Irrigation Pond Suitability in the Anderson Valley, California

Basis for Pond Placement

Courtesy of geology.com

Irrigation ponds are essential for continued access to water throughout the growing season in agricultural areas with very limited and seasonal rainfall. In the Anderson Valley, an agricultural region specializing in grapes, apples, and sheep 100 miles north of San Francisco, some farms struggle at the end of summer when their water sources have run dry. Thus, it is useful to investigate places where ponds could be properly situated based on soil characteristics and accumulation of rainwater in order to better serve these farms.

The USDA's National Recourse Conservation Service Web Soil Survey is a helpful tool for understanding the nuances of soils. The NRCS defines soil as belonging to 4 different classes:

- A: Porous soils with high infiltration rates
- B: Well-drained soils with moderate infiltration
- C: Soils with slow infiltration rates when wet
- D: Poorly drained soils with very slow infiltration rates, high swelling potential, and permanent high water table from clay

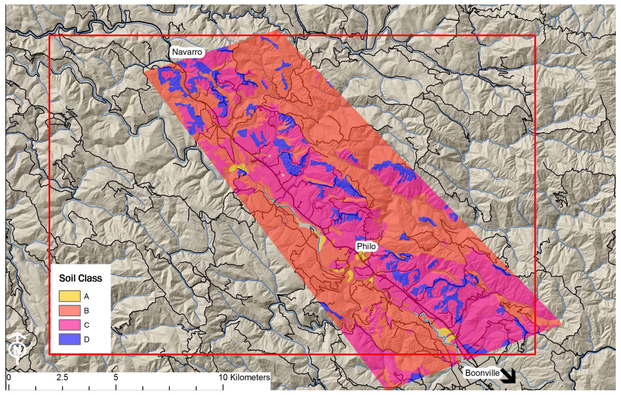
Unlined ponds will work best when situated in poorly drained C or D soils so their water content remains constant.

The NRCS also classifies soil in the Anderson Valley into three categories based on its potential for agriculture: not prime for agriculture, agricultural land of statewide importance and prime for agriculture if irrigated.
It was important that new ponds were near soil prime for agriculture if irrigated.

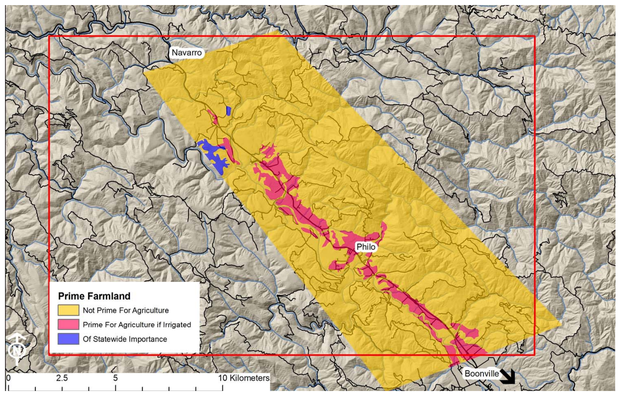
The 1/3 Arc-Second National Elevation Dataset was used as a digital elevation model. This is a raster data set used to show the hill shade of the Anderson Valley in order to gain a better understanding of the terrain. 1/3 arc-second refers to a resolution of approximately 10 meters. The purpose of this dataset is to portray elevation and allow for manipulation of flow accumulation of water based on slope and elevations patterns.

Irrigation ponds in the Anderson Valley tend to be filled by water pumped from the Navarro River or by smaller creeks in the area. This is primarily due the highly seasonal and variable rainfall in Northern California. Though, a pond that is situated in an area where winter rains would be able to easily accumulate and flow into the pond would reduce energy used to pump water from another source, as well as ensure that the river is able to flow it its highest potential. Therefore, areas of high flow accumulation were also taken into account as an influence on best pond placement.

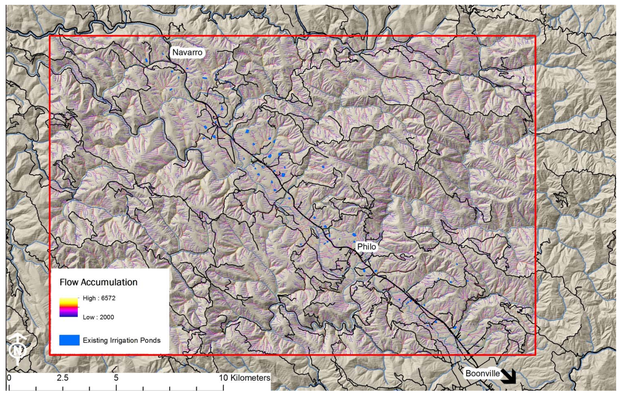
Soil Classification



Agricultural Potential of Soil



Flow Accumulation Based on NED



Data Sources

NED 1/3 Arc-Second, 2013, U.S. Geological Survey, accessed through the National Map Viewer on November 3 2015.

Web Soil Survey, 2013, USDA, Natural Resources Conservation Service, National Cooperative Soil Survey. Accessed through http://websoilsurvey.nrcs. usda.gov/on 30 Nov 2015.

Background soil information was found at www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/NRCS144_p2_030362.pdf

Modeling Soil Potential

First, it was necessary to add joins between the soil shape file and accompanying data. Then, soils were displayed based on soil class and farming potential. Both of these data sets were transformed into rasters and then reclassified based on their suitability for a pond, with class D soils and prime farmland if irrigated garnering highest scores. Then, the soil and farming scores were entered in the raster calculator to combine the data and average the scores to find the best area for ponds, seen to the right.

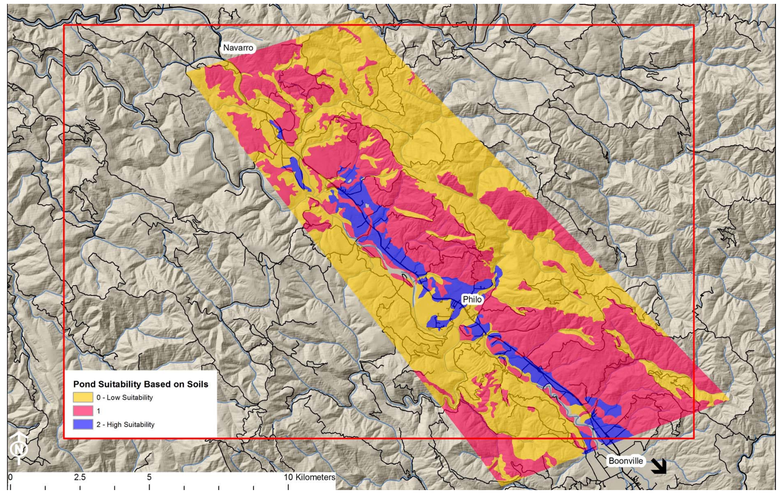
In order to determine the water flow accumulation in the Anderson Valley, it was necessary to create a proper hill shade of the digital elevation model, then take this hill shade take it through multiple different hydrography modeling processes. The area was 'filled', then flow direction was calculated, followed by calculating the total flow accumulation for the area of interest. Then, 2 log functions were completed on the raster data set in order to account for the fact that water doesn't necessarily originate at absolute peaks. This provided an output to display the drainage network in the Anderson Valley.

Suitability scores were reclassified to 2, the highest, and no data. The high suitability area was then broken into regions in order to be able to look at each area individually. In order to determine which area would be best suited based on soils and flow accumulation, a zonal statistic calculation was completed that determined which pond zone had the highest value of flow accumulation. This resulted in many options, but only 3 showing high flow accumulation values.

Evaluation Potential of Model

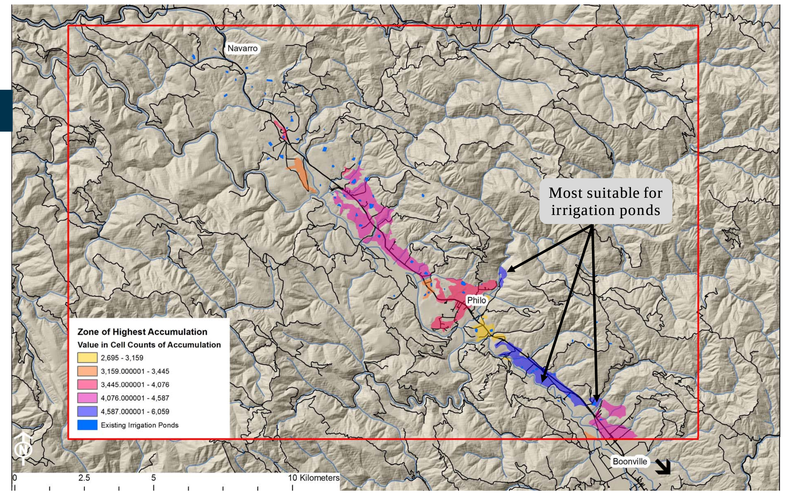
While the model was able to find multiple landscapes well suited for ponds based on soil and flow accumulation, there are many other factors that play into what constitutes suitable pond placement. It is important to take note of where people are actively engaging in agriculture and could benefit from improved access to water. This type of data, as well as precise land cover data, was unavailable to add to the study. Thus, the data used made this process fairly simplified and not comprehensive of a true suitability analysis for locating new sites for irrigation ponds. The analysis would have benefitted from accurate cropland data as it would have been possible to model where ponds could be placed based on where agriculture is occurring and where ponds are currently located. I acknowledge that there are many pieces missing from this suitability study that affect the level of confidence this model could be used in reality. Though, it is still useful in the sense that it provides insight into whether soil type and flow accumulation have an influence on where ponds are actually situated. A large number of ponds are actually located in zones of mid to high pond suitability showing that the factors used in the suitability analysis are likely to be important and valid determinants of pond placement.

Pond Suitability Based on Soil Characteristics



Here, highly suitable ponds sites based on soil characteristics are highlighted in blue, while areas that are not suitable are in yellow and red. This shows that the model was able to find potential sites for ponds based on scoring soil characteristic. It is interesting to note how closely the high suitability follows the same areas labeled as prime for agriculture if irrigated based on NRCS data. Soil characteristics are very important for agricultural irrigation ponds that are mainly filled by pumping water from a river or by hauling in water with a water truck. Though, it is important to also determine which area is most suitable if one was able to account for and capture the natural flow accumulation in the watershed during the winter rains.

Suitability of Soils Considering Flow Accumulation



Based on maximum flow accumulation, there are three main areas that are suitable for ponds based on the three aforementioned characteristics. It is interesting to note that at least 7 irrigation ponds exist in this zone of high accumulation, shown in dark blue. Since there is still space in these areas where there are not ponds, if there is agriculture occurring there, the model shows that these areas would be well suited for new ponds. The areas of mid flow accumulation hold the majority of ponds, which may provide insight to the fact that while D soils are prime for irrigation ponds, this may not necessarily be a place where farming is most appropriate. It is useful to compare this suitability map to the original maps showing prime agriculture potential and soil type to determine what is a larger factor for pond suitability on the landscape.

Cartographer: Krissy Scommegna
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CA State Plane NAD83—meters

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