Visualizing Water is an evolving series of information graphics designed to illustrate key concepts in the flow of water at global and regional scales. Key concepts covered include: global water cycle, river basin, blue water, green water, withdrawals, consumption, return/recharge, surface water, ground water.

Visualizing Water is part of a larger TRUTHstudio initiative, Visualizing Complexity, whose goal is to facilitate the development and release into the public domain a suite of high quality information graphics that may be used by public interest advocates to explain complex concepts relevant to their area of practice.

In general, the intended audience for the Visualizing Complexity project are policymakers, civil society leaders, businesspeople, educators, voting citizens, and anyone else whose better understanding of complexity could lead to more informed decision-making. The individual graphics are arranged in a narrative with accompanying text provided in the notes section of this file.

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Visualizing Water and Visualizing Complexity are works in progress. Please contact the authors if you have suggestions, comments, or requests:

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SOURCES (Global)

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Molden, David et al. Water for food, Water for life: A Comprehensive Assessment of Water Management in Agriculture. International Water Management Institute (IWMI), 2007.

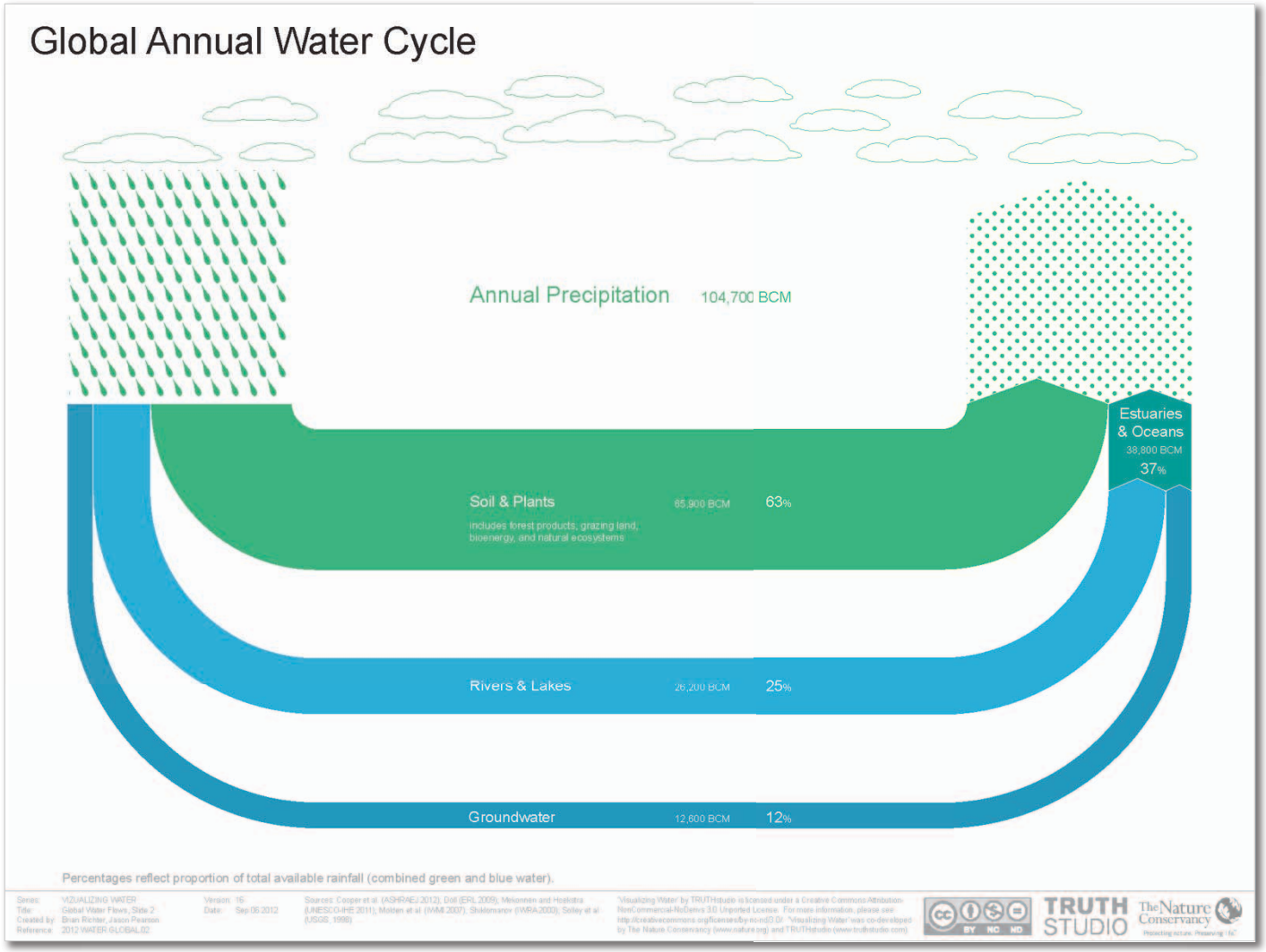
Shiklomanov, Igor A. 'Appraisal and Assessment of World Water Resources' in International Water Resources Association: Water International 25:1 (March, 2000), pp 11-32.

Solley, Wayne B. et al. Estimated Use of Water in the United States 1995. U.S. Geological Survey (USGS), 1998.

SOURCES (Colorado River Basin)

Colorado River System Consumptive Uses and Losses Report 1996-2000. U.S. Department of the Interior (USDoI), 2004.

Colorado River Basin Water Supply and Demand Study, Technical Report B - Water Supply Assessment. U.S. Department of the Interior (USDoI), 2011.



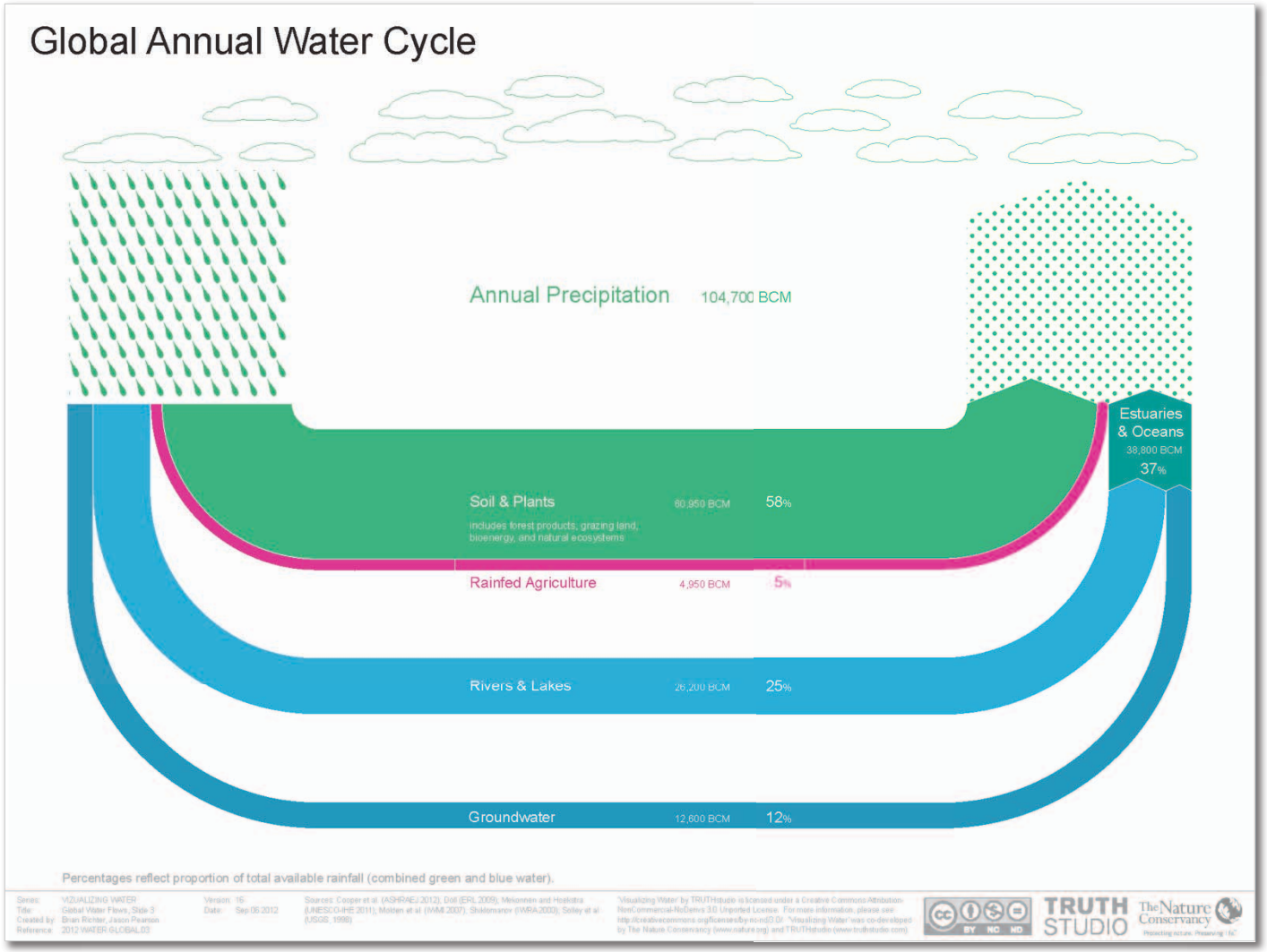
At the global level, about 104,700 Billion Cubic Meters (or BCM) of rain or snow falls on the land surface of our planet each year. Almost 2/3 of that water is quickly evaporated or used by plants, returning to the atmosphere as vapor. We call this water that is absorbed by the landscape 'green water.' This water sustains forests, grasslands, and other natural and cultivated landscapes, and the animals that depend on those habitats.

Another 25% of the rain or snow finds its way into rivers and lakes, before ultimately flowing into estuaries and oceans and then evaporating back up into the atmosphere. We call this water 'surface water.' This is the water that sustains freshwater plants and animals, and of course is very important to us as well.

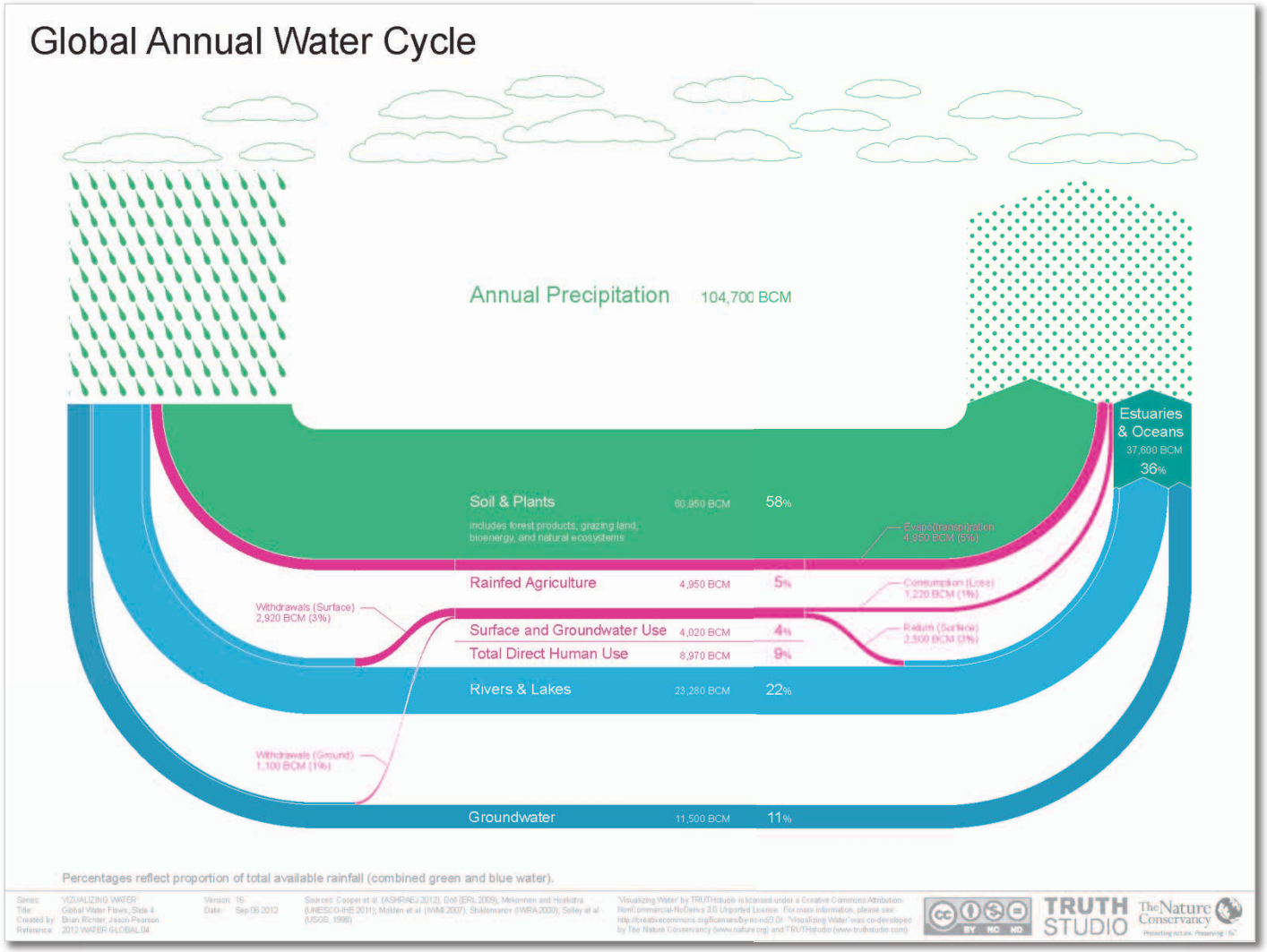
The final 12% of the rain or snow finds its way into underground aquifers, and we call this 'groundwater.' This is the water that we pump from wells or emerges from springs to supply our streams. Much of this water, too, finds its way to the ocean, either through rivers or by seeping into the ocean from coastal aquifers.

We call the combined surface water and groundwater 'blue water', and it makes up a total of about 37% of all the rain and snow in the global cycle. This blue water is of great value to our lives and our economic production.

So how do we use all this water? And how much of it do we use?



On a global basis, we use about 5% of all the green water flow for rainfed agriculture. We also benefit from green water by harvesting products such as timber from forests, grazing animals that feed on grasslands, etc.



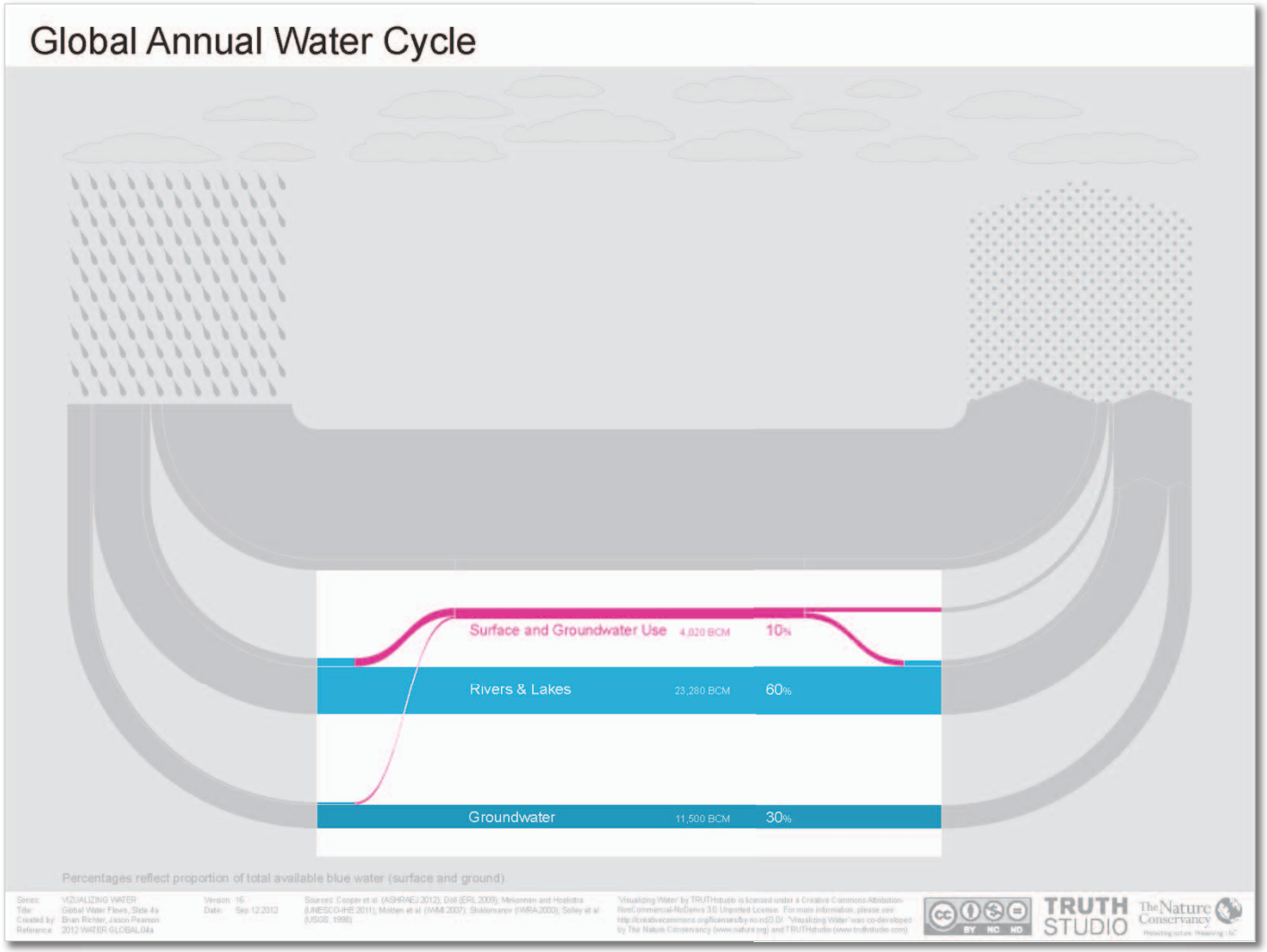
We also extract a significant amount of blue water for our use, both from surface water (rivers and lakes) and groundwater. This is what hydrologists mean by water WITHDRAWALS, i.e., the act of withdrawing water from the annual flows of blue water. If you look to the left side of the diagram, where the pink flows are pulled out from the blue water flows, you can see that we withdraw almost 3,000 BCM of surface water and a little more than 1,000 BCM of groundwater each year. This is equivalent to 4% of the total volume of rain and snow falling each year.

We use that blue water for all kinds of purposes. For irrigation. For cooling our electrical plants. For drinking and sanitation. For industrial processes. Once we're done using it, one of two things happens to the water. It either evaporates to the atmosphere or it flows back into rivers and lakes, where it is potentially available for other uses before it finds its way to the ocean and evaporates, eventually falling back to earth as rain or snow.

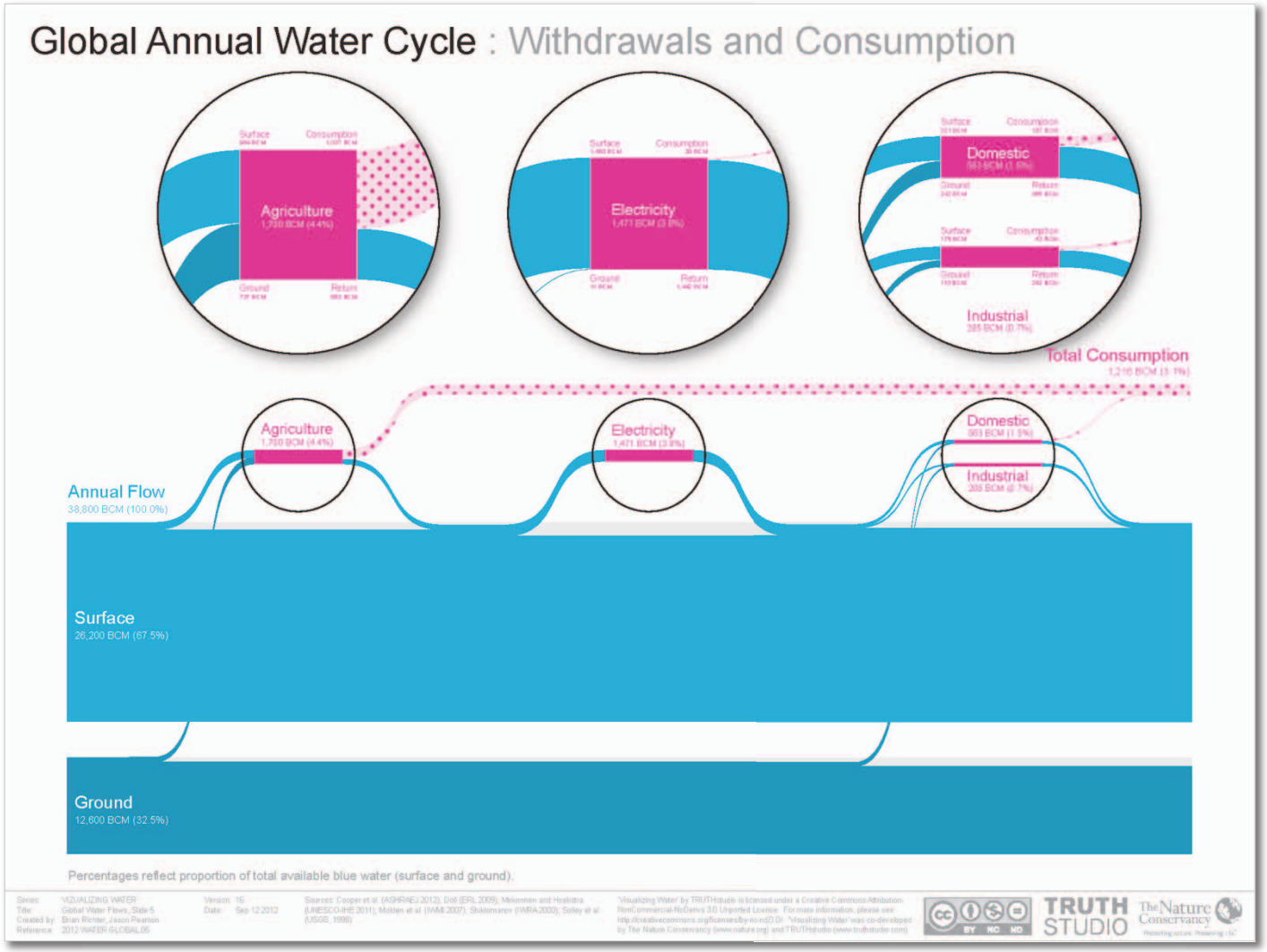
If you look on the right of this diagram, you can see that hydrologists refer to these two different paths that blue water can take after we use it as CONSUMPTION or RETURN flow. Consumption means that we consumed the water by evaporating it to the atmosphere. As a result, it's no longer available to us in rivers and lakes. RETURNED water goes back to rivers and lakes, so it is still potentially available to us for other uses before it ends up in the ocean. Think of it this way: WITHDRAWALS - RETURNS = CONSUMPTION.

That's the global water picture. All in all, we make direct use of 9% of annual rain and snow, about half of it in the form of green water used in rainfed agriculture, and about half in the form of blue water that we withdraw from rivers, lakes, and aquifers. Of all the blue water that we withdraw, about one quarter is CONSUMED through evaporation to the atmosphere, and the remaining three quarters or so is RETURNED to rivers and lakes. 36% of all the water falling from the sky onto the land surface eventually flows back to the ocean.

It's worth noting that we usually don't return water in the same condition, and sometimes not even at the same location, that we withdrew it. Sometimes we return it at a higher temperature, or with added chemicals or nutrients. All of these changes can affect the health of the rivers and lakes to which this water is returned, and its potential to be used again downstream.



If we now look at blue water exclusively, we see that we WITHDRAW about 10% of all available blue water but CONSUME only 3%.



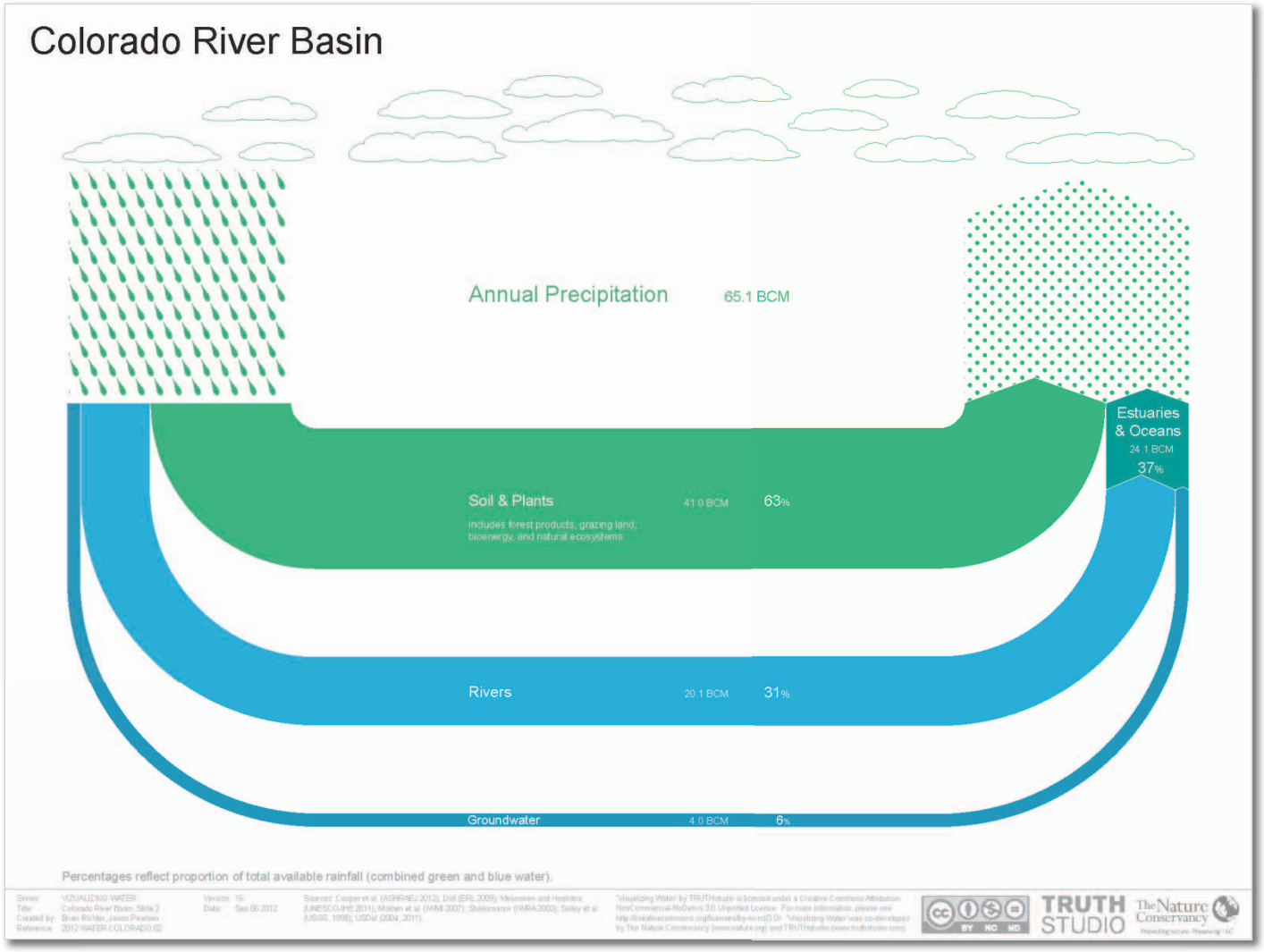
We can categorize our blue water use by major types of human activity. Irrigated agriculture withdraws and consumes the most blue water (both surface and groundwater), followed by electricity, domestic water supply, and industrial uses.

If we zoom in on each, we can see more detail on the relative amounts that they withdraw, return, and consume. In the case of agricultural irrigation, a total of 1,700 BCM of blue water is withdrawn from surface and groundwater sources. Of this water, nearly half is returned and more than half is consumed. That is, it evaporates from the soil or is transpired by plants.

In the case of electricity, about 1,471 BCM of blue water is withdrawn for cooling purposes in thermoelectric power plants, almost entirely from surface water. Almost all of this water is returned to rivers and lakes, though often at a higher temperature than when it was withdrawn.

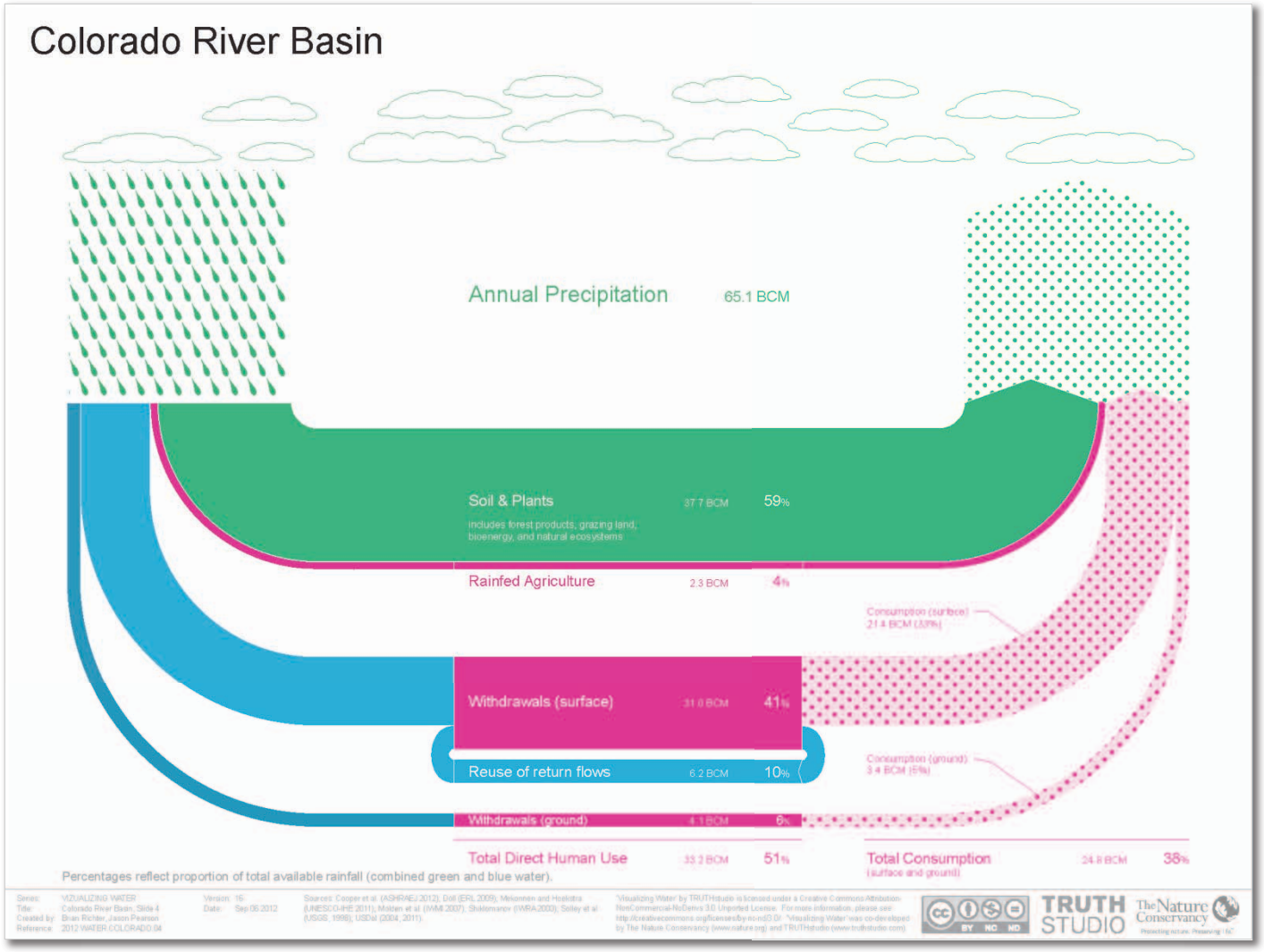
In the case of domestic water supply used in our homes and businesses, a total of 563 BCM of water is withdrawn from rivers, lakes, and groundwater sources. Of this, about 20% is consumed through evaporation to the atmosphere. The rest—about 80%—is returned to rivers, lakes, and groundwater, typically with some level of increased pollution.

In the case of industrial uses, about 285 BCM of water is withdrawn from rivers, lakes, and groundwater. About 85% of this water is returned to these sources, though often with some level of pollution.

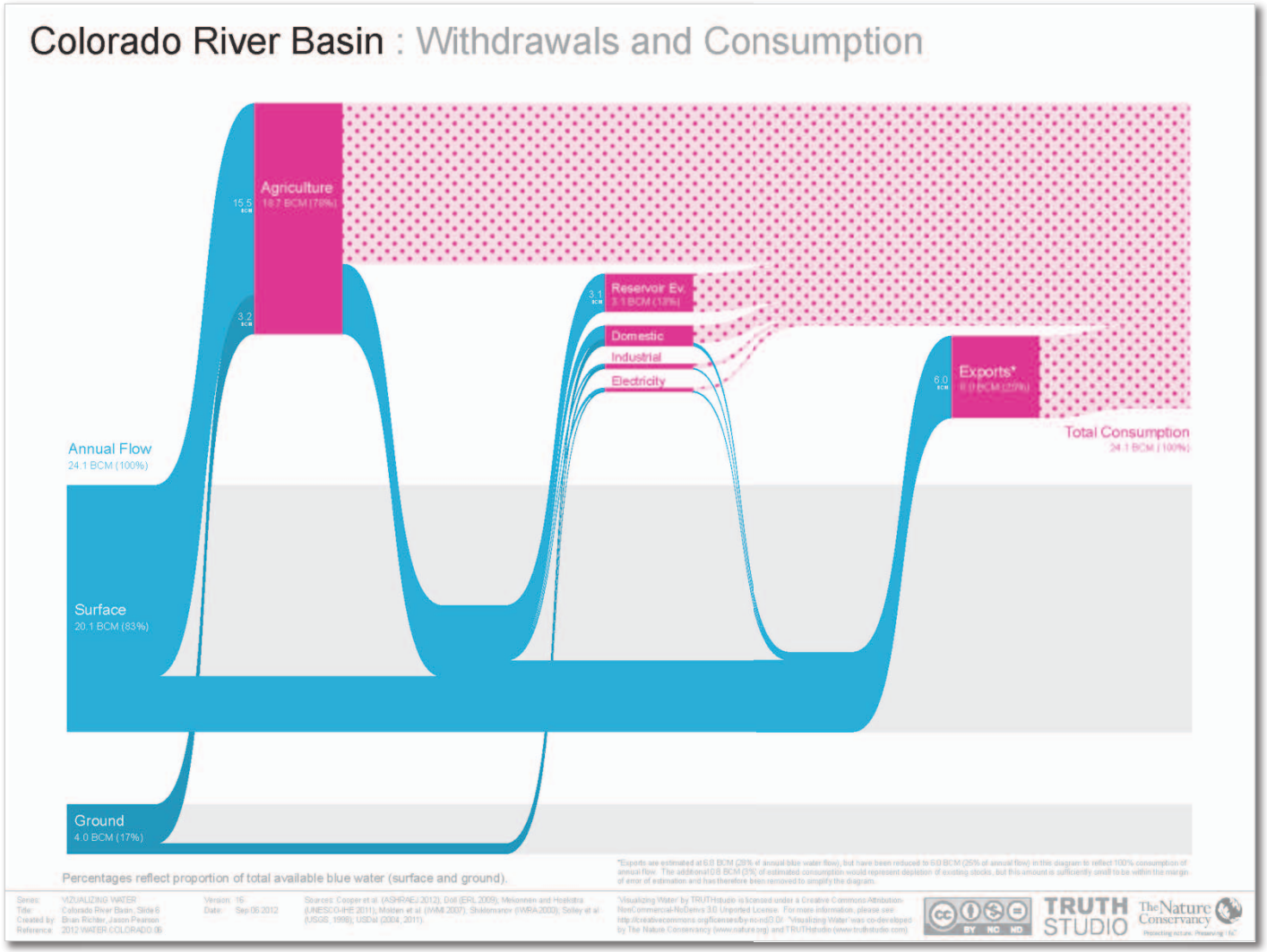


Just as we can look at the global water cycle in this way, we can look at the annual cycle of water in a single river basin, such as the Colorado River Basin in the American West.

Every year, 65 Billion Cubic Meters (BCM) of rain and snow falls in the Colorado River Basin. In the absence of human use, nearly two-thirds of that water is absorbed by soil and taken up by plants as green water before being evaporated or transpired up into the atmosphere. Another 31% finds its way into rivers and lakes as surface water, and another 6% finds its way into underground rivers and aquifers as groundwater. Just as with the global water cycle, that blue water would have historically found its way into the oceans and evaporated back up into the atmosphere.



If we add human uses into the picture, things look MUCH different in the Colorado River Basin than they did for the global situation. In the Colorado River Basin, we withdraw all of the 24.1 BCM of blue water that flows into rivers, lakes and aquifers each year. In addition, we reuse another 6.2 BCM of water that is returned to rivers and streams after being used. What this means is that in most years, the Colorado River no longer reaches the ocean. We withdraw and consume all of the water before it gets there. This has had great consequences for freshwater plants and animals, and people that depend for their survival on fisheries in river's delta.



If we focus only on our use of blue water in the Colorado River Basin, we see that irrigated agriculture withdraws and consumes by far the most blue water in this basin, accounting for 60% of all withdrawals and 53% of all consumption. Urban uses such as domestic water supply, industrial uses, and electricity account for a smaller portion, but they still collectively consume about 20% of all blue water. About 25% of water consumed goes to exports out of the river basin to cities such as Denver and Los Angeles. Evaporation from large reservoirs such as Lake Powell and Lake Mead is responsible for 13% of all consumption in the basin.

As the previous diagram showed, the total withdrawals of over 30 BCM is considerably more than the annual blue water flow of around 24 BCM, and this diagram makes clear how that is possible. Almost three quarters of all the surface water is withdrawn by agriculture, but about a third of that is returned to rivers and lakes. It may be polluted by fertilizers, pesticides, and salts, but it is still available in the system for use by other activities like domestic use or electrical plant cooling.

The Colorado River Basin is an extreme case, and it demonstrates well the importance of concepts like WITHDRAWALS and CONSUMPTION. The Colorado is a “water scarce” river basin because we consume so much of the available water.

One of our greatest challenges is finding ways to deliver the same quality of goods and services in the world’s water-scarce river basins without consuming so much of the valuable blue water. Thankfully, there is plenty of technology and sound approaches available to help us reduce our consumption. We can make improvements in every way that we use water, but because of the volume of water consumed in agriculture, we need to pay particular attention to ‘growing more crops with less drops.”