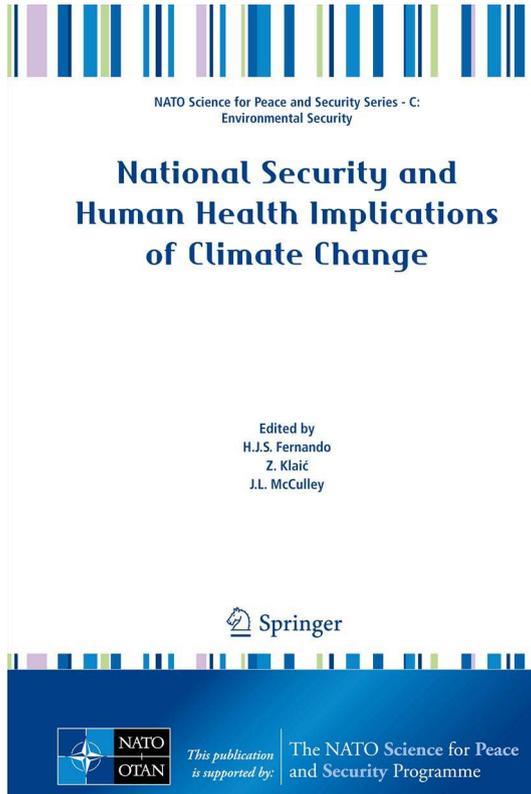


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## Chapter 4

# Climate Change, Tipping Elements and Security

Kjeld Rasmussen and Thomas Birk

**Abstract** Climate change is increasingly being described as a threat to international (as well as ‘human’) security. We examine the claim that it is the so-called ‘tipping elements’ of the Earth System which constitute the most important threats. Three examples of suggested tipping elements, (1) de-stabilization of the West-Antarctic Ice Cap, (2) acidification of the upper layers of the ocean and (3) die-back of the Amazon rain forest, are used to illustrate the ways in which tipping elements may cause insecurity, in various meanings of the term. Further, the use of the tipping element/point metaphor as a means of communicating the risks and uncertainties associated with climate change is discussed, and it is compared to the alternative terminology used by IPCC. Subsequently, we discuss the extent to which the use of the tipping element/point metaphor constitutes ‘securitization’ of climate change, and whether or not such securitization, in ‘hard’ or ‘soft’ versions, is desirable. It is concluded that while ‘hard securitization’, presumably involving use of force, is unlikely to be relevant, ‘soft securitization’ may be realistic – and even necessary - in order to mobilize the reform of international political institutions required to deal efficiently with climate change in general and tipping elements specifically.

### 4.1 Introduction

Climate change (CC) through the twenty-first century, as depicted in IPCC’s Fourth Assessment Report (IPCC 4AR) [13], involves gradual and relatively slow changes in climatic variables, such as average temperatures or average annual precipitation,

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as well as 'impact-variables' such as mean sea level. In most cases the changes in average values projected until 2100 do not exceed the current variability. In addition, IPCC predicts increased variability, involving greater probabilities of extreme temperatures, rainfall events, drought periods and high wind speeds. It may be argued that this may represent greater risks to society than changes in average values: The large damages and great numbers of deaths attributed to climate change mostly occur in connection with extreme events, not the least tropical cyclones. In addition slow and predictable changes in climate are far easier to adapt to. Obviously, slow changes in average conditions and greater variability add up to greater risks of extreme events.

While estimates of changes in both average values and in extreme value statistics may be derived from climate models, the climate system may also display behavior which is not presently possible to reproduce by use of standard climate models. These 'surprises', or 'tipping elements' using the terminology suggested by Lenton et al. [11], of the climate system are associated with its non-linearity, caused by the existence of self-reinforcing mechanisms, or positive feed-backs, which may destabilize the system. A number of possible tipping elements have been identified, and often they involve mechanisms of interaction between the atmosphere, the ocean, sea-/land-ice and the land surface, sometimes associated with changes in bio-geochemical cycles, such as the carbon cycle. When a certain threshold (termed a 'tipping point', see below) is passed, the climate system may 'tip', meaning that it changes its state and behavior substantially within a short period of time, possibly from one 'equilibrium state' to another. Such abrupt climate change with natural causes is known from the paleo-climatic record, documented in ice cores [4]. The current human perturbation of the climate system is believed to make abrupt change far more likely to occur.

Climate change is increasingly being talked about as a 'threat to security' [1, 2]. Such statements require a specification of what is meant by 'security'. Traditional 'security theory' focuses mainly on the national scale and on military threats, yet increasingly the concept is being extended to include other scales, down to the individual and up to the global, and non-military threats such as threats from pandemics, terrorism, loss of access to key resources (e.g. food, water and energy) and environmental and climate change.

Seen from a security perspective, both changes in average values, changes in extreme value statistics and increased risk of 'tipping' of the climate system may be relevant: Slow changes in annual rainfall, in combination with higher temperatures, may have great impacts on rain-fed agriculture as well as on fresh water resources available for irrigated farming, which may have great implications for food security. Gradual sea level rise, as predicted in the IPCC 4AR, may pose threats to food production in coastal areas, deltas and estuaries, as well as threaten the habitability of atolls. Changes in statistics of extreme events will also be of security significance, since they will increase risks of natural disasters, especially in countries exposed to the effects of tropical cyclones. However, we will argue that in the longer term abrupt climate change, associated with so-called 'tipping elements' of the climate system, may well constitute the greatest threat to security: Once a tipping element of the climate system has been triggered, climate change is likely to accelerate and

continue to do so for a prolonged period, in some cases bringing the climate system into unknown territory. This may cause failure of available adaptation measures, which function appropriately as responses to slow and gradual climate change. Once started, such self-reinforcing processes are likely to be irreversible, and reactive strategies may therefore be unsuccessful. The prediction of the behavior of the tipping elements of the climate systems is difficult. It may be feared that prediction cannot be made with the certainty required to warrant preventive action, if such preventive action is associated with great costs.

This paper will examine the ‘security’ implications of the assumed existence of tipping elements of the climate system. The discussion will consider the problem from two sides: After a brief review of the concept of ‘tipping elements’ and some selected proposed tipping elements, we will discuss in what sense tipping elements constitute a potential threat to security, building on the discussion of the broadening of the concept of security from dealing only with military aspects to including also broader issues, e.g. related to ‘human security’. Subsequently we will look at the process of ‘securitizing’ climate change [1, 3, 5] posing the question of whether it makes sense – and is appropriate and wise – to move the climate change issue from the domain of environmental politics to the security domain.

## 4.2 Tipping Elements of the Earth System

### 4.2.1 *The Definition of a ‘Tipping Element’*

While the use of the related concept of a ‘tipping point’ may be traced back more than 10 years, precise definitions of the concept of ‘tipping elements’ are relatively recent. Lenton et al. [11] suggest a formal definition of a ‘tipping element’ which, briefly summarized, includes the following:

1. A ‘tipping element’ is a component of the Earth System characterized by a rapid increase in the rate of change of the state of the system per unit of change in a ‘control variable’, e.g. global average temperature, once a certain threshold (the ‘tipping point’) in the value of the control variable is surpassed, eventually leading to a qualitative change. While the cause of reaching a tipping point may be ‘natural’ or related to human action (or a combination of both), Lenton et al. [11] consider only tipping elements affected by human actions.
2. Human activities should interfere with the component of the Earth System in question in such a way that a political decision taken within a ‘political time horizon’ (proposed to be 100 years) could determine whether the tipping point is reached (yet not necessarily within the same time horizon).
3. The maximum time to observe a qualitative change (plus the time to trigger it) should be less than an ‘ethical time horizon’, suggested to be 1,000 years.
4. A significant number of people should care about the fate of the component in question, which implies that qualitative change should be measured in terms of impact on people.

It is noteworthy that the definition proposed by Lenton et al. [11] not only includes purely bio-geophysical criteria, but explicitly states that mechanisms must be relevant to society in order to qualify. Lenton et al. [11] translates this into requirements on the time perspective within which the mechanism may cause qualitative change in the state of the Earth System.

Several points in this definition may be discussed, and we will return to this in the following brief review of the suggested candidates for tipping elements. Here we will restrict ourselves to tipping elements with significant impacts at time scales less than 100 years, much less than the 'ethical time horizon' of 1,000 years suggested to Lenton et al. [11]. This choice is made because the focus here is on the political and security aspects of climate change, and these aspects, associated with short-term urgency, become extremely speculative beyond a time horizon of 100 years. Political decisions on security issues seldom take time perspectives of more than 100 years into consideration. This implies that certain tipping elements, listed by Lenton et al. [11], become less relevant, e.g. the melting of the Greenland Ice Cap. Restricting ourselves to a 100 year time horizon does not imply that we consider tipping elements with longer time perspectives less important, yet we suggest that these may be better discussed in an ethical, rather than a political, perspective.

#### ***4.2.2 Examples of Tipping Elements***

Rather than going through Lenton's list of candidates for tipping elements, we will choose a few which illustrate the security implications of tipping elements. These are (1) the destabilization of the West-Antarctic Ice Cap, (2) the acidification of the ocean (and the associated die-back of coral reefs) and (3) the die-back of the Amazon rain forest. Two of these, (1) and (3), are on Lenton's list, while ocean acidification is not. In spite of that it is included here, because we believe it may qualify, and because it has a special political significance, as we shall return to below.

The possibility that a rapid disintegration of the ice cap and ice shelves of West-Antarctica may be triggered by a temperature increase has been discussed for decades [14, 15], but it is still not well understood what is required to trigger such a destabilization. Should it happen it may result in a rapid sea-level rise of 1–5 m (depending on whether the entire or only parts of the ice cap disintegrates) over a relatively short period (possibly in the order of decades or few centuries). Lenton et al. [11] suggest that a collapse within a 300 year time perspective is a 'worst case scenario'. The probability of it happening within 100 years must be considered small, but different from zero, as also indicated by Oppenheimer and Alley [15].

Increased CO<sub>2</sub> concentration in the atmosphere will inevitably lead to a drop in pH of the upper layers of the ocean. A reduction of 0.1 has already been observed, and a further reduction of 0.2 is likely given the expected emissions [6, 7, 9]. This reduction will have a strong negative effect on marine calcifying organisms, including corals. This will have two main consequences: Firstly, it may imply decay of coral reefs at a global scale, especially in combination with the effects of increasing sea temperature

and other stressors. The impacts are likely to be large, both in terms of the loss of biodiversity and amenity values, reduction in fisheries, and in terms of reduced coastal protection, all contributing to making low-lying islands less habitable. Secondly, it will reduce the flux of carbon from the atmosphere into the sea water, and further into marine sediments, which is an important CO<sub>2</sub>-sink of the Earth System. As mentioned, the process in question is well-underway, and large-scale die-back of calcifying organisms may happen within 50–100 years, yet the probability is difficult to assess, since it involves estimating the capacity of marine organisms and ecosystems to adapt sufficiently quickly. However, the probability may be assumed to be considerably higher than that of disintegration of the West-Antarctic ice cap.

A combination of climate change, and in particular changes in rainfall associated with increased frequency and strength of El Niño – Southern Oscillation – events [10, 12], and human-induced deforestation may cause large parts of the Amazon rainforest to disappear irreversibly, resulting in large emissions of CO<sub>2</sub> to the atmosphere. These emissions will further amplify climate change significantly. The impacts on biodiversity would obviously be great, and other ‘ecological services’ provided by the rainforest would be lost as well. The probability of irreversible die-back of large parts of the Amazon rainforest is disputed, but it appears likely that a rise in average global temperature of somewhere between 2°C and 4°C (relative to the pre-industrial level), accompanied by continued deforestation, may trigger this change. Temperature increases of this order of magnitude are very likely within the next 100 years, according to the IPCC 4AR, and even greater increases are possible.

It should be noted that while Lenton et al. [11] discuss tipping elements individually, they do interact strongly. Any tipping element, involving a positive feed-back by which higher temperatures will cause increased GHG emissions, will contribute to triggering other tipping elements. One example may be the increased CH<sub>4</sub>-emissions from tundra areas, which Lenton et al. [11] do not consider to qualify as a tipping element because it is relatively slow: This process may not lead to great problems in itself at the time scale considered here, but it may certainly have the effect of contributing to triggering other – and faster – tipping elements. In a security perspective such ‘chain reactions’ must be taken into account.

In the IPCC 4AR the ‘tipping element’ terminology is not used, yet terms such as ‘dangerous’ and ‘abrupt climate change’ and ‘large-scale discontinuities’, which may be interpreted as corollaries of the ‘tipping element’ jargon, appear. In the central diagram of the ‘Summary for Policymakers’ of the IPCC 4AR an indication is given of the intervals of temperature increases that may have detrimental effects. Generally speaking, increased in temperatures greater than 2–4°C above pre-industrial levels (corresponding to approximately 1.3–3.3°C above the present level) are claimed to have strong negative effects on both crop production, water resources, ecosystems, coastal areas and health. This is the background for the present policy goal of limiting the temperature increase to 2°C above the pre-industrial level. The interpretation of the term ‘dangerous climate change’, which stems from the text of the UNFCCC, is ambiguous, yet points in the direction of the ‘securitization’ of climate change which we will discuss below.

### 4.3 Security Aspects of Tipping Elements

The three suggested tipping elements, introduced briefly above, may have quite different ‘security implications’ in a broad sense of the term:

- The destabilization of the West-Antarctic ice cap is characterized by having a low estimated probability (within the time horizon considered), yet extremely large ‘worst case’ effects, including flooding of low-lying areas globally. These areas include some of the most fertile and densely populated agricultural lands, e.g. river deltas in Bangla Desh, Burma, Vietnam and China and Egypt. The resulting food shortages and displacements of people can be considered both a direct threat to ‘human security’ in a broad sense and an indirect threat, through the destabilizing effects of massive food shortages and the associated ‘climate refugee’ problems, to ‘national security’ in a narrow sense. While this might be said just to add to the impacts of the general sea level rise, expected without any contribution from West-Antarctica [8, 16], it does involve a significant increase in the speed of the sea level rise, causing problems of adapting fast enough. In addition, it will certainly cause accelerated flooding of most atolls, which include entire nations.
- The acidification (and warming) of the ocean and the reduced function and subsequent death of calcifying organisms have a higher probability, yet in the first place less disastrous impacts in terms of human suffering. Economic losses may be high since incomes generated from coral reefs are considerable, yet the impact on biological diversity may be claimed to be of much greater significance, but very difficult to quantify in economic terms. From a security perspective it should be noted that only a minor fraction of the World’s population will be directly affected, at least within the time horizon considered here. On the other hand, it should be noted that whole nations, some of the ‘small island states’ such as Kiribati and Tuvalu, will be threatened on their existence, which implies that issues of international law and politics become relevant.
- The probability of the Amazon rainforest die-back is debated, both due to lack of precise modeling of the purely bio-physical aspects and due to the importance of local and global human decisions and actions, yet it appears to be the most probable of the three mentioned. With respect to the importance of human decisions and actions, the ‘Reduced Emissions from Deforestation and forest Degradation’ (REDD) mechanism of the UNFCCC appears to have a considerable potential for influencing whether a tipping point is reached. The potential economic losses from a die-back are likely to be considerable, yet – like in the case of ocean acidification – the losses of biodiversity and ecological services, which are extremely difficult to predict and quantify, may be claimed to be far more significant. In addition, such a die-back would undermine the livelihoods of indigenous people. Seen from a security perspective the Amazon rainforest die-back may serve as a test-case: Will the international political system be able to act with sufficient effectiveness to reduce the human contribution to the threat of irreversible change in the Earth System? The costs of (possibly) avoiding the die-back through the

REDD mechanism or other means of stopping deforestation are likely to be less than it would be for most other tipping elements, since it involves mostly local action, rather than a transformation of the energy system at global scale. If this cannot be achieved it would demonstrate the inability of the international political and regulatory system to deal with the greater challenges presented by other tipping elements.

#### 4.4 Communicating Risk and Uncertainty Concerning CC

The communication of uncertainty and risk in relation to climate change is controversial. While it is generally acknowledged that we do not and cannot predict future climate change with high precision, among other things because of the ‘chaotic’ character of the climate system, the ways in which uncertainty is expressed vary widely, as noted above. The study of ‘climate change discourses’ is presently a field attracting considerable attention [17], and it can only be touched upon briefly here. We will focus on the scientific concept – or metaphor – of ‘tipping points/elements’ (TP/E) [11], as opposed to more conventional representations of uncertainty and risk (using the terms ‘probability’, ‘risk’, ‘uncertainty’) in the IPCC reports.

What does use of the TP/E terminology entail, above and beyond the IPCC formulations? In the IPCC 4AR WG1 report, dealing with the physical basis of climate change, the uncertainties are represented graphically as intervals of possible outcomes (IPCC 4AR, Summary for Policymakers) and described in terms such as ‘likely’/‘very likely’ which may be translated into quantitative probabilities. As mentioned above, the term ‘dangerous climate change’ is used along with references to ‘abrupt CC’ and ‘large-scale discontinuities’. This is the closest IPCC comes to the ‘tipping element discourse’. It may be argued that the difference between the TP/E-formulation and the various IPCC formulations, and in particular the term ‘large-scale discontinuities’, is not great, since both imply the existence of non-linearities and positive feed-backs which may cause state-shifts of the climate system. What might make a difference is that the TP/E definition, presented above, implies human interference as well as relatively short time scales.

Three very different questions may be raised in this context:

1. Does our knowledge of the climate system and its possible positive feed-back mechanisms warrant the use of the TP/E terminology /metaphor and is use of this terminology an ‘appropriate’ way of communicating climate change, since it acknowledges the possible non-linearity of the climate system, as well as the human impact and the short time perspective ?
2. Since the use of the TP/E terminology constitutes a ‘speech act’, what are the objectives and consequences of this act ?
3. Does the use of the TP/E terminology imply ‘securitization’ of CC, beyond what the IPCC discourse entails, and if so is this securitization desirable ?

In the following we will focus on the latter question.

## 4.5 Securitization of CC

As noted above, there has been an increasing tendency in the debate to consider climate change as a 'security issue'. Use of the TP/E metaphor plays a significant role in this context, since it may be interpreted as a deliberate 'act of securitization' [3] aiming at moving the climate change issue from the domain of ordinary politics to the domain of 'security politics', implying that much stronger interventions may be justified. It is obviously difficult to isolate the exact 'securitization effect' of the TP/E terminology in the political discussion of climate change and security, but it is clearly suited as a means of making the point that extraordinary measures are required, outside the traditional realm of international environmental politics.

Securitization of climate change has been ongoing over the last decade as documented by Barnett [1]. It might be useful, however, to distinguish between securitization in the traditional sense, involving the necessity of the use of force ('hard securitization'), and in an extended meaning, not necessarily involving such use ('soft securitization'). In the writings on climate change as a security issue, a number of arguments are given for securitization, the most prominent being the following:

- Climate change will inevitably lead to conflicts over increasingly scarce resources, e.g. of water, food and energy. 'Water-wars' are sometimes mentioned as virtually unavoidable (a case of 'hard securitization'), and large geographical shifts in agricultural potential are by some expected to create international tensions associated with 'food security' (presumably involving 'hard' or 'soft securitization').
- Political tensions will rise between countries particularly seriously affected by climate change, yet not contributing much to it (mostly developing countries), and countries that are not negatively affected to any great extent, but contributing through high GHG emissions or extensive deforestation.

The three examples of candidates for tipping elements of the Earth System have widely different properties as concerns their probabilities, the economic, environmental and political effects and the costs of mitigation. These differences will influence the extent to which they will trigger 'securitization' of climate change, and what sort of securitization might be in question. While the die-back of parts of the Amazon may be a relatively likely event with a great potential to trigger other tipping elements (due to the large CO<sub>2</sub>-emissions caused by it), it seems possible that it can be dealt with in the realm of 'normal politics', such as the negotiations within the framework of the UNFCCC. In contrast to this, the much less likely worst-case-scenario of accelerated sea-level rise due to disintegration of the West-Antarctic ice cap, and the consequences this could have in terms flows of 'climate refugees', may be much more difficult to deal with and could cause attempts to securitize climate change. The medium probability event of die-back of coral reefs at global scale has already been labeled a security issue (e.g. by [1]), yet the fact that the immediate threat to human life may be claimed to be limited implies that it may not be able to justify the mobilization of extra-ordinary use of force associated with 'hard securitization'.

## 4.6 Is Securitization of CC Desirable ?

This question was discussed by Deudney [5], arguing that securitization of climate change and other environmental problems is unlikely to contribute to solving such problems. The only institution presently in a position to react to global 'environmental' threats to security, such as climate change, appears to be the UN Security Council. The types of action taken by the UN Security Council, e.g. international embargos and military intervention, do not immediately lend themselves to the mitigation of climate change, while it may be realistic that the UN could intervene in regional conflicts caused or intensified by climate change. However, the basic causes of climate change are believed to be emissions of GHGs, and these may only be reduced by technological transformation and changes in behavioral and consumption patterns, which the Security Council has little possibility to influence efficiently. This lack of capacity to solve the problem is further emphasized by the fact that the largest GHG-emitters are permanent members of the Security Council with a veto-right. In this situation, 'hard securitization' of climate change may be claimed to be of little consequence – or even counter-productive. On the other hand, the apparent inability of current international political institutions, and more specifically the UNFCCC, to deal with the challenges of climate change points to the necessity to strengthen and reform these institutions, and 'soft securitization' of climate change may (and is probably often intended to) be a means of achieving this.

## 4.7 Conclusion

Briefly summarized, we conclude that:

- Tipping elements of the climate system are likely to be real and to constitute the greatest 'threats to security', in a broad understanding of the term, in a 100 year perspective – and even more so in a longer perspective.
- The three tipping elements discussed are very different in terms of (1) their probabilities of being triggered within a 'political' time perspective, (2) the types of impacts on society and ecosystems that they are likely to have, (3) who will be the most affected and (4) the implications for security and securitization.
- Both 'hard' and 'soft' securitization of climate change are likely to result from the fear for tipping of the climate system, as already evident from the scientific and public debate, yet its precise character will depend on the expected consequences of the tipping element in question, and not the least on who will be most affected.
- It is unlikely that 'hard securitization' of climate change, involving mobilization of extraordinary (military) means, can further an appropriate global response, yet 'soft securitization' may be required to mobilize the necessary reform and strengthening of international political institutions required to address climate change.

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