

Evaluation of Legal Liability for Technological Risks in View of Requirements for Peaceful Coexistence and Progress

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Legal liability for risk-generating technological activities is evaluated in view of requirements that are necessary for peaceful human coexistence and progress in order to show possibilities for improvement. The requirements imply, given that political decision making about the activities proceeds on the basis of majority rule, that legal liability should be unconditional (absolute, strict) and unlimited (full). We analyze actual liability in international law for various risk-generating technological activities, to conclude that nowhere is the standard of unconditional and unlimited liability fully met. Apart from that there are enormous differences. Although significant international liability legislation is in place for some risk-generating technological activities, legislation is virtually absent for others. We discuss fundamental possibilities and limitations of liability and private insurance to secure credible and ethically sound risk assessment and risk management practices. The limitations stem from problems of establishing a causal link between an activity and a harm; compensating irreparable harm; financial warranty; moral hazard in insurance and in organizations; and discounting future damage to present value. As our requirements call for prior agreement among all who are subjected to the risks of an activity about the settlement of these difficult problems, precautionary *ex ante* regulation of risk-generating activities may be a more attractive option, either combined with liability stipulations or not. However, if *ex ante* regulation is not based on the consent of all subjected to the risks, it remains that the basis of liability in the law should be unconditional and unlimited liability.

KEY WORDS: Informed consent; insurance; legal liability; technological risks

1. OVERVIEW

The two requirements for peaceful coexistence and progress that are assumed as the basis for our analysis are presented in Section 2. These are the requirement of informed consent and the requirement of liability in the absence of informed consent. We will refer to these requirements as “our evaluation criteria” or “our requirements.” We discuss the ethi-

cal (Section 2.1) and economical (Section 2.2) underpinnings that provide reasons why respecting the requirements is desirable. In Section 3 it is explained that, assuming these requirements and given that political decisions within nations on risk-generating technological activities are taken with majority rule, liability for these activities should be unlimited (full) and unconditional (absolute, strict). It is also pointed out in Section 3, and further elaborated in Section 6, that in view of these requirements no liability law can fully compensate for the absence of unanimity decisions among all those who are subjected to the risks, and that certain unanimity decisions will always be required. Section 4 offers a historical introduction to the notion of legal liability for risk-generating

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technological activities, revealing a number of common developments in the different legal orders since the 19th century. Having thus set the stage, we evaluate in Section 5 a number of current examples of liability in international environmental law, revealing that apart from enormous differences in liability for different activities, in none of the cases are the standards mandated by our requirements met. As a specific issue, we discuss the precautionary principle in environmental law in relation to liability law. Section 6 assesses the fundamental possibilities and limitations of liability and private insurance as instruments for bringing about credible and ethically sound risk assessment and risk management practices. We discuss how the limitations of liability lead to the desirability or necessity of precautionary *ex ante* regulation for risk-generating technological activities, but we also point out that the basis of liability in the law should remain unlimited and unconditional, as long as precautionary *ex ante* regulation is not based on the unanimity among all who are subjected to the risks. Section 7 provides concluding remarks.

2. THE REQUIREMENTS OF INFORMED CONSENT AND OF LIABILITY IN THE ABSENCE OF INFORMED CONSENT

2.1. Necessary Conditions for Peaceful Coexistence

The two requirements for peaceful coexistence and progress are as follows:

- (1) *The requirement of informed consent*: For all (technological) activities, all those who may experience their effects, including the risks caused by the activities, must have given their informed consent to the activities and to the conditions under which the activities are performed.
- (2) *The requirement of liability in the absence of informed consent*: Those who engage in activities without the informed consent of those who may experience the effects should be fully and unconditionally liable for any negative effects that their activities may cause to those who did not give their informed consent.

The requirements are implied by the ethical principles of restricted liberty and reciprocity, which themselves are necessary conditions for peaceful coexistence. The principles of restricted liberty and reciprocity were discussed by Van Velsen.^(1,2) He showed that restricted liberty, which he called the

right to be safeguarded, and reciprocity together are necessary and moreover sufficient for peaceful coexistence. Below we will briefly discuss how the principles of restricted liberty and reciprocity imply the two requirements mentioned above.

2.1.1. Restricted Liberty and Informed Consent

The principle of restricted liberty holds that everyone is free to do what he/she pleases as long as he/she does not harm others. It is also known as the no harm principle. The restricted liberty principle has a long history. It was included as article 4 in the *Déclaration des droits de l'homme et du citoyen du 26 août 1789* of the French Revolution. The philosopher J. S. Mill defended the principle in his essay *On Liberty* published in 1859.

The restricted liberty principle contains the principle of equal rights but is not equivalent to it. Equal rights may be necessary for peaceful coexistence, but it is not the case that all conceivable rights would lead to peaceful coexistence even if each has the same rights. For example, the principle "Everyone is free to act as he/she pleases (irrespective of whether he/she is harming others)" respects the equal rights principle, but it will only render peaceful coexistence if some people are absolutely tolerant to what others do to them, which is not the case. From the perspective of peaceful coexistence there is hence an asymmetry between different possible principles of individual freedom to act. If all people respect the restricted liberty principle stated above, then peaceful coexistence is guaranteed, but the same does not hold for a "liberty" principle that does not in this way restrict people's actions toward each other.

It is assumed here that harm is a subjective notion: whether and to which extent someone is harmed by something is subjective, or at least has subjective elements. This means that it is not the actor who can determine whether an effect of his/her actions is harmful, but those who experience these effects.

An equivalent formulation of the restricted liberty principle is the right to be safeguarded:

Everyone has the right to be safeguarded from the consequences of another person's actions.
(See Refs. 1, p. 96; 2)

Because of the assumption that there are always subjective elements to the question whether someone is harmed by something, there are only two ways in which it can be ascertained that other people are not harmed by an activity. Either there are no (actual or possible) consequences for others. Or there

are such (actual or possible) consequences, but those who may experience these consequences have given their informed consent to the activity. Hence, the right to be safeguarded implies the *requirement of informed consent* stated at the beginning of this section.

2.1.2. Reciprocity and Liability

The right to be safeguarded does not specify how a violation of that right may be reacted to. Hence there is a need for a second principle that deals with violations of the right to be safeguarded. Such a principle is the reciprocity principle:

He/she who violates a right of another may be reacted to in a reciprocal way. This means that somebody who infringes a right of another, himself loses that same right insofar as that is necessary (and no more than that) in order to restore the situation existing before the violation or to compensate for it, and, if necessary, in order to prevent further infringement. (See Refs. 1, section 7; 2)

Given the right to be safeguarded, the reciprocity principle implies that anyone who did not respect another person's right to be safeguarded and who caused the other person harm may be forced to repair or compensate the harm. Hence the reciprocity principle implies the *requirement of liability in the absence of informed consent* stated at the beginning of this section. This requirement gives anyone who had not given his/her informed consent to a risk creating activity the right to recover (to the extent that this is possible) from any harm ensuing from the activity that may fall upon him/her. But there is no obligation to execute this right.

Having thus presented the two requirements for peaceful coexistence and their ethical underpinnings, I will next explain their relation with basic principles from economic theory.

2.2. External Costs and Progress

Below, the requirement of informed consent will be reformulated using language deployed in economic theory, and it will be shown that the requirement is necessary for progress.

Among the fundamental assumptions of economic theory are some important assumptions that have an ethical dimension. These assumptions include the following: (1) If people freely enter into a

transaction or contract (and if the parties to the transaction or contract have adequate information, do not cheat, and keep their promises), then it makes all parties better off. Otherwise, they would not enter into it. (2) People should be the judges of their own well-being or utility, but not of the well-being or utility of others. (3) People have the right to improve their own well-being, at least as long as they do not harm others.¹ Transitions that make, or are expected to make, at least some better off and no one worse off, in their own judgment, are called (expected) Pareto improvements. It appears that everyone agrees that Pareto improvements represent social progress in an unequivocal way, hence are good. Assuming this as a starting point, it follows that, if there are no negative effects for nontransacting parties, free transactions among people render Pareto improvement, hence are good. This, together with an argument regarding the potentially beneficial effects of specialization and innovation, is the basis for Adam Smith's and later economists' claim, known as the hypothesis of the invisible hand, that free markets and competition benefit everyone, hence are good. The argument holds for contracts in general, but it should be noted that, for the general case, the concept of an *expected* Pareto improvement should be used.

The conclusion that activities governed by free markets and competition render Pareto improvement requires as an assumption that negative effects for nontransacting parties, called *external costs or negative externalities*,^(3,4) are absent or at least sufficiently small. For many contemporary activities this may not be the case, as the actual and potential impacts of technology-enabled human activities upon others are large, and moreover growing. I define here an external cost as a harmful effect, caused by a human activity, that is not accepted by those affected as an element of a voluntary agreement, but instead is involuntarily imposed. Classical examples are toxic smoke from chimneys or cigarettes causing harm or risks to people nearby. If the external costs of human activities are sufficiently large, then these costs may offset their (expected) individual gains from market transactions. If external costs are present, not merely nonactive "bystanders" may end up worse off, but also those who engage in the activities and transactions that generate the external costs. Free markets and competition hence do not guarantee (expected) Pareto improvement if external costs are

¹ Not all authors on economics support the condition in the third assumption.

present. The only way to secure that an activity renders (expected) Pareto improvement is to ascertain the informed consent to the activity of all who may experience the external costs of the activity. This is the requirement of informed consent of Section 2.1, now derived as a necessary condition for securing progress in the sense of (expected) Pareto improvement. I will next clarify that involuntarily imposed risks are external costs.

A risk is a cost not for sure but expected with some probability. For someone who satisfies the “axioms of rationality” assumed in the theory of decision making under uncertainty,⁽⁵⁾ a risk is equivalent to a sure cost, in the following sense. If confronted with a risk, such a person is capable of identifying a sure cost (a negative utility), such that he/she is indifferent between the sure cost and the risk. Any hazardous situation can be evaluated as a risk. Hence, any man-made hazard is equivalent to a real cost to anyone subjected to the hazard who satisfies the “axioms of rationality.” (This holds for natural hazards as well, but as the latter are *not created by humans* they do not concern us here.) For such persons, the statement that the external costs of a hazardous activity include the involuntarily imposed risks stemming from that activity has a perfectly clear meaning. Nevertheless, the determination of the external costs stemming from risks cannot be fully objective, because both the assessment of risks in terms of possible physical effects and probabilities, and the evaluation of those physical risks in terms of disutilities, are at least in part subjective. Also, because of uncertainties in risk estimates, these costs are always vague to a varying degree. Finally, there is no ground for assuming that such costs can (always or in general) be expressed on a finite monetary scale.

For practical reasons, general rules are desirable that specify which (market) activities are allowed and under which conditions. Such rules can be given by adopting laws. However, if progress in the sense of (expected) Pareto improvement is to be secured, these laws must have the informed consent of all those who are subjected to the (possible) consequences of the activities that the laws allow. Two types of conditions may be deployed in such laws. The first type concerns *ex ante* restrictions and precautions that should be observed while performing the activities, meant to make the activities less harmful or hazardous for others. Safety and environmental regulations belong to this type. Conditions of the second type impose on actors a duty to repair or compensate for harm caused by their actions. Such con-

ditions will be called here *ex post* conditions. Third-party liability stipulations are examples. It is always possible to apply both types jointly.

2.2.1. Conclusion

It follows from the fundamental assumptions of economic theory stated above that only if the laws that regulate risk-generating technological activities have the informed consent of all those who are subjected to the risks, a nonsubjective basis can be provided for the expectation that the activities render (expected) Pareto improvement.

3. IMPLICATIONS OF MAJORITY RULE IN NATIONAL POLITICAL DECISION MAKING

It is well known in the science of public choice that the unanimity rule is the only voting rule certain to lead to Pareto improvement.⁽⁶⁾ However, in the current democracies, political decision making relies on the simple majority rule rather than unanimity rule (often within the framework of a constitution that can only be changed with a larger majority). We will proceed our analysis while taking national majority decision making as a given, and we will hence focus on the implications of this fact for liability law. For our analysis, the following implications are relevant:

1. Because of majority decision making at the national level, an activity imposing risks upon others can proceed in a state, even when a minority objects that the activity is harmful. In addition, the possible negative consequences usually transcend national borders, and those living there have usually not been asked for their consent. Agreement among governments, for instance, on an international law that regulates a risk-generating technological activity, does not guarantee unanimity on the issue among the citizens governed. There is ample evidence that many technologies with potentially large and far-reaching consequences actually do violate our first requirement, as active opposition to some of these technologies is widespread. From the fact that an activity is allowed by national or international law, it can therefore not be concluded that the activity satisfies our first requirement, or that it leads to (expected) Pareto improvement.

2. It then follows from the requirement of liability in the absence of informed consent that, given the reliance on majority rule at the level of nations, the standard of legal liability for risk-generating activities should be unlimited (full, no caps) and unconditional (absolute, strict), which means that there should be an absolute requirement to fully repair or compensate any harm that might result. This would give all who are subjected to risks by others the right to reparation of, or if that is not possible, compensation for any harm that may ensue from those risks. People are of course free not to execute that right.
3. Even unconditional (absolute, strict) and unlimited (full) legal liability can usually not fully correct for the violations of the requirement of informed consent brought about by the reliance on majority rule. Decisions based on the consent of all those who may experience the negative consequences of a risk-generating technological activity remain needed regarding several aspects of liability and how it is implemented. These aspects include the rules of evidence for establishing a causal link and the precise allocation of the burden of proof; the way in which irreparable damage will be compensated and the way in which reparation and compensation will be financially guaranteed; the way in which future damages will be discounted to present value; the way in which moral hazard in insurance and in organizations is dealt with; and how access to courts will be secured in view of the fact that mounting a liability case costs money.² We will return to these issues in Section 6 where we discuss the possibilities and limitations of liability and insurance to secure credible and ethically sound risk assessment and management.

The following remarks pertain to the three implications taken together. To the extent that repair of, or compensation for, possible harm is better guaranteed, the willingness to consent to risk-

² Authors from the "law and economics" school have stated that actors who are held strictly liable for the external costs of their activities will internalize these costs into their decisions.⁽⁷⁻¹⁰⁾ Apparently, they asserted that unconditional and unlimited liability for risk-generating activities secures (expected) Pareto improvement, irrespective of whether those subjected to the risks have consented to the activities. In making this assertion, they have ignored the problems enumerated in the text.

generating activities will increase. Also, to the extent that liability for risk-generating activities better approaches the standard of unlimited and unconditional liability, more external costs associated with the risks will be internalized. Therefore, a legal system based upon unlimited and unconditional liability can, if not fully then at least partially, counteract the negative consequences of political majority decision making summarized under point 1 above, and for that reason can make political majority decision making more acceptable in the light of our requirements. For the same reason, the introduction of liability laws that would make liability for the activities of risk-generating technological organizations less conditional and less limited than currently is the case would therewith reduce the ethical problems that their employees currently encounter in their professional activities.^(11,12)

But in virtue of the third implication, bringing liability law closer to the standard of unlimited and unconditional liability, cannot be sufficient to bring about full compliance with the requirements for peaceful coexistence and progress that are the frame of reference for the present article. One must hence also consider how actual political decision making about risk-generating technological activities can be brought closer to the standard of unanimity among all those who are subjected to the risks (or among persons who really represent them). The latter topic is both important and challenging, but it cannot be pursued within the confines of the present article. In its general form, the topic is studied in the field of public choice. One of the challenges of bringing actual decision making closer to the ideal of consensus decision making is to find ways to confine the possibilities and effects of strategic behavior. (A voter is said to behave strategically if he/she is not sincere about his/her true preferences, in order to obtain a more attractive outcome.) Some headway has been made with designing voting procedures based on unanimity decision making that quench the possibilities for strategic behavior and that could be applied to decision making about risk-generating public facilities such as airports, (rail)roads, and industrial installations such as nuclear and chemical installations.⁽⁶⁾

4. HISTORICAL DEVELOPMENT OF LEGAL LIABILITY FOR RISK-GENERATING TECHNOLOGICAL ACTIVITIES

Historically, liability for harm resulting from private activities has been based on principles of

strict and unlimited liability. Thus, both in Roman, Germanic, and later in European law the basic principle of liability has always been that all who unlawfully cause harm to others should fully repair or compensate the harm, regardless of whether they had or had not been careful. Hence, in these legal systems people have always been liable for all injury resulting from risk-creating activity, whether the activity had been careless or not. It was also irrelevant whether the harm was caused by an individual himself or rather by his animals, servants, and such like.⁽¹³⁾ This principle was discarded in the 19th century when the principle of “no liability without fault” was introduced. The latter principle is said to have its roots in the liberal individualism of the 19th century. According to Zweigert and Kötz,⁽¹⁴⁾ this liberal individualism entailed the view that “a responsible individual’s movement should only be limited by the imposition of liability in damages if he culpably failed to conduct himself in accordance with the general duty to act carefully.” This translated to the legal principle that a citizen may only be held liable for harm caused by otherwise lawful activities if he had acted with insufficient care, that is to say, if he was “negligent” or “at fault.” If on the other hand an act was performed in conformity with “the general obligation to act carefully,” that is to say, if “fault” was lacking, then any harm resulting from it should be borne by the victim.⁽¹⁴⁾ In the United States as well as in England, the 19th-century introduction of fault liability as well as of limited forms of liability were explicitly motivated by the desire to promote the developing industry.^(14–16) ³ Such an explicit motivation is less visible for the countries on the European continent. Apart from this, and apart from differences in degree, the transition from relatively strict and full liability to “fault” or “negligence” liability has also taken place in the countries of the European Continent, even though in at least some European countries liability for at least some risk-generating technological activities has always rested on a “strict” rather than a “negligence” rule. (The latter is demonstrated for the case of sparks from railway steam engines burning crops in Ref. 18.)

A particularly clear description of the 19th-century transformation of tort law in the United States is provided in the work of legal historian Horwitz.^(15,16) An instructive example is provided by the changes in the conception of property rights.⁽¹⁵⁾ Up

³ Brenner,⁽¹⁷⁾ writing about the case of England, and Martin-Casals,⁽¹⁸⁾ writing about various European countries, question whether in those countries the adaptation of tort law to the developing industry was a conscious process.

until about 1800, property rights were characterized by the legal adage “use your property in such a way that you do not damage another man’s property.” This implied that if damage did occur, the actor had to refund those harmed, even when the activity was lawful and had been performed with care. Hence, an actor was liable for any risk that he created. About 70 years later, the right to property had changed so as to imply above all the right to develop one’s property for economic purposes, even if this would harm others. An actor could no longer be held liable for harm imposed upon others if the activity was lawful and if there was no evidence of carelessness (“fault”) in the performance of the activity. Although this new principle of “no liability without fault” was initially applied only to the activities of companies working under state grants, which were taken as evidence that the activities, though funded privately, were socially beneficial,⁽¹⁵⁾ the new principle was subsequently extended to all lawful activities.

If it is now commonly stated that “traditional tort law tends to rest on fault-based regimes”,⁽¹⁹⁾ then it must be clear that this tradition was only established in the 19th century. The same holds for two other elements of contemporary law pertaining to liability. Thus, although corporations with limited liability had existed in earlier centuries, their large scale introduction took place, and was enabled by legal changes, in the 19th century (see Refs. 16, Chapter 3; 20, especially the contributions of Diamond, Minchington, and Perrott; 21). Also, the introduction of legal limits to liability unrelated to the harm and of legally fixed amounts of compensation for damage are basically 19th-century developments.⁽¹⁵⁾ It should be noticed that the developments described here—from strict to fault liability; introduction of corporations with limited liability; and the introduction of legal limits to liability and compensation—represent moves away from the requirements that form the frame of reference for the present article, taking into consideration that all these developments were severely contested at the time of their introduction.

The development of legal liability in the 20th century has witnessed certain tendencies back toward stricter, i.e., less-conditional forms of legal liability. Again the overall development has been similar in the different legal systems, in spite of national differences, and in spite of differences in style between the Anglo-Saxon and the continental European legal tradition.⁴ An example of the tendency

⁴ For example, concerning differences in the actual amount of compensation paid in liability cases, see footnote 7.

toward strict(er) forms of liability are the principles and regulations that govern products liability in the United States and in the EU. These are said to be based on strict liability, as opposed to fault liability, even though products liability remains in important respects conditional (see, on this, note 12). Another manifestation of the trend is a tendency toward strict liability for so-called ultra hazardous activities, based either on sector legislation of which CERCLA and OPA in the United States are examples, or on general legal liability rules for dangerous activities (see Ref. 19, Chapter 7). At the international level, there are many activities aimed at strict(er) liability rules for risk-generating technological activities. Despite this level of activity, general principles of strict liability have so far not been firmly established in international law. Even where they are said to exist, states have often been unwilling to apply them.^(22–24) The clearest expressions of strict liability in international law have taken the form of sector treaties, addressing the liability of specifically circumscribed technological activities, but so far only two of these have actually entered into force. These two “exemplary” treaties will be analyzed in the next section in the light of our requirements (Section 5.1), but we will also consider areas of risk-generating activities for which there is a complete lack of established liability principles.

Concerning the limited liability of corporations, despite certain measures that have been taken to facilitate in certain circumstances the “piercing of the corporate veil,” the basic elements remain largely unaltered. These elements include that a shareholder cannot be held accountable for harm done by the corporation in excess of the value of his shares, and that employees including officers cannot, or only under stringent conditions, be held accountable for harm caused by the corporation. We will return to corporate liability in Section 6.

5. LIABILITY IN INTERNATIONAL ENVIRONMENTAL LAW

In the present section we have two aims that both stand in the service of identifying possibilities for improvement of (international) liability law. Firstly, we want to illustrate that there are enormous differences in legal liability in international law between different types of technological activities: whereas for some areas of risk-generating activities there is significant liability legislation in place, such legislation is virtually absent for other areas. Secondly, we want

to show that even for the areas for which a principle of strict liability is said to be implemented (to be discussed in Section 5.1), the standard of unconditional and unlimited liability that is mandated by our evaluation criteria, given the fact of political decision making at the level of nations, is not fully met.

A comprehensive overview of international law pertaining to liability and compensation for harm from technological activities is not aimed at and would be out of the scope of this article. For such overviews, see Refs. 22–27.

5.1. Oil Pollution and Nuclear Accidents

There exist international conventions regarding third-party liability for oil pollution from maritime transport and for nuclear accidents from the peaceful use of nuclear energy. These agreements have several elements in common (see Refs. 25, pp. 356–358; 28; 29), and have moreover served as models for several later (draft) conventions on civil liability for risk-generating technological activities.⁽²⁵⁾ Of the two agreements, only the one regarding oil pollution from maritime transport has been successfully relied upon by pollution victims.⁽²⁵⁾ Nevertheless, both agreements must be considered as relatively successful efforts to implement strict liability in international law, as none of the other liability conventions have entered into force, and as the prospects for their entering into force are on the whole considered dim by experts.^{(22,23,25)⁵}

The common elements of the conventions on third-party liability for oil pollution from oil vessels and for damage from accidents with nuclear facilities mentioned above are as follows:

- (1) Liability is “strict,” meaning that actors are not exempted from liability if they were not “at fault.”
- (2) Liability is “channeled,” meaning that only designated actors (the oil tanker owner and

⁵ The liability conventions that have been drafted but so far have not entered into force include the 1962 Brussels Convention on the Liability of the Operators of Nuclear Ships; the 1977 International Convention on Civil Liability for Oil Pollution Damage resulting from Exploration and Exploitation of Seabed Mineral Resources; the 1993 Council of Europe Liability for Dangerous Activities Convention; the 1996 IMO International Convention on Liability and Compensation in Connection with Carriage of Hazardous and Noxious Substances by Sea (HNS Convention); and the 1999 Basel Hazardous Wastes Liability Protocol (see Refs. 22, p 96; 26, 27).

the nuclear facility operator, respectively) can be held liable.

- (3) The liability is limited to a fixed amount per accident.⁶
- (4) The liability (up to the limit specified) must be covered by insurance or by other financial security held by the actor to which the liability has been “channeled.”

In addition to these liability stipulations there is an international Oil Pollution Compensation Fund, financed by levies on imports of oil, from which damage may be compensated that exceeds the limit of the ship owner’s liability, up to a further limit. The nuclear liability conventions hold the state in which the nuclear plant is situated liable for damage above the limited liability of the operator, again up to a limit.⁷

5.1.1. Evaluation

The first element of “strict” liability is consistent with our evaluation criteria. The third element, however, is not, given that the limits have been fixed at levels that are well below realistic levels of the costs of damage in the case of the more serious accidents.⁽²⁸⁾ This remains true after later revisions of the nuclear liability treaties.⁽²⁹⁾⁸ The channeling of liability (point 2 above) can be sound, but only if the liability would be unlimited and the party to which the liability is channeled would have provided (financial) guarantees for recovery of injured parties in a worst-

⁶ A few national legislations provide for unlimited liability. In the discussion regarding limited versus unlimited liability, some authors argue that the more important issue is the amount of liability covered by insurance or other financial security. They note that unlimited legal liability without financial guarantees has no significance.

⁷ The United States is no party in the international treaties referred to above. Liability for oil pollution during transport at sea is regulated in the United States in the federal Oil Pollution Act. It has similarities to the treaties described above⁽²⁶⁾ but some relevant liability limits are higher.⁽²⁸⁾ The same holds for the U.S. regime for nuclear liability as compared to the international treaties on nuclear liability (see Refs. 4, p. 249 ff. on Price-Anderson Act; 28). Radetzki and Radetzki noted⁽²⁸⁾ that case experience has shown that actual compensation paid after oil pollution accidents can be much higher in the United States than in Europe.

⁸ Ashford and Caldart⁽⁵⁹⁾ mention efforts of various industry groups in the United States to have legislated limits on liability and monetary damages installed. Similar efforts can also be observed in Europe, e.g., in the context of the EU Products Liability Directive or the EU Environmental Liability Directive. Such limits to liability and damages are not in agreement with our criteria as they have been introduced using majority rule.

case accident scenario. This is actually not the case. For irreversible harm, such as deaths or irreversible environmental damage, our evaluation criteria require that all who may be harmed should consent to the means of compensation if harm occurs. Alternatively, the informed consent of those at risk might be obtained for being exposed to the risk, which may require to compensate them for being at risk.^(30,31)

5.1.2. Governments as “Insurers of Last Resort”

In the scientific literature, legal limits to the liability for technological risks have been related to the circumstance that private insurance for larger amounts cannot be obtained. Radetzki and Radetzki,⁽²⁸⁾ quoting other authors, concluded that “the governments of the OECD countries have implicitly assumed the role of insurer of last resort for the top nuclear risk, thereby affording the industry with a subsidy” and that other industries are subsidized in similar ways.⁹ They suggested that such public assumption of the top catastrophe risks of an industrial activity could be justified as a government policy for correcting a failing private insurance market. In evidence for the nuclear case, they quoted calculations based on probabilistic safety assessments (PSAs) that purportedly show that the expected costs of accidents, including the large ones, are only a small fraction of the production costs of nuclear energy. Hence, the public assumption of the top risk of nuclear energy can be based upon “a political value judgment that these activities provide a social benefit that is greater than the social cost of the risks that they cause,” but that would otherwise not be undertaken due to a failing insurance industry.

5.1.3. Evaluation

The following comments can be made based on our evaluation criteria. (1) The political value judgment referred to should be based on the consent of all involved (or of those who truly represent them), rather than on a majority decision. (2) Given the possibilities for biased assumptions in the required PSAs, the reliability or trustworthiness of a PSA that is not backed by a commercial insurance may always be questioned. (3) Governments, by assuming the

⁹ The existence of caps on liability that are lower than the maximum possible harm is a common trait of international conventions that deal with legal liability.⁽²⁶⁾

role of insurer of last resort, contribute to the persisting existence of the presumed market failure rather than to its disappearance.

5.2. Transboundary Movements of Genetically Modified Organisms

There is as yet no international liability legislation covering the environmental risks of using genetically modified organisms (GMOs) in agriculture. The Cartagena Protocol on Biosafety (CPB) adopted in 2000, and entered into force in 2003, addresses transboundary movements of GMOs. It is the first binding international legal instrument addressing some of the environmental and health impacts of modern biotechnology.⁽³²⁾ However, as a consensus on a liability regime under the CPB could not be reached, the CPB merely contains a clause stating that rules and procedures regarding liability and redress for damage resulting from transboundary movements of GMOs should be elaborated within four years after the Protocol's entry into force (see Refs. 25, pp. 362–363; 26, p. 45 no. 8; 33, p. 10). An *ad hoc* workgroup on liability was formed for that purpose, but in 2010 the goal of establishing a detailed liability regime under the Protocol has not been reached and could still be far removed.¹⁰

5.2.1. Discussion

It has been claimed⁽³⁴⁾ that liability for transboundary GMO trade should be unconditional and unlimited, and that liability insurance should be mandatory for GMO traders. This claim finds support in our evaluation criteria, given that there is no agreement about the deployment of GMOs in view of the environmental and other risks they may create. Even if the governments that are party to the CPB would decide, unanimously, on a liability and redress regime that is in some respect conditional and/or limited, then the resulting legal regime could not be justified by our evaluation criteria, as decision making at the national level is based on majority rule rather than unanimity rule.

¹⁰ For background and up to date information regarding the work on “liability and redress” under the Cartagena protocol, see <http://bch.cbd.int/protocol/cpb/art27.shtml> (accessed July 2010).

5.3. Chemicals in the Environment

The European legislation on Registration, Evaluation and Authorisation for Chemicals (REACH) was first proposed in a European Community White Paper published in 2001.⁽³⁵⁾ The White Paper stipulated that the evaluation of chemicals (= testing and risk assessment) should be carried out and paid for by the industry. In the discussion that followed the White Paper and a subsequent proposal for legislation in 2003, different stakeholders defended widely diverging viewpoints regarding how strictly the REACH system should be implemented. While representatives of the chemical industry argued for relaxation of the originally proposed REACH procedure because they thought it too costly, environmental and consumer organizations urged for strict implementation because the social benefits of more extended testing, i.e., reduction of future harm, would in their view exceed its costs.¹¹

5.3.1. Discussion

Our evaluation criteria suggest that discussions like here, on precautionary (*ex ante*) regulation, should be coupled to the liability (*ex post*) aspects. Very often, and unfortunately so from the present article's perspective, the latter aspect is omitted from discussions on precautionary regulation. Examples are Refs. 35–48.

For the case highlighted here, the following can be said. If producers think that *ex ante* risk evaluation should not be legally required for certain (classes of) chemicals because the costs of performing the risk evaluation would exceed the social costs of the risks posed by these chemicals, then they should prefer to accept unconditional and unlimited liability for these risks, this being the more cost-effective option for them. Conversely, if producers would accept this liability, then the relaxation of *ex ante* testing requirements might be more acceptable for other parties involved. The actual legal liability is, however, both conditional and limited. Thus, the European Directive on environmental liability (2004/35/CE) allows EC member states to exempt actors from liability for damage caused by an activity or an emission that was expressly authorized (Art. 8.4(a)), or that “was not considered likely to cause environmental

¹¹ For this discussion see, e.g., the Euractiv article “Chemicals Policy Review (REACH),” available at <http://www.euractiv.com/Article?tcaturi=tcm:29-117452-16&type=LinksDossier#lxciehxh.Issues> (accessed October 2008).

damage according to the state of scientific and technical knowledge at the time when the emission was released or the activity took place” (the so-called risk of development) (Art. 8.4(b)) (see Refs. 49, p. 86; 50, p. 53; 51, p. 552).¹² Clearly, this provides ample possibilities for member states to exempt actors from liability. Karlsson⁽⁵⁰⁾ holds that “as soon as a producer has fulfilled his obligations under REACH, e.g., once a substance has been authorised, the so-called duty of care is considered fulfilled and liability claims can never be raised, regardless of the magnitude of any negative consequences in case of unexpected harm.”

5.3.2. *The Precautionary Principle in Environmental Law and Liability*

The above discussion can be extended to a more general consideration regarding the precautionary principle. One reading of this principle holds that “the proponent of an activity posing uncertain risk bears the burden of proving that the activity poses ‘no’ or an ‘acceptable’ risk before the activity can go forward.”⁽³⁵⁾ This reading finds support in our evaluation criteria, if it is added that what constitutes sufficient evidence of “no” or an “acceptable” risk should be judged by those who are subjected to that risk. Activities for which conclusive evidence of no, or an acceptable, risk cannot be provided would more easily receive the approval of those subjected to the risk if the proponents would guarantee recovery in the case that harm would materialize. There are many difficulties that may stand in the way of obtaining agreement on acceptable guarantees of recovery, having to do with problems of causation, of proof, of compensation for irreparable harm, and more. These difficulties, to be discussed in Section 6.2, should not obscure that the unanimity requirement (among those involved or among those who truly represent them) is necessary if progress in the sense of (expected) Pareto improvement is to be secured. Neither do these difficulties annihilate the insight that the requirements of peaceful coexistence and progress mandate that actors who proceed with an activity without the consent of those who may experience the consequences should face un-

¹² The European Directive on product liability (85/374/EEC) likewise exempts producers from liability if the state of scientific and technical knowledge at the time when the product was put into circulation was not such as to enable the existence of the defect to be discovered (Art. 7(e)).

conditional and unlimited liability for any resulting harm.

5.4. Climate Change Through Fossil Fuel Combustion

Principle 13 of the 1992 Rio Declaration on Environment and Development says that states shall develop national law regarding liability and compensation for the victims of pollution and other environmental damage, and that states shall also “cooperate in an expeditious and more determined manner to develop further international law regarding liability and compensation for adverse effects of environmental damage caused by activities within their jurisdiction or control to areas beyond their jurisdiction.”¹³ In spite of this, there is a virtually complete lack of an international regime of liability for the adversarial effects of possible climatic change due to CO₂ production.¹⁴ Nevertheless there are no fundamental legal obstacles that prevent the introduction of an effective regime.⁽⁵²⁾

5.4.1. *Discussion*

The complete lack of legal liability for climate change clearly is not in agreement with our evaluation criteria. This lack of liability implies that the recovery of people who will be harmed is not guaranteed, and that the costs of recovery from damage are excluded from the price of fossil energy. If such costs were to be included, even if only partially, into market prices by introducing market share liability for climate effects and by requiring coverage of liability by financial security, then this would surely affect the level of energy consumption and/or the choice for renewable energy sources.

¹³ <http://www.unep.org/Documents.multilingual/Default.asp?DocumentID=78&ArticleID=1163>. The statement quoted in the text is a reiteration of principle 22 of the Stockholm Declaration on the Human Environment, which precedes the Rio Declaration by 20 years. See <http://www.unep.org/Documents.multilingual/Default.asp?DocumentID=97&ArticleID=1503>.

¹⁴ The trading system of CO₂ emission rights that has been installed in recent years cannot make good the lack of liability legislation, as the amount of tradable emission rights was not the result of a consensus decision among all who may experience the effects of CO₂ emissions.

6. POSSIBILITY AND LIMITATIONS OF LIABILITY AND PRIVATE INSURANCE FOR SECURING CREDIBLE AND ETHICALLY SOUND RISK ASSESSMENT AND RISK MANAGEMENT

The requirements that are assumed in this article are applied to assess the fundamental possibilities (Section 6.1) and the fundamental problems and limitations (Section 6.2) of liability, combined with private insurance, to secure credible and ethically acceptable risk assessment and risk management practices. The discussion of the problems and limitations will lead in Section 6.3 to a consideration of the role of precautionary *ex ante* regulation.

6.1. Possibilities

In any assessment of the risks of an existing or proposed technological activity, it is unavoidable that assumptions are made that do not follow from direct observation, established science, and/or logic. Such assumptions are subjective in the sense that no one can be forced on the basis of empirical facts and logic alone to accept them. Such assumptions can be denied without denying any empirical or scientific facts or (deductive) logic.¹⁵ Any risk assessment leading to a definite risk estimate must necessarily contain subjective assumptions in this sense. Outsiders are usually unable to evaluate the credibility of these assumptions and hence of the outcomes of an assessment. In view of this, it may be expected that someone who is exposed to the risk attaches credibility or trust to a risk assessment only if an individual or a group of individuals (i.e., a market party) has agreed to insure the risk for a premium that is related to the expected costs of the risk.¹⁶ It would actually be in agreement with our evaluation criteria to allow only those hazardous activities of which the

risks are completely covered by private insurance or other financial warranty, for instance, along the lines proposed by Meyer⁽⁵³⁾ for commercial nuclear power plants and LNG terminals. Actual applications of this idea in (American) environmental law exist, such as the bonding systems and liability systems described in Ref. 4, pp. 80–82. Under the condition described above, private insurers, while acting according to the established principles of risk management and insurance,⁽⁵⁴⁾ can be effective and trustworthy risk assessors and safety inspectors, as it is in their best interest (1) to determine insurance premiums that are both profitable and competitive, and (2) to set and supervise conditions and constraints aimed at optimizing the activity's safety. This consideration finds empirical support in Freeman and Kunreuther's⁽⁵⁵⁾ analysis of examples of private insurance of (liability for) environmental risks.¹⁷ From their study it can be concluded that many environmental risks are readily insurable by the private insurance industry, provided that (1) there is sufficient legal/regulatory clarity about who is liable for what, and (2) governments do not interfere in the insurance market, e.g., by installing guarantee funds fed with tax money in order to cover up (part of) the harm resulting from the environmental risk for which a private actor was supposed to be liable. (See also Ref. 56.)

In this section the focus is on the organizations that run high risk technological activities, such as nuclear or chemical plants, railway companies, etc. Examples of safety management issues in such organizations are provided in Refs. 57–58. If such organizations are held liable for the costs of accidents caused by their activities, then safety decisions obtain a financial translation. Such decisions are therewith brought on a par with all other management decisions, which, in private organizations at least, are ultimately governed by financial goals and considerations. This can provide for an effective intra-organizational mechanism for safety management and safety decision making. The mechanism can comply with our evaluation criteria, within limits that will be discussed in Section 6.2.

As the examples of Section 5 show, at present many hazardous technological activities proceed of which the risks have not, or at best only partially,

¹⁵ This definition of a subjective statement is due to Van Velsen (see Ref. 2, pp. 49–50).

¹⁶ A particular example that may illustrate the statements in the text can be found in Ref. 53. Based on the U.S. Nuclear Regulatory Commission's Reactor Safety Study published October 1975, and assuming a cost of \$500,000 per casualty, the expectation value of a catastrophic risk would be as low as \$64 per reactor year (total possible damage \$64 billion, with a probability of occurring once in a billion years). Yet in testimony supporting the original passage of the Price-Anderson Act, the nuclear industry insisted that nuclear power would not be possible if the industry should bear the cost of liability above a limit of \$560 million. How can this claim be reconciled with the quoted outcome of the risk analysis?

¹⁷ The examples involved insurance for operator liability for health risks from asbestos during clean-up activities; property owner liability for environmentally contaminated property; liability for risks of groundwater contamination from underground petroleum storage tanks; and liability issues in lead-based paint abatement activities.

been insured or otherwise guaranteed by or on behalf of the actors. Hence, enormous improvements are possible here, in spite of the problems and limitations that we will turn to now.

6.2. Problems and Limitations

The list of problems and limitations inherent in liability that follows below is not claimed to be exhaustive. Deeper and richer discussions of these and related problems can be found in Refs. 59–62. Our requirements leave open the following responses to such problems. Either the liability laws are “fixed” in ways that render the activities performed under those laws acceptable to all who are subjected to the risks. Below, we will make some suggestions. Or, if that is impossible or impractical, *ex ante* requirements and conditions can be imposed on the activities, either or not in combination with provisions for liability, to make them less dangerous and/or more acceptable to those subjected to the risks. If none of these responses succeeds, the activity should be banned altogether.

1. *Establishing a causal link.* In order to hold an actor liable for harm resulting from an activity, a causal link must be established between the activity and the harm. If the causes remain unknown, or cannot be linked to an actor, then the harm will remain uncompensated. Even if statistical evidence is available that a certain percentage of occurrences of a disease are caused by exposure to a chemical pollutant, problems remain, at least in the actual legal systems. As an example, current tort law in the United States requires proof that a pollutant is more likely than not the cause of someone’s disease, in order to hold the polluter liable for compensation (see Refs. 59, pp. 230–232; 60, p. 382). A consequence of this rule is that statistically proven harms from a certain pollutant remain uncompensated when the probability that an individual’s harm was caused by the pollutant does not exceed 50%. A remedy for this particular case would be to award partial damages calculated in proportion to the attributable risk (see Refs. 60, p. 378; 59, p. 232). As the latter remark, this would be challenging but not impossible to implement. To further increase the likelihood of compensation, the rules of evidence may be modified in other ways, the bur-

den of proof may be (partially) shifted from those who are subjected to a risk to those who caused it, market share liability may be imposed, etc.

2. *Discounting future damages to present value.* It has been stated by Ashford and Caldart that “even if the defendant believes that some plaintiffs will eventually sue and recover monetary damages, the costs of future lawsuits, when discounted to present value, may not be sufficient to provide a financial incentive to the defendant to invest now in the pollution reduction that would be necessary to avoid the lawsuits.”⁽⁵⁹⁾ A similar argument can be mounted regarding the safety management of risk-generating activities such as nuclear and chemical installations, transport of hazardous substances, oil exploration and exploitation activities, etc. For an analysis of this problem it is useful to distinguish between damage that is repairable, and damage that is not repairable, hence can at best be compensated. The first case is the least complicated.¹⁸ Assume, in agreement with our requirements, that hazardous activities are only allowed if the worst-case harm is fully covered by a financial warranty held available by the actors themselves, by private insurance, or by yet other warrantors other than governments. If this warranty is invested in useful activities or assets (unrelated to the risk), its value will develop on a par with market rates of return. The assumption might then be accepted that the warranty will suffice to repair that same physical damage at any later time and it could no longer be claimed that harms falling in the future provide insufficient financial incentive to actors to reduce the risks generated by their activities.

Irreparable harm such as irreversible harm to the environment and to human health and life can at best be compensated. For full internalization of such external costs, potential victims must beforehand agree to how such harms, if they occur, will be compensated. Otherwise, it could never be claimed in a nonarbitrary way that the compensation, whatever the amount, is “full” or “fair.” At

¹⁸ This case becomes more complicated if the determination of the worst-case scenario contains subjective assumptions, as will often be the case.

present, there is no ground for a claim that this condition is satisfied. If there were such ground, then the approach described above for reparable harm might in principle be followed here as well, although, because of the many uncertainties, it might be wise to periodically reassess whether the agreed-upon amount of financial warranty is still sufficient for adequate compensation in the worst possible case.

3. *Moral hazard in insurance.* When the risks of a company's activities are covered by an insurance policy, the insured company may be tempted to behave in a more risky manner, resulting in more negative consequences (that the insurer must pay for) as would have occurred without insurance policy. This is called moral hazard. Considered from the perspective of our requirements, moral hazard would not cause a problem if all potential harm would be reparable or fully compensable and if the worst possible accident would be financially covered. But as not all harm is reparable or fully compensable, moral hazard, like "discounting the future," limits the use of liability and insurance for bringing about ethically acceptable risk management. Strategies to reduce moral hazard do exist, such as coinsurance, co-payments, and deductibles, but it is questionable whether this can completely eliminate moral hazard.
4. *Moral hazard in corporations.*⁽⁶²⁾ If corporate managers are insufficiently exposed to the negative effects of their business decisions, they may take decisions that generate more risks than is desirable from the perspective of the company and/or of society at large. There is reason to believe that such moral hazard in organizations actually occurs in modern business organizations. It could be reduced by imposing upon managers and perhaps other employees, as well as on shareholders, more (financial) responsibility than is the case under the current legal regime that tolerates private legal persons with limited liability. Important improvements in business and corporate law seem possible here.¹⁹ To see more clearly both the problems and the possible so-

lutions, a comparison with older legal forms might be inspiring.⁽²⁰⁾

5. *Investment necessary to mount a case.*⁽⁵⁹⁾ Law-suits cost money. As a consequence not all cases will be brought to court, either because the harm is not severe enough or because the plaintiff or his lawyer does not want to run the financial risk of a negative court decision.

6.3. The Role of Precautionary *Ex Ante* Regulation

One line of action in response to the problems attached to liability offered by our requirements is to make adjustments or additions to the current liability laws so as to make the activities performed under those laws acceptable to all who are subjected to the risks. Depending in part on the nature of the risk, this may prove to be very difficult, as the above exposition and discussion may show. The other line of action is to adopt precautionary *ex ante* regulation aimed at restricting or constraining the risk-generating activities directly. But which *ex ante* regulation, and how should it be enforced? How will compliance be guaranteed? How will compliance be inspected and controlled, and what will be sanctions on violation? Our first requirement calls for consensus on these issues among all who are subjected to the risks generated by the regulated activity. Without such agreement, the activity violates the requirement of informed consent, which means in virtue of the second requirement that the legal liability for those activities should be unconditional and unlimited. One important practical implication is this. It is a frequent phenomenon that actors are legally exempted from liability as long as the activities are within regulations or if the activities are authorized by a government. An example mentioned in Section 5.3 is the EU directive on environmental liability. Taking into account that such exemptions are based on majority decision making, they violate our requirements. For the same reason, the exemption of liability for the "risk of development" in the EU directives on environmental liability and on products liability (Section 5.3) are violations of our requirements.

7. CONCLUDING REMARKS

Using examples from international environmental law, we have tried to show that current legal

restores corporate limited liability "to its rightful place as one of the most controversial parts of the global political economy."

¹⁹ Recently, the *Cambridge Journal of Economics* published a special issue on the topic of corporate accountability and legal liability (Vol. 24.5, 2010) for which its (guest) editors claim that it

liability for risk-generating technological activities deviates in several ways from the standard of unlimited and unconditional liability that is mandated by our requirement of informed consent and of liability in the absence of informed consent, given that the collective decision making within states about these activities relies on majority rule. Liability is not, and cannot, be developed into a full substitute for precautionary *ex ante* regulation. In view of our requirement of informed consent, and in order to safeguard progress in the sense of (expected) Pareto improvement, the decision making on such precautionary *ex ante* regulation should be based on the consent of all who are subjected to the risks of the regulated activity. As long as the actual decision making proceeds on the basis of majority rule within nations, our requirements call for unlimited and unconditional liability as the basis for liability in the legal systems.

We hope to have revealed opportunities and directions for improvements of legal liability for risk-generating technological activities and of risk management practices based on liability. Although such improvements cannot fully compensate for the negative effects of political majority decision making, they can at least quench some of these effects by promoting precautionary behavior and by enhancing the prospects of reparation of or compensation for harm. In addition, such improvements will promote political decision making practices based on the consent of a larger fraction of those who are subjected to the consequences of the decisions made than is presently the case.

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