# Modelling the Potential Costs & Benefits of Protecting an Island Nation from Extreme Pandemic Threats

Nick Wilson (presenter), University of Otago Wellington (UOW)
Matt Boyd, Adapt Research; **Michael Baker**, UOW;
Oz Mansoor, PHP; **Giorgi Kvizhinadze**, UOW

UNIVERSITY of OTAGO
Te Whare Wānanga o Otāgo
NEW ZEALAND

H E I R U   **Health Environment Infection Research Unit**
University of Otago

Background: Global trends

- Population growth: 1 → 7+ billion in ~100 years
- Growth of jet travel volumes
- Climate change → favours some infectious diseases & environmental refugees
- Expansion of settlements in wilderness areas; disturbing microbial ecosystems
- Biotechnology & potential for bioweapon development

Human Population Growth
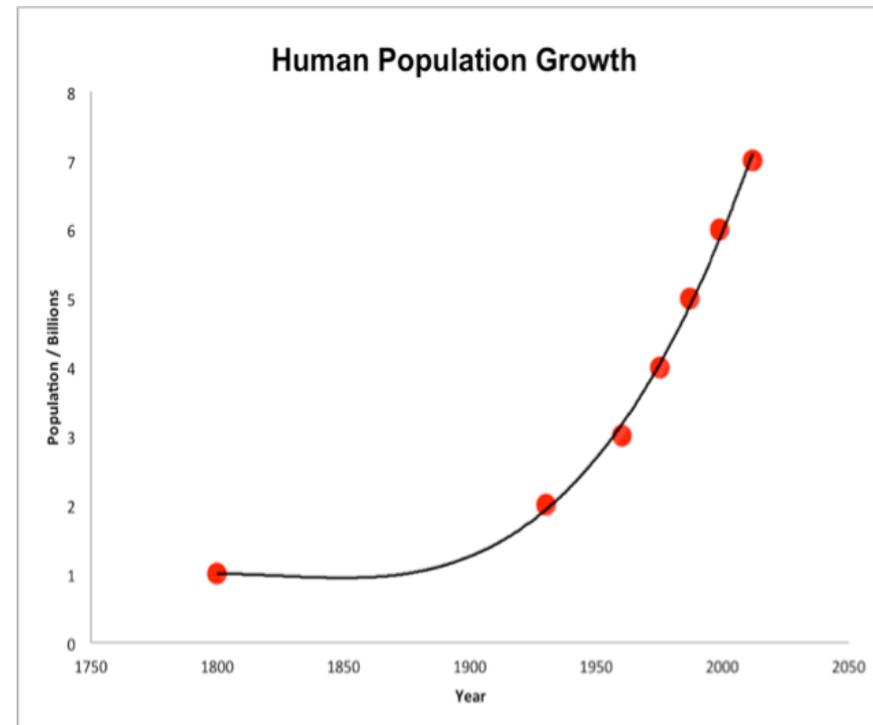
Global air traffic volumes
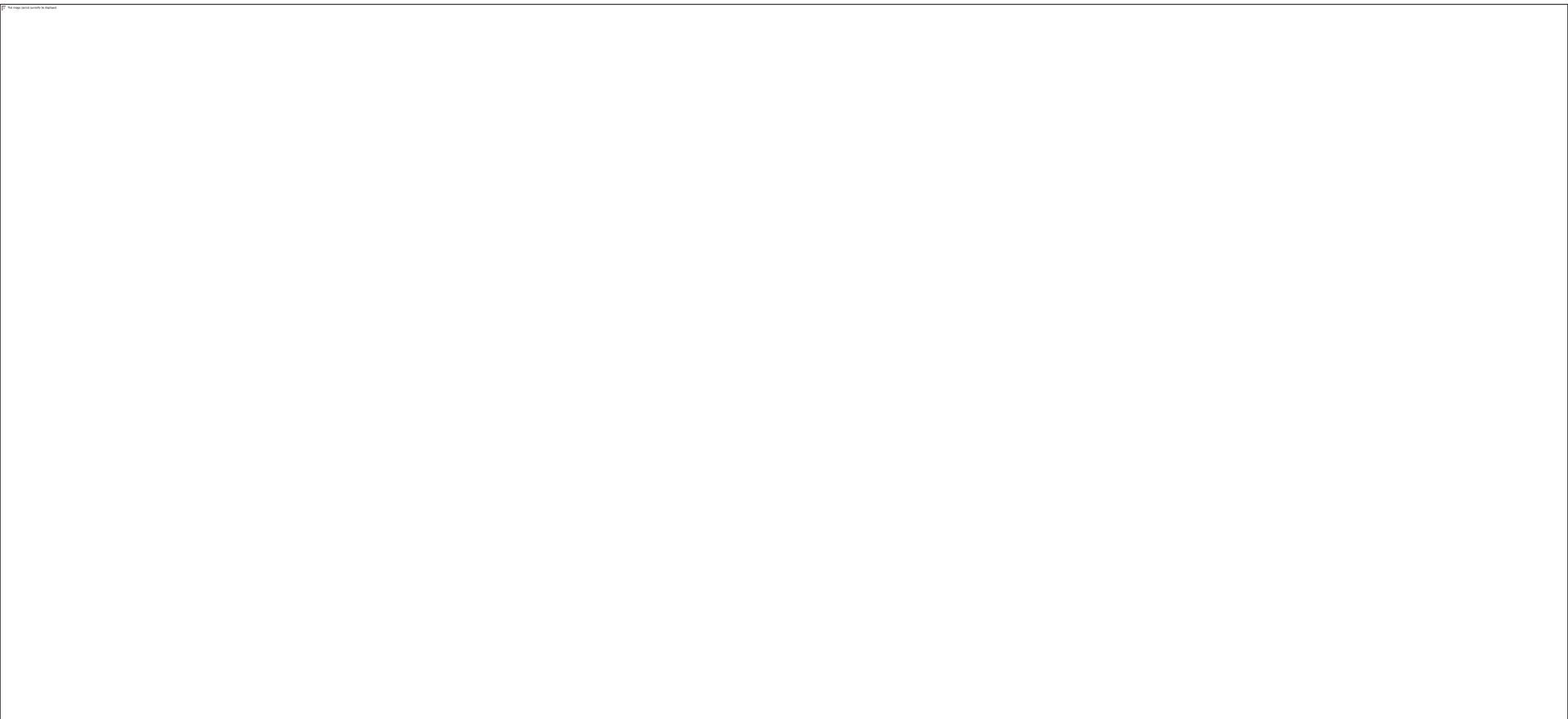
Border closure for pandemic control

- Generally not supported in the international literature and IHR – high failure rate & economic harm

- But this literature hardly considers island nations

- Border closure actually worked on occasions in 1918 influenza pandemic (islands, military bases)

- Modelling (small islands) favours border control (Eichner M, Schwehm M, Wilson N, Baker MG. *BMC Infect Dis* 2009;9:160)

- There could be time to close borders in some modern day scenarios eg, the spread of SARS was slow enough

Aim & Methods (Study 1)

Aim: To estimate costs & benefits of complete border closure in response to pandemic threats for NZ

Methods:

- Cost-benefit analysis, spreadsheet model (Excel)

- Epidemiological data – past NZ pandemics

- NZ data on: health costs, valuation of life, tourism revenue

For more see: Boyd et al. Protecting an island nation from extreme pandemic threats: Proof-of-concept around border closure as an intervention. *PLoS ONE* 12(6): e0178732. https://doi.org/10.1371/journal.pone.0178732

H E I R U Health Environment Infection Research Unit
University of Otago

Key assumption: End to international tourism but shipping and cargo flights continue (but crew don't disembark)
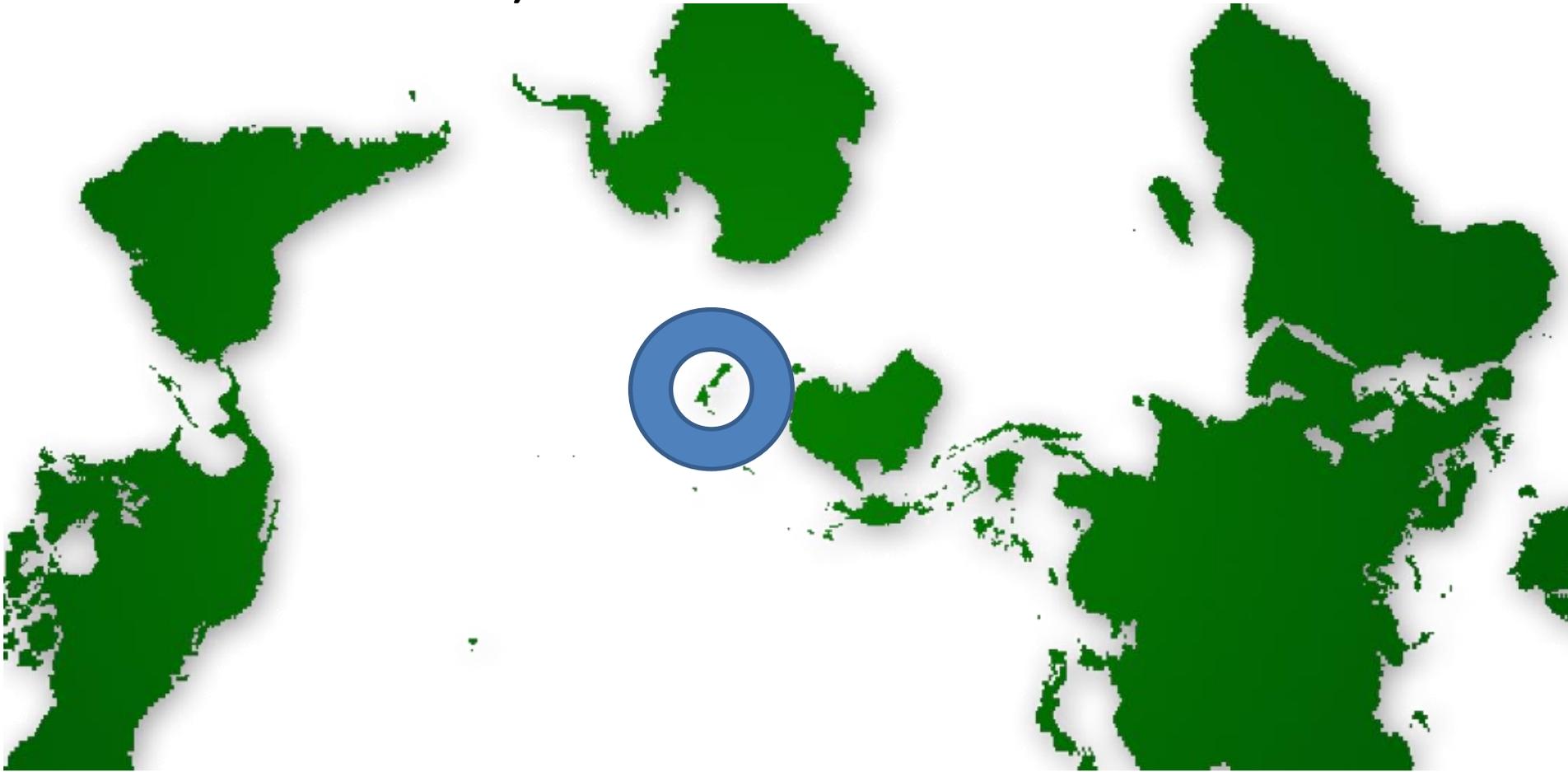
Results (Study 1)

Threat: Pandemic A with **half mortality** rate of 1918 influenza pandemic:

Intervention: 26 weeks of successful border closure (tourism ends; healthy year-of-life valued at $45,000 [GDP/capita]):

➢ Net societal benefit of **NZ$11 billion**

Threat: Pandemic B with **10 times above mortality rate**

Intervention: Border closure + *trade also stopping (scenario)*

➢ Net societal benefit of **NZ$54 billion**

Aim & Methods (Study 2)

Aim: To estimate the costs & benefits of complete border closure in response to pandemic threats for NZ – **but using NZ Treasury's CBAx model**

Methods:

- CBAx model – includes productivity, welfare payments, tax revenue

- Cost data as in CBAx

- Epidemiological parameters (as per Study 1)

Further methods details on request: Boyd et al. *Economic evaluation of border closure for a severe pandemic threat using New Zealand Treasury methods.* (Submitted manuscript)

Results (Study 2)

Threat: Pandemic A

Intervention: 26 weeks of successful border closure (tourism ends; CBAx methods/costs, 50y time horizon, 6% discount rate):

➤ Net societal benefit of **NZ$7.9 billion**

Threat: Pandemic B

Intervention: Successful border closure

➤ Net societal benefit of **NZ$144 billion**

Results (Study 2): Cost-utility analyses

Threat: Pandemic A

Intervention: Successful border closure

- ICER (societal perspective) **$14,400** per quality-adjusted life-year (QALY) gained
- ICER (health system perspective but with tourism losses included): **$51,300** per QALY

HEIRU Health Environment Infection Research Unit
University of Otago

Limitations of this work

- Border closure may fail (but even failure after 1-2 weeks may provide some time for preparations); failure risk might decline with drone cargo ships

- NZ Treasury model – doesn't value the future as much as standard analyses (DR=6% vs 3%)

- Hard to cost trade disruptions eg, some products can be left growing (eg, trees), others can be stored (eg, milk powder).

Possible implications

1. Island nations could reasonably **plan for border closure** (including laws that protect politicians from legal action & allow compensation to tourism sector)

2. NZ could work to produce better **international guidance** (eg, via WHO) for island nations around border closure & pandemics

Conclusions

1. Two different modelling approaches **suggest high net societal value in border closure** for NZ – for severe pandemic threats

2. All such modelling has limitations – but historically border closure has sometimes worked

3. Island nations could reasonably **plan for border closure**

Selected new results for the prevention of two pandemic scenarios via border closure for NZ (using CBAx, net present values, discount rate = 6%) (Boyd et al *Submitted manuscript*)

CBA / CUA	Scenario A Pandemic (similar to 1918)	Scenario B Pandemic (10 x the severity of 1918)
CBA: Full societal perspective (monetised QALYs, productivity/tax, health system costs/savings, superannuation, tourist revenue)	($2.88b) – 5 year horizon $994m – 10 year $7.86b – 50 year	$44.9b – 5 year horizon $80.4b – 10 year $144b – 50 year
As above but excludes monetised QALYs	($2.60b) – 50 year	$40.8b – 50 year
CUA: cost per QALY gained	• ICER (societal perspective) $14,400 per QALY gained • ICER (health system perspective but with tourism losses): $51,300 per QALY	• ICER (societal perspective) cost-saving • ICER (health system perspective but with tourism losses): $6970 per QALY

Does border closure have a legal base?

- Enabling legislation for NZ State response to infectious threat
  - **Epidemic Preparedness Act 2006**.
- Issuing of notice in response to "an outbreak of a stated quarantinable disease" as defined by the Health Act 1956, Part 3:
  - Avian influenza (capable of being transmitted between human beings)
  - Cholera
  - Middle East Respiratory Syndrome
  - Non-seasonal influenza (capable of being transmitted between human beings)
  - Plague
  - Viral haemorrhagic fevers (capable of being transmitted between human beings)
  - Yellow fever
- Does not apply to a new pathogen?

"The modelling undertaken for New Zealand suggests that the most effective single intervention at the border to prevent or delay the introduction of a pandemic virus into New Zealand would be to minimise numbers of incoming travellers."*

high costs   limited effectiveness