## **Cascades and Transitions in Human-Environment Interactions**





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## **Questions on the sustainability transition**

- ➤From where do we leave?
- >Where do we want move in the transition?
- ≻How do we get there?
- >What do we need to do for the transition?
- >Where will we end if we don't move?
- ≻Who are we?
- >Are we going to change ourselve in the transition?

## Lines of conflict and cooperation

Human sphere and natural sphere

Individuals and the group/collective

>We and the other

## **Perspectives from natural and social sciences**



## A scientific discourse on complexity...



### A scientific discourse on complexity...



## What is complexity?

**Complex:** "made up of parts; difficult to understand of explain" (Advanced Learners Dictionary)

- •Parts: elements/units of a system
- •Made-up: Composition of elements to a whole
- •Understand: model representation
- •Explain: system reconstruction

Complexity is the minimal length (size) of a system description (model) that reproduces the essential system qualities in an appropriate language.

Albert Einstein: "As simple as possible but not more simple"

## **Complexity and stability**

- Increasing complexity  $\rightarrow$  more potential instability?
- Why do complex systems exist?: biological organisms, ecosystems, societies, networks, technical systems, ...
- →Evolutionary selection: Unstable systems disappear, stable systems remain
- →Adaptation and learning improves stability
- →Evolution towards increasing complexity and stability by natural selection
- $\rightarrow$  Intentional action, control and innovation in social evolution

### **On-going transformations in the human sphere**



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#### **Global growth patterns of the human sphere**





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WEEKLY August 4 - 10, 2012

## **COLLAPSE** WHEN NATURE DESTROYS CIVILIZATIONS

#### UNTIDY UNIVERSE Sweeping up the mystery of cosmic dust

LOST WORLD? Dino stomping grounds under threat

KNOW THYSELF Tracking your life from food to mood HYPERSONIC COOL Frigid air gives extra boost to spaceplane



## **Example: The East-West conflict**





Strategic Defense vs. Nuclear Disarmament



## **Security bifurcation diagram**





## **Transition towards nuclear disarmament**



## 2008 economic crisis



## **Price cascading effect**



http://dangerousintersection.org/wp-content/uploads/2008/05/energy-domino-effect.jpg

## Is there a link between riots and the price of food?



#### Food Prices Could Hit Tipping Point for Global Unrest

By Brandon Keim 🖾 August 15, 2011 | 1:02 pm | Categories: Food

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**Domino effect in North Africa** 



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mag 27.1.1 ZAP ino p. 22

## **Development of global mean temperature**



WBGU 2009 p. 23

## **Tipping elements in the climate system**



tipped already

in limbo

still stable

- 01 Arctic Sea Ice Loss
- 02 Greenland Ice Sheet
- 03 Thawing Permafrost / Methan Escape
- 04 Boreal Forest Dieback
- 05 Suppression of Atlantic Deep Water Formation

- 06 Climatic Change-Induced Ozon Hole over Northern Europe
- 07 Albedo Tibetan Plateau
- 08 Indian Monsoon
- 09 Re-Greening Sahara / Sealing of Dust Sources
- 10 West African Monsoon

- 11 Dieback of Amazon Rainforest
- 12 Southern Pacific Climate Oscillat
- 13 Antarctic Deep Water Formation Nutrients Upwelling
- 14 Westantarctic Ice Sheet
- 15 Antarctic Ozone Hole
  - Source: Lenton et al 2008

## Possible global emission paths for the 2°C goal

To keep the 2 degree temperature goal with 67% probability, the world should not emit more than 750 billion tons CO2 by 2050 into the atmosphere.



## Theoretical trajectories of per-capita emissions of selected countries under the WBGU budget approach



## Framework of climate-society interaction



#### Indicators and regulators of global temperature



## Adaptive carbon control under uncertainty



## **Transition functions**



## **Conflict or cooperation: How will human beings and societies respond?**



# Cascading conflicts and cooperative transitions in climate change



## **Damped interaction**



## **Escalating interaction beyond tipping point**



#### Interactions between climate and society: Human-society impacts on the climate system



## What is guiding human action?

>Values and goals: What do we want?

Capabilities and means: What can we do?

Behavioral attitudes, opinions, priorities and rules: Which paths do we follow?

Natural and social environmental conditions: In which systems do we act?

## The action triangle



## Human action cycle



Benefit-cost-risk assessment

## Human action cycle



#### Integrated decision-making on energy options



#### $U(E) = q f_{\gamma} p C(E) / c$ R(E) = q (D/G) (G/E) (E/Y) (Y/P) P = q d g e y P

### **Balance between natural resources and human needs**



## Factors of greenhouse gas emissions: The Kaya Equation



G = (G/E) \* (E/W) \* (W/P) \* P = g \* e \* w \* P

G is global greenhouse gas emissions from human sources (e.g. CO2)

P is global population

W is world wealth (GDP)

E is global primary energy consumption

w = (W/P) is global per-capita wealth (labor productivity) e=(E/W) is the energy intensity of world wealth (GDP) g=(G/E) is the carbon intensity of energy. Yoichi Kaya, 1993, Environment, Energy, and Economy: strategies for sustainability p. 42

## **Strategies for emission reduction**



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## Adaptive vs. optimal control



## **Carbon Intensity vs. Accumulated Emissions**



p. 45

# North South Transitions to Green Economies

#### HEINRICH BÖLL STIFTUNG

By Tilman Santarius, Jürgen Scheffran, and Antonio Tricarico

Making Export Support, Technology Transfer, and Foreign Direct Investments Work for Climate Protection

Edited by the Heinrich Böll Foundation 2012

	Public sector	Private sector
North (Inves- ting country)	<ul> <li>Reduce the role of current export credit agencies.</li> <li>Build new institutional mechanisms that promote foreign investments to make them work for climate protection and sustainable development that will.</li> <li>Raise public money to support and leverage climate-friendly foreign investments so as to insure investments against financial and market instabilities, incentivise investments into markets with limited demand, and thus make investments attractive, even where returns on investments are expected to be low</li> </ul>	<ul> <li>Support should be offered to companies, e.g. renewable energy companies that aim to invest in countries with low production capacities.</li> <li>The level of support should significantly raise companies' interests to go abroad.</li> <li>Only those investments should be supported that conform to the highest standards at home.</li> <li>Both public and private money raised may be used by countries to fulfil their international climate finance obligations</li> </ul>
South (Reci- pient country)	<ul> <li>Implement strong, stable, transparent, coherent, credible, and ambitious long-term enabling environments.</li> <li>Develop domestic technology roadmaps that identify countries' nationally appropriate mitigation actions.</li> <li>Establish investment policies to effectively govern foreign investment inflows.</li> <li>Design these policies in a way to maximise foreign investments' mitigation potentials as well as economic diversification and sustainable development.</li> </ul>	<ul> <li>Setting the stage for sustained economic growth as "green growth" and "energy autonomy" through domestic renewable energies have more long-term prospects than "fossil growth".</li> <li>Provide opportunities for economic diversification by catalysing foreign capital to climate-friendly sectors.</li> <li>Foster ownership and competitive strength of domestic/local companies in the global market by demanding foreign investors engage in joint ventures and purchase local goods.</li> </ul>

## Climate change: Are we all in one boat?



## Interaction of multiple actors in climate policy



#### **Micro-macro and multi-level decision-making**



## Social and cultural adaptation among multiple actors



## Human inter-action cycle



Benefit-cost-risk assessment

## Cycle of violence or cycle of cooperation



## The complexity of conflict in Darfur



Adapted from: Scheffran, Modeling Climate-Induced Instabilities and Conflicts

Graphics in: Science, July 24, 2009

## Spiral of violence in Darfur, Sudan



Violence multiplier socio-economic marginalization oil revenues refugees division between farmers & herders climatic changes/ resource scarcity



#### Adaptation options of pastoralists, farmers and government in Morocco

## **Energy as a field for inter-regional copoperation**



### **Network formation processes**



## **Strategies for Preventing Climate Risks and Conflicts**



**Climate justice** 

## Landscape of climate impact dimensions



# Human capability, livelihood, resilience and security

**Capability** is associated with 'capital' used to create goods & services (natural, physical, financial, human, social, political, cultural capital)

**Amartya Sen's capability approach**: true development requires every person's access to real freedoms, which people have to achieve prioritized outcomes (functionings and capabilities)

**Livelihood** "comprises the capabilities, assets [...] and activities required for a means of living: a livelihood is sustainable which can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets" (Chambers & Conway 1991)

**Resilience:** Capacity to resist shocks and surprises and, if damaged, to rebuild. Resilient communities will be able to cope with stress and retain its qualitative structure in a dynamic and flexible way that preserves, rebuilds, or transforms their livelihood.

**Human security** relates to "the well-being of individuals, including both freedom from fear and freedom from wants. As a concept, human security refers not only to security from physical violence, but also to food security, livelihood security, environmental security, health security and energy security".(O'Brien & Leichenko 2007:3).

## **Elements of sustainable development**

Sustainable development: Satisfy the needs of today's generations without endangering the needs of future generations.

 $\rightarrow$  Combines two goals:

Preservation of the natural life-preserving basis of social systems

Development: unfolding the possibilities and abilities of social systems

Instead of destroying boundaries through the growth of material and energetic goods, a development into a multidimensional space of values ensures the preservation of natural conditions and boundaries.

## **Elements of peace**

With accord to the human rights, that are supposed to warrant the basic rights of the individual for its preservation of existence and development, peace is determined by (according to Ernst-Otto Czempiel):

``1. preservation of the existence of the individual based on diminishing violence.

2. contiguous development of existence of the individual based on increasingly equal distribution of developmental chances"

Preservation and development (unfolding) are therefore not only essential categories of sustainable development but also of peace. While sustainability links the development of the individual to the preservation of the environment, the preservation of existence of the individual becomes the basic condition for its development in times of peace. Equally is human existence unthinkable without a development that leads to the self-realisation of the individual.

## **Transition to sustainable peace**

"Concepts of peace and sustainable development are closely interconnected in both the positive and negative senses. The crucial question of the next decades will be, whether it will be possible to evade the vicious circle of environmental destruction, underdevelopment and violence.

How can the transition be made from a world that is out of order to a peaceful and sustaining world without destructive turbulences?

It is obvious that enormous requirements will be raised to the social systems and the conflict regulating systems of humanity."(Scheffran 1996)

## Peace and sustainable development: From the positive to the negative coupling



## World at the crossroads: Towards sustainable peace?



# How will we act and interact in the sustainability transition?

