Alternative Water Source Detection
For Decision Support in Disaster Response Planning

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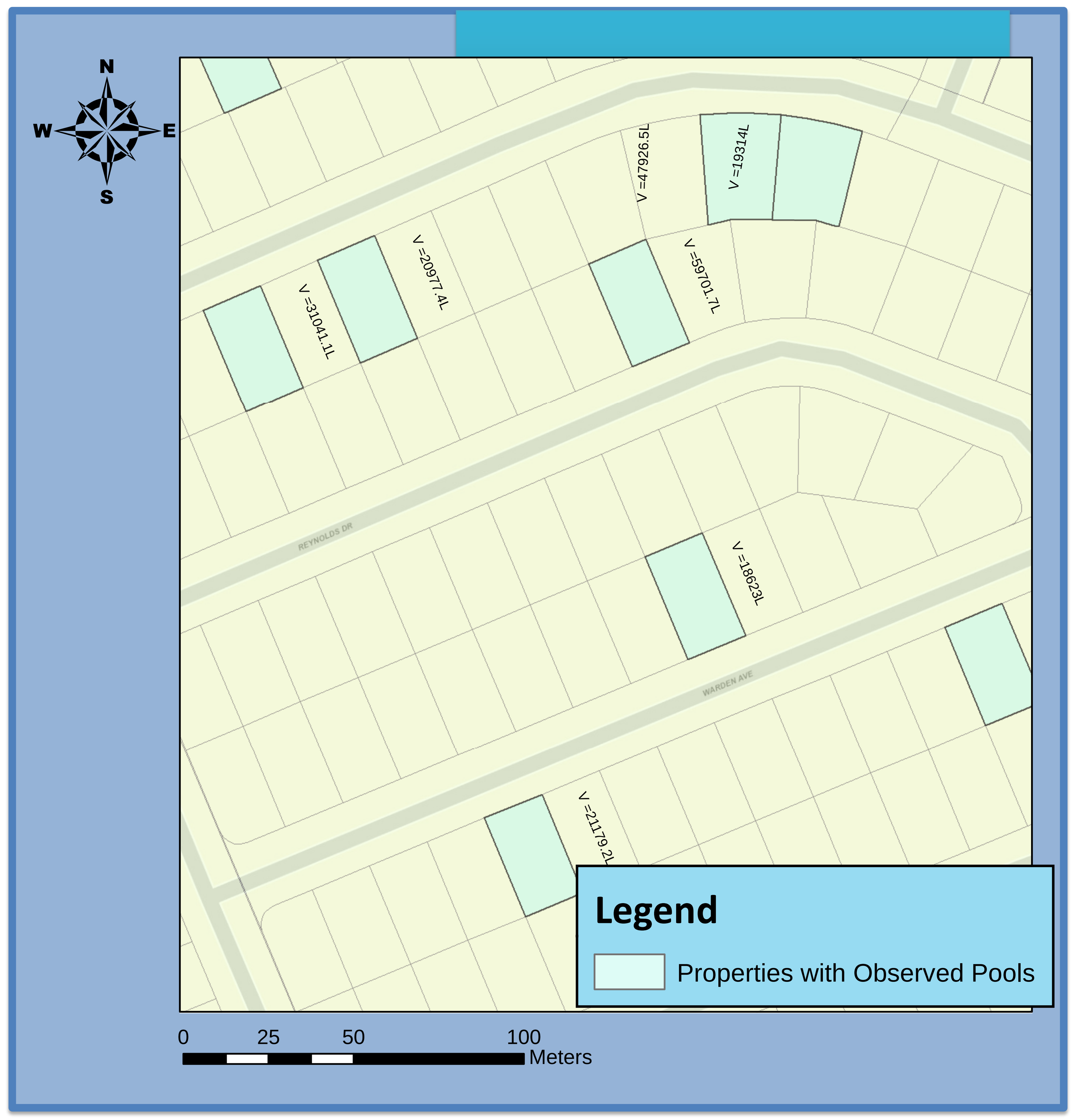
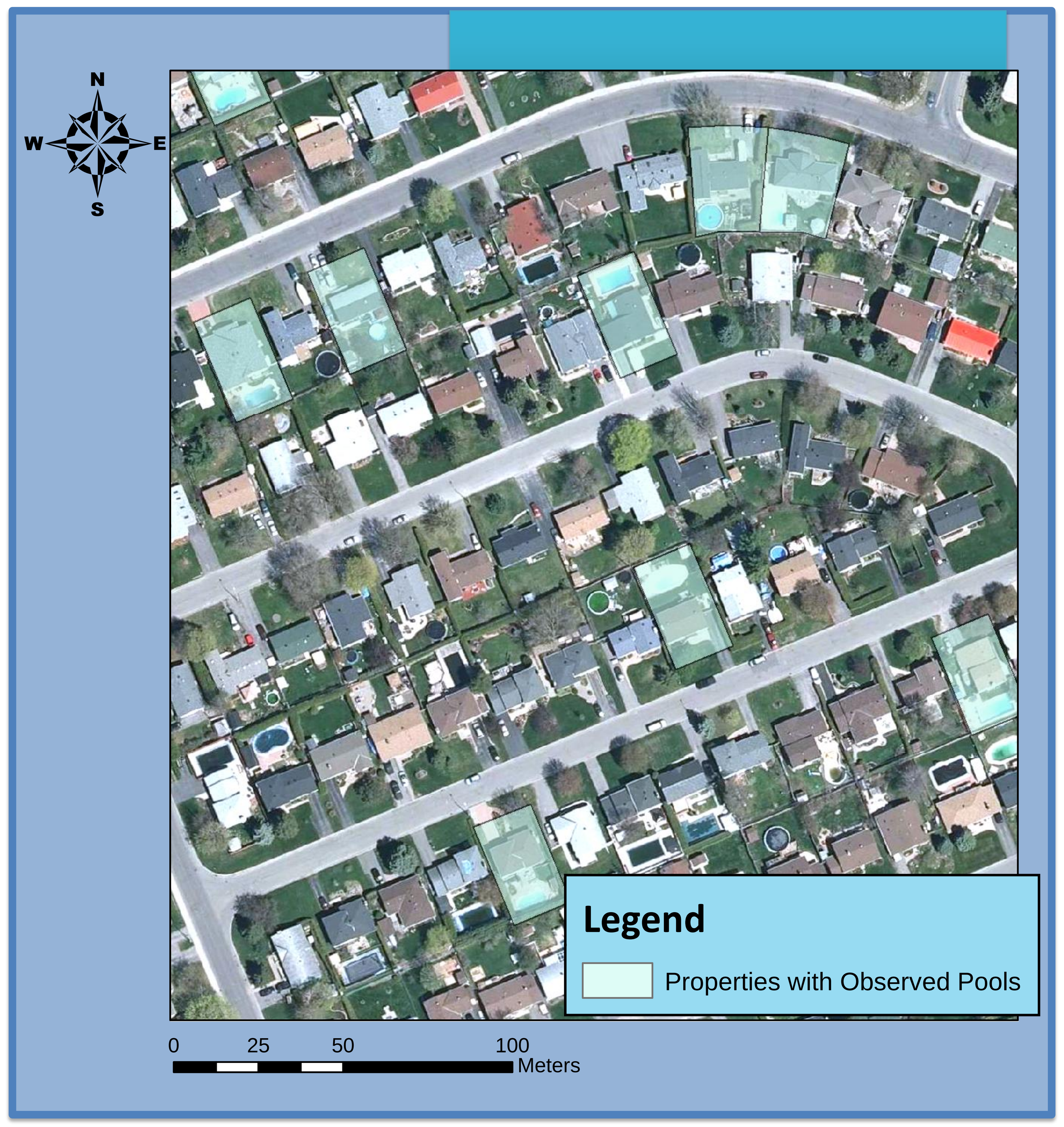
Introduction

When planning for disaster, the lessons learned from the 1994 earthquake in Los Angeles show that city infrastructure is susceptible to damage at a time when that infrastructure is most urgently needed. In that disaster, fire hydrants and the water mains which serviced them were rendered inoperable, forcing firefighters to improvise by using alternative sources of water, or carrying out triage on burning buildings. Since then, ESRI technologies have considerably developed in the areas of automation, GIS and Remote Sensing to facilitate the detection and estimation of alternative water sources before disaster strikes so that first responders can save valuable time and thereby focus on saving lives and infrastructure.

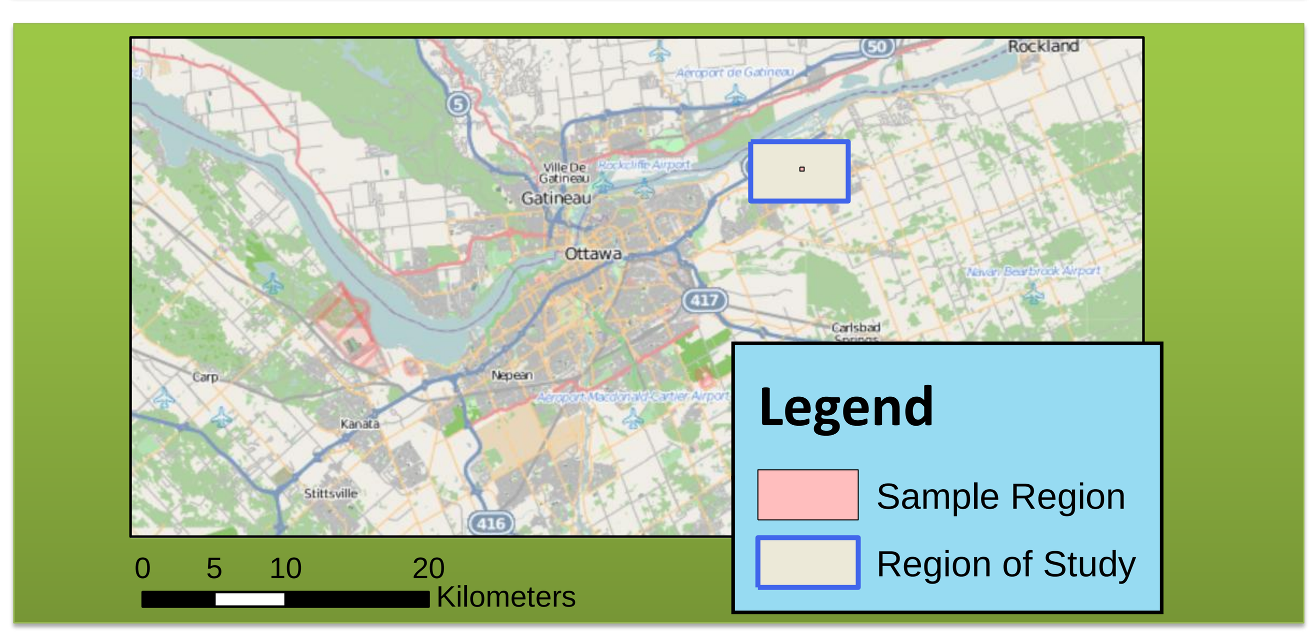
This project demonstrates how spatial analysis, image classification and automation through model builder in ArcGIS 10 can be used to create a database which contains locations of alternative water sources and is interoperable with existing city databases in support of disaster preparedness.





The model used for this project can be accessed using the above QR code or at
http://www.brianbancroft.net/files/OrleansProject.tbx

Figures 1 (left) and 2 (right). Figure 1 shows a subset of the final "pool-equipped" parcels with the volumes of water estimated to be in the pools. Figure 2 shows that the images captured in Fig 1 are comprehensive for all uncovered pools, but cannot be used for covered pools.
Figure 3 (lower right) shows the relation between these maps and the entire region of interest to the City of Ottawa



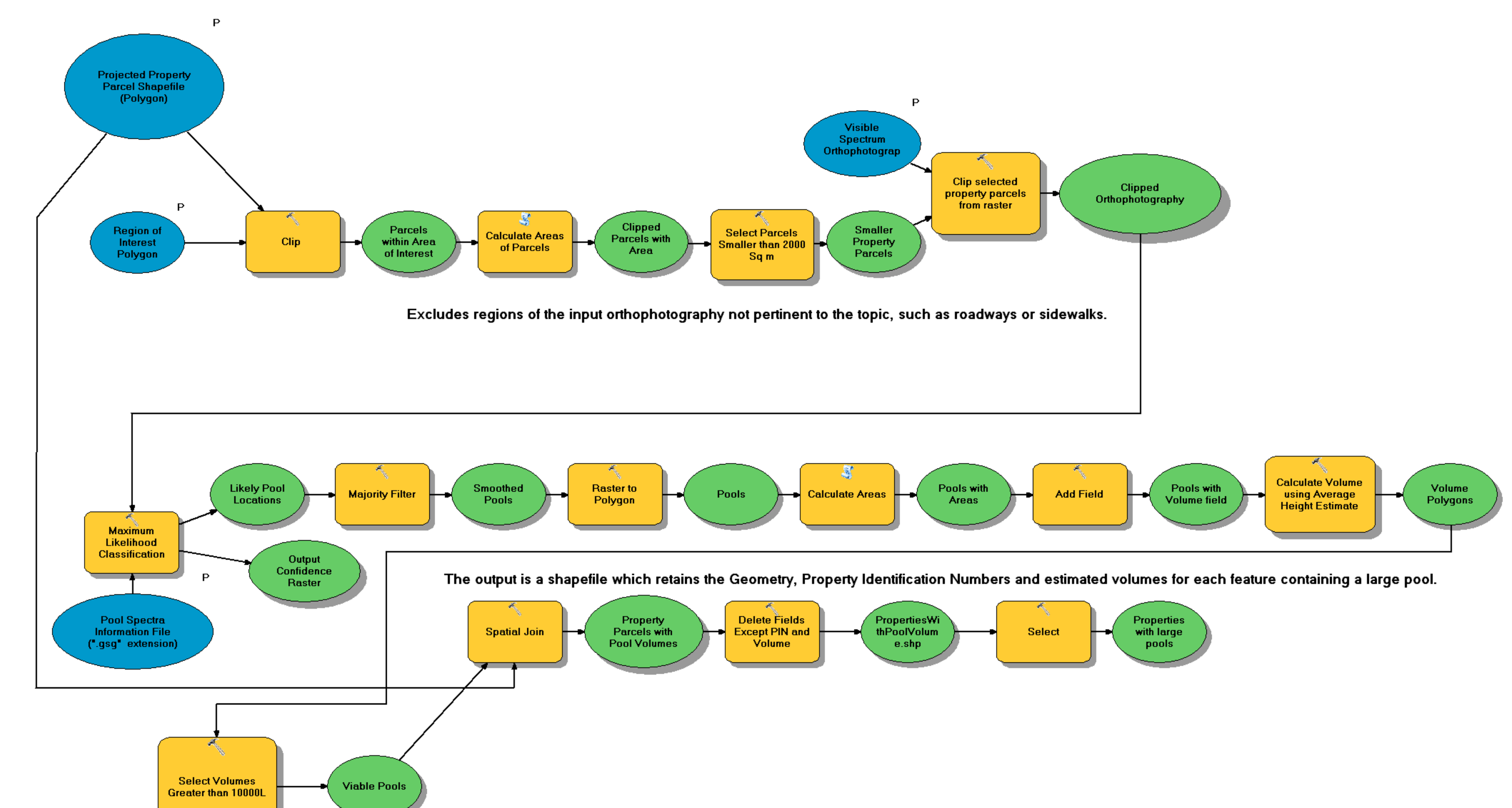


Figure 4: This parameterized model is capable of estimating the volume of pools, and requires a mosaic of aerial photography, a polygon shapefile to determine the extent of processing, a property parcel shapefile which holds a unique identifier field for each feature, and a signature file that contains the spectra of 12 uncovered pools as a single class.

Methodology

All of the input data was projected into MTM Zone 9 before any processes were run. A property parcel layer was clipped to the area of interest and used as the clipping features for an aerial photography mosaic. A supervised classification was carried out using Maximum Likelihood. The classified objects were converted to polygons with calculated areas. Volume of the pools was estimated assuming a constant depth of 1.2m, which is the depth of shallow ends at many pools. Classified objects identified as pools were removed if their volume did not exceed 10000L (which removed objects such as blue cars mistaken as pools as well as smaller pools). Output data was merged with the input property parcel layer to ensure interoperability with other data from the City of Ottawa.

Results

Within my region of study, I was able to create 2253 polygon features with PINs (property unique identifiers) and estimated pool volumes of which only two features were incorrectly identified as rooftops. For the pools identified within these features, a sample size of 20 random pools was used to determine deviation from accepted values which were measured directly from the aerial photography using the measure tool in the "tools" toolbar. This deviation was 11%, which an acceptable level of uncertainty given the RGB imagery used. For a measure of overall effectiveness I chose one random region of 1.5 km^2 and counted pools. Of 43 total pools within this sample region, 15 pools were correctly identified and made the 10000L-threshold, while a further 4 were classified as pools, only a small subset of those features were classified as a pool due to light refraction. Of the 43 pools, 22 were covered, and could not be classified using visible spectrum photography despite many previous attempts, and the remaining 2 were partially obscured by trees.

Conclusion

While there still remain some limitations to overcome, this project shows that cities already have the means to estimate pool volumes in an effective manner to assist disaster relief planners in mitigating the consequences of a worst-case scenario. In the event that I gain better means of object detection or if I acquire NIR photography, I intend to use this parameterized tool to estimate pool volumes for the entire City of Ottawa. From there, my next steps will be to seek integration or interoperability into HAZUS, as well as further analysis that uses Network Analyst to support contingency plans for future disaster scenarios.

Table

Properties with Observed Pools

PIN	EstVolume
145313388	61710.3
043921085	39404.8
145020053	42007.3
145220360	40523.1
145150186	11902
145240095	47518.7
043910696	72187.6
145030079	14608.9
145040080	63188.1
044110007	18823.1
145210039	26526.6
145260803	29175.1
044040261	24426.7
039400106	31954.5
043910709	57938.3
044090219	32550.7
044201198	32492.2
044140112	42768.6
145110116	51042.9
145120264	32108.8
044260063	67208.5
145252668	66273.1
047450055	55177
044060071	52358
044060005	46100.5
044140158	22549
044110036	23555.9
145120339	34503.7
047560510	80865.2

0

(0 out of 2253 Selected)

Properties with Observed Pools

Figure 5: A sample of the table of contents for the output shapefile which contains estimated volumes as well as the PINs which allow for interoperability with other data held by city planners.

Bibliography
City of Ottawa. (n.d.). 2008 Aerial Photography. City of Ottawa, Acquired through the University of Ottawa Geographical, Statistical and Government Information Center (GSG). / City of Ottawa. (n.d.). 2008 Aerial Photography. City of Ottawa, Acquired through the University of Ottawa Geographical, Statistical and Government Information Center (GSG). / City of Ottawa. (n.d.). 2008 Aerial Photography. City of Ottawa, Acquired through the University of Ottawa Geographical, Statistical and Government Information Center (GSG). / City of Ottawa. (n.d.). 2008 Aerial Photography. City of Ottawa, Acquired through the University of Ottawa Geographical, Statistical and Government Information Center (GSG). / City of Ottawa. (n.d.). 2008 Aerial Photography. City of Ottawa, Acquired through the University of Ottawa Geographical, Statistical and Government Information Center (GSG).