Background for Water Conservation Labs

Engineering Statistics I (MA223)

"The 2030 Agenda for Sustainable Development, adopted by all United Nations (UN) Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future."[1] The agenda describes seventeen goals for sustainable development (SDGs), the sixth being "clean water and sanitation":

> UN SDG 6: Ensure availability and sustainable management of water and sanitation for all.

For many of us, it is difficult to imagine access to water being a challenge; between oceans, rivers, ground wells, and city water (not to mention spring storms), water seems to be abundant. However, it is a fixed resource. "About 70 percent of the earth is water, but only 2.5 percent of that is freshwater. Of the freshwater, 68.9 percent is in the form of glaciers and snow cover, 30.8 percent is groundwater, and about 0.3 percent is in lakes and rivers."[2] And, due to climate change and pollution, these sources of water are threatened each year. "The latest assessment of American surface waters found that, of those assessed, 39 percent of river and stream miles, 45 percent of lake, pond, and reservoir areas, and 51 percent of estuary areas were impaired."[3]

The UN infographic for the clean water goal (Figure 1) summarizes the need for water conservation and management. For many of us, access to clean water is something we take for granted. However, "37% of countries are experiencing high to extremely high levels of water stress."[4] This means that the demand for water exceeds the supply.

[1] https://sdgs.un.org/goals
[2] https://www.safewater.org/fact-sheets-1/2017/1/23/facts-and-statistics
[3] https://www.safewater.org/fact-sheets-1/2017/1/23/facts-and-statistics
[4] https://mcic.ca/uploads/public/files-sf/SF-Full-FINAL-WEB-ISBN-2021-EN.pdf

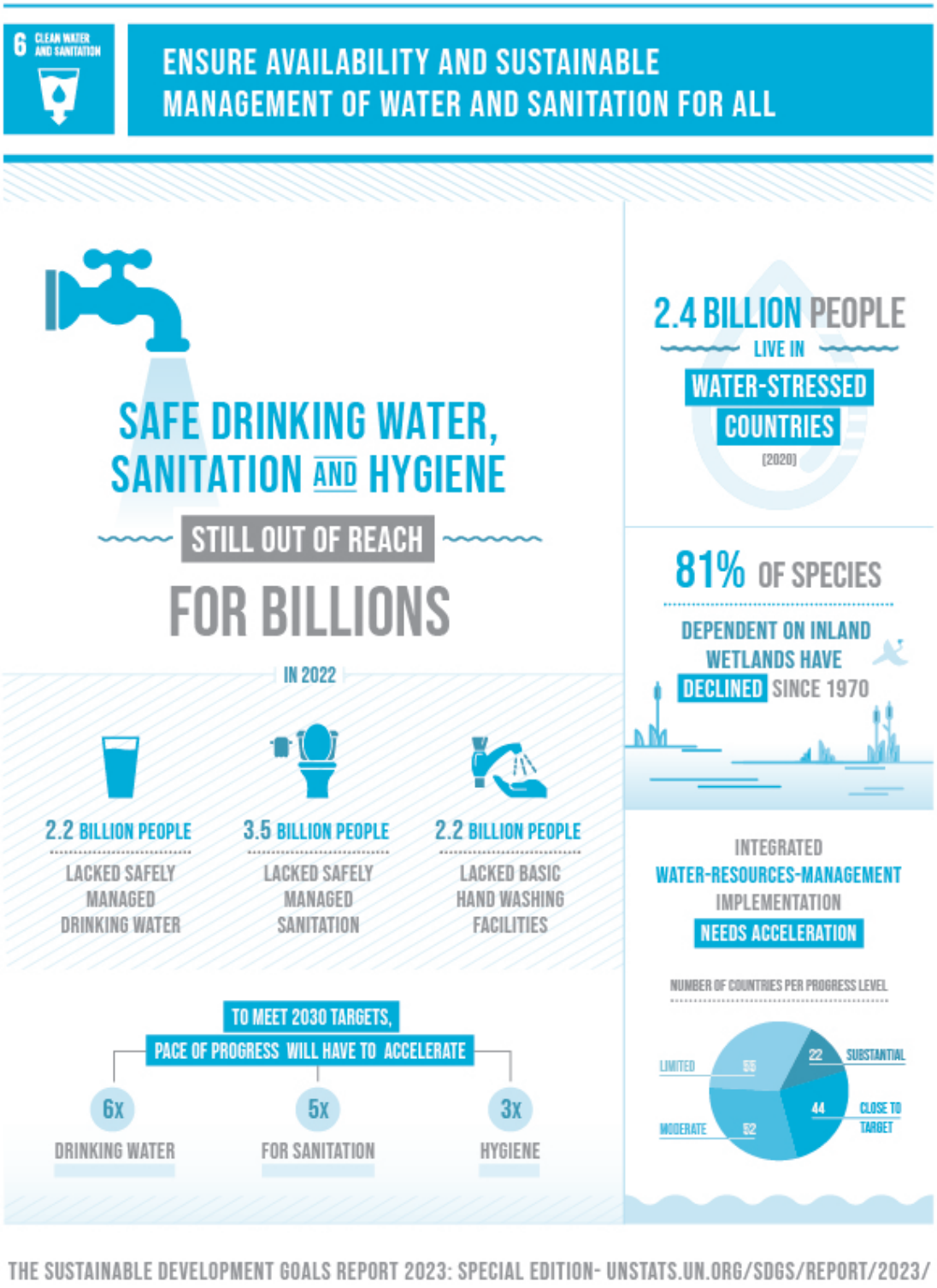

Figure 1: UN Sustainable Development Goal 6

The reason is that humans consume much more water than is strictly necessary to sustain life. According to the World Health Organization, a person could survive on approximately 5 gallons of water per day, and a very conservative individual could sustain a lifestyle in an emergency on approximately 18 gallons per day.[5] However, our intake is much greater (Americans use approximately 100 gallons per day[6]).

Improving water resource management therefore requires us to consider water conservation. Before we can conserve water, we must understand current trends and patterns in water consumption. When asked to estimate personal water usage, our first instinct is to consider the amount of water we drink, use in cooking, bathing, cleaning clothes, flushing toilets, and maybe watering the lawn. However, the largest chunk of our water consumption is indirect, through the products we purchase and the food we consume; this is known as "virtual water,"[7] and plays an important role in understanding our true water footprint.

In brief, a water footprint captures all the water consumed, evaporated and polluted as a result of the production process for an item. Water consumption is generally divided into three categories:

- Blue Water: the amount of surface or groundwater required (evaporated or used directly)
- Green Water: the amount of rainwater required (evaporated or used directly)
- Grey Water: the amount of freshwater required to dilute the waste water generated during production, in order to maintain water quality regulations.

For example, take a simple apple. The tree from which the apple is taken grows primarily with rain water (green water), supplemented slightly with irrigation (blue water). However, large producers also treat crops with pesticides that cause water pollution that must be treated (grey water). In total, it is estimated that a single 4 ounce apple requires 25 gallons to produce (16% of which is blue water, 68% is green water, and 15% is grey water).[8] The "25 gallons" is the "water footprint" of the apple. The website waterfootprint.org provides an accessible summary of the use of water in the production process as well as a library of resources.

From a statistical perspective, water footprints are estimates. They are generally computed by computing the ratio of the *average* amount of water consumed in a production process and the *average* volume of product manufactured. For our apple, the water footprint is computed by taking the average amount of

[5] https://cdn.who.int/media/docs/default-source/wash-documents/who-tn-09-how-much-water-is-needed.pdf
[6] https://www.safewater.org/fact-sheets-1/2017/1/23/water-consumption
[7] https://www.watercalculator.org/footprint/what-is-a-water-footprint/
[8] https://www.watercalculator.org/footprint/what-is-a-water-footprint/

water used to grow an apple tree and dividing by the number of apples, on average, a tree produces.[9] A gentle introduction to water footprints can be found on SafeWater.org, or at WaterCalculator.org. National Geographic has also put together a short video summarizing the importance of understanding our water footprint.

Our labs this term will investigate trends in the water footprint of members of our community. While the data we collect is at the individual level, understanding the water footprint of individuals allows us to characterize the water footprint of a larger community, and it is at this level that changes can have a significant impact.

[9] https://www.safewater.org/operation-community-water-footprint-1/2017/2/11/introduction-of-water-footprints-handout