

# **SUMMARY AND ANALYSIS OF ADDITIONAL RESEARCH WORK (LEGAL AND FINANCIAL)**

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## **Introduction**

The run to the Moon has started. China, US and Europe are the main players.

On 2 January 2019, China successfully landed the first spacecraft, called the Chang'e-4, on the dark side of the Moon. On 21 February 2019, Israel launched a lander to the Moon that will become – if all goes well – the first privately funded craft to touch down on the Moon.

Ariane Group has signed a contract with ESA to examine the possibility of going to the Moon before 2025. Ariane 64 will be able to carry the equipment needed for a Moon landing.

In the U.S. Trump called on the Department of Defence and the Pentagon to develop a “Space Force,” a sixth branch of the military for the purpose of protecting U.S. assets in space and attacking its enemies during wars. The program includes mission to the Moon. But it has to be stressed that this is against Article 4 of the 1967 Space Treaty which states that space can be exploited for civil use only. Today, though space it is possible the blockade of one country (TLC, financial Transaction, navigation, etc) (see: Alfredo Roma “Space Blockade: a thread to the space activities? – The Aviation & Space Journal – Oct/Dec 2014).

Moon Express, the first private US company in history to obtain governmental permission to travel beyond Earth's orbit, has collected substantial capitals for the purpose of Moon exploration.

All this seems to open a new era of lunar exploration, in which national space agencies work alongside private industry to investigate and exploit the Moon and its resources. Dan Hendrickson of Astrobotics has shown that landers and other technologies enabling missions to celestial bodies to procure goods and commercial services are already available. No doubt that Moon is the short term destination, as stated by Mirra of AIRBUS which is another provider of space transportation system.

## **The Moon's resources**

Water seems to be the most important resource of the Moon. Ben Roberts of Moon express has called it “the oil of the solar system”. When, in 2008, samples from the 1970s Apollo 15 and other 17 missions were re-examined, the presence of water brought greater hope of establishing lunar habitations. Since then, multiple studies have confirmed that the Moon has water in abundance. Water ice (and other volatile substances) is found in the dark areas near the poles and have many uses, including rocket propellant. Hydrogen and oxygen can be separated by electrolysis and stored as liquids, ready to fuel a rocket.

Also for any future mining activities water will be necessary, both for operations and for sustaining a crew. Georg Sowers of Colorado School of Mining, has given us a complete picture on ice resource exploration, the cost of propellant produced on Earth or on the Moon and the relevant business plan.

Ian Crawford has recalled the Lunar and Asteroids resources using facilities in situ like a Moon Village. Confirming the existence of various minerals like H, He3, He4, carbon and nitrogen, he raised the question whether there is anything worth importing to Earth. Not a long time ago Crawford said that it is hard to identify any single lunar resource that will be sufficiently valuable to drive a lunar resource extraction industry on its own. Nonetheless, he said, the moon does possess abundant raw materials that are of potential economic interest. He also expressed some reserves regarding Helium-3. His assessment should have been published on the journal *Progress in Physical Geography*.

Chinese believe that the Moon is so rich in Helium-3, that this could “solve humanity’s energy demand for around 10,000 years at least if used for nuclear fusion. However, sustainable nuclear fusion using helium-3 has yet to be shown to be feasible.

Roger Lenard of Zodiac Planetary Service has confirmed the enormous potential business of mining the Moon but expressed also some caveats.

Besides the exploitation of the Moon’s resources there is also the project to set up a Moon village - as presented by Giuseppe Reibaldi - which has nine very ambitious principles.

### **Problems for mining the Moon**

Many hurdles remain before mining the Moon can happen, not least getting there. In all of human history only 12 people have ever walked on the Moon. This is, in part, due to the colossal expense of such a venture, so the cost must

come down before industry can proceed. Presently, research is trying to create reusable rockets, something SpaceX is working on.

The temperature on the Moon varies from 123°C to -233°C, making human habitation and activities very difficult. Furthermore, on the moon there is only about one sixth of the gravity that we experience on Earth, complicating mining operations substantially.

### **Economic and financial aspects**

Space economy is the full range of activities and the use of resources that create value and benefits to human beings in the course of exploring, researching, understanding, managing, and utilising space. Nowadays, most of the activities on the Earth are governed from space. Just think of tTLC, radio, television, air navigation, sea navigation, train control, control of movements of people or vehicles of all kinds. Our smartphone, through the satellites, tells us in which part of the world we are and guides us to our destination. This gives an idea of the economic dimension of today's space activities that in 2014 reached the amount of 314 billion dollars.

Today the space sector attracts much more attention worldwide, as public and private investors look for new sources of economic growth and innovation, and space economy has become a relevant domain for high-tech innovation, commercial opportunities and strategic development.

The space sector has some constraints – like many other economic activities - such as the longer terms for both project development and return on investments. Till now it has been a government dominated sector, as access to space has been controlled by the military authority, requires huge capitals and involves technical risks. Now, the increasing number of private entities currently engaged in space activities is gradually operating a shift in the traditional roles of public and private sector. If Governments invested in space activities without a lucrative intent, private entities must establish an efficient cost-effective business model targeting a profitable result.

Peter Marquez has offered an evaluation of the space resources starting from the identification of goods and services, revenue and profits, through exploration, appraisal, planning and production. However, such evaluation raises various questions not easy to be answered.

Now, 50 years after the first landing on the Moon, we still don't have a complete picture of the Moon's economic potential, and obtaining one will require a more rigorous programme of lunar exploration than has been undertaken to-date. But, as already said, a private company prepared to invest in space is forced to set up a business plan considering the NPV (Net Present Value) of long-

term investments necessary for many years to come, and the relative ROI (Return On Investments) that should be compared with that of other alternative investments. This was not considered in the past as space exploration was a State activity. Now the participation of private entities in space activities requires such analysis.

Pierre Larroque raises important questions regarding mining the Moon, making a comparison with similar projects on the Earth that sometimes have failed for lack of capitals or for technical reasons. Do we understand the mineralisation/reservoirs? For Larroque the answer is NO. The path forward he suggests is not easy to run. His conclusion is: Only move to develop mining when you have a predictable outcome.

The economic theory requires also the risk assessment analysis which includes political risks relating to government stability and internal conflict due to domestic ethnic, cultural or religious tensions. However, the detailed level of risk assessment appears excessive and is difficult to evaluate for the many variables involved.

## **Legal aspects**

Most of the legal principles have been deeply examined by the speakers of the fifth session. In particular it has been stressed that the 1967 United Nations Outer Space Treaty establishes that no nation can claim ownership of the any celestial body or its parts.

Basic rules of space treaties establish that space resources are “common heritage of mankind”, supported by moral and ethical claims that the developing nations should not be deprived of any possibility to enjoy the benefits of outer space activities, notably, in this case, mineral and other resources of the Moon.

As remembered by Tanja Masson, the *Corpus juris spatialis internationalis* is based on the United Nations Space Treaties, which include, in particular: The 1967 UN Space Treaty – the Moon Agreement – the Convention on International Liability and the Convention on registration of Space objects.

From the number of States that have ratified the various treaties, it clearly appears that a relatively small number of States are involved in space activities and these States have adopted domestic rules for space that differ from one country to another. This is also the case in the European Union, where, in the absence of a harmonized approach, a number of member States have adopted widely divergent sets of national rules (see: Frans Von Der Dunk – National

Space Legislation in Europe). At present, there is no EU space legislation. The Council of the EU, in 2010, only proposed a draft Code of Conduct “to enhance the security, safety and sustainability of all outer space activities.”

Article 6(2) of the Moon Agreement may be seen as an exception to the space property right as it grants the right to collect and remove from celestial bodies samples of its minerals and other substances to carry out scientific research. This principle has been adopted by the US space law of 2015 as pointed out by Henry Herzfeld.

Recently, it has been expressed a new and open interpretation regarding the appropriation and sharing of common space resources in the case of commercial use of space. Commercial space activities are not per se unlawful; a clear example is represented by INTELSAT and IMMERSAT providing “community service”. The interpretation of article I of the Outer Space Treaty prescribing a duty to share the “benefits” derived from outer space activities, has not been widely accepted because the principle of non-discrimination refers to the freedom of exploration, use and access by States and not to the “benefits and interests of all countries”. According to this interpretation, in case of commercial mining operations on celestial bodies, minerals would not have to be made available to other States.

Another controversial position is offered by the mandatory transfer of technology provided by the Convention on the law of the sea and the common attitude of industrialised States, determined to prevent the transfer of such technologies to developing States.

Actually, some issues on the exploration and extraction segment of a commercial space mining venture need to be revised, especially the concept of “common heritage of mankind” or “Province of all mankind” of Article I of the Outer Space Treaty, that appear to be today no more than philosophical concepts. These concepts need a revision in consideration of the progressive development of space enterprises financed by private entities, maintaining only the prohibition of territorial sovereignty and ownership.

I believe that the entire *Corpus Juris Spatialis* needs a revision being based on activities performed by States only, and on a liability regime that identifies – *juris et de jure* - the launching State as the only liable party, for any space activity (Masson and Hertzfeld).

In essence, if private property rights are not made available in case of commercial space mining activities, the regulatory framework is unable to attract private investments in such activities. Therefore, only resolving these

problems will open the path to the creation of an international legal framework that will provide legal certainty for commercial mining activities in outer space.