

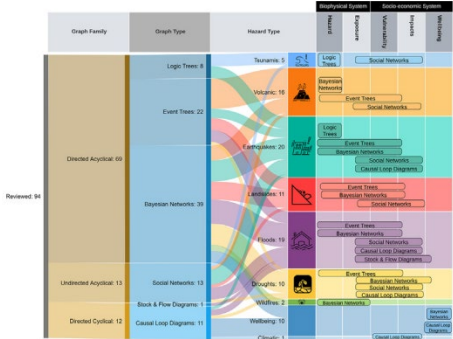
# Socio-Economic Consequences of Disruptive Technologies

- Building on existing research
- Hazard to wellbeing chain
- Static simulation of network disruptions
- Dynamic supply chains
- Dynamic simulation of network disruptions
- Household decomposition to assess distributional impacts
- New PhD

Review  
 A review of graphical methods to map the natural hazard-to-wellbeing risk chain in a socio-ecological system☆

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<sup>b</sup> M.E Research, Level 5, 507 Lake Road, Takapuna, Auckland 0622, New Zealand



Journal of Rural Studies  
 Volume 84, May 2021, Pages 108-123



### Assessing the economic implications of land returned to the Te Hiku iwi collective, Tai Tokerau, Aotearoa New Zealand

G.W. McDonald <sup>a,\*,</sup>, T.T. Kingi <sup>b,</sup>, J.-H. Kim <sup>a,</sup>, L. Dowling <sup>b,</sup>, P. Journeaux <sup>c,</sup>, A. Dunningham <sup>b,</sup>, S. Wakelin <sup>b,</sup>, J. Monge <sup>b,</sup>, B. Hock <sup>d</sup>

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Bulletin of Volcanology (2020) 82:64  
<https://doi.org/10.1007/s00445-020-01400-9>

RESEARCH ARTICLE

### Simulation of post-volcanic eruption time variant land use and economic impacts in the Auckland region of New Zealand

Robert J. Cardwell <sup>1,2</sup>, Garry W. McDonald <sup>2</sup>, Liam M. Wotherspoon <sup>1</sup>

Received: 27 January 2020 / Accepted: 15 July 2020  
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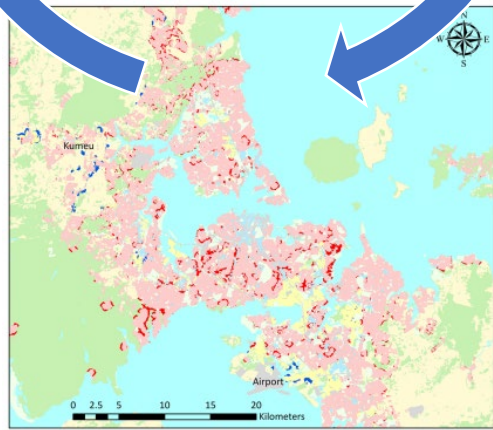
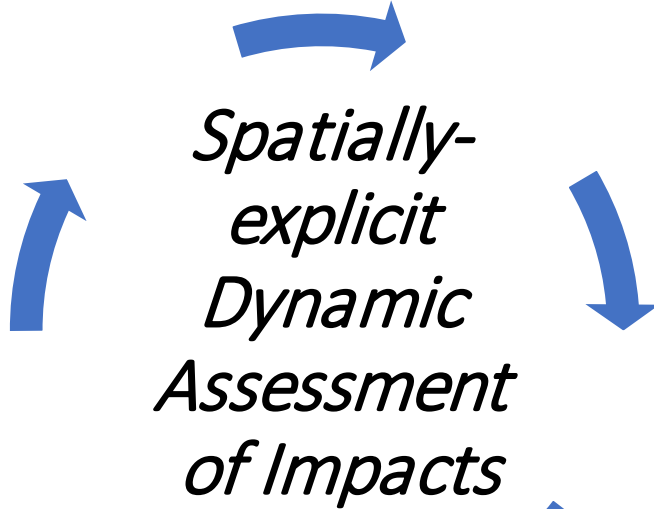
Article

### Towards a Dynamic Equilibrium-Seeking Model of a Closed Economy

Nicola J. McDonald and Garry W. McDonald \*

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PhD Student

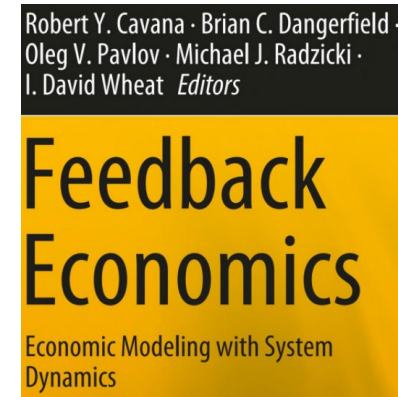


Duncan Grimson

Dynamic value chains

Supervisors

Dr Garry McDonald  
 Prof. Mark Bebbington



19 Extending the Boundaries of Economics to Well-Being: An Interlinked Thinking Approach ..... 521  
 Vicky E. Forgie, Marjan van den Belt, and Garry W. McDonald



Journal of Volcanology and Geothermal Research  
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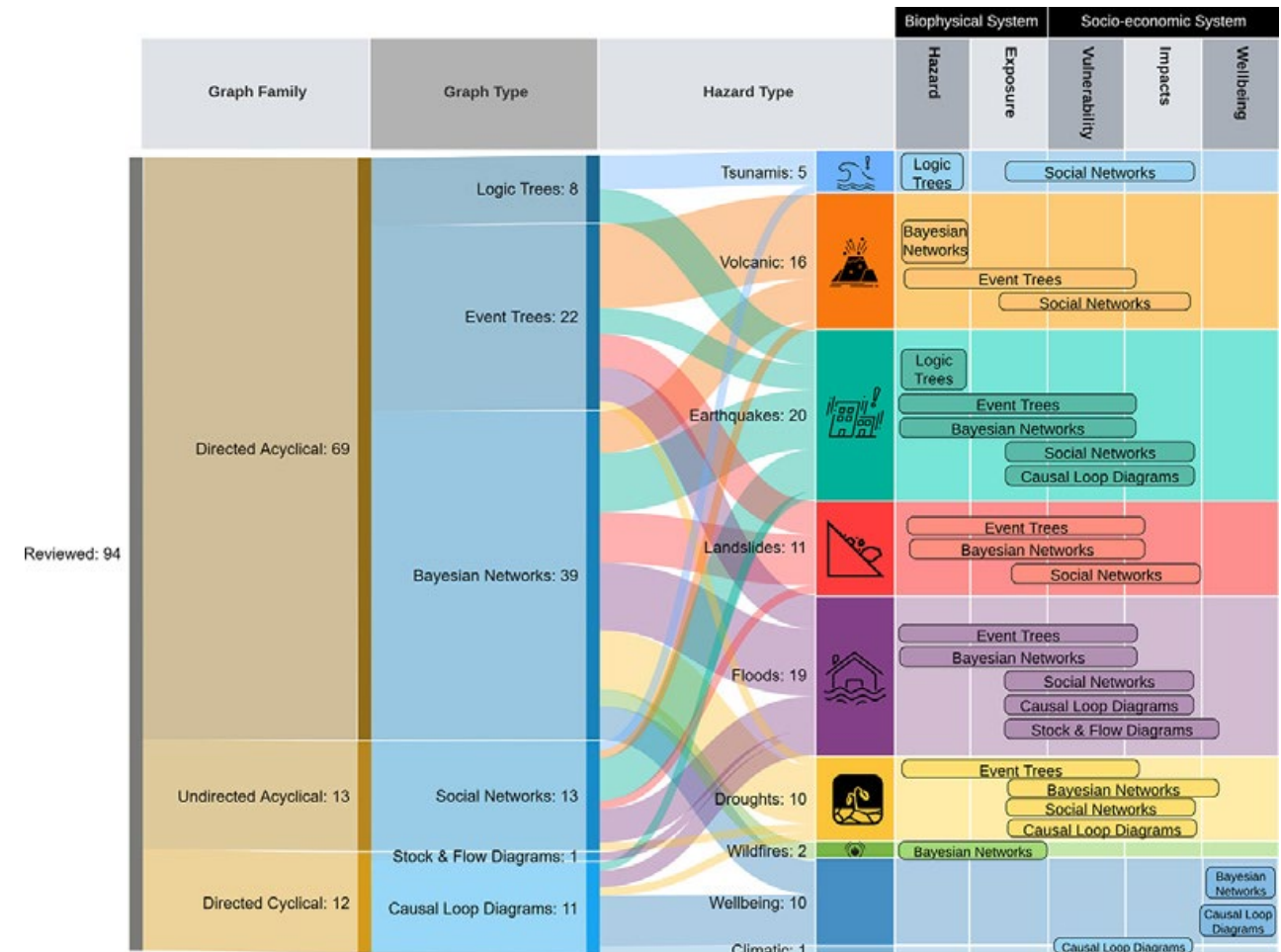
### Simulation of post volcanic eruption land use and economic recovery pathways over a period of 20 years in the Auckland region of New Zealand

Robert Cardwell <sup>a,\*,</sup>, Garry McDonald <sup>b,</sup>, Liam Wotherspoon <sup>a,</sup>, Jan Lindsay <sup>a</sup>

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# 1. Hazard-to-wellbeing chain modelling

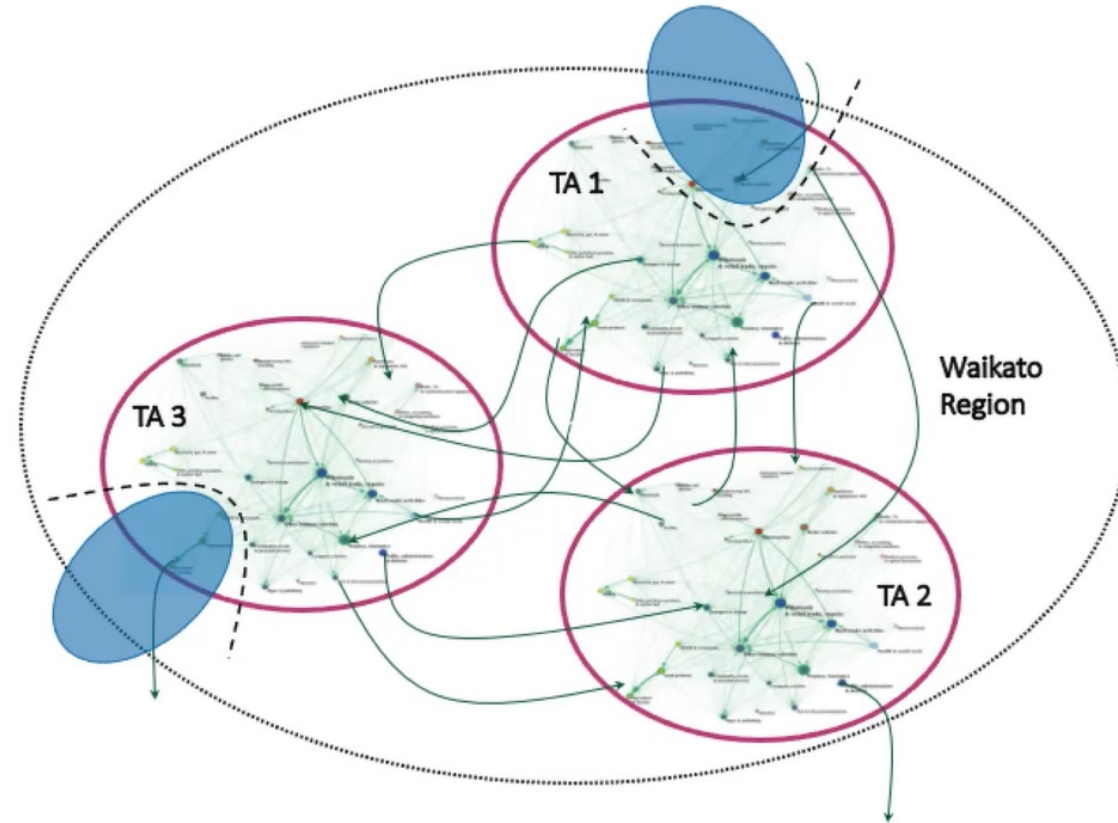
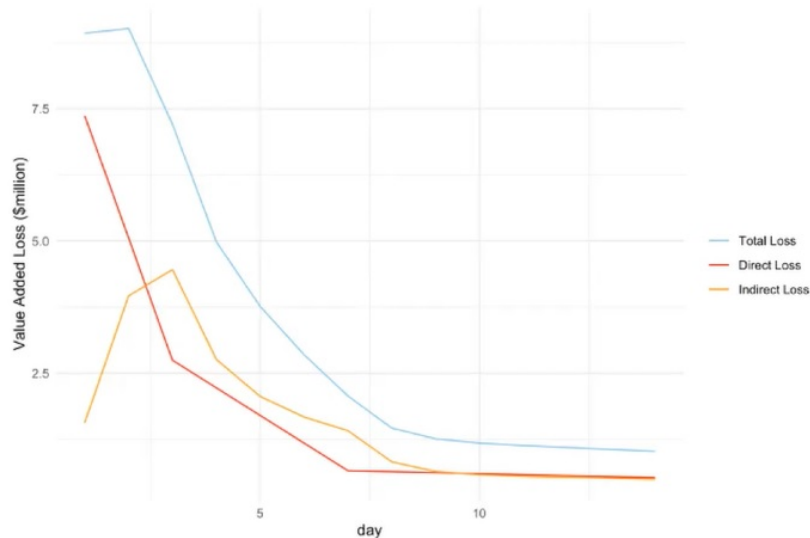
- Review of 94 papers
- Looked at potential for graphical approaches in end-to-end model
  - Logic trees
  - Event trees
  - Bayesian networks
  - System dynamics (CLD, SFD e.g., MERIT)
  - Social networks
  - Neural networks (e.g., COVID-19 modelling)



# 2. Static simulation of networks disruption

## Key findings

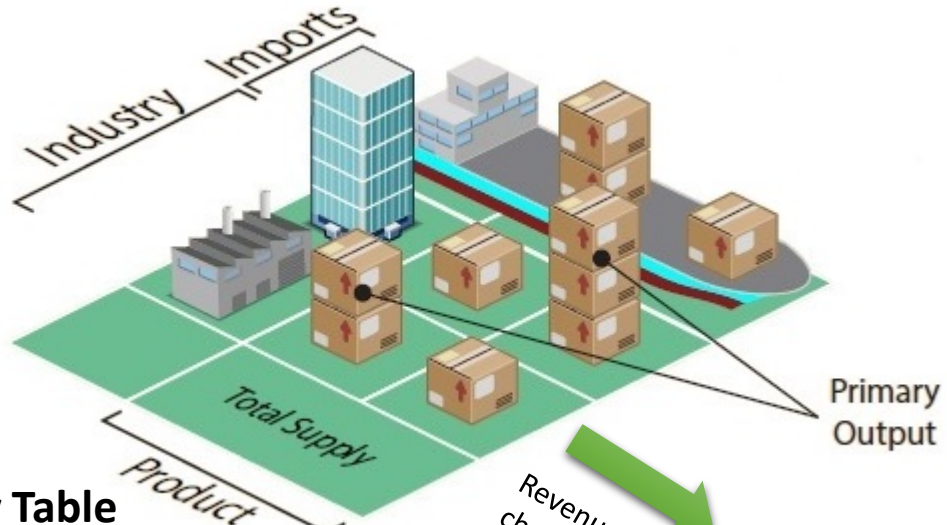
- Indirect costs similar size to direct costs, but occur with a time lag
- 'Nodes' with the largest direct impact (industry multiplier) was correlated with 'PageRank centrality'
- 'Nodes' with the largest 'Disruption' impact were those with highest 'betweenness' and 'closeness' centralities



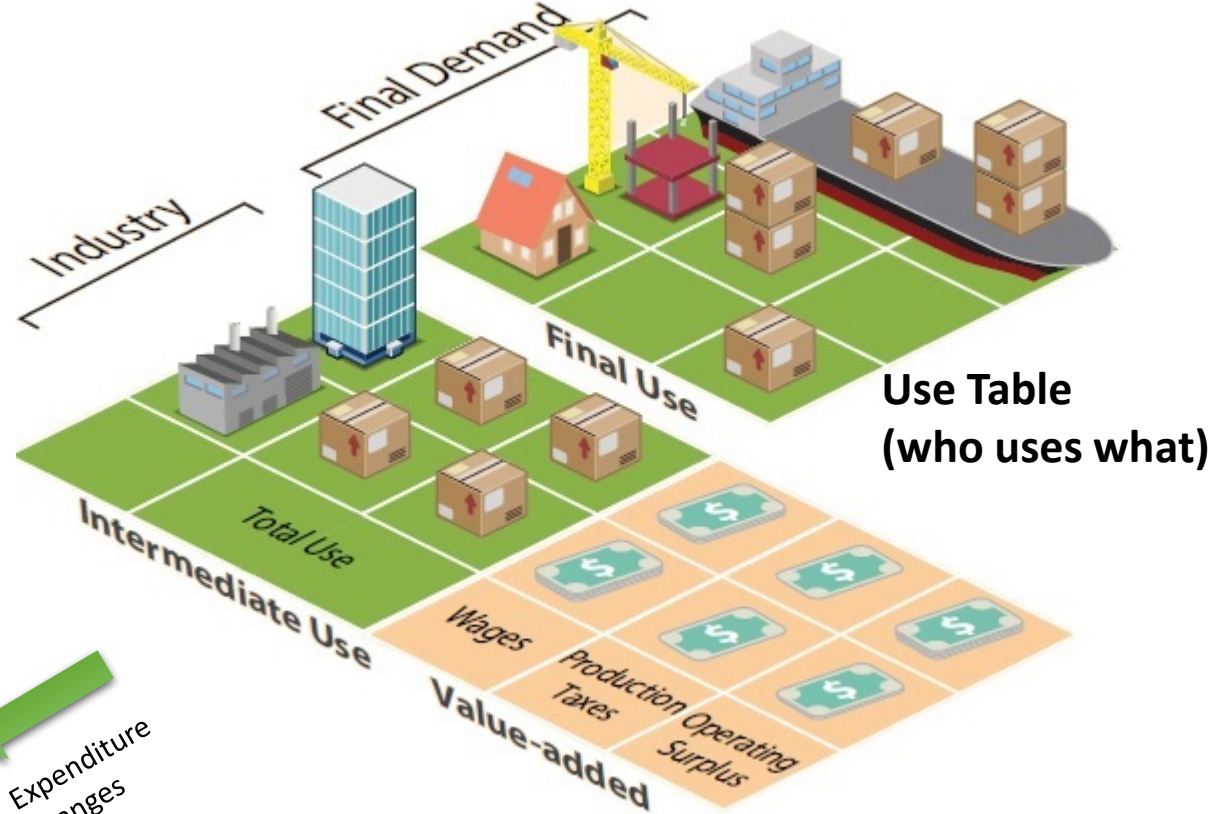
Static backward and forward linkage supply chain analysis to identify pinch-points for disruption



# 3. Dynamic supply chains



**Supply Table**  
(who produces what)



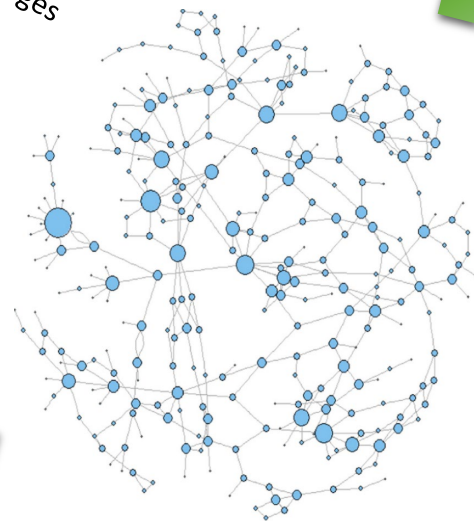
**Use Table**  
(who uses what)

## Interdependencies

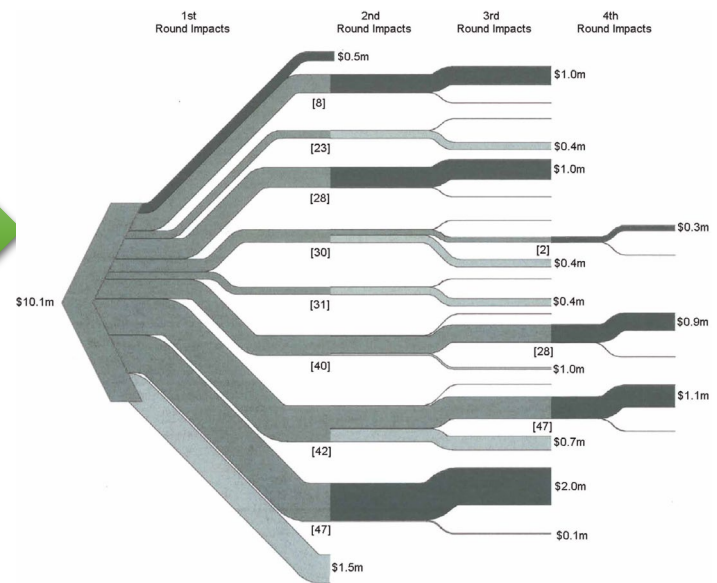
- Direct impacts
- Indirect impacts
  - Backward (supply chain)
  - Forward (processors)
- Induced impacts
  - Household spending

## Resilience options

- Expenditure
- Rebalanced budget



**Input-output Table**  
(inter-industry transactions)



# 4. Dynamic simulation of networks disruption

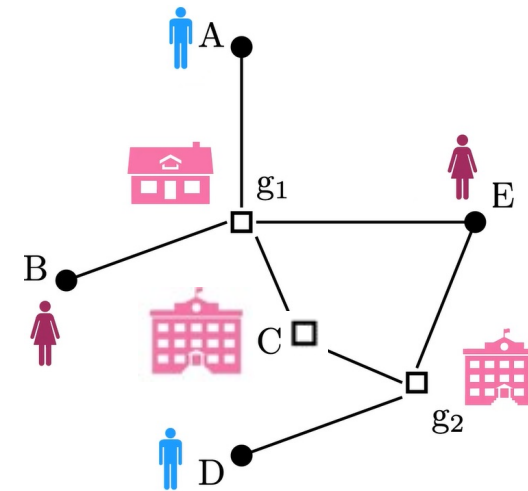
- Using unit record data (individuals, firms) from the IDI/LBD we will create *heterogenous* bi-partite networks:-

- From annual to monthly averages → short-run analyses, perishable goods
- Decomposition of hhld\_impacts → distributed analyses, mitigation, adaptation, resilience targeting

- Significant improved calibration and accuracy of IO/CGE/MERIT work

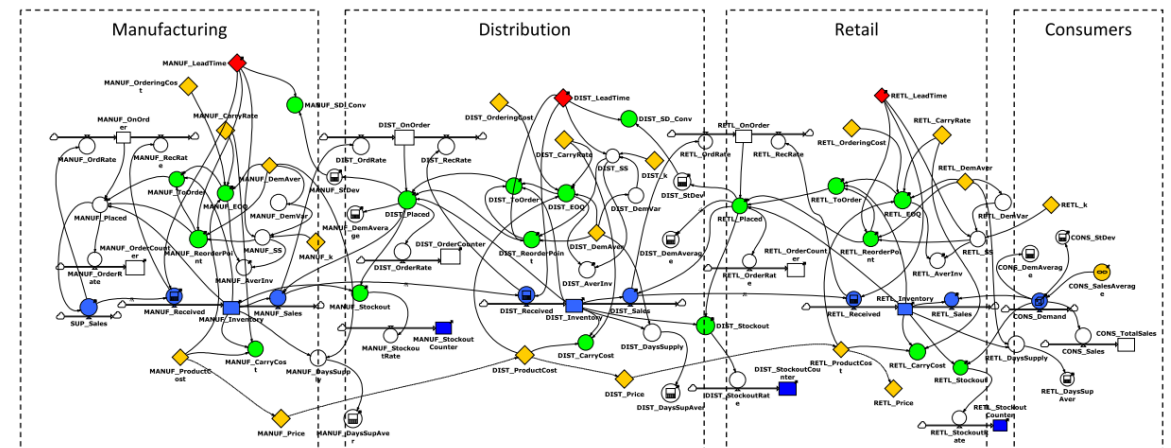
- Simplification of MERIT – using deep learning algorithms → faster runtimes, increased accuracy

- Global step-change in impact analyses



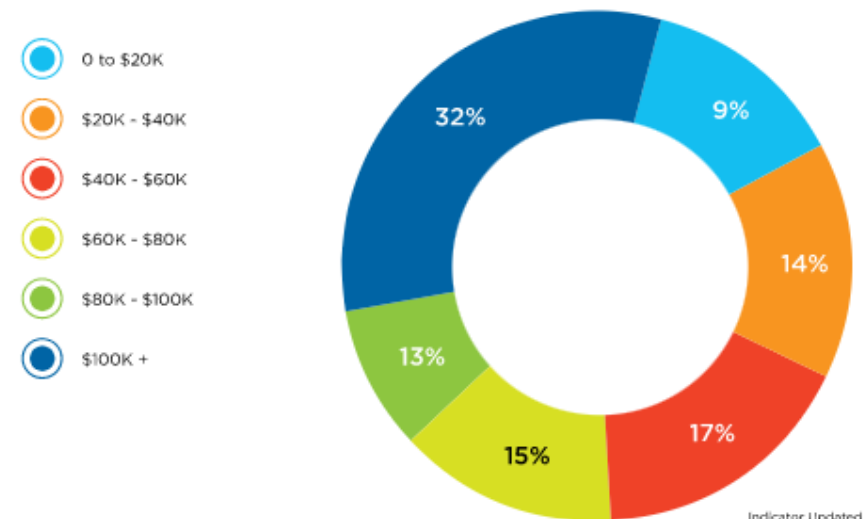
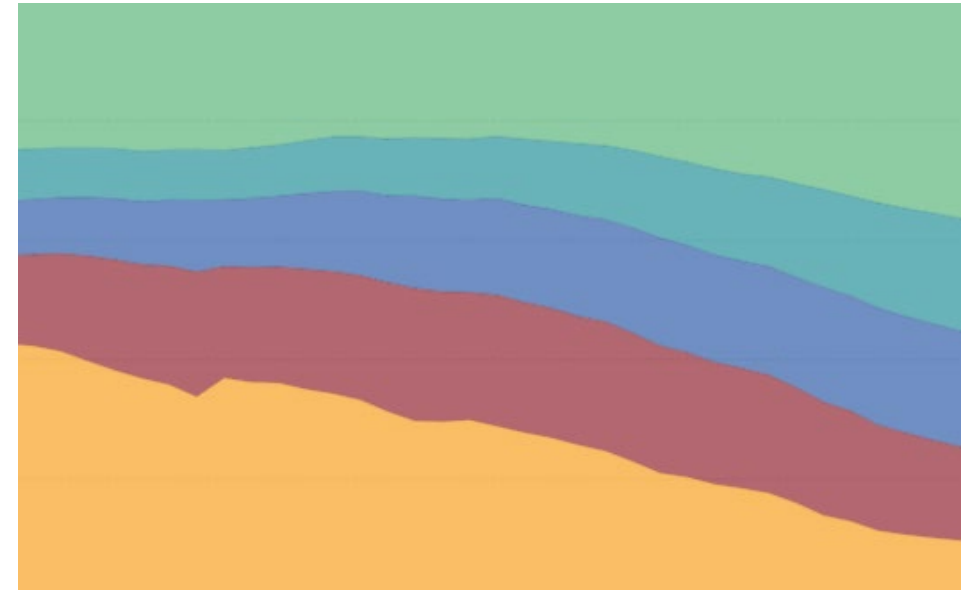
## Bi-partite network

- individuals
- groups (interactions)
- HS\_imp\_com-to-6DANZSIC
- firm-to-6D\_ANZSIC
- 6D\_ANZSIC-to-Hhld\_type
- 6D\_ANZSIC-to-HS\_exp\_com



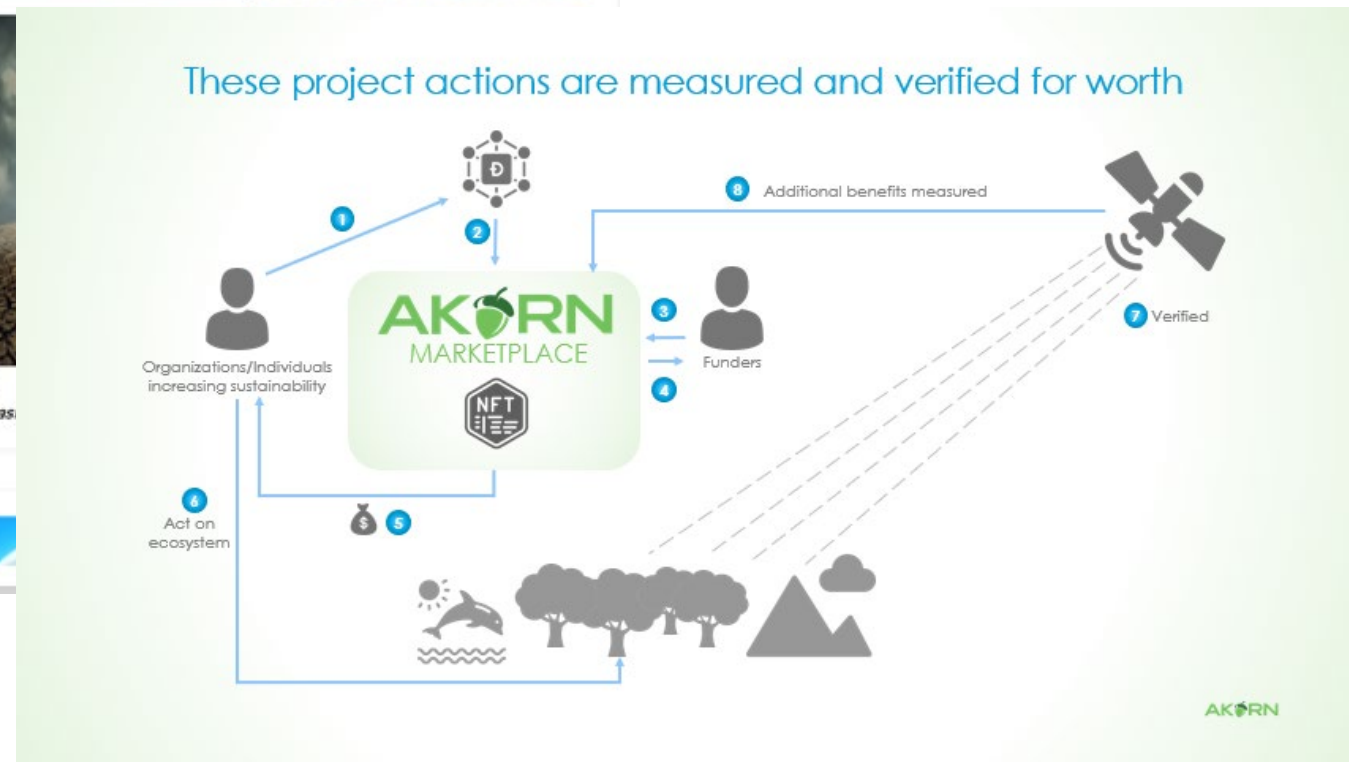
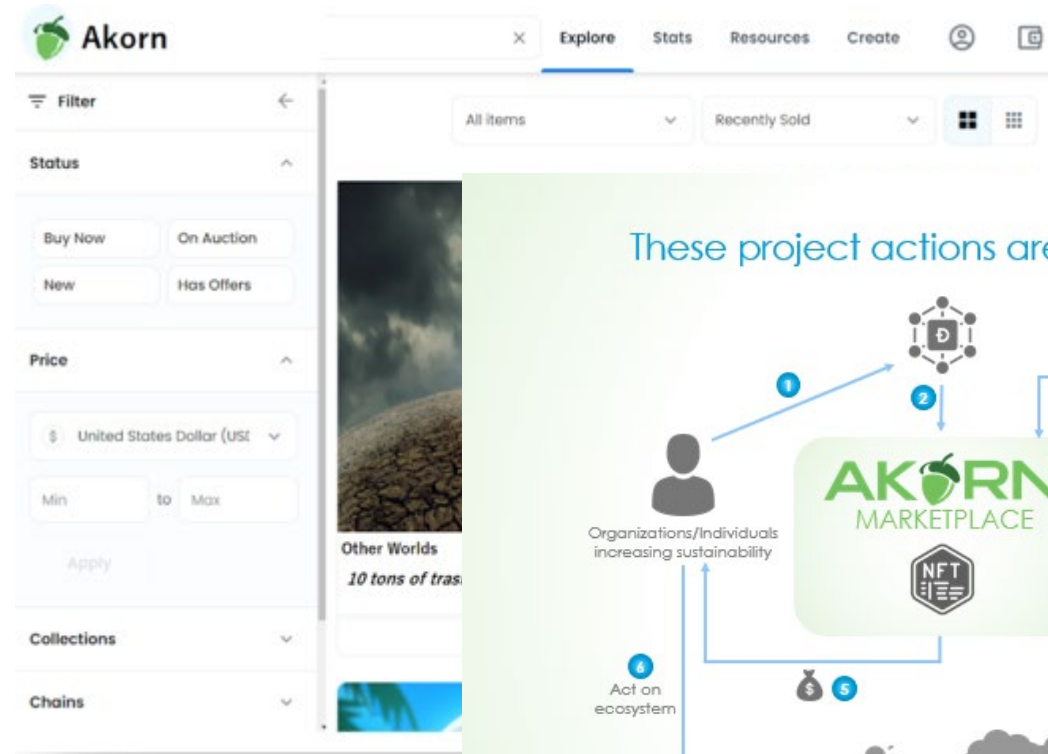
# 5. Household distributional impacts

- Heterogenous distribution impacts, impacts are not felt uniformly across categories, vulnerabilities often at the extremes
- SA2 Level, Territorial Local Authority, Regional Council
  - Urban, peri-urban, rural ?
- 294 Household types
  - Age-groups (15-29, 30-39, 40-49, 50-64, 65-74, 75+)
  - Household income (20-30K, 30-50K, 50-70K, 70-100K, 100-150K, 150K+)
  - Household types (One-person, Couple, 2 Parents with 1-2 children, 2 Parents with 3 or more children, 1 Parent, multi-family, non-family)
- Other
  - Ethnicity ?
  - Other breakdowns ?
- Near data – Cellular phone GPS pings from apps



# 6. Spatially-explicit dynamic robust decision making

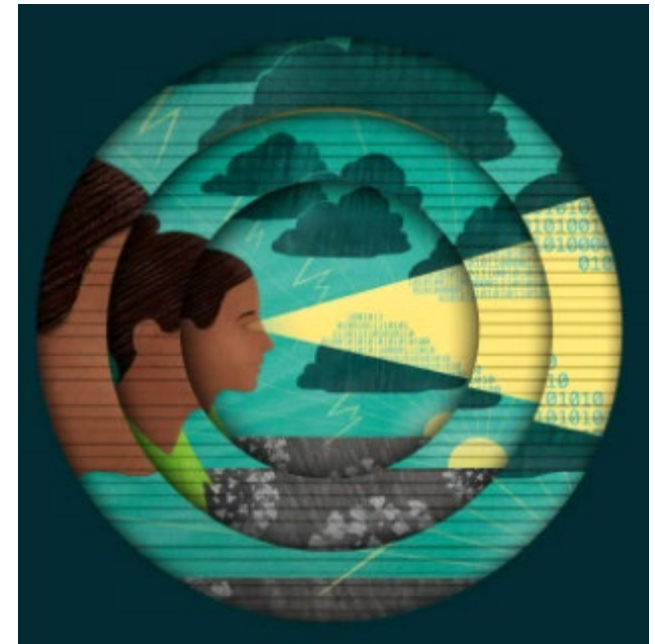
- Tom Price, PhD candidate – stranded in US due to COVID-19
- Supervisors: Dr Garry McDonald & Assoc. Prof. Anita Wreford and
- Creating resilience through ecosystem service provisioning – global focus
- Robust decision-making
- Trinity challenge (£1m) runner-up





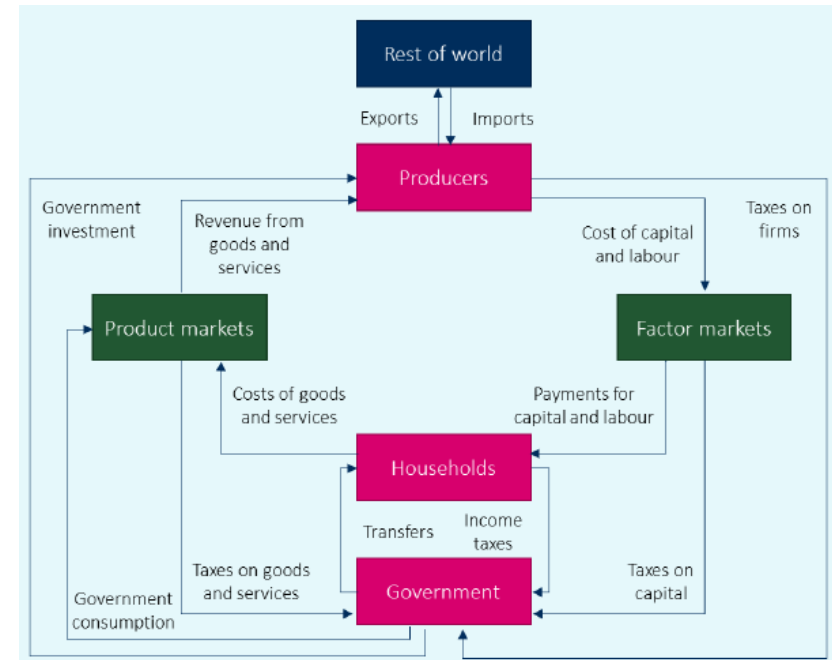
# 7. New PhD

- Heterogeneous business-to-business transactions – linking business transactions with critical interdependencies across space and time
- Unintended consequences of disruptive technologies – moving beyond direct assessment to understanding the consequences of adoption
- Transitioning through time to ongoing disruption – making robust decisions
- Interweaving MM and western science to understand consequences of disruptive technologies



# Aligned studies

- 2022 Waikato RC, Dynamic Spatial Planning
- 2022 Otago RC, Water Accounting, MERIT/SEM, NPS-FM
- 2021-22 Auckland Council, Consumption emissions, DIO
- 2021-22 Waikato RC – WRTM, DIO/MERIT
- 2021-22 Auckland Unlimited, CC implications of policy, C-PLAN, DCGE/MERIT
- 2021-22 MPI, M.bovis, DIO
- 2020-21 Hawkes Bay RC, Water security under CC, MERIT
- 2013-26 Southland Regional Council & Industry Partners, Southland Economic Project, SEM/MERIT, NPS-FM
- 2020 MBIE & Rio Tinto, Aluminum Smelter, DIO
- 2020-21 Otago RC, Manuherehia Catchment, NPS-FM
- 2020-21 Waikato RC – WISE Modelling and NPS-UC
- 2020 Te Hiku Platform, Te Hiku Iwi, DCGE



## Research Projects

- 2021-27 QuakeCoRE - Harnessing Disruptive Tech
- 2021-26 Future Coast Aotearoa, MERIT
- 2021-23 Deep South NSC, Water Security, MERIT
- 2019-24 TTVF He Mounga Puia, MERIT
- 2019-24 RNC MRm, MERIT