IV. LEGAL IMPLICATIONS OF TECHNOLOGICAL DEVELOPMENTS

Two technological developments are potentially so far-reaching in their effects as to call for special mention. The first development concerns man's incipient capability to alter natural atmospheric processes to his benefit. The second concerns his capacity to employ satellites to gather data useful in disaster prevention and mitigation.[52/] The legal implications of both of these developments are profound, and in both cases the legal issues are barely at the stage of formulation, much less resolution.

4.1 Weather Modification [53/]

It has been established that ice crystals can be caused to form in super-cooled clouds by seeding them with dry ice, silver iodide or other nucleants. Since ice crystals are known to play an important part in the formation of precipitation, cloud seeding may become a significant method of modifying the precipitation process. The theoretical benefits of this for disaster mitigation are considerable: precipitation may be enhanced or retarded; hail may be suppressed; tropical storms may be modified. But the state of the art is uncertain. For example, in only a few experiments has it been clearly demonstrated that cloud seeding increased precipitation. In some experiments claims were made that a decrease was observed.

Experiments with hail suppression have also yielded ambiguous results. The state of scientific knowledge has a necessary bearing on the formulation of appropriate legal principles to govern

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52/ A brief summary of some present and future applications of this technology is contained in the working paper entitled The Potential Applications of Satellite Remote Sensing Technology to Natural Disasters, prepared by UNDRO for the Committee on the Peaceful Uses of Outer Space, 9 February 1977, (A/AC.105/C.1/L.92).

53/ For the most recent discussion of the science and the law, see William A. Thomas (ed), Legal and Scientific Uncertainties of Weather Modification, Durham, North Carolina, Duke University Press, 1977.

weather modification activities. Discussions in the WMO/UNEP informal meetings on Legal Aspects of Weather Modification 54/ have revealed that there is a fear that concentration on rules related to the harmful effects of weather modification activities, such as rules with regard to liability for damage, may impede the development of what is recognized to be a beneficial technology. As a result, discussions have centered on the preventive functions of administrative law, such as appropriate licensing and monitoring procedures.

As has been mentioned above, weather modification activities raise a number of complex legal problems which are still barely at the stage of formulation. Perhaps the simplest issues relate to the appropriate forms of administrative control of these activities, such as through the licensing of weather modification projects. Secondly, the most difficult group of questions relate to the liability of the weather modifier for damage that may be caused as a result of his activities. And, finally, because weather is inherently transnational, weather modification activities will often have transnational effects, and therefore important questions of international law arise.

The first general issue relates to the legal regime which regulates weather modification activities. The establishment of such a regime has in the past been considered a matter for national Governments, and legislation in fact exists in only a few countries, among them the United States of America, Canada, Australia and South Africa. Yet, at the time of writing, 74 States have, at one time or another, attempted weather modification activities (see Figure 4). It can be concluded that in most countries weather modification activities have been carried on in the absence of legal regulation.

54/ World Meteorological Organization/United Nations Environment Programme. It should be noted that discussions between these two United Nations bodies have been informal and unofficial, and no set of legal principles has been approved or adopted. See also Report of WMO/UNEP meeting of experts designated by Governments on the legal aspects of weather modification, Geneva, 17-21 September 1979.

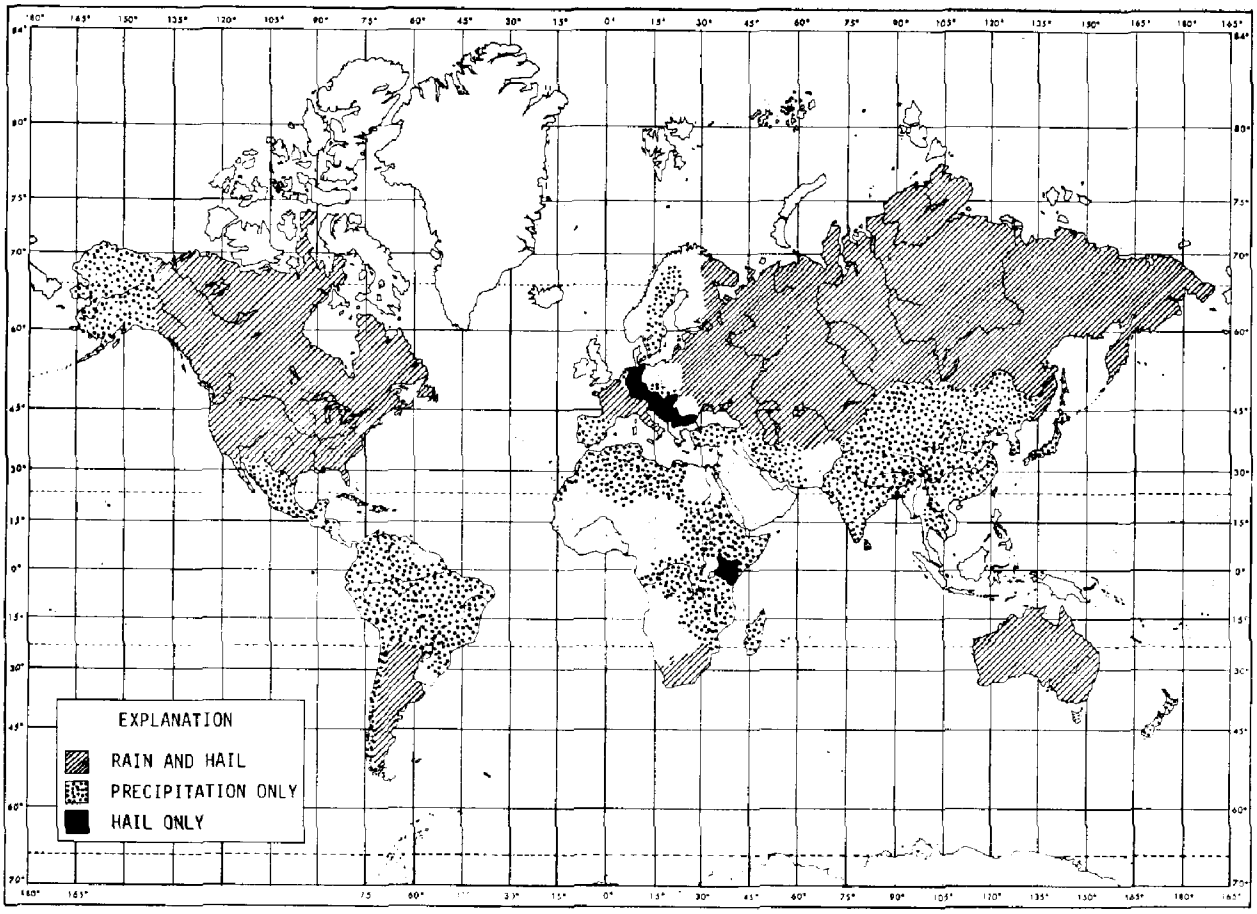

Fig. 1. Nations in which weather (precipitation and hail) modification projects (experimental or non-experimental) have occurred since 1945. (Source: Bulletin American Meteorological Society, Vol. 56, Number 1).

The country whose weather modification legislation is most developed is the United States of America, where approximately 30 states have passed legislation. However, most of the state legislation concerns only licensing procedures for the registration of individuals wishing to conduct weather modification activities. This is hardly a stringent form of control, and a number of states are in the process of considering measures to ensure more effective control, such as the submission of an impact statement, before a weather modification activity is carried out, identifying the range of possible benefits and harmful effects to local and neighbouring environments.

The inevitable increase in the use of weather modification requires States to consider desirable principles of regulation to keep apace with scientific developments. National legislation

should have as its goals the prevention of damage to persons, to property and to the environment itself. These goals can be secured by the establishment of an administrative system which provides for the licensing of weather modification operators, the authorization of weather modification projects and the monitoring of individual operations.

One objective of a national regime should be to ensure that weather modification operators have the necessary technical expertise required for the safe conduct of their operations. This can be done by licensing. The license itself would be issued subject to the demonstration of appropriate qualifications, such as the possession of the necessary skills and proven financial responsibility.

A second objective of a national regime should be the establishment of an authorization procedure for the conduct of each project. It is not appropriate here to discuss in detail the data which should be supplied in order for the responsible governmental authority to establish whether permission for the project should be granted or denied, but the data should indicate the nature of the project, the area to be affected, and the likely impact on the environment.

Finally, the national regime should provide for the registration of the data derived from weather modification operations and also for the monitoring of operations by the agency established to authorize them.

The regulation of weather modification operations also has an international dimension. 55/ Both research activities and

55/ With reference to the international dimension of weather modification activities, the Seventh Congress of the World Meteorological Organization (May 1975) considered that international legal principles and guidelines on weather modification should be developed hand in hand with scientific progress in this field, and that a better understanding of the physical basis of weather modification was needed before the WMO would be in a position to provide definitive advice to Member States on this particular aspect of weather modification. See Abridged Report with Resolutions of CG-VII, paragraph 3.2.3.6, WMO, Geneva, 1975.

actual operations may well have transnational effects. At present in international law a State has the right to conduct weather modification operations in the air space over its territory or in international air space, and it is not clear to what extent this right is circumscribed by the rights of other States. It is also not clear, for example, whether the State desiring to conduct operations must give notice to all States that might potentially be affected. Nor has it been determined whether there is an additional obligation for the State to enter into consultations with any interested States requesting them. Further, it is not clear whether there is an obligation for the State to receive the actual consent of these other States to the weather modification operation.

In the absence of a treaty or a convention outlining the general obligations of States, the foregoing questions are difficult to answer. Customary international law has an imprecision which can only be remedied by expressing the legal obligations in treaty form. In any case, it is of interest to note that although it is generally believed that international law does not presently require their consent, states desiring to conduct some types of weather modification operations have nonetheless been reluctant to proceed without it. For example, the United States of America has been unwilling to proceed with certain tropical storm experiments in the Western Pacific in the absence of the consent of Japan and the People's Republic of China.

International legal principles concerning weather modification are now being developed. Since 1975 two informal meetings of experts have been convened under WMO/UNEP auspices to draft guidelines for general principles of State conduct.[56/] At its April 1978 meeting the experts decided to recommend nine draft principles for further discussion by the relevant bodies of the World Meteorological Organization and the United Nations Environment

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56/ See footnote 54, which points out the informal nature of these meetings.

Programme. The principles therefore have the status of recommendations, but it is probable that an eventual convention or protocol will develop along the lines indicated by them.

One of the suggested principles provides that whatever techniques are developed to modify the weather they should be dedicated to peaceful purposes.[57/] Another provides that timely notification should be given to WMO of major weather modification activities; WMO, in turn, should transmit the notification to all interested States. Another suggested principle, and from the point of view of disaster prevention perhaps the most important, is that a State desiring to conduct weather modification operations should be under a legal obligation to consult with other States where the operations are likely to affect significantly the environment outside its own jurisdiction.[58/]

57/ In this connexion, see also the Convention on the Prohibition of Military or any Other Hostile Use of Environmental Modification Techniques, under Article I of which each State Party undertakes not to engage in "military or any other hostile use of environmental modification techniques having widespread, long-lasting or severe effects as the means of destruction, damage or injury to any other State". The Convention has now entered into force.

58/ For an example of a treaty requiring consultation, see the "Agreement Between the United States of America and Canada Relating to the Exchange of Information on Weather Modification Activities", 14 International Legal Materials (1975), p. 589. Under Article V the Parties "agree to consult, at the request of either Party, regarding particular weather modification activities of mutual interest. Such consultations shall be initiated promptly on the request of a Party, and in cases of urgency may be undertaken through telephonic or other rapid means of communication". Weather modification activities are agreed to be of "mutual interest" if they are carried out "in or over the territory of a Party within 200 miles of the international boundary" or if they are activities, wherever conducted, "which, in the judgement of a Party, may significantly affect the composition, behaviour or dynamics of the atmosphere over the territory of the other Party" (Article I).

It should be noted that the proposed obligation is merely to enter into consultations. The decision to conduct weather modification activities is now, and is likely to remain in the foreseeable future, a matter of national discretion.

It is also necessary to examine the question of liability for damage. Administrative regulation of weather modification activities does not preclude the possibility that harm may be caused to private rights as a result of such activities, either because the intended result had undesired extra-area effects or because unintended results occurred altogether. The uncertainties with regard to natural atmospheric processes, to the possibilities of their modification and to the existence of extra-area effects are so great, that it is not impossible that substantial damage may sometimes result from weather modification activities. In an early hurricane seeding experiment in 1947, off the east coast of the United States of America, the seeded hurricane veered 120° westward, causing property damage in the states of Florida, Georgia and South Carolina.

At the present time there is little judicial authority on the legal consequences of the adverse effects of weather modification activities, nor is it certain what basis of liability is appropriate. Essentially, liability may be founded on fault, that is, for damage caused as a result of negligent or otherwise wrongful acts; or liability may be absolute, that is, liability may be imposed for any damage caused by the weather modification operator, no matter how careful he may be. The trend in many countries is to impute absolute liability for activities that are regarded as ultra-hazardous. It is possible to regard weather modification as such an activity.[59/] Internationally, too, the trend is to impute absolute liability for damage caused by ultra-hazardous activities. The three multilateral conventions that

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59/ In two states of the United States of America, Pennsylvania and West Virginia, weather modification legislation specifically applies the theory of absolute liability. The Pennsylvanian statute, for example, provides that "any licensee who causes a drought as determined by the Board shall compensate farmers for damages. Any licensee who by causing damage to lands as determined by the Board shall compensate farmers and property owners for such damages".

deal with civil liability for environmental damage are based on absolute liability.60/

The problem of liability takes on an international dimension where the weather modification operation has transnational effects and damage is caused. Under international law a State bears responsibility for activities within its jurisdiction or control which cause damage to the environment of other States. This principle is articulated, for example, in Principle 21 of the Declaration of the United Nations Conference on the Human Environment:

> States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.61/

Where, therefore, transnational damage results from a weather modification operation, the State over whose territory the operation was conducted may be liable under international law for the damage done. But, again, it remains an open question as to whether that liability is based on fault or whether it is absolute.

Whatever theory of liability is adopted, both nationally and internationally, it must be proved, whenever damage follows a weather modification operation, that the damage was a result of the operation. At least in the immediate future, proof of this

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60/ They are the Convention on Third Party Liability in the Field of Nuclear Energy, 1960; the Convention on Civil Liability for Oil Pollution Damage, 1969; and the Convention on Civil Liability for Oil Pollution Damage Resulting from Exploration for and Exploitation of Seabed Mineral Resources, 1977.

61/ Report of the United Nations Conference on the Human Environment, Stockholm, 5-16 June 1972, United Nations, New York, 1973 (A/CONF.48.14/Rev.1).

sort will be extremely difficult to establish. The range of natural variability of atmospheric processes is too great, and our present understanding of these processes and of the effects of seeding on them is too limited, to prove beyond doubt that the weather actually altered, and that damage was caused as a result of a modification operation. However, as scientific understanding improves, proof of causation will no doubt become progressively easier.

It should be added, in conclusion, that the whole question of liability for damage resulting from weather modification operations is a very sensitive one. The informal discussions between the WMO/UNEP experts, referred to previously have not dealt with the question of liability because it was strongly felt by the meteorologists participating in the WMO/UNEP meetings that, given the present stage of scientific knowledge, rules on liability would be premature and might even be counter-productive to the development of the technology. It is of interest to note that the treaty between the United States of America and Canada, mentioned earlier, also avoids dealing with the question of liability. Article VII of the treaty provides that:

> Nothing herein relates to or shall be construed to affect the question of responsibility or liability for weather modification activities, or to imply the existence of any generally applicable rule of international law.

The caution of both of these documents suggests that the problem of liability may prove to be one of the most difficult issues to resolve internationally.

4.2 Remote Sensing by Satellite[62/]

Remote sensing by satellite refers to the viewing of the earth's surface and its surrounding environment by means of sensing

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62/On the application of remote sensing to disaster prevention and mitigation, see David S. Simonett, "Possible Uses of Space Satellites for Disaster Warning, Monitoring and Damage Assessment", in The Role of Technology in International Disaster Assistance, Washington, D.C., National Academy of Sciences, 1978. For a detailed discussion of the legal aspects of remote sensing, see Nicolas Mateesco Matte and Hamilton DeSaussure, Legal Implications of Remote Sensing from Outer Space, Leyden, A.W. Sijthoff, 1976.

devices affixed to platforms orbiting the earth from the near reaches of outer space. Remote sensing is likely to prove of considerable benefit in providing information necessary for the physical planning process. This information will be of value in the adoption of land-use legislation, which, as has been seen, is one of the basic tools for minimizing disaster risk in vulnerable areas.

Remote sensing data has already proven of value in delimiting areas subject to floods with a view to adopting preventive measures. For example, data from LANDSAT, an American earth resources observation satellite, enabled planners in Bangladesh to predict areas likely to experience major flooding and to choose other areas upon which safer development could take place. Remote sensing data has also already proven useful in identifying earthquake-prone areas. Images from LANDSAT revealed that a fault line in the United States of America that had been believed to be only 5 kilometres long actually extended for 97 kilometres.

In addition to the mapping of hazardous areas, remote sensing can be applied to the monitoring of natural phenomena. To take one example, a prototype volcano monitoring system has been developed under the LANDSAT data collecting system and is being applied to 15 volcanoes in 5 countries. A further use of remote sensing data will consist in the assessment of widespread damage caused by such natural phenomena as tropical storms, forest fires and droughts.

The value of remote sensing data to disaster prevention, preparedness and relief co-ordination is manifest. However beneficial the data may be in disaster-related fields, they also have highly sensitive economic and military applications which, from the point of view of many States, dwarf in significance its other uses. As a consequence, remote sensing has raised profound questions which go to the very heart of State sovereignty: is 'information' about a State part of its 'natural wealth and resources', over which it has permanent sovereignty? 63/ Does a

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63/ See United Nations General Assembly resolution 1803(XVII), 14 December 1962.

State have a right to forbid or control the sensing of its territory? does a sensed State have a right to object to the distribution of data about its territory to third parties, or at the very least, to receive and analyze data prior to its distribution to third parties? These and related questions have been the subject of discussion in the Legal Sub-Committee of the Committee on the Peaceful Uses of Outer Space (COPUOS) of the United Nations General Assembly.

Discussions in the Legal Sub-Committee of COPUOS have revealed agreement on a number of principles, but these relate, for the most part, to matters of high generality.[64/] It is agreed, for example, that remote sensing of earth is to be carried out for the benefit of all countries and in accordance with whatever principles of international law may be applicable. Draft Principle VIII, which expresses a specific obligation, is of particular relevance to this monograph:

> Data and/or information obtained by remote sensing of the earth indicating an impending natural disaster shall be disseminated as promptly as possible to those States likely to be affected (all States, priority being given to those likely to be affected).
>
> (This provision shall also apply to data and/or information obtained by remote sensing during and after natural disasters, in order to help affected States combat such disasters).

Of more significance at the present time are the areas of disagreement because they may inhibit the use of the technology. It has not yet been possible to reach agreement as to whether a State which intends to conduct remote sensing must give advance notification to States whose territory will be sensed. And, finally, it is not agreed under what circumstances a State carrying out remote sensing may disseminate data to third parties without the approval of the State or States affected.

64/ For the text of the Draft Principles, see Report of the Legal Sub-Committee on the Work of its Eighteenth Session, 10 April 1979, Annex I, United Nations, New York (A/AC.105/240).

Discussions in the Sub-Committee have been made difficult by the apparent conflict of two principles long espoused by the United Nations: the principle that peoples and nations have a right to permanent sovereignty over their natural resources and the principle of freedom of information articulated in Article 19 of the Universal Declaration of Human Rights.[65/] At one extreme, a number of States have maintained the point of view that 'information' about a State is one of the resources over which the State has permanent sovereignty, and these States have opposed even the sensing of a State without its consent. At the other extreme, some States, invoking the principle of freedom of information, have advocated a policy of open sensing and of the public, unrestricted dissemination of all data. Given the fundamental division that exists within the Sub-Committee at present, it is likely to be some time before complete agreement can be reached on a set of principles which both facilitate remote sensing activities and yet safeguard the sovereign rights of sensed States.

65/ Article 19 provides that everyone has the right to "seek, receive and impart information and ideas through any media and regardless of frontiers".

V. CONCLUSIONS

The monograph on Land Use Aspects in this series has shown that zoning, subdivision and other regulatory measures have been used by many countries as techniques of land development and land-use control, and that these techniques can be extended for the purpose of disaster prevention or for risk mitigation and management.[66/] The major legal difficulty is that many developing countries which have land-use controls do not in fact enforce them. The problem of non-enforcement is a disparate one throughout the developing world, and it will probably constitute the greatest single obstacle to the successful use of regulatory measures as strategies in disaster prevention and mitigation. The main cause of non-enforcement is the lack of administrative infrastructure in developing countries, especially at municipal level. Research is urgently required into techniques of enforcement suitable for developing countries, given their often meagre economic, administrative and other resources.

Traditional regulatory techniques pose fundamental problems of constitutional law in each jurisdiction, especially regarding the question of when a land-use regulation, which is non-compensable, becomes a 'taking' of property without just compensation. Ironically, courts have preferred not to deal with broad constitutional issues. Rather, they have preferred to examine a particular regulation on the basis of its validity or invalidity with reference to a specific parcel of land. That a municipal court tends to confine itself to the facts of the case before it points out the legal importance of proper vulnerability analysis, can provide the best evidence available that such regulations are reasonable and non-discriminatory, and therefore valid.

66/ cf. footnote 3 , page 5 of this text.

The problem of jurisdictional lacunae has proven to be a significant hindrance to satisfactory land-use control in developing countries. Acts enabling municipalities to assume jurisdiction for zoning and other purposes often restrict the exercise of the power to municipal limits. Hence, municipalities in many developing countries find they have not got the legal power to control those very areas of growth where control is most needed. This is an acute problem in much of Latin America and in the Asia and Pacific region.

The solution to the problem of jurisdictional loopholes in enabling acts is common to all developing countries where the problem exists. But for many problems, there is no such common solution. For example, it has already been seen that citizen participation in the planning process may be critical to the ultimate success of planning proposals. Yet such participation in developing countries has often had the effect of slowing down considerably the process of development and the doubt is raised whether many developing countries can afford the comparative luxury of a slow, albeit democratic, planning process.

Research is required into the question of the balance that should be struck between the requirements of public participation in the planning process and the imperatives of an immediate land-use policy for disaster prevention. It is likely that no single solution will, or ought to, command universal support. Rather, the balance ultimately struck by a developing country will be in response to its own political, legal and cultural traditions. In the same way, research is required into the use of insurance and tax strategies in disaster prevention, so that developing countries can adopt policies appropriate to their distinct requirements and traditions.

This study has also shown that the degree of preparedness varies greatly from country to country. Many developing countries have no preparedness plans at all, and few countries have plans

which can be regarded as satisfactory. Yet preparedness plans are essential if loss of life and physical destruction are to be minimized.

A number of points about national preparedness plans should be emphasized. National legislation, and regional legislation where appropriate, should make provision for the declaration of a state of disaster emergency. It is advisable that the legislation set some brief statutory limit on the duration of the state of disaster emergency. The powers to be exercised by the chief executive officer in the event of an emergency should be clearly outlined.

In countries where the incidence of natural disasters is high, it is desirable to establish a disaster preparedness planning unit. One of the most important matters is the location of the unit within the decision-making structure of the Government. It is desirable that the planning unit be located within the office of the chief executive of the Government. The legislation establishing the disaster preparedness planning unit should clearly outline its powers and duties, the principal duty being the preparation and the periodic review of a disaster plan.

Planning by local governmental authorities is an essential part of a national preparedness strategy, and local authorities should also be required to establish disaster preparedness plans. One of the most important matters for consideration in such plans is the question of interjurisdictional co-operation.

Finally, the financing of disaster-related activities is an important, but often overlooked, detail. It is desirable to create a disaster emergency funding committee to vote funds and to take action should the legislature not be in session.

This study has endeavoured to demonstrate the importance of law as an instrument of disaster prevention and mitigation. The dearth of legal studies on almost all aspects of disaster prevention and mitigation clearly supports the conclusion that comparative research into these areas of law is urgently required.

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