

Application Form for World Centre of Excellence on Landslide Risk Reduction 2020-2023

1. **Name of Organization:** Amrita Vishwa Vidyapeetham, Amritapuri campus, India

2. **Name of Leader:** Dr. Maneesha V Ramesh

Affiliation: Director, Amrita Center for Wireless Networks & Applications,

Contact: Amrita Vishwa Vidyapeetham, Amritapuri, Kollam, Kerala, India. PIN- 690525

Core members of the activities

Names/Affiliations: (4 individuals maximum)

Dr. Venkat Rangan, Vice chancellor, Amrita Vishwa Vidyapeetham, Coimbatore campus.

Dr. Nirmala Vasudevan, Associate Professor, Amrita Vishwa Vidyapeetham, Amritapuri, Kerala.

Mr. Sangeeth Kumar, Research Associate, AmritaWNA, Amrita Vishwa Vidyapeetham, Amritapuri campus

Ms. Hemalatha T, Research Associate, Amrita WNA, Amrita Vishwa Vidyapeetham, Amritapuri campus

Ms Divya P, Research Associate, Amrita WNA, Amrita Vishwa Vidyapeetham, Amritapuri campus

3. **Date of Submission of Application:** 17-August-2019

4. **Activity scale and targeted region.**

1) Global, 2) Intercontinental, 3) Continental, 4) Regional, 5) National

5. **Short Title (10 words maximum) characterizing past and planned activities:** Internet of Things (IoT) for landslide disaster risk reduction

6. **Objectives for the initial 3 years:** (5 lines maximum; what you expect to accomplish?)

Our objective is to utilize interdisciplinary capabilities to develop systems and solutions for effective monitoring and early warning of landslides. The major objectives are (a) development of low cost Deep Earth Probes and Intelligent Wireless Probes with Edge Computing for Enhanced monitoring, (b) development of IoT framework for large scale monitoring of landslides, (d) decision models using machine learning and artificial intelligence, (e) adaptive multi scale warning models, (f) enhancing community resilience through multiple techniques.

7. **Background Justification:** (10 lines maximum)

Amrita University is performing research and development for landslide risk reduction for more than a decade. Amrita has deployed India's first landslide monitoring, and early warning system consisting of more than 150 geo physical sensors in Western Ghats, India. This system has collected data from 2009 onwards and has issued real-time warnings in the year 2009, 2011, 2013, 2018 and 2019, thus validating the WSN based technology. The increase in fatalities in Himalayas has prompted us to deploy an enhanced system in Himalayan region also. The real-time data from this system is also streamed to Amrita University and used for issuing real-time warning in North East Himalayas in Sikkim, India. One of the major focus of this research group is to enhance the research capability to cater to the numerous requests for this system in the whole country to reduce the landslide risk levels.

For better understanding of the landslide phenomena, to develop thresholds for each landslide parameters and to develop unique models for monitoring and detecting landslides, Amrita University has designed and developed India's first landslide laboratory capable of simulating landslides with respect to the dynamic variation of several geological and hydrological parameters that could trigger a landslide. Amrita University's research and deployment work on landslide early warning system was appreciated by the Indian government's apex body 'The Rajya Sabha' and extended their further support for development of such system in Himalayas, This research work were awarded one of the prestigious national award the NABARD award for rural innovation[14]. The innovativeness of the system developed by AMRITA has also brought in a US patent for the knowledge and system [13]. This work was appreciated by UN and invited Dr. Maneesha to present the work in the conference UNAI (United Nations Academic Impact).

8. Resources available for WCoE activities

Personnel: We have experienced geologist (including Dr. S.K. Wadhawan, Retd, Director General, Geological Survey of India), landslide experts, computer scientist and data scientist who had worked for the real-time deployment of landslide monitoring systems in Western Ghats and Himalayas, India.

Facilities: Landslide laboratory for conducting experiments related to landslides, Real-world fields where a monitoring system based on Internet of Things (IoT) is deployed for landslide early warning.

Budgets: Landslide research in Amrita is continuously funded by both international and national bodies at different time windows.

Contribution to ICL/IPL-GPC: As part of the ongoing WCoE we have completed a real-time deployment for monitoring landslides in Sikkim Himalayas. The same has been submitted as a report to the ICL project committee.

9. Description of past activities related to risk reduction of landslides and other related earth system disasters (30 lines maximum)

1. Amrita University has developed and deployed landslide monitoring and early warning system in two major landslide prone areas in India Western Ghats: The WSN system for landslide monitoring & early warning is deployed in an inhabited place “Anthoniar Colony” in the town Munnar, Kerala, India (10.0892 N, 77.0597 E). Two major landslides had already occurred in this area. The landslide monitoring and early warning system using wireless sensor network technology consist of 150 geological sensors embedded and installed at various locations on the slope. The complete functional system is deployed in 2008 and data is been gathered since 2009. A real-time warning for landslides is issued in 2009, 2011, 2013, 2018 and in 2019. After the success of this work, in 2013 Government of India has encouraged and funded Amrita University to deploy one such system in Chandmari, Sikkim, located on North Eastern Himalayas.
2. North Eastern Himalayas: Sikkim is a state situated in North Eastern Himalayas where more number of fatal landslides are reported every year. Our landslide monitoring system is deployed in Chandmari, Sikkim. The complete deployment of the system completed in December 2018. This work was as part of the WCoE 2017-2020. Along with this research work the team has initiated research on Landslide Vulnerability mapping in Western Ghats and Himalayan ranges, Pre disaster studies which includes susceptibility mapping and landslide inventory mapping, Crowd sourcing for Disaster risk reduction, Mobile phone app and game development for educating the community, Community engagement for Disaster Risk Reduction and Post disaster immediate and long term relief work.
3. We have also conducted community engagement programs in Munnar and Sikkim regions where we have installed our system for landslide monitoring. We have created a whatsapp group which is an active source of information during 2018, 2019 floods and landslides in Kerala, India. With respect to Crowd sourcing for Disaster risk reduction, we have developed a mobile application “Amrita Kripa” for crowd sourcing from the people living in susceptible landslide locations. Amrita Kripa app was very helpful during 2018 and 2019 flood and landslides in Kerla, India and in total it has rescued 408145 people from 17 districts in Kerala, India. The

people affected due to flood and landslide participate by providing inputs like, the people standard at different locations, amount of water in a particular area, road blocks, landslides, requirements in relief camps, the amount of rain, small displacements or cracks noticed in the slope, landslides in their area, emergency requirements, etc in the form of text and images. We have also developed algorithms for analyzing the crowd sourcing data. We have also developed games for educating the children and the community about the emergency responses and mitigation measures, first aid measures, etc. Training sessions were provided for community engagement in Disaster Risk Reduction and short and long term post disaster relief camp development was performed. In this regard Amrita University has involved in several facets of Landslide Disaster Reduction.

10. Planned future activities /Expected Results: (20 lines maximum; work phases and milestones)

S. No	Task	Start date	End date	Duration
1	Development of low cost Deep Earth Probes	01-01-2020	31-9-2020	9 months
	Initial design, Simulation Deep Earth Probe Prototype			
2	Design of Intelligent Wireless Probe	01-10-2020	30-12-2021	15 months
	Design of interfacing circuits for various sensors			
	Interfacing the circuit to a wireless sensor mote and networking Edge computing: Implementing data collection, aggregation & dissemination algorithms in sensors and motes			
3	Development of IoT Framework	01-07-2021	31-03-2023	20 months
	Developing Database & visualization Creating Edge, Fog and Cloud computing frameworks			
4	Development of decision models using machine learning and artificial Intelligence	01-02-2021	31-12-2022	23 months
	Developing dynamic thresholds for sensors			
	Developing slope stability models Developing forecast models			
5	Multi-level warning models	01-02-2021	31-12-2022	23

	Developing warning models based on the sensor thresholds and forecast models			months
6	Enhancing Community resilience	01-01-2022	31-12-2022	12 months
	Educating the public about the landslide monitoring and early warning system			
	Introducing the crowd sourcing mobile app and disaster risk reduction games to the community.			
	Conducting programs in schools to educate the children about landslide disaster risk reduction			

11. **Beneficiaries of WCoE:** (5 lines maximum; who directly benefits from the work?)

Direct beneficiaries from this project are 1. Public people and their properties. 2. National and State level Disaster management board 3. Government economy

12. **References: 10 lines maximum, i.e. relevant publications, international/regional/national recognition supporting items 9-10.**

- [1] Ramesh, Maneesha Vinodini. "Design, development, and deployment of a wireless sensor network for detection of landslides." *Ad Hoc Networks* 13 (2014): 218.
- [2] Ramesh, Maneesha V. "Real-time wireless sensor network for landslide detection." *Sensor Technologies and Applications, 2009. SENSORCOMM'09. Third International Conference on*. IEEE, 2009.
- [3] Ramesh, Maneesha V., and Nirmala Vasudevan. "The deployment of deep-earth sensor probes for landslide detection." *Landslides* 9.4 (2012): 457-474.
- [4] Ramesh, M. V. (2014). U.S. Patent No. 8,692,668. Washington, DC: U.S. Patent and Trademark Office.
- [5] Geethu Thottungal Harilal, Dhanya Madhu, Maneesha Vinodini Ramesh, Divya Pullarkatt. "Towards establishing rainfall threshold for a real-time landslide early warning system in Sikkim, India." *Landslides published online 15-August-2019*
- [5] <https://www.amrita.edu/news/nabard-rural-innovation-award-amrita>
- [6] <https://www.amrita.edu/news/dr-maneesha-vramesh-amritawna-speaks-wireless-communication-disaster-management-unai-amrita>
- [7] Hemalatha, T., Maneesha Vinodini Ramesh, and Venkat P. Rangan. "Adaptive Learning Techniques for Landslide Forecasting and the Validation in a Real World Deployment." *Workshop on World Landslide Forum*. Springer, Cham, 2017.

- [8] Ramesh, Maneesha Vinodini, et al. "Wireless Sensor Networks for Early Warning of Landslides: Experiences from a Decade Long Deployment." *Workshop on World Landslide Forum*. Springer, Cham, 2017.
- [9] Guntha, Ramesh, Sangeeth Kumar, and Balaji Hariharan. "Scalable, secure, fail safe, and high performance architecture for storage, analysis, and alerts in a multi-site landslide monitoring system." *Workshop on World Landslide Forum*. Springer, Cham, 2017.
- [10] Hemalatha, T., Maneesha Vinodini Ramesh, and Venkat P. Rangan. "Effective And Accelerated Forewarning of Landslides Using Wireless Sensor Networks and Machine Learning." *IEEE Sensors Journal* (2019).

13. If your organization is an ongoing WCoE 2014-2017, please attach the articles reporting activities of WCoE, IPL project and ICL network published/contributed to either in *Landslides: Journal of International Consortium on Landslides* or/and the Fourth World Landslide Forum 2017.

- [1] Geethu Thottungal Harilal,. Dhanya Madhu., Maneesha Vinodini Ramesh., Divya Pullarkatt. "Towards establishing rainfall threshold for a real-time landslide early warning system in Sikkim, India." *Landslides published online 15-August-2019*
- [2] Ramesh, Maneesha V., and Nirmala Vasudevan. "The deployment of deep-earth sensor probes for landslide detection." *Landslides* 9.4 (2012): 457-474.
- [3] Hemalatha, T., Maneesha Vinodini Ramesh, and Venkat P. Rangan. "Adaptive Learning Techniques for Landslide Forecasting and the Validation in a Real World Deployment." *Workshop on World Landslide Forum*. Springer, Cham, 2017.
- [4] Ramesh, Maneesha Vinodini, et al. "Wireless Sensor Networks for Early Warning of Landslides: Experiences from a Decade Long Deployment." *Workshop on World Landslide Forum*. Springer, Cham, 2017.
- [5] Guntha, Ramesh, Sangeeth Kumar, and Balaji Hariharan. "Scalable, secure, fail safe, and high performance architecture for storage, analysis, and alerts in a multi-site landslide monitoring system." *Workshop on World Landslide Forum*. Springer, Cham, 2017.

14. List of published or planned reports of WCOE 2017-2020 in journal "Landslides" or "WLF5 books" for ongoing WCOE organization.

(Those organizations with no activity report/no achievement in WCOE 2017-2020 will not be accepted as the candidate of WCOE 2020-2023 to be submitted to the Independent Panel of Experts for WCOEs.)

Published work in Landslides Journal:

[1] Geethu Thottungal Harilal,. Dhanya Madhu., Maneesha Vinodini Ramesh., Divya Pullarkatt. “Towards establishing rainfall threshold for a real-time landslide early warning system in Sikkim, India.” *Landslides published online 15-August-2019*

List of planned publications in WLF-5

[1] Enhancing the reliability of IoT System for landslide monitoring by integrating learning models – by Dr. Maneesha V Ramesh in Theme-3

[2] Challenges and opportunities in landslide early warning system by Hemalatha T in Theme-5

Comparison of Data Networking Architectures for Remote Landslide Warning System: Pros and Cons by Sangeeth Kumar in Theme-3

Rainfall thresholds for landslide initiation by Dr. Dhanya Madhu in Theme-3

Planned session in WLF-5:

Proposing a session in Theme-8: “Subsurface monitoring technologies for landslide monitoring and early warning” at the upcoming WLF-5

Note: Please fill and submit this form by 15 August 2019 to ICL secretariat <secretariat@iclhq.org>