Evaluating Economic Risk for Agricultural Land Use in the San Joaquin Delta

Background: Characteristics of the San Joaquin Delta and its agriculture

The San Joaquin/Sacramento Delta region contains one of the most fertile soil regions in our country and home to many of California's most productive agricultural enterprises. The total area is around 1,100 square miles, around 70 reclaimed islands and tracts, surrounded by 1,100 miles of levees. Lying at the junction point to where the north and south halves of the Central Valley meet, the shared delta of the Sacramento and San Joaquin Rivers is comprised of a large expanse of interconnected canals, sloughs, marshes, and peat islands. The Sacramento-San Joaquin Delta is the largest estuary in the United States as well as being home to one of only a few inverted river deltas there are in the world. The San Joaquin delta consists of a number of small natural and man-made channels creating a system of isolated lowland islands and wetlands created by levees and dikes built by Chinese labor beginning in the 1850's. Land subsidence, changing inflows, sea level rise, and earthquakes all act to shift the Delta from a system of narrow, leveed channels surrounding deeply subsided islands, to that of a large body of open water.

The Delta's peat soil is so conducive to agricultural farming that it is arguably one of the most highly valued agricultural regions in the country. Today the San Joaquin/Sacramento Delta a source to billions of dollars in revenue for the State of California mainly through exports to the rest of the United States as well as the world. This San Joaquin agricultural region so prolific that it leads the nation in the production of crops ranging from asparagus to almonds. Following the events of Hurricane Katrina, concerns have emerged about the security of the levees which if fail could cut off billions in revenue for the California Economy as well as cutting off the supply of many fruits, vegetables, grains, and cow products to the rest of the nation.

Problem Statement: Goals and Solutions

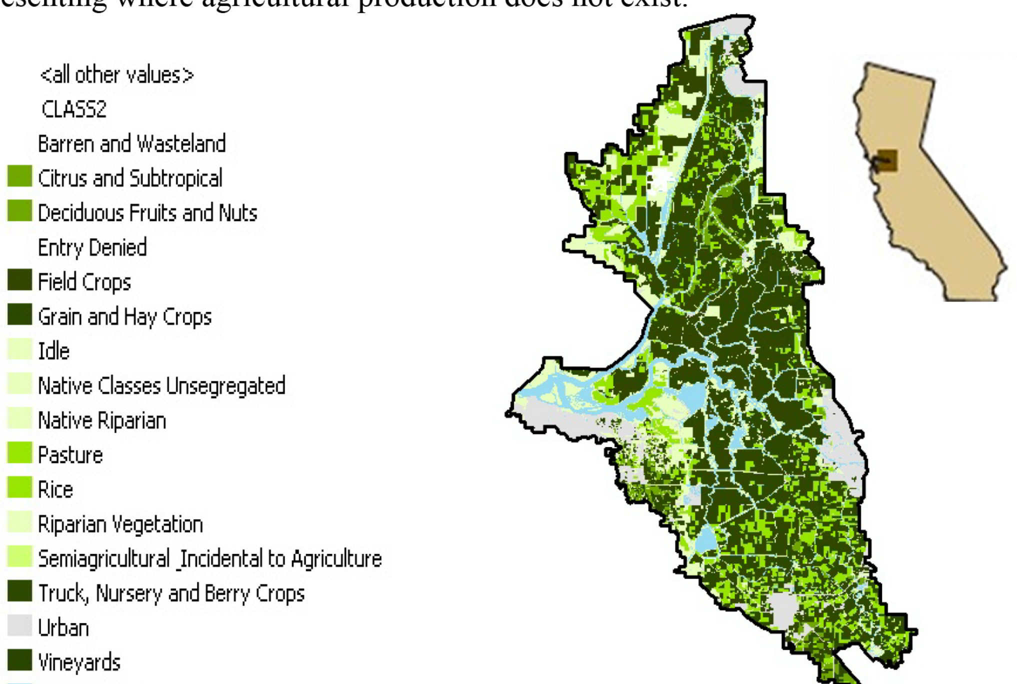
Project Goals:

For my project I decided to analyze agricultural economic risk in the San Joaquin delta and the economic impact a catastrophic event would have on the California economy if agricultural in this region were to cease. My project's goals are to get a better understanding of where the most valuable agricultural land presides in the San Joaquin Delta along with learning which agricultural land is at highest risk of flooding if the levees failed due to a catastrophic event.

Solution:

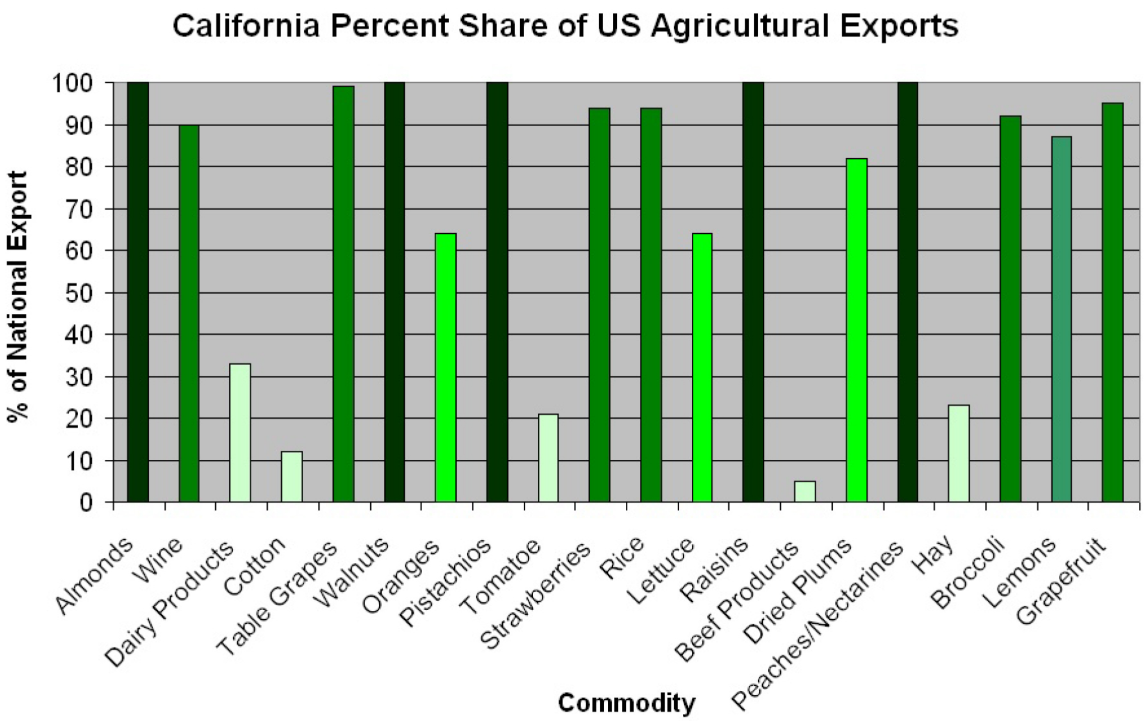
Mapping Value of Land

In my first step I acquired a Land_Use layer provided by Delta Vision at UC Davis. In this layer there contains a value field entitled "classes" which classifies what types of agricultural production that each plot of land is being used for in the delta. In my second step I researched which agricultural crops lead California in revenue through value of exports as well as quantity of exports. I believe by independently looking at the export value of the commodity I can best compare in the most unbiased manner what that value of each piece of land is objectively. I then went into the attribute table and added another field entitled "degree." It is in this field that I gave each value originally from "classes" a new classification to that of a number on my number scale ranging from 0-7. The values 0 (the least valuable and the lightest green) to 5 (the most valuable and the darkest green) based on their export value in dollars to the California economy. The degrees 6 and 7 that are not part of my green color gradient or colored gray and blue to show where there are urban areas and waterways; these colors representing where agricultural production does not exist.



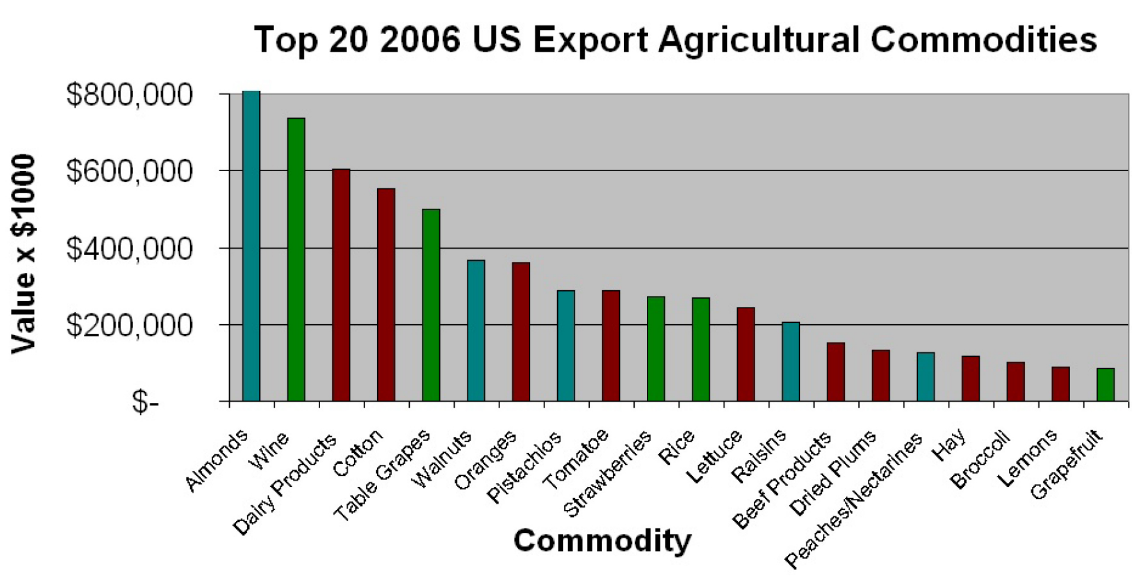
How I Determined my Agricultural Classification for the Map above.

Source: California Department of Agriculture



Source: California Department of Agriculture

<u>IMPORTANT: Almonds are actually $1,898,839, taken out to fit scale</u>

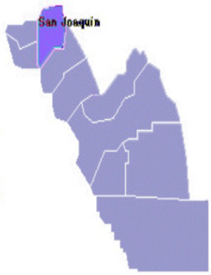


The Delta's Connection to California's Export Commodities

San Joaquin County

This information was compiled from the 1995 Agricultural Commissioners' reports and a 1997 survey of Agricultural Commissioners.

Crops grown in this county:



A-C

Alfalfa, Hay; Almond; Apple, All; Apricot, All; Asparagus; Barley; Barley, Hay (or Silage); Bean, Blackeye (Peas); Bean, Garbanzo; Bean, Lima; Bean, Red Kidney; Bean, Succulent; Beet, Garden; Blueberry; Bok Choy (Pak Choi, Patsai, Taisai, Tat-soi, Tsatsoi, Wong bok); Broccoli; Cabbage, Head; Carrot; Carrot, Seed Crop; Cauliflower; Celery; Cherry, Sweet; Chestnut; Chives; Collard Greens; Corn, Field; Corn, Sweet; Cucumber;

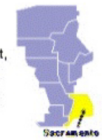
D-W

Daikon (Lobok); Eggplant; Garlic, All; Grape, Table; Grape, Wine; Kale; Kiwifruit; Melon, Cantaloupe; Oats; Olive; Onion, Dry Bulb; Pea, English; Peach, Cling; Peach, Freestone; Pear, Bartlett; Pecan; Pepper, Bell; Pistachio; Potato, Irish; Potato, Seed; Prune; Pumpkin; Rice; Safflower; Silage; Spinach; Squash, Winter; Stevia; Strawberry; Sudan Grass, Seed Crop; Sugarbeet; Sunflower, Oil; Teff; Tomato, Fresh Market; Tomato, Processing; Walnut, English; Watermelon; Wheat.

Sacramento County

This information was compiled from the 1995 Agricultural Commissioners' reports and a 1997 survey of Agricultural Commissioners

Crops grown in this county:



A-C

Alfalfa, Hay; Alfalfa, Seed; Almond; Apple, All; Apricot, All; Asparagus; Barley; Barley, Hay (or Silage); Bean, Blackeye (Peas); Bean, Dry; Bean, Garbanzo; Bean, Seed Crop; Bean, Succulent; Beet, Garden; Bok Choy (Pak Choi, Patsai, Taisai, Tat-soi, Tsatsoi, Wong bok); Bok Choy, Flowering (Choysum, Yu Choy); Broccoli, Chinese (Gai Lon); Cabbage, Napa (Pe Tsai); Cabbage, Savoy; Chayote; Cherry, Sweet; Christmas Trees; Clover, Hay; Clover, Ladino Seed Crop; Clover, Red, Seed Crop; Clover, White, Seed Crop; Collard Greens; Coriander, Leaves (Cilantro); Corn, Field; Corn, Indian; Corn, Popcorn; Corn, Silage & Forage; Corn, Sweet; Cucumber;

D-P

Daikon (Lobok); Dill, Leaves; Feijoas; Forestry, Wood Pulp; Garlic, All; Grape, Wine; Hay, Grain; Hay, Grass; Kiwifruit; Lemon Grass; Lettuce, Romaine; Melon, Cantaloupe; Mustard, Seed; Nectarine; Nursery, Flowers, Potted; Nursery, Ornamentals, Herbaceous; Nursery, Ornamentals, Woody; Nursery, Turf; Oats; Oats, Hay (and Silage); Oats, Seed Crop; Okra; Olive; Onion, Dry Bulb; Onion, Green; Pea, Edible Pod; Peach, Freestone; Pear, Anjou; Pear, Asian; Pear, Bartlett, Pear, Bosc; Pear, Comice; Pepper, Bell; Pepper, Chile; Persimmon, Fuyu; Persimmon, Hachiya; Poplars, Hybrid for pulp; Pumpkin;

R-Y

Rice; Rice, Seed Crop; Rice, Wild; Rye; Rye, Hay; Safflower; Sorghum, Grain; Spinach; Spinach, Chinese; Squash, All; Squash, Summer; Stevia; Strawberry; Strawberry, Nursery Stock; Sudan Grass, Hay; Sudan Grass, Seed Crop; Sugarbeet; Sugarcane; Sunflower, Seed ; Tomato, Fresh Market; Tomato, Processing; Tomato, Seed Crop; Turnip; Walnut, English; Watermelon; Wheat; Yam, Shoots (Leaves).

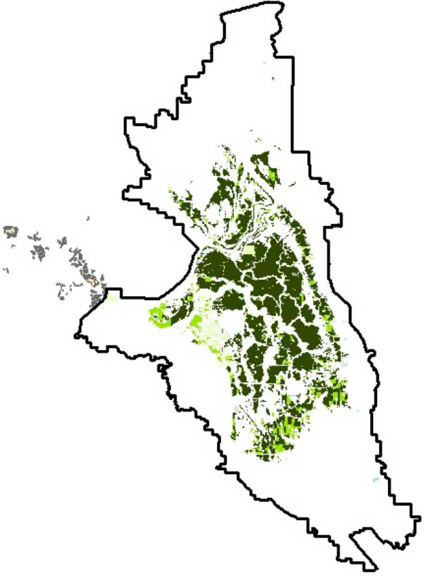
SOURCE: California Pest Management Center — Western IPM Center

Mapping land greatest at risk for flooding

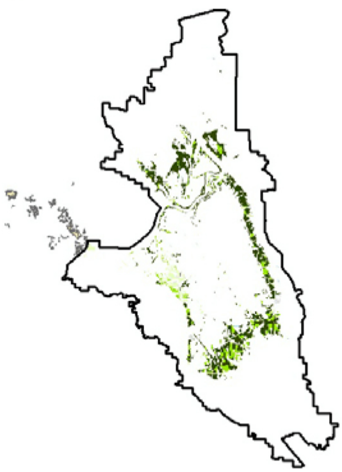
In the event of a catastrophic event like an earthquake the chances of the levees breaking is high and with that the guaranteed result of flooding of all land below sea level as well. In my project I looking at all land below sea and their degree in how many feet they are by using an Elevation_Layer provided by Delta Vision at UC Davis. The further below sea level, I conclude, the higher the price as well as longer the time it will take to dredge the water out and restore it to pre-flooding conditions. In my project I look at land below sea level only, because it is here where there is guaranteed inundation of agricultural land in the event of a flood. I break up sea levels by 0 to –5 feet, -5 to –10 feet, -10 to –15 feet, and >-15 feet elevation. I then created a union between my land use layer and my elevation layer to find out the different values of land that are below sea level (at risk of flooding). Results show that an overwhelming amount of all agricultural land below sea level is composed of prime farmland (shown in dark green).

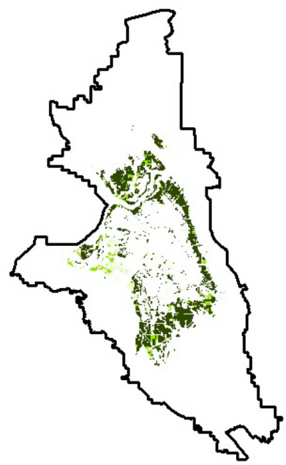
Land Use and Elevation below Sea Level Union

- elevation_Union_>-15
- elevation_Union_-10-15
- elevation_Union_-5-10
- elevation_Union_-5_0

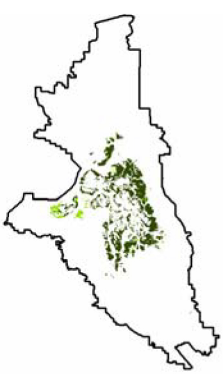


elevation_Union_-5_0 elevation_Union_-5-10





elevation_Union_-10-15

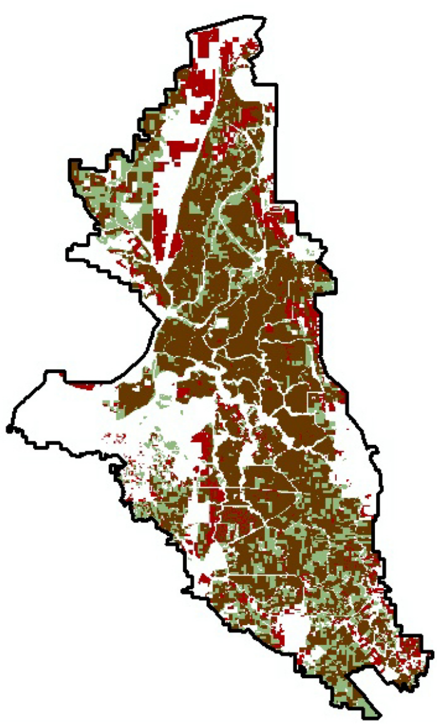


In my next step I went to the California Department of Conservation website and downloaded GIS data for all six counties that make up the legal boundaries of the San Joaquin Delta (San Joaquin, Sacramento, Yolo, Solano, Contra Costa, and Alameda county) I then went to their symbology and visually only turned on the areas that were designated, according to California Department of Conservation, as prime farmland. I thus compared my results of where prime agricultural land lay to their results of where prime agricultural land lay giving me a benchmark of how accurate my map is. The bellow picture shows these results with the green polygons representing California Department of Conservation prime farmland and the red polygons showing where my determined prime agricultural land lie.

CA.GOV State of California
Department of Conservation

Prime Farmland (P)

Farmland with the best combination of physical and chemical features able to sustain long term agricultural production. This land has the soil quality, growing season, and moisture supply needed to produce sustained high yields. Land must have been used for irrigated agricultural production at some time during the four years prior to the mapping date. Download information on the soils qualifying for Prime Farmland. More general information on the definition of Prime Farmland is also available.

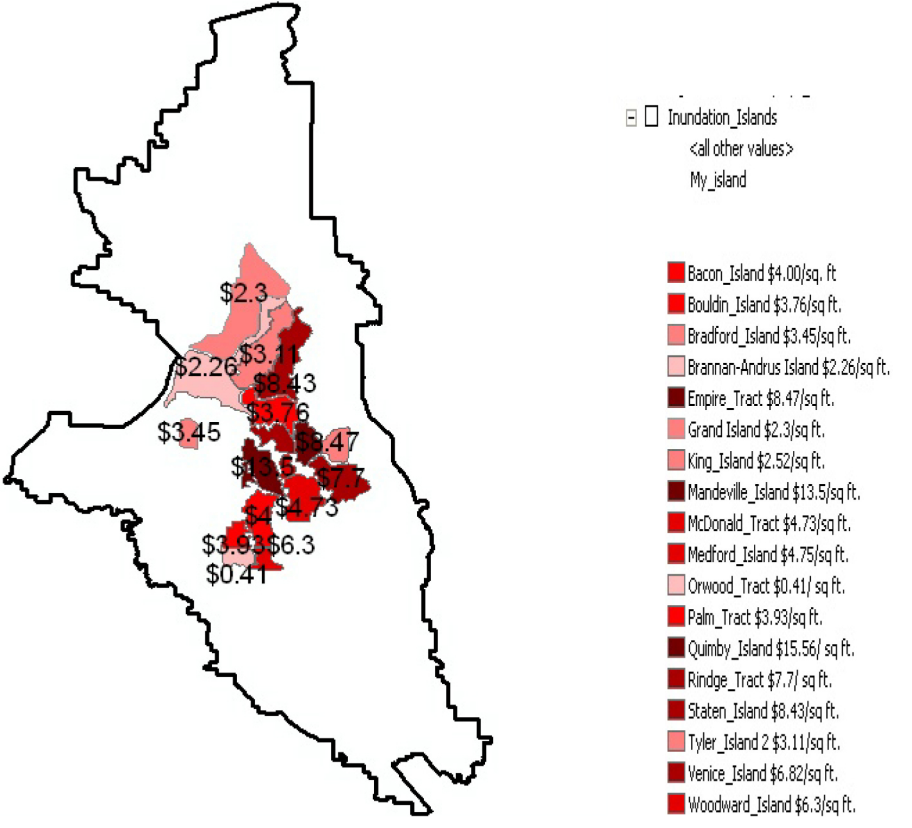


In my next step I uploaded the layer “inundation islands” from the Johns ARB study, a comparative study done at UC Davis analyzing levee failure in the San Joaquin delta funded by the Public Policy Institute of California. It is through the graph below that I gain the knowledge of island names, land value, and asset value in the delta of 18 delta islands. With this information I then added a field to my “inundated island” layer and calculated the area of each island (polygon) in feet through “calculate geometry.”

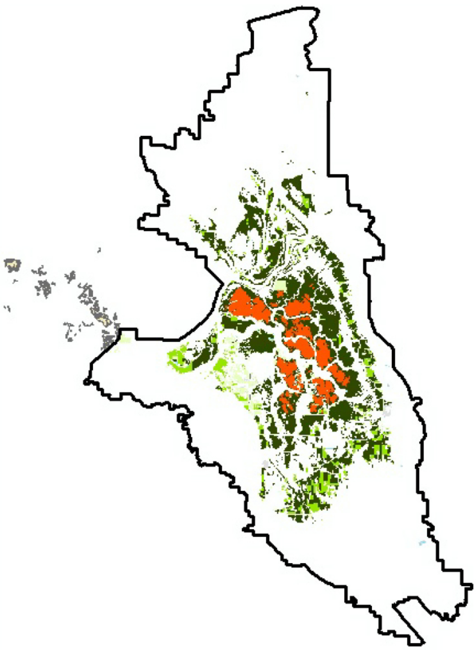
Table B.3 Land and Asset Values

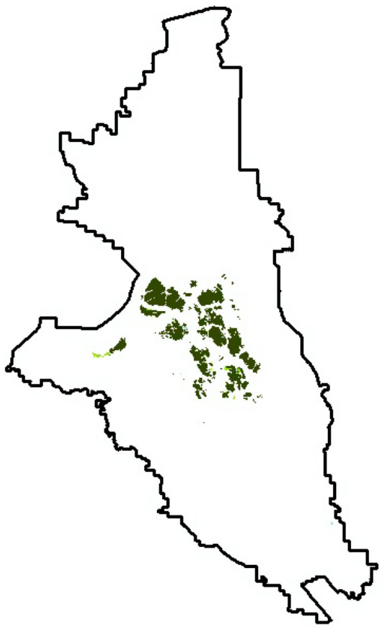
zone	NAME	Land Value	Asset Value	Land + Asset
Central	Bacon Island	$16,248,424	$43,916,000	$60,164,424
Central	Bouldin Island	$13,040,542	$25,897,000	$38,937,542
Central	Empire Tract	$9,114,605	$9,790,000	$18,904,605
Central	Mandeville Island	$11,731,203	$5,212,000	$16,943,203
Central	McDonald Tract	$20,591,848	$36,246,000	$56,837,848
Central	Medford Island	$2,221,145	$8,559,000	$10,780,145
Central	Quimby Island	$1,565,687	$626,000	$2,191,687
Central	Rindge Tract	$19,906,394	$18,516,000	$38,422,394
Central	Venice Island	$6,839,964	$13,308,000	$20,147,964
Eastern	King Island	$12,081,613	$44,049,000	$56,130,613
Eastern	Terminous Tract	$50,975,498	$93,400,000	$144,375,498
Eastern	Wright-Elmwood	$26,166,120	$16,429,000	$42,595,120
Northern	Brack Tract	$23,205,096	$14,021,000	$37,226,096
Northern	Canal Ranch Tract	$27,692,544	$20,757,000	$48,449,544
Northern	Dead Horse Island	$862,581	$998,000	$1,860,581
Northern	Grand Island	$64,673,235	$253,978,000	$318,651,235
Northern	Ryer Island	$38,670,068	$61,494,000	$100,164,068
Northern	Staten Island	$26,409,675	$20,596,000	$47,005,675
Northern	Tyler Island	$33,202,759	$92,866,000	$126,068,759
Southern	Coney Island	$2,438,255	$21,921,000	$24,359,255
Southern	Jones Tract	$42,496,164	$507,972,000	$550,468,164
Southern	Orwood Tract	$8,893,034	$251,172,000	$260,065,034
Southern	Palm Tract	$5,346,593	$22,562,000	$27,908,593
Southern	Roberts Island	$164,103,230	$64,446,000	$228,549,230
Southern	Union Island	$80,672,567	$156,763,000	$237,435,567
Southern	Victoria Island	$22,618,787	$57,078,000	$79,696,787
Southern	Woodward Island	$4,637,580	$124,671,000	$129,308,580
Western	Bradford Island	$5,518,842	$21,630,000	$27,148,842
Western	Brannan Island	$73,173,177	$216,612,000	$289,785,177
Western	Holland Tract	$8,823,343	$15,787,000	$24,610,343

I used the total value of the island (price of assets plus the price of land) given to me from the above table and divided it by the square footage of the island calculated in ArcMap. From this I got price per square foot on the island shown in the following map.



In my last step I intersected my determined prime agricultural layer with the islands that I managed to calculate price per square foot of land shown in the image below. I then calculated, through the "calculate geometry" tool, the area for each of the intersecting prime farmland polygons and that of the eighteen calculated islands. After this I went to the attribute table and created a new field and gave values (1-18) to each polygon based on which island it overlay. I then added up these values to give me the total area of prime agricultural land for each island (orange polygons below).





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After this I multiplied the total area of prime agricultural land to the price per square foot of land for each island. This followed by adding all the islands together to give me the grand total cost of $1,012,736,520 of prime agricultural land represented above in the orange polygons. In the end I did not find the total cost for all land below sea level; instead I did managed to find is the cost of the most at risk areas of land in the delta (those at the greatest negative depth) for analysis.

Conclusions

In the end this project portrayed very conclusive evidence that the agricultural production, along with state revenue, that presides in the Sacramento/San Joaquin Delta is at great strategic risk of being destroyed in the advent of a catastrophic event. With roughly a billion dollars predicted in just the orange polygons alone, a catastrophic event that causes flooding would guarantee the flooding all lands below sea level, roughly three times area of the orange polygons. With this I predict a three billion dollar revenue lose for California agricultural exports if all agricultural production below sea level were to be stopped. One finding that was striking to me was how much land is below sea level. Essentially, the delta is a “sinkhole” with roughly a half below sea level. Another striking finding was that there seemed to be a correlation with how the quality of the land and how far below sea level it is. That is, the most prime land was at the most negative depth. And lastly, the finding I found the most interesting was the spatial correlation of the value of land in per square footage terms with my results showing the highest in the southwestern region of the delta.

Appendix

Calculations

Island	Land+Assett Value	Sqaure Foot of Island
Bacon_Island	$60,164,424	243324627.05
Bouldin_Island	$38,937,542	263173814.118
Bradford_Island	$27,148,842	93768691.3962
Brannan-Andrus Island	$289,785,177	655427448.898
Empire_Tract	$18,904,605	160186236.691
Grand Island	$318,651,235	731661810.418
Holland_Tract	$24,610,343	186707384.603
King_Island	$56,130,613	141678611.238
Mandeville_Island	$16,943,203	228500025.317
McDonald_Tract	$56,837,848	268913802.621
Medford_Island	$10,780,145	51245914.8217
Orwood_Tract	$260,065,034	105617316.888
Palm_Tract	$27,908,593	109776829.186
Quimby_Island	$2,191,687	34109871.9077
Rindge_Tract	$38,422,394	298469856.381
Staten_Island	$47,005,675	396134214.096
Tyler_Island	$126,068,759	391481695.512
Venice_Island	$20,147,964	137492243.699
Woodward_Island	$129,308,580	81441421.1943

Island Value/Square Foot

Bacon_Island	$4.044/ft
Bouldin_Island	$3.76/ft
Bradford_Island	$3.45/ft
Brannan-Andrus	$2.26/ft
Empire_Tract	$8.47/ft
Grand Island	$2.3/ft
King_Island	$ 2.52/ft
Mandeville_Island	$13.5/ft
McDonald_Tract	$4.73/ft
Medford_Island	$4.75/ft
Orwood_Tract	$0.406/ft
Palm_Tract	$3.93/ft
Quimby_Island	$15.56/ft
Rindge_Tract	$7.7/ft
Staten_Island	$8.43/ft
Tyler_Island	$3.11/ft
Venice_Island	$6.824/ft
Woodward_Island	$6.3/ft

The amount of Prime Agricultural land below 15 feet of Sea Level multiplied by the average price per square foot of that island

Brannan-Andrus Island
22743700.4 sq ft. * $2.26/ sq ft. = $51400762.9

Tyler Island
1686333.5 sq. ft. * $3.11/sq ft. =$5244497.18

Staten Island
10273683.3 sq. ft. * $8.43/sq ft.=$86607150.2

Bouldin Island
16977555.5 sq. ft. * $3.76/sq. ft.=$63835608.7

Venice Island
9244602.9 sq ft.* $6.82/ sq. ft. =$63048191.8

Empire Island
9039340 sq. ft.* $8.47/sq. ft.=$76563209.8

Mandeville Island
11249705.7 sq. ft. * $13.5/sq. ft=$151871027

Medford Island
280332.5 sq. ft. * $4.75/sq. ft.=$1331579.38

McDonald Island
91717612.9 sq. ft. * $4.73/sq. ft.=$433824309

Bacon Island
4047502.2 sq. ft.* $4/ sq. ft.=$16190008.8

Rindge Tract
8137706 sq. ft.* $7.7/ sq. ft.=$62660336.2

Woodward Island
25371.8 sq. ft. * $6.3/sq/ ft.=$159842.34

Grand Total: $1,012,736,520