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THE PROGRESSIVE USE OF SATELLITE TECHNOLOGY FOR DISASTER MANAGEMENT RELIEF: CHALLENGES TO A LEGAL AND POLICY FRAMEWORK

"It has become clear that no country is immune to disasters (...)"
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All countries, even rich ones, are vulnerable to natural disasters. While this may not be avoidable the impacts on affected populations can be minimized through implementing an efficient disaster management policy. This is particularly significant given that the cost to human life and the economy rises each year, regardless of how many natural disasters occur per annum. For instance, 244 million victims were impacted by natural disasters in 2011, compared with 217 million victims in 2010. In 2011 an estimated US$366 billion was incurred in damages. This is three times the damages incurred in 2010, which was registered at US$109 billion. Consequently, national governments and the international community have recognized the necessity of using all available assets and means for effectuating a more progressive disaster management practice. Remote sensing technologies, in particular, have proven to be a most useful tool and have been utilized in several natural disasters situations, such as the Sichuan Earthquake in China in 2008, the Honshu Tsunami in Japan in 2011, and Hurricane Sandy in the US in 2012. Many challenges still remain before these satellite applications can be made widely accessible to all nations for disaster management. This paper identifies ongoing challenges in space policy and law, correlating remote sensing practices, and data sharing issues for humanitarian relief following natural disasters. This paper concludes that, a new policy framework should be developed specific to the application of satellite technologies for disaster management.

I. INTRODUCTION

According to the United Nations Office for Disaster Risk Reduction (UNISDR), disaster risk management is “the process of using administrative directives, organizations, operational skills and capacities to implement strategies, policies and improved coping capacities.”[1] Among these operational skills and capacities is the increased use of satellite technologies for disaster prevention, mitigation and preparedness.

Over the last ten years, the use of satellite-delivery maps by disaster managers and early responders has grown to more effectively respond to global humanitarian crises.[2] In the last five years alone, the resources on Geographic Information Systems (GIS) and mapping creation available under the Charter on Space and Major Disasters have been activated 182 times. The years 2009 and 2010 saw the most Charter activations with 41 and 39 activations respectively.[3]

In 2012, the United Nations Operational Satellite Applications Programme (UNOSAT) registered an increase in requests and delivery of mapping services using satellite imagery, which mainly came from various United Nations organizations.[4]

These events illustrate the pertinent use of satellite imagery and its increasing role in providing prompt, effective coordination and relief response to the frequent and complex disasters that occur worldwide. Satellite technologies and capabilities, however, remain a restricted tool, not easily accessible to those who need them. As demonstrated in Table I.1, the regions most affected by disasters are also the regions with limited or no access to local satellite technology.

Region	Disasters	Killed	Affected (‘000)	Total Damage (‘000)
Asia	644	283 451	834 584 616	477 700 085
Americas	4012	231 803	52 127 001	308 316 831
Africa	320	4 213	108 204 525	3 143 690
Europe	226	59	1 678	57 737

Oceania	62	1036	942 1 284 073	282 42 331 974
Total	1010	237 111	163 294 541	411 529 777

Table I.1: Disaster Facts from 2008-2012[5]

For a more thorough discussion on the use of satellite applications in disaster management it is helpful to first understand what remote sensing actually implies and how it is used.

Remote Sensing Applied to Disaster Management

Satellite remote sensing refers to technology used for observing various earth phenomena with instruments that are typically onboard a spacecraft. These observations consist of measuring the electromagnetic energy of phenomena that occur without initiating physical contact with the object of interest. The main advantage derived from remote sensing systems is the accurate and timely nature of the information. That is, as long as the ground segment remains unaffected by the disaster. Satellite remote sensing, therefore, enables information to be provided throughout the different phases of disaster management: assessment, preparedness and mitigation planning, early warning, impact assessment, and emergency communications. This diagram illustrates the remote sensing process as applied to disaster management.

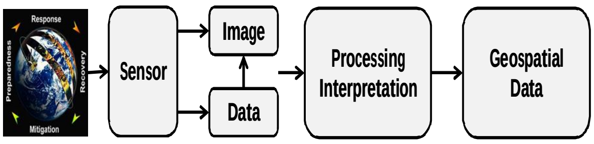

Figure I.2: The remote sensing process applied to disaster management. Source: Enrique Urquijo, 2013

The end product obtained from remote sensing that is particularly useful for disaster management is geospatial data.

In addition, bandwidths are a crucial component of remote sensing operations. The different bandwidths of the electromagnetic spectrum are related to certain phenomena and Earth parameters that can be monitored and analyzed using various sensors and related interpretation techniques.

However, not all remote sensing technologies for disaster management are available to all countries, and neither are data interpretation skills. Some major differences exist between the developed and developing world as mentioned below.

Developed countries: The majority of developed countries have elaborated complex mathematical models based on meteorological stations placed on a grid over a certain region to provide real time data. These models have evolved to incorporate remote sensing data.

Developing countries: The hydrological models, telemetric models and radar data are scarce.[6]

Hence, access to this tool is still limited due to several factors. The foremost challenges are political ones that likewise reflect on the legal frameworks, as discussed in the next section.

II. POLITICAL CHALLENGES

For purposes of clarity, the reference of 'politics' in this paper implies "the activities or policies associated with government, especially those concerning the organization and administration of a state […] and with the regulation of relationships between States."[7] A 'challenge', on the other hand, refers to a difficulty or problem to be surmounted.[8] This section identifies some of the political issues and challenges that the relief community faces in moving forward.

The methodology applied here in the identification and analysis of these challenges is adopted from the international aid system classification, based on mission type.

To have a better understanding on what we imply with the relief community, Figure II.1 displays an organigram made by the Sahana Foundation explaining the variety of actors.

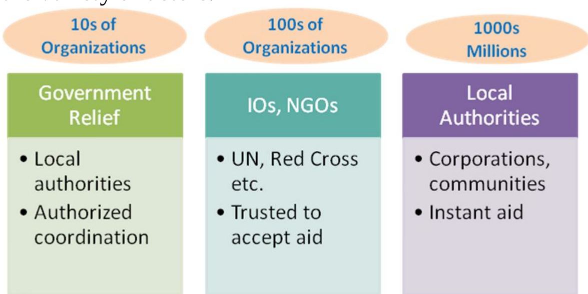

Figure II.1: The Humanitarian and Disaster Relief Community is comprised of diverse actors and their relationship in responding to disasters.

International Level Challenges

The organigram below describes the two-part classification analysis for identifying international challenges. One prong identifies the geographical scope, the other the type of disaster mission. Subsequent subcategories highlight the first prong according to its activities. The challenges identified in this paper are based on this last subdivision and described in the following sections.

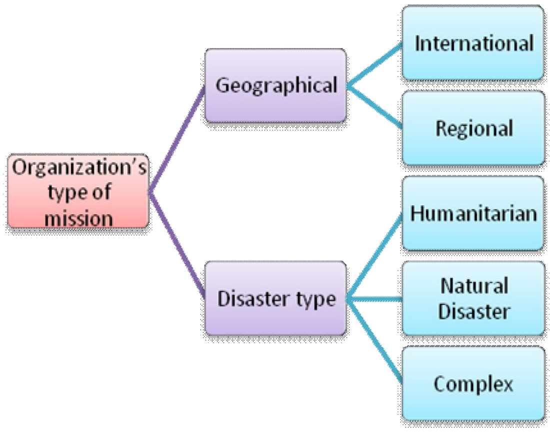

Figure II.2: International Level Aid System Source: Sandra Cabrera Alvarado (based on 2013 interview with Mr. Luc St-Pierre from UNOOSA).

Geographical

Challenge 1 International Level: Reduced Satellite Technology Knowledge For Disaster Managers.

Some of the international organizations that use satellite technology for humanitarian activities are the United Nations Institute for Training and Research (UNITAR)[9] through its Operational Satellite Applications Programme (UNOSAT), and the United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER).[10] The core missions of these UN agencies involve improving and increasing the use, access, and know-how capabilities of satellite technology, especially in developing States. However, the existing lack of training, knowledge, and infrastructure of end users in these developing countries impacts the State's decision-making abilities and complicates the tasks of UN agencies.

For example, in October 2011, Thailand, Cambodia, Laos, and Vietnam, faced floods that affected over 6.5 million people and claimed at least 500 lives. This particular region has been identified as one of the most impacted by natural disasters. As a result, UNITAR is leading efforts in Thailand to develop satellite based maps and GIS analysis to aid with assessing floods as well as to assist national, regional, and local agencies with planning an efficient disaster management response. However, the main challenge here for UNITAR, and other similar agencies, is not the sharing of the technology itself but working in close partnership with these States (the end user), helping them to develop and manage their own local expertise on geospatial data and to create efficient disaster preparedness frameworks.

UNOSAT and the Asia Disaster Preparedness Center (ADPC) both have acknowledged that countries in South Asia are progressively increasing their knowledge, expertise, and use of satellite data for this purpose.[11] They are better prepared today to act on and mitigate disasters as a result. A lot of work still remains, however, towards optimizing the institutional knowledge of this technology on a decision-making level and allow for prompt and effective communication and application of this satellite-derived information.

Challenge 2 Regional Level: Expertise Acquired and Shared With Regional Members Only

Other regional satellite platforms sustained by a subsidiary model from their governments, allow for the sharing of state-of-the-art technology among members. For the most part, the members receiving the benefit of this technology exchange are developed countries. Nonetheless, the cooperative design of this platform could be more useful if this regional knowledge was shared with other (nonmember) countries who lack this expertise, or even the specific disaster relief community. The European Earth observation program, *Copernicus*,[12] is one such example. The benefits of this program are limited to its (regional) users. However, international organizations would also likely be able to apply such a significant platform to increase their range of available resources for the international community, with regard to disaster management. The challenge here is to enable an appropriate framework that would encourage this business model to be open to other sectors as well.

Disaster type

Challenge 3: Providing Imagery For All Disaster Management Phases

Promoting efforts to share satellite data and images through international platforms is not enough in and of itself. The number of disasters that routinely occurs in different regions of the world creates a persistent need to not only respond to them but also to address the other phases of disaster management. The humanitarian and disaster relief community faces the ongoing challenge of having to request and purchase high quality satellite imagery from only a few distributors to develop its activities in line with occurring disasters.

Even though the Disaster Charter is an example of a free and useful repository for the sharing of satellite imagery for any disaster, its mandate restricts its use of resources for *disaster response only*, limiting time and opportunity for data utilization. Meaning, this excludes the other phases of the disaster management process.[13] According to Article I, the Charter can be activated during a "crisis," this is defined as "the period immediately before, during or immediately after a natural or technological disaster, in the course of which warning, emergency or rescue operations take place." Moreover, the imagery available under the Charter has a limited authorized duration of only 15 days, immediately following Charter activation.

Cost remains one of the major obstacles here, as private companies remain the sole providers for specific satellite imagery. But cost is not the only obstacle. On the political side, terms of usage and image resolution are also key issues.

Consequently, it is up to nations to start establishing appropriate political guidelines to overcome economic costs, facilitate the free flow and use of data, and build up satellite networks with tailored technologies capable of timely and continuous monitoring for natural disasters. The Table below illustrates the need for sharing satellite technology. As the chart indicates, these are all developing countries without satellite remote sensing resources, except for the United States.

The list includes the top 10 countries that have used the Charter resources in the past five years, from 2008 to 2012.

Country	Total
USA	18
Chile	10
Vietnam	6
Pakistan	6
China	6
Philippines	6
Colombia	5
Canada	5
Nigeria	5
Algeria	4

Table II.1: The list includes the top 10 countries that have accessed Charter resources in the past five years (2008-2012) based on the Charter activations archive, 2013.

Given the need to enhance or establish national guidelines and policies on disaster management, some nations inevitably require more attention than others in elaborating national frameworks. This paper highlights the problems nations need to address in order to progress in this area.

National Level Challenges

Applying the same methodology as before to the national level, we classify the types of challenges based on whether a domestic disaster policy and framework already exists. The three types of disaster policies and correlating challenges are identified and explained below.

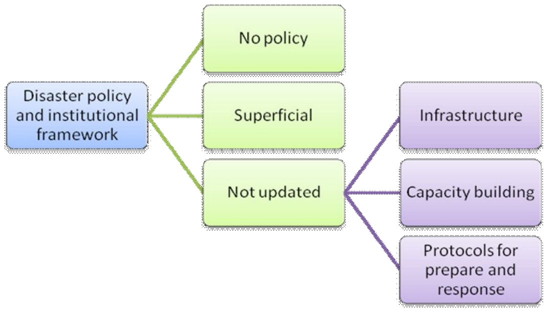

Figure II.3: National Level Aid System.Source: Sandra Cabrera Alvarado, (based on 2013 interview with Mr. Luc St-Pierre from UNOOSA).

Disaster Policy and Institutional Framework

Challenge 1. National Awareness of Disaster Frameworks

It is generally accepted, that governments *should* have national disaster risk reduction guidelines established under strong institutional frameworks to ensure the public welfare of their citizens. Some countries, however, have a superficial institutional framework or lack one altogether. Moreover, available training in and knowledge of satellite imagery can be minimal as well. When the State (end user), has only partial knowledge and expertise of GIS and related applications this often results in a slow or difficult coordination of satellite imagery resources, as well as hinders third party assistance in data interpretation and distribution.

To overcome this challenge, States should adopt UN recommended practices to promote national efforts in establishing efficient disaster management phases. In 2012, UN-SPIDER prepared a set of activities, particularly for developing countries, to promote the use of space-based information to reduce the impacts of natural disasters under these topic frameworks:[14]

- Satellite imagery inventories;
- Geo-spatial information management;
- Imagery processing;
- Changes in natural hazards associated with land-use changes;
- Strategies to promote the use of information generated using recommended practices.

The orgranigram below illustrates efficient management of domestic space resources, with contributions from international aid agencies. The core of this system is based on the objective of national governments improving their domestic knowledge and management of technology by cooperating with key international actors and domestic space agencies.

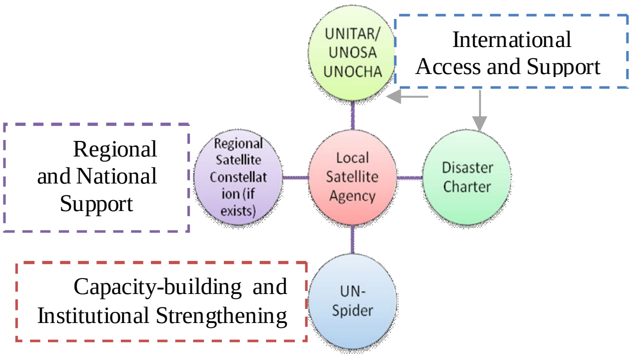

Figure II.4: An efficient domestic Disaster Risk Management and Cooperation Framework would suggest a disaster management organization scheme like Thailand's disaster management structure using satellite resources.[15]

Besides establishing a solid political framework, a legal framework is necessary on both the international and national levels to manage the acquired satellite data. The following section describes the legal challenges the international community faces in obtaining and making use of satellite data for natural disasters.

III. LEGAL CHALLENGES

First, it is significant to note that a single overarching legal framework governing satellite data for disaster management does not yet exist.[16] Consequently, various instruments and legal regimes may apply, depending on the case and previously enacted agreements between specific parties. Notwithstanding, five types of legal issues have been identified as they frequently emerge with regard to space based applications for disaster management.

Significantly, these five legal issues create pertinent ongoing challenges for the relief community. The implications of these issues affect the acquisition, sharing, and use of remote sensing data, which can result in conflicts of law and interests. An evaluation of the applicable law is therefore required on a case-by-case basis, even where the provision of data is strictly for humanitarian purposes. This illustrates the evolving nature and challenges that (space) technologies pose for the legal community and governments while simultaneously seeking to maintain the certainty and sovereignty of national laws and frameworks:[17]

Challenge 1. Privacy and National Security

Some issues, like privacy and national security concerns, are subjective to the cultural values and geopolitical climate of the particular State.[18] With satellite imagery and privacy concerns in particular, this allows for possible variances in legal interpretations and applications between States, leading to an absence of widespread legal uniformity on the issue. Similarly, a lack of current applicable national law on issues of privacy may likewise create legal uncertainty.[19] For these reasons, acquiring adequate data and higher quality imagery resolution can prove problematic for relief efforts.

Challenge 2. Intellectual Property

It has long been held that a right of authorship, or copyright, automatically vests with the creator of a work. Various national and international laws apply depending on whether the intellectual work is an image, information, or a database etc. The genius of technological development is that it continually allows for new modes of creation. However, this also challenges traditional intellectual property rules and regulations as extended to space based data, images, and information. Ownership of spaced based intellectual property is not always clear or easy to trace anymore. This provides a complicated context for identifying ownership and the subsequent sharing of data.

Challenge 3. Liability

Liability is always a primary concern for both public and private entities. Here, liability for the accuracy of data is significant and can result in a reluctance of parties to share data internationally. Specifically, satellite imagery and data that are inadequate in part, or not as timely as may be required, run the risk of hindering relief efforts when relied upon. Potentially, this can result in lives lost, a waste of limited financial and other resources, and susceptibility to subsequent lawsuits as a result. A situation no entity would choose, even if the data, as is, could save some lives.

Challenge 4. Licensing

Licensing limitations from private and commercial satellite providers also remain vital concerns. Technological advances in satellite data and processing, which allow for public and commercial applications, are also challenging legal definitions and source ownership lending an impression of legal uncertainty where satellite data is concerned.[20] These issues prevent the formulation of an easy legal answer to the use and dissemination of remote sensing data for disaster management and currently require a case-by-case and state-by-state analysis instead.

Challenge 5. Harmonization of Data

In order for countries (national authorities, disaster management bodies, and emergency response) to be able to use data for disaster management, data must be organized into user-friendly categories. Such identifications include: searchability, findability, usability, and shareability (as free of charge as possible). The Open Geospatial Consortium (OGC) and UN-SPIDER are two relevant organizations working towards the standardization of geospatial data. The goal is to establish uniform and compatible standards at both the domestic and international levels. These standards include, for instance, how the data is sourced, organized etc.

For purposes of this paper, the most significant legal issues which international organizations and governments face in utilizing satellite technology for disaster management are illustrated below.

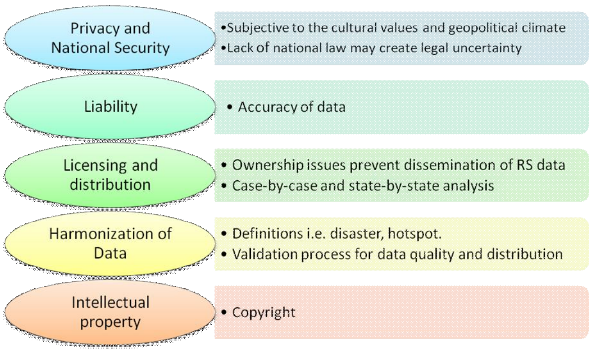

Figure III.1: Summary of Legal Challenges based on the author's research. Source: Sandra Cabrera Alvarado, based on 2013 interview with Mr. Luc St-Pierre from UNOOSA.

Some Recommendations

"Good Samaritan" Principle

Some lawyers have suggested that States can adopt the "Good Samaritan" principle with regard to data distribution for disaster management to incentivize States and entities to provide much needed satellite data to affected regions.[21] The international community is already taking the lead in this regard. For instance, the 1998 Tampere Convention provides protection for authorized persons and NGOs rendering assistance in disaster regions.[22] While non-liability clauses are routinely included in bilateral assistance agreements between States.

Bilateral Agreements

As it stands, most States currently favor bilateral agreements to allow for discretion and flexibility in both the requesting and rendering, or committing to rendering, any form of assistance; whether it be financial, human expertise, goods, or equipment etc.[23] At the same time, NGOs and IGOs have labored towards harmonizing data exchange platforms and space applications for humanitarian purposes. These efforts, however, have created a trend towards "soft law" mechanisms rather than giving impetus to establishing a unified and binding legal regime on disaster relief. While politically and financially viable alternatives, these piecemeal agreements, laws, and policies fail to provide for a harmonized distribution structure for satellite data, fail to address the imminent and ongoing needs of most disaster prone regions in the developing world, and create legal uncertainty in the face of progressive technological applications.

IV. CONCLUSIONS

No country can effectively monitor the entire planet. International cooperation is the only way to get the most up to date satellite imagery for disaster relief and humanitarian efforts. To effectuate this objective, an open data access policy is key, allowing for the free and timely sharing of data. International organizations, along with several nations, have already acknowledged this necessity instigating a trend of open data policies and guidelines. Challenges to achieve this purpose still remain, mainly in the political and legal sectors. Consequently, the political will and authority to make these changes lies with States. The urgency and humanitarian nature of this framework, however, should serve to spur Nations into acting. Even laws may be modified for this purpose. The particular and effective use of existing and available satellite technologies for improving disaster risk management strategies is too significant to be waylaid by politics.

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[1] 2009 UNISDR Terminology on Disaster Risk Reduction, available at http://www.unisdr.org/we/inform/terminology (last accessed Aug. 2, 2013).

[2] World Disasters Report 2012, Satellite analysis and forced displacement, International Federation of Red Cross and Red Crescent Societies, p228 (2012).

[3] Charter Activations, International Charter on Space and Major Disasters, 2013 available at http://www.disasterscharter.org/web/charter/activations (last accessed Aug. 12, 2013).

[4] UNOSAT Rapid Mapping Service Activity Report 2012, available at http://unosat.web.cern.ch/unosat/unitar/publications/UNOSATRapidMappingGeneralReport2012.pdf (last accessed Aug. 2, 2013).

[5] Data taken from EM-DAT, CRED, University of Louvain, Belgium (2013)

[6] See e.g. Lettenmaier, De Roo and Lawford, *Towards a capability for global flood forecasting*, World Meteorological Organization BULLETIN 55 (3), (July 2006).

[7]Oxford English Dictionary online, 2013, available at http://www.oed.com/

[8] Id.

[9] UNITAR (The United Nations Institute for Training and Research), The mission, United Nations Institute for Training and Research http://www.unitar.org/the-institute

[10] UNITAR delivers satellite imagery analysis and knowledge transfer to develop capacities of

beneficiaries and NGO's in the field of disaster management and assist other UN agencies with their humanitarian activities for free. UN-SPIDER ensures and provides capacity building to States for a better disaster management using UNITAR's satellite expertise per region.

[11] See e.g. IRIN, ASIA: How space technology aids a flood response, available at http://www.irinnews.org/report/93933/asia-how-space-technology-aids-a-flood-response (last accessed Sept. 2 2013).

[12]See e.g. Copernicus in brief, available at http://copernicus.eu/pages-principales/overview/copernicus-in-brief/ (last accessed Aug. 15 2013).

[13] The Disaster Charter does not authorize the release of images for the other phases of the disaster management cycle, such as mitigation, preparedness, risk, and reduction.

[14] UNOOSA, 2012, Technical Cooperation Concept Note, available at http://www.unoosa.org/pdf/donors/FRT_2012_spider.pdf (last accessed Aug. 4 2013).

[15] See e.g. Srivastava, Sanjay K, Satellite Imagery for Disaster Risk Management: Policy Issues for South East Asia, UNESCAP, p7, available at http://www.unescap.org/idd/events/2012-Workshop-on-flood-risk-reduction-through-space-applications-in-south-east-asia/Satellite-imagery-for-disaster-risk-management-Sanjay.pdf (last accessed Sept. 2 2013).

[16] Ito, Atsuyo, "Legal Aspects of Satellite Remote Sensing" at 162 (2011).

[17] See e.g. Annelie Schoenmaker, "Community Remote Sensing Legal Issues" p2, available at http://swfound.org/media/62081/Schoenmaker_Paper_Community_Remote_Sensing_Legal_issues_Final.pdf (last accessed Aug. 3 2013).

[18] For instance, some countries, like Switzerland, may apply strict protections to guard the right to privacy, as seen in the Google Earth 2009 lawsuit and other like investigations. See e.g. http://epic.org/privacy/streetview/ (last accessed Aug. 2, 2013). Likewise, most space faring nations have national security policies applicable to private remote sensing operators concerning resolution limits and/or access restrictions for satellite data distribution to foreign nations. "The Land Remote Sensing Laws and Policies of National Governments: A Global Survey", National Center for Remote Sensing, Air, and Space Law, University of Mississippi (2007).

[19] Annelie Schoenmaker, supra note 24, at p5.

[20] E.g. Schoenmaker, supra note 17.

[21] Ito, supra note 16, at 180.

[22] Tampere Convention on the Provisions of Telecommunication Resources for Disaster Mitigation and Relief, 1439 U.N.T.S. 275 (1998) at art. 5.

[23] Marco Ferrazzani, *Alternative Approaches to International Space Cooperation*, ESA BULLETIN 110, 76 (May 2002).