CASCaDE

Computational Assessments of Scenarios of Change for the Delta Ecosystem

Lisa Lucas,
Noah Knowles,
& the
CASCaDE
Team

USGS

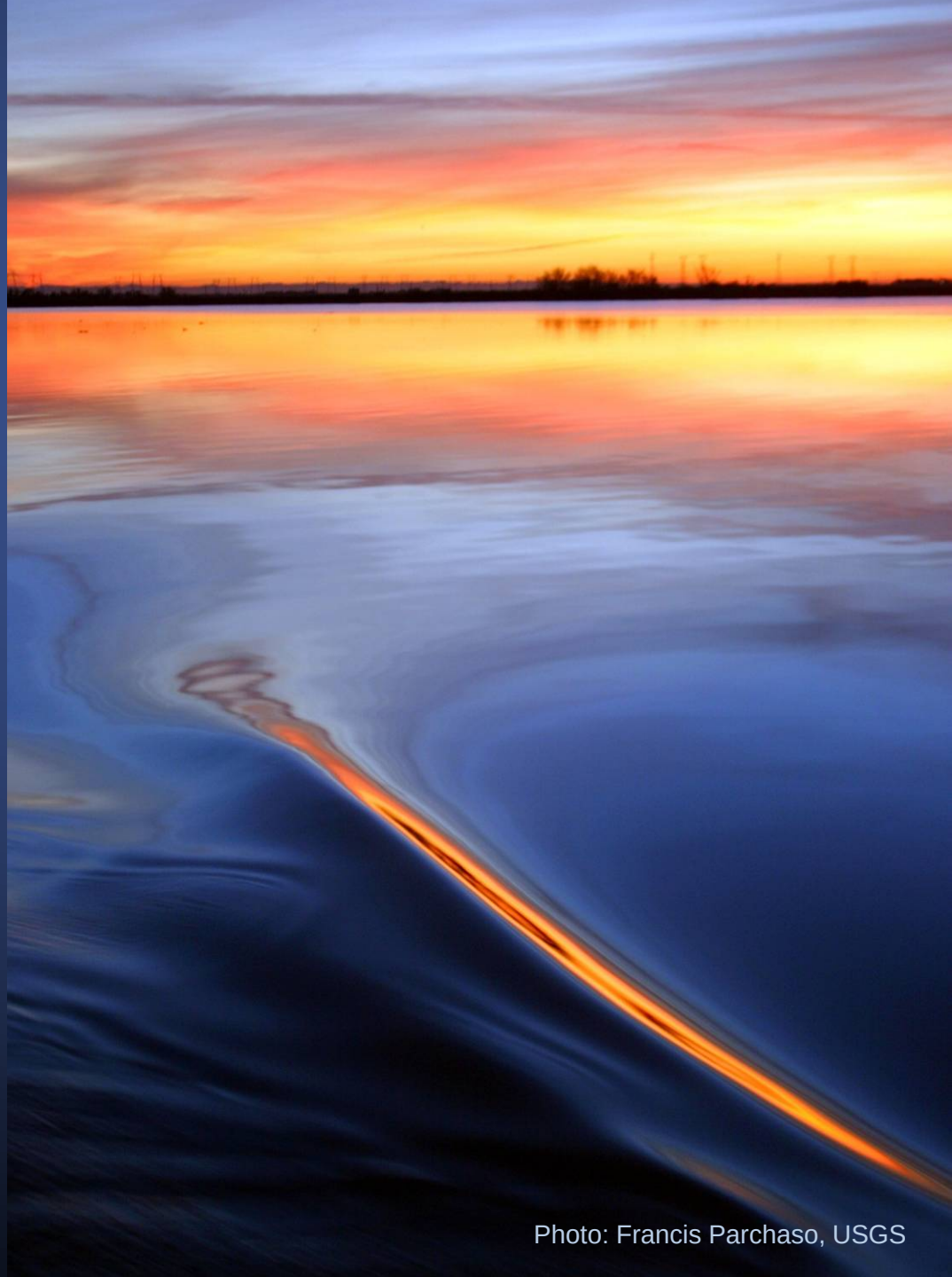


Photo: Francis Parchaso, USGS

CASCaDE 1

(2006-2010)

Primary Forcing: Climate

CASCaDE 2

(2011-present)

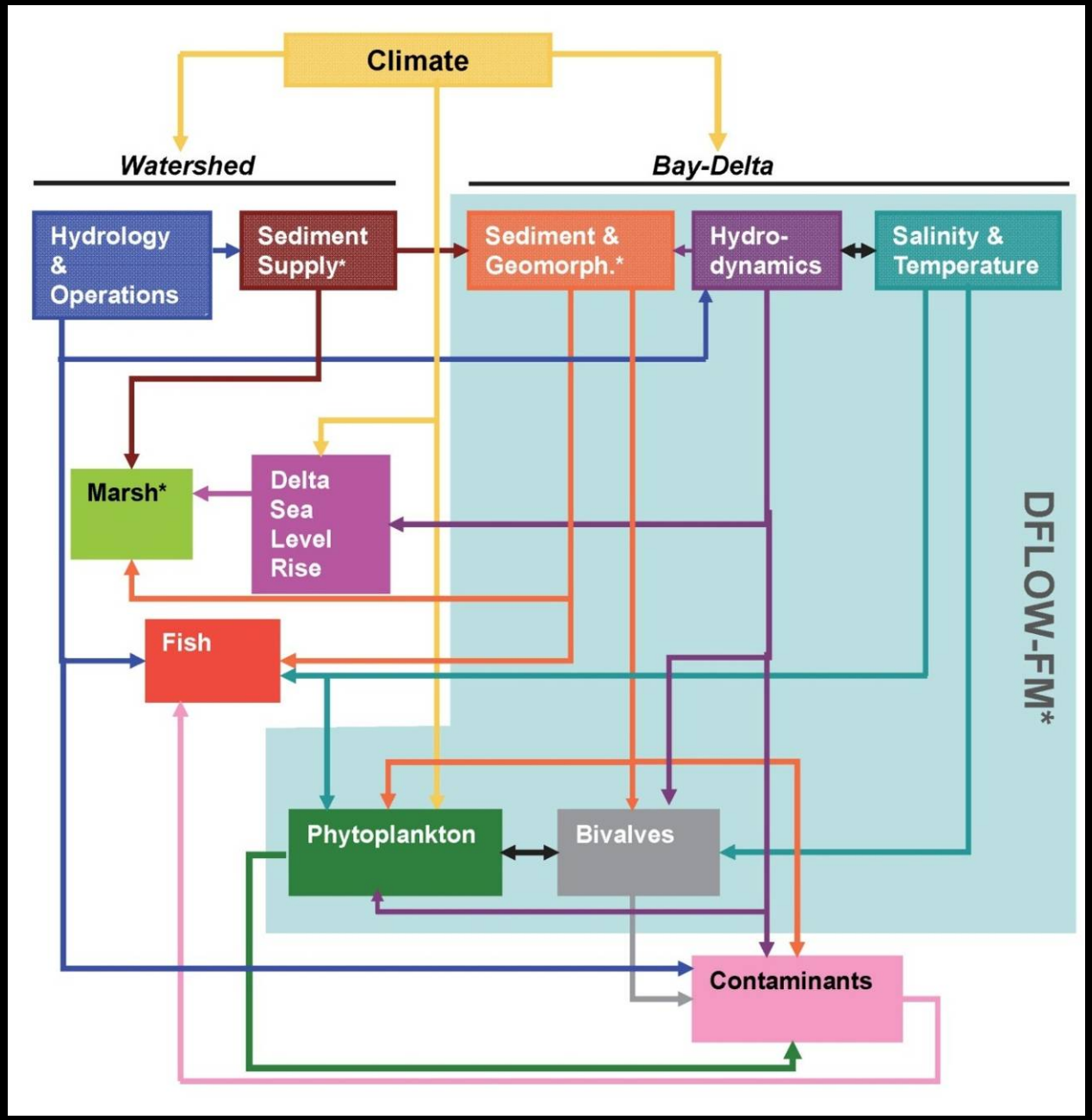
Forcing: Climate
+ Infrastructure Change

(and refined, expanded modeling capabilities)

CASCaDE:

Linked modeling framework to evaluate Delta responses to multiple forces of change

- **>30 scientists**
- **4 USGS Offices**
- **4 Universities**
- ***Cooperators*: Deltares, DWR, USBR**
- **Funded by USGS, Delta Science Program**



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PLoS one

Projected Evolution of California's San Francisco Bay-Delta-River System in a Century of Climate Change

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Abstract

Background: Accumulating evidence shows that the planet is warming as a response to human emissions of greenhouse gases. Strategies of adaptation to climate change will require quantitative projections of how altered regional patterns of temperature, precipitation and sea level could cascade to provoke local impacts such as modified water supplies, increasing risks of coastal flooding, and growing challenges to sustainability of native species.

Methodology/Principal Findings: We linked a series of models to investigate responses of California's San Francisco Estuary-Watershed (SFEW) system to two contrasting scenarios of climate change. Model outputs for scenarios of fast and moderate warming are presented as 2010–2099 projections of nine indicators of changing climate, hydrology and habitat quality. Trends of these indicators measure rates of: increasing air and water temperatures, salinity and sea level; decreasing precipitation, runoff, snowmelt contribution to runoff, and suspended sediment concentrations; and increasing frequency of extreme environmental conditions such as water temperatures and sea level beyond the ranges of historical observations.

Conclusions/Significance: Most of these environmental indicators change substantially over the 21st century, and many would present challenges to natural and managed systems. Adaptations to these changes will require flexible planning to cope with growing risks to humans and the challenges of meeting demands for fresh water and sustaining native biota. Programs of ecosystem rehabilitation and biodiversity conservation in coastal landscapes will be most likely to meet their objectives if they are designed from considerations that include: (1) an integrated perspective that river-estuary systems are influenced by effects of climate change operating on both watersheds and oceans; (2) varying sensitivity among environmental indicators to the uncertainty of future climates; (3) inevitability of biological community changes as responses to cumulative effects of climate change and other drivers of habitat transformations; and (4) anticipation and adaptation to the growing probability of ecosystem regime shifts.

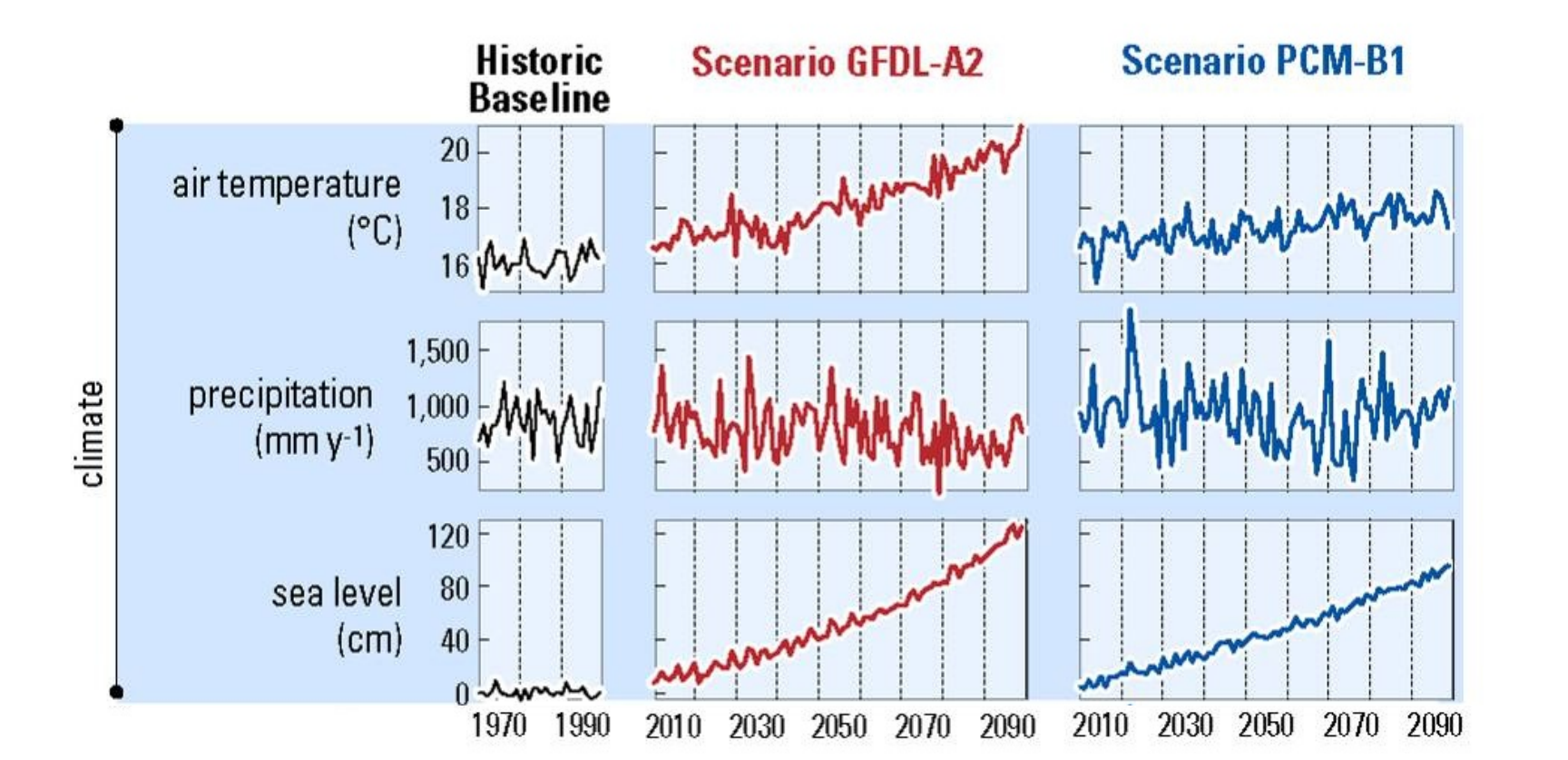
Citation: Cloern JE, Knowles N, Brown LR, Cayan D, Dettinger MD, et al. (2011) Projected Evolution of California's San Francisco Bay-Delta-River System in a Century of Climate Change. PLoS ONE 6(9): e24465. doi:10.1371/journal.pone.0024465

Editor: Zoe Finkel, Mt. Alison University, Canada

Received July 26, 2011; **Accepted** August 10, 2011; **Published** September 21, 2011

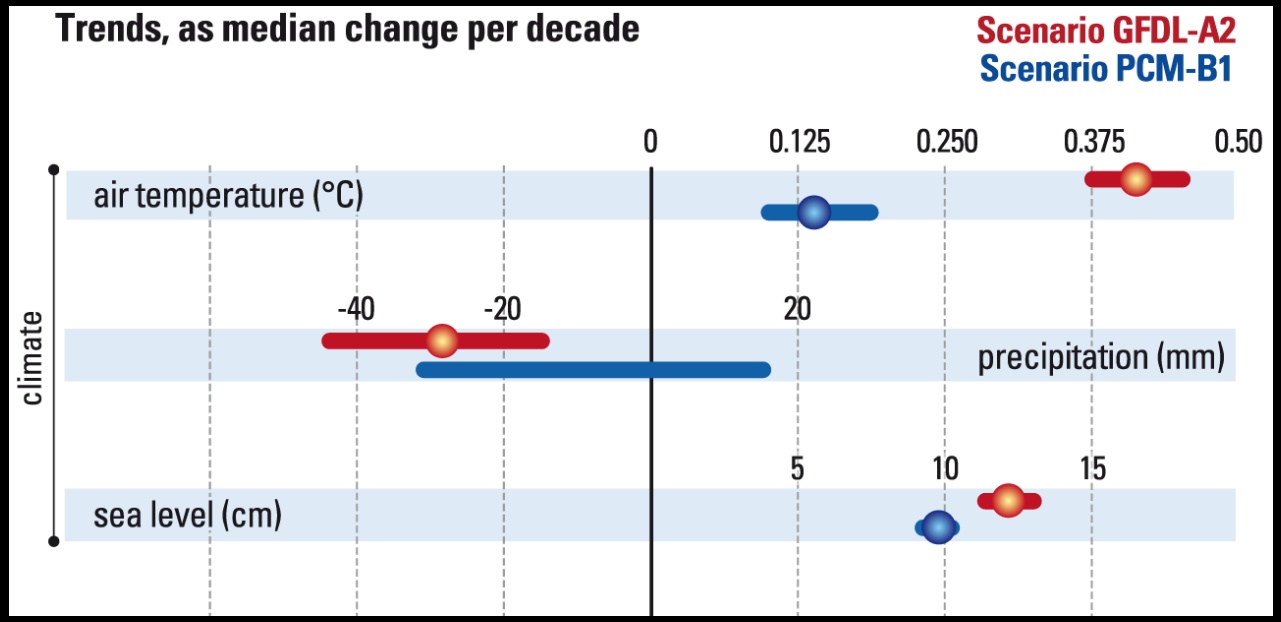
Available through cascade.wr.usgs.gov

California: warmer, possibly drier, and with higher sea levels



Mike Dettinger (USGS-NRP), Dan Cayan (USGS-NRP, UCSD); Cloern et al. 2001, PLoS ONE

Trend Summaries



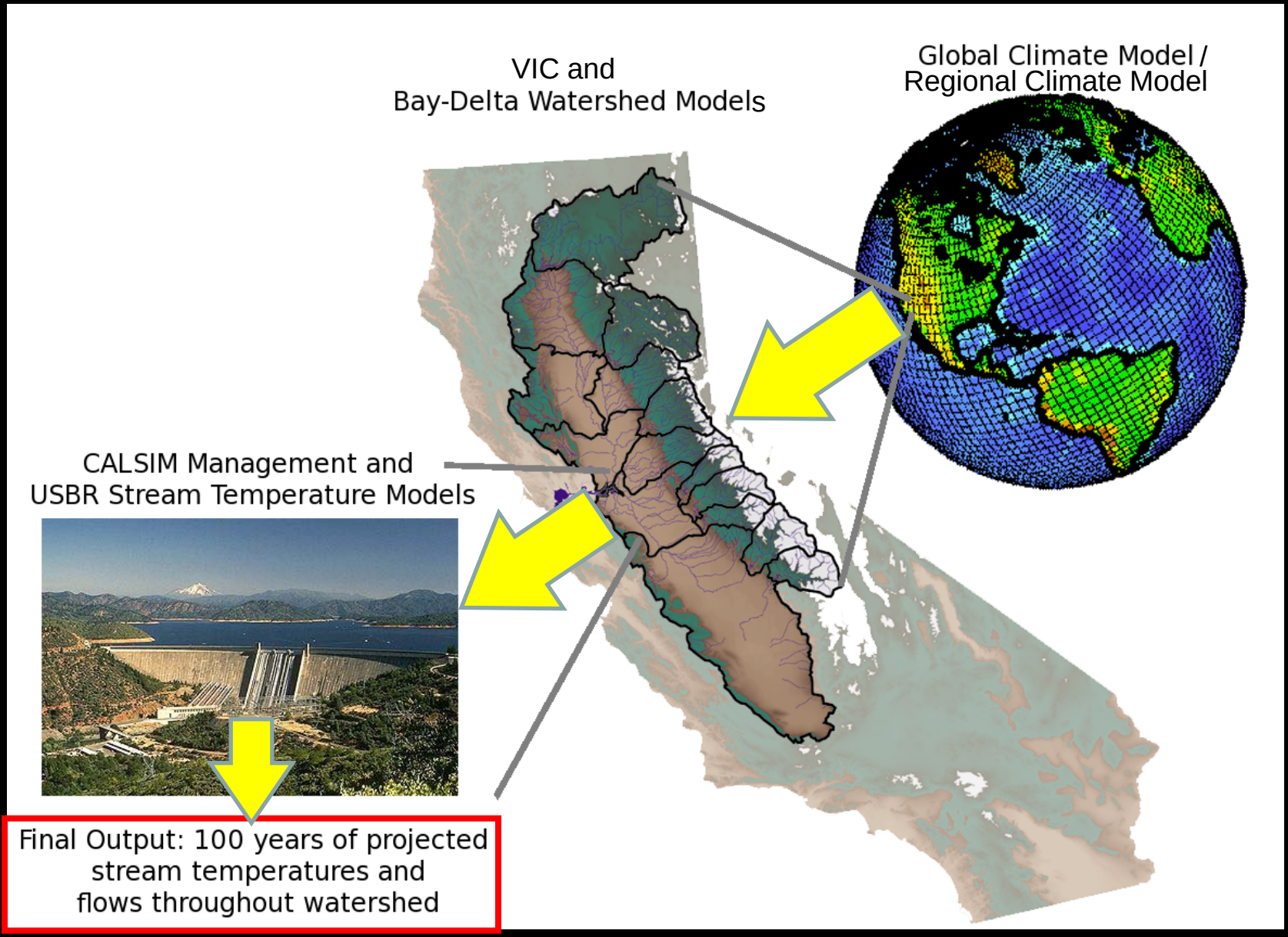
M. Dettinger
USGS-NRP

D. Cayan
USGS-NRP
UC San Diego

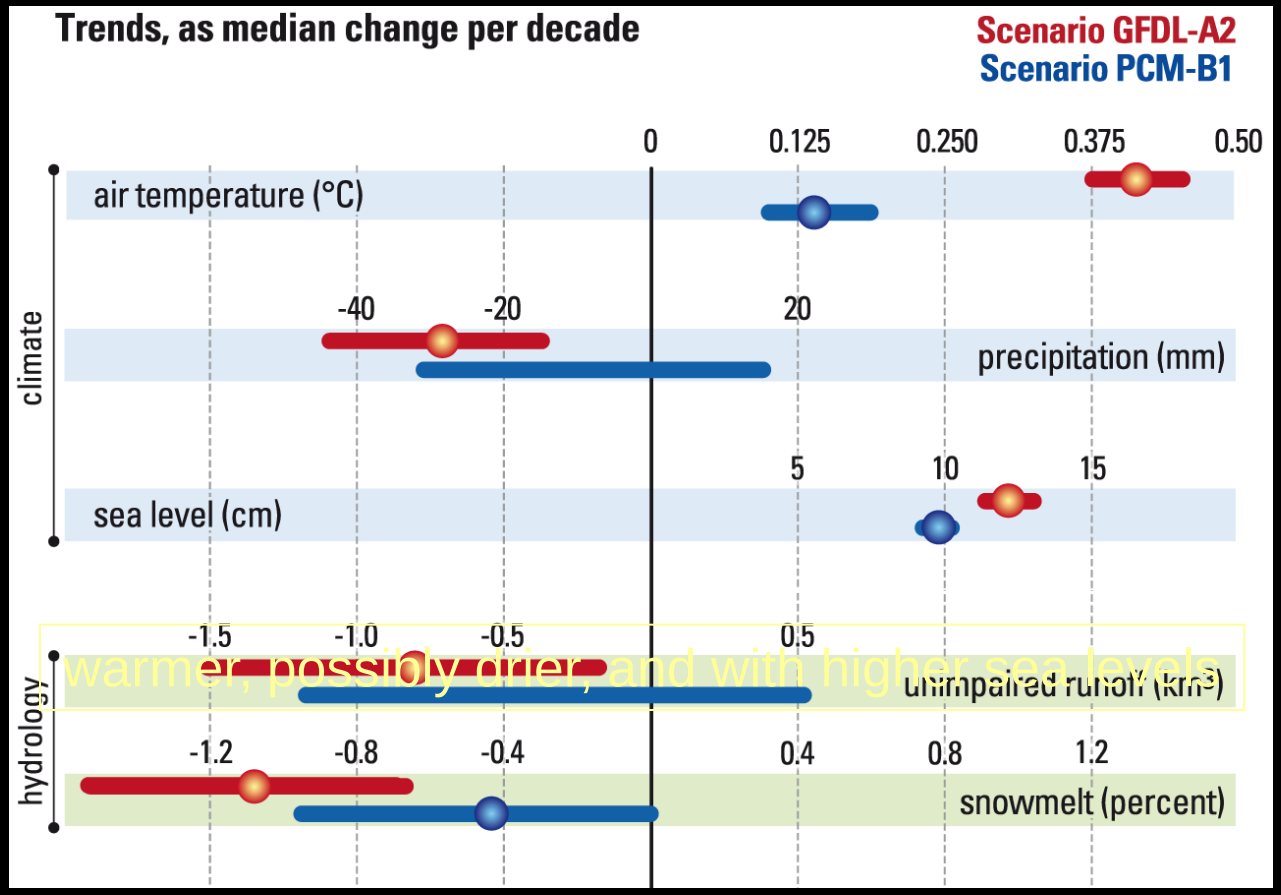
warmer, possibly drier, and with higher sea levels

Watershed Hydrology Modeling

(Noah Knowles, USGS-NRP)



Trend Summaries



warmer, possibly drier, and with higher sea levels

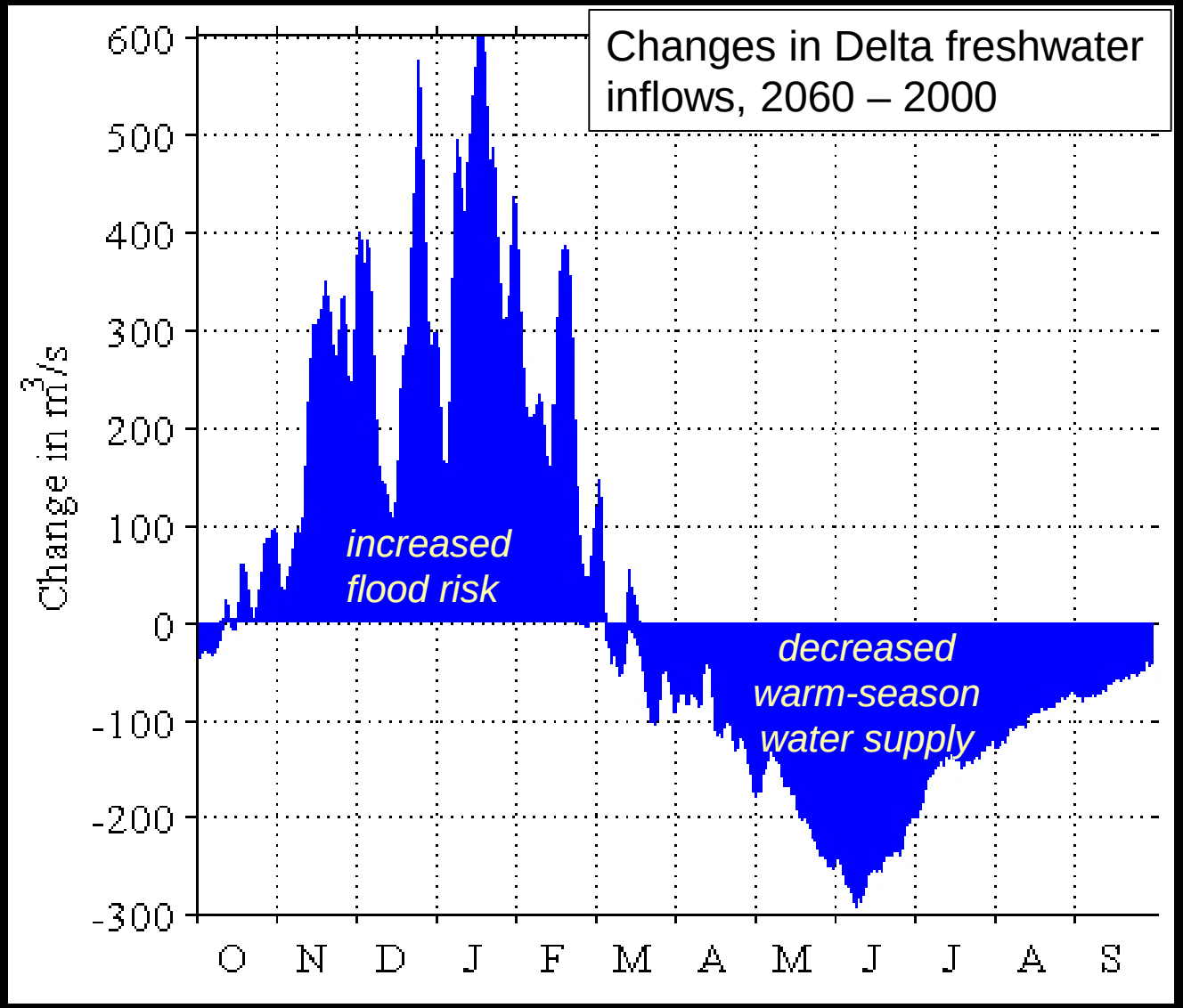
M. Dettinger
USGS-NRP

D. Cayan
USGS-NRP
UC San Diego

N. Knowles
USGS-NRP

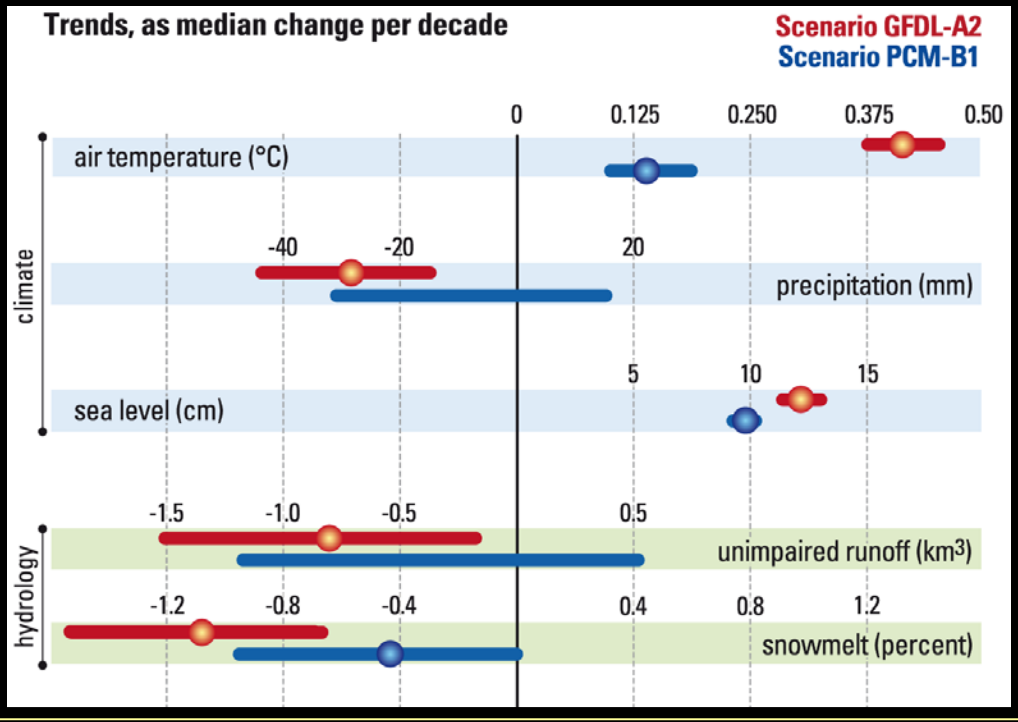
possibly reduced runoff, and much less snowmelt

Broad flow changes managers will try to mitigate



Knowles and Cayan 2004, *Climatic Change*

Trend Summaries



N. Knowles
USGS-NRP

possibly reduced runoff, and much less snowmelt

W. Wagner
W. Stacey
UC Berkeley
N. Knowles
USGS-NRP

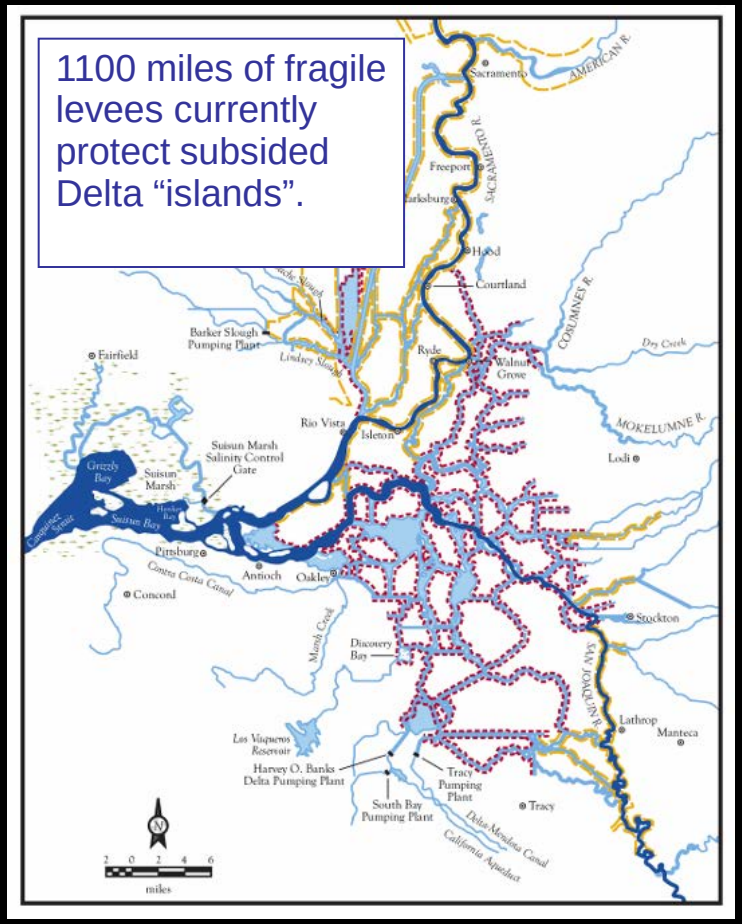
warmer river temperatures

M. van der Wegen
UNESCO-IHE
N. Knowles
USGS-NRP

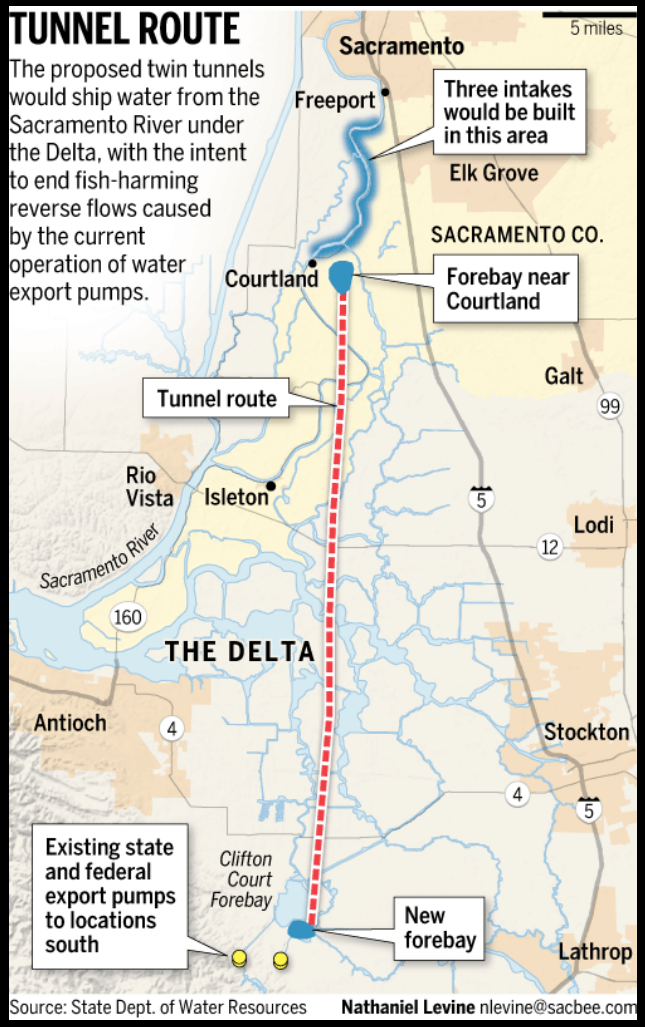
increased salinity intrusion into upper estuary

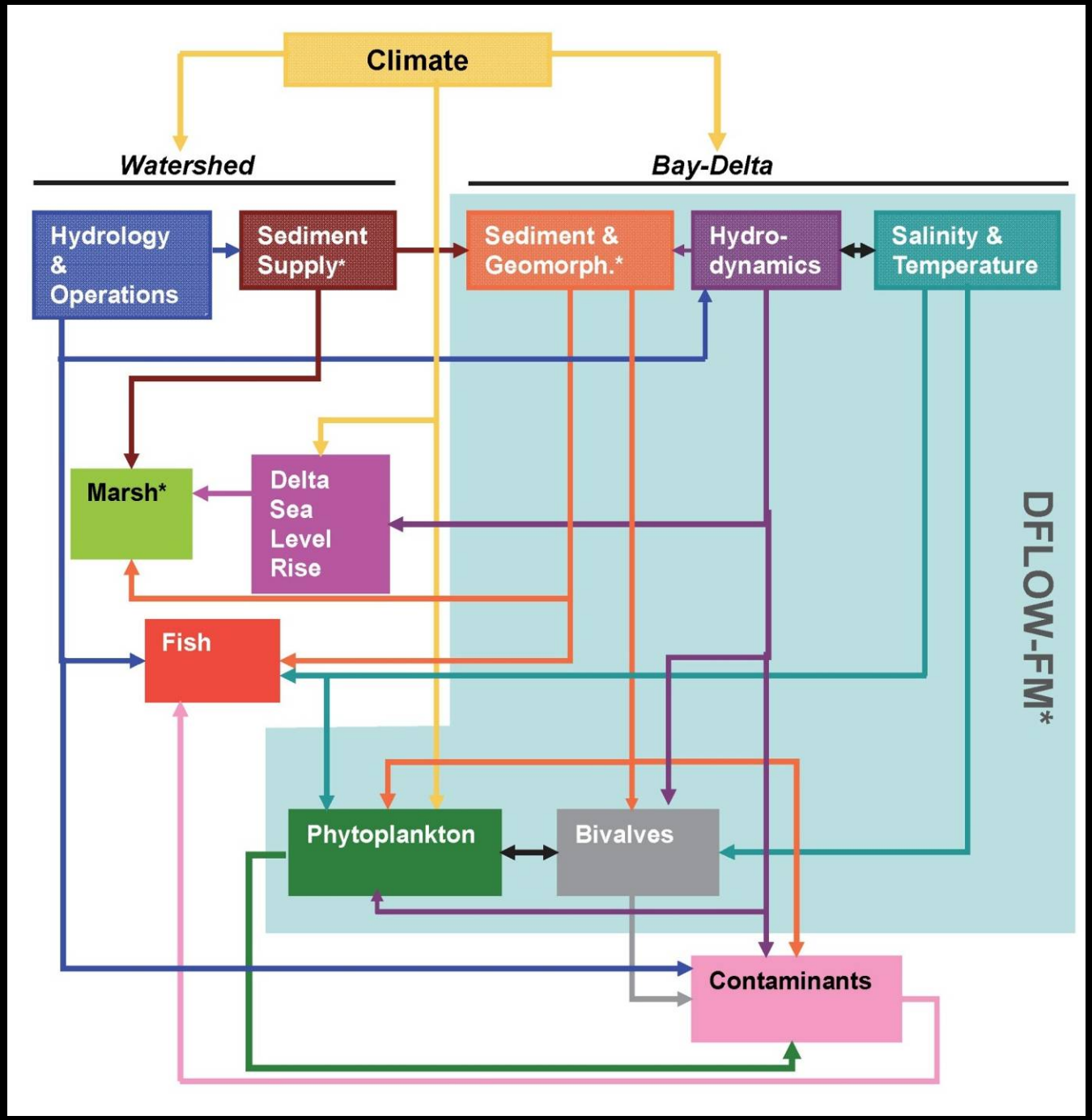
Scenarios of Infrastructure Change

Multiple Flooded Islands

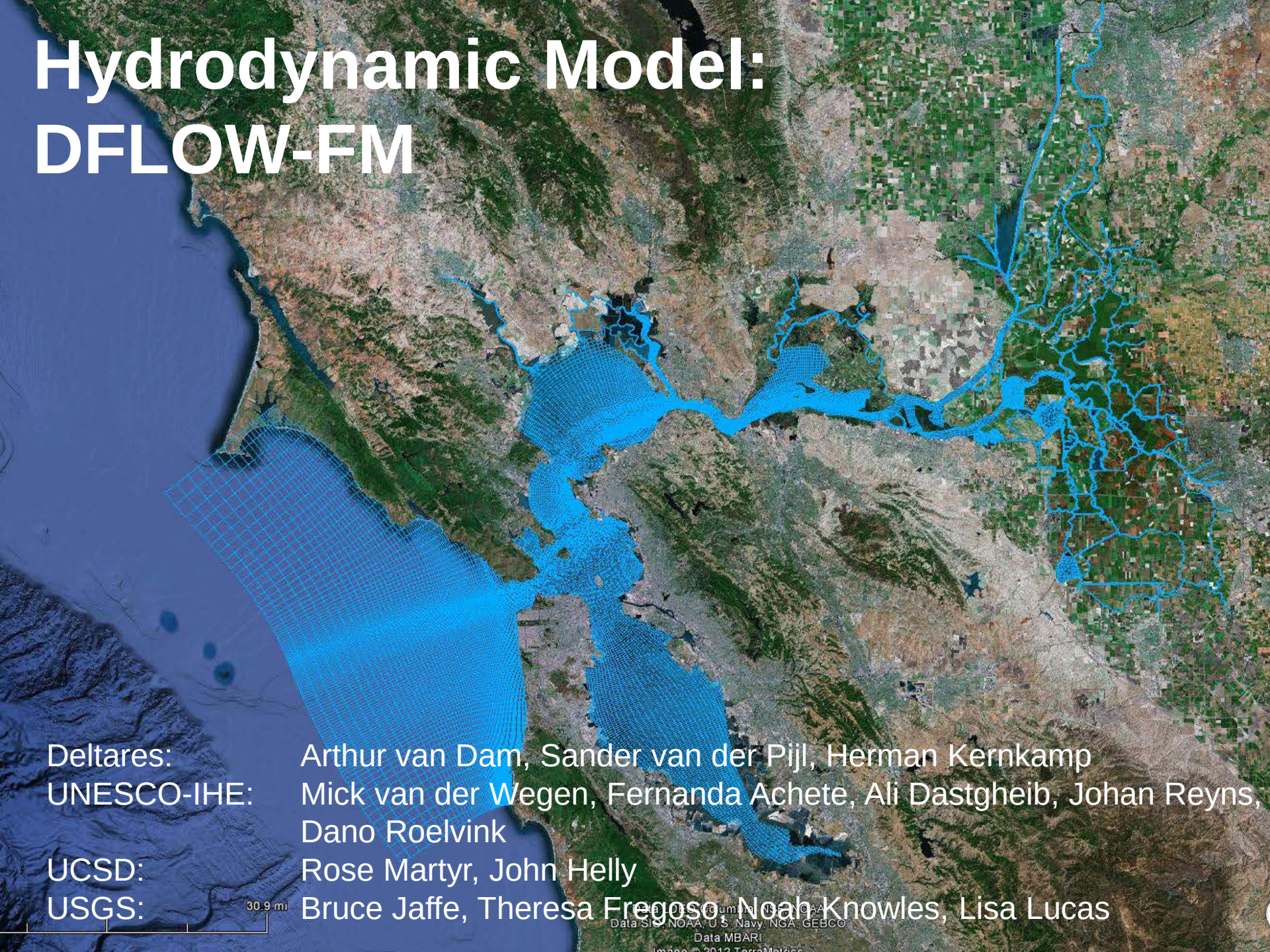


Delta Tunnels

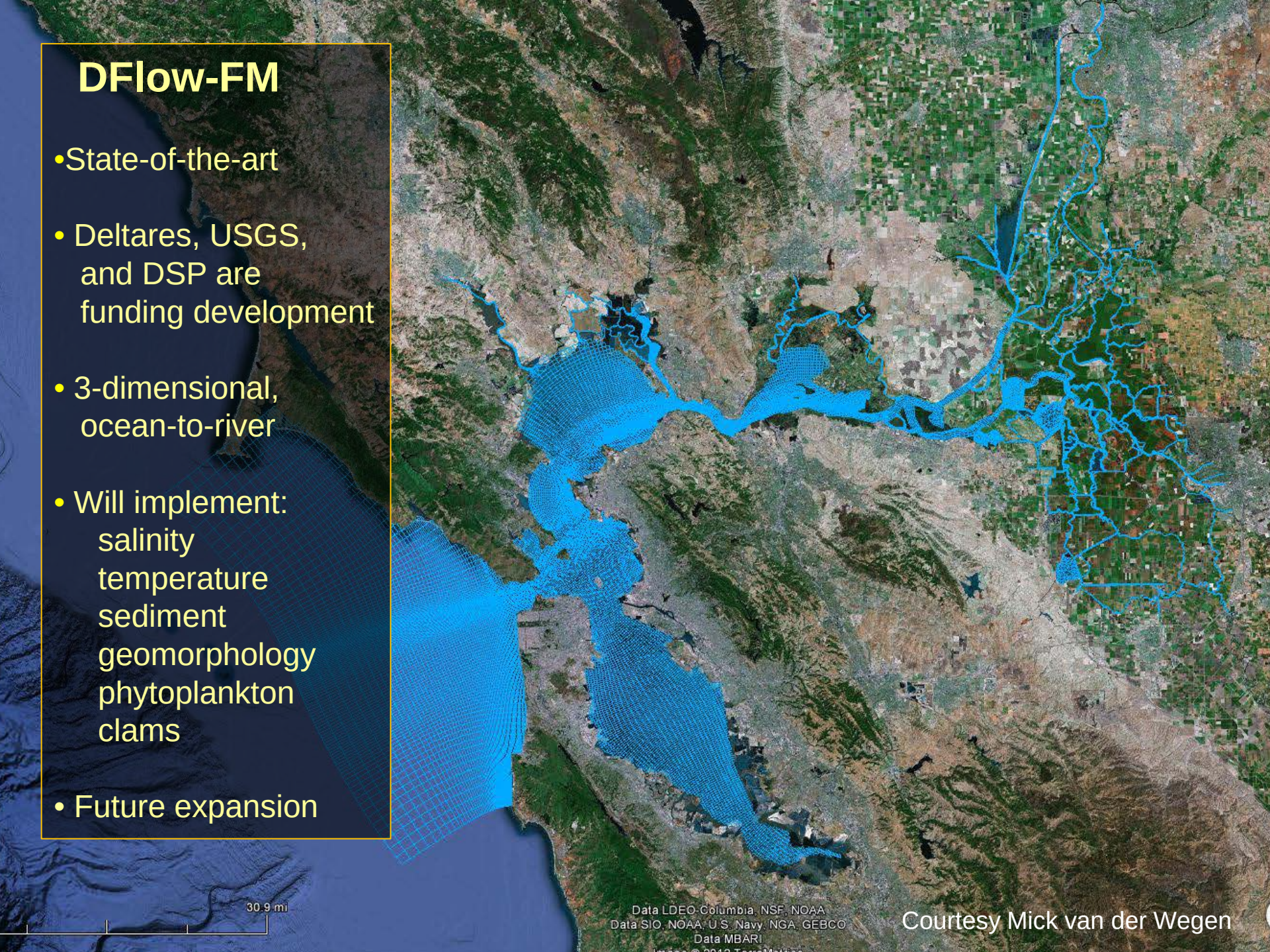


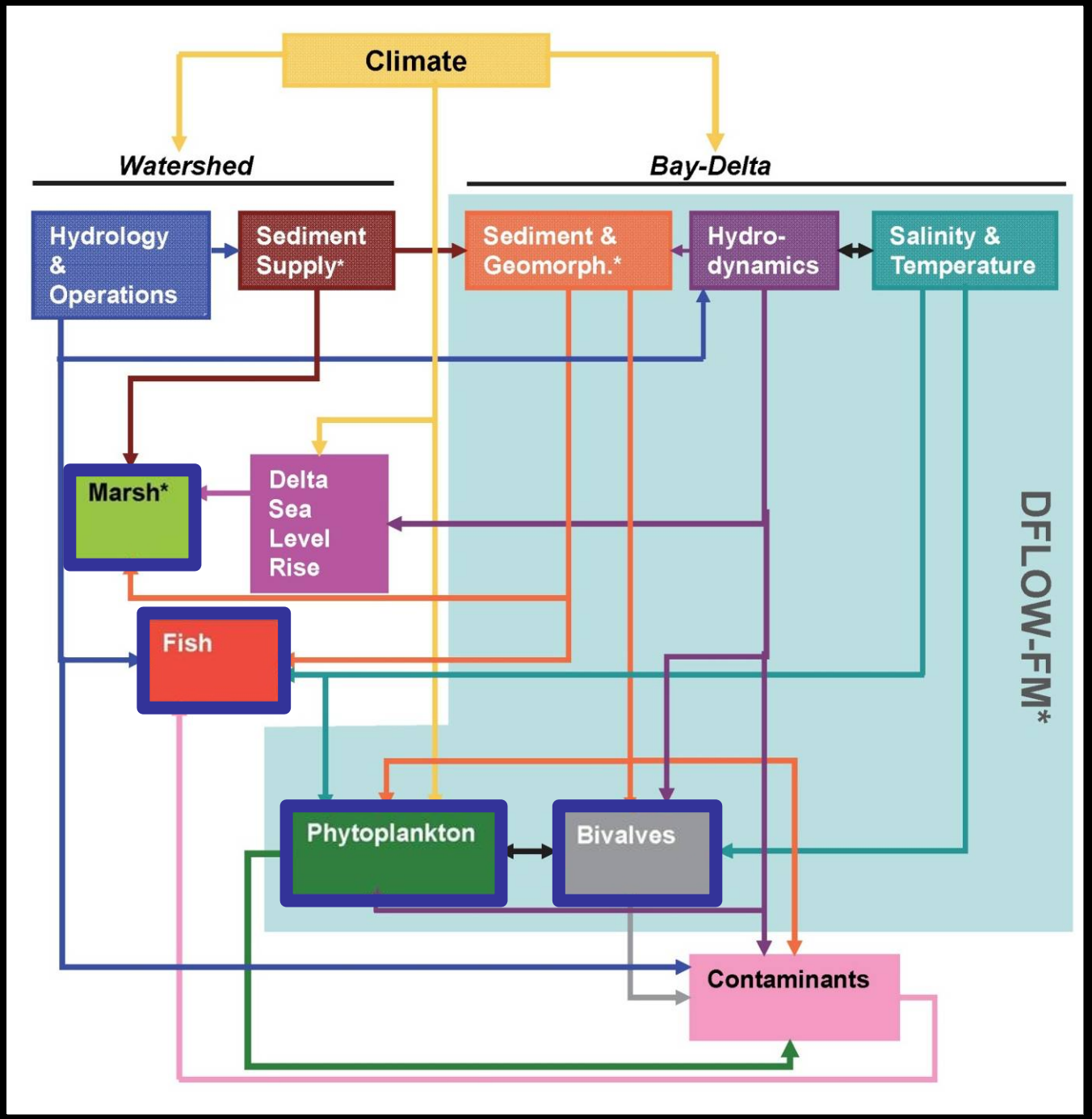

Climate
Watershed
Bay-Delta
Hydrology & Operations
Sediment Supply*
Sediment & Geomorph.*
Hydro-dynamics
Salinity & Temperature
Marsh*
Delta Sea Level Rise
Fish
Phytoplankton
Bivalves
Contaminants
DFLOW-FM*

Hydrodynamic Model: DFLOW-FM



Deltares: Arthur van Dam, Sander van der Pijl, Herman Kernkamp
UNESCO-IHE: Mick van der Wegen, Fernanda Achete, Ali Dastgheib, Johan Reyns, Dano Roelvink
UCSD: Rose Martyr, John Helly
USGS: Bruce Jaffe, Theresa Fregoso, Noah Knowles, Lisa Lucas


DFlow-FM
•State-of-the-art
• Deltares, USGS, and DSP are funding development
• 3-dimensional, ocean-to-river
• Will implement:
salinity
temperature
sediment
geomorphology
phytoplankton
clams
• Future expansion
30.9 mi
Data LDEO-Columbia, NSF, NOAA
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Data MBARI
Courtesy Mick van der Wegen


Climate
Watershed
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Salinity & Temperature
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Fish
Phytoplankton
Bivalves
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DFLOW-FM*

Summary

- CASCaDE is an interdisciplinary modeling effort aimed at helping illuminate plausible futures for the Delta ecosystem as a function of changing climate and physical infrastructure.

- CASCaDE was designed to provide useful information and tools for management of the Delta ecosystem.

Many forces of change

Figure by J. Dileo, USGS

<u>Climate</u>: sea level rise, precipitation & resultant streamflows, direct atmospheric forcing over the Delta

<u>Infrastructure/Physical Configuration</u>: alternative conveyance, island flooding, ecosystem restoration

<u>Pollution/Water Quality</u>: invasive species, contaminants, decreasing turbidity