Updated 1991-2020 Snow Survey & Water Supply Normals and Impacts: Special Report of the NRCS Idaho Snow Survey

Introduction

The purpose of this Special Report is to provide an overview of the updated normals for the 1991-2020 period published by the NRCS' Snow Survey and Water Supply Forecasting (SSWSF) Program. This report is intended to be a general overview of the updated normals, additional resources regarding the updated normals may be obtained via the National Water and Climate Center's webpage dedicated to this topic.

SSWSF normals refer to the measure of central tendency used for a given data type over a sufficiently long period of time. For example, when referring to a given SNOTEL site's inches of snow water equivalent (SWE), it is useful to contextualize that value against the range of values previously observed at that site for the same time of year. By providing a percent of normal, water users are able to quickly assess how the current data compares to past conditions.

Every 10 years, the SSWSF Program updates normals for the previous 30-year intervals consistent with the World Meteorological Organization (WMO) standards in recognition of changing climatic conditions that impact these parameters. In recognition of the need to update normals from the 1981-2010 to 1991- 2020 periods, the SSWSF Program took the opportunity to (1) reevaluate which measures of central tendency would best suit Snow Survey and Water Supply data, (2) update calculation methodologies, and (3) consider additional statistical output that may be of value to water managers. The following sections outline each of these changes and provide instructions for where users can find normals data.

In summary, the change from average to median as the normal reference statistic for precipitation and streamflow has *mostly* resulted in decreased reference values throughout the Idaho network. These decreases appear to be primarily a function of differences in central tendency statistics (i.e. – median vs. average) rather than climatological differences between the two reference periods. For SWE, the impact of updated reference normals is less pronounced since the median was previously used as its measure of central tendency, so the largest component of change results from climatological differences between reference periods.

Obtaining the updated normals

As of October 1st, 2021, all SSWSF products (graphs, maps, and reports) now reference the 1991-2020 updated normals. Users may obtain these reference values via the National Water and Climate Center (select "Retrieving 1991-2020 Normals"), Report Generator, the Interactive Map, and as a .csv file. The Interactive Map link defaults to reference SWE normals but the same capacity is available for other parameters by selecting those options in the tool interface. These tools can also be used to compare the updated normals with previous ones for all SSWSF parameters listed above. For questions on retrieval of SSWSF normals, please contact the Idaho Snow Survey staff.

Average versus median

All SSWSF parameters now base what is considered 'normal' on the median as the measure of central tendency. Again, these parameters are: snow water equivalent (SWE), snow depth (snow course data only), precipitation accumulation, streamflow volume, and reservoir storage. All of these parameters previously used average as the measure of central tendency except for SWE. The statistical median of a dataset is the number where half of the data points are lower and half are higher – it's the exact middle point of the dataset. Meanwhile, the statistical average is the number resulting from the summation of all data points within the dataset divided by the total number of data points. The median and average statistic are often quite similar, however, large outlier events (i.e floods, droughts), can skew the average higher or lower than the middle point (median) of a dataset. For this reason, the use of medians is generally recommended for natural phenomena that experience occasional large outlier events, such as extreme floods for streamflow discharge data. In such situations, the 'normal' value produced by the median statistic will typically be lower than that produced by the average because averages are disproportionately influenced by those large (or small) infrequent events.

Figure 1 illustrates this concept for precipitation data at the Mill Creek Summit SNOTEL site. The use of median as measure of central tendency results in lower normal values than using the average. Discussion regarding assessment of the updated normal values is provided in subsequent sections of this document. It should be noted the inverse can occur too, where the median value is higher than the average This can happen when extreme outlier events (exceptional drought) occur on the lower end of the spectrum, skewing the average data lower than the median.

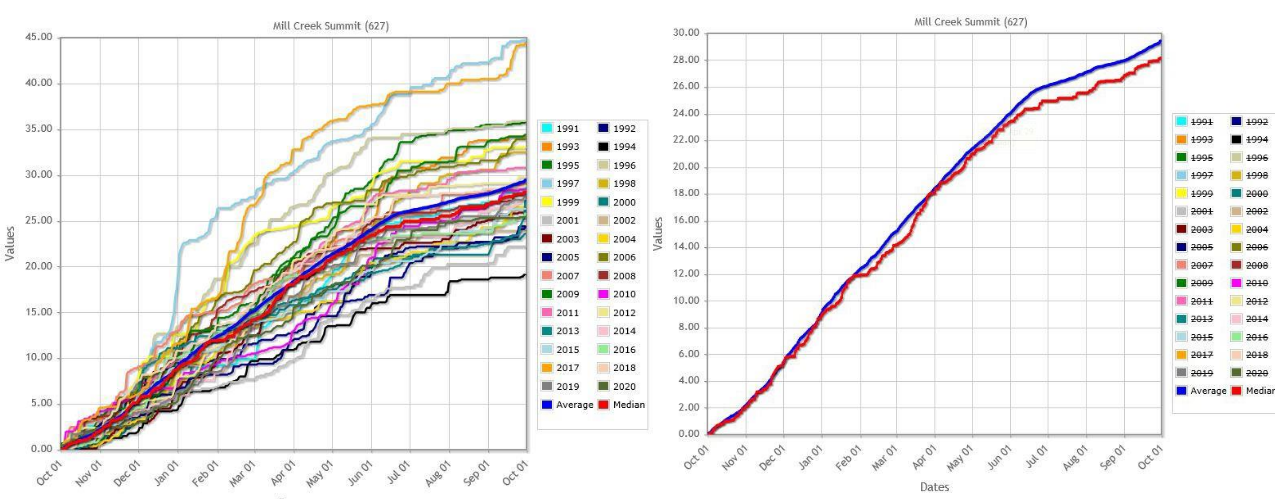

Figure 1: Precipitation data at Mill Creek Summit SNOTEL for each year during the 1991-2020 period (left panel), and differences in calculated normals for each day based on 30 year average (blue line) and median (red line) in right panel.

Updated normals calculation methodology

Several improvements were made to the calculation procedure used by SSWSF to determine normals for the parameters listed above. First, normals are no longer subjected to a smoothing process. This difference is shown in the right panel of Figure 1, where the previous normal was smoothed and the updated normal is not. While this change produces normals with a jagged appearance, values are more accurate. However, some caution should be used when interpreting peak SWE at sites that commonly experience multiple annual SWE increases and decreases. This example is explored in more detail in the SSWSF Reference Guide for updated normals.

Other updates to the calculation procedure include: (1) parameters no longer require serially complete data for a normal to be calculated, and (2) parameter data require a minimum of 10 years to calculate normals. Therefore, sites or individual sensors with period-of-record data shorter than 10 years cannot be included in the SSWSF normals at this time. The SSWSF Reference Guide provides a detailed explanation for the rationale and impact of these updated procedures for calculating normals.

New snowpack statistics

As outlined in the SSWSF Reference Guide, several additional snowpack statistics are now available to assist with snowpack and water resource investigations and management. These include: updated process for calculating (1) peak SWE, (2) date of peak SWE, (3) SWE onset date, and (4) SWE melt-out date. Regarding the latter, the removal of the smoothing process (see previous section) allows users to assign a normal value to the date that snowpack starts accumulating (onset) and completely melts out. The median melt-out date, for example, is the day of year when SWE values go to zero for half of the years within the 1991-2020 period. Likewise, the SWE onset date is the day of year when SWE values are above zero for half of the years within the 1991-2020 period.

The impact of the updated normals on interpretations of Idaho's hydro-climatic conditions

Water and resource managers should be aware of the impact that these updated normals may have on interpretations of snowpack and water supply conditions going forward. As noted elsewhere, the change from average to median as the normal reference statistic for precipitation and streamflow has *mostly* resulted in decreased reference values (Table 1, Figure 2, Figure 3). These decreases appear to be primarily a function of differences in central tendency statistics (i.e. – median vs. average) rather than climatological differences between the two reference periods. This is, in part, revealed in Table 2, which highlights reference period differences for precipitation and streamflow with the same central tendency statistic (average). In this comparison, more increases were observed than decreases for both annual precipitation and streamflow. Interestingly, while the average April – July streamflow has increased at a majority of sites across the Idaho network, there appears to be a geographic pattern of decreased April – July streamflow in and near the Snake River Plain (Figure 4). It's likely there are multiple factors leading to these changes in reference values. Therefore, it's important for those who make operational water management and agricultural decisions, especially those who rely heavily on percent of normal information, to carefully consider the underlying reference data.

The impact of updated reference normals is less pronounced for SWE data since the median was previously used as its measure of central tendency, so the largest component of change results from differences between reference periods. April 1 SWE, which is a frequently used proxy for the peak snowpack in Idaho's mountains, has increased at 58 sites and decreased at 43 sites (no change at 10 sites) for the 1991-2020 period relative to the 1981-2010 period (Table 1, Figure 5). Similar to streamflow changes highlighted above, there appears to be a geographic concentration of decreased April 1 SWE for SNOTEL sites near the Snake River Plain, especially those stations near and along the southern Idaho border (Figure 5), which could be a signal of earlier snowmelt. Conversely, nearly all SNOTEL sites in the Upper Snake River basin above Palisades Dam have increased April 1 SWE values for the 1991-2020 reference period.

A key takeaway from this report is that differences in updated normals are more pronounced for precipitation and streamflow parameters because they include statistical differences (average to median) as well as climatological differences between the 1981-2010 and 1991-2020 reference periods. One example of a potential interpretation issue is the following: consider precipitation data at SNOTEL site "A", which had a 1981-2010 normal (average) value of 20.0" on April 1, but now has a 1991-2020 normal (median) value of 17.0" on April 1. If we consider a condition of 17.0" of precipitation at SNOTEL site "A" on April 1, 2022, it will be 100% of normal, but this same 17.0" value would only be 85% of the previous normal. We feel there's increased potential for examples like these to create messaging and interpretation problems for our water user community, which underscores the importance of understanding the nature of these changes in the reference values. For detailed statistics pertaining to the changes in streamflow reference period normals, see this comprehensive comparison tool. As noted above, please direct any questions regarding the updated normals to Idaho Snow Survey staff.

Differences between 1991-2020 and 1981-2020 Official Normals

Variable	*# of Increases*	*# of Decreases*	*No Change*
April 1 SWE (n = 111)	**58**	**43**	**10**
Annual Precipitation (n = 112)	**38**	**74**	**0**
Apr-July Streamflow (n = 66)	**21**	**42**	**3**

Table 1: *Normal reference changes between 1991-2020 and 1981-2010 for April 1 SWE, Annual Precipitation (water-year), and April-July streamflow. The 1991-2020 reference value is the median for all variables, whereas the 1981-2010 reference is the median for SWE, and average for precipitation and streamflow.*
**n is the total number of SNOTEL sites or streamflow stations with reference ("normal") values for both 1981-2010 and 1991-2020 reference periods in the Idaho Data Collection Network.*

Differences between 1991-2020 and 1981-2020 Averages

Variable	***# of Increases***	***# of Decreases***	***No Change***
Annual Precipitation (n = 112)	**65**	**40**	**7**
Apr-July Streamflow (n = 66)	**35**	**27**	**4**

Table 2: *Average reference changes between 1991-2020 and 1981-2020 for Annual Precipitation (water-year) and April-July streamflow.*
**n is the total number of SNOTEL sites or streamflow stations with average values for both 1981-2010 and 1991-2020 reference periods in the Idaho Data Collection Network.*

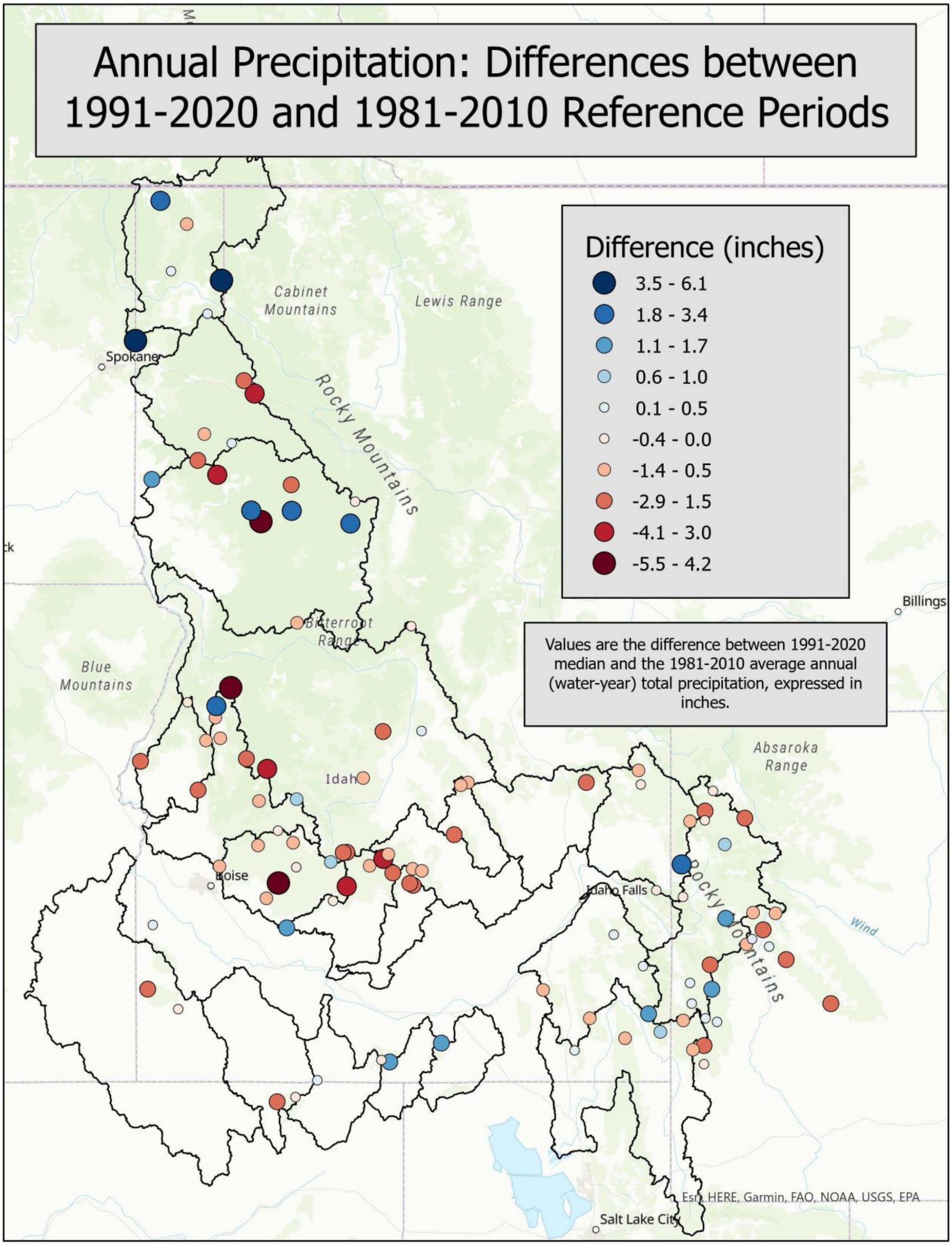

Figure 2: *Normal reference change between 1991-2020 and 1981-2010 reference periods for annual precipitation (water-year).*

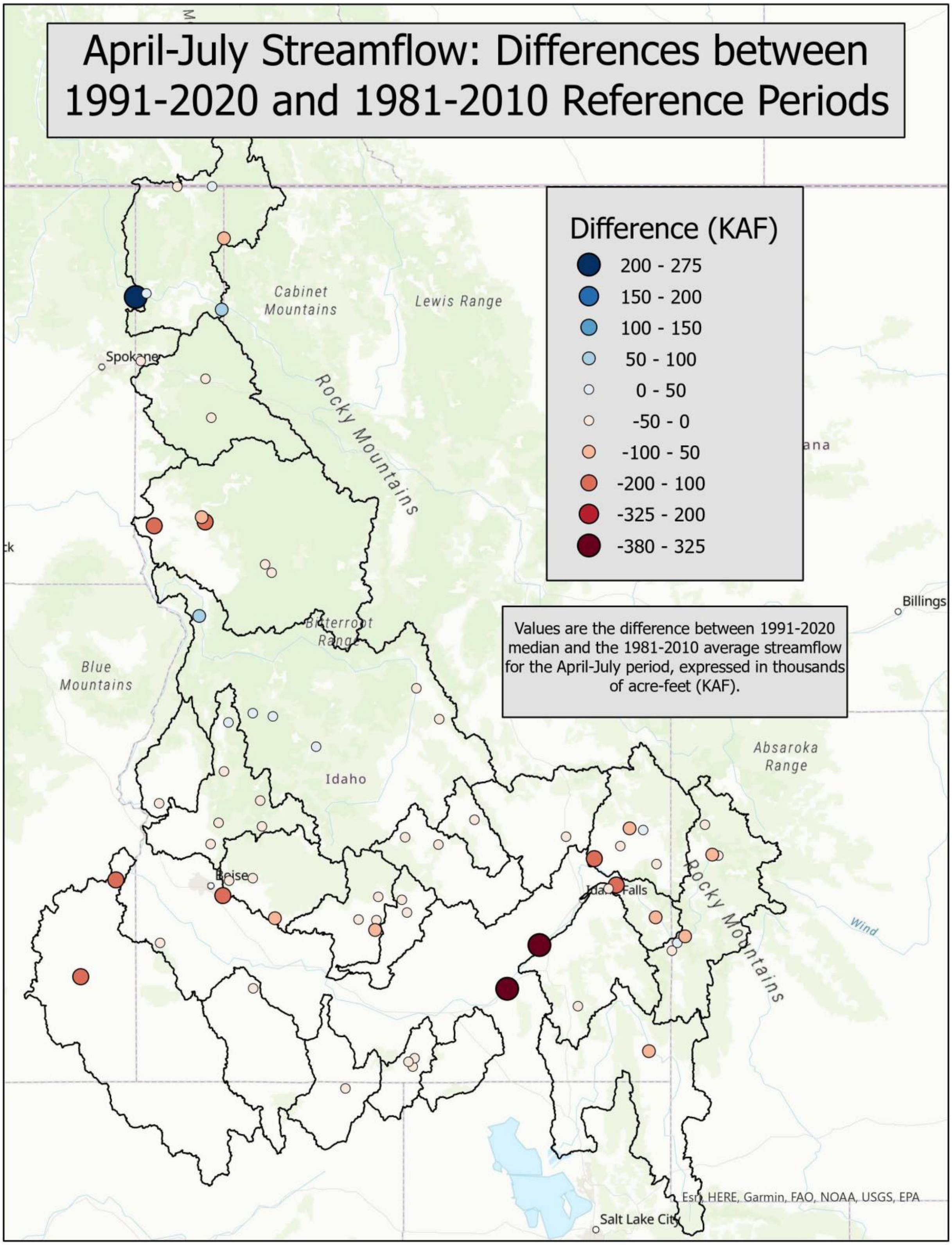

Figure 3: *Normal reference change between 1991-2020 and 1981-2010 reference periods for April-July streamflow.*

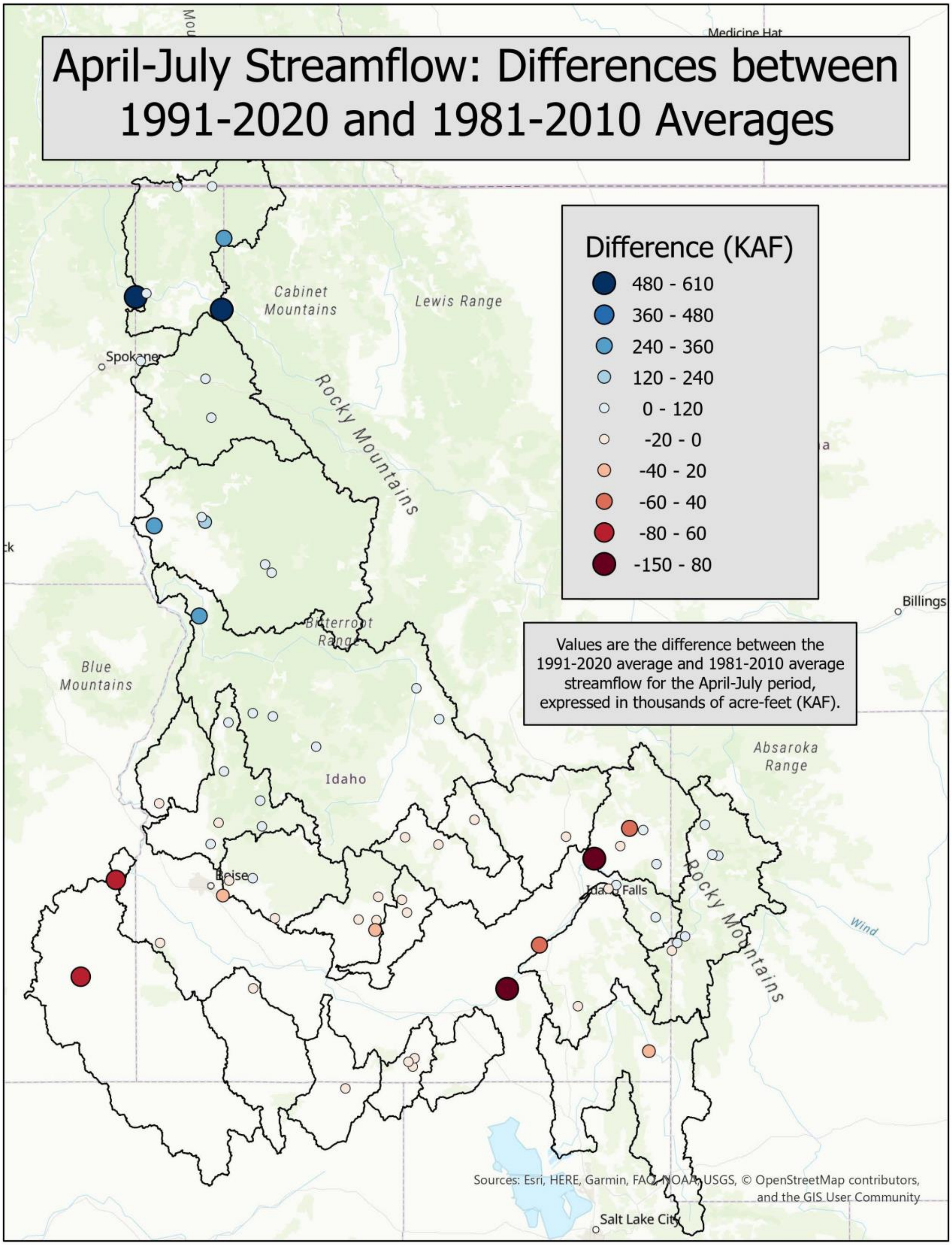

Figure 4: *Average reference change between 1991-2020 and 1981-2020 for April-July streamflow.*

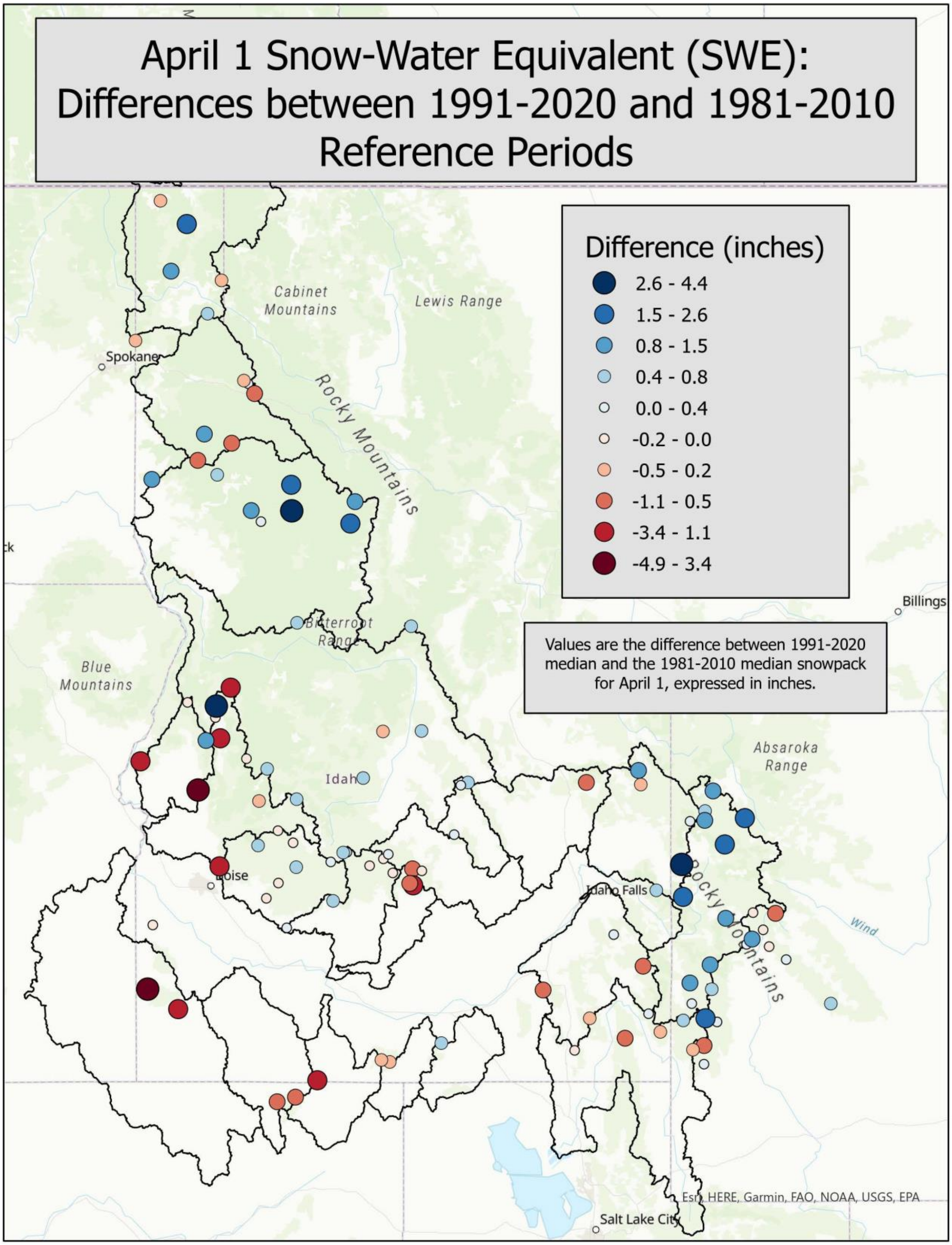

Figure 5: *Normal reference change between 1991-2020 and 1981-2010 reference periods for April 1 SWE.*