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Land Cover Classification of Northern and Southern California Suburbs using ArcGIS

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Introduction

Impervious surfaces are believed to be a major conduit for contaminant transport. In urban areas, impervious surfaces can account for up to 90% of the total surface (1). Previous studies indicate that impervious surfaces act as a reservoir for pyrethroids, resulting in higher urban runoff concentrations of pyrethroids for an extended period of time (2). This study is part of a long-term effort to better understand the environmental fate of pesticides in urban environments.

Using the Image Classification tool in ArcGIS, we will conduct an unsupervised image classification to identify the impervious surface coverage of five field sites that are contributing areas to watersheds in Northern and Southern California. The unsupervised image classification uses computer algorithms to assign pixels of multi-band imagery (e.g. satellite, orthoimagery) to classes based on the spectral signatures of individual pixels. Pixels with similar spectral signatures are assigned to the same classes. These classes are then manually assigned to land cover types like concrete, asphalt, or grass. For this study, impervious land cover is defined as roof, sidewalk/driveway, and road while impervious land cover is defined as vegetation. This process is largely computer automated and post-processing tools are available to minimize noise and assess the classification accuracy of the final product. Unsupervised image classifications are inexpensive, require minimal field work, and can easily be conducted for large areas. The information gained in this analysis will be incorporated into an urban runoff model used for the prediction of pesticide concentrations on a watershed scale (Figure 5).

Objectives

1) Classify field sites based on ground cover classification of impervious and pervious
2) Identify differences in impervious surface coverage between field sites
3) Compile input parameter data for urban runoff model development

Methods- Field

- 5 sites chosen in urban areas in Sacramento County (FOL002, FOL003) and Orange County (SC1, SC2, SC3) (Figure 1, 2, 3)
- Field sites represent contributing areas to watersheds and were delineated using storm drain maps, topographic maps, and visual observations

Figure 1. Sacramento County suburb.

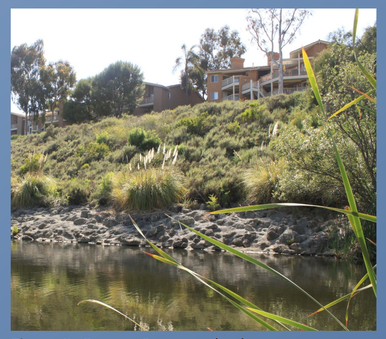

Figure 2. Orange County suburb.

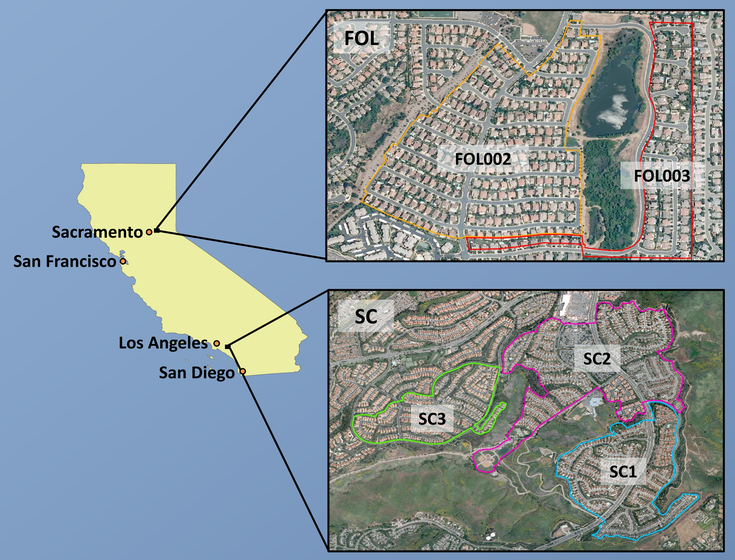

Figure 3. Sacramento and Orange County field sites.

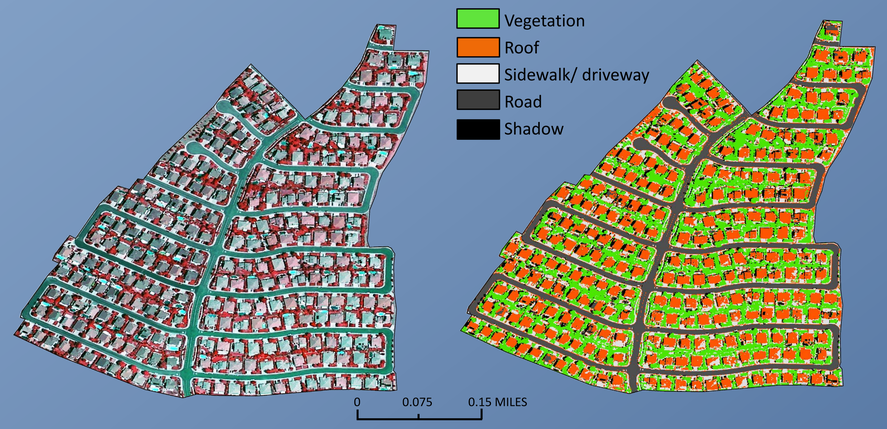

Figure 4. False color composite image of FOL002 on left, classified image on right.

Methods- Image Classification

Pre-Processing
- Digitize field site boundaries

Data Acquisition
- Imagery source: USDA datagateway.nrcs.usda.gov
  - 2012 NAIP imagery
  - 4-band (RGB + NIR), 1-meter resolution

Imagery Pre-Processing
- Compile images into raster dataset
- Composite false color image of NAIP imagery
  - Red channel: band 4 (NIR)
  - Green channel: band 3 (green)
  - Blue channel: band 2 (blue)
- Clip to field site boundaries

Image Classification
- Activate Spatial Analyst Extension in ArcMap
- Perform Iso Cluster Unsupervised Classification with following specifications:
  - Number of classes = 50
  - Minimum class size = 40
  - Sample interval: 10

Imagery Post-Processing
- Conduct majority of filter on image classification
- Manually review each class, and assign to classification of vegetation, roof, sidewalk/driveway, road, or shadow
- Reclassify classes to impervious, pervious, or shadow
- Repeat process for each field site

Results and Conclusion

- FOL002 had the highest impervious surface cover, SC3 had the lowest (Table 1)
- No major differences in groundcover composition percentages, but large difference in impervious cover area (Table 1)
- Impervious cover area likely affects the generation of storm runoff (Table 1)

Table 1. Image classification results by field site.

County	Site	Number of Houses	Impervious Cover	Pervious Cover	Shadow Cover	Impervious Cover Area (acres)
Sacramento	FOL002	255	**64%**	28%	9%	**41**
Sacramento	FOL003	85	**55%**	35%	10%	**14**
Orange	SC1	511	**54%**	40%	6%	**83**
Orange	SC2	780	**58%**	38%	4%	**128**
Orange	SC3	352	**52%**	44%	4%	**52**

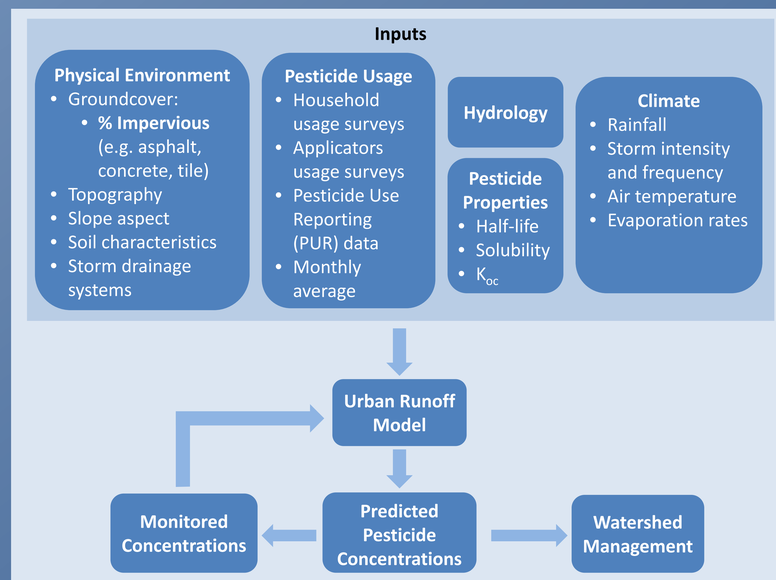

Figure 5. Flowchart illustrating the urban runoff model development.

Next Steps:

- Use a Digital Elevation Model and ArcGIS to determine water flow direction and delineate contributing area watersheds, slope aspect
- Determine pesticide usage through household and applicator surveys
- Record climatic events e.g. rainfall, storm intensity
- Identify relationships between impervious cover and maximum runoff during storm events
- Develop urban runoff model based on input parameters, verify with monitoring data

References

1. Arnold, C. and Gibbons, C. 2010. Impervious Surface Coverage: The Emergence of a Key Environmental Indicator. Journal of the American Planning Association, 62: 243-258.
2. Jiang, W., Gan, J., and Haver, D. 1996. Sorption and Desorption of Pyrethroid Insecticide Permethrin on Concrete. Environmental Science and Technology, 45: 602-607.

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