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Effects of surrounding buildings on structural damage caused by strong winds during a typhoon

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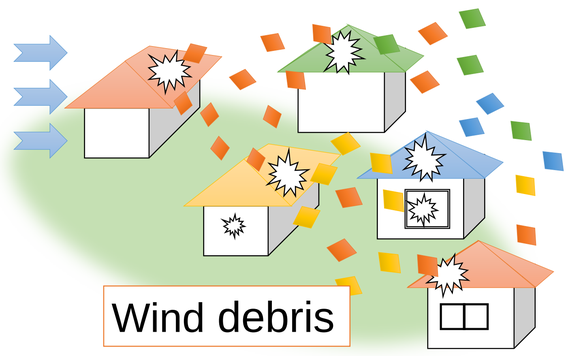
WRDM
Wind-Related Disasters & Mitigation

1. INTRODUCTION

- After buildings suffer severe damage caused by extremely strong winds, **portions of some damaged buildings become wind debris** that may strike surrounding buildings and thereby **worsen the damage to buildings**
- Secondary structural damage **occurred in a dense residential area** due to abundant wind debris.
- **Expanding wind damage is affected** not only by wind speed but also by **structural characteristics, surrounding buildings,** climate, and land use of damaged areas



Secondary structural damage occurred in a dense residential area

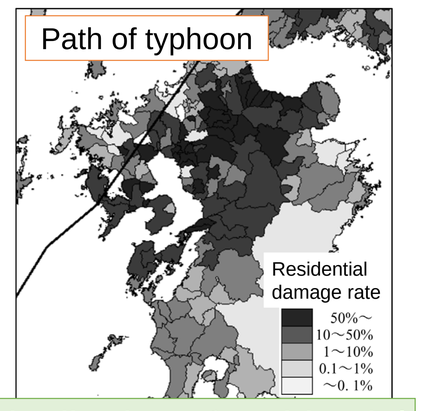
We investigated **some of the effects of surrounding buildings on the expansion of structural damage** caused by strong winds

2. OUTLINE OF DAMAGE FROM TYPHOON MIREILLE

- We focus on structural damage caused by **Typhoon Mireille** (No. 9119)
- Typhoon **Mireille struck Nagasaki, Japan**, on September 27, 1991. **Many people suffered casualties** and **many** houses suffered damage
- The Japan Building Center conducted a **questionnaire survey of residents who experienced Typhoon Mireille** in 1991

The results of **this questionnaire survey were adapted** for our research

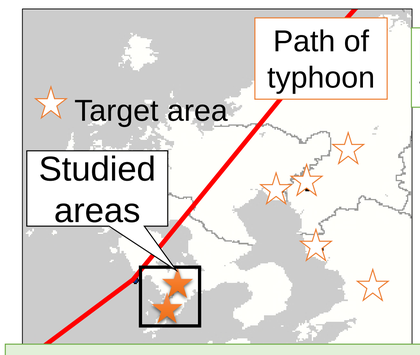
Path of typhoon Mireille (9119)



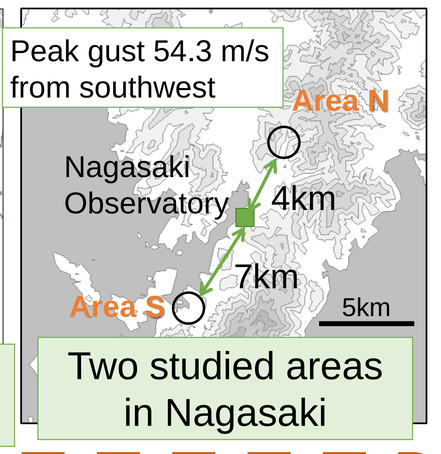
Distribution of residential damage rate in Kyushu

3. CHARACTERISTICS OF STUDIED AREAS

- In this study, **two areas in Nagasaki Prefecture were selected** from seven target areas of questionnaire survey
- The **peak gust was 54.3 m/s, from the southwest**, at 4:41 p.m. at the Nagasaki Local Meteorological Observatory on September 27, 1991.



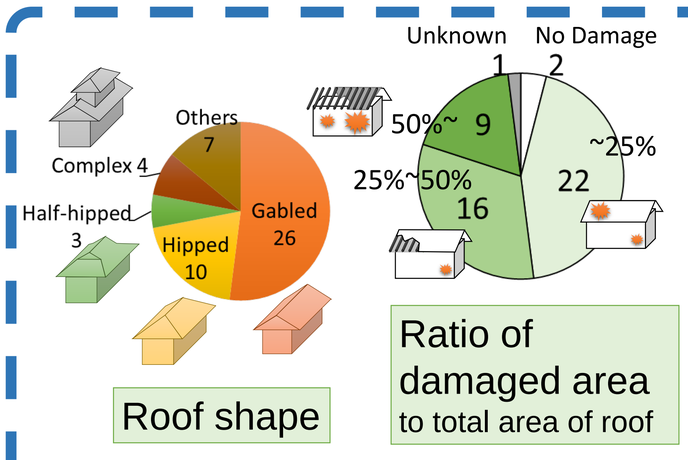
Seven target areas of questionnaire survey



Two studied areas in Nagasaki

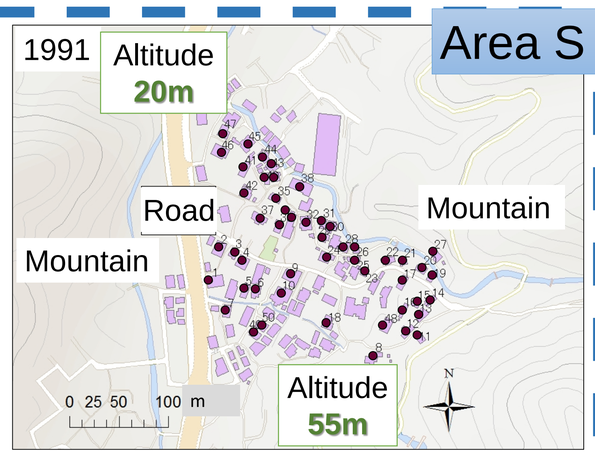
Local Terrain and characteristics of houses

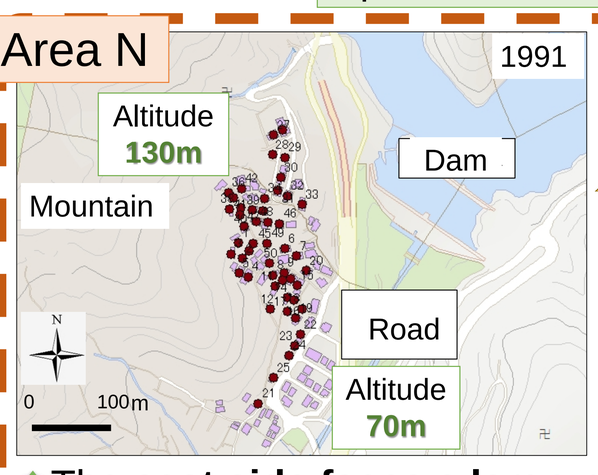
- Almost all of the houses in both areas were **made from wood**
  Averaged **total floor area: about 100 m²**, Averaged **building age: about 20 years**

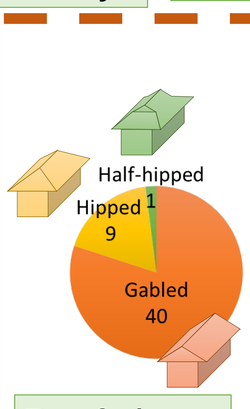


Roof shape

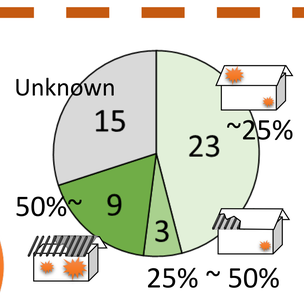
Ratio of damaged area to total area of roof







Roof shape



Ratio of damaged area to total area of roof

- The **west side faces a large road**
- **Differences of altitude** among adjacent houses were **not large**

- The **east side faces a large road**
- **Differences of altitude** among adjacent houses were **large**

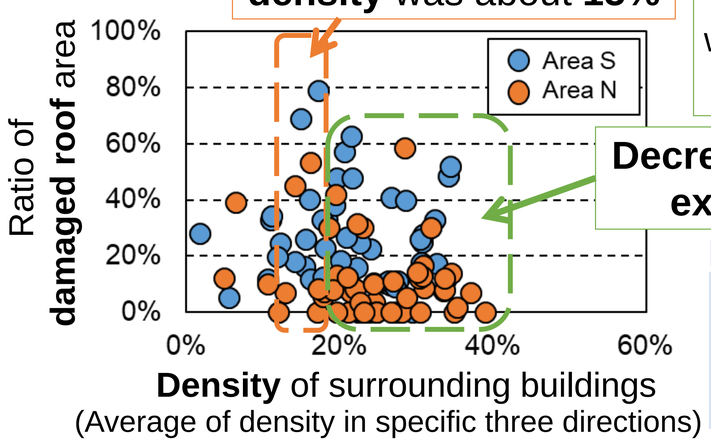
4. EFFECTS OF SURROUNDINGS ON WIND DAMAGE TO HOUSES

- We focused on the **density of surrounding buildings** and the **distance from adjacent buildings** in three specific directions
  The specific directions in **area S: west, southwest, south / area N: east, southeast, south**

Density of Surrounding Buildings

Increased when **density** was about **15%**

Ratio of the total area of buildings within the circle with a 50 m radius centered on a particular house

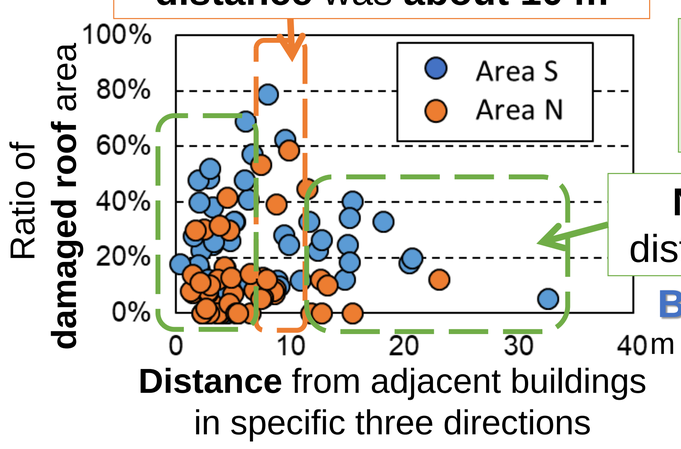


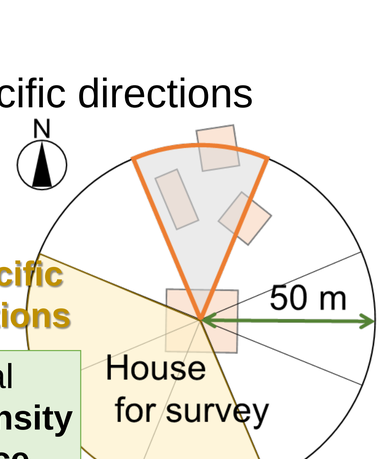
Decreased as density **exceeded 20%**

Because
Surrounding buildings weakened the effect of the strong winds

Distance from Adjacent Buildings

Extended substantially when **distance** was **about 10 m**





Conceptual diagram of **density** and **distance**

Not expanded much when distances were **close and large**

Because
Wind debris from surrounding buildings did not strike the roof

Buildings suffered severe damage caused by **both strong wind pressure and wind debris,** which **correlate differently with the surrounding environment**