

## Background

- Water resource models are powerful tools to support water management decision making process and are developed to deal with a broad range of issues.
- Efforts in recent decades have led to two main categories of auto-calibration methods of uncertainty-based and optimization-based algorithms.
- SUFI-2 benefits from capabilities of both types which is capable of finding optimal parameters values regarding a single objective and providing interval estimation of parameters.

## Motivation of Research: Improving Quality of SUFI-2 Results

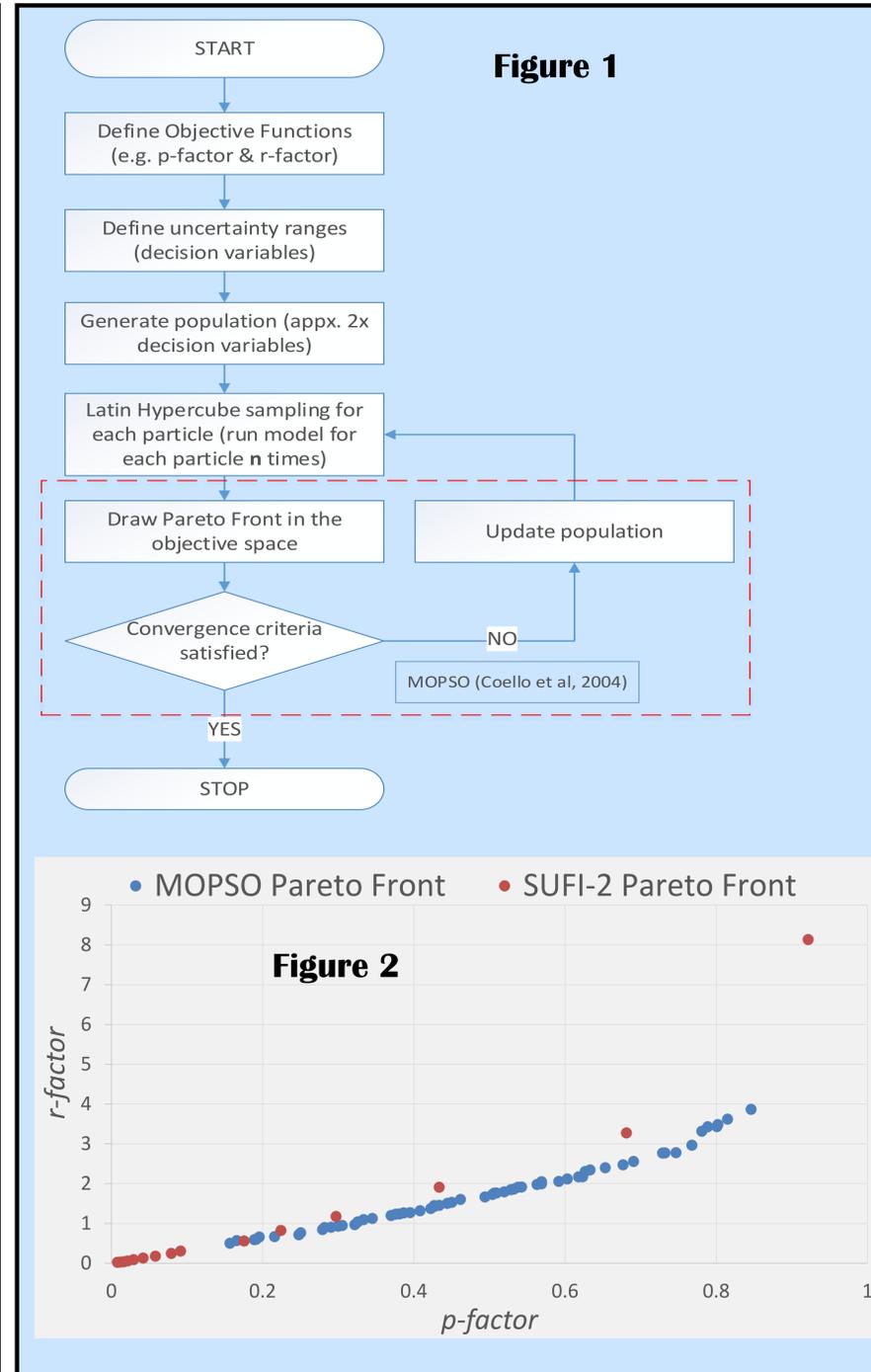
- Based on a single-objective, SUFI-2 proposes a routine to find the best point and interval estimation of parameter and corresponding prediction intervals (95PPU) of time series of interest.
- Final results are presented using two uncertainty measures of *p-factor* quantifying percentage of observation covered by 95PPU and *r-factor* quantifying the degree of uncertainty.
- Given that in SUFI-2, final selection is based on the two measures or objectives and on the other hand, knowing that there is no multi-objective optimization mechanism, are the final estimations Pareto-optimal?
- Moreover, can systematic methods be applied to select the final estimations?

## Water Resources Planning Model of Helleh River Basin

- Helleh river basin is located at the southwest of Iran where its rivers have high amounts of Total Dissolved Solid (TDS).
- A comprehensive water quantity-quality model developed in the previous researches in order to analyze the impacts of different water resources management strategies including dam construction, increasing cultivation area, changing crop pattern, etc.
- The quantity module is developed in the WEAP software in order to allocate water throughout the watershed. The quality module combining:
  - The relation between TDS and river flow (O'Connor, 1976)
  - Mass balance equation at rivers nodes
  - Mass balance equation at agricultural sites

## New Multi-objective Uncertainty-based Algorithm

- The uncertainty measures are considered as two objectives to find non-dominated interval estimations of parameters by means of coupling Monte Carlo simulation and Multi-objective PSO (Figure 1).



## Results and Discussion

- Both the proposed algorithm and the SUFI-2 are applied to calibrate parameters of water resources planning model of Helleh river basin (Figure 2).
- Comparing the Pareto frontier resulted from the proposed auto-calibration algorithm with SUFI-2 results, it is revealed that the new algorithm leads to a better and also continuous Pareto frontier.
- The new proposed algorithm is more computationally expensive compared to SUFI-2.
- Nash and Kalai-Smorodinsky bargaining methods could be used to choose the compromised interval estimation regarding Pareto frontier.

## References

- O'Connor, D.J., 1976. The concentration of dissolved solids and river flow. Water Resour. Res. 12, 279–294. doi:10.1029/WR012i002p00279
- Coello, C. a C., Pulido, G.T., Lechuga, M.S., 2004. Handling multiple objectives with particle swarm optimization. Evol. Comput. IEEE Trans. 8, 256–279. doi:10.1109/TEVC.2004.826067