UNIVERSITY OF SASKATCHEWAN

Global Institute for Water Security

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Vulnerability analysis of environmental change: water resource futures for Saskatchewan

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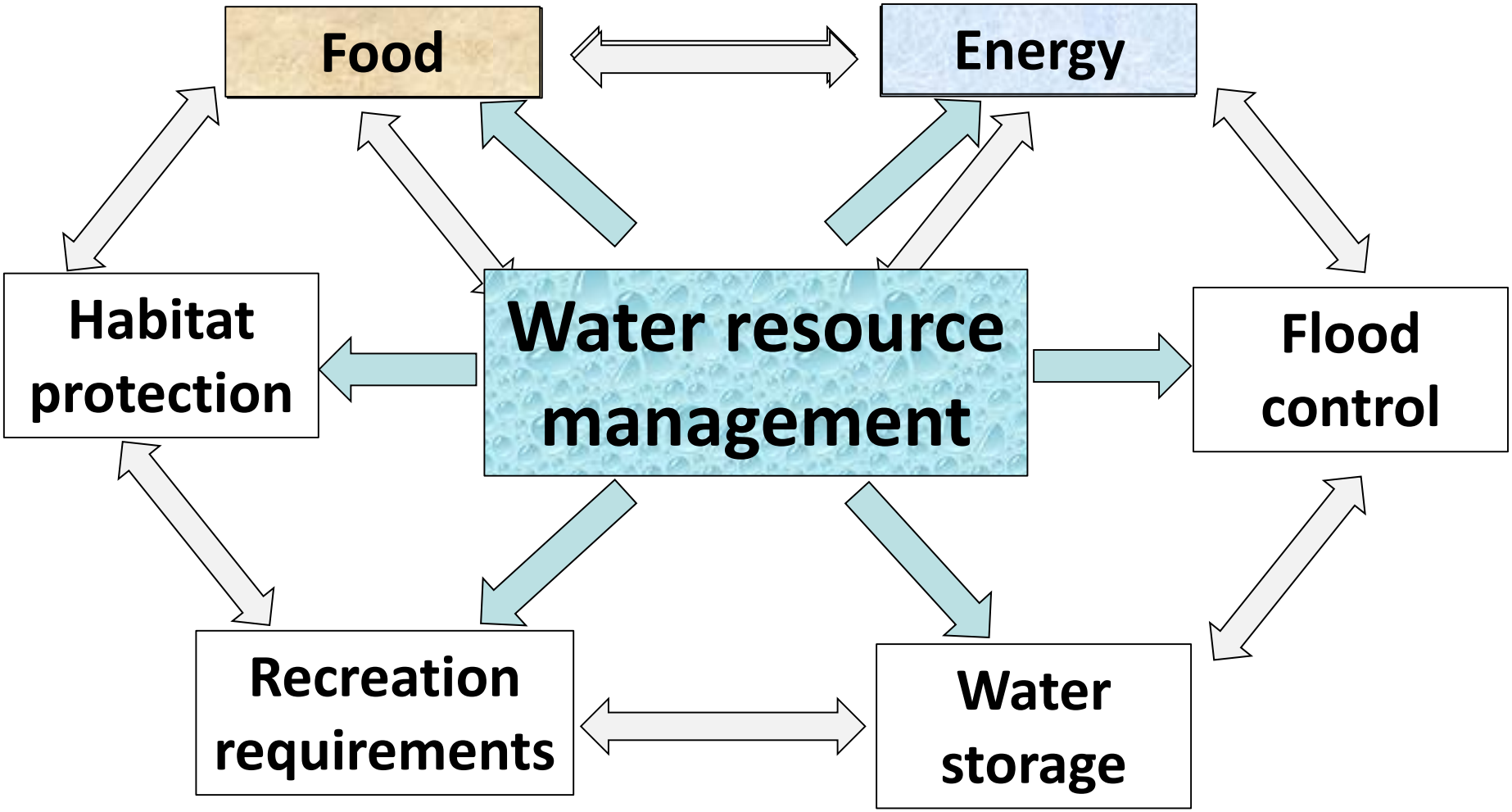
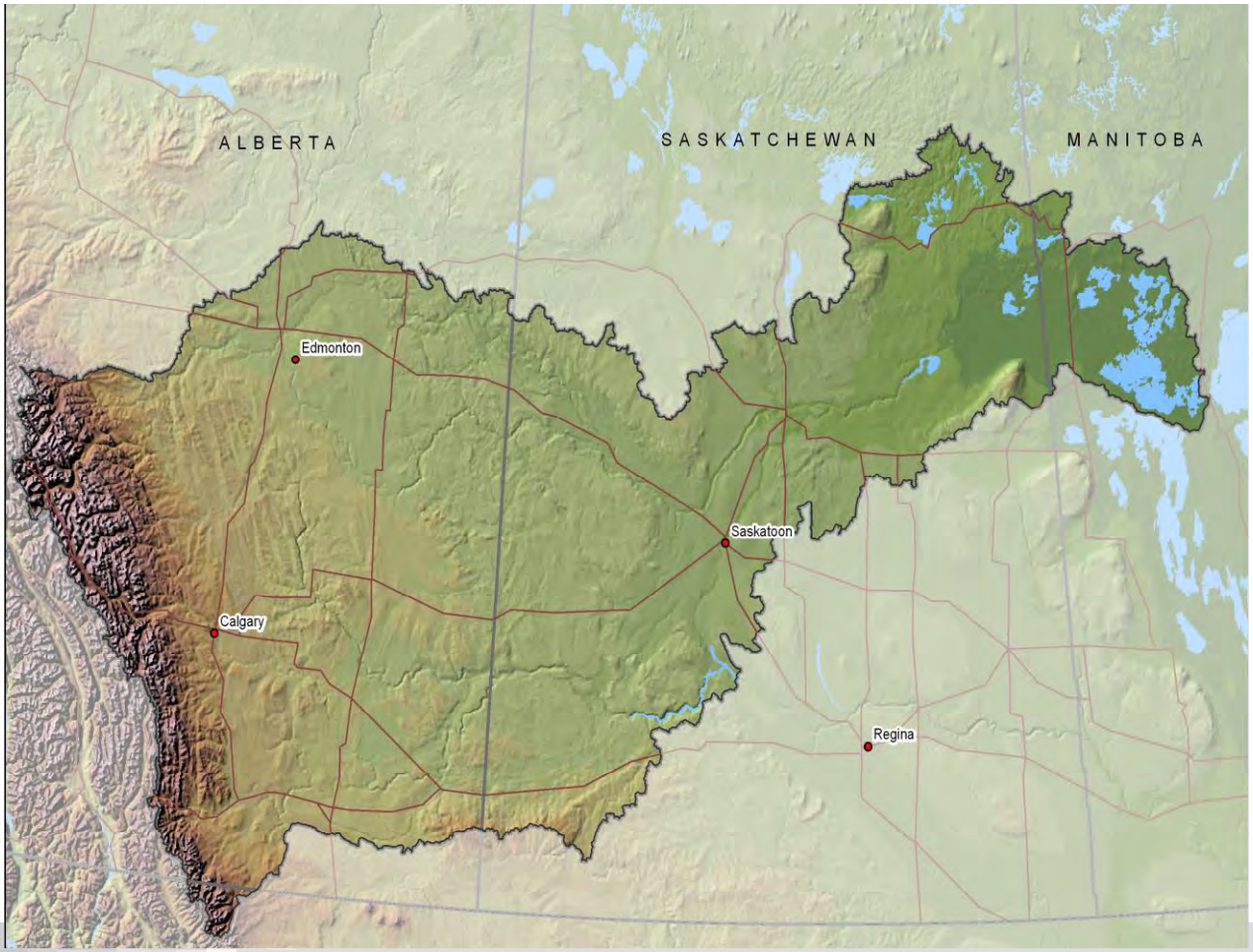
Multiple dimensions of water resource management



Wheater & Gober. 2013. Philosoph. Trans. Royal Soc.

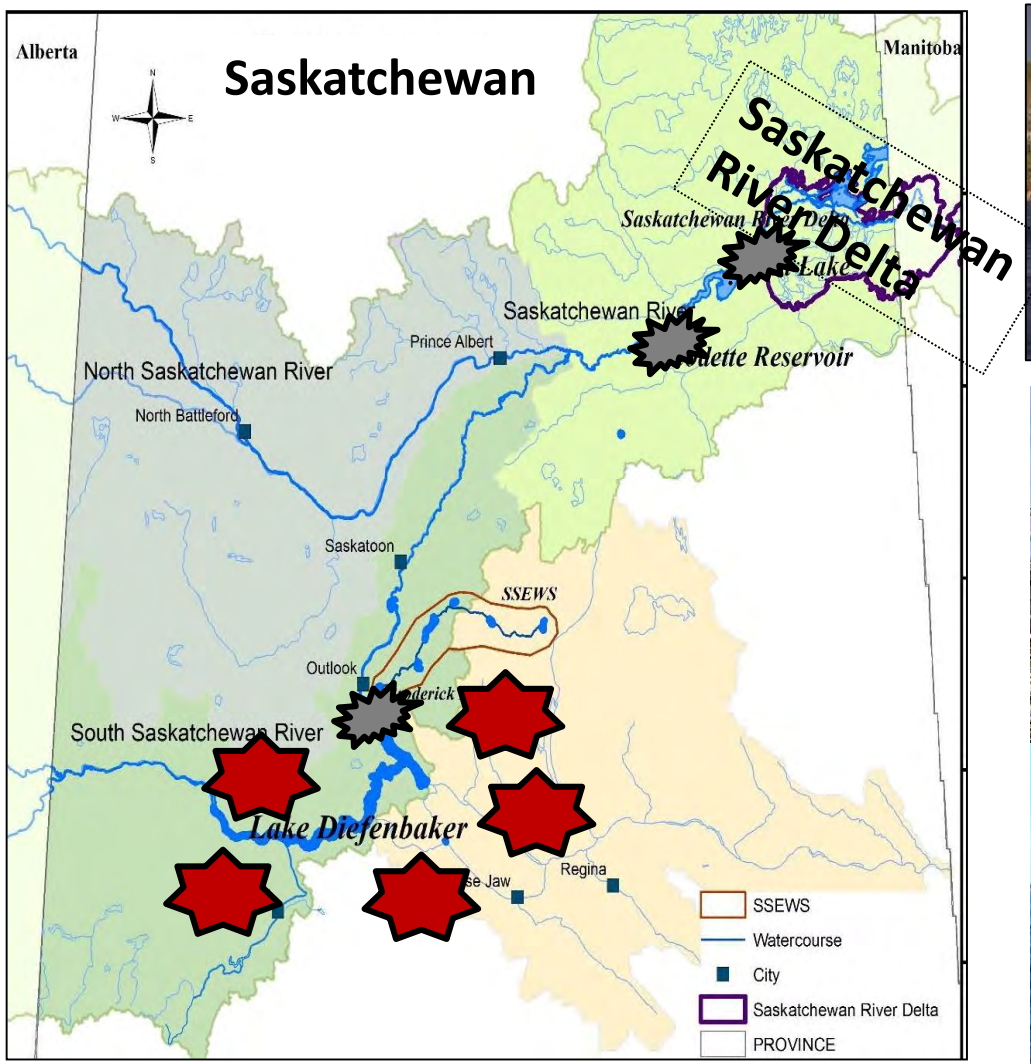
Saskatchewan River Basin
- a GEWEX Regional Hydroclimate Project



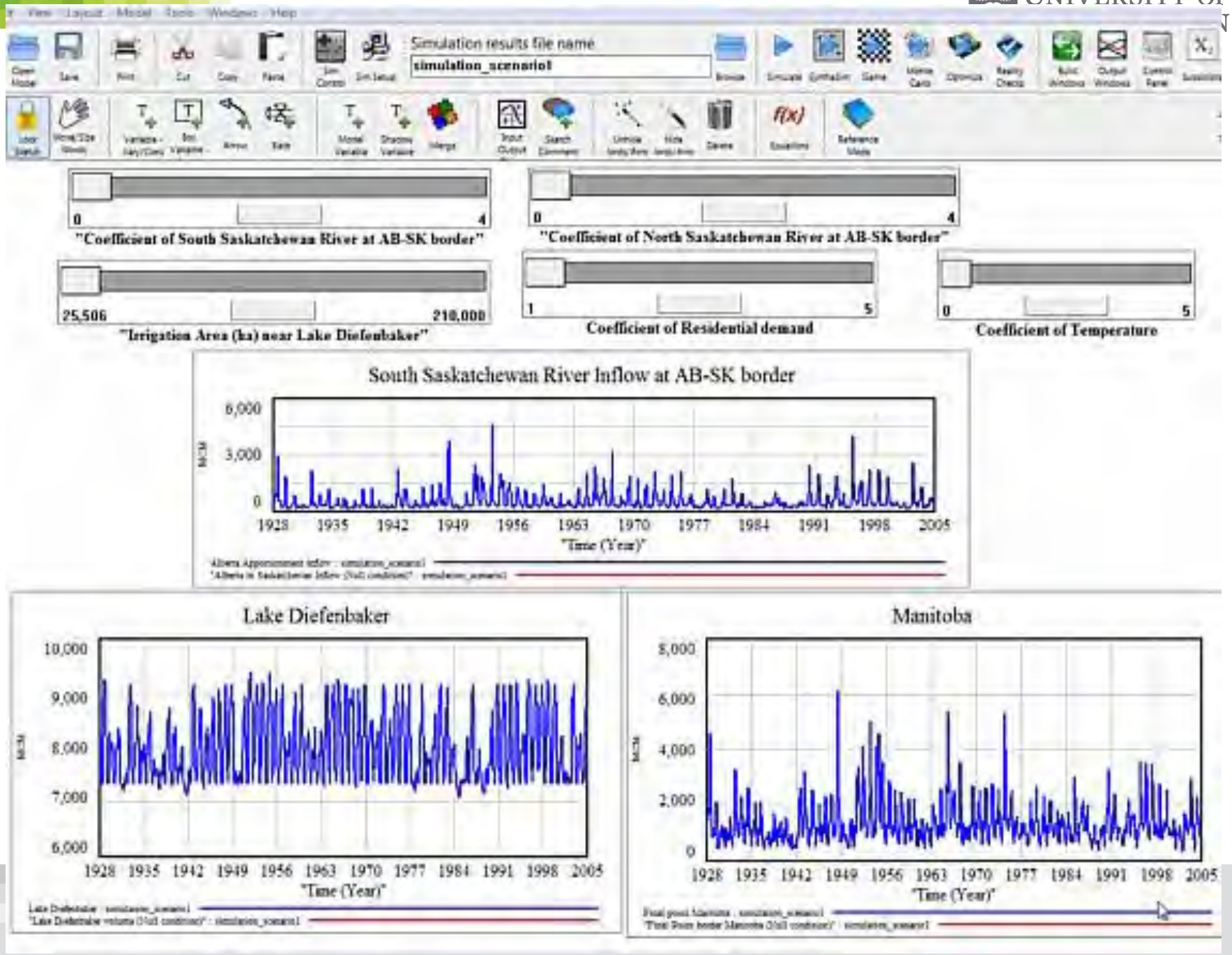
Area 406,000 km^2

- Drains from continental divide in Alberta, through Saskatchewan to Manitoba

SaskRB-Saskatchewan



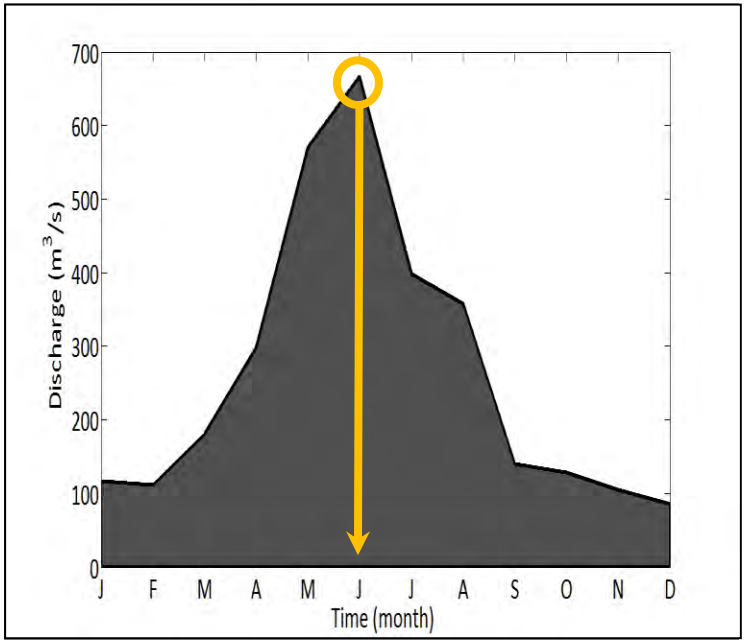
Hassanzadeh et al. 2014. Environ. Modell. Softw.


Simulation results file name
simulation_scenario1
0
4
"Coefficient of South Saskatchewan River at AB-SK border"
0
4
"Coefficient of North Saskatchewan River at AB-SK border"
25,506
210,000
"Irrigation Area (ha) near Lake Diefenbaker"
1
5
Coefficient of Residential demand
0
5
Coefficient of Temperature
South Saskatchewan River Inflow at AB-SK border
6,000
3,000
0
MCM
1928 1935 1942 1949 1956 1963 1970 1977 1984 1991 1998 2005
"Time (Year)"
Lake Diefenbaker
10,000
9,000
8,000
7,000
6,000
MCM
1928 1935 1942 1949 1956 1963 1970 1977 1984 1991 1998 2005
"Time (Year)"
Manitoba
8,000
6,000
4,000
2,000
0
MCM
1928 1935 1942 1949 1956 1963 1970 1977 1984 1991 1998 2005
"Time (Year)"

Challenges in SaskRB-Saskatchewan

Alberta

Flow @ Alberta/Saskatchewan



Saskatchewan

Climate change

Anthropogenic effects

Annual flow volume

Annual peak flow timing

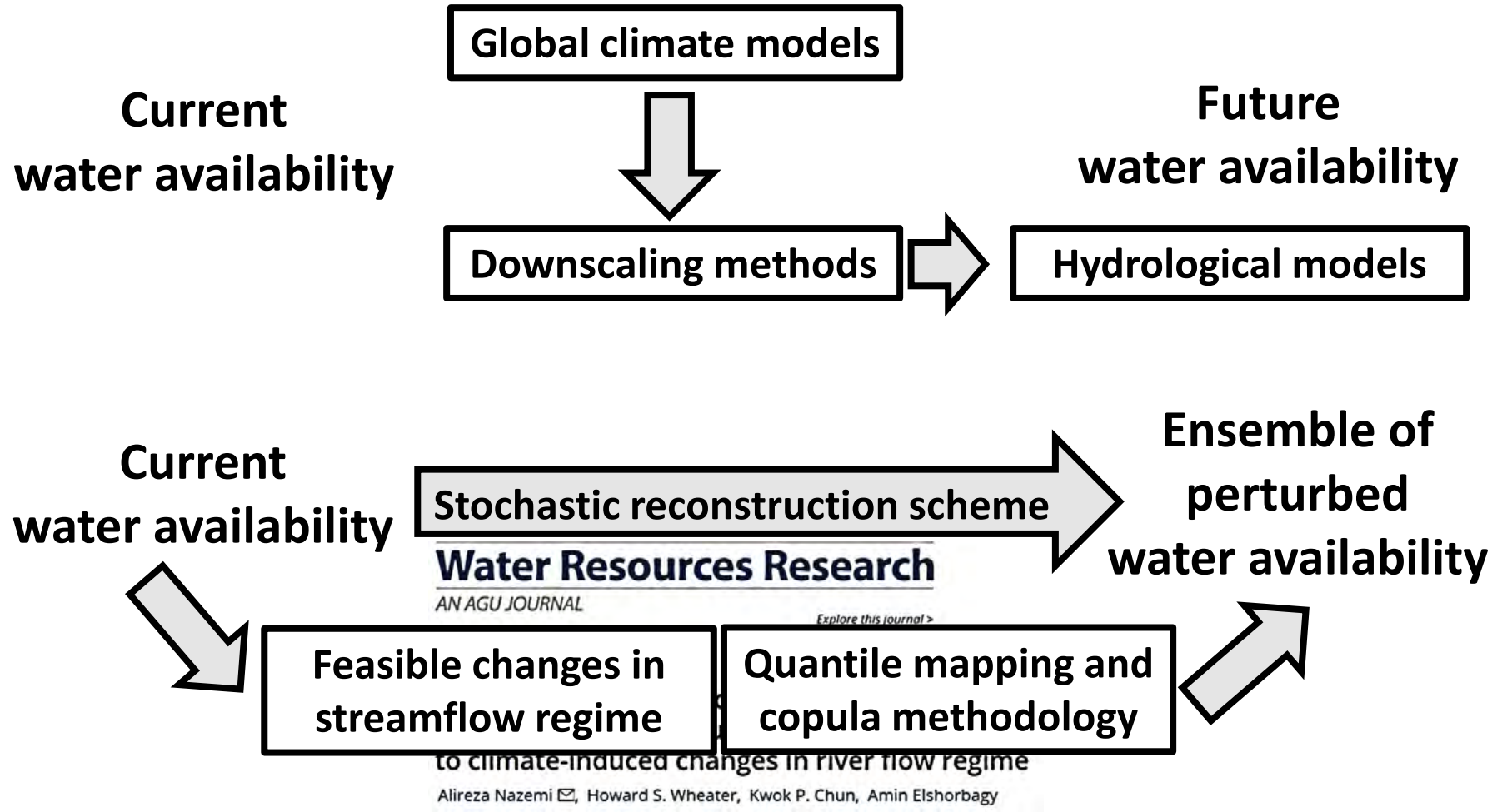
Environment

Socio-economy

Wheater & Gober. 2015. Water Resour. Res.

400% irrigation expansion

System vulnerability to climate-induced changes in streamflow



Synthetic flow generation

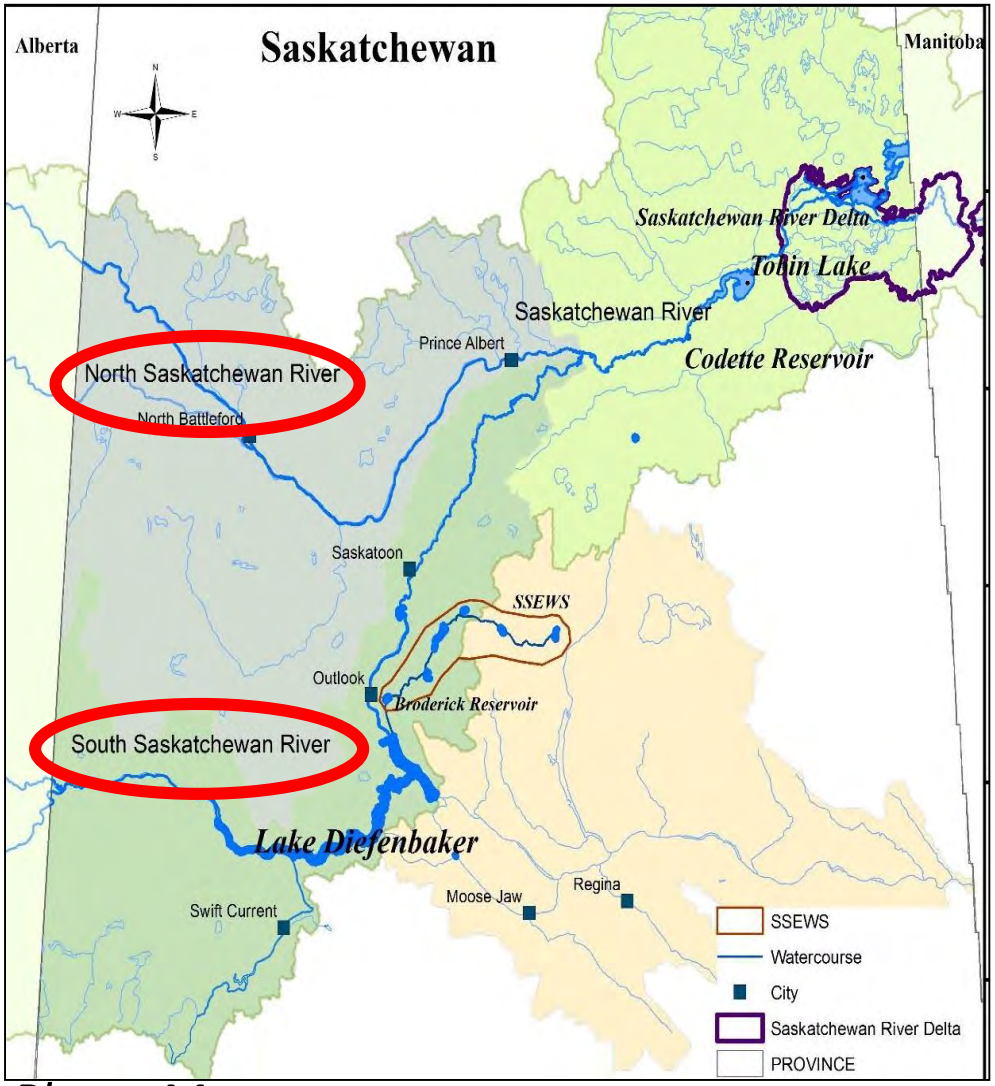
Changes in annual flow volume (-25%, -20%, -15%,…, 15%, 20%, 25%)

Changes in annual peak flow timing (-5, -4, -3, …, 6, 7, 8 weeks)

154 streamflow conditions

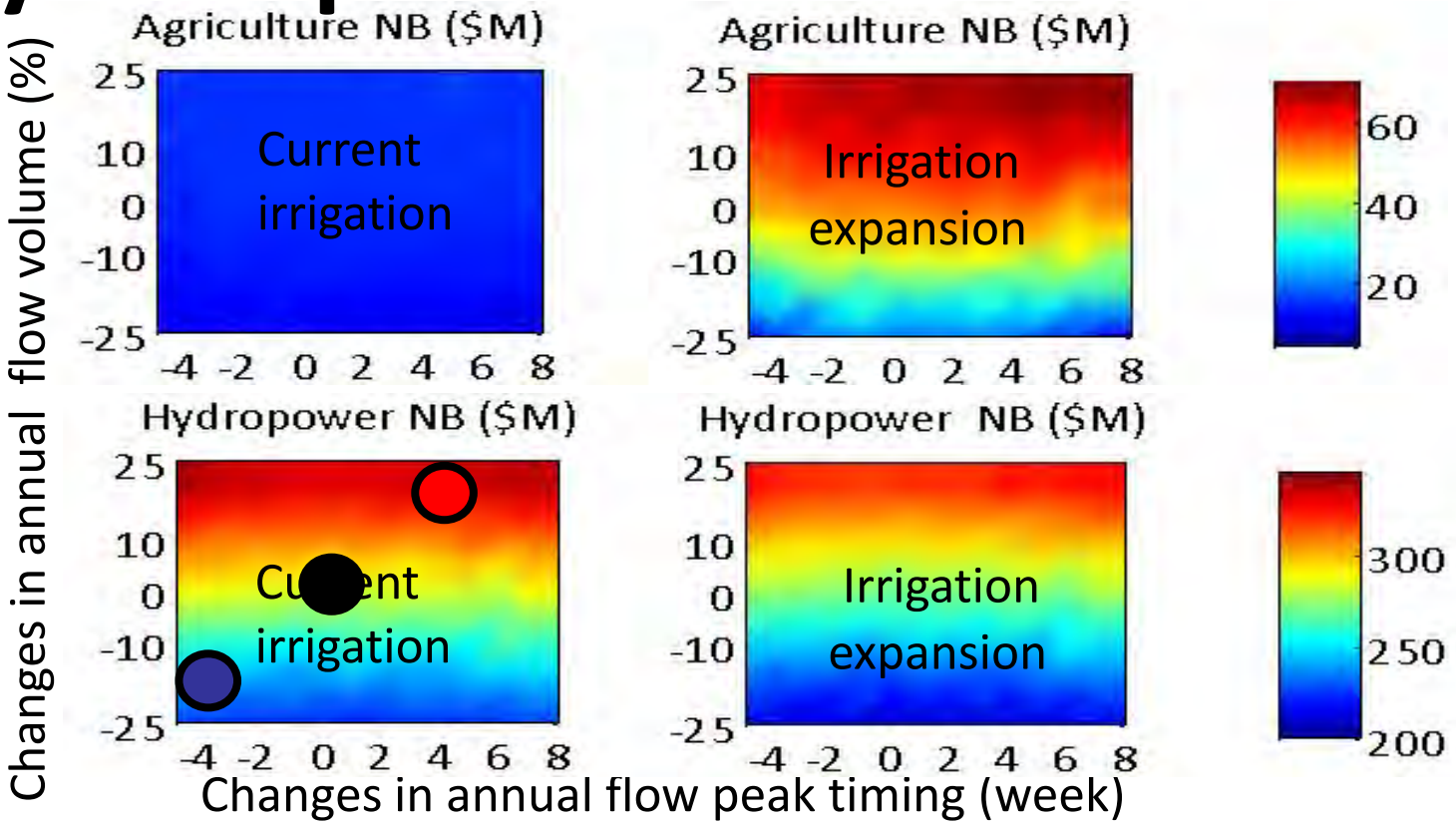
200 realizations for each streamflow conditions

30,800 streamflow time series were generated



Hassanzadeh et al. 2015. J. Water Resour. Plann. Manage.

System performance

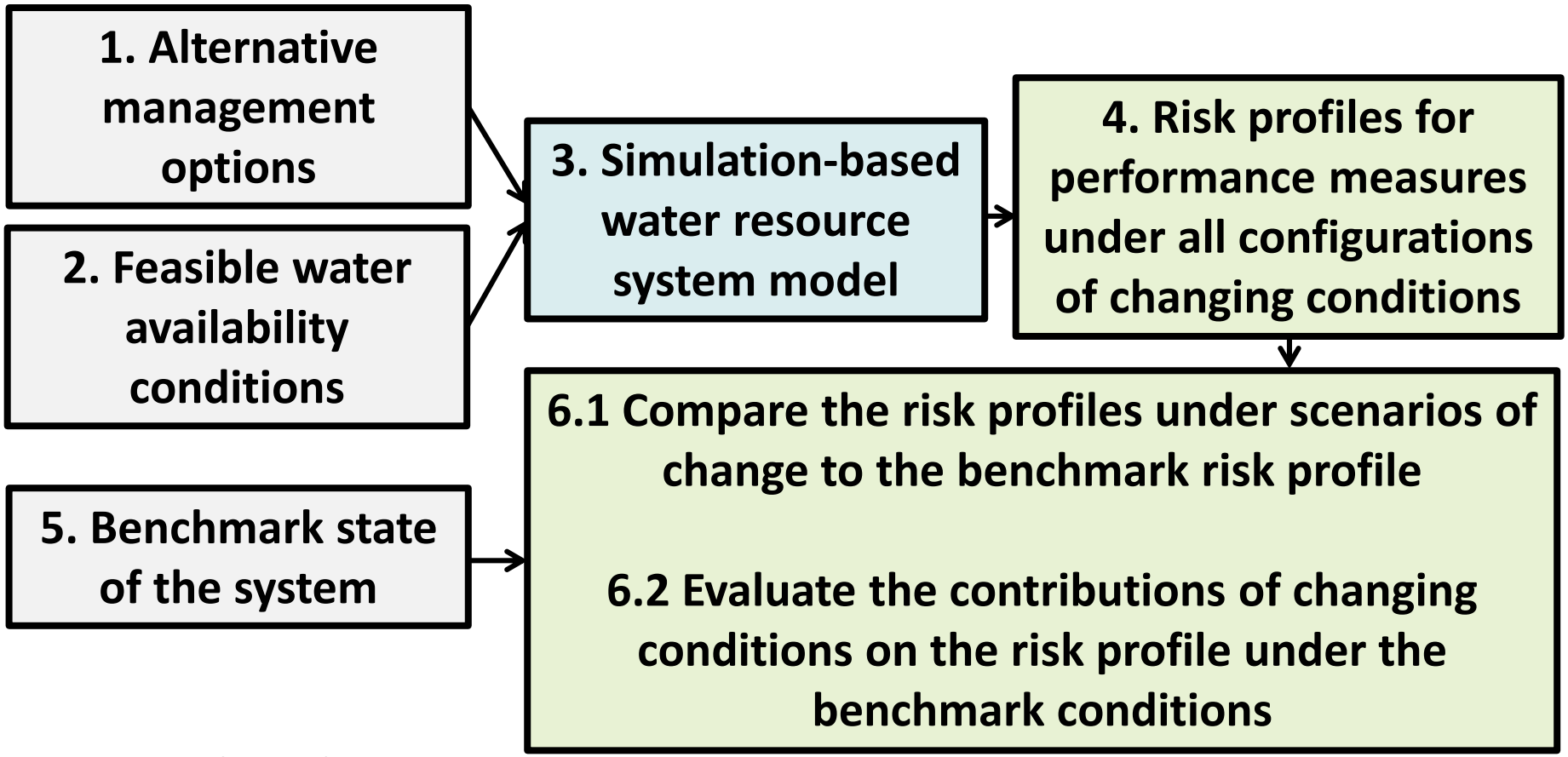


Percentage of realizations that present chance of flooding in the delta		
Flow conditions	**Current irrigation**	**Irrigation expansion**
(4, 25%)	49%	49%
(0, 0)	42%	41%
(-4, -25%)	20%	9%

Hassanzadeh et al. 2016. Ecohydrol (under review).

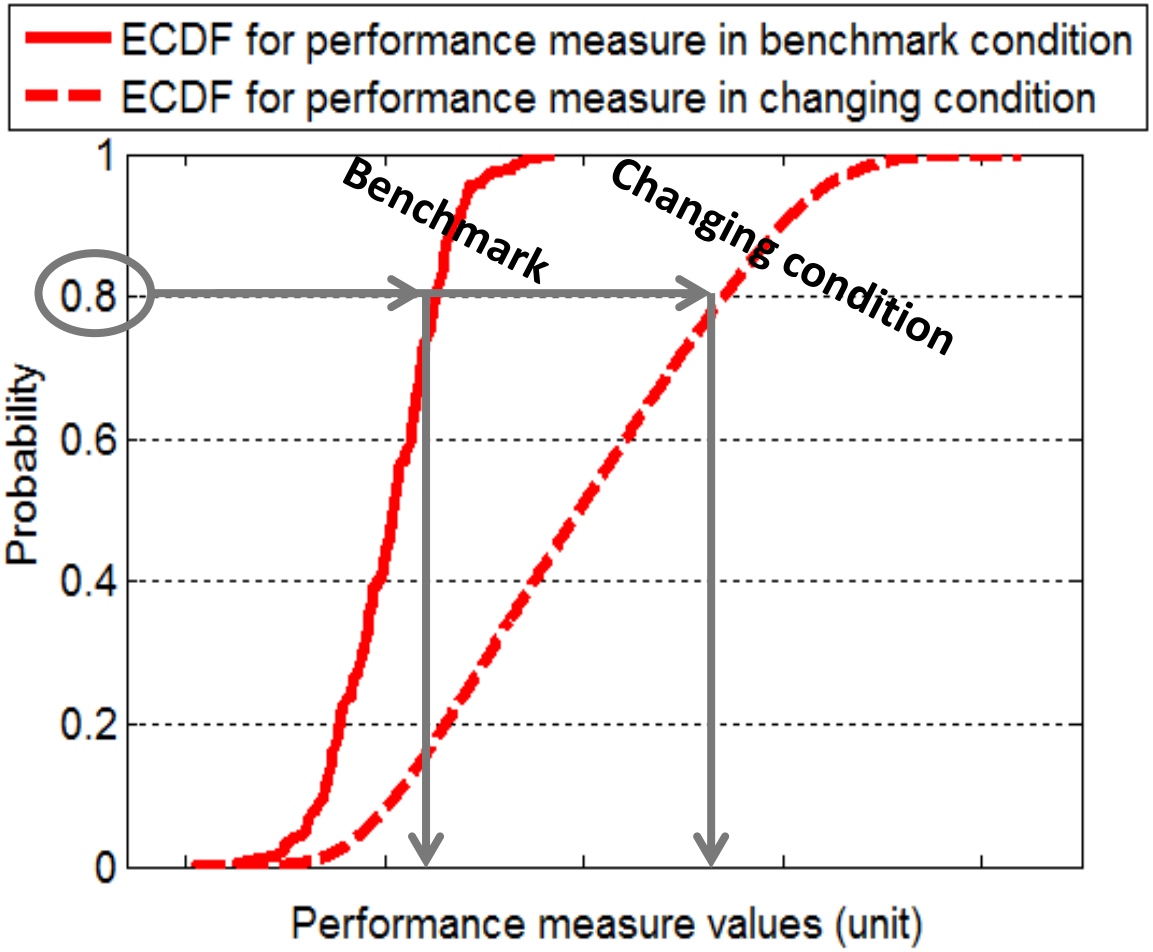
A framework to management Risk

How single and joint effect of changing water availability, demand and policy conditions can suppress or intensify risk in system performance?



Hassanzadeh et al. 2016. Adv. Water Res.

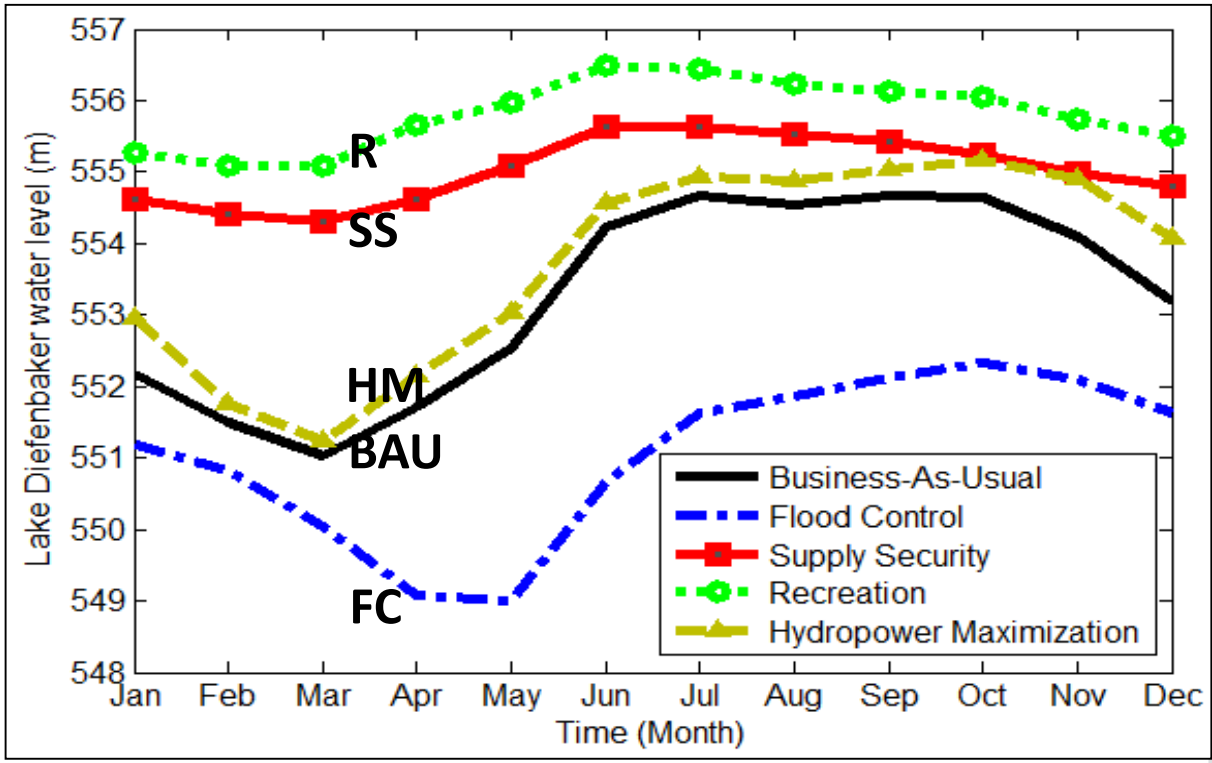
Relative effects of changing conditions in altering benchmark performance



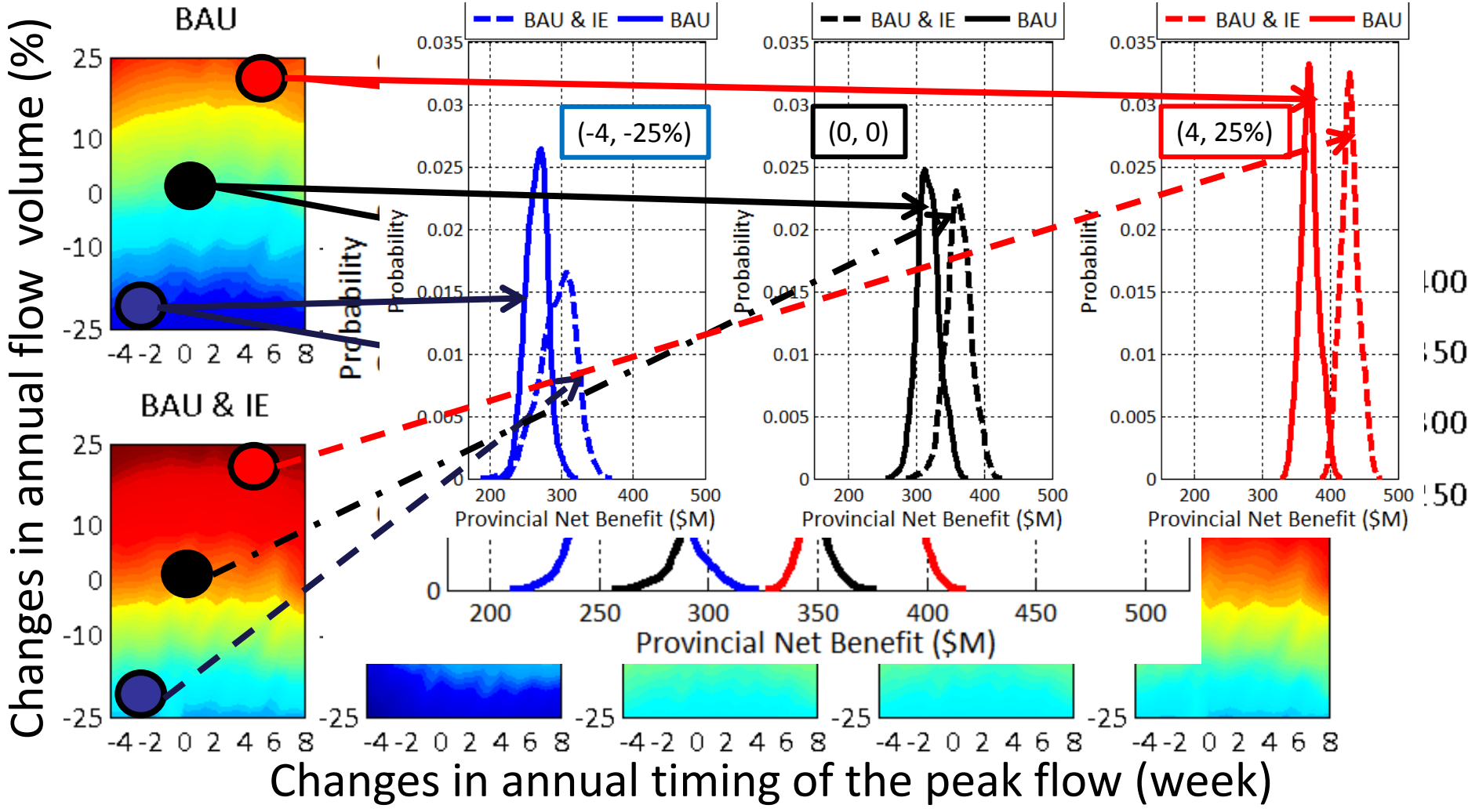
$$\Delta_p = \frac{q_{c,p} - q_{b,p}}{q_{b,p}} \times 100$$

Management policy alternatives

- Business-As-Usual (BAU)
- Hydropower Maximization (HM)
- Flood Control (FC)
- Supply Security (SS)
- Recreation (R)



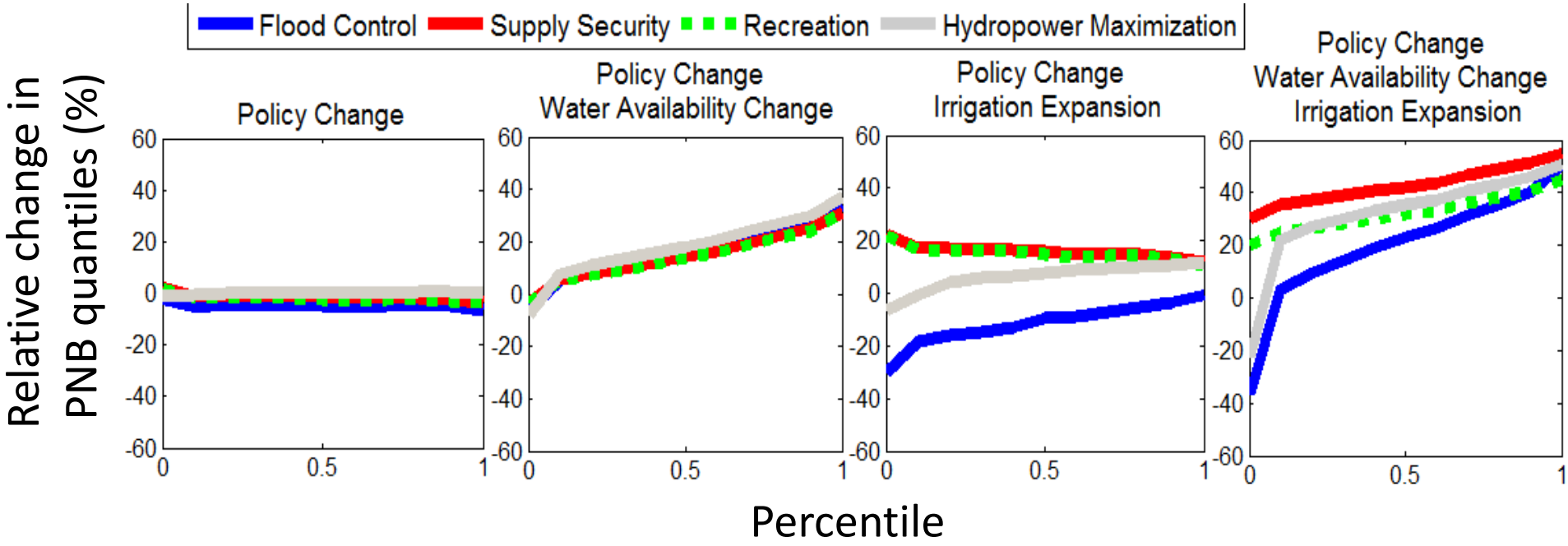
Response surfaces for the provincial Net Benefit



Relative impact of management policies on benchmark PNBs

Benchmark system performance here:

PNBs under current irrigation area, Business-As-Usual policy, dry flow conditions



Conclusions

- The water-food-energy nexus is a simplified term to highlight water uses. Managing water resources, and conflicting water demands, is often more complex.
- There is a need to understand single and joint effects of changing water availability, demand, and policy conditions on water resource system performance.
- In SaskRB-Saskatchewan: When irrigated area is increased, policy selection becomes important.
- The joint impacts of changing water availability, policy, and irrigation expansion are complex nonlinear functions of individual drivers