SPACE FOR SUSTAINABLE DEVELOPMENT

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BACKGROUND

At the Rio+20 Conference held in June 2012, Austria, Brasil and the United Nations Office for Outer Space Affairs (UN-OOSA) sponsored a Side-Event on "Space for Sustainable Development" to high-light the role of space as an indispensable tool of sustainable development; the side event was held on June 19, 2012 at the Rio+20 Conference grounds. The space journey at the United Nations, as we know it today, began in 1959. That was when the General Assembly of the United Nations formally established its Committee on the Peaceful Uses of Outer Space (COPUOS) and mandated the Committee to promote international cooperation in the peaceful uses of outer space, to encourage the development of national research programmes for the study of outer space, and to render all possible assistance and help towards their realization. Thereafter, a number of United Nations offices and agencies, namely: FAO, ITU, IMO, UNESCO, WHO, WMO, and UN-OOSA[2] built necessary capabilities for their own use of space-acquired data, in the discharge of their responsibilities; they are also mandated to promote the development of space knowledge and applications in the developing countries.

Yet, in the space age of today, United Nations meetings on sustainable development have consistently failed to give any recognition to the fundamental tool needed – space tools - to achieve sustainable development goals on planet Earth. This paper reflects on the deliberations on this subject at this side-event at the Rio+20 Conference. It notes the consistent growing human dependence on these same space tools and their multi-various applications, globally, to address human problems and meet most of our basic daily needs. All the same, the understanding of the role of space assets and space data as major tools of national development, human safety and national security is still eluding many of the world's decision makers. Irrespective of the nature of such commitments, the global community is already grappling with a number of sustainable challenges that will remain with us for a while; these include the management of our natural endowments such as water and forest resources, marine ecosystems and healthcare delivery; human population pressures and related consumption patterns; impact of climate change; food security and major natural disasters. Space is a critical part of the human solutions to these problems. This paper highlights the array of space assets that are contributing to human understanding of these sustainable challenges and the attributes and availability of the data they provide. The paper concludes that national, regional and global policies that advance the use of space tools in sustainable development agenda may help in accelerating the attainment of the major elements of the millennium development goals (MGD).

Understanding the value of space data in development

The observation and study of the Earth has always been a human pre-occupation, initially from *terra firma*, until in 1957 when, in practical terms and with the successful launch of Sputnik-1 by the USSR, we humans rose above the surface of the Earth in order to know our world better. The USA launched the first civilian Earth observation satellite, Landsat-1, on July 23, 1972, to aid in such an effort. Between that date and June 1992 when the world convened at Rio de Janeiro under the banner of the United Nations Conference on Environment and Development (UNCED), also known as the Rio Summit, or Earth Summit, over 15 earth observation, meteorological and environmental monitoring satellites had been successfully launched to provide information about planet Earth and its environment. But the organisation and the report of the 1992 Earth summit neither recognised nor mentioned, once, the use of such space tools to meet human needs on Earth. The same was true of the report of the 2002 World Summit on Sustainable Development held in Johannesburg. In the first draft of the Rio+20 Conference document, the word "space" was also not mentioned once, although, today, over 75% of the world is space-knowledgeable and consumes a large amount of space products and services daily.

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[1] The author was the Moderator of the Rio+20 Side-Event on *Space for Sustainable Development*, sponsored by Austria, Brasil and the United Nations Office for Outer Space Affairs and held on June 19, 2012 on the grounds of the Rio+20 Conference. This paper is a personal reflection of the author on the "Rio+20 Side Event: Space for Sustainable Development," and does not reflect the opinion of Austria, Brasil nor that of the United Nations.

[2] Food and Agriculture Organisation of the United Nations (FAO), The International Telecommunication Union (ITU), The United Nations Education, Scientific and Cultural Organisation (UNESCO), The World Health Organisation (WHO), The World Meteorological Organisation(WMO) and The United Nations Office for Outer Space Affairs (UN-OOSA)

At stake here is that, in many countries, the resource-management communities still seem to need an enhanced understanding of the potential contribution of space for attaining the key objectives of sustainability in the development process. This bridge must be crossed if, in the space age of today, the fundamental role of space science and technology (space) in the pursuit of sustainable development is to gain the required recognition at all levels of governance, including its use to attain the Millennium Development Goals (GMD).

The above circumstances notwithstanding, the collection, analysis and use of available information, including the space-acquired ones, to properly manage our life-support systems has been confirmed in many parts of the world as a necessary starting point on the path towards sustainable development and must be rigorously pursued.[3] Why does a society need to collect such data? In part, because space acquired data are being used, routinely, in many corners of our world to develop image-rich maps (thematic maps) for the benefit of the society. Decision makers need to recognise that. One such recognition is that maps and geospatial data are part of a nation's infrastructure, just as a network of transportation, healthcare, education, telecommunications and water supply systems are.

While countries such as Australia, Canada, Ethiopia, Japan and most of the European countries continue to use space acquired data to up-grade their national base maps, examples abound globally showing that failure to recognise the indispensable roles and use of accurate maps in the development process has and continues to result in the wrong location of roads, housing estates and agricultural plantations - into swamps, flood plains and Earthquake zones - with their attendant casualties. The routine use of the computer and a base map has made it possible to geographically reference a large array of data, including those from Earth observation and geo-positioning satellites, and in the process capture, store, check, integrate, manipulate, analyse, display and deliver accurate information to consumers, such as project managers, farmers, foresters and transportation authorities. Indeed, space tools (satellites and space-acquired data) have been found to be adequate for use to solve many human problems on Earth, including its use in transmitting education (tele-education) and healthcare (tele-health) programmes, in the mitigation of a host of disasters and in the management of our transportation systems and our water and marine resources.

Sustainable development challenges

Water resources - According to the United Nations, more than two billion people suffer from water-borne diseases with more than 2.2 million people dying every year. By 2015, 3 billion people - nearly 40% of the world population - are expected to live in countries that find it difficult or impossible to mobilize enough water to satisfy the food, industrial and domestic needs of their citizens. Projections indicate that, by 2025, two out of every three persons on Earth will live in water-stressed conditions. To achieve sustainability of water resources on Earth, there must be shared management based on a shared system of information, data and analysis. Because of its reliability and consistency, space acquired data offers the right solution. With the aid of Jason-2 and Envisat satellites, satellite-enabled river gauges are in use to monitor water flows along international rivers; similar devices are also in use, globally, to monitor the levels of lakes and reservoirs.

Another challenge is the trans-national dimension of water that reaches beyond the limits of national sovereignty with an inherent trans-boundary nature of surface, ground, and atmospheric water resources.[4] Forty percent of the world population in almost 50% of the Earth's land surface live within such basins whose water resources are shared by two or more sovereign states; the Amazon, the Brahmaputra, the Nile and the St. Lawrence Rivers come to mind. Similarly, the tremendous spatial extension of territorial waters and related exclusive economic zone poses a fundamental challenge, not only of monitoring the resource systems but also of maintaining an effective legal regime in the coastal waters, particularly in the interest of the local population. The type of data needed to exercise such controls cannot depend on the use of conventional and manual techniques.[5] Because of the unequal natural distribution of water resources in the world, advanced modes of water management would be the answer. Space is an indispensable component of the needed management tools.

Marine Ecosystems - Many of the 64 coastal and marine ecosystems of the world are today suffering from environmental degradation, including the mismanagement

[3] Life-support systems include, but are not limited to air, land, water, agricultural resources and wholesome environment

[4] Lichem, Walther (2012). *Space-based data and sustainable water and ecosystem management*, Rio+20 Side Panel on "Space for Sustainable Development," Rio+20 Conference, Rio de Janeiro, Brasil. June 19, 2012

[5] For example, today, it is not practicable to use conventional techniques to observe, reliably, the natural changes and human impact within the Gulf Current Large Marine Ecosystem (GCLME), in West Africa, including its mangroves, coastlines and waters. From its northernmost shore in Guinea Bissau, to its southernmost shore in Angola, the distance is in excess of 5,000 km. Dependence on conventional techniques and

of their fisheries resources because of stock depletion, mariculture extinction, industrial and municipal pollution, contamination by ballast water, coastal erosion and the destruction of upstream spawning areas. The exploration and exploitation of petroleum and gas resources, particularly in the mangroves, has led to a situation where these ecosystems suffer an average of more than 1,000 oil spills and related fires every year. Many of such problems are easily captured by Earth observation satellites of today, using such instruments as MER on board ESA's Envisat satellite, MODIS on board both the Aqua and the Terra satellites and the IMAGER on board INSAT. Marine and coastal ecosystems also need recovery and sustenance of their depleted fisheries, the restoration of degraded habitats, the reduction of land- and ship-based pollution and a reversal of coastal area degradation and living resources depletion. These and other related problems can be resolved, among often competing interests and institutions, through cooperation in a regional and/or international setting, with the aid of copious satellite data. Needed are shared objectives, a degree of coordination of the different governmental, inter-governmental and non-governmental responsibilities, and the willingness to work with shared information and data.

Healthcare – Health, as an information-intensive sector, requires extensive data collection, information management and knowledge utilization at all levels and at all times. Space tools are indispensable in the monitoring of diseases or disease-spread as well as in the provision of healthcare through tele-medicine.[6] In Argentina, for example, *Rodents are known to be hosts of Argentine Hemorrhagic Fever, Hantavirus Pulmonary Syndrome and Dengue Outbreaks.* Ants and flies also serve as hosts for *Chagas, Malaria, Dengue and Leishmaniasis* which are also life-threatening tropical diseases and are prevalent in Argentina and in other parts of South America.[7], Understanding the characteristics of the eco-geographical areas where diseases develop has thus become a national challenge. Space is aiding in that process.

To control these diseases, the Argentinean Space Agency) CONAE), in collaboration with the Italian Space Agency (ASI) and Cordoba National University, Argentina (UNC), has embarked on a mission that addresses the question: "How does a community develop a set of numerical tools, as an early warning system that is devoted to the surveillance of a population under risk from *rodent or insect attack?"* The above partners have embarked on a three-prong approach.[8] The first is the development of plans of action. Next is the development of a health information system which integrates the use of communication satellites for data transmission and the use of earth observation satellites for data collection in the affected areas. The third step, called '*Cartography of Risk Factors*,' is the fusion of epidemiological, biological and remote sensing data in order to develop the maps of the affected areas. The fourth step, known as '*Space-temporal modeling of epidemics,'* models the inter-relationships between the hosts, vectors, reservoirs and the ecosystem of the affected areas. Presently, efforts are in progress to build a multi-scale and a multi-factor system based on remote sensing and GIS in order to be able to improve the ability to predict future outbreaks of virological and entomological diseases as well as be able to support the Dengue control actions in the affected areas.

In the immediate future, projects of this nature would need to take into account the impact of increasing human population on the population density of these hosts (rodents, bugs and insects). This is necessary because a number of these hosts are also adapting to climate change and are thus migrating to geographical and ecological areas that were at one time alien and/or climatically hostile territories to them.

***Human population pressures*:** The 1992 Earth Summit in Rio and subsequent similar international meetings galvanized governments all over the world to cooperate to address pressing environmental challenges, namely, Climate change, Biological diversity, Desertification, Forest conservation and management, and Pollution control and reduction. But the world population which, as shown earlier, has dramatically increased from 5 billion in 1992 to

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manual data collection practices, for the assessment of nature's and human actions within the GCLME, over the years, has made the sustainable development and management of such an expansive area, and similar areas around the world, an unattainable goal.

[6] Telemedicine is the use of telecommunication and information technologies (ICTs) such as satellites, television, video conferencing, internet, mobile phones etc., to provide clinical health care services in such areas as radiology, cardiology, pathology, dermatology, psychiatry, pharmacy, etc., at a distance. Telemedicine helps eliminate distance barriers and it can improve access to medical services that would often not be consistently available in distant rural communities. It is also used to save lives in critical care and emergency situations, such as in floods, earthquakes, fire, wars etc. The use of the telemedicine tool can be generalised to also enable primary care to be provided from industrialised countries to areas around the world that are in desperate need of basic healthcare. Telemedicine is practiced in many parts of the world today.

[7] Chagas are transmitted by an insect called Triatomine bugs; Both Malaria and Dengue are transmitted by mosquitoes while Leishmaniasis, which causes skin ulcers, is transmitted by Sand flies.

[8] Lanfri, Mario Alberto (2012). *Space for sustainable development - Remote Sensing in Health Applications*, Rio+20 Side Panel on "Space for Sustainable Development," Rio+20 Conference, Rio de Janeiro, Brasil. June 19, 2012

7 billion in 2012, will most likely exceed the projected figure of 9.1 billion by 2050.[9] Such a population growth would constitute a major barrier to the attainment of sustainable development efforts. Meeting the many demands of such a growing world population, which increased in the last 20 years at an average growth rate of 100 million per year, along with its consumption patterns, will continue to exert untold human pressures on the Earth, on its resources and on its environment, resulting, in part, in accelerated climate change.

In addition to the satellites already identified above, a host of other satellites such as *Aura* (2004), *Cloudsat* (2006), *OCO-2* (2014), *Parasol* (2004) and *Calipso* (2006) are monitoring our human consumption patterns including the green-house-gases we spew into the atmosphere. *SRMSAT*, an experimental nano satellite, built by students at Sri Ramaswamy Memorial University in India, with a secondary mission of monitoring greenhouse gases, was launched by the Indian Space Research Organisation in October 2011. All these space assets and many more are revealing to us, even if we fail to admit same, what our consumption patterns here on Earth are, namely:

- Rapid reduction in fossil fuel reserves and in the loss of tropical forest areas due to deforestation;
- 27% per capita increase in natural resource use;
- 12 million hectares a year in lost land productivity;
- 50% global mangrove loss in coastal areas;
- More than half of all accessible freshwater (1% of total water on Earth) is already used directly or indirectly by humankind; and
- Growing human consumption-related activities particularly industrial processes and the operation of cement plants and oil refineries, agricultural processes, transportation systems, and energy generation, among others, continue to contribute to increasing heat-trapping gases, i.e., green-house-gases (GHG) concentration particularly water vapour (H_20), carbon dioxide (CO_2), nitrous oxide (N_2O) and methane (CH_4) in the upper atmosphere.[10]

Impact of Climate Change**:** What is very apparent today is that these human consumption-activities are already wreaking havoc in many ways here on Earth. Through a variety of communications and information networks, humans are gradually getting accustomed to savage wildfires, 25-mile long icebergs, disappearing lakes, freak allergies, rapidly accelerating species extinction rates, and the threat of re-emergence of long-gone diseases and the submergence of low-lying and coastal communities. Rising sea levels and more extreme weather have the potential to damage irreplaceable sites, including temples and ancient settlements. Floods attributed to global warming have already damaged a 600-year-old site, Sukhothai, which was once the capital of a Thai kingdom; the tourist attractions along the East coast of Africa may also not survive our warming planet.[11]

According to the Intergovernmental Panel on Climate Change (IPCC), most of the observed increase in global average temperatures since the mid-20th century is ***very likely*** due to the observed increase in anthropogenic GHG concentrations. It is *likely* that there has been significant anthropogenic warming over the past 50 years averaged over each continent (except Antarctica).[12] On October 4, 2010, NASA's Goddard Institute for Space Studies (GISS) at Columbia University, in New York, predicted record high global temperatures for the year 2012.[13] That prediction is becoming real. In the week of 24 - 30 June 2012, in the USA, 1,011 temperature records were broken around the country, including 251 new daily high temperature records established on Tuesday (June 26).[14]

In its report on the status of the global climate that was issued on March 23, 2012, the **World Meteorological Organization** (WMO) confirmed that 2011 was the 11th warmest year since record-keeping started in 1850. The report also showed that, far from slowing down or stopping, climate change accelerated in the past decade (2001-2010), the warmest 10-year span ever recorded in all continents of the globe. Numerous weather and climate extremes affected almost every part of the globe with flooding, droughts, cyclones, heat waves, and cold waves. A large number of countries reported extreme drought conditions, including Australia, eastern Africa, the Amazonia region and the western United States. Two

9 United Nations Population Division, United Nations, New York

10 Brigg, Stephen (2012). *Space-Based Earth Observations to Support Sustainable Development: Contributions from the Committee on Earth Observation Satellites (CEOS),* Rio+20 Side Panel on "Space for Sustainable Development," Rio+20 Conference, Rio de Janeiro, Brasil. June 19, 2012

11 The Atlas of Climate Change: Mapping the World's Greatest Challenge compiled by researchers with the Stockholm Environment Institute with assistance from the United Nations Environment Programme (UNEP) and presented by Tom Dowling Statement on November 7, 2006 at the 12th Conference of the Parties to the UN Framework Convention on Climate Change and the 2nd Meeting of the Parties to the Kyoto Protocol in Nairobi, Kenya,

12 http://www.ipcc.ch/publications_and_data/ar4/syr/en/spms2.html

13 http://www.accuweather.com/en/weather-blogs/climatechange/2012-likely-to-reach-record-hi-1/38255

14 http://www.livescience.com/21291-us-heat-wave-map.html

exceptional heat waves hit Europe and Russia during the summer of 2003 and 2010 respectively, with disastrous impacts, thousands of deaths and outbreaks of prolonged bush fires.[15]

OXFAM also weighed in and noted that the number of climate-related disasters, particularly floods and storms, is rising far faster than the number of geological disasters, such as earthquakes. Between 1980 and 2006, the number of floods and cyclones quadrupled from 60 to 240 a year.[16] The year 2007 was a year of climatic crises, especially floods, often of an unprecedented nature. These included Africa's worst floods in three decades, unprecedented flooding in Mexico and the United Kingdom, massive floods in South Asia including Indonesia, Malaysia and Australia, and heat waves and forest fires in Europe, Australia, and California. By mid-November the United Nations had launched 15 'flash appeals', the greatest number, ever, in one year. All but one were in response to climatic disasters. The period 2008-2011 was no different for South America where most of the countries of the region experienced unprecedented rainfall, heavy floods accompanied with landslides and related debris.[17]

Major natural disasters: In addition to all of the above, the fury of nature also continues to take its tolls on humans at different levels, in different circumstances and at different locations around the world. Loss of life, human dislocations and considerable devastation of land and properties are often the end results. Unfortunately, a far higher percentage of the world's population, which has dramatically increased from 5 billion in 1992 to 7 billion in 2012, live near dangerous coastlines and thus become the first respondents to coastal storms and tsunamis that kill more people nowadays than in the past.

The devastating consequences of living along coastal and low lying areas, particularly when disasters strike, are reflected by the following disaster statistics which include: The Dec. 26, 2004 *Sumatran tsunami* - 225,000 lives lost and over $10 billion in damages in a region covering 13 countries; The August 28-29, 2005 *Hurricane Katrina* - 1,800 lives lost and properties destroyed estimated between $96 billion to $125 billion; it is the costliest hurricane in U.S. history; The May 2, 2008 *Cyclone Nargis* in Myanmar (Burma) - estimated 140,000 lives were lost with damages estimated at over US$10 billion, which made it the most damaging cyclone ever recorded in the basin; and The March 11, 2011 *Tohoku, Japan earthquake* - 15,854 lives lost and estimated $210 billion in damages. It is the fourth largest earthquake in the world and the largest in Japan since instrumental recordings began in Japan in 1900.

But there are no known conventional techniques, today, that could have satisfactorily addressed each of the resource management issues or emergency concerns cited above. In each of these and many other instances, space (communications, earth observation, meteorological, oceanographic, search and rescue and geo-positioning and earth science satellites) tools provided and continue to provide the needed critical information to support subsequent actions. In emergency cases such as described above, satellite-aided mitigation actions include early warning, preparation, response and recovery.

Food Security: When emergencies such as cyclones, hurricanes, earthquakes and related tsunamis, droughts and floods hit any community, the first concerns are how to feed, house and provide for the healthcare of the affected population. This is so because, by-and-large, the crops and other other critical infrastructure such as shrimp farms, fishing ponds, nursery hatcheries and fishing boats, water works, health facilities and transportation systems that sustain the affected population are often destroyed by nature's fury. In the process, the victims are often without any livelihoods – particularly without water, food and/or shelter.

According to the World Food Programme (WFP), climate risk is one of the drivers of food security; it is projected that by 2050, 10-20% more people could be at risk of hunger due to climate risks. Thus, how to prepare for human vulnerabilities in a future, with a human population that continues to exert increasing pressure on the earth's resources and its environment, is one of WFP's pre-occupations. Among the several steps WFP is taking to ensure *food security* for those in need are the following:

· Vulnerability assessments: The use of space-based information to manage risk and plan for food security because space data is able to provide critical information about where the most food insecurities (scarcities) are.

· Climate risk analysis**:** (i) The use of space-based information to provide data about climate-related trends and impacts: and (ii) The use of space data and vulnerability information to assist in prioritizing interventions.

· Early Assessment and Protection project (LEAP)**:** To support national food security efforts, WFP has also developed an early warning programme known

[15] WMO's press Release No. 943 issued March 23, 2012.

[16] Climate Alarm - Disasters increase as climate change bites, Oxfam Briefing Paper No. 108, November 2007.

[17] Nobre, Carlos Afonso and Carlos Frederico Angelis (2012). *Space for Sustainable Development - Disasters*, Rio+20 Side Panel on "Space for Sustainable Development," Rio+20 Conference, Rio de Janeiro, Brasil. June 19, 2012.

as LEAP. In practical terms, LEAP, as a Food Security Early Warning Tool, converts agro-meteorological data, obtained via meteorological satellites, into crop or rangeland production estimates and it allows for the quantification of the financial resources needed to scale up the national food security initiative/programme in case of a major drought. WFP is also equipping each participating member state with the necessary automated weather stations that will enable each of them to obtain needed meteorological information directly from meteorological satellites. Presently Ethiopia and Uganda are beneficiaries of the LEAP programme, a step that should contribute significantly to food security in both countries.[18]

Space data

Satellites as sources of data: There are numerous observing systems in space that offer fundamentally important opportunities for the management quantum leap achievable through the use of high quality and reliable information. Amongst these are more than 98 earth observation satellites, 38 weather satellites, 14 disaster-related satellites, 15 search and rescue satellites, 80 global positioning satellites and about 145 space and earth science satellites – the latter include a host of satellites specifically dedicated to the monitoring of the outer space environment and its constituent elements. [19]

Attributes: Earth observation satellites are designed to provide global coverage, and to be able to undertake repeatable, consistent, objective, uniform measurements which compliment aerial and *in-situ measurements*. Depending on its swath, a single satellite image can show the spread of air pollution across many political boundaries and continents, revealing in the process the damage done as was the case during the Mount Pinatubo volcanic eruption of June 1991.[20] By their performance to-date, satellites have confirmed that it is only from space altitude that humankind can fully understand the world in which we live.

Value: Because of these and other attributes, satellite-based Earth observation enables goal-setting and analysis of progress by providing authoritative evidence that is objective and one which can be verified or validated.[21] Accordingly, many governments and municipalities around the world have come to depend on its use for establishing base lines against which changes can be measured, while the global community has accepted it as an indisputable source of unbiased information in support of confidence building, for global collective actions, for implementation of major multilateral environmental agreements and for monitoring compliance regimes.[22] Accessing space-acquired data, today, is easier than ever before.

***Sources of free space-acquired data*:** In August 1982, the cost of a single scene on a Landsat computer compatible tape (CCT) was US$650.00. With time, data cost went up astronomically as value added companies entered the geo-spatial market. On October 1, 2008, everything changed; that was the day the global internet free access policy for Landsat (Landsat 1-5 and -7) satellite data went into effect.[23] China and Brazil soon followed; jointly, they have agreed to provide free land images from their joint optical remote sensing satellite, CBERS-2B (2.36m panchromatic and 20m multi-spectral resolution), launched in September 2007, along with the software needed to read the data, to African and Asian countries. The offer is intended to help the beneficiaries respond to threats such as deforestation, desertification, and drought. In addition, India already decided to freely share with its neighbours in the Asia-Pacific region, the data acquired by

[18] World Food Programme (2012). *Space for sustainable development,* Rio+20 Side Panel on "Space for Sustainable Development," Rio+20 Conference, Rio de Janeiro, Brasil. June 19, 2012

[19] http://www.n2yo.com/satellites/

[20] When Mount Pinatubo in the Philippines erupted very violently in June 1991, more than 5 billion cubic meters of ash and pyroclastic debris were ejected from its fiery bowels producing eruption columns 18 kilometers wide at the base and heights reaching up to 30 kilometers above the volcano's vent. For months, the ejected volcanic materials remained suspended in the atmosphere where the winds dispersed them to envelope the earth, reaching as far as Russia and North America. This phenomenon caused the world's temperature to fall by an average of 1 degree Celsius. Clearly, Pinatubo's eruption signals the world's most violent and destructive volcanic event of the 20th century. http://park.org/Philippines/pinatubo/ http://park.org/Philippines/pinatubo/

[21] In 1974, Landsat data provided indisputable key evidence in the State of Minnesota, in a judicial litigation brought by the US Government (EPA) and the State of Minnesota, against the Reserve Mining Company in its discharge of taconite tailings both in the waters of Lake Superior and in the ambient air in surrounding communities. The practice resulted in the release, into the air and waters of the lake, large amount of minute amphibole fibers said to be a cause of various types of cancer in humans. The court ordered the company to seize the practice. *United States v. Reserve Mining Co.*, 380 F. Supp. 11 (D.C. Cir. 1974), http://earthpace.com/resources/nepa/court.html#water

[22] Remote sensing satellites have served as national technical means of verification of international nonproliferation, arms control, and disarmament regimes. SALT 1 and the Anti-Ballistic Missile Treaty.

[23] http://landsat.usgs.gov/products_data_at_no_charge.php.

its Earth observation satellites for disaster management; the plan would also provide data analysis and training to countries without independent access. The University of Dundee Satellite Receiving Station also "maintains an up-to-date archive of images from NOAA, SeaStar, Terra and Aqua polar orbiting satellites." These and other images from geostationary satellites covering the whole earth are also available, free-of-charge.[24] A number of websites also provide an array of sources of free satellite imagery.[25] Today, automatic weather stations and receiving earth stations for acquiring free data from meteorological satellites are also very affordable. The availability of free data is growing and the user has more choices of data suppliers than ever before.

CONCLUSION

The formulation and implementation of sustainable development policies can succeed only with accurate information of the Earth system. Today, satellites provide such accurate information. To be able to gauge and manage societal impacts on our planet, the global community will continue to require consistent and accurate information that can be used to measure such impacts. As an enabler of informed decision-making at all levels of society, space acquired data can produce shared vision and understanding which in turn can produce joint actions. The millennium development goals (MDG) belong to this category of actions which, if attained, can foster global yearning for sustainable development.

[24] http://www.sat.dundee.ac.uk/

[25] http://www.ppgis.net/imagery.htm