The Asia-Pacific Economic Cooperation [APEC] CLIMATE SYMPOSIUM November 2-4, 2015.

Vulnerability assessment of precipitation extremes

Eylon Shamir, Ph.D. Eshamir@hrcwater.org

Collaborators:

Konstantine P. Georgakakos Sc.D. & Theresa Modrick Ph.D.

Hydrologic Research Center, San Diego, California, U.S.A.

www.hrcwater.org

Hydrologic Research Center, San Diego California, U.S.A.

Established in 1993 as a nonprofit research, technology transfer, and training organization.
HRC's objectives are to help bridge gaps between scientific research in hydrology and applications for the solution of important societal problems that involve water.

HRC

www.hrcwater.org

Presentation Outline

Extreme events with extreme impact

- **Analysis of the very extreme (un-observed) events and their water resources impacts: an example from the Panama Canal watershed**

Non extreme events with extreme impact

- **Analysis of frequently occurring events with extreme impact: Climate change assessment of flash flood frequency in Southern California**

Panama Canal Watershed

KONSTANTINE P. GEORGAKAKOS, EYLON SHAMIR, AND CRIS SPENCER

Hydrologic Research Center

in collaboration with

FORREST M. HOLLY, JR (CONSULTANT)

and

JORGE ESPINOSA, ABELARDO BAL AND MICHAEL HART

Water Resources Section, Water Division, Panama Canal Authority

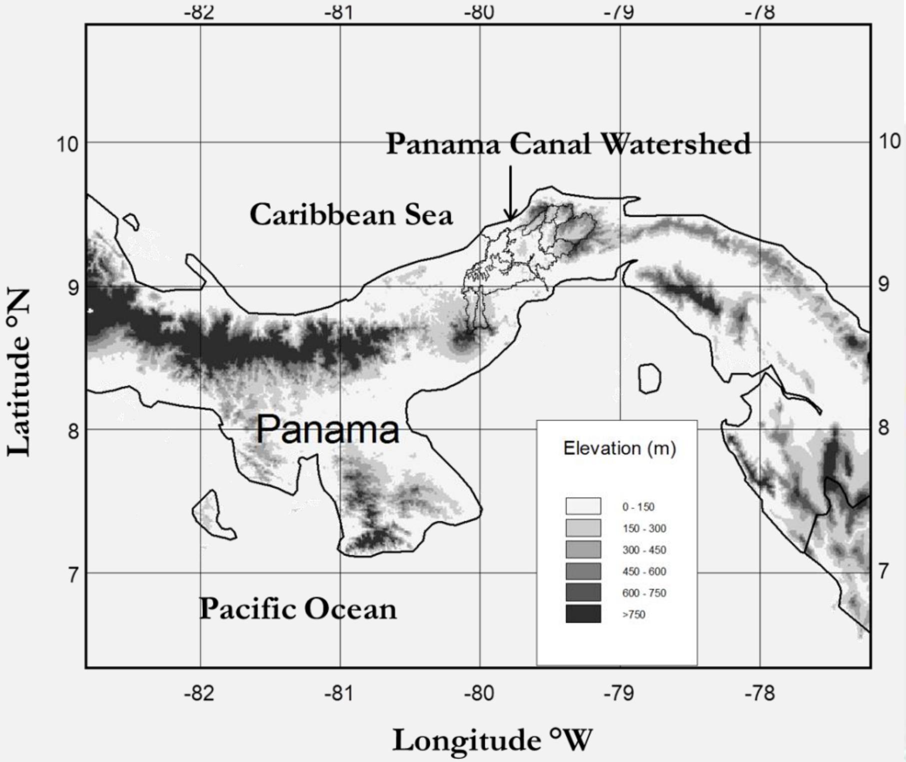
Sponsored by Panama Canal Authority, Water Division, Water Resources Section

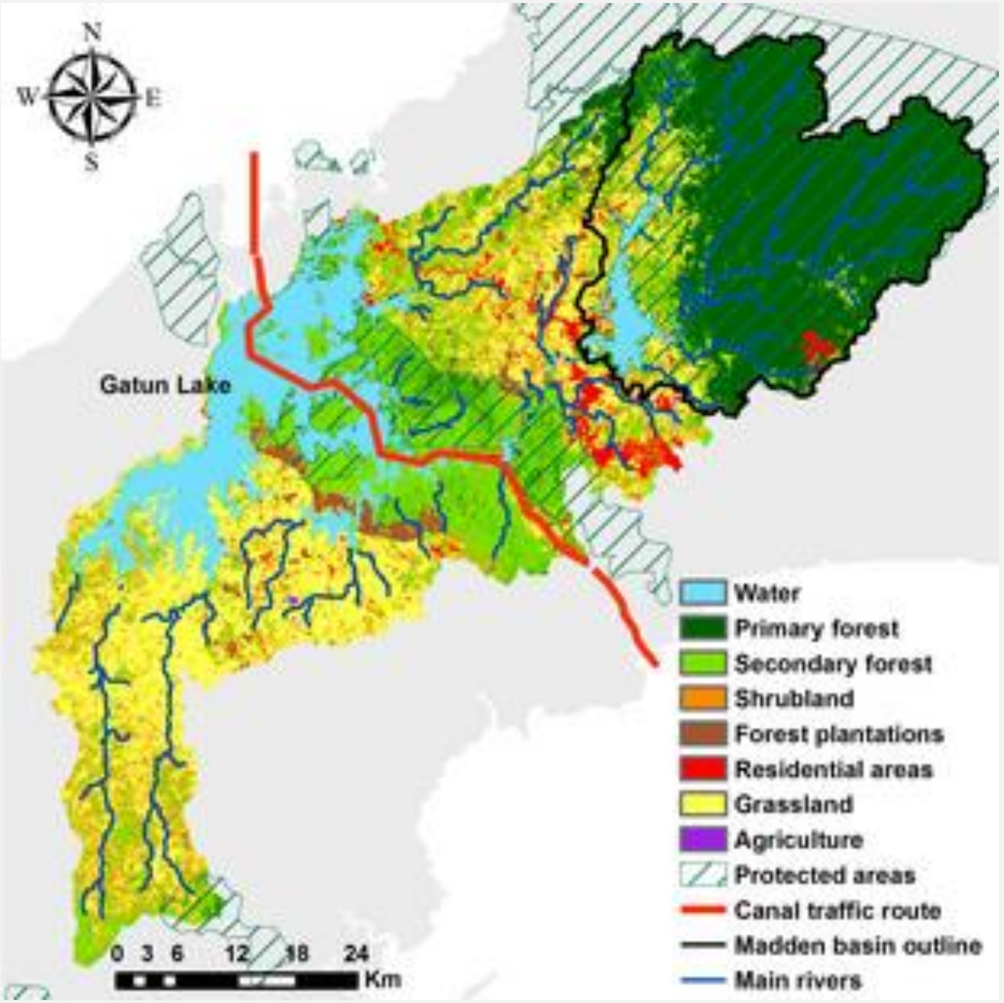
(Award Nos. CDO227937FGP, CDO233632EAP and DPO246911EAP)

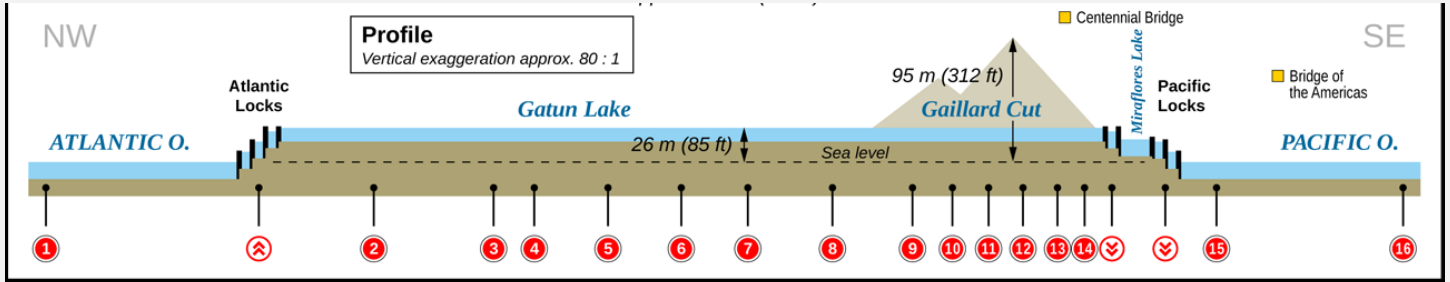
Study Objectives: Estimate very low frequency rainfall events and assess their impact and potential damage on the canal operation.

Panama Canal Watershed

[~3,300 km2]



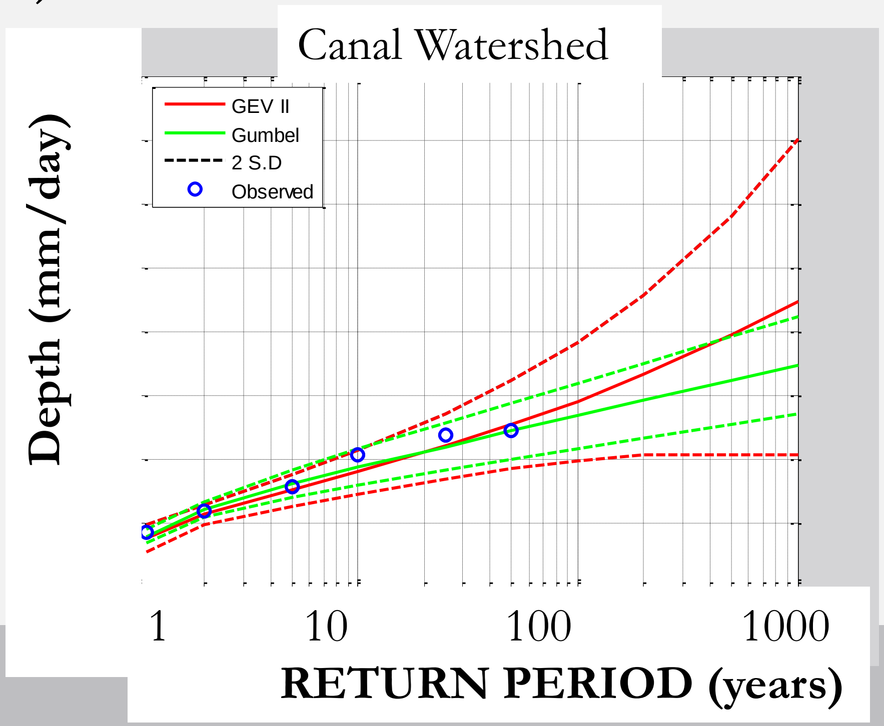




The idea of predicting events with a magnitude that is not yet observed

Steps:

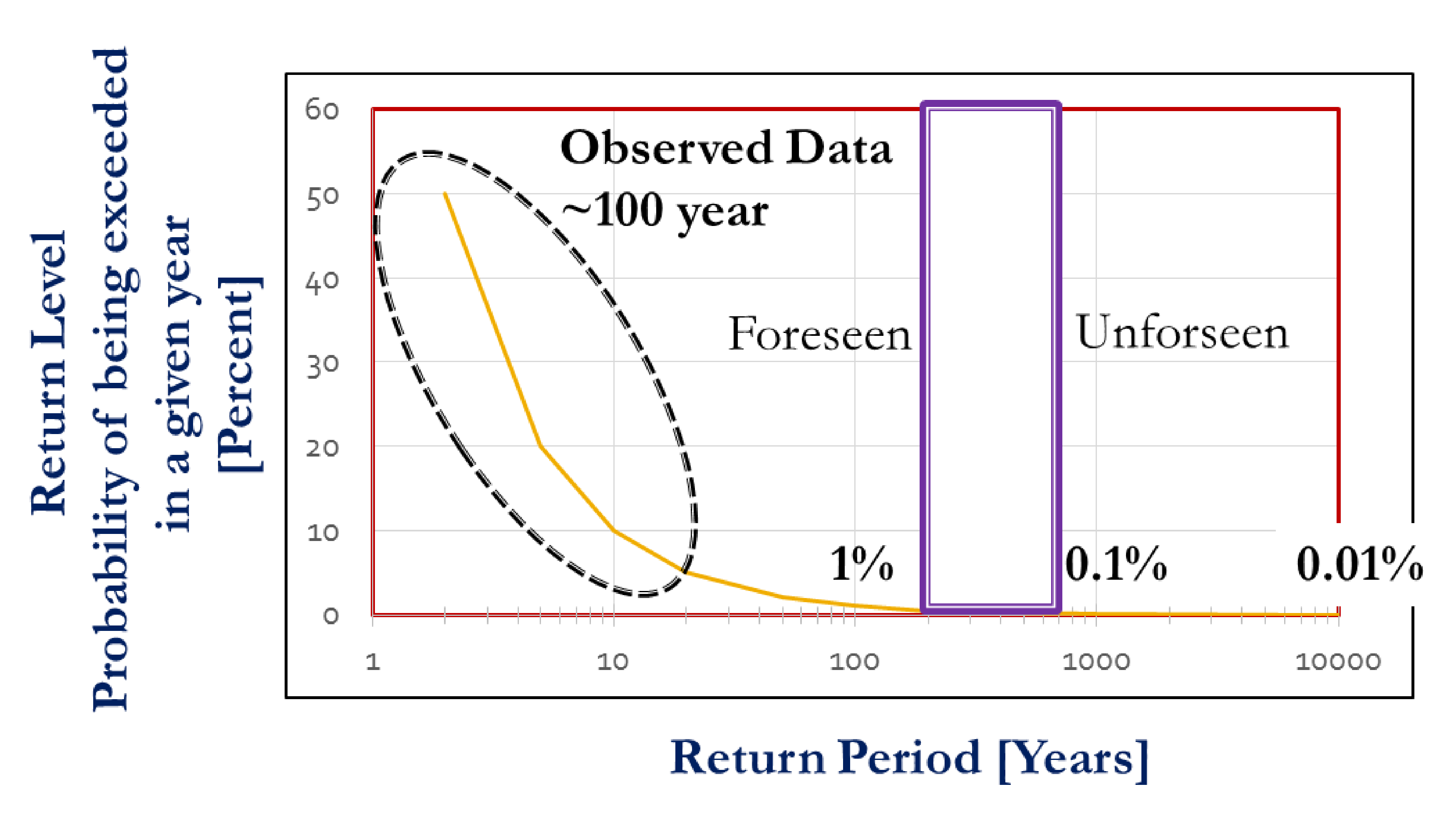
- Analysis of the observed record
- Fitting an extreme value distribution (e.g. GEV)
- Assess the tail of the distribution



Augmenting the observed record:

- Paleo-climatic flood records
- Stochastic weather generator to simulate likely to occur events
- Simulating events that occurred in similar setting and/or neighboring watersheds
- Simulating possible synoptic conditions that may lead to extreme events

Rare but probable [Foreseen] versus Unforeseen Events



Likely extreme rainfall Event

↓

Stream inflow into Gatun Lake

↓

Lake Gatun level

↓

Economic analysis of Expected damage

Risk-Based Analysis of Spillway Capacity Alternatives for the Gatun Lake in Panama

Konstantine P. Georgakakos, Eylon Shamir, and Cris Spencer

Hydrologic Research Center, San Diego, CA 92130

in collaboration with

Forrest M. Holly, Jr (Consultant)

and

Jorge Espinosa and Abelardo Bal

Water Resources Section, Water Division, Panama Canal Authority

Sponsored by Panama Canal Authority, Water Division, Water Resources Section

(Award Nos. CDO227937FGP and CDO233632EAP)

HRC Limited Distribution Report No. 33

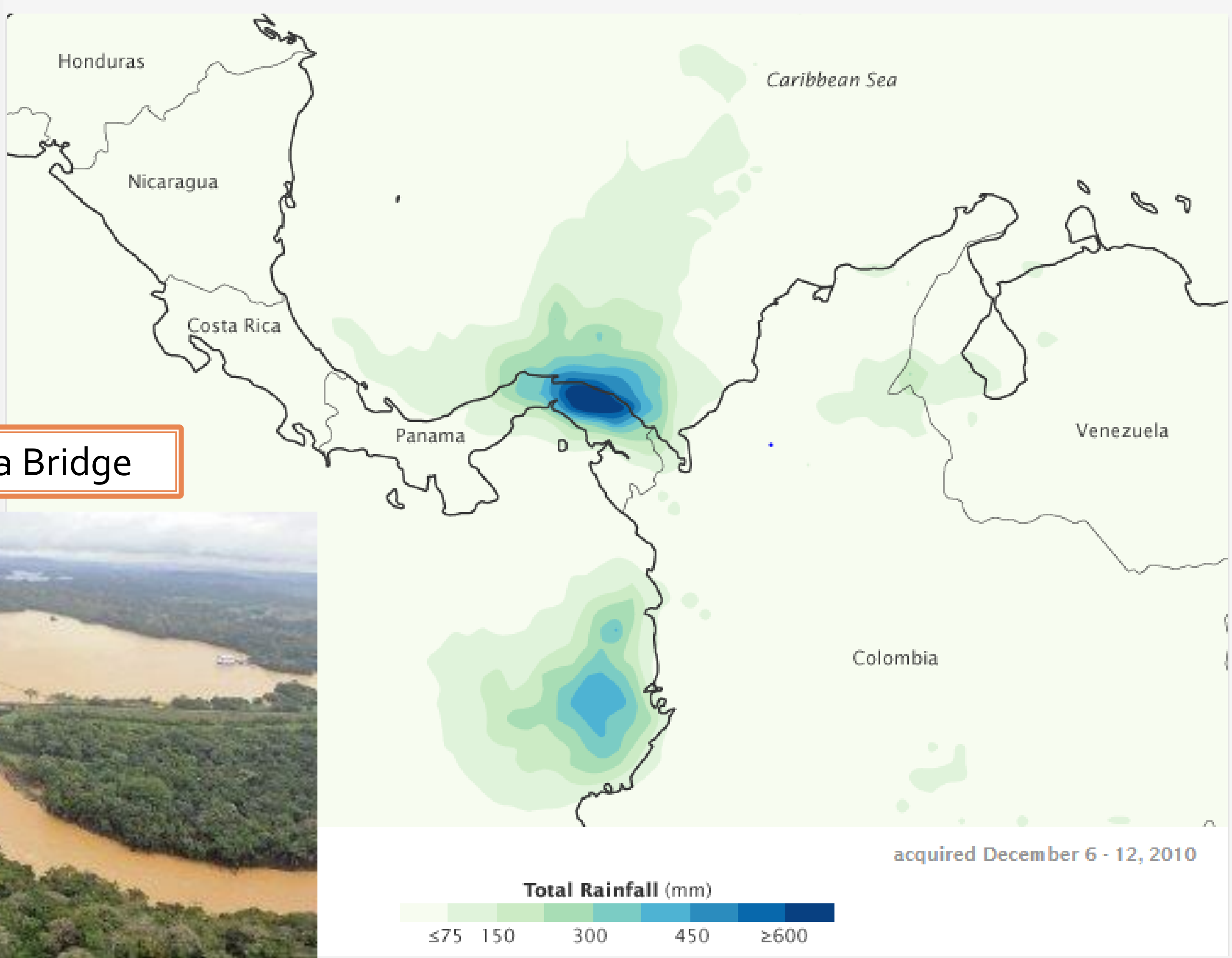
Hydrologic Research Center

12780 High Bluff Drive, Suite 250, San Diego, CA 92130, USA

20 October 2010

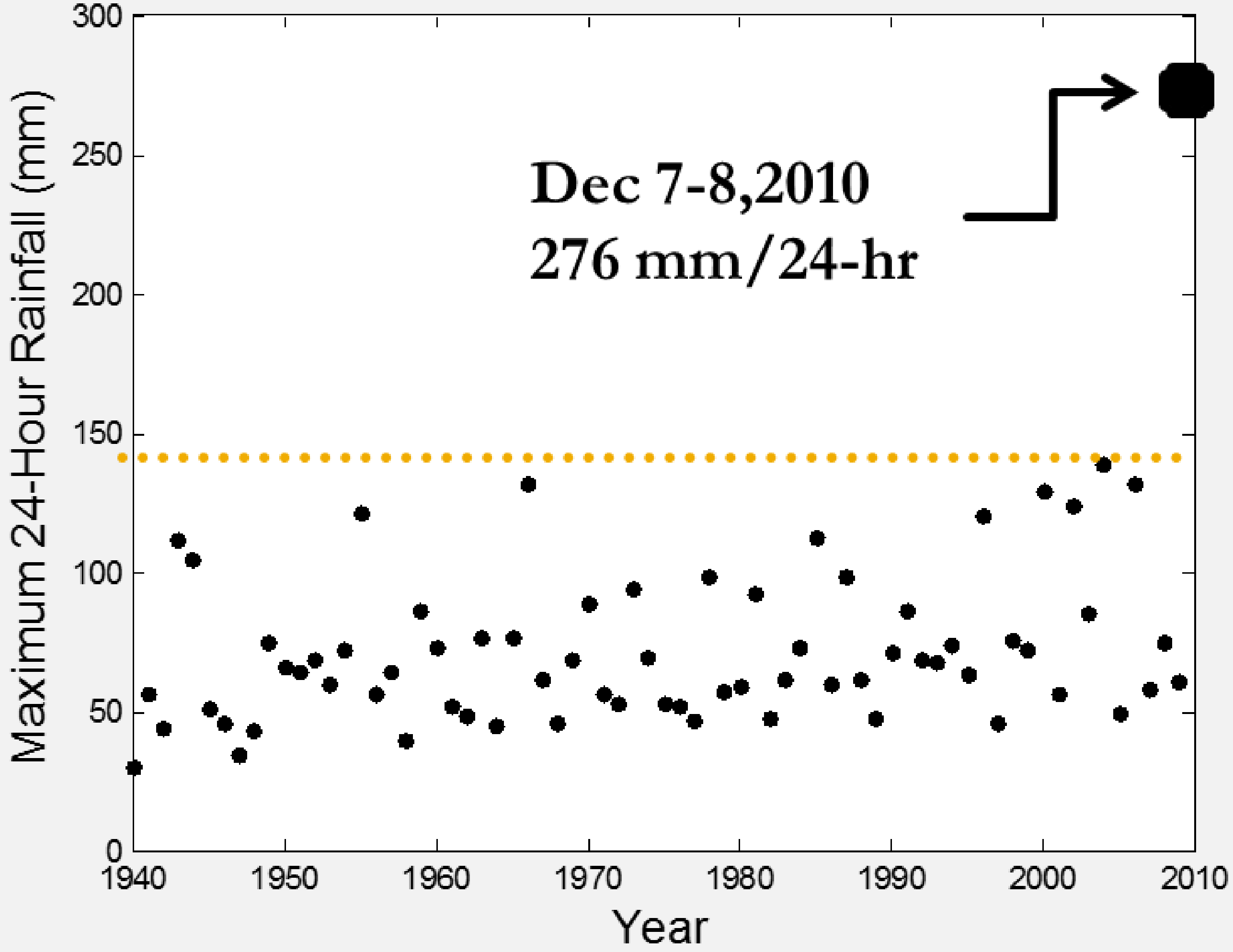
December 6-12, 2010

NASA Tropical Rainfall Measuring Mission [TRMM]

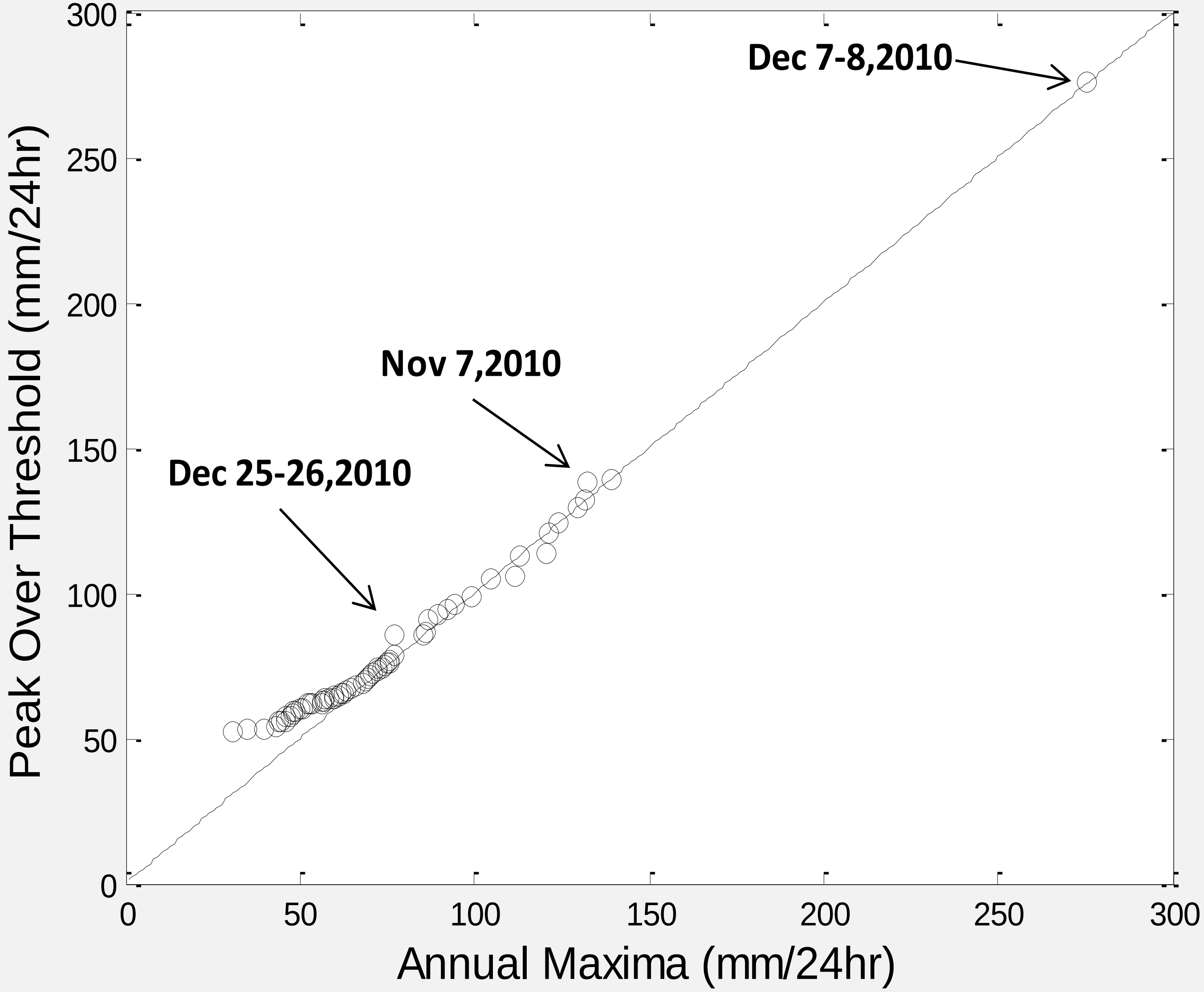


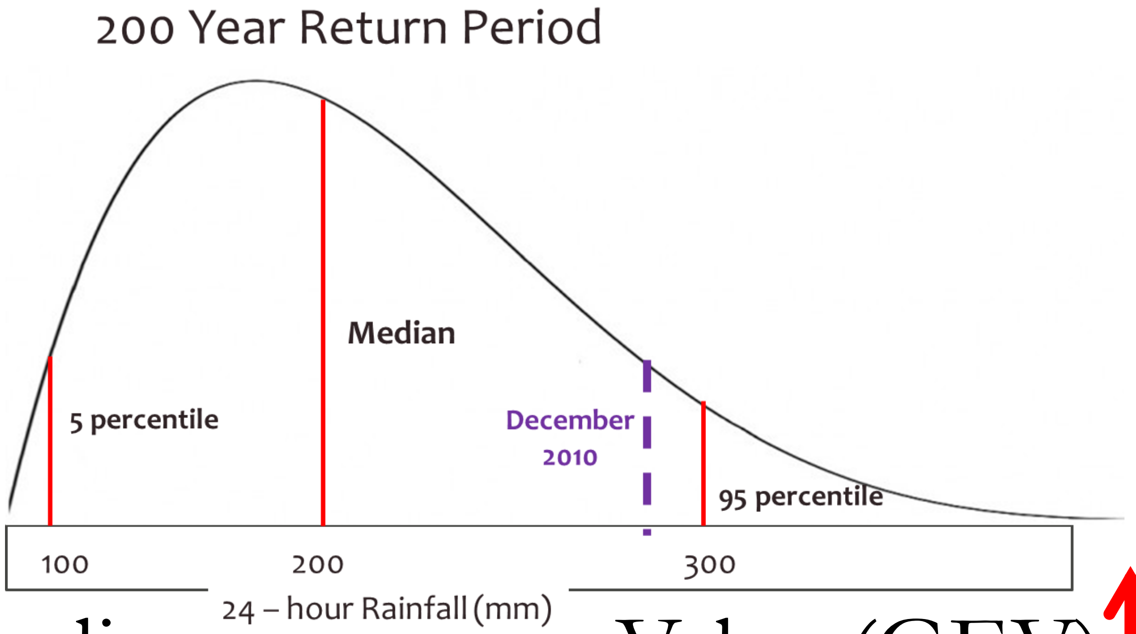
Madden Lake Gamboa Bridge

Annual Maxima Series
24 –Hour Mean Areal Rainfall over the Canal Watershed

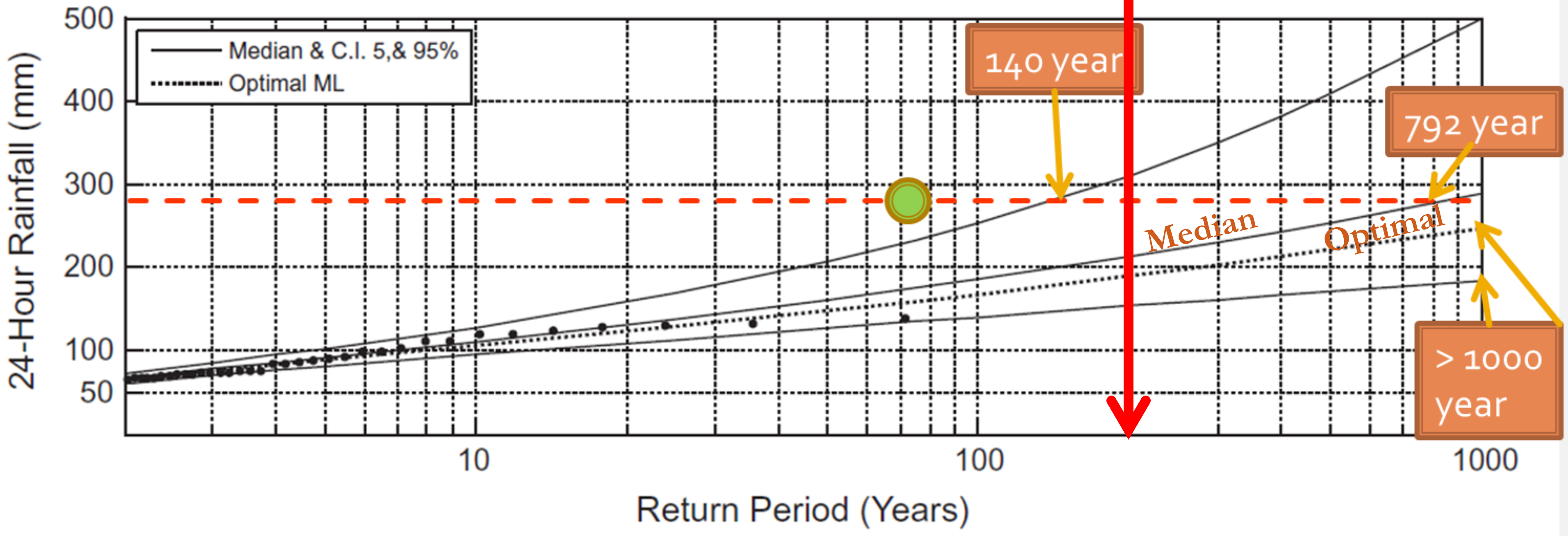


Peak over Threshold





Generalized Extreme Value (GEV) Distribution

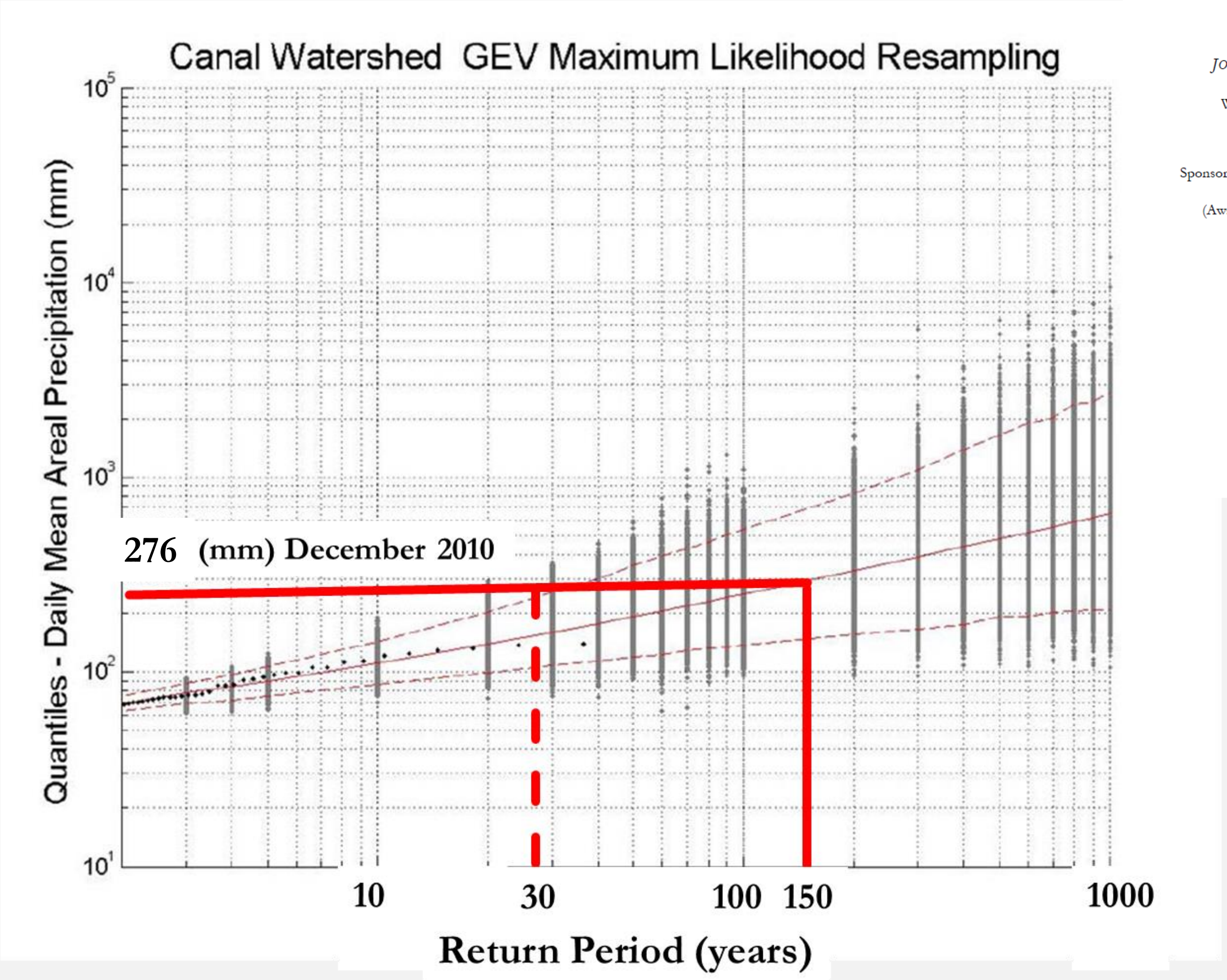


Daily rainfall over the Canal Watershed

7-8 December, 2010	276 mm
Max. Previously Observed [1908-2007]	124 mm
Max. Stochastic Weather Generator Model	315 mm
Maximum Probable Precipitation [PMP]	130 mm
Max. Atmospheric model (e.g. WRF) Weather Simulations (1 out of 20)	326 mm

Wang , Shamir, and Georgakakos, 2007

The Revised Risk Study



RISK-BASED ANALYSIS OF GATUN SPILLWAY CAPACITY AFTER THE EXTREME RAINFALL OF YEAR 2010

KONSTANTINE P. GEORGAKAKOS, EYLON SHAMIR, AND CRIS SPENCER

Hydrologic Research Center

in collaboration with

FORREST M. HOLLY, JR (CONSULTANT)

and

JORGE ESPINOSA, ABELARDO BAL AND MICHAEL HART

Water Resources Section, Water Division, Panama Canal Authority

Sponsored by Panama Canal Authority, Water Division, Water Resources Section

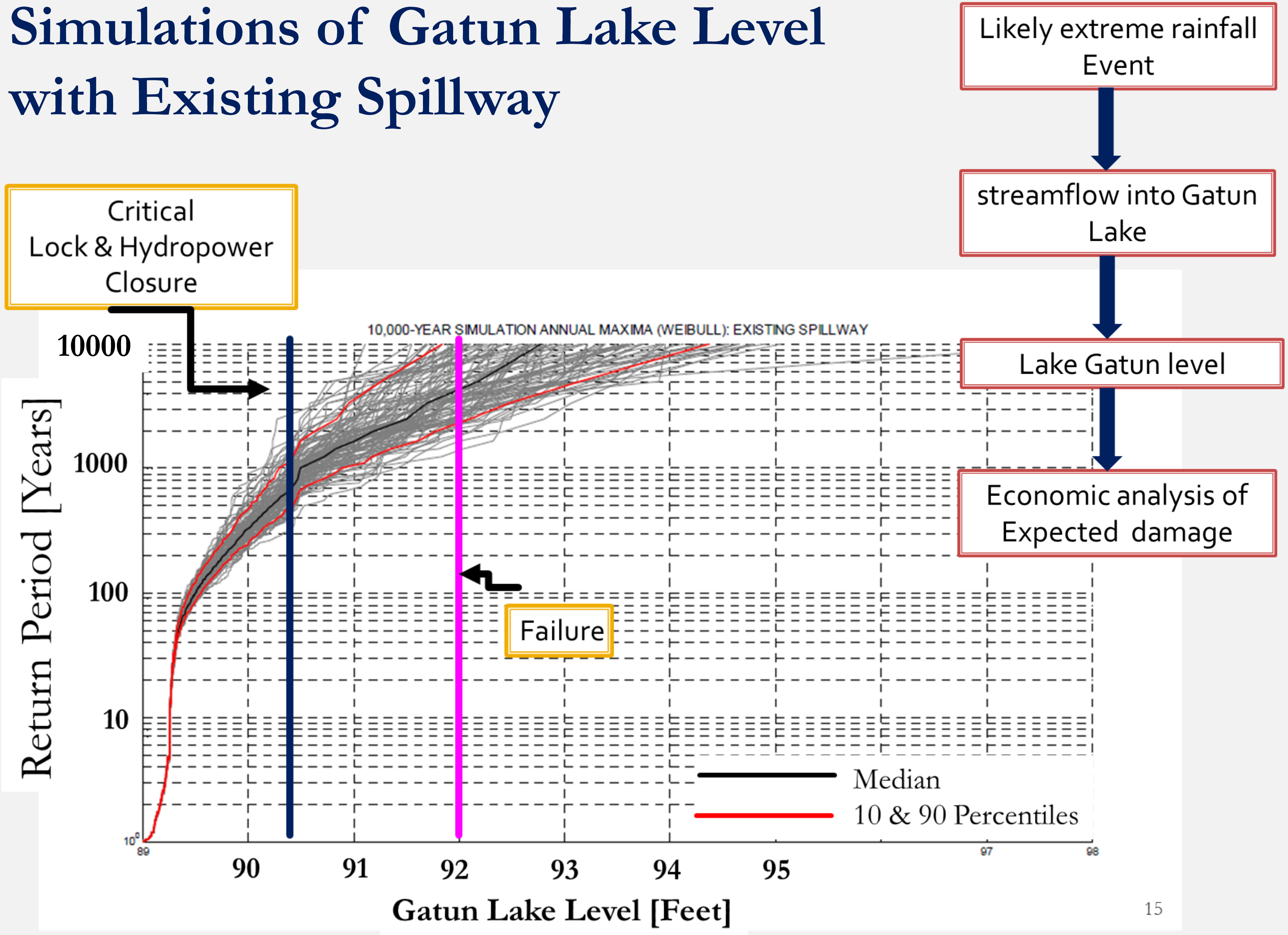
(Award Nos. CDO227937FGP, CDO233632EAP and DPO246911EAP)

HRC LIMITED DISTRIBUTION REPORT NO. 36

Hydrologic Research Center
12555 High Bluff Drive, Suite 255, San Diego, CA 92130, USA

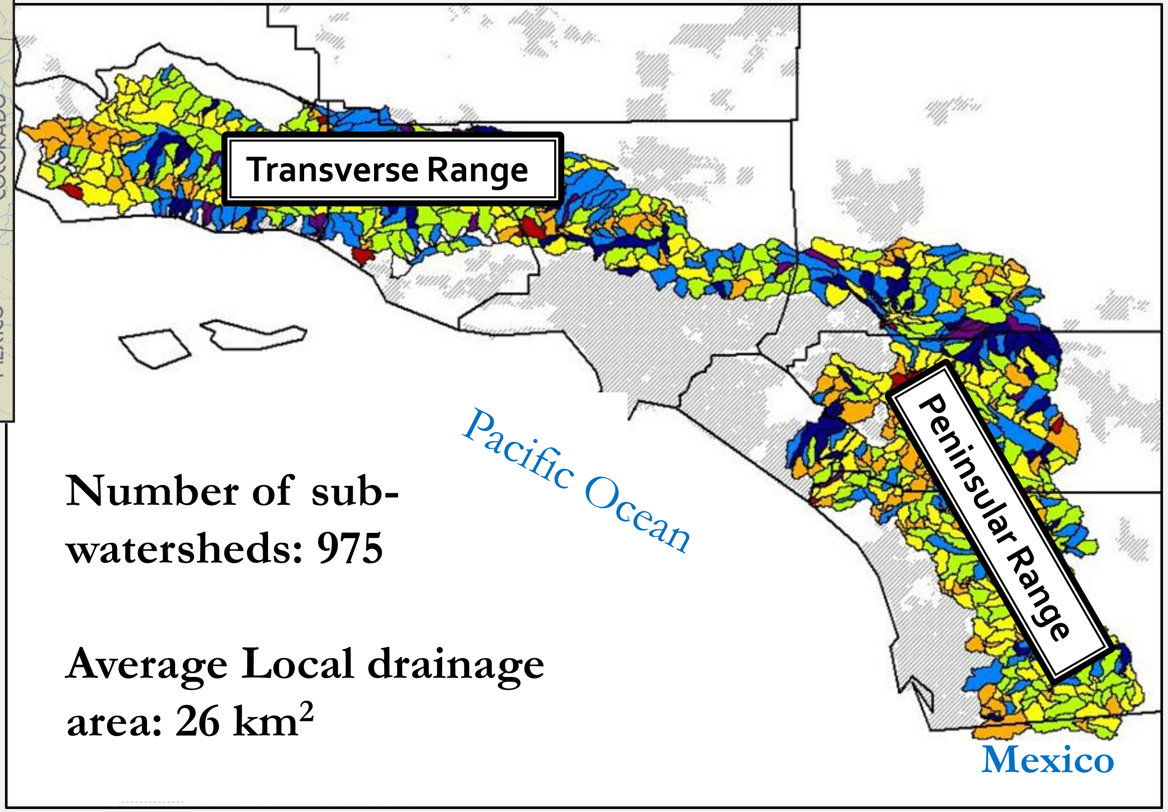
29 August 2011

Simulations of Gatun Lake Level with Existing Spillway



Climate Change assessment on Flash Flood Frequency In Southern California

Dr. T. Modrick (UCSD/Scripps Ph.D. Dissertation)



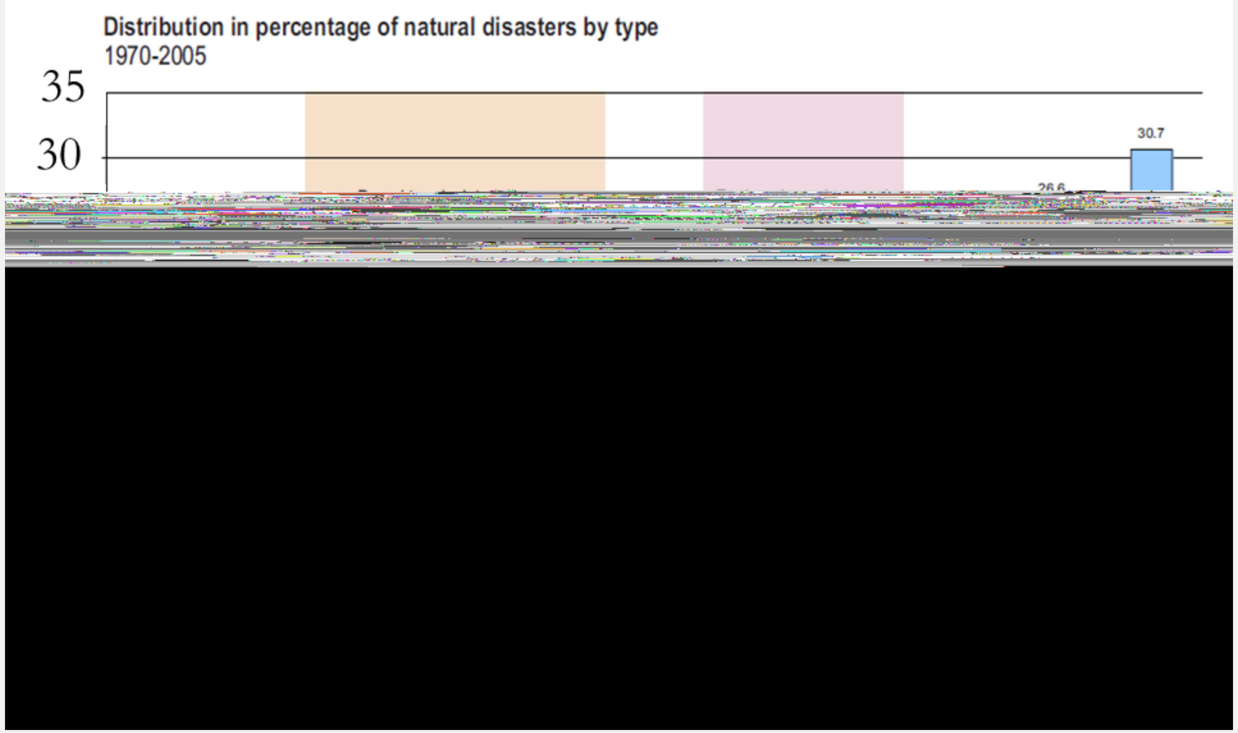
http://www.hrc-lab.org/projects/projectpdfs/HRC%20Technical%20Report%20No%208.pdf

Flash Floods

“Recent findings of the WMO (2008) country-level survey where of the 139 countries, 105 indicated that *flash floods were among the top two most important hazards around the world and require special attention”*

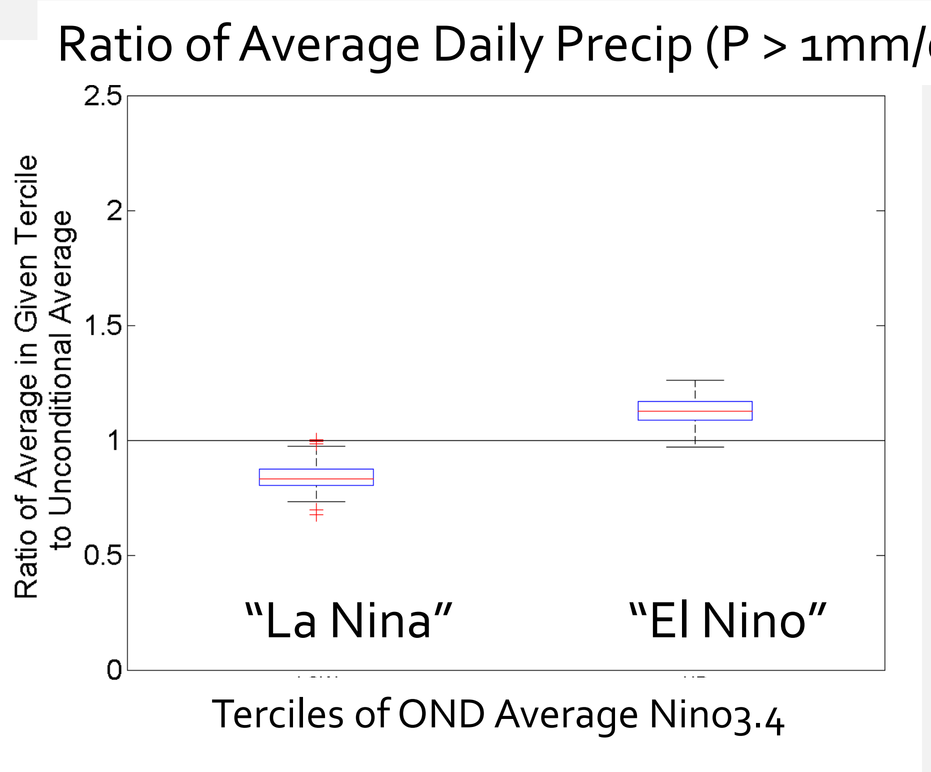
“On the average, these events kill more people worldwide than any other natural disaster – in an average year, flash floods kill over 5,000 unsuspecting people and cause millions of dollars of property damage

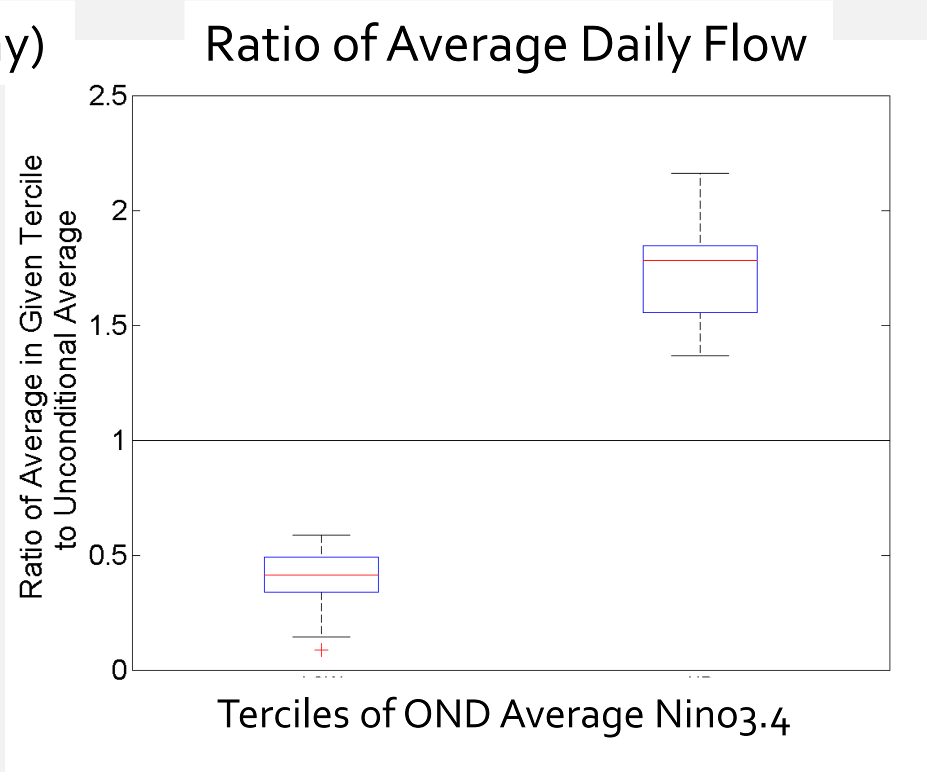
U.N. International Strategy for Disaster Reduction



Large-Scale/Climate Influences

Station Precipitation, Streamflow Conditioned on "El Nino"

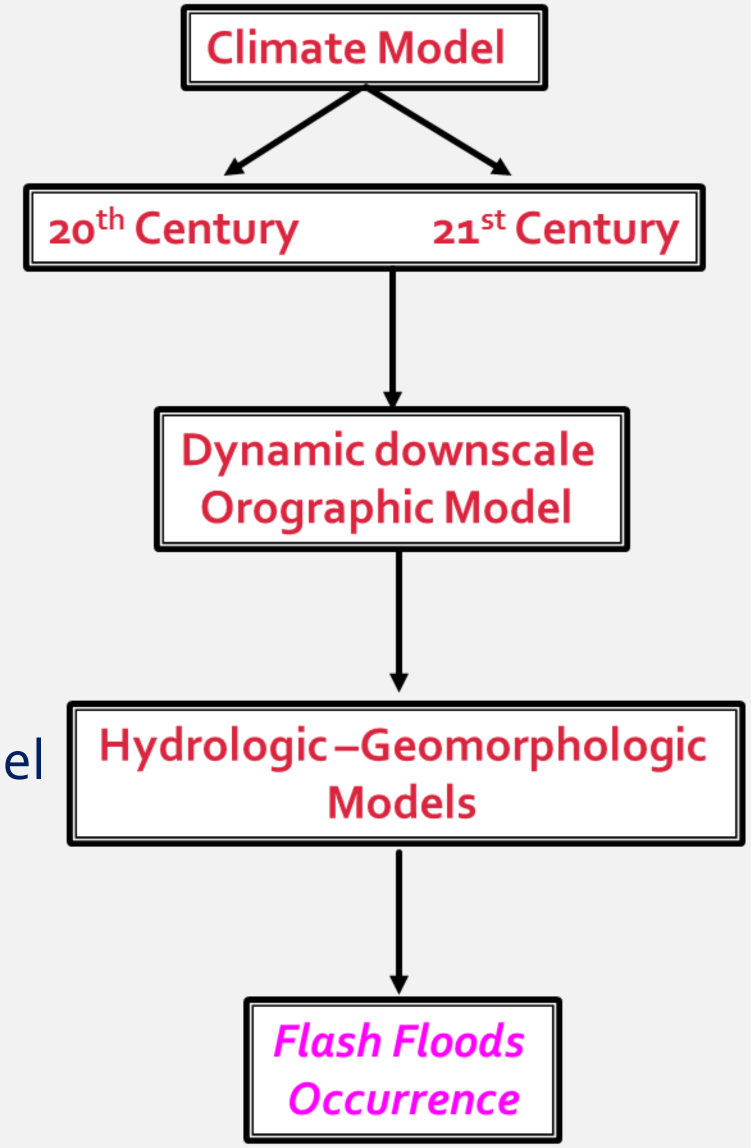




Increase in Precipitation and Streamflow during "El Nino–favorable" conditions

Climate Change Scenario Input

- CCSM3 climate model for "control" and "A1B" climate change scenarios
- Define two periods:
  - 20th Century (control, 1970-1999)
  - 21st Century (A1B, 2070-2099)
- CCSM3 model output provides input to Simplified Orographic Precipitation model
- Hydrology and geomorphology models remain the same.

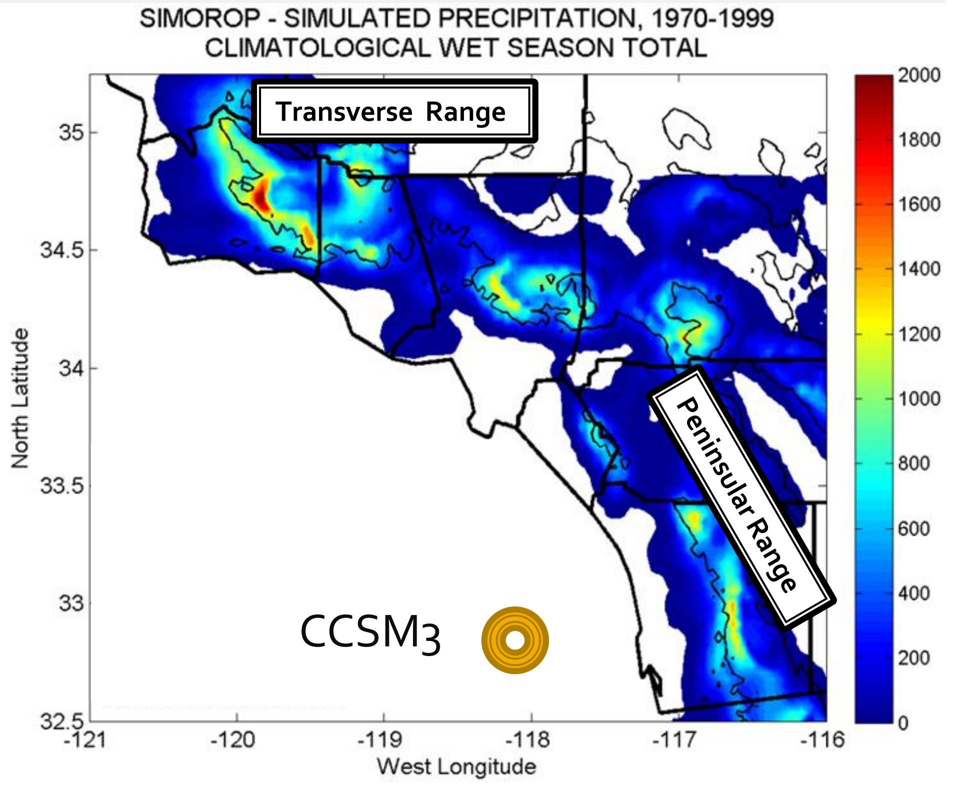


Simulated Precipitation Differences

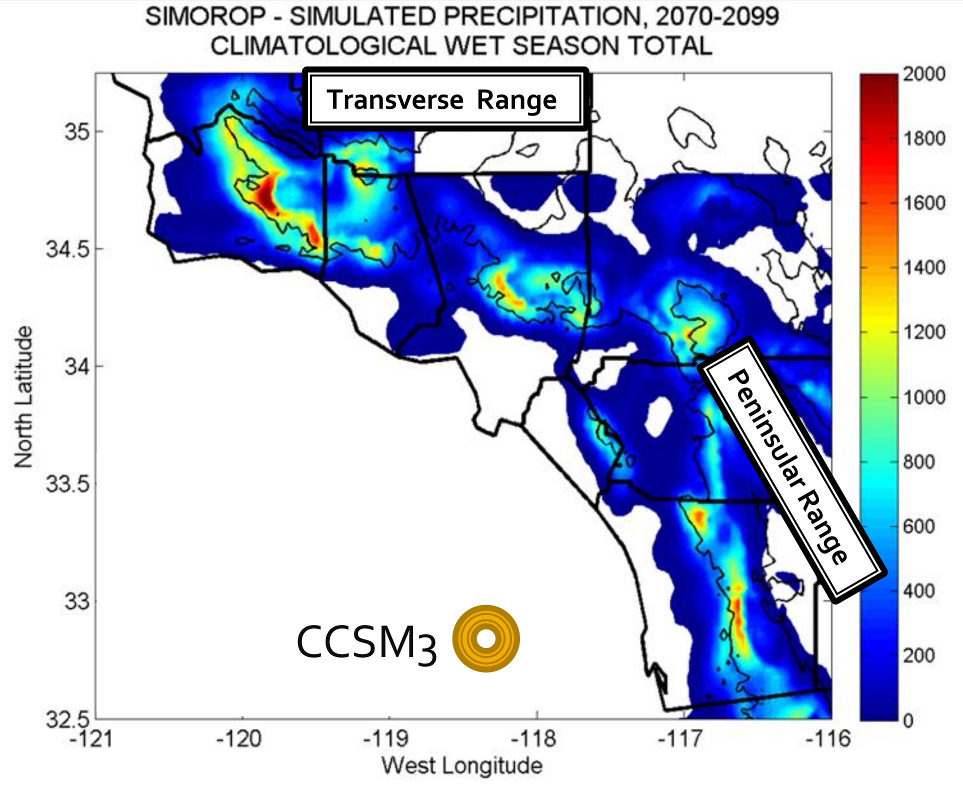
Wet Season (October – April) Total Climatology

CCSM3 IPCC-SRES A1B Scenario – Middle of the road emission scenario.

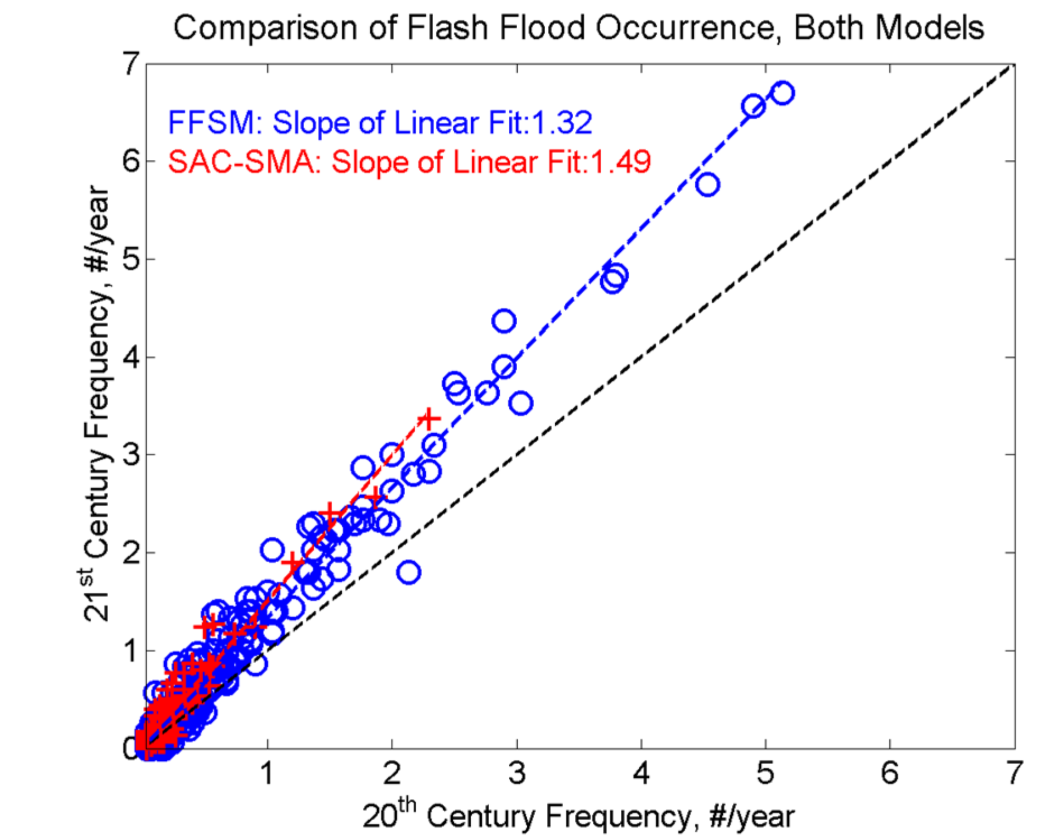
End of 20th Century



End of 21st Century



Change in Flash Flood Occurrence Frequency



Increase flash flood frequency at the end of the 21st century.

The cause of projected changes:

- **Increase in rainfall magnitude**
- **Increase in event duration**
- **Decrease in number of events**

Take Home messages

- **Prediction of extreme events with extreme impact MUST consider uncertainty bounds**

- **Climate change impact on the frequency of flash floods occurrence has to consider properties that dominate the local hydrologic processes.**

THANKS !!!

Eylon Shamir, Ph.D. Eshamir@hrcwater.org

Hydrologic Research Center, San Diego, California, U.S.A.

www.hrcwater.org