12.4.4 Simulation of December 12, 1999 Earthquake and August 1, 1968 Earthquake

The recent earthquake motion in Metro Manila was simulated by the method that was adopted in this study. The subjected events are the December 12, 1999 earthquake of magnitude 6.8 that occurred at Manila Trench of 200 km north-northwest of Metro Manila, and the August 2, 1968 earthquake of magnitude 7.3 that occurred at Casiguran Fault of 200 km north-northeast of Metro Manila. In addition, the Model 01 almost corresponds to 1990 Luzon earthquake.

The simulated PGA distribution of December 12, 1999 Earthquake is shown in Figure 12.4.7. In this earthquake, PHV and MRK station of MM-STAR, which is shown in the figure, observed the earthquake ground motion. The observed horizontal acceleration at PHV is 36gal in NS and EW component. MRK observed 39 gal in NS component and 102 gal in EW component, and geometric mean is 63 gal. The simulated PGA corresponds to these observed records.

The simulated seismic intensity distribution in MMI scale of August 2, 1968 Earthquake is shown in Figure 12.4.8. By this earthquake, Ruby Tower in Metro Manila has collapsed and several buildings were severely damaged. On the other hand, 1990 Luzon Earthquake affected only minor damage to the building in Metro Manila, nevertheless the 1990 Luzon Earthquake show larger intensity.

On April 7, 1970, another earthquake of magnitude 7.3 occurred along Casiguran Fault and some buildings in Metro Manila were badly damaged. The magnitude of 1968 Earthquake and 1970 Earthquake are smaller than 1990 Luzon Earthquake and the focal distance are larger, but the damage situation was more serious than 1990 Luzon Earthquake. Several cause of this phenomena are assumed. The earthquake motion may be larger than the estimated one because the rapture of the fault propagated toward Metro Manila along the Casiguran Fault, which has the strike of east to west. The probability of high Q zone existence from Casiguran area to Metro Manila is the other hypothesis. The possibility that the earthquake along Casiguran Fault generate larger amplitude of seismic wave comparing to the other region cannot be denied. To study this phenomenon, not only the strong motion records in Metro Manila but also the records in other region are effective. The enhancement of strong motion observation network is called for.

As the above mentioned, the information about the earthquake, which occur at Casiguran Fault is not enough at this moment. Therefore, the earthquake estimation method that can fully evaluate the earthquake at Casiguran Fault cannot be made in this study. Other area might have the site-specific characteristics like Casiguran Fault, which can be revealed by future study. By this reason, the real earthquake motion may become larger than estimated in this study. The user of the estimated ground motion should keep this situation in mind.

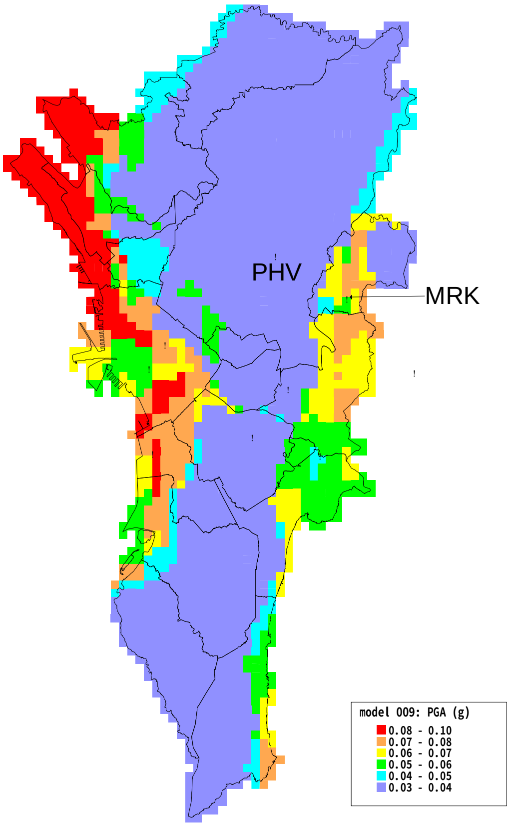

Figure 12.4.7 Simulated Acceleration distribution of December 12, 1999 Earthquake

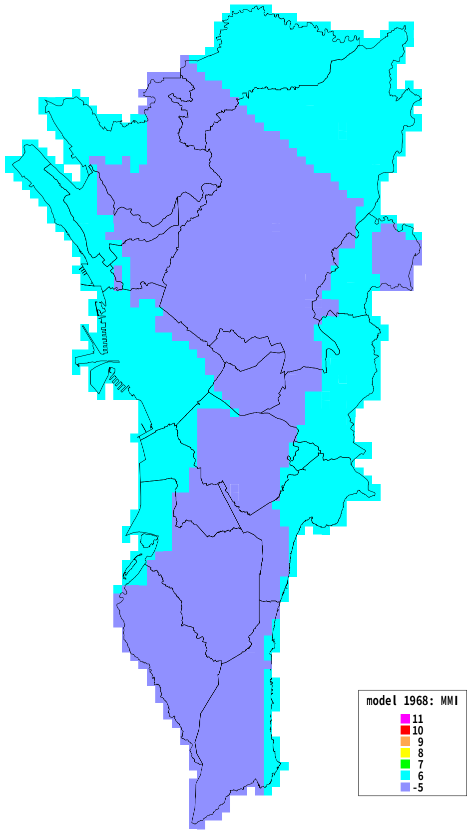

Figure 12.4.8 Simulated Seismic Intensity in MMI Scale of August 1, 1968 Earthquake

12.4.5 Calculation of Earthquake Ground Motion

The surface ground acceleration, velocity and acceleration response spectrum (h=5%) were calculated from bedrock motion and response analysis.

1) Peak Ground Acceleration (PGA)

The PGA distribution maps are shown in Figure 12.4.9. Model 07, Model 08 and Model 09, which are based on the West Valley Fault, show large PGA, especially along the fault in Marikina and Pasig. The lowland area along the Manila Bay experiences more than 0.6 g. Even the Central Plateau feels more than 0.3 g. All of the area in Metro Manila suffers very strong seismic motion. On the other hand, the area that experiences more than 0.3 g is limited to Marikina, Passig and part of the lowland along the Manila Bay in case of Model 10, which is based on the East Valley Fault. Model 13 and Model 18 also show comparatively larger PGA than the other model at the lowland along Manila Bay.

2) Peak Ground Velocity (PGV)

The PGV distribution maps are shown in Figure 12.4.10. Model 07, Model 08 and Model 09, which are based on the West Valley Fault, show large PGV, especially along the fault in Marikina and Pasig. The lowland area along the Manila Bay experiences more than 70 kine in case of Model 08 and Model 09. Almost all of the area in Metro Manila experiences more than 25 kine. Model 18 shows more than 25 kine along the Manila Bay, especially the coast area shows over 45 kine.

3) Seismic Intensity

The following empirical relation between acceleration/velocity and seismic intensity by Trifunac and Brady (1975) was used to estimate the seismic intensity distribution.

$$\log PGA = 0.014 + 0.30 * I \quad \text{---------------} \quad (12.4.1)$$

$$\log PGV = -0.63 + 0.25 * I \quad \text{----------------} \quad (12.4.2)$$

PGA : acceleration (gal)

PGV : velocity (kine)

I : Intensity in MMI Scale

Midorikawa et al. (1999) pointed out that the products of acceleration and velocity or such like combination show better correlation with seismic intensity than acceleration or velocity alone. In reference to this study, the average of the value by formula (12.4.1) and by formula (12.4.2) was used as estimated seismic intensity.

The MMI Intensity distribution maps are shown in Figure 12.4.11. Models 07, Model 08 and Model 09, which are based on the West Valley Fault, show large seismic intensity, especially along the fault in Marikina, Passig, Taguig and Muntinlupa. The lowland area along the Manila Bay experiences intensity 10 in case of Model 08 and Model 09. Almost all of the area in Metro Manila experiences intensity 9 or 10. Model 10 shows intensity 9 from Marikina to Pasig and Model 18 shows intensity 9 along the Manila Bay.

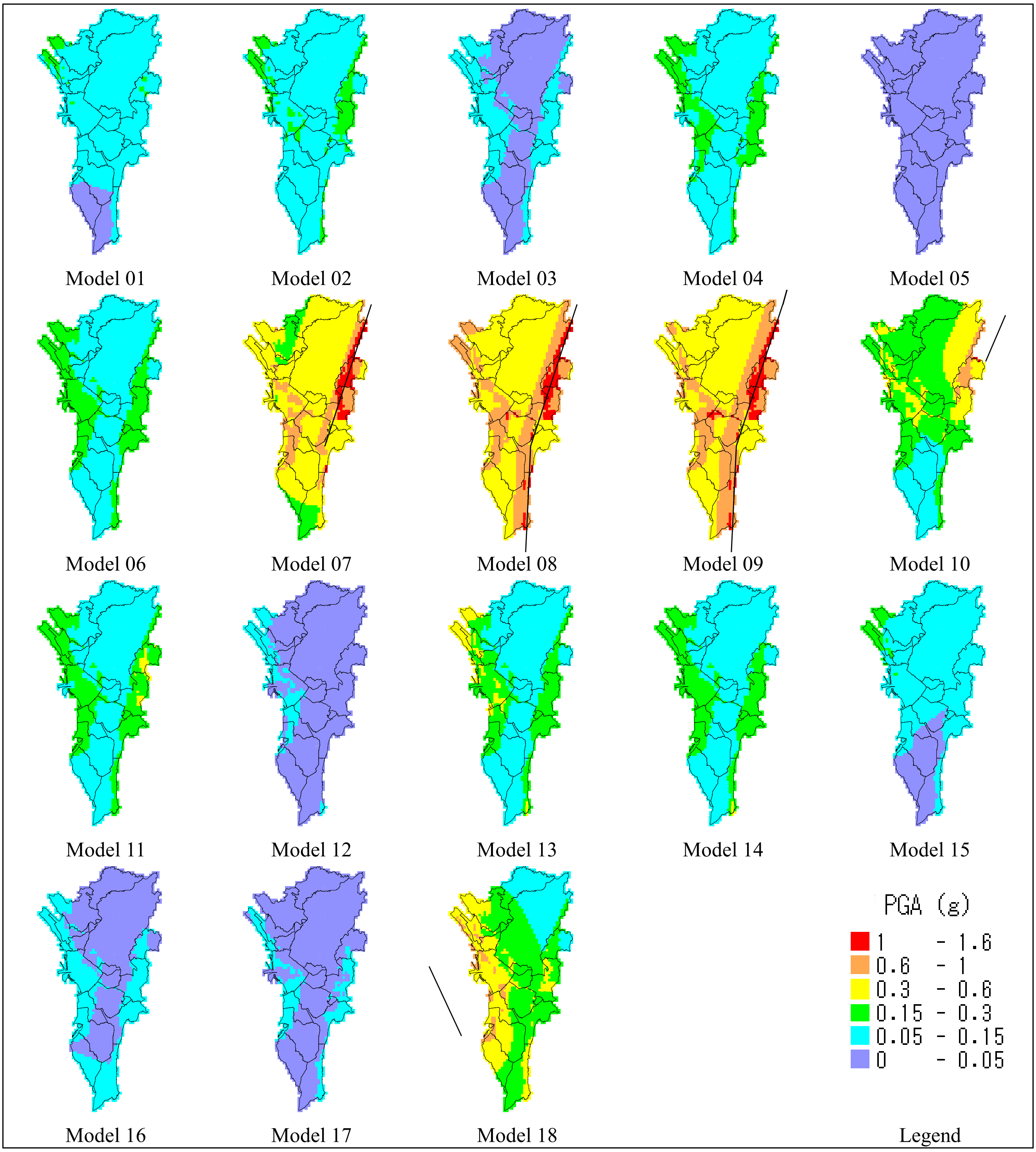

Figure 12.4.9 Distribution of Peak Ground Acceleration

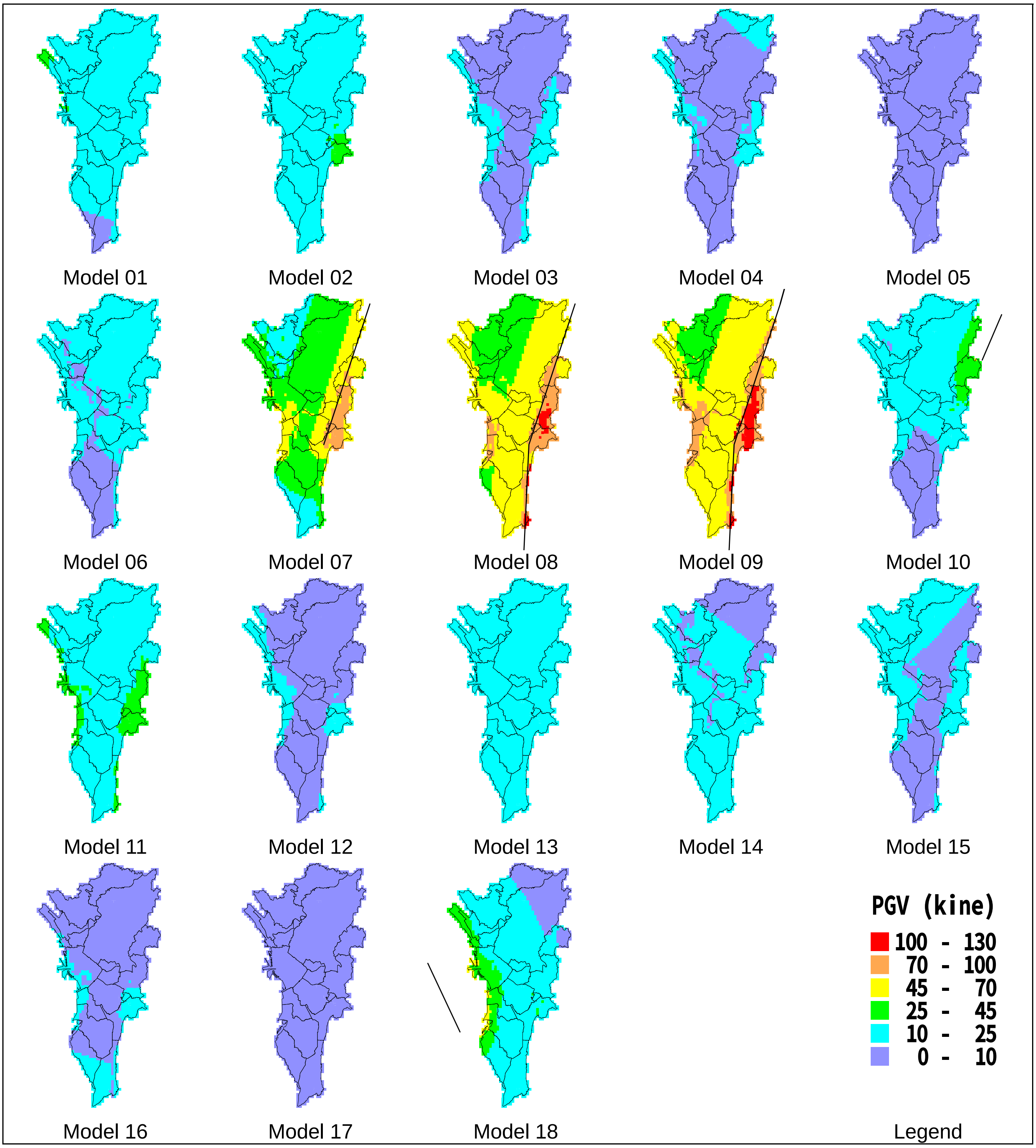

Figure 12.4.10 Distribution of Peak Ground Velocity