Expert Group- Freshwater Resources in Pakistan

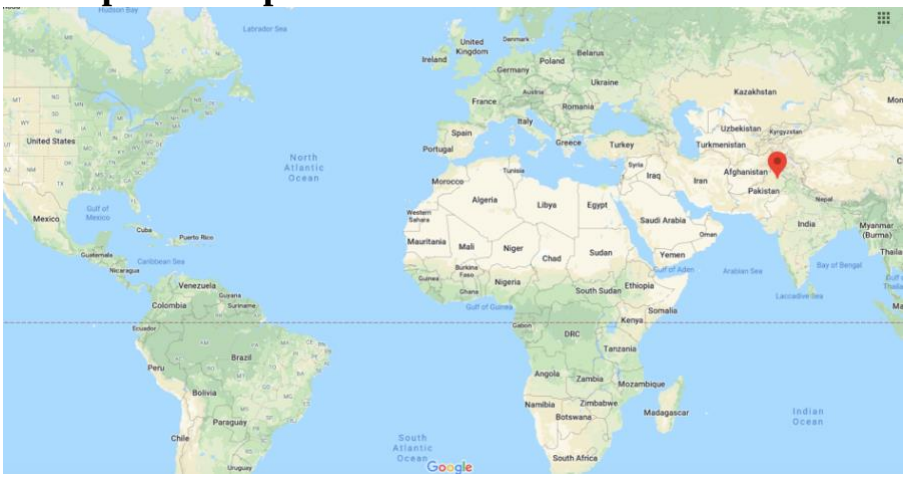


Figure 1:Location of Sargodha, Pakistan. Developed using Google Maps

When you turn on your faucet and get water, have you ever wondered where that water comes from? In the United States, most of our water is delivered through a public supplier such as the local county water department. These water suppliers get the water from either a groundwater source, such as a well, or from a surface-water resource, such as a river, lake, or reservoir. In some locations, especially rural communities, people may get their water from wells. In the U.S., the average person uses about 300 to 374 liters/80 to 100 gallons per day for indoor home uses. You can see about how much water you are using in your home through this form. Read this article, "When it Comes to Water, You Have to Think Global" to learn more about the many ways that NASA is tracking Earth's water.

Figure 2: By Openstreetmap contributors

Pakistan's main freshwater source for irrigation is the Indus Basin System. A "river basin" is land that the water in the area runs into, similar to a "watershed". This river basin system irrigates over 45 million acres of farm land throughout the country. The Indus River is one of the longest rivers in Asia, and it runs from the far northern part of the country down to the Indian Ocean. The blue line shows us where the Indus river is located.

Today, Pakistan does not have enough freshwater resources to meet the needs of all the people who live there. It is known as a "*water scarce*" country, and freshwater availability is less than 0.001 liter/0.00026 gallon per person per day. There are many reasons for this freshwater scarcity. One of the reasons is that water management has not been a big focus of

the government until recently. Agriculture is the biggest water user in Pakistan, and about 90% of the crops use irrigation, rather than relying on rainfall, to water their crops.

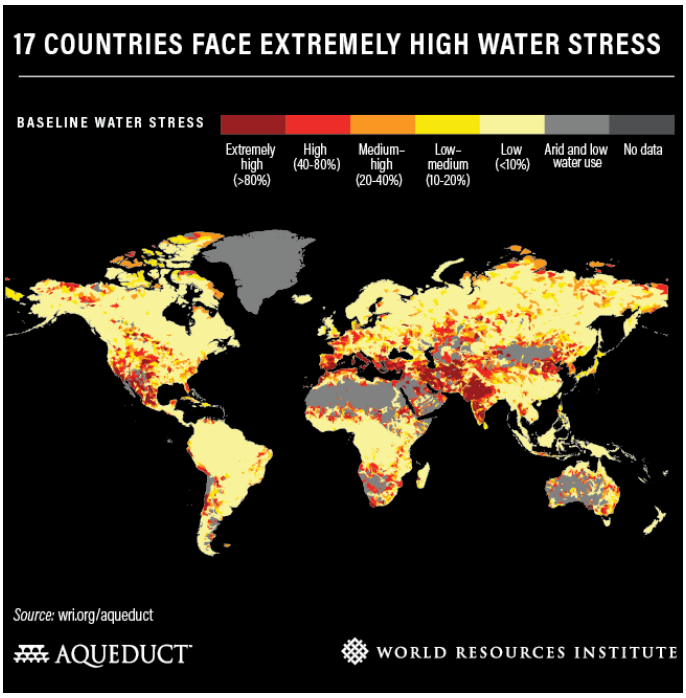


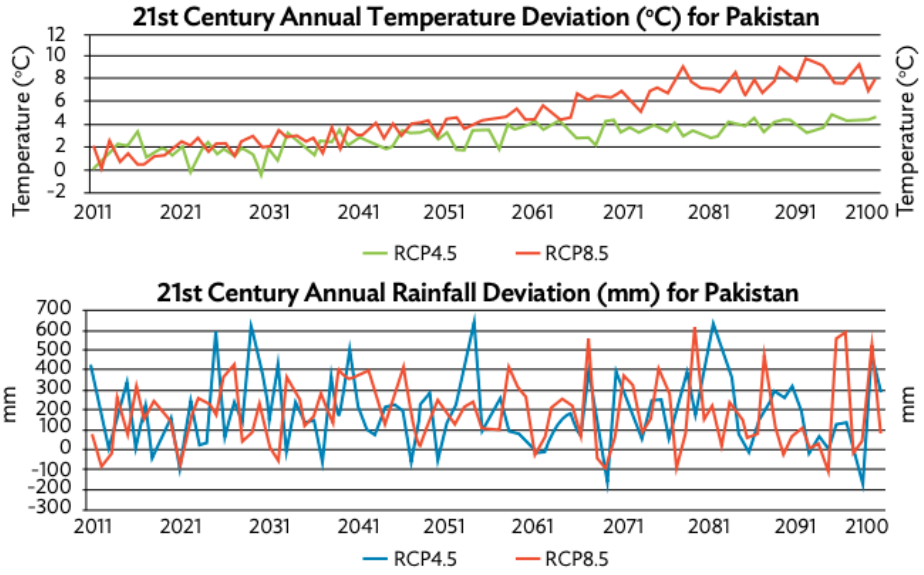
Figure 3:Countries Facing Lack of Freshwater Resources/ Image credit: WRI

Figure 3 shows which locations around the world are facing problems with not having enough freshwater resources. You can see that Pakistan falls into the dark red, meaning it is a country with extremely high "*water stress*". That is another way of saying that there isn't enough freshwater for people in that country to have access to enough freshwater to meet their needs. As you have probably noticed, some places in the world get a lot of precipitation, whereas other countries don't get enough.

There are many impacts of having either too much or too little precipitation. Watch the video "Where the Rain Falls" (11:45) to learn how rainfall variability, food security, and migration interact. While this video is not focusing specifically on Pakistan, we can gain a larger perspective for the impact of precipitation and the inequitable availability of freshwater resources on developing countries. You can learn more about this issue here.

Climate change will impact freshwater availability in Pakistan in the future. Climate change is primarily due to the increase in the concentration of greenhouse gases (GHGs) like carbon dioxide, methane and nitrous oxide through anthropogenic (human) activities. These gases trap the sunlight and increase the earth's overall temperature. The National Climate Change Policy (NCCP) of 2012 has stated that there is anticipated to be a "considerable increase in the frequency and intensity of extreme weather events, coupled with erratic monsoon rains causing frequent and intense floods and droughts". The graph below shows two potential climate change projections and indicates how each of these would impact both temperature

and precipitation in Pakistan. This higher temperature may negatively affect the growth process of wheat and hence decreases the productivity of wheat.



mm = millimeter, RCP4.5 and RCP8.5= Representative Concentration Pathways (RCPs) are emission IPCC AR5 scenarios. RCP4.5 is a stabilization scenario where greenhouse gas emissions stabilize by 2100. In RCP8.5 radiative forcing does not peak by year 2100.

Source: Pakistan Meteorological Department. 2015. High Resolution Climate Scenarios. http://www.pmd.gov.pk/rnd/rndweb/rnd_new/climchange_ar5.php

Figure 3: Pakistan's Mean Annual Temperature and Precipitation Deviation

Some of the reasons that farmers are facing a shortage of freshwater for irrigation include dated farming methods, reduced water availability, dam silting, and an increasing population in the catchment areas. Pakistan is the sixth most populated country in the world, with a population of 184.5 million people. At the current average annual population growth rate of 2%, it is projected to be the fifth most populous country by 2050. The rivers which feed into the Indus river basis have reduced the per person water availability from 5,000 cubic meters in 1951 to less than 1,000 cubic liters in 2010. Today over 85% of Pakistan's wheat production is dependent upon irrigated water.

Irrigation generally consists of flooding the wheat fields with water from the local tributaries. "Farmers are giving 40 to 50 percent more water than what is needed," said Faisal Hossain, the head of the Sustainability, Satellites, Water, and Environment (SASWE) research group at the University of Washington. "The overwatering comes from what they have learned from their fathers and grandfathers, from an era when water was abundant."

Water management is crucial for several reasons. First, applying too much water can actually slow down crop production, waterlogging the plants and decreasing yields. An example of this occurs in the Punjab province with rice farming. Rice requires 60 centimeters (24 inches) of water, but farmers often apply as much as 220 centimeters (87 inches). The efficiency of water use for crops in Pakistan is lower than the rest of the world. Rice growers in Pakistan average 0.45 kilograms of rice per cubic meter of irrigation water, while the world average is 0.71 kg/m3.

Second, excess water usage is depleting valuable water resources. Previous generations of farmers used water supplies from rivers, streams, and lakes, but with the country's growing population and increased farming demand, surface water is no longer enough. Modern-day Pakistani farmers must pump additional water from underground, which requires costly amounts of fuel to pump. It also depletes groundwater reservoirs, which are important during the country's dry periods and droughts.

"In the dry season, you use all the water from the ground, but then during monsoon season you would recharge the groundwater—like charging a battery," said Hossain. "Now that resource is being challenged because you are using the groundwater at such a fast rate."

NASA's Gravity Recovery and Climate Experiment (GRACE) mission was able to map the groundwater storage across the world. GRACE consisted of two identical spacecraft that flew about 220 kilometers (137 miles) apart in a polar orbit 500 kilometers (310 miles) above Earth. GRACE mapped Earth's gravity field by making accurate measurements of the distance between the two satellites, using GPS and a microwave ranging system. It provided scientists from all over the world with an efficient and cost-effective way to map Earth's gravity field with unprecedented accuracy. This short animation shows the groundwater storage data as measured by GRACE between August 2005 and June 2014.

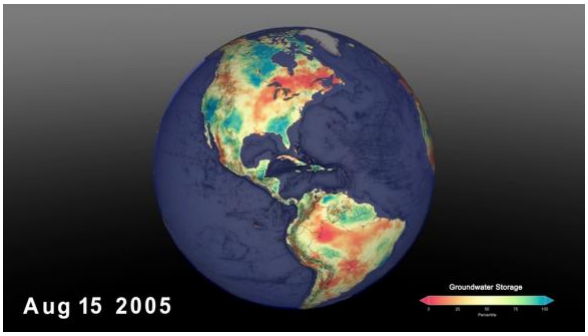


Figure 4: GRACE data Image credit: NASA/GSFC

The WRI (World Resources Institute) found that one of the best ways to reduce the use of valuable freshwater resources is to increase agricultural *efficiency*, meaning finding ways for farmers to plan ahead and be very careful with how much water they use. Farmers can reduce their use of freshwater on their crops by using "*precision watering*". There are many engineers working around the world to develop technologies that improve farmers access to

precipitation data. Dr. Hossain Faisal, a Civil & Environmental Engineering professor at University of Washington, is using data from one of NASA's Earth observing satellite missions to do just that. You will learn more about him and his work later in this lesson.

Resources:

- USGS
- WWF
- SmartWater Magazine
- AgroChart
- Our World-United Nations University
- Climate Change Profile for Pakistan
- NASA's Earth Observatory
- Watershed Rehabilitation and Irrigation Improvement in Pakistan
- NASA's GRACE mission website
- NASA Earth Science Water page