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Periodic Atlas of the Metroscape: The Geography of Water

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Periodic Atlas of the Metroscape

The Geography of Water

By Vivek Shandas, Alton Straub, and Yongxia Kou

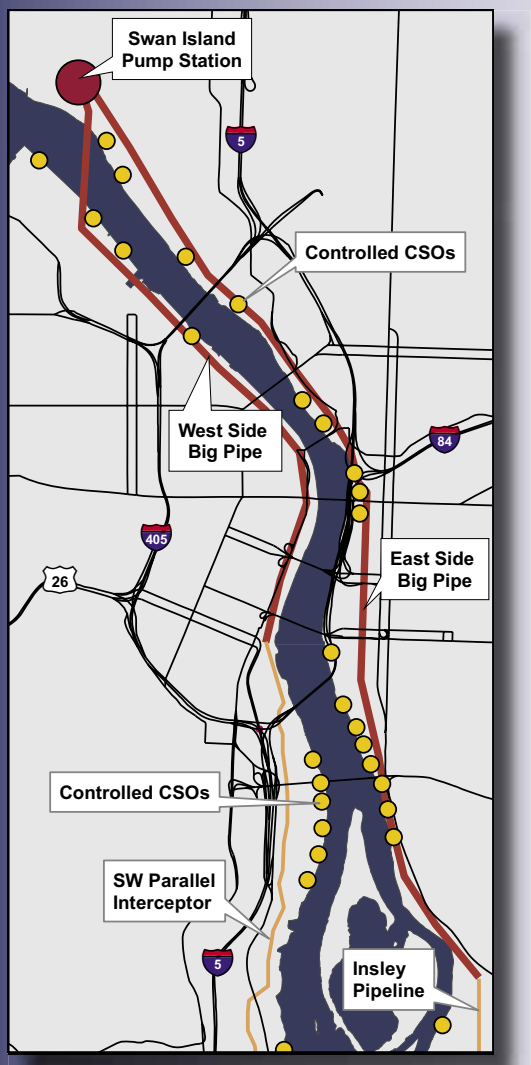
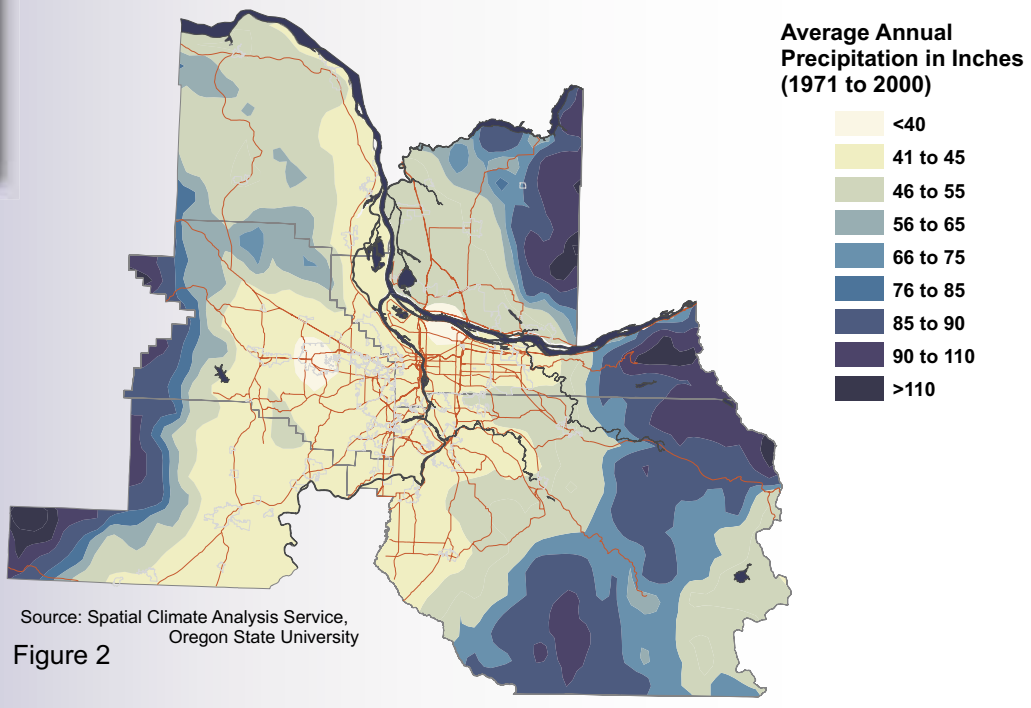


Figure 1

Water defines us. The Pacific Northwest is known around the world for moss-filled Douglas fir forests, salmon spawning in clear streams, and the astounding variety of agricultural products that grow in our moist, rich, volcanic soils. Multnomah Falls is the area's most visited attraction. Pictures of aquatic animals – beavers and ducks – dot our vehicles. Even Vikings are vaguely aquatic, or at least marine. It's no surprise that our major city identifies us as a "land of ports."

The geography of water is extremely complex. The simple act of drinking water from a tap is based on historical development patterns, with several systems that work in synergy to provide adequate water resources for our region – an ecological system that cleans and replenishes it, an engineering system that transports, processes and disposes of it, and a cultural system that determines the type of use. In addition, providing water to our growing population requires the coordination of several local, state, and federal government agencies to ensure that every drop can travel from the source over 40 miles through volcanic and sedimentary soils, valleys and mountains, swamps and forests, arriving clean to your tap. This process of capture, use and disposal describes a "metabolism" of water as it moves through the metroscape.

We begin by describing the system's inputs (precipitation, surface and groundwater) and outputs (how we use it on a large scale). Then, we investigate these processes on a smaller scale – where you get your water and some interesting patterns of use. Figure 1 shows one of the reasons water use and disposal can be expensive. To protect water quality in the Willamette River and control runoff of polluted stormwater from downtown streets, Portland's Bureau of Environmental Services is overseeing the construction of two "big pipes." These tunnels (14 feet and 22 feet in diameter) will carry sewage and stormwater to the Swan Island Pumping Station, where it will be pumped to the Columbia Boulevard Wastewater Treatment Plant. The Westside Pipe, recently completed, is 3.5 miles long; the Eastside Pipe, recently started, will be



Source: Spatial Climate Analysis Service, Oregon State University

Figure 2

six miles long. When everything is completed in 2011, the project will likely have cost more than $1.4 billion.

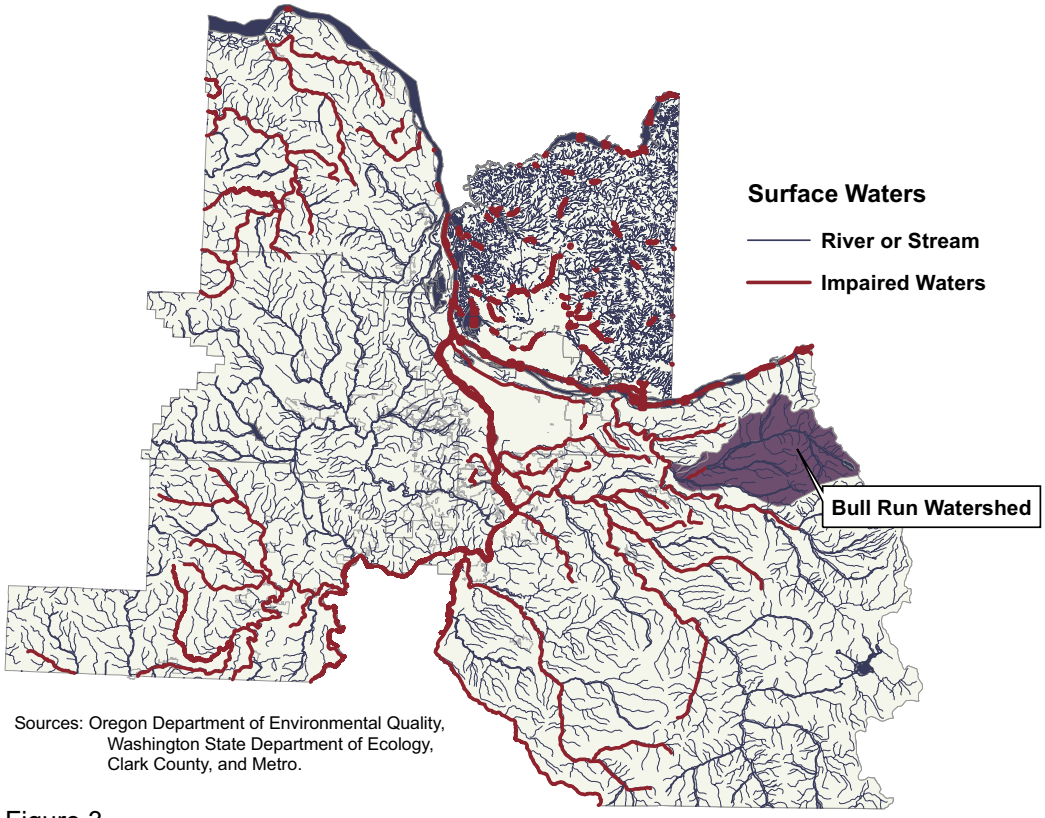
Inputs: Where Does It Come From?

It might make more sense to measure our rain and snowfall in feet, rather than inches. Figure 2, based on data from Oregon State University's Spatial Climate Analysis Service, shows localized variation in the amount of rain and snowfall. The Coast Range and the Cascades receive large amounts of precipitation while the valleys where most of us live stay relatively dry. In fact, the city of Portland, with average annual precipitation of less than 40 inches per year, has less rain than Seattle, New York, Boston, Miami and Portland, Maine.

Surface water contained in the metroscape's lakes, rivers, and streams is shown in Figure 3. In Oregon, the map shows named streams, and in Washington it shows both named and unnamed surface waters. The Bull Run watershed, the City of Portland Water Bureau's primary surface water source, is outlined in purple.

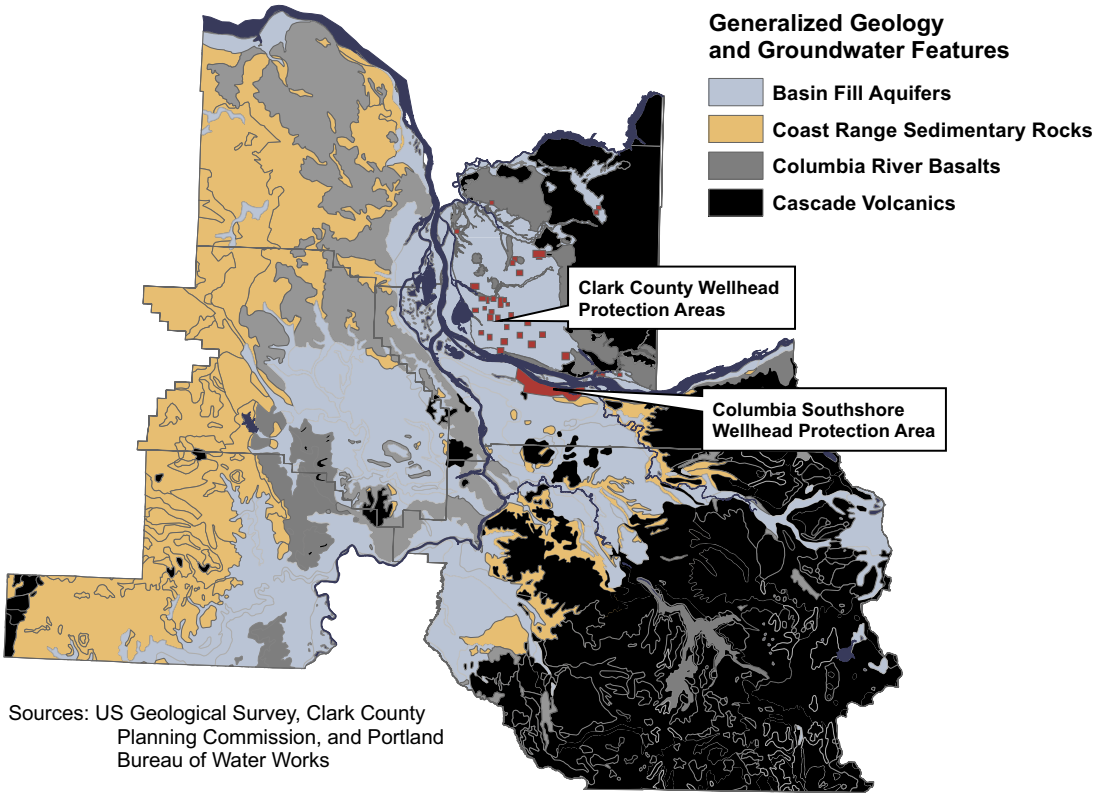
Few regions of the United States have more flowing water than does the metroscape. However, we need to be better stewards of those water resources. The rivers presented in red contain "impaired" water quality under Section 303d of the Clean Water Act. Some of our rivers have high levels of contaminants like PCB and DDT (Johnson Creek) or fecal coliform bacteria (Yamhill River). Many are too warm in the summer. And our biggest rivers—the Columbia and Willamette—fail in clean water categories too numerous to mention. While local and state agencies and several non-governmental organizations are working to protect and improve surface water quality, we still have a long way to go.

For many people, ground water is "out of sight, out of mind," especially when we seem to have so much surface water available. Ground water, however, is a critical albeit hidden resource in the metroscape's current and future water needs. Figure 4 is a simplified map of the region's geology and ground water. The region's aquifers are defined



Sources: Oregon Department of Environmental Quality, Washington State Department of Ecology, Clark County, and Metro.

Figure 3



Sources: US Geological Survey, Clark County Planning Commission, and Portland Bureau of Water Works

Figure 4

by geological structures (layers of different types of rock) that vary is size, depth, and quality. The Willamette and Tualatin Basins are filled with unconsolidated gravel and sand deposits that contain our largest and most easily accessible basin-fill water resources. Other geologic formations around the metroscape also contain important ground water resources, but they are smaller and more difficult to access. Portland's back-up to Bull Run surface water is a well-field on the south shore of the Columbia River. A ground water protection area, outlined in red on the map, has been recently established in the area to prevent contamination. Clark County relies heavily on groundwater and it has recently established extensive ground water protection areas around major well-fields (also shown in red on the map).

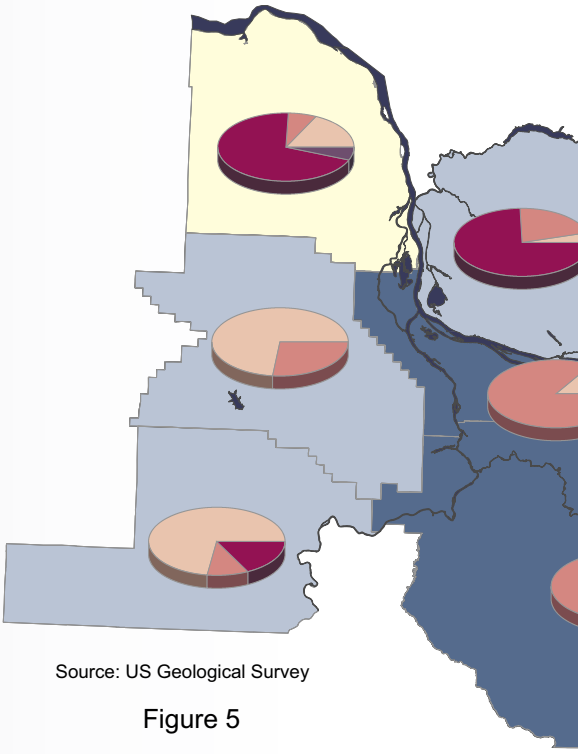
Processing: How Is It being used?

Water use is notoriously difficult to measure. The maps presented in this section draw on U.S. Geological Service data to illustrate the amount of water used for various purposes in each of the metroscape's counties. Figure 5 shows each county's total annual water usage by sector. The USGS categorizes water use into four general sectors: thermoelectric power (mostly cooling for fossil fuel power plants); irrigation (the largest use of freshwater in the United States); public supply (a USGS category for water withdrawn by both public and private suppliers for domestic, commercial and industrial uses); and industry (a USGS category including only self-supplied industrial use).

While these data are far from perfect or complete, they do reveal some interesting patterns. Clackamas County uses the most water of any metroscape county (more than 300 million gallons per day, almost enough to fill every New York City resident's bathtub every day). A significant portion of water use in Clackamas County is public supply and is intended for industrial and commercial purposes. Similarly, most water use in Clark and Columbia counties is self-supplied industrial water (think wood and paper products). Multnomah and Washington counties use very little self-supplied industrial water (1.77Mgal/day and none, respectively).

Figures 6 and 7 focus on two (of the four) USGS water use categories – irrigation and public supply. Due to the hot and dry summers and extensive agricultural production in the metroscape, we use a large amount of water for irrigation. Clackamas county, with 56,270 acres of irrigated land, tops the metroscape in the amount of water use for irrigation. Groundwater is used to irrigate the majority of crops in Clark and Multnomah counties, although Sauvie Island may use a mixture of Columbia River and groundwater resources.

More public supply water is used in Multnomah and Clackamas counties, but per capita Columbia County is third in line. Washington County appears to use less water person; however, many of the metroscape's counties may be undercounting water used for industrial purposes. The map in Figure 8, developed using drinking water data from the U.S. Environmental Protection Agency, identifies the sources of drinking water in the region. With almost three-quarter-million people in Multnomah County, it is no surprise that the Bull Run Watershed (surface water), provides the largest amount of water to metroscape residents. Clark County relies almost exclusively on groundwater for its supplies. Columbia and Yamhill counties, the two most rural in the metroscape, use equally ground and surface water for their consumers.



Source: US Geological Survey

Figure 5

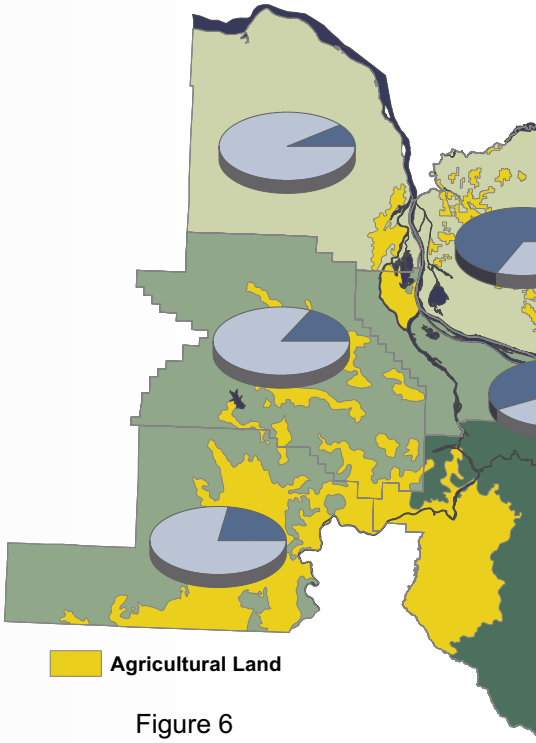


Figure 6

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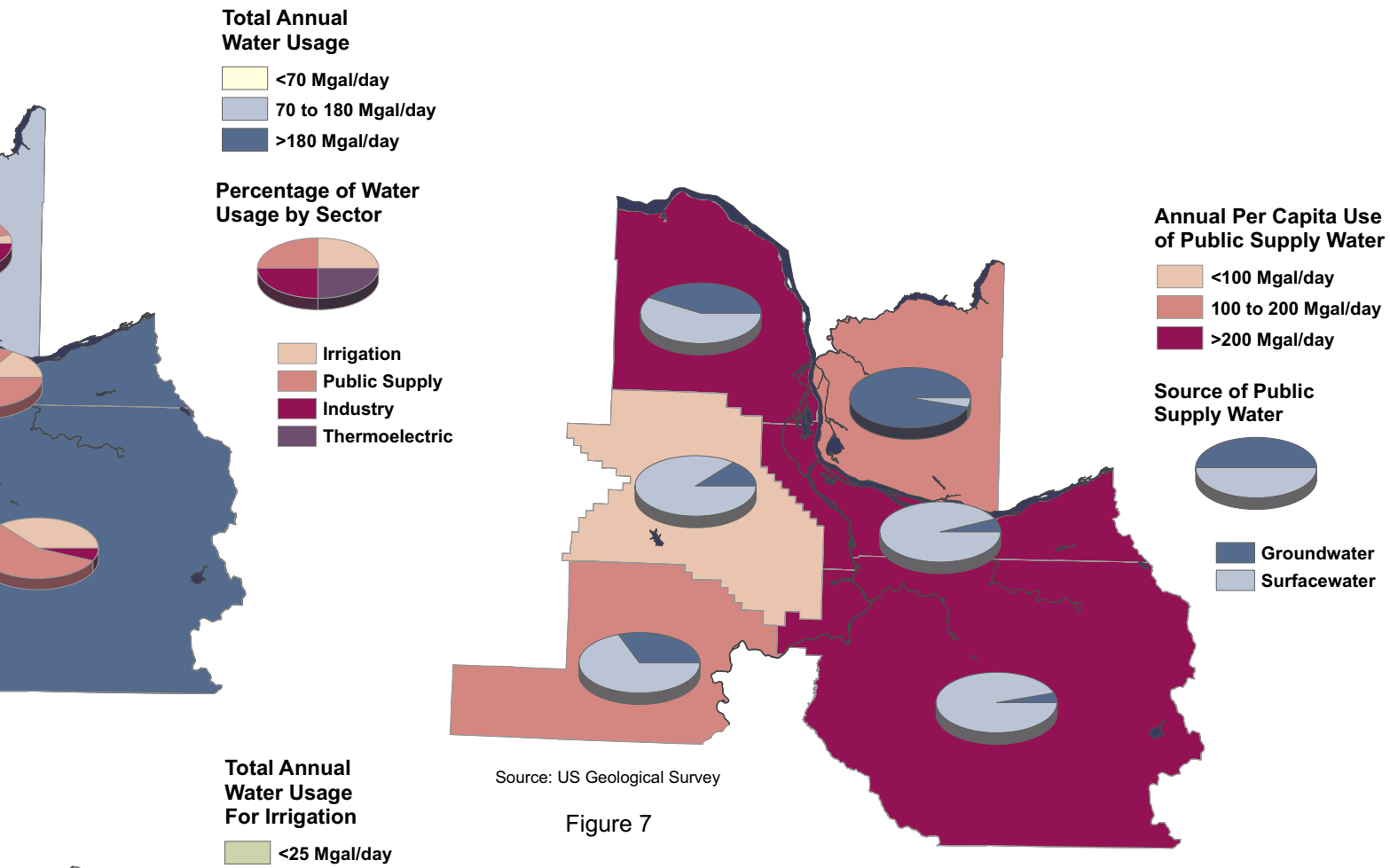
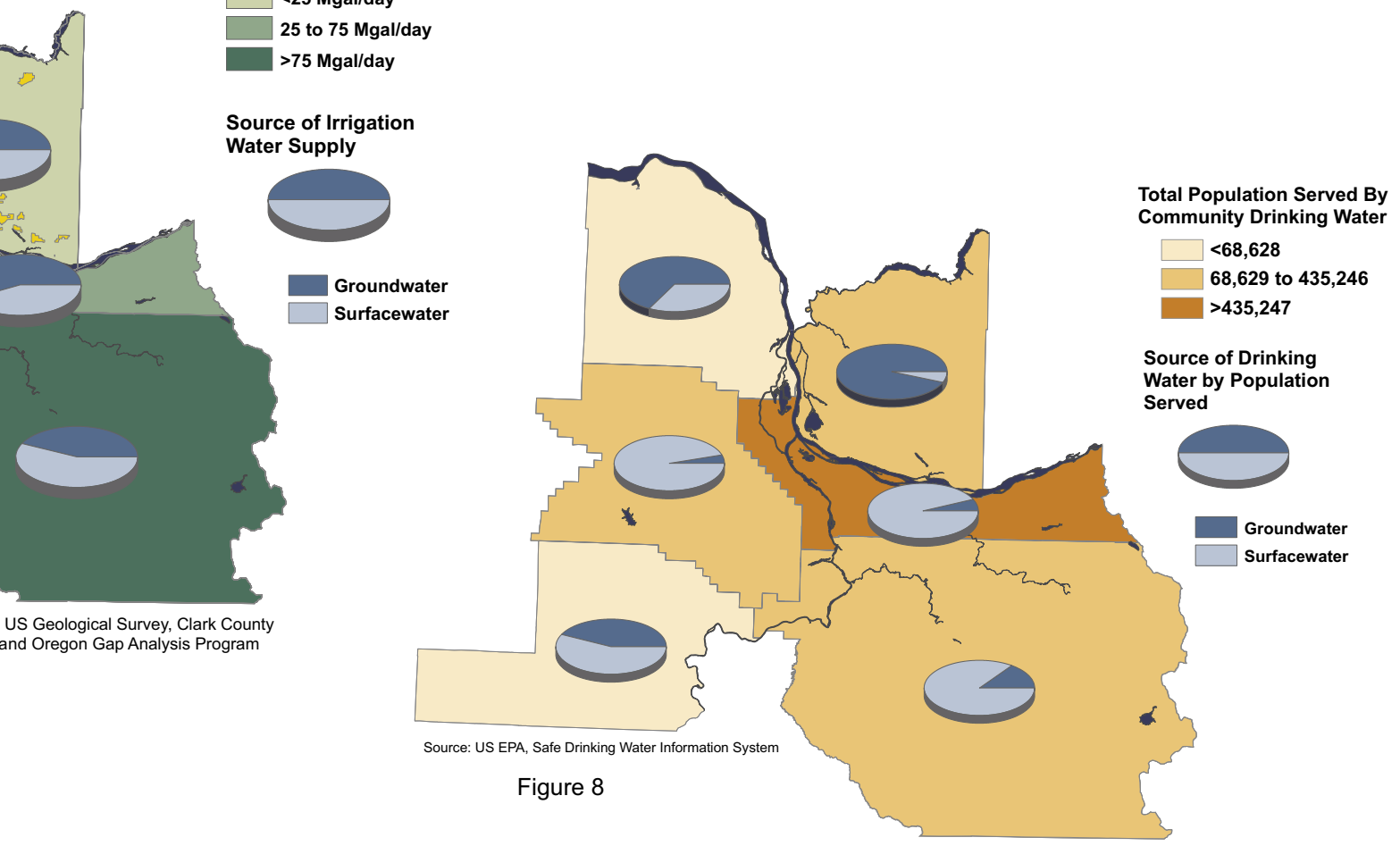


Source: US Geological Survey

Figure 7



US Geological Survey, Clark County and Oregon Gap Analysis Program

Source: US EPA, Safe Drinking Water Information System

Figure 8

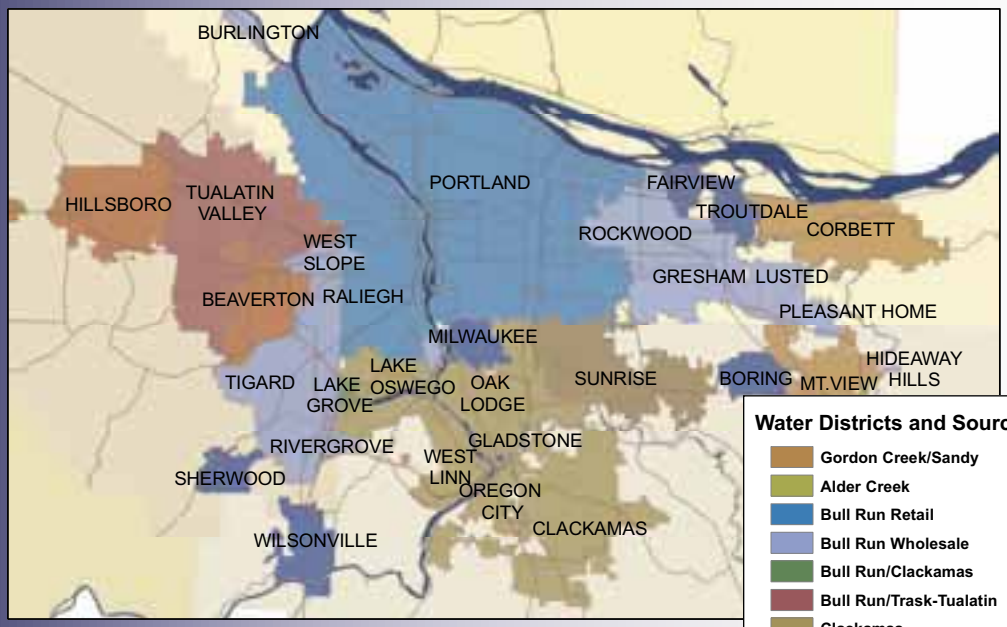
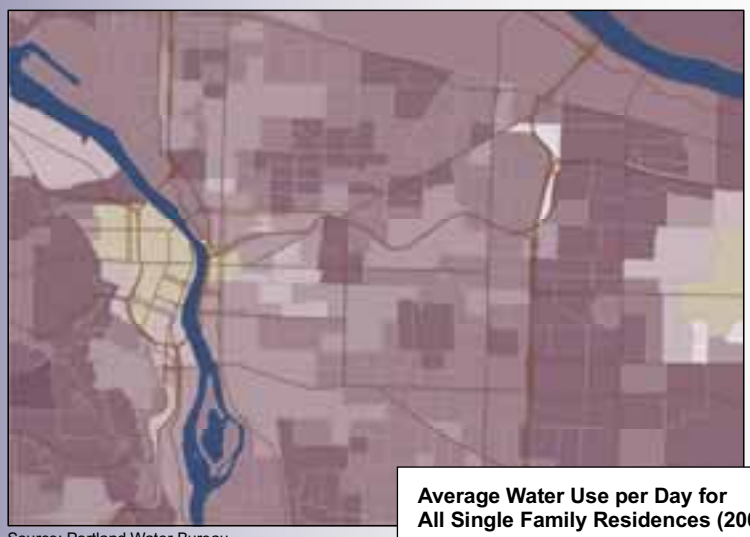


Figure 9

Figure 10

Source: Portland Water Bureau
US Census



Source: Portland Water Bureau
US Census

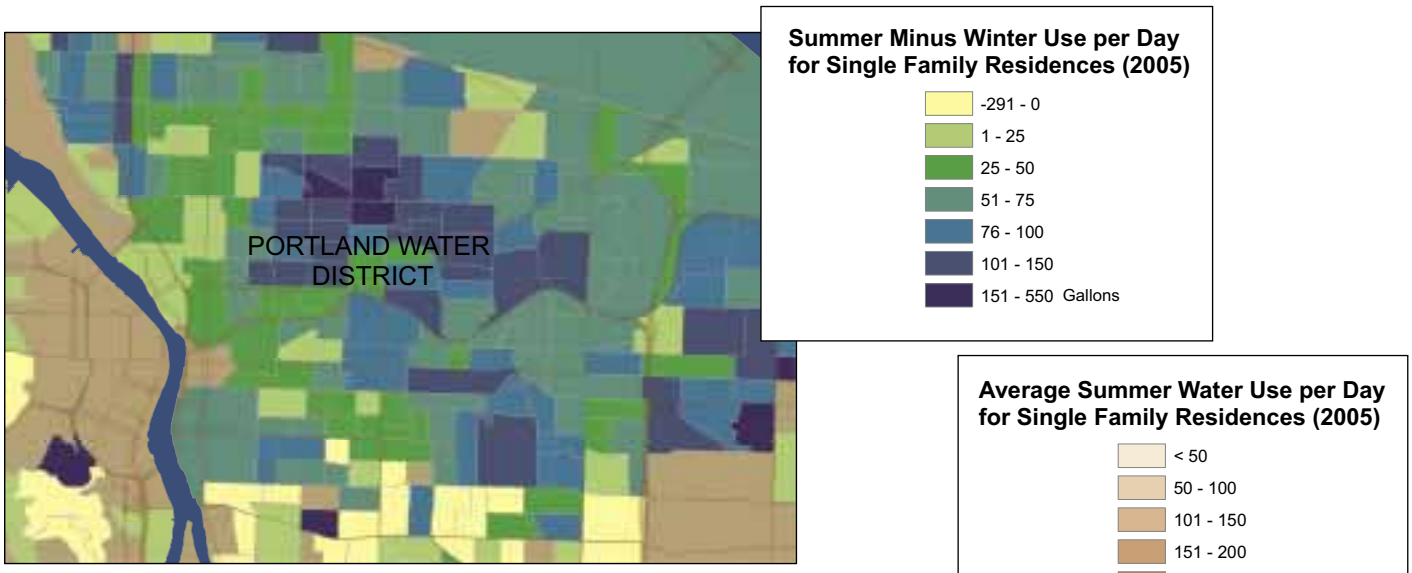
Figure 11

Relating water use data to our own lives can be difficult. For most, water simply appears from the spigot and disappears down the drain. We have little idea where exactly it comes from or where it goes. A central player in the provision and disposal of water is your local water district. Water districts coordinate the capture, delivery, and disposal of water to households, businesses, and public agencies. Districts either purchase water from a retailer or capture it from a nearby source. Without water districts, we would be hard pressed to ensure the safe provision of water for all metroscape residents. Figure 9 identifies several water districts in our region and illustrates the diversity of water sources for each respective jurisdiction. Surface water can originate from small creeks or large rivers, depending on several conditions including the location and quality of water, and the amount demanded in a region. While several smaller creeks such as Gordon and Alder Creeks serve smaller populations, the Bull Run and Clackamas rivers are the main source for our region.

Total water use within the Portland metropolitan area has been relatively consistent over the past several years. But does the amount of water used in our region vary according to the type of land use, time of year, or characteristics of the user? If, for example, each household consumes, on average, 133 gallons in the Portland metropolitan region, then are there patterns of water use according to neighborhood? Or does the presence of different land uses in a neighborhood affect the amount of water used? How about the time of year, or the size of the household? Does wealth matter in water use?

Figure 10 describes the average consumption per day in 2005 using U.S. Census block groups. By examining the spatial patterns, it seems that land use may influence the total amount of water use. For example, areas with greater water consumption (darker colors) often correlate with the increased water demand for commercial or industrial processes, while areas with primarily residential land use tend to have lower total water use rates (lighter colors).

While industrial and commercial land uses accounts for a portion of Portland water metabolism, residential use account

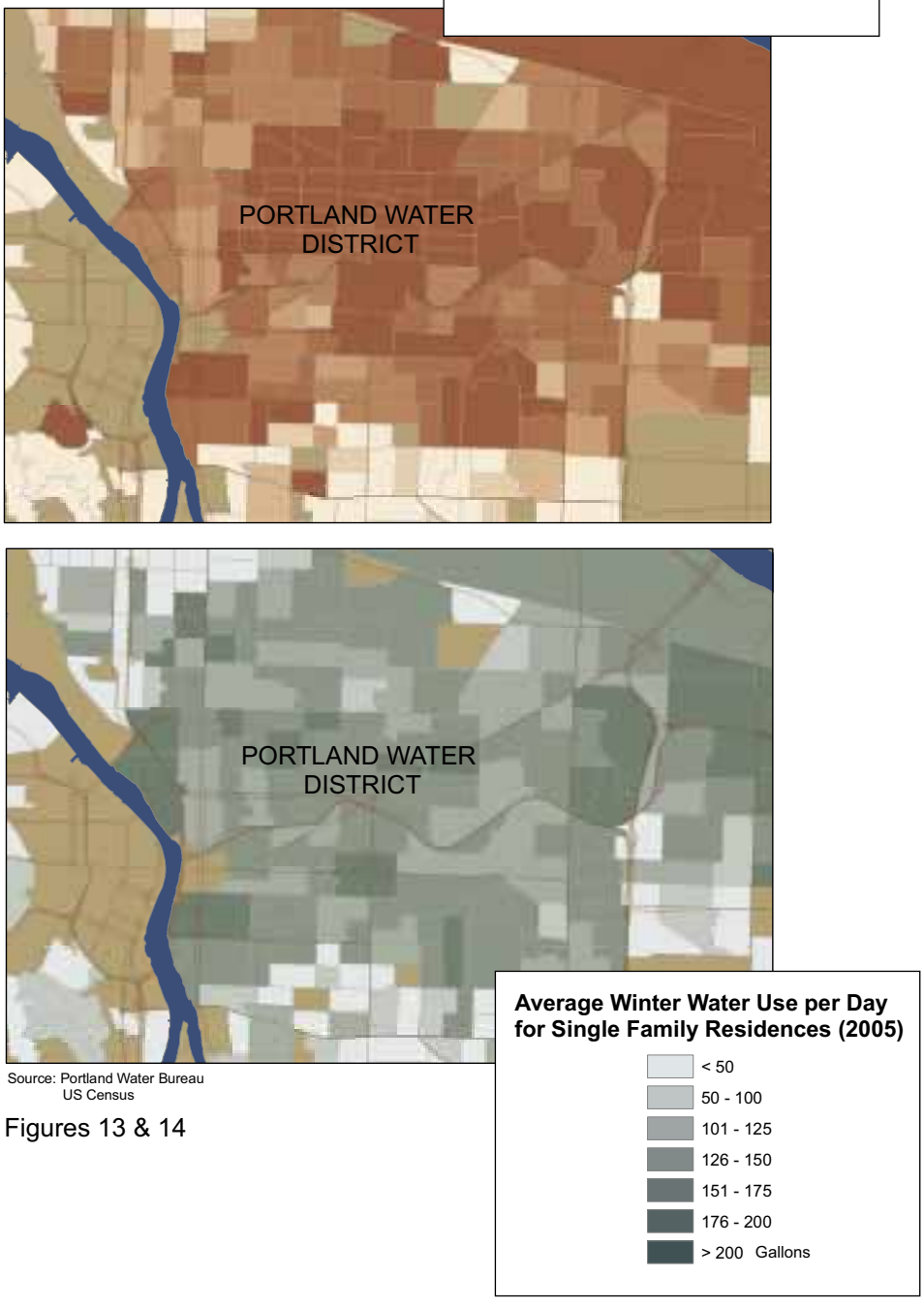


Source: Portland Water Bureau
US Census

Figure 12

for over 82% of total water use. With the majority of water being used for bathing, washing (clothes, dishes, cars), landscaping, and other household activities, a closer look provides insight about the variability according to geographic region and time of year as well as by household characteristics of users. Consider Figure 11, which illustrates average residential water use per day in 2005 within the Portland Water District. While every quadrant in the city has residences using greater than 300 gallons of water per day, the majority of Portlanders seem to be using between 100 and 200 gallons of water per day.

With the warmer and longer days of summer upon us (and this being the Summer issue of Metroscape), we examine whether water use varies seasonally. With the abundance of precipitation (AKA "liquid sunshine") one could surmise that the amount of water use in winter (December, January, February) would be substantially less than summer months (July, August and September). Figures 12 and 13 show that summer water use among residences in the City of Portland during 2005 is, on average, three times greater in the summer than in winter. However, while the majority of residential water use is greater in the summer, Figure 14 suggests that a few block groups use a greater amount of water in the winter than in the summer (summer use minus winter use in 2005). Indeed, water use also varies by season.



Source: Portland Water Bureau
US Census

Figures 13 & 14

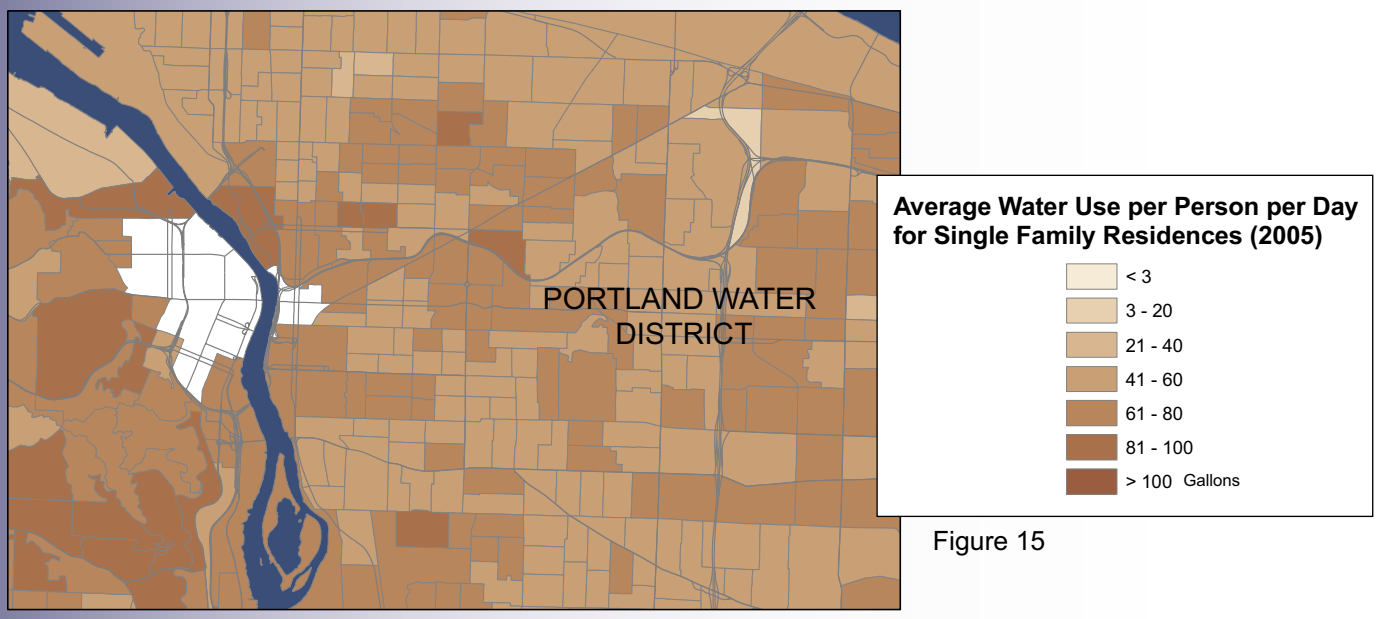


Figure 15

Source: Portland Water Bureau
Metro

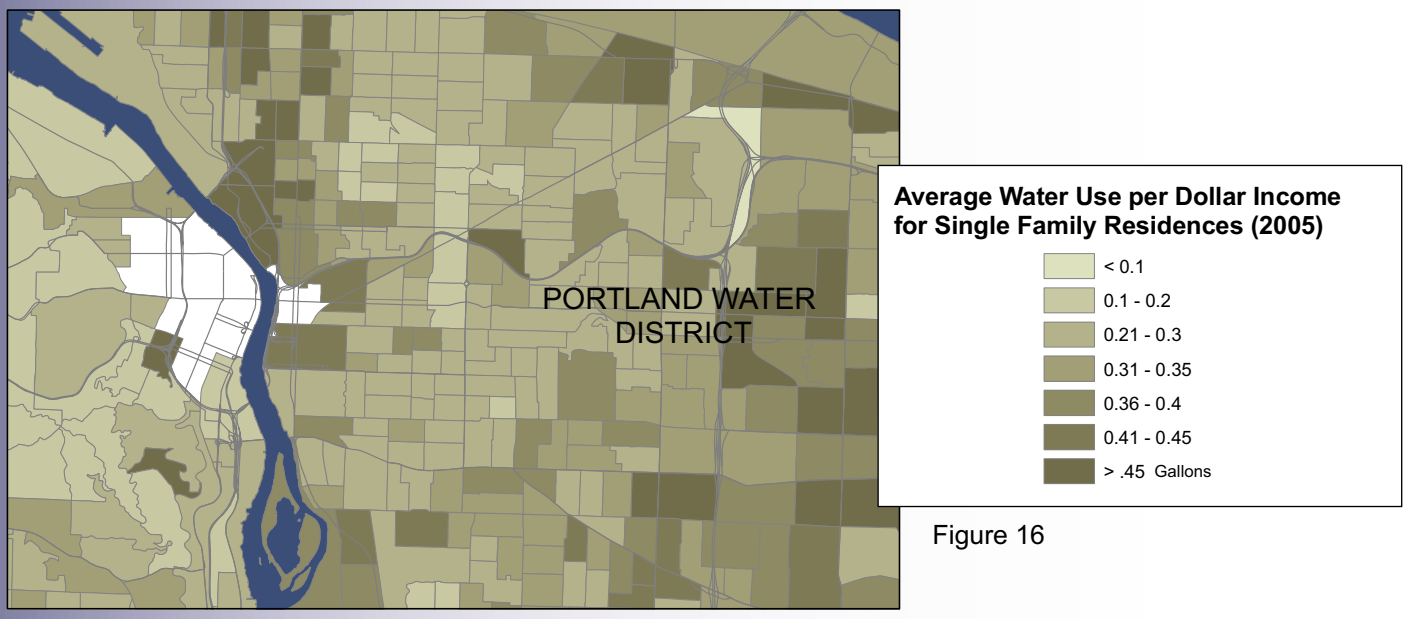


Figure 16

Source: Portland Water Bureau
US Census

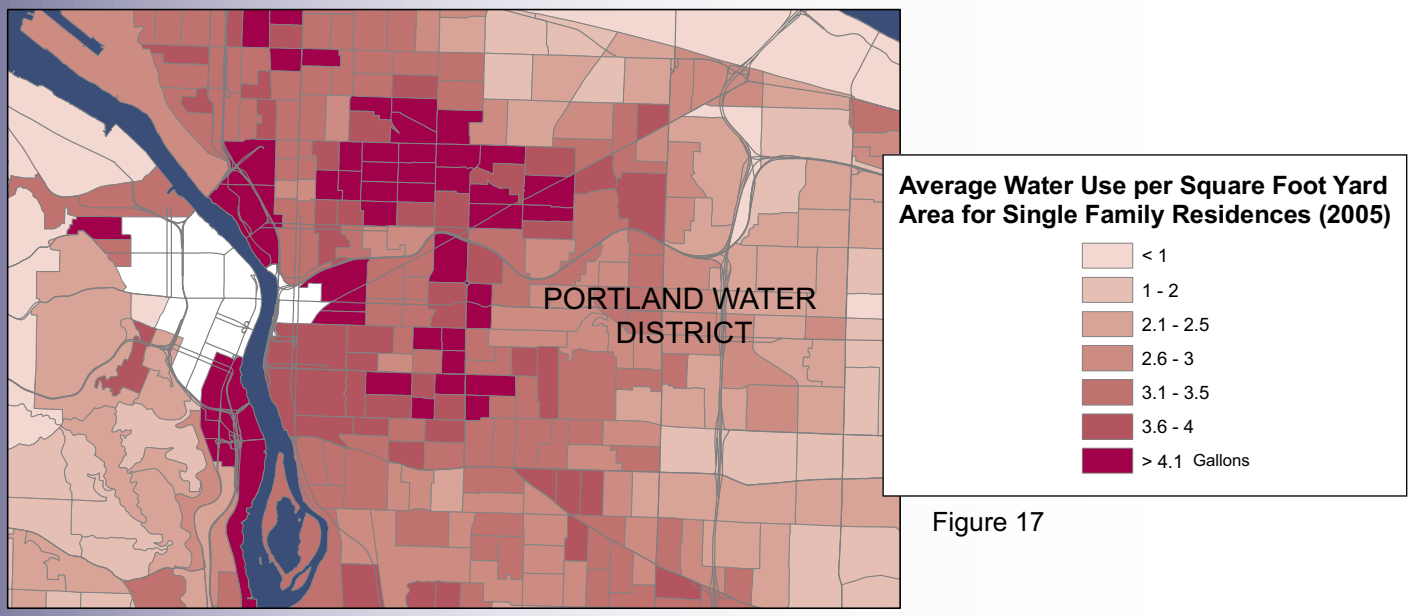


Figure 17

Source: Portland Water Bureau
US Census

Does the amount of water used within single family households vary according to household characteristics? Does household size, for example, influence the amount of water used? Figure 15 illustrates the relationship between the total amount of water consumed per day in 2005 and the average number of people per household in the census block. The darker colors suggest that each person in the household uses more water than do individuals located in lighter colored areas. While these maps may not provide conclusive evidence that larger households consume more water, they do suggest that type of water use may vary according to the location of the household. For example, there is a greater probability that you use more water if you live in the southwest hills than do your "close-in" southeast neighbors.

If it is true that how the water is being used among residential households determines the amount of water use, then perhaps the amount of yard area helps explain patterns of use. Figure 16 illustrates the relationship between average yard area within each block group and total water use in some of Portland's residential areas. The darker areas on the map suggest that households are using more water per square foot of yard (yard watering intensity) area than are households depicted in lighter colors. For example, the darkest areas in Northeast (north of Sandy Blvd.) seem to be using a lot more water per square foot of outdoor yard space than are households located "close-in" southeast.

Since money plays such an important part of our consumption patterns, we were curious if the average income per block group had any association with the amount of water consumed. Figure 17 describes the relationship between median income of the block group and daily water use for residences in the Portland Water District. In this example, the darker areas suggest that water use plays a larger proportion of expenditure of the household, while lighter areas describe regions with expenditure on water as a smaller proportion of income. While this result may be simply illustrating the income differences across the city, when we juxtapose Figure 16 (outdoor water use) with this income map, we may wonder if certain types of water use (e.g., outdoor landscaping) might be less dependent on income, and more on neighborhood or cultural norms.

Why is it that these patterns of water use vary so much? Do cultural norms of landscaping and property care differ from one part of the metroscape to another? Are there other household or land use characteristics that can help explain water use patterns in our region? These questions are central to the issue of how water is brought into our system, and what happens once it is available to us.

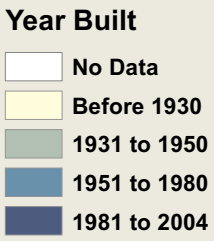
Outputs: Where Does It Go?

Bringing our attention away from the city of Portland to another part of the metroscape, we begin to see how water, once used, is taken away from our households. Figure 18 zooms in on a rapidly-growing part of Clark County just inside I-205. The area and location of development affect how water is disposed. Some of our homes, most likely those built after 1980, have both community water and sewer connections, while others built before 1950 may have neither, relying on well water and septic tanks.

Regardless of our exact connections to the metroscape and how we experience the movement of water through our region, we share much of the same precious resource. Our water may come from ground or surface sources, from far away or nearby, but after we use it, the same water will find its way back to us. Your drinking water was once someone else's, and soon it will be theirs again.

Eventually, all things merge into one, to paraphrase Norman Maclean. And a river runs through it. *We are haunted by waters.* M

Figure 18



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Alton Straub has a masters degree from Oxford University in environmental management and is currently a Ph.D. student in environmental sciences and an instructor in University Studies at Portland State.