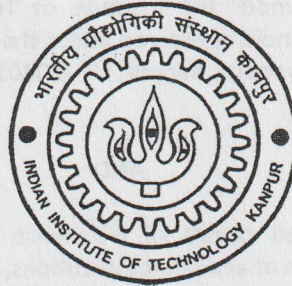


MEMORANDUM OF UNDERSTANDING

BETWEEN



INDIAN INSTITUTE OF TECHNOLOGY KANPUR [IIT KANPUR]

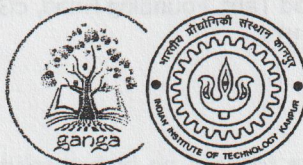
AND



SPACE SI

SLOVENIAN CENTRE OF EXCELLENCE FOR SPACE SCIENCES AND
TECHNOLOGIES [SPACE-SI]

FOR



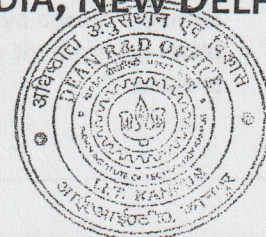
CENTRE FOR GANGA RIVER BASIN MANAGEMENT AND STUDIES
[CGANGA]

SUPPORTED BY

NATIONAL MISSION FOR CLEAN GANGA

MINISTRY OF JAL SHAKTI, GOVERNMENT OF INDIA, NEW DELHI,
INDIA

SEPTEMBER 2019



Memorandum of Understanding

This Memorandum of Understanding ("MoU") is made and entered into this 16, day of September 2019, ("Effective Date") by and between:

1. **Indian Institute of Technology Kanpur**, a research and educational institution of national importance, established under the Institute of Technology Act, 1961, enacted by the Parliament of Republic of India registered under the Societies Registration Act 1860, having its office at IIT Kanpur, Kalyanpur, Kanpur, UP -208016, India, (hereinafter referred to as "IIT Kanpur").

AND

2. **Space-SI**, a Slovenia based centre of excellence for space sciences and technologies established by a consortium of academic institutions, high-tech SMEs and large industrial and insurance companies in order to take advantage of the benefits of small satellite technologies and applications in Earth observation, meteorology and astrophysics (hereinafter "Space-SI").

In this MoU, IIT Kanpur and Space-SI are collectively referred to as the "Parties", and individually as the "Party", wherever the context so requires.

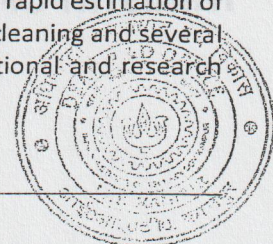
1 Background

1.1 IIT Kanpur (For Centre for Ganga River Basin Management and Studies-cGanga)

IIT Kanpur is one of the premier institutes to provide meaningful education, to conduct original research of the highest standard and to provide leadership in technological innovation for the industrial growth of the country. IIT Kanpur imparts and undertakes cutting-edge research in various areas of science, engineering, design, management, and humanities. The Centre for Ganga River Basin Management and Studies (cGanga) has been established at the Indian Institute of Technology, Kanpur (IIT Kanpur) as a Centre of Excellence for Management and Conservation River Basins. It acts as a comprehensive think-tank for the Ministry of Jal Shakti (Water Empowerment, formerly Water Resources, River Development and Ganga Rejuvenation, MoWR, RD & GR)), Government of India, in its stated goals and objectives vis-à-vis the River Basins. Dr Vinod Tare, Founding Head, cGanga will execute the responsibilities under this MOU on behalf of IITK.

1.2 Space-SI

The activities of Space-SI are focused on high resolution interactive remote sensing and formation flying missions. These goals are supported by the concurrent development of micro and nano satellite platforms, an advanced ground control infrastructure and satellite integration facilities as well as a multidisciplinary laboratory for testing of satellite systems and components in simulated space environments. On the application side, Space-SI is developing a complete and fully automatic processing chain from raw satellite data to web-delivered map-ready images and products. For the efficient utilisation of geo-located data a crowd-sourced dissemination platform Geopedia.si has been developed in Slovenia and thousands of data sets with several million data entries have been collected over the past few years. Space-SI has applied these systems to several solutions including advanced visualisation of real-time high-resolution forecasts of weather and pollution dispersion, rapid estimation of damages caused by floods, detection of invasive plants, illegal dump site cleaning and several other government and privately run initiatives as well as several educational and research projects.



Taking into account the background, the Parties have reached the following understanding:

2 Overall Aim

The overall aim of this MoU is to jointly develop a state of the art system for remote sensing using satellites. The system, initially called "GANGASAT" will add to the efforts of Ganga river rejuvenation (and other river basins) by integrating satellite data acquisition systems and services that are being developed in Europe for Danube river macro region with Indian remote sensing systems in order to set-up the most advanced infrastructure for water and agriculture monitoring in GRB.

Main Slovenian contributions will be STREAM system for multi-satellite data acquisition, STORM chain for automatic processing of satellite data and GANGASAT services for delivery of map-ready thematic products. These systems will be integrated with IIT Kanpur technologies and infrastructure to setup a pilot multi-purpose ground control station for cGanga which will be applicable not only to demonstrate its operational potentials to governmental institutions, but also as a very versatile platform for research, education and rising public awareness. It is envisaged that after the pilot project several mirror ground control sites will be setup at strategic institutions and locations along the Ganga River Basin to support its revitalisation efforts. The new high-tech system developed by Indian-Slovenian partnership will have high internationalisation potential not only for large transborder river basins in Asia and Europe but also for other continents including Africa and South America.

3 Areas of Cooperation

This MoU has identified a number of areas of cooperation listed further below:

a. Water bodies detection

Space-SI developed a system for detection of water bodies from Sentinel-1 data. The system is triggered when new data becomes available on the Sentinel Hub. It automatically detects water bodies with machine learning techniques and prepares the results for distribution.

The system has many benefits:

- daytime and nighttime observations
- independent of weather conditions
- fully automatic operation with short processing time
- the water state is available in less than 12 hours after the satellite image becomes available

Products: maps of the water bodies (and flooded area) at a selected moment / along with time series analysis in case of an emergency event

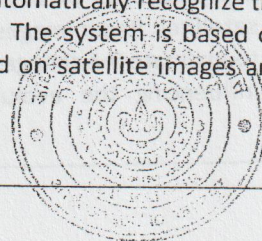
b. Water condition change

Optical Sentinel data can be used to observe the change in the water composition. This change can be caused by a combination of factors (e.g. sediments, chlorophyll, pollution). This service will use time series of satellite data to estimate the change in the water condition.

Product: maps of the change of water bodies condition

c. Agricultural drought and water scarcity monitoring

The objective of the agricultural drought monitoring service is to automatically recognize the state of vegetation and anomalies through satellite data (image). The system is based on machine learning procedures to build a classification system based on satellite images and



ancillary data. Auxiliary data can be obtained from various state institutions and international organizations.

d. Automatic processing chain

SPACE-SI owns a fully automatic processing chain for image geometric and radiometric processing. The chain works with many optical satellite images of medium, high and very-high spatial resolution. The processing is rapid and its products can be used in many applications.

Products: orthorectified optical satellite images that enable spatial comparability with other data as well as atmospherically and/or topographically corrected optical satellite data.

4 Details of the Work Programme

The GANGASAT pilot project will integrate hardware, software and knowledge from three major systems dedicated to satellite data *acquisition* (STREAM 54), automatic data *processing* (STORM) as well as from GANGASAT *services* for delivery of map-ready data products.

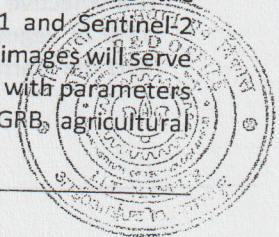
a. Satellite data acquisition system (HW/SW)

Delivery and Commissioning of STREAM 54 system

To facilitate direct acquisition of satellite data an innovative STREAM 54 ground station system will be installed at IIT Kanpur. The station will allow advanced satellite communications in S, X, Ka/Ku bands including interactive and low latency services to support domestic and international space missions. In the GangaSat pilot project we will demonstrate multi-purpose capabilities of the STREAM system for commercial, governmental, research and educational purposes. There are several options for the installation of the STREAM system. The first option is mobile/portable installation where the antenna positioner, reflector and radome are mounted on the top of two shipping containers where one of them can be used as a small control room for acquisition, processing and distribution of satellite data. The second option is a rooftop installation where a larger control room can be set-up in IIT Kanpur building and potentially combined with larger classroom facilities for educational purposes and for raising public awareness. As the third option the advantages of mobile antenna installation and large control room in the building can be combined. In the pilot project the RF chain for X band communications will be installed but the hardware system will be capable of supporting satellite communications within a wide range of other frequencies up to 40 GHz. To enable cost efficient and versatile data acquisition from various satellites the software defined radio (SDR) technologies will be applied. Furthermore, since Space-Si is an official Copernicus Relay Centre, the open data policy for Sentinels will be exploited to combine direct data acquisitions with sources from cloud based data hubs.

b. Automatic processing of remote sensing data (SW) - Delivery and Commissioning of STORM system

To efficiently process data acquired from multi-sensor, multi-satellite and multi-mission sources a STORM chain for automatic processing of remote sensing data will be installed. This will minimize time and costs required to transform raw sensor data from satellites to map-ready information products to be provided to the end-users. This means that the STORM system will automatically execute all tasks required for geometric, topographic and atmospheric corrections of satellite images and convert them into thematic maps that will be easily understood by the end-users from different application sectors. For those interested in water bodies, several specialized data products will be provided that combine the characteristics of both optical and radar satellite images from Sentinel-1 and Sentinel-2 satellites. Radar images will be used to detect water bodies while the optical images will serve to estimate the change in the condition of the water. These will be combined with parameters influencing the evolution of vegetation and environmental state in GRB, agricultural



production which leads to drought monitoring products. These products show the state of vegetation through the entire season (year) and are the base for drought services. The mentioned products with additional indices were already used in the Danube region to monitor the river and its basin. These data products can be integrated with Indian remote sensing services to provide holistic GRB solutions.

- c. **End-user services for water and agriculture monitoring (SW) – GANGASAT thematic products.** Scientists and experts from India and Slovenia will join forces to formulate most relevant system requirements for the STREAM 54 and STORM systems in order to enable optimal capabilities for GANGASAT data services. The aim is to match the end-user needs in the Ganga River Basin in the best possible way. The good practices and several successful solutions (VodaKjeSi, DriDanube, Applause, NewRadome) developed by Space-Si in Slovenia and European macro regions in collaboration with local enterprises, governmental agencies, European Commission and European Space Agency will be transferred to GRB to commercialize most recent research and innovation developments. Special attention will be given to selected satellite image based services.

5. Form of Cooperation

The approach the Parties involved under this MoU shall take is one of joint IP development and co-creation. Both the Parties shall contribute their technical knowhow, resources and expertise to develop a new product offering. The following steps will be taken to develop the cooperation:

- Step 1: Signing of this MOU
- Step 2: Space-SI shall prepare a small demonstration version of the Indian data it has already acquired and downloaded from the various European and other satellite resources.

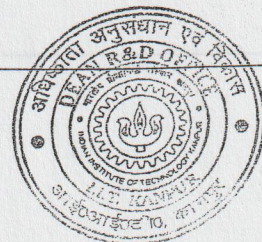
IIT Kanpur shall support Space-SI in contextualising the demonstration version.

- Step 3: Presentation of the demonstration to cGanga Management Board.
- Step 4: Feedback and gap assessment.
The Parties shall revise the proposition should the need arise.
- Step 5: Preparation of joint IP framework including the budget and financial aspects.
- Step 6: Funding of the IP
cGanga shall lead the efforts in seeking Government, scientific philanthropic and commercial investment partners for the project.
- Step 7: Signing of the IP framework agreement and funding

The Parties aim to reach Step 6 by December 2019 and Step 7 by March 2020. These timelines have been suggested on a best-effort basis.

6. Financial Arrangements

Until the signing of the IP framework agreement, the Parties involved under this MoU have no prior financial binding on each other. Any specific funding requirement will be worked out on the basis of specific activities as and when they arise.



7. Duration and Non-Binding Character

This MoU will take effect upon signature by all sides from the Effective Date for an agreed period of **3 years**. The MoU can be modified or terminated if either side expresses this wish in writing.

This MoU is not intended to create any legal or financial obligations under domestic or international law in respect of either side. The Parties may terminate this MoU by giving a prior written notice of 60 (Sixty) days mentioning sufficient reason of termination.

EXECUTED by the Parties on the Effective Date:

SIGNED BY: **Dr S Ganesh**
(Dean Research & Development, IIT Kanpur)
For and on behalf of
Indian Institute of Technology Kanpur

अधिष्ठाता
DEAN
अनुसंधान एवं विकास
Research & Development
आई० आई० टी० कानपुर
I. I. T. KANPUR

SIGNED BY: **Dr. Tomaž Rodič**
(Director)
For and on behalf of
Space-SI

16th SEP 2019