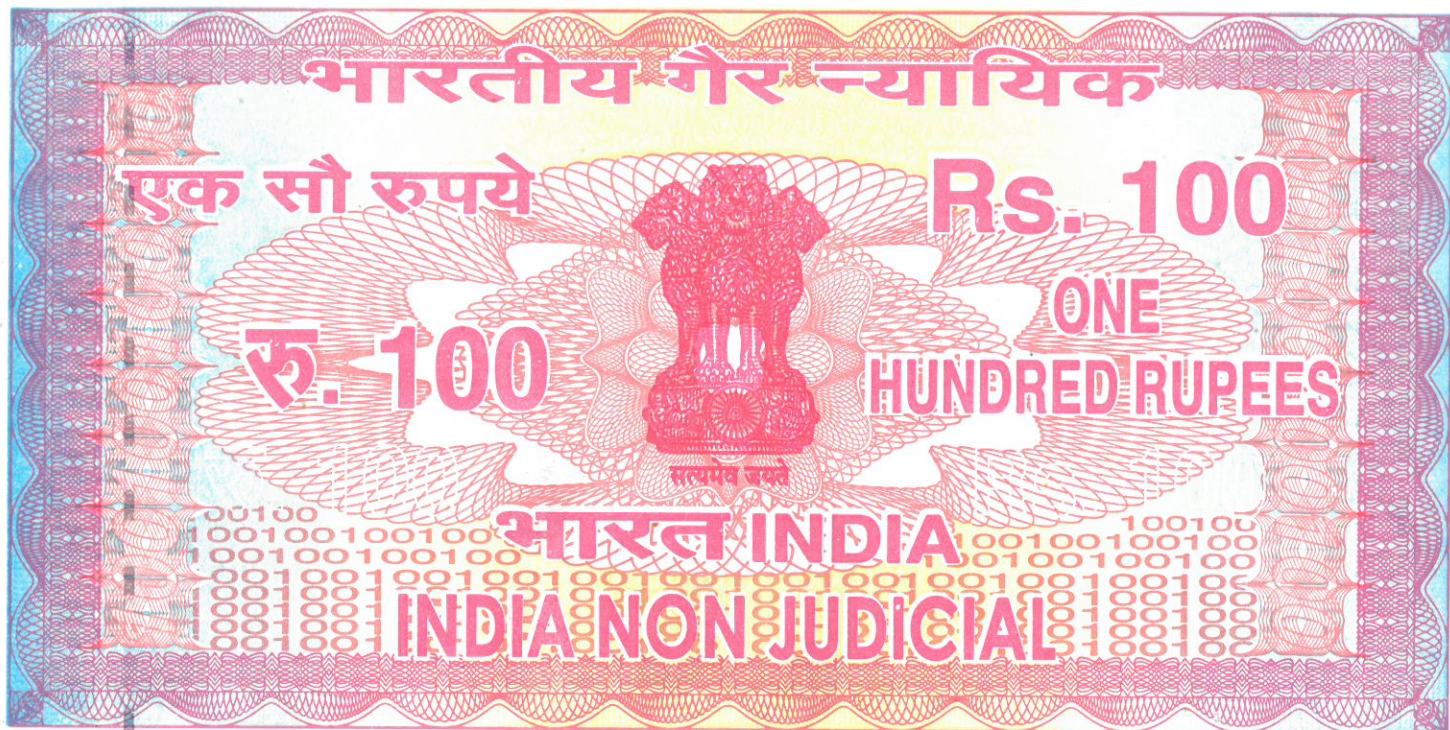




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MEMORANDUM OF UNDERSTANDING

Between

KARNATAKA STATE NATURAL DISASTER MONITORING CENTRE, BENGALURU  
Department of Revenue (Disaster Management)  
Government of Karnataka

And

AMRITA VISHWA VIDYAPEETHAM (Amrita)  
Amritapuri Campus, Amritapuri, Clappana P. O.  
Kollam, Kerala – 690 525

Entered into on 8<sup>th</sup> day of December in the year 2022,

No. 23136 Date 8/12/22  
Issued to: അമൃത വിദ്യാപീഠം, കോളം.  
അംഗീകൃതം

പി. ബാലകൃഷ്ണപിള്ള  
ചീഫ് ഓഫീസ് ഓഫീസർ

*(Signature)*



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KARNATAKA STATE NATURAL DISASTER MONITORING CENTRE, BENGALURU

Department of Revenue (Disaster Management)

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And



AMRITA VISHWA VIDYAPEETHAM

Amritapuri Campus, Amritapuri, Clappana P. O.

Kollam, Kerala – 690 525

November 2022

This Memorandum of Understanding (hereinafter referred to as 'MoU') is entered into on 8<sup>th</sup> day of December month in the year 2022.

## BY AND BETWEEN

**Karnataka State Natural Disaster Monitoring Centre, Department of Revenue (Disaster Management), Government of Karnataka** through its Authorized Signatory **Dr. Manoj Rajan, Director** having its office at Bengaluru, Karnataka (hereinafter referred as the **KSNDMC**, which term or expression, unless excluded by or repugnant to the subject or context, shall mean and include its successor(s)-in-office, administrators and permitted assignees) on the **First Part**.

## AND

Amrita School for Sustainable Development [AST], UNESCO Chair on Experiential Learning for Sustainable Innovation & Development, Amrita Centre for Wireless Networks and Applications [AmritaWNA], **Amrita Vishwa Vidyapeetham**, Amritapuri Kollam, Kerala through its Authorized Signatory **Dr. Maneesha Vinodini Ramesh, Provost, Research & Innovation**, Dean, School for Sustainable Development, and International Programs, UNESCO Chair on Experiential Learning for Sustainable Innovation & Development, Director, Center for Wireless Networks and Applications, having its office at Ettimadai, Coimbatore, Tamil Nadu (hereinafter referred to as **AMRITA**, which term or expression, unless excluded by or repugnant to the subject or context, shall mean and include its successor(s)-in-office, administrators and permitted assignees) on the **Second Part**.

Both **KSNDMC** and **AMRITA** are individually referred to as "Party" and collectively as "Parties".

The Parties hereby agree to and set forth the terms governing their collaboration on the Project (as defined below).

## PREAMBLE

One of the most beneficial projects developed by AMRITA for society - **Landslide Early Warning System (LEWS)** involves design, development and deployment of a real time **Wireless Sensor Network (WSN)** for landslide detection and early warning. This is a comprehensive system for management of risk arising due to landslide hazard that

contains an online data visualization software for real-time data analysis, visualization & assessment of risk and a Landslide tracker app for crowd-sourced collection of data. This system addresses one of the most pressing needs for saving lives in the nation's disaster prone areas. Along with the real-time deployment, large and medium scale landslide laboratory setups have been developed for conducting extensive experimentation to gain a better understanding of landslide phenomena. Currently, Amrita has LEWS deployed in Munnar, Idukki district, in the State of Kerala, and Chandmari, Gangtok, in the State of Sikkim.

KSNDMC is responsible for providing Science & Technology (S&T) inputs for managing and mitigating natural disasters in the Karnataka State. KSNDMC is engaged in a number of activities related to synergizing S&T activities and providing a common platform for the responsible stakeholders in Disaster Management for Karnataka State. KSNDMC has installed a network of weather monitoring stations, which comprises Solar Powered & GPRS enabled Telemetric Weather Stations (TWS) (~250 Sq. km.) and Telemetric Rain Gauge Stations (TRG) at all the *Gramapanchayaths* (~25 Sq. km.). The data on temperature, relative humidity, wind speed, wind direction, rainfall intensity, and amount of rainfall is being collected at every 15 minutes. The near-real time data collected through this network is being analysed to generate maps and reports in near real time.

**AMRITA & KSNDMC** are putting collaborative efforts towards making Karnataka safer and landslide resilient. In this regard, detailed studies will be jointly undertaken to study and understand the natural disasters in Karnataka with a special focus on rainfall induced landslides. The Parties shall exchange required data in support of the above mission to make the communities in Karnataka, resilient to landslides and also to help the communities to better adapt to the increasing climate change related disasters. The parties will undertake conducting of capacity building activities for mitigation, preparedness, and response to potential disasters.

Though some of the work in this respect has already been initiated jointly by KSNDMC and AMRITA, it was felt that the engagement process be institutionalized with mutual strengths of these Organizations to facilitate future roadmap for meaningful interactions.

#### **ARTICLE-1: MoU**

KSNDMC recognizes the importance of research, development, and utilisation of latest technologies for upgrading the skills of its personnel and to copeup with climate change -landslide hazards in Karnataka. KSNDMC also recognises that AMRITA, by virtue of its focus in this field is an organisation having state-of-the-art infrastructure managed by highly accomplished and reputed scientists. This collaboration would be to synergise the experience, expertise, and efforts of both Parties towards management of landslide hazards for the State of Karnataka. Research activities leading to better understanding of landslide risk, adoption of latest technology to mitigate and manage these risks will be initiated as a part of the Programme. The Parties shall put in collaborative efforts in seeking funds for the above purpose and in execution of the projects with this aim.

Therefore, in consideration of the above mentioned purpose, both Parties hereby agree to sign a Memorandum of Understanding (MoU) on mutually agreed scope/terms hereinafter mentioned.

#### **ARTICLE-2: SCOPE OF THE MoU**

This MoU defines the broad framework of interaction and engagement of the Parties and spells out the rights and responsibilities of the Parties hereto. The broad scope of MoU includes the following areas but is not limited to:

1. To identify locations vulnerable to landslides and assess the exposure of elements at risk in these locations
2. To develop rainfall threshold models specifically for multi-hazard scenarios such as landslides, floods, and drought in the locations identified
3. To develop an impact based weather forecast for the locations identified
4. To implement systems for multi-hazard (Landslides, Floods etc.,) monitoring, modeling, and mitigation

5. To develop an IoT based early warning system for selected multi-hazards at the locations identified, based on real-time & historic data along with field visits
6. To analyze climate change adaptation and mitigation through a strategic framework for assessing current level of community disaster resilience
7. To study the communities in the identified areas and to determine interventions that make these communities disaster resilient
8. To study and quantify the impact of climate change and anthropogenic activities on the frequency & intensity of such natural hazards
9. To take up geospatial modeling of earth observations by applying state-of-the-art methodologies in the area of big data analytics, statistical downscaling, deep learning modeling
10. Utilization of Amrita's existing Landslide Early Warning System products for KSNDMC operations
11. Carry out joint validation of Landslide Early Warning System products vis-a-vis weather experienced
12. Combined efforts for the development of landslide forecasting models

### **ARTICLE-3: SHARING OF FACILITIES/ RESPONSIBILITIES**

Both AMRITA and KSNDMC shall encourage interactions between personnel, scientists, research fellows, faculty members of their organizations through sharing of responsibilities as enumerated below:

#### **Responsibilities of AMRITA**

1. Detailed field investigations for assessment of area's underlying regolith material, surface geomorphology and geological features along with identification of elements at risk for selected and prioritized landslide prone areas, which are mutually agreed by both Parties
2. Design, development and deployment of real-time monitoring solution for multi-hazard monitoring in the identified locations
3. Research on evolving village level '*Dynamic Multi-hazard Map*' to facilitate district administration in capturing the real-time risk and managing the available resources in collaboration with the stakeholders

4. Develop real-time monitoring of surface water discharge at selected locations and design thresholds on hydro-meteorological parameters for early warning of multi-hazards, which will be of immense help to the district administration
5. Developing AI and ML models for the aforesaid designed thresholds
6. Utilization of an existing mobile app already developed by Amrita for facilitating rescue & relief measures during floods and multi-hazards and enhancing the features of the app in collaboration with KSNDMC requirements
7. Instrumentation-based real-time monitoring systems need to be deployed at selected strategic and vulnerable locations to capture a comprehensive set of triggering factors to deliver real-time warnings for multi-hazards and thereby assess its impact on the elements at risk
8. Real-time threshold development for heterogeneous triggering parameters is envisaged using AI/ML based methods for prediction and early warning of multi-hazards
9. Enhancement of the landslide tracker app in collaboration with KSNDMC to build Dynamic Risk Assessment for early warnings at Gramapanchayath level

#### **Responsibilities of KSNDMC**

1. To share the hourly cumulative rainfall data and weather data from the weather stations network established in Karnataka
2. To share the available weather forecast data
3. To provide detailed landslide inventory/incidences location data for the study area
4. To provide past and real-time dam opening and discharge data for building of the flood models
5. To provide required Satellite imageries (Landsat-FCC) for the study area
6. To provide past and real-time seismological data and event information in the state
7. To provide 1:25,000 scale Toposheets, Digital Elevation Model (DEM), Village & GP boundary files, building footprints and other required maps

8. Nominate a single point of contact from KSNDMC for communication regarding technical / operational and administrative activities under the purview of this project
9. To prepare and submit periodical reports on the nature of work and the results achieved.
10. KSNDMC will create/ ensure satellite data products over the study area availability to AMRITA through dedicated FTP over Internet/ leased lines
11. KSNDMC will share other available ground observations with AMRITA for the improvement in the model predictions
12. KSNDMC in co-ordination with the district administration will allocate facilities to host the equipments in the form of land and building (Field Management Center) to set up the observatories for monitoring of multi-hazard

#### **Joint responsibilities and Coordination**

1. Each party shall pursue its own research and operational programmes that involve data from other sources
2. Each party shall appropriately acknowledge the contribution of the other party while publishing the work in National/International journals or in any other form
3. Both Parties shall work together to provide science & technology based inputs to the State Government towards Disaster Risk Reduction and Resilience of Karnataka
4. To periodically carry out validation exercises and periodically review the project deliverables
5. To prepare and submit periodical reports on the nature of work and the results achieved
6. To periodically carry out validation exercises jointly with Technical personnel of AMRITA.

#### **General**

1. Any amendments to this MoU will be treated as valid and effective if made in writing with consent of both the Parties of this MoU
2. This MoU will be in effect as long as there is no breach of responsibilities by the Parties or terminated by the Parties on mutual consent. Parties obligations if any, will survive even after the termination of this MoU

#### **ARTICLE-4: COORDINATION**

AMRITA and KSNDMC together will cooperate and co-ordinate in the following areas:

1. Parties will form a Project Monitoring Unit (PMU) consisting of at least two members from both the organizations including the Heads of both Parties
2. Facilities in the form of equipment and expertise from both the organizations will be utilized and extended to each other over the study area based on mutual agreement
3. Parties will try to jointly or individually raise funds for the objectives of the MoU to achieve the scope of this MoU in the form of research projects
4. Both Parties will provide possible logistics under the joint programme implementation. The cost, if any, will be borne by KSNDMC
5. Both Parties will cooperate in deployment and operationalization/utilization/calibration of developed observational equipment
6. Both Parties will participate in mutual training programmes and workshops conducted at KSNDMC and AMRITA
7. Both Parties will meet periodically for knowledge sharing and mutual updation of work carried out by them under this MoU
8. Both Parties will conduct an annual symposium/workshop to disseminate the research outcomes gained under this MoU

#### **ARTICLE-5: EFFECTIVE DATE AND DURATION**

This MoU shall be effective for a **period of Five (05) years** from the date of signing of MoU. The validity of the MoU may be extended by mutual agreement, which shall be in writing and signed by both the Parties.

#### **ARTICLE-6: PRE-CLOSURE**

This agreement is signed in the interest of the nation and the mutual professional benefits of the two organisations and is valid for the specified period agreed upon therein. However, in the event of any requirement to pre-close this agreement on reasons that warrant such an act, the same may be done with mutual consultations and prior intimation to the other party with a notice **not less than three months** in advance. The pre-closure of this agreement shall not be liable for any compensation to or from either of the parties under this agreement.

#### **ARTICLE-7: CONFIDENTIALITY**

During the initial tenure of five years of FIVE (05) years of this MoU and extended period, if any the Parties shall undertake on their behalf and their employees or representatives to maintain strict confidentiality and avoid disclosure to any third party of any information and data exchanged or generated pertaining to work or results of this MoU for any purpose other than this MoU. Each party shall treat the technical and financial information as confidential and shall not make any private announcement without the written approval of either of the party.

Any confidential information exchanged by the Parties and entitled to protection hereunder shall be identified as such by affixing appropriate stamp on each document designating that the information as "Confidential". Both the Parties acknowledge that confidential information is valuable and unique and in the case of any breach, the affected party shall be entitled to claim injunctive relief in addition to all other remedies available in law or equity, including monetary damages.

Upon expiry or the termination of this MoU, the receiving party shall return to the disclosing Party's all of the disclosing Party's known tangible forms of the confidential information and copies thereof in the receiving Party's possession.

Information received/gathered during the course of performance of this MoU either written or oral in respect of but not limited to any software/hardware material, product specifications, designs, financial, information, documents etc., shall be deemed to be

in private domain and it shall not be made public or shared with any other party without the prior written consent of the party which owns it.

#### **ARTICLE 8: AMENDMENTS**

This MoU represents the understanding between KSNDMC and AMRITA in the present circumstances and supersedes any earlier understanding either oral or written hitherto with respect to the subject matter of the agreement.

No amendments or modification of the MoU shall be valid unless it is made in writing and signed by both the parties and specifically stating the same to be an amendment of the MoU. The modifications changes shall become part of the MoU from the date on which they are executed unless otherwise agreed to in writing.

#### **ARTICLE-9: FORCE MAJEURE**

Force Majeure is an event for which either party cannot be held accountable. For events constituting force majeure, they must be unforeseeable, external to both the parties and unavoidable. Neither party shall bear responsibility for the complete or partial non-performance of any of its obligations if the non-performance is because of Force Majeure circumstances such as Flood, Fire, Pandemic, Earthquake and other acts of God, as well as War, Military operations, blockade, Acts or Actions of state Authorities or any other circumstances beyond the control of the parties that might arise after the conclusion of the MoU. In the event of any dispute arising out of Force Majeure wherein any of the party under this agreement is unable to meet the specific requirement due to the reasons beyond the control of the organization, the same may be resolved on mutually agreeable terms and conditions including waiver if applicable with regard to time, space, quantity or quality of the deliverables.

#### **ARTICLE-10: INTELLECTUAL PROPERTY AND PUBLICATION**

## **1. General Clauses**

- i. Each party will ensure appropriate protection of Intellectual Property Rights (IPR) generated from cooperation pursuant to this MoU, consistent with laws, rules and regulations of India
- ii. In case of research results obtained through joint activities, the grant of IPR will be sought by both the Parties jointly and once granted, these rights will be jointly owned by the parties
- iii. The Parties shall not assign any rights and obligations arising out of the IPR generated to inventions/activities carried out under this MoU to any other third Party without prior written consent of either of the Parties.

## **2. Publication**

Any publication, document and/or paper arising out of joint work conducted by the participants of both the Parties pursuant to this MoU will be jointly owned. The use of the name, logo and/or official emblem of the participants on any publication document and/or paper will require prior permission of both the participants. It may however, be ensured that the official emblem and logo is not misused

## **ARTICLE-11: DISPUTE SETTLEMENT MECHANISM**

- i. All disputes arising between the Parties in any way connected with this MoU or in regards to the interpretation of the context thereof shall be resolved amicably on mutual consultations and negotiations between the two Parties. If the matter remains unresolved, the same will be referred to the Director's of both the Organisations, whose combined decision will be final
- ii. Notwithstanding, anything mentioned in the above para, the party to this MOU with written mutual consent may take recourse of any alternative dispute settlement mechanism

## **ARTICLE-12: GOVERNING LAW**

This MOU shall be governed as per provisions of the applicable Indian Laws.

### **ARTICLE-13: MISCELLANEOUS**

The headings and sub-headings are inserted for convenience only and shall not affect the construction of this MoU.

After this Agreement has been signed, all preceding understandings/ negotiations and correspondence pertaining to it shall become null and void.

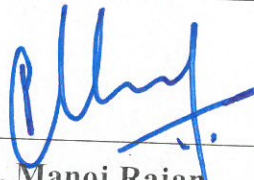
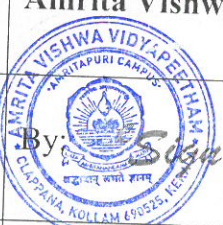
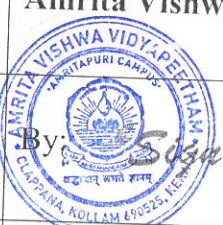
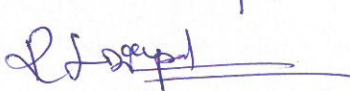
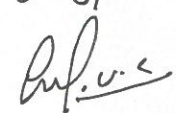
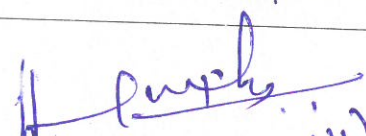
All disputes or differences arising out of or in connection with this understanding shall be settled only through mutual discussions and negotiation.

### **ARTICLE-14: FOCAL POINTS**

|                                                                                                                                                   |                                                                                                                                      |
|---------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|
| <b>Amrita Vishwa Vidyapeetham</b>                                                                                                                 | <b>Karnataka State Natural Disaster Monitoring Centre (KSNDMC)</b>                                                                   |
| <b>Prof. Maneesha Vinodini Ramesh</b><br>Provost of Strategic Initiatives,<br>Research, and Innovation,<br>Clappana P O, Kollam-690 525<br>Kerala | <b>Dr. Manoj Rajan</b><br>Director<br>Major Sandeep Unnikrishnan Road<br>Attur Layout, Yelahanka<br>Bangalore - 560 064<br>Karnataka |

IN WITNESS WHEREOF PARTIES HERE TO HAVE ENTERED INTO THIS AGREEMENT EFFECTIVE AS ON THE DATE AND YEAR FIRST WRITTEN ABOVE.

On Behalf of:

|                                                                                                                 |                                                                                                                                                                           |
|-----------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Karnataka State Natural Disaster Monitoring Centre, Bengaluru</b>                                            | <b>Amrita Vishwa Vidyapeetham, Kerala</b>                                                                                                                                 |
| By:                           | By:   |
| Name: Dr. Manoj Rajan                                                                                           | Name: Dr. Maneesha Vinodini Ramesh                                                                                                                                        |
| Designation: Director, KSNDMC<br>Director<br>Karnataka State Natural Disaster<br>Monitoring Centre<br>Bengaluru | Designation: Director, AMRITA Center<br>for Wireless Networks & Applications                                                                                              |
| Witness:                                                                                                        | Witness:                                                                                                                                                                  |
| 1. Dr. Ramesh Deepal<br>     | 1. Gosh. V. G<br>                                                                     |
| 2. <br>(S. JAGADEESH)        | 2. Nabin Kumar M<br>                                                                  |