Spatial Interpolation and Rainfall: Assessing Interpolation Methods Over the Rideau Valley Watershed

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Introduction:

Rainfall is an important component of the hydrological cycle, and accurate quantification of the amount of rainfall that occurs across space is essential in many hydrological studies. Hydrological models aid hydrologists, hydrogeologists, and engineers in understanding the physical processes occurring in a system so that effective water management strategies can be made (Wang et al, 2014). Quantifying the amount of rainfall that occurs in a given catchment is limited by the amount of available rain gauge data, which is often sparse due to the costs of installing and maintaining gauges (Ahrens, 2006). As a result, interpolation methods are employed in order to obtain values at ungauged locations, and although numerous methods have been developed, there is no overarching method that is suitable for all basins (Chang et al, 2005).

Objectives:

Evaluation of the optimal interpolation method for different watersheds is essential in protecting and managing local water resources. Accurate characterization of precipitation data can support conservation authorities and flood forecasting and warning programs, in mitigating and managing flooding. This task is made easier by commercially available GIS software with various deterministic and geo-statistical interpolation methods built in (Ly et al, 2013). As a result, the objectives of this study are i) To determine the most acceptable interpolation technique for the Rideau Valley Watershed using industry standard software ii) Evaluate model performance on a yearly growing season basis to determine whether certain interpolators perform better during different years (i.e. wet year versus dry year) iii) Evaluate model performance on a monthly basis to determine whether certain interpolators perform better during different months (i.e. spring versus summer).

Methods:

There are approximately 26 rain gauges within the Rideau Valley Watershed that collect precipitation data at various time intervals. The first part of this study required analyzing the various datasets to determine which would be included in the testing of the various interpolation models. This was achieved by:

1) Identifying a time frame in which the majority of gauges had overlapping data
2) Identifying a recording interval that best reflected the varied datasets
3) Performing quality control on the data to identify any data gaps that could impact the interpolation results, and deleting gauges thought to be unsuitable
4) Combing the different datasets into monthly, and seasonally averages and totals
5) Creating a precipitation database that contained feature datasets of the precipitation gauge feature classes

Methods Continued:

Data analysis produced a total of 19 gauges seasonally, and as many as 24 gauges monthly, with daily rainfall data ranging from 2009 to 2014 to be tested on 4 different interpolators. The evaluated interpolators included IDW, Ordinary and Simple Kriging, Radial Basis Functions, and Local Polynomial Interpolation. Each of the interpolators was run on monthly total data, average total growing seasonal data for each year, and average total growing season data for 2009 to 2014. Error assessments were conducted on all models by sub-setting the data into 80% training data and 20% validation data, and then computing mean absolute error, root mean squared error and R^2 values.

Preliminary Results:

Preliminary results indicate that IDW with a power of 2, and Ordinary Kriging with anisotropy set to true perform fairly well for the summer months of 2009. Simple Kriging performed very well in June, but had high mean absolute error and root mean square error for July, in addition to a poor R^2 value (See Table 1 and 2 below). Modeled results for May 2009, and August 2009 were poor for most of the interpolators investigated, although Ordinary Kriging did produce an R^2 of 0.88 for May. Visual inspection of the image however, seemed appeared less than optimal. Differences between months could be due to differences in the amount and types of rainfall that occurred at the various locations, but further investigation into modelled results is ongoing.

Table 1 – Model error assessment of monthly total rainfall June 2009.

	MAE (mm)	RMSE (mm)	R^2
IDW	4.08	4.11	0.84
Radial Basis Function	4.23	5.06	0.79
Ordinary Kriging	4.97	5.49	0.93
Simple Kriging	2.25	2.75	0.97

Table 2 – Model error assessment of monthly total rainfall July 2009.

	MAE (mm)	RMSE (mm)	R^2
IDW	14.59	16.65	0.90
Radial Basis Function	21.85	24.92	0.87
Ordinary Kriging	21.88	24.92	0.87
Simple Kriging	32.32	38.37	0.15

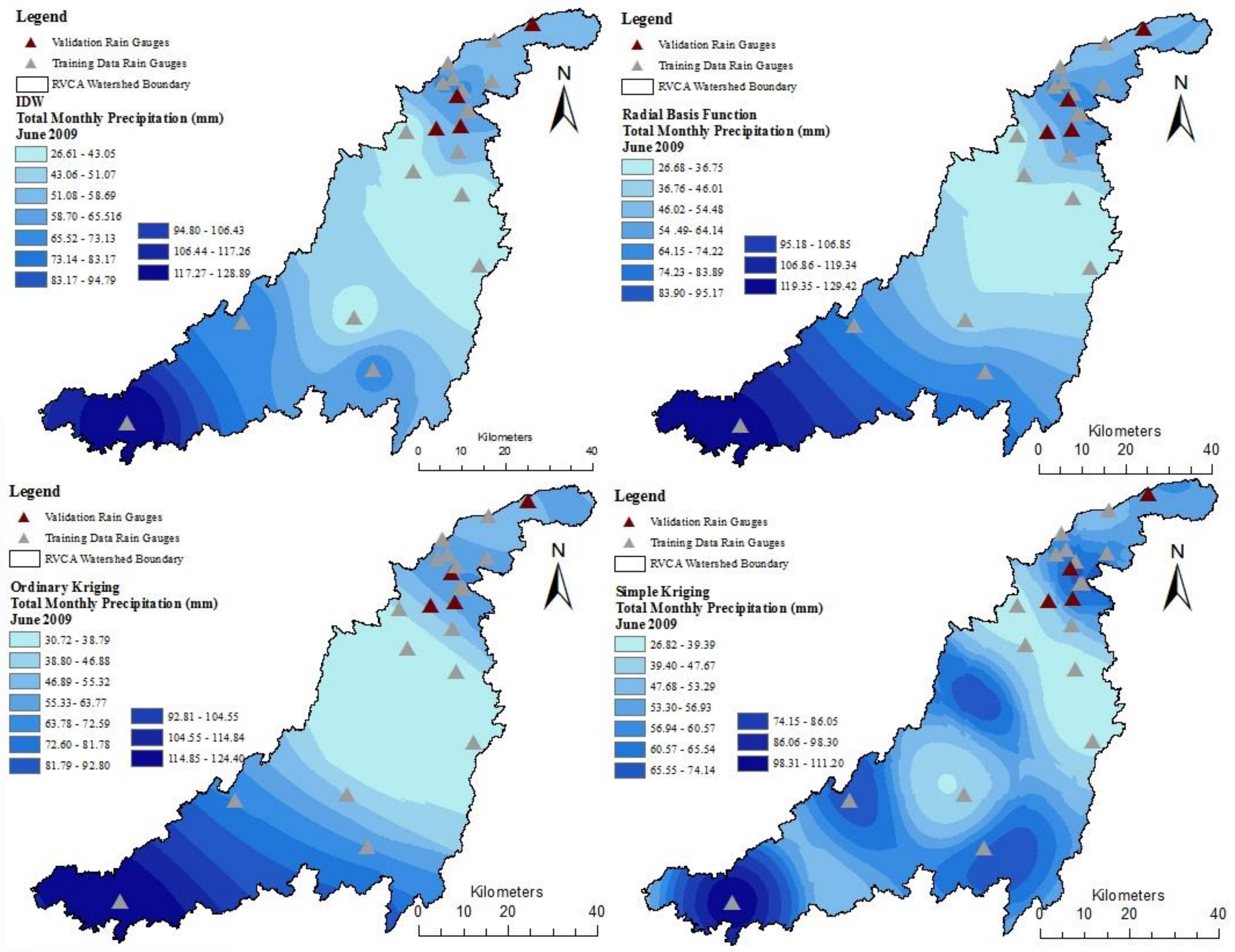

Figure 1 – Interpolation results for monthly total rainfall (mm) for June 2009. Investigated interpolators include IDW, Radial Basis Function, Ordinary Kriging, and Simple Kriging.

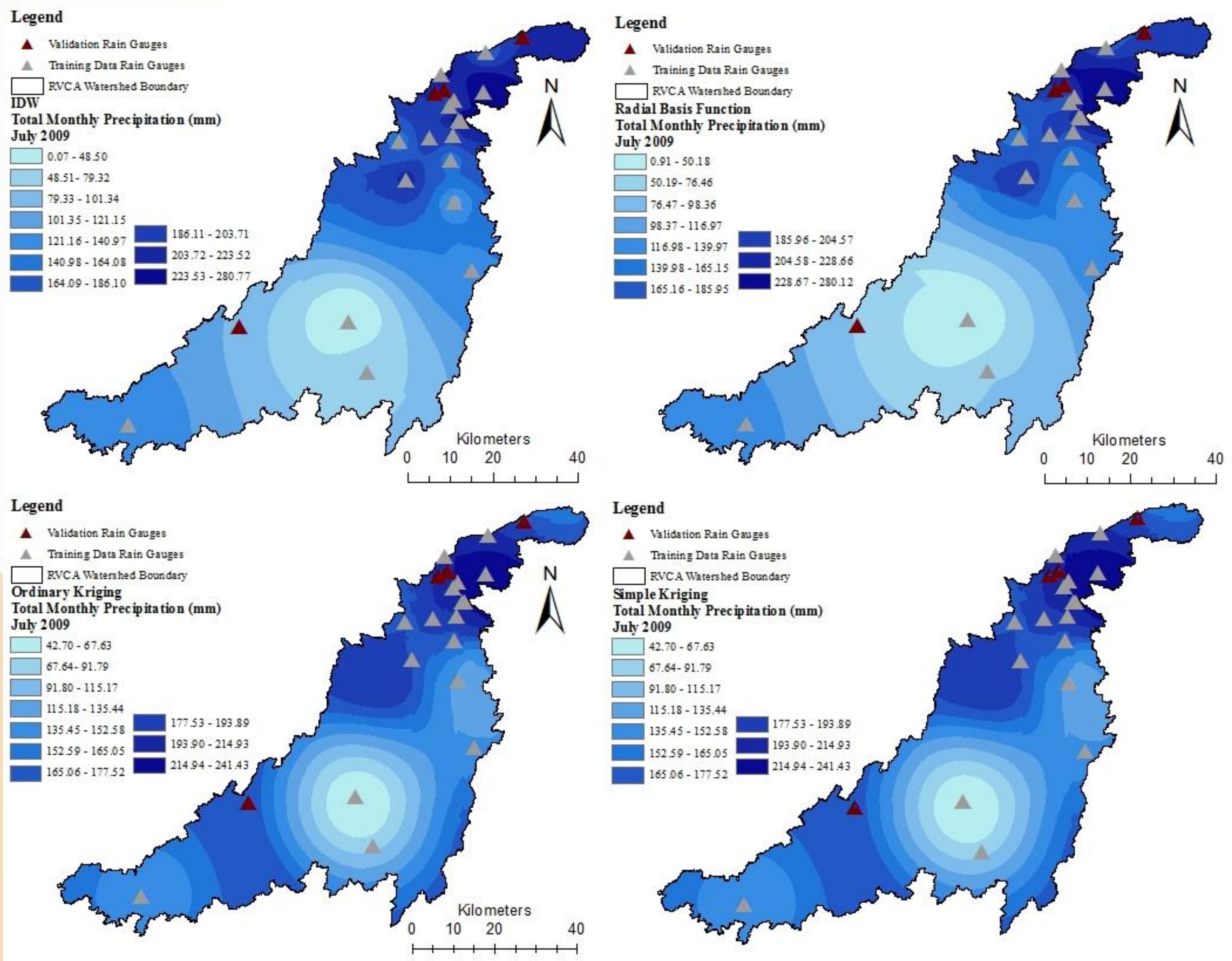

Figure 2 – Interpolation results for monthly total rainfall (mm) for July 2009. Investigated interpolators include IDW, Radial Basis Function, Ordinary Kriging, and Simple Kriging.

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