



River Management

2013 Colorado Flood

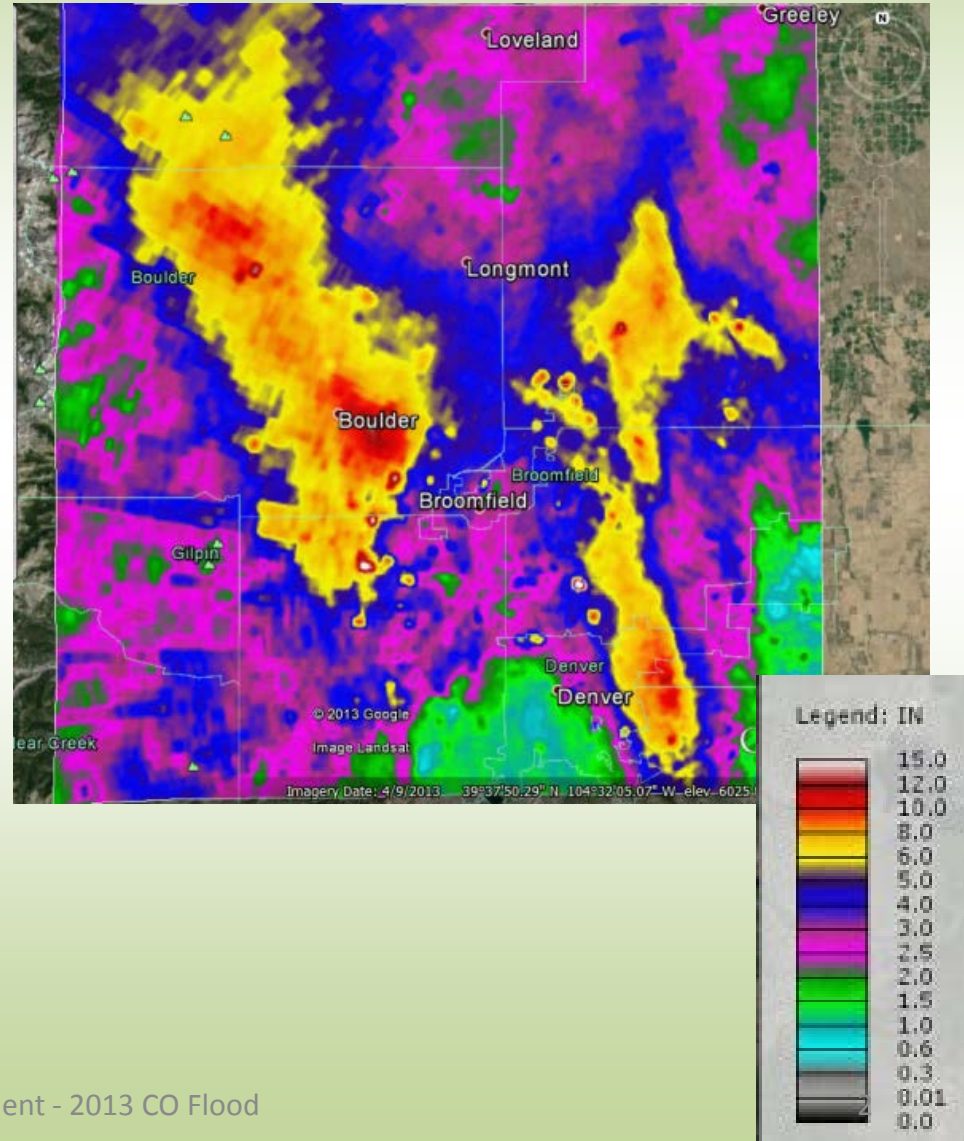
Damages, Countermeasures, Socio-Economic Impacts

Miles Blair, Allen Chestnut,
Hwayoung Kim, & Caroline Ubing

CIVE 717 – Spring 2014

Flood Statistics

- Sept 9th – 16th, 2013
- 17.2 inches of precipitation in Boulder County
- Floodwaters impacted:
 - 17 counties
 - 2,000 square miles



Damages

- Life
- Property
- Dams
- Roads
- Sewage Lines
- Oil Wells



Glade Park, no plans to rebuild

*Most data and numbers are estimate as actual values are unknown

Life

- 8 people killed total
- 11,000 evacuations
- Additional people left stranded in remote locations for days at a time
- Lyons completely cut off with air rescue a necessity
- Estes Park cut off as major roads into town destroyed



Property

- Up to 20,000 homes damaged statewide
- Many people lacking flood insurance
- Agriculture in Weld County over 2,000 parcels impacted



River Management - 2013 CO Flood

Dams

- 6 dams
 - Small earthen dams with minimal impact
- Used as a reason to perform dam safety inspections of all dams even touched by the event
 - Volunteer engineers performed many



Rainbow Lake just before dam failure

Roads



Highway 34

- Major roads damaged:
 - Highway 14 (Poudre Canyon)
 - Highway 34 (Big Thompson)
 - Highway 36 (St. Vrain)
 - Highway 72
 - Most main roads into foothills
- Additional 200+ miles of roads damaged
- 50+ state highway bridges damaged

Sewage Lines

- Up to 300 million gallons of sewage released
- Resulted in mandatory water restrictions such as no flush orders
- Potable water delivered to residents
- E. Coli up to 900 ppm
 - 126 ppm is unsafe



Oil Wells

- 48,000 gallons of oil leaked
- 43,000 gallons of produced water leaked
- 1,300 fracking wells flooded
 - Damage and contaminate leakage unknown



River Management - 2013 CO Flood

Damages Sources

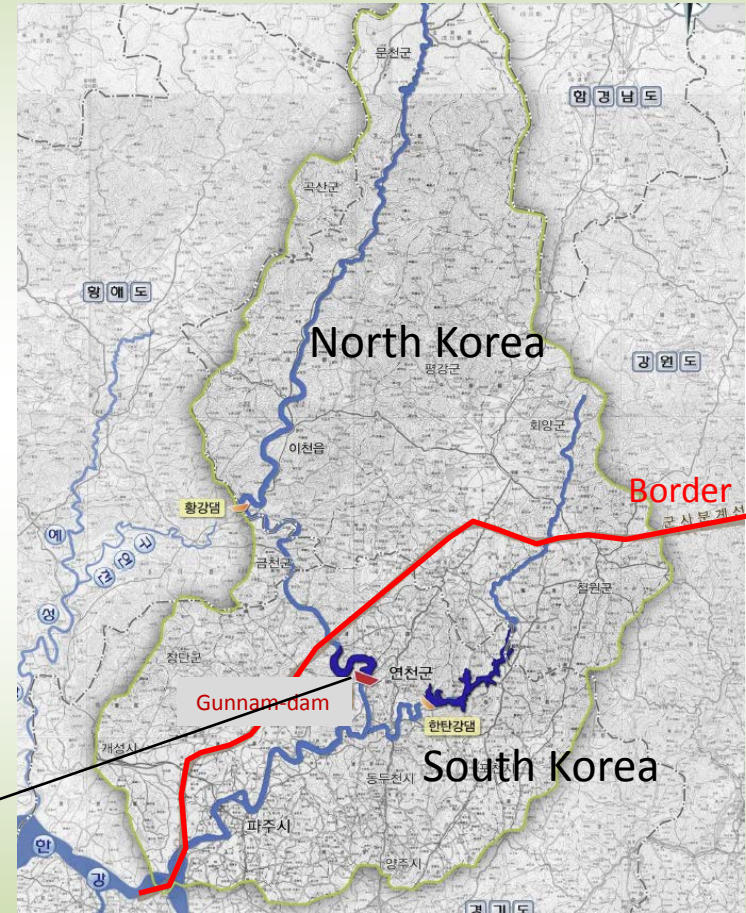
- <http://www.usatoday.com/>
- <http://www.cnn.com/>
- <http://www.dailycamera.com/>
- <http://www.9news.com/>
- Colorado State University
- <http://www.denverpost.com/>
- Colorado Oil and Gas Conservation Commission (COGCC)

Proposed Countermeasures

- Life & Property
 - Establishing warning system
 - Construction of new dam(s) in upper basin.
- Dam Failure Prevention
 - Increase spillway capacity.
- Lack of conveyance
 - Dredging riverbed in downstream.
 - Construction/improvement of levees.
- Sewage Lines
 - Adapt or improve the sewage line system.

Dam Construction in upper basin

- Dam construction in upper basin is the fundamental measure that can minimize the damage from flood.



Gunnam-dam for flood control in Imjin River in Korea (2011, www.MLTM.go.kr)

Increasing spillway capacity

- To respond to the intense rainfall, increasing the flood discharge capacity may be very important for existing dams.
- To avoid the worst scenario, like dam break, we can install an additional spillway.



Additional spillway of Imha dam in Korea (2010)

Dredging/Excavation of Riverbed

- Downstream dredging is one effective method to increase the flow capacity of a river by increasing the cross sectional flow area.



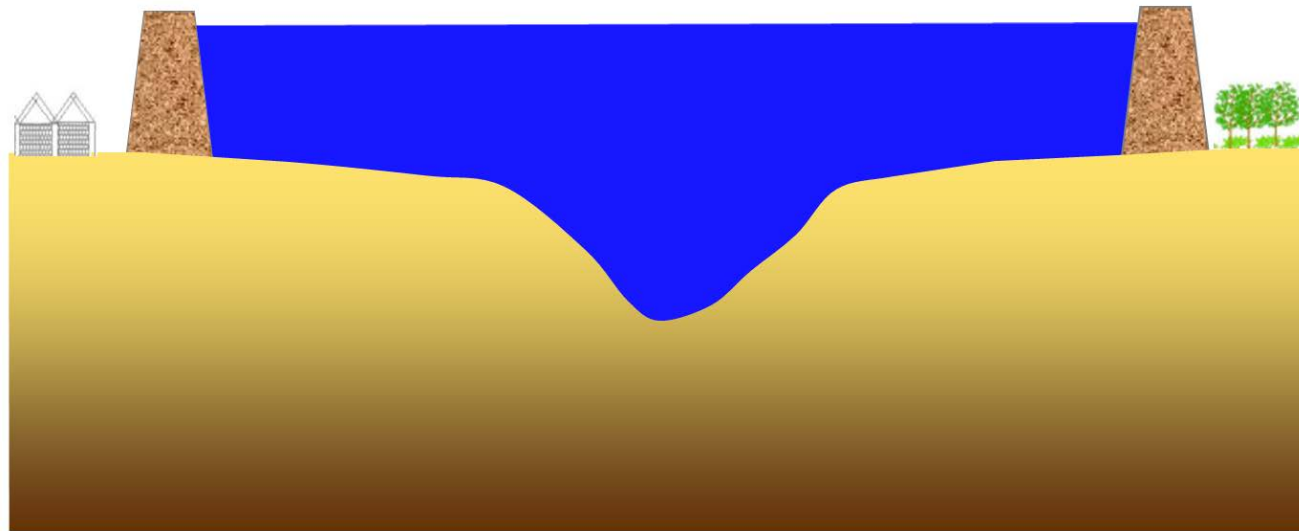
Dredging in Nakdong River in Korea
(2012, www.pressian.com)



Dredging in United Kingdom
(2014, www.telegraph.co.uk)

Levee Improvements

- Flood damage may be caused by overtopping of levees
- If levees are high enough to block the flood level, flood damages are decreased.



The Four Rivers Restoration Project (2012, Ministry of Land, Transport and Maritime affair)

Reinforcing revetment



Road erosion and failure
(2013, www.bizjournals.com)

- One way to prepare for flooding is reinforcing revetments using larger riprap.
- Concrete walls can also be effective as a retaining wall for roads adjacent to rivers.

Sewer Improvements

- Separate storm and sanitary sewers are better.
- Need to reduce stormwater inflow to sanitary sewers.
- For a combined sewer, we could protect the system with inlet plugs during a flood.

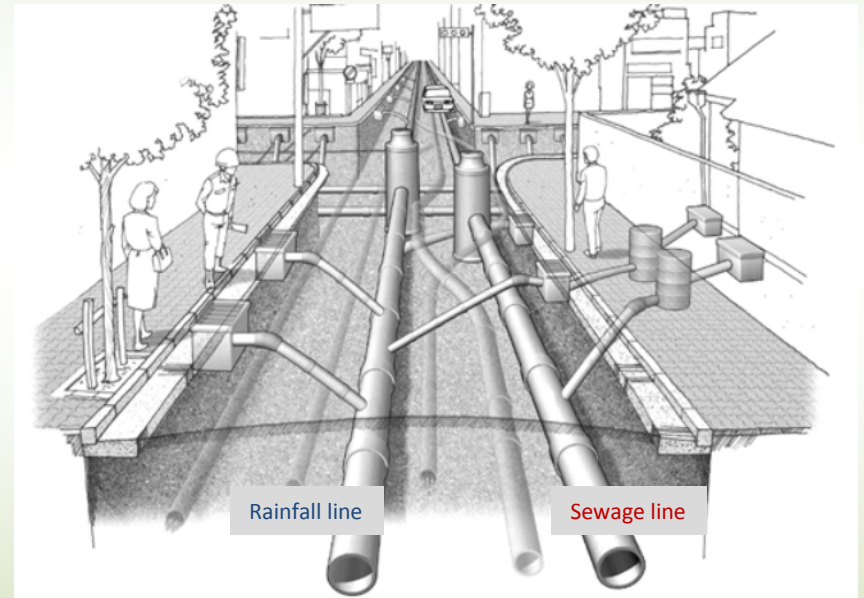


Diagram of rain drain pipe and sewage lines
(www.waterjournal.co.kr)

Socio-Economic Impacts

- Destroyed Infrastructure
- Displaced Residents/Workers/Jobs
- Direct damages to businesses
- Residential Damages
- Environmental Damages
- Recovery Money provides boost to economy
- Higher flood awareness
- Increase in flood insurance policies
- Overall damages may be >\$2B



Infrastructure Impacts

- Estimated \$475 M cost to repair roadways
- Cost of State Flood Operations: \$19.5M
- State funding available for community recovery: \$91.5M
- Federal Aid dispersed: \$246M
- Damage to irrigation ditches may lead to decreased agricultural productivity in 2014.
- River instabilities induced by flooding may continue to cause damages.

Displaced Residents/Workers

- Low availability of housing leads to higher prices. (e.g. Boulder houses for sale 40% of average number)
- Out of state construction crews arrive to help repair damages.
- Many business owners lost their livelihoods due to flood.

Residential Damages

- Many residents repairing minor flood damage.
- Construction materials suppliers increase sales.
- Auto Repair shops handled additional business to repair flood damaged cars.



Rocky Mountain National Park

- 73% decrease in Park visitation in Oct. 2013
- Flood combined with Gov't shutdown cost the park \$10.9M in lost revenue in 16 days.
- Continued closure of some trails into summer 2014 and Fall River Road closed through 2014 could lead to continued decline in visitation.
- Decreased visitation means less funds to improve the park and repair flood damages.

Small Communities

- Estes Park economy hit hard
 - Large decrease in sales tax revenue (~30%)
- Jamestown – 20% of homes, 50% of roads and both bridges gone. Rebuilding.
- Drake, Glenn Haven – future uncertain



Large Communities

- Boulder had \$49M of damages to parks/infrastructure
- Classes cancelled at CU-Boulder, Facilities damaged
- Loveland water supply pipes damaged, City attempting to restore, otherwise water shortages may occur.
- Longmont spending millions on flood recovery and improvements.



Street in Boulder, CO



Socio-Economic Impact Sources

- www.nps.gov/romo
- www.denverpost.com
- www.Jamestownco.org
- www.Nbcnews.com
- www.msn.com
- <http://www.dailycamera.com>
- www.Huffingtonpost.com



CASE STUDY: U.S. HIGHWAY 34 – BIG THOMPSON CANYON

Damages, Countermeasures, and Socio-Economic Impacts

18 miles of US HWY 34 was damaged.



- 85 % was a total loss
- Including 25 bridges
- Big Thompson River retaining wall

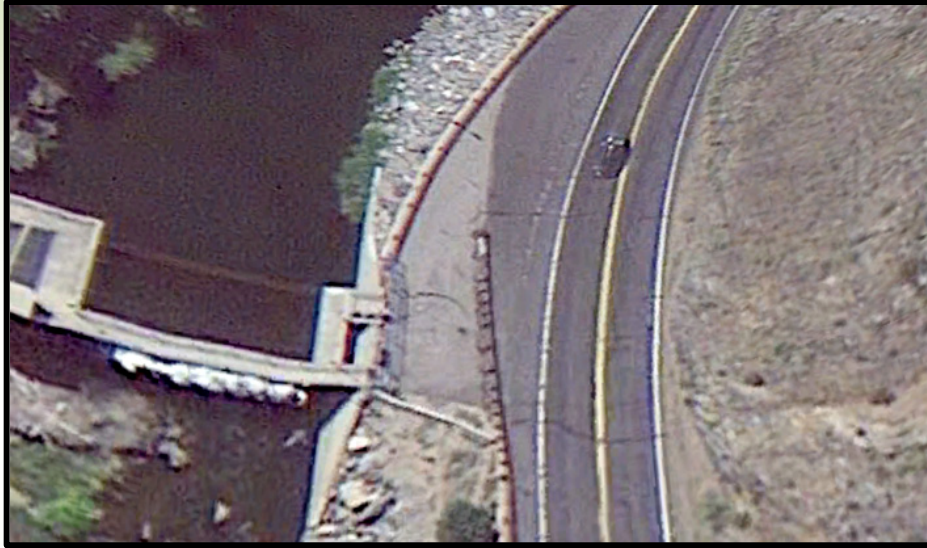
HWY 34 is the primary route connecting Northern Front Range to Estes Park.



- Built in 1926
- Avg. Daily Traffic: 13,000 vehicles
- Major Tourist Artery
- 2 Lanes
- Follows the Big Thompson River



Before & After Photos 6 miles east of Drake, CO



HWY 34 was reopened on Nov. 21st, 2013.

- Kiewit Construction
 - 160 personnel
 - 70 pieces of equipment
- Temporary Fix
 - Narrow lanes
 - Limited shoulders
 - Reduced speed limits
- Permanent improvements in next 3 years



Multiple road closures isolated Estes Park at the busiest time of the year.



- If visitors decline 70%:
 - 1,000 jobs lost
 - \$90 million in spending
 - \$10.2 million in state and local taxes
- 43% of jobs directly related to tourism (65% of sales tax)

Case Study Sources

- www.denverpost.com
- www.bloomberg.com/news
- www.Denver.cbslocal.com/
- <http://www.coloradodot.info/projects/floodrelatedprojects/>
- www.thedenverchannel.com/news
- www.coloradoan.com