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Tipping Points in the Earth System – Consequences on Ecosystems and Society

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“Tipping Point” – Malcolm Gladwell – published in 2000, marked the beginning of the use of the expression “Tipping Point”, and the concept was initially used in Epidemiology. “Critical Mass” by Philip Ball, published in 2004, is another known book on the subject.

Tipping points have been referred to several times throughout the Summer School.

Diana will mainly refer to the work being developed at the Potsdam Institute.

Tipping points can be represented in diverse ways.

Diana showed a video on the subject, where tipping points are explained. Tipping points derive from a series of positive feedbacks on Earth’s systems. The sudden release of the methane stored in the deep is an example of a possible effect that will contribute to go beyond a tipping point.

Tipping point...:

-...beyond which the spreading of an infectious disease (or other populations in unbalanced ecosystems) can no longer be controlled from spreading more widely

-...was included in the Word lover’s guide to new words, 2009

-...refers to a critical threshold

-refers to a turning point.

Tipping points in the Earth System:

Critical thresholds reached as a result of human-induced climate change of which the smallest of changes could take us to the point-of-no-return (environmentaldebate.com).

Several characteristics make tipping points critical.

The IPCC, in 2007, refers to abrupt temperature changes as having occurred during the last ice age.

Diana showed two diagrams representing tipping points, used previously by the IPCC with 8 potential policy-relevant tipping elements.

Lenton & Schellnhuber, 2007. Diana showed a graph.

Lenton et al., 2008. Some tipping points that may be achieved in this century. Diana showed a map with examples of potential tipping points in the world.

Diana continued the presentation by showing a table with parameters and measurements relevant to the issue, and used the arctic summer sea-ice, as an example. It is regarded as a non-linear

transition. To ecosystems, an impact will be the reduction of habitat and breeding places (e.g.: polar bears and seals).

A second example was presented: the Greenland ice sheets (GIS) which models indicate, can totally decrease in about 300 years. One question about the eruption of the Pinatubo volcano was placed – if a cooling effect was observed why did it help to increase melting in the Greenland?

The impacts on the ecosystems would include effects on the mangroves, marshlands, and on the species that inhabit those ecosystems.

Another example presented was the Antarctic ice sheet (WAIS). The difference from the Arctic situation is mainly due to the fact that Antarctica has a rock platform beneath the ice. Tipping point is considered to be at 5 to 8 Celsius degrees. A question was placed regarding the way how the melting of different pieces will help further pieces to melt and/or separate. Another question about the existence and number of pockets beneath the ice was presented. The number and reason for their existence is not very well known. The effects for ecosystems include the rising of the sea level, changing the ecology of the ocean and affecting seals, as these species require ice to reproduce and feed the juveniles.

A further example was referred: the thermohaline circulation of the Atlantic Ocean (THC). Rapid changes were historically observed. The tipping point may be reached in 20 to 30 years. Two questions were presented about the reasons why freshwater on the surface is not able to push the salt water down. 0.1 to 0.5 units of volume transport may be the tipping points. Another question was presented on how much would the collapse of the North Atlantic current affect other currents in the world. It would certainly affect several other currents, despite the uncertainties. The tipping point may be reached in this century. Subtropical and mid-latitudes (and atmospheric circulation) would be affected. NA-current disrupted. The cooling effect could possibly be compensated by radiative forcing and warming. Most of the current scientific knowledge does not believe that a new ice age could be triggered by the cessation of the North Atlantic current.

Another example referred to the El Nino effect – southern oscillation (ENSO). 7 to 11 years is usually the duration of the cycle. This effect has been known to occur in other geological ages. The La Nina effect is the counterpart effect of El Nino. The maintenance of the Amazon rainforest is very much dependent on the El Nino effect. A global mean temperature warming of about 4 degrees Celsius may trigger the die-back of the Amazon region.

The Indian Summer Monsoon (ISM) was also presented as an example. Aerosols, land-use, CO₂ and global warming are influential. Stronger warming over land strengthens monsoons and an increase in continent albedo weakens it. A question was present on whether more concentrated rain is likely to occur. According to Diana, it does.

The Sahara/Sahel and West African monsoon (WAM) example was presented. This could be a rare positive effect. Vegetation could re-appear but could also be compensated by intense grazing.

The Amazon rainforest example was further referred.

On another part of the presentation, consequences for societies were explored. An example of a scenario for India was presented. What would happen if a 10m rise in sea water level would occur? Measures to adapt to that scenario have been suggested. 1 meter of sea level rising would be enough to submerge nearly 6000 m² of coastal area.

As a conclusion, enormous political and ecological conflicts are expected. Other conclusions were referred. The need to find tipping points from awareness to action and the need to understand social tipping points were referred.

The questions presented in the final part of the presentation include the following:

If Earth always had tipping points, could this fact be used to discredit people? And how are these changes and tipping points inter-connected? Studies have been made. Measures to assess whether we have or have not crossed one or more tipping points, need to be applied. What will happen after tipping points are crossed? Migrations will certainly take place. A comment underlined the fact that migrations and social changes will happen between countries and within countries.

A comment was added: the early work by Schaeffer included references to tipping points in the oceanic systems, with several equilibrium states having been observed and situations shifting from one to another state.

A final comment highlighted the fact that the multi-equilibria and tipping points research has emerged in several scientific areas, such as freshwater and marine ecosystems.

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