I. General information

Project title: ***OpenRainGuru – A free, AI-based nowcasting tool for heavy precipitation***

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Co-applicants: Dr. F. Fioranelli (Dept. of Microelectronics, Faculty of EEMCS) and Dr. R. Taormina (Dept. of Water Management, Faculty of CITG)

II. Summary of the proposed research project/program

1. Project description.

Context: The RainGuru is a deep-learning based, rainfall forecasting model developed by TU Delft researchers and HKV, a flood risk and water management consultancy company based in Delft and Lelystad, with the help of seed funding from the TU Delft Safety & Security Institute. RainGuru is different from other nowcasters because 1) it uses artificial intelligence to perform its predictions, and 2) it was trained specifically to understand and reproduce the dynamics of extreme rain phenomena. The initial release in 2022 triggered a lot of interest among staff and students. However, there is one challenge that still needs to be addressed, which is to make RainGuru accessible to the broader community of researchers and students.

Objectives: We request 15 k€ in seed funds to clean up, package, document and push the RainGuru code (i.e., both the source code and the web app) to a public GitHub repository from where others will be able to download it, use it, and contribute to its development.

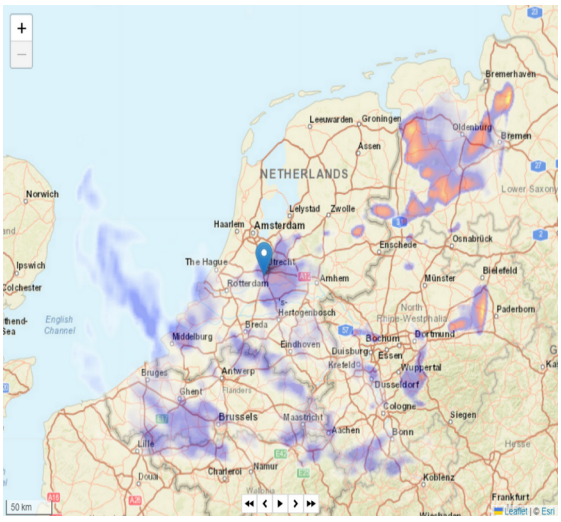

Figure 1: Screenshot of RainGuru web application

Expected results: The outcome will be an easily findable, accessible, interoperable and re-usable (FAIR) open-source library in Python (i.e., a public repository on GitHub) for real-time forecasting of extreme rain, together with an open-access publication in the Weather & Forecasting (WAF) journal that describes the science behind the model.

Proposed activities: The majority of the requested seed funds would be used to hire a student assistant with a strong computer science background to help clean up the RainGuru codes (source code + web app) and prepare it for public dissemination (approx. 1 month). Another 2 months of work are needed to write a comprehensive documentation for how to install and use the app, together with examples/tutorials to be shared to support the users, as well as a short publication in the Weather & Forecasting journal.

Partners and interdisciplinary aspect: The project will be supervised by the RainGuru core development team (Dr. M. Schleiss, Dr. F. Fioranelli and Dr. R. Taormina). To ensure the project complies with international and university standards, we will seek help and advice from the Digital Competence Centre and the Open Science Community Delft with whom the applicants have successfully worked and collaborated in the past.

Potential impact and relevance for future activities: Extreme rain and flooding driven by climate change are a major threat to the economy and society, in The Netherlands and elsewhere. An open forecasting tool such as RainGuru would therefore have a widespread impact on education and research related activities. Specifically, we envision that this tool can play a key role in educating the new generation of scientists and engineers by providing hands-on experience and concrete examples of applications for AI-driven solutions tailored to the urgent problem of heavy rain nowcasting. For example, MSc students in the MUDE (Modeling, Uncertainty, Data for Engineers) course of CITG could use a Jupyter Notebook that runs a clone of RainGuru in order to play around with model parameters and assess performances for different lead times and scenarios. This is a compulsory course for all MSc students, hence we foresee a significant prospective impact. Furthermore, other Bachelor or Master students across the university will be able to download and use the app to perform case studies and assess the risks associated with extreme rain and flooding, as well as propose improvements for the tool, for example by adding more advanced visualisation features or

developing enhanced versions of the deep learning based algorithm at the core of RainGuru. Assignments along these lines could for example involve the MSc students in the course Data Science and Artificial Intelligence for Engineers coordinated by Dr Taormina (about 50-100 students per year).

The biggest impact, however, would be on research. Practitioners and academics would be able to use RainGuru for flood forecasting in cities, water management and road safety applications (among others), while researchers around the globe could contribute to the development of the code by proposing changes and adaptations based on their specific needs. Private companies could use the source code to develop commercial products and provide concrete solutions to help mitigate the effects of a rapidly changing water cycle. For example, the main applicant is currently collaborating with WeatherImpact (a company which provides agribusinesses with easy to access, reliable weather and climate information) to develop novel precipitation nowcasts in Africa based on infrared satellite imagery, to warn farmers about heavy rain and help them optimize agricultural yield.

These opportunities for impact are only achievable by proper cleaning and documenting of the current version of the software behind RainGuru, in order to make it easily understandable and reusable.

2. Relevance for Climate Action Programme:

The ability to understand and predict extreme rain using AI-based solutions has several direct connections to the Climate Action Programme (e.g., Climate Science, Mitigation and Adaptation). We foresee strong links and contributions to at least three flagships (i.e., “urban flow”, “sponge cities”, and “AI for climate”). We also foresee long-term collaboration with the TU Delft AI initiative (e.g., the Aidrolab) and the Ruisdael observatory for atmospheric science, which aims to develop a network of advanced sensors for improving the accuracy of climate, weather and air quality predictions at regional scales in the Netherlands.

3. Follow-up

Our long-term goal is to promote the science needed to better understand, measure and predict heavy rain and its associated risks in the context of global warming. One logical follow-up will be to link RainGuru with other digital tools, such as the outdoor Mobility Digital Twin, and Graph Neural Networks for Flood Prediction within the Aidrolab. A small case study for the city of Rotterdam within the context of the resilient delta initiative could also be envisaged as part of a future seed fund proposal. Finally, the core-team is working on a NWO Open Competition Science Proposal to hire 2 PhD students for improving the science behind the modeling and prediction of heavy convective rainfall systems by combining remote sensing techniques and machine learning.

Another important follow-up activity will be the development of a professional mobile phone app for RainGuru, similar to Buienradar, but based on open source software and tuned to the specific needs and wishes of researchers, students and the general public. For example, an app that provides concrete recommendations for when to leave work, how to travel from point A to B or where to seek shelter from heavy rain. This development will start in the spring-summer of 2023 in collaboration with the department of software technology at TU Delft, through one or several student-led software projects for the course CSE2000.

III. Budget

Budget	
Description of costs	Costs in euros
Personnel costs for hiring a student assistant through FlexDelft at the rate of 27.36€ per hour for 40 hours/week for a total duration of 3 months.	13,133
Costs for article preparation and open access publication fee	2,200
Total:	15,333