**Data Source**

Groundwater stock and flow values used are based on “Visualizing a Stochastic Model of Californian Water Resources Using Sankey Diagrams” (Curmi, E., R. Fenner, K. Richards, J. M. Allwood, B. Bajželj, and G. M. Kopec. 2013. Visualising a Stochastic Model of Californian Water Resources Using Sankey Diagrams. Water Resources Management 27:3035–3050).

**Setting up the scenarios**

Groundwater

Stock

Flow in geom\_text(x = 2030, y = 25,

label = "flow out",

color = "red")

Flow out geom\_text(x = 2030, y = 25,

label = "flow out",

color = "red")

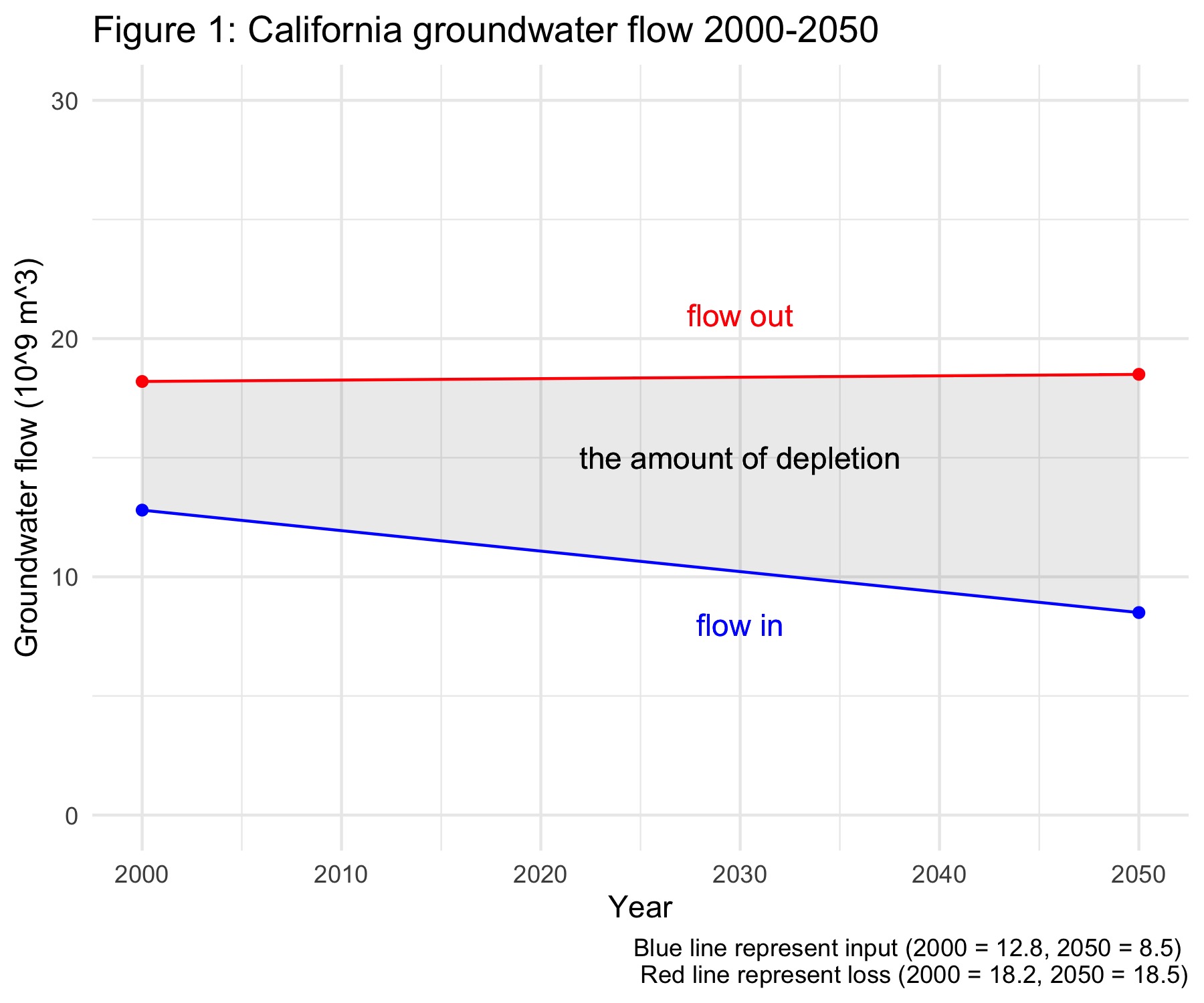
The flow and stock of California groundwater can be simplified as a mass balance model above.

**Groundwater stock**. In 2000, the expected value of groundwater stock was 350x109 m3 with a standard deviation of 115x109 m3. Assuming normal distribution, there is a 90% chance that the initial groundwater stock is between 190x109 m3 and 550x109 m3 in 2000.

**Groundwater flow**. In 2000, the annual input to the groundwater is 12.8x109 m3 while the annual loss is 18.2x109 m3. In 2050, the annual input is projected to decrease to 10.3x109 m3 while annual loss will increase to 27x109 m3.

**Amount of groundwater depletion 2000-2050**

From 2000 to 2050, the magnitude of groundwater extraction exceeds recharge every year. Assuming the flow in and flow out during these years are linear (Figure 1), the shaded area represents the amount of cumulative groundwater depletion, the difference between flow out and flow in from 2000 to 2050: 385x109 m3. The fitted line for flow in is , and that for flow out is .



**Groundwater stock in 2050**

I found the groundwater stock in 2050 by subtracting the depletion amount out of the initial amount in 2000 under three initial scenarios: expected volume, lower estimate volume, and upper estimate volume.

*Expected stock of 350x109 m3*

The volume in 2050 is estimated to be -35x109 m3, which indicates groundwater in California will completely run out before 2050. Calculations showed that the stock will deplete in 2047.

*Lower estimate volume of 190x109 m3*

In this case, the volume in 2050 is estimated to be -195x109 m3, which means groundwater in California will completely run out. Calculations showed the depletion would happen in 2029.

*Upper estimate volum*e of 550x109 m3

The volume in 2050 is estimated to be 175x109 m3. Fortunately, groundwater in California will not run out in the upper estimate scenario, which would happen right in 2066.

Summarizing the results, groundwater will deplete in expected value and lower limit scenarios and will not deplete in upper limit scenarios (Figure 2). Groundwater will deplete in 2050 if initial stock is no more than 385x109 m3, which is about 60% chance based on the assumption of normal distribution. I recommend policymakers to increase groundwater use efficiency, reduce used amount, and raise people’s awareness of groundwater shortage.

