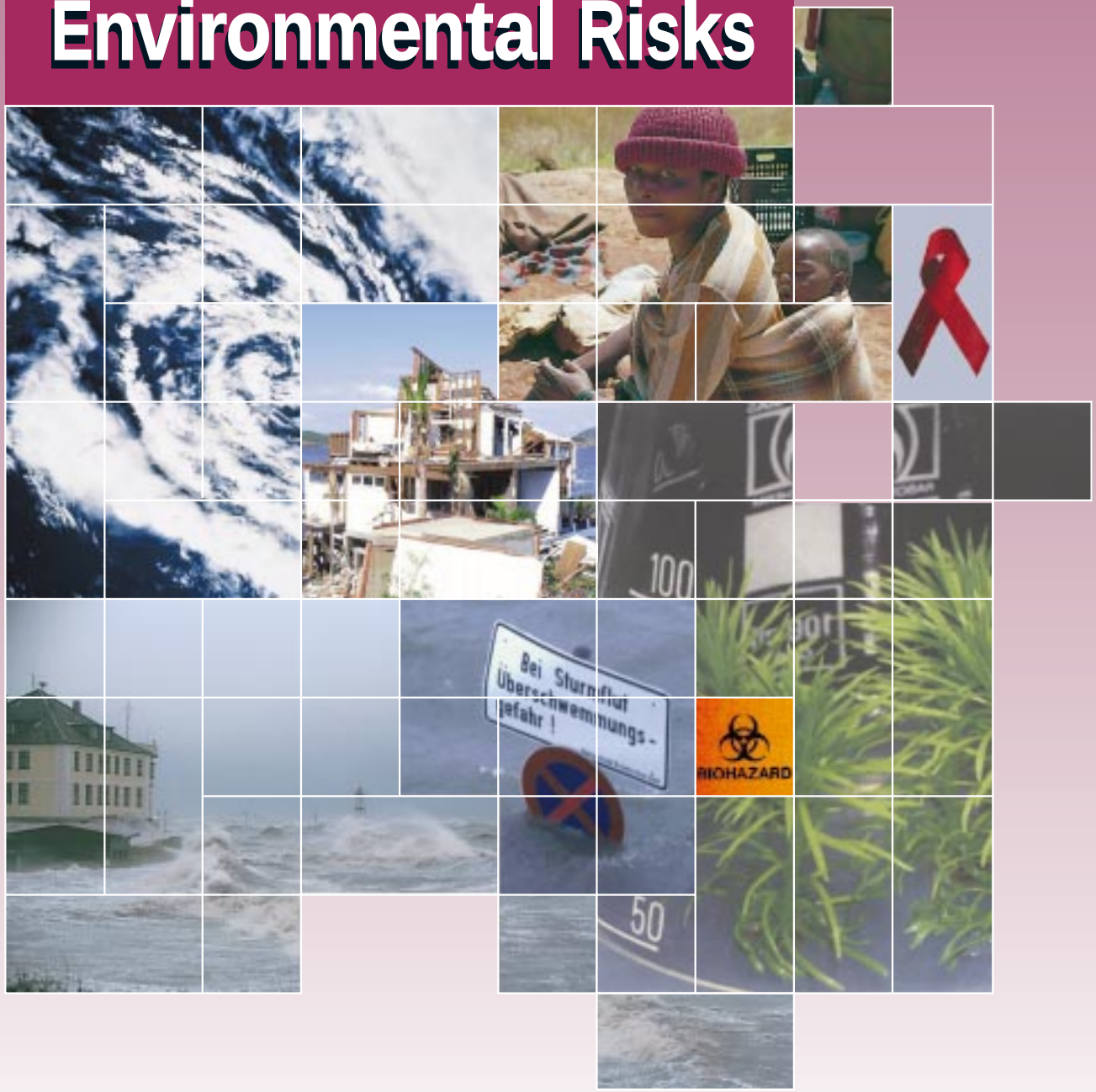
World in Transition

Strategies for Managing Global Environmental Risks

German Advisory Council on Global Change (WBGU)

Annual Report 1998

Executive Summary



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World in Transition:

Strategies for Managing Global Environmental Risks

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The full Report will be published by Springer Verlag, Berlin - Heidelberg - New York
in autumn 1999.

ISBN 3-9806309-3-5

Imprint:

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Translation: Christopher Hay, Darmstadt

Cover design: Erich Kirchner, Heidelberg using the following illustrations
Satellite image of a thunderstorm. Source: Pure Vision Photo Disc Deutschland GmbH
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Copy deadline: 20.11.1998

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Global change: A fresh approach to new risks

Global risk potentials and their interplay with economic, social and ecological processes of change have emerged as a novel challenge to the international community. Never before has human intervention in nature assumed global dimensions. This has been driven on the one hand by a growing global population, particularly in developing countries, and on the other hand by rising human aspirations in conjunction with specific patterns of production and consumption (throughput growth), above all in industrialized countries. By presenting this report, the Council hopes to contribute constructively to an effective, efficient and objective management of the risks of global change. The approach taken by the Council is to:

- identify a *taxonomy of globally relevant risks* and highlight the particularly relevant classes of risk;
- link both established and innovative risk assessment strategies and corresponding risk management tools to these classes, in order to define *management priorities*.

The approach taken to generate and apply knowledge relating to the identification and management of risks is a decisive element in the quest for ways to deal with global risks. It is plain enough that it is essential to depart from the principle of 'trial and error' that has until now dominated in empirical science. An error with global consequences can lead to unacceptable damage. In a globally intermeshed world, in which disasters can assume global proportions more rapidly than ever before, letting events run their course and mitigating any damage that may arise is not an ethically acceptable principle. In the past, environmental risks were generally restricted to the regional level. For instance, while the deforestation of ancient Greece has significantly impaired the utilization potentials of the soil there through erosion and karstification, these environmental impairments have remained locally contained. By contrast, many of today's environmental risks are global by nature. If the Gulf Stream ceases, sea levels rise or a new Spanish Influenza pandemic afflicts the world, then the consequences for the whole of humanity will be so incisive and conceivably also irreversible that – even if the probability of these events occurring is slight – timely counterstrategies are essential. The more far-reaching the possible effects and the fewer avenues for compensation there are, the more important a risk policy centered on precautionary measures becomes, in order to prevent global disasters as far as possible.

At the same time, however, it is impossible to safeguard against all global risks, particularly as opportunities will always entail risks. The American sociologist Aaron Wildavsky has fittingly characterized this dilemma: "No risk is the highest risk at all". This is why a further hope placed by the Council in the present report is that it may contribute to an approach in which the expedient combination of licensing procedures, state regulation, liability rules and the application of state-enforced precautionary principles may enhance confidence in the management capacities of modern societies and may thus help to make the international risk debate more rational and objective. By 'rational' we do not mean blaming the potential victims for their understandable aversion to tolerate risks. Still less do we wish to play down the severity of global risks. By an objective approach the Council rather means the urgent necessity to face real hazards – with all the associated uncertainties and ambiguities – in a manner that is targeted, rational and efficient, while at the same time exploiting the opportunities associated with taking risks. Without a willingness to venture upon risks, there will be no innovation. Without innovations, in turn, the economic and ecological problems of the world will remain unsolved. We need to steer a prudent middle course between boldness and caution.

Charting this middle course is hampered by the circumstance that empirically oriented research is not in a position to prove experimentally – not to mention predict – the consequences of global environmental risks. Although partial aspects of global risks can indeed be analyzed in model experiments, opportunities to carry out empirical experiments on global effects are limited for obvious reasons. For example, no one will wish to try out whether an event in a nuclear power plant that slightly exceeds the most

credible accident scenario really leads to the predicted impacts upon human health and the environment. Geophysical risks place even greater constraints upon empirical testing.

For the first time in human history, anthropogenic emissions account for a substantial proportion of geochemical cycles in nature. Measurements can reflect the dynamics and distribution of concentrations, but tell us little about long-term consequences. Attempts to model these consequences in the laboratory at a smaller, scaled-down level soon meet the limits of transferability. Here science is largely dependent upon analogies (for instance in the sphere of medical risks) or computer simulation (for instance in the sphere of climate risks). As yet, however, non-linear processes and complex cause-effect patterns in nature can only be captured to a limited extent by modeling, simulation or other analytical tools. If we further consider that ecology is a field particularly characterized by these non-linear and complex cause-effect chains, then scientific forecasts are inescapably subject to large uncertainties and ambiguities. Even where the greatest efforts are applied, these uncertainties and ambiguities can only be reduced to a certain extent (Section E). Risk policy is thus inescapably bound to seek an objectively appropriate and ethically acceptable pathway in a cloud of uncertainty, gaps in knowledge, ambiguity and indeterminacy (Section G).

Against this backdrop, the Council hopes that its annual report may promote, through its painstaking analysis and assessment of the risks of global change, an objective debate on the acceptability of risks. In its previous reports, each focusing on a specific domain of global change, the Council has identified *'guide rails'* for these domains that cannot be crossed without incurring excessive damage to humanity and the environment. The present report identifies such guide rails for the domain of global risks, too. Where activities constitute a risk, the guide rails are extended to form a boundary zone – a *critical zone*. If a risk falls in the boundary zone, then particular care and special precautions need to be taken.

In the opinion of the Council, the risks inherent in global change can only be estimated with sufficient accuracy and managed effectively through applying a systemic approach. The impact areas characteristic of the human-environment relationship overlap in many ways, forming a complex structure of triggers, modulators and effects. For instance, the risks of climate change, biodiversity loss, soil degradation and food insecurity interlock with typical manifestations of global change such as urbanization, population growth, migration or impoverishment. Political factors (e.g. human rights, type of governance, institutional stability and credibility) also play a crucial role here.

As a matter of principle, the risks of global change should be tackled as closely as possible to the individual generators of risk, i.e. where possible at the local or regional level. In this respect, the Council endorses a management philosophy that initially largely relies on the liability principle. However, this requires appropriate structural conditions in the individual countries. Where these are not given, they would need to be created. Particularly where the severity of their effects is largely uncertain, many global risks further require a supraregional and state or international regulation (Section H 2).

It is not only the inherent characteristics of global problems that call for global policies provisioning against risks. It is also the asymmetries among individual countries in their capacity to manage such risks effectively and efficiently that point to the necessity of international efforts to put in place a supranational system of cooperation and coordination in risk prevention and emergency planning. The Council sees such disparities particularly in the capacities to identify and assess global risks, in the corresponding management competency and in the vulnerability to the risks of global change. For instance, the governments of some developing countries are inadequately able to assess new risks and to take effective countermeasures, or are only able to do so after some delay. This is compounded by the circumstance that many countries have not established strong institutional provisions for risk management and emergency planning. Structural deficits and problems of implementation also need to be noted here. This is why the Council accords particular importance to financial and technical development cooperation in global policy. Furthermore, risks of global change that affect internationally highly valued assets or that can be expected to develop global impacts call for management at the global level. This is exemplified by the prospect of a global food security crisis (Section E 3.2), global climate change (Section D 6) or the spread of 'old' and new pandemics (Sections D 3 and E 3.1).

Given the great number of risks and possible threats on the one hand and the undisputed necessity to promote innovation and technological development on the other, the Council hopes to have developed an approach that is appropriate to the phenomenon of risk, while also being practicable and making a contribution to structuring global change in a way that limits risks and extends opportunities. This approach combines the 'guide rail' philosophy, emphasis on the liability principle and a management oriented classification of classes of risk. Core elements of this concept include measures to improve the use

of existing knowledge or by which to generate new knowledge, and strategies aimed at 'containing' risks. For each class of risk, graduated responses and appropriate tools for containment are elaborated (Section H 2).

The decision-making support provided by the following strategies for action thus pursues the guiding objective of ensuring that, while the capacity for action and innovative vigor of the international community does not slacken or even retract into unproductive wariness, the hazard potentials of global risks are not ignored but rather taken to heart and tackled in a precautionary fashion. These recommendations build upon the taxonomy of risk that the Council has developed for this report. These classes of risk are characterized in detail in Section C and are used in Section H to substantiate class-specific strategies. These classes are further discussed in the proposals for handling deficits in knowledge (Section G 4) and for managing global risks (Section F 6).

2 Localizing risks in normal, transitional and prohibited areas

The risks to which humanity is exposed are almost beyond number. Some of these risks are associated with natural processes and events, while other have been created or intensified by human activities. The fundamental dilemma is that all human activities can be associated with unintended side effects, while at the same time human needs cannot be met without such activities. Taking risks is thus a necessary element of human behavior and indeed a precondition to economic and social development. At the same time, an accumulation of risk threatens the continued viability of a society. As set out above, a middle course needs to be charted between taking opportunities and containing risks.

The Council is convinced that there is no simple recipe for assessing risks. In view of divergent preferences and states of development worldwide, risks must be viewed as heterogeneous phenomena that preclude standardized assessment and handling. At the same time, however, risk policy would be overburdened if it were to develop and employ a special strategy for the assessment of the risk of each individual activity. The Council views a categorization of the various risks in risk classes to be expedient, in a manner similar to that already commonly applied today in the assessment of toxicological risks. Categorization in these risk classes is guided above all by the basic concern to develop class-specific procedures and management rules that permit handling risks in a way appropriate to the individual risk and commensurate to the need for risk containment.

The procedure for handling risks recommended by the Council can be represented as a simple *decision tree* (Fig. 2-1). If an operator, a regulatory authority or any other group interested in an activity or technology that constitutes a risk needs to assess this risk, then the questions should be answered in the order that is posed in the decision tree. At the top of the tree we find the question whether the risks of a new activity or technology are sufficiently known for there to be reasonable grounds to assume a causal link between the risk cause and possible adverse effects, and, further, whether the potential severity of effects can at least be identified and the probabilities of these effects occurring roughly estimated. If the risks are entirely or largely unknown, then the classic precautionary strategies are called for, consisting of three parts:

- first, a prudent further development of risk-generating activities that is informed by risk containment or limitation;
- second, strengthening the resilience of affected systems; and
- third, intensifying research efforts in order to permit in future an unequivocal categorization according to the various classes of risk and in order to identify possible side effects early on.

Finally, an early warning system for the perception and researching of risks needs to be established (Section G 4).

If the first question leads to the conclusion that there are reasonable grounds to assume a causal link between a specific cause and effect, that the magnitude of potential damage is largely identifiable and that probabilities can be roughly estimated, then the second question arises of whether the risk is situated in the 'normal area', 'transitional area' or 'prohibited area'. The distinction between these three areas is set out in detail in Section C, and graphically illustrated in Fig. 2-2. Risks in the *normal area* have the following characteristics:

- low uncertainties regarding the probability distribution of damage,
- in total, a small catastrophic potential,
- low to medium uncertainty about both the probability of occurrence and the associated magnitude of damage,
- low statistical confidence intervals with respect to probability and magnitude of damage,
- low levels of persistency and ubiquity (scope in time and space),
- high reversibility of potential damage, and
- low potential for social conflict and mobilization (above all, no distinct inequities resulting from discrepancies in the assessments made by the group that is exposed to the risk and the group to which opportunities and benefits accrue).

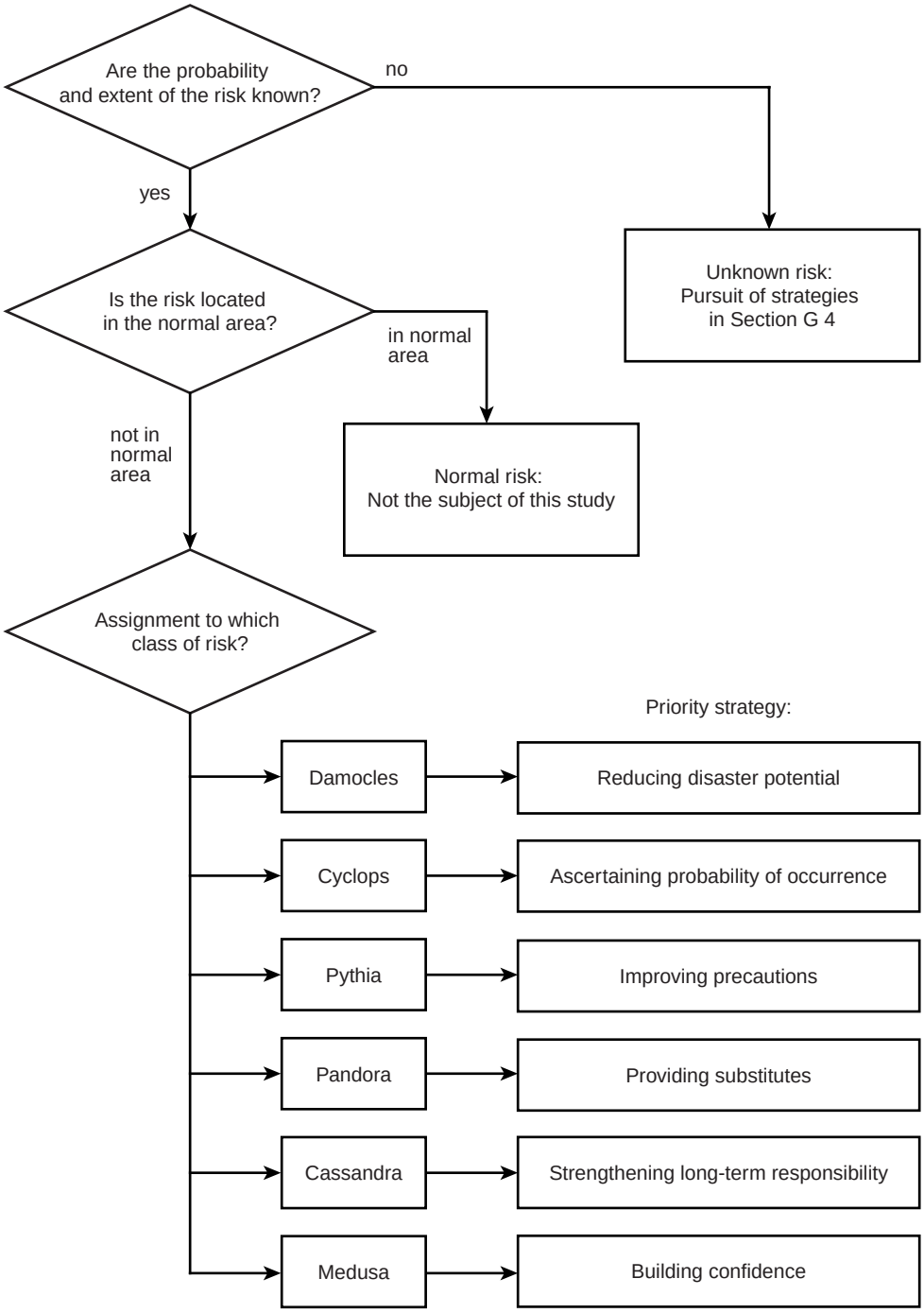

Figure 2-1
Decision tree for classifying the risks of global change.
Source: WBGU

In this 'normal' case a simple link of probability and severity through multiplication, with due consideration to respective variances, is expedient and appropriate, as practiced for many years in technical risk analysis and in the insurance industry. If the two factors – probability and severity – are relatively small, then the product of the two falls in the normal area. For politicians, risks situated in this area indicate the 'routine case', for which, at least in Europe and in many other countries, the existing laws and regula-

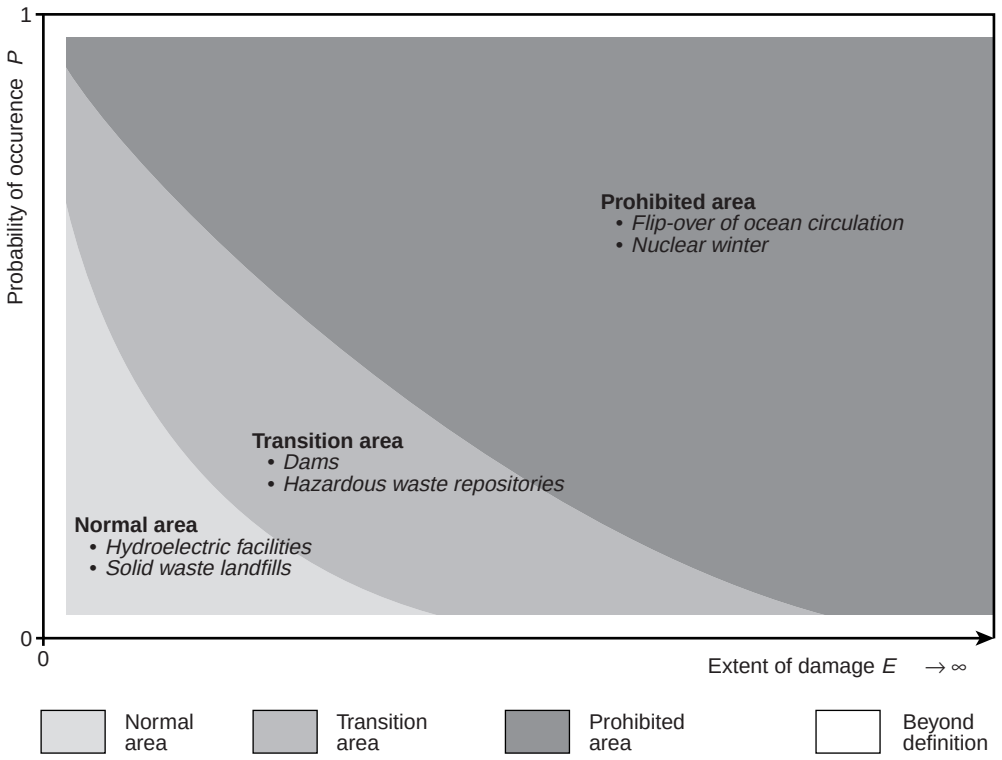

Figure 2-2
Normal, transition and prohibited areas.
Source: WBGU

tions generally suffice. Indeed, further deregulation could even be considered here. At the international level, too, the Council sees no immediate need for action on normal risks other than making sure that proper management procedures are in place.

Most risks will already have been sieved out after the second question. The definition of a normal area thus allows effective and innovation-promoting policies that permit opportunities to be taken. Under such policies, opportunities and risks can be compared and weighed systematically.

The situation becomes more problematic when risks touch areas that significantly transcend everyday levels. The *transitional area* is reached if one or more of the following conditions are met:

- the damage potential is high,
- the probability of occurrence is high, approaching 1 (where none of the other conditions is given, this case is not so relevant at the global level),
- the uncertainty of the probability distribution of adverse effects is high,
- the confidence intervals of probability and magnitude of damage are large,
- persistency, ubiquity and irreversibility are particularly high, whereby there must be reasonable grounds to assume a causal link between trigger and effects, and
- for reasons of perceived distributional injustice or other social and psychological factors, a major potential for conflict or mobilization is to be expected (migration, refusal, protest, resistance).

If one of these conditions is given, then the product of probability and severity will usually be in the transitional area. If the high level of risk is further joined by a low benefit or a low expectation of opportunity, or if the product of the two components of risk assumes extreme levels, then the risk is situated in the *prohibited area*. This area is also easy to handle. In the prohibited area, the consequences to be expected from taking a risk are so severe that risk reduction is unconditional. In extreme cases, the proper response here is an immediate ban or moratorium.

Handling risks in the transitional area is more problematic. Here either relatively high factor products or high uncertainties are to be expected, or one of the exacerbating assessment dimensions is clearly violated (Section C 3). These include the criteria of *irreversibility* (damage cannot be remedied), *persistency* (contaminants accumulate over long periods), *ubiquity* (contaminants spread worldwide) and *mo-*

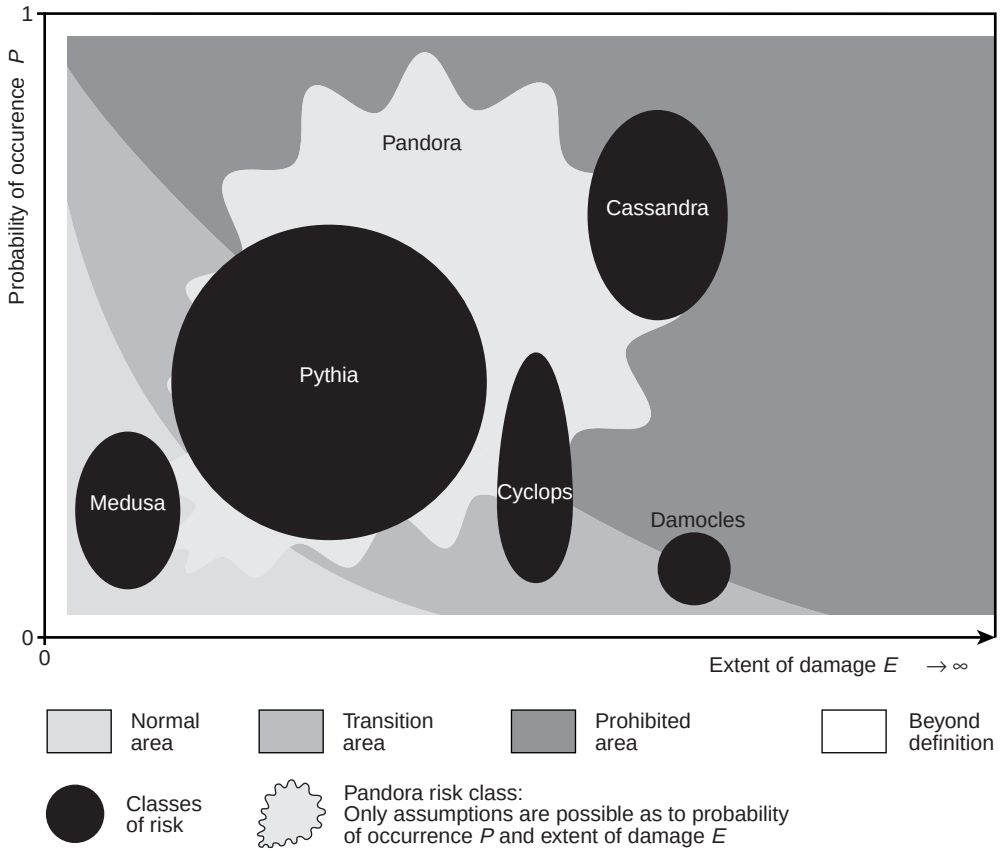

Figure 2-3
Classes of risk and their location in the normal, transition and prohibited areas.
Source: WBGU

bilization (risks lead to severe conflicts and dread among the general public). A special case is to be seen in risks that combine high severity with high probability. Normally, such risks will not be permitted at all and are situated in the prohibited area without much further discussion. However, if a sufficiently lengthy period (delay effect) lies between the triggering event and the occurrence of damage, then decision-makers are often not aware of or easily dismiss the problems associated with such a risk. Such risks are effectively unacceptable, but are frequently not perceived as such, neither politically nor socially.

If thus the answer to the second question in the decision tree places a risk in the transitional area, risk policy must proceed with particular caution. In this case we need to move on to the next question in the decision tree and to assign the risks to certain risk classes, as specific strategies need to be chosen for each class. The localization of the risk classes developed by the Council is shown in Fig. 2-3.

3 Categorization according to risk classes

The task of the decision-maker at this node in the decision tree is thus to categorize risks located in the transitional area according to specific classes. How are these classes of risk defined? The characteristics of the 6 classes identified by the Council are described in detail in Section C and are summarized here in Table 3-1.

Damocles

Greek mythology reports that Damocles was once invited by his king to a banquet. However, he was obliged to take his meal under a razor-sharp sword hanging above him on a fine thread. For Damocles, opportunity and danger were closely linked, and the 'Sword of Damocles' has become a byword for a happy situation overshadowed by danger.

However, the thread seems to have been quite strong, for the fable tells us nothing of its having torn with deadly consequences. The threat was expressed as the possibility that, at any point in time, if albeit with low probability, an event deadly to Damocles could occur. This class of risk accordingly comprises sources of risk that have a very high catastrophic potential but where the probability that this potential manifests itself as damage is considered to be conceivably low. Nuclear power plants, large-scale chemical facilities and dams are examples. In addition to large-scale industrial risks, various types of natural disaster also fall within this class. In a fashion similar to the large-scale technology risks, natural disasters with known damage-probability functions entail major damage potentials in conjunction with usually low probabilities of occurrence, as is for instance the case for meteorite impacts. However, in contrast to large-scale technology risks, the potential for political mobilization and the pressure to implement precautionary risk management is weak for natural risks. In societal discourse, natural disasters tend rather to be attenuated, while technological risks tend rather to be amplified (Kasperson et al., 1988).

Cyclops

Ancient Greek mythology tells of mighty giants who, for all their strength, were limited by having only one single, round eye, which was why they were called "round eyes" or Cyclopes. With only one eye, only one side of reality can be perceived. In the Cyclops class, the probability of occurrence is largely uncertain, while the maximum damage is well defined. A number of natural events such as floods, earthquakes and El Niño fall in this class, as does the occurrence of AIDS, wherever there is no or only contradictory information about the probability of occurrence.

Pythia

When in doubt, the ancient Greeks consulted one of their oracles, among which the most famous was the Delphic Oracle with its blind seeress Pythia. However, Pythia's answers always remained unclear: Pythia's prophecies illustrated that a major danger might be impending, but not how large its probability of occurrence, its severity or its distribution might be. Thus Pythia prophesied to King Croesus that if he were to attack Persia he would destroy a great empire. Belligerent Croesus failed to realize that this meant his own empire. The Pythia class thus involves, for definable damage, a high degree of uncertainty as to possible adverse effects and as to the probability of the risk's occurrence. The potential for damage can be stated, but the scale of damage is still unknown. This class includes risks associated with the possibility of sudden non-linear climatic changes, such as the risk of self-reinforcing global warming or the instability of the West Antarctic ice sheet, with far more disastrous consequences than gradual climate change. It further includes far-reaching technological innovations such as certain applications of genetic engineering, for which neither the precise level of risk nor the probability of certain damaging events occurring can be estimated at the present point in time.

Pandora

This class of risk includes such risks that have persistent, ubiquitous and irreversible effects. Persistent organic pollutants (POPs), which remain stable over long periods in the environment, are a typical example of this. Often the effects of these risks are still un-

Table 3-1
Overview of risk classes: Characterization and substantive examples. *P* signifies the probability of occurrence and *E* the extent of damage.
Source: WBGU

Risk class	Characterization	Examples
Damocles	*P* is low (towards 0) Certainty of assessment of *P* is high *E* is high (towards infinity) Certainty of assessment of *E* is high	• Nuclear energy • Large-scale chemical facilities • Dams • Meteorite impacts
Cyclops	*P* is uncertain Certainty of assessment of *P* is low *E* is high Certainty of assessment of *E* tends to be high	• Floods • Earthquakes • Volcanic eruptions • AIDS infection • Mass development of anthropogenically influenced species • Triggering of nuclear, biological and chemical weapons systems • Collapse of thermohaline circulation
Pythia	*P* is uncertain Certainty of assessment of *P* is low *E* is uncertain (potentially high) Certainty of assessment of *E* is unclear	• Self-reinforcing global warming • Release and spread of transgenic plants • BSE/nv-CJD infection • Certain genetic engineering applications • Instability of the West Antarctic ice sheets
Pandora	*P* is uncertain Certainty of assessment of *P* is unclear *E* is uncertain (only assumptions) Certainty of assessment of *E* is unclear Persistency is high (several generations)	• Persistent organic pollutants (POPs) • Endocrine disrupters
Cassandra	*P* tends to be high Certainty of assessment of *P* tends to be low *E* tends to be high Certainty of assessment of *E* tends to be high Long delay of consequences	• Gradual human-induced climate change • Destabilization of terrestrial ecosystems
Medusa	*P* tends to be low Certainty of assessment of *P* tends to be low *E* tends to be low (exposure high) Certainty of assessment of *E* tends to be high Mobilization potential is high	• Electromagnetic fields

known, or there are at most reasonable grounds to assume their adverse effect. The Council has named these risks after Pandora. The ancient Greeks explained many ills of their times with the myth of "Pandora's Box", a box that was brought down to the Earth by the beautiful Pandora created by Zeus, but that only contained evils. As long as the evils remained in the box, no damage was to be feared. If, however, the box was opened, all of the evils contained in it were released, then to plague the Earth irreversibly, persistently and ubiquitously.

Cassandra

Many types of damage occur with high probability, but in such a remote future that for the time being no one is willing to perceive the threat. This was the problem of Cassandra, a seeress of the Trojans, who correctly predicted the danger of a victory of the Greeks, but was not taken seriously by her countrymen. The Cassandra class of risk thus harbors a paradox: Both the probability of occurrence and the damage potential are known, but because the damage will only occur after a long period there is little concern in the present. Risks of the Cassandra class are only then of interest if the damage potential and the probability of occurrence are both relatively high. This class is accordingly located in the prohibited area. If the time interval were shorter, the regulatory authorities would most probably intervene. The distant time horizon between trigger and consequence easily creates the fallacious impression of security. A typical example of such an effect is gradual anthropogenic climate change, which can trigger severe damage in vulnerable areas such as coastal and mountain zones.

Medusa

In classical mythology, Medusa was one of 3 cruel Gorgon sisters whose sight alone made people turn into stone. Some novel phenomena have an effect on modern people in a way similar to that in which the Gorgons, as purely imaginary figures of fable, aroused fear and terror. Some innovations are reject-

ed even if scientists scarcely view them as dangerous. Such phenomena have a high potential for public mobilization, as did once the fear of the actually nonexistent Gorgon sisters. According to the best knowledge of the risk experts, risks of this type are located within the normal area, but, due to certain characteristics of the risk source, are a particular source of dread that leads to massive rejection (a criterion for mobilization). A good example of such mobilization is given by the concern over the carcinogenic effect of electromagnetic radiation in low concentrations.

The risks in the Damocles or Cyclops classes are more characterized by sudden occurrence, while the risks in the Medusa, Cassandra and Pandora classes tend rather to involve gradual dangers that also arise in 'normal operations'. The Pythia class includes both accidents and accumulative effects through continuous emissions.

Class-specific strategies and tools for action 4

These 6 classes of risk call for specific strategies. The associated tools (Section H 2.1) are presented here in summary and listed in the following Tables (Tables 4-1 to 4-6). The Council makes important recommendations for the classic fields of action of risk policy elsewhere in this report (Section H 2.2). The goal of the specific strategies for the risk classes identified here is to shift these from the prohibited or transitional area into the normal area (Section 4). The aim is thus not to reduce risks down to zero, but to a level that permits routine management. Both the strategies and the tools or measures are listed in receding order of priority. Naturally, more than one strategy and more than one tool will be necessary in most cases. If, however, a limited selection must be made, the items at the top of the list should be considered first.

Strategies for the Damocles risk class

For Damocles-type risks, the Council recommends 3 prime strategies: Firstly, reducing disaster potential through research and technological measures, secondly, strengthening resilience, i.e. the robustness of a system against surprise, and finally, ensuring effective disaster management (Table 4-1).

The 1st strategy – reducing damage potential and preventing the occurrence of damage – is concerned with improving technological measures to reduce the disaster potential and with researching and implementing measures to contain the spread of damage. In nuclear energy, for instance, the main strategy implemented in the past has been to further minimize the probability of occurrence of core meltdown by means of technological barriers. This has not been adequate to move this risk from the transitional area into the normal area. Design changes aimed at reducing the disaster potential would have been more expedient (and this is indeed the avenue now pursued). The Council further recommends introducing or strengthening liability rules, which can provide an incentive to improve knowledge and to reduce residual risks. It is further necessary to research and develop alternatives to technologies with unavoidably high disaster potential, and to substitute them with others whose disaster potential is significantly lower. Under certain conditions, this can require subsidization in the introductory and trial phase.

The 2nd strategy is aimed at enhancing resilience to risk potentials. This necessitates strengthening the overarching institutional and organizational structures that impact upon licensing procedures, monitoring, training etc. At the same time, liability law can promote a careful approach to these risks. In addition, technological methods for enhancing resilience need to be introduced or improved. This can be done through, for instance, redundant design measures for technologies and safety-relevant organizational units, through introducing leeway, buffers and elasticity (error-friendly systems) and through diversification, i.e. thinly spreading risk potentials or sources. Organizational forms and proven licensing procedures that are viewed as resilient should be made available to other states, as a template or model, through the transfer of technology and knowledge. Furthermore, international control and monitoring needs to be strengthened, and an international safety standards authority established.

Disaster management is the third and last priority among the strategies for action in this risk class. While not unimportant, this should nonetheless be subordinated to risk-reducing strategies as a back-end strategy aimed at limiting damage. Here, as before, human resources and institutional capacities need to be further strengthened by developing and promoting national emergency planning, preparedness and response programs. Through technology and knowledge transfer, the emergency planning measures and techniques that have proven themselves in many industrialized countries can be passed on to local risk managers in the form of education, training and empowerment. Finally, international, precautionary disaster relief, such as is aimed at under the aegis of the International Decade for Natural Disaster Reduction (IDNDR) initiated by the UN, is also requisite to counter human-induced disasters.

Strategies for the Cyclops risk class

Among the measures and tools for the Cyclops class, determining the probability of occurrence has

Strategies	Tools
1. Reducing disaster potentials	• Research aimed at developing substitutes and reducing the disaster potential • Technological measures for reducing the disaster potential • Stringent liability regimes • International safety standards authority • Subsidization of alternatives that have equal utility • Containment (minimizing the spread of damage) • International coordination (e.g. to mitigate meteorite hazards)
2. Strengthening resilience	• Human-resource and institutional capacity building (licensing procedures, monitoring, training etc.) • International liability commitments • Expansion of technological procedures by which to improve resilience (redundancy, diversity etc.) • Blueprint for resilient organizations • Model role: Licensing procedures • International controls (IAEA)
3. Emergency management	• Human-resource and institutional capacity building (emergency prevention, preparedness and response) • Education, training, empowerment • Technological protective measures, including containment strategies • International emergency groups (e.g. fire services, radiation protection etc.)

Table 4-1
Strategies and tools for the Damocles risk class. The main problem in this class is the high disaster potential. Source: WBGU

supreme priority. This calls for promotion of the necessary research (Table 4-2). Furthermore, international monitoring needs to be ensured through national and international risk centers. Here, the Council relies above all upon the establishment of a UN Risk Assessment Panel, whose task would be to network the national risk centers and to collate and evaluate the knowledge gained about global risks. The tasks, structure and functions of this Panel are explained in detail in Sections F 6.3.1 and H 2.2.

The 2nd strategy for action is aimed at preventing undesirable surprises and safeguarding society against these. One option for doing this is to introduce a strict liability regime. Under certain preconditions, mandatory insurance (or possibly a fund model) should be considered. The tools for strengthening human-resource and institutional capacities and the technological measures correspond largely to those set out for the Damocles class above.

The 3rd strategy, disaster management, applies the same tools as in the Damocles class.

Strategies for the Pythia risk class

In the Pythia class, which is characterized by particularly high uncertainties concerning both components of risk – probability and severity – it is similarly necessary to improve knowledge, particularly in basic research (Table 4-3). However, as compared to the Cyclops class, an even stronger focus needs to be placed on precautionary strategies, as the liability principle can possibly only be enforced to a limited extent and the severity of effects can assume global proportions. Regulatory impositions and containment measures are generally indispensable in this area.

Concerning precautions, the Council recommends pursuing a strategy that employs tools such as the ALARA (As Low As Reasonably Achievable) principle or the 'best available scientific knowledge and technology' test, under which the sum of the costs of not implementing risk reduction policies plus the costs of risk reduction policies implemented is to be kept as low as possible. Limiting the sphere of action and impacts in which the risk is permitted is also an important precautionary tool. The severity of an unpredictable disaster can thus be contained expediently. Instruments of liability law are in principle recommendable here, too, but are possibly not always enforceable. This is why the use of fund models should also be considered. Global Pythia-type risks call for international institutions in order to carry out controls and monitoring and to put in place safety precautions. Tools aimed at containing the spread of damage, strengthening human resources and institutional capacities and improving resilience have already been discussed for the previous two classes of risk.

The second strategy is to improve knowledge in order that future risk analyses can deliver more reliable appraisals. This necessitates research to identify probabilities and possible severities. An internation-

Table 4-2
Strategies and tools for the Cyclops risk class. The main problem in this class is the uncertainty of occurrence.
Source: WBGU

Strategies	Tools
1. Ascertaining the probability of occurrence *P*	• Research to ascertain numerical probability *P* • International monitoring through – National risk centers – Institutional networking – International Risk Assessment Panel • Technological measures aimed at estimating probabilities
2. Preventing surprises	• Strict liability • Compulsory insurance for risk generators (e.g. floods, settlements) • Capacity building (licensing procedures, monitoring, training etc.) • Technological measures • International monitoring
3. Emergency management	• Human-resource and institutional capacity building (emergency prevention, preparedness and response) • Education, training, empowerment • Technological protective measures, including containment strategies • International emergency groups (e.g. fire services, radiation protection etc.)

al early warning system is further necessary here, as in the Cyclops class.

The specific tools of damage management are very similar to those of the previous risk classes. The distinguishing feature here is the limitation of damage severity through local restrictions upon risk-generating activities.

Strategies for the Pandora risk class

The Pandora class of risks is characterized by uncertainty as to both probability and severity (only assumptions) and by high degrees of persistency and ubiquity (Table 4-4). As the negative effects of these risk sources are still unknown, but can, in the worst case, assume global proportions with irreversible consequences, there is an urgent need for research efforts to develop substitute substances, and for regulatory measures aimed at containing or reducing these sources of risk. Implementation needs to cover the international context, too.

In the Pandora class, the provision of substitute substances or processes has priority over all other

Table 4-3
Strategies and tools for the Pythia risk class. The main problem in this class is the low certainty of assessment, in conjunction with plausible scenarios suggesting high damage potentials. *P* signifies the probability of occurrence and *E* the extent of damage.
Source: WBGU

Strategies	Tools
1. Improving precautions and mitigating effects	• Institutionalized, precautionary technical standards such as ALARA, BACT, state-of-the-art etc. • Fund solutions • Mitigation (minimizing the spread of damage) • International agreements on control, monitoring and safety measures • Human-resource and institutional capacity building (licensing procedures, monitoring, training etc.) • Technological measures aimed at enhancing resilience (redundancy, diversity etc.)
2. Improving knowledge	• Research to ascertain *P* and *E* • International early warning structure through: – National risk centers – Institutional networking – International Risk Assessment Panel • State-sponsored (basic) research
3. Emergency management	• Containment strategies • Human-resource and institutional capacity building (emergency prevention, preparedness and response) • Education, training, empowerment • Technological protective measures • International, rapidly deployable task forces (e.g. for decontamination)

Strategies	Tools
1. Developing substitutes	• Research aimed at developing substitutes • Technological measures aimed at disseminating and enforcing substitutes • Promotion of basic research • Subsidization of alternatives that have equal utility
2. Enforcing restrictions upon substance quantities and dispersal, through to outright bans	• Regulatory limitation of quantities, through – environmental standards or – incentive schemes (certificates) • Strict liability, where appropriate • Improving and extending retention/containment technologies • Command-and-control limit values and bans • Capacity building (technological know-how, technology transfer, training) • Joint Implementation
3. Emergency management	• Human-resource and institutional capacity building (emergency prevention, preparedness and response) • Technological protective measures, including containment strategies • Education, training, empowerment

Table 4-4
Strategies and tools for the Pandora risk class. The main problem in this class is the uncertainty of both the probability and extent of damage, in conjunction with high degrees of persistency and ubiquity.
Source: WBGU

strategies. As concerns researching and developing substitutes, the same applies in principle as in the Damocles class. Beyond this, the Pandora class requires wide-ranging basic research that needs to be promoted accordingly.

In a 2nd step, the risk potentials should be reduced by minimizing, locally containing or even completely prohibiting certain sources of risk. Here, both a command and control approach is suitable, for instance through quantitative restrictions by means of environmental standards, and economic incentive systems using certificates can be applied. In some cases, the implementation of a strict liability regime is also appropriate. Technological approaches to risk reduction and strengthening human resources and institutional capacities apply as in the previous classes of risk.

Strategies for the Cassandra risk class

With Cassandra-type risks, there is scarcely any uncertainty, but people dismiss these risks in view of their gradual form or the time lag between triggering event and occurrence of damage (Table 4-5). Frequently, the short-term legitimization of politicians brought about by short periods of office leads to a lack of motivation to tackle such long-term threats. Here, the Council takes the view that long-term responsibility needs to be strengthened worldwide, by means of collective self-commitments (such as codes of behavior of multinational corporations), by means of global institutions with a long-term perspective (UN Risk Assessment Panel) and by means of international conventions. To minimize the risks themselves, restricting the emissions of substances is a suitable tool.

Where there is a substantial time lag between triggering event and damaging effect, appropriate instruments need to be used to strengthen long-term responsibility to future generations. Here, the Council relies primarily upon voluntary commitments of states and important actors (such as multinational corporations or reinsurers). Fund models may also be useful here. At the more individual level, potentially affected persons can gain more capacity for action through a combination of participation and empowerment, thus receiving impulses for long-term responsibility vis-à-vis their own life world.

The 2nd priority is to reduce continuously risk potentials by developing alternatives in the form of substitute substances and processes, and containing unsubstitutable risk potentials through quantitative limits or at least limits upon the scope of application. The requisite tools have already been discussed for the other risk classes.

Strategies for the Medusa risk class

The Medusa class of risks requires measures aimed at building confidence and improving knowledge in order to reduce the remaining uncertainties (Table 4-6). Public education alone does not suffice here. The affected people must rather have a part in the structuring of their own life worlds, and must constructively integrate in their own decisions the uncertainties and contradictions that remain intrinsic to these risks.

In this class of risk, the severity of effects and the probability of their occurrence are low, but the potential for mobilization is particularly high. In order to be able to educate the public about the actual severities and probabilities, confidence needs to be built first of all. Independent institutions providing

Table 4-5
Strategies and tools for the Cassandra risk class. The main problem in this class is the delay between triggering event and damage (high latency, insidious risks). Source: WBGU

Strategies	Tools
1. Strengthening long-term responsibility	• Voluntary commitments, codes of conduct of global actors • Coupling participation, empowerment and the institutional bolstering of long-term strategies • Remedying state failure • Fund models • International coordination
2. Steady reduction through substitutes and quantitative restrictions, through to outright bans	• Incentive schemes (certificates and levies) • Strict liability, where appropriate • Quantitative restrictions through environmental standards (also international) • Improving and extending retention/containment technologies • Human-resource and institutional capacity building (technological know-how, technology transfer, training) • Joint Implementation
3. Contingency management	• Human-resource and institutional capacity building (ecosystem restoration, emergency prevention, preparedness and response) • Technological protective measures, including containment strategies • Education, training, empowerment

open information about the findings of scientific research but also about the purely hypothetical character of many fears can play a role here. Furthermore, affected persons should have an opportunity to participate actively in structuring their life world. This confronts them with decisions that frequently involve making a choice between options that constitute different levels of risk. When weighing these risks, they must then decide themselves to what extent they accord more weight to the often poorly founded fears in the public than to the proven damage potentials of alternative options. Affected parties should also be able to participate in licensing procedures in order to weigh for themselves the value conflicts and to select from the range of options that which is most acceptable. To deal with the problem of Medusa-type risks in society, social science research that studies mobilization potentials and the social handling of risk conflicts needs to be promoted.

For this class, too, the knowledge of presumed risk potentials should be improved. There is a need for research to improve the certainty of assessments and for basic research. In addition, effective and credible risk communication measures need to be instituted.

4.1 A dynamic perspective

The ultimate goal of all measures taken for class-specific risk reduction is to commute risks from the transitional area to the normal area. In stating this aim, the Council proceeds from the fundamental understanding that it cannot be the concern of risk policy to reduce risks down to zero, but rather to transmute risks such that they reach a scale at which the common methods of risk-benefit assessment can be applied by market participants and by state regulators. The Council further wishes to stress that the management of global risks located in the normal area need not necessarily require international efforts. Nonetheless, here the industrialized countries can provide assistance in establishing effectively operating regulatory authorities, functioning insurance markets and effective contingency measures. If, however, by applying the decision tree explained in Section 2 a global risk is identified as belonging to one of the risk classes localized in the transitional area, then international measures are indeed called for in order to move the risk from the transitional area to the normal area.

This commutation will generally need to follow a process passing through several stages. Regardless of the success of individual measures, a risk can move from one class to another without directly entering the normal area. Fig. 4.1-1 illustrates this movement from class to class.

In general, we may distinguish between 2 types of measure: measures aimed at improving knowledge (through research and via liability), and regulatory measures impinging upon critical, class-specific quantities (probability, severity, irreversibility, persistency, time lag and mobilization). As Fig. 4.1-1 indicates, improved knowledge generally leads to a

Strategies	Tools
1. Building confidence	• Establishing independent institutions for information and public education • Improving opportunities for individuals to participate in decisions affecting their own life worlds, with an obligation to chose among conflicting options • Promotion of social science research on mobilization potentials • Model function: Licensing procedures with participation rights of parties affected • International controls (IAEA) • International liability commitments
2. Improving knowledge	• Research aimed at improving the certainty of risk assessments • State-sponsored (basic) research
3. Communicating risks	• Clear presentation of the cause-effect relationships between triggers and consequences • Intensified environmental education in schools and in adult education • Direct feedback of measured data to the public

Table 4-6
Strategies and tools for the Medusa risk class. The main problem in this class is the high mobilization potential, while the probability and extent of damage tend rather to be low.
Source: WBGU

movement from one class of risk to another (for instance, from Pandora to Pythia, from Pythia to Cyclops and from there to Damocles or Medusa). Measures acting upon a specific critical quantity can similarly trigger a cascade movement, or can bring about a direct movement to the normal area.

In the following, this movement from one class of risk to another is explained for a fictitious example. Imagine a substance that is used globally, is highly persistent and for which there are reasonable grounds to assume that it causes irreversible effects. This risk belongs in the Pandora class. It is located in the upper third of the transitional area, whereby the uncertainty bars (confidence intervals) extend into the unacceptable range. A risk of this type suggests 2 primary strategies: Expanding knowledge and limiting the risk potential. Let us first examine the outcome of expanding knowledge: The knowledge pertaining to the risk can be further quantified, in the process of which the assumption of irreversible consequences or of high persistency may be substantiated. If this is the case, a substitution of the substance or even a ban is urgently called for. The risk is thereby unequivocally moved into the prohibited area. We are dealing with a special case if a large period of time will elapse between the triggering event (human or environmental exposure) and its consequence, so that there is little political prospect of taking direct influence through a ban or restriction. We then have a typical Cassandra-type risk. To handle this, long-term responsibility needs to be strengthened and principal actors need to be mobilized in order that the necessary strategy of substitution or at least of containment is effectively implemented.

Let us assume in our illustrative example that the spatial distribution of this substance can indeed be limited such that ubiquitous dispersal is prevented. In this case, the risk is moved to the Pythia class, as the probability of occurrence and the severity of effects are still both subject to major uncertainties. The next step in this case is thus to determine the severity more clearly. Let us then assume that there are grounds to assume substantial damage and that this damage seems large enough to preclude locating the risk in the normal area. Under these conditions, movement continues in the direction of the Cyclops class. Cyclops forms a pivotal node in Fig. 4.1-1, as risks can undergo transmutation from there to a variety of other classes. If, for instance, we can succeed in determining the probability of occurrence and this is relatively low, then the risk can be categorized as belonging to the Damocles class, characterized by high severity and low probability. If, however, probability is found to be high and there is a time lag, the risk again moves towards the Cassandra category. Without this time lag, a ban or a rapid substitution can be expected (movement to the prohibited area). If technological or other measures can be applied to reduce the severity to a 'normal' level, nothing now stands in the way of commutation to the normal area.

If the disaster potential remains very high despite reduction efforts, the risk lands in the Damocles class. From here, too, it can be moved to the normal area through a two-pronged strategy of improving knowledge and reducing disaster potential. If all reduction tools fail, then a fundamental decision is due as to whether the benefit associated with this risk is considered to be so substantial that the high potential for damage is tolerated, its probability of occurrence be-

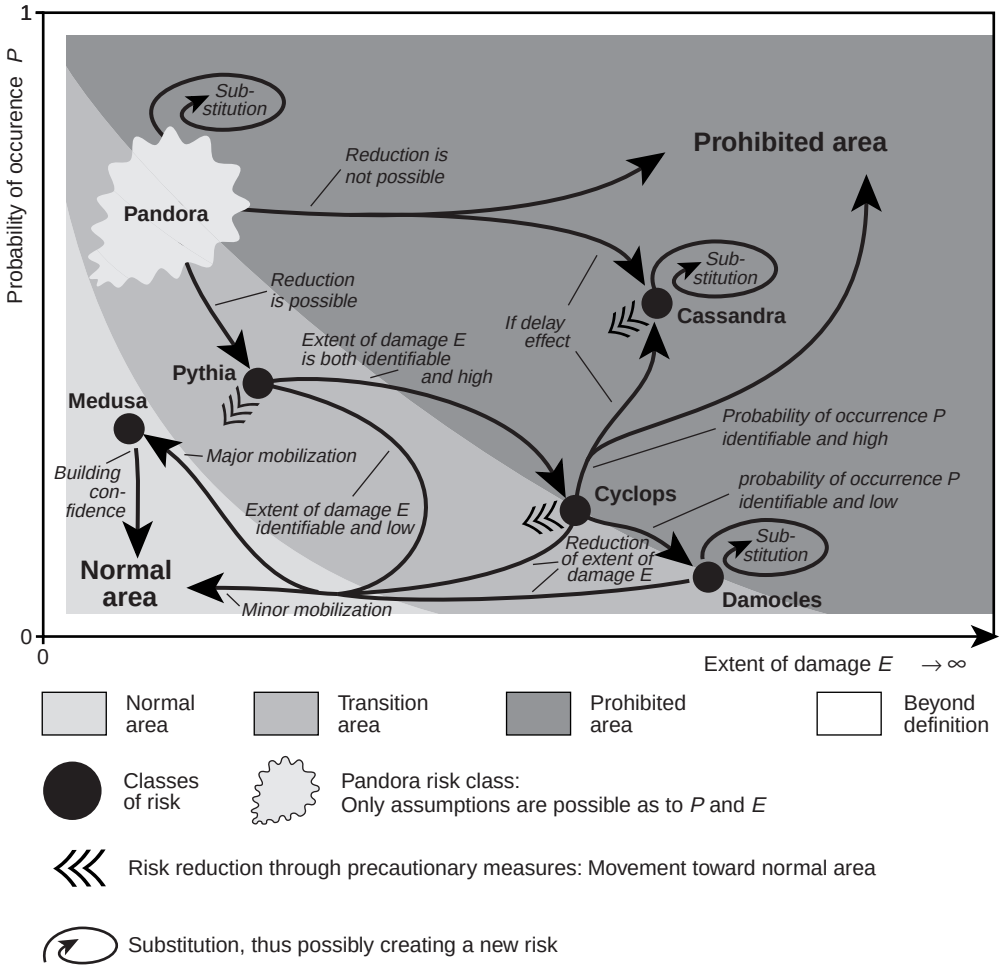

Figure 4.1-1
Risk dynamics in the normal, transition and prohibited areas.
Source: WBGU

ing low. If the outcome of this decision is negative, the risk moves into the prohibited area.

For all types of risk, the desired commutation to the normal area can be via the Medusa class. Thus, in our fictitious example, the public may have little confidence in the purported reduction of damage potential. By way of illustration, we only need to recall the uproar caused in Germany by the "Castor" nuclear waste transports. Even if the health risk from radiation is assessed as low in terms of both probability and severity – which appears justified considering the isolated cases of radiation dose limits being exceeded – the loss in terms of credibility and reliability is large enough to generate a major political and psychological mobilization effect. Acting on a long history of suffering in public risk debates and their political ramifications, many risk regulators may prefer to opt for a ban, even though both probability and severity indicate a normal risk. In such a case, measures aimed at building confidence and further improving knowledge are necessary in order to convince the public of the 'normality' of the risk and at the same time to commit technology operators to handle the risk as required by law. In addition, a need always remains to critically review whether the measures instituted really have led to the intended risk reduction.

After passing through all these stations, the normal area will finally be reached. The Council realizes that this cascade movement presupposes intensively tackling the risks to be assessed, and continuously monitoring and evaluating the risk reduction measures to be taken. This requires time, institutional provisions and resources. Nonetheless, the Council is convinced that, given the extent of global threats, investments in global risk management are worthwhile. The analytical framework of risk classes put forward here and the associated dynamic conception of measures offer a logically consistent and politically prac-

ticable concept. This concept can help the German government and the international community at large to concentrate on those risks that have the potential to emerge as global threats, while risks in the normal area are adequately addressed by national regulatory structures. Concentrating on essentials is in fact an important message to the public, which, beset by widespread confusion as to the disaster potential of risks, expects the policy-makers and the scientific community to deliver orientation and certainty in action. At the same time, the categorization in risk classes and the implementation of class-specific measures can help society to deal with risks effectively and targetedly, and can instruct risk managers in industry and policy on how to handle risks rationally.

Prime recommendations for action 5

5.1 Extending strict liability

We find that there is an array of global trends which may compromise the sustainability of society (for instance, growing world population, economic development, socio-economic interpenetration of nations and economies). Reactions to this can take 2 forms. One approach is to attempt to use expert stipulations, technology assessment and consensual debate in society to define a development path that proves to be sustainable. At the global level, limits are imposed upon such an approach by the diversity of preferences and interests, disparities in the risk acceptance of individual societies and gaps in available knowledge. There are albeit global environmental risks for which a global consensus is emerging concerning the developments that are viewed as undesirable and unsustainable. Thus for climatic risks, for instance, (variable) 'guide rails' or 'development corridors' can be stated which should not be overstepped or left.

This approach has its limits. Limited knowledge of the consequences of today's actions for the future and the associated assessment problems, in conjunction with limited capacity to control complex economic and social systems, hamper a stringent formulation of 'guide rails' and targeted direction of systems. Sustainability is thus not so much a definable target than rather a charge upon the people living today to develop rules and regulations that point the production of knowledge in a direction guided by long-term perspectives. Furthermore, through timely revelation of the negative implications of today's activities, these rules and regulations should make it possible to trigger rapid societal adaptation reactions in terms of risk reduction. Sustainable societies must thus be continuously innovating and learning systems equipped with incentive arrangements for risk reduction.

The Council therefore accords great importance not only to creating new knowledge, but also to mobilizing the potentials of problem-solving competence which are available decentrally within society but unknown to any central agency. This is above all a matter of revealing previously unidentified risks and promoting the innovation of new, less risky lines of technological development. Because an assessment of risk consequences is not possible, or only to a limited extent, appropriate incentives should be provided for the production and mobilization of knowledge. In addition to promoting basic research, this further entails guaranteeing room for maneuver, and thus also assigning clearly defined property and utilization rights. The door can thus be opened to diverse searching processes, taking place on the market under competitive conditions, which are able to reveal errors and avoid mistakes in time. An important element in such processes is the enforcement of the liability principle, which, due to its preventive effect, can contribute to precluding damage. As the Council has repeatedly stressed, the preventive side of liability is the main aspect. This preventive effect is enhanced if the risks in question are insurable. The insurance companies will then set up expert groups to assess these risks and will arrive at premiums reflecting their assessments. This will in turn lead to the acceleration of risk-reducing knowledge production – for insurer and insured alike will conduct risk research in their own best interests in order to avoid faulty assessments and in order to limit losses and reduce the probability of these losses occurring.

Where risks are found to be uninsurable, this might well have the effect that the risk-generating activity is discontinued. If that is not in the interest of the state, liability must be limited.

5.2 Precautionary knowledge production

Knowledge of the causes, mechanisms and adverse effects of possible, undesired events forms the basis for managing global environmental risks. The production of new knowledge, however, which is generally by processes of technological innovation, can itself generate new risks with previously unknown

characteristics. In a highly dynamic society, policy-makers are under a particular obligation to ensure that the 'ignorance coefficient' – the ratio between the totality of risks and the relevant prevention and management knowledge – at least does not deteriorate.

The ignorance coefficient can be positively influenced by issue-focused risk research tackling such hazards that are known or that can at least be surmised. It follows that it is essential to maintain or indeed even raise the high standards that research has reached in Germany in this field (from technology assessment to global systems research). This cannot be delivered for free, but the requisite expenditure is politically reasonable.

Managing still unknown or not systematically identifiable risks that may perhaps be far in the future is a much more problematic situation. Here, clearly defined, objectives-oriented knowledge production with short-term safety yields is impossible. The Council has discussed this situation repeatedly and in detail elsewhere.

Proactive risk management does not turn on ad-hoc knowledge production, but on a store of knowledge produced in advance. This can only be delivered by broad, 'value- and purpose-free' basic research. Only a continuously replenished and extended stock of knowledge not subject to direct exploitation requirements will make it possible to discover complex risk constellations coincidentally, in passing or playfully, and to find management strategies in a similar manner. This is why the Council advocates an undiminished *basic funding for the environmental sciences* in the broadest sense, whereby the long-term objective must be to significantly improve our understanding of the interconnections in the Earth System. Such research will uncover real risks which are presently not visible in the slightest, but will presumably be amenable to management by appropriate measures.

The Council notes in this connection that research thrives on diversity and competition: It would be a dangerous fallacy to assume that basic research can be made 'leaner' through rigidly avoiding duplication and parallel efforts – such as by commissioning *one* institute worldwide with researching *one* specific compartment of the ecosphere. Quite on the contrary – a spectrum of opinions, approaches and methods is necessary in order to subject the space of possible risk constellations to a sufficiently tightly meshed scan. This applies particularly to simulation models for the climate, ocean circulation, vegetation dynamics and so forth, where it is precisely a broad spread of different research designs and realization that will permit the coincidental identification of critical – i.e. *not* evident – hazard aspects. Knowledge is venture capital, and this capital needs diversification!

5.3
International mechanism for risk detection and assessment

Knowledge thus holds the key to risk management – but the key must also be used. Worldwide, this use has in the past been completely inadequate. Various factors have been responsible for this inadequacy: insufficient integration of specialist knowledge, asymmetrical access to knowledge, ineffective structures of knowledge transfer and so forth. We do not mean here the implementation of insights in concrete actions for dealing with risk, but a preliminary stage where knowledge provides an indication of the need to act. Particularly in terms of global environmental threats, there can as yet be no talk of any such processing of the already available insights. Here action-relevant risk knowledge would need to make global hazard potentials visible in a geographically explicit manner. Concerning, for instance, the perspectives of global food security, we presently have nothing more than an array of speculations, built on shaky ground, that do not even begin to make use of the knowledge already available today (e.g. on the impacts of expected climate change or continuing soil degradation processes).

The Council therefore recommends that a (UN) Risk Assessment Panel be established. The essential functions of this Panel should be similar to those of the Intergovernmental Panel on Climate Change (IPCC), but the task of the (UN) Risk Assessment Panel would be less to analyze already detected risks, and more the timely and integrated detection of novel risks of global import that are only just beginning to become visible.

The (UN) Risk Assessment Panel should not conduct research of its own, but should underpin and stimulate existing relevant research structures, condense their findings and – after a comprehensive international scientific assessment process – present these to policy-makers in a purposeful form. The main aim would be to establish a network node in which various national risk identification and assessment processes come together, are collated and coordinated. Thus, under the aegis of this Panel, certain tasks or functions set out in Section F 6 could partially be delegated to already existing international organizations or institutions. Such a Panel would not involve founding a new international organization, but would make use of the capacities and competencies of existing bodies.

In particular, the Panel should assume 5 focal tasks:

- *Early warning system:* For an international networking of early detection and early warning, as much scientific data and findings of early detection research as possible should be collected, systematized and synthesized worldwide. This can ensure reliable forecasting of impending threats. A precondition would presumably be to support certain countries in the creation of national early detection systems or risk centers, particularly in vulnerable areas.
- *Evaluation of monitoring:* The Panel should evaluate the findings of monitoring systems in a timely and action-focused manner. The task would be to monitor, control and regulate risk potentials. In order to ensure effective monitoring, states would need to commit themselves to certain technical and organizational standards. The review of and compliance with these standards could be the remit of an international safety standards authority (Section H 2.2.4), which could be modeled on institutions such as the International Atomic Energy Agency (IAEA). International monitoring can only be effective if national monitoring structures are effectively coordinated through institutional linkages.
- *Knowledge production and dissemination:* A (UN) Risk Assessment Panel can function as a multiplier of 'risk knowledge' by making available to all interested actors the scientifically substantiated findings of risk analysis and risk assessment (Section C). In addition, the Panel should stimulate, support and coordinate basic risk research in order to close the gaps in knowledge relating to the analysis and assessment of certain risk potentials (in the transitional area, see Section C).
- *International risk evaluation methodology:* The proposed (UN) Risk Assessment Panel could also contribute to ensuring that a uniform method of risk analysis and assessment attains collective validity. Risk assessments would then become easier to compare and to operationalize. The Council proposes basing such a methodology on the differentiation according to normal, transitional and prohibited areas set out in Section C. Global risk potentials would need to be treated in accordance with this risk classification. This means that a collectively recognized risk assessment procedure would evaluate those risk potentials that are located in the prohibited area as being unacceptable, and would ban them. Risk potentials located in the transitional area would need to be handled by regulatory policies, whereby considerable importance would attach to continuous knowledge production.
- *Focusing on essential issues and determining the 'safety margin':* The (UN) Risk Assessment Panel should identify the essential policy domains (perhaps 4 or 5), concentrate its work on these and determine for these the respective 'safety margins', i.e. the just acceptable boundary zones to intolerable conditions.

The function of the Panel would thus be to condense, in an interdisciplinary fashion, the scientific research on the risks of global change (policy-oriented weighing of all individual findings). In this, it should make all efforts to be:

- independent of the direct interests of individual states,
- independent of the direct exploitation interests of private industry,
- independent of the direct influence of non-state political associations and lobby groups.

The (UN) Risk Assessment Panel should moreover serve as a – scientifically substantiated – interface between non-state actors (environmental and development organizations, industry federations) and the body politic, by permitting submissions of non-governmental organizations and scientifically examining and assessing these. A further important task of the Panel would be to inform both state and non-state actors (at all levels) about the state of knowledge of all environmental risks of international relevance.

5.4
Building effective capacities for dealing with risk

The above recommendations are geared to ensuring that environmental risks cannot arise in the first place, or are detected early on and assessed properly. However, these political measures will not lead by themselves to a complete prevention of global hazard potentials, nor to a total suppression of regionally damaging events. It remains essential to transpose knowledge into action and contingency measures. There is a lack of the necessary institutional and technical capacities. This already applies to many industrialized countries, and all the more to most developing countries. At the international level, we can only find first rudiments. The Council makes the following recommendations in this area:

- *Enhancing national and international civil protection:* Almost all of the risks of global change call for investment in emergency prevention, preparedness and response capacities. Where existing mechanisms are not fully operative, the establishment of new structures should be considered in order to resolve acute problems. At the national level, each government will have to make its own provisions, whereby the financially constrained devel-

oping countries should be offered financial and technical assistance by the international community. At the international level, the establishment of supra-state 'stand-by' emergency response units should be considered. The emergency relief units of the Red Cross or the international task force for decontamination at the IAEA are examples of such units. These could be expanded to form 'rapid deployment forces' and, with due regard to considerations of national sovereignty, could be specially trained to deal with environmental disasters. The control center for these units should be integrated in an international organization in the United Nations system, and closely linked to the (UN) Risk Assessment Panel proposed above. It also needs to be examined in this context whether the implementation of a voluntary international environmental inspection system could enhance risk regulation and remediation.

- *Strengthening non-state actors, in particular NGOs:* Strengthening non-state environmental associations could form a crucial element in the long-term management of global environmental risks. In intrastate politics, it needs to be considered to what extent environmental associations might be allowed to use collective litigation (or individuals might be allowed to bring environmental citizen suits) to champion the interests of the environment and of future generations more effectively than has been the case in the past. However, there are concerns that an unconsidered widening of avenues of litigation, or indeed the introduction of public-interest popular action in environmental law, may create opportunities for abuse, and may further lead to international competitive distortions. Nonetheless, a careful broadening of access to justice would correspond to the general tendency of European Community law. A precondition to this would be to promote a culture of open communication, in firms, in municipalities and within states – a culture open to different value judgments and different notions of what constitutes environmental quality and the quality of life. In international politics, environment and development groups have attained ever growing importance. In some arenas, non-governmental organizations (NGOs) are already granted the right to be heard at diplomatic conferences and within the United Nations system, and have access to many documents. It should be examined to what extent NGOs could be integrated even more effectively in the international negotiation and implementation processes. With a view to a global strategy for dealing with risk, the Council recommends an extensive right of NGOs (including industry federations) to initiate proceedings in the proposed (UN) Risk Assessment Panel. Here, the problem of a possible lack of legitimization of non-state actors needs to be taken into consideration.
- *Promoting self-help potentials in developing countries:* In its previous reports, the Council has repeatedly noted that the risks of global change are distributed very unevenly among the countries and populations of the world. People in developing countries are particularly at risk. Strengthening capacities to cope with these risks in the developing countries, particularly among the poor, who are those most at risk, is therefore an important element of effective global risk policy. A further reason why combating poverty through self-help is such an important part of global risk prevention and attenuation policy is that it not only aims at broad impact, but at the same time stimulates structural reform in state and society. In some cases, the basic essentials for an effective handling of the risks of global change first need to be created, namely the basic structures of an issue-focused state administration. Here, too, the international community is called upon to exercise solidarity. In sum, further technical and financial development cooperation can be brought to bear in such a way that the potential extent of damage of risks is significantly reduced. Through its 3 focuses – "poverty alleviation", "environmental protection and the conservation of natural resources" and "education and training" – German development cooperation already makes an important contribution to handling the risks of global change. Nonetheless, the available funding does not suffice. The Council has therefore repeatedly called for a significant boost in government funding for development cooperation. The capacity of a society to deal with the risks of global change, its knowledge of causation and cause-effect linkages and its ability to communicate about risks depend directly upon the level of education and the available scientific competence. But the education sector is an area where the North-South gradient has become particularly steep in recent years. The production of risk knowledge in the innovation process is gaining particular importance for those countries whose industrialization is only just beginning, and where crucial decisions are due to be taken in the future in key sectors of the economy. Knowledge transfer in all purposeful forms between industrialized and developing countries is thus an indispensable instrument of global risk management. Here, the (UN) Risk Assessment Panel proposed above could play a pivotal role.

5.5
Ecological criteria in development cooperation

Even best-intentioned solidarity with the countries and groups that are particularly vulnerable to global change is doomed to fail if the recipients of solidarity inputs do not themselves observe a number of basic rules concerning the protection of our common environment. The Council therefore recommends giving greater consideration to ecological criteria in development cooperation.

Environmental protection was already included by the German government in 1975 in its catalog of development policy objectives, and was declared in 1986 to be one of the 5 thematic foci of development cooperation. Since the Rio Earth Summit, this trend has gathered momentum. More than a quarter of all bilateral development cooperation commitments now relate to the field of environmental protection. In recent years this has amounted to more than DM 1 billion.

The Council views these activities as a very important contribution to reducing global environmental risks. It welcomes the circumstance that environmental acceptability has now been integrated as an element in the project promotion procedures of the German Federal Ministry for Economic Cooperation and Development (BMZ). Environmental standards should gain a higher priority in the future as a basis of development cooperation. In this connection, the ongoing efforts of the OECD Development Assistance Committee to harmonize the protection and monitoring measures of the various donor countries deserve support. Not least, it should be examined at the European Community level whether the protection of the global environment should be enshrined as a Community-wide objective of development cooperation through insertion in Article 130u para 2 of the EC Treaty (or, after entry into force of the Amsterdam Treaty, Article 177 para 2).

5.6
Promoting risk awareness

If indispensable socio-economic opportunities are to be seized, then there is no risk-free path for a dynamically developing global community. In fact, a policy of risk aversion can be all the more hazardous over the long term, as avoiding known hazards can mean foregoing opportunities for later handling currently unknown risks. However, global change harbors risks with novel characteristics (e.g. the danger that ocean circulation patterns are changed) which concern practically everyone on the planet, albeit in most cases with a highly asymmetrical distribution of consequences, and whose potential effects can extend far into the future of humankind. This special quality of risk demands a new quality of risk responsibility such as can only be assumed by the *'risk-aware citizen'*.

The risk-aware citizen

- should be adequately informed about the current state of knowledge of global environmental risks,
- should be involved to the greatest possible extent in really critical decisions on the acceptability of certain environmental risks, and
- should continue to stand by the decisions taken with his or her involvement, even if these subsequently prove wrong.

The Council recommends that the German Federal Government examines whether the existing tools for promoting these 3 principal elements of risk-awareness have in the past really been exploited, and whether these tools should be further developed. The not exactly confidence-inspiring events surrounding BSE and shipments of radioactive material give ample reason to presume that distinct improvements are indeed possible here.

This endeavor needs to address 2 fundamental challenges: Firstly, when dealing with global hazards – i.e. in particular hazards that transcend national boundaries and human generations – competent, fair and efficient forms of political representation and participation need to be developed. It is around this challenge that the debate on the perspectives of 'global governance' currently revolves. The process of forging and implementing the UN Framework Convention on Climate Change (FCCC) may offer a paradigm for what could correspond in the global context to local consensus-building processes (including 'round tables').

Secondly, risk-awareness is not an objective whose realization devolves entirely to politicians or public authorities. Opportunities for information, discourse, co-determination and joint responsibility must be made use of by the 'global citizen'. Insofar, this summary ends with a call to all those who feel themselves or their descendants put at risk by global environmental changes to engage in a risk partnership. Even relative safety is not an asset that can be made freely fungible – not by any collectivity, no matter what kind.

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