

# Central Valley Flood Protection Plan Risk Analysis Update

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# Overview

- Background
- Risk Analysis Overview
- 2017 CVFPP Update Risk Analysis
- 2022 CVFPP Update Risk Analysis
- Questions



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# BACKGROUND

# Authorization

## 2008 Central Valley Flood Protection Act

*(Water Code Sections 9600-9625)*

- Mandated adoption of a Central Valley Flood Protection Plan, to be updated every five years (*Water Code Section 9612*)
- Identified requirements for evaluating flood system conditions and performance (*Water Code Section 9614*)



# Supporting the CVFPP

**CVFPP Primary Goal**  
Improve Flood Risk Management

CVFPP Supporting Goals

Improve  
Operations &  
Maintenance

Promote  
Ecosystem  
Functions

Improve  
Institutional  
Support

Promote  
Multi-Benefit  
Projects



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# Building Upon Foundational Work

## 2012 & 2017 CVFPP Technical Analyses

- Provided technical justification for the State Systemwide Investment Approach (SSIA)
- Advanced methods for consideration of life safety benefits of the CVFPP
- Updates reflect changes to flood risk over time



# **RISK ANALYSIS OVERVIEW**



*"I think you should be more explicit in your explanation of this step."*

(Adapted from a cartoon by Sidney Harris, Science 80, Nov/Dec 1979)

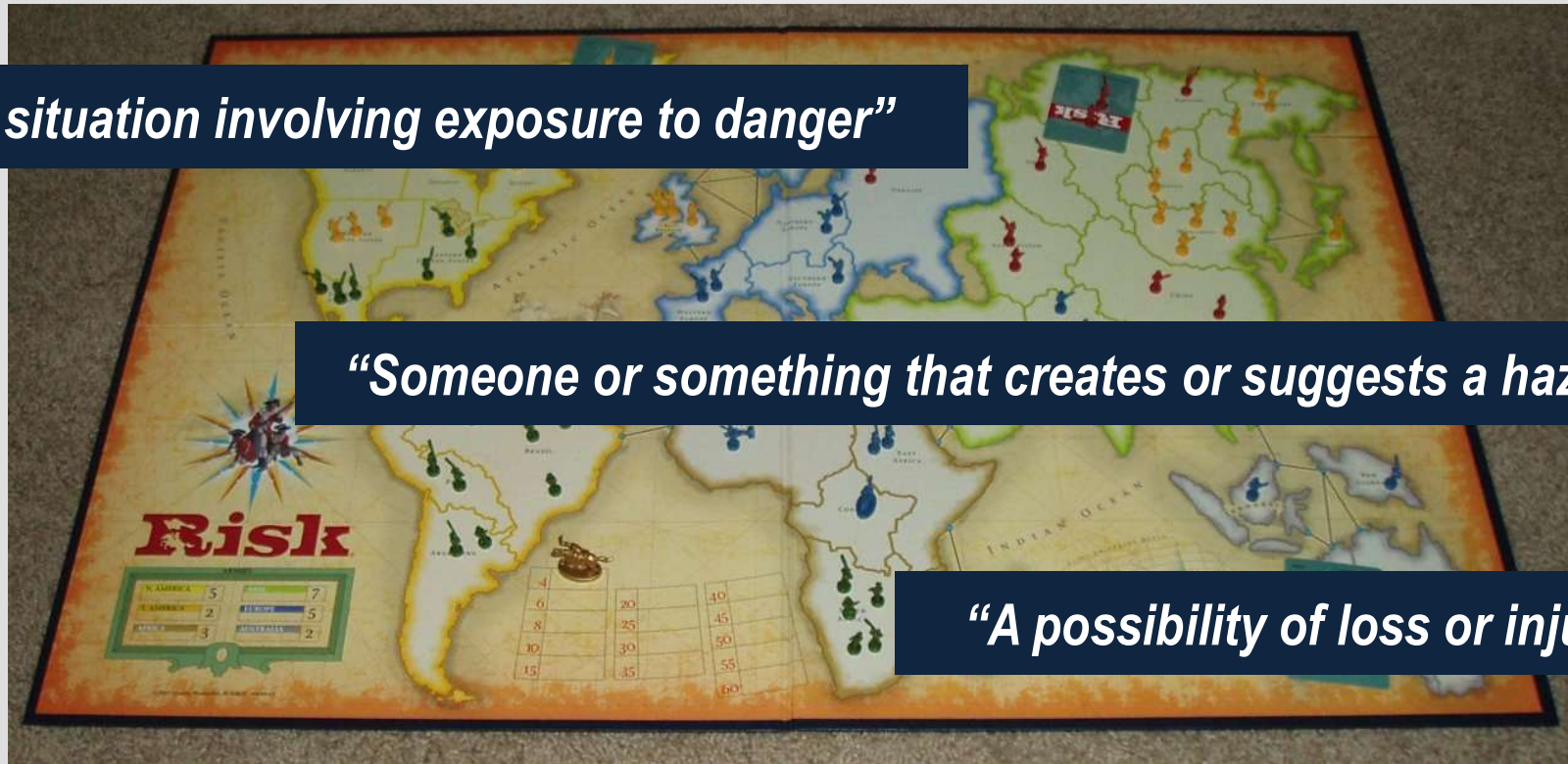


# What is Risk? Something bad could happen.

*“A situation involving exposure to danger”*

*“Someone or something that creates or suggests a hazard”*

*“A possibility of loss or injury”*



# Risk Analysis is...

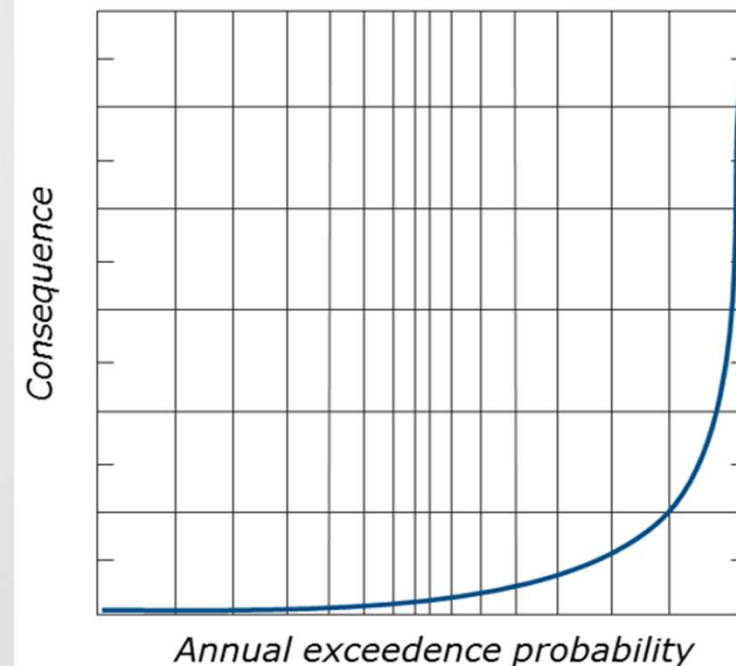
... Asking and Answering.

- What can go wrong?
- How can it happen?
- What is the likelihood?
- What are the consequences?
- What can be done about it?

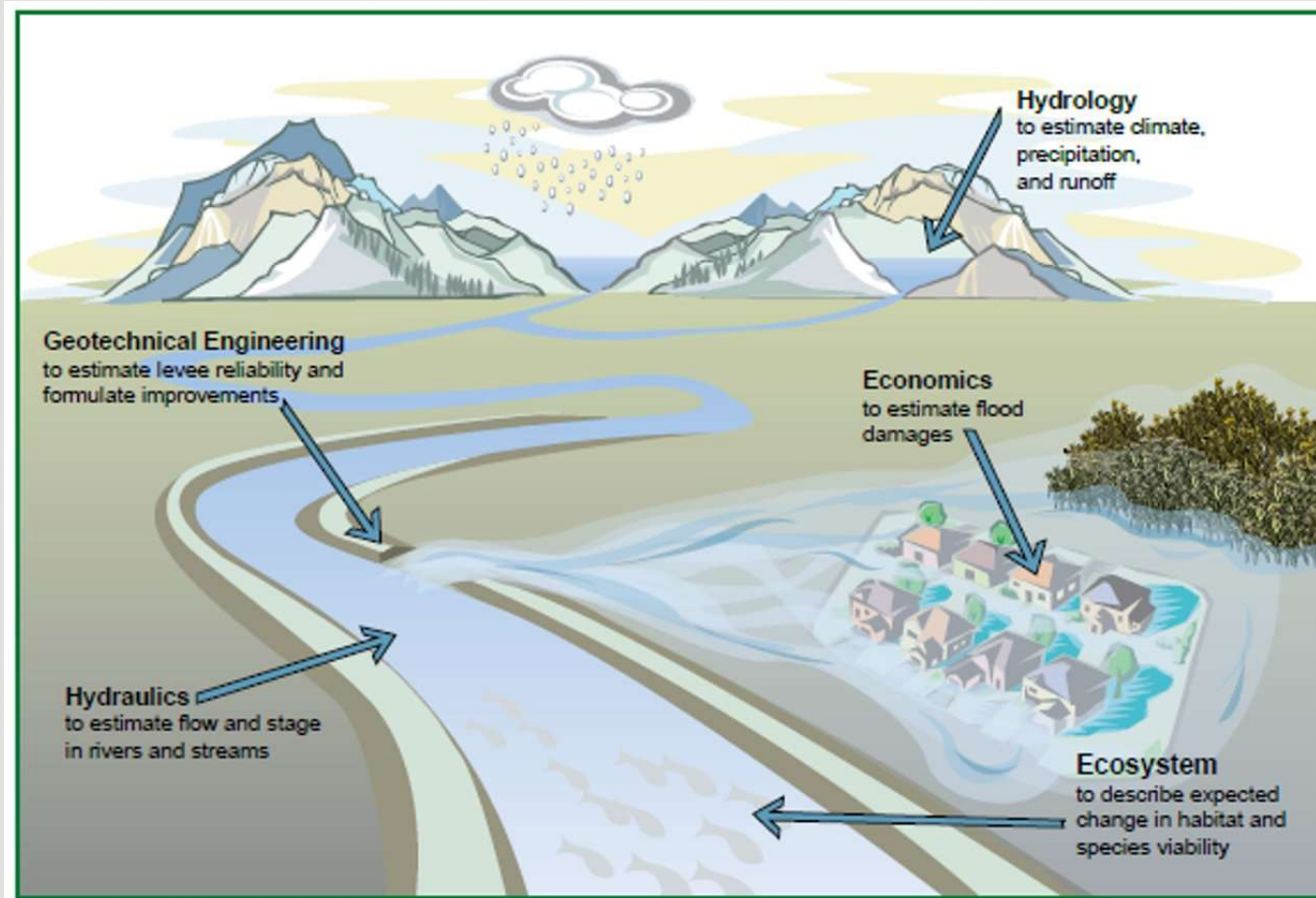
***Risk = Consequence and Exceedance Probability***



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# Components of Flood Risk Assessment



# Components of Flood Risk Analysis



# Risk Analysis Requirements and Guidance

## Consistency with USACE methods is required

- Potential changes to State/federal facilities (SPFC)
- Federal funding and permits depend upon USACE approval

## USACE documents and guidance

- Planning guidance notebook (ER 1105-2-100)
- ECs, EMs, ERs, EGMs, etc.
- NED manuals

## DWR documents and guidance

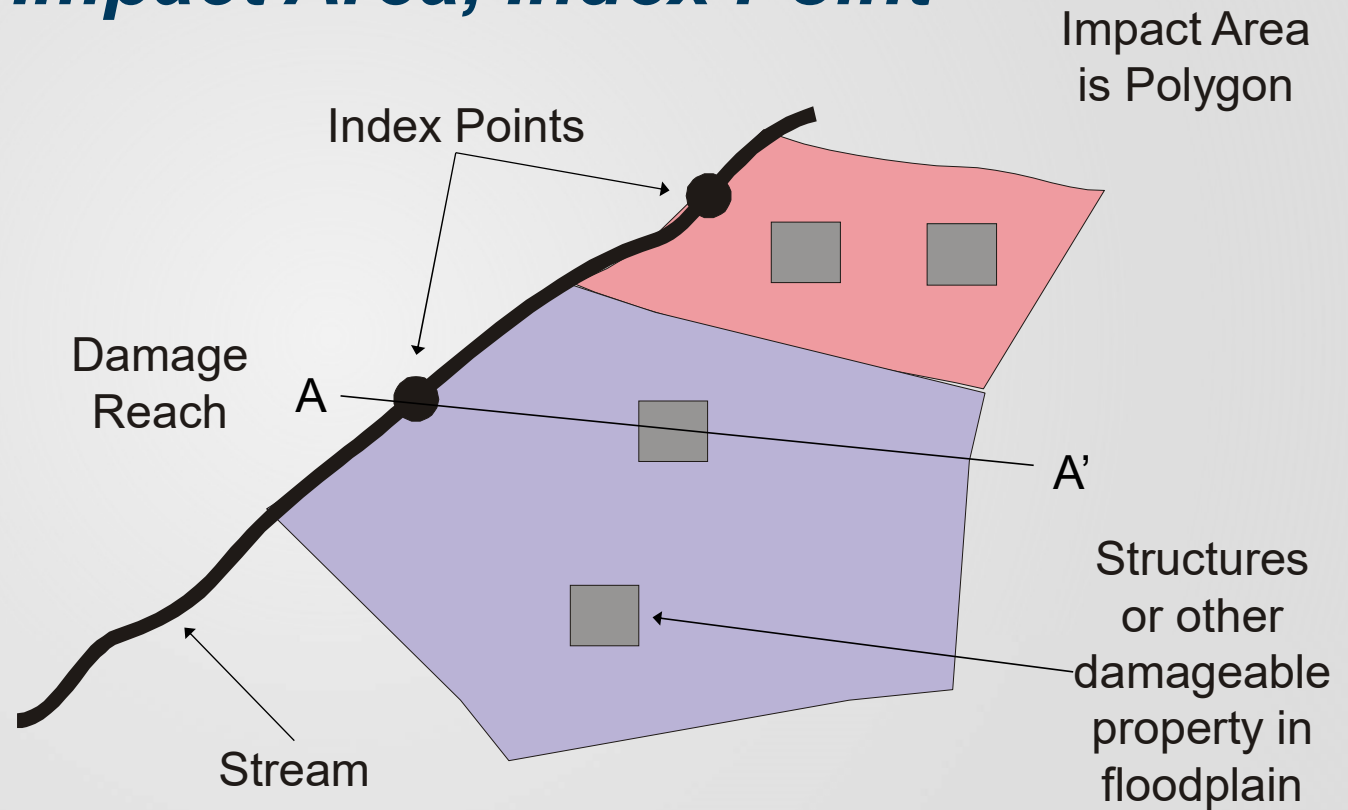
- Draft economics practices manual (1977)
- Economic analysis guidebook (2008)
- Handbook for Assessing Value of State Flood Management Investments (2014)
- EIP/IRWM/Common Assumptions
- 2012 CVFPP and 2017 CVFPP Update documents



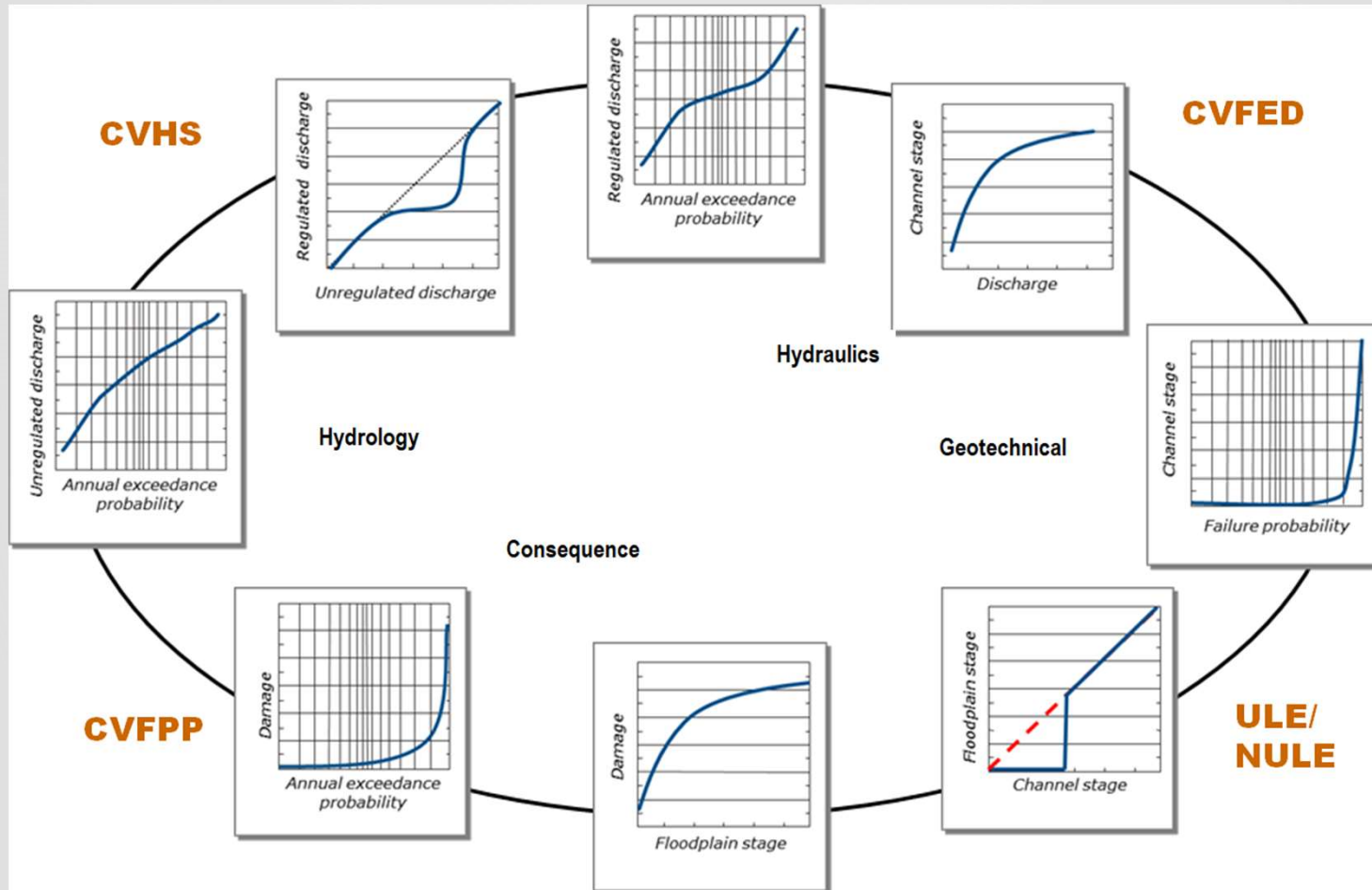
# Terminology

## *Damage Reach, Impact Area, Index Point*

- Divide floodplain into *impact areas*, channel into *damage reaches*.
- Impact for area/reach related to hydraulic or hydrologic state at *index point* (cross section) for reach.



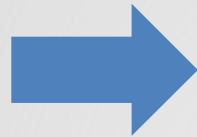
# State of Practice Risk Analysis (Leveed System)



# Depth-Percent Damage Functions

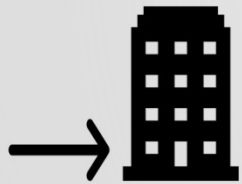
## INPUT

Depth of flooding at structure



## OUTPUT

Damage caused to structure and contents



*Depths referenced to 1st floor elevation*

*Damage based on % of total value (structure + content)*

Depth	Damage (%)
-1.00	0.0
0.00	7.0
1.00	22.0
3.00	31.0
5.00	32.0
10.00	54.0
15.00	86.0





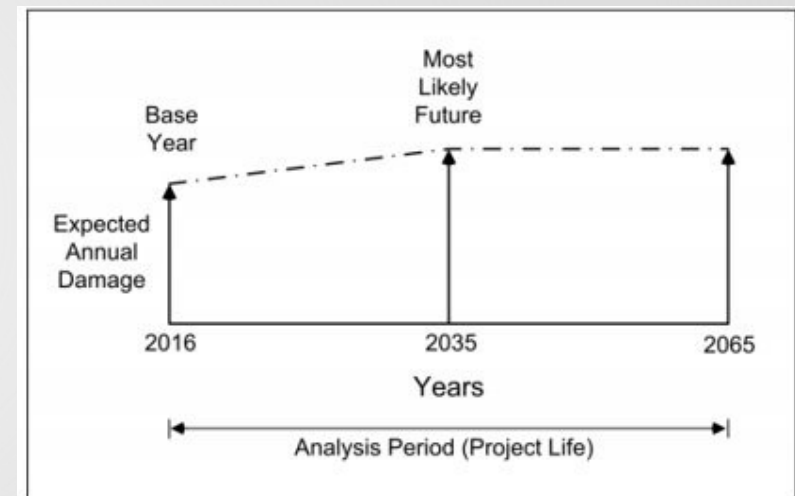
# Role of HEC-FDA in Flood Risk Analysis

- Developed by HEC to analyze the economic benefit of flood damage reduction projects
- Stores hydrologic, hydraulic, and economic data and information
- Implements procedures described in EM 1110-2-1619
- DWR adapted FDA to compute life loss per State's priorities on public safety
- Flood risk assessment follows guidelines described in DWR's Handbook for Assessing Value (HAV)



# HEC-FDA Analysis Results

- Stage-damage (intermediate output)
- Expected annual damage
- Equivalent annual damage
- Project performance statistics
  - Annual exceedance probability
  - Long-term risk
  - Conditional non-exceedance



# **2017 CVFPP UPDATE RISK ANALYSIS**

## *2017 CVFPP Update*

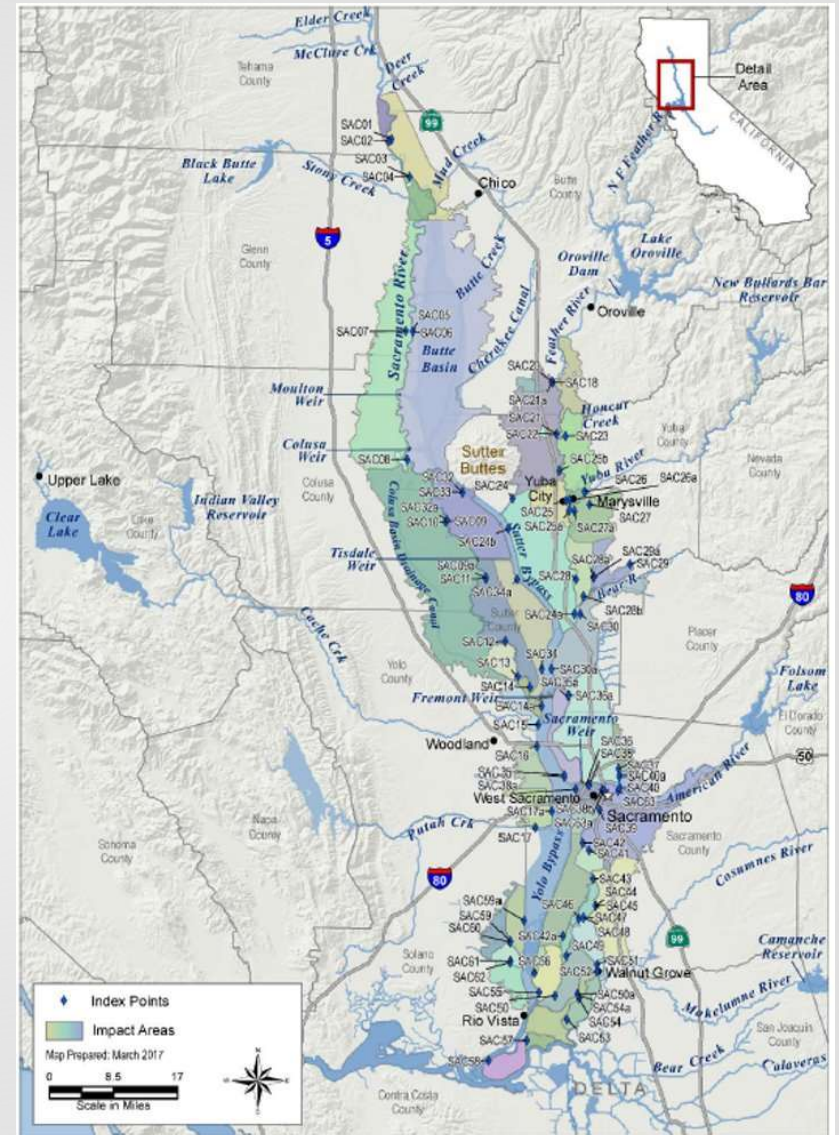
# Flood Risk Analysis

- Completed with HEC-FDA
- Damage categories
  - Structures/contents
  - Crops
  - Vehicles
  - Roads/highways
  - Loss of business income
  - Emergency response costs
  - Loss of life
- 1 HEC-FDA model for each index point



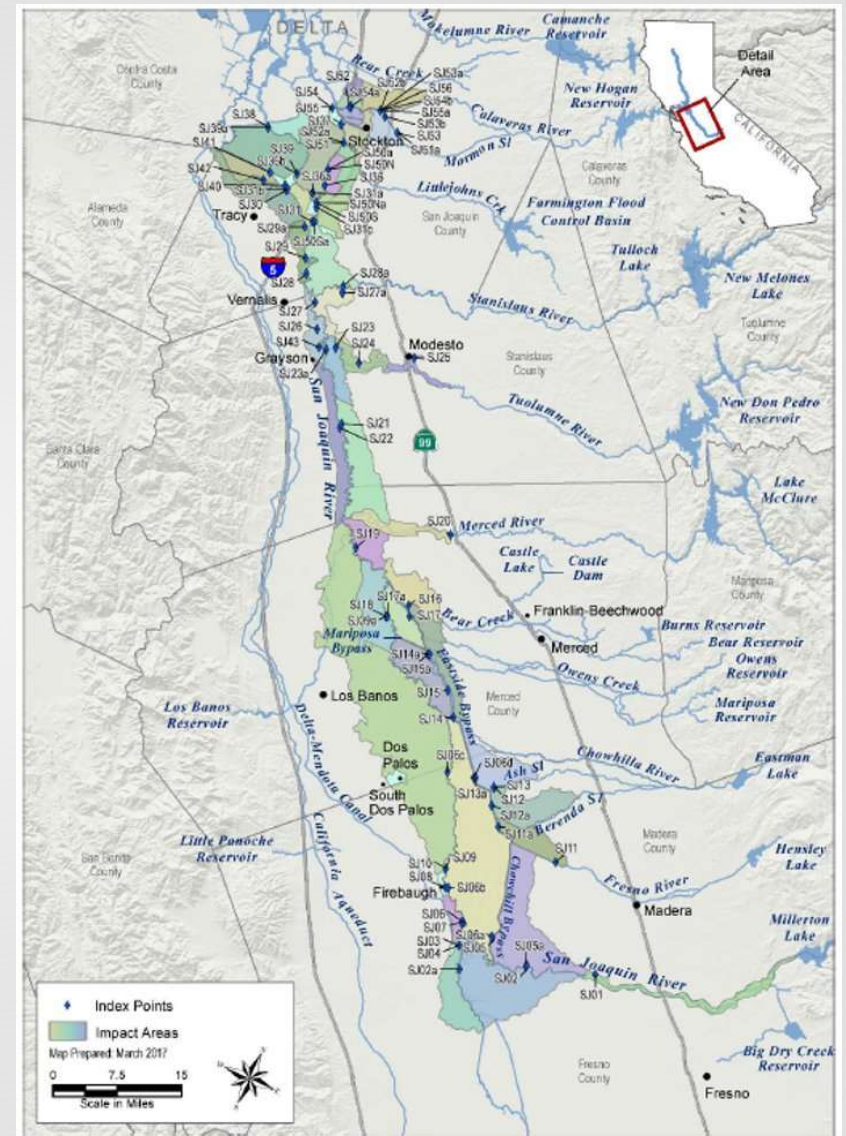
# Sacramento River Basin

	Impact Areas	Index Points
Sacramento River Basin	61	87



# San Joaquin River Basin

	Impact Areas	Index Points
San Joaquin River Basin	39	66
Stockton	7	19



## 2017 CVFPP Update

# Risk Analysis Inputs

Risk Assessment Component	Input	Source
Hazard	In-channel volume-frequency Stage-flow relationships Exterior-interior relationships	CVHS models CVFED models CVFED floodplains
Performance	Levee performance functions Flood warning system effectiveness	ULE & NULE Programs DWR & NOAA expert elicitation
Exposure	Structure inventory Vehicles Crop inventory Population	2010 ParcelQuest 2010 US Census DWR GIS county land use 2010 US Census
Vulnerability	Depth - % damage functions Depth - % mortality functions Crop damage/acre estimates	USACE HEC-FIA Updated from 2012

# 2017 CVFPP Update

## Risk Analysis Conditions

Analysis Year	Condition	Hydrology	Fragility Curves	Population/ Structure Inventory
2007	System risk before state investment	CVHS	Pre-EIP work	2010
2017	2017 Update of system flood risk	CVHS	Post-EIP	2010
2017	2017 Update of System risk WITH enhanced flood response	CVHS	Post-EIP	2010
2067	Future system without project	CVHS (CC) +SLR	Post-EIP	2010 +Growth Factors
2067	Future system WITH enhanced flood response and SSIA	CVHS (CC) +SLR	With-Project	2010 +Growth Factors



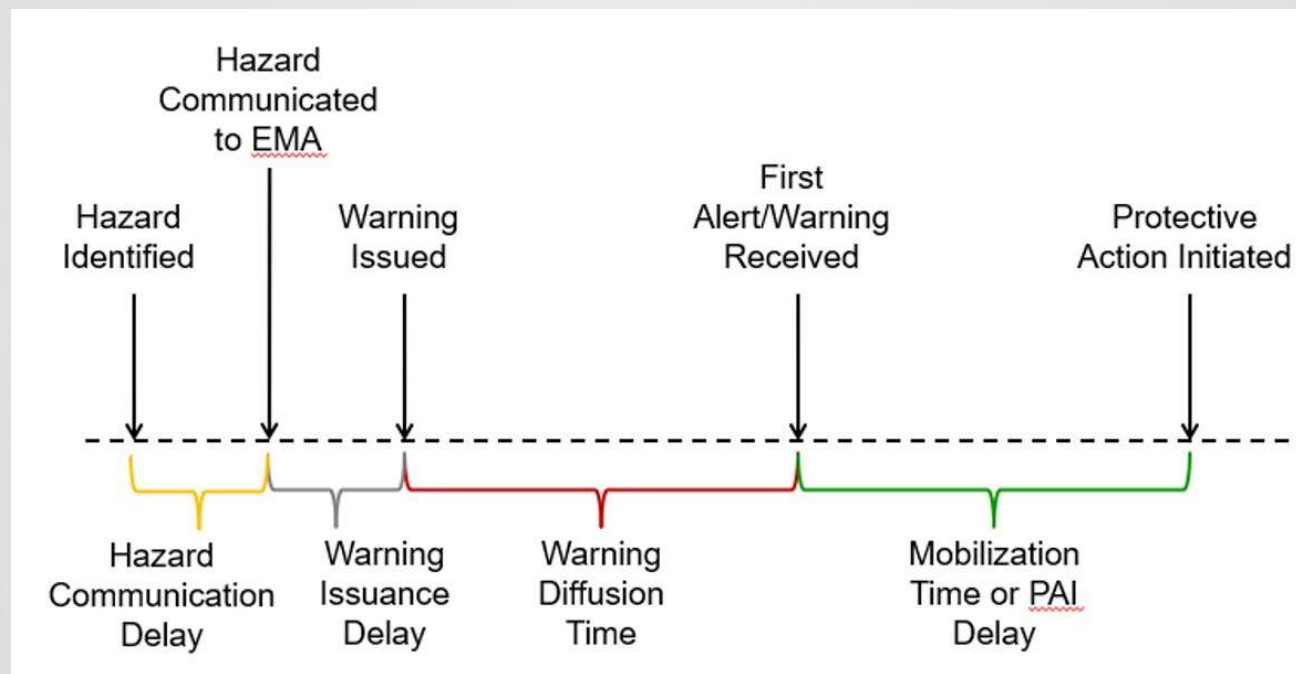
# Life Risk Essential Elements

- Initial distribution of people
    - At home
    - At work
  - Redistribution of people
    - Warning issued
    - Response
    - Evacuation method
- Evacuation Effectiveness**



# Life Risk Essential Elements

- Redistribution of people

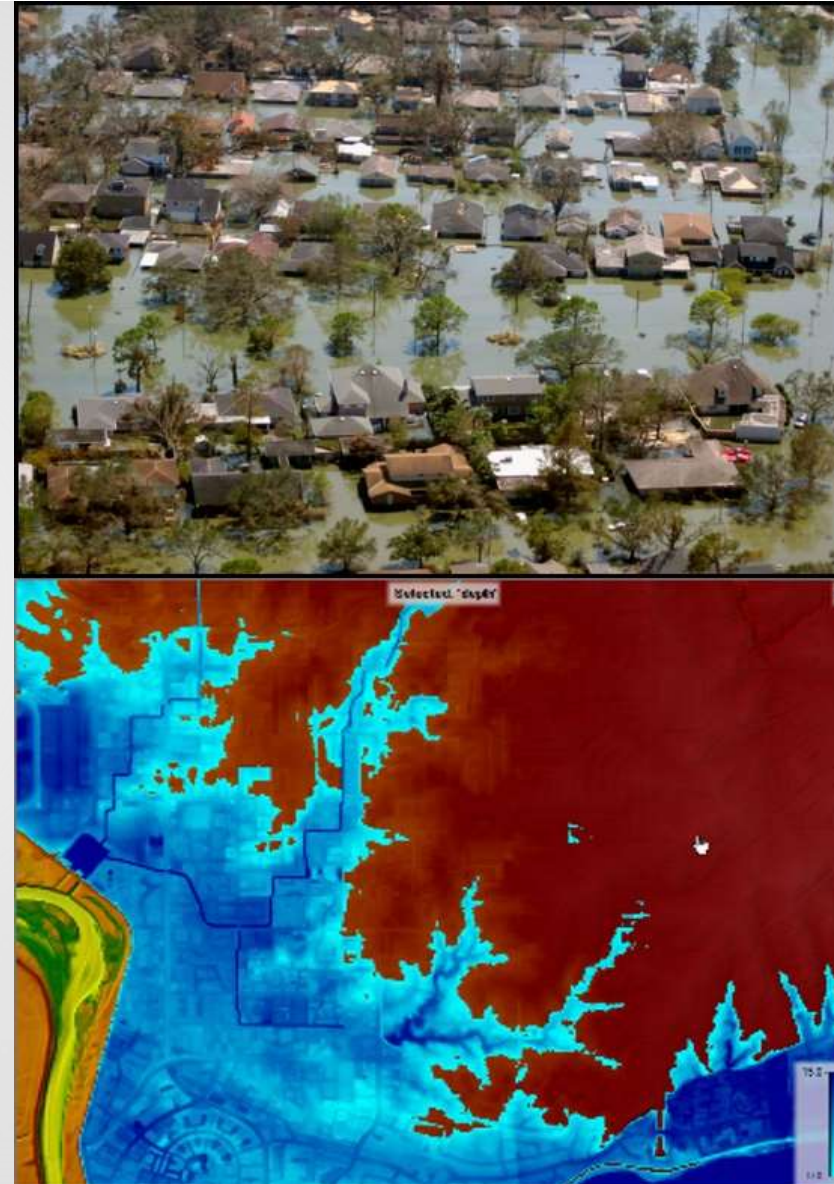


# Life Risk Essential Elements

- Flood characteristics
- Fatality rates (depth-mortality)



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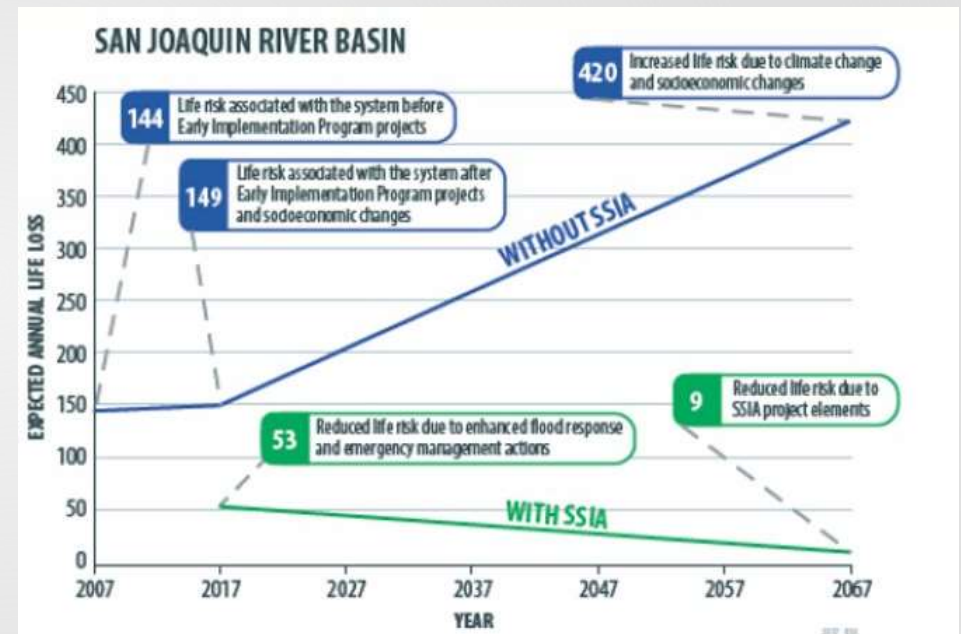
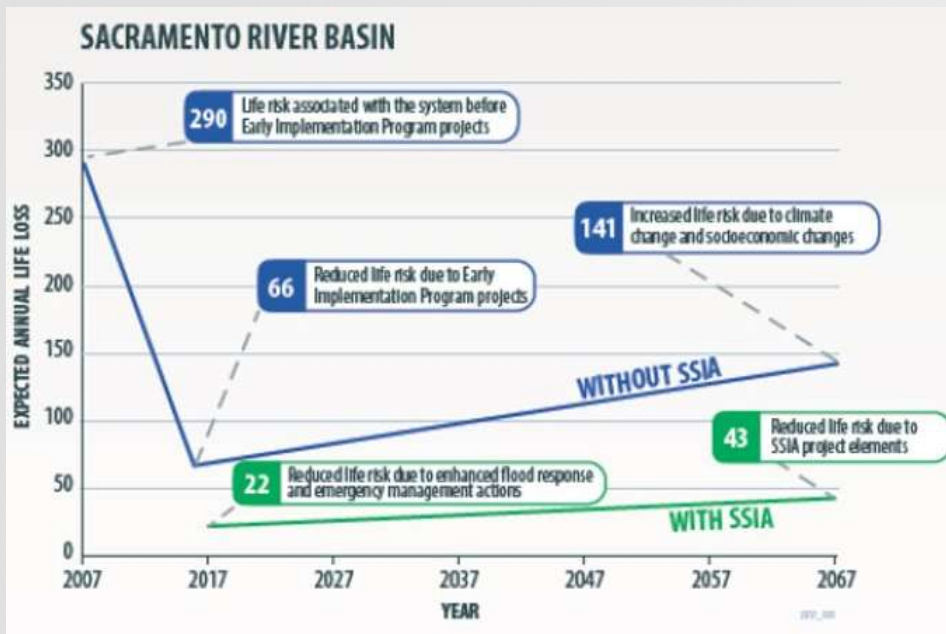
## *2017 CVFPP Update*

# Life Risk

- Updated 2012 mitigation times
- Estimated persons/structure (under and over 65) then reduced those estimates based upon updated mitigation times
- Replaced residential structure \$\$ values with adjusted persons/structure
- Replaced depth-percent damage with depth-percent mortality functions
- FDA estimated expected annual life loss



# Expected Annual Life Loss



What's New?

# **2022 CVFPP UPDATE RISK ANALYSIS**

# 2022 CVFPP Update

## Risk Analysis Inputs

Risk Assessment Component	Input	Source
Hazard	In-channel volume-frequency Stage-flow relationships Exterior-interior relationships	Same as 2017 except <b>updated future year climate change analysis</b>
Performance	Levee performance functions Flood warning system effectiveness	Same as 2017 Same as 2017
Exposure	Structure inventory Vehicles Crop inventory Population	<b>2019 Land Vision state parcel</b> 2010 US Census 2016 DWR state land use 2010 US Census; PCensus
Vulnerability	Depth - % damage functions Depth - % mortality functions Crop damage/acre estimates	Same as 2017 Same as 2017 Updated from 2017

# CVFPP Update Risk Analyses Comparison

	2017	2022	Difference
<b>Analysis Years</b>	2007; 2017; 2067	2022; 2072	Different Years
<b>Impact Areas</b>	Same	Same	None
<b>Damage Categories</b>	Same	Same	None
<b>Number of Structures</b>			
Sacramento	256,586	308,441	+ 51,855
San Joaquin	91,937	122,846	+ 30,909
<b>TOTAL</b>	<b>348,523</b>	<b>431,287</b>	<b>+ 82,764</b>
<b>Crop Acres</b>			
Sacramento	825,946	1,014,247	+ 188,301
San Joaquin	487,275	611,594	+124,319
<b>TOTAL</b>	<b>1,313,221</b>	<b>1,625,841</b>	<b>+ 312,620</b>



# CVFPP Update Risk Analyses Comparison

	2017	2022	Difference
<b>Population</b>			
Sacramento	903,323	954,586	+ 51,263
San Joaquin	354,714	371,906	+ 17,192
<b>TOTAL</b>	<b>1,258,037</b>	<b>1,326,492</b>	<b>+ 68,455</b>
<b>Future Growth</b>	Yes (2013 CWP and DOF)	Yes (DOF)	- 2013 CWP
<b>Flood Damage Models</b>	HEC-FDA	HEC-FDA	None
<b>Life Loss Models</b>	HEC-FDA	HEC-FDA HEC-LifeSim inputs for urban and small communities	+ HEC-LifeSim inputs for urban and small communities

# 2022 Enhancements to... Climate Change

2012 CVFPP

2017 CVFPP

2022 CVFPP

- What vulnerabilities can be identified with a potential 30% increase in flood size?
- Chain-of-models analysis framework used to generate median end-of-century projection for increases to flood flows relative to historical conditions via scaling factors
- Vulnerability/uncertainty/adaptation analysis building off of 2017 analyses
- Provide a plausible range
  - Median
  - Driest, least warming (best case)
  - Wettest, most warming (worst case)



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*\*Taken from DWR's presentation at the CVFPB Workshop 2/14/20*

## *2022 Enhancements to...*

# Structure Inventory

- DWR has acquired statewide Land Vision parcel data
- HEC is developing a California Structure Inventory (CSI) based on 2019 statewide Land Vision parcel data
- The CSI will be formatted similar to the USACE National Structure Inventory (NSI)
- In addition to the 2022 CVFPP risk analysis, the CSI can be used to support other DWR programs



# 2022 Enhancements to... Life Loss Analysis



- HEC-LifeSim
  - Hydrodynamic model
  - Depth and arrival time information
- Direct consequence analysis
  - Structure inventory (all structure types)
  - Warning and evacuation information
  - Population under and over 65
  - Road network
  - Time of day
- Results = Life loss for a single event



# 2022 Enhancements to...

- HEC-LifeSim will be run for several events to develop suite of stage-life loss functions to be input into HEC-FDA
- HEC-LifeSim will be used for the urban and small community impact areas (up to 30 impact areas) which will:
  - Provide a more robust method to estimate life loss for these impact areas
  - Be more consistent with USACE life loss methods
- For rural impact areas, the 2017 life loss approach of using adjusted population assigned to residential structures will be used



# *Continued Engagement* **Related CVFPP Topics**



Regional Flood  
Management  
Planning



Climate  
Resilience



Conservation  
Strategy



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# Questions & Open Discussion

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