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ENVIRONMENTAL DEGRADATION AS A CAUSE OF CONFLICT?
Theoretical Conceptualization and Empirical Analysis of the Relationship
between "Environment" and "Security"

by

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Is there a relationship between environmental degradation and war? Do the destruction of the natural bases of existence or disputes over jointly used natural resources cause violent international or domestic conflicts? We shall take up these questions empirically, both quantitatively as well as qualitatively, and in doing so bring together two research approaches from different fields. On the one hand, with the help of the syndrome-analytical research approach which has been developed by the German Advisory Council on Global Change (WBGU) and cooperating research groups, we shall identify critical vested interests for which the origin of a (violent) conflict can serve as a plausible hypothesis. In a second step, on the basis of the research work of the Heidelberg Institute for International Conflict Research and the conflict simulation model (KOSIMO) elaborated there, we shall test the hypotheses developed in this manner. Our empirical analysis firstly shows a significant correlation of physical regional

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international interdependence in the case of surface water where there is a relatively low per capita water supply with international conflicts over water, although this finding should be interpreted cautiously. Secondly, our analysis shows that countries in which the dynamic "Sahel Syndrome" is a particularly strong factor are disproportionately often affected by violent conflicts.

Ecological Security: the Diffusion of the Discussion

Is there a connection between environmental degradation and "security"? If one goes through popular and academic journals, this question seems to be settled for many authors: in recent years only a few concepts have experienced such a career as "ecological security". Meanwhile, German environmental non-governmental organisations are demanding that "questions of ecological security be institutionally embodied in the UN system" (Forum Umwelt und Entwicklung 1997.27), although indeed not explaining this more precisely – the message is evidently that the state and the public should now accord the fight against "ecological security risks" with the status formerly applied to military security risks during the Cold War. Many experts on international law have also attempted to get a grasp of the global environmental crisis by developing a new legal concept of the "ecological security of humanity", and to derive from such a concept of security concrete standards for state action (in this connection, cf. Biermann 1997). According to Timoshenko (1992.418), for example, the theme is similar to that of the environmental non-governmental organizations:

"The notion of 'security' is universally understood and has served as a basic ingredient in all periods of human history. The conception of ecological security adds a security dimension to the ecological problem and vice versa, thereby putting global ecology into the range of security issues."

A sub-programme has also been set up within the framework of the international inter-disciplinary research network "Human Dimensions of Global Environmental Change", in which the ecological security of the (individual) person is to be investigated (Lonergan 1997). Here ecological security is broadly conceptualized and de facto becomes a synonym for the concept of sustainable development, which since the Brundtland Report (Hauff 1987) has likewise experienced a notable career.

On the other hand, a large part of the narrower debate on security policy is confined to exploring the relationship between war and environmental destruction. The great interest in military planning cells and the ranks of professional "security politicians" is apparent, for example, in the US Department of Defense, where the post of a Deputy Under Secretary of Defense

for Environmental Security was recently set up (Griffiths 1997; Wöhlcke 1996.13–16). NATO has also taken up the theme: since 1995 a pilot study on "Environment and Security in an International Context" has been conducted under its civil arm, the Committee on the Challenges of Modern Society, under the joint central coordination of the German Federal Ministry for Environment and the US Department of Defense, the project being conceptualized and coordinated on the German side by the Berlin institute Ecologic (Carius et al. 1996).

Even before war as a consequence of environmental destruction became a central theme, environmental destruction as a consequence of war became the subject of research and negotiation (Albrecht 1986). At a very early stage treaties aiming to limit environmental damage through armed conflicts were concluded, for example in the Protocol I to the Geneva Red Cross Convention in which all forms of war causing "widespread, long-term and severe damage to the natural environment" were prohibited (Geneva Protocol 1977: Arts. 35, 55; cf. Biermann 1995.77–81). An additional convention in 1977 includes a prohibition on using the environment itself as a weapon, for example by deliberately influencing the weather and regional climate or through defoliation campaigns such as those in the Vietnam War (Convention on the Prohibition of Military or Any Other Use of Environmental Modification Techniques 1977; cf. also Westing 1997).

However, our study deals with the currently more topical linkage of environmental destruction and war – conflicts within and between states as a dependent variable of the destruction, degradation and alteration of the ecosystems by people. (For their valuable critiques and suggestions we owe our thanks to Günther Bächler, Alexander Carius, Carsten Helm, Kurt M. Lietzmann, Steve Lonergan, Carsten Loose, Matthias Lüdeke, Sebastian Oberthür, Benno Pilardeaux, Bert Spector, Udo E. Simonis, the anonymous reviewer at the ZIB, as well as Christoph Weller. Parts of this study were supported with funds from the German Federal Ministry for Environment, Nature Preservation and Reactor Safety and the Berlin institute Ecologic within the framework of the NATO/CCMS pilot study on "Environment and Security").

With the objective of bringing conceptional and methodical clarity into an overflowing debate, we shall discuss a question of equal significance for both environmental policy and research on peace and conflict: whether, when and how the degradation of the natural bases of existence or the reduced availability of jointly used natural resources can cause violent or peaceful international or domestic conflicts. In this connection we shall apply two different research approaches and bring them together for these purposes. An additional contribution to the debate based on the same theme is to be found in the special

edition on environmental conflicts of the *Journal of Peace Research* of May 1998 (35.3), in which amongst other things there is a quantitative investigation of the relationships between environmental degradation and population growth (Tir/Diehl 1998) as well as democracy (Midlarsky 1998).

On the one hand, with the help of the syndrome-analytical research approach which has been developed since 1992 by the German Advisory Council on Global Change (WBGU) and cooperating research groups, we shall identify critical vested interests for which the origin of a conflict, possibly even a war, can serve as a plausible hypothesis. These research groups include the staff of the core project Questions of the Potsdam Institute for Research on Climatic Effects (Qualitative Dynamics of Syndromes and Transition to Sustainability), the staff of the "Syndrome Dynamics" projects sponsored by the Federal Ministry for Research, the members of the WBGU as well as the staff of the Bremerhaven branch of the WBGU. In the 1996 Annual Report, "Welt im Wandel. Herausforderung für die deutsche Wissenschaft", the WBGU argued that the syndrome-analytical approach could and should be accorded an important role in social scientific and natural scientific research into global environmental changes (WBGU 1996.171 f.). We take up this postulate in the present article and attempt to show that the syndrome-analytical approach can also be used to investigate the relationship between environmental degradation and domestic and international conflicts. In this connection, the syndrome concept provides us with a typology of relationships between humanity and the environment, which has been obtained independently of conflicts. Therefore it is possible to examine in methodical terms to what extent domestic or international conflicts are more probable than others in the case of individual types of these relationships between humanity and the environment. At the same time, in its practical application the syndrome concept provides us with a concrete list of states or international constellations in which we should most probably anticipate a conflict or even a violent dispute.

In a second step, we will test these hypotheses developed from the syndrome concept on the basis of the research work of the Heidelberg Institute for International Conflict Research (HIK). We shall investigate to what extent conflicts have in fact been observable, and which of these have been peacefully or violently conducted or how they have been settled. In this connection we use the KOSIMO "conflict simulation model" developed in Heidelberg. For us, this has as it were the function of a test case, for which KOSIMO is suitable due to its worldwide scope, its fifty-year observation period (1945–1995) and because it covers not only the violently conducted conflicts but also those which have run peacefully.

Firstly, in the next section we shall discuss developments in research, in order to then explain our syndrome-analytical/conflict theory approach in the

following section. In the next two sections we will then apply the approach empirically, in an investigation of the relationship between water scarcity and international conflicts, and the relationship between progressive soil degradation and rural poverty on the one hand and violent (usually domestic) conflicts on the other hand. Against the background of the existing research and the findings of our investigation, we finally call for an intensified interdisciplinary research programme on the relationship between "environment" and "security".

"Environment and Security" in the Literature

In addition to the strategic papers by environmental associations and NATO planning cells, there is now a large number of social scientific contributions to the discussion on "environment and security", whereby there are often differing research objectives and research methods. We refer in particular to Westing (1989), Falkenmark (1990), Homer-Dixon (1991, 1994), Lodgaard/Ornäs (1992), Brock (1991), Käkönen (1994), Dokken/Grøeger (1995), Grøeger (1996), Swain (1996), Carius/Lietzmann (1998), Eberwein (1997, 1998) as well as the extensive bibliography in the Environmental Change and Security Project Report published by the Woodrow Wilson Center (1997). It is evident that up to now there have only been a few violent conflicts which have been exclusively or predominantly caused by environmental degradation. With such a lack of empirical material it is of course difficult to build theories.

Therefore, in this respect many people make use of a "reverse prognosis" and draw their empiricism from the future. If the population increases further and if no new sources of energy or food can be found, then the future would be a future of war over the last resources. For example, Christopher Stone (1992:456) graphically portrays the possible consequences of an unsuccessful climate protection policy:

"One can only conjecture the tensions on boundaries and civil order, if environmental degradation imposed unprecedented stress on food and water supplies, arable zones shifted and traditional population centers were threatened by rising tides. In the ancient world, prolonged and severe climate change led to mass migrations. But today, populations are denser and migrating peoples would transgress political boundaries and exacerbate cultural tensions – with all the ominous frictions such conflicts portend."

The International Organization for Migration estimates that by the year 2000 up to a thousand million people worldwide could be forced to leave their homes because of environmental destruction and become "environmental refugees" (Klingebl 1994:19). In such circumstances violent conflicts could not be ruled

out. Even gloomier scenarios are presented by Robert D. Kaplan (1994) in his much cited apocalyptic study *The Coming Anarchy*, or by Manfred Wöhlcke (1996), who already takes the future failure of world environmental policy as a certainty and now wants to see preparations for military prevention within NATO. Wöhlcke (1996) repeatedly states that there will be environmental wars in the future. Typical of his proposition, for example, is the prophecy of doom which is even italicised in the original: "The fact that environmental problems have so far only relatively seldom led to scenarios relevant to security policy in no way means that this will also remain the case in the future. On the contrary, it is to be anticipated that such scenarios will mount up. Although it is correct that the deployment of military resources cannot eliminate the ecological causes of such conflicts, it can nevertheless be an answer to their political and military dimension" (Wöhlcke 1996.18). Many authors paint a pessimistic picture from another point of departure. Elmar Altvater and Birgit Mahnkopf (1997.532) prophecy, for example, that if the industrialized countries were eventually no longer able to defend their supremacy effectively enough through practical economic constraints, they would endeavour to protect their "plutocratic lifestyle" by another means, not least militarily through a "world police". Similarly, the conflict researcher Ulrich Albrecht (1996b.116) also anticipates "rather militant, dissociative patterns of conflict behaviour" in international environmental policy (cf. also Biermann 1998).

Further criticism of the prevailing form of economic activity and the political institutions is expressed by Michael Zürn (1995), whose access to the ecological security debate is determined by the identification of increasing global dangers which he claims have created a "world risk society" going beyond national borders. In this connection Zürn does not confine himself to poverty-induced environmental destruction, but in a global "threat rectangle" develops a relationship network of synergetic effects between poverty-induced and wealth-induced environmental destruction as well as the dangers emanating from the proliferation of weapons of mass destruction and from the failure of recuperative development. He sees the causes, on the one hand, in "the prevailing form of economic activity". On the other hand, according to Zürn "existing political institutions [seem] unsuitable to confront the dangers resolutely enough" (Zürn 1995.249). For as long as this lack of regulation prevails, conflict lines will continue to form with "explosive" (Zürn 1995.260). A solution is offered by the voluntary regulation and institutionalization by international regimes.

Despite all these scenarios, we admittedly still do not know how many people will, for example in forty years' time, in fact be sharing how much food or water. And furthermore, we do not even know – and this is the interesting question for us here – whether increasing water scarcity or soil degradation will lead to conflict and war at all, or rather to increased cooperation. For example, the

Dutch conflict research Institute PIOOM (1996) points to the conspicuous relationship between a low Human Development Index – a complex indicator of the United Nations, primarily based on a long and healthy life, education and reasonable living conditions as measurable variables (UNDP 1997, 1998) – and a high violent conflict quota for states, but in the same sentence suggests that a causal linkage cannot necessarily be assumed. And if in many cases violent conflicts actually follow environmental degradation, but in others do not, what then distinguishes these cases? What conditions form the basis for a peaceful solution to bilateral or domestic environmental problems? As yet this question has only been partially answered by the empirically oriented research on the subject of “environment and security”, i.e. by those studies in which current conflicts, induced by environmental degradation, have been empirically analyzed.

The best-known here are the studies by the research group centred around the Canadian Thomas Homer-Dixon, who counts amongst the pioneers in environmental conflict research (Homer-Dixon 1991, 1994). He proceeds from the proposition that environmental degradation and scarcity of resources can definitely lead to armed conflicts. Building onto this, he has attempted in case studies on the empirically observable violent environmental conflicts to identify the conditions, causal chains and socio-structural relationships through which such violent conflicts actually arise (Homer-Dixon 1994). To overstate this, here the very selection of cases studies determines the result, since by only including “prima facie” violent conflicts in his sample (cf. Homer-Dixon 1994.7), Homer-Dixon already refutes the null hypothesis that environmentally induced conflicts – under certain circumstances in most cases – do not lead to violence. However, the relative significance of environmental degradation as a cause of escalations of violence compared to other causes of violence from case to case, and differently evaluated by various authors, can remain unaffected thereby. This approach seems to us problematic, particularly with regard to the necessary and sufficient conditions for the escalation of conflicts in violence and war. For without a comparative investigation of environmentally induced conflicts which are not conducted violently, but peacefully and cooperatively, the question of how many and which critical environmental situations escalate into violence at all can virtually not be answered.

Nevertheless, with Homer Dixon's (1991, 1994) approach it is possible to empirically chart the course of those conflicts which at a certain stage have been conducted with violence. Through the case studies, the violence-promoting effect of environmental degradation has been elaborated for those cases in which a reduction in renewable sources of energy and unequal access to resources coincided with strongly increased population growth. In conclusion, Homer-Dixon (1994.35) forecasts that violent conflicts, irrespective of the degree of their internationalization, will certainly remain the exception (apart from

international conflicts over river water, which we therefore discuss in greater detail in our empirical analysis). Nevertheless, according to Homer-Dixon (1994.20), the escalation potential of domestic conflicts over water relating to distribution and access and their social consequences, such as resettlement, is to be estimated as much higher than the possibility of international wars over water. There would be a high escalation potential for conflicts relating to distribution and access in the case of water if this is intensified through population growth or migration. The group identity conflicts resulting therefrom can in addition be instrumentalized ethno-politically.

Finally, Homer-Dixon (1994.24) establishes a direct causal connection between environmental destruction, impoverishment and war: "Environmental scarcity does produce economic deprivation, and this deprivation does cause civil strife". His forecasts for the future are correspondingly pessimistic: either the increasing exploitation of the environment strengthens "hard" authoritarian regimes, as in Nigeria for example, or it weakens them if there is a lack of corresponding control capacities, as in India or China (Homer-Dixon 1994.36). However, in our opinion these gloomy prospects result from the very choice of the cases investigated, which all have a violent course: because to test the proposition that the world is primarily threatened by violent environmental conflicts, there is in Homer-Dixon an absence of a counter-proposition that they are not threatened thereby.

This critical question can also be similarly formulated according to the second large empirical research project in this subject area, the Environment and Conflicts Project (ENCOP). In a likewise inductive approach, Bächler et al. (1996.295) identify seven types of conflict in a large number of investigated environmental conflicts and conflicts over the use of resources. Such an approach helps to concentrate the research onto these phenotypes but again, as in the case of Homer-Dixon (1991, 1994), suffers from the deficiency that the selection of case examples has been based on the dependent variable. We learn, for example, that "centre-periphery conflicts" – one of the seven types of conflict according to ENCOP – lead to violent conflicts. However, we do not discover whether this applies to all such "centre-periphery conflicts", to most of them or only to an insignificant minority (Bächler et al. 1996.296).

At least in ENCOP there is also an analysis of environmentally induced domestic conflicts which have not been conducted with violence. But again, the selection of the overall number is not made independently of the critical ecological situation, but on the basis of empirically observable occurrences of conflict, whether with or without violence. The possibility that comparably critical environmental situations will not become a subject of conflict at all is not taken into consideration in the inductive, conflict-oriented ENCOP approach. However, the merit of the empirical ENCOP project is its ability to show when, in the existing empirically observable conflicts, the threshold to

violence is ultimately crossed. In this connection five conditions have been identified, which are only partially related to the criticality of environmental damage. In the meantime, there has also been an attempt within the framework of the ENCOP project to apply the syndrome approach of the WBGU to the ENCOP collection of empirical case studies (Bächler 1998.31). However, this involved using a rather intuitive understanding of syndromes, which does not determine the criticality of the syndromes on the basis of transparent criteria and measurable indices, but rather attributes individual syndromes to individual regions arbitrarily and not always comprehensibly.

There are also a number of studies in which environmental problems are selected as an independent variable, i.e. studies which – unlike the ENCOP project – methodically can definitely admit the finding that even very critical environmental situations are nevertheless overcome cooperatively in many cases. For example, Detlef Sprinz (1997) has presented a research design according to which a (single) overall class of environmental problems is to be used as an independent variable to explain “environmental conflicts”. His hypothesis is that if such a (not further differentiated) environmental problem exceeds a certain “threshold value”, this must necessarily lead to a conflict. This hypothesis makes sense in formal methodical terms, but it is condensed into a form which makes it almost impossible to test empirically. For meaningful empirical investigations and theoretical conclusions it therefore seems to us more appropriate not to proceed on the basis of a single threshold value for environmental problems, but to distinguish between different types of environmental problems and conflicts over the use of resources, as we shall undertake below with the help of the syndrome-analytical approach.

To clarify the relationships between environment, conflict and security, Lothar Brock (1991) has developed a comprehensive categorization in an eight-plane matrix. In principle, for him there are four possible linkages between environmental concerns and peaceful or military conflicts, which in each case can have negative and positive characteristics. The fact that cooperative solutions to environmental conflicts are also included in Brock's design is in itself already a step in the right direction. To this extent Brock's matrix serves to reinforce our investigation, in that we also conceptionally leave open the possibility of critical environmental situations being solved peacefully. The research into the relevant conditions for a peaceful course of a conflict, for example in the research on the causes of peace or on the prevention of violence, is also based on such a dually pronged concept (Matthies 1996.9; Rohloff 1996.18). Not least, the incorporation of cooperatively solved environmental conflicts into the investigation sample as well provides practical protection against narrow and rash conclusions which continue to restrict environmental conflicts to military scenarios alone.

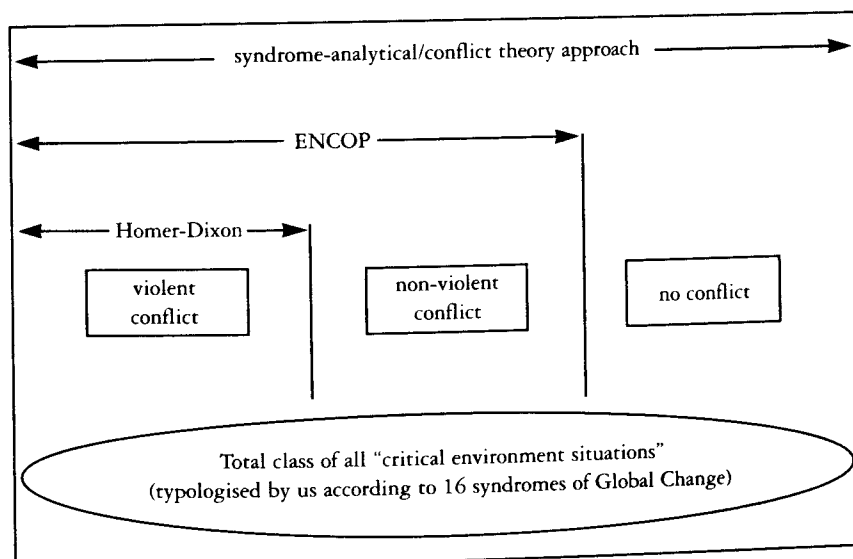


Fig. 1 – Analytical scope of different approaches: Homer-Dixon, ENCOP and the syndrome-based conflict research approach

Wolf-Dieter Eberwein's (1997, 1998) approach to the relationship between environment, conflict and security is primarily determined by methodical considerations. According to him, the meagre empirical findings on environmental conflicts are not caused by a lack of data on environmental conditions or conflicts; the direct conceptual equal treatment of environment and conflict in one causal model seems dubious to him. If environment is now understood as a class of naturally occurring structural conditions – also caused by the hand of man ("human system") – which have an effect on the action of the actors responsible for the security of a state or a region, the resulting conflicts take place in an area of tension between the political system, which regulates the access to and the distribution of resources, and the human system. Eberwein (1998.183) shifts the environmental conflict away from environmental conditions in the political sphere. Despite the plausibly shown relationships, Eberwein (1997.20) only vaguely indicates the path towards a conflict model:

"In order to be able to carry out such analyses systematically, there must be available the appropriate database which, beyond the occurrences of conflict, would have to include indicators of equal relevance to the environment, such as those relating to distribution and redistribution mechanisms".

As an initial attempt to fulfil this desideratum, we should now like to explain our syndrome-analytical/conflict theory approach in greater detail.

The Syndrome-Analytical Conflict Theory Approach

How can the debate on "environment and security" be dealt with in social scientific terms without confusing independent with dependent variables, without arguing from the future or overtaxing empirical research with excessively or inadequately complex models? In the following we present a research approach which integrates two existing approaches and, in our opinion, offers a serviceable basis for an examination of the "environmental wars" proposition. With regard to a typology of environmental problems, we take the syndrome-analytical research approach as a basis. In respect of the conflict research, we build upon preliminary studies and above all upon the database developed by Frank R. Pfetsch (1990) at the Heidelberg Institute for Political Science and currently being continued by the Heidelberg Institute for International Conflict Research in cooperation with the University of Heidelberg (cf. Diagram 2).

The Syndrome Approach as a Typology of Environmental Problems

If one wants to empirically investigate the respective escalation potential of various environmental problems or conflicts over the use of resources, for practical purposes one needs a typology of environmental problems or of

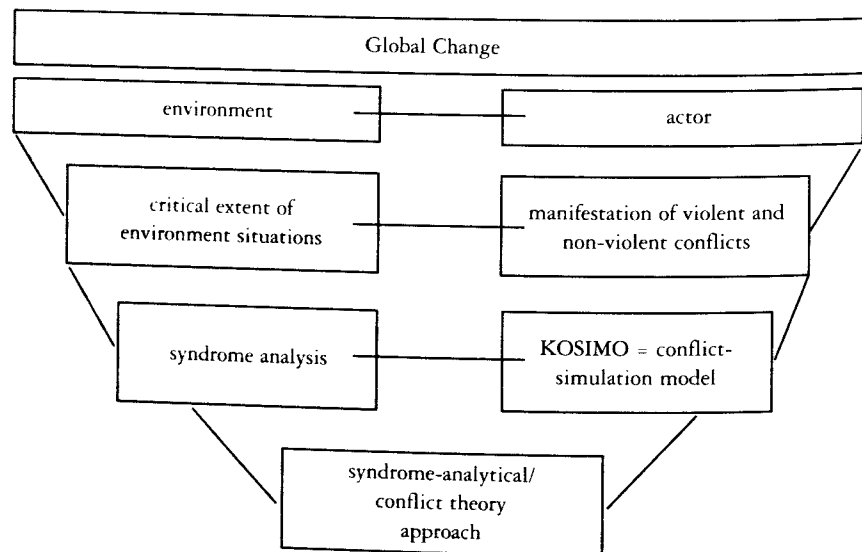


Fig. 2 – Schematic explanation of the syndrome-analytical/conflict theory approach

problems arising from a lack of certain natural resources. Such a typology is offered, for example, by the ENCOP project (Bächler et al. 1996:324), although as mentioned above this has not been derived independently, but simply inductively "discovered" from observed – often even violent – conflicts. An alternative typology would be a classification based on individual environmental media, such as soil, air or water, further differentiation being possible (troposphere, stratosphere, etc.). However, this would implicitly involve separating environmental media from their social function: soil degradation through industrial land development in parts of the USA, for example, is distinct from soil degradation through poverty-induced overuse, as in certain regions of Africa for example. The syndrome concept avoids this trap. Since its first formulations (WBGU 1993), the concept has been methodically refined, and elaborated on the basis of empirical investigations, by interdisciplinary working parties; in addition to the members and staff of the WBGU, the scientists of the core project Questions of the Potsdam Institute for Climate Impact Research (Qualitative Dynamics of Syndromes and Transition to Sustainability) and the "Syndrome Dynamics" projects sponsored by the Federal German Research Ministry are also cooperating in the research teams.

The motive for the development of this interdisciplinary approach was the realization that global environmental changes can no longer be analytically considered in isolation. To achieve an overall assessment of the current processes and damage, experts in the various scientific fields must cooperate across the disciplines and in an integrated manner. In the 1980s this led to the formation of the International Geosphere-Biosphere Programme (IGBP), in which the natural scientific disciplines joined to form a common research strategy. Subsequently, with the International Human Dimensions Programme of Global Environmental Change (IHDP) a corresponding research network was also established for the social sciences. The IHDP was set up (as the Human Dimensions Programme) in 1990 by the International Social Science Council in order to supplement corresponding research initiatives in the natural sciences in the IGBP and World Climate Research Programme (WCRP); the international secretariat of the programme is located in Bonn (cf. Globe 1997). The emphasis on the social aspect in the man-made environmental crisis led in practice to the now usual widening of the terminology: the reference is no longer to global environmental changes, but usually in general to global change.

The scientific analysis of this global change requires its reduction to a limited number of variables, whose relationships can be theoretically documented and empirically investigated. In the syndrome approach used by us this occurs in the form of around eighty different variables which, according to the imagery of the syndrome approach borrowed from medicine, are described as "symptoms" of global change. These symptoms interact, with for example some symptoms

reinforcing others or perhaps, however, weakening them. Here the syndrome approach is based on the assumption that in the mixture of interactions of various symptoms from various spheres of global change, certain dynamic patterns are revealed: typical influential structures of individual developments, which are closely inter-related and can be identified as a dynamic mechanism by their interactions, and then analyzed in detail. If such – partly self-reinforcing – dynamics cause damage to humanity and nature, they are deemed to be “disease patterns” or “syndromes” of global change.

The assumption, initially based on experts’ assessments, is that there are sixteen such syndromes of global change, which have been systematized into three groups on the basis of their core causes. The “utilization” group includes the Sahel Syndrome (overcultivation of marginal land, combined with rural poverty), the Overexploitation Syndrome (overexploitation of natural ecosystems), the Rural Exodus Syndrome (environmental and developmental problems through the abandonment of traditional agricultural practices), the Dust Bowl Syndrome (environmental degradation through agro-industry), the Katanga Syndrome (environmental degradation through depletion of non-renewable resources), the Mass Tourism Syndrome (destruction of nature by tourism), as well as the Scorched Earth Syndrome (environmental destruction through military impacts). The “development” group includes the Aral Sea Syndrome (environmental and developmental caused by large-scale, centrally planned projects), the Green Revolution Syndrome (disruption caused to the environment and society as a consequence of inappropriate rural development policies), the Asian Tigers Syndrome (disregard for environmental standards in the course of rapid economic growth), the Favela Syndrome (environmental degradation and urban poverty through uncontrolled urbanization), the Urban Sprawl Syndrome (destruction of landscapes through the planned expansion of cities and infrastructures), as well as the Major Accident Syndrome (environmental disasters as a result of technical failures and industrial accidents). The “sink” group includes the Smokestack Syndrome (environmental degradation through large-scale diffusion of long-lived substances), the Waste Dumping Syndrome (threats to the environment through the disposal of waste), as well as the Contaminated Land Syndrome (long-term pollution at or near industrial locations). For more detailed accounts in this connection, cf. WBGU (1993, 1994, 1995, 1996, 1998).

All these syndromes are investigated in the interdisciplinary syndrome working parties: what course does a particular syndrome take, which symptoms are especially important for the mechanism? Which regions in the world are now already “suffering” from particular syndromes? Where, on the other hand, is there a threat of an “outbreak” of a syndrome? Where could and should practical policies begin in order to stop a specific syndrome mechanism?

The individual syndromes as well as their totality – the “global relationship network” – are not intended to outline any mechanistic world model, but only to identify and explain individual, typical dynamic mechanisms of non-sustainable development. In this connection the totality of syndromes can assist in serving as a structured, interdisciplinary research plan for global change. There is particularly interesting potential here in the intensive cooperation between the social and natural sciences, which within the framework of the syndrome concept (as also in our study) are working along the lines of common questions and initial hypotheses on global change.

The possible increase in international (or domestic) conflicts is understood in the syndrome concept as one of the eighty symptoms of global change. One example is the “Aral Sea Syndrome”, which we investigate in more detail below. It describes the typical dynamic interactions in the case of misguided or failed, centrally planned large-scale projects, for example the construction of a dam or irrigation plants, as in the Aral Sea project – from which the name of the syndrome is derived – in the former Soviet Union (WBGU 1998.183–204). In this connection it was initially assumed that the construction of large dams or other large-scale projects can, in addition to many instances of damage to the natural environment, also lead to international conflicts, as illustrated by the conflict between Turkey and Syria and Iraq over water from the Euphrates and the Tigris. This means that the increase of the “dam construction” symptom tends to cause the increase of the “conflicts” symptom, although this need not be empirically observable in every case. To what extent relationships are actually to be established here and what role (violent) conflicts play in the Aral Sea Syndrome, we shall investigate in the empirical application of our approach.

Linkage with the KOSIMO Datasets

To what extent now do individual syndromes correlate with violent and non-violent conflicts between and within states? In order to systematically examine this question and not only be confined to anecdotal experiences, the linkage of the findings of the syndrome analysis – i.e. the identification of individual syndromes or symptoms of global change – with datasets from the Heidelberg KOSIMO database presents itself, as we shall show in our empirical analysis by way of two examples.

The KOSIMO (conflict simulation model) conflict theory approach was elaborated from 1988 to 1991 by Frank R. Pfetsch at the Heidelberg Institute for Political Science. The approach has since been empirically reviewed in several individual studies, but particularly by means of an extensive database project (cf. Pfetsch (1990, 1991a, 1991b, 1993, 1996); Billing (1992); Pfetsch/Billing (1994); Rohloff (1998); Schindler (1998); Trautner (1997).

Since 1991 the Heidelberg Institute for International Conflict Research, in cooperation with the Institute for Political Science, has managed the updating and evaluation of the database). The KOSIMO approach is intended, principally by means of frequency counts of operationalized variables, to arrive at probability statements providing information about the validity of concrete propositions, which are derived from the major theories of international relations or simply – as in our study – from the syndrome approach.

In order to enable a direct linkage of the syndrome approach with the KOSIMO datasets, in our analysis we adopt the premises of the KOSIMO approach, i.e. we also proceed from the basis of an international system predominantly determined by state action, which is to be explained in terms of action theory and actor orientation. The analytical access to the occurrence of conflict is therefore achieved by identifying the actors and their respective interests. In the KOSIMO approach the positional differences over which the parties are in dispute include identifiable goods as well as identifiable values; this also comprises conflicts over resources, for example over jointly used waters.

In our opinion, overall the empirical research is still too little concerned about researching into the issues involved in conflicts. Even the prominent English-language war databases such as the Correlates of War Project (Small/Singer 1982) or the Conflict and Peace database (Gochman/Maoz 1984) have only inadequately covered the nature and number of disputed values and goods or their importance for the actors (Diehl 1992:335). The Hamburg Study Group for Research on the Causes of War approaches this problem by in each case forming four types of war and kinds of conflict (Gantzel/Schwinghammer 1995:44). KOSIMO combines seven matters of dispute: 1. territory, frontier, water; 2. colonial possessions, national independence; 3. ethnic, religious, regional autonomy; 4. ideology, system; 5. national power; 6. international power, geostrategic position; 7. resources (Pfetsch/Billing 1994:32).

Through this actors' perspective, in the KOSIMO approach the dynamics of a conflict can in principle be illustrated by means of phases and escalation models, although the current standing of our research does not yet allow such a linkage of individual phases of environmental conflicts with the syndrome approach. For KOSIMO, the definition of conflict is: "Conflict as a generic term includes clashes of interests (positional differences) over national values (independence, self-determination, frontiers and territory) of some duration and scope between at least two parties (states, groups of states or organizations, organized groups), which are determined to resolve them in their favour". (Pfetsch/Billing 1994:15) In the KOSIMO approach structural variables, such as for example the political system of the actors, their bloc or cultural affiliation or the attitudes of the superpowers to the conflict, are assigned to each phase and each escalation

level on which the conflict is conducted. Nevertheless, the actor-orientation remains the focal point because the actors are a priori not subjected to any preferences (such as power maximization or territorial expansion, for example). Structural and systemic variables can, however, have an effect on the actors and influence their decisions. Therefore, account is also taken of variables such as the geographical location of the conflict in, alongside or outside the spheres of interest of the great powers and superpowers, the reactions of the neighbouring states and the great powers and superpowers to the conflict, the economic level of development of the actors, as well as the political system of the actors with regard to its capacity to resolve conflicts.

One problem with the KOSIMO approach and other quantitative conflict research approaches is the definitional downward delimitation of the samples, i.e. up to the point where there is no longer any conflict. Of course, not only conflicts between states but also conflicts within states are included. However, a prerequisite is that a state be involved at least on one side of the conflict. This is a problem insofar as violence is increasingly more frequently being conducted between non-state actors, for example through drugs wars, "warlordism" or gang violence. A limited or even complete breakdown of the state, as in Somalia, the Sudan, or also in parts of Colombia, promotes this trend (Holsti 1995). In order to be able to also include and conceptualize such types of violence, it would really be necessary to use approaches with an even lower conflict threshold, as for example Ted R. Gurr's (1994) approach for analyzing ethno-political conflicts. Such an extension and further modification of the analysis – although highly complicated in methodical terms because of the problems of delimitation and data-recording – is therefore a meaningful objective for the improvement of our approach as well.

In conventional conflict databases only conflicts with an actual use of violence have hitherto been taken into account, although the empirical study by Hugh Miall (1992) is a notable exception. The KOSIMO approach used by us goes beyond this, because non-violent conflicts and crises are also included. For only if conflicts, which in some cases escalate and in other cases are conducted without violence, are compared quantitatively and qualitatively in their synchronic and diachronic relationships, can probability statements on the necessary and sufficient conditions for a peaceful or violent resolution of a conflict be meaningful. War and peace cannot be explained statically; it is rather the case that they are processes which are determined by the behaviour of the actors in constantly new conflict situations. Therefore, war and peace must not be separated conceptionally. So if, as most usually, the analysis is only based on samples which exclusively include wars, neither the threshold of war nor that of peace can be recognized and explained.

Application I: Are there Wars over Water?

In the following we shall apply the methodical instruments developed in the previous section to one of the most discussed questions in connection with the "wars over the environment" – the question of the impending, or even already existing, "wars over water" (cf. Albrecht (1996a:9); Barandat (1997); Dombrowsky (1995); Gleick (1996); Klötzli (1996); Starr (1991); Swain (1993); Wolf (1997)). In this respect, a frequently represented hypothesis is that an increasing number of inhabitants, combined with growing demands on the quantity of water consumed, use regional supplies to excess and, particularly where meagre natural resources are still cut through by state frontiers, this can lead to international conflicts (Wöhliche 1996:40–41). Here the Middle East is often cited, where conflicts over water from the Euphrates, Tigris and Jordan indeed most readily support the proposition that transfrontier resources are likely to induce conflicts (Albrecht 1996a:10; Dombrowsky 1995; Libiszewski 1996). But the proposition of the approaching water wars continues to be disputed within the social sciences. For example, Gleditsch (1997b) represents the counter-proposition that clashes of interests over the use of transfrontier water resources would lead rather to greater cooperation than to increasing (violent) conflicts. However, there are as yet scarcely any systematic empirical studies to clarify these questions. An initial attempt has been presented by Malin Falkenmark (1990), who on the basis of a "water stress profile", which the FAO drew up for six African states in 1986 within the framework of the UN Water Decade, has developed a "water scarcity" system for the whole of Africa. Based on a comparison of the availability of water and cultivation periods, Falkenmark has calculated critical "stress values" for individual states for both the years 1982 and 2025, which Falkenmark hopes could be used as early warning indicators for state and international cooperative action.

According to the current hypothesis, international conflicts over water are primarily imminent in those cases where a state lying on the upper reaches of a river changes the natural discharge system in such a manner that the lower lying state has less or qualitatively poorer water at its disposal. In the syndrome analysis such relationships, which are triggered by people through large-scale projects, are included under the ideal type of the "Aral Sea Syndrome". These primarily comprise the national and international consequences of large dam constructions, but also large irrigation projects, particularly as they have been carried out on the Aral Sea with devastating environmental damage. A comparable, although not yet fully realized large project is the "Great River of the Human Hand" in Libya, whereby waters are to be pumped from the desert to irrigate the land in coastal areas; this requires the immigration of two million workers into a thinly populated country with five million people, which may create the risk of ethnically structured struggles for distribution (Albrecht 1996a:8).

Insofar as such large-scale projects relate to resources which are shared by two states, there is a presumption of an increased propensity towards international conflict or, according to the counter-proposition, increased cooperation. Here, the syndrome-analytical approach in principles enables those regions to be identified – independently of international conflicts – in which the Aral Sea Syndrome occurs, and on the basis of this list, with the help of the KOSIMO database and qualitative analyses, enables the propositions on the probability of conflict or cooperation of such situations to be tested. An initial such identification of the worldwide occurrence of the Aral Sea Syndrome appeared in the WBGU Annual Report of 1997 (WBGU 1998.175 f.).

However, at this stage our analysis does not cover the entire mechanism of the Aral Sea Syndrome because we have deliberately cut out many variables of the "Aral Sea syndrome" relationship network, for example in particular the diverse environmental consequences which can arise from hydraulic engineering projects. In addition, the determination of the Aral Sea Syndrome presented in WBGU (1998) had to be modified, because there the indicators to ascertain the "intensity" of the Aral Sea Syndrome had already been supplemented with an initial indicator for the "conflict propensity" of a particular situation. For example, it was taken into account whether two states are strongly integrated (e.g. through customs and economic unions or military alliances) or whether – as in the extreme counter-case – the states are instead involved in violent conflicts or were recently. According to the plausible assumption of the syndrome approach, such special features of an international relationship influence the probability of whether a bilateral conflict over the use of resources is conducted violently or peacefully, so that existing conflicts have been evaluated as an intensification of the syndrome. However, since the conflict propensity has already been included in the identification of the syndrome, this analysis can no longer be used directly for our plan, because the explanandum would be confused with the explanans. To this extent our analysis is not based on all elements, but only on the essential component of the previous research on the Aral Sea Syndrome, in particular the MEGARUS global discharge model (Model to Estimate Global Run-off and River Discharges; Petschel-Held/Plöchl 1997), which we combine with population data and the datasets of the KOSIMO project. Of course, even population data cannot be used without difficulty. Precisely because in many states the total population is a highly political value and, amongst other things, serves as a basis for development cooperation aid, these data are frequently manipulated. However, we assume that these alterations do not significantly influence our analysis.

In particular, this approach not only enables possible conflicts over water to be investigated with regard to their political dimension in individual studies, as in

the ENCOP project, for example, but rather – by way of cooperation with the natural sciences – also enables the natural physical conditions to be adequately and independently incorporated into the conflict analysis. For how much surface water and renewable ground water a state can use at all is initially determined by the complex climatic, orographic and pedologic conditions. Here, people can at most intervene on a regulatory basis, attempting to make better use of the natural supply through hydraulic engineering projects such as canals, dams or irrigation plants. However, where there is a relative shortage of water in the region, the construction of such plants can lead to competition between states in a particular water catchment area.

Where are such competitive situations in terms of the natural physical conditions, but also demographic factors, so clearly apparent? We have investigated this on the basis of the MEGARUS global discharge model, which was linked to population indicators, for all states throughout the world, insofar as ascertainable. The underlying natural scientific analysis in this connection is based on a global model with a relatively refined dispersal of regional processes (at the equator approximately 55 km x 55 km), which for the first time enables a global synopsis of possible conflicts over water. In this respect we proceed from the working hypothesis that the conflict propensity in a specific situation is all the greater,

- the more a state is dependent on the inflow of surface water from another state (i.e. the greater the share of the available surface water flowing in from the other state);
- the more the downstream suffers from a shortage of water (which therefore increases the dependency on the upstream water);
- the more the upstream suffers from a shortage of water (which increases the interest of the upstream in using the discharged water to a greater extent in its own country, for example by improving irrigation plants, dams and the like).

Overall, our working hypothesis is consequently that the more strongly these three factors are present, the “more critical” are the vested interests between the states in a specific discharge system. We have investigated these factors in all 460 upstream and downstream situations worldwide and evaluated these according to their “criticality”. In this connection the situations were analyzed in a multistage process and finally brought together into a single, aggregated indicator for the criticality of vested interests.

Our indicator in this respect is based specifically on

- the MEGARUS global discharge model (Petschel-Held/Plöchl 1997);
- the “climate database” (made available to us (in Version 2.1) by Wolfgang Cramer, Potsdam) consisting of monthly data for temperature, precipitation

and insolation as well as the water retention capacity of the soil;
– the population figures for 1995 (World Bank 1997).

In order to calculate the water shortage in the states, in addition to the determination of water availability, ideally a comprehensive estimation of the water requirements is necessary, which can, however, only be made with great difficulty (WGBU 1998:129). In the following we therefore use the threshold value of 1,000 cubic metres per capita and year for chronic water shortage and 2,000 cubic metres for water scarcity, as introduced in the literature (Falkenmark/Widstrand 1992). To avoid the distortions arising through acute threshold values (for example: up to 999 cubic metres "critical", from 1001 cubic metres upwards "non-critical"), we use fuzzy logic methods (Zimmermann 1992; Cassel-Gintz et al. 1997), which help to solve these specific problems.

Consequently, there are therefore critical vested interests if, in the downstream state, without the water of the upstream a noticeable scarcity would arise with regard to per capita availability. In this connection we have evaluated a mutual scarcity as having greater conflict propensity than only a one-sided dependency of the downstream. However, in our opinion a scarcity of the upstream alone does not justify the assumption of critical vested interests.

Diagram 3 illustrates the relative criticality of international interdependencies calculated with our method in the case of surface water; of all of the 460 bilateral situations investigated we have only listed the 30 most critical. In a few cases – primarily for some regions extremely rich in water and for many very short state frontiers – the global discharge model used by us does not allow any country-specific analysis. Thus we could take no further account of these combinations of states in the following analysis. For this reason, the German-Belgian-Dutch and Tajikistan-Pakistani constellations of interests in particular had to be excluded from our sample, so that now 460 constellations remain. All values are to be understood as relative criticality on a scale of 0 to 1. In this connection the value $x(o)$ indicates the criticality regarding the water supplies for the upstream, which in this case specifically means how dependent the upstream is on the use of the water which flows to the respective downstream. The higher the $x(o)$ value, the greater according to the modelling is the probability that in the event of increases in its own consumption, the upstream will either use the discharged water more, or at least will not use it less, should the downstream need more water. On the other hand, the value $x(u)$ indicates the criticality of the downstream with regard to the inflowing water of the upstream; the higher this value is, the less the downstream would be able to do without the inflowing surface water and the greater is the interest in inducing the upstream to increase the inflow or at least not to restrict it – with the possible consequence of a bilateral conflict. Beyond this, it is of course also

crucial what quantity of the resource "water" is involved for the two countries which are jointly suffering from a scarcity of it. In this connection, we proceed on the basis that the pressure of competition, and thus the conflict potential, is all the greater the more water is exchanged between the countries.

The value $x(\text{total})$ produces an aggregated indicator, which indicates the criticality of the interdependence for water between the respective states, on a scale from 0 to 1. In detail, the aggregated criticality indicator is calculated as

	Upstream o	Downstream u	$x(o)$	$x(u)$	$x(\text{total})$	Distribution and access conflict over "water"
1	Israel	Jordan	1.000	1.000	1.000	x
2	Ukraine	Moldova	0.335	1.000	0.655	
3	Algeria	Tunisia	0.742	1.000	0.637	
4	India	Pakistan	0.000	1.000	0.500	x
5	Afghanistan	Pakistan	0.000	1.000	0.500	
6	Iraq	Kuwait	0.000	1.000	0.500	
7	Sudan	Egypt	0.000	1.000	0.500	x
8	Turkey	Syria	0.000	0.946	0.473	x
9	Afghanistan	Uzbekistan	0.874	0.393	0.368	
10	Oman	Utd. Arab Emi.	0.335	1.000	0.353	
11	India	Bangladesh	0.698	0.367	0.312	x
12	Belarus	Ukraine	0.000	0.616	0.308	
13	North Korea	South Korea	0.000	0.971	0.269	
14	Austria	Czech Rep.	0.000	0.477	0.238	
15	Syria	Iraq	1.000	0.236	0.236	
16	Saudi Arabia	Utd. Arab Emi.	0.856	1.000	0.209	
17	Russia	Ukraine	0.000	0.393	0.197	
18	France	Germany	0.000	0.378	0.189	
19	Germany	Czech Rep.	0.067	0.386	0.187	
20	Czech Rep.	Germany	1.000	0.186	0.186	
21	Jordan	Israel	0.832	1.000	0.184	x
22	Turkmenistan	Iran	0.000	0.361	0.181	
23	Austria	Germany	0.000	0.329	0.164	
24	Armenia	Iran	0.000	0.288	0.119	
25	Russia	China	0.000	0.285	0.114	
26	Oman	Saudi Arabia	0.642	0.893	0.086	
27	Saudi Arabia	Jordan	0.865	0.819	0.070	
28	Saudi Arabia	Oman	0.861	0.357	0.052	
29	Saudi Arabia	Yemen	0.881	1.000	0.043	
30	China	North Korea	0.189	0.058	0.034	

Fig. 3 – The 30 most critical upstream-downstream vested interests
(N = 460 pairs of states)

follows: we take as a basis a quantity of water f_{ik} which flows from country i to country k , the total water availabilities w_i and w_k of the two countries calculated from the discharge model and the respective populations p_i and p_k . Thus, independently of the quantity of water exchanged between the two countries, the freely available quantity per capita and year in country i is given by and analogously for country k . Measured in cubic metres per year and capita, this quantity of water is now shown on an index between 0 and 1 oriented to the usual values in the literature of 1,000 or 2,000 cubic metres, and in fuzzy logic interpreted as the "truth value" of the statement "there is only a critical quantity of water freely available". Values below 1,000 cubic metres are indicated with 1, values above 2,000 cubic metres with 0 and intermediate values are adjusted linearly (for example, 1,350 cubic metres is indicated as 0.65). The criticality K_{ik} of the exchanged quantity of water is then calculated according to the formula. In terms of fuzzy logic, this linkage corresponds to a logical AND between the sole dependence of the downstream and the joint dependence of the upstream and downstream. In order to further take into account the quantitative significance of the quantity of water exchanged for the respective countries, the relative share of the quantity of water exchanged is likewise converted into an index between 0 and 1 (increasing linearly and 1, if more than 20%). In order to be able to take into account the asymmetry between the upstream and downstream in the same manner as for the above estimation of criticality, a "significance value" for the exchange of water is determined from this according to the formula. The logical AND linkage, which must finally be applied between the criticality and the significance in order to estimate the conflict potential, is realised by determining the minimum between B_{ik} and K_{ik} .

Since we have incorporated the absolute quantity of exchanged water, our aggregated criticality indicator $x(\text{total})$ is in some cases significantly lower than the separate indicators $x(o)$ and $x(u)$, as for example for Jordan/Israel, Oman/Saudi Arabia, Saudi Arabia/Jordan, Saudi Arabia/Oman and Saudi Arabia/Yemen.

The 30 states with the highest values for criticality (of all 460 pairs of states investigated) are listed above; they were compared with conflicts where water played a part, which have been empirically observed to date. In this connection, the "water conflict" criterion is based on the quantitative KOSIMO database, revealing a bilateral conflict, combined with the qualitative KOSIMO datasets, which attribute to the conflict "water" as the issue in dispute (Pfetsch/Rohloff 1998).

A glance at this table shows that even in the 30 most critical situations (out of all bilateral situations totalling 460), the relative water shortage situation between two states overall has rather seldom led to conflicts. For example, an



actual conflict explicitly over the use of surface waters is only to be observed in seven of these very critical cases. These include the conflict between the Sudan and Egypt over the Nile water (maximum criticality for the downstream Egypt: 1.0) and the conflict in the Middle East with a maximum criticality between Jordan (downstream) and Israel (upstream) (in each case 1.0). The conflict between Syria, Iraq and Turkey over the water of the Euphrates and the Tigris also emerges clearly in the table; here the criticality for Syria (as downstream) vis-à-vis Turkey is 0.95.

According to our analysis there is likewise a considerable dependency between India and Bangladesh; here the water problem is actually considered "the most disputed issue" in bilateral relations (Hafiz/Islam 1996.66). There is also a very high dependence in the case of Pakistan vis-à-vis India; India in fact exploited this dependence in April 1948 and retained the water of the Indus, with the consequence that 600,000 hectares of land could not be irrigated for a period of five weeks. In this connection E.E. Lilienthal, the former chairman of the Tennessee Valley authority, noted: "No army with bombs and shellfire could devastate a land so thoroughly as Pakistan could be devastated by the simple expedient of India's permanently shutting off the source of water that keeps the fields and people of Pakistan alive" (cited from Hafiz/Islam 1996.86).

However, the example of India/Pakistan highlights a problem with our linkage of two datasets, namely their chronological classification. The water criticality was measured for the present, while the retention of the water of the Indus goes back half a century. If it is assumed that the quantity of water of the Indus has not since changed, the populations in both countries have, however, changed considerably, so that the criticality in the case of the Indus in 1948 must have been clearly lower. The remaining conflicts we list are, however, contemporaneous with the criticality analysis. The example of India/Pakistan further clearly shows the need to combine global quantitative analysis models with qualitative individual case studies, because the India-Pakistan conflict was neither in 1948 nor is it at present a conflict in which water was the subject of the dispute, but rather a conflict in which water was used as a means. Although our quantitative analysis cannot show the causes of the conflict between India and Pakistan (in contrast to the Turkey/Syria case, for example), the model does help us to understand what significance water has in the conduct of a conflict between two countries.

In addition to the chronological dynamics, the formation of new states also influences the result of our investigation. The absence of conflicts over water between the new states of the former Soviet Union is therefore to be evaluated more cautiously than the absence of conflicts over water between states which have already existed for fifty or more years. Finally, there are cases in which two states are reciprocally at the same time upstream and downstream, as in the case

with Jordan/Israel and Oman/Saudi Arabia. This tends (depending on the extent of the interdependence) to reduce the upstream-downstream asymmetry and rather creates a symmetrical interdependence, which in turn could lead rather to cooperative behaviour. However, we have not separately calculated these cases in our calculation of criticality (i.e. no reciprocal "cancellation" of criticality), since the respective weighting factor for reciprocal interdependencies can only be subjective and would thus reduce the transparency of the data analysis.

If these problems of each global, integrated data analysis are left aside, conflicts over water are observed in 23% of the 30 (of a total of 460) most critical bilateral situations, in 30% of all cases if only the twenty most critical states are considered, and in 45% of all cases if the analysis is confined to the most critical eleven constellations. Applied to the overall sample of 460 situations, a significant correlation is established.

For example, if in the case of a conflict over water the value 1 is taken – and otherwise the value 0 – assuming three categories of criticality, a corrected contingency coefficient of $k = 0.428$, or a test function value of Chi-square = 6.369, is produced, which with the size of the sample would imply an error probability of 4.1% if the counter-proposition (i.e. that there are no scarcity-induced conflicts over water) is rejected. Consequently, in statistical terms the probability of an international conflict in which water plays a part increases with the criticality of the situation.

However, this correlation should in no way be over-interpreted in view of the few situations overall in which water has played a part within a conflict and the fact that in the conflict in the Middle East over the Jordan, an already existing conflict was only intensified through the water problem, or that the Indus water was essentially only exploited by India in 1948 in the existing conflict against Pakistan. Furthermore, overall in the majority even of the 30 most critical cases (of all 460 situations investigated) no conflicts can be established or they are explicable in other ways, despite considerable national problems with water supply in some cases. This – in view of the catastrophic scenarios represented in the first section – currently still positive finding is reinforced by the fact that, according to the indicators of the KOSIMO database, the 30 states overall have as a group greater conflict propensity than the average of all states (or all 460 international constellations). This means that here a non-cooperative approach to the relative water shortage would still be the most likely.

However, there are also conflicts over water which do not find themselves on our list of 30 particularly critical situations, namely the conflict – in the meantime negotiated before the International Court of Justice in The Hague – between Hungary and Slovakia over the use of the Danube, i.e. over the planned construction of the dam at Gabčíkovo. Here, however, above all ecological

arguments on the Hungarian side were indeed decisive, in particular the protection of river meadows (WBGU 1998.225–226), which are not so ascertainable in our globally aggregated model. The conflict over the Mekong likewise does not appear on our list, although here a (non-violent) conflict between China as upstream and the downstreams of the Mekong is observable (Thomas 1996). Here, according to our analysis based on all the national territories, criticality is low because sufficient water from the tributaries of the Mekong is available to the countries bordering on the Mekong.

Overall the analysis shows that environmental interdependencies between states, combined with a relatively low relative per capita water supply, do not sufficiently support the proposition of the inevitability of international conflicts over water in the case of the currently existing degrees of criticality. Although the degree of relative water scarcity and the international dependence correlate statistically with the probability of a conflict in which water plays a part, this is however contrasted with a large number of situations with a potentially equal conflict propensity, in which no conflict over water can as yet be ascertained.

Application II: Wars through Poverty-induced Soil Degradation?

A second of the total of sixteen syndromes especially presenting itself for empirical conflict research is the "Sahel Syndrome". It describes the characteristic dynamic interactions in the poverty-induced overuse of marginal areas of land for which the Sahel is particularly well-known. An analysis of the Sahel Syndrome was presented for the first time in 1994 in the Annual Report of the WBGU (1994) and subsequently further elaborated in various studies (Cassel-Gintz et al. 1997; Schellnhuber et al. 1997; Block et al. 1998). A distinction should be made between the respective proneness of a region to a syndrome (susceptibility) and the extent to which a region is currently affected by a syndrome (intensity). In both cases social and natural factors are taken into account.

Firstly: In the analysis of the environmental proneness to the Sahel Syndrome, it is on the one hand a question of determining the marginality of land: which land is marginal in such a way that overuse leads to an often irreversible destruction of the soil? For this purpose, building onto available datasets a number of individual factors were incorporated, such as for example the gradient of a location, the precipitation variability, the aridity and temperature limitation for plant growth, the degree of soil fertility and the degree to which surface water can be used for irrigation (WBGU 1996.161 f.; Cassel-Gintz et al. 1997). Even if an environmental situation determined in this manner were to reach critical values, this does not mean that harmful dynamics of environmental degradation are in fact set in motion. Social factors have already

influenced the determination of the environmental susceptibility, since the possibility of using surface water has been taken into account, which is only meaningful in combination with an "irrigable" social system. Without the "irrigation" factor, Egypt in particular would be defined in the analysis as extremely poor in water, a frequent error in earlier studies (for a more detailed account, see Cassel-Gintz et al. 1997). Therefore, the indicators for the proneness of a region to the Sahel syndrome must be supplemented by the social situation and people's alternatives to act: the more people are dependent on producing food in marginal locations and the less the farmers and herdsman can apply capital- and technology-intensive, environmentally sustainable farming methods, the more inevitable is the further overuse of the arable soil and the pastures.

The direct dependence of people on the use of their fragile land is difficult to measure: first of all, for this purpose within the framework of the syndrome analysis the extent of the subsistence economy in a country was used as an indicator, i.e. to what extent the market supply of food differs from the estimated requirement for food. This was supplemented by people's dependence on the use of firewood as a second indicator, which was calculated on the basis of the energy consumption per capita and the share of the use of firewood in energy consumption (WBGU 1996.138 f.).

Secondly: The intensity of the Sahel syndrome, i.e. the extent to which the syndrome is already to be ascertained in various regions, is to be determined separately. Starting from the central dynamic relationship of effects of the Sahel syndrome, namely a vicious circle arising from (a) impoverishment, (b) intensification and/or extension of agriculture on a low level and (c) the degradation of the natural environment, the actual occurrence of this cycle is determined on the basis of data on poverty, soil and use of land from the 1980s and early 1990s (Schellnhuber et al. 1997.26 f.; Block et al. 1998.26 f.). The Sahel intensity indicator with values between 0 and 1 has in the syndrome approach hitherto been explicitly defined on a sub-national level; for the linkage with the KOSIMO data, which undertakes coding on a country level, we have aggregated this sub-national intensity indicator – weighted with the local population – on the country level. The OECD states for which there are no data on poverty, some micro-states which could not be taken into account in the model due to the inadequate resolution of the data for the state territory (Gambia, for example), as well as some additional developing countries for which data on rural poverty could not be obtained, were not taken into account.

It should be emphasized that the criticality of the Sahel syndrome cannot be understood statically. In the case of the Sahel syndrome, a high criticality does not mean that indicators such as rural poverty are absolutely high, as would be the case in the correlation with the Human Development Index, for example.

For us, a high criticality value rather indicates that since the 1980s the indicators firstly for the impoverishment of the population, secondly for an intensification and/or extension of agriculture on a low level, and thirdly for the continuing degradation of the soil, have at the same time drastically deteriorated. Therefore it is not conditions which are measured, but dynamics.

Such dynamics of a "Sahel vicious circle" have hitherto not been modelled in the research, let alone been related to data on violent conflicts. In fact, however, a comparison of the states with high criticality values for the dynamic Sahel Syndrome and the states with violent conflicts shows a significant correlation (while we have only taken into consideration the conflict data from 1980 to 1995): an above-average large number of the states strongly affected by the dynamics of the Sahel Syndrome are also affected by violent domestic or international conflicts. The lower the criticality for the Sahel syndrome, the lower the number of violent conflicts, though the occurrence of the Sahel Syndrome in itself appears more significant than its respective criticality value. Diagram 4 shows this for three groups of states: those with no Sahel Syndrome, those with a weak and those with a strong Sahel Syndrome. The total number investigated are 73 states; essentially, as mentioned, the OECD states and the micro-states are absent due to a lack of data.

If the respective characteristics of the Sahel Syndrome are initially left aside, the investigation sample of 73 states – i.e. essentially all except for the OECD states and the micro-states – shows an even share of states with and without violent conflicts. This means that from 1980 to 1995 every other one of these 73

	No Sahel Syndrome (0)		Weak Sahel Syndrome (0-0.5)		Strong Sahel Syndrome (0.6-1)		Total	
Number of states	as %		as %		as %		as %	
without violent conflicts	15	84 %	15	41 %	7	39 %	37	51 %
with violent conflicts	3	16 %	22	59 %	11	61 %	36	49 %
Total	18	100 %	37	100 %	18	100 %	73	100 %

Fig. 4 – Relationship between Sahel criticality and frequency of violent conflicts, 1980-1995

states was involved in conflicts. The fact that between 1980 and 1995 only barely half of these 73 states were involved in a conflict could point to a distorted sample, but over the fifty years from 1945 to 1995 only 34% of all the states covered by KOSIMO remained uninvolved in violent conflicts, or – if only the developing countries are considered in this connection – only 13%. The higher share of predominantly violence-free states amongst the 73 states is to be explained by the significantly shorter investigation period from 1980 to 1995, which no longer covers the decolonization conflicts.

However, of the states which were not affected by a dynamic Sahel Syndrome, only 16% were at the same time affected by violent conflicts, whereas in the case of the states most strongly affected by the syndrome, this quota amounts to 61%. Therefore there is a noticeable correlation between the dynamic vicious circle of increasing rural impoverishment, intensification of agriculture on a low level and deterioration of the natural resources on the one hand and violent social conflicts on the other hand. In Diagram 5, for illustrative purposes, of the total list with 73 states, the 30 states are listed in which the Sahel Syndrome is currently most strongly evident.

The relationship occurs the most clearly in the case of states in and adjacent to the Sahel zone, namely Senegal, Niger, Algeria, Burkina Faso and Mali. These states are on the one hand characterized by a high intensity value for the dynamic Sahel Syndrome, and on the other hand by a high violent conflict quota. Thus for example, the constantly escalating Tuareg conflict is an expression of diminishing renewable resources with a growing population (Lume 1996). The civil wars in the Sudan and Ethiopia as well as the regional international disputes, for example in the Ogaden conflict, have in several case studies been identified as conflicts partly or predominantly induced by environmental degradation (cf. Bächler et al. (1996:329); see also the articles in Bächler/Spillmann (1996a, 1996b)). As an example, for the Sudan it has been established: "The war in the South [of Sudan] is best understood as resulting from opposing political approaches to the reality of diminishing resources, and in the search for a lasting peace it is necessary to understand this new dimension to the old conflict" (Suliman 1996:112).

Additional large regions which are affected by the dynamic Sahel Syndrome, and in which violent conflicts have occurred during the last fifteen years, are Central Asia and the Middle East. However, ideological conflicts, as well as internal conflicts over control and power distribution, have often overlapped or determined the outcome of these wars. Iran, Afghanistan and Tajikistan, three states with a high intensity of the Sahel Syndrome in Central Asia, have been involved for many years in domestic and international wars, which in some cases are related to the access to and the distribution of scarce subsistence resources. In the Middle East, Syria (including the Golan Heights), Lebanon and the

Israeli-occupied Jordan West Bank are particularly affected by the Sahel Syndrome. For both regions a strong overlapping of the environment-related threat by geo-strategic power interests, conflicts over access to industrially usable resources, as well as religious factors, is evident. Additional individual

Country	Sahel syndrome criticality	Violent conflicts between 1980 and 1995	Conflict
North Korea	0.88	no	-
Senegal	0.86	yes	Casamance conflict
Niger	0.77	yes	Tuareg conflict
Algeria	0.76	yes	Islamist conflict
Iran	0.74	yes	First Gulf War
Turkmenistan	0.72	no	-
Burkina Faso	0.69	no	-
Colombia	0.67	yes	Guerilla
Mali	0.63	no	-
Guatemala	0.63	yes	Civil war
Guinea	0.62	no	-
Afghanistan	0.58	yes	Civil war
Sierra Leone	0.57	yes	Civil war
Syria	0.55	yes	Domestic crises
Panama	0.53	yes	US intervention
Dominican Republic	0.53	no	-
Cameroon	0.52	no	-
Nigeria	0.52	yes	Ogoni minorities conflict
Tajikistan	0.49	yes	Civil war
Brazil	0.49	no	-
Sudan	0.46	yes	Civil war
Pakistan	0.46	yes	Afghanistan-Pakistan: Pashtunistan
Lebanon	0.46	yes	Israel-Lebanon conflict
Uzbekistan	0.43	no	-
Ethiopia	0.41	yes	Oromo conflict
Eritrea	0.40	yes	Civil war
El Salvador	0.40	yes	Civil war
Ecuador	0.38	yes	Ecuador-Peru border war
Bhutan	0.36	no	-
Mongolia	0.36	no	-

Fig. 5 - Intensity of the Sahel Syndrome

states which are affected by the dynamic Sahel Syndrome, such as Colombia, Guatemala or Sierra Leone, have experienced – or are still experiencing – civil wars and extraordinarily high rates of criminality. Nevertheless, at least in Guatemala and Sierra Leone, it is clear that the Sahel syndrome is also due to already existing wars, in contrast to Colombia or Guinea, for example. The border conflict between Ecuador and Peru over the use of gold and ore resources is evidently not related to the Sahel Syndrome.

If we leave it at this finding, the pessimistic statements of the previous prognostic and empirical environmental conflict research would be reinforced. However, through the comparison of the intensity list for the Sahel Syndrome with the peacefully conducted conflicts, which are recorded in the KOSIMO database, cooperative conflict constellations in states or regions affected by the Sahel Syndrome can also be identified. These mainly include Turkmenistan, the Dominican Republic, Cameroon, Brazil, Uzbekistan and Mongolia. Panama and Bhutan likewise show no violent conflicts, neither over access to and distribution of resources nor over other values and goods (except for partly violently conflicts between the USA and Panama over the Canal).

The KOSIMO coding of peaceful as well as violently conducted conflicts with the respective political system of the conflicting parties, as well as with the operationalized behaviour of the neighbouring states and with the big powers and superpowers with regard to the respective conflict, offers initial explanatory approaches to why comparable degrees of intensity of the Sahel Syndrome correlate with varying violent conflicts. For example, what distinguishes Mongolia from West African Sahel states, which although affected by the dynamic Sahel Syndrome nevertheless deal with this problem differently in political terms? Here for example, political systems with increased capacities for dealing with conflicts, such as functioning traditional regulative mechanisms in Mongolia seem to be better able to deal with the socio-political consequences of the Sahel Syndrome than ideologically and territorially competing societies of the Sahel which are broken in the modernization process (cf. Siegelberg 1995:68). However, precisely such cases require further, in-depth qualitative individual case studies in order to be able to investigate in greater detail the correlations obtained through our global approach.

Conclusion

The syndrome-analytical/conflict theory approach covers the relationships between environment and conflict by means of an interdisciplinary and integrated method. With the help of the syndrome concept, the approach enables – independently of conflicts actually observed – “critical environmental situations” to be investigated and to be related to real conflicts. Even if the

approach can in no case explain the causes of individual conflicts, due to its global perspective and the quantitative natural scientific analyses, the determination of significant global correlations between individual syndromes of global change and conflicts is nevertheless possible.

This applies on the one hand to the results of the analysis of the worldwide critical upstream-downstream situations within the scope of the research on the Aral Sea Syndrome. Here our investigation shows that there is a statistically significant relationship between environmental interdependencies, a relatively low water supply per capita and international conflicts. However, due to the low absolute number of conflicts and a number of special conditions, this ought only to be interpreted cautiously. Although conflicts over water can in fact be established in some of the cases we have analyzed, this is often explicable through other influencing factors (above all the wars between India/Pakistan and Israel/Arabic states and not on the basis of the critical water situation itself. This means that additional influencing factors have led to the outbreak of the conflicts over scarce water or have significantly fostered them, such as for example security policy (Turkey/Kurdistan), an isolated regime prepared to enter into conflict (as in Sudan) or an existing international conflict (Israel/Jordan, India/Pakistan). Where such special influencing factors do not exist, in the event of comparable critical vested interests, either no conflict or a cooperative manner of dealing with the situation can be established. Therefore, the propositions on imminent "water wars" discussed at the beginning are in each case put into perspective through our investigation.

The results of the analysis of the Sahel Syndrome show a striking correlation between the occurrence of the dynamic syndrome and domestic violent conflicts. This correlation is still no explanation for a causal relationship, since in many cases it cannot be ruled out that already existing domestic violent conflicts have influenced, if not indeed caused, the outbreak of the syndrome. The special features of the cases must furthermore be explained in qualitative case studies and through field research. Ultimately, however, with our method, in which the cases – in contrast to previous approaches – were selected independently of the conflicts, we can confirm the proposition of a fundamental relationship between environmental destruction and force, at least for poverty-induced soil degradation.

The interdisciplinary further development – based on natural science and conflict research – of the approaches used promises a further broadening and sophistication of the analysis, which brings out into sharper relief the most strongly correlating variables at the interface between environment and security, and thus makes an improved methodical and empirical contribution to the debate on environment and security. As far as the syndrome concept is concerned, in addition to a broadening and sophistication of the discussion in

the case of the Aral Sea and Sahel Syndromes, for example the analyses of the following syndromes present themselves here: the "Overexploitation Syndrome" (overexploitation of natural ecosystems), the "Rural Exodus Syndrome" (environmental and developmental problems through the abandonment of traditional agricultural practices), the "Katanga Syndrome" (environmental degradation through the depletion of non-renewable resources) as well as the "Green Revolution Syndrome" (disruption caused to the environment and society as a consequence of inappropriate rural development policies).

The syndrome-analytical/conflict theory approach can and should not now replace the empirical case studies, such as those by the group centred around Homer-Dixon and under the ENCOP project. We rather envisage a phased research agenda in order to analyze the relationship between environment and security. Thus:

- in a first stage, with the help of the syndrome analysis, different types of critical environmental situations could be independently established and be made explicit for individual countries, so that then
- in a second stage, with the help of the KOSIMO approach, the correlation between the intensity of syndromes and different special features of conflicts could be independently investigated, so that then
- in a third stage these research findings could be used as a guideline for the systematic case study analysis, possibly in the style of the previously rather ad hoc selected case studies in the ENCOP project. For example, it could then be investigated in empirical comparisons on the spot why an identical criticality of the environmental situation has in one case led to armed conflict, but in another case has not even led to an observable conflict; on this basis, then
- in a fourth stage the findings of the case studies could be used to optimize both the syndrome analysis and the KOSIMO data.

To this extent, empirical case collections such as ENCOP and the syndrome-analytical/conflict theory approach working with globally aggregated quantitative data are not alternatives but complementary elements of a joint research programme to evaluate global environmental changes in terms of peace policy. It will not be possible to explicitly predict conflicts on the basis of the syndrome-analytical/conflict theory approach; but it may help empirically oriented science and practical policies to pay attention in a more target-oriented manner to specific regions, but above all to specific relationships, to research more thoroughly in this connection and – it is to be hoped – to anticipate violent escalations.

REFERENCES

- ALBRECHT, U. (1986): Weltweite Rüstung als Problem der Internationalen Umweltpolitik. In: C. Mayer-Tasch (ed.): Die Luft hat keine Grenzen. Internationale Umweltpolitik – Fakten und Trends, Frankfurt a. M.; pp. 257–270.
- ALBRECHT, U. (1996a): Krieg um Wasser? In: Prokla. Zeitschrift für kritische Sozialwissenschaft 26.1 (102); pp. 5–16.
- ALBRECHT, U. (1996b): Internationale Politik. Einführung in das System internationaler Herrschaft, 4th ed. Munich.
- ALTVATER, E. / B. MAHNKOPF 1997: Grenzen der Globalisierung. Ökonomie, Ökologie und Politik in der Weltgesellschaft, 2nd ed. Münster.
- BÄCHLER, G. (1998): Environment and Security in an International Context. The Conflict Dimension (Contribution to the NATO CCMS Pilot Study on Environment and Security), Berne, unpublished manuscript.
- BÄCHLER, G. / V. BÖGE / S. KLÖTZLI / S. LIBISZEWSKI / K. R. SPILLMANN (1996): Kriegsursache Umweltzerstörung, Volume 1: Ökologische Konflikte in der Dritten Welt und Wege ihrer friedlichen Bearbeitung. Chur.
- BÄCHLER, G. / K. R. SPILLMANN (eds.) (1996a): Kriegsursache Umweltzerstörung, Volume 2: Environmental Degradation as a Cause of War. Regional- und Länderstudien von Projektmitarbeitern. Chur.
- BÄCHLER, G. / K. R. SPILLMANN (eds.) (1996b): Kriegsursache Umweltzerstörung, Volume 3: Environmental Degradation as a Cause of War. Länderstudien von externen Experten. Chur.
- BARANDAT, J. (ed.) (1997): Wasser – Konfrontation oder Kooperation. Ökologische Aspekte von Sicherheit am Beispiel eines weltweit begehrten Rohstoffs. Baden-Baden.
- BIERMANN, F. (1995): Saving the Atmosphere. International Law, Developing Countries and Air Pollution. Frankfurt a. M.
- BIERMANN, F. (1997): Umweltvölkerrecht. Eine Einführung in den Wandel völkerrechtlicher Konzeptionen zur Weltumweltpolitik (Wissenschaftszentrum Berlin für Sozialforschung Paper FS II 97–402). Berlin.
- BIERMANN, F. (1998): Weltumweltpolitik zwischen Nord und Süd. Die neue Verhandlungsmacht der Entwicklungsländer. Baden-Baden.
- BILLING, P. (1992): Eskalation und Deeskalation internationaler Konflikte. Frankfurt a. M.
- BLOCK, A. / M. CASSEL-GINTZ / J. KROPP / M. LÜDEKE / O. MOLDENHAUER / G. PETSCHHEL-HELD / F. REUSSWIG / H.-J. SCHELLNHUBER (1998): GIS-gestützte Erfassung und Modellierung der Syndrom-Dynamik (Final Report of the BMBF Project 01LG9401–5). Potsdam.
- BROCK, L. (1991): Peace Through Parks. The Environment on the Peace Research Agenda. In: Journal of Peace Research 28: 4; pp. 407–423.
- BROCK, L. (1994): Ökologische Sicherheit. Zur Problematik einer naheliegenden Verknüpfung. In: W. Hein (ed.): Umbruch in der Weltgesellschaft. Auf dem Wege zu einer "Neuen Weltordnung"? Hamburg; pp. 443–458.
- CARIUS, A. / K. M. LITZMANN (eds.) (1998): Umwelt und Sicherheit. Herausforderungen für die internationale Politik. Berlin.

- CARIUS, A. / S. OBERTHÜR / M. KEMPER / D. SPRINZ (1996): Environment and Security in an International Context. State of the Art and Perspectives. Interim Report of the NATO CCMS Pilot Study (abridged also in: Environmental Change and Security Project Report 3 (1997); pp. 55–65).
- CASSEL-GINTZ, M. A. / M. K. B. LÜDEKE / G. PETSCHL-HELD / F. REUSSWIG / M. PLÖCHL / G. LAMMEL / H.-J. SCHELLNHUBER (1997): Fuzzy Logic Based Global Assessment of the Marginality of Agricultural Land Use. In: Climate Research 8; pp. 135–150.
- CONVENTION ON THE PROHIBITION OF MILITARY OR ANY OTHER USE OF ENVIRONMENTAL MODIFICATION TECHNIQUES (1977): (Geneva, 18 May 1977, in force on 5 October 1978). In: Bundesgesetzblatt II 1983, 125.
- DIEHL, P. F. (1992): What are They Fighting For? The Importance of Issues in International Conflict Research. In: Journal of Peace Research 29.3; pp. 333–344.
- DIEHL, P. F. (1998): Environmental Conflicts. An Introduction. In: Journal of Peace Research 35.3; pp. 275–277.
- DOKKEN, K. / N. GRÜGER (1995): The Concept of Environmental Security. Political Slogan or Analytical Tool? (PRIO Report 2/1995). Oslo.
- DOMBROWSKY, I. (1995): Wasserprobleme im Jordanbecken. Perspektiven einer gerechten und nachhaltigen Nutzung internationaler Wasserressourcen. Frankfurt a. M.
- EBERWEIN, W.-D. (1997): Umwelt – Sicherheit – Konflikt. Eine theoretische Analyse (Wissenschaftszentrum Berlin für Sozialforschung Paper P 97–203). Berlin.
- EBERWEIN, W.-D. (1998): Umweltbedingte Konflikte – Methodologische Notizen. In: Carius/Lietzmann 1998; pp. 179–194.
- FALKENMARK, M. (1990): Global Water Issues Confronting Humanity. In: Journal of Peace Research 27.2; pp. 177–190.
- FALKENMARK, M. / C. WIDERSTRAND (1992): Population and Water Resources. A Delicate Balance (Population Bulletin. Population Reference Bureau, Washington, D. C.
- FORUM UMWELT UND ENTWICKLUNG (1997): Fünf Jahre nach dem Erdgipfel. Umwelt und Entwicklung – eine Bilanz (erstellt von Sascha Müller-Kraenner und Barbara Unmüssig). Bonn.
- GANTZEL, K. J. / T. SCHWINGHAMMER (1995): Die Kriege nach dem Zweiten Weltkrieg 1945–1992. Münster.
- GENFER PROTOKOLL (1977): Protocol I Additional to the Geneva Conventions of August 12, 1949, and Relating to the Protection of Victims of International Armed Conflicts, Geneva, 8 June 1977, in force on 7 December 1978. In: Bundesgesetzblatt II 1990, 1550.
- GLEDITSCH, N. P. (1997a): Environmental Conflict and the Democratic Peace. In: Ibid. (ed.): Conflict and the Environment (NATO ASI Series 2: Environment, Vol. 33). Dordrecht.
- GLEDITSCH, N. P. (1997b): Armed Conflict and the Environment. A Critique of the Literature. Paper Presented to the 1997 Open Meeting of the Human Dimensions of Global Environmental Change Research Community, IIASA. Laxenburg, 12–14 June.

- GLEICK, P. H. (1996): Fresh Water. A Source of Conflict or Cooperation? A Survey of Present Developments. In: Bächler/Spillmann (1996b); pp. 1-25.
- GLOBE (1997): Editorial. In: *The Globe* 37, June 1997; pp. 1-3.
- GOCHMANN, C. / MAOZ, ZEEV (1984): Militarized Interstate Disputes, 1816-1976. Procedures, Patterns, and Insights. In: *Journal of Conflict Resolution* 28: 4; pp. 585-615.
- GRÖGER, N. (1996): Environmental Security? Review Essay. In: *Journal of Peace Research* 33: 1; pp. 109-116.
- GRIFFITHS, F. (1997): Environment in the U.S. Security Debate. The Case of the Missing Arctic waters. In: *Environment Change and Security Project Report* 3; pp. 15-28.
- GURR, T. R. (1994): Peoples Against States. Ethnopolitical Conflict and the Changing World-System. In: *International Studies Quarterly* 38.3; pp. 347-377.
- HAFIZ, M. ABDUL / ISLAM, NAHID (1996): Environmental Degradation and Intra/Interstate Conflicts in Bangladesh. In: Bächler/Spillmann (1996a); pp. 1-108.
- HAUFF, V. (ed.) (1987): *Unsere gemeinsame Zukunft. Der Brundtland-Bericht der Weltkommission für Umwelt und Entwicklung*; Greven.
- HOLSTI, K. J. (1995): War, Peace, and the State of the State. In: *International Political Science Review* 16.4; pp. 319-340.
- HOMER-DIXON, T. F. (1991): On the Threshold. Environmental Changes as Causes of Acute Conflict. In: *International Security* 16.2; pp. 76-116.
- HOMER-DIXON, T. F. (1994): Environmental Scarcities and Violent Conflict. Evidence from Cases. In: *International Security* 19.1; pp. 5-40.
- KÄKÖNEN, J. (ed.) (1994): *Green Security or Militarized Environment*, Dartmouth.
- KAPLAN, R. D. (1994): The Coming Anarchy. How Scarcity, Crime, Overpopulation, Tribalism, and Disease Are Rapidly Destroying the Social Fabric of Our Planet. In: *The Atlantic Monthly*, February 1994; pp. 44-76.
- KLINGEBIEL, S. (1994): Entwicklungszusammenarbeit und die Flüchtlings- und Migrationsproblematik. In: *Aus Politik und Zeitgeschichte* 44.20; pp. 18-25.
- KLÖTZLI, S. (1996): The Water and Soil Crisis in Central Asia. A Source for Future Conflicts? In: Bächler/Spillmann (1996a); pp. 247-335.
- LEVY, M. A. (1995): Is the Environment a National Security Issue? In: *International Security* 20.2; pp. 35-62.
- LIBISZEWSKI, S. (1996): Water Disputes in the Jordan Basin and their Role in the Resolution of the Arab-Israeli Conflict. In: Bächler/Spillmann (1996a); pp. 337-460.
- LODGAARD, S. / A. H. ORNÅS AF (eds.) (1992): *The Environment and International Security (PRIO Report No. 3)*. Oslo.
- LONERGAN, S. (1997): Global Environmental Change and Human Security. In: *Changes* 5 (special edition); pp. 1-6.
- LUME, W. (1996): The Ecological Background to the Struggle Between Tuaregs and the Central Government of Niger. In: Bächler/Spillmann (1996b); pp. 175-202.
- MATTHIES, V. (1996): Friedenserfahrungsforschung und Friedensursachenforschung. In: Matthies, Volker/Rohloff, Christoph/Klotz, Sabine: *Frieden statt Krieg (Stiftung Entwicklung und Frieden. Interdependenz 21)*, Bonn; pp. 7-17.

- MIALL, H. (1992): Peaceful Settlements of Post-1945 Conflicts. A Comparative Study. In: K. Rupesinghe / M. Kuroda (eds.): *Early Warning and Conflict Resolution*. London; pp. 62–86.
- MIDLARSKY, M. I. (1998): Democracy and Environment. An Empirical Assessment. In: *Journal of Peace Research* 35.3; pp. 341–361.
- MÜLLER, F. (1993): Internationale Konflikte durch Umweltgefährdung. In: *Europa-Archiv* 48: 16; pp. 471–480.
- PFETSCH-HELD, G. / M. PLÖCHL (1997): A Model to Estimate Global Runoff and River Discharges (Potsdam-Institut für Klimafolgenforschung Paper), Potsdam, unpublished manuscript.
- PFETSCH, F. R. (1990): Conditions for Non-Violent Resolution of Conflicts. In: E.-O. Czempiel / L. Kiuzadjan (eds.): *Non-violence in International Crises* (European Coordination Centre for Research and Documentation in Social Sciences). Vienna; pp. 99–123.
- PFETSCH, F. R. (1991a): Internationale und nationale Konflikte nach dem Zweiten Weltkrieg. In: *Politische Vierteljahresschrift* 32.2; pp. 258–285.
- PFETSCH, F. R. (ed.) (1991b): *Konflikte seit 1945*, 5 volumes, Freiburg.
- PFETSCH, F. R. (1993): Der verstehende und der erklärende Ansatz in der internationalen Konfliktforschung. Möglichkeiten und Grenzen quantitativer Konfliktforschung. In: O. W. Gabriel (ed.): *Verstehen und Erklären von Konflikten*. Munich; pp. 33–53.
- PFETSCH, F. R. (ed.) (1996): *Globales Konfliktpanorama 1990–1995*. Münster.
- PFETSCH, F. R. / P. BILLING (1994): *Datenhandbuch nationaler und internationaler Konflikte*. Baden-Baden.
- PFETSCH, F. R. / C. ROHLOFF (1998): *New Trends in Conflict Research*. Paper presented at the III. Pan-European International Relations Conference and Joint Meeting with the International Studies Association. Vienna, 16–19 September.
- PIOOM (1996): *World Conflict Map 1996*. Prepared by PIOOM (Interdisciplinary Research Program on Causes of Human Rights Violations) for FEWER (Forum on Early Warning and Early Response). Leiden.
- ROHLOFF, C. (1996): *Frieden machen! Konzepte und empirische Befunde zu Friedenserhaltung und Friedenssicherung*. In: V. Matthies / C. Rohloff / S. Klotz: *Frieden statt Krieg* (Stiftung Entwicklung und Frieden. Interdependenz 21). Bonn; pp. 18–32.
- ROHLOFF, C. (1998): *Empirische Konfliktforschung und Umweltkonflikte. Methodische Probleme*. In: Carius / Lietzmann 1988; pp. 155–175.
- SHELLHUBER, H.-J. / A. BLOCK / M. CASSEL-GINTZ / J. KROPP / G. LAMMEL / W. LASS / R. LIENENKAMP / C. LOOSE / M. K. B. LÜDEKE / O. MODENHAUER / G. PFETSCH-HELD / M. PLÖCHL / F. REUSSWIG (1997): *Syndromes of Global Change*. In: *GAIA* 6.1; pp. 19–34.
- SCHINDLER, H. (1998): *Konflikte in Südamerika*. Münster.
- SIEGELBERG, JENS (1995): *Umweltprobleme und Gewaltkonflikte aus der Sicht der Kriegsursachenforschung*. In: J. Calliess (ed.): *Treiben Umweltkonflikte in Gewaltkonflikte? Ökologische Konflikte im internationalem System und Möglichkeiten ihrer friedlichen Bearbeitung* (Loccum Protokolle 21/94). Rehburg-Loccum; pp. 67–72.

- SMALL, M. /D. SINGER (1982): Resort to Arms. Beverley Hills, Cal.
- SPRINZ, D. F. (1997): Die Modellierung umweltbedingter Konflikte. Vortrag aus Anlass des Internationalen Workshops "Umwelt und Sicherheit", Wissenschaftszentrum Berlin für Sozialforschung, 3-4 July, Berlin, unpublished manuscript.
- STARR, J. R. (1991): Water Wars. In: Foreign Policy 82; pp. 17-36.
- STONE, C. D. (1992): Beyond Rio. "Insuring" Against Global Warming. In: American Journal of International Law 86; pp. 445-488.
- SULIMAN, M. (1996): Civil War in Sudan. The Impact of Ecological Degradation. In: Bächler/Spillmann 1996a; pp. 109-143.
- SWAIN, A. (1993): Conflicts Over Water. The Ganges Water Dispute. In: Security Dialogue 24.4; pp. 429-439.
- SWAIN, A. (1996): Displacing the Conflict. Environmental Destruction in Bangladesh and Ethnic Conflict in India. In: Journal of Peace Research 33: 2; pp. 189-204.
- THOMAS, C. (1996): Water: A Focus for Cooperation or Contention in a Conflict Prone Region? The Example of the Lower Mekong Basin. In: Bächler / Spillmann 1996b; pp. 65-125.
- TIMOSHENKO, A. S. (1992): Ecological Security. Response to Global Challenges. In: E. Brown Weiss (ed.): Environmental Change and International Law. Tokyo; pp. 413-456.
- TIR, J. / P. F. DIEHL (1998): Demographic Pressures and Interstate Conflict. Linking Population Growth and Density to Militarized Disputes and Wars, 1930-89. In: Journal of Peace Research 35.3; pp. 319-339.
- TRAUTNER, B. J. (1997): Deeskalation und Konfliktbeilegung im Vorderen und Mittleren Orient. Münster.
- UNDP - UNITED NATIONS DEVELOPMENT PROGRAMME (1997): Human Development Report 1997. New York.
- UNDP - UNITED NATIONS DEVELOPMENT PROGRAMME (1998): Analytical Tools for Human Development. In: Internet, <http://www.undp.org/undp/hdro/anatools.htm>, September 1998.
- WBGU - WISSENSCHAFTLICHER BEIRAT DER BUNDESREGIERUNG GLOBALE UMWELTVERÄNDERUNGEN (1993): Welt im Wandel. Grundstruktur globaler Mensch-Umwelt-Beziehungen. Jahresgutachten 1993. Bonn.
- WBGU - WISSENSCHAFTLICHER BEIRAT DER BUNDESREGIERUNG GLOBALE UMWELTVERÄNDERUNGEN (1994): Welt im Wandel. Die Gefährdung der Böden. Jahresgutachten 1994. Bonn.
- WBGU - WISSENSCHAFTLICHER BEIRAT DER BUNDESREGIERUNG GLOBALE UMWELTVERÄNDERUNGEN (1995): Welt im Wandel. Wege zur Lösung globaler Umweltprobleme. Jahresgutachten 1995. Berlin.
- WBGU - WISSENSCHAFTLICHER BEIRAT DER BUNDESREGIERUNG GLOBALE UMWELTVERÄNDERUNGEN (1996): Welt im Wandel. Herausforderung für die deutsche Wissenschaft. Jahresgutachten 1996. Berlin.
- WBGU - WISSENSCHAFTLICHER BEIRAT DER BUNDESREGIERUNG GLOBALE UMWELTVERÄNDERUNGEN (1998): Welt im Wandel. Wege zu einem nachhaltigen Umgang mit Süßwasser. Wissenschaft. Jahresgutachten 1997. Berlin.
- WESTING, A. H. (ed.) (1989): Comprehensive Security for the Baltic. An Environmental Approach. London.

- WESTING, A. H. (ed.) (1997): Environmental Warfare. Manipulating the Environment for Hostile Purposes. In: Environmental Change and Security Project, Report 3; pp. 145–149.
- WÖHLCKE, M. (1996): Sicherheitsrisiken aus Umweltveränderungen (Stiftung Wissenschaft und Politik, Paper No. SWP-AP 2977). Ebenhausen.
- WOLF, A. T. 1997: International Water Conflicts and Conflict Resolution. "Water Wars" and Water Reality. Seattle.
- WOODROW WILSON CENTER (eds.) (1997): Environmental Change and Security Project, Report 3. Washington, D.C.
- WORLD BANK (1997): World Development Indicators CD-ROM. Washington, D.C.
- ZIMMERMANN, H.-J. (1992): Fuzzy Set Theory – and Its Applications, 2nd revised edition. Dordrecht.
- ZÜRN, M. (1995): Globale Gefährdungen. Auf dem Weg zu einer Weltrisikogesellschaft? In: Calliess, Jörg (ed.): Treiben Umweltkonflikte in Gewaltkonflikte? Ökologische Konflikte im internationalem System und Möglichkeiten ihrer friedlichen Bearbeitung (Loccumer Protokolle 21/94). Rehburg-Loccum; pp. 229–262.