Multi-Criteria Decision-Making (MCDM) problems are often associated with tradeoffs between performances of the available alternative solutions under decision-making criteria. These problems become more complex when performances are associated with uncertainty. This study proposes a stochastic MCDM procedure that can handle uncertainty MCDM problems with multiple decision-makers. The proposed method converts a stochastic MCDM problem into many deterministic ones through a Monte-Carlo (MC) selection. Each deterministic problem is then solved using a range of MCDM methods and the ranking order of the alternatives is established for each deterministic MCDM. The final ranking of the alternatives is determined based on their ranking probability distribution. The ranking probability distribution can help with identifying the best alternatives as well as the risk associated with them. To facilitate the application of the proposed approach in real-world multi-participant decision-making, a Group Decision Support System (GDSS) is developed here with a user-friendly interface. This GDSS uses a range of decision-making methods to increase the robustness of the decision analysis outputs and understand the sensitivity of the results to level of cooperation among the decision-makers. These methods include: 1) conventional MCDM methods (Maximin, Lexicographic, TOPSIS, SAW and Dominance), reflecting a high cooperation level; 2) social choice rules or voting methods (includes Condorcet Choice, Borda scoring, Plurality, Anti-Plurality, Median Voting, Hare System of voting, Majoritarian Compromise and Condorcet Practical), reflecting a medium cooperation level; and 3) fallback bargaining methods (Unanimity, Q-Approval and Fallback bargaining with Impasse), reflecting a low cooperation level. To underline the utility of the proposed method and the developed GDSS in providing valuable insights into real-world hydro-environmental group decision making, the GDSS is applied to a benchmark example, namely the California's Sacramento-San Joaquin Delta decision-making problem. Results are compared with those of previous studies which used other methods to solve this problem and the implications of ranking distributions are discussed.