Effect of land use database using remote sensing data in air quality modeling

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The BVOCs account for a major fraction of total VOCs emission affecting atmospheric O_3 and secondary aerosol concentration. Over 90% of global annual VOCs are emitted by plants (Guenther et al., 1995). Since forest lands account for 59% of total area in Taiwan and previous studies have indicated that BVOCs contribute to about 33% total VOCs in Taiwan (Chang et al., 2009).

The original database of land use types used in Taiwan BVOCs emission inventory system (TBEIS) (Chang et al., 2009) was based on the survey data of forest resources and land use collected by the Forestry Bureau of Taiwan in 1995. However, land use pattern has been dramatically changed due to typhoons, mudslides and more importantly, the horrible September 21, 1999 earthquake. Also, both cultural and ecological changes also affect land use type. Consequently, the need for developing a new land use database is urgent.

To modify the changes in land use, the satellite remote sensing data collected by the Center for Space and Remote Sensing Research of National Central University (CSRSR) from 2005 to 2006 were adopted in this study. These image data were sorted from remote sensing image pictures obtained by FORMOSAT-2. The highest spatial resolution is 8 m×8 m and an image identification ratio of 79%. Except for unidentified data, twelve types of objects including clouds, water bodies, buildings, seas, roads, riverbeds, beaches, dry farmlands, grass lands, paddy fields, small amount of plants, and plants in the mountains can be identified.

The comparison between original and new land use database is shown in Table 1. Clearly, there are significant differences between these two database sets. An additional area of 1790 km^2 (398% increase) and 2100 km^2 (65%) was added to grass lands and paddy fields, respectively. Only dry farmland was reduced by 1830 km^2 (61% decrease). A new forest area of 2400 km^2 was also added with the overall net increase of about 4460 km^2, which accounts for 16% of the total vegetation area of Taiwan.

Table 1. Areas in original and new land use databases

Land use type	Original database (km^2)	New database (km^2)	Difference ratio (%)
Forests	20580	22980	+12
Grass land	450	2240	+398
Paddy field	3210	5310	+65
Dry farmland	2990	1160	-61
Total	27230	31690	16

The Taiwan Air Quality Model (TAQM) with four-level nested domains (Chen and Chang, 2006; Chang, 2008) was used to simulate air quality; and the impact of updating the land use database was evaluated. The meteorological information required for simulation is based on MM5.

The period from July to September was selected to simulate air quality because of maximum BVOCs emitted in Summer in Taiwan. The impact on O_3 and secondary $PM_{2.5}$ levels by original and new land use databases will be discussed. The maximum difference of ozone values for each grid during simulation is shown in Figure 1. It reveals a significant increase in ozone was located in the mountain areas of central and southern Taiwan. The greatest increase in ozone was 5-7 ppb in southern Taiwan and 3-6 ppb in central Taiwan.

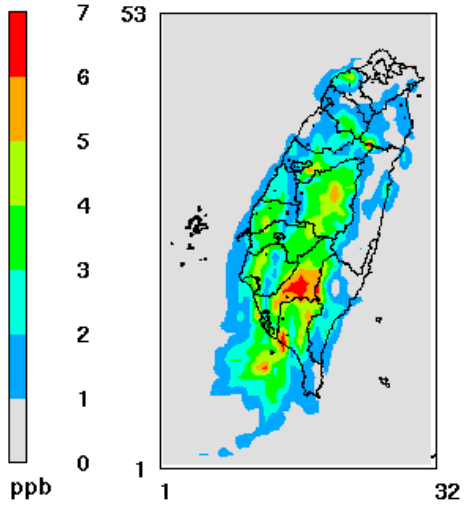

Figure 1 Spatial distribution of maximum ozone difference between original and new land use database.

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