

Application of Methods for Analysis of Rainfall Intensity in Areas of Israeli, Jordanian, and Palestinian Interest

***Supplement:* Radar Analysis of Rainfall Intensity in the Mujib Basin**

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Compiled by the
U.S. Geological Survey

For the
Executive Action Team,
Middle East Water Data Banks Project

Multilateral working groups, to advance the Middle East Peace Process, were formed in January 1992. One of these groups, the Working Group on Water Resources, endorsed the Water Data Banks Project in November 1994. The Water Data Banks Project consists of a series of specific actions to be taken by participating Israelis, Jordanians, and Palestinians (Core Parties) that were designed to foster the adoption of common, standardized data collection and storage techniques among the Parties, to improve the quality of the water-resources data collected in the region, and to improve communication among the scientific communities in the region. The project is managed by an Executive Action Team (EXACT) composed of water experts from Israeli, Jordanian, and Palestinian water-management agencies. Technical and financial support to EXACT is contributed by donor countries that include the United States, European Union, France, and the Netherlands. The authors of this report are Joseph Morin and Shmuel Arbel of the Israeli Soil Erosion Research Station, Avner Furshpan of the Israeli Meteorological Service, Gavriel Weinberger of the Israeli Hydrological Service, Efrat Morin of Hebrew University, Issa Al-Nsour, Zakaria Haj-Ali and Najib Sabbagh of the Ministry of Water and Irrigation-Jordan, Moh'd Semawi and Khaled Sewafteh of the Jordanian Department of Meteorology, Yousef Abu Asad and Ali Abu Eid of the Palestinian Meteorological Office, and Sami Hamdan and Adel Yasin of the Palestinian Water Authority. Numerous other members of the above-named institutions contributed to this project. Contributions from the Core Parties were compiled by Charles Parrett and Daniel J. Goode of the U.S. Geological Survey. Ted Campbell of the U.S. Geological Survey (now at North Carolina Department of Environment and Natural Resources) provided technical leadership throughout this project. The software described in this report was developed in cooperation with Ron Eaglin of the University of Central Florida and Or Cohen of the Israeli Soil Erosion Research Station.

Introduction

The report *Application of Methods for Analysis of Rainfall Intensity in Areas of Israeli, Jordanian, and Palestinian Interest* (EXACT, 2006) was developed as part of the Water Data Banks Project, based on rainfall data collection and collaborative compilation of the data by the participating Israeli, Jordanian, and Palestinian water agencies (Core Parties). The purpose of this supplement is to describe results of an application of the radar analysis methods described by EXACT (2006) to analyze rainfall intensity in the Mujib Basin. Background information on the Mujib Basin and gage precipitation measurements in the basin are described in the main report.

The methods include computer software developed specifically for rainfall data compilation and analyses by the Core Parties, but which has broad application for the management and analysis of precipitation data anywhere. The computer software is intended for the storage and analysis of long-term at-site precipitation data collected at precipitation stations. The methods also include the use of radar to analyze the spatial distribution and intensity of rainfall during storms. Although radar analysis of rainfall is relatively new technology, it offers particular promise for better understanding storm behavior and rainfall intensity over the complete area of the storm.

Rainfall Intensity in the Mujib Basin

Radar Analysis of Storm of May 1-2, 2001

The storm of May 1-2, 2001 was characterized by convective rainfall with high intensities that caused floods in some Dead Sea tributaries and destruction of infrastructures. Rain depths ranged between 5 and 71 mm at rain gages east and west of the Dead Sea.

The radar provides reflectivity data in polar coordinates in resolution of 1° azimuth and

250 m radial. The area of these polar pixels is roughly 0.3 km^2 over the Mujib Basin. Most of the basin is more than 100 km from the radar, and this may increase errors in radar rainfall estimates. Rain depth data at 17 gages located within the basin were used for radar calibration. Rain depth data at 26 other gages on the western side of the Dead Sea were used for validation of radar rainfall estimates (fig. 1).

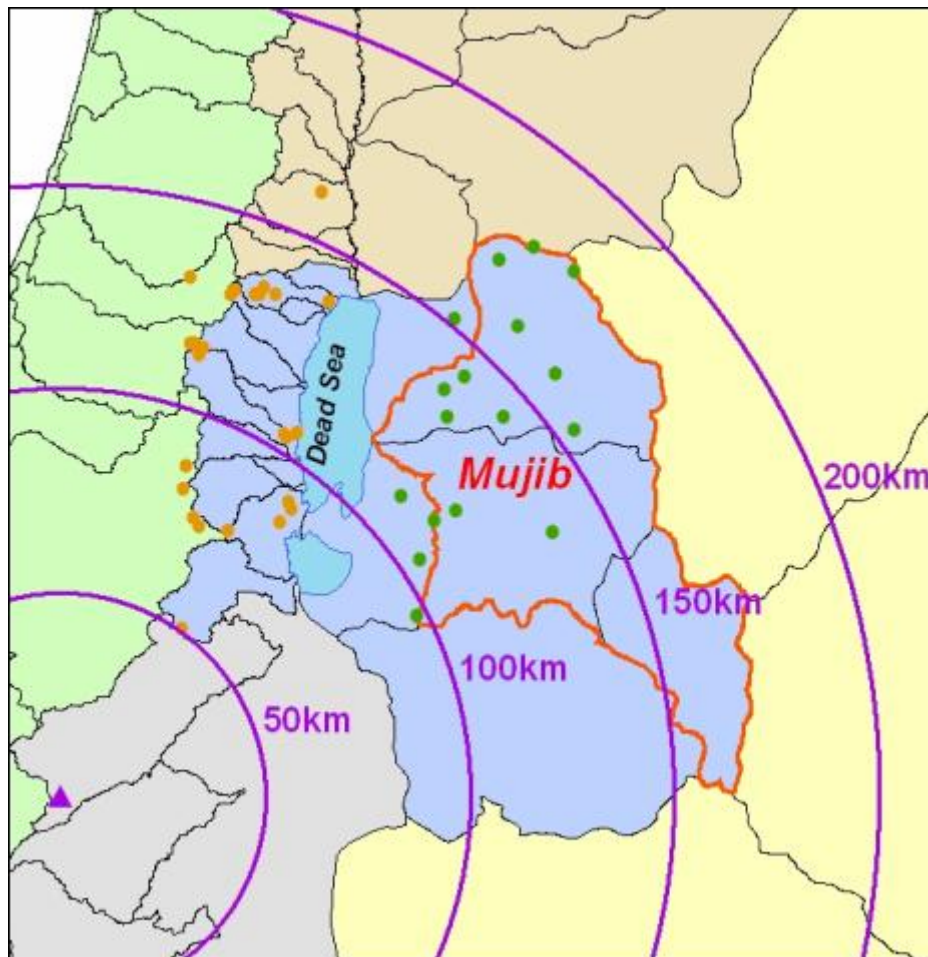


Figure 1. Map showing location of radar station used to analyze storm of May 1-2, 2001, over the Mujib Basin. Dots indicate calibration (green) and validation (brown) gages.

The gage bulk adjustment approach was used for radar rainfall estimation. For the power law Z-R relationship, the value of the exponent parameter was selected to be 1.6, just as it was for the Besor basin (EXACT, 2006). The multiplicative parameter was computed such that the average storm depth for the 17 calibration gages was equal to the average storm depth in radar pixels above these gages. The resultant Z-R relationship

was: $Z=37R^{1.6}$, where Z is radar reflectivity [mm^6/m^3] and R is rain intensity [mm/h]. Average differences between gaged rain depth and radar rain depth were 20 mm (72%) for the calibration gages and 14 mm (44%) for the validation gages. Accumulated total storm depth is shown in figure 2.

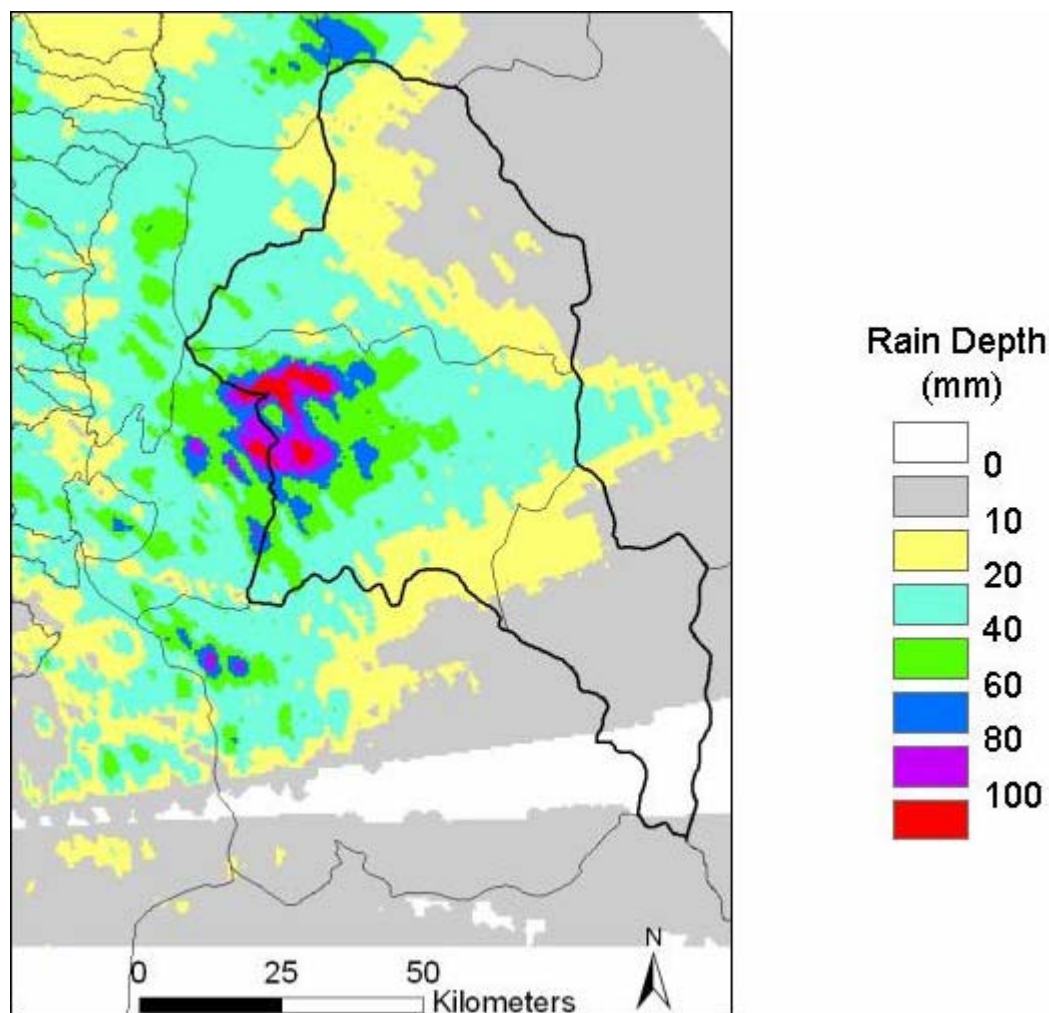


Figure 2. Accumulated rain depth over Mujib Basin for May 1-2, 2001, based on radar.

Rain intensities at two successive times during the storm are shown in figure 3. The localized nature of the storm is well demonstrated in these images. The rainstorm was composed of small cores of intense rainfall (area with rain intensity greater than 10 mm/h was about 50 km²), while most of the basin had low rain intensity. According to radar estimates, the highest rain intensity within the basin for this storm was 190 mm/h. Rain intensities over 100 mm/h at any time during the storm covered a total area of 90 km², less than 2% of the basin area.

Analysis of spatial correlation of storm rain depth for a 50 km by 50 km region centered over the maximum rain depth area indicated a

significant reduction of correlation with distance. For example, correlation (r^2) between storm depths dropped from 0.68 at 10 km separation distance to less than 0.5 at 20 km separation distance.

Recorded intensities at the Qatraneh gage were compared with radar estimates in the pixel above this gage. Results (fig. 4) indicate a poor match between gaged data and radar data that may be due to (1) errors in radar estimates, (2) possible errors in digitized chart data at the gage, or (3) possible errors in either radar data or gaged data resulting from high winds that may be particularly pronounced in short-duration, synoptic storms.

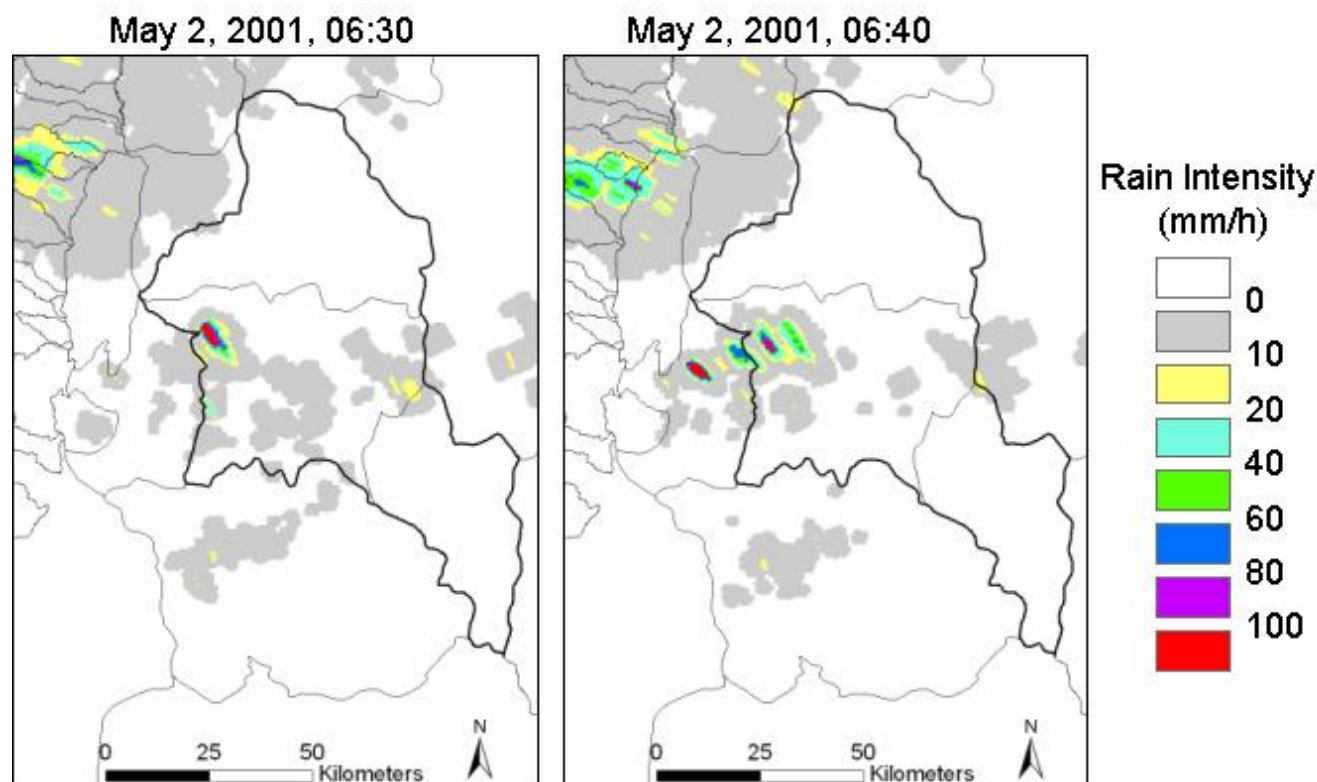


Figure 3. Rainfall intensity over the Mujib Basin at 06:30 and 06:40 (local time) on May 1-2, 2001, calculated from radar.

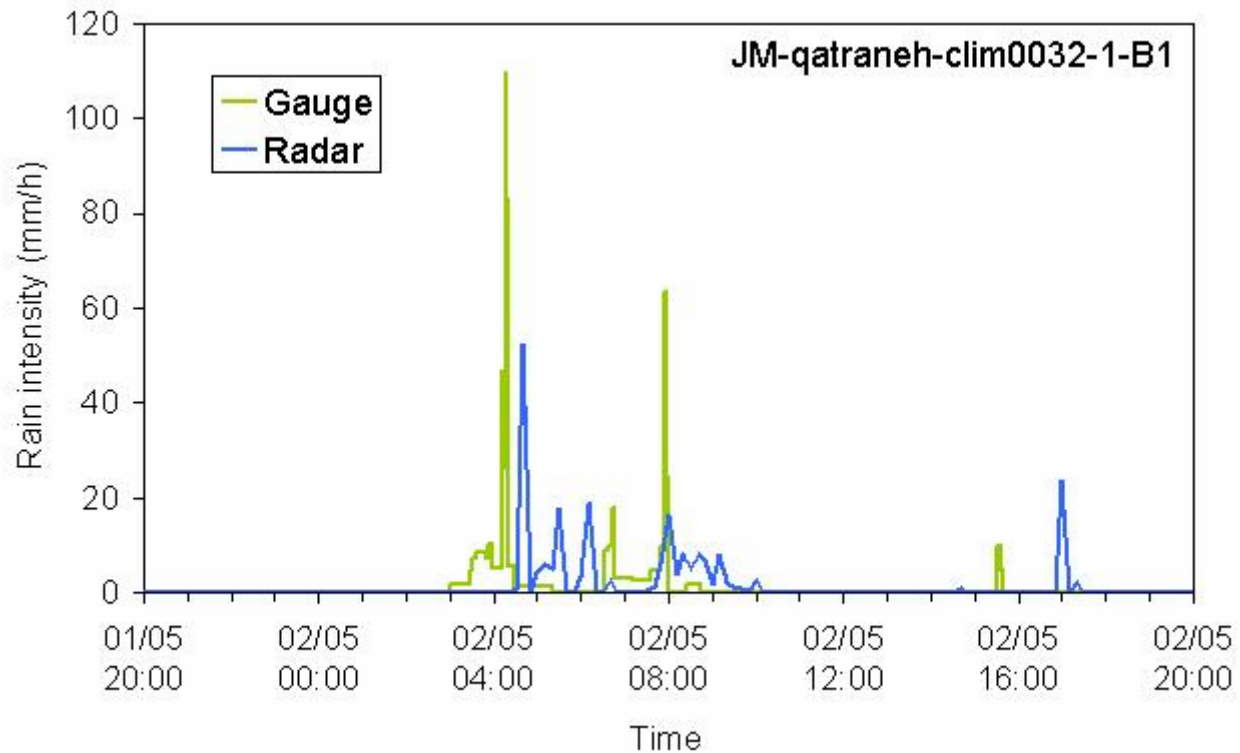


Figure 4. Rainfall intensity at Qatraneh gage and from radar.

Summary and Conclusions

Rainfall intensity for a storm in the Mujib basin was analyzed using radar data and software (RAINPLOT) developed by the Core parties. The storm analysis using radar showed that radar can be used to provide useful information about storm intensity, especially on an areal basis. The storm analysis for the Mujib basin showed that the storm was very limited in areal extent but had core areas of very high intensity. Care needs to be taken to ensure that radar characteristics and performance are stable over time.

References Cited

EXACT (Executive Action Team, Middle East Water Data Banks Project), 2006, Application of methods for analysis of rainfall intensity in areas of Israeli, Jordanian, and Palestinian interest: 31 p.
<http://exact-me.org/ri/>