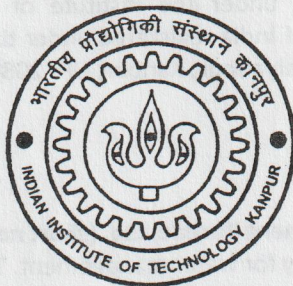


MEMORANDUM OF UNDERSTANDING

BETWEEN



INDIAN INSTITUTE OF TECHNOLOGY KANPUR [IITK]

AND

VGB (SLOVENIA)

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. **Maribor Water Management Bureau, Ltd. (short name VGB Maribor)**, a research and project design Slovenian company for water management. The company is registered in the following official registers of the Republic of Slovenia: in the Court Register dated 22 November 1989 with number 5150531, to the directory of design companies under order number 0866 at the Chamber of Engineering of the Republic of Slovenia and in the records of research organizations at ARRS (Slovenian research agency) under number 0274. It has its office at Glavni trg 19c, SI-2000 Maribor, Slovenia (hereinafter "VGB").

In this MoU, IIT Kanpur and VGB 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 of 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 IIT Kanpur.

1.2 VGB

VGB has joined the program of cooperation between India and Slovenia named Ganesha with pilot project within ICT for Water Resource Management, including surface / groundwater and flood modelling tools with a strong emphasis on inundation visualization. These tools built on existing commercial and open source modelling tools and VGB own work for preprocessing needed input data and postprocessing modelling results with geoprocessing, mapping and visualization with animation. The visualization tools will help policy makers and urban planners on the assessment of potential flood damage. MSc. Smiljan Juvan, CEO of VGB, will execute the responsibilities under this MOU on behalf of VGB.

Planned scope of the work and related activities, which will be made at the selected location of the pilot project are as follows:

1. Data preprocessing
2. Modelling with MIKE21/ArcInfo and HEC-RAS/QGIS, comparing the accuracy of the results
3. Determination of Flood risk-classes (and/or some other parameters)
4. Postprocessing of modelling results
5. Geoprocessing model in action
6. Dissemination
7. Matching stakeholders needs and additions
8. Final report with mapping and visualization, conclusions and proposal for further work.

Considering 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 advanced water flow modeling and visualization in order to achieve improved water flooding predictions and support operational and strategic decision making within the Ganga River Basin (GRB).

The system will add to the efforts of Ganga river rejuvenation (and other rivers) by integrating the advanced surface and underground 2D/3D modelling tools and services that are being developed and used in Europe with Indian water management applications and systems in order to set-up the most advanced infrastructure for water and agriculture simulations in GRB.

Main Slovenian contributions consist of:

- Data preprocessing;
- Modelling and visualization;
- Postprocessing of modelling results and geoprocessing model in action.

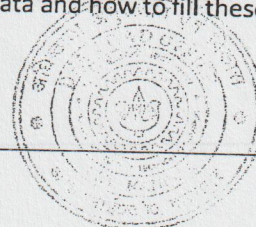
These system/tools will be integrated with IIT Kanpur technologies and infrastructure to setup a comprehensive and single point of water management for the Ganga river. It will be also used as a tool for potential applications to governmental institutions, but also as a very versatile platform for research, education and raising public awareness. It is envisaged that after the pilot project the system will be scaled-up and spread on the entire length of the Ganga river and within the Ganga River Basin to support its revitalization efforts. The new high-tech system developed by Indian-Slovenian partnership will have high internationalization 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. Field study, data collection, data processing, mapping and preparation for hydraulic modelling

The Parties will jointly determine the location and extent of the pilot area in this pilot project and the range of the optimal data. IIT Kanpur will check data availability for pilot area, including meteorological data, hydrological data, topographical information, land use and land cover, soil map, flood history and exposure elements, including demographic and household data, housing classification, infrastructure and agricultural data. The Parties will jointly evaluate the quality and reliability of the data, define gaps in data and how to fill these gaps, generate GIS layers and prepare data for hydraulic modelling.



Products: Report on field study, collecting existing data, their processing, mapping and preparation for hydraulic model.

b. Hydraulic modelling

VGB will use own tools for data preprocessing for terrain data in unordered ASCII format (LIDAR) and for importing exact elevation for possible flow barriers in inundations (roads, dams, railways, buildings etc.) via geoprocessing model. VGB will perform hydraulic modelling of pilot area with professional tool MIKE 21 / ArcInfo and open resource HEC-RAS / QGIS and compare the accuracy of the results. The Parties will jointly determine flood risk classes and/or some other parameters needed by stakeholders.

Products: Hydraulic model in MIKE 21 / ArcInfo and HEC-RAS / QGIS, report on hydraulic modelling results, estimated reliability commercial MIKE 21 / ArcInfo vs. open resource HEC-RAS / QGIS, determination of flood risk classes and/or some other parameters

c. Postprocessing of hydraulic modelling results and geoprocessing model in action

The Parties will determine the extent and manner of presentation of the hydraulic modeling results. VGB will present modelling results with ArcInfo, QGIS and Google Earth and use animation for timely display of flood expansion and decline. With geoprocessing model for postprocessing of hydraulic modelling results will be presented flood risk classes (or some other parameters relevant for stakeholders) also in the timing and animation.

Products: Presentation of hydraulic modelling results with ArcInfo, QGIS and Google Earth and animation, automatic creation of flood risk classes (or some other parameters), mapping and animation with geoprocessing model

d. Dissemination and matching stakeholder needs

In order to maximize the results of the pilot project, it is necessary to involve key stakeholders in the dissemination activities. The Parties will prepare plan for dissemination activities and it will be implemented to demonstrate the results of the pilot project and its usefulness in both the pilot area and the rest of the Ganga River Basin.

Product: Presentations for stakeholders, final report on pilot project with key results with spatial animation, conclusion and proposal for further work

4 Details of the Work Programme

The VGB advanced water modelling pilot project with included expanded and visually clear data preprocessing and postprocessing of hydraulic model results with adapted geoprocessing models will give a tool for managing flood hazard in the Ganga River Basin in specific local operational areas. Floods represent a natural risk, which can produce important material and human losses.

A comparison between more financially demanding commercial tools with the required licenses and open resource tools will answer which data set, terrain properties and hydrogeological conditions make the financially less demanding open resource tools completely equivalent to more expensive commercial ones. The advantage of open resource tools is that both data and the results in the form of maps are easier to share and use among stakeholders, which ensures their more efficient use.



a. Data preprocessing

The quality of the models depends on the availability, quality and reliability of the input data. Thus, data collection and compilation, including field review, are an important part of the pilot project to be supported by IIT Kanpur. All data will be reviewed, assessed and maintained in data inventory sheets along with the information regarding the vintage, source, resolution and other feature attributes. Data, without any gaps, will be considered for processing, appropriate sources or methods will be identified to fill any gaps for the remaining data sets in collaboration with both the Parties. The Parties will prepare a plan and carry out a review of the data quality check and data quality assurances. These will be mainly concentrated in the areas of resolution of data, projection system, positional accuracy, topological error of the data, creation of unique ID, essential fields, standard unit in all datasets, file naming convention and versioning. Data will be presented in generated GIS layers, presented in ArcInfo and QGIS and prepared for hydraulic modelling.

b. Hydraulic modeling and results visualization

Hydraulic modelling identifies and demarcates those parts of the pilot area which can be exposed to the floods. It will be providing information on the extent and depth of flooding throughout flood prone areas for a range of flood magnitudes. Previously collected and compiled existing and relevant data will be used in hydraulic modelling. For this commercial MIKE 21 /ArcInfo and one open resource HEC-RAS / QGIS tool will be used. For both VGB will give geoprocessing models for data preprocessing and model results postprocessing. Calibration and validation of hydraulic models will be done using historical flood gauge-discharge data. Probabilistic analysis of runoff to simulate various return periods will be done in coordination with IIT Kanpur. Flood maps will be prepared in cooperation with both Parties as important for government strategies and flood risk management. Animations in Google Earth will be prepared for individual flood events, showing the timing of the flood rise and its withdrawal for better stakeholders understanding.

c. Postprocessing of modelling results with geoprocessing model

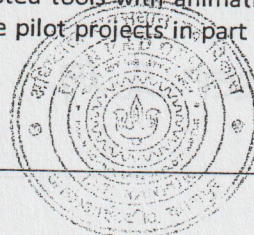
Postprocessing of hydraulic modelling results are very important part to make these results more useful in government strategies and to facilitate stakeholders understanding. Therefore, the partners will pay special attention to this; IIT Kanpur with stakeholder needs and VGBs with their developed geoprocessing models to quickly display desired results (e.g. flood risk classes with required, legally defined attributes, automatic rendering of styling of created layers).

This pilot project will consider relevant Ganga River Basin Management reports from cGanga. All approaches will be coordinated with IIT Kanpur and this will ensure that they are coordinated and applicable to the pilot area and Indian professional culture.

5 Form of Cooperation

The approach the Parties involved under this MoU shall take is 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: VGB will prepare a demonstration version of suggested tools with animation on some projects done in Slovenia and proposed contents of the pilot projects in part of the Ganga river basin, coordinated with IIT Kanpur collaboration.



- 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

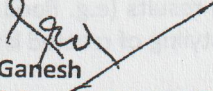
Until the signing of the IP framework agreement, the Parties involved under this MoU have no prior financial binding on each other. Any specific funding requirement will be worked out based on specific activities as and when they arise.

7 Duration and Non-Binding Character

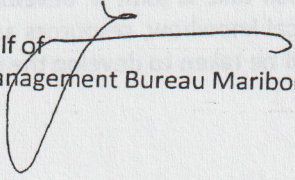
This MoU will take effect upon signature by all sides from the Effective Date for an agreed period of **3 years**. The MoU can be modified or terminated if either side expresses this wish in writing.

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 enough 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: 
MSc. Smiljan Juvan
(CEO of VGB)
For and on behalf of
VGB – Water Management Bureau Maribor

16th SEP 2019