Department of Hydrology and Water Resources Management

Institute for Natural Resource Conservation

Assessing the hydrologic regime alteration of a Wadi system as a proxy on initial ecological responses to climate change and growing water demand

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Study area: Halilrood Basin, Iran

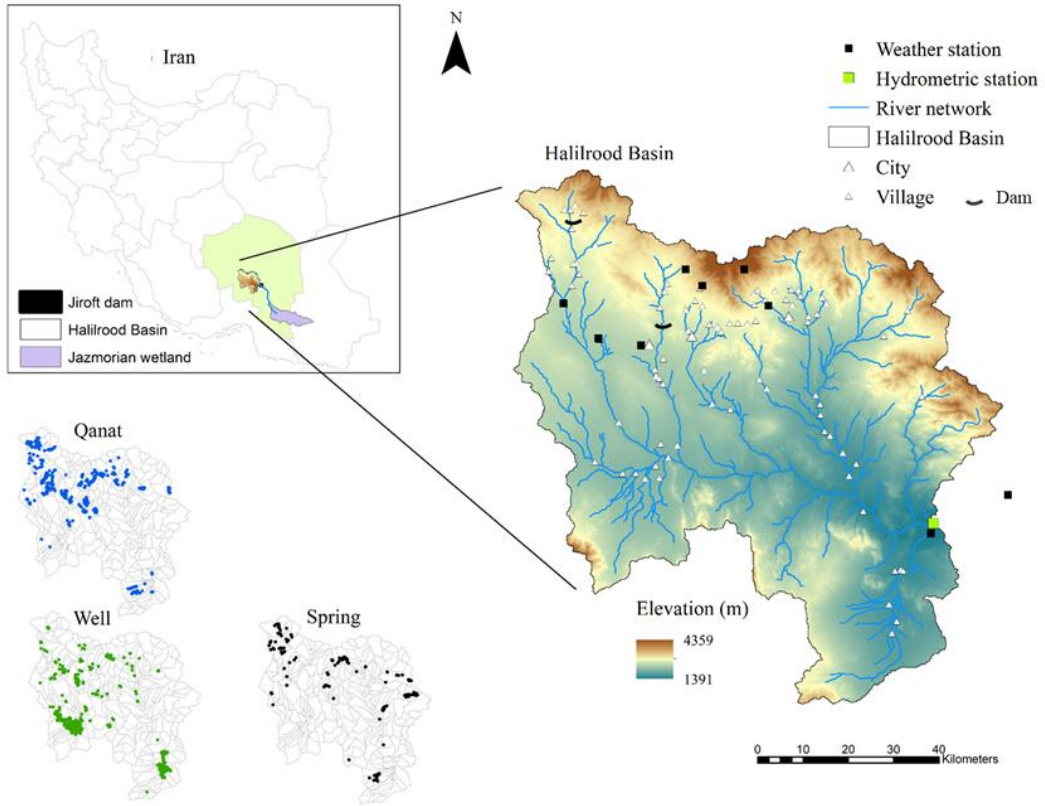
- Halilrood is a major river in the Kerman province, Iran
- Provides different ecosystem services by supplying water for:
  - Domestic uses
  - Agricultural and Industrial purposes
  - Energy (Jiroft Dam)
  - Jazmorian wetland

- Characteristics:
  - Annual precipitation: 295 mm (1979-2011)
  - Annual temperature: 13 °C
  - Annual discharge: 7.68 $m^3 s^{-1}$ (1993-2009)

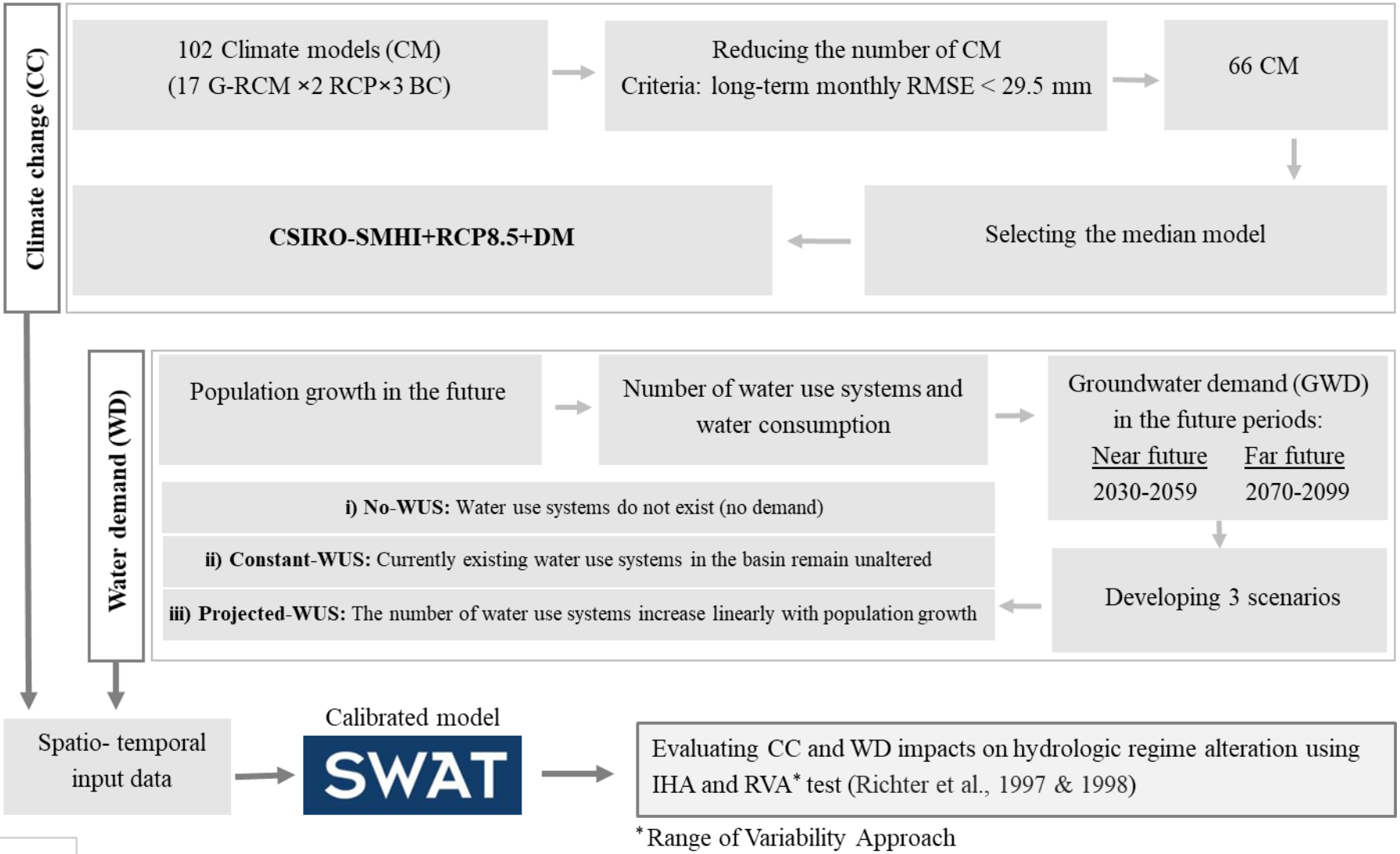
- Hydrologic catchment model (SWAT):

Calibration (1995-2003)			Validation (2004-2009)		
KGE	NSE	PBIAS	KGE	NSE	PBIAS
0.87	0.76	4.7	0.62	0.54	7.1

Mahmoodi et al., 2020



Materials and methods



Methods: Indicatorts of Hydrologic Alteration (IHA)

IHA parameters group	Hydrologic parameters	Unit
Group 1. Magnitude of monthly water conditions	Median flow for each calendar month	$m^3 s^{-1}$
		$m^3 s^{-1}$
Group 2. Magnitude of annual extreme discharge events with different durations	1-day minimum flow (1-day min)	$m^3 s^{-1}$
	3-day minimum flow (3-day min)	$m^3 s^{-1}$
	7-day minimum flow (7-day min)	$m^3 s^{-1}$
	30-day minimum flow (30-day min)	$m^3 s^{-1}$
	90-day minimum flow (90-day min)	$m^3 s^{-1}$
	1-day maximum flow (1-day max)	$m^3 s^{-1}$
	3-day maximum flow (3-day max)	$m^3 s^{-1}$
	7-day maximum flow (7-day max)	$m^3 s^{-1}$
	30-day maximum flow (30-day max)	$m^3 s^{-1}$
	90-day maximum flow (90-day max)	$m^3 s^{-1}$
	Base flow index (Base flow)	$m^3 s^{-1}$
Group 3.Timing of annual extreme water conditions	Date of annual minimum flow (Date min)	day of year
	Date of annual maximum flow (Date max)	day of year
Group 4. Frequency and duration of high and low pulses	Number of low pulses each year (Lo pulse)	dimensionless
	Number of high pulses each year (Hi pulse)	dimensionless
	Duration of low pulses (Lo pulse D)	dimensionless
	Duration of high pulses (Hi pulse D)	dimensionless
	Number of zero flow days (Zero days)	days
Group 5. Rate and frequency of water condition changes	Median rate of positive changes in flow (Rise rate)	$m^3 s^{-1} day^{-1}$
	Median rate of negative changes in flow (Fall rate)	$m^3 s^{-1} day^{-1}$

Methods: The Range of Variability Approach

Degree of alteration in *i*th IHA (*DAi*)

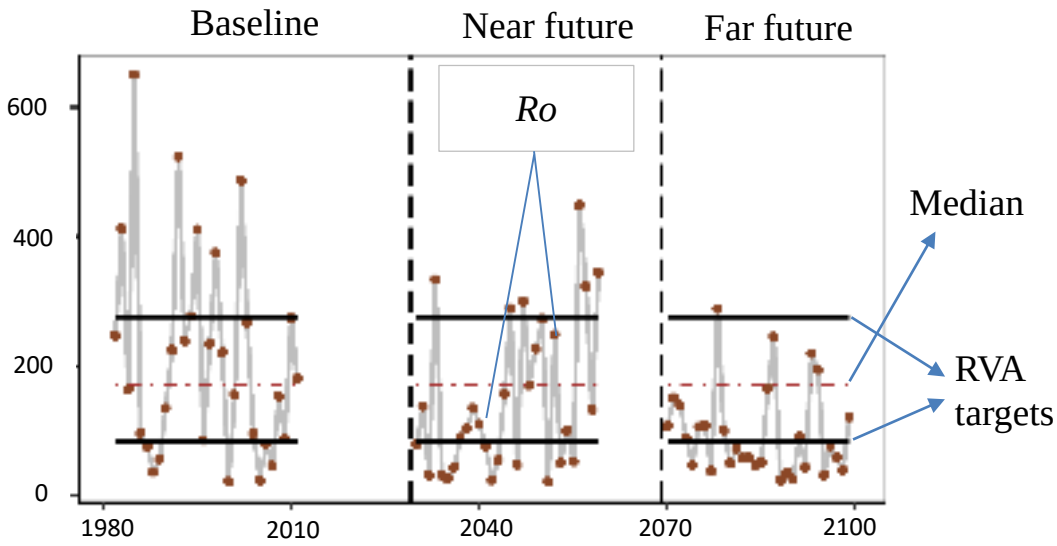
$$DAi = \frac{Roi - Rei}{Rei} * 100\%$$

Roi: number of observed repetitions within the RVA targets
Rei: number of expected repetitions within the RVA targets
RVA targets: median ±25th percentile of the baseline data

$$Rei = \gamma Rt$$

γ**:** proportion of a single indicator's values falling within the RVA target range (i.e. γ = 0.5)
Rt: total number of values for each indicator (i.e. 30)

IHA: 3-day max



$$DA(3-day\ max) = \frac{12-15}{15} * 100\% = -20$$

Results: Hydrologic regime alteration

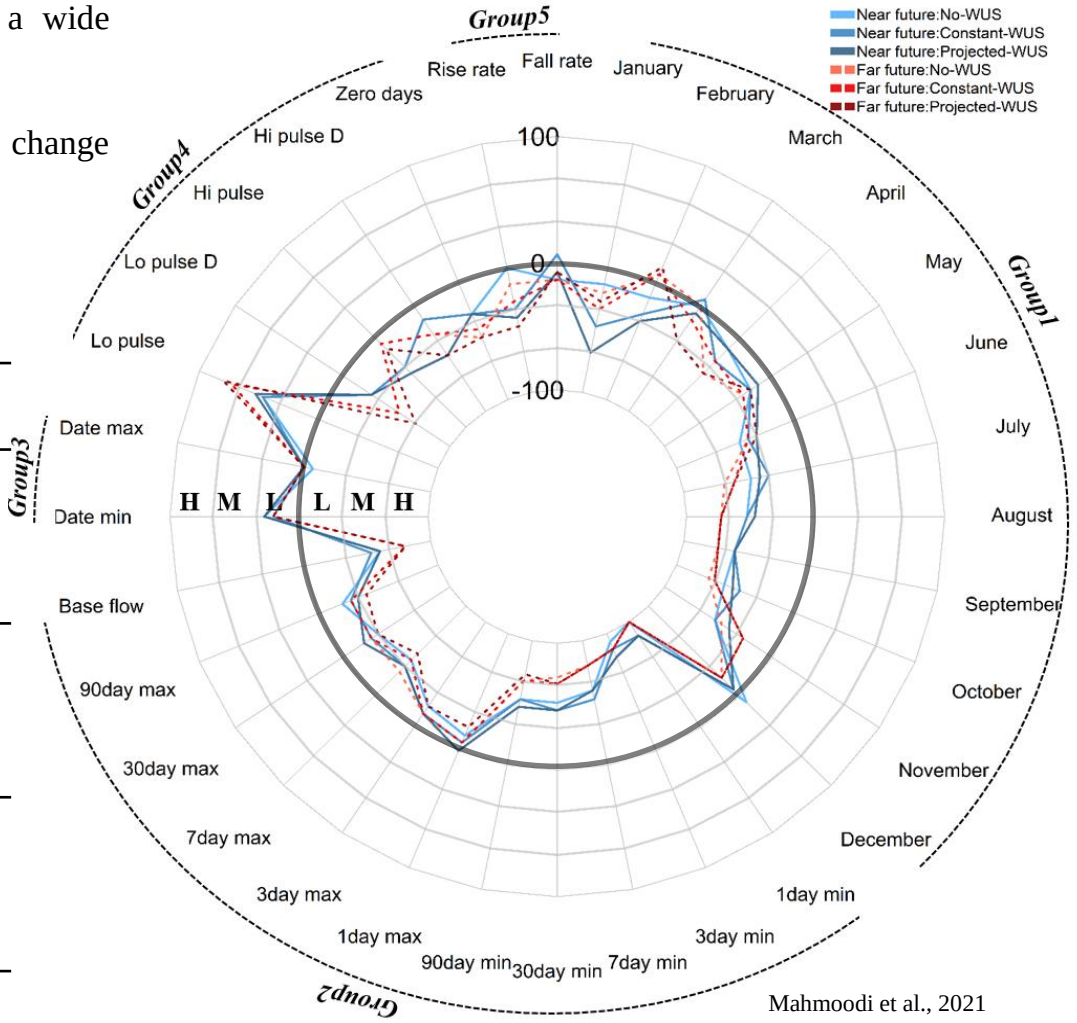
- The indicator changes that agree most are pretty robust results (e.g. the Low pulse count, the December flows), while uncertainty is obvious for the indicators, showing a wide spread result (e.g. rise rate, January flows).
- The direction of change is relatively stable, but can change from near to far future (e.g. February flows)

Number of indicators with high, moderate, and low changes

Alteration	Scenarios	Near future	Far future
High	No-WUS	2	11
	Constant-WUs	2	10
	Projected-WUS	3	11
Moderate	No-WUS	12	5
	Constant-WUs	11	5
	Projected-WUS	13	7
Low	No-WUS	18	16
	Constant-WUs	19	17
	Projected-WUS	16	14

Degree of alteration (%) for each IHA under three WUS-scenarios

H: high **M**:moderate **L**: low



Mahmoodi et al., 2021

General conclusions

- Different magnitude of changes under the three WUS scenarios indicated that the influence of climate change on the flow regime alteration is stronger than estimated future groundwater withdrawals.
- Impacts on freshwater ecosystem (Jazmorain wetland):
  - A smaller inundated area and shallower water body in Jazmorian wetland are expected in the future, as among 23 IHA considered for the magnitude of monthly flows and annual extreme flows, 15 are representing high and moderate levels of alterations.
  - High and moderate alterations in number and duration of low pulses and number of days with zero flow show lower water availability for the wetland in the future.
  - Alteration in falling rates (median rate of negative changes in flow), coinciding with alteration in the magnitude of flows, influence soil moisture in the wetland and consequently change the distribution of the plants by an intensification of drought stress on plants, which are vital for preventing wind and water erosion.
  - Assessing the hydrologic regime alteration can provide initial information on the responses of freshwater ecosystem to human interactions, prior to any ecological indices investigation or assessments using ecological models.

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A dead turtle, Jazmorian wetland, Iran (2018)