

# Responsible Innovation in an age of Planetary Crises

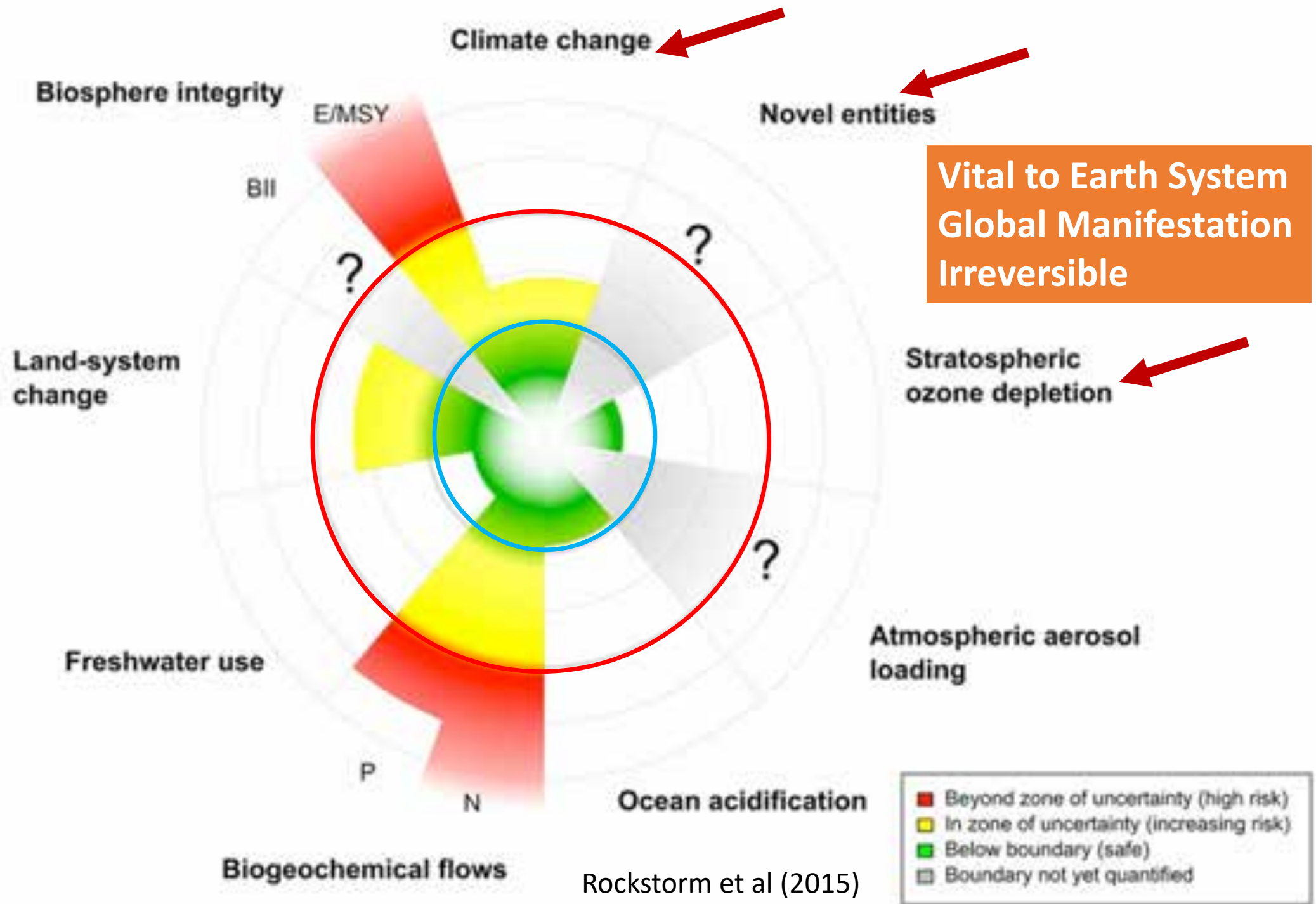
5th Singapore Sustainability Symposium (S3)

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# Innovation & Long-term Sustainability

- Technical progress has driven economic growth for decades
- Governments use policy and R&D investments to promote innovation & kick-start new industries.
- Long-term global impacts have begun to hit planetary limits
- Do we need to think innovation anew?



Climate change

Novel entities

Vital to Earth System  
Global Manifestation  
Irreversible

Stratospheric  
ozone depletion

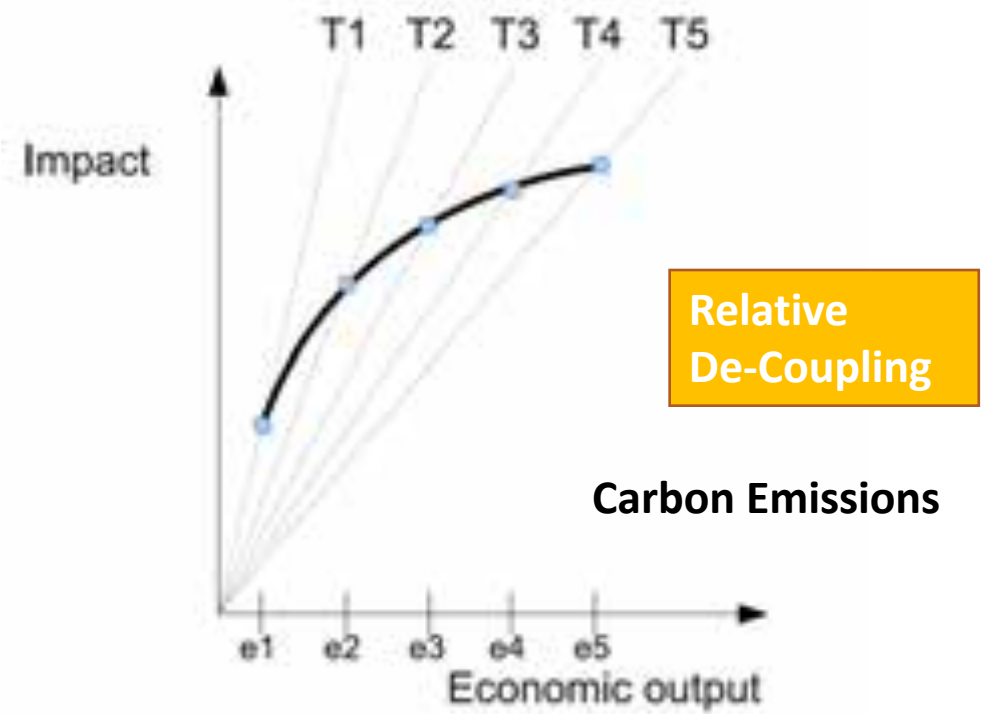
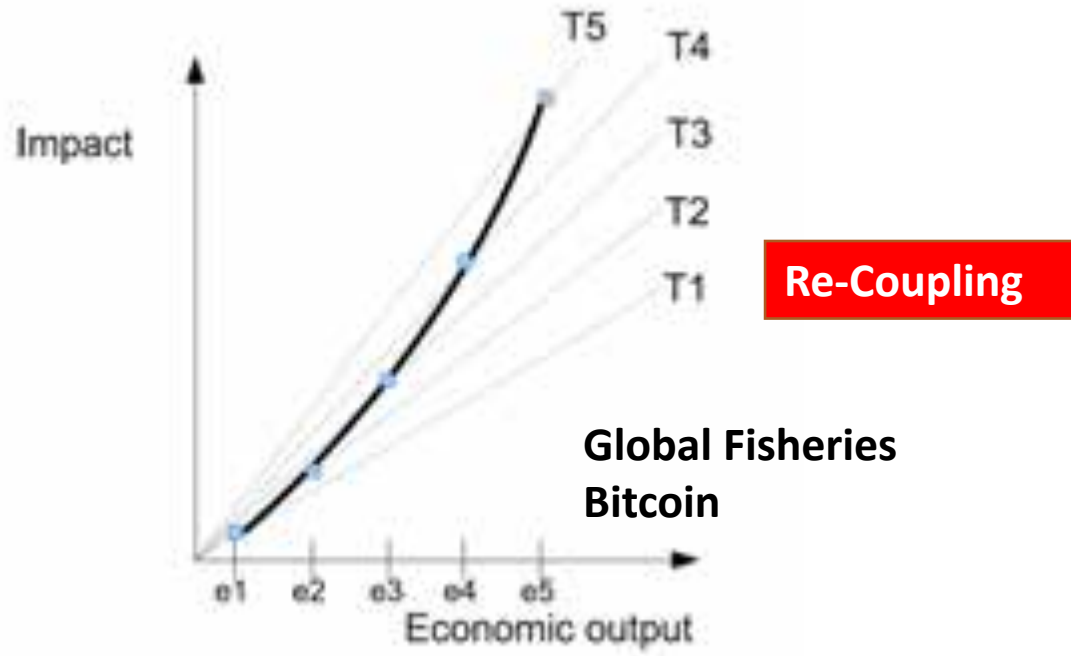
Atmospheric aerosol  
loading

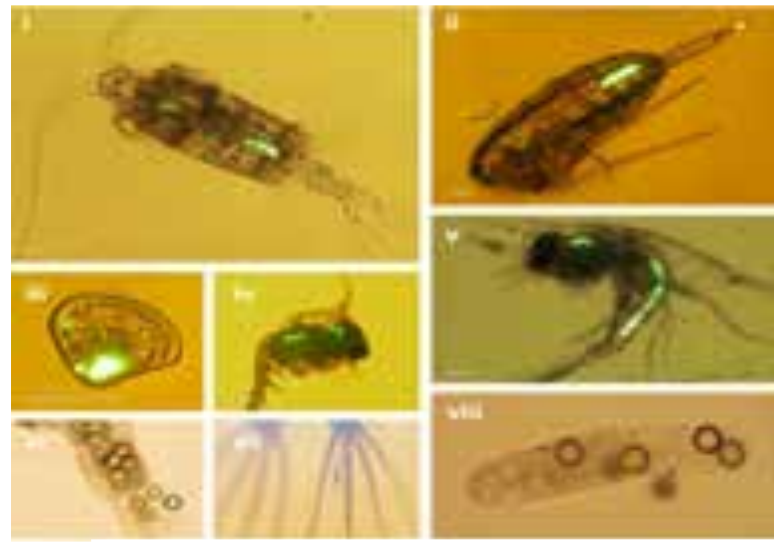
Ocean acidification

Biogeochemical flows

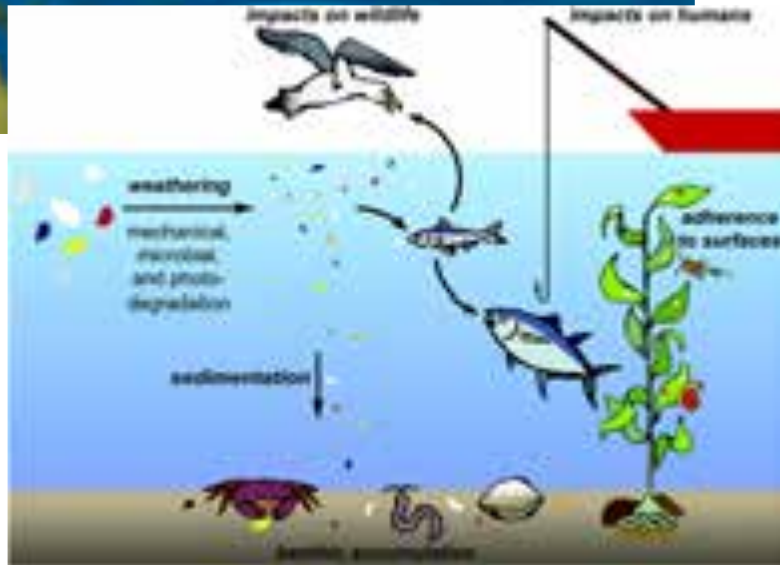
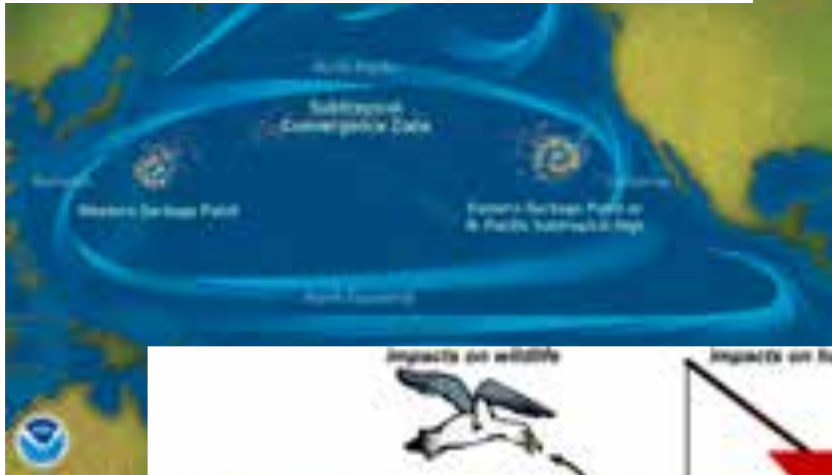
Rockstorm et al (2015)

■	Beyond zone of uncertainty (high risk)
■	In zone of uncertainty (increasing risk)
■	Below boundary (safe)
■	Boundary not yet quantified





Cole, Matthew, et al. "Microplastic ingestion by zooplankton." ES&T 2013



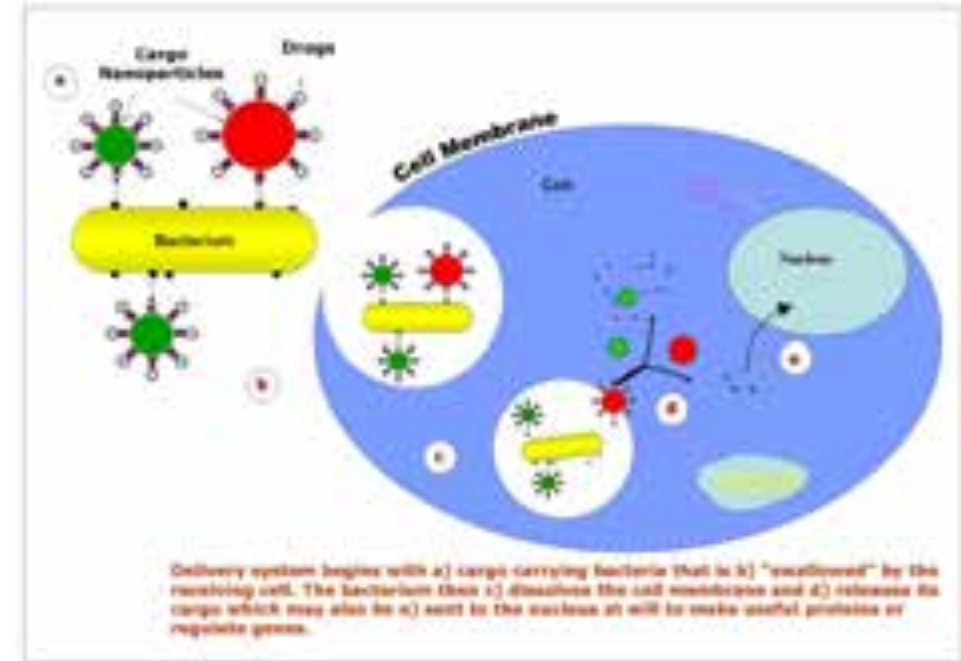
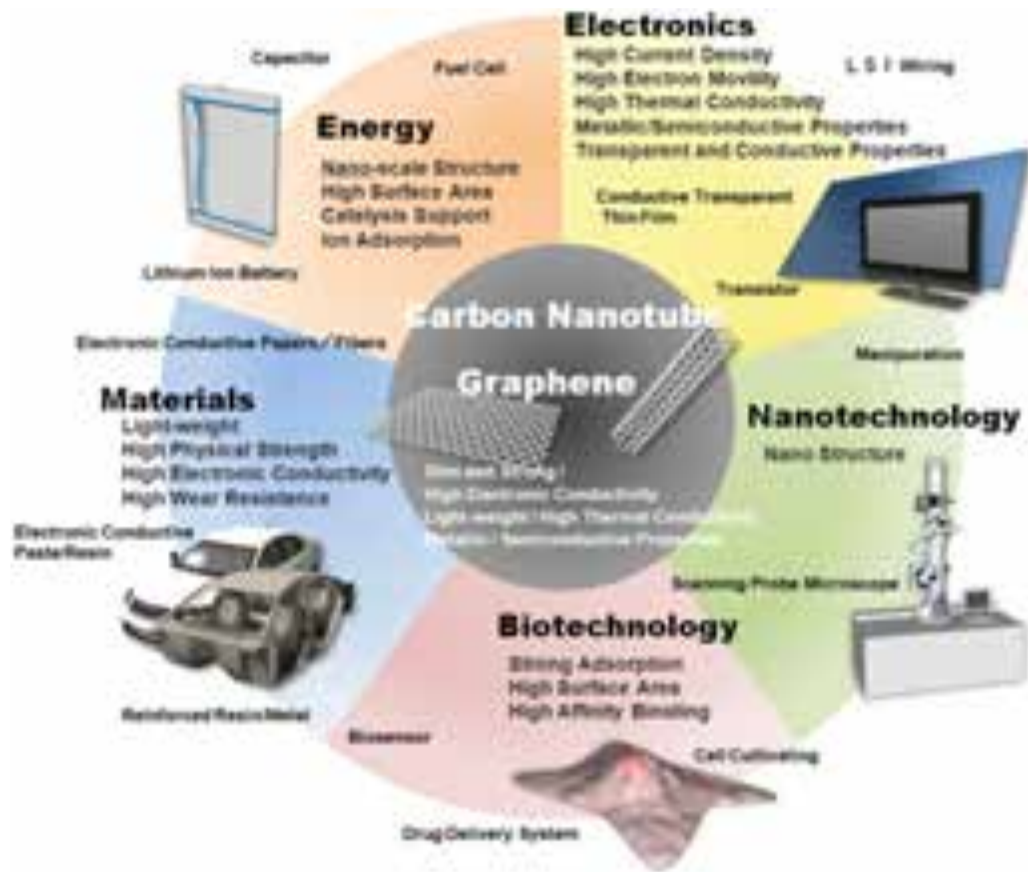
# Plastics in the Oceans: A 'Sudden' Planetary Crisis

- **Lurking Problem:** > 50 years for the problem to manifest itself, sudden 'arrival' in the past 10 years
- Uncertain Science – potentially **Catastrophic and Irreversible**
- Pressing need for a **global treaty** AND materials **innovation** for substitutes
- Is it possible to avoid such outcomes in the future?

# An ounce of prevention....

- Current models of innovation have an inherent “**optimism bias**” - do not **anticipate** future impacts
- Need for a new paradigm of ‘upstream’ engagement during and prior to technology development
- **Responsible Innovation** draws on a wide range of stakeholders, academics and public
- Nanotechnology example

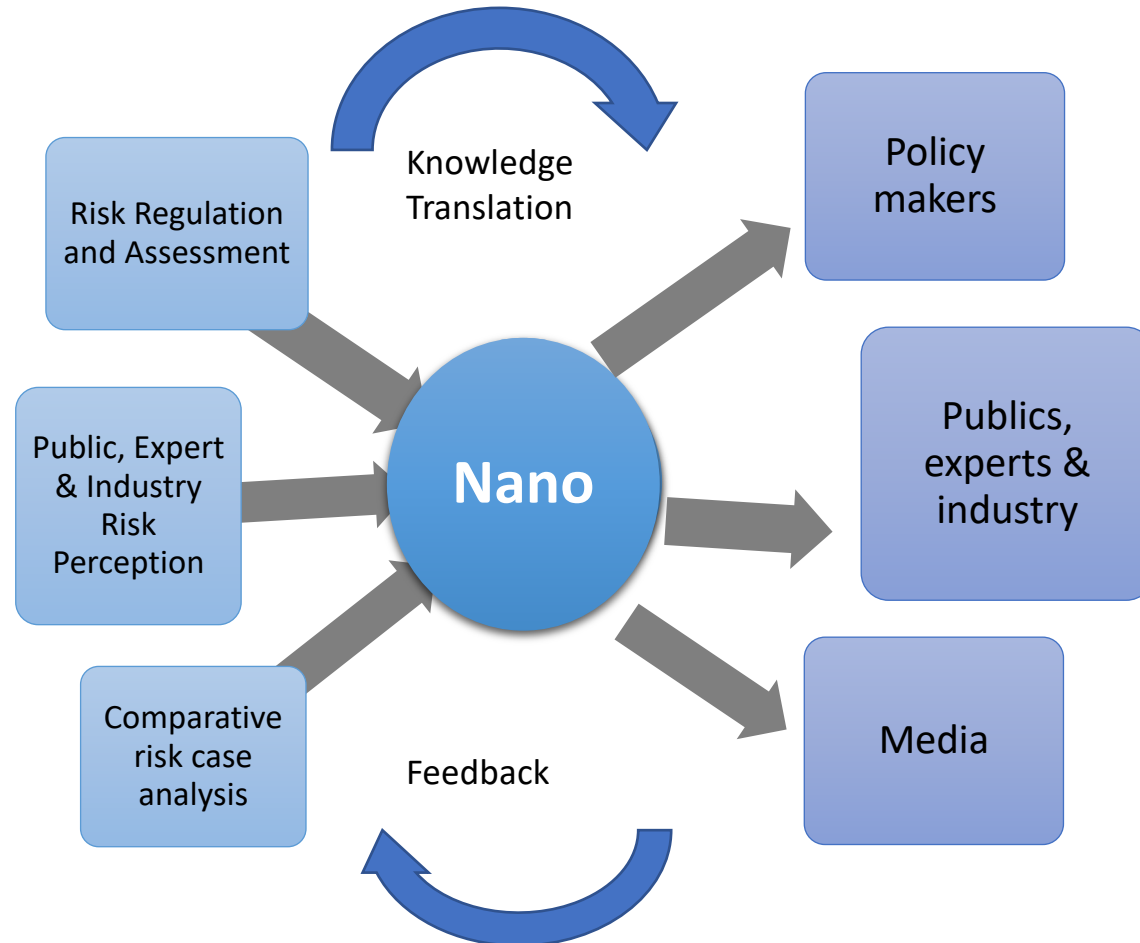
# Nanomaterials



The same properties that make Nanoparticles attractive can also be the cause of negative health effects



# Upstream Engagement

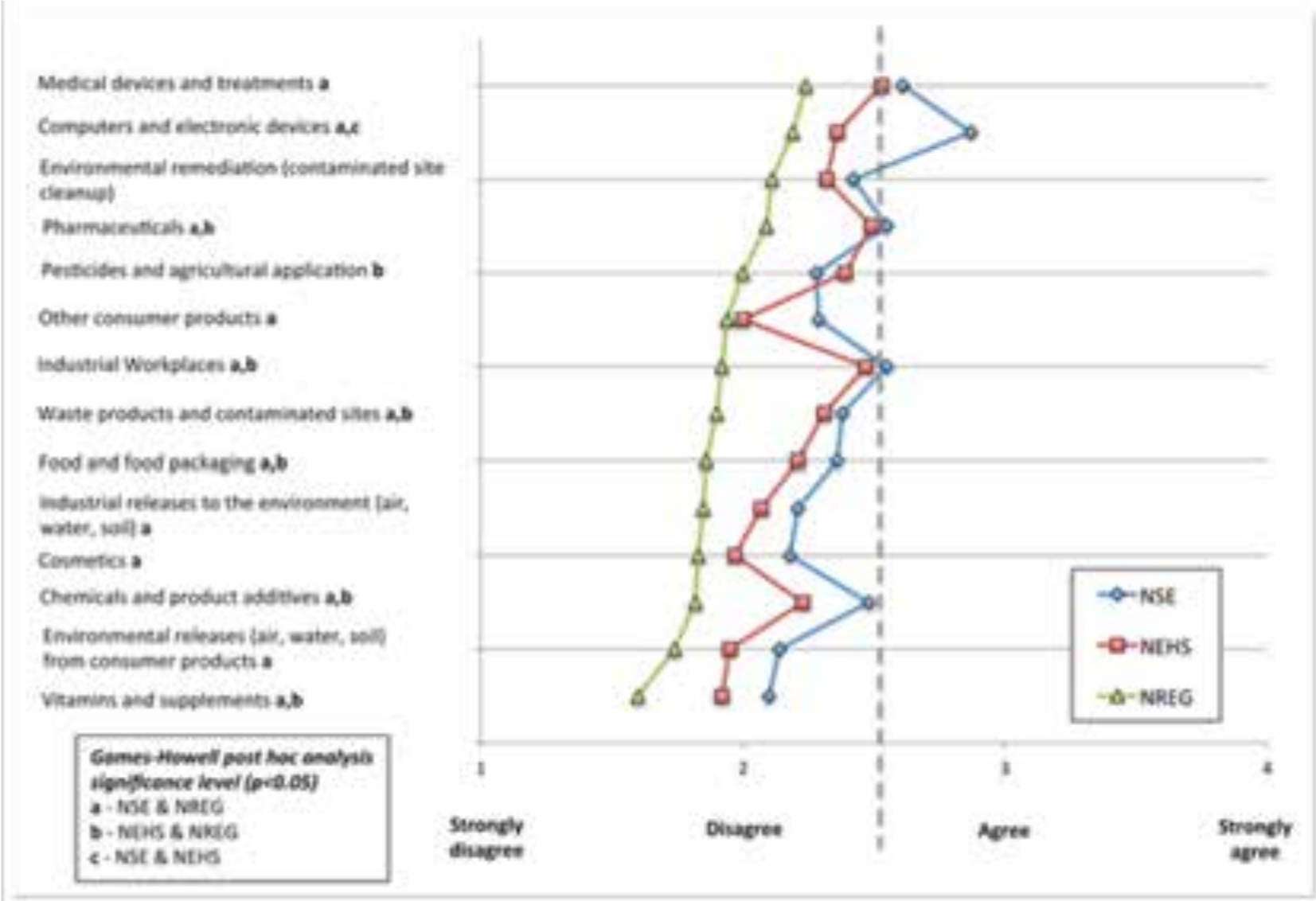


**UCSB + UBC  
collaboration**



# Perceptions of Agency Preparedness

Survey of 424 nano experts  
**NSE** – Nanosci and engineers  
**NTOX** – Nano EHS researchers  
**NREG** – Nano regulators, risk assessors in Govt.



# Structured Decision Making

- Preliminary framework & discussion
- Case studies & discussion
- Collaborative model building



- Breakouts:
  - *Exposure & Toxicity components*
  - *Properties & Measures*
  - *Product Characteristics*
- Mock-up of a final model & discussion

# Public views **Sustainability** in Nano more broadly

- Technological Optimism is more tempered
  - The social trumps the scientific in the discussion of ‘risk’
  - Anxieties over social impacts – ‘**technological unemployment**’ dominate environment/health
  - Equity and benefit sharing – the scientific community largely silent on this

# Responsible Innovation (Old vs. New)

- Local vs. Global
- Short-term vs. Long-term
- Public vs. Private
- Economy vs. Society