Heavy Rainfall Control for Living Together with Isolated-Convective Rainstorms and Line-Shaped Rainbands

R&D Theme

Research and development theme 2 (Construction of a control system)

Progress until FY2022

1. Outline of the project

Develop a control system that combines observation, prediction, and decision-making to effectively suppress heavy rains by implementing multiple engineering methods at different times and stages. Additionally, the control system would be designed to intervene at multiple stages to course-correct when an unexpected deviation occurs. Furthermore, our goal is to implement multiple types of interventions at various stages to increase the regulatory effect. Specifically, we aim to develop a decision-making support system that can derive optimal solutions by combining multiple control methods in real-time by (1) simplifying the time evolution model for heavy rain events and constructing an ensemble prediction method, (2) constructing monitoring methods for regulation, (3) setting appropriate objective functions based on the output of ELSI/RRI research, and (4) optimizing algorithms.

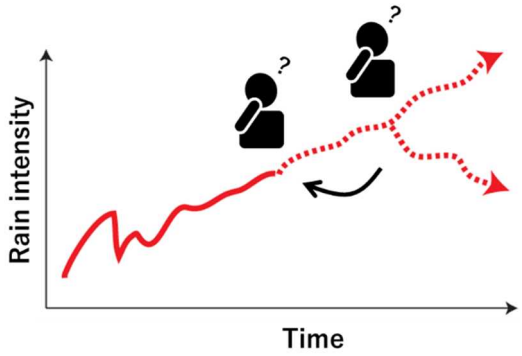

Figure 1. Schematic diagram showing decisions being made at multiple points in time and at multiple stages

2. Outcome so far

①Roadmap for the manufacturing of the regulatory device

In this research and development theme 2, the goal is to develop a system that can derive optimal solutions for real-time regulation while incorporating knowledge of impact assessments.

Optimizing decision-making before heavy rain progresses is considered a non-real-time decision-making issue, and the advance placement of the regulatory device ensuring its exposure to heavy rains is important. Meanwhile, constantly optimizing decision-making while heavy rain is occurring is considered a real-time decision-making issue, and decision-making factors such as where and when to deploy the regulatory devices for heavy rain observation require attention. Therefore, when and where to focus to control heavy rain is also a future issue, so we decided to create a map, which is shown in Fig. 2.

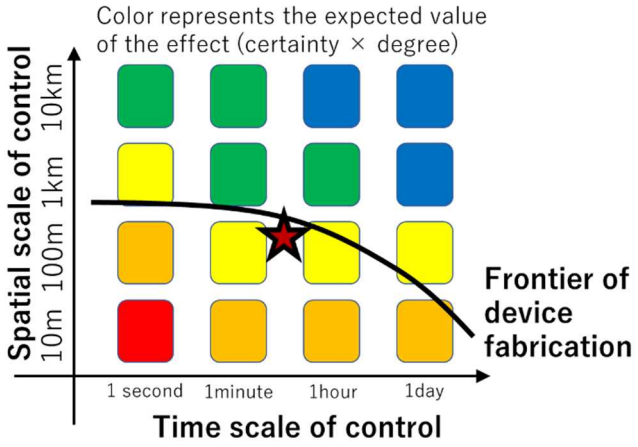

Figure 2. Target map for regulatory device scale

②Map of how often heavy rain occurred and characteristics of the mechanism

We examined how often heavy rains occurred while determining the pre-placement of regulatory devices and the field to be checked. We examined the Keihanshin and Kyushu regions for the model.

Regarding the characteristics of heavy rains, heavy rains accompanied by a front tended to have a large spatial scale and lasted for long periods, whereas isolated and localized heavy rains occurring south of fronts tended to have a small spatial scale and very strong rainfall. Isolated and localized heavy rains had greater atmospheric instability and vertical shear than heavy rains accompanied by a front. Therefore, it was suggested that an intervention approach that analyzes such an idealized environmental field is required. Additionally, there was the simultaneous possibility to suppress heavy rains with smaller interventions since isolated and localized heavy rains occur and develop in the absence of external forces as opposed to heavy rains accompanied by a front.

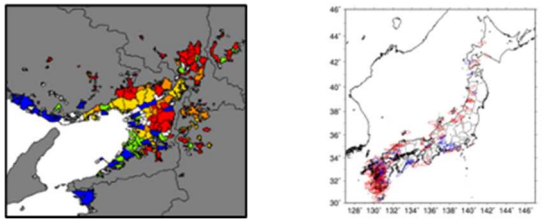

Figure 3. Map of how often sudden heavy rains occurred (left) and linear convective heavy rains occurred (right)

3. Future plans

Our goal is to create a decision-making graph based on the characteristics of regulatory methods, associations between effects generated by the modulation (i.e., impacts directly related to heavy rains and social impacts), and the scope of decision-making.

国立研究開発法人 科学技術振興機構
Japan Science and Technology Agency