Room for the River: What it Means for the Dutch and What it Means for US.

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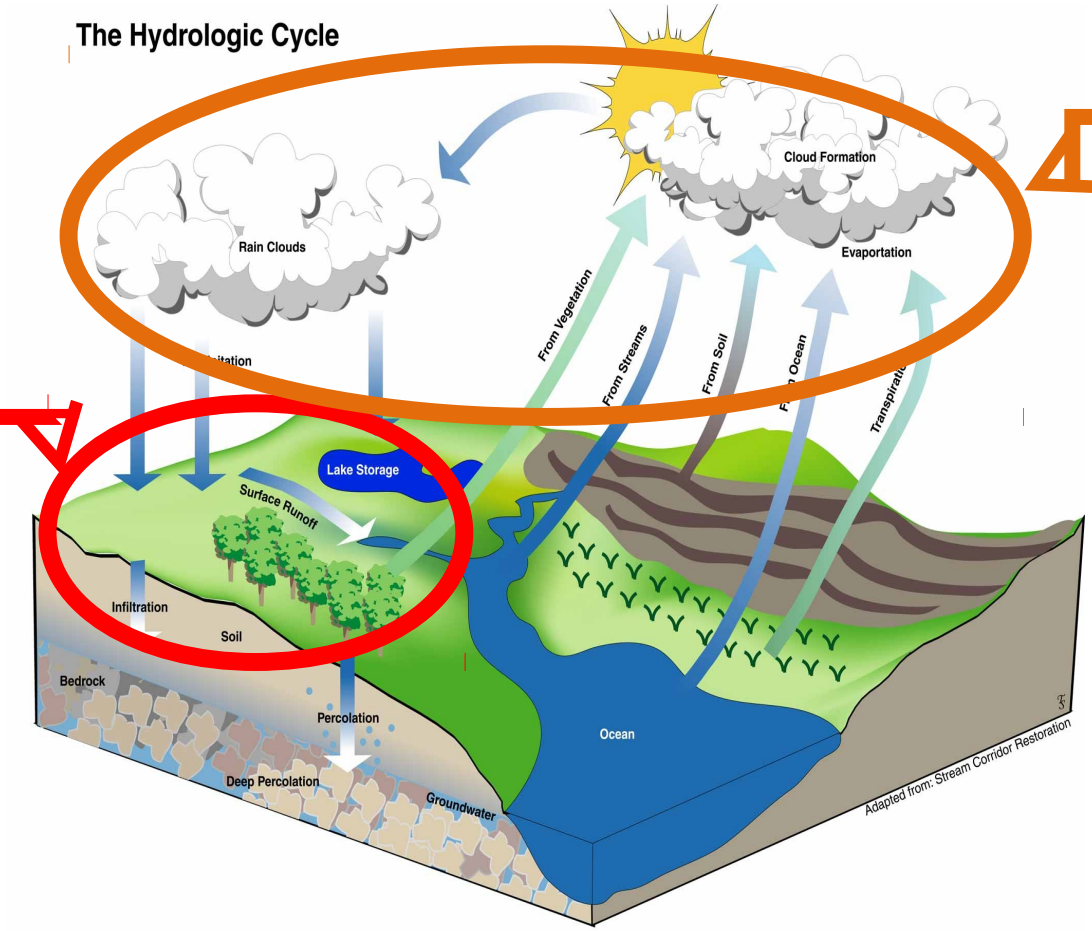
Walsh Environmental

Oct 9, 2013

CWA Avon Colorado

Probability

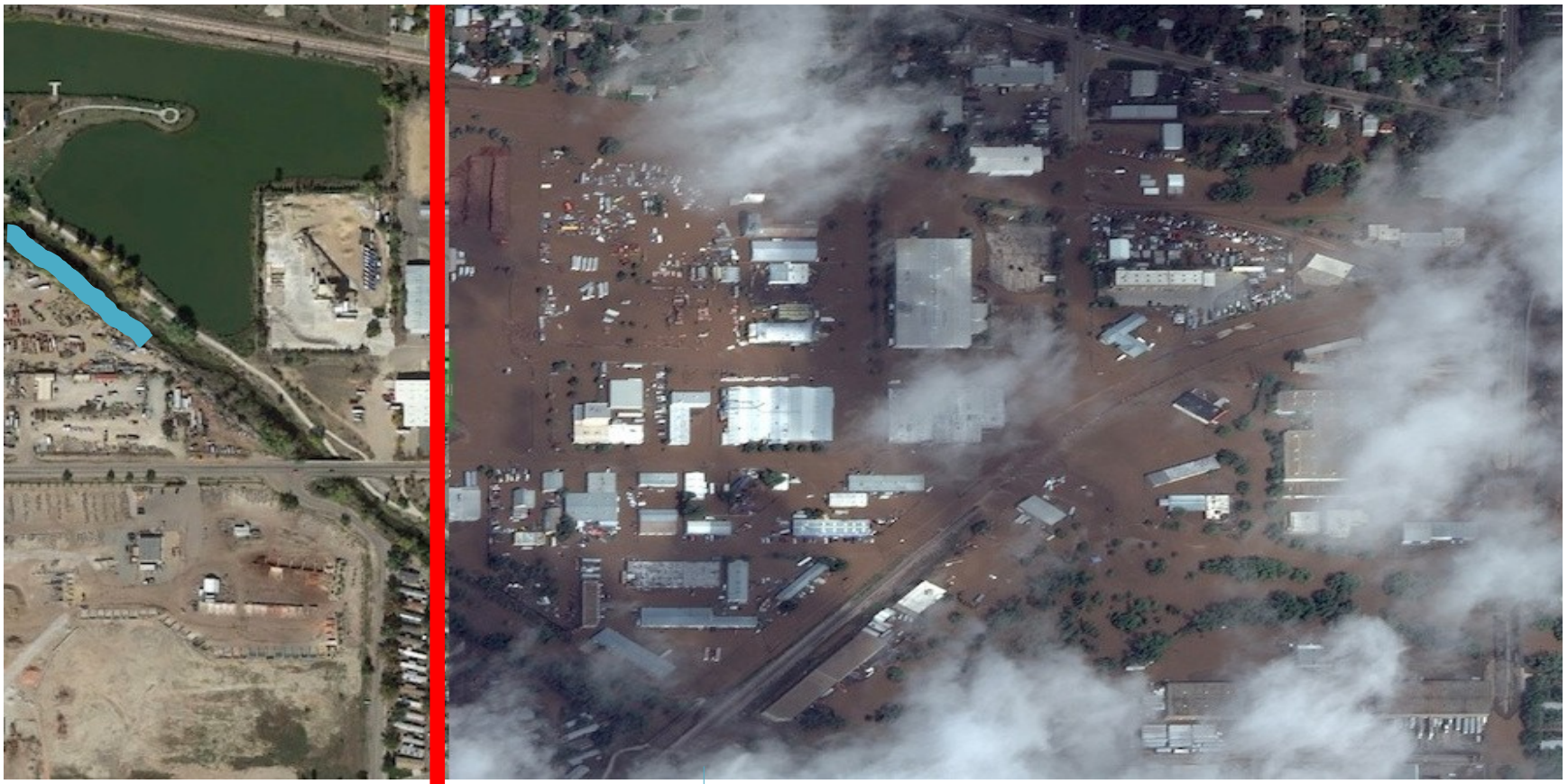
Effects of land use and watershed management affect how much and how quickly rainfall is transformed into river flow.



gas emissions can increase rates of evaporation and the quantities and intensities of rainfall as well as the percentage of precipitation that falls as rain vs. snow.

Background Photo Credit: Iowa State University

Consequence



Longmont, Colorado September 2013 Photo Credit: Huffington Post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The Netherlands

Or is it Holland?

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Cross Culture Comparison

Population	16.7 million	38 million (CV: 6.5 million)	4.5 million
Land Area	16,039 sq mi	163,696 sq mi (CV: 22,500 sq mi)	51,843 sq mi
Percent Water	18.41 %	4.7%	15%
Population Density	1,047.9/sq mi	242/sq mi (CV: 288/ sq mi)	105/sq mi
Per Capita Income	$50,355	$61,021	$26,100
Temperature of Flood Water	37 to 48°F	50°F	80°F
Number of Cows	4 million	CV: 1.8 million	0.5 million
Estimated Value of Agriculture	$55 billion (3rd in world-wide exports)	38 billion (CV: 17 billion)	10.7 billion

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Dutch Water

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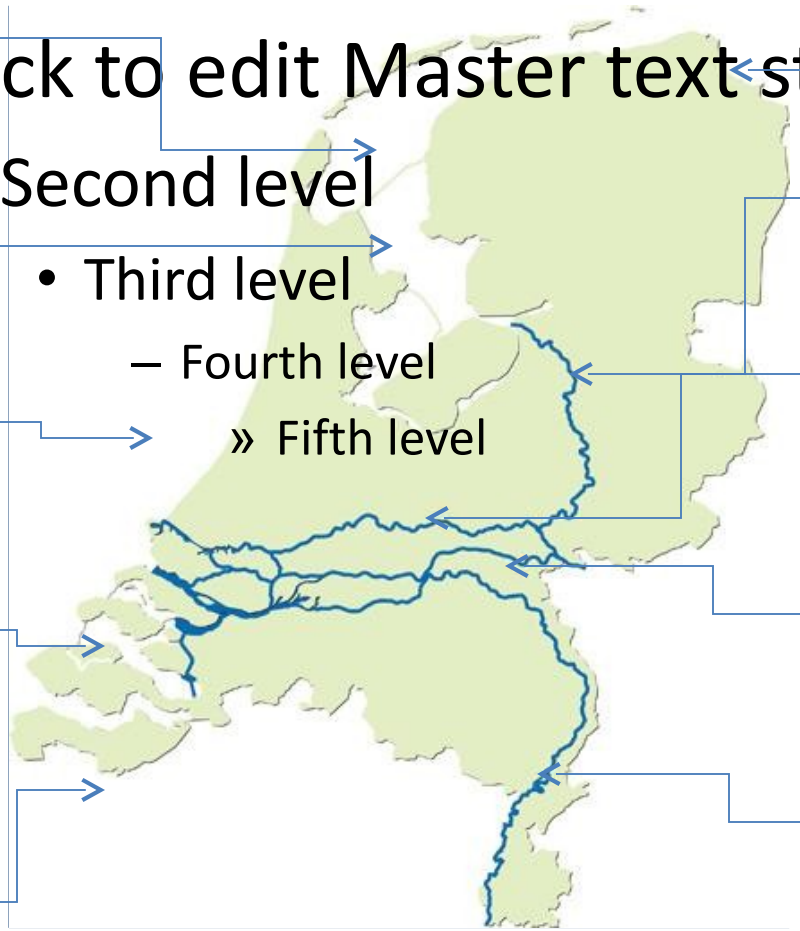

Wadden Sea

Ijsselmeer

North Sea

Zeeland/The Delta

Schelde

Elbe River

Ijssel River

Rhine River

Waal River

Meuse (Maas) River

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Types of Flooding

- From the Sea (storm surges)
- From the Rivers (high flows)
- From Precipitation (localized)

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History of the battle with water

- 1906 Storm surge flood in Zeeland
- 1910 Sturgeon extinct
- 1916 Flood in North Holland➔Afsluitdijk
- 1953 Storm Surge flood in Zeeland
- 1954 Salmon extinct

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But, these are Risk Based Standards?

Risk = Probability x Consequence

1) Match flood protection investment with risk

2) Time flood protection investment with development and growth

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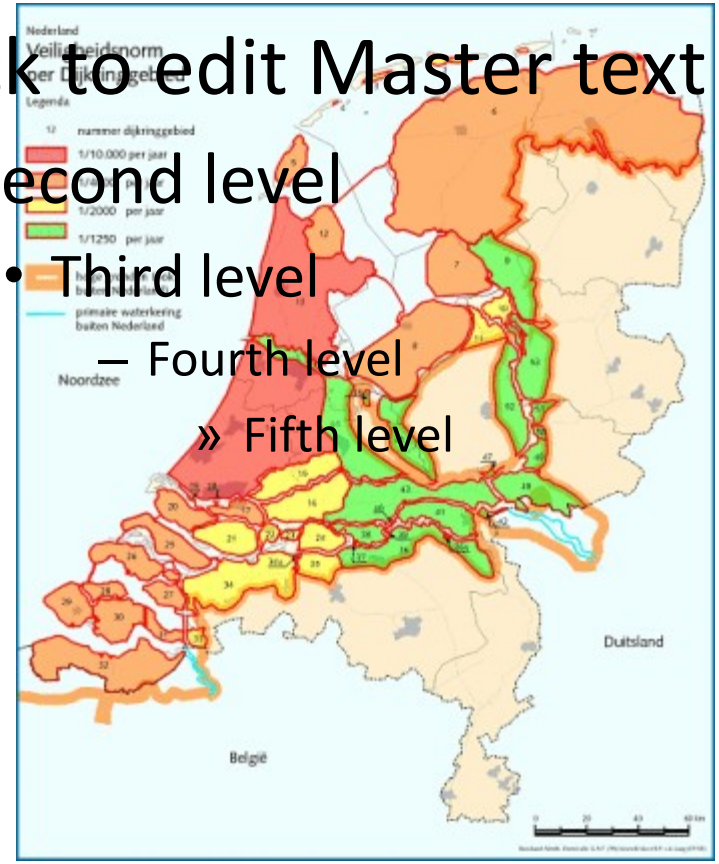

But, these are Risk Based Standards?

Protect the property and economic investments in a dike ring to a level that is commensurate with the value of property and investment.

We beginnen met de definitie voor het gemiddelde van de verwachte schade ((A.35) in Eijgenraam (2006)) te herhalen voor een optimaal interval:

$$S_{k+1}^{mean} = \frac{1}{D}\int_{o}^{D} S_k^+ e^{\beta t}\, dt = S_k^+ \frac{1}{\beta D}\left(e^{\beta D} - 1\right) \qquad (2)$$

$$met \quad D_{k+1} = t_{k+1} - t_k \qquad en \quad t \in [t_k, t_{k+1}) \qquad en \quad k = 1,2,...$$

waarin	D	lengte (standaard)interval tussen opeenvolgende investeringen
	S^+	verwachte schade onmiddellijk na investeren
	β	groeivoet van de verwachte schade

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10,000 year flood protection?

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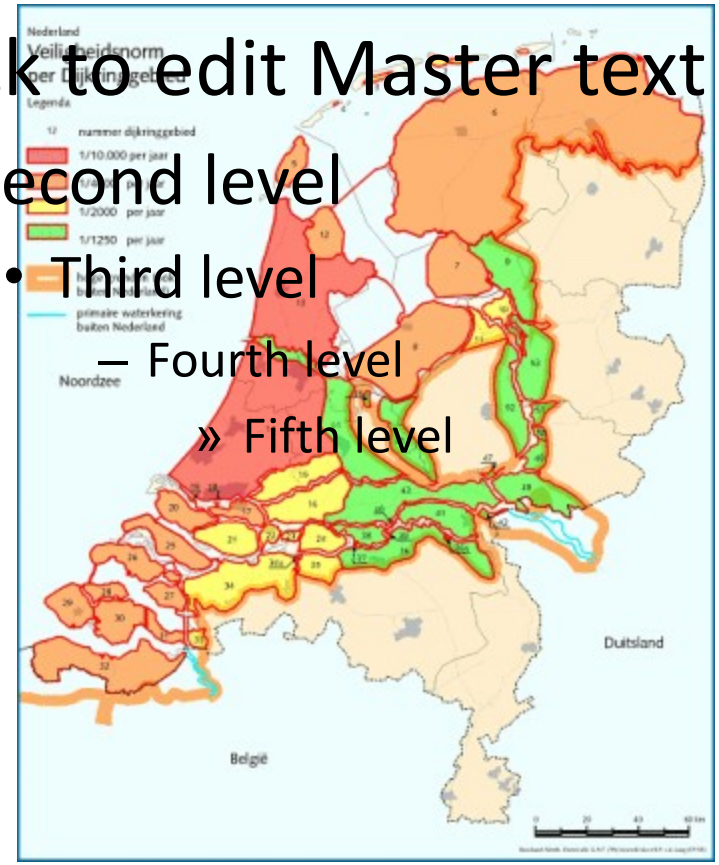

- 1 in 10,000: highly populated coastal areas
- 1/4000: less populated coastal areas
- 1/2000: tidal zones
- 1/1250: Rhine river corridors
- 1/250: Maas river corridors
- 1/? : localized intense precipitation

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Traditional Measures

“There are two kinds of levees—

“There are two kinds of levees—

Those that HAVE FAILED and those that WILL FAIL”

Probability	Consequences
System was not built large enough—esp with the uncertainty of climate change	Dense urban development behind levees
Poorly constructed levees	Critical infrastructure impacts
Subsidence, earthquakes, sea-level rise	Water Quality and Soil Contamination

Room for the River

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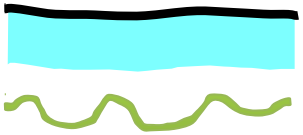
Rivers need Room

Room for the River

Existing floodway

Expanded Floodway



Room for the River

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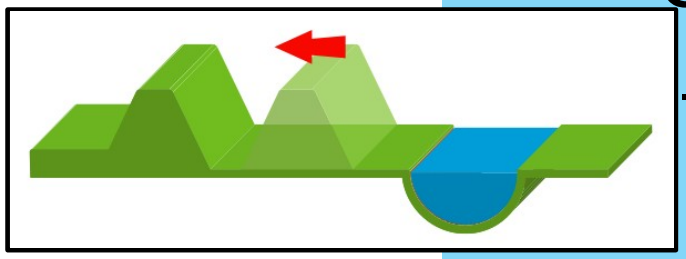

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Room for the River

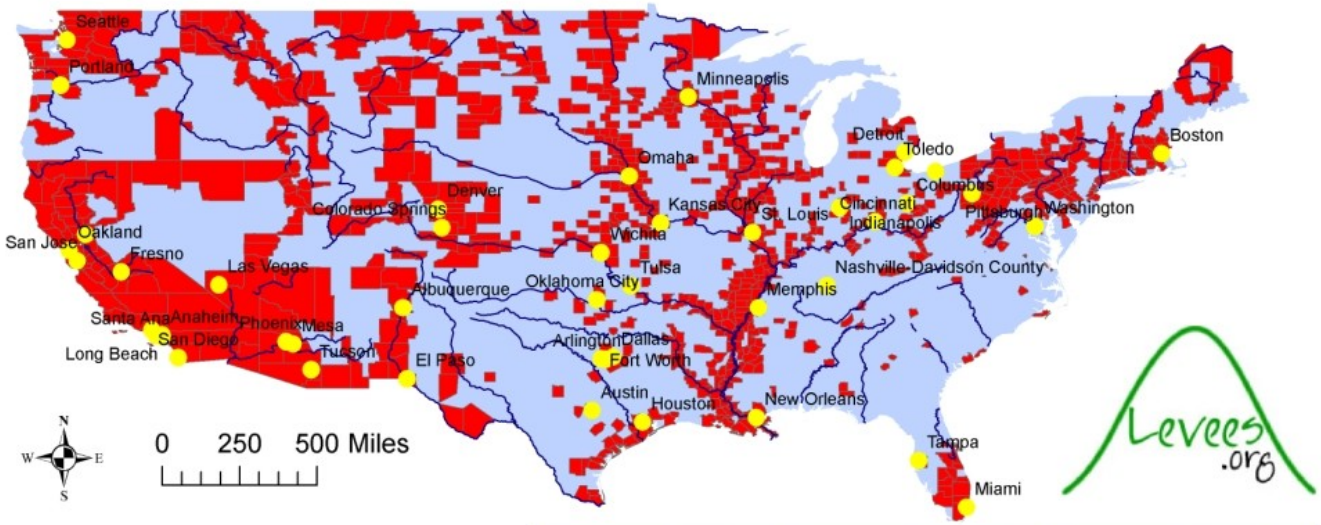
Reduces Risk

Improves Water Supply

Enhances Ecosystem

US flood protection?

United States Counties Protected By Levees



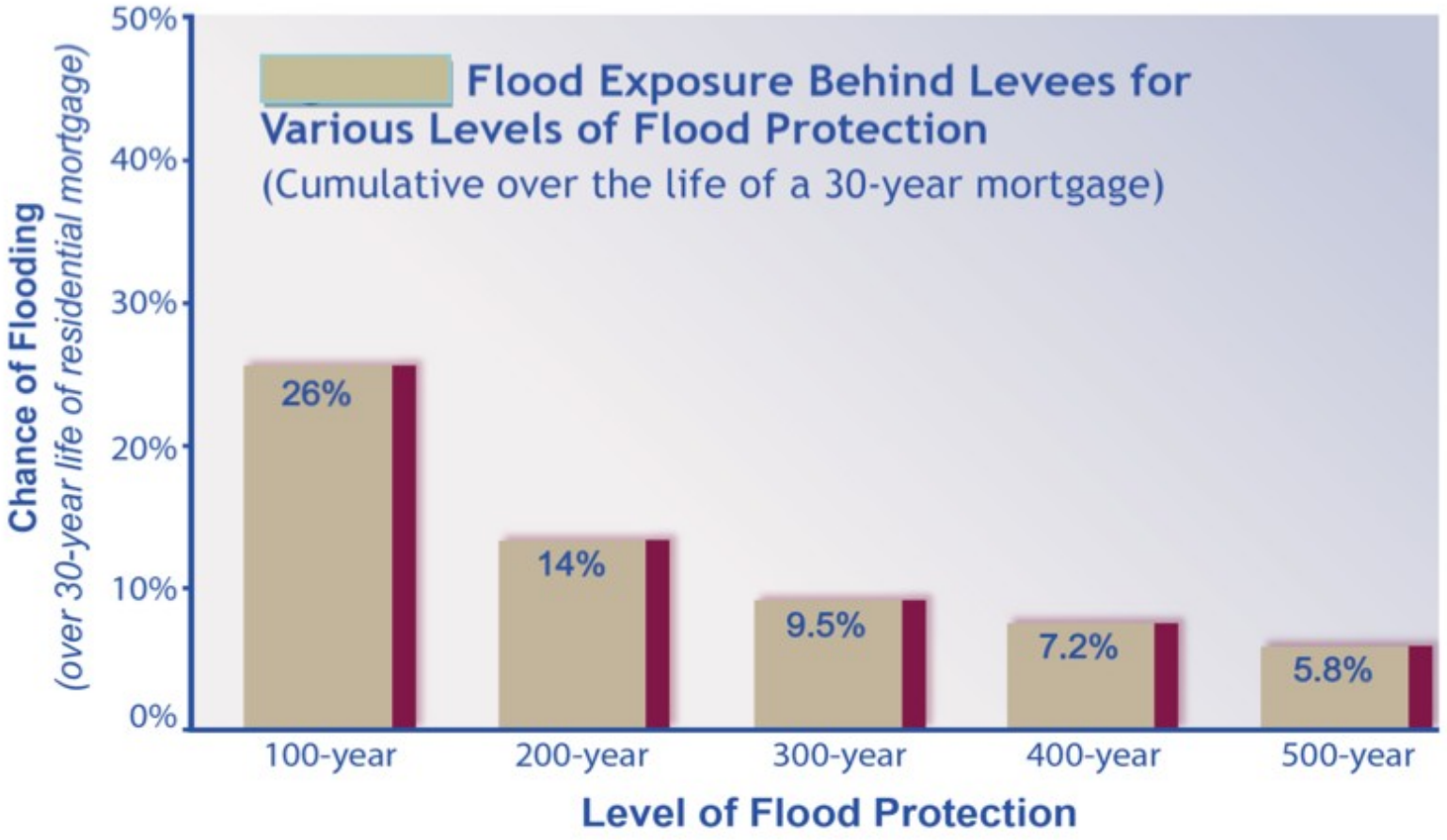
Legend

- City within Levees with Pop. > 300,000
- US County with Levee
- Major Rivers

Data provided to Levees.org by FEMA in request #09-325 under the Freedom of Information Act (9-18-09). Population data from 2000 Census. Map produced by Ezra Boyd, Oct. 2009.

City	Population (2000)	City	Population (2000)	City	Population (2000)
Los Angeles	3,694,820	Nashville	545,524	Tulsa	393,049
Houston	1,953,631	Fort Worth	534,694	Omaha	390,007
Phoenix	1,321,045	Portland	529,121	Minneapolis	382,618
San Diego	1,223,400	Oklahoma City	506,132	Honolulu	371,657
Dallas	1,188,580	Tucson	486,699	Miami	362,470
Detroit	951,270	New Orleans	484,674	Colorado Springs	360,890
San Jose	894,943	Las Vegas	478,434	St. Louis	348,189
Indianapolis	781,870	Cleveland	478,403	Wichita	344,284
Columbus	711,470	Long Beach	461,522	Santa Ana	337,977
Austin	656,562	Albuquerque	448,607	Pittsburgh	334,563
Memphis	650,100	Kansas City	441,545	Arlington	332,969
Boston	589,141	Fresno	427,652	Cincinnati	331,285
Washington	572,059	Sacramento	407,018	Anaheim	328,014
El Paso	563,662	Oakland	399,484	Toledo	313,619
Seattle	563,374	Mesa	396,375	Tampa	303,447
Denver	554,636	**Total 2004 Population for Counties with Levees = 160 million in 881 counties.**			

US flood protection?



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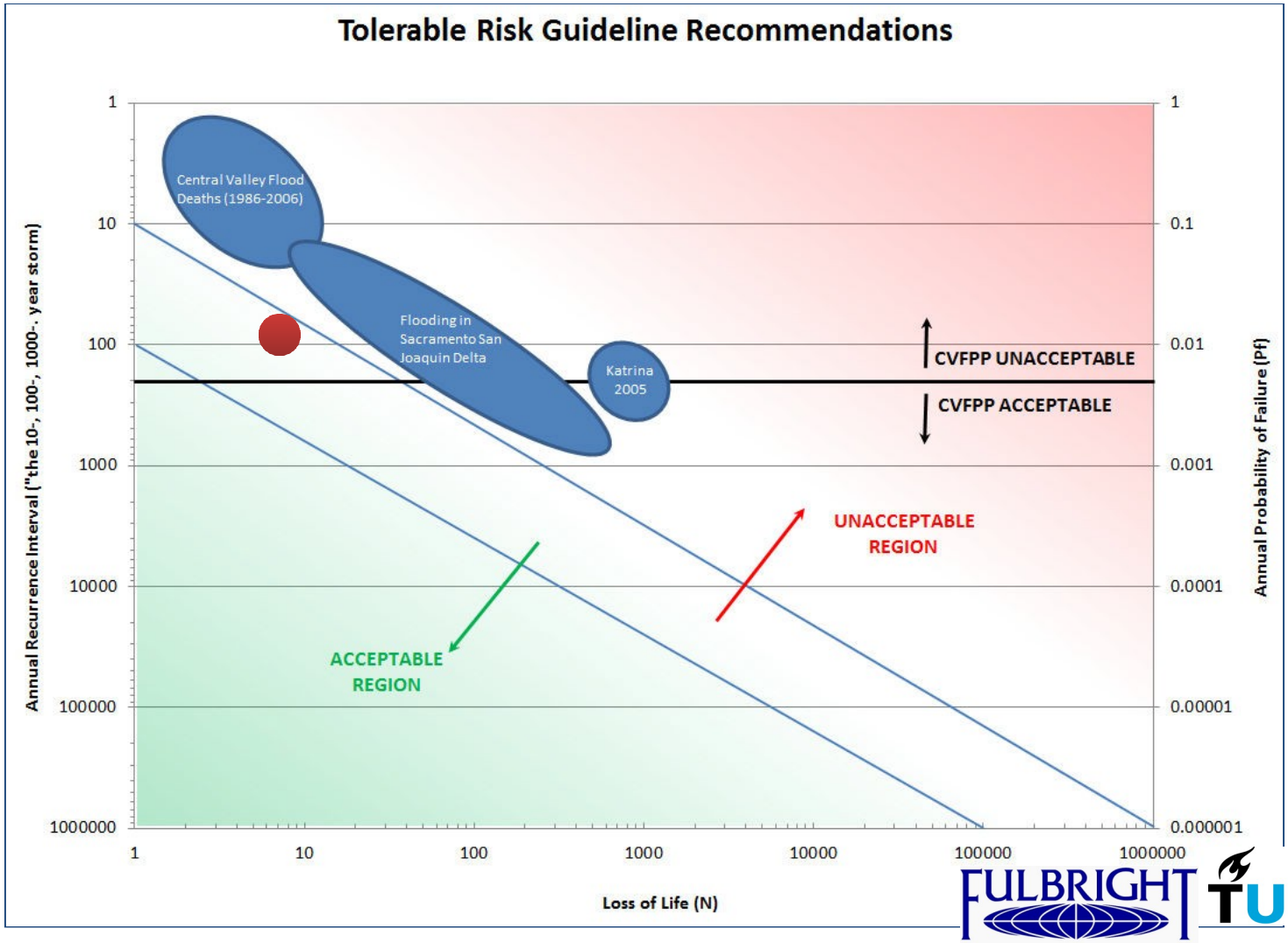
Lessons Learned: Safety



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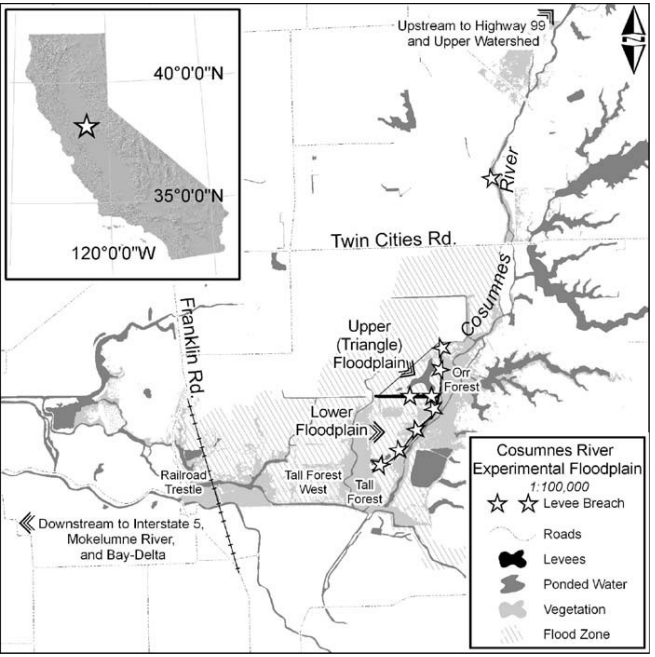
Floodplains Enhance Fish Growth



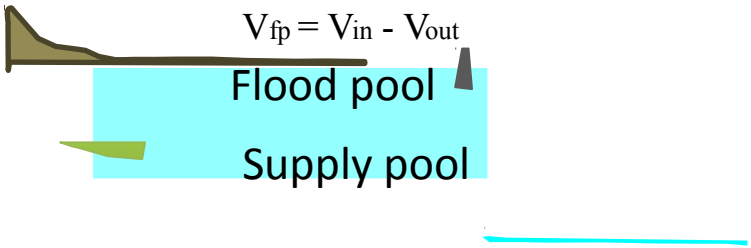
Below floodplain Floodplain

Jeffres et al. 2008

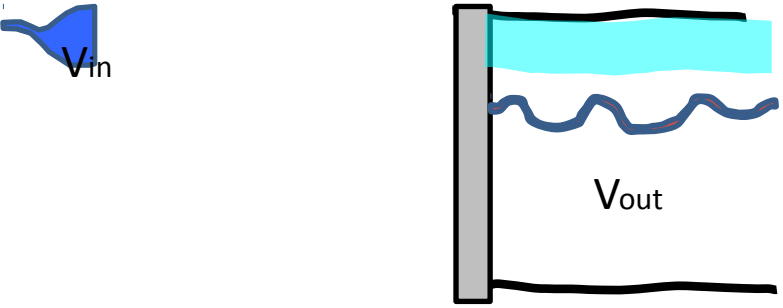
Enclosed experiment, same age Chinook

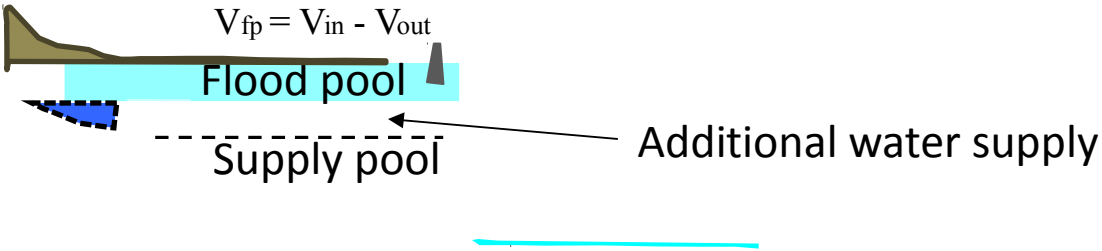
Water Supply Benefit of expanding floodways and bypasses

Existing levee system constrains rate of downstream release, requiring a large flood pool



If downstream capacity allows larger releases, the flood pool can be smaller -- leaving more water in the supply pool





New Madrid Birds' Point Floodway

1928 Mississippi River and Tributaries project

Yolo Bypass

Can convey 80% of flood flows (500,000cfs= 14,000 m3/s)

2/3 is privately owned and used for agriculture

When wet, critical habitat for migratory salmon and birds

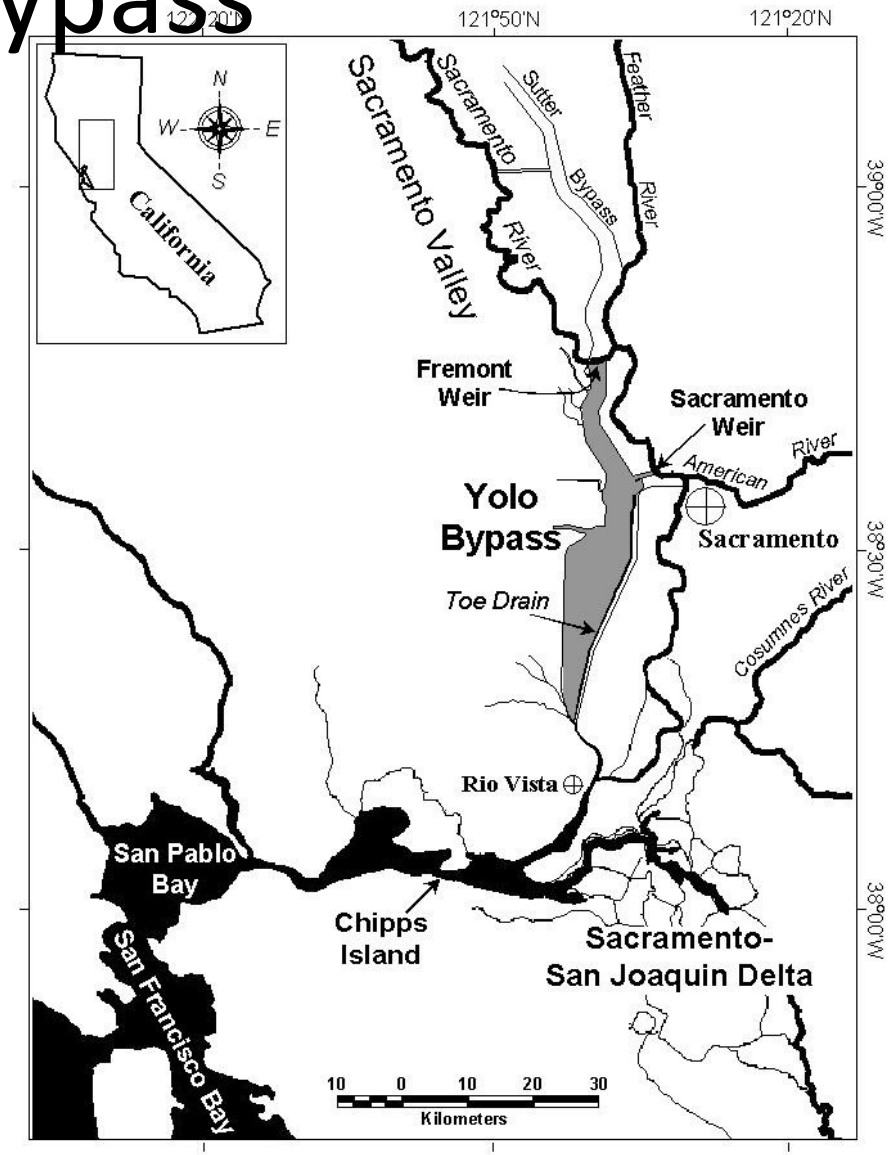


Figure 1: Location of Yolo Bypass

Questions?

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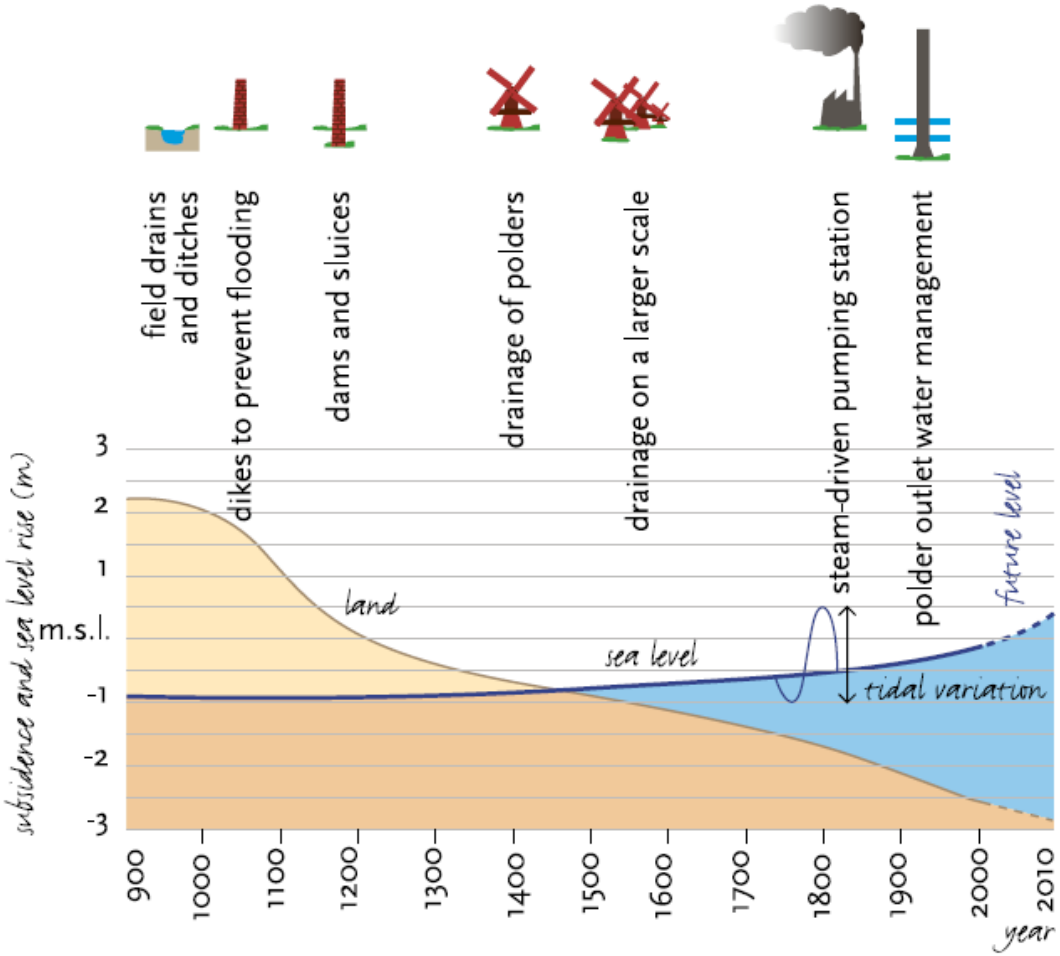
Let's talk taxes: Funding has to come from somewhere…

Waterboards are 95% funded via a pollution levy and population tax

And WBs function under their own budgets

Nationally, all flood defense expansion and maintenance cost 1.2-1.5B euros per year--less than 1% of GNP

Land Subsidence



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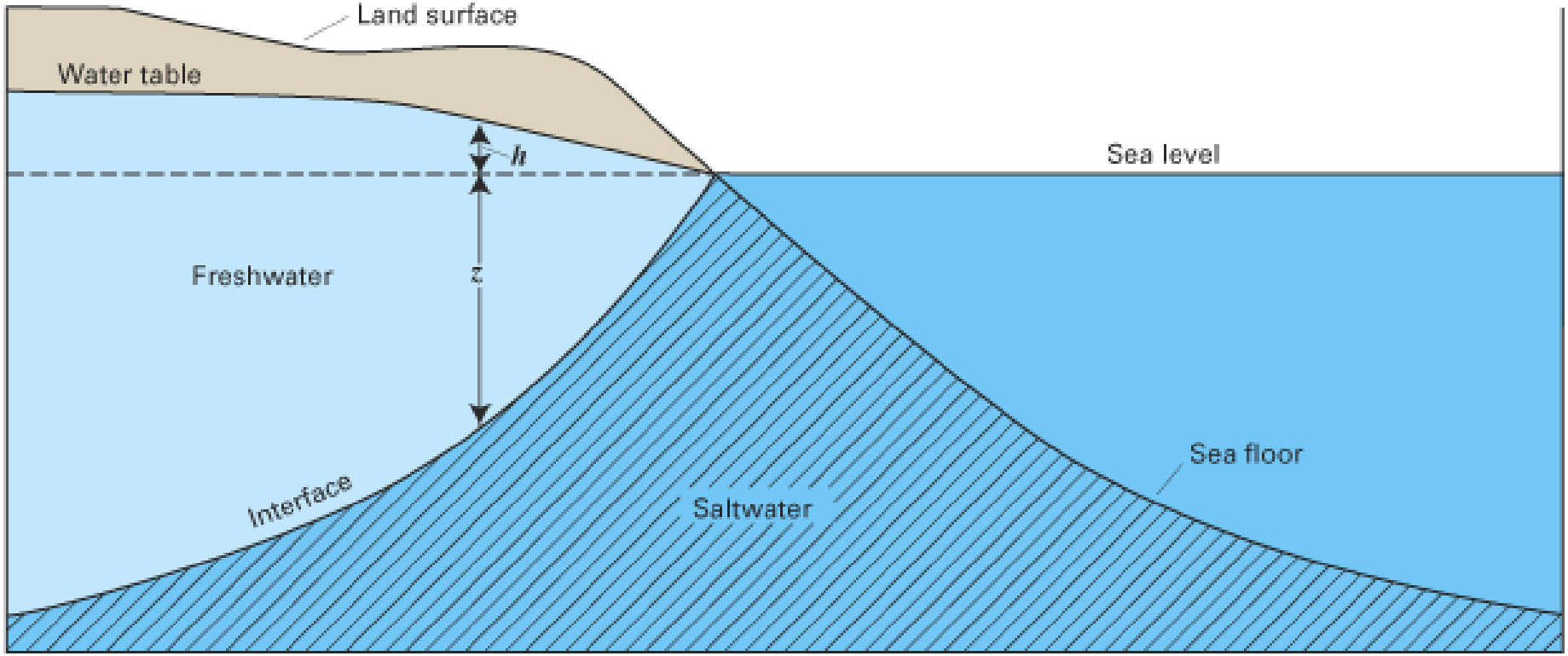
Land Subsidence—Ground Water



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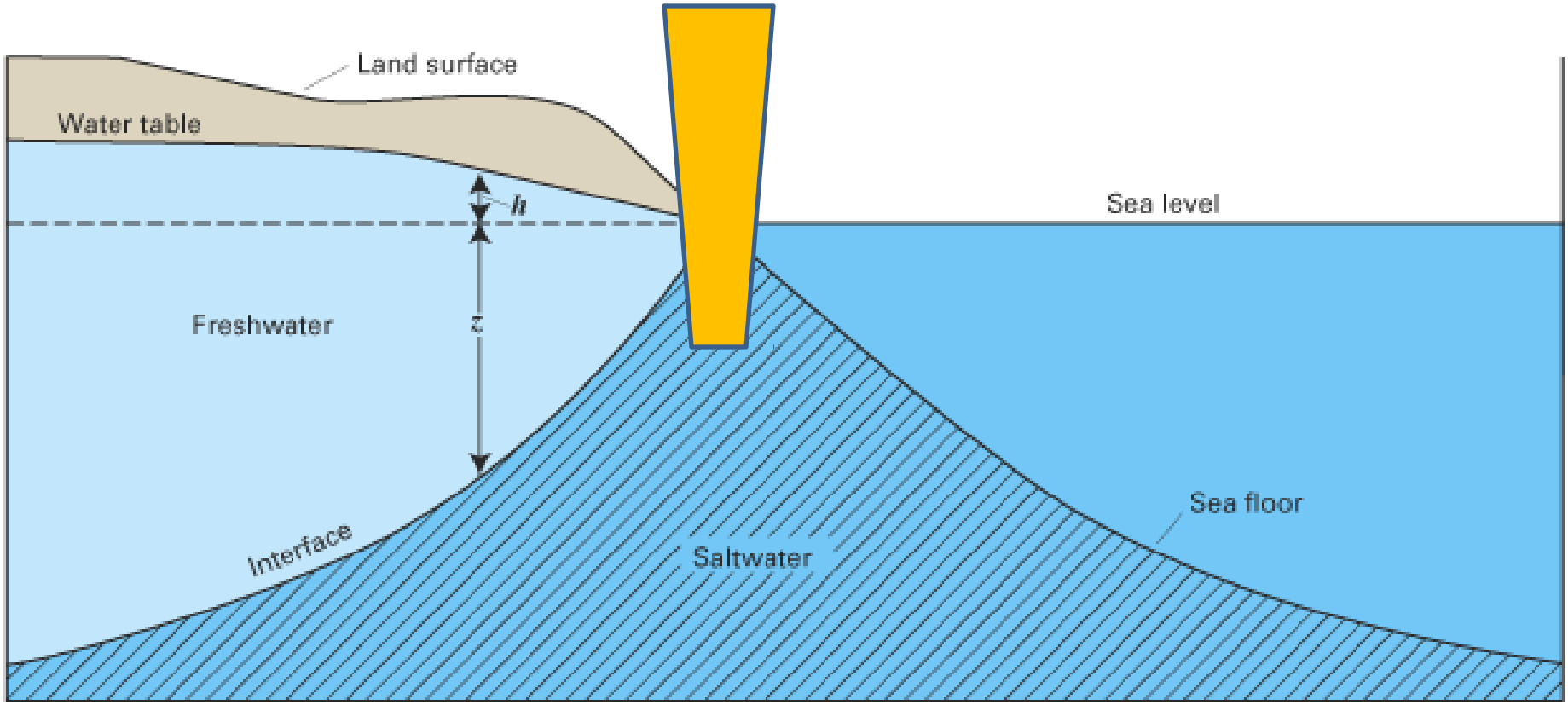

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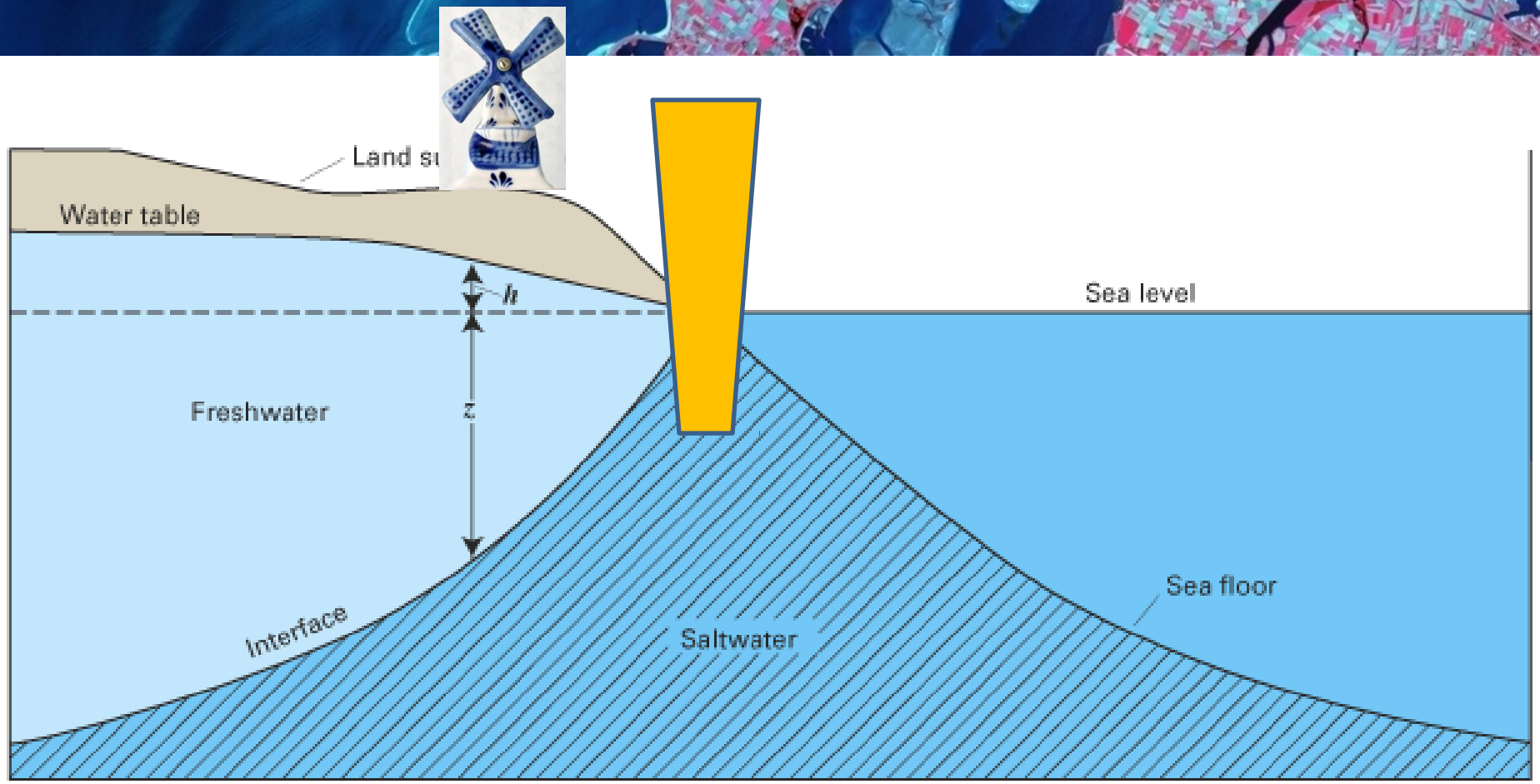

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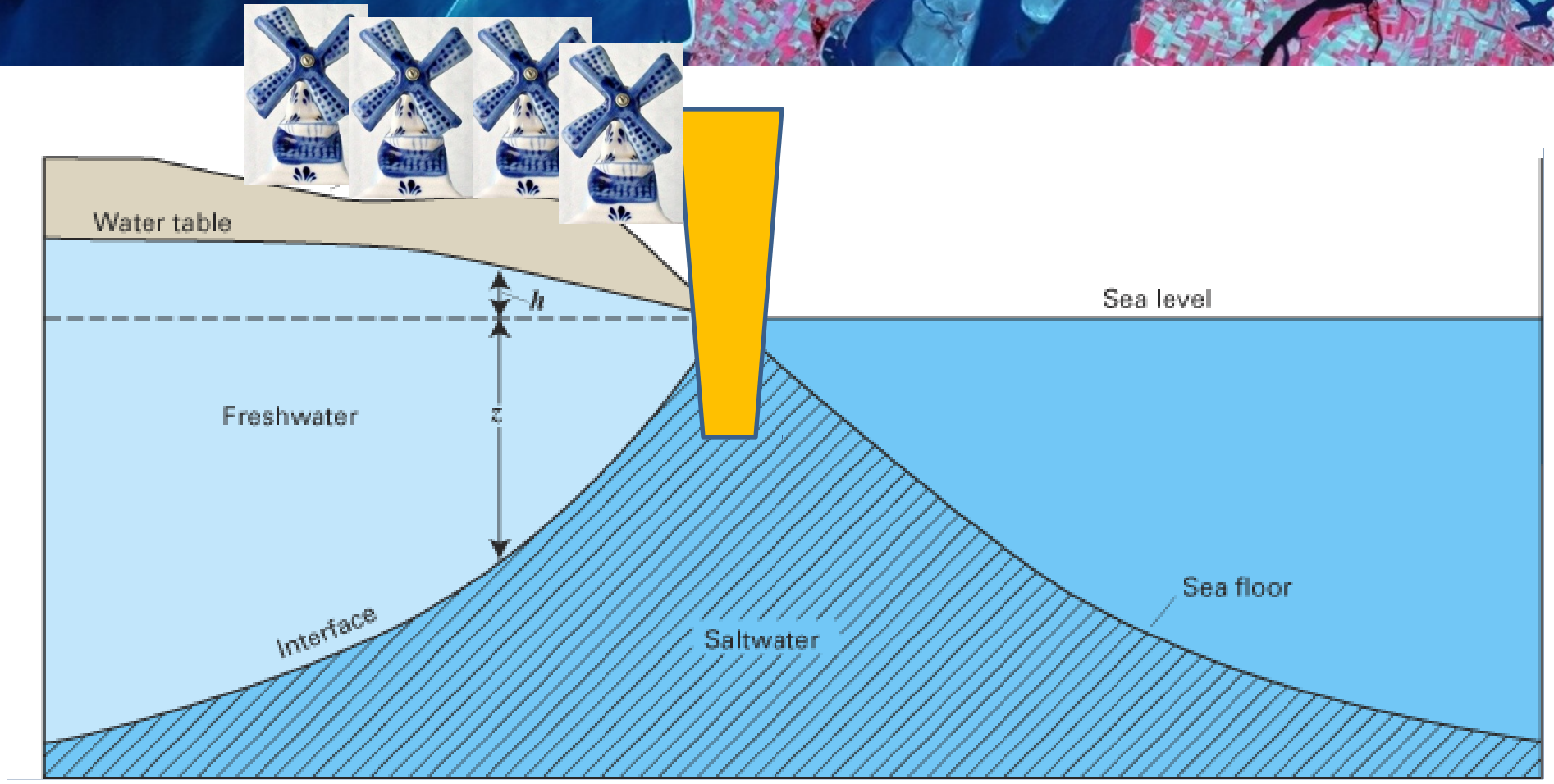

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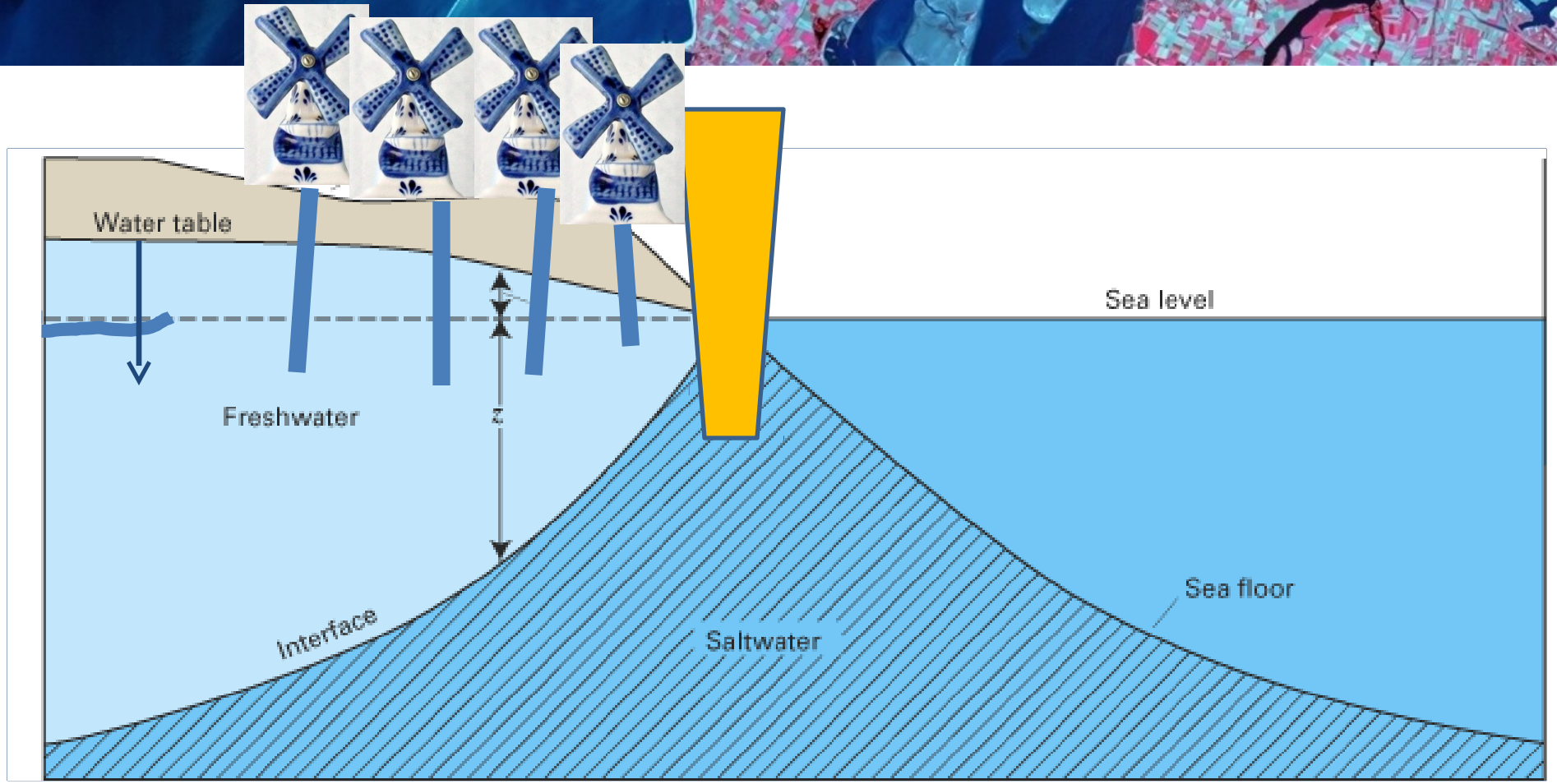

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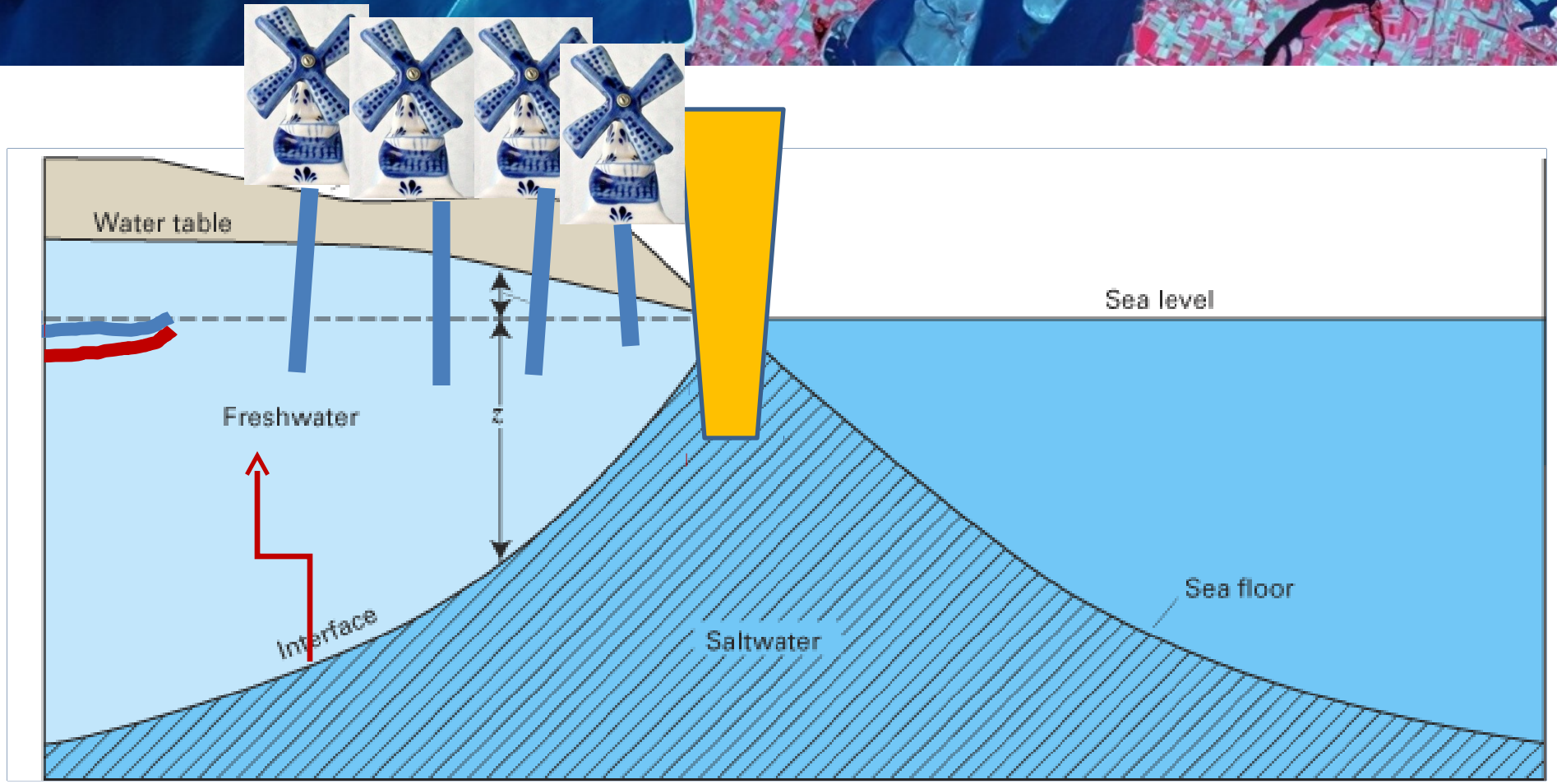

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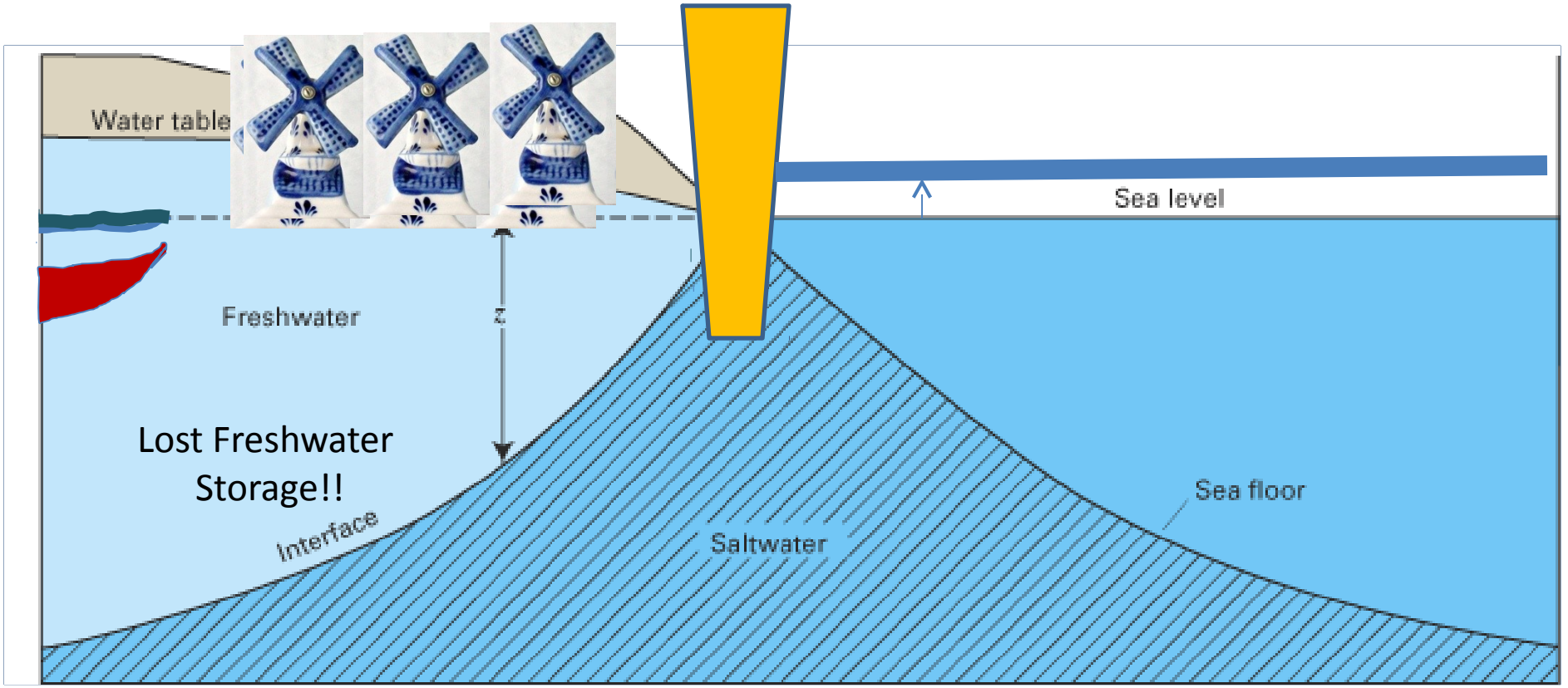

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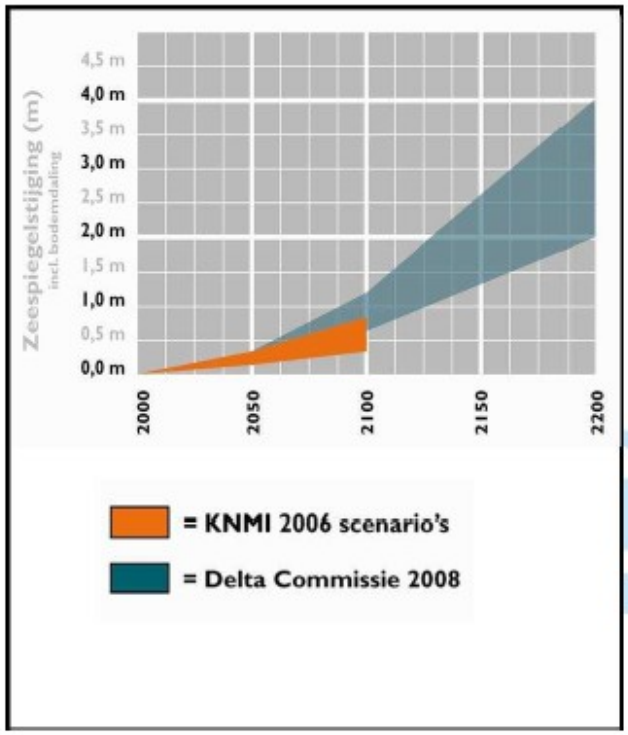
Land Subsidence

Relative SLR



High-end scenarios:

- Round 2050: 40 cm/century
- Round 2100: 65 to 130 cm/century
- Round 2200: 2 to 4 m/century

NB: a bit confusing cause KNMI are best estimates

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