Heavy Rainfall Event in Central Viet Nam in December 2018 and QPE/QPF at VNMHA

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1. Introduction

In Viet Nam, meteorological disasters occur every year and their mitigation is an important issue. Since June 2018, a bilateral cooperative project between the Japan International Cooperation Agency (JICA) and the Viet Nam Meteorological and Hydrological Administration (VNMHA) for strengthening capacity in weather forecasting and flood early warning system in Viet Nam has been conducted (Fig. 1). This project is relating to S-band radars that installed in Hai Phong (Phu Lien) and Vinh by another grant aid project in September 2017, and the Japan Meteorological Business Support Center (JMBSC) is contributing to four scopes of the project on surface meteorological observation, radar maintenance and products, weather forecasting, and regional weather dissemination.

VNHMA has deployed about 1,100 AWS stations and nine radars in Viet Nam. Precipitation estimation from radar composite data are combined with AWS precipitation data and satellite estimated precipitation to produce precipitation nowcasting 3-hourly.

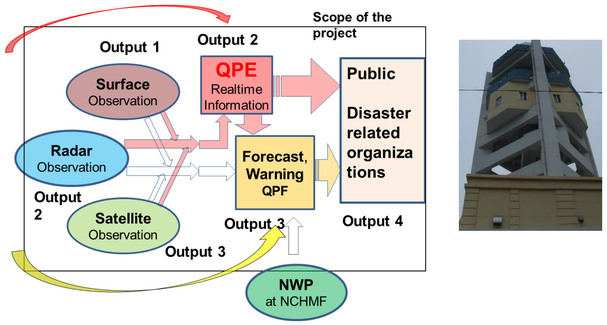

Fig. 1: Left) Concept of the JICA program.
Right) S-band radar at Phu Lien.

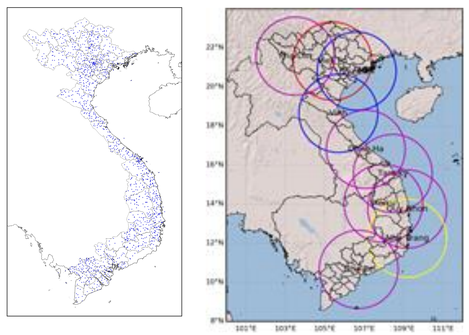

Fig. 2: Left) AWS stations of VNMHA.
Right) Meteorological radars of VNMHA (as of 2019).

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2. Heavy rainfall event in central Viet Nam on 9 December 2018

On 9 December 2018, a heavy rainfall event occurred in Central Viet Nam, and at Da Nang, a record-breaking rainfall 972 mm was observed in 24 hours from 01 LST 9 December (Fig. 3). This heavy rainfall occurred in a typical heavy rainfall situation in Viet Nam, relating to the northeasterly cold surge at surface. At 700 hPa level, southeasterly warm and moist air was lifted up, suggesting abundant water vapor convergence in the lower troposphere (Fig.4).

Geostationary satellite (Himawari-8) images on the day (Fig. 5 left) showed that this event was not brought by deep convection but by the warm rain process, because the cloud top height of the rainfall system was not high. Relationship between TBB and rains by Vicente et al. (1998; Fig. 5 center),

$$R = 1.1183*10^{11} exp(-3.6382*10^{-2}\mathrm{TBB}^{1.2})$$

that VNMHA used to estimate the rainfall intensity significantly underestimated the rains around central Viet Nam (Fig. 5 right). Precipitation analysis at VNMHA (Fig. 3 right) also underestimated the rains.

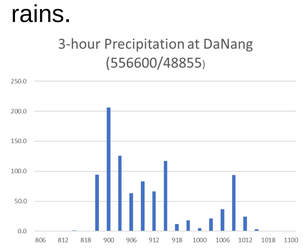

Fig. 3: Left) Observed 3-hour rainfalls at Da Nang from 12 UTC 8 to 18 UTC 10, December 2018 . Center) Observed 6-hour precipitation at SYNOP stations for 00 to 06 UTC. Right) Precipitation analysis at VNMHA for 00 to 03 UTC 9 December 2018.

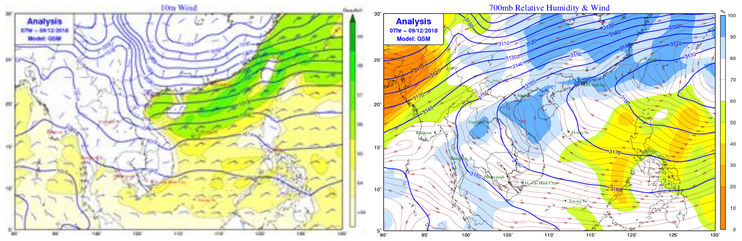

Fig. 4: Global analysis at 00 UTC 9 December 2018 by JMA. Left) Mean sea level pressure and surface wind. Right) Relative humidity and wind at 700 hPa.

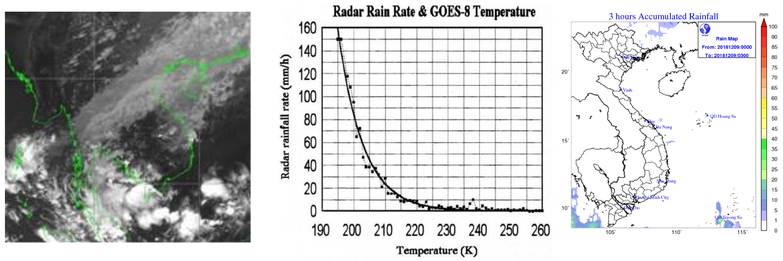

Fig. 5: Left) Infrared satellite image at 00 UTC 9 December 2018.
Center) Relationship between TBB and rains by Vicente et al. (1998).
Right) Three-hour rain estimated by Vicente et al. (1998) for 00-03 UTC (07-10 LST) 9 December 2018 .

3. Application of GSMaP estimated rain

GSMaP is rainfall estimation operated by JAXA EORC based on satellite observations. Main source is microwave data from GPM satellites. GSMaP detected the intense rains over central Viet Nam on 9 December 2018 up to a point. As show in Table 1, operational GSMaP products are classified to several kinds according to their latency. Figure 6 shows hourly rainfall intensity by GSMaP_MVK and GSMaP_NOW. Since latency of GSMaP_MVK is 3 days, GSMaP_NOW is more suitable for real time application to nowcasting.

Figure 7 shows modified 3-hour precipitation analysis for 00 to 03 UTC 9 December 2018 corresponding to Fig. 3 right. Here, AWS data and Vinh radar data are used in addition to GMaP data. Figure 8 shows resullts of verification of GSMaP and Himawari-8 estimated rains against AWS observation. Both GSMaP_MVK and GSMaP_NOW notably outperform the Himawari-8 estimation.

Table 1: Classification of operational GSMaP data. After Kubota (2017).

Operational
GSMaP_NOW (Realtime Ver.) • Geostationary satellite "Himawari-8" observation area, 0.1 degree, hourly • Estimated by 0.5-hour extrapolation by cloud motion vector • Updated in half hourly
GSMaP_NRT (Near-Real-Time Ver.) • Global 0.1 degree grid, hourly • 4-hr data latency, hourly
GSMaP_Gauge_NRT (Near-Real-Time Gauge-calibrated Ver.) • Same specification as GSMaP_NRT • Corrected by past period GSMaP_Gauge
GSMaP_MVK (Standard Ver.) • Global 0.1 degree, hourly • 3-day data latency

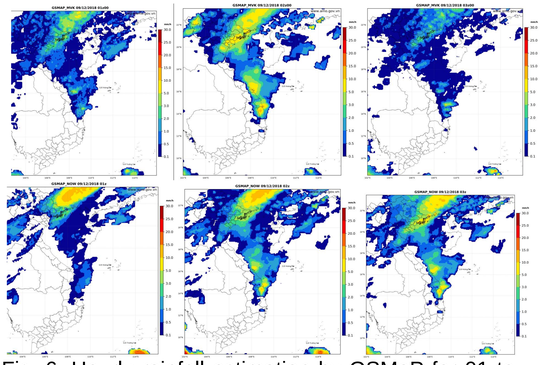

Fig. 6: Hourly rainfall estimation by GSMaP for 01 to 03 UTC 9 December 2018. Upper) GSMaP_MVK. Lower) GSMaP_NOW.

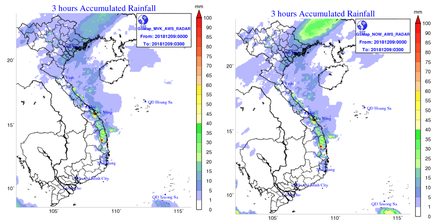

Fig. 7: Left) Modified precipitation analysis for 00 to 03 UTC 9 December 2018 using AWS and Vinh radar data with GSMaP_MVK. Right) Same as left figure but with GSMaP_NOW.

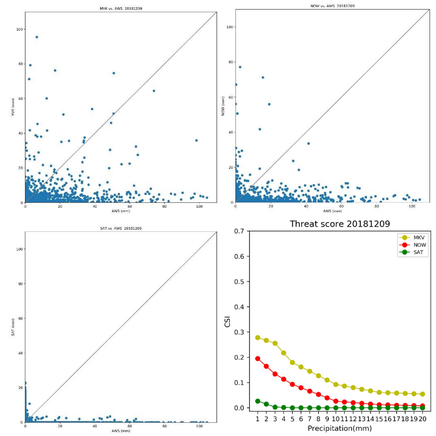

Fig.8: Upper left) Scatter diagram between GSMaP_MVK (vertical axis) and AWS (horizontal axis) for 3-hour precipitations in 9 December 2018 (00-24 UTC). Upper right) Same except for GSMaP_NOW. Lower left) For Himawari-8. Lower right) Threat scores of GSMaP_MVK (light green) GSMaP_NOW (red) and Himawari-8 (green) 3-hour precipitations in 9 December 2018 (00-24 UTC) against AWS observation.