Flood: Are You at Risk? – or Ambiguity in Data


Abstract

This concerns studies in support of a determination on whether it is in the public interest to remove four hydroelectric dams on the Klamath River. Of particular interest to those living along the Klamath River downstream of these dams is the effect on flood risk. FEMA conducted a risk assessment along the Klamath River several years ago to produce Flood Insurance Risk Map (FIRM) panels for a 100 year event. In 2010, high resolution LiDAR data and associated imagery were collected for a portion of the river. This LiDAR data collection is the basis for flood inundation models with and without the dams. The resolution of this recent data collection is substantially different than the elevation data available to FEMA at the time of the original flood inundation studies. This paper examines the various data layers available. Methods are presented on effective ways to permit those living along the Klamath River to identify whether they may be at risk from a 100 year flood event with or without the dams.

Introduction

The Klamath River Basin is in south central Oregon and northwestern California. The Klamath River begins at the outlet of Upper Klamath Lake in the upper basin and flows over 250 miles into the Pacific Ocean near Klamath, California. The lower basin for this study starts downstream of Iron Gate Dam. This dam is the first of a series of dams in Siskiyou County, California and Klamath County, Oregon. Four of these dams (Iron Gate, Copco I & II, and J.C. Boyle) are being considered for dam removal under the Klamath Hydroelectric Settlement Agreement (KHSA, 2010). All four dams are used exclusively for hydro power generation and are not used for flood control purposes. The lower Klamath River below Iron Gate flows for 190 miles to the ocean with major tributaries of Shasta, Scott, Salmon, and Trinity Rivers contributing to the flows from the upper basin. Figure 1 shows the primary area of interest for KHSA and the four dams along the Klamath River under consideration for dam removal.
The Klamath River has been subject to flooding with major flood events in 1861, 1890, and 1964. FEMA has done flood risk mapping for portions of the Klamath basin in Siskiyou, Del Norte, and Humboldt Counties. These are available both as a web mapping service and for download. This information includes FEMA Flood Insurance Rate Maps (FIRM panels) and associated Flood Insurance Studies (FIS). These products were developed over an extended time period depending on the area. FEMA FIS studies for the Klamath River in Siskiyou County are based on hydrologic analysis completed in 1979 with revisions completed in 1985 to generate FIRM panels. FEMA has been in the process of updating the FIRM products to North American Vertical Datum (NAVD 1988) and the North American Datum (NAD 1983).

For Siskiyou County, California, revised FIRM and FIS were released on January 19, 2011. Besides conversion of the base information to the new base datum, additional data were incorporated for road centerlines, elevation data, and hydraulic analysis. Except for road center lines, additional elevation data and flood analysis are outside the area of interest of this report and not near the Klamath River. For the Klamath River and sub watersheds of the Klamath River, FEMA flood analysis is based on studies and cross sections largely developed prior to 1985 with the last revision date in 1987. Delineations of the 100 year flood plain are based on contour intervals of approximately 5 to 20 feet except for portions of the flood plain near Happy Camp where 2 foot contours were
Key flood risk flood zone designations for the Klamath River in the lower basin are Zone A, Zone AE, Zone AO, Zone X, and areas with a 0.2 percent annual chance of flooding.

- **Zone A** represents a flood insurance rate zone corresponding to the 1 percent annual chance of flooding determined by approximate methods. No base flood elevations have been developed for this zone. This is the predominant zone recognized by FEMA along this stretch of the Klamath River.

- **Zone AE** represents a flood insurance rate zone corresponding to the 1 percent annual chance of flooding determined by detailed methods. Base flood elevations are provided in the FIRM data to the nearest whole foot. These areas are mapped near the communities of Klamath River, Seiad Valley, and Happy Camp.

  - **FIRM Panel 060993C0945D**
  - **FIRM Panel 060993C0965D**
  - **FIRM Panel 060993C0985D**
  - **FIRM Panel 060993C1035D**
  - **FIRM Panel 060993C1055D**

- **Zone AO** represents a flood insurance rate zone corresponding to the 1 percent annual chance of shallow flooding where average depths are expected to be between 1 and 3 feet.

- **Areas with a 0.2 percent annual chance of flooding. This is often referred to as areas subject to a 500 year storm event. This zone occurs along isolated portions of the Klamath River.**

- **Zone X** represents a flood insurance rate zone corresponding to areas generally outside of the 0.2 percent annual chance of flooding or the 1 percent annual flooding chance. They may include both of these zones where water depth is expected to be less than 1 foot or the contributing drainage is less than 1 square mile.

Figure 2 shows a portion of FEMA FIRM panel for the Klamath River from Seiad Valley to Happy Camp. Hydrologic analysis for this area is based on studies done in the 1980’s. The mapping has been transformed and adjusted by FEMA to conform to current datums and released in January, 2011.
Modeling of 100 Year Flood Events with and without Dams

With known flood risk along the Klamath River, concern has been expressed that removals of Iron Gate, Copco I & II, and J.C. Boyle Dams would lead to increased flood risk downstream. The Reclamation Denver Technical Service Center modeled flood events meeting criteria for a 100 year event from Iron Gate Dam (mile 190) downstream to the community of Happy Camp (mile 105). This simulated 100 year flood event corresponds to FEMA flood zone designations of A, AE, and AO. The methodology followed is similar to modeling done for the FEMA flood risk assessment, but does not represent the same hydrographic base data for flood events. For model development, enhanced elevation data was collected that was not available for the analysis developed by FEMA. The Reclamation analysis is based on LiDAR data with elevation values sufficient to support 2 foot (0.60 meter) contours along the reach of the Klamath River from Happy Camp to above Iron Gate Dam. The collection was in March, 2010 and included orthophoto raster imagery with an ADS40 digital camera. Source files were used to generate a terrain data model and DEM files. Raster data cell size is 3 feet (0.91 meters). This elevation data and associated imagery is available at the Klamath Restoration home page.

Modeling of flood flows downstream of Iron Gate Dam indicate that the inundation area from a 100 year event could change with removal of the dams. Copco II and Iron Gate Dams provide a slight attenuation of peak flood flows. Preliminary estimates are that the
discharge of the 100 year peak flood immediately downstream of Iron Gate would increase by up to 7 percent with dam removal. Increased discharge would increase flood elevations by approximately 1 to 2 feet on average in the reach from Iron Gate (mile 190) to Willow Creek (mile 185). The impact of dam removal decreases with distance downstream. It is estimated that there is no significant effect of dam removal on flood elevations downstream of Humbug Creek (mile 172).

The area identified by FEMA as within zones A, AE, and AO correspond fairly closely with the Reclamation modeling of flood risk both with and without dams. Figure 3 shows the same area from Seiad Valley to Happy Camp as figure 2 with the simulated 100 year flood event with and without the dams.

The modeled flood event with the dams produces a flood risk map similar to the FEMA flood zones A, AE, and AO. These newly modeled flows are not comparable to the coarser resolution of elevation data and model characteristics used to generate the FIRM panels. The modeled peak flood flows with and without the dams show isolated areas that may be inundated. These areas are scattered throughout the river reach studied.

**Evaluation of Flood Risk**

This area of the Klamath River is rural with mixed public and private land ownership. There are several unincorporated communities such as Happy Camp, Nolton, Fort Goff, Seiad Valley, Hamburg, Horse Creek, Klamath River, and Gottville. Of the parcels
immediately adjacent to this segment of Klamath River, approximately 35% are in private ownership. The private lands range from a fraction of an acre to over 600 acres (242 hectares) in size. The average size is about 14 acres (5.6 hectares). The remaining parcels are in Federal, State, or County ownership.

To provide flood risk information to those living downstream of Iron Gate Dam, a series of maps have been generated. These series were generated as map books or data driven pages. The first set was developed in January, 2011. This series is available on the Klamath Restoration web site.

This first series allows the user to scan along the full segment of the river from Iron Gate Dam downstream to Happy Camp. The isolated and scattered areas modeled for a 100 year flood event without the dams are easy to spot along the modeled current 100 year flood plain. However, the orientation of each map sheet is set to maximize the display area of the river corridor. This means that each sheet does not exactly match the effective neat line of adjacent sheets. In some cases, the sheets are oriented in different cardinal directions as the general direction of the river changes. Figure 4 shows a map sheet from this series.

The second map series covers the same river segment as the first map series except that areas of public land ownership were excluded. This series maintained a common cardinal direction with north at the top of the map page and a standard scale for all maps of 1:6,000. Map sheets were developed with an index grid to provide overlap to adjacent sheets to allow the user to easily follow areas of interest between map sheets. This map
Identify the names and roles of the key persons involved in the project.

**Identification of Structures at Risk**

To understand what structures might be affected by peak flood flows, imagery was examined to identify structures in or near the modeled flood zones. Available imagery includes 3.2 foot (1 meter) 2009 NAIP imagery and 2.0 foot (0.6 meter) 2010 natural color imagery. The 2010 imagery was collected at the same time of the year (March) as the LiDAR collection. The 2009 NAIP imagery was collected in June. Structures were identified as within either the modeled flood zone with the existing dams or without the existing dams. Most structures also fell within a currently identified FEMA flood zone.

- Structures within the 2010 modeled 100 year flood plain with the dams in place
  - 659 structures within modeled 100 year flood plain
    - 205 upstream of river mile 172
    - 454 downstream of river mile 172
- Structures within the 2010 modeled 100 year flood plain without the dams upstream of river mile 172
  - 36 structures within the expanded flood plain without the dams
Over 70 percent of the identified structures are also within the FEMA designated 100 year flood plain. Many of the structures identified appeared to be clustered. Over 600 structures are within 100 feet (30.5 meters) of each other. One parcel contained over 100 structures. Some structures are clustered in or near unincorporated communities. In other areas, clusters of structures near the river appear to be mobile homes or trailers. This was apparent from comparison of the location of structures from the summer of 2009 to the early spring of 2010. Approximately 150 structures were not present for both image dates.

A main concern has been to verify the existence of structures identified in the expanded 100 year flood plain if the dams are removed. In March 2011, a reconnaissance was done of these 36 structures. This verification indicated that some are built structures of residences and associated out buildings. However, some are mobile homes, trailers, and utility buildings.

Another map series with enhanced 2010 imagery was developed in May, 2011. This set represents a subset where structures have been identified throughout the stretch from Iron Gate Dam downstream to Happy Camp. It highlights areas with structures at risk with or without the dams based on the 2010 modeling. This map series follows the same format as the second map series, but it is a further reduced subset that includes 2 foot contours from the LiDAR data. Contours are included to assist the user to understand the range in elevations within the area of a structure. Figure 6 shows a map panel from this map series.
Summary

A series of map books have been developed to assist in recognizing flood risk along a portion of the Klamath River with and without four hydroelectric dams. This flood risk is based on hydrologic modeling simulating a 100 year flood event with enhanced elevation data that was not available at the time that FEMA developed the original FIRM panels and flood insurance studies. The model simulations and available imagery indicate that there are potentially several hundred structures that may be a risk from a 100 year storm event. Most of these structures are within a FEMA designated flood zone. FEMA will develop new flood risk assessments based on the newly available enhanced elevation data. If a determination is made to remove the four dams a more detailed evaluation would be required.

The sets of map series illustrating the 2010 modeling of a 100 year flood event are intended only as guides in assessing flood risk. They are preliminary assessments. The Klamath River corridor is under a County flood ordinance consistent with FEMA requirements for the National Flood Insurance Program. Actual flood risk determinations for any structure require a field investigation by a qualified representative of Siskiyou County. Some structures which appear in these map books have a determination that they are outside the FEMA flood zones. These are documented either with a letter of map revision (LOMR) or an elevation certificate on file with the County or FEMA. Figure 7 shows the modeled portion of the Klamath River for the simulated flood events and corresponding FIRM panels.
References

FEMA, 2011, Flood Insurance Study, Siskiyou County, California, and Incorporated Areas; Federal Emergency Management Agency; Flood Insurance Study Number 06093cv000A; FIS initial countywide effective date, January 19, 2011; Access to FEMA Map Service Center for FIRM Panels and FIS reports:
http://www.msc.fema.gov/webapp/wcs/stores/servlet/FemaWelcomeView?storeId=10001&catalogId=10001&langId=-1
   Siskiyou County FIS 06093CV000A Date: January 19, 2011
   Del Norte County FIS 06015CV00B Date: November 26, 2010
   Humboldt County FIS 060060V000 Date: February 8, 1999
   Klamath County FIS 410109V000 Date: June 18, 1984

FEMA, 2011, Flood Insurance Rating Panels, Siskiyou County, California, and Incorporated Areas; Federal Emergency Management Agency; FIRM panels effective date, January 19, 2011; Access to FEMA Map Service Center for FIRM Panels and FIS reports:
http://www.msc.fema.gov/webapp/wcs/stores/servlet/FemaWelcomeView?storeId=10001&catalogId=10001&langId=-1

FEMA Mapping Information and access to interactive Risk Map viewer:
https://hazards.fema.gov/femaportal/wps/portal/!ut/p/.cmd/cs/.ce/7_0_A/.s/7_0_CM9/_s.7_0_A/7_0_CM9

Klamath Hydroelectric Settlement Agreement (KHSA), February 18, 2011 – Signed agreement by various parties on the removal of four hydroelectric dams on the Klamath River.


U.S. Bureau of Reclamation; Klamath River Dams Project Geospatial Base Map Data Dictionary; Denver Technical Service Center, Environmental Services Division; September, 2010.

Author:
David T. Hansen, GISP
GIS Specialist / Soil Scientist
Phone: (916) 978-5268
Email: dhansen@usbr.gov
U.S. Bureau of Reclamation
Mid-Pacific Region
2800 Cottage Way
Sacramento, CA 95825-1898