Executive Summary
California's Water Footprint

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December 2012

25 YEARS PACIFIC INSTITUTE

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The average Californian uses about 140 gallons of water per day for drinking, bathing, washing clothes, watering gardens, and other household uses. These direct uses of water, however, are only part of the story. Considerably more water is used to produce the goods we consume, and much of this is in the form of "virtual water" – the water required to produce the food we eat, the clothes we wear, the beverages we drink, and the other industrial goods on which we rely. That virtual water may come from California, but it also may come from anywhere in the world where the products we consume are made.

As pressures on water resources intensify, there is growing interest in evaluating the complex ways in which everyday human activities impact the world's water resources. The "water footprint" has emerged as one tool for quantifying this impact. A water footprint is defined as the amount of water that is consumed (i.e., is no longer available for immediate reuse) to produce a product. While some of that water is incorporated into the final good, much of it is consumed through evapotranspiration during the production process. For example, an average 35 gallons of water is consumed to produce a cup of coffee, including the water required to grow the coffee crop.

A water footprint can be calculated at different levels of consumer activity, e.g., for an individual, household, region, state, nation, or even all of humanity. A water footprint of an individual includes the direct uses of water in the home and the indirect uses of water to produce the goods and services the individual consumes. The water footprint of a nation includes the water used to produce the goods and services consumed by the inhabitants of the nation. We present here the first comprehensive assessment of the water footprint of the state of California – one of the largest and most populous states in the United States, a major producer of agricultural and industrial goods, and a significant consumer of water.

Our assessment finds that California's total water footprint is about 64 million acre-feet[1] per year, or 20 trillion gallons of water per year, which is more than double the annual average combined flows of the state's two largest rivers, the Sacramento and San Joaquin Rivers. California's water footprint is a function of its consumption of goods and has an internal and an external component. The internal water footprint is the water required to make the goods that are produced and consumed within California, as well as the direct use of water inside the state. The external water footprint includes the water required to make goods that are imported from other places and then consumed in California.[2]

[1] One acre-foot is the amount of water that would fill one acre to a depth of one foot, or about 325,851 gallons.
[2] Note that the water footprint of products produced in California but exported and consumed outside of the state's borders become part of the external water footprint of that region.

As Figure ES 1 shows, most of California's water footprint is external, meaning that Californians are more dependent on water resources from outside the state's borders. An estimated 38 million acre-feet of water is used to produce goods within California – and almost half of that water, or 19 million acre-feet, goes to producing goods that are then exported and consumed outside of California. An additional 44 million acre-feet of water is required to produce the goods that are imported into California and consumed here, making California a net *importer* of virtual water.

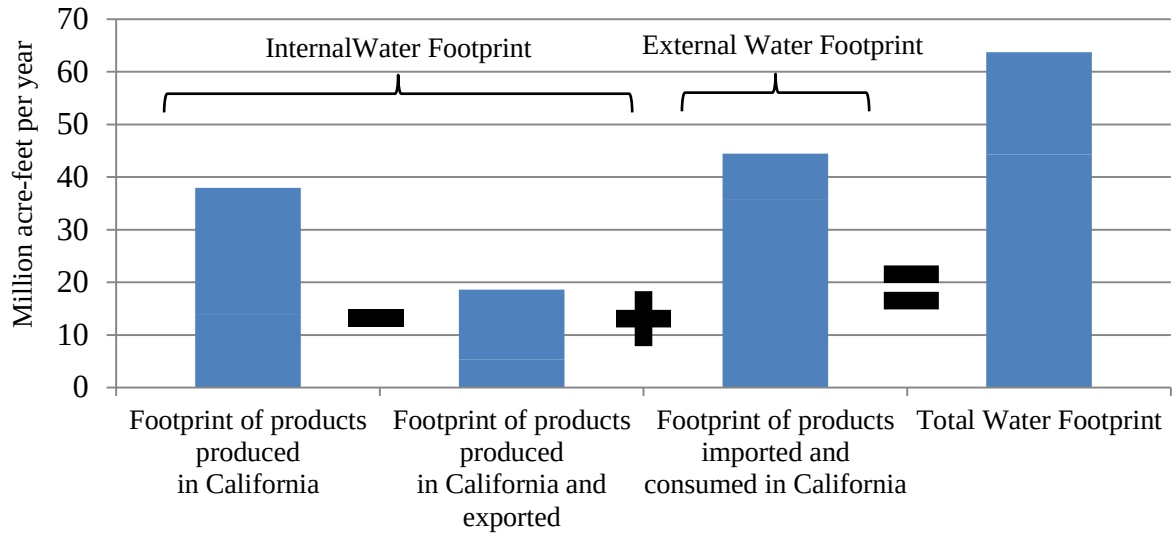
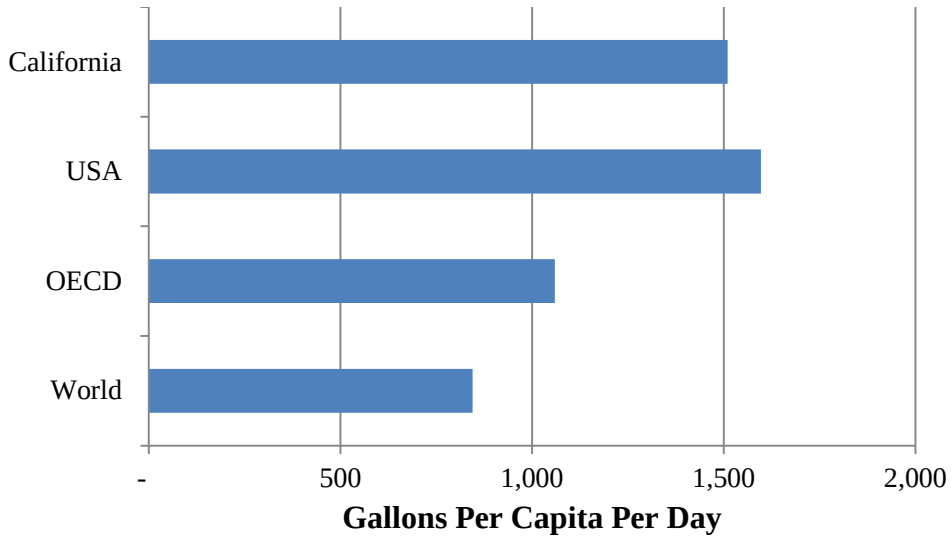


Figure ES 1. Major Components of California's Water Footprint

On a per-capita basis, the water footprint of the average Californian is 1,500 gallons per day. By comparison, the average Californian's water footprint is slightly less than the average American but considerably more than the average resident in other developed (OECD) countries or the world (Figure ES 2).



E.S. Figure 2. Water Footprints in Gallons Per Capita Per Day

Source: USA estimate from OECD; world estimate from Mekonnen and Hoekstra 2011

As shown in Figure ES 3, more than 90% of California's water footprint is associated with agricultural products. Meat and dairy products have especially large water footprints due to the amount of water-intensive feed required to raise the animals. An additional 4% of California's water footprint is associated with direct household water consumption (e.g., for landscape irrigation), and the remaining 3% with other industrial products we consume, such as clothing and electronics.

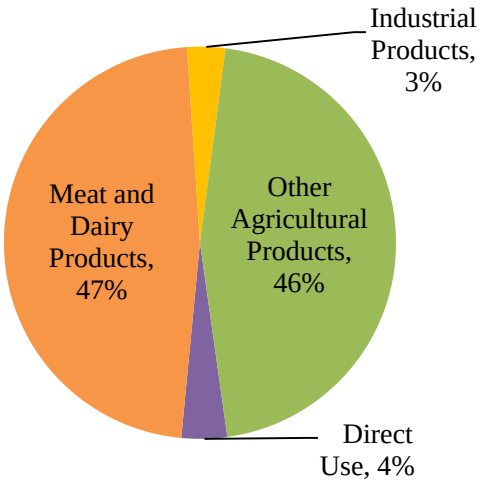


Figure ES 3. California's Water Footprint by Sector

Much of the water that makes up California's water footprint is in the form of goods Californians consume that are produced outside the state. About half is associated with water use in other U.S. states and 11% is associated with water use in Mexico, Canada, and China (Figure ES 4). These findings suggest that California's economic and social well-being is intimately connected with water resources beyond our borders and is vulnerable to water-supply constraints in those regions. Additionally, Californians can exacerbate local environmental or social concerns outside of its borders through the consumption of goods produced in those regions.

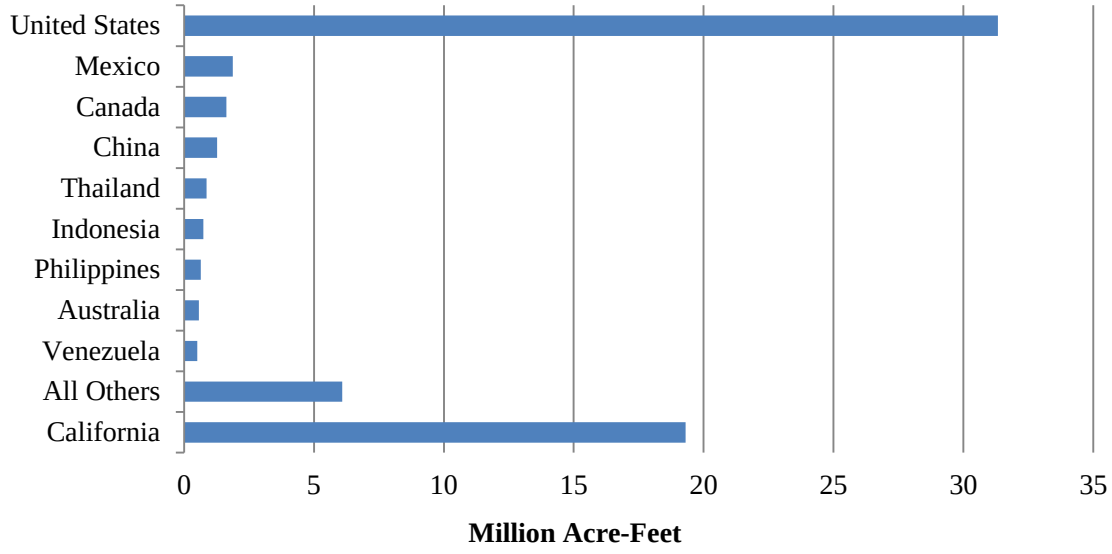


Figure ES 4. California's Water Footprint by Location

Note: This refers to the location and quantity of water resources consumptively used in the production of products consumed in California.

The water footprint, when combined with data on the monetary value of production and trade, highlights some of the connections between water use and California's economy, including the economic productivity of water. The economic productivity of water is measured in dollars per gallon of water consumed. Overall, California's economy generates about $3.1 trillion in revenue (sales) while using 38 million acre-feet (MAF) of in-state water resources, equivalent to $0.25 per gallon of water (Figure ES 5). Exports generate $0.6 trillion in revenue for California using 19 MAF, or $0.10 per gallon. California imports $0.8 trillion worth of goods that have a total water footprint of 44 million acre-feet; thus, we are paying the equivalent of about $0.05 for every gallon of water imported into the state in the form of goods.

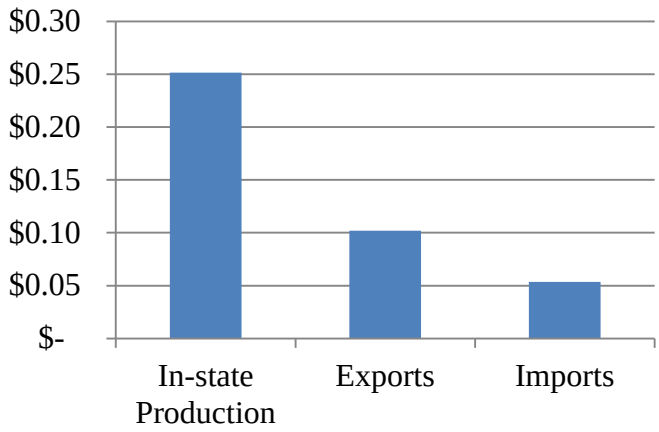


Figure ES 5. Dollars per Gallon of Production and Trade

These findings indicate that the economic productivity of exports ($0.10 in export sales per gallon of water) is greater than of imports ($0.05 per gallons) but far less than the productivity of California's entire economy ($0.25 in sales per gallon). The reduced economic benefit of those exports suggests that California could realize an economic benefit if more of the available water were used for higher value products. We note that while these findings can inform state and national policies and decisions, maximizing the economic value per unit of water used is only one consideration in water policy and decision making. Environmental outcomes, social preferences, and equity issues are also important and must be taken into consideration.

Conclusions

Conventional water-use assessments tend to focus on water supply and direct water use in discrete sectors of society. This approach, however, offers incomplete information on impacts to water resources, which are interconnected through economic activity to our daily consumption of goods. By focusing on actions of discrete sectors, conventional analyses also limit our range of options for addressing water resource impacts – for example irrigation efficiency measures in agriculture.

A water footprint analysis provides a unique perspective on California's relationship with water that acknowledges the interconnections between everyday activities and impacts to water resources – both at home and around the world. It is a perspective that can be valuable for water managers, policymakers, and the concerned public, providing new leverage points for reducing those impacts and creating a more sustainable society. These may include policies that consider the environmental implications of various trade regime options, or educational programs to help individuals and institutions make better decisions about their purchasing habits.

This study from the Pacific Institute includes extensive detail on California's water footprint for the overall economy, the production and consumption of specific products, and information on different types of water, including both "green" and "blue" water (representing rainwater/soil moisture or surface irrigation water, respectively). We also offer preliminary estimates of California's grey water footprint, which is an indicator of water-quality impacts of water use.

Our work on California's water footprint is just beginning. The water footprint concept is constantly evolving and further analysis will expand and refine the analysis presented here; currently we are looking at California's water footprint related to energy products such as electricity, natural gas, and transportation fuels. Future work includes identifying how the footprint has changed over time under different climatic conditions, trade regimes, and policies, and offering improved estimates of uncertainty, as well as developing a better understanding of the roles that different regions play in the overall water footprint of the state. Water quality issues are also important to incorporate into the water footprint indicator in a meaningful way, and we are working with other researchers to develop these methods. Most importantly, ongoing water footprint work will provide more contextualized information for citizens, businesses, government, and all stakeholders in California's water future.