmers

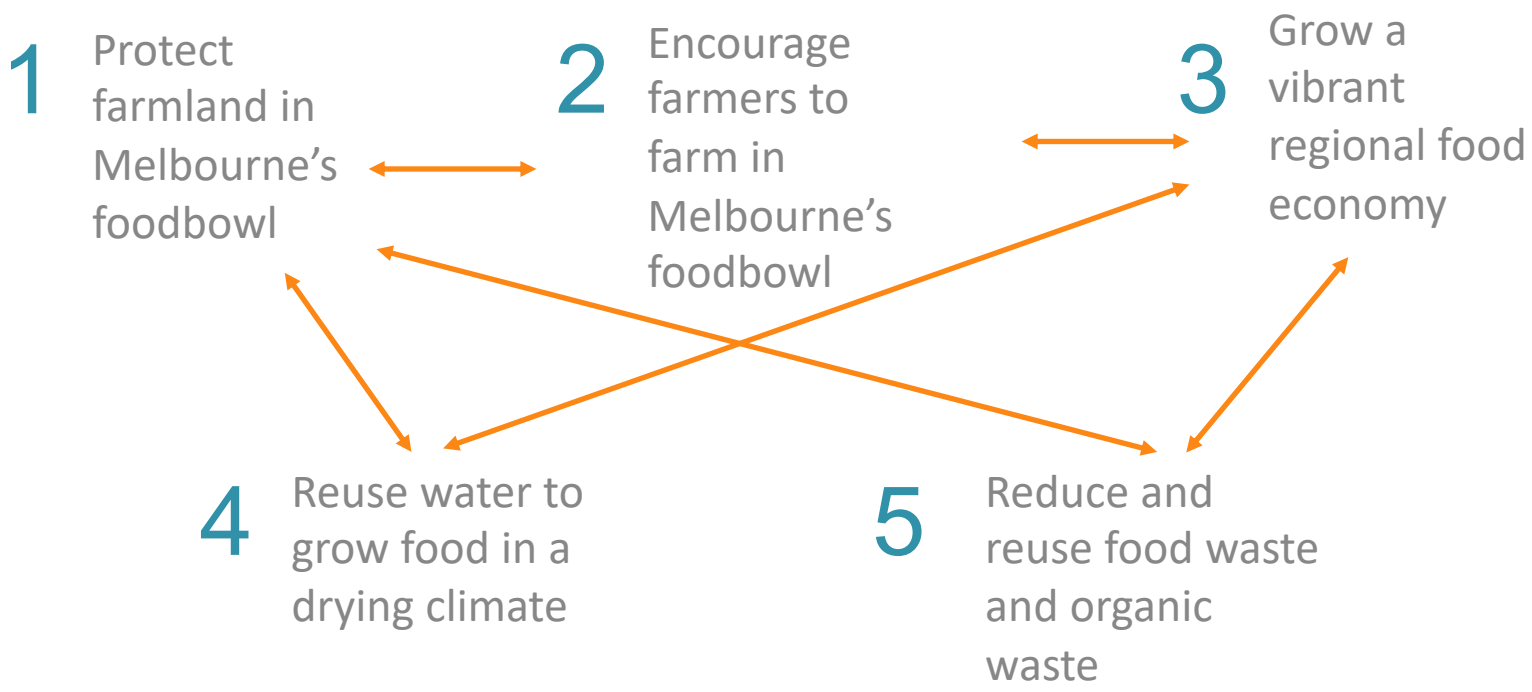


Vision creation

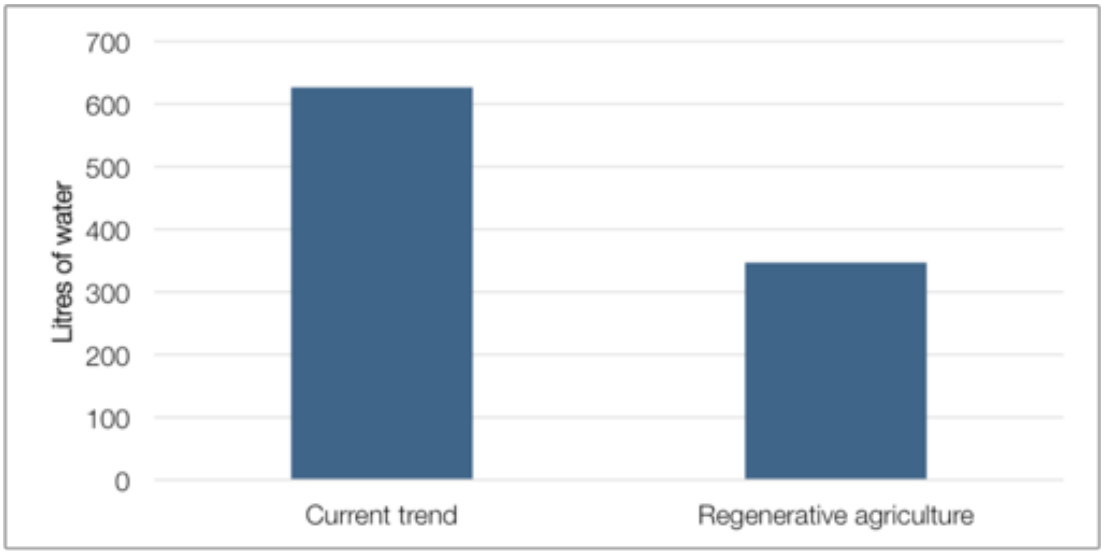


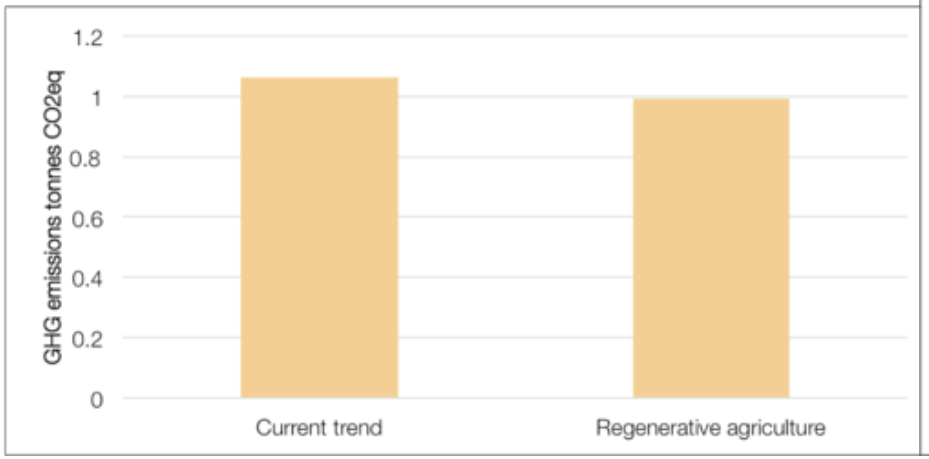
Source: https://research.unimelb.edu.au/foodprint-melbourne/publications/a-vision-for-a-resilient-city-foodbowl-for-melbourne

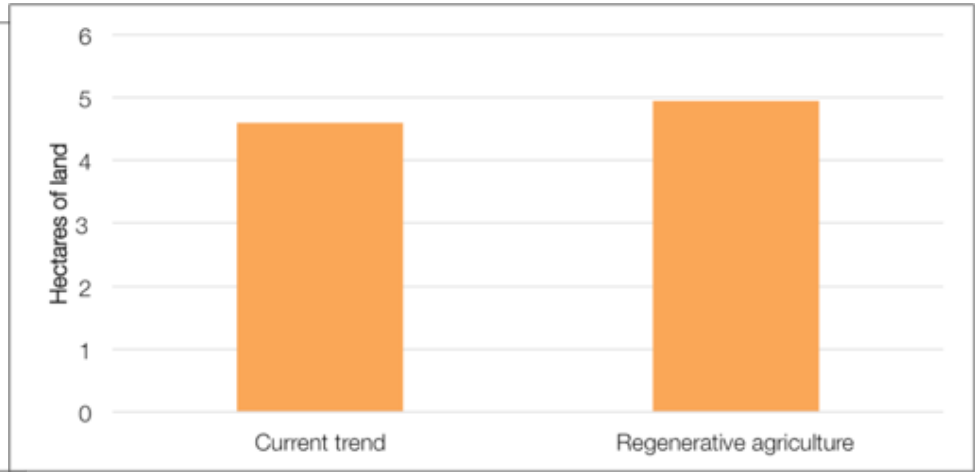
Integrated Policy Framework



Regenerative agriculture

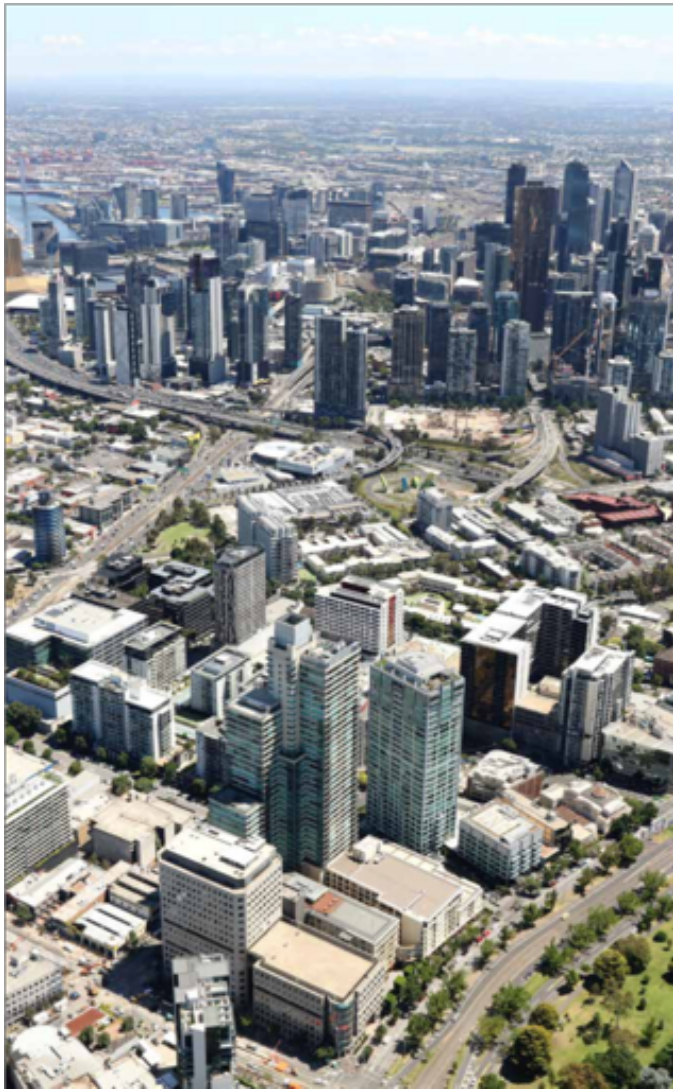






Example: City of Port Phillip Eco-Footprint project

- Investigated the environmental impacts of urban lifestyles in the City of Port Phillip, a beachside municipal council in Melbourne.
- Transdisciplinary knowledge to action project
- Qualitative and quantitative methods



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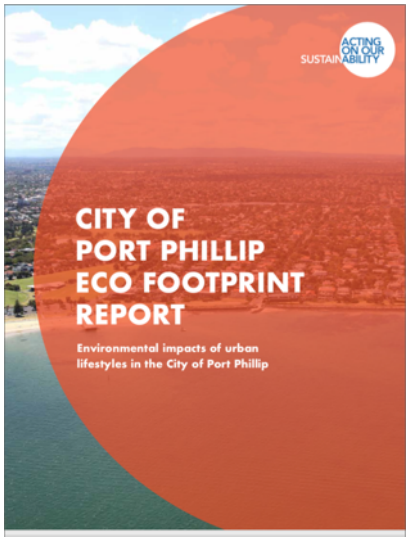
Baseline Mapping (system knowledge)	Scenario modelling (materials flow analysis and stakeholder consultation)		
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Research questions

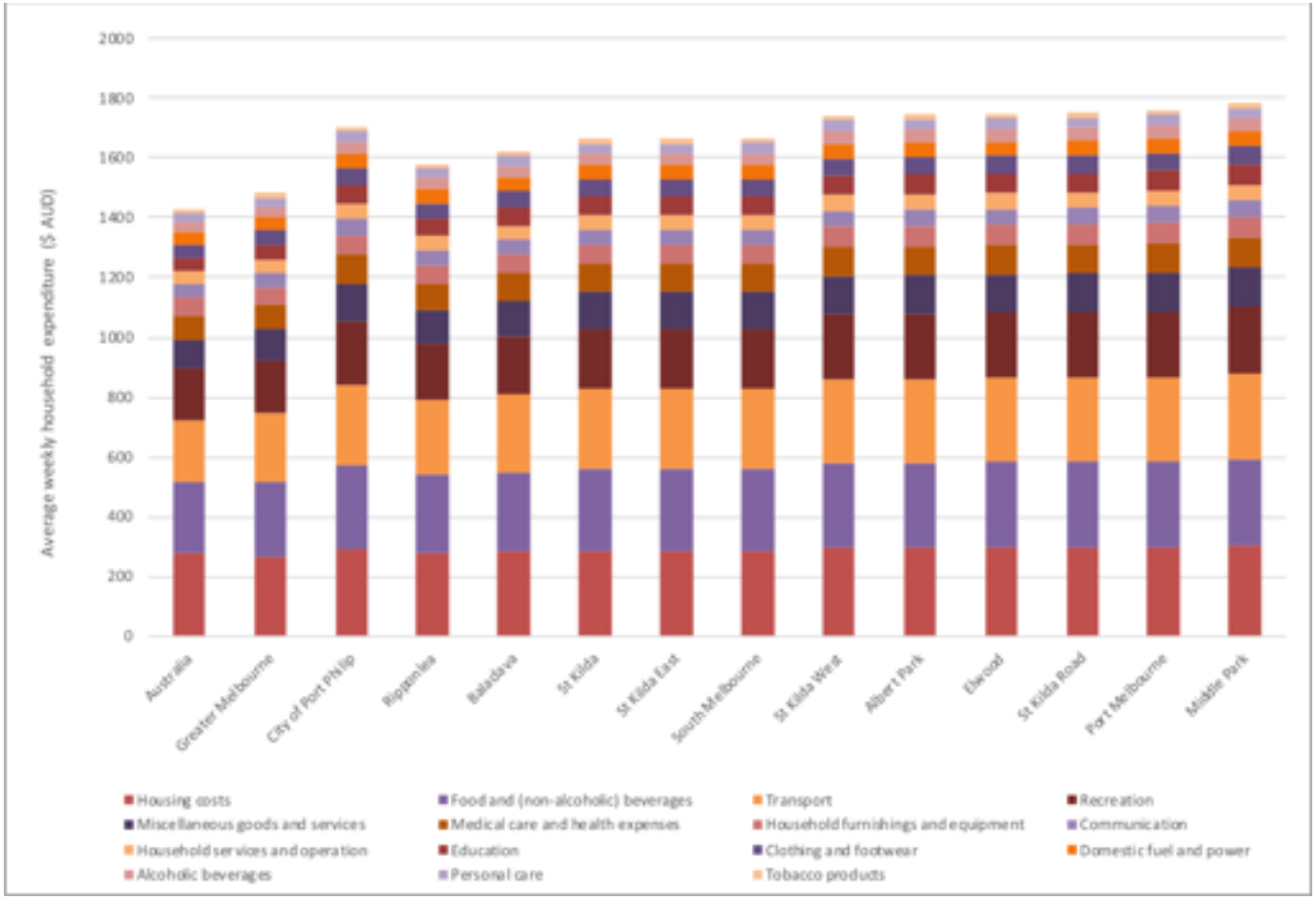
- What is the city's current and future environmental footprint – the natural resources required to support urban lifestyles and the greenhouse gas emissions and waste generated?

- What are the opportunities to reduce this footprint and increase the sustainability of the city?

Modelling

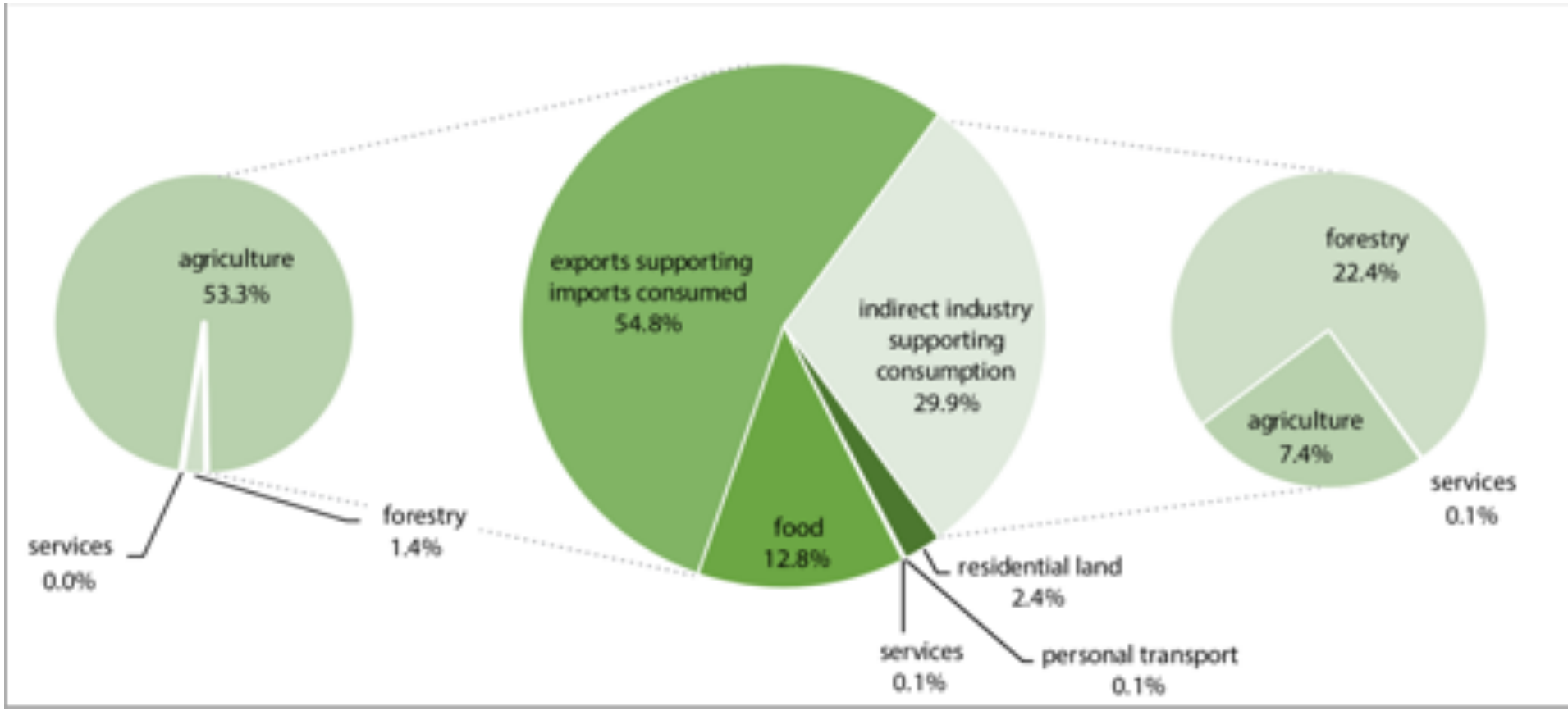
National scale → Municipal scale

- Used ratio of local to national Household Expenditure Data.
- Incorporated offshore impacts by factoring in 'exports to support imports consumed'



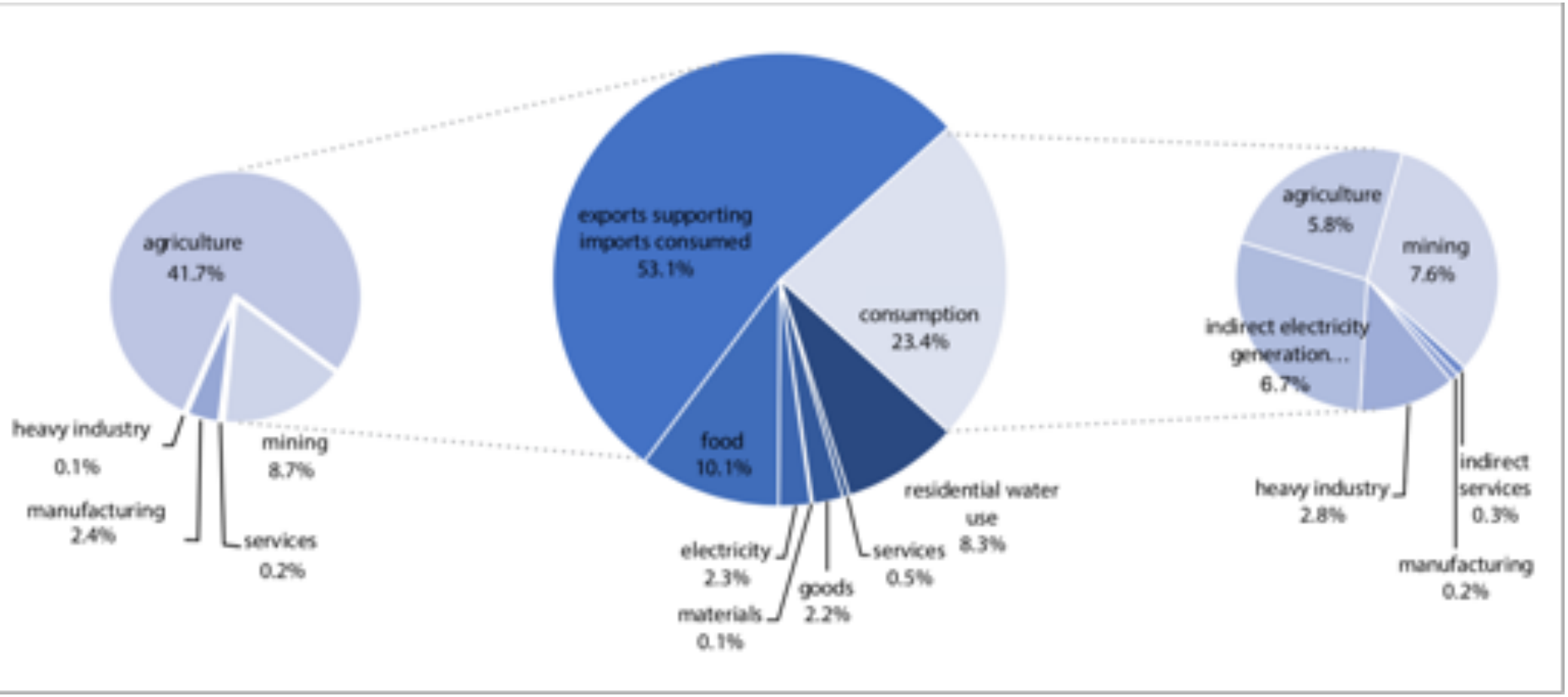
Land

48294 sqm /person



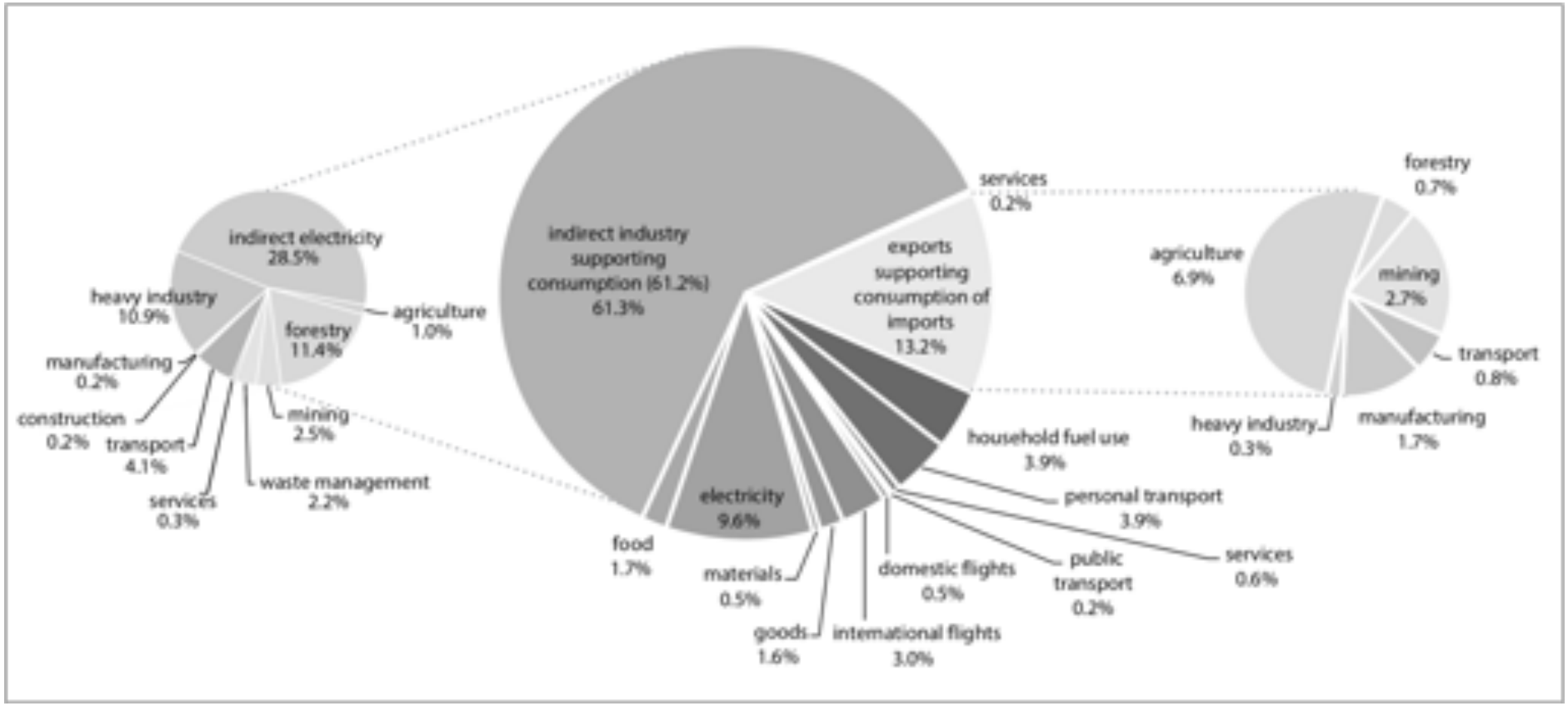
Water

3808 sqm /person/year



Carbon emissions

29798 kg /person/year



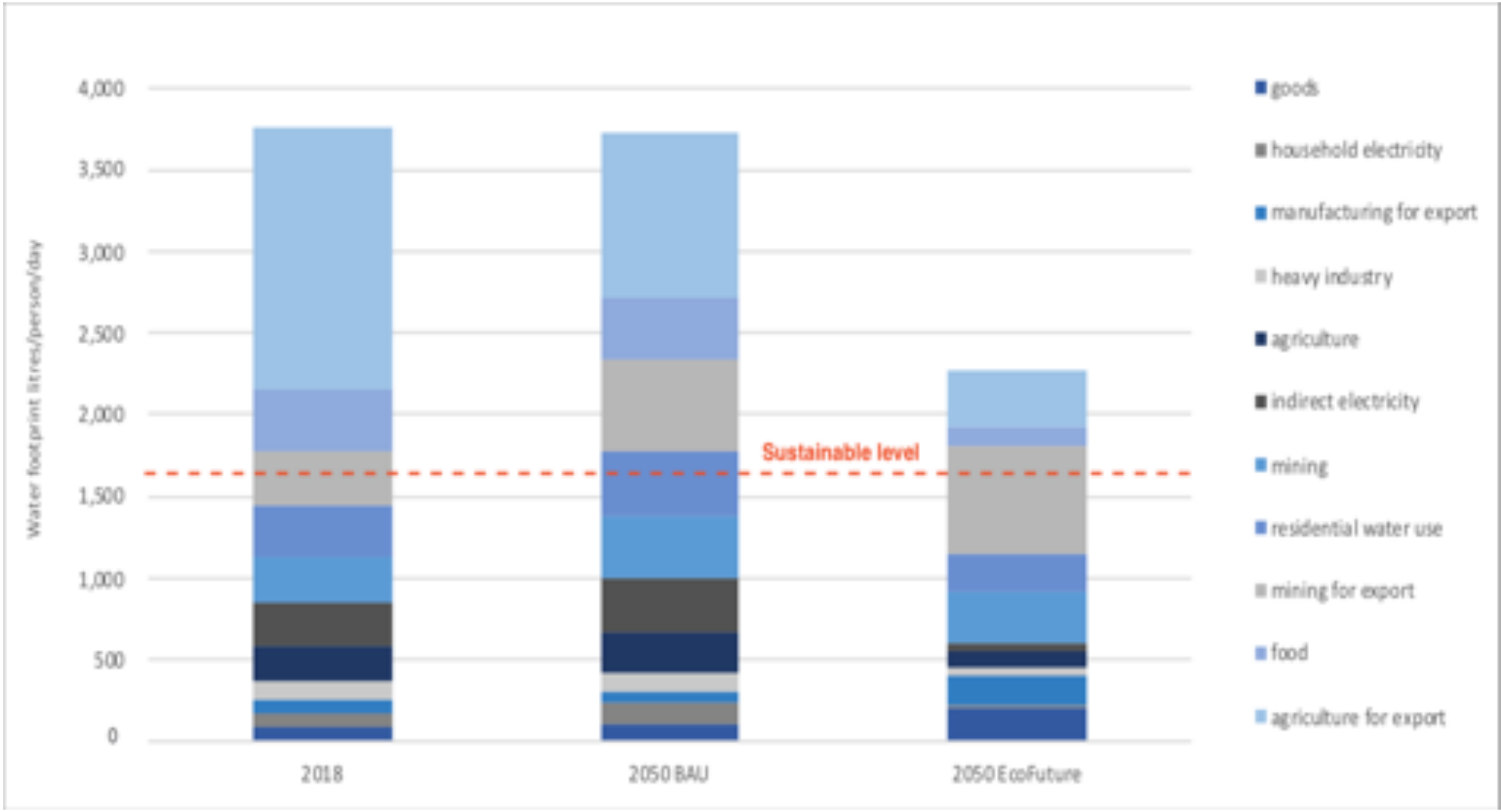
Eco-future scenario

- Better insulated homes
- Reduced consumption of goods
- Reduced consumption of red meat
- Switch to renewable energy
- Reduced car use
- Reduced consumption of imported goods

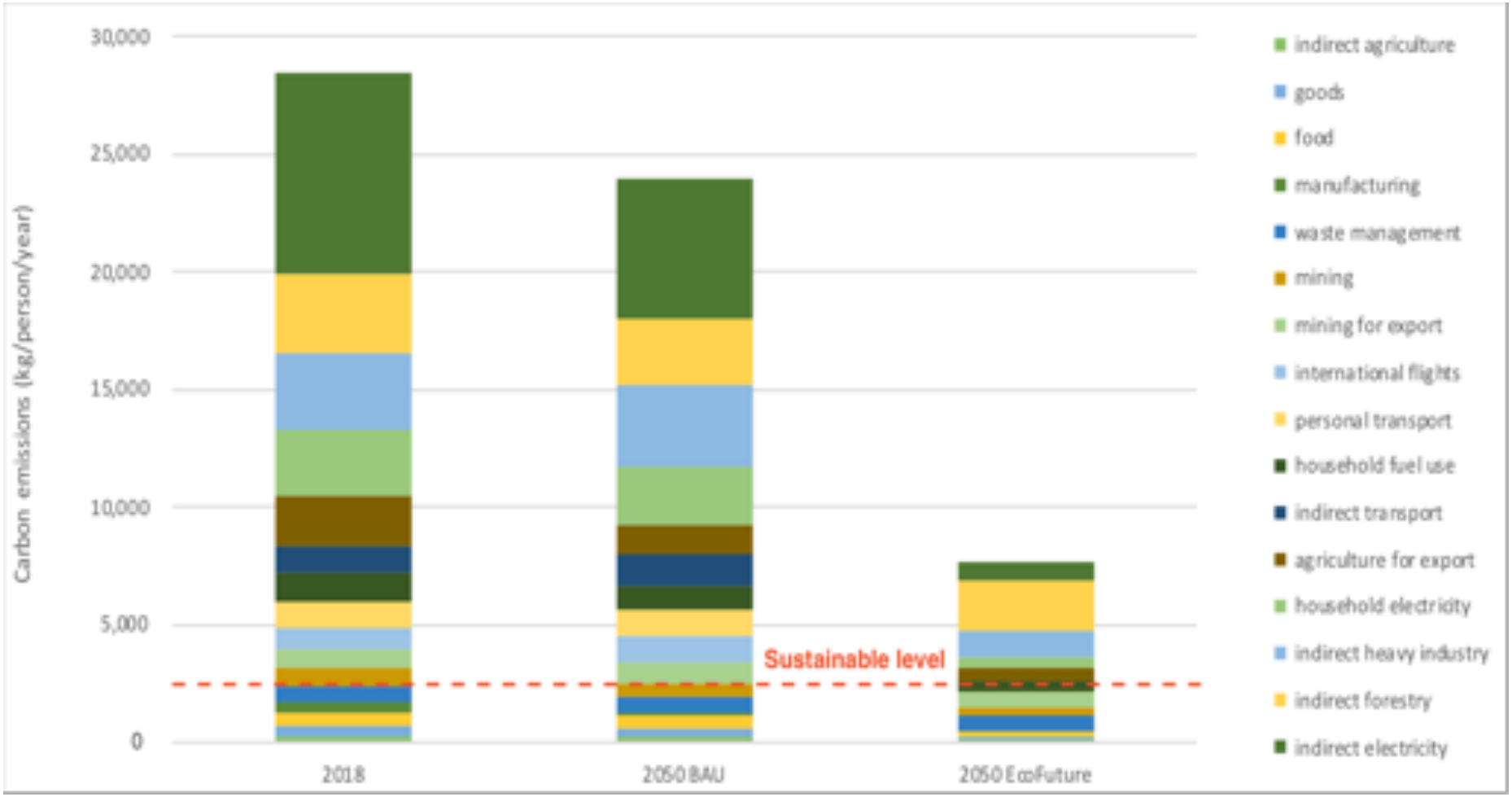
Land


60,000
50,000
40,000
30,000
20,000
10,000
0
Land footprint sqm/person/year
Sustainable level
2018
2050 BAU
2050 EcoFuture
forestry for export
residential land
indirect agriculture
food
forestry
agriculture for export

Water


4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
Water footprint litres/person/day
Sustainable level
2018
2050 BAU
2050 EcoFuture
goods
household electricity
manufacturing for export
heavy industry
agriculture
indirect electricity
mining
residential water use
mining for export
food
agriculture for export

Carbon emissions



Policy recommendations

- Support sharing, reuse, recycling, repair programs to reduce consumption of goods
- Increase awareness about impacts of food choices and diets, and how to reduce food waste
- Encourage and support residents to switch to green power and reduce consumption of energy
- Advocate for de-carbonization of electricity supply (state level)

Thank you!

More information:

https://research.unimelb.edu.au/foodprint-melbourne/home

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