Water Quality & Environmental Justice: A Case Study of Los Angeles County

BASINS PLOAD & SCAG Land Use Dataset

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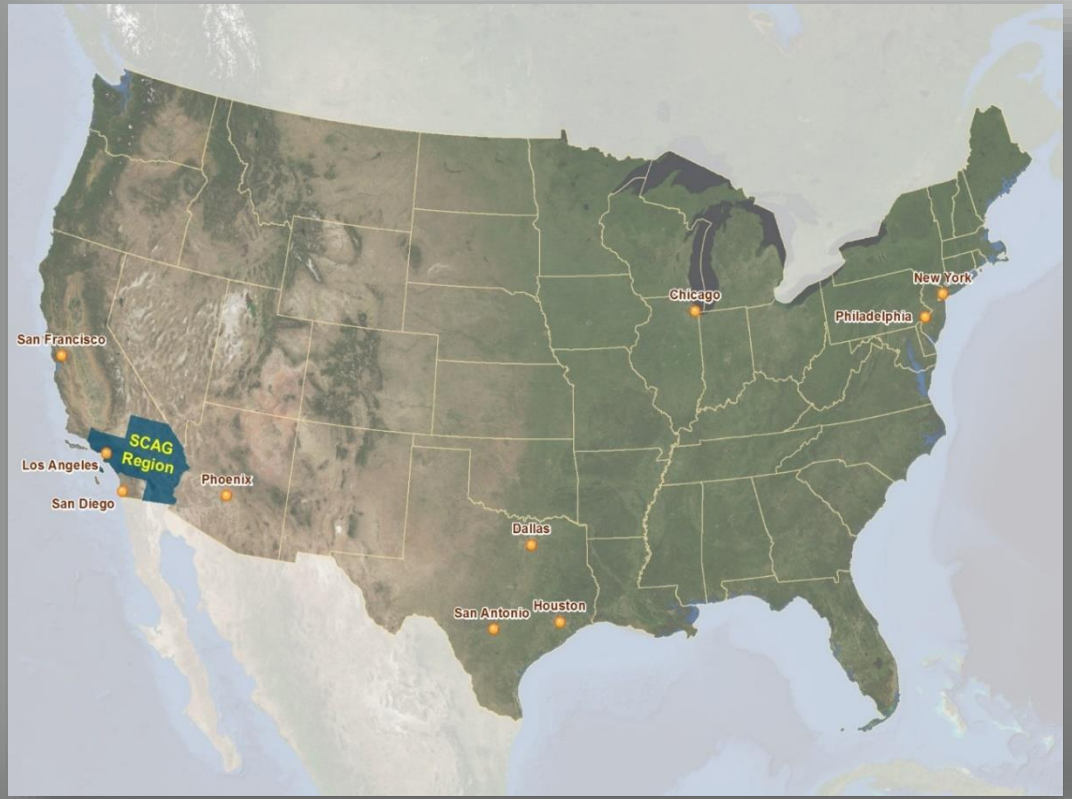
Presentation Overview

- SCAG Introduction
- Research Questions
- Theoretical Background
- Modeling Framework
- Results and Discussion
- Future Improvement

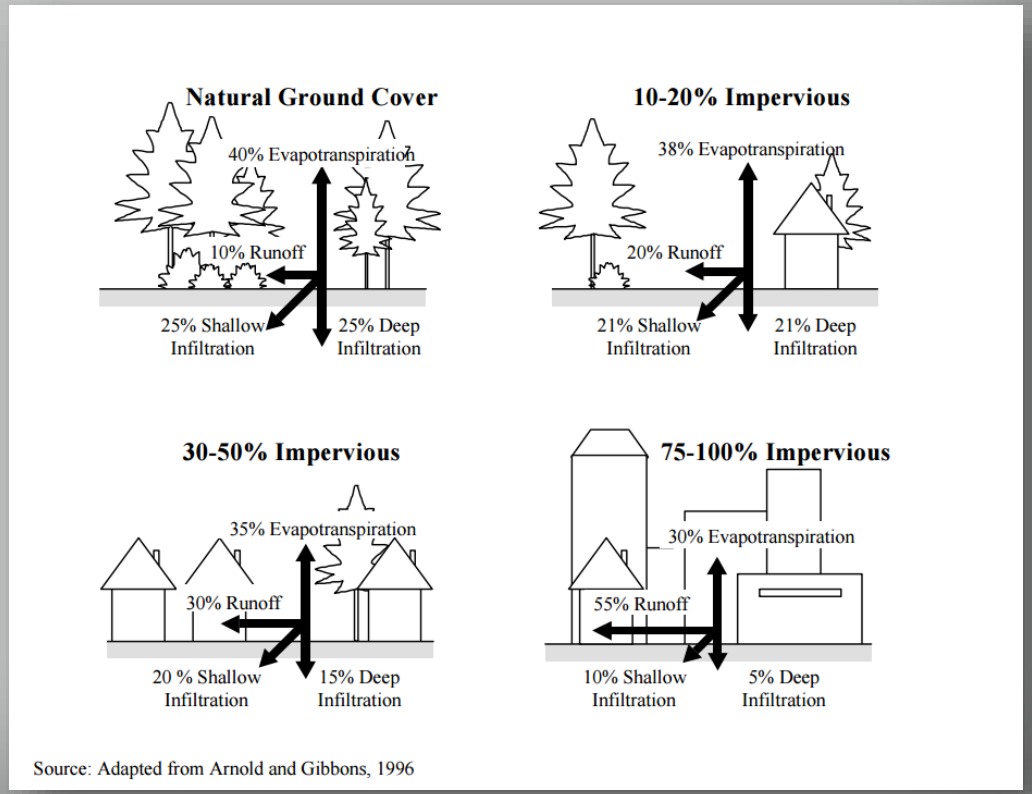
SCAG Introduction



- Nation's largest Metropolitan Planning Organization (MPO)
- **6** counties and **191** cities
- **15** sub-regions
- **19** million people (2015)
- **38,000** square miles
- **16th** largest economy in the world (GRP: **$1,008** Billion in 2015)
- Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS)

Research Background

- Urbanization, Imperviousness, Urban Runoff Pollutants
  - Non-point source (NPS) pollutants from urban runoff exert significant impacts on watershed environment
  - Many local jurisdictions have concerns about the water quality control within their administrative boundary
  - Urbanization changes land use pattern, which is related to the urban imperviousness pattern and NPS spatial distribution (Moglen et al, 2007 & Jacobson and Carol, 2011)



Source: Adapted from Arnold and Gibbons, 1996

Research Questions

1. How the spatial distribution of imperviousness will effect the NPS-pollutants distribution based on different land use scenarios?

2. What is the impact of urban runoff pollutant (total phosphorus) on environmental justice (EJ) population in High Quality Transit Area (HQTA)?

    1. HQTA represents the ***half-mile*** zone surrounding all rail transit stations, ferry terminals served by bus or rail transit service, the intersection of two or more major bus routes with a frequency interval of ***15 minutes or less*** during morning and afternoon peak commute periods, and corridors with fixed route bus service with headways of no longer than 15 minutes during peak commute hours (SCAG 2016 RTP/SCS)

Theoretical Framework (1)

- The imperviousness as an indicator is commonly used as benchmarks in local, watershed, and regional planning efforts (Lee et al, 2003)
- Predicted stormwater loads are highly sensitive to land use designations and their associated EMC estimates (Park and Stemstrom, 2008).
- Environmental Protection Agency (EPA)'s Better Assessment Science Integrating point and Nonpoint Sources (BASIN) Pollutant Loading Estimator (PLOAD) model

Theoretical Framework (2)

- Event Mean Concentration (EMC) is defined as the total constituent mass discharge divided by the total runoff volume (EPA 1983)

Table 4-1. Median Event Mean Concentrations for Urban Land Uses

Pollutant	Units	Residential		Mixed		Commercial		Open/ Non-Urban	
		Median	COV	Median	COV	Median	COV	Median	COV
BOD	mg/l	10	0.41	7.8	0.52	9.3	0.31	--	--
COD	mg/l	73	0.55	65	0.58	57	0.39	40	0.78
TSS	mg/l	101	0.96	67	1.14	69	0.85	70	2.92
Total Lead	µg/l	144	0.75	114	1.35	104	0.68	30	1.52
Total Copper	µg/l	33	0.99	27	1.32	29	0.81	--	--
Total Zinc	µg/l	135	0.84	154	0.78	226	1.07	195	0.66
Total Kjeldahl Nitrogen	µg/l	1900	0.73	1288	0.50	1179	0.43	965	1.00
Nitrate + Nitrite	µg/l	736	0.83	558	0.67	572	0.48	543	0.91
Total Phosphorus	µg/l	383	0.69	263	0.75	201	0.67	121	1.66
Soluble Phosphorus	µg/l	143	0.46	56	0.75	80	0.71	26	2.11

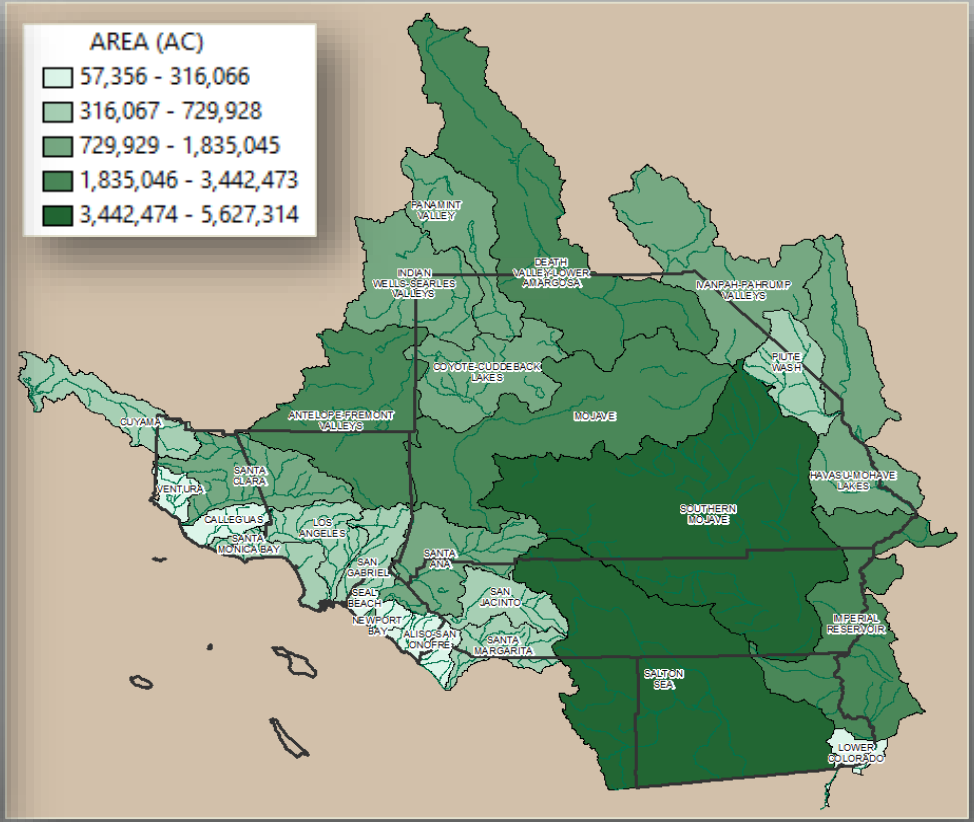
COV: Coefficient of variation
Source: Nationwide Urban Runoff Program (US EPA 1983)

Table 4-9. Cumulative Event Mean Concentrations 1994-2000 Storm Season

GROUP	Constituent	Unit	High Density Single Family Residential	Light Industrial	Vacant	Retail/ Commercial	Multi-family Residential	Transportation	Education	Mixed Residential
GENERAL MINERALS	Dissolved Phosphorus	mg/ℓ	0.29	0.28	0.06	0.30	0.16	0.36	0.27	0.20
	Kjeldahl-N	mg/ℓ	2.80	3.07	0.81	3.37	1.86	1.81	1.62	2.70
	NH3-N	mg/ℓ	0.36	0.48	0.08	0.91	0.38	0.23	0.26	0.58
	Nitrate-N	mg/ℓ	1.04	0.86	1.11	0.58	1.73	0.75	0.63	0.71
	Nitrite-N	mg/ℓ	0.09	0.09	0.05	0.14	0.08	0.09	0.08	0.10
	Suspended Solids	mg/ℓ	104.65	229.37	164.68	67.40	46.35	75.35	103.02	69.06
	Total Phosphorus	mg/ℓ	0.39	0.44	0.11	0.41	0.19	0.44	0.31	0.26
HEAVY METALS (DISSOLVED)	Dissolved Cadmium	µg/ℓ	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m
	Dissolved Chromium	µg/ℓ	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m
	Dissolved Copper	µg/ℓ	8.44	20.22	n/m	14.60	6.75	32.68	12.80	11.52
	Dissolved Lead	µg/ℓ	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m
	Dissolved Mercury	µg/ℓ	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m
	Dissolved Nickel	µg/ℓ	n/m	4.85	n/m	n/m	n/m	3.73	n/m	n/m
	Dissolved Selenium	µg/ℓ	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m
	Dissolved Silver	µg/ℓ	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m
	Dissolved Zinc	µg/ℓ	39.11	460.19	n/m	164.12	75.36	203.89	65.97	125.83
HEAVY METALS (TOTAL)	Total Cadmium	µg/ℓ	n/m	n/m	n/m	0.71	n/m	1.05	n/m	n/m
	Total Chromium +6	µg/ℓ	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m
	Total Copper	µg/ℓ	15.30	31.04	9.12	34.77	12.23	51.86	21.49	17.33
	Total Lead	µg/ℓ	9.59	14.87	n/m	11.53	5.13	9.08	4.53	8.70
	Total Mercury	µg/ℓ	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m
	Total Nickel	µg/ℓ	n/m	8.92	n/m	6.71	n/m	5.76	4.65	n/m
	Total Selenium	µg/ℓ	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m
	Total Silver	µg/ℓ	n/m	n/m	n/m	n/m	n/m	n/m	n/m	n/m
	Total Zinc	µg/ℓ	80.35	565.60	38.81	238.53	134.88	279.45	123.69	184.85
MISCELLANEOUS	Cyanide	mg/ℓ			n/m					n/m
	Oil and Grease	mg/ℓ	1.36	1.87	n/m	3.65		3.19		n/m
	Total Petroleum Hydrocarbons	mg/ℓ	1.36	1.87	n/m	3.65		3.19		n/m
	Total Phenols	mg/ℓ	n/m	n/m	n/m	n/m		n/m		n/m

Watershed Characteristics (1)

NAME	AREA
SOUTHERN MOJAVE	5,627,314
SALTON SEA	4,648,451
DEATH VALLEY-LOWER AMARGOSA	3,442,473
MOJAVE	2,984,066
IMPERIAL RESERVOIR	2,163,208
ANTELOPE-FREMONT VALLEYS	2,141,754
IVANPAH-PAHRUMP VALLEYS	1,835,045
HAVASU-MOHAVE LAKES	1,774,070
INDIAN WELLS-SEARLES VALLEYS	1,309,627
COYOTE-CUDDEBACK LAKES	1,175,680
SANTA ANA	1,080,899
PANAMINT VALLEY	1,031,603
SANTA CLARA	1,027,243
CUYAMA	729,928
PIUTE WASH	666,531
LOS ANGELES	534,151
SAN JACINTO	492,617
SANTA MARGARITA	470,887
SAN GABRIEL	457,471
SANTA MONICA BAY	370,347
ALISO-SAN ONOFRE	316,066
CALLEGUAS	243,837
LOWER COLORADO	180,054
VENTURA	174,749
NEWPORT BAY	101,813
SEAL BEACH	57,356



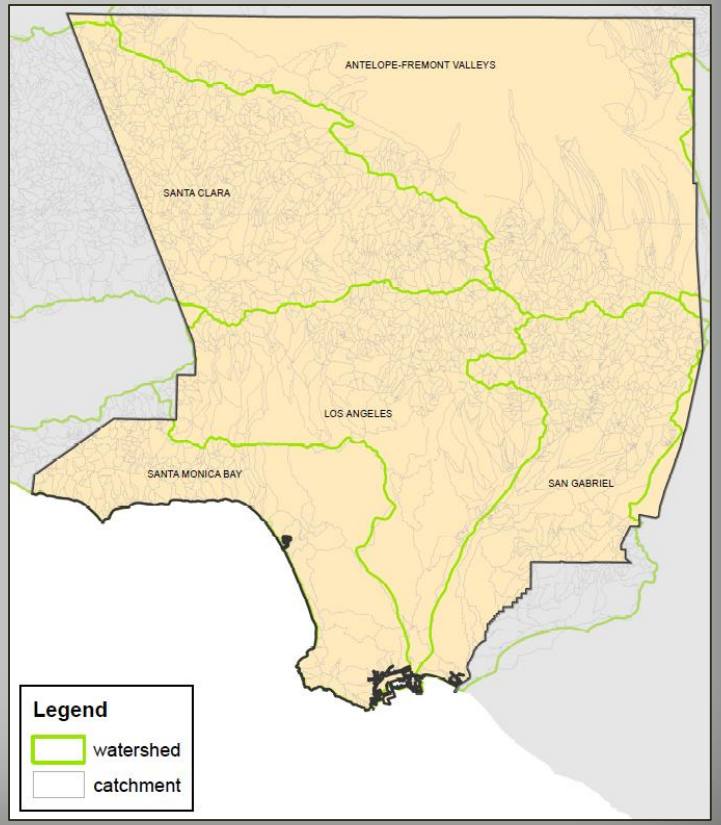
Watershed Characteristics (2)

Watershed characteristics of LA

- Total watersheds: 5
- Minimum size: 370.3 k ac
- Maximum size: 2.1 mil ac
- Sum of watersheds: 4.5 mil ac
- Mean of watersheds: 906.1 k ac

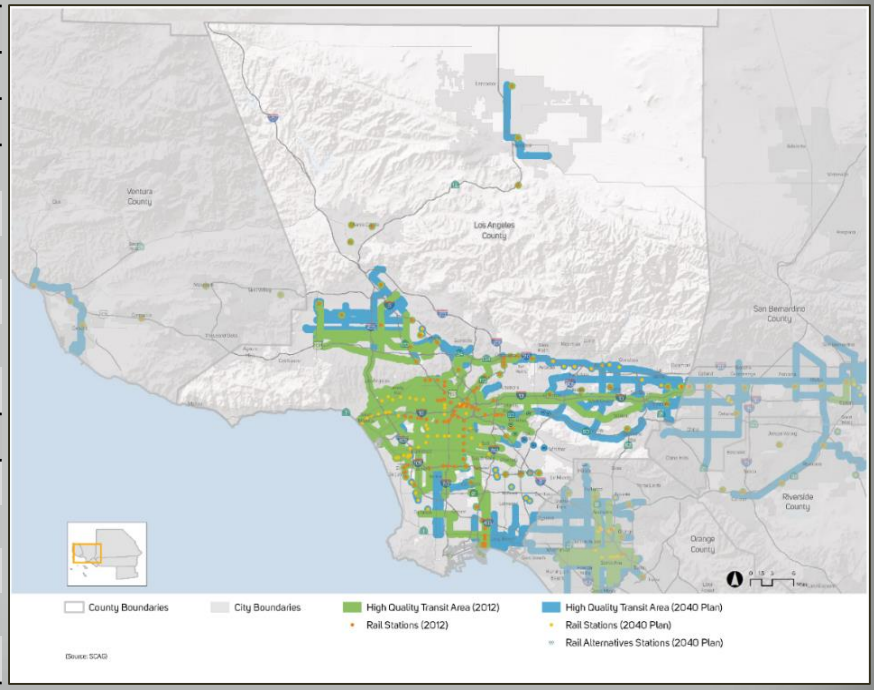
Catchment characteristics of LA

- Total Catchments: 2889
- Minimum size: 0.218 ac
- Maximum size: 662.8 k ac
- Sum of catchments: 2.7 mil ac
- Mean of catchments: 967.2 ac



High Quality Transit Area (HQTA)

	HQTA in LA County			LA County		
	2040 BL	2040 PL	*BL vs. PL*	2040 BL	2040 PL	*BL vs. PL*
Population	7,049,117	7,234,011	***3%***	11,507,758	11,508,857	***0.010%***
Hispanic	3,819,213	3,909,960	***2%***	5,806,434	5,806,417	***0.000%***
NH White	1,254,306	1,286,633	***3%***	2,436,978	2,437,714	***0.030%***
NH Black	433,412	439,987	***2%***	621,541	621,671	***0.021%***
NH Am. Indian	18,805	19,450	***3%***	31,405	31,370	***-0.111%***
NH Asian & PI	1,308,903	1,356,384	***4%***	2,244,071	2,244,378	***0.014%***
NH Others	214,478	221,597	***3%***	367,329	367,307	***-0.006%***
Households	2,427,084	2,517,377	***4%***	3,943,952	3,944,036	***0.002%***
HH Quintile 1	598,253	617,759	***3%***	891,114	891,362	***0.028%***
HH Quintile 2	531,724	550,700	***4%***	828,536	828,540	***0.000%***
HH Quintile 3	474,591	492,559	***4%***	772,149	772,062	***-0.011%***
HH Quintile 4	425,055	442,440	***4%***	730,013	730,068	***0.008%***
HH Quintile 5	397,461	413,919	***4%***	722,140	722,004	***-0.019%***



Modeling Framework (1)

- The Simple Method Model is applied to estimate the pollutant exporting from urban development sites and is limited to small drainage areas of less than one square mile.

$$\boldsymbol{R_{vu} = 0.05 + (0.009 * I_u)}$$

where R_{vu} = Runoff Coefficient for land use type u,
I_u = Percent Imperviousness

$$\boldsymbol{L_p = \sum u\left(P * P_j * R_{vu} * C_u * A_u * 2.72/12\right)}$$

where L_p = Pollutant Load, lbs
P = Precipitation, inches/year
P_j = Ratio of storms producing runoff (default = 0.9)
C_u = Event Mean Concentration for land use u, miligrams/liter
A_u = Area of Land use type u, acres

- Export Coefficient (the areal export coefficient model) is provided for agricultural and undeveloped land uses or larger watersheds (not applicable for urban area)

Modeling Framework (2)

- How to identify the potential impacts of estimated runoff to environmental justice (EJ) population?
  - Calculate the estimated runoff pollutant per capita

$$\mathbf{ROP}Cap_{His} = \frac{(\%\ of\ HispPop_{taz1} * ROP_{taz1}) + (\%\ of\ HispPop_{taz2} * ROP_{taz2}) + (\%\ of\ HispPop_{taz3} * ROP_{taz3}) + \cdots + (\%\ of\ HispPop_{tazj} * ROP_{tazj})}{Total\ HispPop}$$

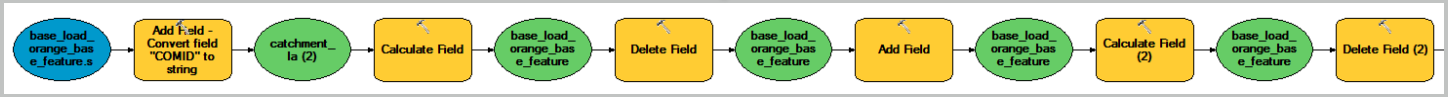
Where: ROPCap = Estimated Runoff Pollutant per Capita (unit: pound/person)

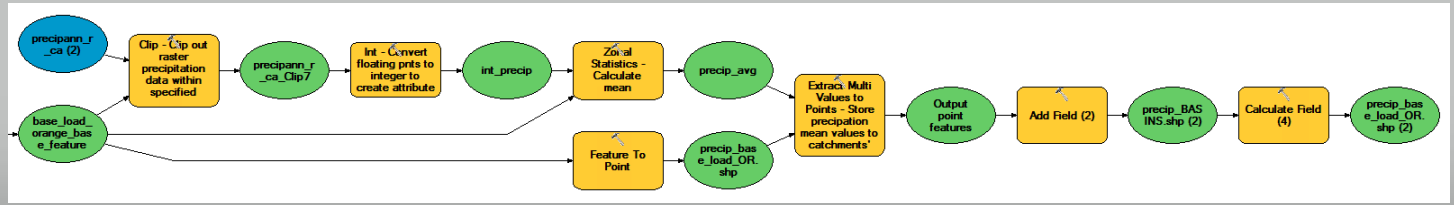
ROP = Estimated annual pollutant loading of the TAZ (unit: pound)

% of HispPop = Share of Hispanic population of the TAZ

30-Y Annual Precipitation Data

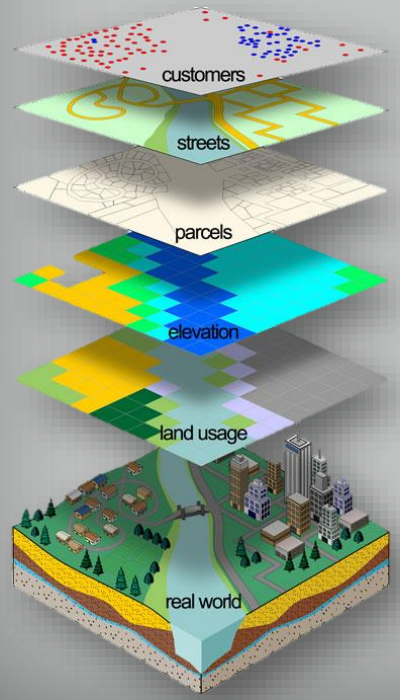
- Utilize ModelBuilder function in ArcGIS to calculate average annual precipitation for each zone

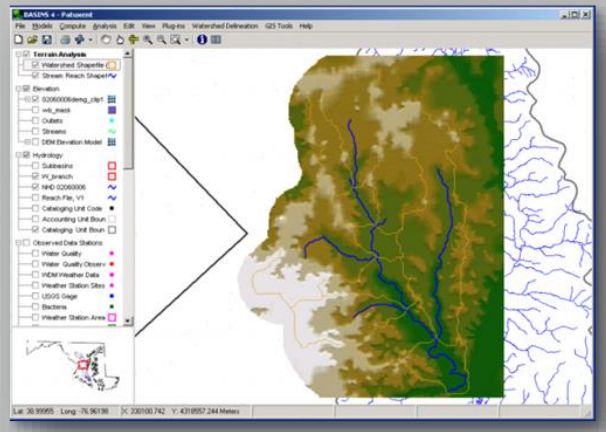




Modeling Framework (3)

- Using ArcGIS 10.3, BASINS 4.1-PLOAD Methodology, and SAS





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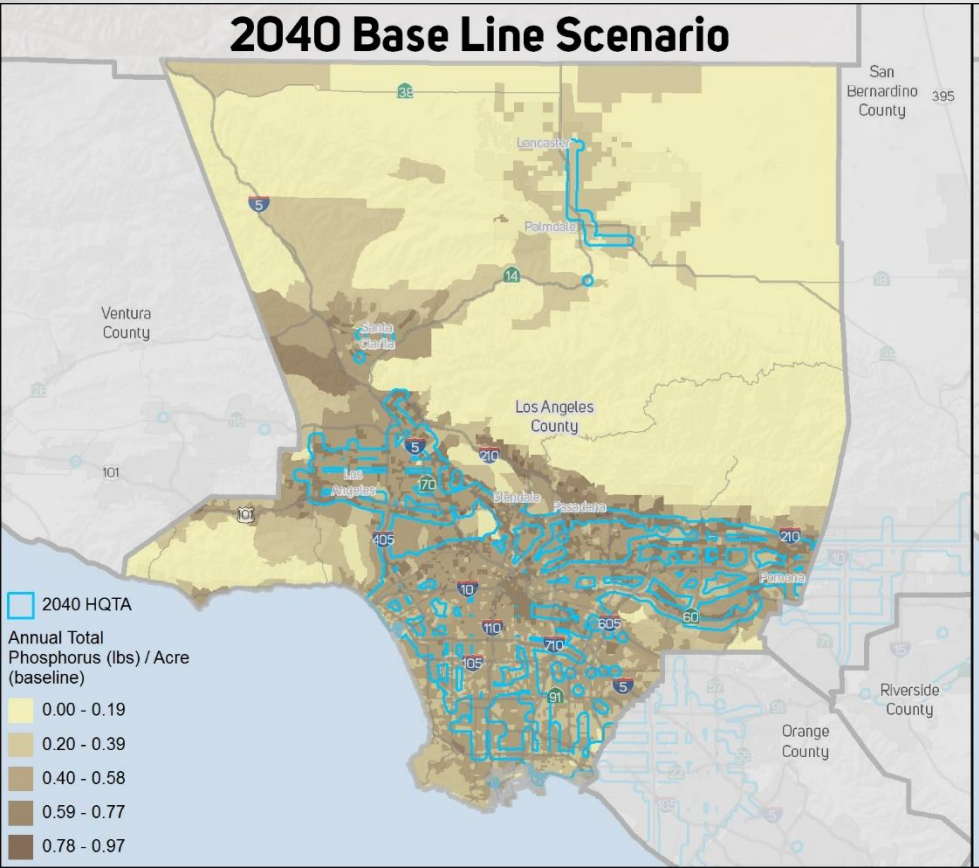
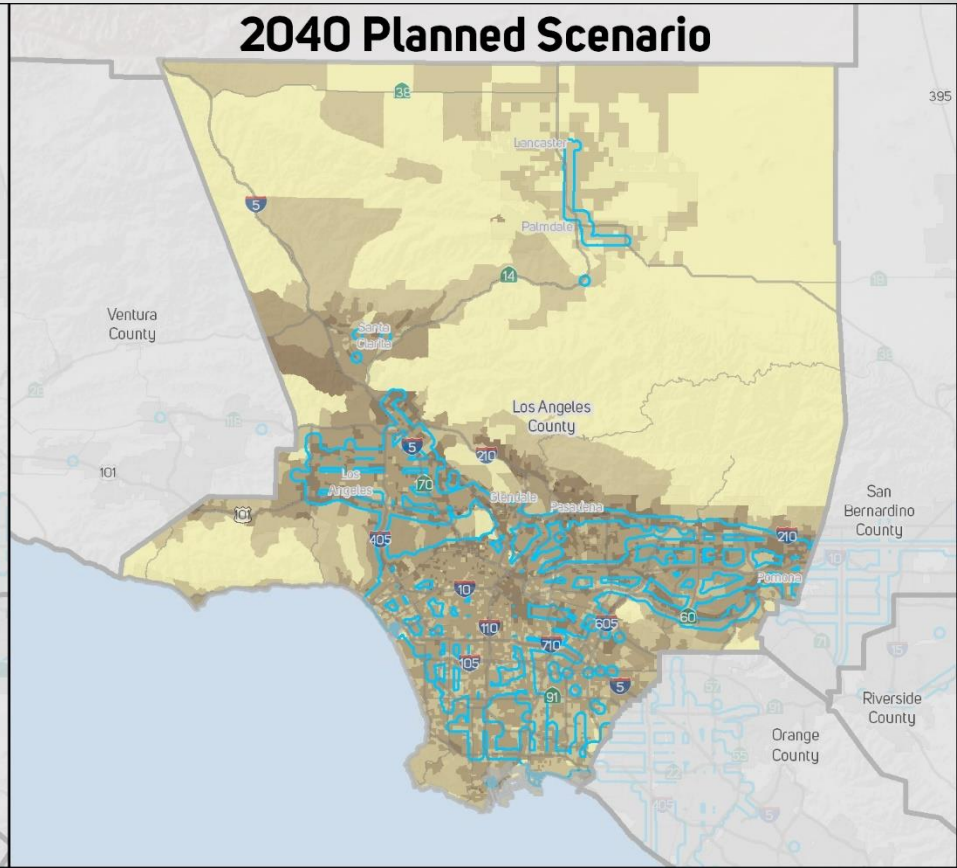
Results (1)


2040 Base Line Scenario
San Bernardino County
Lancaster
Palmdale
Ventura County
Santa Clarita
Los Angeles County
Los Angeles
Glendale
Pasadena
Pomona
Riverside County
Orange County
2040 HQTA
Annual Total Phosphorus (lbs) / Acre (baseline)
0.00 - 0.19
0.20 - 0.39
0.40 - 0.58
0.59 - 0.77
0.78 - 0.97


2040 Planned Scenario
San Bernardino County
Lancaster
Palmdale
Ventura County
Santa Clarita
Los Angeles County
Los Angeles
Glendale
Pasadena
Pomona
Riverside County
Orange County

Conclusion

- Per person pollutant in LA County declines across county between 2040 baseline and 2040 plan, while they decline even further in HQTA during the same period
- For per person pollutant, there is a steady decline between two scenarios. Non-White population has improved but less improved than the White population in LA County. This trend switched in HQTA.
- For per household pollutant, low income households has gotten worse across LA County. On the other hand, low income households in HQTA has shown improvement but still less than non-low income households.

Estimated Urban Runoff Pollutant (TP) per Capita by Demographic Groups						
	HQTA			LA County		
	2040 BL	2040 PL	% Diff	2040 BL	2040 PL	% Diff
Estimated TP	182,675	177,061	-3%	626,452	611,401	-2%
Population	0.025	0.024	-5%	0.053	0.052	-2%
White	0.030	0.029	-4%	0.072	0.069	-4%
Non-White	0.024	0.023	-6%	0.048	0.048	-1%
Households	0.073	0.069	-6%	0.154	0.152	-2%
Low Income	0.066	0.062	-5%	0.130	0.132	2%
Non-Low Income	0.076	0.071	-7%	0.162	0.157	-3%

Future Improvements

- Collaborate with various interested stakeholders (i.e. water agencies, NGO, etc.) to improve methodology of estimating urban runoff pollutant analysis
- Refine the EMC table and other input variables to better characterize the pollutant coefficients into SCAG region
- More advanced analysis to better identify impacts of estimated urban runoff pollutant load on EJ population
- Web-based map application for stakeholders to estimate runoff pollutant based on different land use scenarios (part of SCAG's scenario planning model)

Thank you!

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