Global System Dynamics and Policies

Julian Hunt
Earth Sciences & Mathematics
University College London, UK
Trinity College, UK
Arizona State University
House of Lords

Perspectives on complex systems analysis (CSA) for policies to deal with serious, international, complex, interconnected problems

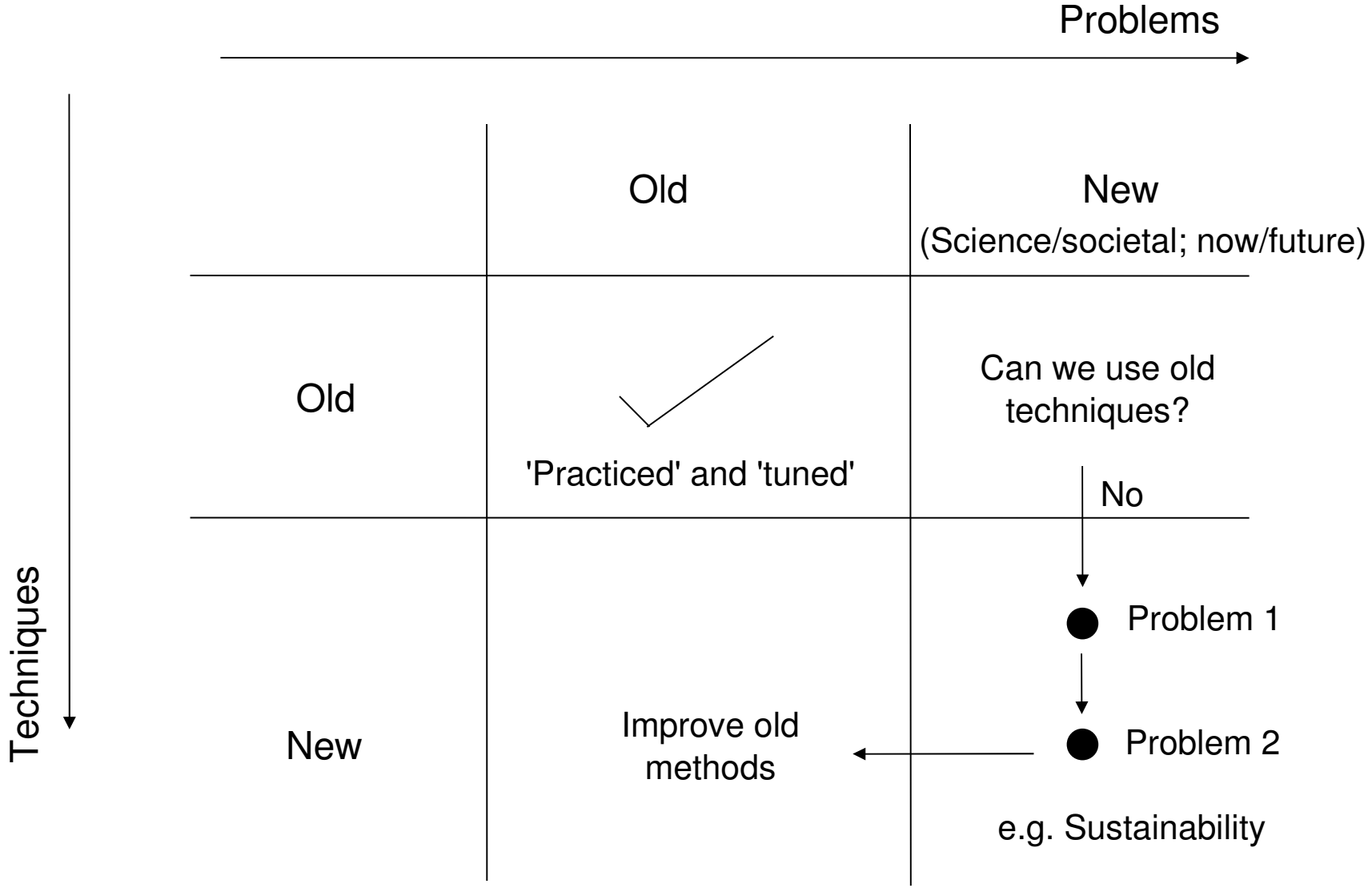
GSD emphasis: New frameworks and modelling techniques for analysis, predictions (using data/experience)

- Scenarios, policy options and the risks, e-governance
- Using system models for decision-making, understanding/explanations and data
- Allow for feedbacks/interactions of groups

* FUNDING FOR FUTURE → leverage; EU/Government + Industry

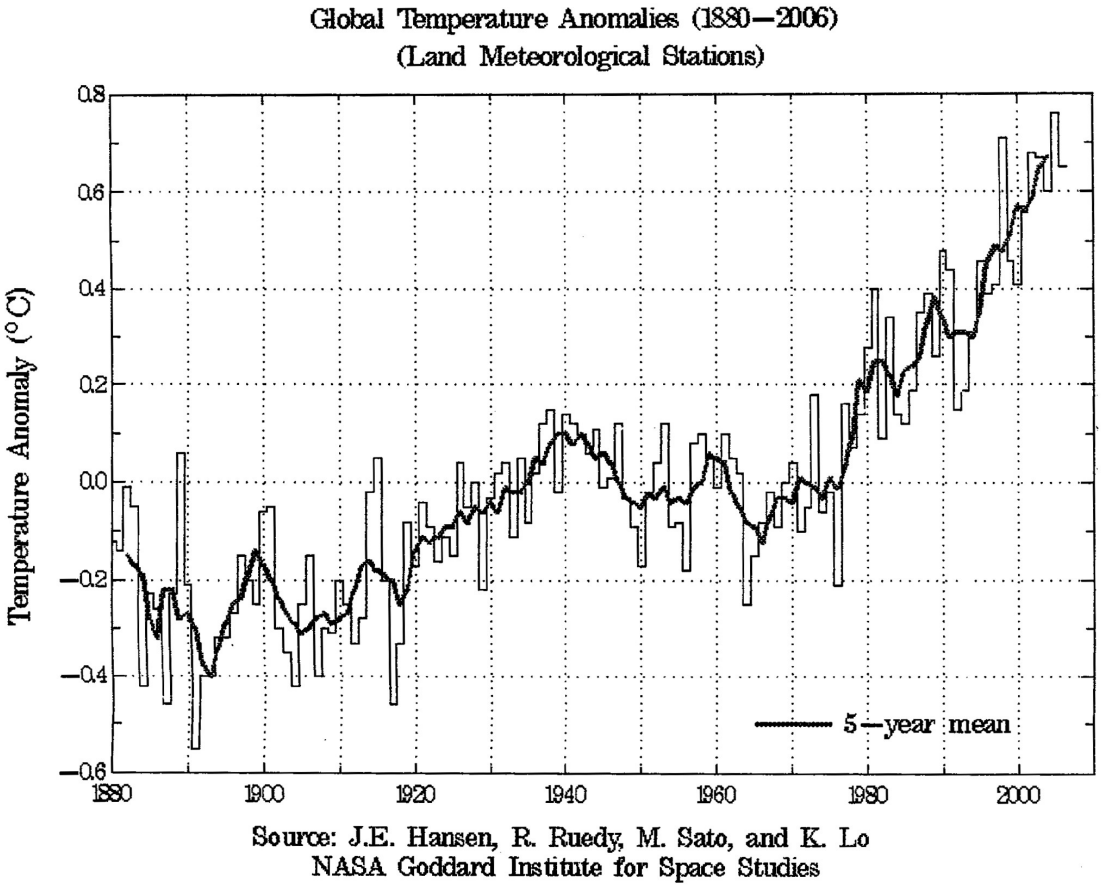
Why use new techniques/approaches?

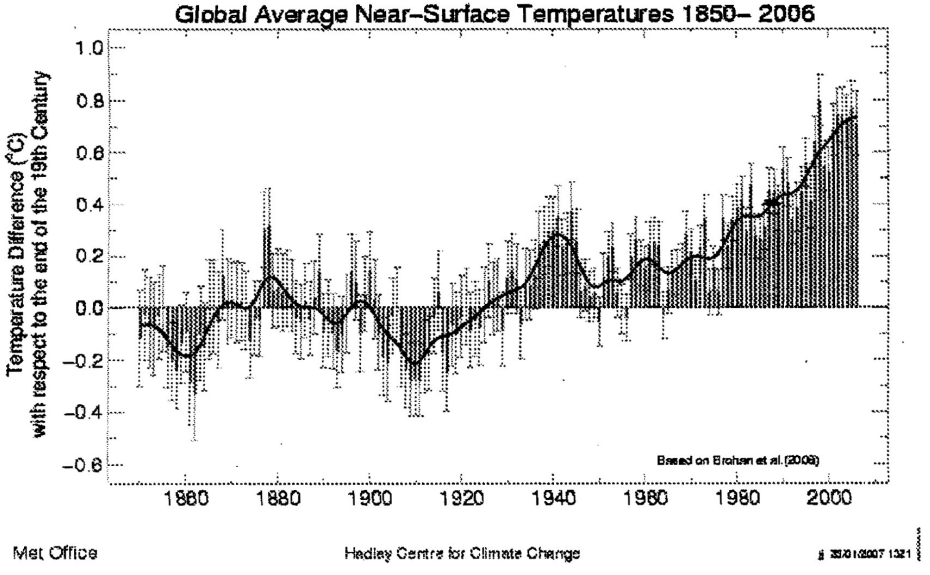
(for the sceptical policy maker)



RELEVANT FOR RESEARCHERS TOO??!!

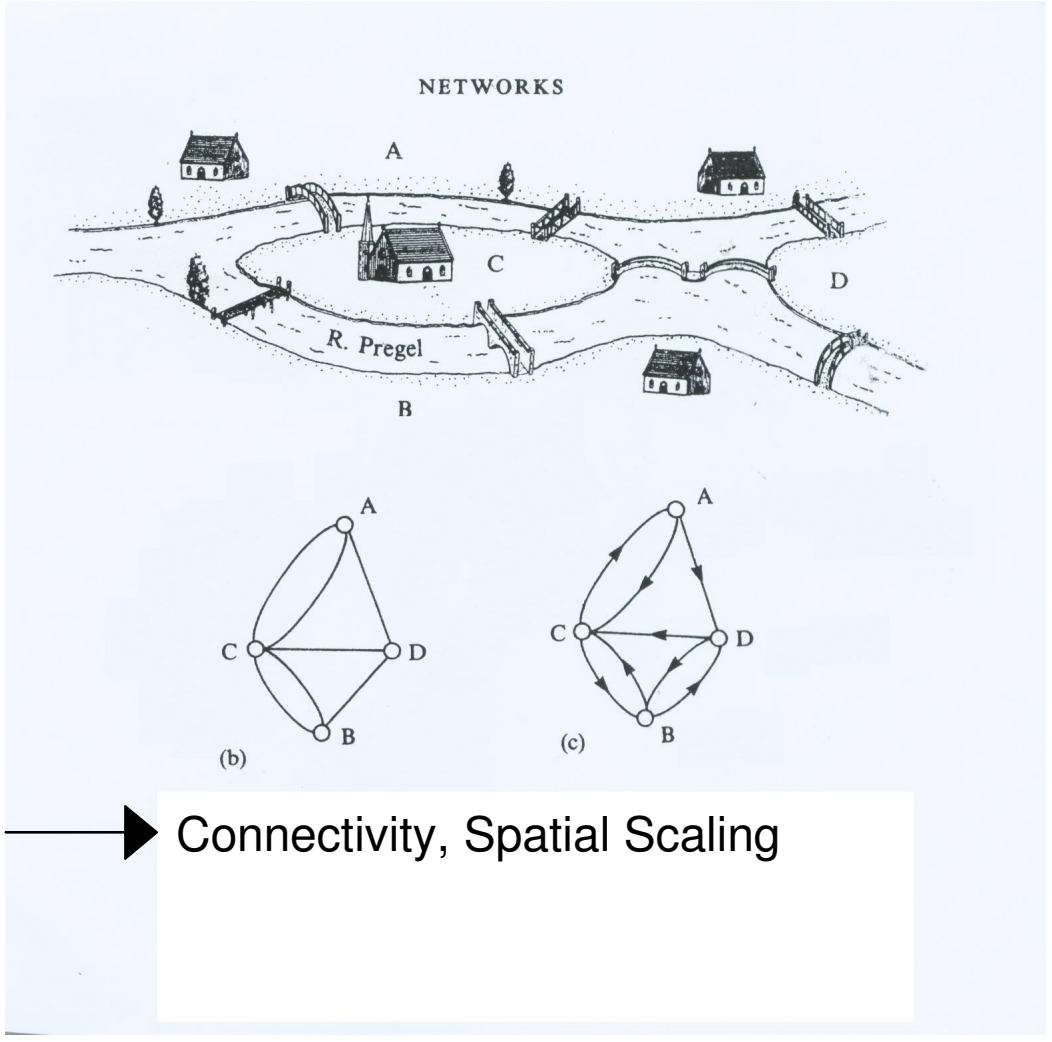
GSD


Global Temperature Anomalies (1880—2006)
(Land Meteorological Stations)
Temperature Anomaly (°C)
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
1880
1900
1920
1940
1960
1980
2000
5—year mean
Source: J.E. Hansen, R. Ruedy, M. Sato, and K. Lo
NASA Goddard Institute for Space Studies


Global Average Near-Surface Temperatures 1850– 2006
Temperature Difference (°C)
with respect to the end of the 19th Century
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
1860
1880
1900
1920
1940
1960
1980
2000
Based on Brohan et al.(2006)
Met Office
Hadley Centre for Climate Change

Abstract Geometrical System Thinking – Euler 18th Century

Topology/Dynamics



→ Connectivity, Spatial Scaling

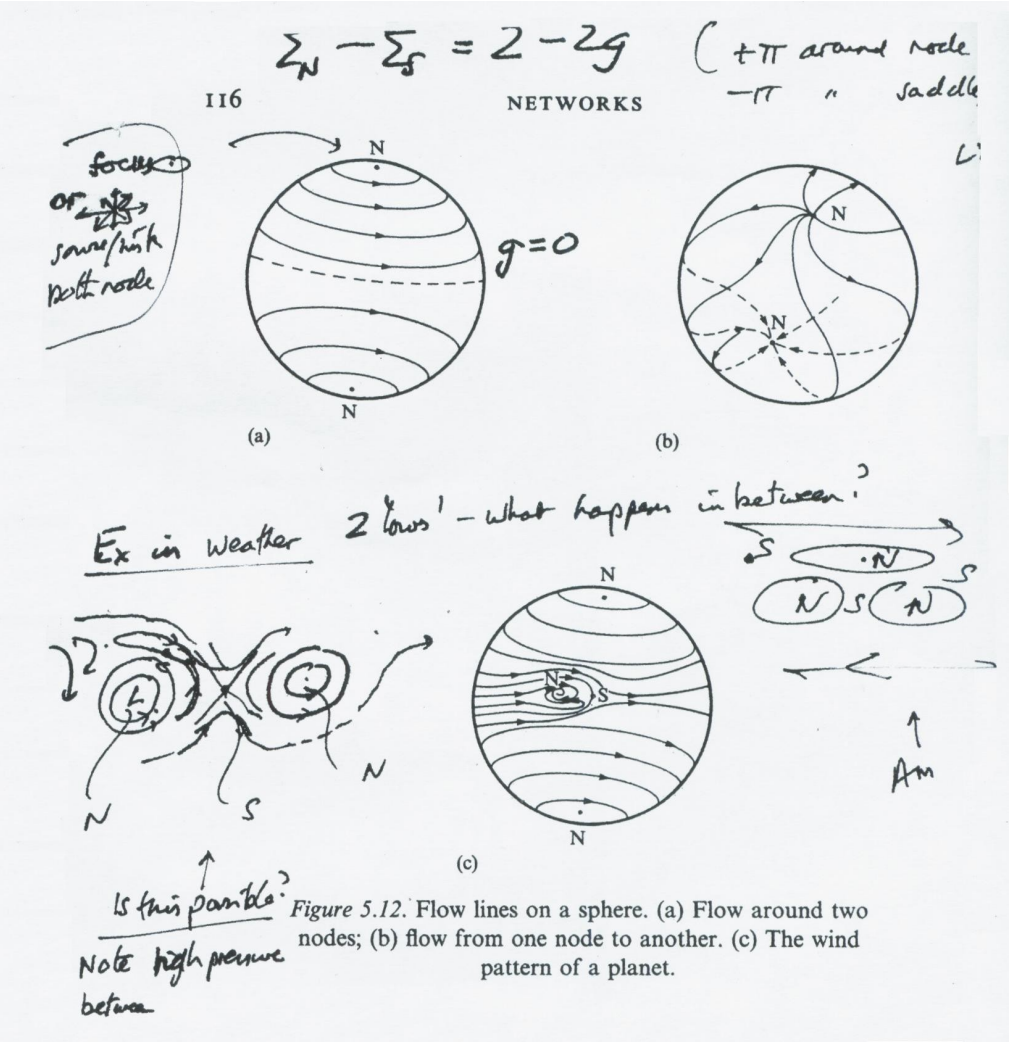


Figure 5.12. Flow lines on a sphere. (a) Flow around two nodes; (b) flow from one node to another. (c) The wind pattern of a planet.

GSD

Challenges for Global System Dynamics for Policy

1. How to apply GSD to complex multi-component problems with many interactions.

   a) System models with feedback from society (explicitly or indirectly)

   b) Simplified decision models (e.g. urban development, resilience, energy and environment) based on complex models. *

2. Enable*** decision makers to understand and use systems approaches at a strategic level

*e.g. integration of sustainable development policies via markets, government/community projects, changes in lifestyle.

***e.g. via a manual/guide book or computer instruction packages (similar to ERCOFTAC guideline for CFD – now widely used in industry) plus workshops for different sectors.

Report of mtg dec 2009 , see gsd website.

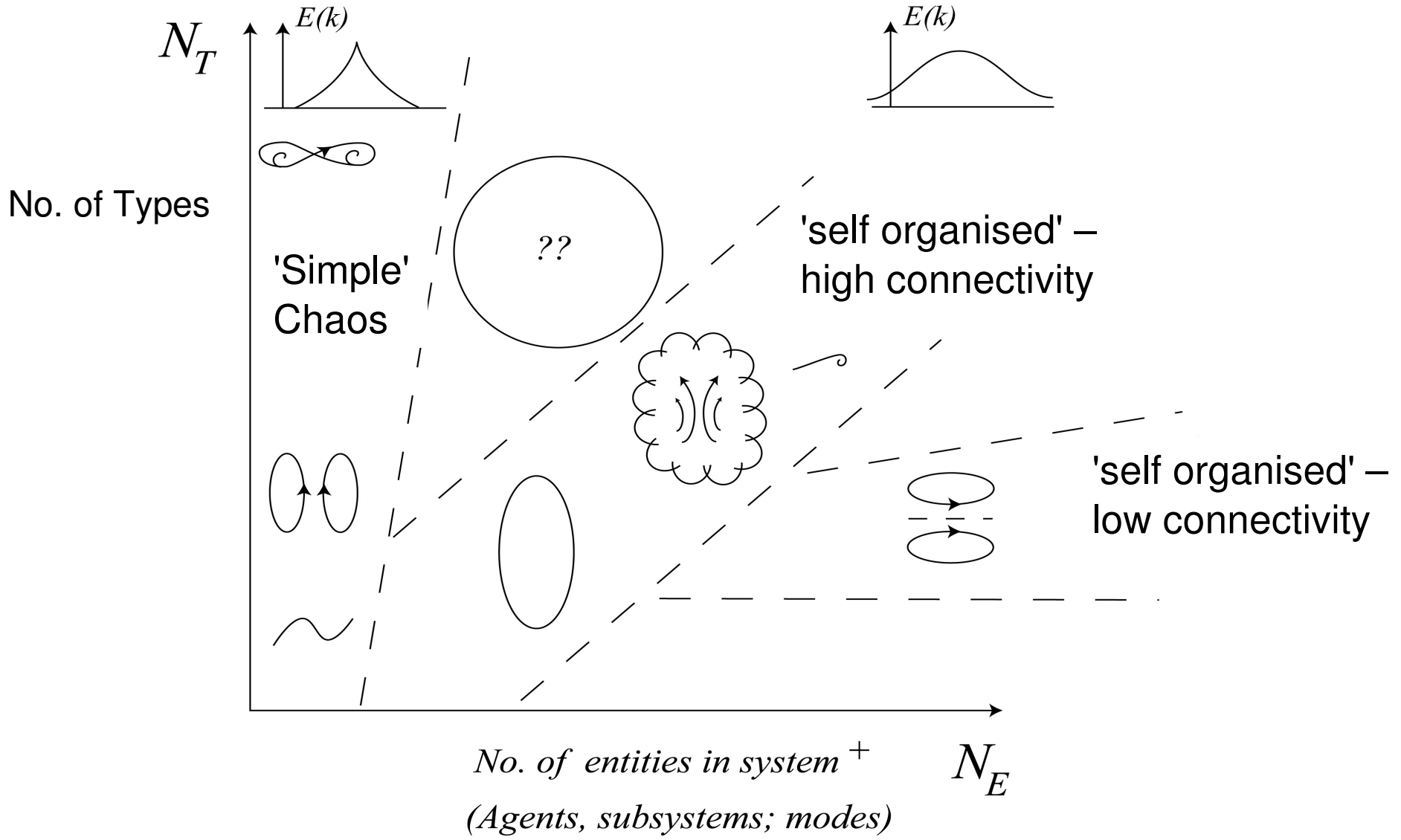
GSD

Levels of Complexity in C.S.A. Modelling

Input - Output	Dynamics	Connections
1. Direct complete (could be random)	Unique relation - simple model	Fixed network/process - path chosen by *I* data
2. Complex input-output Incomplete (Input during process)	Non-unique ensemble - feedback depends on *O* - oscillating - chaos	Dynamical networks/ bodies - Extremes
3. Auto-adaptive - online adjustment - strategic input and resolution	Process evolves goal seeking external effects Interactions (Non-unique as above)	Evolving networks - Singularities

GSD

Maps of Types of Behaviour of Complex System

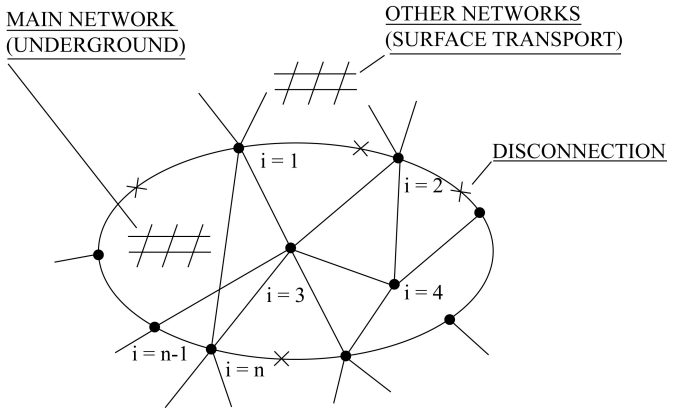


* *also selective*
stimulated
non-unique (history)
hence guide to possible unpredictability

\+ *For continuum* → N_T *increases with Re*
N_E *increases with number of modes*

GSD

From networks to macro dynamics

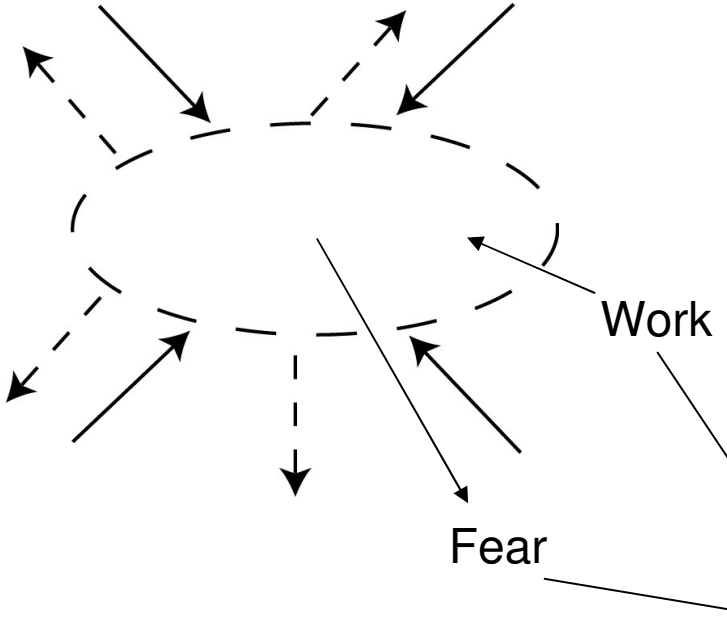


Connected Networks

- **Effects of breakdowns:**
- **response of other networks**
- **dependence on 'drivers', desires, fears**
- **model → sensitivity; online control**

→

$$\frac{\partial C_P}{\partial t} = \nabla\left(D_{TN}\nabla C\right) + \nabla\left(D_{SN}\nabla C\right) - S_W + S_F$$



TRAINS

$D_{TN} \sim < V > L_{TN}$, ↓ with BD

SURFACE

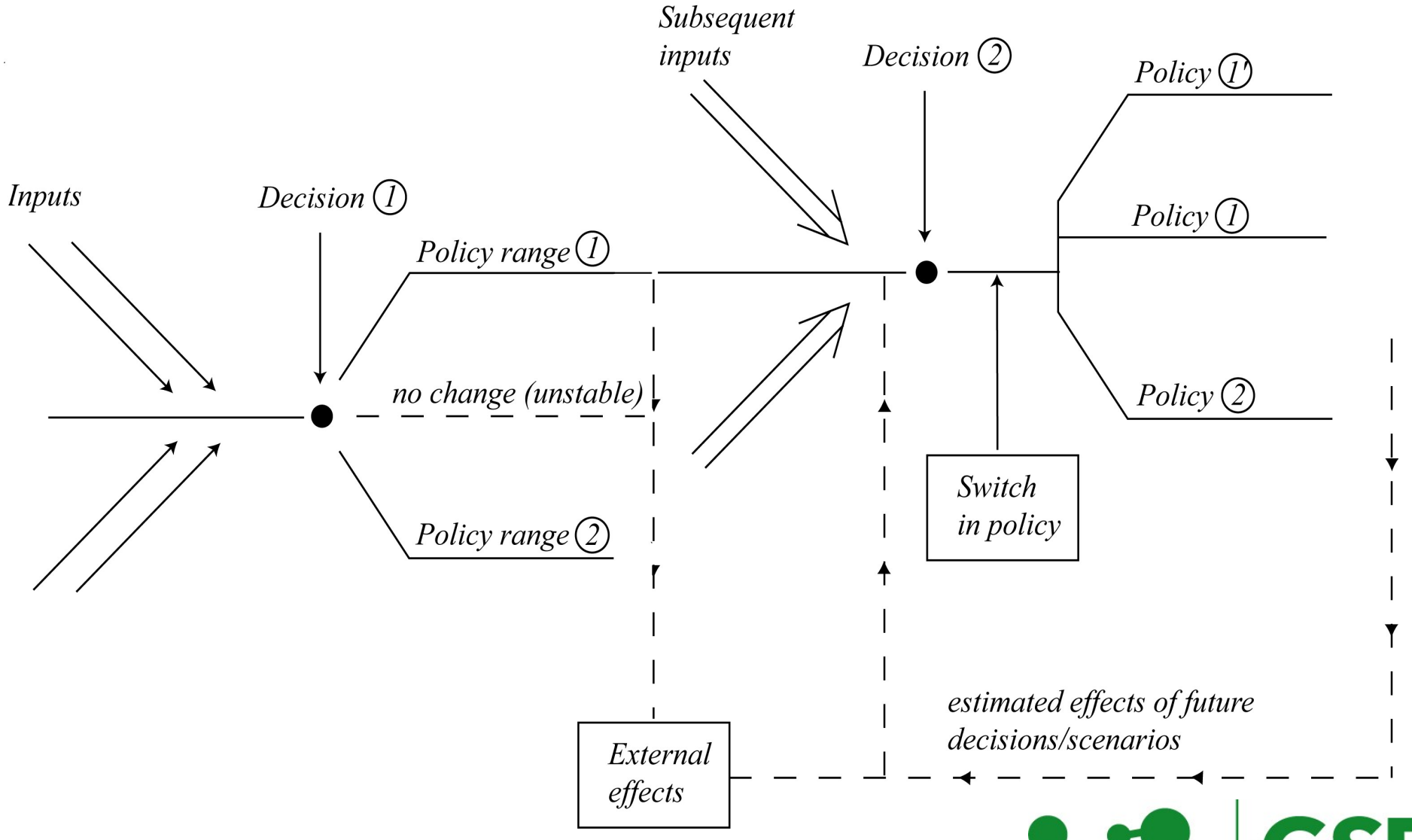
$D_{SN} \sim v'l$

, train transport ↓ with break-down. Surface transport increases takes over- depends on drivers(source terms in diffn eqn).

GSD

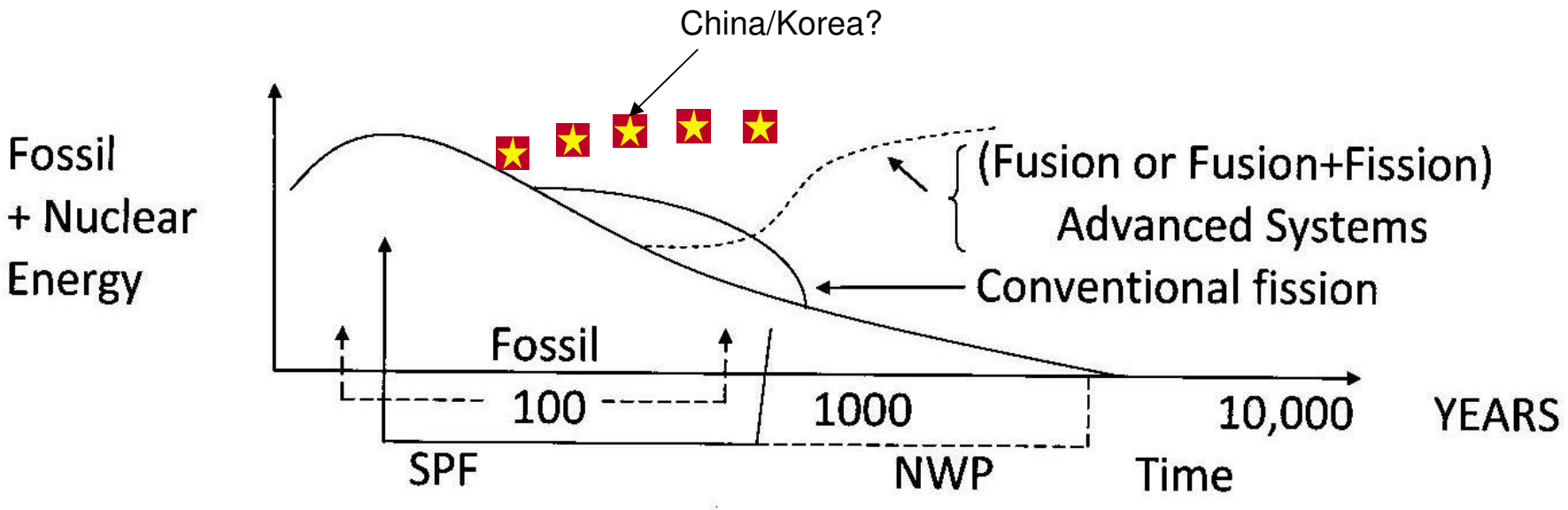
Mapping and Dynamics of Decisions

(Can we be more open?)



Very Long Timescale

5. TIME SCALES FOR ENERGY POLICIES AND FEEDBACKS



Note:

SPF = Social / Political Feedback
NWP = Nuclear Waste Policies

} Affecting present policies from future scenarios

Fusion Research ⟶ Hybrid Fusion-Fission?

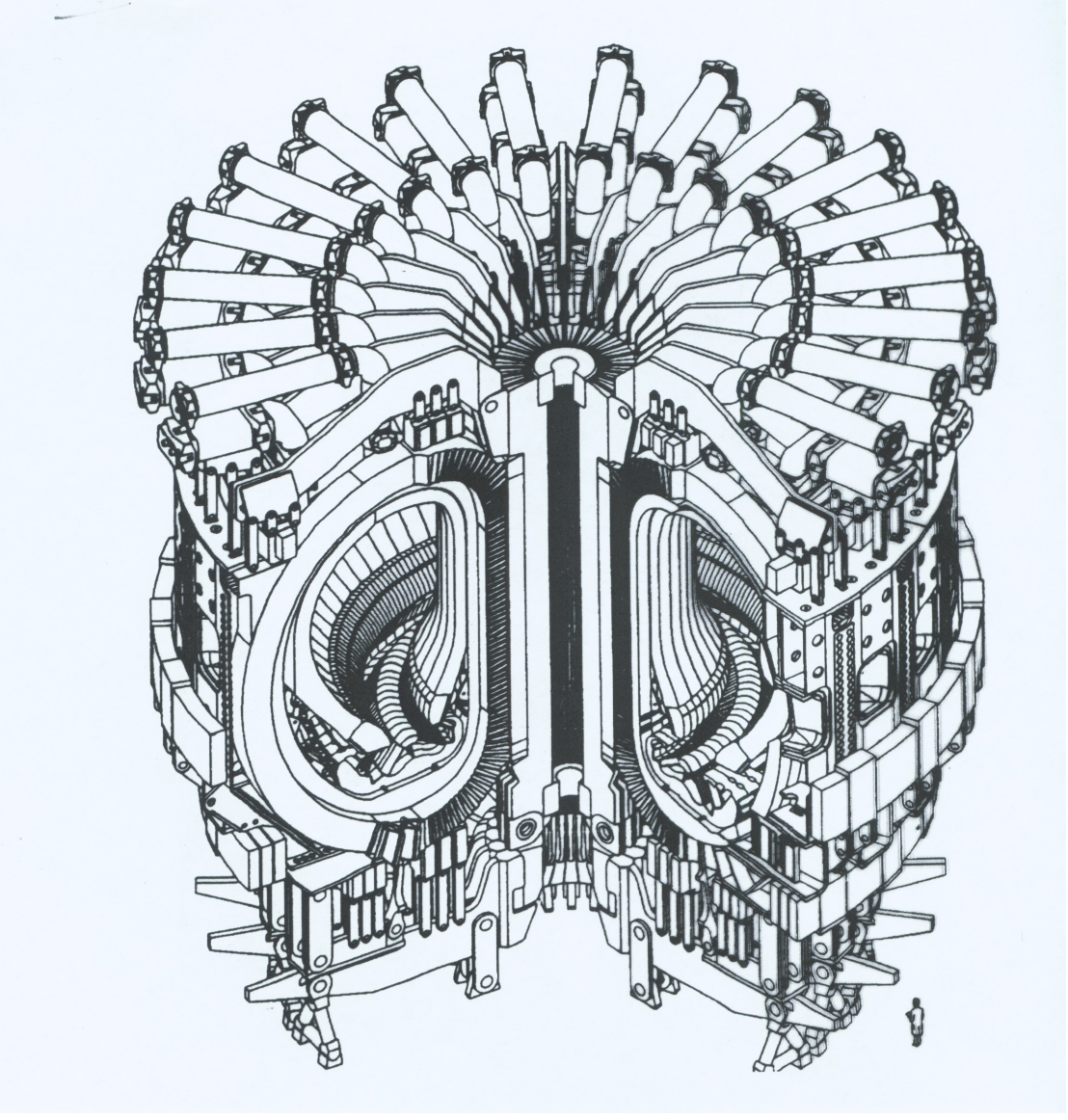
Hybrid FF ⟶

Efficient use of uranium/ thorium resources

- no long term radioactive waste (100 yrs)?

China – pilot project 2020?

No plans for Europe?



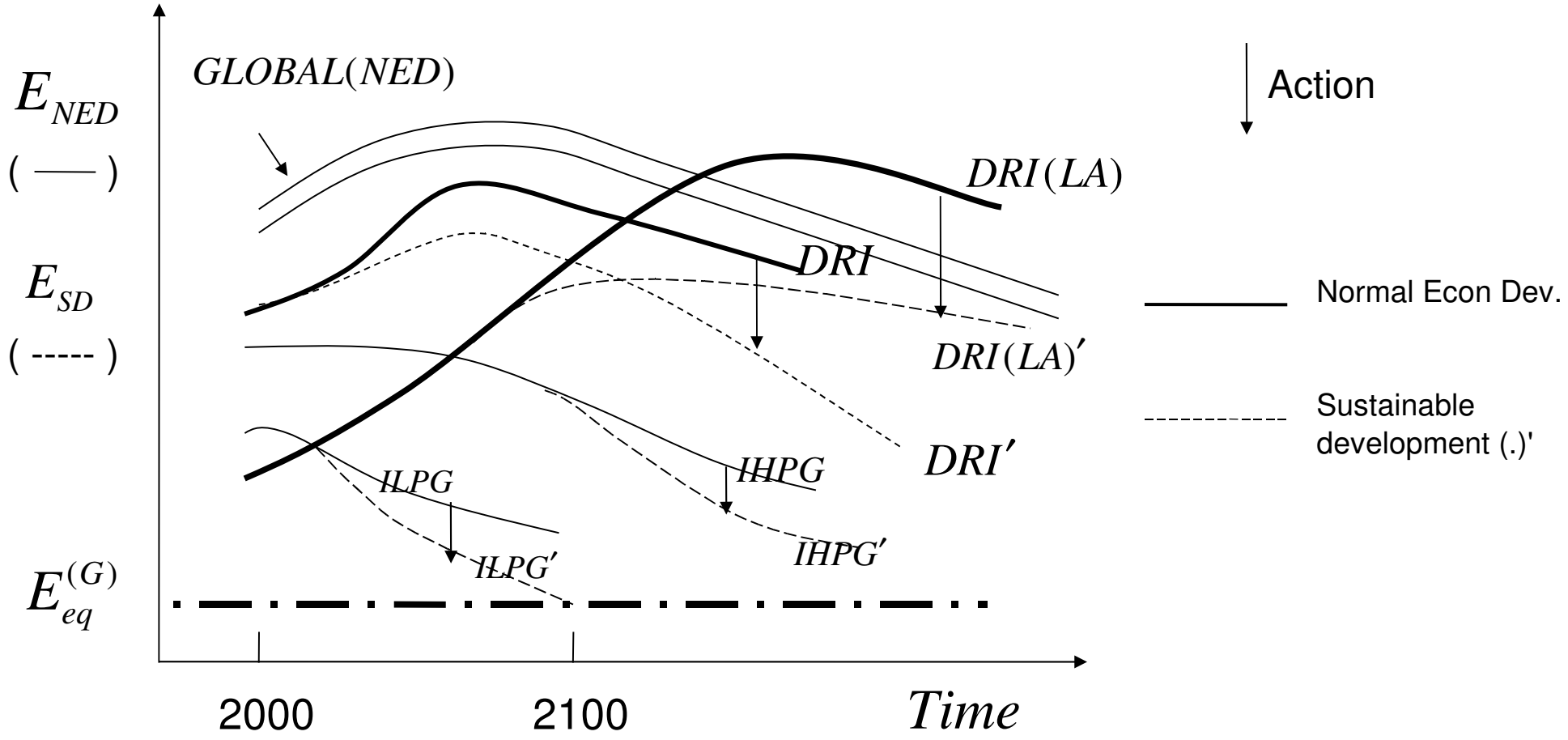
TOKAMAK Fusion Device

GSD

Trends and Time-scales for Policies

RANGES OF LIKELY EMISSIONS FOR DIFFERENT TYPES OF COUNTRY

Normal Economic Development or with sustainable development policies



ILPG – Industrialized low pop. Growth (EU; Japan)

IHPG – Industrialized High pop. Growth (USA)

DRI – Developing- rapid industrialization- limited pop. Growth (China)

DRI(LA) – DRI plus large agricultural sector – high pop. Growth (India)

GSD

Integration of Mitigation and Adaptation and Resilience - Political Challenges

Coast

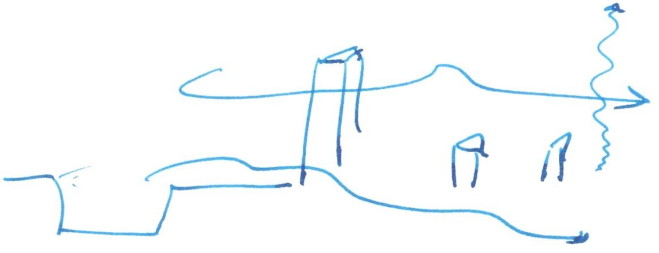
Perimeter Defence

Interior Defence

Mitigation
via Wind Power
+ Adaptation
via Dykes

Mitigation ⇨

Urban



Temperature ↓

Health ↑

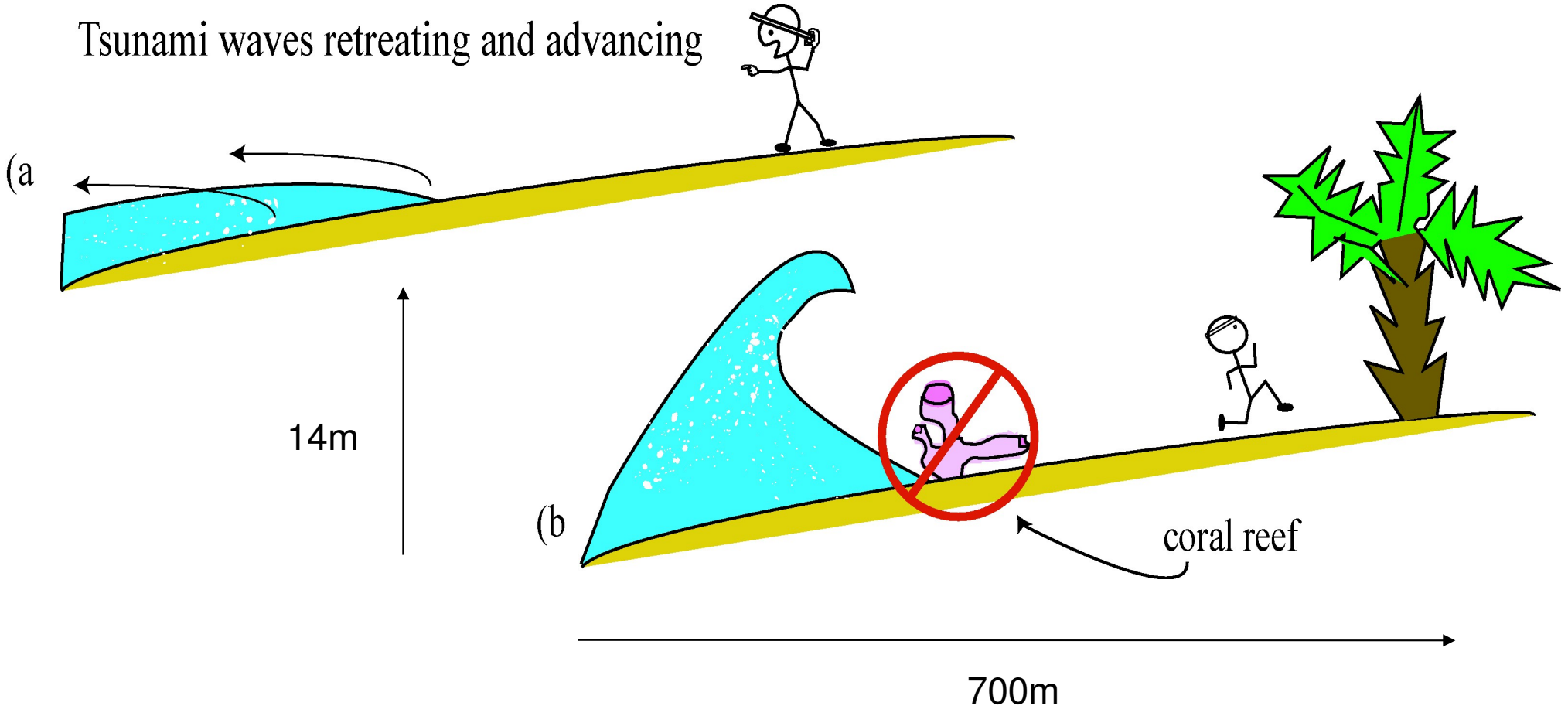
Agriculture

Mitigation ↑ ↓

Sustainability ↑ ↓

GSD

How to model? How to Communicate?



29th September 2009, Samoa

GSD

Wednesday 14th April

Energy and the Environment

09.30-11.00: **Keynote Addresses**

11.00-11.30: *Coffee*

11.30-13.00: *Panel*: **The Energy and Environment Policy Process**

13.00-14.30: *Lunch*

14.30-16.00: *Case Study* – **The Future of Energy**

16.00-16.30: *Coffee*

16.30-17.30: *Discussion*: **The requirements of Policy-makers: Government and Industry**

17.30-17.45: Summary from Host

17.45: *Close*

19.30: Cocktail Reception & Conference Dinner
to be held at the Radisson BLU Royal Hotel, Rue du Fosse-aux-Loups 47

GSD