Karnali River Basin Decision Support Tool

System-scale planning to support sustainable energy systems and conservation of freshwater resources for people and nature

System scale planning (SSP) is a planning framework for hydropower that is quantitative, multi criteria, multi project and iterative. It is used to inform the hydropower planning decision-making process by visualizing options & making explicit the tradeoffs that are inherent in hydropower development. Combinations of potential future hydropower projects are assessed across multiple criteria. Therefore, SSP allows for the analysis of how each combination of projects (solutions) perform across a range of metrics which assess environmental, social, financial and energy-related dimensions.

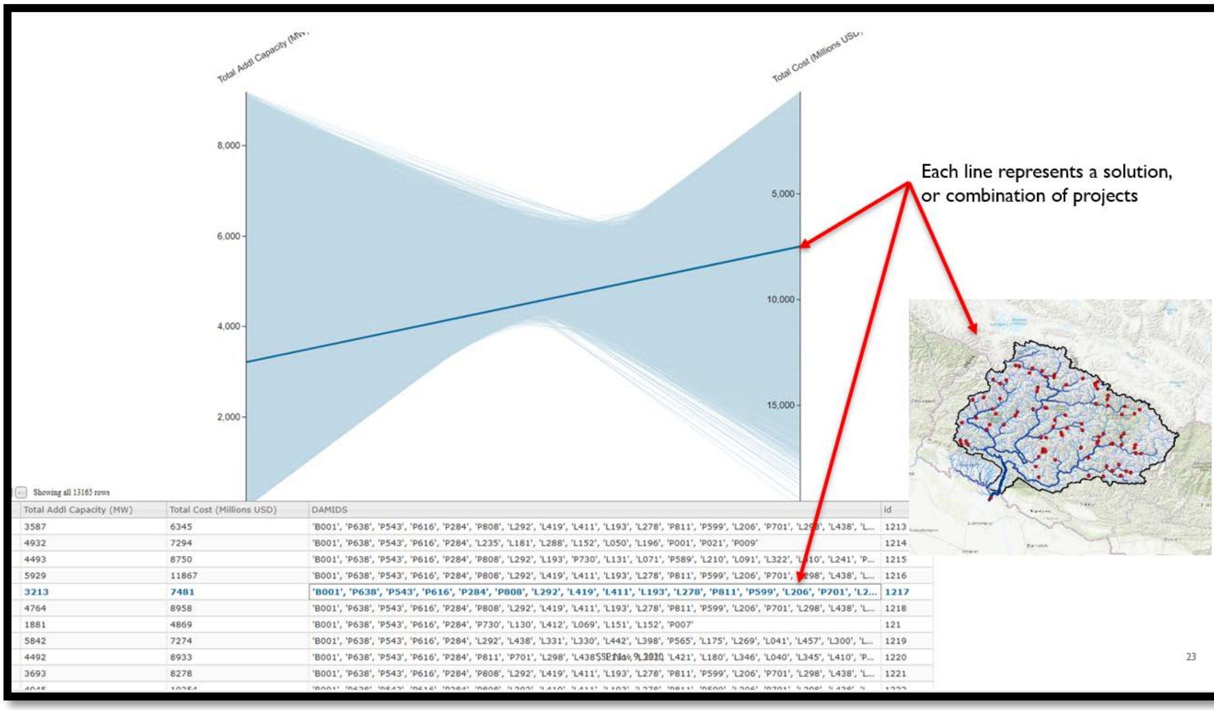
This decision support tool presents the results of the Karnal River basin SSP results. The bulk of the document that follows is extracted from the SSP technical report, where additional information and context can be found.

What are Parallel Plots

Parallel axis plots are a type of graph that can facilitate the exploration of multiple metrics for many thousands of solutions by simultaneously plotting many metrics for all solutions. These can then be interactively explored by the user to identify solutions and inform discussions around which solutions have acceptable impacts across the multiple criteria.

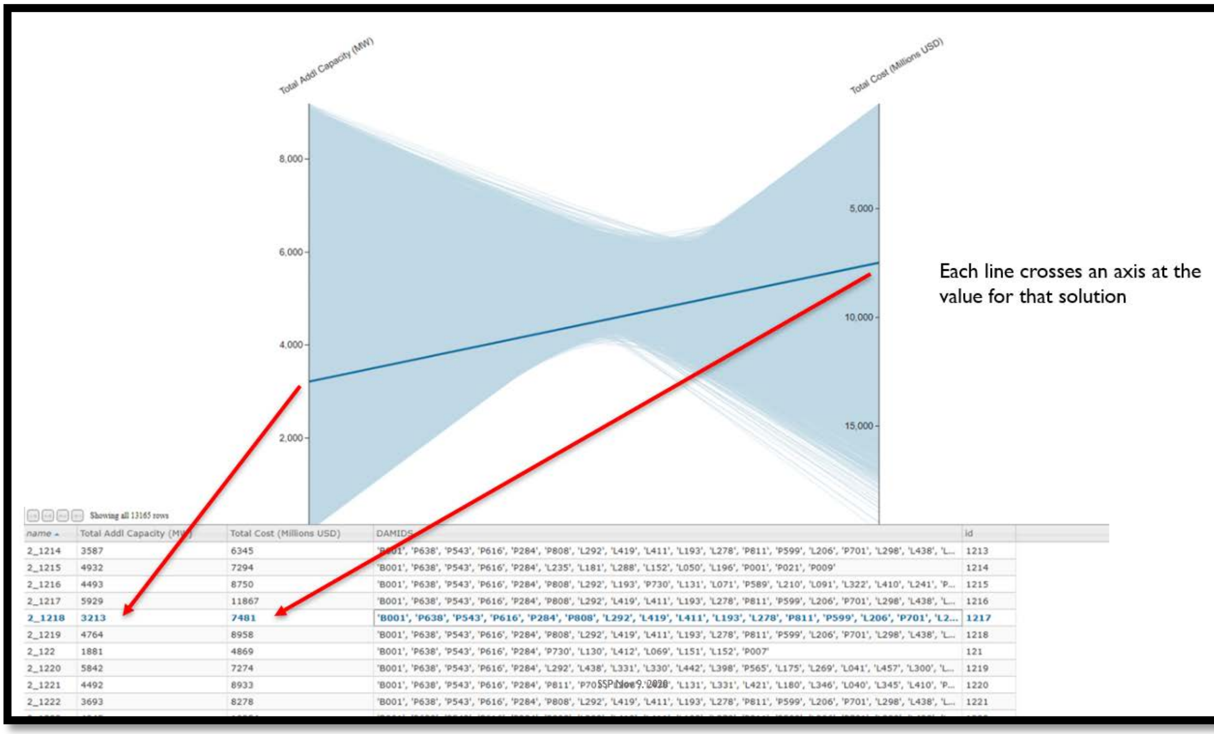
In parallel axis plots, each solution, or combination of dams is displayed as a line, rather than as a point like in scatterplots.

Figure 1 Each line in a parallel axis plot represents a solution, or combination of dams



Each of the vertical axes in the plot correspond to a metric. Where each line crosses an axis represents the solution's value for that metric. Figure 2 shows a highlighted solution and its values for installed capacity (MW) and total cost (millions of US dollars). The values for the solution are also available in the linked table below the parallel plot.

Figure 2 Where each line crosses an axis indicates that solution's value for that metric



Traditionally in SSP analyses, the axes are arranged so that desirable values are oriented at the top of the axis. Thus, the axes that evaluate negative environmental or social impacts are oriented with zero at the top. Similarly, as low-cost projects are desirable, the lowest cost is also at the top of the axis. While the actual "desirable" amount of installed capacity is a function of a number of variables, in this structure we put the highest capacity at the top of the axis since more installed capacity for the same amount of impacts would be preferable. Thus, a hypothetical ideal solution would be represented by a straight line across the top of the graph. This hypothetical ideal is, of course, unobtainable. In this example it would be a solution with the most possible installed capacity for the least possible cost. In fact, the parallel plots reveal an intuitive inverse relationship between installed capacity and total cost.

The power of parallel plots come not from just displaying two metrics, but rather from displaying many metrics simultaneously.

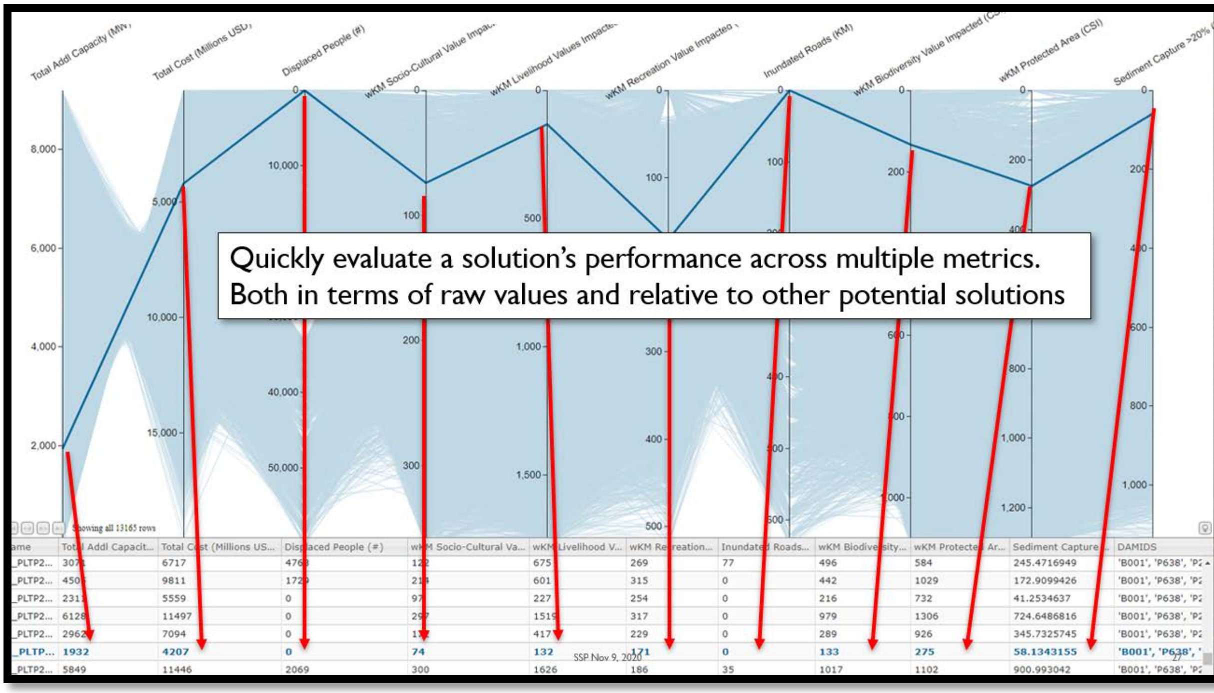


Figure 3 shows a scenario highlighted in the parallel axis plot and the corresponding table. Here we can see that the highlighted solution performs very well for people displaced in both absolute terms (zero) and relative terms (no solutions perform better). For recreation value impacts, it performs in roughly the top third of all possible solutions. In absolute terms, we can see from the table that this equates to 171 km impacted (weighted KM).

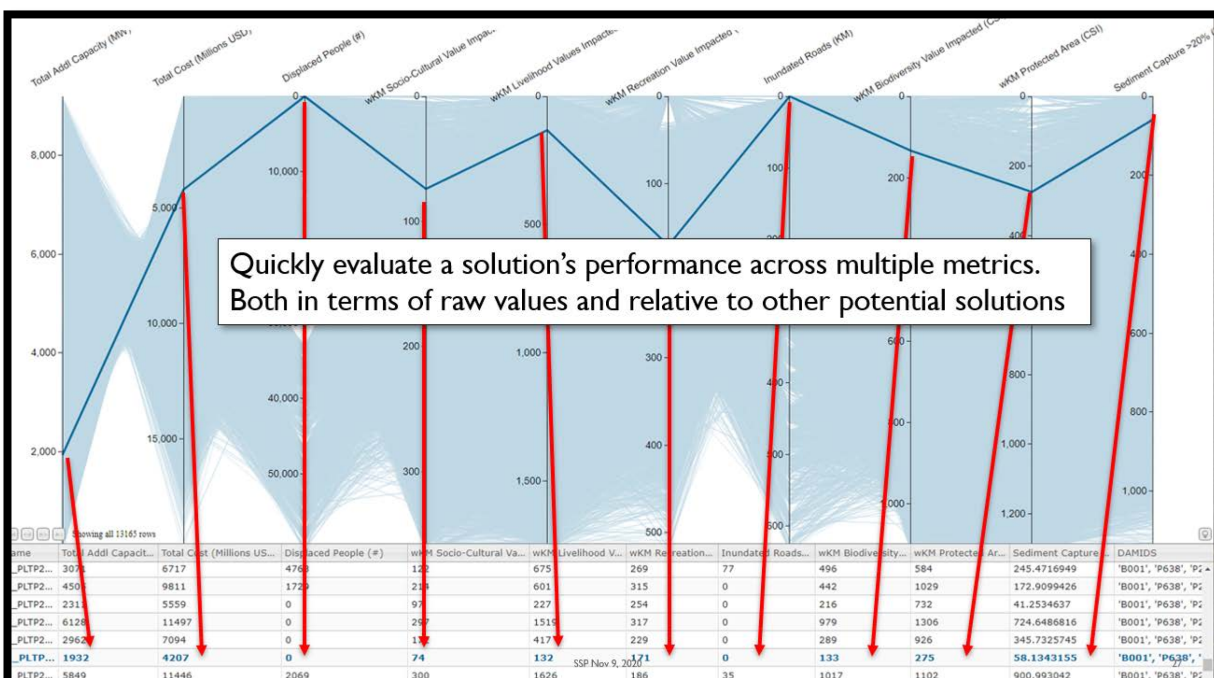
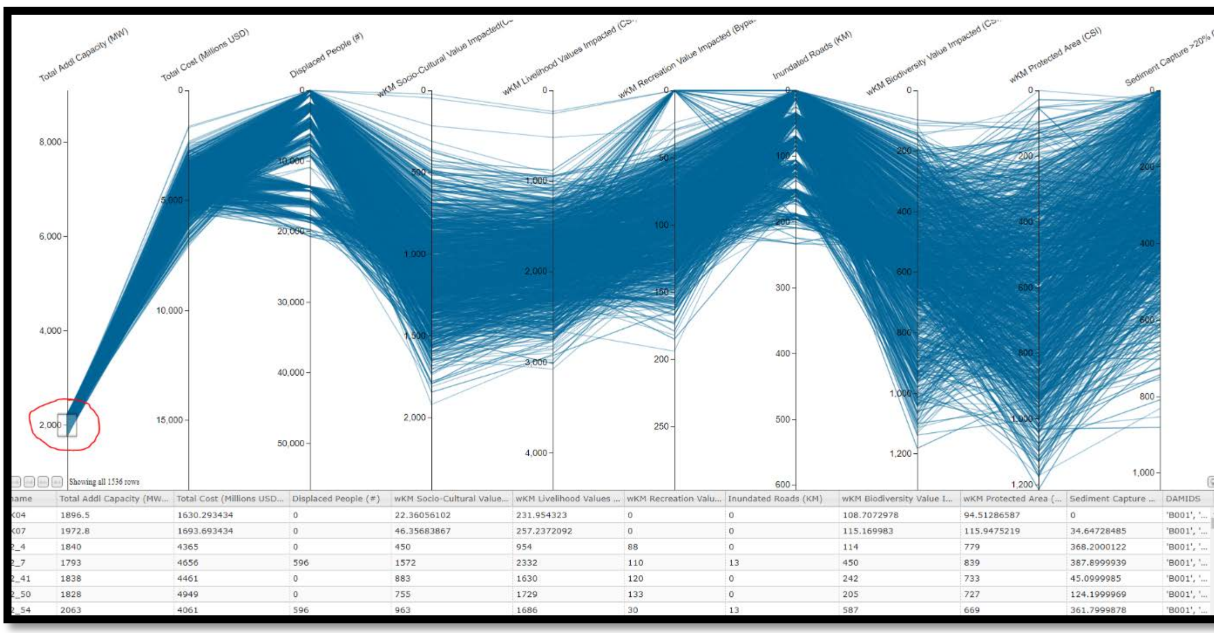


Figure 3 Parallel plots and their linked table allow for the quick evaluation of a solution in both absolute and relative terms. (the figure is repeated twice – delete one?)

For many metrics which do not have clear "no-go" thresholds, the parallel axis plots can be used to enable a conversation amongst stakeholders on acceptable impacts.

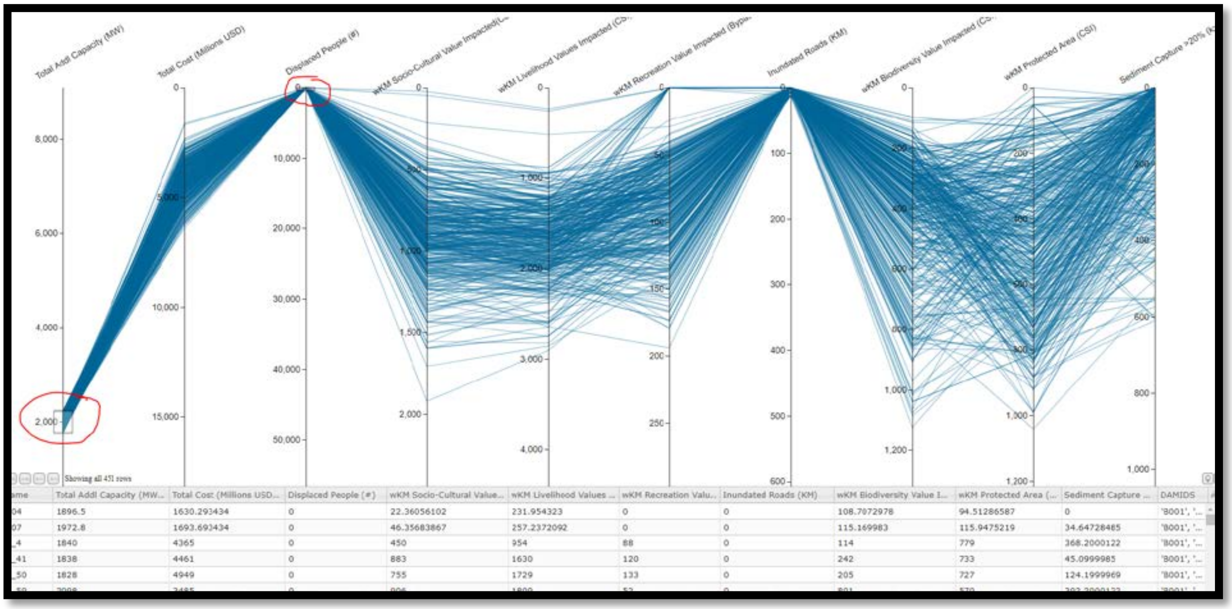
Filters can also be applied to the parallel plots to further explore how these thresholds interact across multiple metrics. These filters can be drawn on one or more of the axes to restrict the solutions displayed to those whose values for that metric fall within the selected range. Figure 4 shows how a filter can be applied to a range of values on an axis. Here, only those solutions with a total installed capacity near 2,000 MW are displayed in the graph.

Figure 4 A filter applied to limit the displayed solutions to those with a combined installed capacity close to 2,000 MW



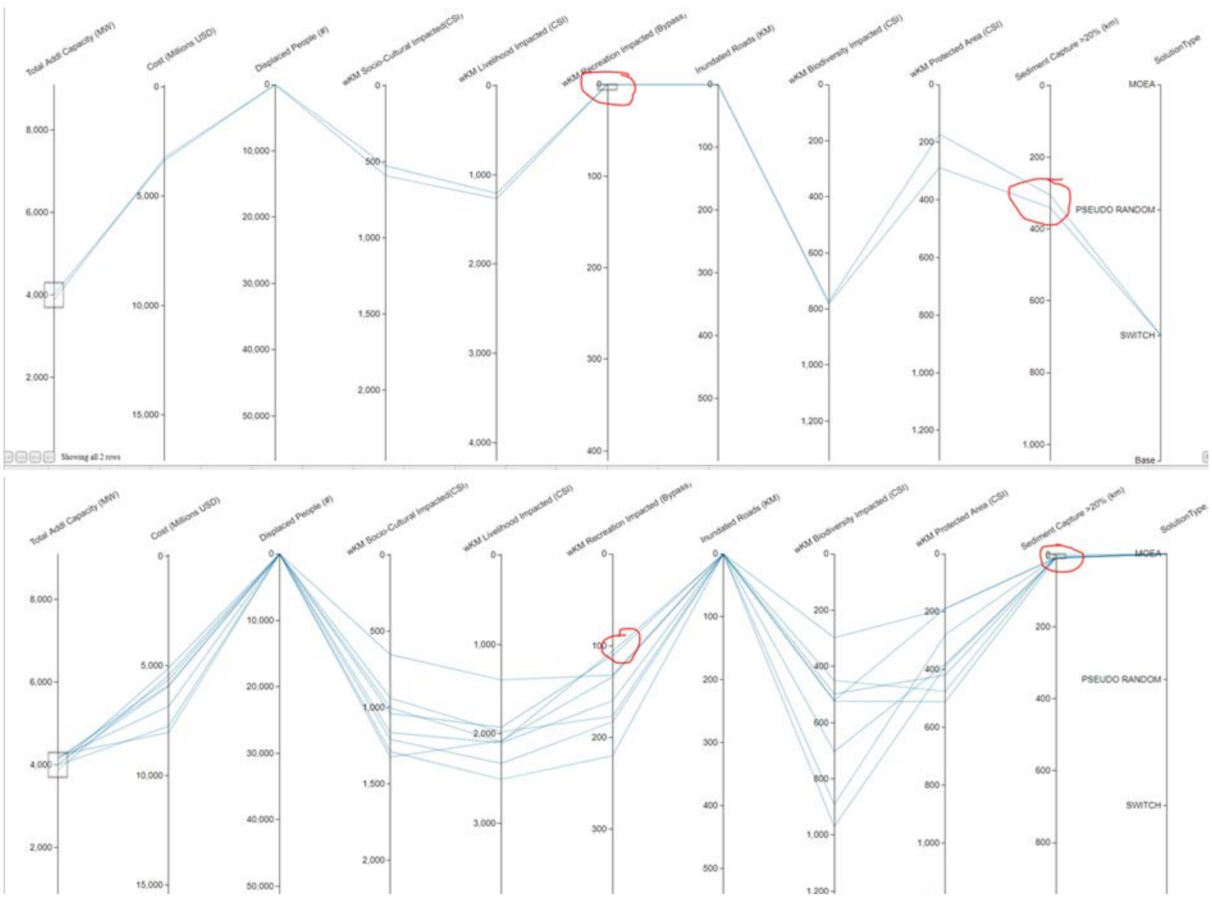
This could be further refined, as in Figure 5, where filters are applied to the installed capacity and people displaced axes, to limit those scenarios displayed to those that have around 2,000 MW of installed capacity and that don't displace any people. Continuing this process, filters can be applied to other metrics to identify solutions that have the most acceptable balance of impacts and highlight thresholds where improving one metric begins to conflict with another.

Figure 5 Filters applied to the Installed capacity and people displaced metrics



Applying successive filters can also quickly reduce the many thousands of potential solutions while simultaneously illustrating tradeoffs that are inherent in development in the basin. For

Figure 6 Using multiple filters to quickly reduce the number of solutions shown and illustrate one of the tradeoffs that are inherent in hydropower development in the basin



example, as illustrated in Figure 6 there is a tradeoff between the impacts to rivers with recreation values and sediment capture for solutions with around 4,000 MW installed capacity. It is possible to minimize one of these impacts, but the solutions that have the lowest impacts for one of these metrics have higher impacts for the other. By quantifying and making this tradeoff visible to decision makers, it can empower them to make the most informed decisions possible that balance the interests of all stakeholders.