FLUVIAL HAZARD ZONE (FHZ) MAPPING

FACT SHEET | Colorado Water Conservation Board (CWCB)

Accounting for Fluvial Processes

Year after year, Colorado streams dependably rise in the spring and drop in the summer supplying our communities and farms with water, providing for recreational opportunities, and nourishing plants and animals that depend on this precious resource. For decades at a stretch, a stream may maintain its course, giving communities a false sense of security and allowing for development to creep into areas once occupied by the stream. When floods occur, streams are prone to dramatically alter their size, shape and location within a fluvial hazard zone (FHZ), causing considerable damage to infrastructure and property and endangering lives (Figure 1).

Flood Insurance Rate Maps (FIRMs) inform communities of where flooding might occur. These are federally regulated maps that determine flood insurance rates and requirements and advise land use decisions. However, FIRMs only provide a snapshot of flood inundation and do not inform users of dynamic fluvial processes, which naturally occur within river systems. Fluvial processes erode and deposit sediment within stream corridors, sometimes outside of mapped floodplain areas. In order to better account for these natural changes, some communities are now mapping the FHZ - the area a stream has occupied in recent history, could occupy, or could physically influence as it stores and transports sediment and debris during flood events. The primary objective of mapping the FHZ is to identify areas most vulnerable to fluvial hazards in order to inform land use decisions. FHZs are mapped primarily through the use of geologic and geomorphic information (i.e., data that describes the physical form and processes of a riverine system).

Floods and Floodplain Mapping

Flooding represents the most common natural disaster in the United States, resulting in significant property and infrastructure damage.[1] Floods have resulted in 11 federal disaster declarations for Colorado with one or more major floods occurring every decade in the State.[2] Average ***annual*** flood losses in Colorado are estimated to be $83,000,000 in property damage based on data from 1911 to 2013 (inflation-adjusted 2013 dollars).[2]

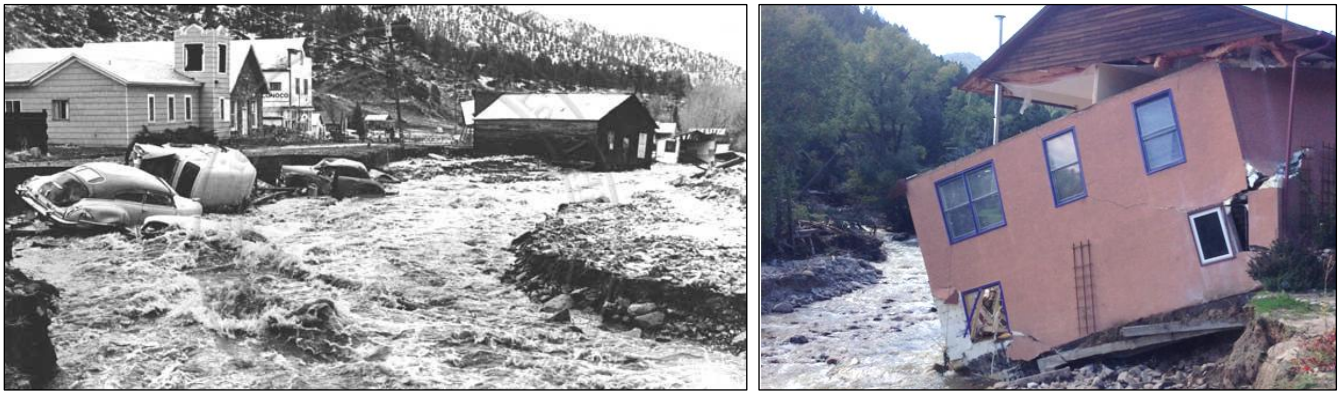

Figure 1: Flood damage in Jamestown, Colorado in 1969 (left image courtesy of the Carnegie Branch Library/Boulder Historical Society), and 2013 (right image courtesy of CWCB) demonstrate fluvial hazards inherent to James Creek and many of Colorado's riverside communities. Jamestown also experienced devastating flooding in 1913.

[1] https://community.fema.gov/hazard/flood-en_us/be-smart?lang=en_US

[2] http://cwcb.state.co.us/water-management/flood/Documents/ColoradoFloodMitigationPlanUpdate2013.pdf (p. 31)

Historically, landowners and local governments have determined and regulated areas within river corridors susceptible to flood damage by relying on FIRMs created using Federal Emergency Management Agency (FEMA) Guidance and Standards, which are used to establish insurance premiums through the National Flood Insurance Program (NFIP) as well as local land use regulations. These maps are elevation-based, delineating ***only water depth*** hazards. These maps do not consider stream movement and the impacts of erosion and sediment deposition. Streams can become highly energetic during a flood event and properties located well above mapped floodplains may be affected by erosion and depositional processes not captured by standard floodplain mapping.

Since 1978, approximately 49% of all NFIP claims in Colorado have come from policies written outside the high risk area depicted on the FEMA FIRMs.[3] The 2013 Colorado Front Range flood resulted in 52% of flood insurance claims originating outside of regulatory floodplains, demonstrating that reliance on flood inundation maps alone does not provide a complete picture of flood hazards.[4]

Fluvial Processes - Natural and Dynamic

Until recently, stream and flood management has largely focused solely on water: where it is expected to move during a flood and how to avoid or mitigate flooding through engineering means. However, streams transport more than just water. Streams gather, store, and move water, sediment and debris. Most of the time these processes are hardly noticeable but sometimes, especially during a flood event, erosion and deposition can happen rapidly, resulting in the movement of the river channel into new (or former) locations, bank retreat, and hill slope failures. This dynamism is innate to a stream. The resulting landscapes created by moving rivers, scientists have found, have positive impact on the ecology and function of a river corridor through the creation of new channels, wetlands, and riparian habitats.[5,6]

Fluvial Hazard Mapping

Fluvial processes become hazardous when an adjusting stream channel threatens public infrastructure, houses, businesses, and other investments. In order to address the unrecognized hazards associated with erosion, sediment deposition and other dynamic river processes, the CWCB has developed a FHZ program to identify and map the hazards posed by these natural river processes and develop tools to help communities and landowners better understand the hazards associated with flood events.

Fluvial hazard mapping is a component of the Colorado Hazard Mapping Program (CHAMP) effort underway by the Colorado Water Conservation Board in partnership with local governments, the State Legislative Assembly, landowners, watershed associations, and regional planning commissions. More information about CHAMP can be found at www.coloradohazardmapping.com.

Ultimately, it can be argued that the most effective method of long-term flood hazard reduction may be the establishment of a Fluvial Hazard Zone in combination with floodplain inundation mapping.

[3] Personal Communication FEMA Region 8, March 2017.

[4] Gease, M. FEMA natural hazards specialist, quoted in Walker, R. (2014). Coming Home, a Calculation of Risk, Reward and Restitution in Flood Zones. Headwaters. Colorado Foundation for Water Education. p 23-27.

[5] Cluer, B. and Thorne, C. R., 2014. A stream evolution model integrating habitat and ecosystem benefits, River Research and Applications,30, 135-154.

[6] https://cpw.state.co.us/Documents/Research/Aquatic/pdf/PostFloodAssessmentandGuidelines.pdf

Conclusion

Fluvial Hazard Zone mapping represents a significant and necessary step forward in identifying and addressing hazards posed by flood events. Flood hazard reduction, in the long-term, will primarily be measured by our ability to solve problems at the watershed and river corridor scale, and secondarily, by how we resolve conflicts at individual sites. From a physical standpoint, this means recognizing that rivers transport and deposit water ***and*** sediment and debris, and that streams are naturally dynamic systems prone to move.

Because rivers and waterways do not follow political boundaries, preparation for flood related fluvial hazards requires an individual, local, regional, state and federal partnership that can work in watersheds to identify these areas and develop management policies that reduce long-term threats to human life and property (Figure 2).

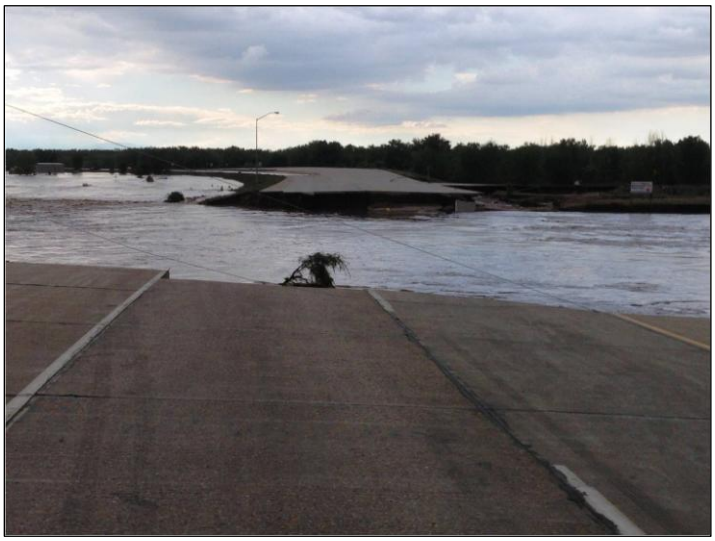

Figure 2: Highway 34 East of Greeley in 2013 flooding.

Fluvial Hazard Mapping Pilot Program Goals and Objectives

In order to develop the methods behind these maps, the CWCB has initiated a pilot program. The following goals and objectives are actively being pursued:

Goal 1: *Develop a scientifically defensible set of standards for Colorado.*
Objective: Determine through a piloted, field verified, and peer-reviewed approach an easily interpretable and repeatable methodology for identifying fluvial hazard zones across Colorado. It will be sensitive to the variety of geographies and hydro-climates within the state. When and where appropriate, we will leverage existing tools to support this objective. Where uncertainty exists within the methodology or within map products, the team will identify it. The process will be transparent.

Goal 2: *Implement fluvial hazard mapping throughout Colorado.*
Objective: Select study areas to pilot the protocol in watersheds that are susceptible to fluvial erosion hazards, are undergoing or show signs of future growth, and are in communities that have shown an interest and commitment to implement more comprehensive hazard planning.

Goal 3: *Reduce damage from future flood events by increasing awareness of fluvial (river-related) erosion and deposition hazards thereby leading to better land use decisions.*
Objective: Develop a FHZ program that centers around a vetted and scientifically sound protocol and is easy to interpret, is widely supported, and readily adoptable by communities. Promote natural processes as part of the FHZ mapping to assist communities in understanding that fluvial erosion and deposition processes are natural and fluvial hazards should be included in the discussions of 'flood hazards'. Produce additional information including but not limited to: scenarios for mitigation, resources for how and when to implement, an outline of roles and responsibilities of how communities can incorporate mapping into local planning and regulations, and model land use code(s).

Sources of Additional Information

This document can be found at: http://coloradohazardmapping.com/hazardMapping/fluvialMapping
CWCB Flood Info Website: http://cwcb.state.co.us/water-management/flood/Pages/main.aspx
Colorado Risk Map: http://coloradofloodrisk.state.co.us/PublicOutreach/Pages/Homeowners.aspx

Flood Inundation Hazards vs. Fluvial Hazards

Flood Insurance Rate Maps (FIRMs):	Fluvial Hazard Zone Maps (FHZMs):
- Map areas of flood ***inundation*** (e.g., the land expected to be wet during a 1% annual chance flood) - Use a variety of data and methods to map flood surface elevations and extent. This may include historic flood data, rainfall data, topographic data (i.e., LiDAR and field survey), along with computer models that calculate results for hydraulic equations. -Assume a static river system with no changes to a river's shape and no debris or sediment being transported by flood waters. - Are typically made by engineers with experience in hydrologic (rainfall and watershed) and hydraulic (stream channel and floodplain) computer modeling. - Maps are part of the National Flood Insurance Program (NFIP) and determine where flood insurance is required. - Many local governments participate in the NFIP and regulate development in the floodplain, as defined by these maps. - Federally regulated product (for participating NFIP communities)	- Maps identify where a stream or river ***could move*** or could cause damage during a flood (e.g., erode a high bank and undermine a structure or deposit sediment and debris). - Are separate and different than FIRMs, but may use information from FIRMs to inform their extent. - Use a variety of data and methods including high resolution topographic data (i.e., LiDAR), geologic and soils maps, and field verification. -Assumes that river dimensions change during a flood event and that flows are transporting sediment and debris. - Rely on fluvial geomorphic (stream form and process) expertise to interpret landforms within the floodplain and along a stream. - Do not affect flood insurance rates, though those with structures within the FHZ are encouraged to purchase flood insurance. - Regulation, if any, is determined by local communities. -Non-Federally regulated product