WARNING FROM THE PAST: THE MESSAGE, METEOROLOGY, AND MYTHS OF THE GREAT WEST COAST WINTER OF 1861-62

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ABSTRACT

The extreme flooding and cold of 1861-62 was like nothing ever documented for the West Coast of the United States. The two month onslaught of winter storminess was relentless. In an eight week period, at least six major storms pummeled the West Coast. From southern Washington State to Southern California, the flooding was so extreme, the high water marks of many major Western rivers remain records to this day.

The core of the extreme winter was actually a series of storms from early December 1861 to late January 1862. The severe weather affected Washington, Idaho, Oregon, California, Nevada, Utah and Arizona. Snows were deep, cold was intense and rainfall extreme. The floods were catastrophic. The Central Valley of California filled to a 300 mile long lake. The lower Colorado River peaked at 400,000 cfs. Fresh water "floated" on top of the near offshore waters of California. The author isolates several major atmospheric river weather patterns at the root of this sequence of unsettled weather. This investigation also dispels the common myths of 1861-62 flooding, then proposes lessons learned. (KEYWORDS: 1861-62, flooding, Pacific coast, California Central Valley, little ice age)

INTRODUCTION

The West Coast flooding of 1861-62 demonstrates extreme winter weather along the Pacific coast of the United States during the wintertime rain and flood season. By investigating this infamous series of storms we can gain insight into the effects of multiple extreme precipitation events. This will assist in understanding the potential and recognizingfd the weather pattern, if a similar future event unfolds. Unfortunately, weather forecast accuracy decreases after five to seven days. As a result, we will only see the pattern develop about a week at a time, if a future pattern replicates the 1861-62 series. Also, details of any one storm event, tend not to reveal themselves until the storm is in progress. This paper and presentation is intended to shed light on the myths and the reality of the Great West Coast Flooding of 1861-62, while attempting to describe the meteorology and finally the lessons of that memorable and historic series of storms.

THE FLOODING OF 1861-62: MYTHS AND REALITIES

There are many legends about the winter of 1861-62. Most misunderstandings center on the northern California part of the storminess. The flood was so usually big, many want to blame it on something besides heavy rain. The reality is; it was all about the heavy rain. The winter boils down to optimum antecedent flood conditions which include saturated soils, with copious of rainfall - priming the background flows. Then a series of large storms resulting in high water volumes, building over the winter with each specific storm.

Here are the myths and realities:

Myth: The storm was one big storm concentrated in Northern California.

This was a series of storms from Oregon to southern California. They were likely all major atmospheric rivers (ARs), with at least five or six extreme, distinct storm events over an eight-week period moving north to south, December through January. The concentration of the wettest weather, was focused into northern California.

Myth: The Central Valley of California filled with water – true.

Paper presented Western Snow Conference 2016
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More than adequate written accounts, combined with high water marks indicate this is true. Stratigraphic studies of dry lake-bed sediments and even greater high water marks indicate the Great Central Valley would partially fill, periodically. This probably happened a few times a century and most certainly happened in 1862.

Myth: Frozen ground caused the flood

There are no weather data or written accounts to indicate this is true. It was cool. However, not the sustained, bitter cold needed to freeze the ground at lower elevations in California. A series of heavy rainstorms caused the flood, with especially heavy rain in December and January for California.

Myth: Rain on snow caused the flood

Snows were heavy in the mountains. There was rare and limited snow (trace – 12") down in the lower elevations (1000-4000 ft) of California. However, there is no evidence rain on snow caused any more than the typical snowmelt runoff contribution, which is estimated to be 0 - 23%.

Myth: Hydraulic mining sediment caused the flood

Hydraulic mining was not as sophisticated and widespread as it would become in later years, after 1862. There was probably some local sediment, clogging some drainages on tributaries, resulting in local problems. The overall volume of water and size of the Sacramento drainage would be far greater than the relatively minor mining sediment contributions.

WEATHER, CLIMATE AND HYDROLOGY OF 1861-62

The period of the mid 1800's is considered the end of the Little Ice Age. The Little Ice Age was a short – lived climate swing, which lasted about 450 years. It was characterized by chilly and unsettled weather, causing the advance of glaciers for some regions of the planet. The unsettled, cold weather of 1861-62 may be linked to the last gasp of that cool, stormy period. However, The Little Ice Age effects were uneven and not synchronous across the globe

Although the exact ENSO (El Nino Southern Oscillation) data is not available for that winter, there are indications the SOI (Southern Oscillation Index) was neutral. Many of the greatest modern day floods in northern California (1986 & 1997), Oregon (1996) and Washington (2007) are associated with ENSO neutral. Although Southern California El Nino's are often wet, the largest SoCal floods appear to have no ENSO preference.

The hydrology of 1861-62 was mainly natural, but there were some diversions and small, poorly constructed levees around the Sacramento area. Many areas of the West had well developed natural wetlands which would have stored flood waters during the worst storms. Most of those are now lost to modern engineered leveed, channelized river systems, farming and urbanization. In the 1800's rivers were the highways of the time. Settlements were built on the flat and adjacent flood plains, with an eye for availability of local water supply, farmland, grazing and commerce.

For the winter of 1861-62, the weather pattern was generally cool and unsettled from November through February for much of the West Coast. This is not unusual. But the individual storms from that winter were all very strong, which is rare. Plus, the consistency of the wet weather was unusual. The pattern was caused by a storm track, with well-developed storms, migrating from north to south. Given the magnitude of each storm, it's likely all the storms were connected with atmospheric rivers. There is high confidence the Oregon storm of early December was an atmospheric river. In the NW, two days before the flood peak was observed, a warm temperature of 59 degree F, at 7:00 am, was recorded at Ft Vancouver, WA. A typical December morning would be in the 30's. This is virtual proof of an AR. Warm air advection, causing temperature anomalies, are the hallmark of strong incoming ARs for the Pacific NW and that mild temperature on a December morning is clear evidence. In Northern California, the hydrograph shows several peaks on the Sacramento River for 1861-62. The multiple 1861-62 peaks, on that graph, correlate with heavy precipitation data and anecdotal written reports.

The approximate dates for the major storms on the West coast are: December 2-4, 1861 - for Oregon and the Willamette River. A very large storm occurred on December 8-12th in Northern California. Then a new storm

arrived in Northern California: December 23-26, then another new major storm arrived on January 9-10. Finally, an intense crescendo storm, riding on the elevated stream flows of the preceding storms: January 16-20. This storm may have started in Northern/Central California, then moved to Southern California. It is unclear if this last major storm was one long-lasting, five-day storm or two separate storms. ARs can persist for several days in a region, but rarely are seen over a specific basin for more than 24 hours.

It is important to note, like in modern times, ARs penetrated inland in 1861-62. There are reports from the Inland NW, Nevada, Utah and Arizona of severe mid-winter flooding during the dates of some of these storms.

It is common, when the storm track consolidates and moves into California, the Pacific NW is engulfed by extremely cold air on the north side of the jet, during winter. In December and January of 1861-62 extreme and sustained cold was recorded in the NW. Temperatures east of the Cascades were recorded colder than -30 F. West of the Cascades temperatures below zero were seen for a time. This type of synoptic weather pattern is sometimes associated with a stagnant Rex blocking pattern. The Rex pattern is seen, when the jet focus occurs to the south, into California, with a higher latitude ridge and lower latitude toughing at a similar longitude. However, this pattern is rarely seen to the magnitude of the 1861-82 weather anomalies. Another blocking pattern possible is an Omega block. An Omega block may also have played a role in producing these extreme weather patterns. We do not know the specific magnitude, location or configuration of any of these patterns, so this is conjecture, based on what we see in modern day patterns. Blocking patterns can often sustain themselves for a several days to a couple of weeks. This will cause consistent spells of weather like; cold, wet or dry. The type of weather one would endure, depends on the location of the blocking pattern over their region.

A different weather circulation caused the Oregon flood in early December, 1861. That NW flood pattern was completely separate and unique – but still an AR. The pattern, which caused the Oregon flood, was probably a pattern like the extreme NW AR of early February, 1996. The magnitude in 1861 was likely greater, but it was probably a classic west-southwest moist and mild AR flow from the subtropics with heavy rain.

CONCLUSIONS

Understanding the nature of the floods of 1861-1862 is important for hydrologists and emergency/water resource managers to better understand possible impacts to public safety and infrastructure. In short, what is the potential of a future sustained series of extreme rain events? Modern reservoirs, with storage for flood risk management complemented by levee systems, will assist managing some of the effects of a heavy rainfall pattern like 1861-62. That said, the hydrologic system will be stressed and require complex reservoir regulation decisions regarding public safety.

Clearly, heavy rainfall from a series of storms was the primary driver of the West Coast flooding of 1861-62. There was especially heavy rainfall in December and January for California. The heaviest rain, in early December for Oregon, was followed by extreme cold in later December and January for the NW. The storms in California and Oregon came on a background of optimum antecedent conditions including snowmelt, saturated soils and elevated stream flows.

Many historic river high-water marks on Western rivers were set in 1861-62. Most have not been exceeded since that time. This fact underlines the importance and magnitude of this historic stormy period. A similar sequence, today, would severely impact river systems and flood risk management. The USGS ARk Storm simulation is a good tool for understanding the possible impacts and scenarios of flood like 1861-62. While modern weather forecasting will help prepare professionals and the public, heavy precipitation forecasts are prone to errors and low skill levels. As details of a flood event unfold, difficult water management decisions would be required. Also, if the weather sequence continues beyond 5 days, water managers will not see subsequent extreme weather patterns beyond the forecast window. Uncertainty in extreme precipitation events past three to five days is high and beyond meaningful forecast skill levels. Even in the short term forecast window of zero to three days, extreme precipitation forecasts are very difficult and limiting, but some flood preparations can be achieved. An extended major series of ARs will create demanding water management challenges. With that in mind, water managers will need to consider the profile, character and lessons from the storminess and flooding of the Great West Coast Winter of 1861-62.

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