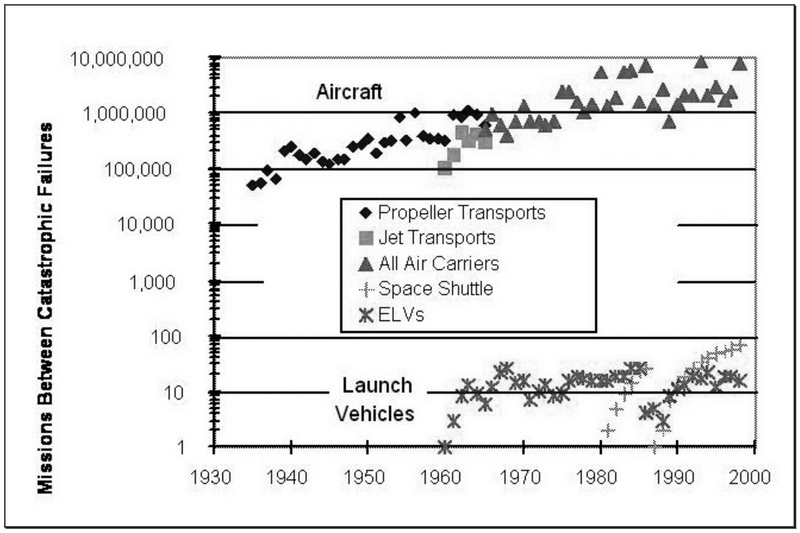

Figure 7: Missions between catastrophic failures for air and space transportation systems.[306]

Within the FAR Part 1 and Part 21 guidelines, the FAA should establish a *Directorate for Aerospace Vehicles*, patterned after the existing FAA Directorates (i.e., Transport Aircraft, Engine, Small Aircraft, and Helicopter). Staffed with dedicated "subject matter" experts, this new *Directorate* could work with the aerospace vehicle industry, through the MAVA, to formulate flightworthiness standards that complement existing FARs only to the extent necessary to regulate AVs. These FARs, 14 CFR 1 – 199, could be synthesized into a separate "FAR Part for Aerospace Vehicles" that addresses the major areas listed in Table 5, *infra*.

[306] Provided courtesy of Space Access, L.L.C.

• **AV Design and Maintenance Standards** – Demonstrable Flight Characteristics – Structural Capability – Manufacturing and Materials – Equipment and Systems – Operating Limits – Instructions for Continued Flightworthiness	• **Operations Requirements and Training** – Flight Operations – Ground Operations – Maintenance Operations – Personnel Training, Currency, Medical
• **Airspace Requirements** – Flight Rules – Air Traffic Control	• **Facilities and Ground System Requirements** – Mission Control – Maintenance – Support Equipment
• **Provisions for Recognizing New Technologies**	

Table 5: Major areas addressed by proposed FAR Part for AVs.

The standards and requirements of Table 5 should be defined with an eye toward how they will be employed in the design and verification of next generation, aerospace vehicle systems. Hence, the commercial AV development process should emphasize a methodology for integrating the systems engineering design and verification process with the certification process:

> The FAA, in cooperation with the Society of Automotive Engineers (SAE), has taken a major step towards incorporating [system engineering principles] into the certification process with the publication of ARP 4754 [*Certification Considerations for Highly-Integrated or Complex Aircraft Systems*] . . . it represents a look into the future of certification and demonstrates the FAA's and SAE's commitment to the [systems engineering] process.[307]

d. Contracts for AV-Transport Services

As previously stated, *supra*, although NACA was the predominant government agency supporting civil aircraft R&D, the Air Mail Service of the U.S. Post Office represented the largest

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[307] JACKSON, *supra* note 121, at 41.

number of federal dollars directed toward the development of the commercial aviation market.[308] This was because of the Kelly Act, which empowered the Postmaster General of the United States to expand the domestic air route system by awarding contracts to fly specific airmail routes in a successful effort to streamline and rationalize the air transportation industry.[309] Also, under the Kelly Act, important aviation-related infrastructure was developed to spur private investment, and thus forge a national system of air transportation. Clearly, the Federal Government, in conjunction with private investors, invested in the development of commercial aviation because there was a market for going "somewhere to somewhere" on Earth. Although the Space Station provided the initial impetus for going "somewhere to somewhere" in space, it wasn't until the advent of the Vision for Space Exploration (VSE) that the first significant opportunity has manifested itself.

The overarching goal of the VSE program is to establish a permanent lunar base, in preparation for human exploration of Mars and other destinations.[310] To accomplish this vision, NASA is developing the *Space Shuttle*'s next generation replacement, the *Crew Exploration Vehicle* (*CEV*). The *CEV* design is, fundamentally, a throwback to the 1960's vintage *Apollo* moon launch system, except with a "reusable" capsule launched on top of an expendable in-line booster.[311] Furthermore, the *CEV* is part of NASA's Constellation Systems, which also comprises "In-Space Transportation Systems" such as the *Earth Departure Stage* (*EDS*) and *Lunar Surface Access Module* (*LSAM*).[312] Perhaps NASA's transportation architecture for space exploration is counterintuitive; but why would an agency design an architecture where the in-space systems are fully reusable and the Earth–to–low-Earth-orbit (LEO) system is not? Regardless of NASA's reasons, which are beyond the scope of this paper, it is

[308] *See* Douglas, *supra* note 8, at 154.
[309] *See supra* note 9.
[310] *See supra* note 274.
[311] *See supra* note 159.
[312] *See* About.com: Space/Astronomy, *Constellation Systems*, *at* http://space.about.com/od/nasanewscurrentevents/a/cevsystem.htm?p=1 (last visited June 29, 2008).

intuitively obvious that once a permanent lunar base is established, the *CEV*'s launch costs using in-line expendable launch vehicles are going to become untenable.[313]

On the other hand, the ideal fully reusable Earth/Lunar space transportation architecture would employ a next generation aerospace vehicle—a fully reusable, two-stage-to-LEO system capable of lifting 35,000 lbs. for less than $25M per launch.[314] With launch costs down to less than $725 per *payload* pound, limited financial resources that ordinarily would have been wasted on expensive, expendable hardware ($10K+ per *payload* pound) could now be leveraged into the development and production of the reusable in-space systems necessary for sustaining permanent lunar settlements. In addition, the AV would have a turn-around time of three days, which would allow the rapid deployment, re-supply, and expansion of NASA's first lunar base.

Assuming that the first four elements of the *Collective Development Strategy*, discussed *supra*, are successfully implemented in the near term, there is a good possibility that a small, *DC-3* type aerospace vehicle could be ferrying astronauts (or at least 5 thousand pounds of cargo) to and from the Space Station within a reasonable time period.[315] And, like the *DC-3*, this small AV could revolutionize space transportation and pave the way for larger, more advanced (and economically efficient) space

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[313] This is analogous to throwing away a brand new *Boeing 747* freighter after it makes its first and only cargo delivery. Multiply this scenario by at least four times per year, and the losses begin to add up.

[314] Fundamentally, the $25 million would be the cost of the propellants, routine maintenance, and amortization of AV development costs; because the AV would be fully reusable. These figures are based on a study performed by the author as part of his Masters program in Space Studies. *See* H.A.M.L.E.T. Earth/Lunar Space Transportation System (1998) (unpublished graduate Space Studies Capstone Project course final report, University of North Dakota) (on file with the University of North Dakota Department of Space Studies).

[315] The *Douglas DC-3* is an American fixed-wing, propeller-driven aircraft whose speed and range revolutionized air transport in the 1930s and 1940s. Because of its lasting impact on the airline industry and World War II, it is generally regarded as one of the most significant transport aircraft ever made. *See* WIKIPEDIA, *Douglas DC-3, at* http://en.wikipedia.org/wiki/Douglas_DC-3 (last modified on June 24, 2008). U.S. Centennial Flight Commission, The Douglas *DC-3*, http://www.centennialofflight.gov/essay/Aerospace/DC-3/Aero29.htm (last visited June 25, 2009).

transports capable of providing the first leg (Earth–to–LEO) of an Earth-to-lunar space transportation system.

However, implementation of the fifth and final element of this *Strategy*—NASA contract guarantees for AV transport services—is absolutely necessary. Just as the Kelly Act was the final step for enabling the commercial aviation industry, so must the Federal Government, once again, step up with an equivalent *Space Act* to enable the AV industry.

III. Conclusion

The foregoing analysis has shown that neither NASA's "megalithic" development programs nor the New Space "laissez-faire" approach to developing commercial space transportation systems work because neither approach will "build an industry." Successful transportation industries "for the masses" are built upon a solid foundation of technology and regulation, as the U.S. aviation industry was. Aerospace vehicles are the key to realizing safe, reliable point-to-point space transportation and will, therefore, require an empirically-proven development paradigm to make New Space market dreams a reality.

Modern cross licensing, patent pooling and government-led cooperative standard setting doctrines, in concert with NACA-like, government-sponsored R&D, could be used by the New Space industry to collectively develop commercial aerospace vehicle enabling technologies and flightworthiness standards for both suborbital and orbital vehicles. These doctrines, as part of an alternative strategy to the one presently employed by the New Space CST industry, could be implemented within the purview of the following elements:

1. Formation of an IP-sharing, patent pool / standard setting organization;

2. NACA-like, government-sponsored R&D for aerospace vehicle technologies;

3. Government-led development of aerospace vehicle flightworthiness standards;

4. FAA certification of suborbital and orbital aerospace vehicles transporting passengers and cargo; and,

5. NASA contracts to private companies using aerospace vehicles for transporting passengers and cargo to low earth orbit.

The successful implementation of these five elements in the near term could easily lead to the development of a small, *DC-3* type aerospace vehicle capable of ferrying astronauts (or at least 5 thousand pounds of cargo) to and from the Space Station within a reasonable time period. And, like the *DC-3*, this small AV could be the forerunner of future systems providing routine access to space that is truly affordable and reliable—not just for the wealthy, but for the masses.

THE DUTY TO RESCUE SPACE TOURISTS AND RETURN PRIVATE SPACECRAFT

Mark J. Sundahl[*]

I. INTRODUCTION

In late 2010, a long-awaited moment in the history of space flight will finally arrive when private space tourism companies send their first customers into space. Virgin Galactic, the space tourism company launched by Sir Richard Branson, will be the first to begin operations by flying tourists into suborbital space from Spaceport America, which is currently under construction in New Mexico.[1] Other space tourism companies will be entering the market soon thereafter. As the prospect of a space tourism industry becomes a reality, various legal issues are taking on a new urgency. This article addresses one of the more important issues from the perspective of a space tourism company, namely, whether the duty to rescue astronauts and return spacecraft under existing space law treaties also requires states to rescue space tourists and return the spacecraft to the launching state following an accident.

Virgin Galactic's customers will not be the first space tourists. In 2001 the Russian Space Agency began to fly tourists to the *International Space Station* – a trip which has recently gone up in price from $20 million to $30 million – and has to date sent a total of six tourists to the space station without complica-

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[*] Associate Professor of Law, Cleveland State University, Cleveland-Marshall College of Law. This Article stems from an earlier paper entitled *Rescuing Space Tourists: A Humanitarian Duty and Business Need*, which the author presented at the 2007 International Astronautical Congress and which appeared in the conference proceedings. *See* Mark J. Sundahl, *Rescuing Space Tourists: A Humanitarian Duty and Business Need*, *in* PROCEEDINGS OF THE FIFTIETH COLLOQUIUM ON THE LAW OF OUTER SPACE 204 (2008). This Article expands considerably on the material contained in the earlier paper and incorporates comments from the conference panelists and other reviewers. The author would like to thank his fellow panelists at the 2007 IAC, and in particular Prof. Francis Lyall, for their helpful comments.

[1] Jeff Jones, *Bill Would Prevent Space Tourist Lawsuits*, ALBUQUERQUE J., A2 (Feb. 10, 2009).

tion.[2] Now private companies are preparing to do what only governments have done before and will be doing it on a far grander scale. The number of space tourists will climb into the hundreds within the next few years and, if the business model succeeds, Virgin Galactic predicts that the number will soon reach into the thousands as daily flights leave out of Spaceport America and other facilities around the world. And Virgin Galactic is not the only name in space tourism. Excalibur Almaz, a company based on the Isle of Man, plans to put tourists into orbit in Soviet-made *Almaz* space capsules.[3] The company is also preparing to use an *Almaz* space station as the first space hotel. Space stations that could be used as orbiting hotels are also being built by Bigelow Aerospace, which is headquartered in Las Vegas.[4] Bigelow's *Genesis* space station is an inflatable orbiting platform that can house scientific, manufacturing, or leisure activities, depending on the needs of the client.[5] Other space tourism companies are also taking shape – such as Rocketplane, which plans to launch suborbital flights out of Dubai, Xcor Aerospace, which is offering suborbital flights for a competitive price of $95,000, and Blue Origin, a highly secretive space tour-

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[2] The six tourists who have visited the *International Space Station* are Dennis Tito, Mark Shuttleworth, Gregory Olsen, Anousheh Ansari, Charles Simonyi, and Richard Garriott. Erin Killian, *Next space tourist starts training in Russia*, WASH. BUS. J. (Jan. 21, 2008). The flights to the *International Space Station* have been booked through a private company, Space Adventures, Ltd. *Id*. However, the Russian Space Agency announced in January of 2009 that it would be suspending its tourism operations due to the need for an expanded Russian crew on the space station. *Russia Grounds Space Tourism: International station will be too full for civilians after 2009*, CHI. TRIB. 21 (Jan. 26, 2009). Space tourism could be said to have truly begun in 1990 when Toyohiro Akiyama, a Japanese journalist who spent almost eight days on the Russian space station, Mir, became the first private person to go into space. MANNED SPACE FLIGHT: LEGAL ASPECTS IN THE LIGHT OF SCIENTIFIC AND TECHNICAL DEVELOPMENTS 168 (Karl-Heinz Böckstiegel ed., 1993) (hereinafter MANNED SPACE FLIGHT). Other private individuals who have flown aboard the Space Shuttle include Senators John Glenn and Jake Garn – as well as a schoolteacher from Concord, New Hampshire, Christa McAuliffe. *Tourist Class: Tito had fun, but NASA still has a point*, COLUMBUS DISPATCH 6A (May 8, 2001).

[3] Stephen Baird, *Space: The New Frontier!*, TECH. TCHR. 13 (April 1, 2008).

[4] Frank Morring, Jr., *High Mileage*, AVIATION WK. & SPACE TECH. 21 (May 19, 2008).

[5] *Id*.

ism company owned by Jeff Bezos, the founder of Amazon.[6] Another Internet mogul, PayPal-founder and high-tech visionary Elon Musk, has also positioned himself on the cutting edge of commercial space by creating a new type of rocket that can deliver payloads – and eventually people – into space in a highly efficient and cost-effective manner.[7]

As the private space industry evolves in these new and exciting ways, it is beginning to outgrow the existing space law regime that was created at the advent of the space age – when only governments had a presence in space and the private use of space was a distant dream. Of the many legal issues that have emerged with respect to space tourism, one of the most critical issues is whether the duty to rescue astronauts and return errant spacecraft will apply to space tourism ventures. As tourism companies prepare to launch their maiden flights, their primary concern will be the safety of their customers and ability to recover their spacecraft. A steady flow of customers will be essential to the success of the tourism business model and this flow will only be possible if the public views the flights as safe. Safe operations will also reduce the risk that a space tourism company will be subjected to the crushing liability that would follow an accident. Moreover, since all of the space tourism companies plan to use reusable spacecraft to some degree, they will want to provide for the recovery of their spacecraft in the event of a flight anomaly.[8] In addition to the issue of whether the treaties apply to tourists, clarity is also lacking with respect to other aspects of the duty to rescue – such as whether there is a duty to rescue astronauts stranded in orbit.[9] The United Na-

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[6] Jacqui Goddard, *Up, Up And Ka-Ching! In a Time of Tight Budgets and Earthly Priorities, the Space Business is Getting a Rejuvenating Jolt from Entrepreneurs Who Do the Right Stuff on the Cheap*, NEWSWEEK (Feb. 11, 2008).

[7] In December of 2008, Musk's company, SpaceX, along with another private company, Orbital Sciences, was awarded a $3.5 billion contract by NASA to deliver cargo to the *International Space Station*. This contract was a watershed moment in the private space industry because NASA selected two newer companies over NASA's traditional launch service providers, Lockheed Martin and Boeing. Dana Hedgpeth, *Smaller Companies Win NASA's Space Race*, WASH. POST, at D1 (Dec. 24, 2008).

[8] Virgin Galactic and RocketPlane will use spaceplanes that take off and land horizontally, while *Excalibur Almaz* will send tourists into orbit in reusable space capsules.

[9] The gaps and ambiguities in the law of rescue has been traditionally viewed as a result of the hasty drafting process that produced the Agreement on the Rescue of As-

tions Committee on the Peaceful Use of Outer Space (UNCOPUOS) has been urged by member states on more than one occasion to try to resolve the flaws in this area of space law – but the issue has not yet been added to the UNCOPUOS agenda.[10]

This article seeks to clarify the extent to which space tourism companies can rely on states to assist with the rescue of space tourists and the return of their spacecraft in the event of an emergency. Unlike previous treatments of this subject, this article adopts an approach to treaty interpretation that rigorously adheres to the canons of interpretation set forth in the *Vienna Convention on the Law of Treaties* (the "Vienna Convention"). Section II of this article lays the groundwork for this analysis by describing the basic contours of the duty to rescue astronauts and return errant spacecraft under international law. Section III will then take up the fundamental questions regarding whether the duty to rescue applies to commercial ventures and whether tourists are beneficiaries of the duty to rescue. Finally, Section IV explores how the law of rescue and return should be reformed and what the best approach to reforming the law would be. Among other things, this discussion will take into account the proposals for reform set forth in the *Draft for a Convention on Manned Space Flight*, an illuminating (but surprisingly overlooked) document jointly drafted by Professors Böckstiegel, Gorove, and Vereshchetin some twenty years ago.

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tronauts, the Return of Astronauts and the Return of Objects Launched into Space. The urgency with which the treaty was drafted was due to the importance placed by the United States and the Soviet Union on the protection of its astronauts. References to the accelerated drafting process can be found throughout the comments of the delegates to the Meeting of the General Assembly when the treaty was opened for signature. See, *e.g.*, *Provisional Verbatim Record of the Sixteen Hundred and Fortieth Plenary Meeting*, U.N. GAOR, 22d Sess., at 36, 41, & 47, U.N. Doc. A/PV.1640 (Dec. 19, 1967) [hereinafter Provisional Verbatim Record]. In response to this criticism, the U.S. delegate, Mr. Goldberg, asserted that "it would be a mistake to assume that the draft had not been carefully prepared . . . [and that it] will stand the test of time." *Id.* at 56.

[10] In 1987, the United Kingdom and Czechoslovakia recommended that UNCOPUOS study the possibility of clarifying the law regarding the rescue of astronauts. See *Working Paper Submitted by The United Kingdom of Great Britain and Northern Ireland*, U.N. Doc. A/AC.105/C.2/L.159 (Mar. 27, 1987); *Working Paper Submitted by Czechoslovakia*, U.N. Doc. A/AC.105/C.2/O.161 (Apr. 2, 1987).

II. AN OVERVIEW OF THE DUTY TO RESCUE AND RETURN

This section describes the scope of the duty to rescue astronauts and return errant spacecraft as the duty has evolved through the drafting of three space treaties. This analysis will show how certain weaknesses in the original expression of the duty to rescue was cured by later treaties – and how other flaws emerged in the process. As will be seen, the duty to rescue and return is broad in its conception and is motivated by a concern for human welfare. Nevertheless, certain questions of interpretation remain regarding the precise scope of the duty to rescue – such as whether the treaties require the rescue of tourists. These outstanding issues will be presented at the close of this Section and then resolved in Section III through the application of the Vienna Convention.

A. The Duty to Rescue

Ideally, space law would impose a duty to rescue whenever anyone aboard a spacecraft experiences distress, whether on the ground, in space, or on a celestial body. However, as the following description of the duty to rescue under existing space law shows, the space treaties were drafted in a manner that creates uncertainty about whether the duty to rescue under the treaties reaches this ideal.

In 1968, the first space treaty, the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (Outer Space Treaty), was opened for signature.[11] This "Magna Carta" of space law set forth the basic principles that would guide the future use of space. Article V of the Outer Space Treaty created the foundation of the duty to rescue with broad brushstrokes that were animated by a humanitarian concern for the safety of astronauts.[12] Article V requires states to "regard astronauts as envoys of mankind" and to give astronauts "all

[11] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, art. V, Jan. 27, 1967, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty].

[12] *Id*. art. V.

possible assistance in the event of accident, distress, or emergency landing on the territory of another State Party or on the high seas."[13] The treaty also requires astronauts to provide "all possible assistance" to each other.[14] This duty for astronauts to assist each other has the advantage of being utterly unqualified – and therefore requires such assistance under any circumstances and in any location. Unfortunately, the duty of *States* to rescue astronauts is not quite as comprehensive. Although Article V appears to take a comprehensive approach to the duty to rescue, there are three limitations on the duty to rescue. First, rescue is only required when "possible" – which could refer to a state's technological or financial capability to engage in a rescue operation. Second, a careful parsing of Article V reveals a gap in the duty to rescue when astronauts have made an emergency landing, namely, that rescue is not required in the event of an emergency landing on Antarctica or on a celestial body since the duty to rescue is triggered by emergency landings only when the landing takes place "on the territory of another State Party or on the high seas."[15] Finally, the treaty only requires states to rescue "astronauts" – which raises the question whether states would be required to rescue non-crew members, such as passengers.

Just one year after the Outer Space Treaty was opened for signature, the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Space (Rescue Agreement) was concluded in order to elaborate upon the duty to rescue and return that had been established in Article V of the Outer Space Treaty.[16] The Rescue Agreement

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[13] *Id*. The language of Article V closely tracks the wording of Paragraph 9 of the Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space, G.A. Res. 1962 (XVIII), U.N. Doc. A/RES/1962 (Dec. 24, 1963), 3 I.L.M. 157.

[14] *Id*.

[15] Outer Space Treaty, *supra* note 11, at art. V. On the other hand, rescue of astronauts stranded in space would be covered under the language of Article V. *See*, *e.g.*, R. Cargill Hall, *Rescue and Return of Astronauts on Earth and in Outer Space*, 63 AM. J. INT'L L. 197, 205 (1969).

[16] Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, Apr. 22, 1968, 672 U.N.T.S. 119 [hereinafter Rescue Agreement].

addresses the rescue of spacecraft personnel in two provisions. Article 2 addresses "unintended landings" of spacecraft personnel in a state's territory and requires that the state "immediately take all possible steps to rescue them."[17] Article 3 complements Article 2 by addressing accidents that occur outside of any state's jurisdiction and provides that if a state discovers that "the personnel of a spacecraft have alighted on the high seas or in any other place not under the jurisdiction of any State, those Contracting Parties which are in a position to do so shall, if necessary, extend assistance in search and rescue operations."[18] These two provisions, working together, would appear to provide for rescue wherever a spacecraft experiences distress. The gap in Article V of the Outer Space Treaty that excludes crash landings on Antarctica or a celestial body is corrected by the Rescue Agreement since rescue is required under Article 3 if a spacecraft alights "any other place not under the jurisdiction of any State" (which would include parts of Antarctica as well as a celestial body).[19] However, despite the fact that the Rescue Agreement fills a gap in the Outer Space Treaty, it opens a new gap at the same time by using the word "alighted" in Article 3. The effect of this word is to make the duty to rescue contingent on the landing of the spacecraft – which, as a result, appears to rule out any duty to rescue personnel stranded in orbit or in deep space.[20] Finally, Article 4 of the Rescue Agreement requires states to "safely and promptly" re-

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[17] *Id*. at art. 2.

[18] *Id*. at art. 3.

[19] *Id*. *See also* CARL Q. CHRISTOL, THE MODERN INTERNATIONAL LAW OF OUTER SPACE 171-72 (1982) (explaining that a U.S. delegate to the Rescue Agreement negotiations understood "any other place not under the jurisdiction of any State" to include the moon and celestial bodies."). Regarding jurisdictional claims over Antarctica see Joseph J. Ward, *Black Gold in a White Wilderness--Antarctic Oil: The Past, Present, and Potential of a Region in Need of Sovereign Environmental Stewardship*, 13 J. LAND USE & ENVTL. L. 363, 367 (1998) (explaining that fifteen percent of Antarctica is not claimed by any country).

[20] CHRISTOL, *supra* note 19, at 171-72; *see also* Paul G. Dembling & Daniel M. Arons, *The Treaty on Rescue and Return of Astronauts and Space Objects*, 9 WM. & MARY L. REV. 630, 649 (1968). This unfortunate gap in the Rescue Agreement created by the use of the word "alighted" could not have been intended, as is indicated by the comment of the French delegate, Mr. Berard, that the Rescue Agreement "applies to research and rescue undertaken not only on the earth and in its environment, but also in outer space and on celestial bodies." *Provisional Verbatim Record*, *supra* note 9, at 41.

turn the rescued personnel to representatives of the launching authority following a successful rescue operation.[21]

The duty to rescue was next addressed in the 1979 Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (Moon Agreement).[22] The approach to the duty to rescue taken in the Moon Agreement was the most comprehensive of all the space treaties. First, the treaty requires states to take "all practicable measures to safeguard the life and health of persons on the moon."[23] There are no gaps in this language. All people, whether crewmembers, scientists, or tourists, must be safeguarded. Second, the Moon Agreement requires states to "offer shelter in their stations, installations, vehicles and other facilities to persons in distress on the moon" as well as allowing states to use the facilities of other States in the event of an emergency.[24] Finally, the Moon Agreement extends the duties owed to "astronauts" and "personnel" under the Outer Space Treaty and Rescue Agreement to all people on the Moon.[25]

Despite the admirable breadth of the rescue provisions in the Moon Agreement, the value of the treaty is compromised in two ways. First, it is restricted to the Moon and therefore is not applicable to the early stages of private spaceflight, which will be suborbital and orbital for the near term. Second – and more importantly – the Moon Agreement has been ratified by only thirteen states (compared to the Outer Space Treaty and the Rescue Agreement which have been ratified by ninety-eight states and ninety states, respectively), which renders it the least successful of the space treaties.[26]

As indicated above, the question of whether the duty to rescue applies to space tourists hinges on whether tourists qualify as "astronauts" or "personnel" of a spacecraft under the treaties.

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[21] Rescue Agreement, *supra* note 16, at art. 4.

[22] Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 5, 1979, 1363 U.N.T.S. 3 [hereinafter Moon Agreement].

[23] *Id*. at art. 10(1).

[24] *Id*. at arts. 10(1) & 10(2).

[25] *Id*. at art. 13(2).

[26] *Status of International Agreements Relating to Activities in Outer Space*, U.N. Doc. ST/SPACE/11/Rev.2/Add.1 (Jan. 1, 2008).

Moreover, a preliminary question that is of equal importance to the application of the treaties to tourists is whether the duty to rescue extends to participants (whether crewmembers or passengers) of commercial spaceflights – or is instead strictly limited to state-sponsored missions. These issues will be analyzed further in Section III below after the duty to return errant spacecraft has been described.

B. The Duty to Return Errant Spacecraft

If a private spacecraft veers off course and lands in foreign territory, the owner of the spacecraft will want to be able to retrieve the spacecraft for reasons other than rescuing the passengers and crew. The risk of losing a spacecraft could be devastating to a space tourism company for two reasons. First, the cost of constructing a new vehicle may be prohibitive and, provided that the downed spacecraft is still functional or reparable, the cost of replacement could be avoided.[27] Second, any proprietary technology that falls into the hands of an unfriendly government could result in the theft of the technology – which might eventually be shared with a company's competitors. For both of these reasons, a company will want to quickly recover its errant spacecraft. However, a foreign government that has possession of the spacecraft may not want to part with it. For example, the foreign government may want to impound the spacecraft on the grounds that it violated the country's aircraft regulations. A foreign government may also have more nefarious reasons for refusing to return a high-tech spacecraft since an unintended landing may provide a rare opportunity for certain countries to gain access to exotic technology through reverse engineering. The space treaties provide for a duty to return spacecraft to the launching state in order to prevent such misappropriation of technology. It would provide great comfort to private space companies if they were assured that the benefits of this aspect of space law extended to their vehicles as well as to government spacecraft.

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[27] Although insurance could potentially cover the cost of replacing a spacecraft, it is not clear whether such insurance will be available or affordable.

As is true for the duty to rescue, the duty to return space assets is contained in the Outer Space Treaty, the Rescue Agreement, and the Moon Agreement. Beginning with the Outer Space Treaty, Article VIII provides that "objects or component parts found beyond the limits of the State Party to the [Outer Space] Treaty on whose registry they are carried shall be returned to that State Party."[28] This provision is broadly drafted to require the return of space objects regardless of whether the errant objects are found on Earth, on the high seas, in space, or on a celestial body. Article 5 of the Rescue Agreement elaborates upon and expands this duty in several ways. First, Article 5 has a notification requirement which requires a state "which receives information or discovers that a space object or its component parts has returned to Earth in territory under its jurisdiction or on the high seas or in any other place not under the jurisdiction of any State" to notify the launching state and the Secretary-General of the United Nations.[29] Unlike the other provisions regarding the return of spacecraft, this notification language is drafted narrowly to require notification only when the space object has "returned to Earth," thus apparently releasing states from any duty to notify the launching authority if information is received, for example, that a spacecraft has gone adrift in space or has crashed on the Moon. Second, Article 5 requires a state on whose territory a spacecraft lands to "take such steps as it finds practicable to recover the object" upon the request of the launching state.[30] Third, if a State finds a space object or its component parts outside of the territory of

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[28] Outer Space Treaty, *supra* note 11, at art. VIII.

[29] Article 5(1) of the Rescue Agreement reads thus:

> Each Contracting Party which receives information or discovers that a space object or its component parts has returned to Earth in territory under its jurisdiction or on the high seas or in any other place not under the jurisdiction of any State, shall notify the launching authority and the Secretary- General of the United Nations.

Rescue Agreement, *supra* note 16, at art. 5(1). Although there is a notification requirement in Outer Space Treaty, it only requires states to inform other states of "any phenomenon . . . which could constitute a danger to the life or health of astronauts." Outer Space Treaty, *supra* note 11, at art. V. It is debatable whether this provision requires notification upon the discovery of a crash landing.

[30] Rescue Agreement, *supra* note 16, at art. 5(2).

the launching authority, the state must return the object upon the request of the launching authority.[31] Fourth, Article 5 includes a provision allowing a state to do what is necessary to eliminate any possible danger that might result from a hazardous space object that is found in its territory.[32] Finally, Article 5 places the cost of recovery and return upon the launching authority – a clear distinction from the duty to rescue which does not require reimbursement of expenses incurred by the rescuer.[33]

Article 12(2) of the Moon Agreement simply incorporates Article 5 of the Rescue Agreement by reference and extends it expressly to assets located on the Moon:[34]

> Vehicles, installations and equipment or their component parts found in places other than their intended location shall be dealt with in accordance with article 5 of the [Rescue Agreement].

The practical effect of this provision is small. First, the failure to achieve broad ratification means that few countries are bound by the Moon Agreement. Second, the duty to return space objects under the Moon Agreement does not expand upon the duties imposed by the Outer Space Treaty and the Rescue Agreement – which, as argued above, already applied to lunar activities. The Moon Agreement also requires a State to notify the launching State upon learning of an unintended landing on the Moon.[35]

The application of the duty to return errant spacecraft to private tourism ventures presents fewer problems than are found in the application of the duty to rescue. Namely, there is no controversy regarding the meaning of "astronaut" or "personnel" since the duty to return spacecraft is triggered by the crash of a spacecraft – regardless of who is on board. However, one important question remains regarding the scope of the duty

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[31] *Id*. at art. 5(3).
[32] *Id*. at art. 5(4).
[33] *Id*. at art. 5(5).
[34] Moon Agreement, *supra* note 22, at art. 12(2).
[35] *Id*. at art. 13.

to return, namely, whether the duty applies to private commercial spacecraft. This issue is explored in the following section.

III. DOES THE DUTY TO RESCUE AND RETURN APPLY TO SPACE TOURISM?

As shown above, two interpretational issues cloud the question whether the duty to rescue and return applies to tourists. The first issue is whether the duty applies when the spacecraft in distress is a private commercial vehicle. The second issue is whether tourists would be deemed to be "astronauts" or "personnel" under the treaties – and would therefore be able to rely on the assistance of state governments in the event of an accident. These issues will be examined in this Section in accordance with the interpretational canons of the Vienna Convention which, as seen below, ultimately results in a broad interpretation of the duty to rescue and return that encompasses the rescue of space tourists.

A. The Vienna Convention

The Vienna Convention sets forth the rules that govern the creation, operation, and interpretation of treaties. The rules regarding interpretation, contained in Articles 31 through 33 of the convention, provide a systematic process for determining the meaning of treaty provisions.[36] This systematic approach to interpretation will guide the following analysis of the duty to rescue and return in order to arrive at an interpretation that is supported by the authority of the Vienna Convention. Article 30 of the Vienna Convention, which provides rules that are designed to help resolve inconsistencies between treaties, will also be helpful in the following analysis where it is necessary to resolve certain discrepancies between the Outer Space Treaty and the Rescue Agreement.[37]

The primary rule of treaty interpretation under the Vienna Convention is to give the terms of a treaty their "ordinary mean-

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[36] Vienna Convention on the Law of Treaties, arts. 31-33, May 23, 1969, 1155 U.N.T.S. 331 [hereinafter Vienna Convention].

[37] *Id*. at art. 30.

ing in their context and in the light of [the treaty's] object and purpose."[38] This "ordinary meaning" should be the meaning that was attributed to a term at the time of the treaty's signing.[39] As indicated in the Vienna Convention, a term should not be interpreted in isolation, but should always be viewed in its greater "context" as well as its "object and purpose." The "context" of a term consists of the text and preamble of the treaty – and must be distinguished from the circumstances of the treaty's conclusion (which are only taken into account for the limited purposes described below).[40] Similarly, a treaty's "object and purpose" are to be determined only from the text of the treaty and not from external sources of information.[41] As reflected in these rules, the Vienna Convention takes a text-centered approach to interpreting treaties that generally requires strict adherence to the text.[42] That being said, the Vienna Convention also requires that any subsequent state practice that sheds light on the proper application of the treaty be taken into account when determining the ordinary meaning of a term.[43]

In the event that the ordinary meaning of a term is ambiguous (or needs to be confirmed) "supplementary means of interpretation" may be applied to provide clarification.[44] These supplementary considerations include the *travaux préparatoires* of the treaty as well as the circumstances of the treaty's conclusion.[45] Recourse to these supplementary considerations is also permitted when the ordinary meaning of a term results in a meaning that is "manifestly absurd or unreasonable."[46]

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[38] *Id*. at art. 31(1).

[39] A. D'Amato, *International Law, Intertemporal Problems*, *in* ENCYCLOPEDIA OF PUBLIC INTERNATIONAL LAW 1234-36 (1992).

[40] Vienna Convention, *supra* note 36, at art. 31(2). *See also* International Law Commission, *Draft Articles on the Law of Treaties with Commentaries* 221 (1966); RICHARD K. GARDINER, TREATY INTERPRETATION 178-89, 343-45 (2008).

[41] GARDINER, *supra* note 40, at 192.

[42] *Id*. at 144-45; *see also* R.H. Berglin, *Treaty Interpretation and the Impact of Contractual Choice of Forum Clauses on the Jurisdiction of International Tribunals: the Iranian Forum Clause Decisions of the Iran-United States Claims Tribunal*, 21 TEXAS INT'L L. J. 39, at 44 (1986).

[43] Vienna Convention, *supra* note 36, at art. 31(3).

[44] *Id*. at art. 32.

[45] *Id*.

[46] *Id*.

When determining the meaning of a treaty, the International Court of Justice (ICJ) can also turn to the official translations of the treaty to see whether the terms used in a translation can assist in clarifying the meaning of a term. Specifically, Article 33(4) of the Vienna Convention states that "when a comparison of the authentic texts discloses a difference of meaning . . . , the meaning which best reconciles the texts, having regard to the object and purpose of the treaty, shall be adopted."[47]

The Vienna Convention rules governing the reconciliation of dissonant treaties also provide helpful guidance in the interpretation of the duty to rescue and return – given the fact that the duty to rescue and return is addressed in multiple treaties that are, in certain respects, inconsistent. Under Article 30, a conflict between two treaties should be resolved by the *lex posteriori* rule which gives precedence to the provisions of the most recent treaty – unless the later treaty specifies that it is subject to the earlier treaty.[48]

Although Article 4 of the Vienna Convention states that the convention only applies to treaties concluded after it enters into force, this does not mean that the rules of interpretation contained in the Vienna Convention should not be applied to the Outer Space Treaty and the Rescue Agreement.[49] The interpretational rules of the Vienna Convention were not drawn from thin air, but are instead a codification of customary practice and are binding as an expression of customary international law.[50] In fact, the ICJ has accepted the Vienna Convention rules as applicable to the interpretation of all treaties, including those that were entered into prior to the conclusion of the Vienna Convention.[51] In light of this, any proposed interpretation of the duty to rescue and return under the space treaties must be carried out in accordance with the Vienna Convention rules. These

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[47] *Id*. at art. 33(4).

[48] *Id*. at art. 30(2) & (3).

[49] *Id*. at art. 4.

[50] GARDINER, *supra* note 40, at 14-16, 69. *See also Legal Consequences of the Construction of a Wall in the Occupied Palestinian Territory* (Advisory Opinion) [2004] *ICJ Reports* 38, para 94 (stating that Article 31 of the Vienna Convention expresses the customary international law regarding treaty interpretation).

[51] GARDINER, *supra* note 40, at 14.

rules are put to work in the following sections to resolve the interpretational problems that are relevant to whether the duty to rescue and return applies to space tourists.

B. The Relationship between the Outer Space Treaty and the Rescue Agreement

Before we address the question of whether the duty to rescue and return requires the rescue of space tourists and private spacecraft, the relationship between the Outer Space Treaty and the Rescue Agreement must be clarified. Under the *lex posteriori* rule in Article 30 of the Vienna Convention, the Outer Space treaty applies "only to the extent that its provisions are compatible" with the Rescue Agreement. That the Rescue Agreement was intended to supersede the Outer Space Agreement with respect to the duty to rescue and return is clear. The Rescue Agreement elaborates upon, adds to, and, at times, changes the rules regarding rescue and return set forth in Article V of the Outer Space Treaty. There is no doubt that these changes were intended to supersede the earlier rules, since the drafters would not bother creating a treaty that had no effect. Although the preamble takes note of the Outer Space Treaty and of the Rescue Agreement says that the purpose of the treaty is "to develop and give further concrete expression" to the duty to rescue and return contained in the Outer Space Treaty," this does not rise to the level of explicitly subjecting the Rescue Agreement to the Outer Space Treaty. Therefore, under the operation of the *lex posteriori* rule, the Rescue Agreement must trump the Outer Space Treaty where the terms are inconsistent.[52]

This application of the *lex posteriori* rule gives precedence to the Rescue Treaty with respect to multiple issues that are addressed differently in the Outer Space Treaty. For example, the broader geographic coverage of the duty under the Rescue Agreement supersedes the coverage in the Outer Space Treaty – which left a gap with respect to landings on celestial bodies and Antarctica. Also, the Rescue Agreement's requirement to return

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[52] Rescue Agreement, *supra* note 16, fourth recital.

space objects to the "launching authority" replaces the Outer Space Treaty's rule of returning the assets to the state of registry. However, the changes that are of greatest importance to the question of whether the duty to rescue and return applies to space tourism are (1) the use of the term "personnel" in the Rescue Agreement instead of "astronaut" and (2) the omission from the Rescue Agreement of the phrase "envoys of mankind." As explained in greater detail below, the use of the term "astronaut" and the phrase "envoys of mankind" could support a narrower reading of the duty to rescue – one which would likely exclude space tourists and commercial flights. The omission of this language from the Rescue Agreement changes the substance of the law by broadening the scope of the duty to rescue so that it applies to tourists and commercial flights – and this broader scope supersedes the narrower rule of the Outer Space Treaty under the *lex posteriori* rule.

C. Does the Duty to Rescue and Return Apply to Commercial Ventures?

The preliminary question of whether the duty to rescue and return applies to commercial ventures must be resolved before we turn to the more specific issue of whether tourists can be beneficiaries of the duty to rescue.

When interpreting a treaty under the Vienna Convention, the starting point is always the plain language and ordinary meaning of the text. In light of this, the question of whether the duty to rescue and return applies to commercial ventures would appear to require an affirmative answer since nothing in the text of either the Outer Space Treaty or the Rescue Agreement explicitly excludes commercial venture or limits the scope of the duties to government-sponsored missions. However, in the interest of being thorough, attention should be paid to certain key terms that have a bearing on the scope of the duty to rescue and return to see whether their meaning might operate to restrict the scope of the treaty to government activity. These key terms are "astronaut" and "space vehicle" (in the Outer Space Treaty) and "personnel," "space object," and "spacecraft" (in the Rescue Agreement). None of the terms in the Rescue

Agreement exclude commercial enterprises in their ordinary meaning – in fact, "personnel" is typically used in a commercial context (e.g., cruise ship personnel) as well as in government contexts. This lack of any distinction between private and public spaceflight in the plain language of the Rescue Agreement supports a broad interpretation which would require states to rescue non-governmental personnel and return private spacecraft.

The analysis of the Outer Space Treaty may point at a different result because, as discussed in greater detail below, one could argue that the ordinary meaning of "astronaut" at the time of the signing of the Outer Space Treaty would have been understood to include only the members of the crew on government-sponsored missions. However, as is also explained below, the application of the *lex posteriori* rule results in the Rescue Agreement superseding Article V of the Outer Space Treaty – which deprives the term "astronaut" of any operative force in the context of rescue and return.

An analysis of state practice under Article 31 of the Vienna Convention also supports extending the application of the Rescue Agreement to commercial spacecraft. Although no state has yet been required to fulfill its duty to rescue astronauts, the record is a little richer with respect to the return of space objects. There have been seven instances of space objects being found on Earth resulting in the notification of the Secretary-General and the return of the assets to the launching authority.[53] Five of these episodes involve the discovery of government assets – but two involve the discovery of private spacecraft. Specifically, the governments of Argentina and South Africa, in 2000 and 2004, respectively, notified the Secretary-General of the discovery and planned return to the United States of space objects that had been found in their respective territories.[54] In both cases, the governments had determined prior to giving notification that the space objects were parts of *Delta II* launch vehicles which –

[53] Frans G. von der Dunk, *A Sleeping Beauty Awakens: The 1968 Rescue Agreement after Forty Years,* 34 J. SPACE L. 411, 426-31 (2008).

[54] U.N. Doc. A/AC.105/825 *at* http://www.unoosa.org/oosa/sdnps/unlfd.html; U.N. Doc. A/AC.105/740 *at* http://www. unoosa.org/oosa/sdnps/unlfd.html.

although they delivered government payloads – were owned by a private company, namely, the Boeing Company. Thus, we have some evidence of States extending the duty to return to privately-owned commercial vehicles. And if States feel compelled under the law to fulfill the duty to return private vehicles, there is no reason why the other duties imposed by the treaty, including the duty to rescue, should be viewed any differently.

On the other side of the argument is an oft-cited comment made by the French delegate at the presentation of the Rescue Agreement to the General Assembly. In his comment, the delegate clearly announces that the duties of the Rescue Agreement were not intended to apply to commercial ventures. The relevant part of the comment is reproduced here:[55]

> Before concluding, I should like to emphasize that the text of the convention, as the French Government understands it, applies in full only to flights that are experimental and scientific in nature. The rights of the signatory States must be fully reserved for the time when such flights may become utilitarian or commercial in character, at which time it will doubtless be necessary to negotiate a new convention.

Although this comment would seem to carry great weight due to the fact that it specifically addresses the issue at hand, it cannot be allowed to control the meaning of the treaty. First of all, it is only the opinion of one State that is expressed and there were likely to have been other views. But more importantly, this instance of *travaux préparatoires* does not enter the analysis according to the rules of the Vienna Convention. Under Article 32 of the Vienna Convention, recourse to the *travaux préparatoires* is only allowed for the purpose of *confirming* – not challenging – the ordinary meaning of the treaty language (unless the language is deemed ambiguous or absurd, which is not the case here since the treaty language clearly encompasses both government and commercial operations). Although disregarding the comment of the French delegate may seem imprudent to some, the Vienna Convention rules were written to give primacy

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[55] *Provisional Verbatim Record*, *supra* note 9, at 42.

to the written word for the purpose of limiting recourse to the easily manipulated morass of *travaux préparatoires*.

In addition to the foregoing arguments under the Vienna Convention, the extension of the duty to rescue and return to commercial ventures is also reasonable because it would be consistent with the approach of other duties under the space treaties. For example, Article VI of the Outer Space Treaty extends the application of the treaty to private space operations by requiring that States supervise the space activity of non-governmental entities and bear responsibility for any failure of non-governmental entities to comply with the treaty.[56] It is also generally accepted that a launching state must register under the Convention on Registration of Objects Launched into Outer Space.[57] Similarly, a State is liable for any damage caused by space objects launched from its territory (or whose launch the state procures) under the Convention on International Liability for Damage Caused by Space Objects – whether such objects are owned by the government or a private entity.[58]

Finally, an overwhelming majority of commentators agree with extending the benefits of not only the duty to rescue and return, but of the entire body of space law, to commercial participants.[59] Although the views of commentators do not enter

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[56] Outer Space Treaty, *supra* note 11, at art. VI.

[57] Convention on Registration of Objects Launched into Outer Space, art. 1, Jan. 14, 1975, 1023 U.N.T.S. 15; see also *Practice of States and International Organizations in Registering Space Objects: Replies from Member States*, U.N. Document A/AC.105/C.2/L.250/Add.1 p. 3 (reporting that France "registers national satellites, whether they belong to government organizations or private companies.").

[58] Convention on International Liability for Damage Caused by Space Objects, arts. II & III, Mar. 29, 1972, 961 U.N.T.S. 187 [hereinafter Liability Convention]. Regarding the liability of launching states for harm caused by commercial ventures see Bruce A. Hurwitz, *Liability for Private Commercial Activities in Outer Space*, *in* PROCEEDINGS OF THE THIRTY-THIRD COLLOQUIUM ON THE LAW OF OUTER SPACE 37, 39 (1991); Ricky J. Lee, *Reconciling International Space Law with the Commercial Realities of the Twenty-First Century*, 4 SING. J. INT'L & COMP. L. 194, 230 (2000).

[59] *See*, *e.g.*, I.H. Ph. Diederiks-Verschoor & W. Paul Gormley, *The Future Legal Status of Nongovernmental Entities in Outer Space: Private Individuals and Companies as Subjects and Beneficiaries of International Space Law*, 5 J. SPACE L. 125, 155 (1977).; Frans G. von der Dunk, *Space for Tourism? Legal Aspects of Private Spaceflight for Tourist Purposes*, *in* PROCEEDINGS OF THE FORTY-NINTH COLLOQUIUM ON THE LAW OF OUTER SPACE (2007); Robert C. Beckman, *1968 Rescue Agreement – An Overview*, *in* UNITED NATIONS TREATIES ON OUTER SPACE: ACTIONS AT THE NATIONAL LEVEL 85

into interpretational analysis under the Vienna Convention, such opinions can themselves have the force of law under Article 38 of the Statute of the International Court of Justice.[60]

D. Are Space Tourists Beneficiaries of the Duty to Rescue?

Even if the duty to rescue extends to commercial spaceflight, the question still remains whether the law only requires states to rescue crew members, or private passengers as well. As discussed above, the Moon Agreement requires that states take actions to safeguard the lives of "all persons on the moon." The phrase "all persons" is sufficiently generic to embrace government astronauts, scientists, tourists, and any other people on the Moon. However, the Outer Space Treaty and the Rescue Agreement use narrower terms when they require the rescue of "astronauts" and "personnel," respectively. Whether these terms can be interpreted as including space tourists is an open question – but the Vienna Convention proves to be helpful in arriving at a broad interpretation of the duty, i.e., one that allows tourists to benefit from the rescue duty.

The Outer Space Treaty's use of the term "astronaut" has been understood by some commentators to limit the duty to rescue to (1) the pilot and crew[61] or (2) the pilot, crew, and any professional performing a service on board.[62] Under either approach, private passengers would be excluded. However, it is debatable whether "astronaut" carries such a limited meaning when analyzed under the Vienna Convention.[63] According to

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(2004); Setsuko Aoki, *Commentary on 1968 Rescue Agreement – An Overview*, *in* UNITED NATIONS TREATIES ON OUTER SPACE: ACTIONS AT THE NATIONAL LEVEL 407 (2004).

[60] Statute of the International Court of Justice, art. 38, June 26, 1945, 59 Stat. 1055, 33 U.N.T.S. 993.

[61] *See*, *e.g.*, Dembling & Arons, *supra* note 20, at 642.

[62] Stephen Gorove, *Interpreting Salient Provisions of the Agreement on the Rescue of Astronauts, The Return of Astronauts, and the Return of Objects Launched into Outer Space*, *in* PROCEEDINGS OF THE ELEVENTH COLLOQUIUM ON THE LAW OF OUTER SPACE 93, 93 (1969); Elina Kamenetskaya, *"Cosmonaut" ("Astronaut"): An Attempt of International Legal Definition*, *in* PROCEEDINGS OF THE THIRTY-FIRST COLLOQUIUM ON THE LAW OF OUTER SPACE 177, 177-78 (1989); von der Dunk, *supra* note 59.

[63] For commentators who support a broad reading of "astronaut" to include everyone on board a spacecraft, *see*, *e.g.*, Bin Cheng, *"Space Objects", "Astronauts" and Related Expressions*, *in* PROCEEDINGS OF THE THIRTY-FOURTH COLLOQUIUM ON THE LAW OF

the 1972 *Oxford English Dictionary*, the meaning of "astronaut" is "one who travels in space, i.e. beyond the earth's atmosphere" or "a student or devotee of spaceflight."[64] Putting "students and devotees of astronautics" aside, this dictionary definition is virtually identical to the definition of "astronaut" set forth in the 1965 edition of the *Dictionary of Technical Terms for Aerospace*, which includes in the definition of "astronaut" (1) those who engage in space flight and (2) those who train for spaceflight.[65] There is nothing in the first definition that would exclude private passengers (nor in the second definition since, at least under the law of the United States, tourists will undergo training for their flight).[66] Because there is no ambiguity regarding the inclusion of passengers in either definition (since neither definition exclude passengers), supplementary means of interpretation can only be applied to confirm the inclusion of passengers – but not challenge it.

On the other hand, an argument could be made that the ordinary meaning of "astronaut" at the time of the signing of the Outer Space Treaty would have included only the crewmembers and technicians on government-mounted missions. After all, the drafters of the Outer Space Treaty were creating the treaty at a time when only governments had the ability to put objects into space and private space use was an impossibility.[67] This

OUTER SPACE 17, 26 (1992); Ryszard Hara, *Legal Status of Astronauts and Other Personnel on the Moon*, *in* PROCEEDINGS OF THE TWENTY-SIXTH COLLOQUIUM ON THE LAW OF OUTER SPACE 165, 165 (1984) (relying on comments by the Italian delegation to the legal subcommittee).

[64] *Astronaut*, A SUPPLEMENT TO THE OXFORD ENGLISH DICTIONARY (1972). *See also*, WEBSTER'S THIRD NEW INTERNATIONAL DICTIONARY (1967) (defining "astronaut" as "a traveler in interplanetary space").

[65] Kamenetskaya, *supra* note 62, 177 (*citing* DICTIONARY OF TECHNICAL TERMS FOR AEROSPACE USE 16 (1965)).

[66] Human Space Flight Requirements for Crew and Flight Participation, 71 Fed. Reg. 75616, 75626 (Dec. 15, 2006) (to be codified at 14 C.F.R. §460.51) (requiring an operator to train each space flight participant before flight on how to respond to emergency situations, such as fire and loss of cabin pressure).

[67] In a recent article, Professor Stephan Hobe explains that the term "astronaut" differs from "personnel" in that "'astronaut' has a more explorative or scientific meaning, [while] personnel has a more functional meaning." Stephan Hobe, *Legal Aspects of Space Tourism*, 86 NEB. L. REV. 439, 455 (2007). Professor Hobe thus recognizes that "astronaut" may have held a specialized meaning that would have excluded passengers. *Id*.

would coincide with the current internal regulations of the United States Air Force which grant an astronaut rating only to Air Force officers (and not private parties) who perform duties fifty miles or more above the Earth's surface.[68] Confirmation of this interpretation is also found in the Russian translation of the Outer Space Agreement, which uses the word "cosmonaut" rather than "astronaut." As explained above, Article 33(4) of the Vienna Convention permits recourse to translated versions of a treaty to assist in interpretation. According to the 1970 edition of *Kosmonavtika: Malenkaya entsiklopediya* a "cosmonaut" is a person who is a pilot or crew member of a space vehicle who is specially trained in a medical, biological, scientific or technical field, and, therefore, the term "cosmonaut" would not include private passengers.[69]

Proponents of a narrow interpretation of "astronaut" also point to the use of the phrase "envoys of mankind" in reference to astronauts in the Outer Space Treaty.[70] It can be argued that this phrase serves as relevant context that should be taken into account when determining the "ordinary meaning" of astronaut. However, the significance of the phrase "envoys of mankind" is questionable.[71] Historically, envoys are representatives of government and, therefore, it is not surprising that commentators find in the word an indication that "astronaut" should be defined as participants in a government operation. However, no

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[68] *See* Air Force Instruction 11-402, Aviation and Parachutist Service, Aeronautical Ratings and Badges, Sept. 27, 2007, para. 2.3.2, *available at* http://www.e-publishing.af.mil/shared/media/epubs/AFI11-402.pdf.

[69] Kamenetskaya, *supra* note 62, at 177 (citing *Kosmonavtika: Malenkaya entsiklopediya* 239 (1970)). Under the authority of an interim measure, the Federal Aviation Administration has awarded "Commercial Astronaut Wings" the two commercial pilots who piloted *SpaceShipOne* to victory in the X-Prize competition, Mike Melvill and Brian Binnie. See Commercial Space Data – Active Licenses, Federal Aviation Administration Website, at http://www.faa.gov/about/office_org/headquarters_offices/ast/ launch_data/ current_licenses. However, it is not clear that such astronaut wings will be awarded to mere passengers on future commercial tourist flights.

[70] See, *e.g.*, I.H. Ph. Diederiks-Verschoor, *Search and Rescue in Space Law*, *in* PROCEEDINGS OF THE NINETEENTH COLLOQUIUM ON THE LAW OF OUTER SPACE 152, 156 (1977).

[71] Cheng, *supra* note 63, at 25 (asserting that the phrase "envoys of mankind" is "no more than a figure of speech without any legal significance."); *see also* V.S. Vereshchetin, *Legal Status of International Space Crews*, *in* PROCEEDINGS OF THE TWENTY-FIRST COLLOQUIUM ON THE LAW OF OUTER SPACE 164 (1979).

State has the authority to appoint an "envoy of mankind." This concept is supranational and therefore any person, whether a government agent or private person, has equal claim to the title "envoy of mankind." The insignificance of the phrase is also indicated by its omission from the Rescue Agreement. From this perspective, the phrase fails to impose any limitation on the meaning of astronaut and therefore opens the door to a broader definition that includes anyone on board a spacecraft, including passengers.

Although the foregoing debate is an interesting one, the issue regarding the meaning of astronaut is a moot point because, as discussed above, the Rescue Agreement supersedes the Outer Space Treaty with respect to the duty to rescue under the *lex posteriori* rule. The Rescue Agreement employs the phrase "personnel of a spacecraft" to describe the beneficiaries of the duty to rescue rather than "astronaut" – and this inconsistency is resolved in favor of the later treaty. As a result, space tourism companies only need to concern themselves with the question of whether "personnel" includes their passengers.

With respect to the meaning of "personnel," we begin the analysis once again with its ordinary meaning. According to the 1968 edition of *Webster's New World Dictionary*, "personnel" means "persons employed in any work, enterprise, service, etc."[72] On a positive note, this definition is broad in the sense in that it carries no connotation of government activity (as "astronaut" is more likely to carry), thus allowing for the duty to rescue to extend to personnel of commercial flights. However, the phrase "personnel of a spacecraft" is narrow in the sense that it would only cover the pilot, crew, and other service providers on board, while private passengers (who provide no service on board) would be excluded from the ordinary meaning of the term.[73] There are a number of commentators who would like to define "personnel" broadly so that it would include space tour-

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[72] *Personnel*, WEBSTER'S NEW WORLD DICTIONARY (1968).

[73] Both Stephen Gorove and Bin Cheng reluctantly agree that "personnel" would exclude passengers, although Prof. Cheng makes a point of noting that the drafters of the Rescue Agreement did not intend this result. Gorove, *supra* note 62, at 93; Cheng, *supra* note 63, at 165.

ists – but the challenge is achieving a broad definition in a manner that complies with the customary law of treaty interpretation as codified in the Vienna Convention.[74] The remainder of this section explores potential methods for expanding the scope of "personnel" beyond its dictionary definition.

The simplest solution would be to find support for the contention that the ordinary meaning of personnel at the time of drafting was in fact sufficiently broad so as to include private passengers on a spaceplane. The unforgivingly narrow dictionary definition of the term would make this argument difficult. However, in making this argument one could point to the use of the term "personnel" in Article VIII of the Outer Space Treaty, which is reproduced here:[75]

> A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any *personnel* thereof, while in outer space or on a celestial body.

Scholars have not hesitated to interpret "personnel" in this context broadly to include any and all people on board a spacecraft – which was certainly the intention of the drafters.[76] And if "personnel" was used to refer to all persons in the Outer Space Treaty, it could be argued that this was an ordinary meaning of

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[74] Commentators who have adopted an interpretation of "personnel" that would include private passengers include Dembling & Arons, *supra* note 20, at 642; MANFRED LACHS, THE LAW OF OUTER SPACE 79 (1972); Gabriella Catalano Sgrosso, *Legal Status of the Crew in the International Space Station*, *in* PROCEEDINGS OF THE FORTY-SECOND COLLOQUIUM ON THE LAW OF OUTER SPACE 35, 36, 40 (2000) (citing the NASA definition of "personnel"); Oscar Fernandez-Brital, *Legal Problems of Commercial Space Transportation*, *in* PROCEEDINGS OF THE THIRTY-THIRD COLLOQUIUM ON THE LAW OF OUTER SPACE 30, 33 (1991); Beckman, *supra* note 59, at 88; Steven Freeland, *Up, Up and . . . Back: The Emergence of Space Tourism and its Impact on the International Law of Outer Space*, 6 CHI. J. INT'L L. 1, 10 (2005). Moreover, the recent United Nations Workshop on Space Law held in South Korea concluded that "the term 'personnel of a spacecraft' . . . should be construed to encompass all persons on board a spacecraft." U.N. Doc. A/AC.105/814 at 6.

[75] Outer Space Treaty, *supra* note 11, at art. VIII.

[76] MANNED SPACE FLIGHT, *supra* note 2, at 194; *see also* Hobe, *supra* note 67, at 455.

the term that should also be adopted when interpreting the Rescue Agreement.[77]

Another approach to seeking a broad definition of "personnel" is to take into account the humanitarian purpose of the Rescue Agreement when interpreting the term as is required under Article 31 of the Vienna Convention. That the main principle and purpose behind the Rescue Agreement was the humanitarian desire to protect the life of those aboard a spacecraft is reflected in the treaty's fourth recital which states that the treaty was "prompted by sentiments of humanity."[78] However, the use of the object and purpose of a treaty for interpretational purposes has its limits. Although the object and purpose can be used to help the ICJ select among competing "ordinary meanings" of a term, the object and purpose cannot be used to overrule the accepted meaning of a term and, in effect, allow for the creation of a definition that has no basis in the term itself. Since the dictionary definition of "personnel" refers to a service provider, it is not possible to ignore this and simply create a new definition of "personnel" that would embrace private passengers on the basis of the humanitarian nature of the treaty.

Another way of achieving a broad reading of "personnel" would be to interpret the term in light of *travaux préparatoires* that would support an expansive definition. Such *travaux* exists in the form of the following comment by the Italian delegation, which had followed the lead of the United States by employing the term "personnel" in their proposed text of the Rescue Agreement:[79]

> [The text proposed by Italy] refers to personnel (or crew) and not specifically to astronauts, since *everyone on board* has a right to assistance for humanitarian reasons."

This comment that "everyone on board" has a right to rescue indicates that the drafters understood the term broadly in a way

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[77] GARDINER, *supra* note 40, at 283 (explaining that the use of the same term in another treaty is relevant to determining the ordinary meaning of the term in the first treaty).

[78] Rescue Agreement, *supra* note 16, at recitals.

[79] *Proposals, amendments and other documents relating to assistance to and return of astronauts and space vehicles*, U.N. Doc. A/AC.105/37 Annex I at 10.

that should even include private passengers. However, under Article 31 of the Vienna Convention, *travaux préparatoires* can only be used to assist in interpretation when ambiguity exists in the text, i.e., when a term is not "clear."[80] This prevents the use of *travaux* in this case, since there is no ambiguity in the term "personnel." The term is commonly understood to refer only to service providers and never to passengers, guests or the like. Therefore, we must seek another course to a broad interpretation of the term.

Another argument in support of a broad interpretation of "personnel" might be made under Article 33(4) of the Vienna Convention if it can be shown that the translation of "personnel" in the Spanish, French, or Chinese versions of the treaty referred to all persons on board a spacecraft. The Rescue Agreement supports this approach in Article 10 which states that the texts of the treaty in various languages are equally authentic and carry the same weight.[81] In pursuit of this line of argument, the translations of the word "personnel" in the French, Spanish, Russian, and Chinese versions of the Rescue Agreement have been analyzed in order to see whether the words used in these versions of the treaty might expand the scope of the duty to rescue to include passengers. However, the results of this analysis are not helpful since all of the translations use terms that mean "crew" – which is even narrower in meaning than "personnel" (which encompasses not only the crew, but also other service providers and professionals on board). The French version uses the word "l'équipage" where "personnel" is used in Article 2 and 3, while the Spanish version uses the term "la tripulación." The Russian and Chinese versions of the Rescue Agreement follow in the same vein. The Russian version uses the word "экипаж," which is simply a transliterated version of the French word "équipage" and carries the same meaning. Similarly, the Chi-

[80] International Law Commission, *supra* note 40, at 223; *see also* Prosecutor v. Dusko Tadic´, [1999] ICTY 2, 124 ILR 61 at 183-84 (1999), para. 303 (stating that the "*travaux préparatoires* . . . may only be resorted to when the text of a treaty . . . is *ambiguous or obscure*.").

[81] Rescue Agreement, *supra* note 16, at art. 10.

nese version employs the word "yen ruan" which also translates as "crew."

Even if all of the previous arguments fail, we are left with a final possibility – that the ordinary meaning of "personnel" results in absurdity under Article 31 of the Vienna Convention, thereby allowing recourse to *travaux préparatoires* (such as the comment from the Italian delegation reproduced above) that support an interpretation that would include tourists. However, it is first necessary to establish that the use of the term "personnel" results in absurdity – which is not difficult to do. Imagine, for example, that one of Virgin Galactic's spaceplane crashes in stormy waters just off the coast of a foreign country. Under a narrow reading of "personnel," the nearby state would be required to rescue the pilot and other crewmembers, but would be free to leave the passengers to face their destiny on the high seas. This scenario could not have been contemplated by the drafters of the Rescue Agreement since there is no reason why the duty to rescue would be limited in this way. Once the rescue expedition had reached the spacecraft, there is no sense in only rescuing some of the people in danger, but not others. This is a ridiculous scenario that would support a finding of absurdity.[82] Facing such absurdity, the ICJ would be forced to remedy the flawed language of the Rescue Agreement by giving "personnel" a broader meaning that would encompass space tourists.

IV. The Way Forward: Reforming the Law to Benefit Space Tourism

The purpose of this article is not merely to describe the current state of law regarding the rescue of astronauts and the return of spacecraft. Although there is value in informing existing tourism companies of the contours of existing law and how the law can benefit their operations, this study was also undertaken in order to identify those aspects of the current law that need to be reformed in order to meet the needs of the private space in-

[82] Other commentators have noticed the absurdity of this situation. *See*, *e.g.*, Freeland, *supra* note 74, at 10; Beckman, *supra* note 59, at 88.

dustry. Those issues that demand further clarification, or are in need of more substantial reform, include the following:

1. *Does the duty to rescue and return apply to commercial ventures?*

2. *Is there is a duty to rescue passengers?*

3. *Is a suborbital spacecraft a "space object"?*

4. *Should the requirement under the Rescue Agreement that personnel "alight" prior to the rescue duty being triggered be abolished?*

5. *Does the duty to rescue and return apply during all stages of flight?*

6. *What is the definition of "launching authority"?*

7. *Should expenses for rescue be reimbursed?*

8. *Should the notification requirement under Art. 5 of the Rescue Agreement be expanded to include notification regardless of where the accident occurs?*

9. *Should the duty to return be triggered by the request of a private party?*

10. *Should spacecraft design standards be implemented to facilitate rescue?*

Before recommending specific solutions to these issues, it is instructive to observe the work product of three leading figures of space law, Prof. Karl-Heinz Böckstiegel, Prof. Stephen Gorove, and Prof. Vladlen Vereshchetin, who joined efforts in 1988 to write the *Draft for a Convention on Manned Space Flight* (the "Draft Convention"), which was an attempt to create a new body of rules to address the perceived needs of future space industries.[83] Given the usefulness of this draft convention as a source of ideas, the entire text of Article VI of the convention, addressing the rescue of astronauts, is reproduced here:[84]

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[83] MANNED SPACE FLIGHT, *supra* note 2, at 7.
[84] *Id.* at 11.

Article VI Mutual Assistance in Space

1. In accordance with Art. V of the Outer Space Treaty and the respective provisions of the Rescue Agreement, the crew participating in a manned space flight of a State Party to this Agreement shall render all possible assistance, including, if necessary, the provision of shelter on their manned space objects, to person who are experiencing conditions of distress in outer space or on celestial bodies.

2. To facilitate such assistance, the States Parties to this Agreement shall study and exchange information on possible steps to ensure the compatibility of manned space objects and technical means for carrying out rescue operations in outer space.

3. Any information received by a State Party to this Agreement concerning an emergency on a manned space object of another State shall be immediately transmitted to the launching State and to the Secretary-General of the United Nations in accordance with Art. I of the Rescue Agreement so that any State may come to the rescue of the persons experiencing conditions of distress.

4. In the event of an emergency situation arising on a manned space object, the States Parties to this Agreement shall ensure by all possible means that communication to and from the manned space object in distress shall be available and that they shall not interfere with such communication.

5. Unless otherwise agreed by the States Parties concerned, the expenses incurred by a State Party or by another State in rendering assistance to a manned space object in distress shall be borne by the launching State of that object, if the launching State has been informed in advance of the assistance and has not objected.

6. States shall regard any person in outer space as an astronaut within the meaning of Art. V of the Outer Space Treaty and as part of the personnel of a spacecraft within the meaning of Art. VIII of the Outer Space Treaty and the Rescue Agreement.

The Draft Convention has been the most comprehensive attempt to reform existing space law in order to accommodate the needs of a private spaceflight. Nevertheless, however progressive this Draft Convention may be, it is not the final word on space law reform. In some cases, the provisions of the Draft Convention provide valuable guidance, while in other cases it falls short. However, even in its shortcomings the Draft Convention has proved to be helpful in the formation of the following recommendations.

1. *The extension of the duty to rescue and return to commercial ventures should be made explicit.* Although I have argued above that the existing duty to rescue and return applies to commercial ventures, private companies will want clarity on this point. Clarity can be provided by reforming the law to make explicit that the rights, duties, and obligations contained in the treaties apply to commercial ventures. Although no such explicit statement is contained in Article VI of the Draft Convention regarding mutual assistance, the Draft Convention does propose to extend liability to states for damage caused by any of its space flights "irrespective of whether they are carried out by governmental or non-governmental entities."[85] This language is a useful model for how obligations under the existing law of rescue and return can be extended to cover private ventures. However, care must be taken when drafting this language. If the language is overly broad and extends all duties and obligations contained in the Rescue Agreement to private entities this would have the effect of requiring private companies to engage in rescue operations themselves. The duty of private parties to engage in rescue missions would potentially place a great burden on companies that are already subject to great financial pressures. In Article VI, the Draft Convention extends the duty to rescue to the crew of a spacecraft – thus requiring not only states to mount rescue expeditions, but requiring the pilots and crew of any spacecraft to engage in rescue operations if possible. This debate regarding the extension of the duty to rescue to private parties was recently taken up in two papers delivered at

[85] MANNED SPACE FLIGHT, *supra* note 2, at 12.

the 2008 International Astronautical Conference in Glasgow and is adequately handled there.[86] However, in this early phase of the space tourism industry, the question of whether private parties can benefit from the duty to rescue is more important than whether the duty to rescue should be imposed on private parties.

2. *"Astronaut" and "personnel" should be defined to include passengers.* Although there are strong arguments that the terms "personnel" and "astronaut" should be interpreted under the Vienna Convention to include passengers, it would be preferable to make the scope of the duty clear by stating explicitly that states must rescue all persons on board a spacecraft. This could be achieved simply by clarifying that the duties set forth in the Outer Space Treaty and the Rescue Agreement apply to all persons on board a spacecraft – as is stated in Article V(6) of the Draft Convention.

3. *The definition of "space object" should be clarified.* A threshold question that must be resolved to ensure that suborbital tourism companies will be able to benefit from current space treaties is whether suborbital spacecraft will be deemed to be "space objects" under the Outer Space Treaty and "spacecraft" under the Rescue Agreement. Virgin Galactic and the other suborbital tourism companies will be sending their tourists 100 kilometers above Earth, which is widely acknowledged to be the lower limits of space – since it crosses the so-called Karman Line. However, the question of where space begins has been the subject of a long-running debate that has yet to be resolved.[87] Some would argue that space begins significantly higher than the Karman Line. For example, the national laws of some countries recognize space as beginning at an altitude where orbit can

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[86] Kevin Comer, *A New Indemnification Policy for Spacecraft that Rescue Astronauts in Need*, *in* PROCEEDINGS OF THE FIFTY-FIRST COLLOQUIUM ON THE LAW OF OUTER SPACE 8 (2009); Zeldine Niamh O'Brien, *The Rescue Agreement and Private Space Carriers*, *in* PROCEEDINGS OF THE FIFTY-FIRST COLLOQUIUM ON THE LAW OF OUTER SPACE (2009).

[87] For a discussion of the definition of "space object" *see*, *e.g.*, I.H. PH. DIEDERIKS-VERSCHOOR & V. KOPAL, AN INTRODUCTION TO SPACE LAW 88-90 (2008); Vladimir Kopal, *Some Remarks on Issues Relating to Legal Definitions of "Space Object", "Space Debris", and "Astronaut," in* PROCEEDINGS OF THE THIRTY-SEVENTH COLLOQUIUM ON THE LAW OF OUTER SPACE 99 (1994).

be sustained. Settling this question is of great importance to the suborbital tourist industry in order to ensure that suborbital flights come within the protection of the duty to rescue and return. This can be achieved by making clear that space begins at 100 kilometers above sea level. Under such a definition of space, suborbital vessels would be treated as "space objects" and "spacecraft."

4. *The requirement under the Rescue Agreement that personnel "alight" prior to the rescue duty being triggered should be abolished.* As explained above in Section II, the language of the Rescue Agreement requiring that the personnel "alight" prior to the rescue duty being triggered may be interpreted to rule out any duty to rescue personnel traveling in space. In order to remedy this gap in the treaty, the law should be reformed to provide for rescue when persons aboard a spacecraft are in distress (or, to state this duty even more broadly, whenever persons on board a spacecraft *or elsewhere in space* are in distress – for example, if tourists are stranded in a lunar hotel).

5. *The duty to rescue and return should apply during all stages of flight.* Since it is likely that a mishap involving a suborbital flight could occur before the vessel reaches space, resulting in an unplanned landing in a foreign territory, the duty to rescue and return must be revised in a manner that allows for the duty to be triggered even if the spacecraft never reaches space. The Draft Convention attempts to broaden the duty to rescue in this manner by defining "manned space flight" in the following way:[88]

> [A] flight of a space object with a person or persons on board from Earth to outer space or in outer space and *extends to the embarkation, launch, in orbit, deorbit, reentry, landing and disembarkation*.

While the intent of the drafters is clearly that the duties of the convention apply to all stages of a flight, there is still room to question this conclusion if the definition of "space object" or "spacecraft" does not explicitly state that such term includes an

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[88] MANNED SPACE FLIGHT, *supra* note 2, at 8 (emphasis added).

object or spacecraft that does not achieve outer space. None of the existing conventions define spacecraft or space object – except for the Liability Convention which defines space object as including "component parts of a space object as well as its launch vehicle and parts thereof," which definition fails to address the issue at hand.[89] Article 5 of the Rescue Agreement also fails to resolve the issue by stating that the duty to return applies to "objects launched into outer space," which suggests that objects that are intended to reach outer space but fall short of this goal will not benefit from the duty to return.[90] Nor does the Draft Convention sufficiently handle the issue in its definition of "manned space object" which is defined as "a space object on which a person or persons effect a space flight."[91] This definition suggests that only objects which have "effected" a space flight (i.e., have reached outer space) are subject to the treaty. One solution would be to adopt a definition of "space object" and "spacecraft" that would include those objects that were launched into space as well as those objects that were launched with the intention of reaching space, but failed to do so.

6. *The definition of "launching authority" should be clarified.* The "launching authority" plays a central role in the operation of the Rescue Agreement in a number of ways. For example, notification regarding an unintended landing is to be given to the launching authority, personnel and errant spacecraft are to be returned to the launching authority, and the expenses of salvage are to be borne by the launching authority.[92] However, there are significant problems with the definition of "launching authority" in light of the multi-national and supranational nature of current space operations. Before highlighting these problems, the following definition of "launching authority" set forth in the Rescue Agreement should be considered:[93]

> [T]he term "launching authority" shall refer to the State responsible for launching, or, where an international intergov-

[89] Liability Convention, *supra* note 58, at art. I(d).
[90] Rescue Agreement, *supra* note 16, at art. 5(3).
[91] MANNED SPACE FLIGHT, *supra* note 2, at 8.
[92] Rescue Agreement, *supra* note 16, at arts. 1, 4 & 5.
[93] *Id*. at art. 6.

> ernmental organization is responsible for launching, that organization . . . .

In short, the Rescue Agreement defines "launching authority" as the state that is "responsible for launching." The problem with this definition is that a state may not qualify as being "responsible for launching" a space object when the space venture is private in nature. The analysis is further complicated if a launch takes place in extra-jurisdictional territory, such as the high seas. In order to avoid these complications, the definition of launching authority should be clarified so that no doubt will arise regarding the state that is subject to the duties and benefits of the treaty. The simplest solution would be to define launching authority as the state that has registered the space object under the Registration Treaty.[94]

7. *Expenses for rescue should be reimbursed.* Perhaps the clearest indication of the humanitarian nature of the Rescue Agreement is that there is no requirement for the launching authority to reimburse a rescuing State for the costs of a rescue operation. Although the sentiment is commendable, this lack of a compensation requirement could in the end hamper rescue efforts since the duty to rescue is only triggered if a State is "in a position to do so."[95] The danger is that a State may take finances into consideration when deciding whether it is in a position to undertake rescue operations – particularly if space rescue is demanded. As a result, it would be in the best interests of the space industry to require the reimbursement of funds spent on rescue, just as the costs of retrieving a spacecraft are to be borne by the launching authority. Whether a State will then demand that such costs be subsequently reimbursed by the private company that received the benefits of the rescue should be left to domestic law.[96]

8. *The notification requirement under Art. 5 of the Rescue Agreement should be expanded to include notification regardless*

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[94] For an example of an early debate on this issue see the joint comment by Australia, Canada, and the USSR see *Proposals, amendments and other documents relating to assistance to and return of astronauts and space vehicles*, *supra* note 79, at 12.

[95] Rescue Agreement, *supra* note 16, at art. 3.

[96] *See* Comer, *supra* note 86; O'Brien, *supra* note 86, at 8-9.

of where the accident occurs. The sharing of information about an emergency involving a spacecraft is imperative to ensure that rescue operations are quickly dispatched and that any developments in the situation are transmitted to all parties involved during the course of rescue and retrieval of a spacecraft. While Articles 1 and 2 the Rescue Agreement requires a State to notify the launching authority upon learning of personnel of a spacecraft being in distress – regardless of where the spacecraft is located – and to provide updates regarding any rescue operations, this notification requirement is curtailed with respect to retrieval operations.[97] Under Article 5, notification about the discovery of an errant spacecraft is only required if the spacecraft or its component parts has returned to Earth.[98] This duty to notify should be expanded in two ways. First, the duty to notify should be expanded to require the sharing of all information with the launching authority regarding the discovery of an errant spacecraft (similar to the language used in Article VI(4) of the Draft Convention). Second, the duty should be expanded to cover the sharing of information regarding errant spacecraft regardless of where the spacecraft is located – on the Earth, in space, or on a celestial body.

9. *The duty to return should be triggered by the request of a private party.* As currently drafted, Article 5 of the Rescue Agreement only requires a State to retrieve an errant spacecraft upon the request of the launching authority. This provision should be revised to allow this duty to be triggered either upon the request of the launching authority or the owner of the spacecraft. This would enable recovery operations to be launched more quickly without the private owner of a spacecraft having to go through governmental channels in order to request recovery.

10. *Spacecraft design standards should be implemented to facilitate rescue.* Although rescue operations involving suborbital flights are likely to involve nothing more than locating and recovering the spacecraft when it has returned to Earth, rescue will be more complicated in those situations where spacecraft

[97] Rescue Agreement, *supra* note 16, at arts. 1 & 2.
[98] *Id*. at art. 5(1).

face emergencies in orbit, in deep space, or on a celestial body. In those cases, it may be necessary for a rescue vehicle to dock with the vehicle in distress so that the people on board can be transferred to the rescue vehicle and returned to Earth. In order to facilitate such space rescue operations, it would be helpful if hatch design were standardized to allow for docking between all spacecraft. This could be achieved through an international instrument that requires the domestic laws of signatories to impose a standard design such as the Common Berthing Mechanism that is used by vehicles that dock with the International Space Station.[99] While Article VI(2) of the Draft Convention calls for such compatibility of spacecraft, it does so with soft language that merely requires parties to "study and exchange information on possible steps to ensure the compatibility of manned space objects."[100] It would be preferable to draft stronger language that would require parties to comply with a specific design standards, such as the Common Berthing Mechanism, or a variable standard that is determined by an international working group formed by a treaty for the express purpose of developing such standards.

Apart from the challenge of determining what substantive changes should be made to the current law regarding rescue and return, there is also the question of how best to go about making these changes. One possibility is to amend the Rescue Agreement pursuant to the amendment procedures set forth in Article 8 which states that (1) any State may propose an amendment and (2) any proposed amendment shall enter into force upon the acceptance of the amendment by a majority of States that are party to the Rescue Agreement (but shall only bind those States that accept the amendment).[101] However, this procedure sets a high bar for modifying the law since it would require the assent of forty-five countries – a task that would likely take many years to achieve before even a single country

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[99] Richard J. McLaughlin & William H. Warr, *The Common Berthing Mechanism (CBM) for International Space Station*, SAE Int'l Doc. 2001-01-2435, 31st International Conference on Environmental Systems (2001), *available at* http://spacecraft.ssl.umd.edu/design_lib/ICES01-2435.ISS_CBM.pdf.

[100] MANNED SPACE FLIGHT, *supra* note 2, at 11.

[101] Rescue Agreement, *supra* note 16, at art. 8.

would be bound by the amendments. In light of this, the preferable approach would be to draft a separate agreement or protocol containing provisions that would set forth new obligations. This protocol could be drafted in a manner that referenced the Rescue Agreement and stated that the obligations under the Rescue Agreement would be modified as set forth in the protocol. More importantly, the protocol could be drafted in a manner that would allow it to enter into force upon the ratification by two or three countries, thus permitting the changes to go into effect within a short period of time. Of course, the protocol would only be binding on those states that ratified it and it might still take many years before broad ratification were achieved – but at least there would be rather immediate implementation of the changes with respect to those countries that ratified the protocol early on.

V. Conclusion

Virgin Galactic and the other space tourism companies will be pioneers in the next era of human spaceflight. In the early phase of their operations, these companies will face many technological, financial, and regulatory challenges – but the greatest challenge overall will be ensuring the safety of their customers. Passenger safety is a multi-faceted problem that will require safe technology, the proper training of the flight crew, as well as passenger screening and training. In the event that an emergency arises during flight, the ability of a company to rescue its passengers will also be of great importance for the survival of not only the passengers, but of the company as well. In order to assist companies in providing for the safe rescue of their passengers, this article has shown that a strong argument can be made that the Rescue Agreement requires parties to the treaty to rescue space tourists. In addition, this article has shown that the Rescue Agreement requires states to recover and return private spacecraft, including spaceplanes used to ferry tourists into space.

The duty of States to rescue space tourists and return private spacecraft should be taken into account by companies as they create their contingency plans for the rescue of their customers and the retrieval of their spacecraft. While some operations, such as Virgin Galactic's suborbital flights out of New Mexico, are not likely to result in an unintended landing in foreign territory, other companies may be operating in an international environment. For example, Rocketplane's plans to launch suborbital flights from Dubai could result in unintended landings in Iranian waters. Companies, such as Rocketplane, that face the possibility of losing a spacecraft in foreign territory should consider notifying the country prior to launch regarding their duties to rescue the passengers and return the spacecraft in the event of an accident. Alternatively, a company should be prepared to demand that states adhere to their duty to rescue and return in the event that an accident takes place. This article provides the legal framework for such a demand. In the meantime, the law regarding rescue and return should be reformed as recommended herein so that in the future space tourism companies will be able to operate in a legal environment that ensures the safety of their customers and prevents the misappropriation of their spacecraft.

TOWARD IMPLEMENTATION OF THE GLOBAL EARTH OBSERVATION SYSTEM OF SYSTEMS DATA SHARING PRINCIPLES[*]

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[*] This article reflects the views of the authors and not necessarily those of their institutions of employment or affiliation. This article was first written as a "white paper" for the Group on Earth Observations (GEO) under Task DA-06-01, "Furthering the Practical Application of the Agreed GEOSS Data Sharing Principles," which was led beginning in 2006 by the Committee on Data for Science and Technology (CODATA) of the International Council for Science (ISCU) under the auspices of the GEO Architecture and Data Committee. We would like to thank the many individuals who helped facilitate the writing of the article or its review. These include Michael Rast, Michael Tanner, and Masami Onoda of the GEO Secretariat, and Kathleen Cass of the CODATA Secretariat, all of whom provided a great deal of project guidance and administrative support; Charles Barton, Australian National University, and Jack Hill, the U.S. Geological Survey, for their contributions to the drafting of the article; Santiago Borrero, Dora Ann Lange Canhos, Yukiko Fukasaku, Huadong Guo, Alexei Gvishiani, Bernard Minster, Steve Rossouw, and Fraser Taylor for providing review comments on earlier drafts; and the many representatives to GEO from its Member States or Affiliated Organizations, who also provided significant substantive comments and suggestions. We also acknowledge the strong support and encouragement of José Achache, Director of the GEO Secretariat, who recognized early on the importance of this effort. Finally, we wish to thank the editors of the *Journal of Space Law* and the *CODATA Data Science Journal*, for their assistance with the publishing of this article.

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I. INTRODUCTION

The World Summit on Sustainable Development (WSSD) in Johannesburg in 2002 highlighted the urgent need for coordinated observations of the Earth in support of sustainable development. At the first Earth Observation Summit in Washington, DC in 2003, representatives of 33 countries, the European Commission and more than 20 international organizations affirmed the need for a comprehensive, coordinated, and sustained system of Earth observing systems and established the *ad hoc* intergovernmental Group on Earth Observations (GEO), co-chaired by the European Commission, Japan, South Africa, and the United States. In February 2005, GEO adopted the Global Earth Observation System of Systems (GEOSS) *10-Year Implementation Plan*, which establishes the intent, operating principles, and institutions relating to GEOSS [GEOSS, 2005].

The purpose and vision for GEOSS is "to realize a future wherein decisions and actions for the benefit of humankind are informed via coordinated, comprehensive and sustained Earth observations and information." GEOSS is seen as an important contribution to meeting the Millennium Development Goals and to furthering the implementation of international treaty obligations. GEOSS will encompass all areas of the Earth, with a particular emphasis on addressing the needs of developing country users. GEOSS will incorporate *in situ*, airborne, and space-based observations and address the integration of observations with models to support early warning and prediction. It is anticipated that GEOSS will focus initially on information needs in nine societal benefit areas, ranging from disaster management to sustainable agriculture to climate variability and change.

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Consistent with these goals, GEOSS also has a role in raising awareness of the need for more Earth observation efforts and in promoting better use for decision-making and in promoting societal benefits. GEOSS, as a coordinated effort, is expected to help avoid unnecessary duplication of effort, to identify major data and information gaps, and assist governments and Participating Organizations in planning new investments in the sharing of Earth observation and other related data.

The GEOSS *10-Year Implementation Plan* explicitly acknowledges the importance of data sharing in achieving the GEOSS vision and anticipated societal benefits. The Plan, endorsed by nearly 60 governments and the European Commission at the Third Earth Observation Summit in Brussels, highlights the following GEOSS Data Sharing Principles:

1. There will be full and open exchange of data, metadata, and products shared within GEOSS, recognizing relevant international instruments and national policies and legislation.

2. All shared data, metadata, and products will be made available with minimum time delay and at minimum cost.

3. All shared data, metadata, and products being free of charge or no more than cost of reproduction will be encouraged for research and education.

All new members of GEO are required to endorse the Plan and therefore these Principles. The Plan notes that "use of data or products does not necessarily imply agreement with, or endorsement of the purpose behind the gathering of such data."

In 2006, GEO established Task DA-06-01, "Furthering the Practical Application of the Agreed GEOSS Data Sharing Principles," and invited GEO Members and Participating Organizations to help implement the task. The International Council for Science (ICSU), working through its interdisciplinary committee, the Committee on Data for Science and Technology (CODATA), agreed to lead this task, under the auspices of the GEO Architecture and Data Committee. In October 2006, in conjunction with the 20th International CODATA Conference in Beijing, CODATA convened a meeting of experts to discuss the data sharing task and associated implementation issues [see:

http://www.codata.org/GEOSS/DA-06-01MeetingBeijingOct2006review.pdf]. This meeting provided important inputs into the structure and content of this *White Paper and Implementation Guidelines for the GEOSS Data Sharing Principles*.

Following the experts meeting, CODATA developed an international team of authors and reviewers to draft and refine the White Paper, and to coordinate its activities with various GEO Committees and the GEO Secretariat. The names of the individuals on the drafting and review groups, as well as of other experts who have contributed to the White Paper are provided in Appendix A. It should be noted that all the authors and contributors involved in this activity did so in their personal capacities and not as representatives of their employing organizations. The References supporting the analysis in this report are provided in Appendix B. The White Paper was also formally reviewed by representatives of many GEOSS Members, Participating Organizations, and Committees in the summer of 2007, and by the Architecture and Data Committee at its September 2007 meeting. The White Paper was then provided for information to GEOSS Members and Participating Organizations at the GEO Plenary and Ministerial Summit in Cape Town, South Africa in November 2007, and discussed in a side event organized by CODATA during that time. Since then the White Paper benefitted from a series of more formal reviews within the GEO community, leading to further revisions to the text. The White Paper was submitted to the GEO Plenary in Bucharest in November 2008.

GEOSS is envisioned as a "system of systems," built upon existing observational systems and incorporating new systems for Earth observation and modeling that are offered as GEOSS components by Member countries and Participating Organizations. Developing technical interoperability between such diverse systems is clearly a major challenge, but an equally important challenge is the coordination and harmonization of data policies and procedures to facilitate the sharing and use of GEOSS data to maximize societal benefits for the widest possible range of users. Inconsistent or vague data policies and procedures could hamper the rapid dissemination and flexible use of data and information needed for mission-critical and/or lifesaving GEOSS applications. Restrictive policies on data reuse and re-dissemination would significantly reduce the net return on investment of public funds in Earth observations and lead to unnecessary and wasteful duplication of effort. Excessive charges for data would pose substantial barriers to many users, especially those in developing countries, who may have no or few alternative sources for data.

This White Paper reviews the background issues for implementing the GEOSS Data Sharing Principles and recommends Implementation Guidelines to ensure the strongest possible framework for data sharing, consistent with both the spirit and the "letter" of the Principles. As recognized by the *10-Year Implementation Plan*, "ensuring that such information is available to those who need it is a function of governments and institutions at all levels." It is therefore incumbent on governments and institutions participating in GEOSS to continue to develop and implement appropriate policies and procedures that enable and support the GEOSS Data Sharing Principles in fair and effective ways. The implementation approaches discussed here are intended to facilitate this process.

The long-run success of GEOSS is likely to be contingent upon the manner in which the visionary GEOSS Data Sharing Principles are implemented, both by the individual elements of GEOSS and by the GEO overall. Although it is apparent that no single set of rules will apply to all types, sources, and uses of data, a clear set of guidelines, definitions, and minimum expectations should help to improve the sharing of data within GEOSS and facilitate the application of GEOSS data by diverse users in the key societal benefit areas. Such guidelines should also provide useful inputs into the technical evolution of GEOSS, such as in the area of automated digital rights management and the development of appropriate metrics.

II. OVERVIEW OF DATA SHARING LAWS, PRINCIPLES, AND POLICIES

A. Introduction

As the GEOSS Data Sharing Principles make clear, there is a consensus among the GEOSS Members and Participating Organizations that data, metadata, and products that they make available through GEOSS need to be shared and exchanged on a "full and open" basis, with minimum time delay and minimum cost. "Full and open exchange" has been defined as "data and information derived from publicly funded research are made available with as few restrictions as possible, on a nondiscriminatory basis, for no more than the cost of reproduction and distribution" [NRC, 1997]. This definition is adapted from a principle for access to data from global change research that was first articulated as part of the U.S. Global Change Research Program [OSTP, 1991]. The cost of reproduction and distribution, or the marginal cost of fulfilling a user request, on the Internet is either very small or zero. This policy has been used in various international and national environmental projects and in environmental (and other) research over the past two decades. Although intended primarily for data from publicly-funded research, the policy as defined can have broad applicability to other types of public data relevant for inclusion in the GEOSS data system. Moreover, there is an emerging international consensus that openness as the default rule for government data and information—free online and unrestricted in its use—provides the greatest return on the public investments in them and serves the public interest.

At the same time, the diversity of data and data sources expected to be made available through GEOSS makes data sharing difficult and uncertain in various contexts. Different data policy frameworks have evolved for different types of data, including research versus operational data, space-based versus *in situ* data, and data collected by public versus private organizations. Nations have developed different approaches to the ownership and use of publicly generated or funded data. When "raw," that is unprocessed, data are transformed into value-added data and information, differing intellectual property laws may be applicable. Divergent policies may also apply to data used in legal or regulatory processes (i.e., electronic records) versus data collected for other purposes such as scientific research.

Further, the sharing of GEOSS data will in some cases be subject to important exceptions such as the protection of national security, privacy and confidentiality, indigenous rights, and threatened ecological and cultural resources. By "recognizing relevant international instruments and national policies and legislation," the Data Sharing Principles clearly allow for exceptions to "full and open exchange of data, metadata, and products shared within GEOSS." Good faith efforts to limit the scope and application of exceptions are necessary to avoid the development of a complex patchwork of rules that will inhibit desirable uses of data and that will, in the end, fail to provide the desired protections.

Because of the very broad scope of potential GEOSS data and their applications there are many international and national laws, principles, and policies that may be applicable. This chapter begins by examining the variety and complexity of those authoritative sources, with particular focus on policies that promote the open availability, or full and open exchange of data relevant to GEOSS. The underlying rationales for making the data as broadly shared and with the least number of restrictions are then presented, dividing the issues between data that are generated by governments, by other entities with a mix of public and private funding, and by the private sector. Particular attention is devoted to the special status of research, educational, and developing country users. The chapter concludes with an overview of the various legal and policy exceptions to data sharing, which must be taken into account by the contributors to the GEOSS data system.

B. International and Regional Sources of Law, Principles, and Policies

The sources of laws, principles, policies, and definitions of key terms that are relevant to the GEOSS Data Sharing Principles are summarized in this section. They are presented roughly in the order of their importance to topic; that is, from international to regional to national, from specific to general, and in terms of their legal and normative effect.

It is difficult to cover all of the international sources of law, principles, and policies that have some relevance to GEOSS data sharing. These include intellectual property treaties and other types of conventions that carry the greatest legal force and binding commitments for the signatories; international remote sensing principles and policies; United Nations resolutions and declarations; the policies of UN Specialized Agencies and other intergovernmental organizations; public international data system and research program policies; and many regional agreements, laws, and policies, notably within the European Union. These may be characterized in two broad categories: those that are directly relevant to the subject matter areas of the GEOSS data sources and those that address broader information law and policy principles. The examples provided below are not comprehensive, but are intended to identify some of the more important sources of policy in support of the GEOSS data sharing principles.

1. Treaties

There are numerous treaties that cover data and information rights or data sharing obligations or restrictions in specific geographic or subject matter contexts. The various intellectual property conventions are especially important. Copyright treaties [e.g., WIPO Berne Copyright Convention, 1976, and WIPO Copyright Treaty, 1996] and their national legislative implementations (UNESCO, 2004) treat rote, factual compilations that lack creativity or originality in their selection or arrangement, particularly raw data streams, as not copyrightable. The data in those databases are in the public domain and can be used and shared freely, once lawfully accessed. However, as data become more processed and have added value, they may become protectable under copyright law, depending on the particular jurisdiction.

Treaties concerning the environment—the Antarctic Treaty, Convention on the Law of the Sea, Ozone Protocol, Convention on Biodiversity, and the Aarhus Convention, to name but a few that have a strong connection to GEOSS—have various data and information access and sharing provisions as well. To the extent that nations participating in GEOSS are also parties to these various treaties, the agreements impose binding commitments on them with regard to the data gathered and used in those contexts.

2. International remote sensing principles, policies, and definitions

Many, but by no means all, sources of GEOSS data will be from various remote sensing satellite systems. At the global level, there are three main sources of remote sensing data principles and policies relevant to GEOSS: the *UN Principles Relating to Remote Sensing of Earth from Space* (UN Remote Sensing Principles; UNGA, 1986); the international *Charter on Cooperation to Achieve the Coordinated Use of Space Facilities in the Event of Natural or Technological Disasters* (Charter on Space and Disaster Cooperation; International Charter, 2000); and two sets of principles developed by the Committee on Earth Observation Satellites (CEOS). The CEOS Principles are the *Satellite Data Exchange Principles in Support of Global Change Research* (CEOS Global Change Principles; CEOS, 1991), plus a 1992 elaboration; and the *Satellite Data Exchange Principles in Support of Operational Environmental Use for the Public Benefit* (CEOS Public Benefit Principles; CEOS, 1994). These principles apply to all civil government remote sensing satellite data and some nations interpret and apply the principles to private system data as well. Although these international instruments do not have the binding force of law on the parties to GEOSS as do treaties and national legislation, they provide some of the most directly relevant guidance and normative values to the implementation of the GEOSS Data Sharing Principles, as well as useful definitions of key terms.

The UN Remote Sensing Principles. These are the first and foundational source of policy guidance for remote sensing activities. They are contained in a 1987 General Assembly Resolution and cite provisions of the 1967 Outer Space Treaty. That treaty mandates that outer space is the "province of all mankind" and requires that the exploration and use of space be for the benefit of all nations, regardless of their degree of economic or scientific development (UN, 1967).

The UN Remote Sensing Principles address access and distribution of data and information generated by civilian remote sensing systems. "Primary data" are defined as the raw data delivered in the form of electromagnetic signals, photographic film, magnetic tape, or any other means. "Processed data" are the products resulting from processing primary data, and analyzed information means information resulting from interpreting processed data. "Remote sensing activities" include operations, data collection, storage, processing, interpretation, and dissemination.

The UN Remote Sensing Principles set a standard of international cooperation among states operating remote sensing systems (sensing states) and states whose territory is being observed (sensed states), while attempting to achieve a balance between the rights and interests of both groups. On the one hand, sensing states agree to avoid harm to sensed states and to provide them with access to primary data and processed data concerning their own territory on a nondiscriminatory basis. Analyzed information available to sensing states is also to be available to the sensed states on the same basis and terms. On the other hand, sensed states are required to pay reasonable cost terms and do not have access to analyzed information that is otherwise not legally available to them (e.g., proprietary information).

The needs of the developing nations, however, are to be given special regard. Sensing states are encouraged to provide cooperative opportunities to such nations in a wide array of activities, ranging from data collection to establishing and operating storage stations and processing facilities. If requested, a sensing state must consult with a sensed state to make available opportunities for participation. Regional agreements are preferred wherever feasible.

The UN Remote Sensing Principles specifically promote protection of the Earth's environment and of humanity from natural disasters. States participating in remote sensing activities that possess information useful for averting harmful phenomena are required to disclose the information to concerned states. If the potential harm threatens people, the obligation to disclose such information requires promptness and extends not only to the primary data, but to processed data and analyzed information.

The Charter on Space and Disaster Cooperation. Following the 1999 UNISPACE III conference held in Vienna, the space agencies of some major space faring countries initiated the international Charter on Space and Disaster Cooperation, which was later opened to a number of other types of participating organizations. The agreement became operational in 2000. It authorizes a broad range of participants beyond Nation-States to enable pragmatic responses to a disaster by the entities most qualified to do so, such as, rescue and civil protection, defense and security, or other services. A "disaster" includes natural and technological causes. Resources that are to be made available under the Charter include data, information, and facilities. There are definitional differences for "data" and "information" in the Charter as in the UN Remote Sensing Principles. In the Charter "space data" are narrowly defined as "raw data gathered by a space system," controlled or accessed by a party, and transmitted or conveyed to a ground station. "Information" is data that have been corrected and processed by the parties using an analysis program, in preparation for crisis management use by associated bodies to aid beneficiary bodies. Information "forms the basis for extraction of products on location." The Charter on Space and Disaster Cooperation and the UN Remote Sensing Principles also reinforce each other: the purpose of the Charter is to serve populations in great distress from a disaster involving loss of human life caused by a natural phenomenon (or a technological source), while the UN Remote Sensing Principles promote protection of the environment and human life from natural disasters. The Charter's purview goes beyond remote sensing systems by defining "space facilities" as consisting of a wide range of functions, including space systems for observation, meteorology, positioning, telecommunications, and TV broadcasting.

The CEOS Global Change Principles. These Principles affirm the value of investments made by governments and international organizations in Earth observation programs, and that both data providers and users should respect these investments. They also recognize the importance of using appropriate legal mechanisms for the exchange of remotely sensed data. The principles are as follows: global change research requires the preservation of data and easily accessible archives that include information for locating and obtaining data; the greatest use possible of international standards for storing, recording, processing and communicating data; maximizing satellite data use is a "fundamental objective" which requires the "first step" of exchange and sharing mechanisms; nondiscriminatory access is "essential"; there should be no exclusive periods of use for programs except for validations; and priorities for acquisition, archiving and purging should be harmonized. The CEOS Global Change Principles also urge the signatories to adopt the following practices: data suppliers should submit standard product catalogs; international research programs should identify data requirements; researchers need to be chosen through peer review; and written agreements (including the protection of data rights and requirements for publication) need to be signed by selected researchers and their sponsoring institutions; and data must be shared [at a minimum] among selected users.

The CEOS Public Benefit Principles. This document specifically anticipates the emerging operational requirements for global Earth observing systems. The principles apply to satellite, *in situ*, and airborne data and focus on data acquisition, processing, and other functions as they relate to operational environmental use for the public benefit. Both real time and archived data should be available on time scales compatible with user requirements; data suppliers should supply metadata; commons standards should be used to the greatest extent possible for recording, storing, processing, and communicating data; there should be no exclusive periods of data use, except for validation and the limited period should be limited and explicitly defined. "Nondiscriminatory" is defined as "all users in a clearly defined category" who "obtain data on the same terms and conditions." "Real time" is defined as "making data available by direct broadcast or immediately after acquisition and/or initial processing."

3. United Nations Declarations and Resolutions

The provision of broad access to environmental data about the Earth has a high scientific, technological, and political profile within the United Nations system and in other major fora. Notably, the World Summit on Sustainable Development (WSSD), held in Johannesburg in 2002, and recent meetings of the G8 Ministers have emphasized the need for the international community to monitor the environment, improve our knowledge and understanding of environmental processes and be able to predict future changes. At the WSSD, the participating nations issued a Declaration that recognized the need to support "the exchange of observations recorded from *in situ*, aircraft, and satellite networks, dedicated to the purposes of this Declaration, in a full and open manner with minimum time delay and minimum cost, recognizing relevant international instruments and national policies and legislation" [UN, 2002].

The concern for access to public information, in general, and to environmental information, in particular, was also recognized in the World Summit on the Information Society in 2003: "the sharing and strengthening of global knowledge for development can be enhanced by removing barriers to equitable access to information for economic, social, political, health, cultural, educational, and scientific activities and by facilitating access to public domain information, including by universal design and the use of assistive technologies" [WSIS, 2003].

The United Nations Educational, Scientific, and Cultural Organization's (UNESCO) Recommendation Concerning the Promotion and use of Multilingualism and Universal Access to Cyberspace [UNESCO, 2003], also strongly encouraged government bodies in Member States to "develop public domain content" and provided guidance on the implementation of that objective.

4. Policies of UN Specialized Agencies and other intergovernmental organizations

The UN Specialized Agencies, such as the World Meteorological Organization (WMO), the World Health Organization (WHO), the United Nations Environment Programme (UNEP), and UNESCO, among others, have a variety of data programs and policies, some of which provide broad international access to that information. CODATA has a compilation of many of these intergovernmental and international organization policies through the year 1999 available online at http://www.codata.org/data_access/policies.html.

For example, the WMO's World Weather Watch pools meteorological data from around the world and makes it broadly available. WMO Resolution 40 is an important data policy to which many GEOSS Members adhere and is worthwhile to reproduce in relevant part here:

> As a fundamental principle of the World Meteorological Organization (WMO), and in consonance with the expanding requirements for its scientific and technical expertise, WMO commits itself to broadening and enhancing the free and unrestricted [see definition below] international exchange of meteorological and related data and products;
>
> Adopts the following practice on the international exchange of meteorological and related data and products:
>
> (1) Members shall provide on a free and unrestricted basis essential data and products which are necessary for the provision of services in support of the protection of life and property and the well-being of all nations, particularly those basic data and products, as, at a minimum, described in Annex 1 to this resolution, required to describe and forecast accurately weather and climate, and support WMO Programmes;
>
> (2) Members should also provide the additional data and products which are required to sustain WMO Programmes at the global, regional, and national levels and, further, as agreed, to assist other Members in the provision of meteorological services in their countries. While increasing the volume of data and products available to all Members by providing these additional data and products, it is understood that WMO Members

may be justified in placing conditions on their re-export for commercial purposes outside of the receiving country or group of countries forming a single economic group, for reasons such as national laws or costs of production;

(3) Members should provide to the research and education communities, for their non-commercial activities, free and unrestricted access to all data and products exchanged under the auspices of WMO with the understanding that their commercial activities are subject to the same conditions identified in Adopts (2) above; Stresses that all meteorological and related data and products required to fulfil Members' obligations under WMO Programmes will be encompassed by the combination of essential and additional data and products exchanged by Members;

Urges Members to:

(1) Strengthen their commitment to the free and unrestricted exchange of meteorological and related data and products;

(2) Increase the volume of data and products exchanged to meet the needs of WMO Programmes;

(3) Assist other Members, to the extent possible, and as agreed, by providing additional data and products in support of time-sensitive operations regarding severe weather warnings;

(4) Strengthen their commitments to the WMO and ICSU WDCs in their collection and supply of meteorological and related data and products on a free and unrestricted basis;

(5) Implement the practice on the international exchange of meteorological and related data and products, as described in Adopts (1) to (3) above;

(6) Make known to all Members, through the WMO Secretariat, those meteorological and related data and products which have conditions related to their re-export for commercial purposes outside of the receiving country or group of countries forming a single economic group;

(7) Make their best efforts to ensure that the conditions which have been applied by the originator of additional data and

> products are made known to initial and subsequent recipients. (see: http://www.wmo.ch/pages/about/Resolution40.html)

In the context of WMO Resolution 40, "free and unrestricted" means non-discriminatory and without charge [Resolution 23 (EC-XLII) — Guidelines on international aspects of provision of basic and special meteorological services]. "Without charge," in the context of this resolution means at no more than the cost of reproduction and delivery, without charge for the data and products themselves.

Similarly, UNESCO's Intergovernmental Oceanographic Commission's (IOC) Data Exchange Policy states that all IOC Member States shall provide timely, free, and unrestricted access to all data, associated metadata and products generated under the auspices of IOC programs [IOC, 2002]. The IOC also has a specialized program for oceanographic data and information management, the International Oceanographic Data and Information Exchange (IODE), which was established in 1961. It now has 65 national oceanographic data center members that adhere to the IOC Data Exchange Policy.

An important regional organization is the European Meteorological Services (ECOMET), whose data policy has been designed to fully comply with the WMO Resolution 40 and the European directive on the re-use of public sector information. ECOMET is a grouping of 23 national meteorological services in Europe. It has been in operation since 1995 and is still growing with the recently joined European member states. See www.ecomet.eu, where the principles and the benefits of ECOMET are explained.

Also important are the recent OECD Principles and Guidelines on Access to Research Data from Public Funding [OECD, 2007], which identify a number of guiding principles for managing such data. This document, adopted by consensus by the OECD Member States, identifies "openness" as the first principle and default rule for data access from publicly funded research. Openness is defined as "access on equal terms for the international research community at the lowest possible cost, preferably at no more than the marginal cost of dissemination."

5. Public international data system and research program policies

There are several major public international research and data systems that have open access and unrestricted reuse policies. The oldest and perhaps the best known is the World Data Center (WDC) system that was established following the International Geophysical Year (IGY) of 1957. The IGY achieved outstanding success in promoting cooperation among nations to gather, preserve, and make openly available scientific data and information about the Earth and its space environment. Many of the features that are considered part of open access data policy were initiated through the IGY and implemented through the WDC system, making it a highly relevant model for the GEOSS initiative and its data sharing activity.

Many other public international research and data activities have followed, especially in more recent years. Notable examples include the World Climate Research Program, the International Geosphere-Biosphere Program, the International Polar Year, the electronic Geophysical Year, and the Global Biodiversity Information Facility, among many others. These cooperative research and data sharing activities endeavor to make the data contributed into their data systems and served through their online portals openly and freely available, with no restrictions on reuse. The policies of such international research programs through the year 1999 are available at: http://www.codata.org/data_access/policies.html.

6. Regional laws and policies

By far the most prolific implementation of regional laws and policies regarding data access and reuse has been in the European Union (EU). Particularly important in the GEOSS context are the Directive on re-use of public sector information [CEC, 2003] and the Directive on public access to environmental information [CEC, 2003]. The PSI Directive encourages public-sector entities to facilitate re-use and not charge more that the marginal cost of fulfilling a user request, although these principles are not mandated. The Directive on Environmental Information is more prescriptive and requires Member States to make public environmental data and information freely available to users at the source and encourages reasonable pricing externally. It also prohibits re-use restrictions on such data and information. Appendix C, contributed by Katleen Janssen, provides a compendium of some of the other most important examples.

C. National Laws and Policies Concerning Public Data Access

National laws mostly track the international sources described above. However, they are much more voluminous and varied, and in some cases add many details and nuances that are not found in the international instruments, while in other cases, particularly in the less economically developed countries, may not be implemented at all. The two sub-sections below provide only coarse overviews of the national sources in the different categories of data.

1. National laws and policies concerning access to Earth observation data

All space based, non-military remote sensing activities are based on the starting presumption that data are to be made available, particularly to sensed states, on a nondiscriminatory basis and that data should be as openly available as possible. Data denial is the exception, not the rule, although the principle of full and open exchange is not a universal norm. Regarding high-resolution remote sensing data, however, the number of exceptions to the nondiscriminatory access policy is growing due to national security concerns, as discussed further in section II.E.1.

In general, remote sensing states claim to follow the 1987 UN Remote Sensing Principles and incorporate them, or parts of them, in national laws. Although the actual legislative and regulatory implementations vary broadly from country to country and are too numerous to discuss in the body of this report, a comprehensive survey by Prof. Joanne Gabrynowicz of national remote sensing data laws and policies is summarized in Appendix D. Some nations also have laws and policies relating to data overall (see the next sub-section), in which remote sensing data are included.

2. Other national laws and policies relevant to GEOSS data sharing

Of particular importance to the inclusion of national or nationally acquired data into the GEOSS data system are the laws and policies that govern access to the various sources of geospatial data within each nation. All countries with remote-sensing capabilities and almost all other nations have one or more geospatial data repositories. The data access and reuse policies for these data sources vary from free access and unrestricted reuse, to availability at commercial prices and highly restrictive reuse, to conditions of state secrecy and availability only to authorized individuals with national security clearances. It is the data that can be shared from these data centers that will most likely form much of the initial contributions to the GEOSS data system.

Finally, another highly relevant set of laws and policies arises in the context of access to and reuse of government data and information. The overall public information of each country is broadly indicative of its willingness to participate fully in GEOSS and implement the Data Sharing Principles.

D. Policy Rationale for the GEOSS Data Sharing Principles

1. Introduction

As the preceding overview of laws and policies related to public data indicates, a patchwork of supportive international instruments and national policies and legislation already exists. Indeed, there are many compelling reasons for developing more comprehensive access regimes for all types of government data at the institutional, national, and international levels, with openness as the default rule [Uhlir & Schröder, 2007]. In many instances, the same or similar rationale may be extended for publicly funded data produced outside government, especially in academic and not-for-profit organizations, although some important distinctions apply.

This section examines the underlying policy rationales for various aspects of the GEOSS Data Sharing Principles. The key principles of the GEOSS data policy addressed below are: (a) the full and open access to data and [also] information (i.e., metadata and data products) shared through GEOSS, including minimum restrictions on reuse and re-dissemination and minimum costs; (b) special consideration to research, education, and developing country users; and (c) the availability of all shared data and information with minimum time delay.

2. Rationale for full and open exchange and sharing of publicly generated data and information

The arguments in favour of full and open access (and unrestricted reuse) as the default rule for data and information produced by governmental or public entities may be summarized as follows [Uhlir, 2004]:

Legal considerations. Both the activities that the government undertakes and the information produced by it in the course of those activities are a public good, properly in the public domain [Kaul *et al*., 1999]. Data produced through public investments, especially those that are relevant to the nine GEOSS societal benefit areas, frequently have global public-good characteristics [Dalrymple, 2003].

Socio-economic considerations. Because the value of data depends on their use, open access online is the most efficient way to disseminate public data and information online in order to maximize the value and return on the public investment in their production [Stiglitz *et al*., 2000]. There are numerous economic and societal benefits, both direct and indirect and frequently on an exponential basis as a result of "network effects," that can be realized through the open dissemination of public-domain data and information on the Internet [CEC, 1999 and 2001; PIRA International, 2000; Weiss, 2003; Dekkers et al, 2006; OECD, 2006; Mayo and Steinberg, 2007]. Conversely, the proprietary commercialization of public data on an exclusive basis produces *de facto* public monopolies that have inherent economic inefficiencies and tend to be contrary to the public interest. This is particularly true of data in GEOSS that provide unique or historical information about the environment that cannot be obtained after the fact, or that are too expensive and inefficient to collect independently [NRC, 1999].

Ethical considerations. The public has already paid for the production of the information. The burden of fees for access falls disproportionately on the poorest and most disadvantaged individuals, including those in developing countries and not-for-profit researchers and educators, when the information is made available online. This is an important consideration for public, governmental data, such as those relevant to the nine societal benefit areas of GEOSS, which constitute a global public good and are properly in the public domain [Longworth, 2000].

Good governance considerations. Transparency of governance is undermined by restricting citizens from access to and use of public data and information created at their expense and on their behalf. Rights of freedom of expression are compromised by restrictions on reuse and re-dissemination of public information. It is no coincidence that the most repressive political systems make the least amount of government information, especially factual data, publicly available.

By agreeing to the GEOSS Data Sharing Principles, the data system operators allow those data, metadata, and products that they contribute to GEOSS to be shared under clear, predefined terms, consistent with the principle of full and open data exchange. The users of GEOSS data need the flexibility to reuse and re-disseminate resulting data products in order to maximize not only their own uses of the data, but the secondary applications of broad benefit to the world. For example, data and information needed for immediate humanitarian assistance after a natural disaster may also be vital to recovery and reconstruction efforts that are undertaken by a wide variety of both governmental and nongovernmental organizations. Users therefore need to be able to integrate, reuse, and re-disseminate data and information with minimal restrictions in order to achieve the best results in all of the GEOSS societal benefit areas and objectives. By encouraging all publicly funded contributors of GEOSS elements to provide full and open access to their data and information, without reuse or re-dissemination restrictions, GEO will ensure the critical mass of data and information needed to make GEOSS an invaluable resource to the world.

Moreover, for GEOSS to achieve its desired vision and remain consistent with its Data Sharing Principles, the costs of using the data from the system need to be free, or as low as possible, for the widest possible range of users. In particular, metadata (descriptive documentation of the primary data set) should be made available openly at no cost, to enable users to discover sources of data and information without restriction. Metadata are essential to making GEOSS function effectively as a system of systems and to ensuring that all GEOSS data, products, and services are fully accessible on a non-discriminatory basis to all users. Charging for access to metadata would constrain many potential users from discovering useful data and information that might be of significant value to them.

Therefore, the basic presumption of GEOSS should be that Member States and other Participating Organizations are willing to develop, implement, and integrate their GEOSS components using their own resources. These organizations should recognize that they receive direct and indirect benefits from participating in the system, such as the ability to seamlessly integrate their own data with data provided by a range of other sources.

3. Data sharing considerations for data produced by entities with a mix of public and private funding

A diverse panoply of data, much of which could be relevant for inclusion in GEOSS, is produced by many different types of organizations and sectors outside government, but with government funding. Here the mixture of public and private funding with different and sometimes conflicting motivations and uses makes generalizations about data policies and principles difficult.

The issues raised in public-private relationships take many forms and contain some inherent tensions, such as openness versus exclusivity, public goods versus private investments, public domain versus proprietary rights, and competition versus monopoly, among others [Uhlir & Schröder, 2007]. This mix of motivations, priorities, and requirements is context-dependent, typically unique to the parties involved, and frequently not well-served by inflexible statutory and regulatory intellectual property frameworks. In such cases, the ordering of the respective rights and interests of the parties involved is most efficiently accomplished through voluntary agreements under private law. Private contracts or licenses provide maximum flexibility within the larger statutory and public policy context. What is especially important to emphasize here is that such agreements can in many cases provide for conditionally open access that advances the public interest goals associated with the public funding, while effectively protecting existing proprietary private interests [Reichman & Uhlir, 2003].

At the most basic level, it is possible to provide free access to data products for not-for-profit research, educational, or developing-country users, while restricting commercial users and uses to a reimbursable, or even for-profit, basis. A number of common-use licenses have been developed by the Creative Commons organization that can be especially appropriate for making such distinctions between users and uses for copyrightable data products (such as images) in a voluntary and flexible manner, with legal certainty provided by contract and enforced through intellectual property statutes [see www.CreativeCommons.com].

Various techniques of price discrimination and product differentiation may be similarly employed, based on factors such as time (e.g., real-time access for commercial users vs. delayed access for non-profits), scope of coverage (e.g., geographic or subject matter limitations), levels of customer support or service, and other possible distinctions [NRC, 1997]. Such strategies can help promote scientifically and socially beneficial access and use, not only in the complex public-private research relationships, but even in exclusively private-sector settings.

4. Data sharing considerations for data produced by private-sector entities

The presumption for data sources emanating from the private sector is that they are proprietary, subject to commercial terms and conditions. However, at least some data from private-sector entities can meet the data sharing policy conditions of GEOSS and become part of the data system for the same reasons as discussed above.

To meet the full range of user needs identified as priorities by GEO, private-sector or hybrid public-private systems should be equally encouraged to contribute to the data and information made available to users under GEOSS. It is in the interest of all GEOSS participants to ensure that the range and use of GEOSS data continues to expand, especially in developing countries. Providing usable subsets of data, products, and services absent reuse or re-dissemination restrictions from private or public-private data systems will help demonstrate the value of the data to existing and potential users, as well as providing incentives for governments, participating organizations, or other entities to contribute new elements to GEOSS.

5. Special status of research, education, and developing country users and producers of publicly funded data

Modern science is increasingly data driven. This is especially true of Earth and environmental sciences, including global change research, which rely to a great extent on the development of comprehensive global data sets [GEOSS, 2005]. Such research frequently also requires the integration, reuse, and sharing of data from many sources [NRC, 1999].

Most countries have policies that provide special status to the research and education sectors, recognizing their essential role in social and economic development. Such policies typically provide various forms of preferential treatment, incentives, subsidies, and cost allowances to researchers, educators, and students, particularly those who are funded by the public sector. However, even the private sector may offer discounts for their products and services to these groups.

There are two basic issues here. One concerns the preferential access to data for users in research and education. The GEOSS Data Sharing Principles encourage GEOSS data providers to manage their data and information available to such users free of charge or at no more than cost of reproduction. The presumption is that users in these sectors will produce socially and economically beneficial results based on such privileged access conditions, as long as the easy access is accompanied by a concomitant absence of reuse or re-dissemination restrictions.

The other issue focuses on the access to data produced by these sectors, particularly in publicly funded government and university research and education. As has already been noted in section II.B, there are many international research programs and related data activities that provide free and unrestricted or full and open access to such research data. Such international cooperative research policies and practices have parallel examples at the national level of many countries, research programs, and disciplines. In many cases, data sharing is promoted by both official research policy (e.g., through terms and conditions of public research grants) and by the norms of many discipline communities [NRC, 1997; Reichman & Uhlir, 2003].

Because the value of scientific data lies in their use, open access to and sharing of data from publicly-funded research offer many research and educational advantages over a closed, proprietary system that places high barriers to both access and subsequent re-use. Open access to such data:

- reinforces open scientific inquiry,
- encourages diversity of analysis and opinion,
- promotes new research and new types of research,
- enables the application of automated knowledge discovery tools online,
- allows the verification of previous results,
- makes possible the testing of new or alternative hypotheses and methods of analysis,
- establishes a broader base set of data than any one researcher can hope to collect, thereby providing a greater baseline of factual information for the research community,
- supports studies on data collection methods and measurement,

- facilitates the education of new researchers,
- enables the exploration of topics not envisioned by the initial investigators,
- permits the creation of new data sets, information, and knowledge when data from multiple sources are combined,
- helps transfer factual information to and promote development and capacity building in developing countries,
- promotes interdisciplinary, inter-sectoral, inter-institutional, and international research, and
- generally helps to maximize the research potential of new digital technologies and networks, thereby providing greater returns from the public investment in research [NRC, 1997; NRC, 1999; NRC 2003; Arzberger *et al*., 2004; Uhlir & Schröder, 2007].

Such policies and practices should be reinforced and expanded by GEOSS in support of the nine societal benefit areas.

In implementing the preferential access policy for research and education application, GEO should consider several issues. First, many different types of organizations are increasingly involved in research and education in both developed and developing countries, including various commercial, for-profit organizations, nongovernmental organizations, and governmental and intergovernmental agencies. Not-for-profit academic institutions may conduct research for for-profit firms that do not release the results for public use, whereas many for-profit organizations perform research and educational activities on behalf of governments for the public good. Thus, the institutional affiliation of the user is not necessarily a good indicator of the use of GEOSS data, products, and services by the user. Instead, GEO, together with its Member States and Participating Organizations, should define the types of research and education that are to be given preferential treatment in GEOSS, e.g., publicly funded research or research that leads to openly available results. Education should at least encompass all classroom and online educational activities, but whether or not the GEO principle on research and education should apply to educational and scientific publishing is an important policy issue that the GEO community should explicitly consider.

Second, GEOSS should as much as possible inform users about the costs of the data and information they obtain, including any cost reductions provided for research and educational activities or for developing country applications. This will educate users about the costs they should expect when they move from educational and research applications to other operational applications. Tracking aggregate cost reductions for research, education, and developing country applications is also one important element in demonstrating to governments and other sponsors the continuing value of GEOSS in terms of its impact on capacity building.

And third, individuals who utilize GEOSS at reduced or no cost should be expected to provide in-kind assistance in the form of help in documenting the use and impact of data, metadata, and products received. GEOSS should take steps to make submission of qualitative or quantitative impact metrics simple, but also desirable, from a user viewpoint (e.g., as part of setting up a data subscription or notification service, or obtaining a common-use license for downloaded products). See also section IV.B.4 on metrics and indicators.

Finally, with regard to preferential policies for users in the developing world, it is important to note that the existing infrastructure for data delivery over the Internet favors users in developed countries who typically have ready access to relatively low-cost and high-bandwidth connections over those in developing countries, who have limited or expensive connectivity and who are therefore faced with higher costs of access to or delivery of data. GEO needs to work at a technical level to equalize the accessibility of data to users in developing and developed countries through cost recovery models that do not penalize uses of GEOSS data that specifically address developing country problems, or users based in developing countries. For example, since the cost of fulfilling a user order is more likely to be driven by the complexity of the order rather than the volume of data delivered, cost-recovery charges should be based on the characteristics of an order rather than the volume of data (number of bytes) delivered. Moreover, where possible, GEO members should explore ways to waive or minimize costs for developing country uses and users, such as through direct subsidies or recognition of in-kind contributions to GEOSS.

It should be emphasized that an acceptance and implementation of the basic concepts underlying the GEOSS data sharing principles would give an enormous boost to the ability of developing countries to play a much more prominent role in the GEO. To achieve this, what is important is that ever increasing volumes of freely available data in the nine societal benefit areas should begin to flow through GEOSS as soon as possible. Capacity building issues should therefore be more fully considered by the GEO Members and Participating Organizations, especially from the perspective of how data providers can be both encouraged and rewarded for making their data readily available and freely accessible.

6. The principle of minimum time delay for all data and information shared through GEOSS

The standard for "minimum time delay" for data and information shared within GEOSS will depend on the type of data and application and the need for appropriate quality control. Some types of GEOSS data applications will be contingent upon the rapid access to data, derived products, and associated services. Maximizing the potential societal benefits of GEOSS in many cases will require minimizing the time delays in providing the data and information through GEOSS to the users.

In general, operational systems deliver relatively well defined, well understood data on key environmental or other parameters. In most cases, automated quality control procedures can minimize time delays in data delivery.

For research data, time delays may need to include a limited period of quality control by the data provider. These should reflect the norms of the relevant scientific communities or data processing centers. Research data systems tend to deal with instruments or parameters that may be less well understood than those supported by operational systems, and that may be subject to more frequent or serious quality control problems. Some delay therefore may be necessary for preparation of metadata and careful quality control procedures.

In the case of the introduction of new data (e.g., from a new instrument) into an existing GEOSS component, a period of restricted access on the part of the research or instrument team may be needed. Such periods should be kept to a minimum, reflecting the normal practices of scientists and data managers responsible for similar systems or data production activities. Delayed access should be directly relevant to the preparation of metadata and quality control procedures and not to promote exclusivity for principal investigators and other personnel.

E. Legal and Policy Limitations on Data Sharing

There are strong arguments in favour of a default rule of openness for government data and information and for research and education. At the same time there are various legitimate, countervailing laws and polices that will limit full and open data exchange and sharing of government information. Specifically, there are statutory exemptions to public access and use based on national security and law enforcement concerns, the need to protect personal privacy, respect confidential information or indigenous rights, or conserve sensitive ecological, natural, archaeological, or cultural resources. In many jurisdictions, government data and information are treated as proprietary and protected by intellectual property laws and other restrictions. Government entities also should respect the proprietary rights in information originating from the private sector that are made available for government use, unless expressly exempted.

In certain circumstances, these types of data and information will generally only be considered for inclusion as discussed below. Because openness should be the default principle for the data and information made available through GEOSS by government members and participating organizations, however, these exceptions should be properly justified and interpreted as narrowly as possible.

1. National Security

There are, of course, many national space assets and other data collection systems that produce data similar to those that would be included in GEOSS, but that are classified as State secrets on national security grounds. Such data are unavailable for civilian use and therefore are not a part of GEOSS.

Two potential exceptions to this national security exception are possible, however. In some cases, military systems or hybrid military-civilian systems may establish dual-use policies to enable data access for both military and civilian uses. Such data policies may permit direct access to the data by defense entities and civilian users, including commercial entities, although the civilian users may not be able receive all of the data.

Another, more general, exception applies to retrospective or historical data that have been classified for some legally required period, but then subsequently become officially declassified and released into the public domain. For example, in 2001 Italy and France agreed to study and develop procedures jointly for degrading classified images, with the objective of lowering their level of classification, in accordance with the Agreement between the Government of the Italian Republic and the Government of the French Republic on Cooperation in the Field of Earth Observation. There also have been some instances in which imagery that was previously classified for national security purposes was declassified within a short period of time. One case of such dual use data being made openly available involved declassifying imagery of a location that had just recently been used for national security purposes [Gabrynowicz, 2002]. Another involved a review by an expert committee of old classified data sets with a view to their application for environmental research, and many data were subsequently designated for advance declassification. There are various such dual use data sources of significant relevance to GEOSS objectives that should be considered for inclusion in the system, once they are properly declassified.

Although civilian government and private-sector remote sensing systems are not classified, they may occasionally collect data that have national security implications and that may be withheld pursuant to the laws in the controlling jurisdictions. This is particularly an issue regarding high-resolution data collected by non-classified space systems. The number of exceptions to the nondiscriminatory access policy is growing in Canada, Europe (Germany, France, and Italy), India, Israel, and the United States, among others. Recent and pending legislation demonstrate that national security interests are being expanded further over general data access. Governments are engaging in what is more correctly characterized as "controlled access," rather than "restricted access" and are construing the 1987 U.N. Remote Sensing Principles more narrowly. For example, new Canadian legislation specifically contends that a sensed State's right to data of its territory is limited to data used for resource management purposes [Mann, 2006]. In recently enacted German legislation, the terms "non-discriminatory" and "reasonable" are interpreted by imposing security aspects on data distribution, and thereby restricting a sensed State's access to data of its own territory subject to Germany's security or foreign policy interests. [For a review of this legislation prior to its enactment, see Gerhard and Schmidt-Tedd, 2005. An analysis of the law as enacted can be found in Vol. 34, No. 1 of the Journal of Space Law, 2008.].

2. Proprietary Rights

The intellectual property (IP) status of data, databases, and data products is a complex legal subject, depending on the jurisdiction, the source of the data, and the level of creativity. In addition to copyright, proprietary rights can be enforced using trade secret law, unfair competition law, database protection laws (e.g., those in the E.U., such as the 1996 Directive on the legal protection of databases), and private contracts and licenses.

Some countries, such as the United States, expressly exclude government-generated information from copyright. In many other nations, public information is subject to IP protection, although this may be tempered by competing policies, such as the public's right to know and the other policy arguments in favour of openness presented in earlier sections of this chapter.

Moreover, to the extent that the public information is copyrightable, the government can make it openly available with minimum re-use restrictions by applying common-use licenses such as the Creative Commons templates.

On a spectrum with raw data at one end and a highly processed, value-added product on the other, there are varying degrees of statutory IP protection. In general, raw data produced technologically without benefit of human intellectual creativity is unprotected by copyright. More complex information such as metadata and data products that are identified in the GEOSS Data Sharing Policy, however, typically requires creativity and originality in its production, thereby making it copyrightable. Determining where to draw the line on what data, metadata, and products are protectable or not under statutory IP law can be difficult to determine and enforce, which is why most proprietary digital data and information are now protected by restrictive private-law contracts and licenses and by technological means.

Finally, as noted in section II.D.6 above, researchers typically have a proprietary period of exclusive use of data that they have collected using public funds. This period may be established by a research contract or grant for some specific period of time, such as one to three years, or disclosure may be triggered by the publication of results based on the data collection. Following publication, the data on which the results are based need to be made available so that the results can be verified [NRC 1997].

3. Personal Privacy

An important distinction must be made between data collected on human subjects and data on other, impersonal subjects. Data on human subjects are restricted in various ways on ethical and legal grounds to protect personal privacy. Internationally, the OECD issued guidelines on this topic [OECD, 1980] and the EU has strong personal privacy protections [Directive 95/46/EC on the protection of personal data, and Convention No. 108 of the Council of Europe, 1981]. Many countries also have adopted legislation and regulations that protect personal privacy at the national level. Typically, data sources that have been subjected to de-identification of personal information can be shared or made otherwise available, and these types of data may be considered for inclusion in the GEOSS data system.

4. Confidentiality

Data designated as confidential can only be transferred on a very limited, privileged basis, subject to specific contractual provisions between the data source and the recipient. Such data should not be disclosed, and certainly not shared though GEOSS.

5. Indigenous Rights

Observational data (e.g., remote sensing images or photographs) of some indigenous peoples or lands within their jurisdiction may not be either collected or shared. In other cases, data concerning traditional knowledge may not be shared or exploited commercially. Such data types that compromise legitimate indigenous rights may not be made available through GEOSS.

6. Conservation and Protection of Sensitive Ecological, Natural, Archaeological, or Cultural Resources

International treaties that protect rare species of animals and plants, such as the 1975 Convention on International Trade in Endangered Species of Wild Fauna and Flora, as well as biodiversity more generally, such as the 1992 Convention on Biological Diversity, also prohibit disclosure of information about their specific location. Such limitations are implemented and enforced through the legislation and regulations of most countries. Similarly, archeological and cultural sites and relics may be subject to statutory protection as well. Such data cannot be shared through GEOSS either, unless specific steps are taken to meet applicable legislation and regulations.

III. ILLUSTRATIVE CASE STUDIES

This section provides a selection of examples in several of the nine societal benefit areas regarding the potential implications of the GEOSS Data Sharing Principles, depending on key implementation choices. The objective is to illustrate the benefits of data sharing, as well as some of the important obstacles and problems that will most likely surface during the implementation and operation of GEOSS. Given the diversity and complexity of expected applications of GEOSS data, it is not feasible to analyze all possible situations nor to assess objectively the relative importance of different issues. Nevertheless, it is still instructive to review past experience and work through some illustrative scenarios to better understand how strong adherence to the Data Sharing Principles may be able to increase the utility and overall sustainability of GEOSS as a system.

A. Access to Real-time and Historical GEOSS Data for Rapid Humanitarian Response

Perhaps the most visible and pervasive motivation for the establishment of GEOSS is the potential for more rapid and comprehensive monitoring of natural and technological hazards, improved warning and prediction of dangerous events or episodes, and associated improvements in disaster mitigation and response. Better historical data on hazards can help improve risk assessment and planning for future hazards from local to global scales [UNDP, 2004; Dilley *et al.*, 2005; Arnold *et al.,* 2006]. Monitoring of hazardous conditions, through both satellite- and ground-based sensors, can help scientists to improve understanding and prediction of dangerous events. Governmental authorities and other organizations are able to react more quickly when dangerous situations develop. In many cases, such real-time data need to be integrated with computer simulation models to improve the predictions needed for early warning and response, e.g., when a cyclone approaches a populated coast, or weather conditions are likely to result in severe storms or wildfires. Of course, if the disaster is pervasive, communications may break down completely and no system is going to be useful if its information cannot be disseminated where it is needed.

Because time is often the most critical factor in response to hazardous events and it is important to get as many relevant data sources into GEOSS, automated access and integration of data and information from multiple systems within GEOSS is a *sine qua non*. This raises several potential scenarios: *1)* all GEOSS data have to be completely free and open; *2)* all digital rights and cost recovery issues can be addressed after the fact; or *3)* all digital rights and cost recovery issues can be established beforehand, dealt with through automated means online, and updated as appropriate.

Although as a matter of principle scenario 1 is the best option for most GEOSS data, the problem is that some proprietary or otherwise restricted data important for disaster response may not be free and open and therefore may not be accessible to GEOSS users. For example, after the 2004 South Asian tsunami, by far the most detailed imagery of damaged areas along the Indian Ocean coasts came from commercial high-resolution satellites that in many cases imposed reuse and redissemination restrictions. Use of these data by the United Nations and other humanitarian organizations had to be negotiated with the relevant sources [UN Geographic Information Support Team, personal communication, 2007]. It is obviously in the interest of the GEOSS community to ensure that the best available data needed for sound decision making are accessible through GEOSS, but delays in access and reuse of essential data in time-critical disasters should not be increased by bureaucratic negotiations.

Scenario 2, in which digital rights and cost recovery issues are addressed after the fact, poses a number of difficulties, including the likely unwillingness of data sources to make their data available through GEOSS without guarantee of cost recovery and control on use of their data. Legitimate users may also feel constrained on their use of data if they feel that they may be subject to some level of liability for their use and redissemination of data in a crisis situation.

Scenario 3 is the best available option to get proprietary or otherwise restricted data into GEOSS; that is, implementation of automated digital rights management within GEOSS to support real-time access to data and information while respecting pre-determined data usage conditions, which can be updated as appropriate. Such usage conditions should include a) clear definitions of rights and limitations in using data and disseminating derived products in humanitarian situations, b) recovery of costs in line with the GEOSS Data Sharing Principles and recommended Implementation Guidelines and c) a statement that the Implementation Guidelines are a starting point and individual Member States and Participating Organizations are free to provide data and usage rights beyond the principles and guidelines. Since digital rights will be clear in advance, users would be able to adapt their practices to ensure appropriate levels of access prior to a crisis (e.g., if they need to pre-register as a humanitarian organization).

B. Research Uses of Integrated GEOSS Data for Climate Change Impact Assessments

Recent reports by the Intergovernmental Panel on Climate Change (IPCC) have highlighted the multidimensional nature of ongoing climatic variability and predicted climate changes and the many ways in which human health and wellbeing could be affected from global to local scales [IPCC, 2007a, b, c]. Research on the impacts of climate change and potential adaptation and mitigation strategies is increasing rapidly around the world, with particular attention to possible interactions across sectors and issues, e.g., agriculture, water, energy, hazards, and health.

A major constraint on past research efforts has been the difficulty of assembling and integrating diverse data types from multiple instruments and platforms, disparate data systems, and different disciplines. The spatial coverage of measurements often varies significantly over time, and the development of reliable, consistent time series for key climatic and environmental parameters requires careful calibration, inter-comparison, and quality control. Of particular importance are inter-comparisons between remote sensing and *in situ* measurements: satellite- and aircraft-based instruments have the potential to provide data on very large areas of the globe on a regular basis to support both research and applications, but ground-based *in situ* measurements are also needed to calibrate these data and in many cases provide more detailed, frequent, long-term, and/or dense observations for specific regions of interest.

Another challenge is the need for integration of data across scientific disciplines, especially across the natural and social sciences, in order to better understand the interactions between climate and human activity and welfare. For example, it is often necessary to translate remote sensing data collected as pixels on a grid into summary statistics for administrative or political regions that can be used by social scientists or decision makers [NRC, 2002].

GEOSS offers the potential for significant improvement in coordination and quality control of data gathered from different instruments and multiple observing platforms and in providing an overall framework for rapid integration of both remote sensing and *in situ* datasets. By promoting interoperability among many different data sources and systems from around the world, GEOSS will facilitate testing and inter-comparison of measurements and increase the representation and reliability of the results. By increasing the density, frequency, and longevity of measurements, GEOSS can also facilitate more detailed, localized studies of climate change and its potential impacts.

A critical issue for the research community is not only access to relevant data, but a clear understanding of how the data were collected, what quality control procedures were utilized, and what transformation and analysis techniques were applied. A basic step in obtaining such understanding is access to appropriate metadata, i.e., documentation that describes data sources and processing. Encouraging all data providers to provide adequate metadata for their data is therefore a key priority for GEOSS. Free and open access to this metadata is then necessary to ensure that all users can discover the data they may need.

A second critical issue for both researchers and data sources is appropriate data attribution. For data providers to continue providing high quality data and metadata to GEOSS in the long term, they will need to receive appropriate recognition for the data they supply. From the viewpoint of the scientific community, being able to precisely trace data "provenance"—i.e., data sources and processing histories—is essential to the reproducibility of scientific research. From the viewpoint of commercial providers, identifying them as the data source can enhance the reputation of their products and provide a further incentive to provide access to their data.

C. Local Government Uses of High-resolution GEOSS Data for Biodiversity Conservation

Numerous, often new and dynamic, biological issues are now beginning to be addressed by local government decision makers and managers, as well as the public. Of the many new diseases (e.g., hanta virus, West Nile virus, avian flu), approximately 75 percent can affect both humans and wildlife. The number and economic impact of invasive alien species are dramatically increasing. Biodiversity is being reduced and native plants and animals are being added to the threatened and endangered list (which can dramatically restrict local development activities). There is much to be gained from conserving biodiversity, as humans depend upon plants and animals species for food, medicines, and raw materials. There is also no doubt that the beauty and variety of living species also greatly improves the quality of our lives.

There are numerous operational and economic reasons why local governments must monitor, understand, and manage local biodiversity and ecosystems. Local governments need biodiversity data to develop risk analyses and prevention plans in addressing threats to public health. Monitoring and managing/regulating land cover (including vegetation) changes in rapidly expanding urban areas are also very important.

Of the vast amount of biological data collected globally each year to study the above mentioned issues, most of it is inaccessible, because it is not digital, standardized, and/or archived with appropriate metadata. In particular, GEOSS can assist local governments around the world by providing easy access to integrated and updated biodiversity, ecosystems, and associated geophysical data and information that are critical for making informed policy and management decisions. For this particular user community, GEOSS functionality will need to combine such interdisciplinary and diverse information as Earth observations from satellites and aircraft, weather data from satellites and ground stations, historical trends from existing information, and ground observations. These integrated data sets would be used with GEOSS-developed data processing tools, as appropriate, to assess current conditions and make forecasts associated with land cover, biodiversity and ecosystem trends and associated change analyses (i.e., preferably characterizing the types, rates, and temporal and spatial variability of change; documenting driving forces; and predicting the consequences of change). In addition, GEOSS could help enable free web-based, user friendly, easily accessible, and very efficient data input, editing, analysis, visualization, and access, and provide summary statistics and analyses tailored for operational use by local governments.

GEO plans to build on and enhance existing capabilities by ensuring an operational source of existing critical data sets to drive decision support tools when needed, and integrating new data sets to enhance the performance of decision support tools and systems. Therefore, from a remote sensing perspective and for this particular local application, there also needs to be a continuing commitment to provide: 1) a global updated seasonal land cover data base at high resolution (30m; i.e., continuity of Landsat-type observations), and 2) even higher resolution (i.e., 1 to 4m) land cover enhancements and timely updates that are focused on rapidly developing/changing urban communities. Biologists, ecologists, and local natural resource managers and decision makers will also operationally need access to such additional data as: updated higher resolution topography, time series vegetation greenness, measurements of seasonal vegetation characteristics, length of growing season, onset of greenness and onset of senescence (e.g., brown-down, which are also useful in the study of and management of drought, fire, and soil moisture), estimates of soil moisture (presently using precipitation data to model and estimate soil moisture content), and volume of water bodies (which is critical for estimating the water available to local biodiversity and ecosystems).

For local communities to operationally use GEOSS data and information, the best scenario is for all GEOSS data to be completely free and open with all digital rights and cost recovery issues being dealt with in real-time through automated means by GEOSS. However, biodiversity data can be quite sensitive (e.g., location of endangered species, global species assessments, and protected areas). GEOSS could still provide such data to local communities, while respecting pre-determined data usage conditions. GEOSS may need to develop procedures to degrade or filter sensitive biodiversity data to a useful and acceptable level, or else work out an approach to sharing sensitive data in a secure mode with formal agreements between GEOSS, the data providers, and the local governments. Metadata associated with biological data (i.e., museum specimens, field notes, global species assessments) also need to be standardized and encouraged, if not required (e.g., by funding sources), as well as the consistent and timely input of these data into responsible and accessible GEOSS associated archives/servers. Local user training (i.e., available data, products, applications, and system use) also needs to be provided by GEOSS to the local government user community.

IV. IMPLEMENTATION ISSUES FOR GEOSS DATA SHARING PRINCIPLES

A. Implementation Issues

1. Alternative approaches for implementing the data sharing principles

Different approaches may be chosen for implementing the data sharing principles, ranging from formal, legal requirements established by a treaty at the international level and through legislation or administrative regulations at the national level, to much softer and less binding guidelines or ad hoc approaches. Each of these options presents some tradeoffs that the parties need to consider in advance. We suggest here that an approach that reflects non-binding, but commonly-decided guidance with respect to the data sharing principles is likely the best option for GEOSS participants to consider.

Mandated policies. One of the possible options for implementing any international activity, including data sharing, is through a mandated policy. This would require the Member

States to enter into a binding agreement, such as a multilateral treaty. During the negotiations of this convention, the Member States would come to a mutual agreement on the obligations they take upon themselves for sharing Earth observation and other GEOSS-related data. By adopting the convention and implementing the provisions through legislation and regulations at the national level, they would be accepting these obligations. Such an agreement would have to allow Participating Organizations to accede to its rights and obligations. These provisions could be modeled on those contained in the space treaties that allow participation by nongovernmental organizations.

Mandated policies may include sanctions for noncompliance, but not necessarily. However, the effectiveness would be undermined if the obligations are not taken seriously or if enforcement is lax. The biggest drawback to this option is that a mandated policy is difficult to obtain because this would take a strong commitment of all Member States and Participating Organizations and leave very little room for national or regional characteristics or customs, or provide too much restriction on the freedom and autonomy of the Member States and Participating Organizations. Indeed, GEOSS participants have already indicated that their participation is purely voluntary and non-binding, and thus any mandated policies through binding agreements are only possible if the GEOSS cooperative arrangement were renegotiated and restructured sometime in the future.

Implementation guidelines on a minimum set of commonly decided principles. Between the maximalist and minimalist implementation options outlined above, the data sharing principles can be implemented via international guidelines, adopted by consensus, that encourages, but does not mandate, adherence. Desired actions can be encouraged through education, financial assistance, technical assistance, peer influence and other inducements. The advantage of this approach is that the Member States and Participating Organizations retain their full autonomy and can implement these guidelines and practices in their national jurisdiction in whatever way they want. The disadvantage is that the Implementation Guidelines might not be fully implemented and would be less well adhered to than under a mandatory policy.

As a practical matter, however, this type of internationally decided approach could be the only one of the options that is acceptable. It is counter-productive to enforce or otherwise make mandatory anything in an environment where all contributions are voluntary or "best efforts," and where the governing body is operating in a non-legally binding manner. While the participation in and contributions to GEOSS are not legally binding, the presumption must be that the GEO Member States and Participating Organizations are taking part in good faith and will do all they can to make data sharing successful and productive .

2. Involving stakeholders and ensuring sustainability

One of the main challenges of any data sharing policy is ensuring the participation of the representatives of key stakeholder groups, who need to remain engaged on a continuous basis. The categories of major stakeholders include the data producers and users in government, academia, and industry; the public policy and funding organizations with purview over the relevant data activities; and the general public. While the involvement of the data providers is obviously crucial to obtain the GEO goal of implementing the GEOSS data sharing principles, the long-term and sustained involvement of all the other stakeholder groups is also important. Without the commitment of stakeholders across the sectors and from all the Member States, data sharing will remain an abstract principle and never become reality. The Member States and Participating Organizations should therefore be encouraged to raise awareness among their stakeholder constituencies and to continue their efforts toward participatory decision-making.

This commitment of all the stakeholders is intrinsically linked to the issue of sustainability. Operating a data collection system and then managing and making the data available requires the long-term investment of financial and human resources. As these resources are scarce and their use needs to be justified, not only for internal budget allocation within a public agency, but also towards central government and the general public, ensuring sustainability can be a struggle. Therefore it is important that funding mechanisms are elaborated and implemented in the Member States and Participating Organizations and that duplication of efforts is avoided, in order to use resources as efficiently and equitably as possible. Securing the continuous availability of resources entails involving the national policy decision makers of all the Member States and the relevant decision makers for Participating Organizations, and ensuring their understanding and endorsement of the value of GEOSS.

The motives of GEOSS participants are varied and may be driven by diverse objectives and perceived benefits. From the perspective of creating stable relationships that can sustain the GEOSS network, which incentive works best depends entirely on the context of each participant's involvement. Value is thus subjective and the network must be flexible enough to facilitate all forms of value exchange so that a participant's initial interests are met. The interdependence and reciprocity between the participant's and the network's interests needs to be sustained, if not increased.

As the most important output of GEOSS, data access and use provide a strong incentive to join the network. Because local participants can in many cases exist by serving internal or local needs with local data, motivating a member to incur the additional cost of collecting and maintaining data to serve an external, global need requires a corresponding incentive. Access to—and being a local distributor of—a global data set provides one such incentive. The participant also gains prestige as the source for a regional or global product. Additionally, the local, regional, and global data sets provide raw material for higher level value-added products. Because all forms of exchange involve local costs, value-added activities are particularly important. They provide the means to offset the costs while raising members' participation above the local level.

3. Promoting the open access ethos

In view of the vision of GEOSS to realize a future where the decisions and actions for the benefit of humanity are informed by coordinated, comprehensive, and sustained Earth observations and related data sources [GEOSS 2005], the importance of easy access and unrestricted reuse of the data cannot be overestimated. All GEOSS participants and potential participants therefore need to be made aware of the importance of the GEOSS data sharing principles. While many countries have legislation in place to provide information to their citizens, as discussed in chapter III, an effective culture of data sharing needs to be instantiated among the various GEOSS stakeholders. A strategy for promoting and enforcing the data sharing ethos is thus essential.

4. Supporting transparency

Ensuring transparency towards the citizens has a broader meaning than providing them with access to information. A democratic and transparent government allows the citizen to know and to some extent take part in the decision-making process, and to hold the government accountable for its actions. Such meaningful participation is supported by the availability of information. The sharing of data is essential for transparency of decision-making, and this transparency in turn is likely to lead to better decision-making, as the government's actions are followed by the citizens.

Obstacles to transparency include cultural factors and attitudes toward the availability of public information. Excessive official secrecy is a problem in many jurisdictions. Language is another limiting factor. Although English is the accepted language of GEOSS-related activities, not all participants understand English nor are GEOSS data and metadata routinely translated into English.

The GEOSS Data Sharing Principles and the Implementation Guidelines will support governmental transparency by promoting the availability and sharing of data and information in the nine societal benefit areas. However, the participants are encouraged to reach beyond the GEOSS data policy and guidelines and apply these principles more broadly within their public sector.

B. Incentives for Compliance with the Data Sharing Principles

1. Support of other important policy objectives

The GEOSS data sharing principles are intended to improve data access and reuse among all of the stakeholders of a well-functioning Earth observation system of systems, with particular attention to the favorable status of the research and education communities and data users in developing countries for reasons set forth in section III.C. It is essential to keep in mind that data sharing is more than a goal in itself; it is an indispensable means to reaching important policy objectives relating to health, environment, poverty, and other public-interest priorities that have been high on the global agenda for the last few decades. By improving data sharing, and the subsequent continuous availability of that information, researchers and policymakers can react with timely and well-informed decision-making to national, regional, or global issues that threaten the environment, human health, or safety.

An example that quickly comes to mind is the tsunami of 26 December 2004. A more rapid response based on shared seismic, shoreline topography, bathymetry, population, meteorology, and land-use data could potentially have saved many thousands of lives. Disaster reduction is but one of the global concerns that demand greater sharing of data from activities under the GEOSS umbrella.

Similarly, there is now broad international consensus regarding climate change based in part on human activities, resulting in some warming of the global climate over the coming decades. Responding to these changes, either through mitigation and adaptation, requires a better understanding of the natural and human-induced factors leading to those changes. The participants in GEOSS collect most of the data that are relevant to improving understanding and responding appropriately, and therefore need to make the data as broadly available for analysis as possible.

2. Credit to contributors

Sharing of data, especially online because of the potential for exponential network effects, can be much more productive with the involvement of as many stakeholders in the system as possible. Both the data producers and distributors can be encouraged or given incentives to share if they are properly credited for their contributions, not only internally within their institutions, but also externally in their communities of practice and the general public. Acknowledgement of the producers and contributors of the data, metadata, and products should be common practice within the GEOSS system. Being a part of GEOSS, sharing data with other stakeholders, and consequently improving policies on the environment or human health can provide the participants with enhanced reputational benefits and confer goodwill and appreciation from other Member States, Participating Organizations, public agencies, and the general public.

3. Digital rights management and automated online cost recovery mechanisms

A major concern of proprietary data sources, which frequently limit the access to and exchange of data, is that their data are being misused or used for different purposes than they were originally intended or authorized, leading to possible damage, liability, or infringements of intellectual property rights. One possible way to ensure that proprietary data are protected properly, but can still be shared to some extent, is through digital rights management (DRM) technologies. While DRM can have negative effects on deriving full value from the use of data, particularly data produced in the public sector, it can provide some advantages in the GEOSS data sharing context in its uses for the automatic management of data. If properly applied, it can provide clear and standard conditions for obtaining and using data, ensuring easy dissemination. In this way, it may respond to the concerns of the proprietary data sources involved in GEOSS and make them more receptive to making their data available, even if on somewhat more restrictive terms and conditions.