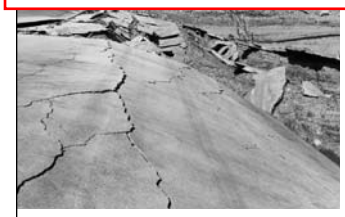
Appendix 5: Comments by the IRP on the revised DRMS Phase 1 Executive Summary



Overview comments by the DRMS Phase 1 Independent Review Panel.

The executive summary is critically important, as this is the single document that most people will read.

The IRP feels that the approach taken here is the right one. This summary is in the most part accurate (although we do caution against the use of language such as "can" and "will" that implies absolute certainty), and in general represents a vast improvement over previous efforts. It is fairly concise, but could be made more so through eliminating repetitious text, and tightening up & increasing the precision of the language used.

The goal of the following comments is to ensure the summary accurately reflects the technical report; does not make any unsubstantiated statements; and is factual, precise, and accurate.

In light of the overwhelming importance of this executive summary, we encourage the DRMS to seriously consider these comments and make the recommended changes to the executive summary.

HASE 1

Delta
Risk
Manag
Strateg

SEPTEMBER 2008

[D A F T]

List of Documents Prepared by

URS Corporation/Jack R. Benjamin & Associates, Inc.,
for Phase 1 of the Delta Risk Management Strategy (DRMS) Project

Executive Summary

The following documents are available electronically on the DVD inserted at the back of this executive summary. They also are available online at www.drms.water.ca.gov.

Risk Analysis Report

should have 3 blue headers:
1. exec summary
2. risk report
3. technical memoranda
Then list the titles of the TMs below the blue "Technical Memoranda" header and remove the repeated "Technical Memorandum" from each item in the bulleted list

- Seismology Technical Memorandum
- Flood Hazard Technical Memorandum
- Climate Change Technical Memorandum
- Levee Vulnerability Technical Memorandum
- Wind-Wave Hazard Technical Memorandum
- Geomorphology Technical Memorandum
- Subsidence Technical Memorandum
- Emergency Response and Repair Technical Memorandum
- Water Analysis Module (WAM) Technical Memorandum
- Impact to Ecosystem Technical Memorandum
- Impact to Infrastructure Technical Memorandum
- Economic Consequences Technical Memorandum

[D R A F T]

Prepared by URS Corporation
for California Department of Water Resources

Pictured on cover:
Earthquake damage – Sylmar (February 9, 1971)
Source: DWR

Upper Jones Tract failure – Delta (June 4, 2004)
Source: DWR

Flood damage – Delta (June 7, 2004)
Source: DWR

Delta islands protected by levees from flooding
Source: DWR

What do "extremely" and "rapidly" mean?

KEY FINDINGS

The risks of levee failure in the Delta Region and their potential impacts on ~~the valuable resources of California~~ are extremely high.

change to: "California's valuable resources"

Re-arrange paragraph to begin with: "The risk due to Delta levee failures is increasing. This is due to future population growth ... " and then continue to list the items that currently begin the paragraph.

Considering future population growth both in the Delta Region and statewide and the increasing threat of earthquakes, sea level rise, floods, and continuing land subsidence, the risk ~~due to~~ of Delta levee failures is increasing rapidly. ~~Clearly,~~ under current practices, uses and configuration, the Delta and Suisun Marsh are not sustainable.

This is not yet clear to the reader - it's only the first page.

From which perspective are they not sustainable - economically? ecologically? other? all perspectives?

re protected by levees from flooding

DRAFT

KEY FINDINGS

The study shows that the single most catastrophic risk to the Delta Region (which includes the Delta and Suisun Marsh) is from a major earthquake along one of the many nearby faults. T[illegible] arthquake event becomes more likely with each passing year ~~without one~~. A major earthquake could cau[illegible] islands to flood simultaneously, which would have a ~~large~~ economic impact on California. The direct a[illegible] an earthquake are likely to exceed $40 billion.

"large" is very vague. There must be a better word.

change "is likely to" to "could be as high as" (use wording from second bullet)

PRESENT-DAY RISKS

~~Specifically,~~ under ~~a business-as-usual assumption~~, the present-day risk estimat~~ions~~ indicate:

Under present conditions, present-day risk estimates indicate:

SEISMIC HAZARD

- The Delta region is situated near a
- A major earthquake from a fault ne
magnitude 6.7 or greater has a 62 percent probability of occurring in the next 30 years.
- Earthquakes in the region of magnitude 6.7 or greater ~~can~~ may cause many levees to fail. For example, 20 islands could flood simultaneously with a 53 percent probability in the 25-year period between 2005 and 2030. Under these conditions, thousands of feet, if not tens of miles, of levees will experience extensive damage.
- Earthquake d possible vees in the Delta poses the most serious threat of catastrophic consequences.
- Although earthquakes are less frequent than floods, they could cause greater damage than floods, in any single event.

FLOOD HAZARD

- Flood hazard is the most common cause of levee failure in the Delta Region. Floods are more frequent than earthquakes ar
failures in the r
- Multiple and sir
flood hazard, t
extensive as those expected under a major earthquake.

from the technical report, it appears this increase is primarily due to increased flood risk from climate change, not inflation.

SUNNY DAY LEVEE FAILURES

- Sunny day nd are not cause occur at an aver cu of levee s t years. These failures/near failures will not have signif economic impacts; however, the total cost of damag repair of a single flooded island is estimated to be ab $100 million, which was the total repair and damage of the Jones Tract levee failure in 2004.

Need some context here. How many islands were involved in the Jones Tract Levee failure?

IMPACTS FROM LEVEE FAILURES

- The economic impact to the state ~~is likely to exceed~~ $40 billion from a major earthquake in the region.
- The economic impact to the state c
$25 billion from a major flood.
- Impacts to the ecosystem are likely difficult to quantify at this time.

This statement is not as straightforward as it should be. The truth is that the quantitative analysis was not done.

FUTURE RISKS

Under a business-as-usual future, risk estimates indicate:

al ~~assumption,~~ ~~the following future risk estimations indicate:~~

- By 2050, the frequency of island flooding from seismic events ~~will~~ increase by about 35 percent over 2005 conditions. "may" or "will probably"
- By 2100, the frequency of island flooding from seismic events ~~will~~ increase by about 93 percent over 2005 conditions.
- By 2050, the frequency of island flooding from flood events ~~will~~ increase by about 260 percent over 2005 conditions.
- By 2100, the frequency of island flooding from flood events ~~will~~ increase by about 800 percent over 2005 conditions.
- It is difficult to quantify future risks for the Delta Region's ecosystem from levee failures.
- The expected economic impacts to the state of a single event ~~will~~ increase in the future ~~with inflation~~. However, the frequency of these events ~~will~~ increase by the percentages above.

repetitive!

Again, this bullet is potentially misleading. The fact of the matter is that a reasonable approach for fish impacts has been proposed but not carried out, while terrestrial and vegetation analyses are cursory. This could therefore more accurately be stated as: "Future risks to the Delta Region's aquatic ecosystem from levee failures have not been assessed in this report." Lack of ecosystem impacts is an item of major concern to the IRP, as any potential user of the report should be aware that ecosystem impacts have not been quantified.

DRAFT

TABLE OF CONTENTS

OVERVIEW 1
DRMS RISK APPROACH AND ASSUMPTIONS 4
SACRAMENTO-SAN JOAQUIN DELTA AND SUISUN MARSH (THE DELTA REGION) 6
CONDITION OF THE LEVEE SYSTEM 8
RISKS TO THE DELTA REGION 12
Seismic Risks 13
Probability of Multiple Island Failures 13
Failure Probability of Individual Islands 13
Emergency Response and Levee Repair 14
Export Disruption 14
Economic Consequences 15
Impact to Water Quality 16
Ecosystem Consequences 16
Public Health and Safety Consequences 18
Future Seismic Risk 18
Flood Risks 19
Probability of Multiple Levee Failures 19
Failure Probability of Individual Islands 20
Emergency Response and Levee Repair 20
Export Disruption 20
Economic Consequences 21
Impact to Water Quality 21
Ecosystem Consequences 21
Public Health and Safety Consequences 23
Future Flood Risks 23
Sunny Day Levee Failure Risks 24
Combined Risk of Island Inundation from Multiple Hazards 25
NEXT STEP 26

Selected References 26
Acknowledgements 27

DRAFT

OVERVIEW

This executive summary describes the key findings of Phase 1 of the Delta Risk Management Strategy Project (DRMS). Phase 1 of DRMS is an analysis of the risks California is facing due to levee failures in the Sacramento–San Joaquin Delta (referred to as the Delta) and Suisun Marsh (together referred to as the Delta Region). Phase 2 is the development of risk reduction strategies to minimize those consequences. The complete Phase 1 Risk Analysis Report is available on the DVD that accompanies this printed report and online at www.drms.water.ca.gov.

The DRMS Phase 1 analysis assesses the risks to Delta Region levees presented by earthquakes, floods, climate change, subsidence, and a combination of these hazards. This analysis estimates their potential impacts to the local and state economy, the environment, and public health and safety. These impacts are estimated for the current Delta (defined as year 2005) and the future Delta in years 2050 and 2100.

The Phase 1 analysis assumes that existing regulatory and management practices and current Delta Region services will continue in the future. This "business-as-usual" assumption (described in DRMS Risk Approach and Assumptions section) guides the analysis for modeling current ~~risk~~ and ~~for~~ projecting future risk.

[DRAFT]

Pictured above: Staten Island on the North Fork of the Mokelumne River. Source: DWR

Aerial View of Franks Tract from Connect Slough between Mandeville Island
Source: DWR

This sentence somewhat overstates what was done by the Technical Report. We recognize that this was certainly the *intent* of the Report to do this. But in our review we have identified areas where we don't feel this was actually accomplished.

The Delta Region **[FIGURE 1]** is a naturally dynamic, highly manipulated landscape. It is subject to major hazards ~~(earthquakes, floods, etc.)~~ whose probability of occurrence are increasing with time, ~~though at an uncertain rate.~~ The timing of these hazards and their impacts on the Delta Region are highly uncertain. The Risk Analysis Report identifies the estimated levels of risk using quantitative metrics ~~(with clear and understandable error margins)~~ or qualitative descriptions, where available data do not permit quantitative evaluation. The Risk Analysis Report also identifies what is not known now; what part of that uncertainty can be reduced through additional research, experimentation, and management choices; what level of uncertainty must be lived with; and the implications of doing so.

such as earthquakes and floods

this same concept is repeated in the next sentence.

This is a noble goal, but we cannot find where this was actually DONE in the Technical Report. If it was not done, you should not say it was done.

missing verb: "and what are the implications..."

DRAFT

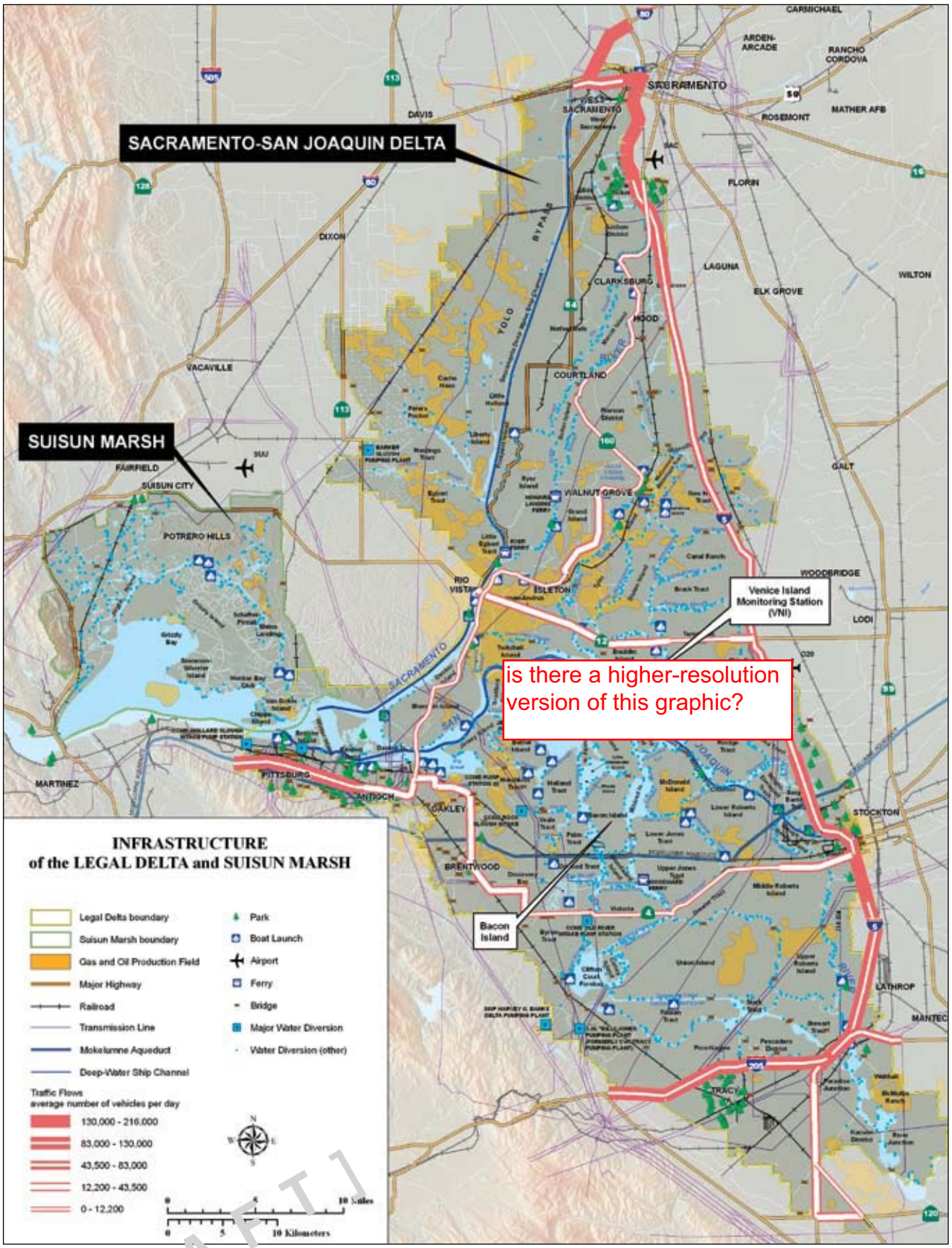
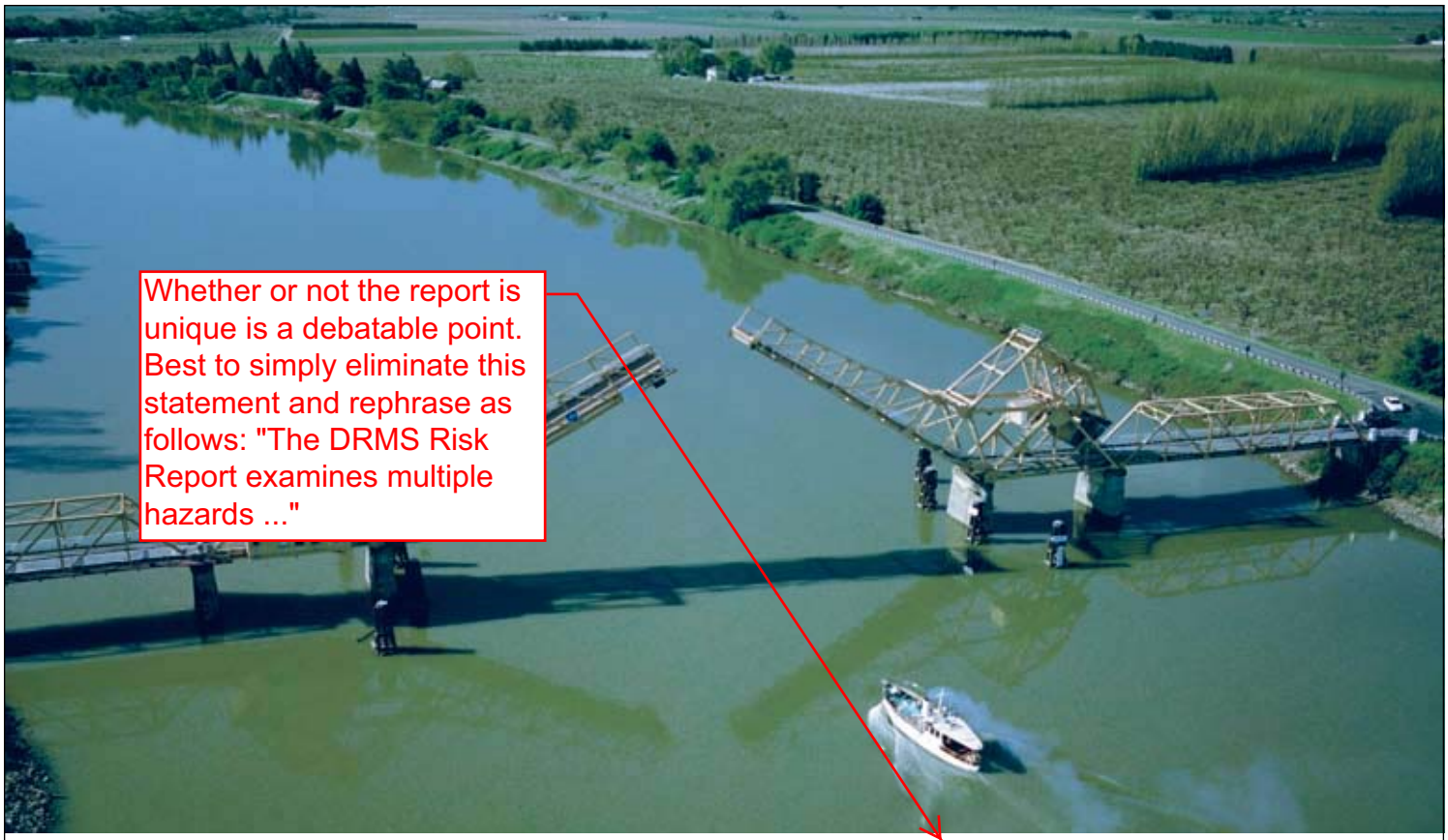


FIGURE 1 **The Sacramento–San Joaquin River Delta and Suisun Marsh (the Delta Region)**

Source: Figure developed by URS for use in Status and Trends Report (URS 2007)

[D R A F T]



Whether or not the report is unique is a debatable point. Best to simply eliminate this statement and rephrase as follows: "The DRMS Risk Report examines multiple hazards ..."

APPROACH

The DRMS ~~framework is unique because it~~ examines multiple hazards and their effects on the Delta Region's levee system ~~and the impact of levee failures on a number of~~ resources and assets.

Need a more accessible word here. "Framework" under the picture of a bridge implies a physical structure.

Language should be precise - "key"or "several" - "number" is too vague.

Run-on sentence. "It also evaluates ...

ssumptions

The DRMS risk analysis evaluates major threats to the Delta Region's levee system that ~~will~~ lead to increased levee failures. The impacts those failures can have on the Delta Region, life safety, its habitat, the state's water delivery system, and those who rely on the Delta for exports of fresh water are evaluated in this report. The DRMS framework ~~is unique because it~~ examines multiple hazards and their effects on the levee system and the impact of levee failures on many resources and assets.

flood and seismic

"can" or "may"

What is "life safety" and "its habitat"? The Delta is not alive, it does not have a habitat. Moreover the ecosystem impacts were not really evaluated by this report.

can you be more specific (many?)

Need to change the wording of this last sentence a little. It is still a run-on sentence, and is exactly the same as the pull-out item at the top.

DRAFT

Pictured above: Bridge on the Sa

The objectives of the DRMS project are to answer the following questions:

fuzzy wording

- **What is the frequency or rate of occurrence of hazard s ~~events~~ of varying magnitudes that can compromise the integrity of Delta Region levees?**
- **How vulnerable are individual levee sections to various hazards?** this question is not really answered by the technical report
- **How do the hazards and levee vulnerabilities interact to produce levee failures?**
- **What are the water quality, economic, ecosystem, and public safety impacts of levee failures?**
- **How will risk change in the future?**

The DRMS Phase 1 Risk Analysis Report identifies the characteristics and problems of the Delta Region with its current practices and uses. This approach, which ~~allows for cor~~ and ~~tion of~~ current policies, funded projects, and practices, is referred to as the "business-as-usual" scenario. Defining a business-as-usual Delta Region is necessary because one ~~of the~~ objectives of DRMS Phase 1 is to estimate whether the current practices of managing the Delta Region are sustainable over the next 100 years. Proposals for Delta Region improvements to reduce these risks are ~~considered~~ in Phase 2 of DRMS.

considers

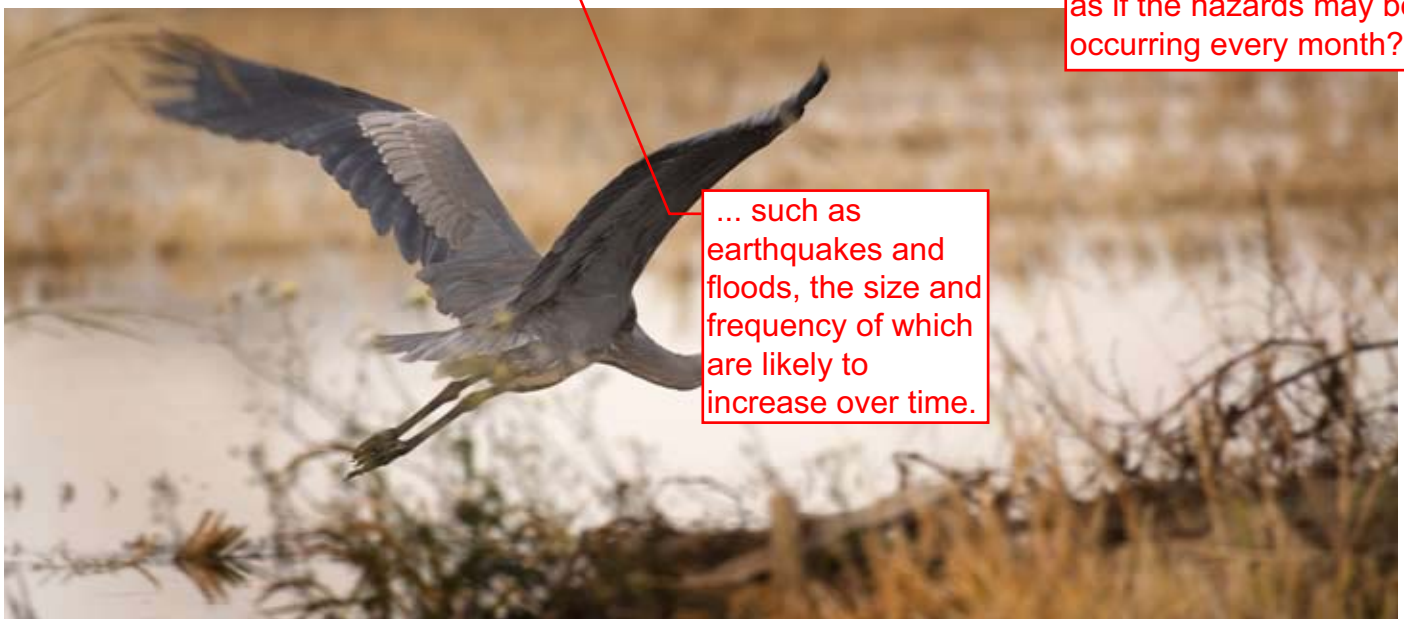
"presented" or "evaluated"

why is water quality first on this list?

This bullet sounds more mechanistically insightful than the technical report actually is.

The Delta Region is a naturally dynamic, highly manipulated landscape. It is subject to major hazards ~~(earthquakes, floods, etc.) whose~~ sizes and frequencies of occurrence are increasing with time...

can this be quantified further, so it doesn't sound as if the hazards may be occurring every month?



... such as earthquakes and floods, the size and frequency of which are likely to increase over time.

Source: DWR

yet ecosystem impacts are not adequately addressed in the technical report

THE DELTA REGION

Although the Sacramento-San Joaquin Delta and Suisun Marsh cover only about 1 percent of California's land area, the region is ~~at the center of many resource issues~~.

"at the center of resource issues" is pure jargon - it means nothing to the average reader. Need to replace this clause with something clearer (i.e., it is the source of drinking water for 2/3 of California's population).

It provides ..

It also houses ...

This is a run-on sentence.

Sacramento-San Joaquin Delta and Suisun Marsh

The Delta and Suisun Marsh are vital to California's economy and environment. The region has highly fertile agricultural land ~~and~~ provides a unique estuarine habitat for many resident and migratory fish and birds, some listed as threatened or endangered species, ~~and~~ houses critical infrastructure for the state's dynamic economy. The Delta is ~~also~~ the hub of the state's water system. About two-thirds of Californians get some portion of their drinking water from the Delta and approximately 3 million acres of agricultural land receive a portion of their irrigation water from the Delta.

Pictured above: Overlooking the Delta at dusk. Source: DWR

[DRAFT]

What is the difference between an engineered vs. a non-engineered levee?

Much of the land in the Delta Region is below sea level and protected by a non-engineered and fragile system of levees. A ~~unique~~ feature of the Delta Region is that much of its land is made up of highly organic soils ~~overlying loose sands~~. These organic soils are fertile and pr[illegible]e an abundant agricultural harvest. However, the process of tilling ~~the soils~~ has caused the land surface to subside at an alarming rate. Over the past 100 years, subsidence has lowered land surface to as much as 25 feet below sea level. The land that is below sea level requires an extensive system of levees to prevent the land from flooding [FIGURE 2].

soil

very subjective. What is "an alarming rate"?

About 1,830 miles of levees protect lands and waterways in the Delta and Suisun Marsh. The levees play a vital role in protecting the various assets, resources, uses, and services that ~~California obtains~~ from the ~~Delta Region~~.

Californians obtain

Better to say "characteristic feature". Most other upper estuarine plains have the same characteristic. So not unique.

This is a good introductory statement but should be moved to a more appropriate place earlier in the document.

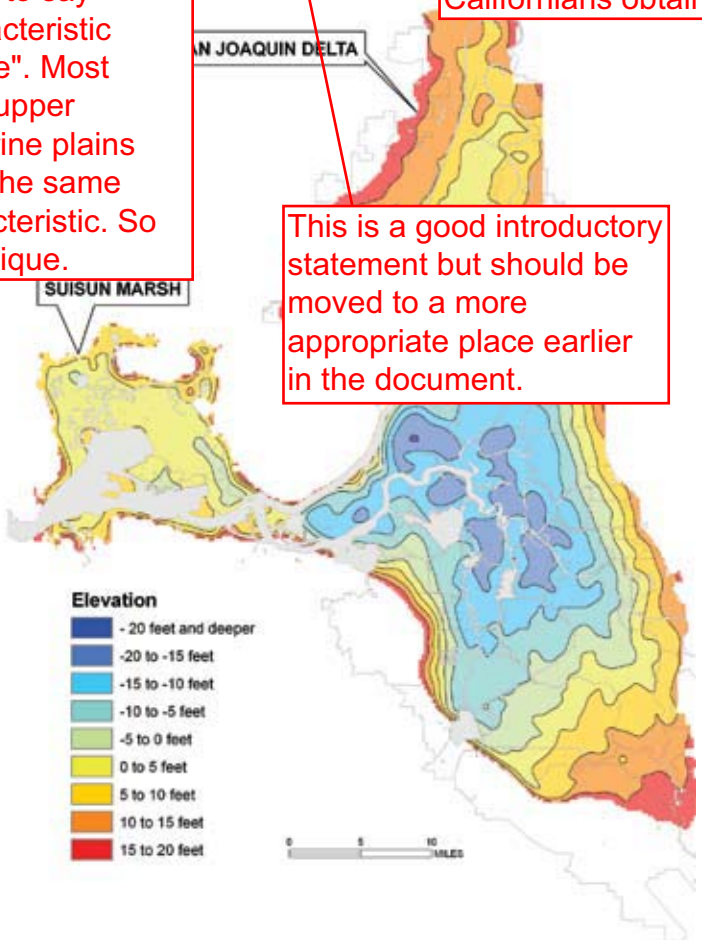


FIGURE 2 **Surface elevation map of Sacramento-San Joaquin River Delta and Suisun Marsh**
Source: DRMS Risk Report (URS/JBA 2008c), Fig. 5-14

Most Delt
Source: D

The most important characteristics of and services provided by the Delta include:

~~Some of the key attributes of the Delta Region are as follows~~:

- Agriculture is the main land use in the Delta.
- Managed conservation land is the main land use in the Suisun Marsh.
- Urban areas are rapidly developing around portions of the Delta Region periphery and within the Delta Region at its margins.
- Over 75 percent of the Sierra Nevada's western watershed in California drains through the [illegible]
- The ecological importance of t[illegible] beyond its boundaries.

By itself, this bullet says nothing concrete. Maybe it should be merged with the next bullet?

- Part of the largest estuary on the west coast of North and South America, the Delta Region supports a unique estuarine habitat. The Delta Region ~~provides for~~ more than 750 resident and migratory aquatic and terrestrial species, some of which are listed as threatened or endangered.

harbors

- About one-quarter of the urban water used in California is diverted from the Delta.
- About two-thirds of Californians get some portion of their drinking water from the Delta.
- Approximately 3 million acres of agricultural land receive a portion of their irrigation water from the Delta.
- Major transportation and utility corridors pass through the Delta Region to other regions of California.
- Wide expanses of open land, interlaced waterways, historic towns, and the feeling of a slower pace of life make the Delta Region attractive for recreation, tourism, and as a place to live.

[DRAFT]

LEVEE CONDITION

Earthquakes, floods, continued land subsidence, and climate change ~~pose threats to the levee system.~~

threaten the levee system.

Condition of the Levee System

Since 1900, levee failures have flooded islands 166 times, some flooded islands have never been recovered. Several Delta islands and tracts have flooded multiple times. Vast land areas lie many ? feet below sea level, and these areas will flood whenever a levee fails. Historically, levee failures have occurred during both flood and non-flood (sunny day) conditions.

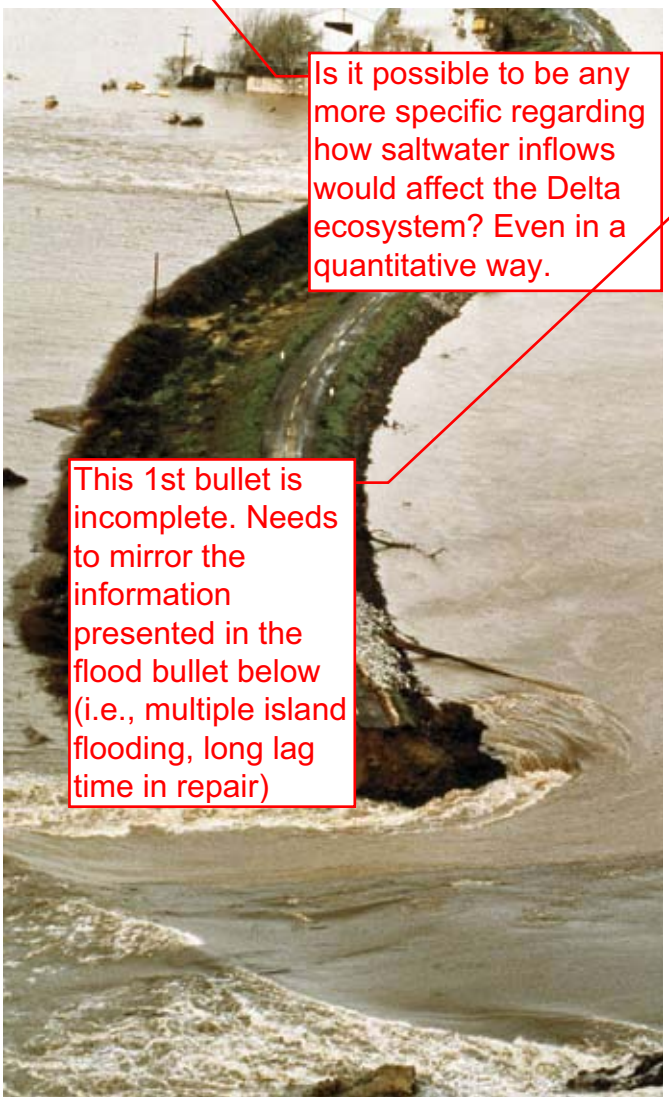
The report doesn't actually talk about island recovery - the flooded islands are now used for recreation and aquatic habitat, and in fact some of them were not recovered intentionally.

[DRAFT]

Pictured above: Protecting the landside of a levee on a flooded island [Jones Tract, 2004].
Source: DWR

The current Delta Region levees have not experienced a damaging earthquake yet. Nonetheless, the risk of widespread damage from a major earthquake is high. An earthquake could cause multiple levee failures and several islands to flood simultaneously. If the disaster occurs during a time of low or moderate Delta inflow, saline water would flow into the Delta from Suisun Bay. This saline water would subsequently fill the islands and cause the Delta waters to become highly salty. Delta waters then could not be used for in-Delta irrigation supplies, local urban supplies (for example, use by the Contra Costa Water District), or state and federal water project exports. Impacts would also occur to the Delta ecosystem.

Key hazards ...



Is it possible to be any more specific regarding how saltwater inflows would affect the Delta ecosystem? Even in a quantitative way.

This 1st bullet is incomplete. Needs to mirror the information presented in the flood bullet below (i.e., multiple island flooding, long lag time in repair)

Levee breaches at Tyler Island (1986). Source: DWR

Delta levees are susceptible to seismic-induced liquefaction. Seismic-induced levee failures in the Delta ~~will~~ be similar to those that occurred in Kobe in 1994. Source: Professor Ray Seed.

would/could/may

~~The~~ hazards and their effects on levee integrity include:

- Earthquakes which ~~can~~ cause damage to many miles of levees.
- Floods (defined as high storm runoff into the Delta Region) combined with high tides can cause water to rise above the tops of the levees or increase pressure on the levees and foundations, causing instability and seepage through and under the levees. These flood-related effects can lead to levee failures and can cause several islands to flood in a single storm. However, because damage typically occurs at discrete points, repairs can typically be made quickly compared to seismic levee damage.
- Subsidence increases the landside height of a levee, intensifying the water pressure on the levee. Greater water pressure increases the risk of seepage through and under the levee. (See **FIGURE 3** for more on subsidence and Delta farmed land.)

It's not clear that this statement is supported by the technical report.

Levee failures flooded islands

166 times since 1900

DRAFT

This is the wrong title for the plot

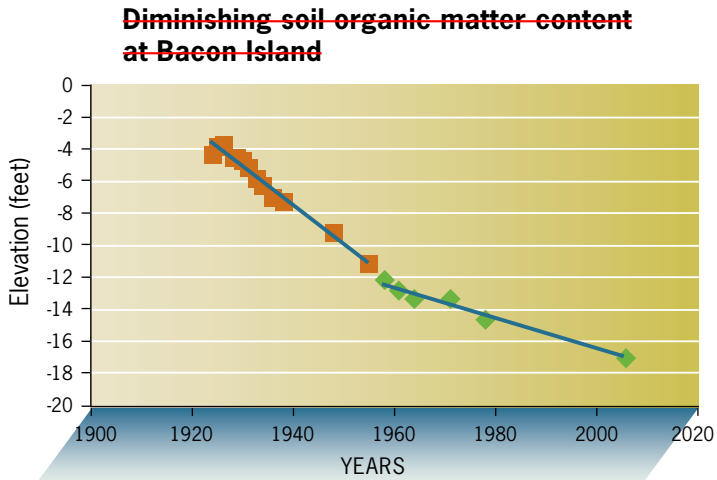


FIGURE 3 *Source: DRMS Subsidence TM (URS/JBA 2007a), Fig. 8*

Figure 3 shows the average change in elevation *for Bacon Island from 1922 to 2006. From 1924 to 1955, the subsidence rate was estimated to be 7.2 centimeters/year (2.83 inches/year). The subsidence rate from 1958 to 2006 was estimated to be 2.9 centimeters/year (1.16 inches/year), which is 40 percent less than the 1924–1955 rate.*

The organic content of the farmed land in the Delta is decreasing exponentially, which combined with improved land-management practices is resulting in a slower rate of subsidence. The change in the rate of subsidence from the pre-1955 period to the present [Figure 3] was in large part due to changing land-management practices.

Ultimately, the depletion of organic matter will result in no further subsidence. Currently, a large portion of the farmed land in the Delta has low to no organic content.

is likely to have

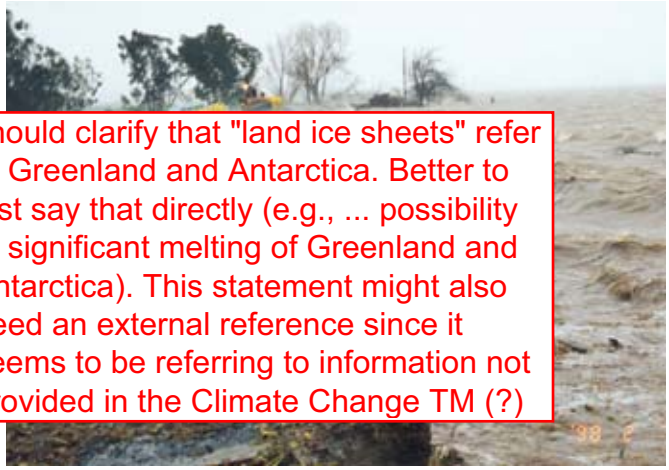
What are the rest? Either say "The primary impact is sea level rise" and just talk about it, or must mention other possible impacts here as well.

- Climate change ~~has~~ multiple impacts. One of the primary impacts on the Delta Region is sea level rise. Sea level rise projections are shown in **TABLE 1**. These projections are based on results from several sources and were developed for the DRMS Phase 1 analysis. Sea level rise will directly affect levee stability and ~~will~~ cause salt intrusion, as shown in **FIGURE 4**. Salt intrusion can affect species dependent on a freshwater environment. The sea level rise projections do not include the possibility of significant melting of land ice sheets, which could further impact the Delta Region.

can

- Sunny day events refer to levee failures that occur during normal, non-flood conditions, typically between the end of the Sierra Nevada snowmelt and the beginning of the rainy season. Sunny day failures are caused by undetected defects, such as burrowing animal activities, pre-existing weaknesses, or high seepage caused by unusually high tides. These events are typically single-island events and historically have been repaired in a matter of weeks.

aken levees but are opes of levees when islands are flooded. Damage to the interior slopes on one island could result in secondary levee failures on adjacent islands if not repaired.

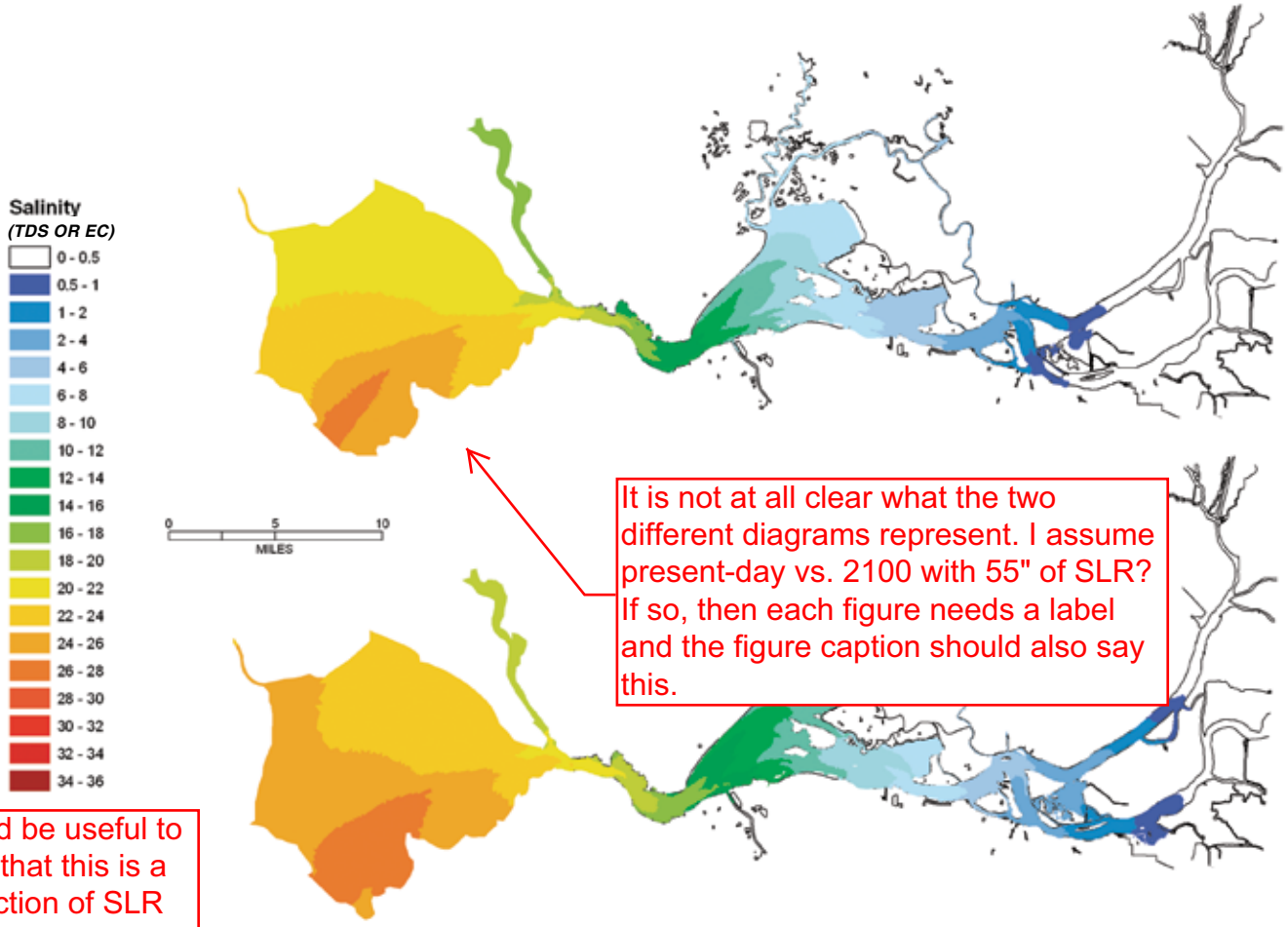


Erosion of a Delta levee during a storm and high tide.
Source: DWR

should clarify that "land ice sheets" refer to Greenland and Antarctica. Better to just say that directly (e.g., ... possibility of significant melting of Greenland and Antarctica). This statement might also need an external reference since it seems to be referring to information not provided in the Climate Change TM (?)

as well as other coastal lowlands.

[D R A F T]



It is not at all clear what the two different diagrams represent. I assume present-day vs. 2100 with 55" of SLR? If so, then each figure needs a label and the figure caption should also say this.

Would be useful to state that this is a prediction of SLR at 2100 (based on Table below)

FIGURE 4 **Estimated saltwater intrusion as a result of 140 centimeters (55 inches) of the sea level rise expected in 2100**

Source: DRMS Water Analysis Module TM (URS/JBA 2007b), Appendix H3, Fig. H3.5-6

Recommended seems like the wrong word here: estimated, or predicted...

RECOMMENDED VALUES FOR GLOBA at the Golden Gate relative to 1990 value (in			
Date	**Range of Sea Level Rise**	**Sea Level Ir (centime**	**ement**
2050	High[1]	41	16
	Mid[2]	30	12
	Low[3]	20	8
	Llinear extrapolation[4]	11	4
2100	High[1]	140	55
	Mid[2]	[illegible]	[illegible]
	Low[3]	[illegible]	[illegible]
	Llinear extrapolation[4]	[illegible]	[illegible]

[1] *Based on Rahmstorf 2006 high estimate.*
[2] *Based on Rahmstorf 2006 mid estimate and IPCC 2001 high estimate.*
[3] *Based on Rahmstorf 2006 low estimate and IPCC 2001 mid estimate.*
[4] *Based on linear extrapolation from observed increases during twentieth century.*

TABLE 1 *Source: URS/JBA 2008a, Table 2*

2 "LL"s in "Llinear"

what does "during 20th C" mean -- 1900 to 1999? SLR rate doubled over > the last half of the century. Therefore would be more accurate to use a shorter time period to base the linear extrapolation on (e.g., the length of the TOPEX record). Otherwise the linear extrapolation method significantly under-estimates even present-day rates of SLR.

RISKS TO THE DELTA REGION

With its current uses and practices, the Delta Region is not sustainable.

... over what time frame? Next 100 yrs?

less dramatic wording - "major"?

A massive failure of the Delta Region's levee system would have ~~staggering~~ effects on California's economy. The risks to the Delta Region are continuously increasing ~~and will increase manyfold over today's risks~~. The risks analyzed in DRMS include seismic, flood, and sunny day levee failures.

Change the order of this paragraph as follows:
"... are continuously increasing. The risks analyzed in DRMS ... failures. Over the coming century, they are likely to increase many times relative to today's risks."

Pictured above: Upper Jones Tract Failure [June 4, 2004].
Source: DWR

DRAFT

The U.S. Geological Survey estimates that ...

SEISMIC RISKS

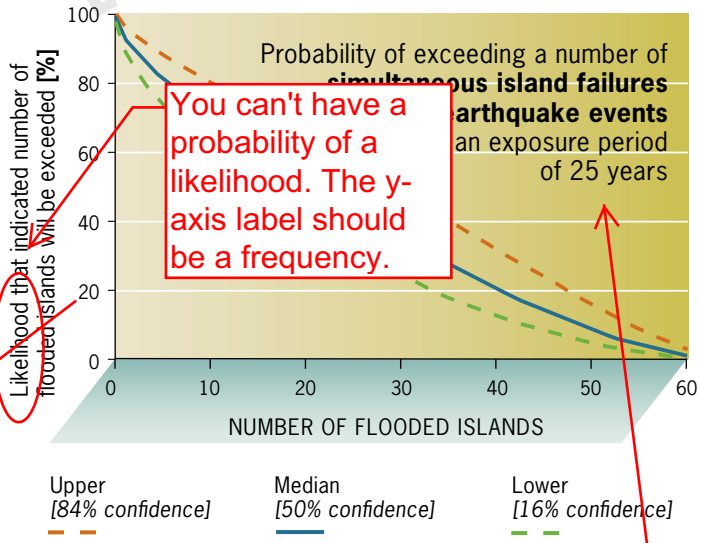
Seismic activity in the Delta region is characterized as moderate to high, as shown in **FIGURE 6**. ~~Experts estimate~~ that an earthquake of magnitude 6.7 or greater has a 62 percent probability of occurring in the San Francisco Bay Area during the next 30 years [**FIGURE 7** – *see next page*]. Such an earthquake ~~is~~ may be capable of causing multiple failures of Delta Region levees and severely affecting export water deliveries for an extended period. The highest potential for seismic levee failures ~~will~~ would come from an earthquake on the Hayward, ~~Midland,~~ Calaveras, ~~or~~ San Andreas faults.

Midland is a buried fault; no historical seismicity, hence not comparable to other faults listed here.

Probability of Multiple Island Failures

Earthquakes can cause extensive damage to thousands of feet, if not tens of miles, of levees. As a result, many islands could flood simultaneously. **FIGURE 5** displays the likelihood of multiple islands flooding as a result of earthquakes in the Delta Region during a 25-year period under current practices. For example, there is about a 53 percent chance that 20 or more islands in the Delta Region will be flooded by a major earthquake in the next 25 years (2005 to 2030).

... during a major earthquake.



You can't have a probability of a likelihood. The y-axis label should be a frequency.

FIGURE 5 *Source: DRMS Risk Report (URS/JBA 2008c), Fig. 13-4*

This text needs to be moved to the figure caption and simplified. The figure title should simply state something like: "Probability of multiple island flooding"

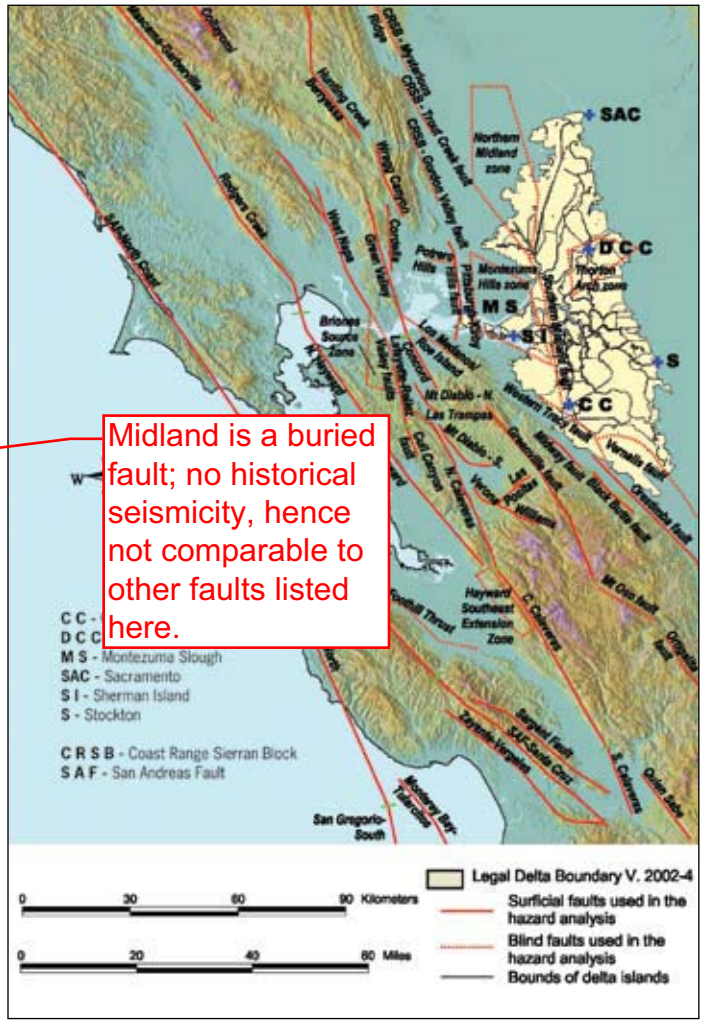


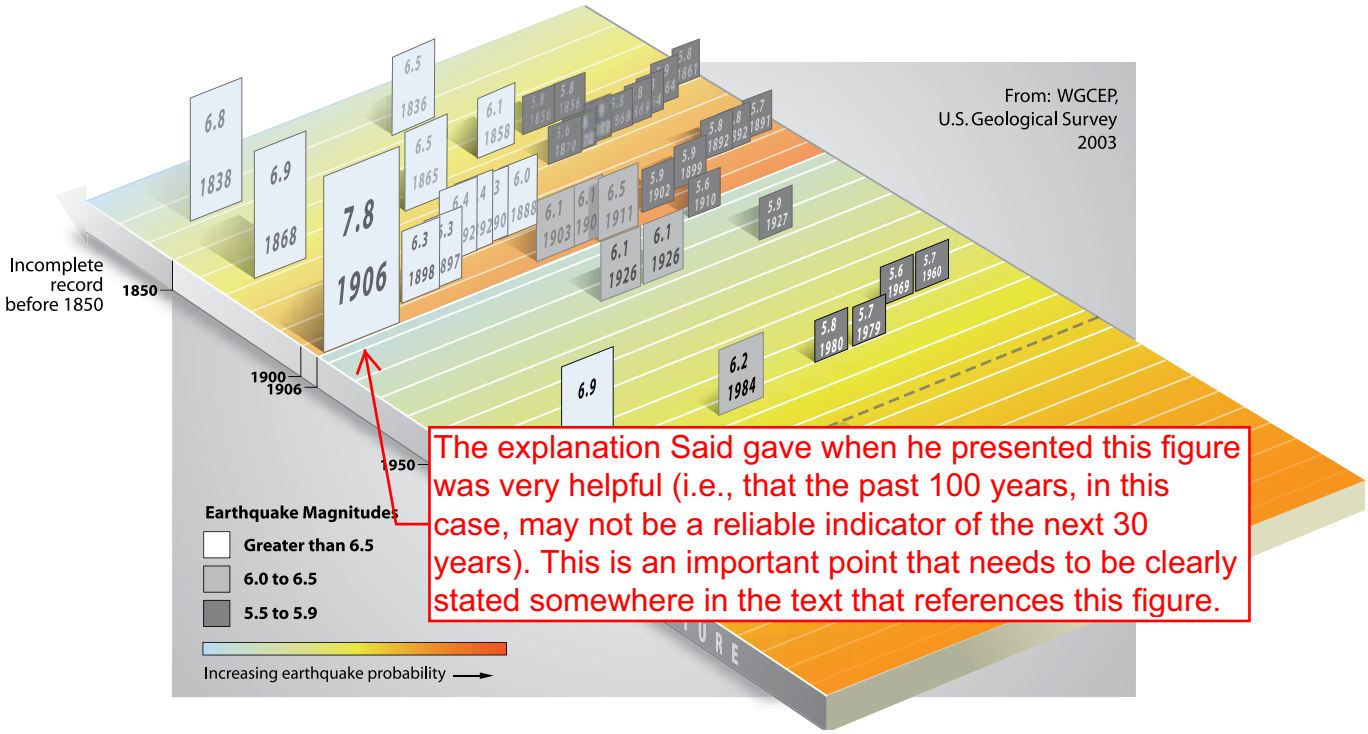
FIGURE 6 **Faults and seismic sources in the regional vicinity of the Delta**

Source: DRMS Risk Report (URS/JBA 2008c), Fig. 6-1

Failure Probability of Individual Islands

The expected annual frequency of failure from earthquakes for each island is shown in **FIGURE 8** *[page 15]*. The map is color coded to show groups of islands with similar ranges of annual seismic failure rates. The areas with lower seismic failure rates tend to be in the western Suisun Marsh and the eastern and northern portions of the Delta. The areas with higher seismic failure rates are in the central and south-western Delta and eastern Suisun Marsh.

[DRAFT]



The explanation Said gave when he presented this figure was very helpful (i.e., that the past 100 years, in this case, may not be a reliable indicator of the next 30 years). This is an important point that needs to be clearly stated somewhere in the text that references this figure.

FIGURE 7 **Past and future earthquakes in the Bay and Delta regions**

Source: DRMS Risk Report (URS/JBA 2008c), Fig. 13-8

DURATION AND COST OF REPAIRS for Earthquake-Induced Levee Failures		
Number of Flooded Islands	Estimated Range of Cost of Repair and Dewatering [$million]	Estimated Range of Time to Repair Breaches and Dewater [days]
1	43 – 240	136 – 276
3	204 – 490	270 – 466
10	620 – 1,260	460 – 700
20	1,400 – 2,300	750 – 1,020
30	3,000 – 4,200	1,240 – 1,660

TABLE 2 *Source: DRMS Risk Report (URS/JBA 2008c), Table 13-9*

EXPORT DISRUPTION from Earthquake-Induced Levee Failures		
Number of Flooded Islands	Duration of Export Disruption [days]	Amount of Water Not Exported [millions of acre-feet]
1	0 – 138	0 – 1.1
3	1 – 197	0 – 2
10	1 – 320	0 – 3.1
20	2 – 481	0.01 – 8.2
30	3 – 624	0.1 – 10.6

TABLE 3 *Source: DRMS Risk Report (URS/JBA 2008c), Figures 13-17 and 13-18; William Betchart, personal communication, July 2008.*

These tables need captions. Also, would be helpful to change "days" to "weeks". No one has a good concept of how many weeks 1,200 days is.

Emergency Response and Lev

This is not only due to the number of ...

The duration and cost of levee repairs rise with the number of islands flooded in an earthquake [TABLE 2]. not only from the number of repairs required but also due to availability of labor and materials to make repairs. For example, it ~~will~~ take 750 to 1,020 days (about 2 to 3 years) and $1.4 to $2.3 billion to repair damaged and breached levees and dewate 20 flooded islands. As noted in the previous section there is about a 53 percent chance that ~~such~~ an earthquake will strike the Delta Region in the next 25 years (2005- 2030).

would

capable of causing such damage

Export Disruption

Earthquake damage to the levees and the islands they protect could take years to repair. The largest and most

...emergency repair could cost up to

$2.3 billion

and take about 3 years to repair 20 flooded islands.

in 2005 dollars?

significant impacts from levee failures are to the state's water supplies. For example, for 20 flooded islands the export of Delta fresh water could be disrupted for about a year and a half, with a loss of up to 8.2 million acre-feet of water to state and federal water contractors and local water districts [TABLE 3]. Again as noted in the probability section there is a 53 percent chance that such an event will occur in the next 25 years (2005- 2030). Contra Costa Water District, an urban agency in Northern California, is likely to be at the greatest economic risk from disruption, particularly in dry years, ~~because~~ this district relies heavily on Delta water.

when

onomic Consequences

The total economic costs and impacts from multiple levee failures in the Delta could be tens of billions of dollars to the state. FIGURES 9A AND 9B show the probability of economic losses from potential earthquakes during the 25-year period 2005 through 2030. For example, there is about 40 percent chance of incurring $22 billion or more in costs [FIGURE 9A] and about $3 billion or more in impacts [FIGURE 9B].

[D R A F T]

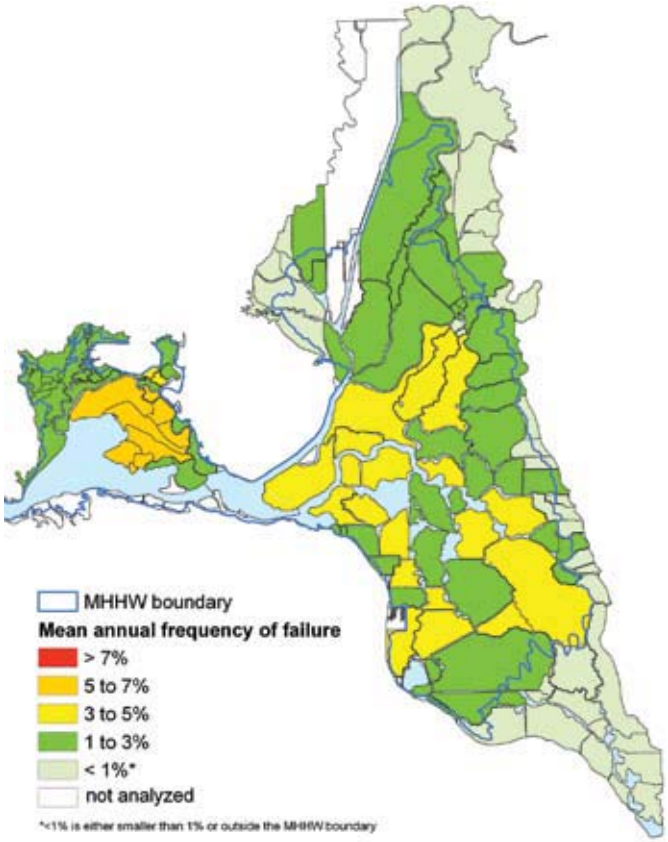
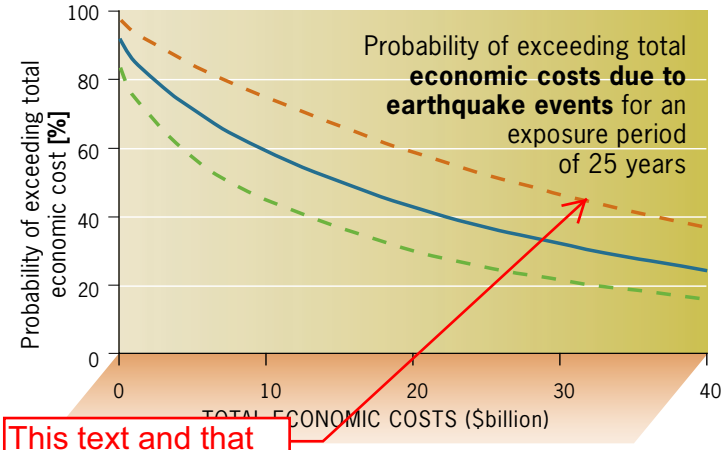
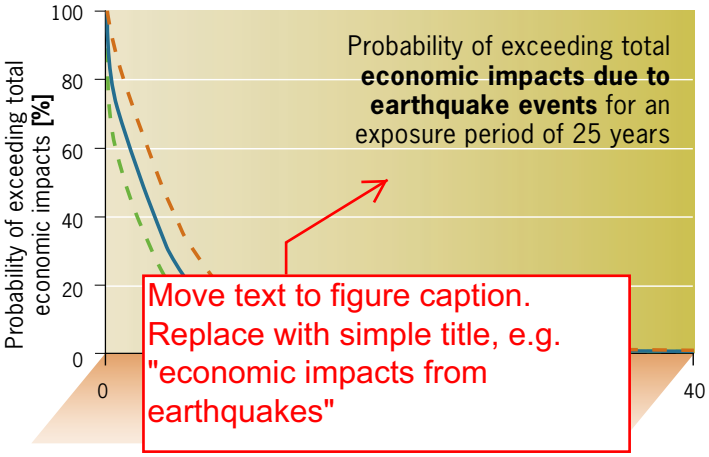


FIGURE 8 Annual frequency of failure of individual islands as a result of earthquakes

Source: DRMS Risk Report (URS/JBA 2008c), Fig. 13-7





Move text to figure caption. Replace with simple title, e.g. "economic impacts from earthquakes"

This text and that on figure 9b should be moved to the beginning of the figure caption. All you need here is a simple title (e.g. economic costs from earthquakes). Also "exposure period" is jargon. Use time period instead.

r *[84% confidence]* — Median *[50% confidence]* — Lower *[16% confidence]*

the direct economic losses associated
racts, islands, and infrastructure; the
and the payment of living expenses for
tural losses; and the lost water supply to
ntractors and local water districts.

S/JBA 2008c), Fig. 13-19a (costs) and 13-19b (impacts)

FIGURE 9b

Economic Impacts *include the indirect economic losses associated with the loss of potential revenues because of services not provided. These include the loss of revenue that customers of Pacific Gas and Electric Company, Metropolitan Water District of Southern California, railroads and other service providers suffer because they lose the services these companies provide, combined with lost wages and jobs that result because consumers lose these services.*

two periods

Impacts to Water Quality

how much?

DISSOLVED ORGANIC CARBON: If subsided Delta islands flood due to a levee breach, significant amounts of dissolved organic carbon (DOC) would be released from the high organic-matter soils. Depending on several factors, these elevated levels of DOC could adversely affect the drinking water supply from the Delta. DOC reacts with disinfectants during the drinking water treatment process to produce disinfection byproducts, many of which can cause cancer ~~at elevated~~ levels.

If they occur at sufficiently high

After the suspended sediments have cleared from Delta island flooding, algae may increase and bloom, which would produce another source of DOC and disinfection byproducts. These [illegible] could challenge water treatment facilities and require ~~costly~~ treatment and could e[illegible]s that supply drinking water to many urban areas for an unspecified period. These events could also increase food supply to the ecological food web, though the food would not necessarily support native species.

expensive

run-on sentence

METHYLATION OF MERCURY: Some soils in the Delta Region ~~have moderate levels of mercury~~ due, among other things, to historical inputs from gold mining activities during the Gold Rush. When islands are flooded, some mercury in the soils can change from a non-toxic element to the toxic methylated form under some circumstances.. Methylated mercury can be absorbed by an organism at a rate quicker than the organism can lose it, allowing the Methylated mercury to move up the food chain to fish and humans. Of particular concern is the availability of Methylated mercury during algal blooms, which provides a pathway up the food chain.

of what - levee failure?

Ecosystem Consequences

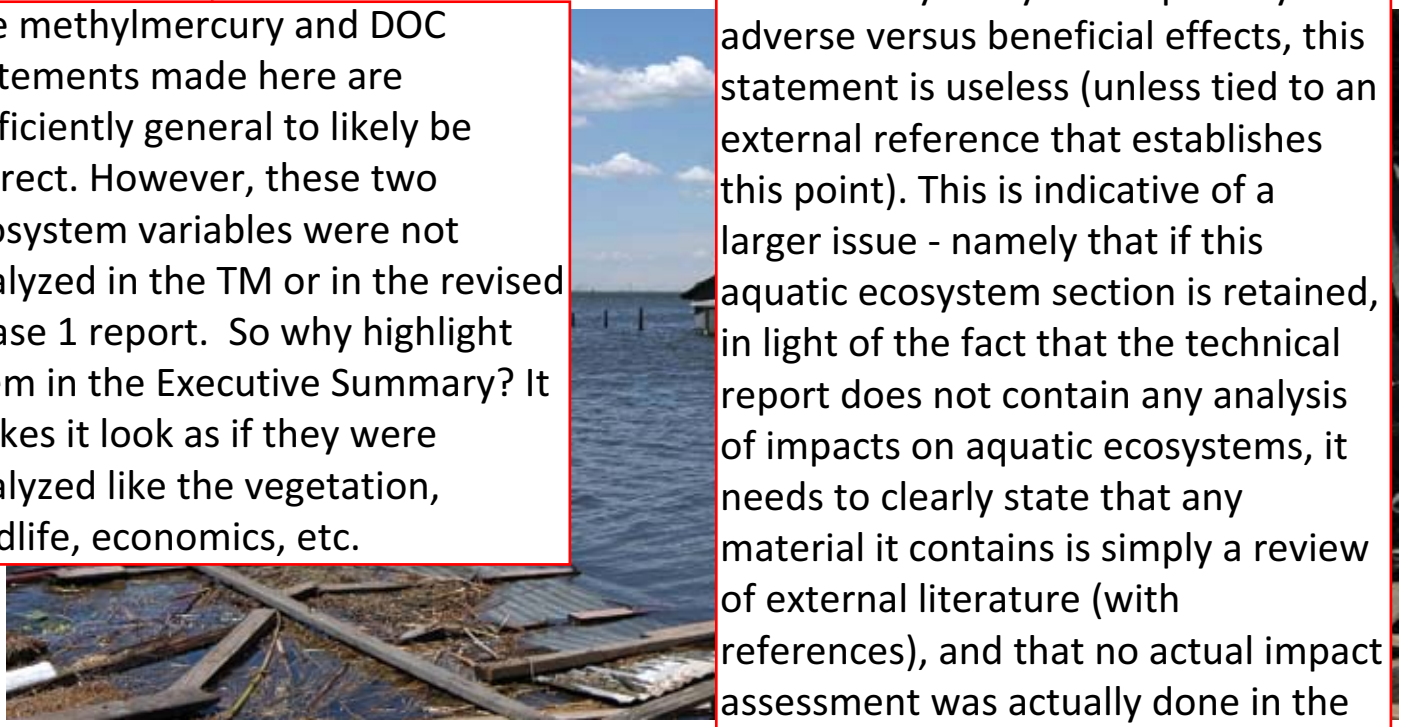
Ecosystem impacts and consequences are similar, whether they result from seismic, flood or sunny day failures. The key factors are time of year, water conditions, location and number of breaches.

Can't state this. Ecosystem impacts were not adequately quantified in the technical report.

IMPACTS TO AQUATIC [illegible] flooding caused by earthquakes can have both adverse and beneficial impacts on the aquatic ecosystem. Aquatic species ~~can die as a result of entrainment~~ (i.e., inflow of water through a breach in a levee that transports fish into a flooding island) combined with the ensuing murky waters during and

The methylmercury and DOC statements made here are sufficiently general to likely be correct. However, these two ecosystem variables were not analyzed in the TM or in the revised Phase 1 report. So why highlight them in the Executive Summary? It makes it look as if they were analyzed like the vegetation, wildlife, economics, etc.

Without any analyses to quantify the adverse versus beneficial effects, this statement is useless (unless tied to an external reference that establishes this point). This is indicative of a larger issue - namely that if this aquatic ecosystem section is retained, in light of the fact that the technical report does not contain any analysis of impacts on aquatic ecosystems, it needs to clearly state that any material it contains is simply a review of external literature (with references), and that no actual impact assessment was actually done in the DRMS Phase I report.



Flood damage – Delta (June 7, 2004). Source: DWR

DRAFT

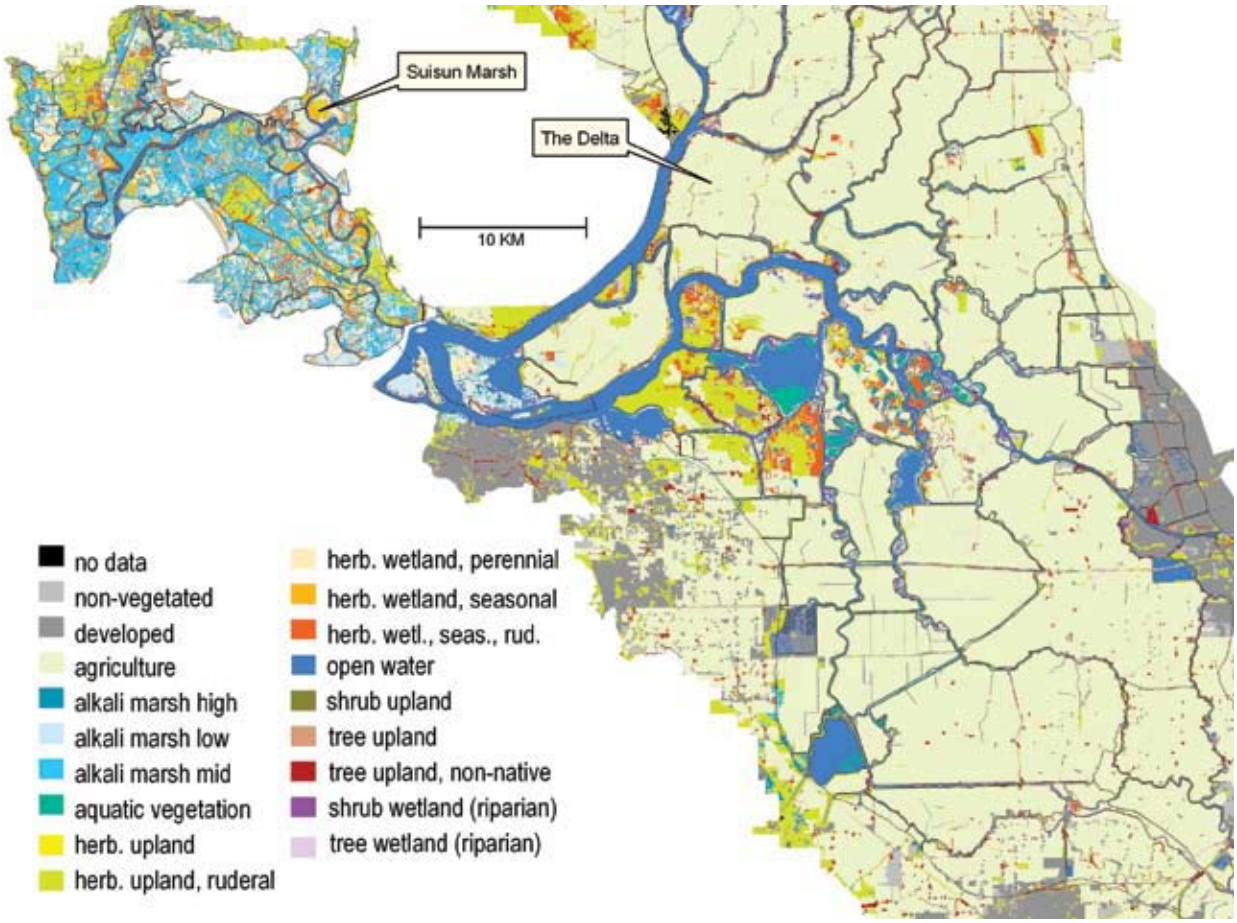


FIGURE 10

Needs a figure caption

Vegetation of the Delta and Suisun Marsh

Source: DRMS Risk Report (URS/JBA 2008c), Fig. 12-13a, 12-13b, and 12-13c

immediately after islands flood. Pumping flooded islands after breach repair will also kill aquatic species that inadvertently colonized island habitat. On the other hand, the temporary stoppage of water export operations and the creation of new aquatic habitat present potential ecosystem benefits. The magnitude of each of these impacts varies by specie, number and location of flooded islands, time of year that flooding occurs and the time that elapses between levee failure and breach repair.

missing comma

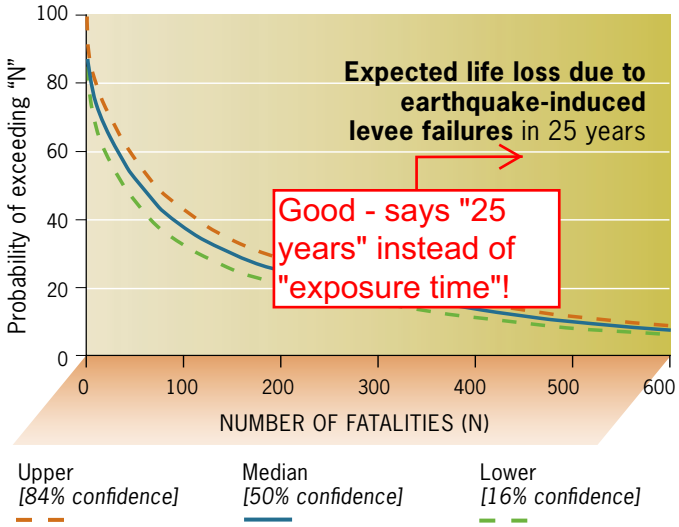
IMPACTS TO NATURAL VEGETATION: FIGURE 10 shows the natural vegetation of the Delta and Suisun Marsh. In all seismic levee failure scenarios, the vegetation area that is damaged increases with the area flooded, but the degree of impact depends on the vegetation type. Results indicate losses of up to 39 percent of herbaceous wetland, seasonal ruderal vegetation; 29 percent of non-native trees; and 24 percent of shrub wetland in the Delta and Suisun Marsh. (Agricultural vegetation is not discussed here.) Of the critical vegetation types that include native vegetation and rare species of vegetation, native herbaceous upland vegetation (which comprises a small total area of the Delta [less than 500 acres]) is not impacted by flooding in any of the cases. Also, less than 12 percent of critical intertidal and aquatic habitat is impacted in any scenario. However, a considerable amount of critica habitat including alkali high marsh, shrub wetland and ripar trees are reduced by 10-24 percent in the Delta and Suisun Marsh. Overall, these results, though not incorporating the impacts of levee breaches on sensitive species, suggest that the primary impacts of flooding are on non-native vegetation types.

how much?

IMPACTS TO TERRESTRIAL SPECIES: The breaching of levees in Suisun Marsh would potentially result in impacts on several terrestrial wildlife species of concern, including

POTENTIAL losses

DRAFT



Good - says "25 years" instead of "exposure time"!

FIGURE 11 *Source: DRMS Risk Report (URS/JBA 2008c), Fig. 13-20*

Needs a caption.

the federally endangered saltmarsh harvest mouse and the California clapper rail, and saltmarsh common yellowthroat and Suisun ornate shrew. The results suggest that large-scale levee breaches cause substantial losses of available habitat, food shortages, and displacement of birds and other terrestrial species. However, other environmental benefits could result due to the increase in tidal water habitat.

Public Health and Safety Consequences

The Delta island levees most likely to fail are generally located in the central-west area of the Delta. Their failure ~~will~~ cause rapid flooding of the affected islands, leaving little time for evacuation.

would

The most immediate public safety concern is for the people on flooded islands. The estimated loss of life resulting from an earthquake in the region is shown on FIGURE 11. For example, there is a 40 percent probability of 90 fatalities or more in the region from earthquake-induced levee failures in 25 years (2005-2030). The expected life loss from earthquake-induced island flooding is higher because of the reduced warning time during major earthquake events.

Future Seismic Risk

Assuming an earthquake does not happen before years 2050 and 2100, all factors considered in developing an estimate of seismic risk are expected to increase. These factors include the likelihood of future earthquakes, the seismic vulnerability of levees, and the consequences of levee failures. TABLE 4 provides a range of low, medium, and high estimates of the increase in these factors for 2050 and 2100 relative to the 2005 business-as-usual assumption. Due to an increase in seismic hazard and levee fragility in the future, the risk of levee failure in the Delta Region increases on average by 35 percent over the next 50 years and 93 percent over the next 100 years. The more significant increases in risk are expected for impacts to in-Delta resources (potential life loss and expected economic losses). These risks increase because of the impact of salinity intrusion and the growing statewide population and economy. The potential loss of life is expected to increase on average by about 250 percent from 2005 to 2050. The expected economic losses are anticipated to increase on average by about 200 percent for 2050 and by about 500 percent for 2100.

DRAFT

EXPECTED FUTURE INCREASE IN EARTHQUAKE HAZARD AND ITS CONSEQUENCES

Risk Factor	2050			2100		
	Low	Medium	High	Low	Medium	High
Seismic Hazard	10%	10%	10%	20%	20%	20%
Frequency of Island Flooding[a]	28%	35%	49%	68%	93%	140%
Potential Loss of Life	229%	249%	283%	N/A	N/A	N/A
Expected Economic Losses	160%	202%	260%	291%	500%	831%

TABLE 4 [a] *Increased frequency in island flooding reflects increased hazard and fragility. N/A = not available.*
Source: URS/JBA 2008c, Table 14-23

Table needs a caption.

FLOOD RISKS

Although earthquakes pose the greatest single risk to the Delta Region, flooding is also a serious hazard. High water during large floodflows into the Delta Region can overtop levees or increase hydrostatic pressure on levees and their foundations, causing instability. High water can also cause through-levee seepage and under-levee seepage failures. Most levee failures in the Delta Region have occurred during floods, often in conjunction with high tides, storm surges, or other storm-related phenomena. FIGURE 12 shows measured and predicted water surface elevation and ranges as a function of return periods at the Venice Island monitoring station (VNI). See FIGURE 1.

What is Fig 1? Need reminder - it's been a long time.

Probability of Multiple Levee Failures

Levee breaches from high floodflows into the Delta are the most common type of failure. Considering the probability of all flood-related levee breaches under current conditions, about 140 failures ~~will~~ occur in the Delta during the next 100-year period (compared to 166 in the past 100 years). This number corresponds to an average rate of 1.4 failures per year.

are likely to (not will)

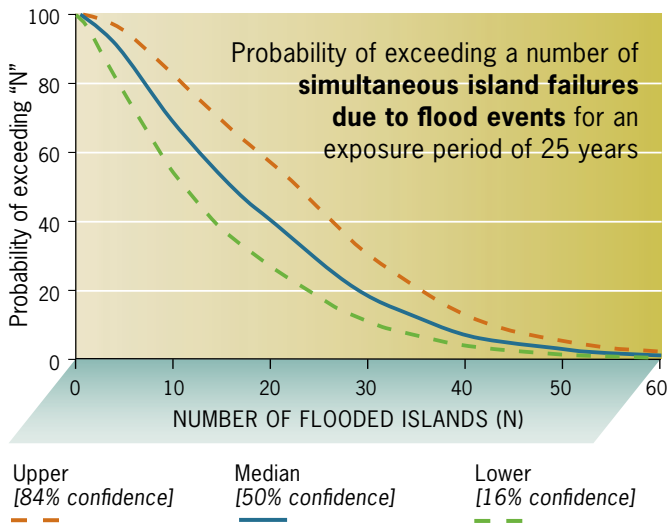
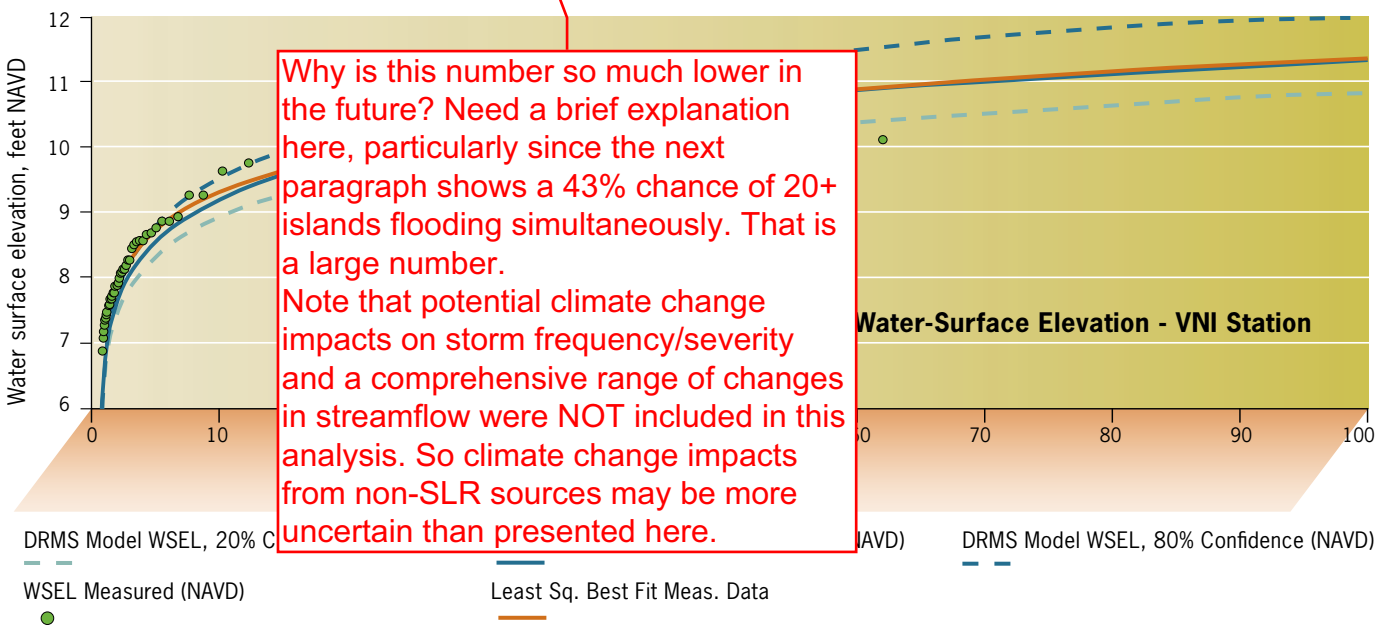


FIGURE 13 *Source: DRMS Risk Report (URS/JBA 2008c), Fig. 13-11*

Need to simplify figure title (probability of multiple island floods) and add figure caption.

Depending on the severity of the in-Delta storm-induced flows, multiple islands could fail during a single storm event. FIGURE 13 illustrates the probability of multiple islands flooding for the 25-year period 2005 through 2030 under business-as-usual conditions. For example, there is a 43 percent chance on average that 20 islands or more will flood in the Delta region during a flood event in 25 years (2005-2030).

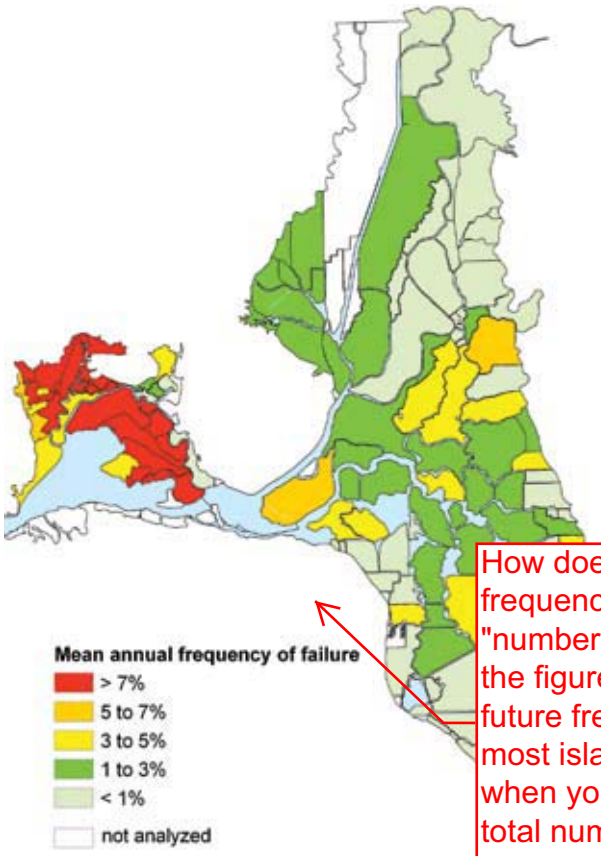


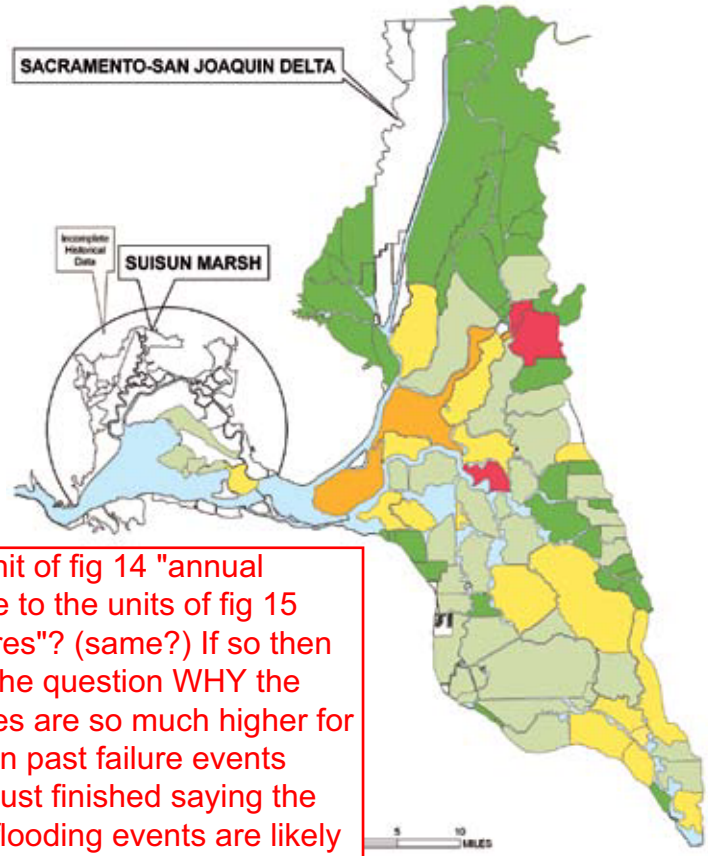
Why is this number so much lower in the future? Need a brief explanation here, particularly since the next paragraph shows a 43% chance of 20+ islands flooding simultaneously. That is a large number.
Note that potential climate change impacts on storm frequency/severity and a comprehensive range of changes in streamflow were NOT included in this analysis. So climate change impacts from non-SLR sources may be more uncertain than presented here.

FIGURE 12 *Source: DRMS Flood Hazard TM (URS/JBA 2008a), Figure 7.1*

Needs caption.

DRAFT





How does the unit of fig 14 "annual frequency" relate to the units of fig 15 "number of failures"? (same?) If so then the figures beg the question WHY the future frequencies are so much higher for most islands than past failure events when you have just finished saying the total number of flooding events are likely to be less in the 2000s than the 1900s.

FIGURE 14 **Expected future mean annual frequency of failure of individual islands as a result of floods**

Source: DRMS Risk Report (URS/JBA 2008c), Fig. 13-13a

FIGURE 15 **Number of failures in the last 100 years for individual islands as a result of floods**

Source: DRMS Risk Report (URS/JBA 2008c), Fig. 13-13b

Failure Probability of Individual Islands

The expected annual frequency of flood-related failure for each island is shown in **FIGURE 14** as fitting into one of five bands (less than 1 percent, between 1 percent and 3 percent, etc.). The areas with higher failure rates tend to be in Suisun Marsh and to a lesser extent in the central and western parts of the Sacramento-San Joaquin River Delta, but overall the patterns appear to be more variable for floods than for earthquakes. **FIGURE 15** shows the actual annualized numb After of levee failures since 1900.

Emergency Response and Levee Repair

In general the cost of levee repairs are less for floods than for earthquakes because flood-related breaches tend to be more localized and much smaller than seismic-induced levee breaches. The duration of repair and dewatering are generally similar for a given number of flooded islands.

is estimated to take

As shown in **TABLE 5**, for example, it ~~will~~ take about 930 to 1,110 days (about 2½ to 3 years) and $990 million to $1.2 billion to repair damaged and breached levees and dewater 20 flooded islands.

Export Disruption

~~Under~~ flood-induced levee failures, no significant export disruptions are expected at the time of the failure. The Delta would be flooded with fresh water; the size and number of levee breaches would be smaller (compared to earthquake-induced breaches); and with fewer breaches the repairs would take less time. Due to these factors the Economic costs and impacts would generally not be as high as ~~with the~~ earthquake-induced failures.

remove "E"

[DRAFT]

Run-on sentence. Change to: "... disrupted. High fresh water flows will dilute ..."

primarily due to

Economic Consequences

Unlike Seismic events, the majority of the total economic costs and impacts from multiple island failures in the Delta and Suisun Marsh from floods, would be in-Delta costs. This is due primarily to the fact that water exports are not expected to be disrupted with the high fresh water flow to dilute any contaminants resulting from flooded islands. **FIGURES 16A AND 16B** show the probability of economic losses from floods over the next 25 years (2005-2030). For example, there is on average a 40 percent chance of incurring about $10 billion or more in costs **[FIGURE 16A]** and about $4 billion or more in impacts **[FIGURE 16B]**.

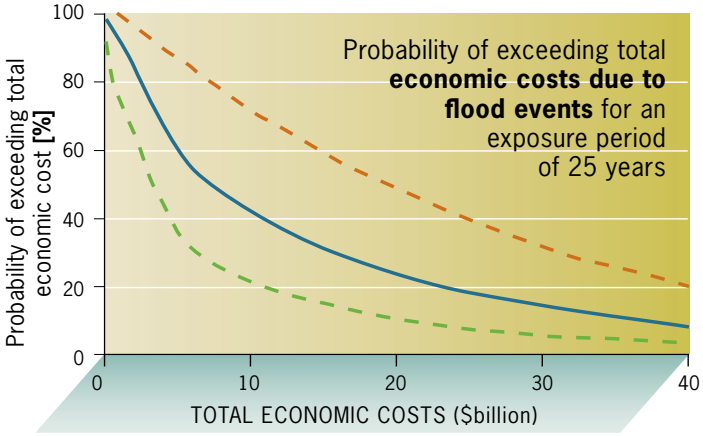


FIGURE 16a

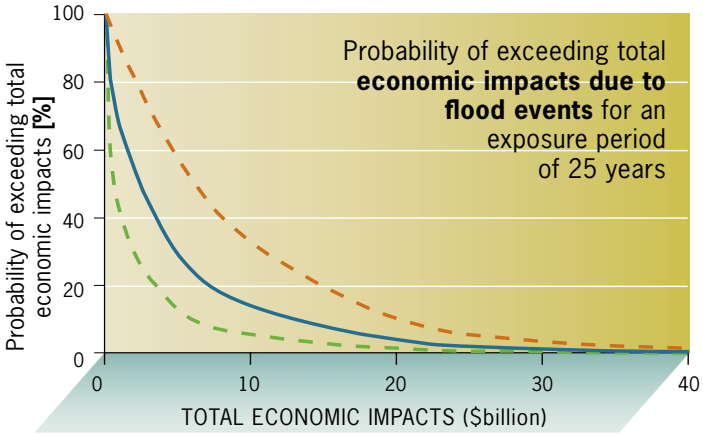


FIGURE 16b

Upper [84% confidence] Median [50 Lower nfidence]

Source: DRMS Risk Report (URS and 13-21b (impacts)

Shorten figure titles and add longer captions.

DURATION AND COST OF REPAIRS for Flood-Induced Levee Failures		
Number of Flooded Islands	Estimated Range of Cost of Repair and Dewatering [$million]	Estimated Range of Time to Repair Breaches and Dewater [days]
1	30 – 110	47 – 170
3	140 – 260	240 – 450
10	490 – 680	590 – 1,060
20	990 – 1,200	930 – 1,110
30	1,500 – 1,800	1,380 – 1,580

TABLE 5 *Source: DRMS Risk Report (URS/JBA 2008c), Table 13-26.*

Table needs caption. Dollars need year attached. Time should be in weeks not days.

Impacts to Water Quality

Although flood-induced impacts to water quality are similar to those following a major earthquake, DOC and Methylated mercury concentrations during and after a flood are expected be lower because of high freshwater inflows during storm events.

DISSOLVED ORGANIC CARBON: If subsided Delta islands flood due to a levee breach, significant amounts of DOC would be released from inside the islands. Depending on several factors, these elevated levels of DOC could adversely affect the drinking water supply from the Delta. DOC reacts with disinfectants during the drinking water treatment process to produce disinfection byproducts, many of which can cause cancer at elevated levels. After the suspended sediments have cleared, algae may increase and bloom, which would produce another source of DOC and disinfection byproducts.

METHYLATION OF MERCURY: When islands are flooded, mercury in the soils can change from a non-toxic element to the toxic methylated form. Methylated mercury can be absorbed by an organism at a rate quicker than the organism can lose it, allowing it to move up the food chain to fish and humans. Of particular concern is the availability of Methylated mercury during algal blooms, which provides a pathway up the food chain.

All of this material is a DIRECT repeat from earlier. Best to condense and refer reader back to previous section.

[DRAFT]

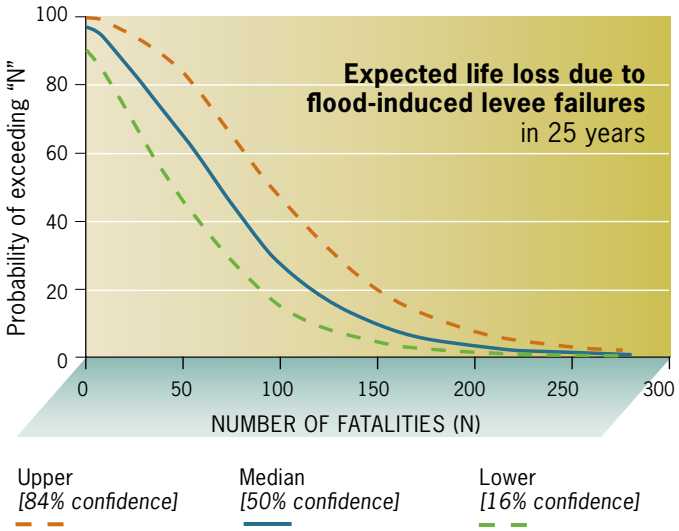


FIGURE 17 *Source: DRMS Risk Report (URS/JBA 2008c), Fig. 13-22*

Add figure caption.

Ecosystem Consequences

IMPACTS TO AQUATIC SPECIES: Levee failure and island flooding caused by floods, like those caused by seismic events, can have both adverse and beneficial impacts on the aquatic ecosystem. Aquatic species can die as a result of entrainment (i.e., inflow of water through a breach in a levee that transports fish into a flooding island) combined with the ensuing murky waters during and immediately after islands flood. Pumping flooded islands after breach repair also kills aquatic species that colonize island habitat. The magnitude of each of these impacts varies by specie, number and location of flooded islands, time of year that flooding occurs and the time that elapses between levee failure and breach repair.

IMPACTS TO VEGETATION: Flooding harms areas of vegetation, but the degree of impact depends on the vegetation type. (See FIGURE 10 Vegetation of the Sacramento-San Joaquin River Delta and Suisun Marsh.) Of the critical vegetation types that include native vegetation and rare species of vegetation, native herbaceous upland vegetation (which comprises a small total area of the Delta Region [less than 500 acres]) was not impacted by flooding in all scenarios. Overall, results, though not incorporating the impacts of levee breaches on sensitive species, suggest that the primary impacts of flooding are on non-native vegetation types.

IMPACTS TO TERRESTRIAL SPECIES: The breaching of levees in Suisun Marsh would potentially result in impacts on several terrestrial wildlife species of concern, including the federally endangered saltmarsh harvest mouse and the California clapper rail, and saltmarsh common yellowthroat and Suisun ornate shrew. The results suggest that large-scale levee breaches cause substantial losses of available habitat, food shortages, and displacement of birds and other terrestrial species.

DRAFT

All of this material is also a direct repeat from earlier. It should be shortened and re-phrased to avoid repetition.

EXPECTED FUTURE INCREASE IN FLOOD HAZARD AND ITS CONSEQUENCES

Risk Factor	2050			2100		
	Low	Medium	High	Low	Medium	High
Flood Hazard	35%	194%	500%	130%	458%	1,140%
Frequency of Island Flooding[a]	241%	261%	297%	681%	798%	1,016%
Potential Loss of Life	676%	723%	803%	N/A	N/A	N/A
Expected Economic Losses	676%	723%	803%	N/A	N/A	N/A

TABLE 6 [a] *Increased frequency in island flooding reflects increased hazard and fragility. N/A = not available.*
Source: URS/JBA 2008c, Table 14-23.

Add table caption.

would

need a time frame here - is already causing SLR? is projected to cause future SLR?

Public Health and Safety Consequences

The primary public safety concern after a flood-induced levee failure is for the people on flooded islands. FIGURE 17 shows estimates of the population at risk. For example, there is on average a 40 percent probability of 80 fatalities or more in the region from flood-induced levee failures in 25 years (2005-2030). The population at risk is high during a flood-induced levee failure because larger areas are at risk to flood (more islands and tracts), such as the Sacramento Pocket Area and the City of West Sacramento.

... as compared to?

This first part of the paragraph needs to be better organized. It alternates between streamflow and SLR impacts in a confusing way. Also second half of paragraph should be separated.

Future Flood Risks

Climate change will cause sea level rise and more frequent floods due to a change in hydrograph to more rain and less snow, which ~~will~~ increase the future flood hazard in the Delta Region. Also, sea level rise will increase the possibility of overtopping during floods. The freshwater inflow from the floodflows will generally prevent immediate salinity intrusion, but long periods to repair levees may present problems in subsequent periods of low flow. Large in-Delta impacts from additional flooding are expected, due especially to increased population and development, as well as increased pressure on the ecosystem. The potential loss of life in the Delta is expected to increase on average by 723 percent from 2005 to 2050. The expected economic losses are also anticipated to increase on average by 723 percent from 2005 to 2050 [TABLE 6].

Are these additional impacts due to climate change alone? Not clear.

DRAFT

SUNNY DAY LEVEE FAILURE RISKS

Sunny day failures occur occasionally during non-flood conditions. Such failures are attributed to many factors: rodent activities, pre-existing weaknesses in the levee fill and foundation (given the non-engineered construction of the levees), slow deterioration with time, and other circumstances ~~(subsidence, ditches, etc.).~~ Often, high tides, low barometric pressure, or sea level surges worsen conditions and lead to failures. The most recent example of a sunny day failure is the June 2004 failure of the Upper Jones Tract levee. The total cost of the damage and island recovery was nearly $100 million.

how many islands flooded in this event?

including subsidence and ditches.

Historical levee failures were used as the model to estimate the rate of sunny day levee failures. Under 2005 business-as-usual conditions, the Sacramento-San Joaquin River Delta is expected to have about ~~ten~~ sunny day breaches and the Suisun Marsh will have about ~~four~~ sunny day breaches in a 100-year period.

10, 4

[DRAFT]

Sandbags temporarily control a sand boil on Staten Island on June 18, 2007. The muddy water indicates that material in the levee or its foundation is being washed away. Unnoticed, sand boils can lead to a failure of the levee.
Source: DWR

COMBINED RISK OF ISLAND INUNDATION FROM MULTIPLE HAZARDS

likelihood or probability - NOT frequency.

The probability that an individual island will flood due to any cause can be estimated from the expected annual ~~frequency~~ of failures due to earthquakes, floodflows, and sunny day events.

Considering the probability of levee breaches from all hazards for the 2005 business-as-usual conditions, the annual ~~frequency~~ of individual islands flooding due to these hazards (earthquake, floodflows, and sunny day) is illustrated in FIGURE 18. This figure indicates that islands in Suisun Marsh and the central-southern Sacramento-San Joaquin River Delta are the most vulnerable with a mean annual ~~frequency~~ of failure greater than 5 percent.

Where is the same map for future conditions?? There should be a side-by-side comparison here.

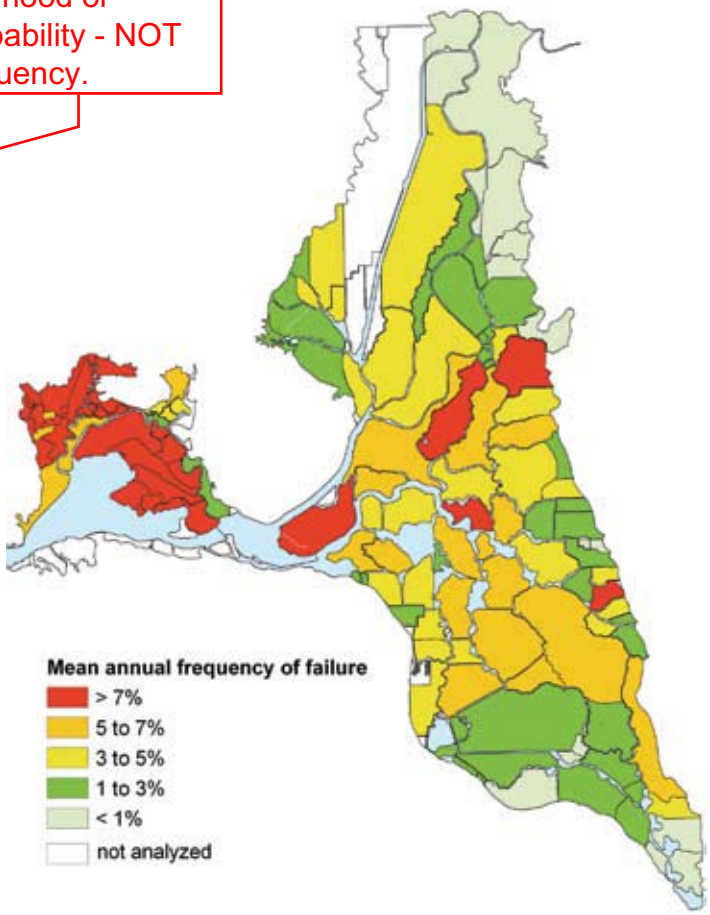


FIGURE 18 **Mean annual frequency of failure for individual islands under combined earthquake and flood risks**

Source: DRMS Risk Report (URS/JBA 2008c), Fig. 13-16

[D R A F T]

This doesn't seem to fit what URS stated to the IRP. i.e., that Phase 2 would be considering 3 scenarios.

NEXT STEP

Source: DWR

Phase 2 of DRMS will evaluate risk-reduction options for long-term management of the Delta and Suisun Marsh levees. It will not propose a new plan for the Delta Region; rather, Phase 2 will describe a set of actions that can be taken to reduce risks to the economy and the ecosystem from levee failures resulting from earthquakes, floodflows, sunny day failures and the effects of ongoing subsidence and climate change. Phase 2 is expected to be available for public review in December 2008.

More information on the DRMS Risk Report and its supporting Technical Memoranda can be found on the DRMS portal, http://www.drms.water.ca.gov/, part of the Web site of the California Department of Water Resources.

General comment on references: For statements made in the executive summary that are not supported directly by the DRMS Phase 1 report, an external reference should be provided.

SELECTED REFERENCES

CALFED. 2000. Record of Decision.

California Department of Water Resources. 2007. Delta Risk Management Strategy. Web site: http://www.drms.water.ca.gov/.

IPCC (Intergovernmental Panel on Climate Change). 2001. Climate Change, 2001: The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the IPCC. Cambridge, England: Cambridge University Press, 2001. Also available at http://www.grida.no/climate/ipcc_tar/.

Rahmstorf, Stefan. 2006. *A Semi-Empirical Approach to Projecting Future Sea-Level Rise, Sciencexpress*, www.sciencexpress.org, 14 December 2006. Science 19 January 2007 315(5810): 368–370. DOI: 10.1126/science.1135456.

URS (URS Corporation). 2007. *Status and Trends of Delta-Suisun Services*. Prepared for California Department of Water Resources. May.

URS/JBA (URS Corporation/Jack R. Benjamin & Associates, Inc.). 2007a. *Delta Risk Management Strategy, Phase 1, Subsidence Technical Memorandum*. Prepared for California Department of Water Resources.

URS/JBA (URS Corporation/Jack R. Benjamin & Associates, Inc.). 2007b. *Delta Risk Management Strategy, Phase 1, Water Analysis Module Technical Memorandum*. Prepared for California Department of Water Resources.

URS/JBA (URS Corporation/Jack R. Benjamin & Associates, Inc.). 2008a. *Delta Risk Management Strategy, Phase 1, Climate Change Technical Memorandum*. Prepared for California Department of Water Resources.

URS/JBA (URS Corporation/Jack R. Benjamin & Associates, Inc.). 2008b. *Delta Risk Management Strategy, Phase 1, Flood Hazard Technical Memorandum*. Prepared for California Department of Water Resources.

URS/JBA (URS Corporation/Jack R. Benjamin & Associates, Inc.). 2008c. *Delta Risk Management Strategy, Phase 1, Risk Analysis Report*. Prepared for California Department of Water Resources, July.

DRAFT

ACKNOWLEDGMENTS

Project Funding

California Department of Water Resources

Project Sponsors

California Department of Water Resources

California Department of Fish and Game

U.S. Army Corps of Engineers

Project Management

Ralph Svetich, California Department of Water Resources

Sean Bagheban, California Department of Water Resources

Steering Committee

Norman Abrahamson, Ph.D., University of California, Davis

Gary Bobker, The Bay Institute

Marina Brand, California Department of Fish and Game

Jon Burau, U.S. Geological Survey

Marci Coglianese, Bay Delta Public Advisory Board

Gilbert Cosio, MBK Engineers

Roger Fujii, U.S. Geological Survey

Jim Goodwin, U.S. Bureau of Reclamation

Sergio Guillen, California Bay Delta Authority

Leslie F. Harder, Jr., Ph.D., former DWR Deputy Director, Public Safety and Business Operations

Wim Kimmerer, Ph.D., Romberg Tiburon Center for Environmental Studies

Dennis Majors, State Water Contractors

Frances Mizuno, San Luis and Delta-Mendota Water Authority

Peter Moyle, Ph.D., University of California, Davis

Michael Ramsbotham, U.S. Army Corps of Engineers

Curt Schmutte, Division of Flood Management

Raymond Seed, Ph.D., University of California, Berkeley

Judy Soutiere, U.S. Army Corps of Engineers

Robert Twiss, Ph.D., University of California, Berkeley

Tom Zuckerman, Bay Delta Public Advisory Board

Technical Advisory Committees

Technical Advisory Committee for Levee Vulnerability:

Leslie F. Harder, Jr., Ph.D., former DWR Deputy Director, Public Safety and Business Operations

Raymond Seed, Ph.D., TAC Chair, University of California, Berkeley

Ralph Svetich, Project Manager, DWR

David Mraz, Contract Manager, DWR

Michael Driller, DWR

Michael Ramsbotham, U.S. Army Corps of Engineers

Lynn O'Leary, U.S. Army Corps of Engineers

Gilbert Cosio, MBK Engineers

Technical Advisory Committee for Ecosystem Impacts:

Wim Kimmerer, Ph.D., Romberg Tiburon Center for Environmental Studies

Peter Moyle, Ph.D., University of California, Davis

William (Bill) Bennett, Ph.D., University of California, Davis

DRMS Consulting Team

URS Corporation: Risk Analysis, Geotechnical Engineering, Seismic Hazard and Earthquake Engineering, Hydraulic/Hydrology, Flood Hazard, Water Quality, Vegetation and Habitat Analysis, Infrastructure, GIS

Jack R. Benjamin & Associates, Inc.: Risk Analysis and Modeling, Water Management

Resource Management Associates: Delta Hydrodynamic Modeling

MBK Engineers: Reservoir Operation and Water Management

Bay Modeling-Hydrodynamics: 3-D Hydrodynamic Modeling, Sea Level Rise Simulation

Watercourse Engineering, Inc.: Hydrodynamics and Water Management

Geomatrix Consultants, Inc.: Seismic Hazard, Earthquake Engineering, Geotechnical Engineering

Kleinfelder, Inc.: Geotechnical Engineering

[DRAFT]

Hultgren & Tillis Engineers: Geotechnical Engineering

HydroFocus, Inc.: Subsidence

WLA Consulting, Inc.: Seismic Geology, Fault Characterization

Pacific Engineering & Analysis: Ground Motions and Site Response

Phillip Williams Associates: Geomorphology, Wind-Wave Modeling

Moffatt & Nichol Engineers: Emergency Response, Erosion

Economic Insight: Economic Analysis

RM Econ: Economic Analysis

Western Resource Economics: Economic Analysis

M-Cubed: Economic Analysis

Redars Group: Traffic Impact Analysis

Hanson Environmental, Inc.: Environmental and Ecosystem Impact Analysis

Stevens Consulting: Environmental and Ecosystem Impact Analysis

Science Applications International Corporation: Terrestrial Habitat

Jones & Stokes: Water Quality, Environmental Impacts

Coppersmith Consulting, Inc.: Seismic Hazard

JRP Historical Consulting: Delta Historical Resources

Philip B. Duffy, Ph.D., Lawrence Livermore National Laboratory: Climate Change

C. Allin Cornell, Ph.D., Stanford University: Risk Analysis

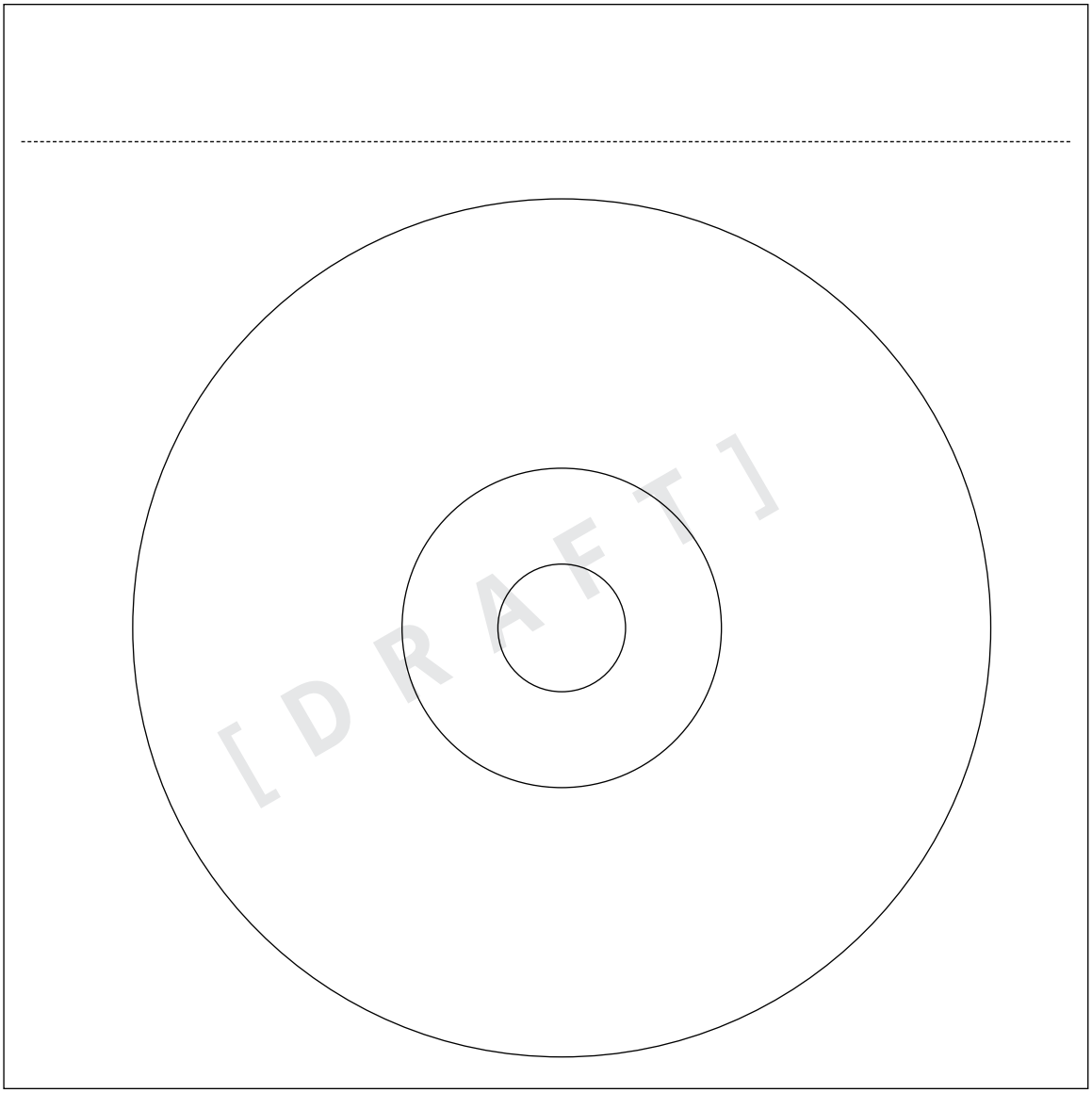
Gregory Baecher, Ph.D., University of Maryland: Risk Analysis

Aquatic Restoration Consulting: Environmental Impacts

Loren Bottorff, Independent Consultant: Technical Writing and Editing

(abridged acknowledgement list)

[DRAFT]


[D R A F T]

[D R A F T]