Climate Change and Role of Outer Space

A Multilevel Framework for Legal and Policy Issues

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Abstract

Outer Space technologies play an inalienable role both in the field of research aimed at greater understanding of Climate Change phenomenon and in monitoring of the state of climate and compliance to international agreements. Various legal and policy measures evolved under different conventions including those under the aegis of UN Framework Convention for Climate Change contain provisions relating to systematic observations and research relating to climate phenomena and also verification needs where in, space technology could play an important role. Notable initiatives in International Cooperation had been taken under the aegis of the UN, CEOS/IGOS, GEOSS and a host of other bodies.

Notwithstanding these developments, defining a set of comprehensive capabilities and policies that address long term needs in this area is still a goal to be realized; As the convergence towards global actions for climate change have been gaining strength as evidenced by the Lima Call for Climate action (2014) and the historic and universal Climate Agreement at Paris, it is pertinent to assess how the diverse initiatives of past and opportunities of New Space developments can be dovetailed into the progress being achieved on global efforts in this arena.

Issues of new developmental agendas of different nations are interwoven with impacts and actions on Climate Change. Such impacts and actions that arise from Climate Change thus involve various levels ranging from the total community of global nations, to national governments to local bodies. In view of the multiple stake holders involved and wide ranging diversities, Policy and legal measures and the processes for their renewal need a flexible and multi-level framework. The paper analyses the diverse policy and legal principles that exist and the rationale and needs for a multi-level framework in this arena.

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I. International Legal Framework for Climate Change

United Nations Framework Convention on Climate Change (UNFCCC, 1992) is a guiding international instrument in the arena of Climate Change, with near universal participation of 196 Parties, with an objective to achieve stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.[1] It was aimed that such a level should be achieved within a timeframe sufficient to allow ecosystems to adapt to natural climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner. The framework encompasses (1) Consideration for special circumstances of Developing Countries to compensate disproportionate or abnormal burdens under the Convention (2) Principle of Precautionary measures to anticipate or prevent or minimize the causes of climate change (3) Commitments on the basis of Common but Differentiated Responsibilities and it calls to promote and co-operate in development, application, diffusion of transfer of technologies, practices and processes that control, reduce or prevent anthropogenic emissions of greenhouse gases.[2]

The aspect of promotion and cooperation is emphasized for scientific, technological, technical, socio-economic and other research, systematic observation and development of data archives related to climate system.[3] Also, provisioned is the full, open and prompt exchange of relevant scientific, technological, technical, socio-economic and legal information related climate system and climate change.[4] The framework reflects commitment of the developed country Parties and other Parties included in Annex I for adoption of National Policies and taking corresponding measures on the mitigation of climate change by limiting anthropogenic emissions of greenhouse gases.[5] Other provisions of the Framework *interalia* include cooperation in education, training and public Awareness[6] and, provisions on adoption of Protocols to the Convention.[7]

The international response to climate change is captured through a timeline of decisions, action plans adopted at the Conferences of Parties over the years at different venues,[8] the most recent of which was the adoption of Paris Agreement on 12 December, 2015 reflecting culmination of the negotiations

1 http://newsroom.unfccc.int/about/ last accessed on 07/03/2016.
2 See Articles 3 & 4 of the UNFCC Convention, http://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/conveng.pdf last accessed on 07/03/2016.
3 *Ibid.,* Articles 4.1 (g) and 5.
4 *Ibid.,* Article 4.1 (h).
5 *Ibid.,* Article 4.2 (a).
6 *Ibid.,* Art. 4.1.i, and Art. 6.
7 *Ibid.,* Art. 17.
8 http://unfccc.int/essential_background/items/6031.php last accessed on 07-03-2016.

under the Adhoc Group on the Durban Platform for Enhanced Action. The Paris agreement reflected commitment of 195 nations to keep global temperature rise well below 2 degrees Celsius above pre-industrial levels by slowing the pace of green gas emissions through national climatic action plans and transparent accounting of climate actions, strengthening adaptation capabilities and support to developing nations.[9] It is instructive to see that beginning with 1987 Montreal Protocol on substances that deplete Ozone Layer (pre-UNFCCC time) there had been progressive movement to galvanize international cooperation and proactive steps for assessing, monitoring and reducing the impacts from the climate change phenomena. The setting up of Intergovernmental Panel on Climate Change (IPCC) by UNEP and WMO in 1998 helped in systematic review of scientific, technical and socio-economic information produced worldwide on a regular basis with international participation. At the risk of being too brief, some important steps, milestones and epochs leading to the latest accomplishment at the Paris Conference is captured as follows:

- Kyoto Protocol adopted in 1997 was an initial major step to operationalize the Convention (UNFCCC) and it set binding emission reduction targets, committing industrialized countries to stabilize greenhouse gas emissions and setting a Clean Development mechanism to achieve sustainable development.
- The year 2001 saw crossing of several milestones including release of IPCC's Third Assessment Report. Marrakesh Accords was adopted at the Conference Of Parties 7, detailing rules for implementation of Kyoto Protocol, setting up new funding and planning instruments for adaptation, and establishing a technology transfer framework.
- In 2005, Kyoto Protocol entered into force.
- Nairobi Work Programme on Adaptation is accepted and agreed in 2006, facilitating and catalysing the development and dissemination of information and knowledge that would inform and support adaptation policies and practices.[10]
- IPCC's Fourth Assessment Report released in 2007. Climate science entered into popular consciousness. Bali roadmap was agreed at the Conference of Parties-13, setting in motion a new negotiation process under Adhoc Working Group on Long Term Cooperative Action.
- Copenhagen Accord was drafted in 2009. Countries later submitted emissions reductions pledges or mitigation action pledges, all non-binding.

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9 http://newsroom.unfccc.int/unfccc-newsroom/finale-cop21/ last accessed on 08-03-2016.

10 https://www3.unfccc.int/pls/apex/f?p=333:1:1921002095217007 last accessed on 07-03-2016.

- Cancun Agreements drafted and largely accepted in 2010 represented a set of key steps forward in mitigation, adaptation and measures for financial, technology and capacity building support.
- The Durban Platform for Enhanced Action (2011) was drafted and accepted, marking a turning point in climate change negotiations where all governments committed to a comprehensive plan and recognised the need to draw up the blue print for a fresh universal, legal agreement to deal with climate change beyond 2020.[11]
- The Doha Amendment (2012) to the Kyoto Protocol opened a gateway to greater ambition and action on all levels, and it set a second commitment period from 2013 through 2020.
- 2013 – Key decisions emerged on further advancing the Durban Platform, the Green Climate Fund and Long-Term Finance, the Warsaw Framework for REDD Plus (Reducing Emissions from Deforestation and Forest Degradation in Developing Countries) and the Warsaw International Mechanism for Loss and Damage.
- LIMA CALL in 2014 is a notable development and it envisaged the following:[12]
  - Step towards a new 2015 agreement on climate change that will harness actions by all nations with elaboration of the elements of the new agreement planned to be agreed in Paris in late 2015.
  - Agreed ground rules on how all countries can submit contributions to the new agreement during the first quarter of the following year.
  - LIMA Call catalysed the parties to work on Intended Nationally Determined Contributions (INDCs) which are designed to form as basis for climate action post 2020. This has potential for significant progress in elevating adaptation onto the same level as action to cut and curb emissions.

II. Space Technology Inputs for Climate Change Action Needs

Space Technologies aid and offer several advantages in observation and monitoring of Climate Change based on the principle of Remote Sensing, for example in measurement of Greenhouse Gas concentrations through passive remote sensing techniques.

Remote Sensing through space based sensors offers unique advantages as the Outer Space providing a vantage point for observing entire globe for climatic change drivers as well as effects. The space based observations overcome the

11 http://unfccc.int/key_steps/durban_outcomes/items/6825.php last accessed 07-03-2016.

12 http://newsroom.unfccc.int/lima/lima-call-for-climate-action-puts-world-on-track-to-paris-2015/ last accessed on 07-03-2016.

limitation of ground observations which are not distributed evenly and hence less supportive to accurate predictions of Global Warming.
Along with the observing platforms, the availability of ground systems for data collection, processing and analysis & interpretation aid in converting the data to information leading to better decision making and monitoring of compliance to international standards. Such scientific data will not only help in informed decision making but also assist in actions aiming to monitor the drivers of Climate Change. Applications examples include but not limited to studies on environment and pollution control, forestation studies involving Carbon stock measurements, marine observations, and monitoring of Sea Surface Temperatures.
Over the past five decades, there has been continuous advance in space capabilities, which proved to be immensely valuable in our endeavour to understand the natural environment and the impacts of anthropogenic activities. Through observations made from space platforms in near-earth polar and inclined orbits as well as geostationary orbits valuable inputs for Climate change actions could be derived as highlighted in Table 1.

Table 1 Inputs for climate change actions

No.	Climate Change Action Needs	Space Technology Input
1.	Detection of Changes	Unique capability for repetitive, well calibrated and consistent global observations on a long term basis
2.	Determining causes of climate change	Enables verification and validation of theoretical frameworks (observations from space play a complementary role)
3.	Modelling and predictions	Provides objective data (complementary role)
4.	Assessing impacts	Validation through observations from space (for synoptic level, space provides unique capability)
5.	Monitoring policy effectiveness	Enables verification/ provides rich source of data representing inputs and outcomes
6.	Climate information services	Space provides Critical Infrastructure for timely service and global access capability
7.	Technical means of compliance verification	Provides objective data, large coverage on cost effective basis
8.	Sustainable development	Enables Integrated analysis and decision support

The range of spatial, spectral and temporal dimensions of data and information derived from space makes it pertinent that for tackling a problem of global dimension such as climate change, the role of space technology is inalienable.

III. International Space Law and the Climate/ Environment Change

It is interesting to examine adequacy or otherwise of the existing International Legal Framework relating to activities in outer space, in particular the provisions of the Outer Space Treaty (1967) vis-a-vis the Climate Change action needs, The key provision of Outer Space Treaty to grant freedom and right of access to all countries without discrimination of any kind and use of outer space for the benefit and in interests of all countries becomes highly relevant for the context of actions to combat the Climate change, particularly for monitoring its state and providing an independent method to assess compliance. The treaty emphasizes international cooperation requiring the States Parties to the treaty to be guided by the principle of cooperation and mutual assistance and shall conduct all their activities in outer space with due regard to corresponding interests of all other States Parties to the Treaty.[13] The Treaty also obligates the States Parties to bear international responsibility for the national activities in space irrespective of whether they are carried out by the government agencies or non-government entities under their jurisdiction. Thus many of the provisions in Outer Space are in harmony with goals sought by the international agreements and actions relating to Climate change.

In the context of Climate Change, a branch of space activity which is intimately connected is remote sensing from space. However, till now the remote sensing principles[14] evolved under the aegis of United Nations Committee on Peaceful Uses of Outer Space (UN COPUOS), is in the nature of soft law and are non-binding. Among other things, these principles lay emphasis on the following:

- 'Use of Remote sensing from space' for the purpose of improving natural resources management, land use and the protection of the environment (Principle I);
- Consideration for the needs of developing countries (Principle II) in accordance with Art I of Outer Space Treaty (Principle IV);
- To promote international cooperation (Principle V);
- To provide for establishment and operation of data collecting and storage stations and processing and interpretation facilities (Principle VI);
- To promote the protection of Earth's natural environment (Principle X);
- To promote the protection of mankind from natural disasters (Principle XI);
- Right of sensed state to access the data on non-discriminatory basis and at reasonable cost (Principle XII).

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13 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, vide STSPACE11E.pdf accessible at http://unoosa.org/pdf/publications/STSPACE11E.pdf, last accessed on 08-03-2016.

14 Principles Relating to Remote Sensing of Earth from Outer Space, See pp. 44-47, United Nations Treaties and Principles on Outer Space, ST/SPACE/11, United Nations, New York, 2002.

While these principles are highly tuned to the goals of various agreements and initiatives on the Climate Change, in the light of Progress achieved in the field of Climate Change actions, it would augur well to evolve binding principles from currently non binding set of Remote Sensing Principles. This could mainly in the nature of harmonizing diversities of laws and policies in different countries.
Another set of Principles relating to outer space having a bearing for Climate Change is UN principles on International Cooperation and access to space benefits,[15] which is titled, "Declaration of International Cooperation in the exploration and use of Outer Space for the benefit and in the interest of all states, taking into particular account the needs of developing countries". Like the other principles, these are also non-binding and are not enforceable. Ensuring the availability of space derived climate data to all countries in a timely manner is quite important in the global context. However, the above provisions of these principles being non binding in nature, their interpretation and implementation by the States vary widely. To help assist meeting various needs of Climate Change actions as detailed in the foregoing section II and effective implementation of international agreements, a multi lateral system of systems is needed to meet the continuity, transparency, reliability and long term sustainability of data and information deliveries. The hitherto existing Principles on Remote Sensing and International Cooperation have to be further elaborated to specifically address the needs of Climate change action programs of international and intergovernmental bodies, national agencies and wherever relevant they have to be translated into legally binding norms.

IV. National/International Space Systems for Climate Observation

Today, there are a host of International Space Systems with a variety of observational capabilities useful for Climate Observation. Some prominent among them can be summarized as below:

- NASA's Cloudsat, GPM, OCO-2, TERRA, TRMM missions;
- JAXA, Japan's Greenhouse Gases Observing satellite (GOSAT);
- EUMETSAT's Meteosat, MetOp, Jason-2 missions;
- European Space Agency's (ESA) ENVISAT-SCIAMACHY payload for observing greenhouse gas;
- ESA's Copernicus Programme (erstwhile GMES), Sentinel-4, 5 and precursor Missions for monitoring atmospheric composition;
- ISRO's Kalpana, Megha tropiques, INSAT-3D Missions;
- The Chinese FY séries and the Russian Electro-L.

15 Declaration of International Cooperation in the exploration and use of Outer Space for the benefit and in the interest of all states, taking into particular account the needs of developing countries, ST/SPACE/11, United Nations, New York, 2002, pp. 55-56.

V. Global Observing System under WMO

World Metrological Organization (WMO) employs the Global Observing System (GOS) for Climate Change studies and monitoring. The GOS provides observations of the state of the atmosphere and ocean surface for the preparation of weather analyses, forecasts, advisories and warnings for climate monitoring and environmental activities. GOS is operated by National Meteorological Services, national or international satellite agencies. Developing the space-segment of the GOS is one of the four main components of WMO Space Programme. This includes planning[16] for operational geostationary satellites and low-earth orbit satellites at global level, as developed in consultation among WMO and satellite operators within the Coordination Group for Meteorological Satellites (CGMS). It includes a nominal configuration and a global contingency plan.

For such global observations, the nominal constellation of operational geostationary satellites includes minimum of six spacecraft to ensure full coverage from 50°S to 50°N with a zenith angle lower than 70°. In the Low Earth Orbit (LEO) sun-synchronous operational missions, the requirement is for four operational satellites optimally spaced in time, two in morning orbits (am), two in afternoon orbits (pm), and also another two spacecraft as in-orbit back-up An overview of space based Global Observing System is presented in Table 2.

Table 2 Geostationary satellites

Geo Satellite	GSO location	Operated by
GOES-West (3rd Generation)	135 degrees W	USA (NOAA)
GOES-East (3rd Generation)	75 degrees W	USA (NOAA)
METEOSAT (3rd Generation)	0 degrees	EUMETSAT
METEOSAT IO	57.5 degrees E	EUMETSAT
Electro L	76 degrees E	Russia
INSAT 3D	82 degrees E	India
FY-4	86.5 degrees E	China
FY-4	105 degrees E	China
GEO-KOMPSAT	128 degrees E	S. Korea
HIMAWARI 8	140 degrees E	Japan

The non geostationary segment of GOS, in low earth sun synchronous or inclined orbits include satellite missions of several space agencies such as A Train (GCOM-W/ Aqua/ Calipso/ Cloudsat), Meteor, FY-3, S-NPP, METOP, TRMM, Sentinel-3, JASON, PCW (Canada) and Arctica (Russia). WMO has also developed a Vision for the GOS in 2025 that provides a long term goal

16 www.wmo.int/pages/prog/sat/globalplanning_en.php accessed on 08-03-2016.

to foster development of GOS and meet the challenges of future weather and climate observation.[17]

VI. Global Climate Observing System (GCOS)

GCOS is an internationally coordinated network of observing systems[18] and a programme of activities that support and improve the network. Established in 1992 as an outcome of the Second World Climate Conference, it is designed to meet evolving national and international requirements for climate observations.

GCOS is a joint undertaking of the World Meteorological Organization (WMO), the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational Scientific and Cultural Organization (UNESCO), the United Nations Environment Programme (UNEP) and the International Council for Science (ICSU).

The goals of GCOS include – provision of comprehensive information on the total climate system, involving a multidisciplinary range of physical, chemical and biological properties, and atmospheric, oceanic, hydrological, cryospheric and terrestrial processes. GCOS includes both in-situ and remote sensing components, with its space based components coordinated by the Committee on Earth Observation Satellites (CEOS) and the Coordination Group for Meteorological Satellites (CGMS).

As a system of climate-relevant observing systems, it constitutes, in aggregate, the climate observing component of the Global Earth Observation System of Systems (GEOSS).

While the Global Observing Systems and GCOS represent enormous progress in the international cooperation and coordination, it is timely to review emerging informational needs out of the latest accomplishments in the Multilateral Agreements on Climate Change and the resultant requirement of Actions at national and international levels. This would take forward the agenda as well as organisational strengthening of global cooperative systems such as GCOS and GEOSS in meeting goals of the Paris Agreement.

VII. Multilevel Framework of Climate Change: Challenges for Law and Policy

Climate Change as a phenomenon is influenced by natural as well as anthropogenic factors and intricately connected with actions at individual, local, national, and international levels cutting across multiple domains of social, cultural, political and economic activities. Hence unitary and prescriptive approaches to deal with the challenges are inadequate. Systems addressing this

17 www.wmo.int/pages/prog/sat/globalplanning_en.php accessed on 08-03-2016.

18 https://www.wmo.int/pages/prog/gcos/index.php?name=AboutGCOS last accessed on 08-03-2016.

challenging frontier should be able to accommodate pluralistic approaches to norms and diverse organisational forms, promoting a learning behaviour. However the unifying thread for all these diverse systems is the supremacy of environmental ethics, which are ultimately in harmony with the well being of human and other species inhabiting our planet and connecting the individual with the collective.

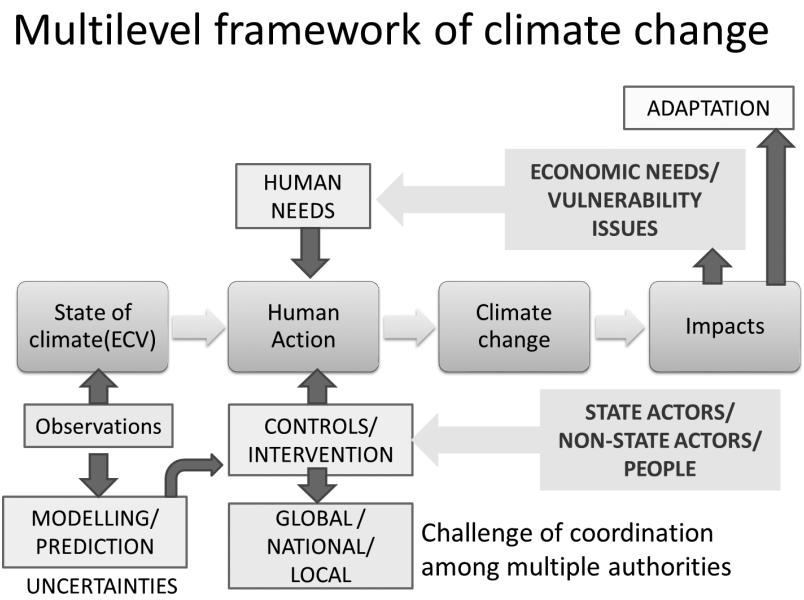
With the above backdrop, a multi level framework can be conceptualised for human actions at individual, local, national and international levels as illustrated in the diagram that follows. Economic factors and vulnerability issues are the two key determinants (though not exclusive) for human needs which in turn drive human actions that lead to impacts on climate. These impacts in turn will have feedback effects for human needs. The impacts would also demand Adaptation efforts. The intervention to moderate climate change and their impacts require information derived through observation of essential climate variables and through models and prediction techniques. There are inherent uncertainties in predictions of future climate state and also imperfections in any prescriptive action to change the climatic state and these are to be addressed by precautionary approaches and other political, legal and managerial mechanisms.

Climate change actions, particularly the human actions, originate at diverse levels starting from individual to international level and are highly complex to be controlled. The key to effective outcomes are the sound legal and policy environment, coordination among diverse levels of actors and creation of learning systems.

While the development and implementation of such a multilevel framework seems ideal to meet the diverse requirements for a comprehensive Climate Change action plans, some challenges are as follows.

- Balancing the interests of global, national and sub-national regimes – coordination complexities
- Institutional issues on integrating scientific inputs into policy/law, managing uncertainties
- Changing influences of state and non-state actors – multiple authorities, interest groups, & diverse silos of policy making organs
- Complexity of incentivizing precautionary principle across the board, and accepting diversity of environmental norms even beyond the economic criteria
- Education and capacity building in best practices

Figure 1 Multilevel framework of climate change



In conclusion, the concept of a multi level framework is to recognise inherent multiplicity of actors and systems at different levels of aggregation. There are consequent challenges to address the goal congruence, capacity building, and access to information in support of decision making. Coordination across the multiple levels is the key to success. Thus multilevel framework addresses the fundamental diversities of human needs and motivations, and the role of empowerment through learning process.