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Examining the Legal Status of Clouds in International Law

[1]Prof, Dr. Mohammad Ekram YAWAR, [2]Dr. Ramazan Ahmadi, [3]Muaiyid Rasooli PhD, [4]Lec. Abdul Jamil Sharify

https://orcid.org/0000-0003-3198-5212 https://orcid.org/0000-0002-8299-7080 https://orcid.org/0009-0000-8968-8910
https://orcid.org/0009-0001-0727-6726

[1]Dean of the Faculty of Law, International Science and Technology University, Warsaw, Poland

[2]Department of Sociology, Faculty of Social Sciences, Bamyan University, Afghanistan.

[3]School of Law, Xi'an Jiaotong University.

[4]Head of Department of Management Information Systems, International Science and Technology University, Warsaw, Poland.

***Corresponding Author :Prof, Dr. Mohammad Ekram YAWAR**

"Dean of the Faculty of Law, International Science and Technology University, Warsaw, Poland"

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Abstract: In contemporary times, the global water crisis represents one of the most critical challenges confronting humanity. International law bears significant responsibility in establishing an effective legal framework for the management of freshwater resources. A key dimension of this challenge concerns the legal regime governing water in the atmosphere, particularly regarding state interventions in precipitation processes, including artificial cloud seeding, which may have transboundary effects. This article, acknowledging the existing ambiguities in international law, examines the role of general principles of international law in defining the legal status of clouds and the international responsibility arising from related activities. In addition to these general principles, the study incorporates the work of the International Law Commission on the Responsibility of States for Dangerous Acts Not Prohibited under International Law as a guiding framework for understanding the legal implications of artificial cloud production.

Keywords: *legal regime of clouds, international responsibility, international law, artificial cloud production.*

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Introduction

Undoubtedly, one of the most pressing crises humanity will face in the near future is the water crisis. Although more than 70 percent of the Earth's surface is covered by ocean water, only three percent of the planet's water is fresh, and the vast majority of this freshwater is either frozen in polar and glacial regions or otherwise inaccessible. Consequently, the volume of conveniently available and usable freshwater is extremely limited and unevenly distributed across the globe.

Under these circumstances, tensions arising from water scarcity are increasingly common, and the search for reliable freshwater sources has become a central concern for governments worldwide. Technological advancements now allow humans to intervene in natural ecosystems in increasingly effective ways. However, such interventions do not always produce predictable or equitable outcomes.

In this context, the recovery and utilization of atmospheric water—particularly water contained in clouds—has emerged as a focus of scientific inquiry. Efforts to influence precipitation processes and modify the natural hydrological cycle may yield significant benefits for some groups while potentially disadvantaging others. Indeed, the potential increase in water resources resulting from human intervention has made this issue a critical challenge for sustainable development.

The legal implications of human intervention in atmospheric water are equally significant, particularly under international law. At the start of the twenty-first century, the World Meteorological Organization noted that "the legal dimensions of artificial cloud seeding, especially when conducted near international borders, could be substantial." In recent years, disputes have arisen between states that employ weather modification technologies, underscoring the need for a clear legal framework.

From the perspective of international law, a central question emerges: Do states have legal rights to the water resources contained in clouds, and if so, can they claim direct entitlements to these resources? While the current treaty system offers limited guidance regarding clouds, it can be hypothesized that the general principles of international law establish rights and obligations governing state behavior in this domain, creating boundaries that must be respected.

The Right of States to Cloud Water Resources from the Perspective of International Law

The concept of utilizing clouds as a source of water is not new. From a technical standpoint, the methods for harnessing water

from clouds can be classified into two main categories: the capture of water vapor and cloud seeding.

The first method involves capturing water molecules directly from clouds using specialized networks designed to "harvest" atmospheric moisture. The second method, cloud seeding, stimulates precipitation by introducing external agents that cause clouds to release their water reserves as rainfall.

Historically, the CIRRUS Project, initiated by the U.S. Army Communications Unit in 1946, represents the first major scientific endeavor to induce rainfall through cloud seeding, which achieved measurable success by 1948. Since then, these techniques have been tested and implemented in various regions worldwide to alleviate seasonal or chronic droughts and to provide water for human populations.

However, because these interventions extract a significant volume of water from the atmosphere within a specific time and location, they may reduce the availability of water for other territories or populations. Such alterations to the natural hydrological cycle raise important questions under international law. Foremost among these questions is the legality of such interventions: to what extent can artificial manipulation of cloud precipitation be considered compatible with the rights of other states or individuals to water resources? More specifically, does such interference risk violating principles of equitable utilization or sovereignty recognized under international law?

The Compatibility of State Intervention in the Process of Precipitation with International Law

In general, international law, there is no specific legal text addressing clouds or the precipitation that results from them. However, it is possible to deduce rules governing atmospheric phenomena implicitly, based on broader legal principles. Clouds are an integral part of the Earth's ecosystem, interacting with water, air, soil, wildlife, and human life. Consequently, international environmental law and instruments designed to protect the environment can provide guidance for the legal status of clouds and rainfall, particularly where human interventions alter natural cycles.

Rain harvesting and cloud seeding are considered forms of environmental modification. The fundamental question is whether these technologies, which can significantly alter natural processes, are legally permissible. The most relevant legal instrument addressing environmental modification is the **Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Technologies (ENMOD Convention), 1977**. This treaty prohibits states from using environmental modification technologies for hostile purposes that cause widespread, long-lasting, or severe environmental damage during armed conflicts.

Despite its significance, the ENMOD Convention has several limitations:

1. **Scope limitation:** The treaty only applies to hostile use between state parties. If a non-party state employs these technologies, treaty parties are not prohibited from responding in kind.
2. **Research and development:** The treaty does not formally prohibit the military research or development of environmental modification technologies, nor does it restrict their potential threat. Covert research or testing can be conducted under the guise of scientific study.
3. **Verification and enforcement:** Enforcement relies on consultations between states and potential referral to the United Nations Security Council. In practice, the process has never been invoked, and permanent Security Council members can veto any action, limiting the treaty's effectiveness.
4. **Ambiguity in terminology:** Terms such as "widespread," "irreversible," or "serious" damage lack precise definitions, leading to potential divergent interpretations. Non-binding interpretative agreements have been proposed to address these ambiguities but remain unenforceable.

The treaty does, however, provide a relatively clear definition of environmental modification technologies: any technology aimed at deliberately changing the dynamics, composition, or structure of the Earth's lithosphere, hydrosphere, atmosphere, or outer space. This definition explicitly encompasses manipulation of clouds, rainfall, and storm generation. It is important to note that ENMOD applies only in times of armed conflict. Peaceful use of cloud seeding or rain-enhancement technologies—intended to increase water availability or protect ecosystems—is not prohibited. The legality of such activities is thus primarily determined by **intent** and **effect**. Hostile intent or reckless use causing serious harm to another state constitutes a violation, whereas peaceful interventions aimed at ecological or resource management purposes are generally permissible.

However, some states, such as Guatemala, have invoked a **right of reservation**, emphasizing that even peaceful environmental modifications must not prejudice their territory or natural resources. Under this view, actions that inadvertently cause temporary drought or other adverse effects on a neighboring state could be considered harmful, regardless of intent. In this context, the consequences and environmental impacts of human interventions take precedence over the state's intentions.

Beyond ENMOD, no other binding international legal instruments explicitly regulate the peaceful modification of clouds or precipitation. Existing environmental law addresses broader harms, such as pollution, greenhouse gas emissions, biodiversity loss, or marine contamination, but does not explicitly cover the redistribution of water through cloud-seeding technologies.

In the absence of clear and specific treaty law, general principles of international law, including customary norms, may be invoked to resolve disputes arising from cross-border effects of cloud seeding. This raises the possibility of applying **principles of equitable use, prevention of transboundary harm, and state responsibility** to regulate access to and modification of atmospheric water resources.

Land Ownership of Clouds in International Law

According to general legal principles recognized in most legal systems, ownership of land often carries with it certain rights over water associated with that land. The right to use surface and groundwater connected to a property is considered an inalienable right in many jurisdictions, and in practice, it significantly increases the economic value of irrigable land. In this context, rainfall that reaches a landowner's property becomes part of the land and may be treated as private property.

However, this right is not absolute. Landowners may be held civilly liable for damage caused by the runoff of rainwater from their property, and they are expected to take reasonable measures to prevent harm to neighboring properties. Thus, the ownership right applies only once the rain has fallen on the land. A key question arises: **who owns water while it is still in clouds?**

Under international law, atmospheric elements, including clouds circulating above a state's territorial airspace, are generally considered part of that state's territory. States exercise complete and exclusive sovereignty over their airspace, regardless of altitude, as a matter of national security. From this perspective, clouds may be viewed as inseparable from a state's territory, and interventions by foreign entities—such as cloud fertilization or "cloud theft"—could be seen as violations of sovereignty.

Some legal scholars and courts have reinforced this analogy between clouds and land. For instance, early U.S. court decisions upheld the principle that landowners have rights to the airspace above their land, including the clouds passing overhead. This analogy allowed courts to assert jurisdiction over disputes involving theft or diversion of atmospheric water.

Nevertheless, this territorial approach is not without limitations or complications. Consider a scenario in which a riverbank owner captures all rainwater falling on their land, preventing it from reaching downstream watercourses, thereby causing a river to dry up. Should this landowner's rights be treated as absolute, even amid climate change and diminishing rainfall, or are exceptions necessary to protect broader ecological or societal interests? Such dilemmas contributed to the gradual abandonment of a purely territorial approach, and the view emerged that clouds and the rain they contain **belong to no one** prior to precipitation.

Despite this, the "rain belongs to no one" perspective has limited support in the western United States, due in part to historical precedents granting private property rights to water and minerals. While the airspace above the land is generally regarded as common, the ownership of water upon precipitation remains contested. Consequently, no uniform federal law exists in the United States, and state legislatures primarily focus on preventing harm to third parties rather than regulating ownership of clouds. Current U.S. law requires cloud seeding operators to obtain permits specifying the scope and duration of operations, yet disputes between private entities and even states continue.

The territorial approach is therefore not fully accepted in legal theory or doctrine. The issue becomes particularly complex when a state fertilizes clouds within its own airspace, but these clouds release rainfall over a neighboring country. In such cases, **can international law provide guidance or a framework for allocating the water contained in clouds?** This question remains a central challenge in the emerging legal regime governing atmospheric resources.

Responsibility for the Distribution of Cloud Water in International Law

Clouds lack a fixed material identity; they are dynamic, constantly changing both in composition and location as they move through the atmosphere. This inherent instability makes it difficult for international law to establish a fixed legal regime for clouds. Unlike land, seas, or outer space, clouds have no established legal framework. However, certain principles of international law can be applied to address issues related to clouds, particularly regarding climate interventions carried out for peaceful purposes.

Given the potential impact of cloud manipulation on neighboring states, the exercise of international responsibility by states in cases of damage caused by such interventions is both relevant and practical under current international law.

The Process of Cloud Seeding and the Principle of Non-Infliction of Harm

Under general rules of public international law, a state incurs international responsibility when it commits an internationally wrongful act—that is, when it violates an international obligation. Since no international treaty explicitly prohibits the peaceful use of cloud-seeding or other climate-altering technologies, such activities cannot, by themselves, constitute internationally wrongful acts.

Nonetheless, the diversion or appropriation of cloud water can have significant consequences for the ecosystems of affected states and may cause serious harm. Two widely recognized principles of international environmental law are particularly relevant here:

1. **The duty of states to protect the environment as a whole.**
2. **The duty of states to prevent harm to the environment of other states.**

In essence, states must ensure that resources under their control do not damage the environment or interests of third states. This principle, expressed in the Latin maxim *sic utere tuo ut alienum non laedas* ("use your property so as not to harm others"), is reflected in multiple international instruments, such as:

- Article 194(2) of the 1982 United Nations Convention on the Law of the Sea;
- Article 6 of the 1997 United Nations Convention on the Non-Navigational Uses of International Watercourses;
- Article 3 of the Convention on Biological Diversity.

The principle emphasizes prevention, requiring states to exercise self-control and take measures to avoid transboundary harm.

State Responsibility for Non-Prohibited Dangerous Acts

The concept of state responsibility for non-prohibited dangerous acts can be applied to artificial cloud interventions. While there is no definitive list of such acts, any state activity posing a serious risk to human interests or the environment may fall within this framework. Four key criteria are generally considered:

1. The activity must not be explicitly prohibited by international law.
2. It must occur within territory under the control of a state.
3. It must involve a significant risk of transboundary harm.
4. The potential harm must have serious physical or material consequences.

Among these, the third criterion—the risk of transboundary harm—requires the most scrutiny. Cloud-seeding or diversion technologies may affect rainfall patterns, potentially causing significant harm to neighboring states' people, property, or ecosystems. When damage reaches a level that is serious and

widespread, the responsible state is obliged to halt the harmful activity and provide compensation.

The term "widespread" is context-dependent and must be evaluated according to the specific circumstances. Factors to consider include effects on human health, industry, private and public property, agriculture, and the environment. For example:

- Drought caused by cloud diversion in a water-scarce region is clearly serious.
- A minor reduction in rainfall in a water-rich area may not meet the threshold.
- Heavy rainfall induced in a neighboring country, causing flooding, could be considered serious and widespread damage.

Proving causality in such cases remains a challenge. States responsible for cloud modification may attribute changes in rainfall to global warming or natural climatic variability, thus denying responsibility.

It is evident that, in order to eliminate uncertainty and potential disputes, the international community should work toward establishing a clear legal regime governing cloud and their water resources.

A. The Legal Regime of Clouds and Principles Governing International Environmental Law

The first principle relevant to the legal regulation of clouds is the **principle of reasonable and equitable utilization**. In the context of shared rivers, this principle grants each state the right to use the water within its territory, while ensuring that such use does not unduly interfere with the rights of neighboring states sharing the same watercourse.

When applied to clouds, however, this principle is not directly transferable and requires adaptation. In the context of cloud water, the concept of **equity** becomes a crucial guiding principle for the distribution of atmospheric water. For example, if a technologically advanced state artificially drains a significant portion of water from clouds before they can reach another country, thereby depriving that country of its potential rainfall, it could be held responsible under the principle of reasonable and equitable utilization.

Nevertheless, like many general principles of international law, this principle lacks precision and clarity, making its practical application difficult except in cases of extreme or catastrophic consequences. The technical complexity of cloud management and the difficulty of quantifying interference—often a matter of state secrecy—further complicate enforcement.

In this context, the **no-harm rule** may offer a more effective guideline for states managing cloud resources. Widely recognized in customary international law, this principle obliges states to conduct their activities in ways that avoid causing harm to other states. Yet, even this principle faces practical limitations, as its enforcement in international relations is challenging except under exceptional circumstances.

A more promising approach lies in emphasizing the **principle of international cooperation**. Cooperation is central to the rational management of shared resources, including transboundary water bodies and, by extension, transboundary clouds. Instead of rigidly enforcing principles of absolute sovereignty over cloud water, states should focus on building consensus and establishing cooperative mechanisms through joint international institutions.

In this regard, the traditional notion of **sovereignty over natural resources** warrants careful reassessment. Modern international law, particularly regarding shared and transboundary resources, increasingly emphasizes collaborative management over unilateral control. The management of cloud water, given its transboundary nature and the technical complexities involved, exemplifies the need to prioritize cooperation, transparency, and equitable distribution among states.

B. Clouds and the Principle of State Sovereignty in the Use of Natural Resources

Another approach to the legal regulation of cloud water is to draw inspiration from the **sovereign rights of states over natural resources**. An instructive analogy can be found in the 1982 **United Nations Convention on the Law of the Sea (UNCLOS)**, which emphasizes the need to balance state sovereignty with equitable resource management:

"It is desirable (...) to establish, taking into account the sovereignty of all States, a legal order for the seas and oceans which will facilitate international relations, promote the peaceful use of the seas and oceans, the equitable and efficient utilization of their resources, the conservation of biological resources, and the study, protection and conservation of the marine environment."

While applied to maritime resources, is equally relevant to atmospheric water resources. Just as states cannot monopolize the resources of the high seas, it would be inequitable to allow certain states to dominate cloud water simply because of their geographical or technological advantage.

The **equitable redistribution of water**—for instance, moisture evaporating from the high seas—could benefit states with low rainfall, much like the shared management of seabed resources. Since the volume of evaporated water and the specific needs of water-scarce countries are difficult to quantify, a **specialized international body under the United Nations** could be tasked with assessing and regulating the allocation of cloud water, including possible funding mechanisms provided by wealthier states. Although such an approach may seem ambitious under current conditions, it is consistent with the broader international law principle recognizing the rights of geographically disadvantaged states as part of the **common heritage of humanity**.

Scientific characteristics of clouds further support the view that cloud water should not be subject to exclusive state ownership. Clouds are **constantly renewed**, losing and gaining moisture as they move through the atmosphere. The water in clouds originates from multiple sources, including terrestrial and marine evaporation, which means that no single state can claim exclusive ownership. In this sense, cloud water is inherently **res communis** (common to all) rather than **res nullius** (ownerless), and cannot practically be monopolized.

Nevertheless, effective use of rainfall ultimately requires a form of ownership or control. To prevent misuse or harm, legal principles such as the **no-harm rule** must govern state management of cloud water, ensuring that interventions do not cause environmental or socioeconomic damage to other states.

In conclusion, clouds and the water they contain should be considered a shared global resource. While states may manage the rain that falls within their territories, the international community

must provide principles and mechanisms to regulate cloud water use, balancing state sovereignty with equitable access, environmental protection, and global cooperation.

Conclusion

The legal status of a complex and dynamic resource such as cloud water depends largely on the perspective from which it is analyzed. In other words, any solution to this issue is inherently shaped by how the nature of clouds is understood.

If clouds are considered a natural resource, their close connection to human society and the broader environment must be recognized. This relationship fundamentally shapes the legal approach to cloud water management. One central issue is the right of states to access water resources. While access to water is increasingly recognized as a basic human need, there remains considerable disagreement regarding the recognition of water as a human right under international law.

International law can therefore approach the legal status of clouds from two complementary perspectives:

1. **Access and equity:** Clouds are essential for the survival of human societies, and states in geographically disadvantaged regions may require equitable access to their water resources.
2. **Protection and responsibility:** Interference with the natural formation and movement of clouds can potentially cause transboundary harm, requiring states to act responsibly and avoid environmental damage.

It is important to note that law should not aim to establish a permanent legal ownership of clouds per se. Instead, it should provide guidance that considers the importance of the water they contain, the ultimate objectives of its use, and the broader implications for human and environmental well-being.

In light of increasing water scarcity and growing international attention to this vital resource, a **transparent legal regime for cloud water** deserves urgent consideration by the international community. As an initial step, general principles of international law can be applied to fill gaps in the current legal framework. However, reliance solely on general principles carries limitations due to their inherent ambiguity and broad interpretation, which can sometimes produce inequitable outcomes.

A more holistic approach is needed—one that balances the emerging needs of the international community with the challenges of commercial exploitation and technological interventions, such as cloud seeding. Such a regime should ensure that the benefits of cloud-fertilization technologies reach regions disadvantaged by geography, while minimizing potential harm to other states and ecosystems.

International law already possesses the conceptual tools to address these issues. What is required is the **serious commitment of the major actors of the international community** to design and implement an equitable, cooperative, and forward-looking legal framework for cloud water management.

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