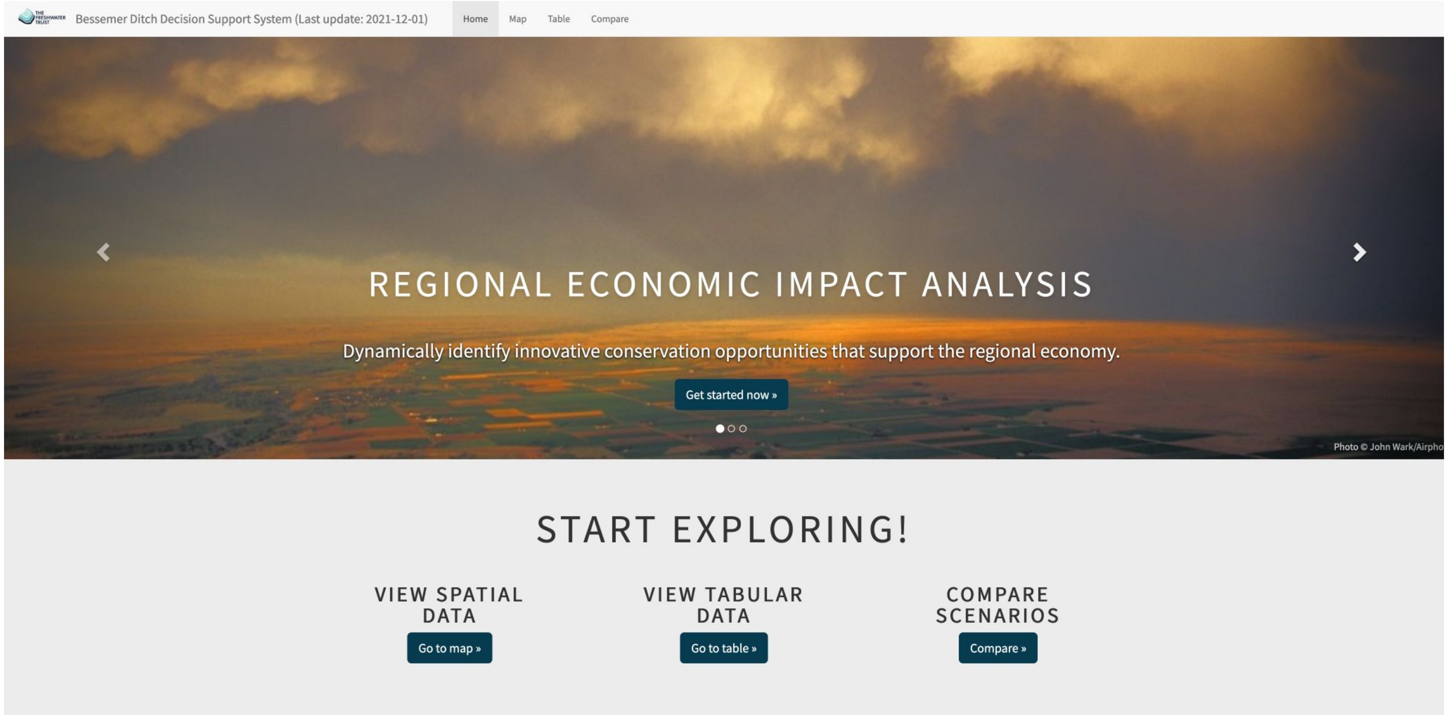
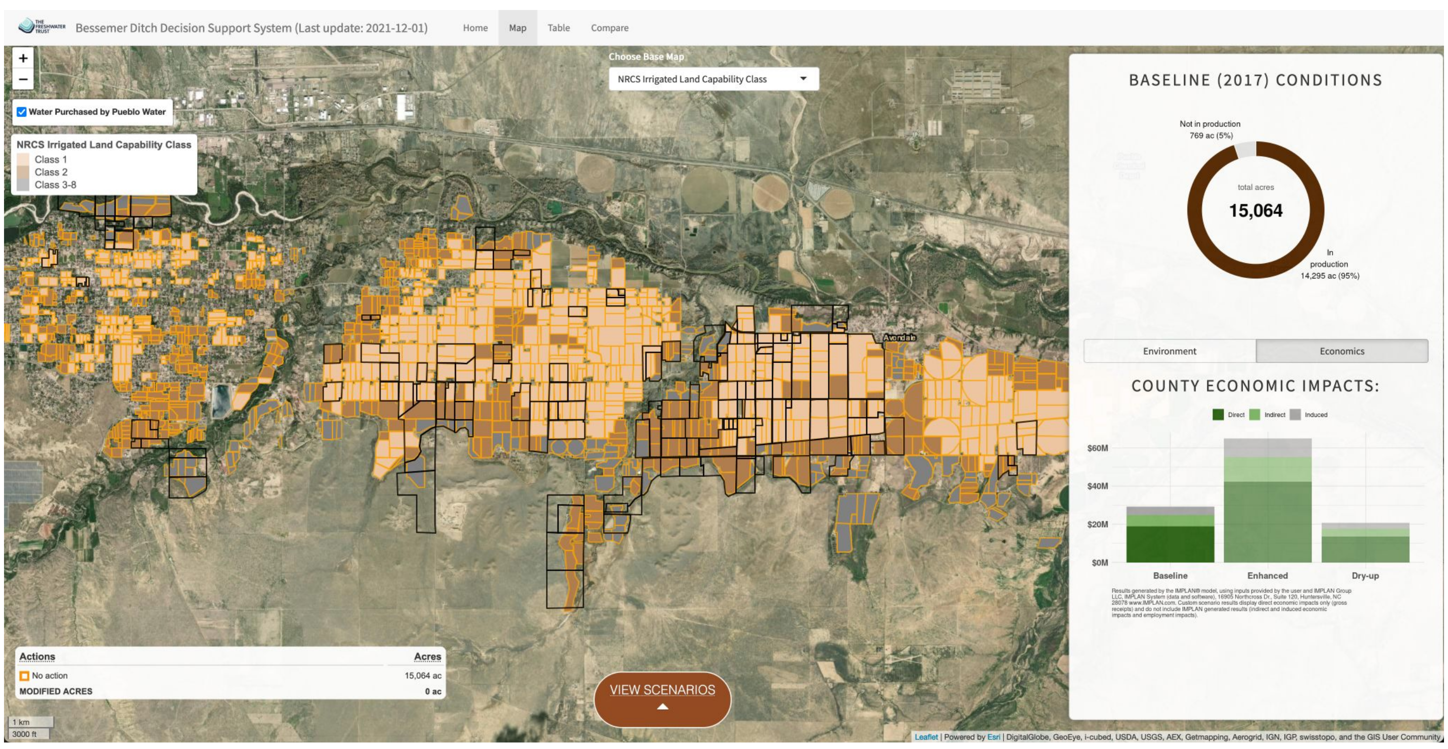
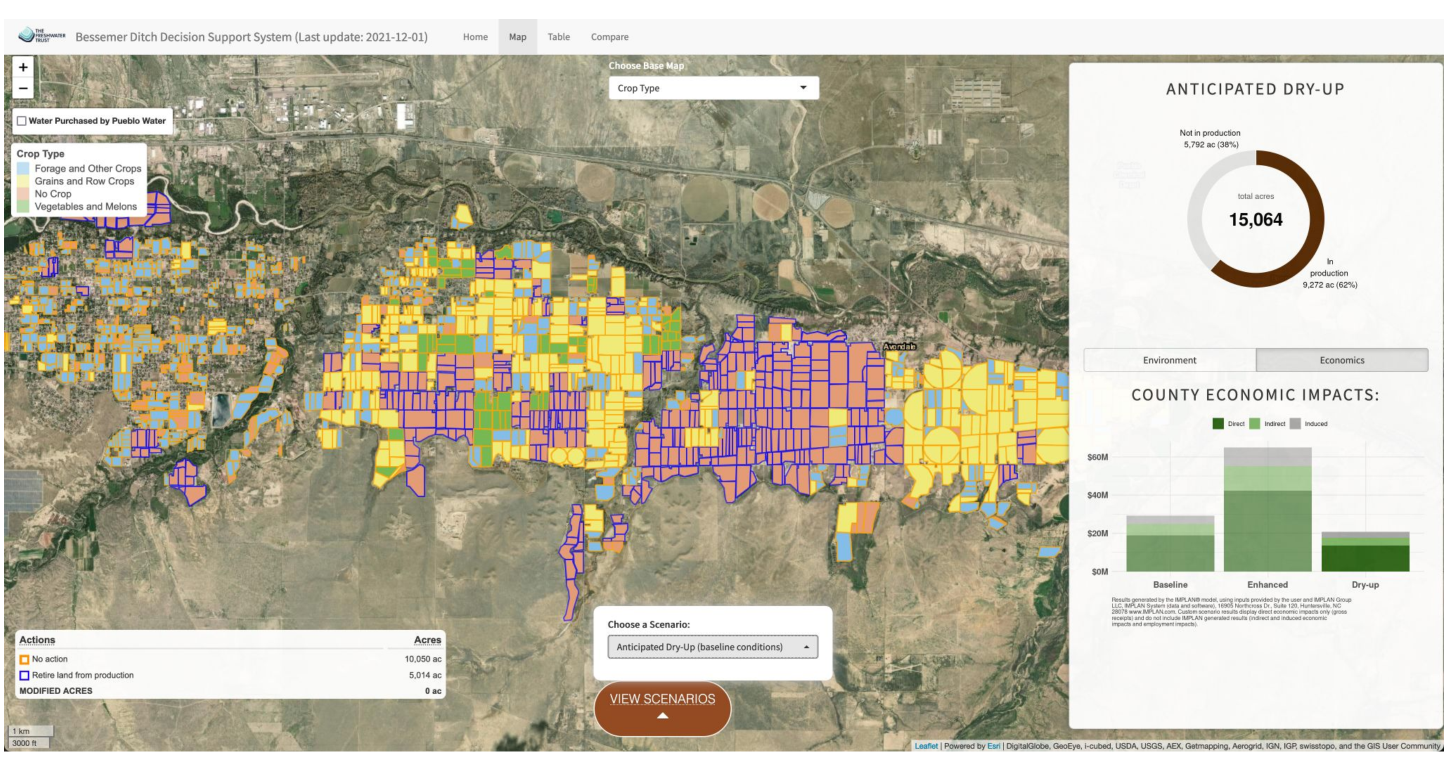


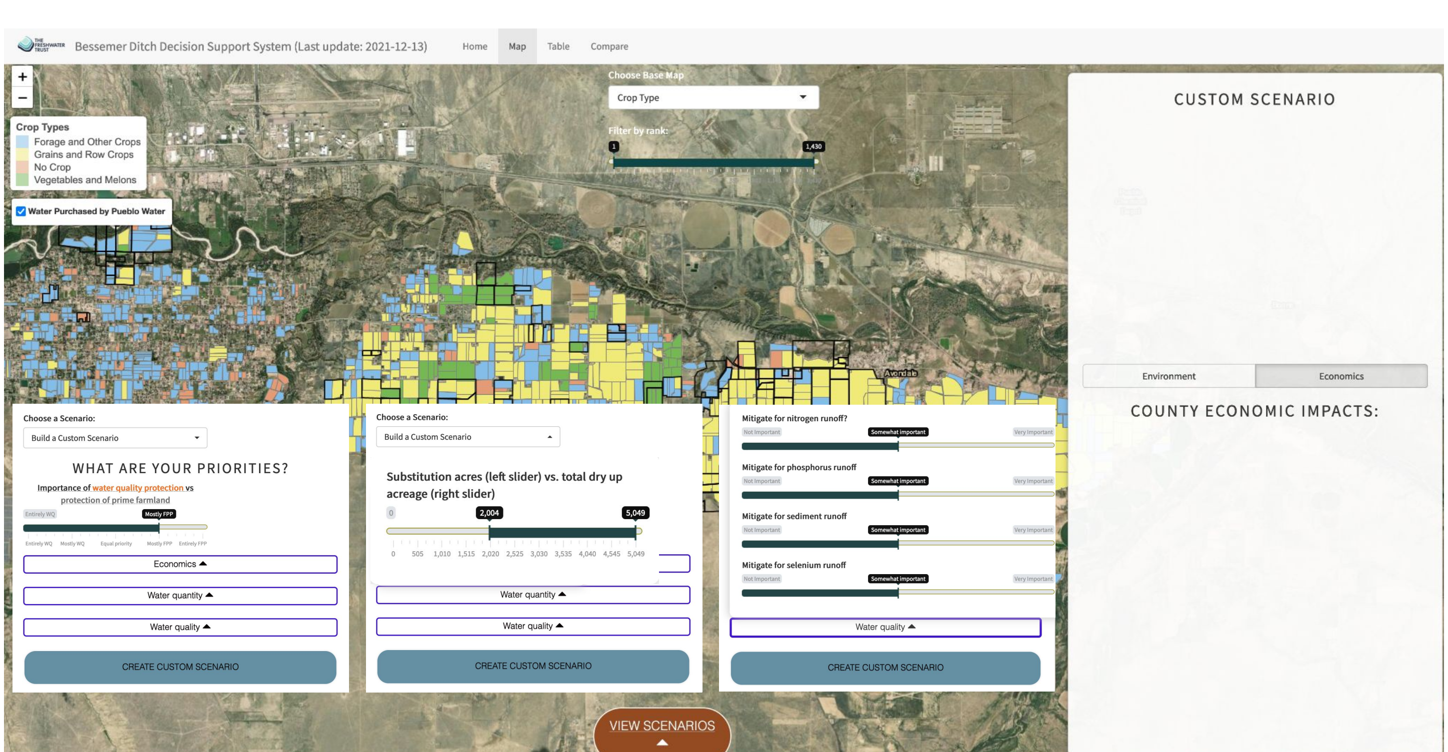
In 2009, Pueblo Water purchased 28% of Bessemer Irrigating Ditch Company shares for municipal and industrial use. Pueblo County is projected to lose $8.4 to $17 million per year in agricultural economic activity following dry-up, and hundreds of jobs (between 144 and 271 full-time equivalents (FTEs)). Without dry-up alternatives, county economic losses will exceed Pueblo Water's purchase price ($56 million) in just 3-7 years. The Bessemer Decision Support System (DSS) was designed to inform dry-up alternatives that support better outcomes.



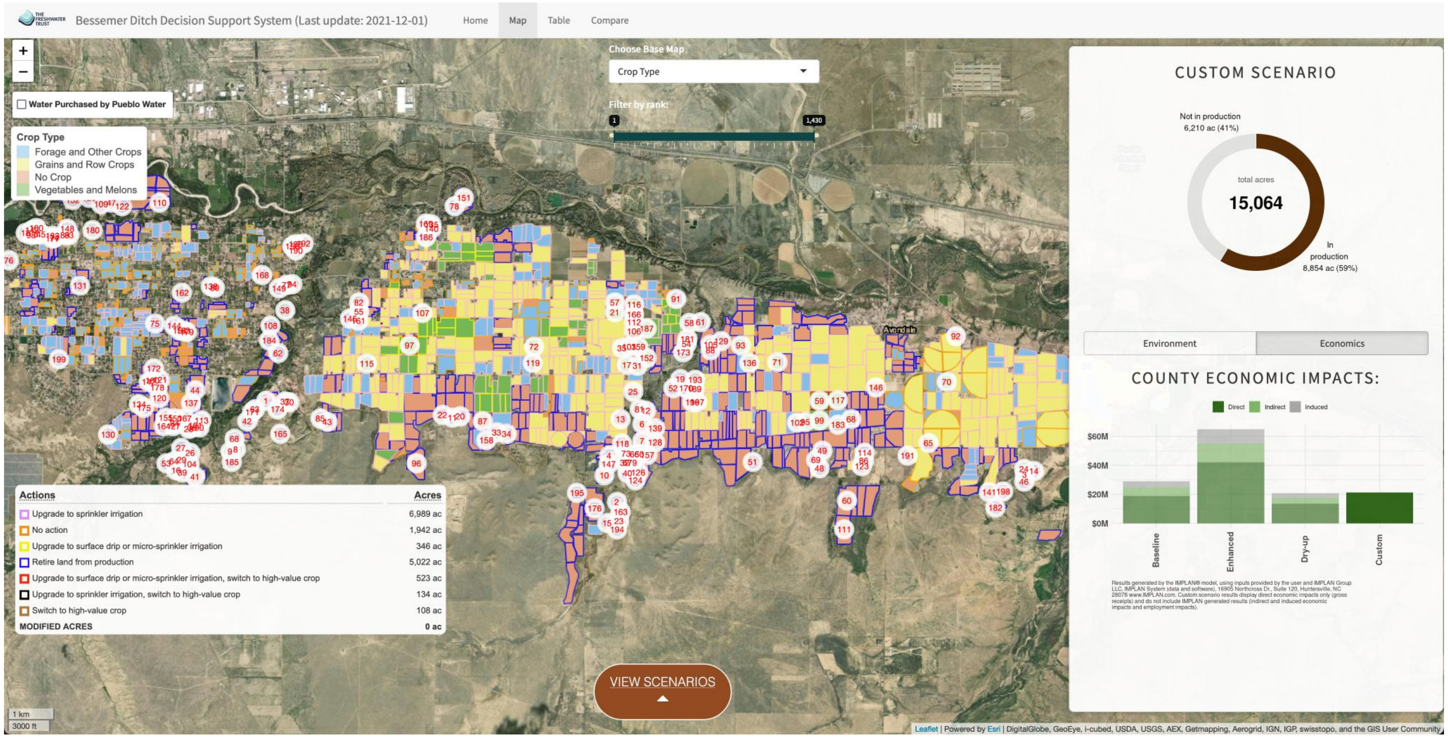
The map tab (DSS screenshot on the left) illustrates the high percentage of Class 1 soils (light-beige-color) on Bessemer-irrigated farmland. Farms poised to be dried by Pueblo Water are outlined in black; 63% of these lands are defined as critical production areas (CPAs)–lands with a high percentage of Class 1 and 2 soils. The dashboard on the right side of the DSS screen shows the total Bessemer-irrigated acreage currently in production (14,295 of 15,064 acres) under a "Baseline Conditions" scenario–an average production year based upon current (in this case, 2017) production. It show the total county economic outputs (direct, indirect, and induced) under this baseline scenario (left bar in the bar graph). In addition to soil class, the DSS enables users to look at the crop type, irrigation method, and water quality improvement potential for every Bessemer- irrigated field (there are 1,430).



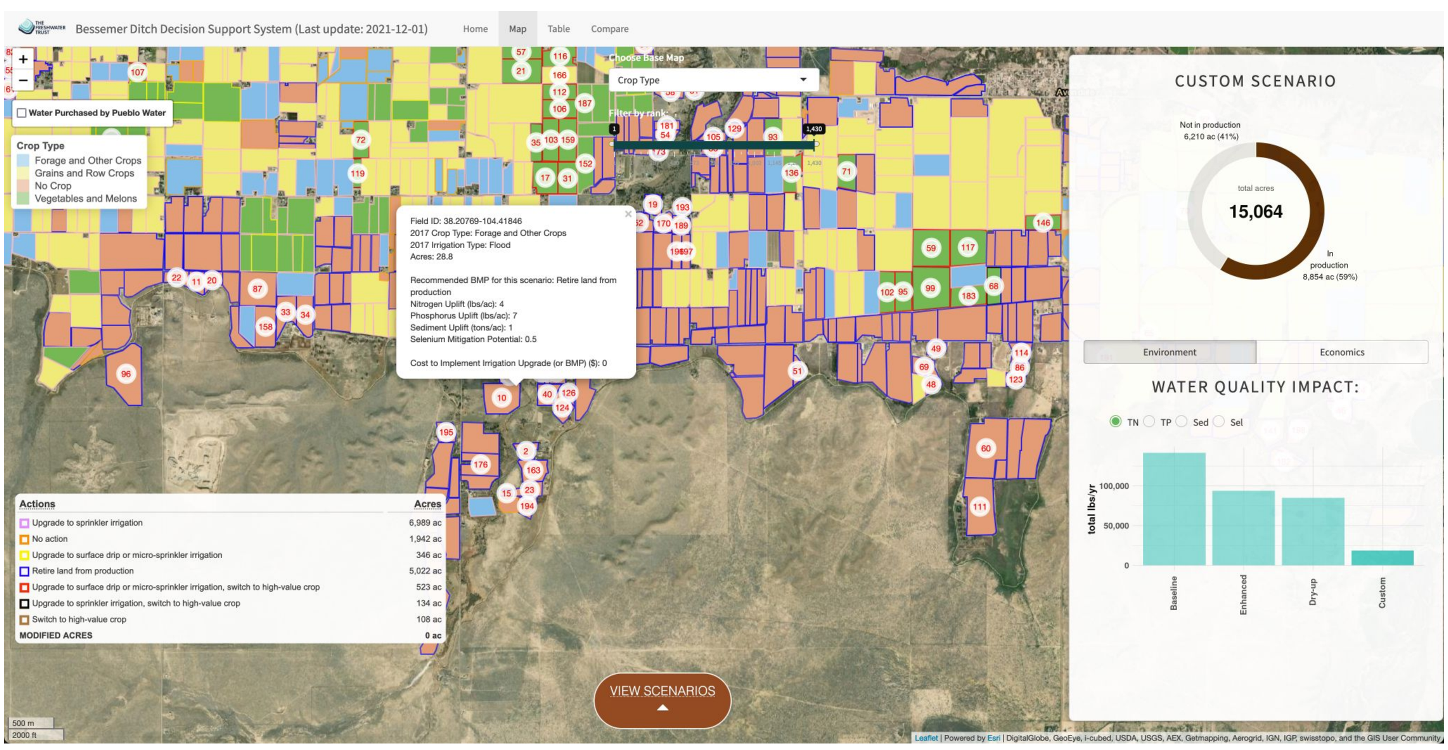
The DSS enables users to examine the impacts of dry-up (the DSS screenshot on the left illustrates dry-up under current production practices) and develop dry-up alternatives based on their own, user-defined preferences. For example: Do users want to protect CPAs, improve water quality, or both? Do they want to promote alternative transfer mechanisms (ATMs), or do they want to enable Pueblo Water to develop its full municipal yield–thus drying up 5,000 acres? If the latter, do they want to support more strategic dry-up that keeps the best lands in production (something enabled by Pueblo Water's decree)? If so, on how many acres? The DSS generates scenarios based on these inputs. It then creates a field-level ranking system that shows what actions can be taken on what fields to best achieve the user's objectives.



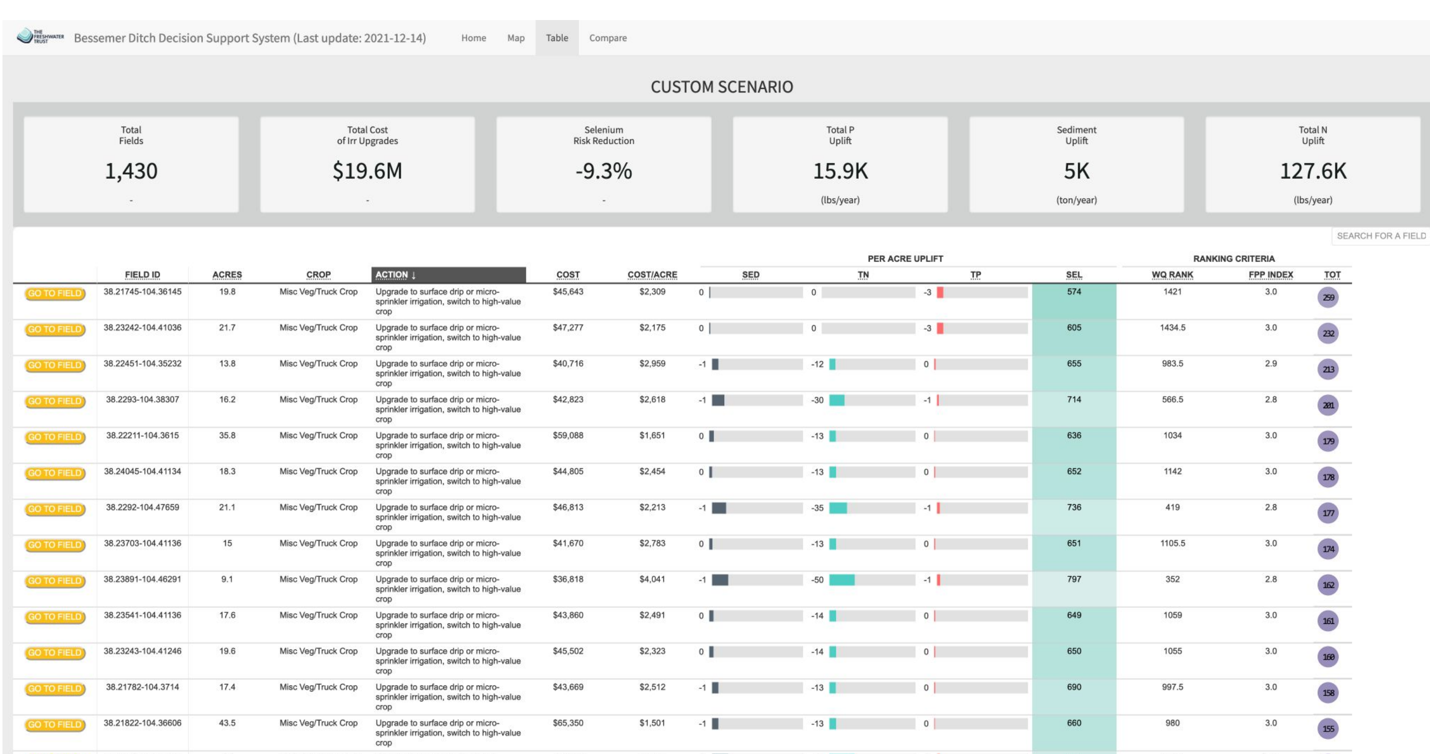
The DSS screenshot on the left illustrates how a user builds custom scenarios by defining priorities in three areas: production economics, water quantity, and water quality. The custom scenario function allows the user to compare the results of his or her scenario against current production (baseline) and anticipated (dry-up) scenarios. It also enables the user to compare his or her results with an enhanced production scenario, which is modeled by combining historic production precedents with improved irrigation practices.



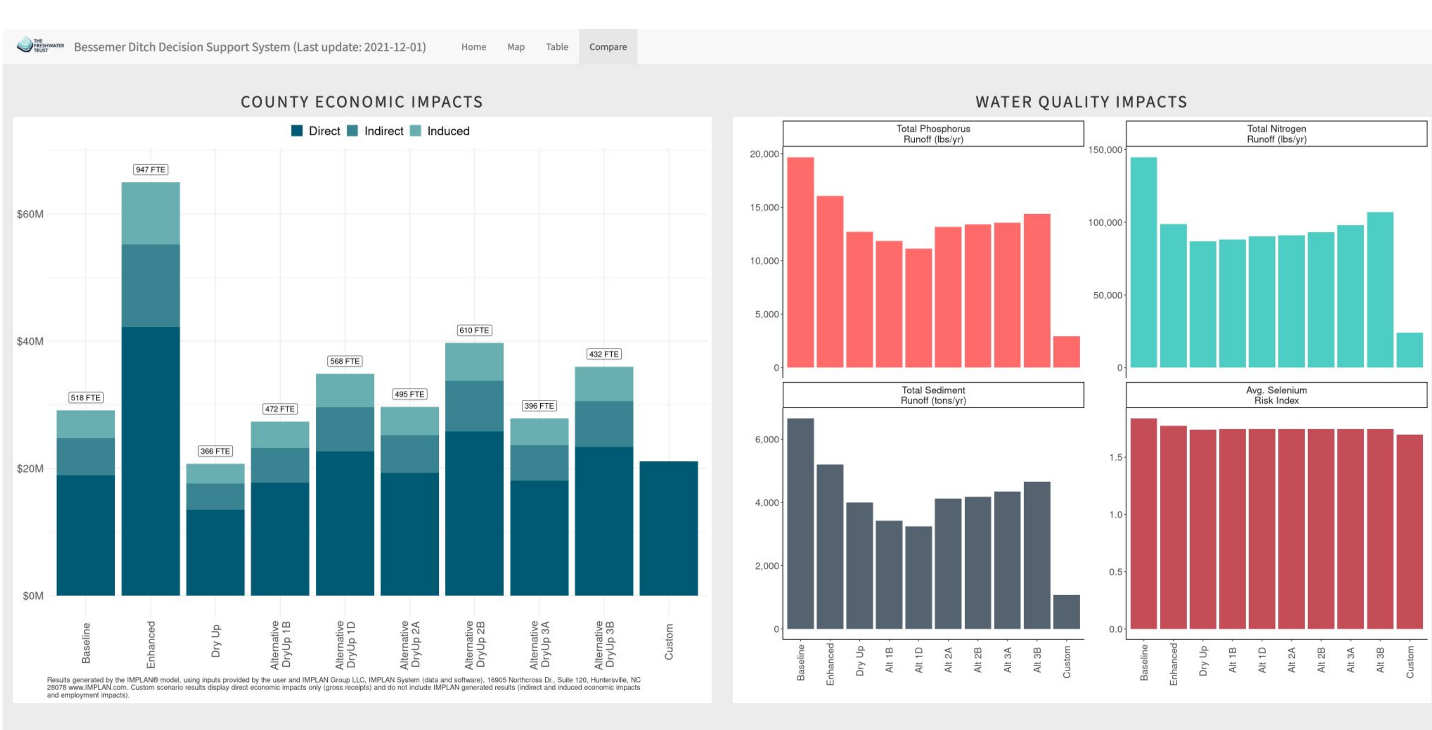
The custom scenario on the left illustrates a highly preferable dry-up alternative. The user has emphasized the importance of protecting prime farmland (in other words: don't dry-up CPAs with Class 1 soils). At the same time, the user wants Pueblo Water to receive its full municipal yield (thus drying up 5,000 acres). The user is not considering any water-sharing or ATM approaches, but the user does want to improve water quality through strategic dry-up approaches and irrigation BMPs (installing sprinkler or drip systems). The user has weighted water quality outputs evenly–in this case, seeking to reduce nitrogen, phosphorus, sediment, and selenium in equal measure. Finally, the user wants to maintain or improve current economic outputs by increasing vegetable production, which will serve Bessemer retail markets that have grown substantially in recent years.



The zoomed in screenshot on the left and the one above it show what it looks like when: (1) Pueblo Water dries up 5,000 acres but does so strategically, retaining irrigation on 2,000 acres of the best lands; (2) farmers increase vegetable production on 750 acres; and (3) irrigation improvements are installed on a percentage of remaining irrigated lands. The actions needed to make this scenario a reality are displayed in the Actions table on the lower left side of the screen. Actions are prioritized using a field ranking system. Fields can be selected to examine recommended BMPs. The screenshot on the left shows the impacts of implementing BMPs on the 10th ranked field. The impacts of implementing BMPs across all fields are shown in the dashboard. As the dashboard illustrates, direct economic outputs of production on less than 10,000 acres in this scenario are better than current production on 15,000 acres, and nitrogen loading across the system is reduced by 85% (110,000 lbs/year).



The results of this scenario can also be viewed as tabular data (screenshot on the left). The dashboard at the top of the tabular data display shows the total cost of irrigation upgrades in the scenario, and it shows the total uplift of sediment, nitrogen, and phosphorus. Tabular data can be sorted. This screenshot is sorted to show fields where the installation of drip systems, coupled with conversions to higher-value vegetable crops, is recommended. The total cost and cost-per-acre of implementing irrigation upgrades is given for each field. A water quality rankings index (third column from the right) weighs the benefits of a change in irrigation practice against the cost. A total rankings column (far right column) shows the field rank based on all user-defined priorities (the same ranking that is displayed on the map tab).



The DSS Compare tab enables custom scenarios to be compared against a variety of predetermined scenarios (screenshot on the left). These predetermined scenarios can also be explored on the map tab.

The power of the DSS lies in its systems approach, and its applicability to other geographies is far reaching. The DSS can be adapted to support better agricultural-economic, ecological, and land use outcomes in multiple water-constrained contexts. It can help decision makers effectively address the impacts of rapid global change (agricultural-to-municipal water transfers, mandatory curtailment, drought, climate change, etc.) in both surface- and groundwater-dependent systems–a holistic approach to agricultural water protection and management that advances sustainability, equity, and resilience.