Resilience to Abrupt Global Catastrophic Risks: Urban and Near-Urban Agriculture for Food Security

Prof Nick Wilson (University of Otago, Wellington)

Dr Matt Boyd (Adapt Research Ltd & Islands for the Future of Humanity)

21st International Conference on Urban Health; 18 November 2025

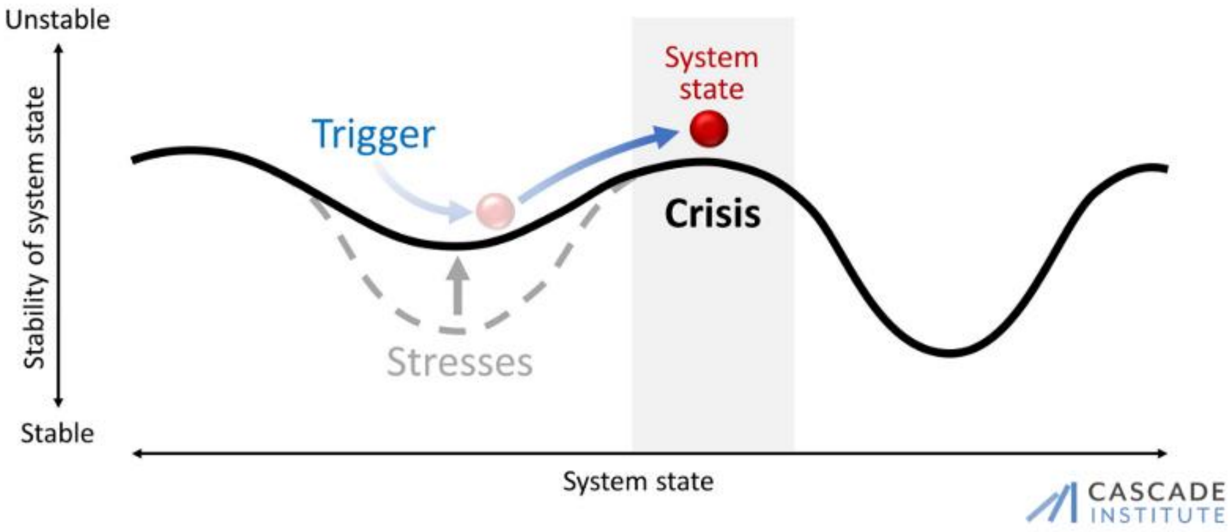
University of Otago
ŌTĀKOU WHAKAIHU WAKA

ISLANDS FOR THE FUTURE OF HUMANITY
www.islandfutures.earth

Global Catastrophic Risks

- Extreme pandemic
- Nuclear war
- Volcanic winter
- Catastrophic infrastructure failure (AI, cyber, solar storm, EMP)
- Global catastrophic food failure (climate, war)

Global Systemic Risk: stress, trigger, crisis



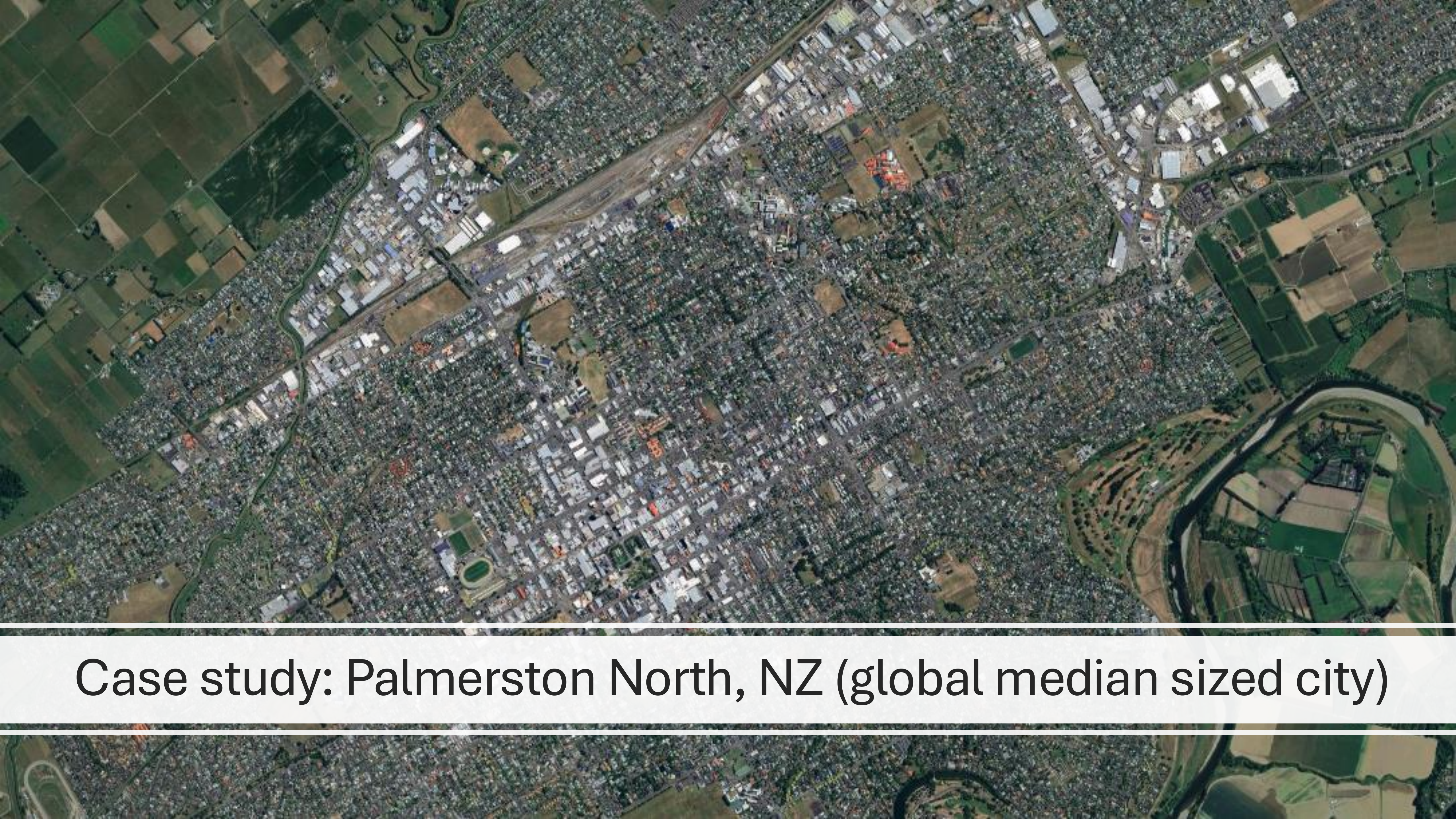
Stresses gradually shallow a basin of attraction so that a trigger event can push the system out of equilibrium and into systemic crisis.

Figure credit: Cascade Institute's 'Stress-Trigger-Crisis' model (2024)

Recent relevant publications:
Wescombe et al. 2025 'Global Catastrophic Food Failure'
Arnscheidt et al. 2025 'Systemic Contributions to Global Catastrophic Risk'
Gambhir et al. 2025 'Systemic Risk Assessment… for the Global Polycrisis'

Previous UA Research - Limitations

- Applicability of existing research to context of global catastrophe resilience limited by:
  - Focus on fruit/vegetables only
  - Studies of yield by weight not total caloric and protein needs
  - Studies of large cities, not representative median sized cities
  - Focus on crops actually grown, not optimal crops for resilience
  - Focus on existing gardens, not potential growing area
  - No consideration of near-urban agriculture to supplement UA shortfall
- Need a comprehensive food energy analysis



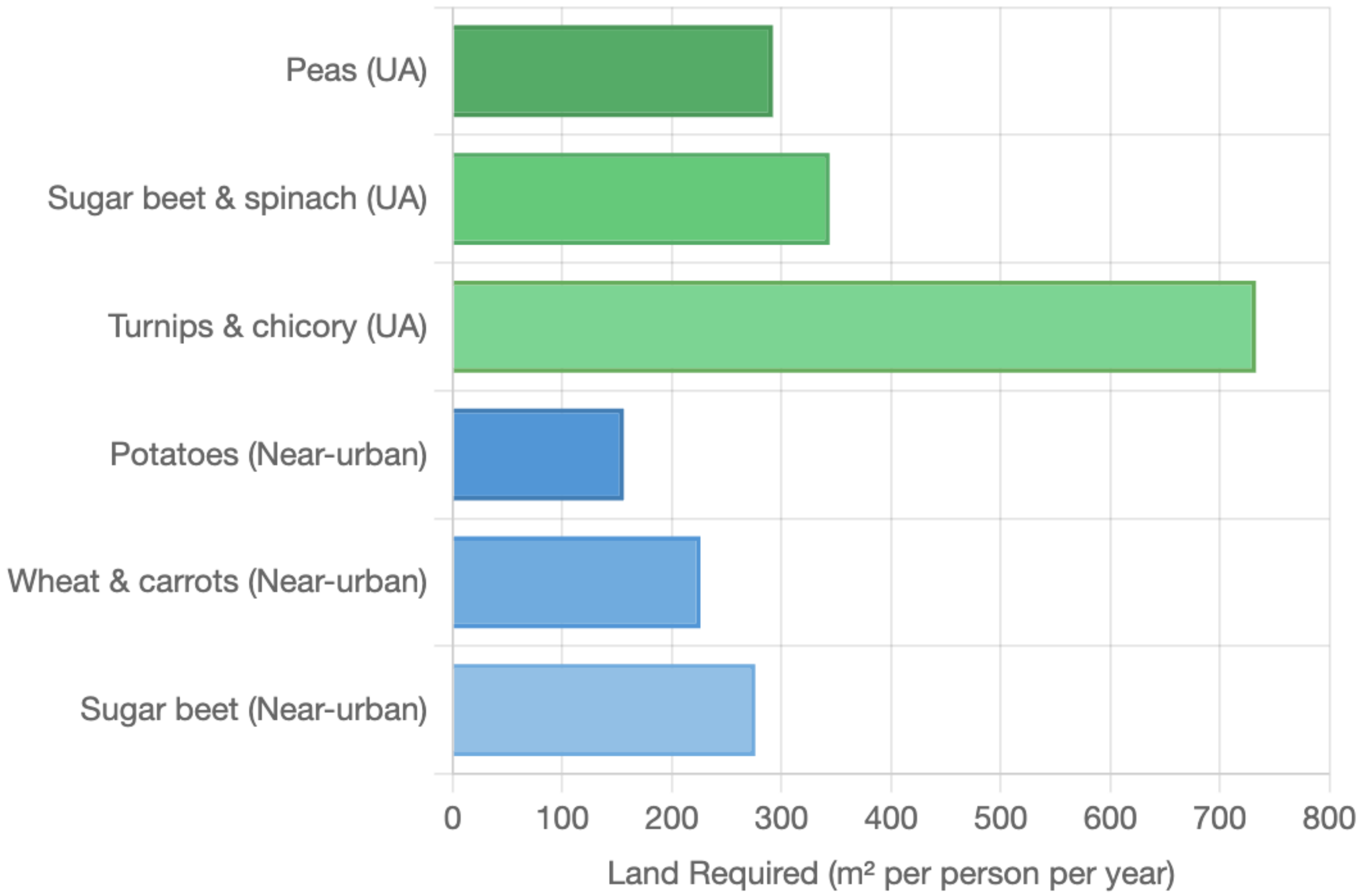
Case study: Palmerston North, NZ (global median sized city)

Methods

- Urban agriculture yield global **meta-analysis** (Payen et al.)
- **Crop optimization** for protein and food energy per square metre (ie square metres to feed one person)
- **Google Earth imagery** – manual analysis (random samples of residential lots and urban green spaces)
- Statistical extrapolation to estimate land area available
- Estimation of **additional near-urban land** to feed the population - based on prior research on industrial farming & fuel requirements
- **Population**: 91,800 people
- **Daily needs**: 8,686 kJ energy + 81g protein per person
- **Land use scenarios**: 25%, 50%, 75% of available UA space

Results – crop optimisation

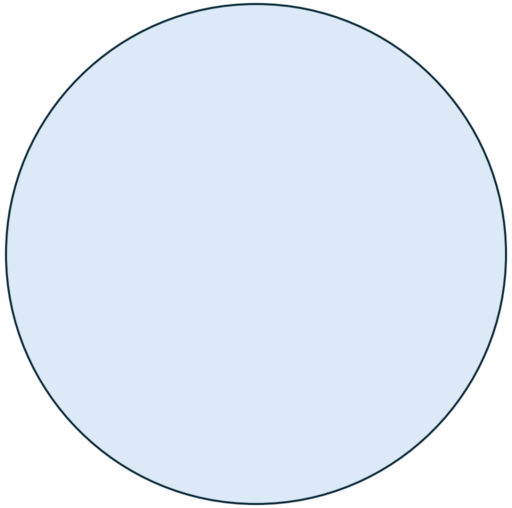
Figure 3: Crop Efficiency Comparison (m² per person per year)



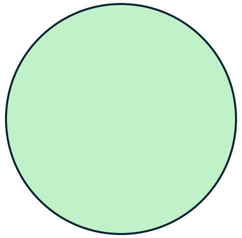
Optimal crop selection significantly reduces land requirements. Peas (UA) and potatoes (near-urban) are most efficient in normal climate conditions.

Urban Agriculture Land Availability

Total built urban area = 3,418 hectares



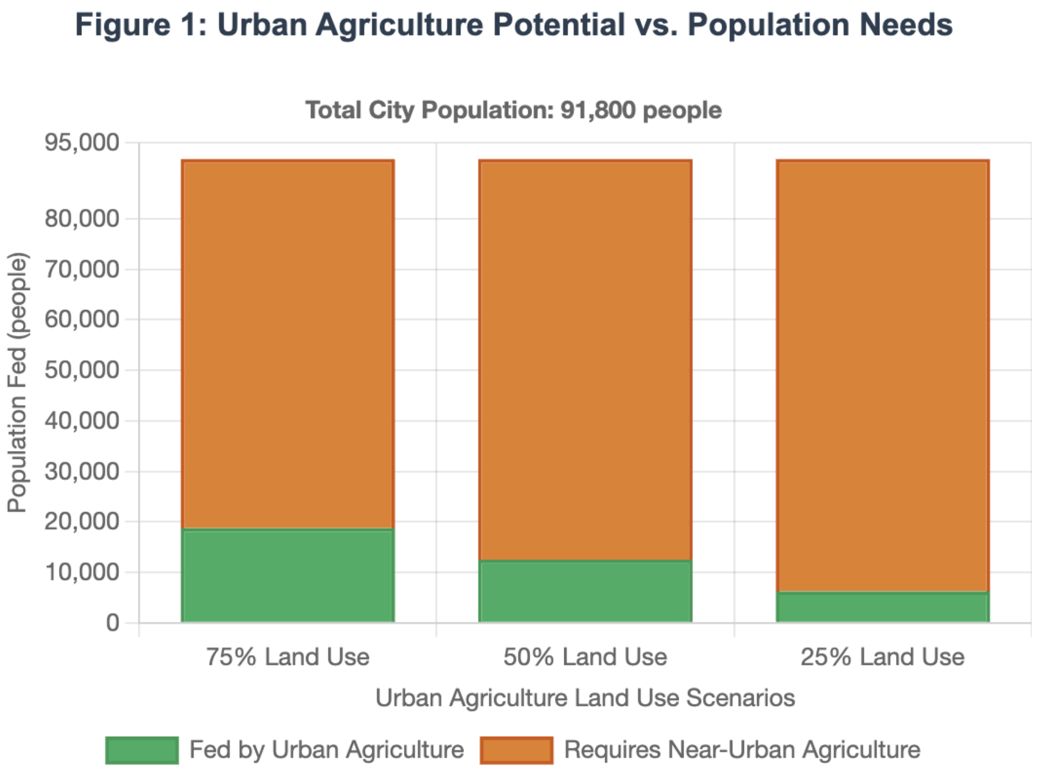
Within which there are >>



730 hectares of 'micro' plus 'meso' UA potential

With the most optimal crops this can feed 18,751 people (75% micro + meso use scenario in a normal climate: just 20.4% of the population)

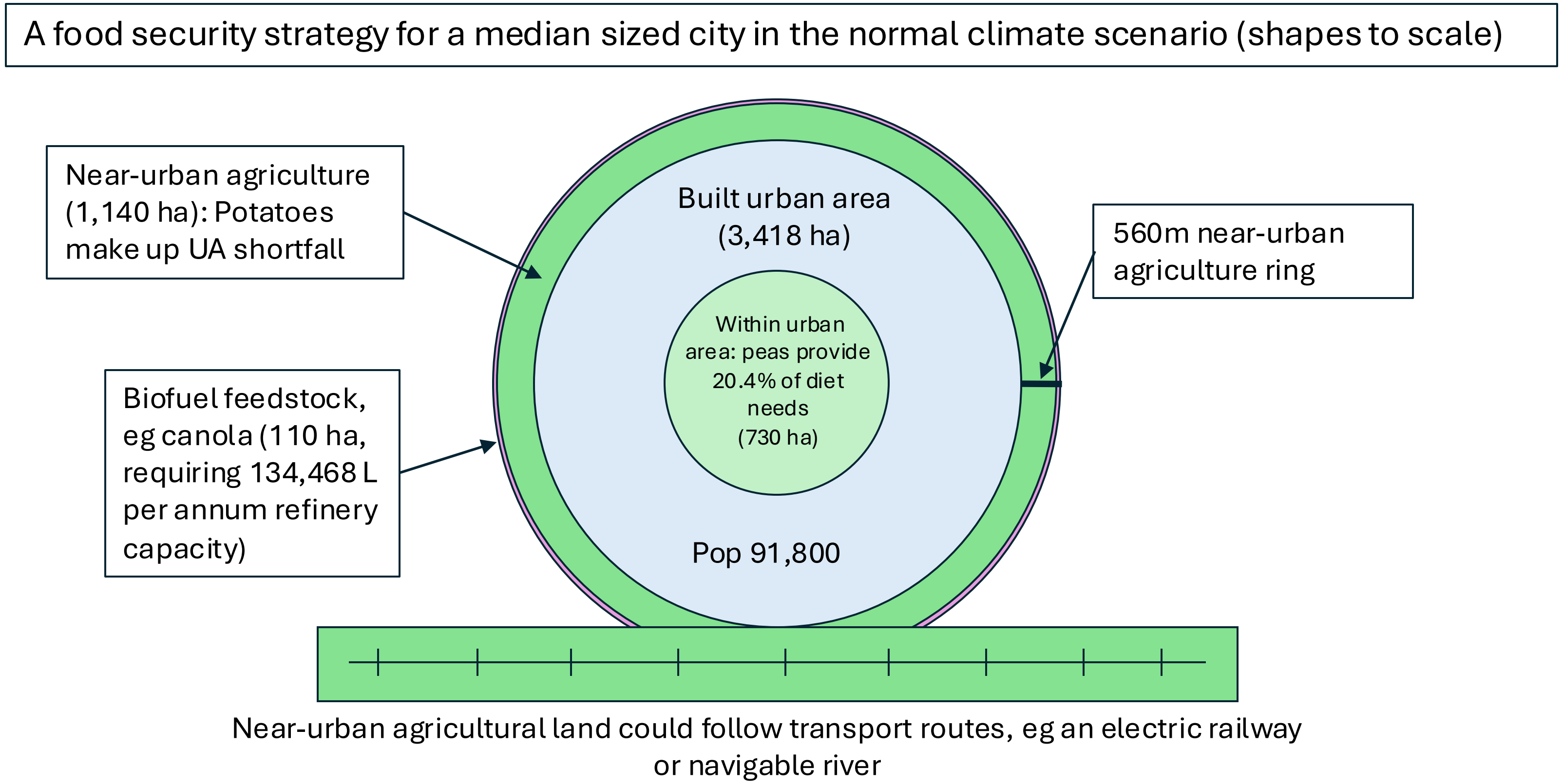
Near-urban agriculture needed



Urban agriculture alone can feed only 20.4% of the city population at maximum (75% land use scenario). Near-urban agriculture is required to feed the remaining 79.6%.

- **Shortfall**: 79.6% of population needs near-urban agriculture
- **Land required**: 1,140 ha near-urban cultivation
- **Comparison**: Equals just 33% of built urban area (not that much extra near-urban land needed)
- **Biofuel needs**: Additional 110 ha canola for biofuel needed for industrial near-urban production (+9% of total near-urban land requirement)

Urban and near-urban agriculture for global catastrophe resilience



Nuclear Winter Scenario Impact

Reduced yields: Require significantly more land

Crop substitution: Must shift to frost-resistant varieties

Population fed by urban agriculture: Drops to 3.2% (with UA only) in severe winter scenario with less optimal crop (turnips & chicory)

Near-urban increase: Up to 6,274 ha near-urban land required

Urban Health & Community Resilience Implications

- **Food security = health security**: Malnutrition prevention, mental health benefits
- **Community cohesion**: Local food production builds social capital
- **Equity considerations**: Access to land, skills, resources
- **Co-benefits**: Air quality, urban heat island reduction, biodiversity
- **Realistic expectations**: Urban agriculture is important but insufficient alone

Challenges & Additional Considerations

Water supply: 5L/m^2/day irrigation needs, storage requirements

Soil quality: Urban contamination, need for soil preparation

Expertise: Scaling requires training, community programs

Processing infrastructure: Biodiesel refinery, storage, distribution systems

Seasonality: Storage, preservation, year-round supply planning

Policy Recommendations & Next Steps

- **Municipal policy priorities**:
  - Protect near-urban agricultural land through zoning
  - Develop UA infrastructure and community programs
  - Invest in processing facilities (biodiesel refineries, storage)
  - Create integrated food-energy strategies
- **Research priorities**:
  - Replicate methodology in different city types/climates
  - Cost-effectiveness analysis of processing infrastructure
  - Citizen science approaches for yield validation
  - Geographic analysis of optimal near-urban locations
- **Take-home message**: Combined urban + near-urban agriculture can provide city-scale food security during global catastrophes, but requires advance planning and policy support

APPENDIX

Published Peer-Reviewed Papers

PLOS ONE

RESEARCH ARTICLE

Resilience to abrupt global catastrophic risks disrupting trade: Combining urban and near-urban agriculture in a quantified case study of a globally median-sized city

Matt Boyd[1]*, **Nick Wilson**[2]

1 Adapt Research Ltd, Reefton, New Zealand, 2 Department of Public Health, University of Otago, Wellington, New Zealand.

scientific reports

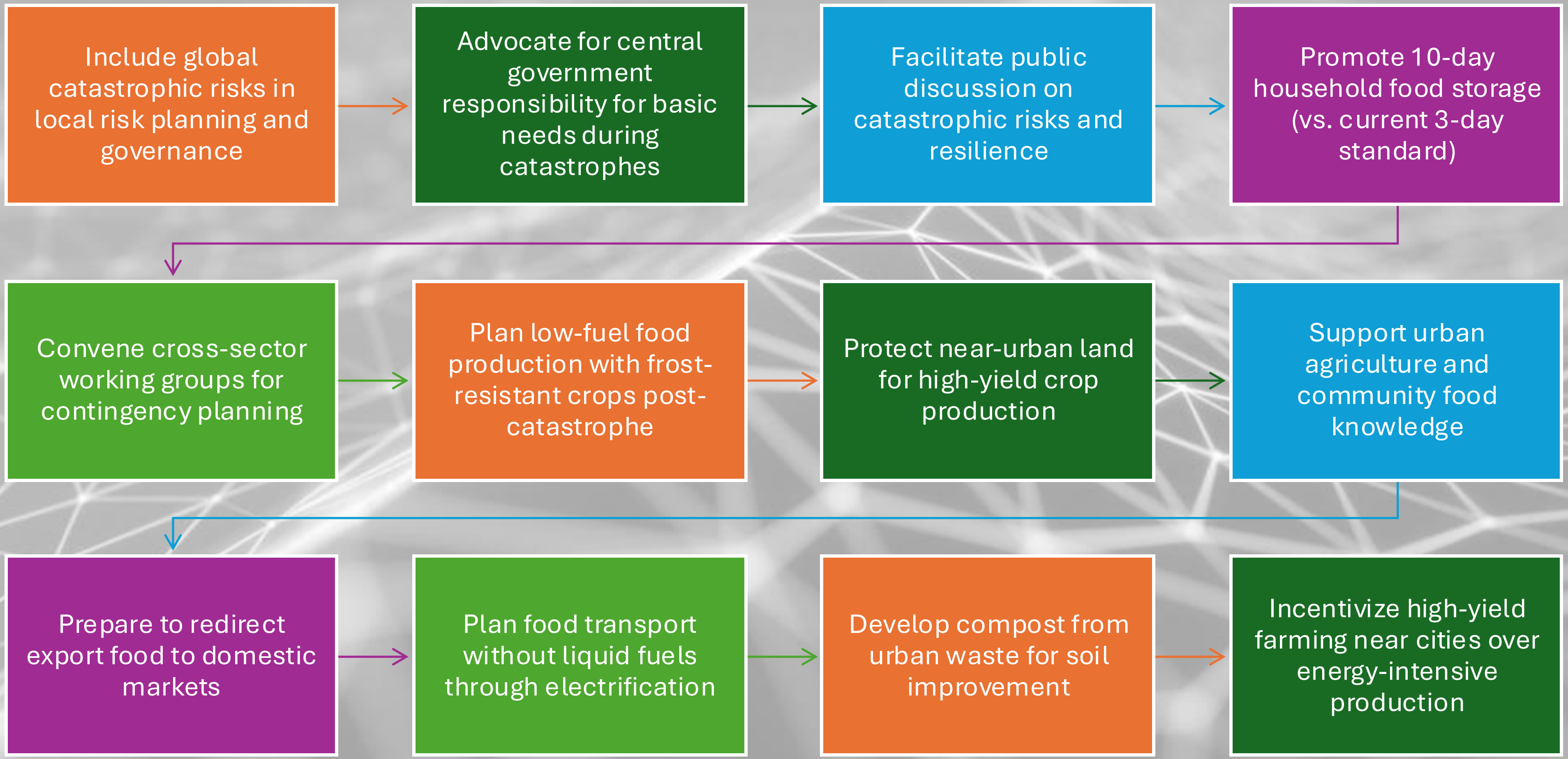
Check for updates

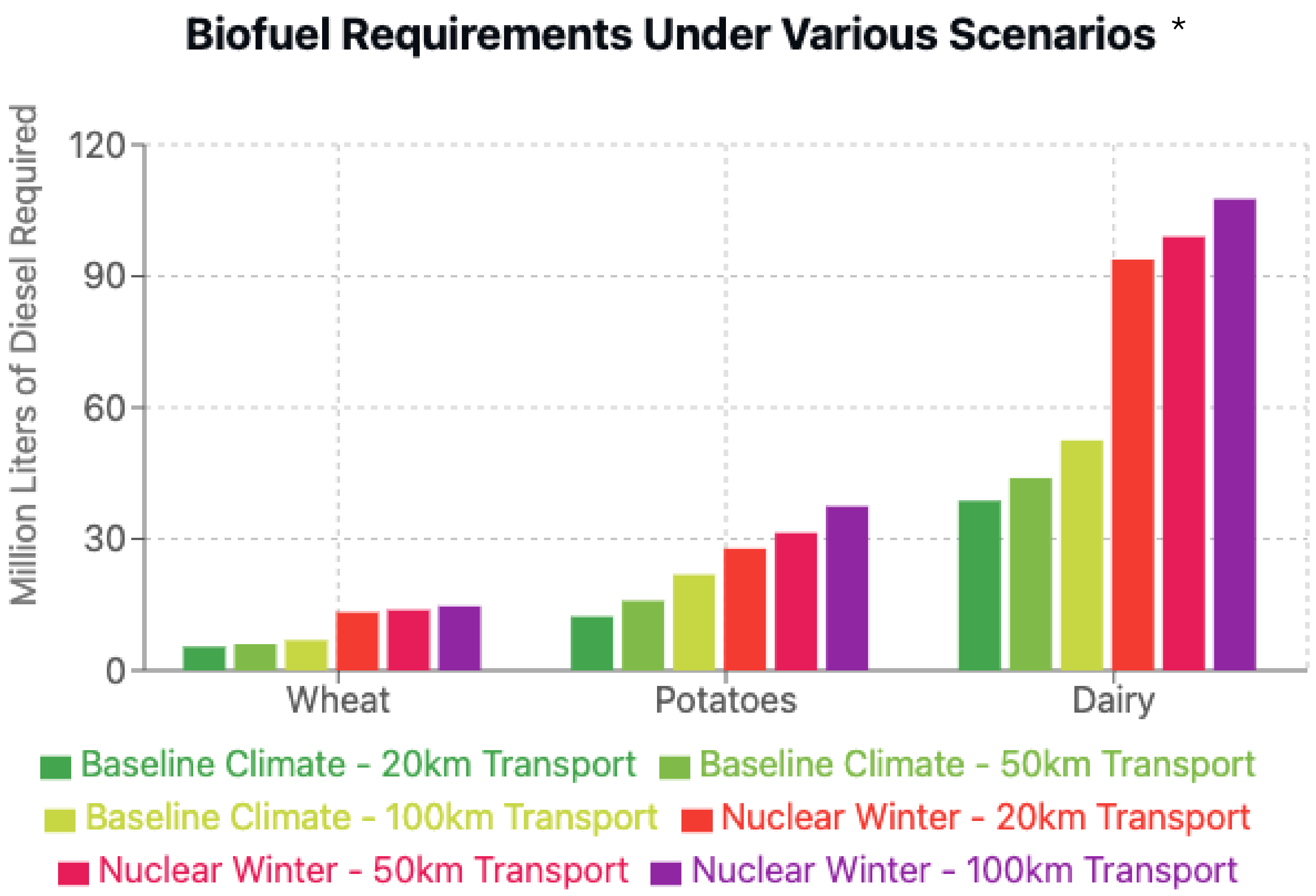
OPEN

Mathematical optimization of frost resistant crop production to ensure food supply during a nuclear winter catastrophe

Nick Wilson[1], Ben Payne[2] & Matt Boyd[3]

Food Security: Actions





* Boyd et al. (2024) *Risk Analysis*