Automated Sampling of Storm Runoff From Residential Areas

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Introduction

As urbanization increases so does the focus on storm water runoff monitoring as a tool to protect surface water quality. In 2006, a project was initiated in Sacramento and Orange Counties to monitor runoff from single family homes. Four urban drainsheds each comprised of 152 - 460 homes were selected per county. Water samples were collected and precipitation and flows were measured at the storm drain outfalls to examine runoff at a neighborhood level. Water samples were analyzed for pesticides, nutrients, biological, and other parameters.

Time vs. Flow Intervals

- Time and flow are the two parameters used to determine sampling intervals;
- Time weighted collection can occur at regular intervals throughout the storm or at variable increments of time in an attempt to capture peak runoff.
- Flow weighted samples are collected at intervals of flow (King et al., 2005).
- For both strategies, it is important to minimize intervals between samples and to sample throughout the storm event.
- However, different methods work for different sites and a sampling program should developed to address the goals of the project (Stone et al, 2000).

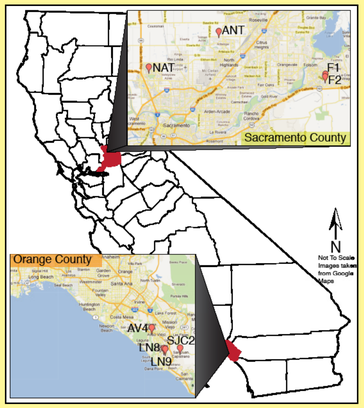
Objective

Examine the use of a landcover model to optimize flow weighted sampling of storm runoff.

Electrical conductivity and pH sensor (top band) and velocity sensor (bottom band). The intake tube for the automated sampler is attached on the top left sensor cover. (L.R. Oki)

Materials & Methods

Study Sites



Site	Constructed	Residential Parcels	Pipe Diameter
Sacramento			
ANT	1993-1997	336	30”
NAT	1989-1995	159	48”
F1	2000-2002	188	48”
F2	1990, 1993-2003	251	48”
Orange			
AV4A	1988-2000*	307	42”
LN8	1988-1995	245	42”
LN9	1986-1993	460	60”

*Insufficient Data

Materials

- Hach Sigma 950 Flow Meter measured and recorded water level, velocity, pH, electrical conductivity, and temperature.
- Hach Sigma 900 MAX Portable Sampler collected composite samples.
- The Sigma 950 was programmed for flow-weighted sample collection and controlled the 900 MAX sampler.
- During storm events, the Hach Sigma 950 measured runoff flows, using water velocity and level, and prompted the Sigma 900 MAX to collect samples
- A rain gauge measured rainfall.
- A solar panel recharged the batteries.

Collection Procedure

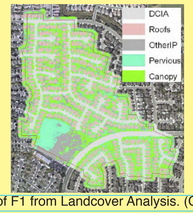


Image of F1 from Landcover Analysis. (Q. Xiao)

- A modified TR55 hydrologic model incorporating land cover information was used in conjunction with forecasted rainfall to estimate the potential runoff volume for each site (USDA, 1986).

	Forecast				Estimated runoff volume				Actual collection	
	Total rain-fall	Storm dura-tion	Back-ground flow rate	Pacing setting	From storm	Back-ground flow	Total runoff	Calculat-ed pacing volume	Runoff	Rainfall
Location	(in.)	(hrs)	(L/s)	(L)	(L)				(L)	(in)
SJC2	0.33	24	0	8,100	400,317	0	400,317	8,006	600,476	0.40
LN9	1.09	24	0	230,00	11,488,564	0	11,488,564	229,771	17,232,845	1.40
LN8	1.09	24	0	110,000	5,220,088	0	5,220,088	104,402	7,830,133	1.40
AV4a	1.55	24	0	190,000	9,248,557	0	9,248,557	184,971	13,872,835	2.10

Orange County pacing table for 12/09/2008 storm event

- The estimated runoff volume was used to calculate the pacing interval and entered into the data logger.

Two Hach Sigma 900 MAX automated samplers with a Hach Sigma 950 (center). (L.R.Oki)

- Rainfall in excess of 0.05 cm over a 15 minute period triggered sampling.
- Each composite sample consisted of 50 subsamples of 400 mL

Site NAT (Sacramento County), the green box holds the data logger and automated sampler, the rain gauge is to the left. (L.R. Oki)

Results & Discussion

- 25 storm events were sampled from 2007-2010; 12 events in Sacramento and 13 events in Orange.
- 89 storm events were sampled from eight sites; 47 in Sacramento and 42 in Orange.

Sacramento County

Site	ANT	NAT	F1	F2	Total %
Success	9	9	10	12	85.71%
Error	2	3	2	0	14.28%

Orange County

Site	AV4	LN8	LN9	SJC2	Total %
Success	6	7	11	12	85.11%
Error	2	3	1	0	14.89%

Sacramento and Orange Totals

	Results	%
Success	76	85.39%
Error	13	14.61%

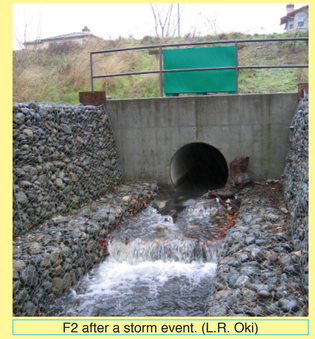
Success- The device yielded enough of a sample for analysis.
Error- No sample was collected due to equipment errors such as low battery, clogged intake, distributor arm error or the rain threshold was not met.

Results & Discussion

- A success was registered when enough water was collected to fill two 1000 mL amber glass jars.
- In 65 of 89 instances, 90% of 50 subsamples were collected.
- In 10 instances between 40% and 70% of subsamples were collected.
- In one extreme case only 5 of 50 subsamples were collected.
- Personnel manually initiated sampling once due to equipment error. This instance was registered as a success.
- Using the automated samplers, it is possible to account for missed samples when calculating loading.
- While the automated sampling equipment is “far from trouble free”, the “considerable maintenance and repair effort” (Harmel, 2006) is manageable if sites are visited frequently.

Conclusion

Overall, use of the automated samplers did prove to be reliable. The ability to take flow-weighted composite samples was worth the effort to set up and maintain the equipment for this study.



F2 after a storm event. (L.R. Oki)

Future Work

Evaluating the model through comparison of recorded flow to estimated flow using measured rainfall data. When the ultrasonic velocity sensor encounters very clear water it records a zero velocity, resulting in a flow of zero which further leads to errors in sampling. Further inquiry of the data is needed to determine the effect of zeros in the flow data.

Acknowledgements

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