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Using big data sets to combat climate change impacts

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Brussels, Belgium, 2018

Eawag: Swiss Federal Institute of Aquatic Science and Technology
University of Geneva, Institute for Environmental Science

Outline

- Climate Change Analysis Steps
- 2w2e
- Climate Change Toolkit (CCT)
- California Case Study

Steps in Climate Change Analysis

- Collect historical measured data
- Collect GCM climate change data (find, extract from NetCDF or other formats, reformat for SWAT, etc…)
- Downscale/bias correct climate change data
- Interpolating to finer resolution
- Run hydrologic model with future data
- Drought, Flood, economical , … analysis

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Water Weather Energy Ecosystem Technology and Data

Climate Change Data for SWAT model (CMIP5)

ReadMore ⓘ

Select Area	Select Models	Select Scenarios	Select Data Type
From Latitude	GCM1 ☐	scenario1 ☐	Precipitation ☐
To Latitude	GCM2 ☐	scenario2 ☐	Temperature ☐
From Longitude	GCM3 ☐	scenario3 ☐	
To Longitude	GCM4 ☐	scenario4 ☐	
	GCM5 ☐	historical ☐	
	ObservedData ☐		

Extract and Download | Map

Location

SAVE EXPORT SHARE EDIT INSIGHTS

All Users
100.00% Users

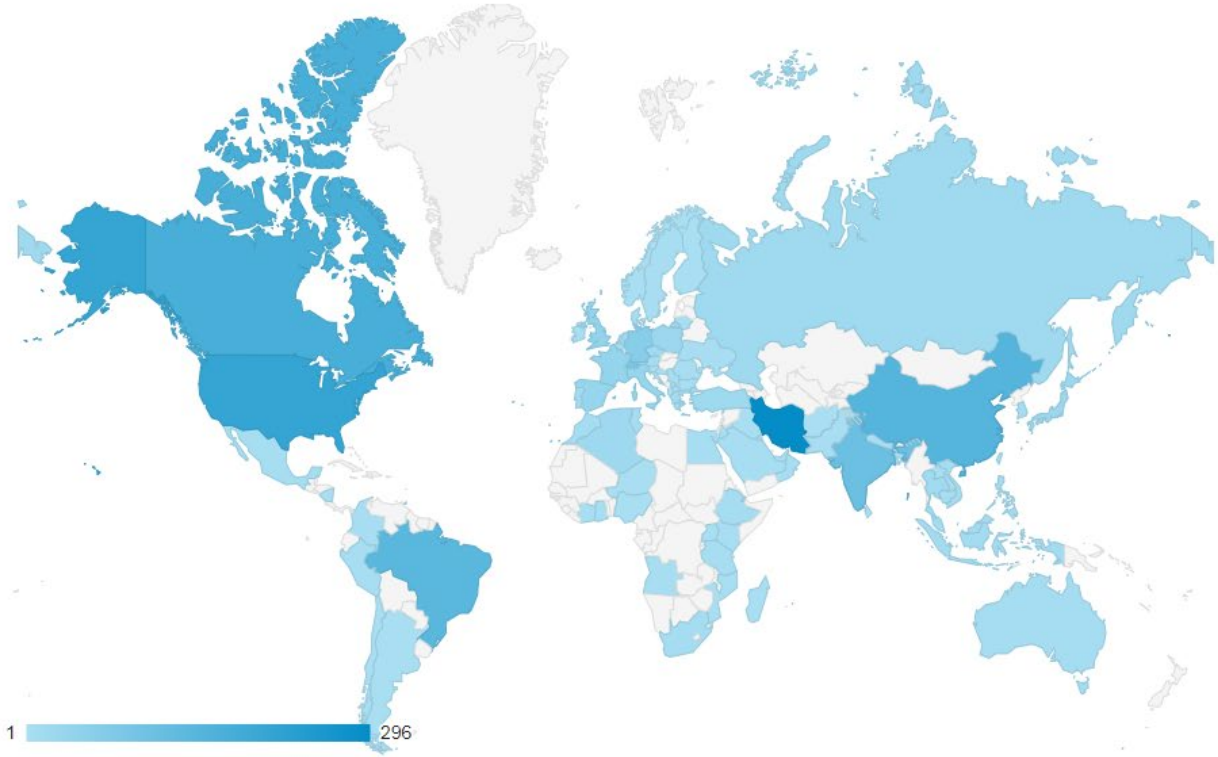
+ Add Segment

Sep 6, 2016 - Sep 14, 2018

Map Overlay Explorer

Summary Site Usage Ecommerce

Users



Primary Dimension: Country City Continent Sub Continent

All Users
100.00% Users

+ Add Segment

Sep 6, 2016 - Sep 14,

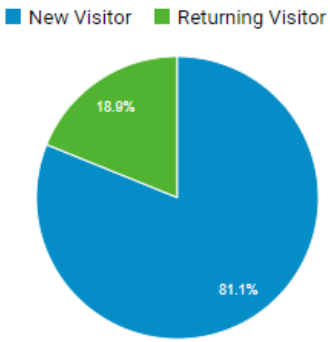
Overview

Users vs. Select a metric

Hourly Day Week

Users	New Users	Sessions	Number of Sessions per User
1,757	1,765	4,269	2.43

Pageviews	Pages / Session	Avg. Session Duration	Bounce Rate
8,485	1.99	00:03:19	75.08%



Country	Users	New Users	Sessions	Bounce Rate	Pages / Session	Avg. Session Duration	Goal Conversion Rate	Goal Completions	Goal Value
	1,757 % of Total: 100.00% (1,757)	1,771 % of Total: 100.34% (1,765)	4,269 % of Total: 100.00% (4,269)	75.08% Avg for View: 75.08% (0.00%)	1.99 Avg for View: 1.99 (0.00%)	00:03:19 Avg for View: 00:03:19 (0.00%)	0.00% Avg for View: 0.00% (0.00%)	0 % of Total: 0.00% (0)	$0.00 % of Total: 0.00% ($0.00)
1. Iran	**296** (16.12%)	280 (15.81%)	743 (17.40%)	67.97%	2.66	00:04:32	0.00%	0 (0.00%)	$0.00 (0.00%)
2. United States	**211** (11.49%)	199 (11.24%)	317 (7.43%)	80.44%	1.79	00:02:07	0.00%	0 (0.00%)	$0.00 (0.00%)
3. Canada	**175** (9.53%)	175 (9.88%)	590 (13.82%)	78.47%	1.47	00:03:10	0.00%	0 (0.00%)	$0.00 (0.00%)
4. China	**151** (8.22%)	154 (8.70%)	242 (5.67%)	73.55%	1.98	00:02:41	0.00%	0 (0.00%)	$0.00 (0.00%)
5. Brazil	**142** (7.73%)	142 (8.02%)	164 (3.84%)	85.37%	2.26	00:02:38	0.00%	0 (0.00%)	$0.00 (0.00%)
6. India	**111** (6.05%)	110 (6.21%)	226 (5.29%)	71.24%	2.18	00:03:03	0.00%	0 (0.00%)	$0.00 (0.00%)
7. Switzerland	**88** (4.79%)	85 (4.80%)	598 (14.01%)	70.07%	1.84	00:04:37	0.00%	0 (0.00%)	$0.00 (0.00%)
8. Germany	**61** (3.32%)	59 (3.33%)	120 (2.81%)	67.50%	1.94	00:03:41	0.00%	0 (0.00%)	$0.00 (0.00%)
9. United Kingdom	**40** (2.18%)	34 (1.92%)	148 (3.47%)	69.59%	2.26	00:04:09	0.00%	0 (0.00%)	$0.00 (0.00%)
10. France	**38** (2.07%)	38 (2.15%)	55 (1.29%)	83.64%	1.55	00:01:33	0.00%	0 (0.00%)	$0.00 (0.00%)
11. Italy	**35** (1.91%)	34 (1.92%)	52 (1.22%)	96.15%	1.06	00:00:13	0.00%	0 (0.00%)	$0.00 (0.00%)
12. Spain	**34** (1.85%)	34 (1.92%)	63 (1.48%)	68.25%	2.54	00:04:31	0.00%	0 (0.00%)	$0.00 (0.00%)
13. Poland	**28** (1.53%)	27 (1.52%)	42 (0.98%)	73.81%	1.52	00:02:41	0.00%	0 (0.00%)	$0.00 (0.00%)
14. Hong Kong	**25** (1.36%)	24 (1.36%)	28 (0.66%)	82.14%	1.25	00:00:40	0.00%	0 (0.00%)	$0.00 (0.00%)
15. Japan	**25** (1.36%)	22 (1.24%)	49 (1.15%)	67.35%	2.84	00:03:15	0.00%	0 (0.00%)	$0.00 (0.00%)
16. Netherlands	**22** (1.20%)	18 (1.02%)	40 (0.94%)	67.50%	1.80	00:01:45	0.00%	0 (0.00%)	$0.00 (0.00%)
17. Algeria	**21** (1.14%)	20 (1.13%)	29 (0.68%)	79.31%	1.76	00:00:42	0.00%	0 (0.00%)	$0.00 (0.00%)
18. Turkey	**20** (1.09%)	20 (1.13%)	34 (0.80%)	52.94%	6.06	00:11:12	0.00%	0 (0.00%)	$0.00 (0.00%)
19. Russia	**18** (0.98%)	18 (1.02%)	26 (0.61%)	61.54%	1.65	00:03:26	0.00%	0 (0.00%)	$0.00 (0.00%)
20. Czechia	**17** (0.93%)	16 (0.90%)	22 (0.52%)	72.73%	1.45	00:02:27	0.00%	0 (0.00%)	$0.00 (0.00%)
21. Thailand	**17** (0.93%)	17 (0.96%)	20 (0.47%)	65.00%	2.85	00:03:13	0.00%	0 (0.00%)	$0.00 (0.00%)
22. (not set)	**15** (0.82%)	11 (0.62%)	18 (0.42%)	94.44%	1.11	00:00:05	0.00%	0 (0.00%)	$0.00 (0.00%)
23. Greece	**13** (0.71%)	12 (0.68%)	22 (0.52%)	72.73%	2.36	00:04:17	0.00%	0 (0.00%)	$0.00 (0.00%)
24. Philippines	**12** (0.65%)	12 (0.68%)	12 (0.28%)	91.67%	1.25	00:00:01	0.00%	0 (0.00%)	$0.00 (0.00%)
25. Portugal	**12** (0.65%)	12 (0.68%)	12 (0.28%)	91.67%	1.08	00:01:37	0.00%	0 (0.00%)	$0.00 (0.00%)

WETechData
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Products

SWAT-CUP 2012

SWAT-CUP is a program for calibration of SWAT models. Read more

Download SWAT-CUP

Climate Change Toolkit

Climate Change Toolkit (CCT) is a program, which handles all climate change analysis' tasks in one package. Read more

Download CCT

SWAT-MODSIM coupled model

The coupled SWAT-MODSIM model is a program that links the SWAT and MODSIM models for better integrated water resource planning and management. Read more

Download SM

Global ET observation

The main objective of this program and the linked database are to prepare a framework allow users to profit from MODIS-NASA available Actual Evapotranspiration (AET) observations to calibrate SWAT hydrological model. Read more

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Previous Projects

Europe project

A continental-scale hydrology and water quality model for Europe: Calibration and uncertainty of a high-resolution large-scale SWAT model Read more

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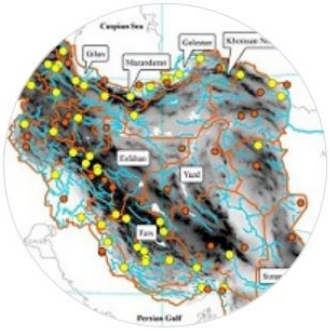

Iran Project

Assessing the impact of climate change on water resources in Iran Read more

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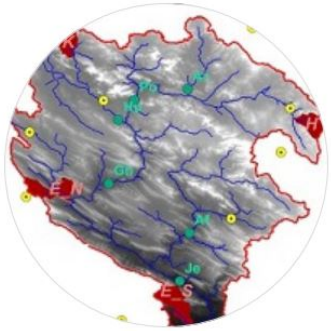

Karkheh River Basin Project

Analyses of the impact of climate change on water resources components, drought and wheat yield in semiarid regions: Karkheh River Basin in Iran Read more

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Data

We have provided the necessary data for building a SWAT model of Global,Iran and Karkheh River Basin.

Karkheh River Basin (KRB)

The KRB (approximately 51,000 km2) stretches from the Zagros Mountains to the Hoor-Al-Azim Swamp, which is a trans-boundary wetland located at the Iran–Iraq border.

Select & Download

Iran

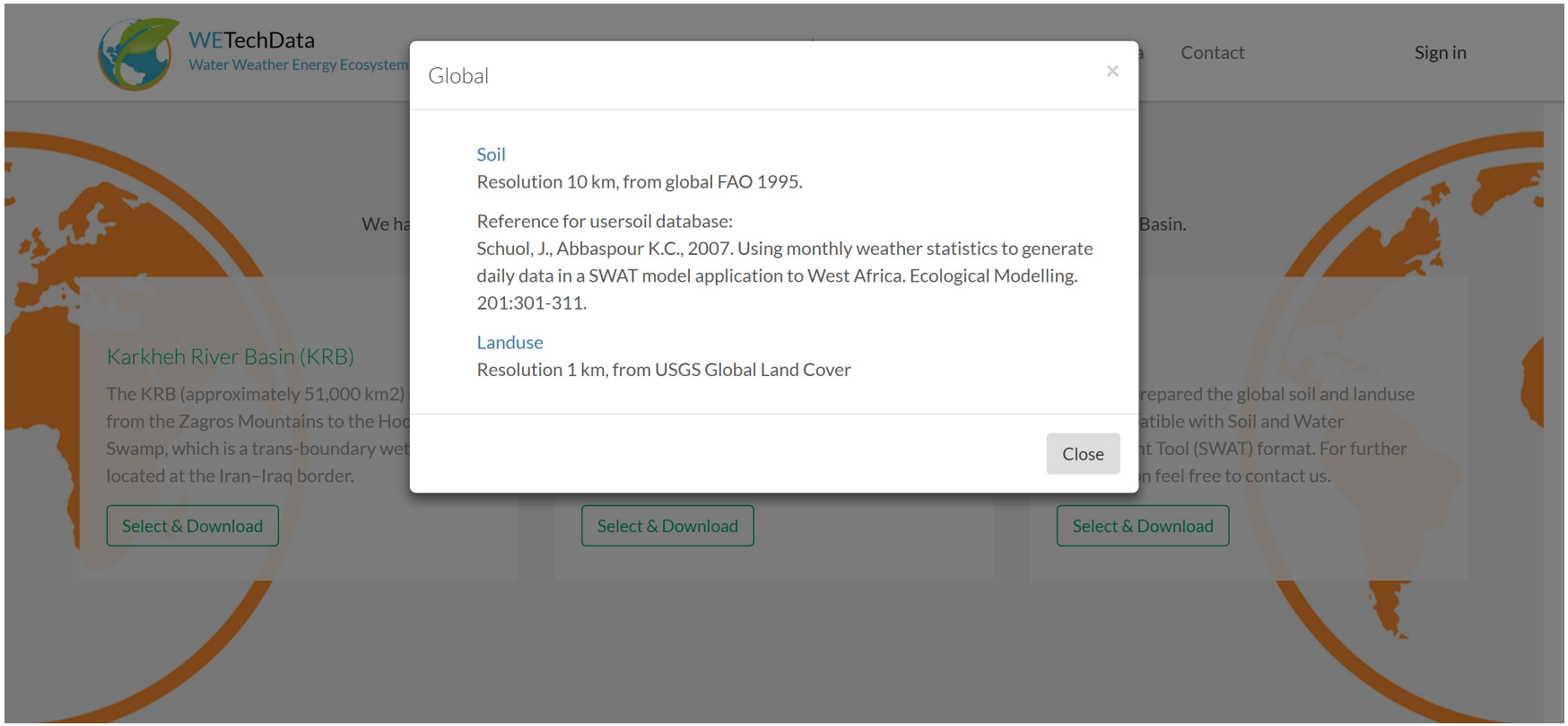
IRAN is located between 25 to 40 north latitude and 44 to 63 east longitude and an area of 1,648,195 km2. The altitude varies from - m to 5670 m.

Select & Download

Global

We have prepared the global soil and landuse data compatible with Soil and Water Assessment Tool (SWAT) format. For further information feel free to contact us.

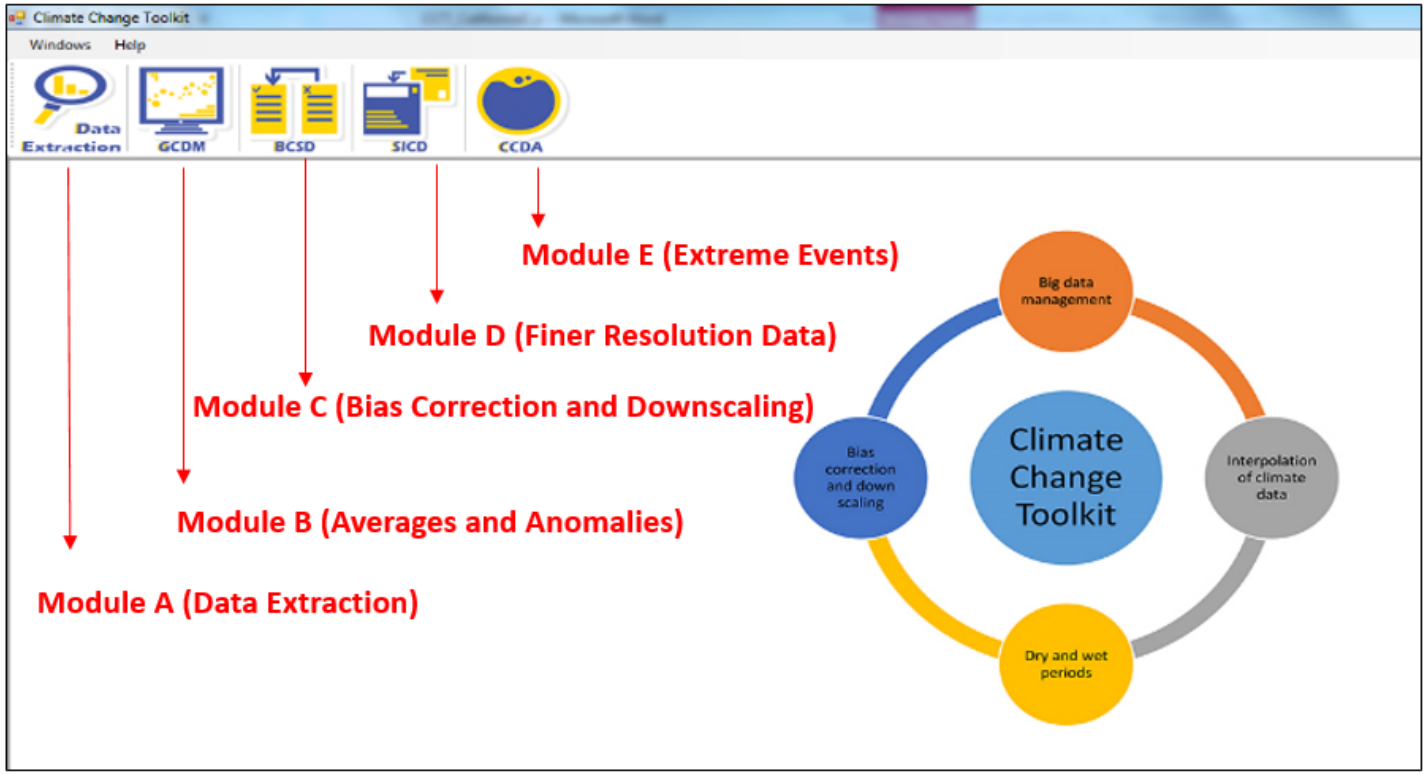
Select & Download


WETechData
Water Weather Energy Ecosystem
Contact
Sign in
Global
Soil
Resolution 10 km, from global FAO 1995.
Reference for usersoil database:
Schuol, J., Abbaspour K.C., 2007. Using monthly weather statistics to generate daily data in a SWAT model application to West Africa. Ecological Modelling. 201:301-311.
Landuse
Resolution 1 km, from USGS Global Land Cover
Close
Karkheh River Basin (KRB)
Select & Download
Select & Download
Select & Download

Climate Change Toolkit (CCT)

- Collect historic measured data
- Colelct GCM climate change data (find, extract from Netcdf format, reformat for SWAT, etc…)
- Downscale/bias correct climate change data
- Interpolating to finer resolution
- Run hydrologic model with future data

- Analysis of extreme events



Data Archive

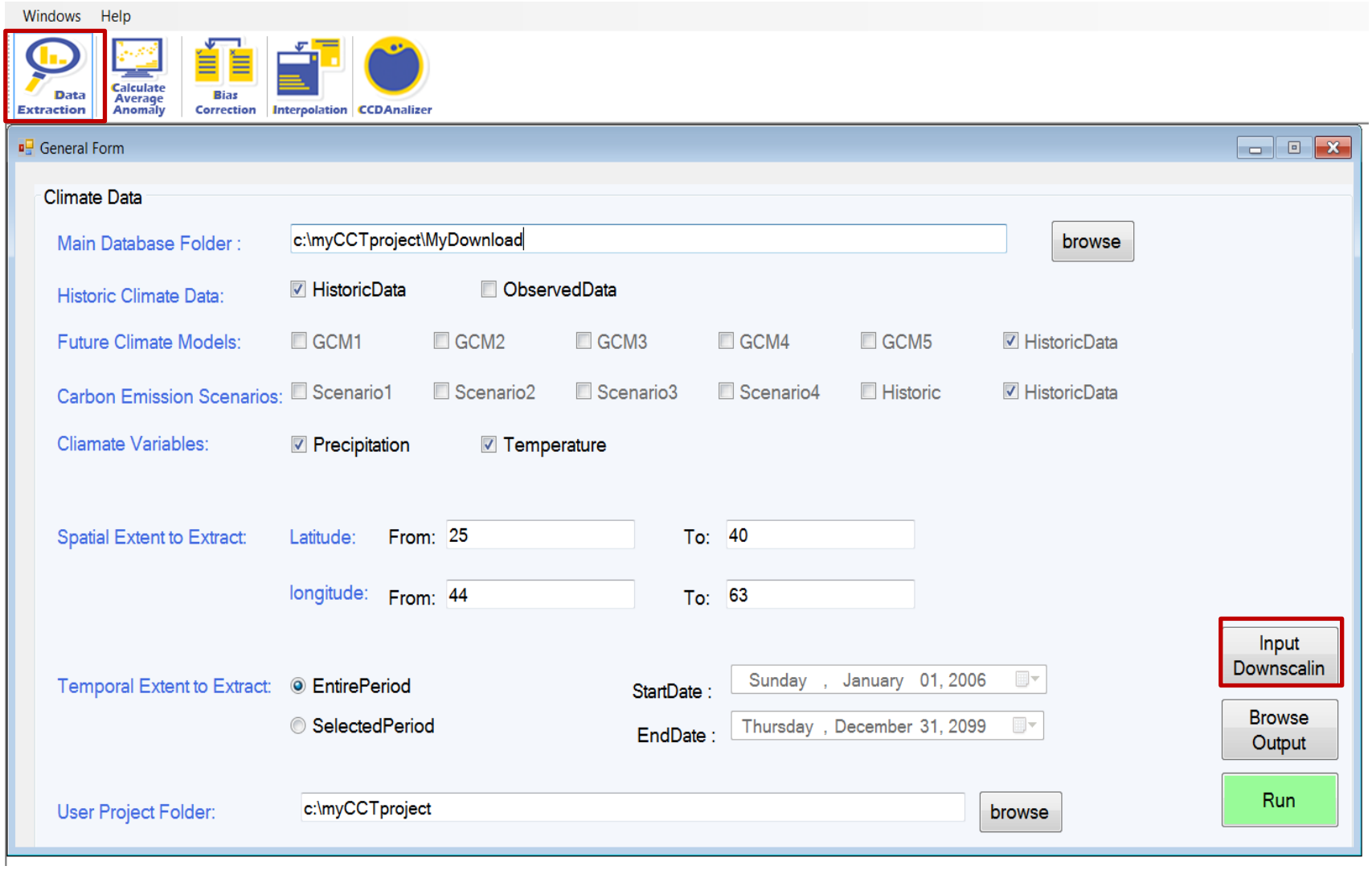
- Consists of 5 global GCMs and 4 emission scenarios (CMIP5) from ISI-MIP (1950-2100) at 0.5 degree resolution

- Historic CRU data (1970-2012) at 0.5 degree resolution
- SWAT-formatted precipitation, max and min temperaturec

GCM	Scenarios	Institute
GFDL-ESM2M	RCPs 2.6,4.5,6,8.5	NOAA/Geophysical Fluid Dynamics Laboratory (USA)
HadGEM2-ES	RCPs 2.6,4.5,6,8.5	Met Office Hadley Centre (United Kingdom)
IPSL-CM5A-LR	RCPs 2.6,4.5,6,8.5	Institute Pierre-Simon Laplace (France)
MIROC	RCPs 2.6,4.5,6,8.5	AORI, NIES and JAMSTEC (Japan)
NoerESM1-M	RCPs 2.6,4.5,6,8.5	Norwegian Climate Center (Norway)

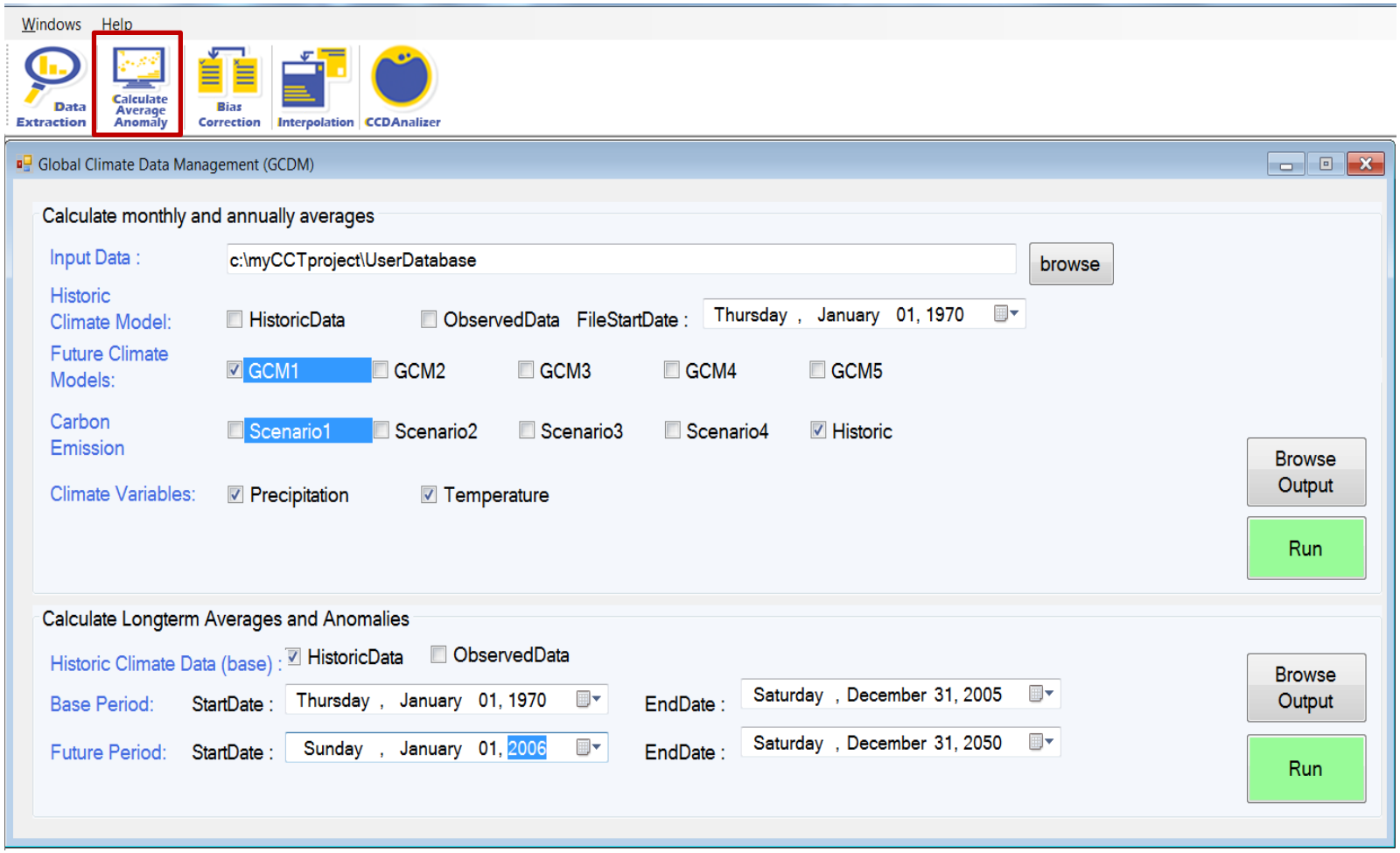
Module A: Data Extraction

- Spatial extraction Lat: -89.75 to 89.75 Long: -179.75 to +179.75



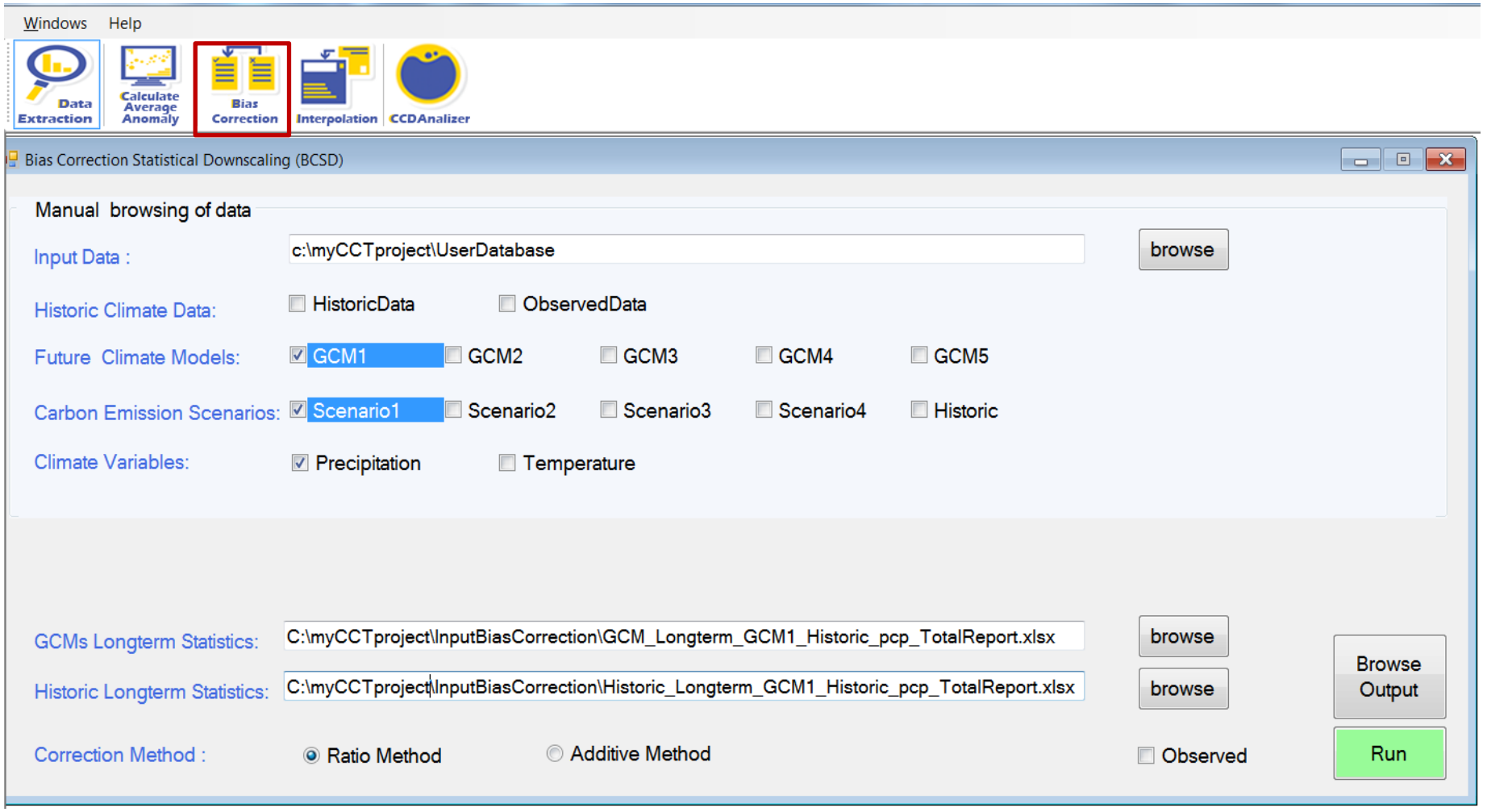
Module B: Global Climate Data Management (Averages and Anomalies)

- Calculate monthly and annually averages and anomalies at each grid point

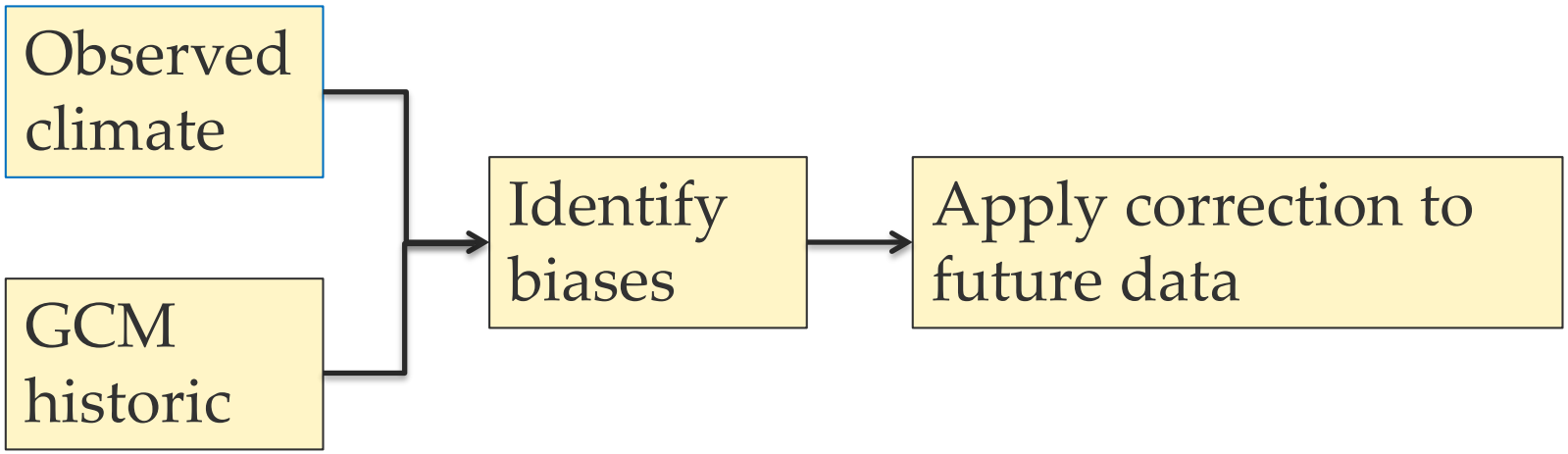


Module C: Bias Correction Statistical Downscaling

- For precipitation: multiplicative correction
- For temperature: additive correction

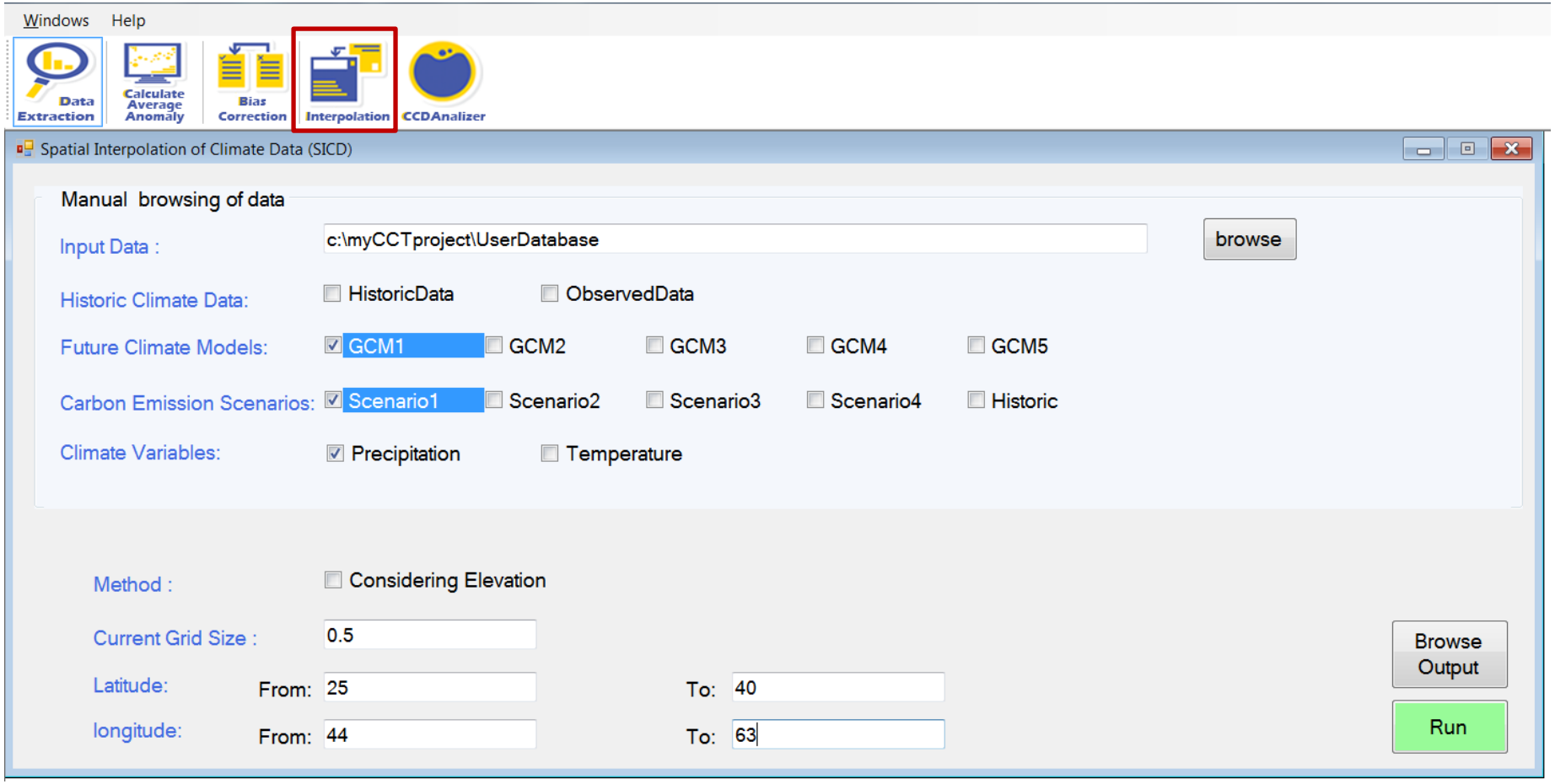


Bias correction

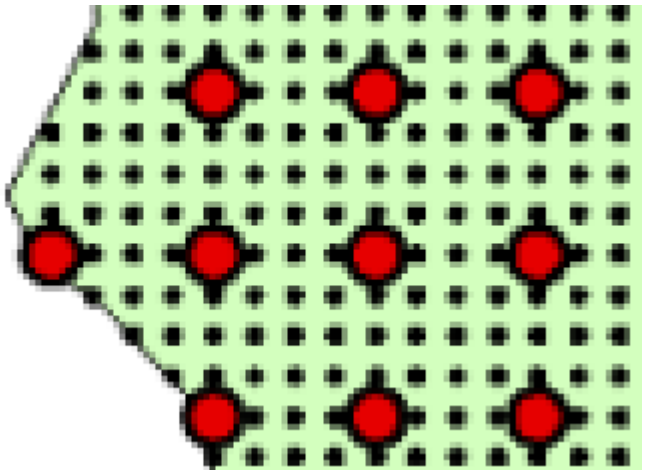


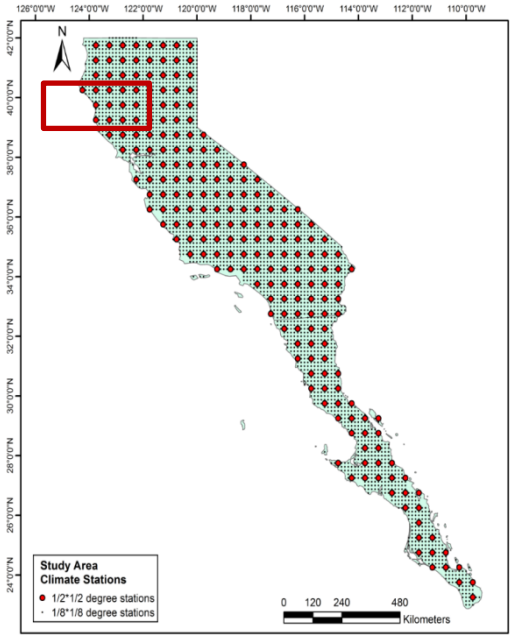
Module D: Spatial Interpolation of Climate Data

- Inverse Distance Weight Method (IDW)

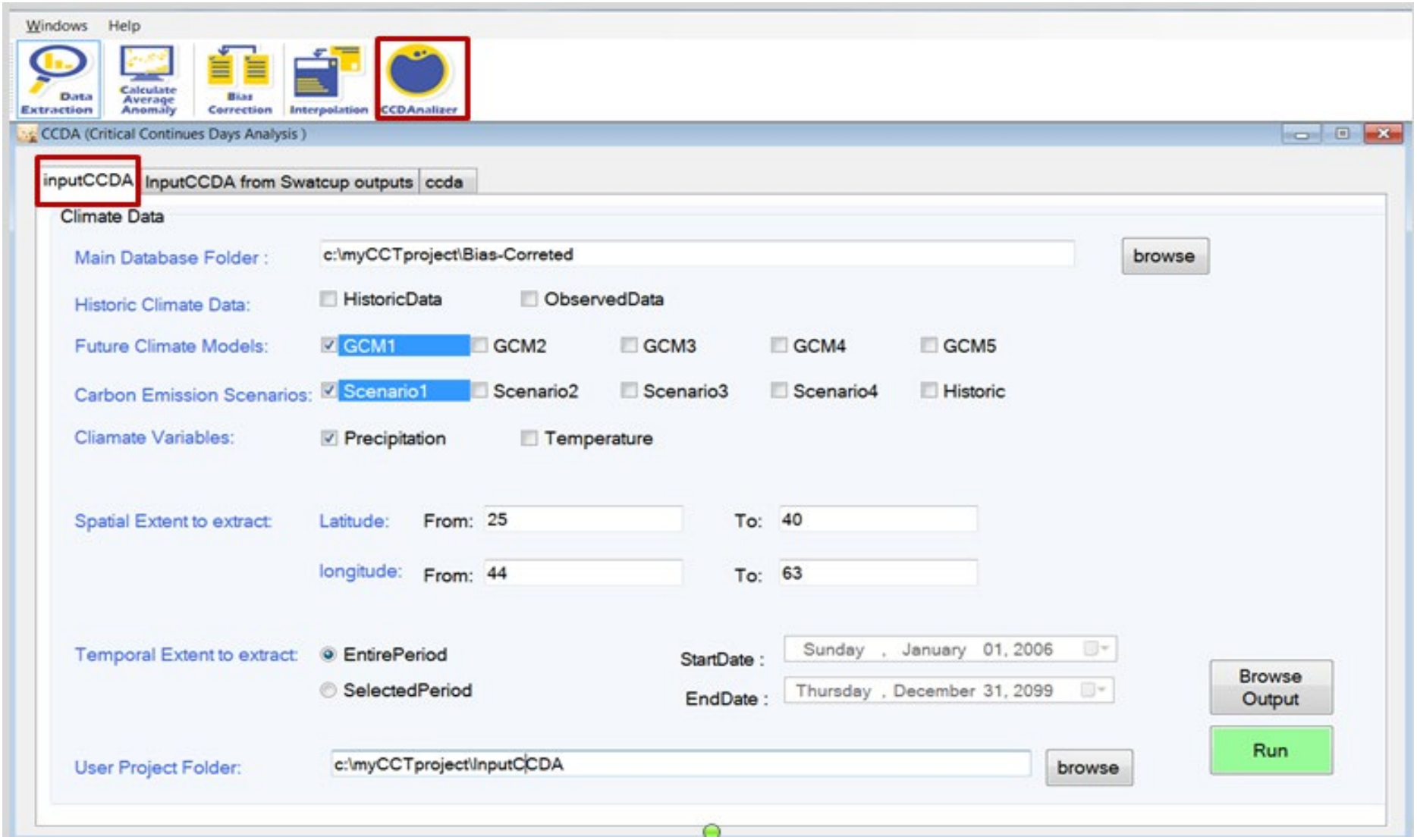


Module D: Spatial Interpolation of Climate Data





Module E: Critical Consecutive Days Analyzer



Module E: Critical Consecutive Days Analyzer

Region	Wet Period	Dry Period
Tropical Regions	What is the frequency of: Period Length > 2 days precipitation > 50 mm/day	What is the frequency of: Period Length > 60 days precipitation < 2 mm/day **.and.** max temperature > 30° C
Semi-Arid Regions	What is the frequency of: Period Length > 1 day precipitation > 20 mm/day	What is the frequency of: Period Length > 120 days precipitation < 2 mm/day **.and.** max temperature > 35° C

California example: Flood analysis

Table 4

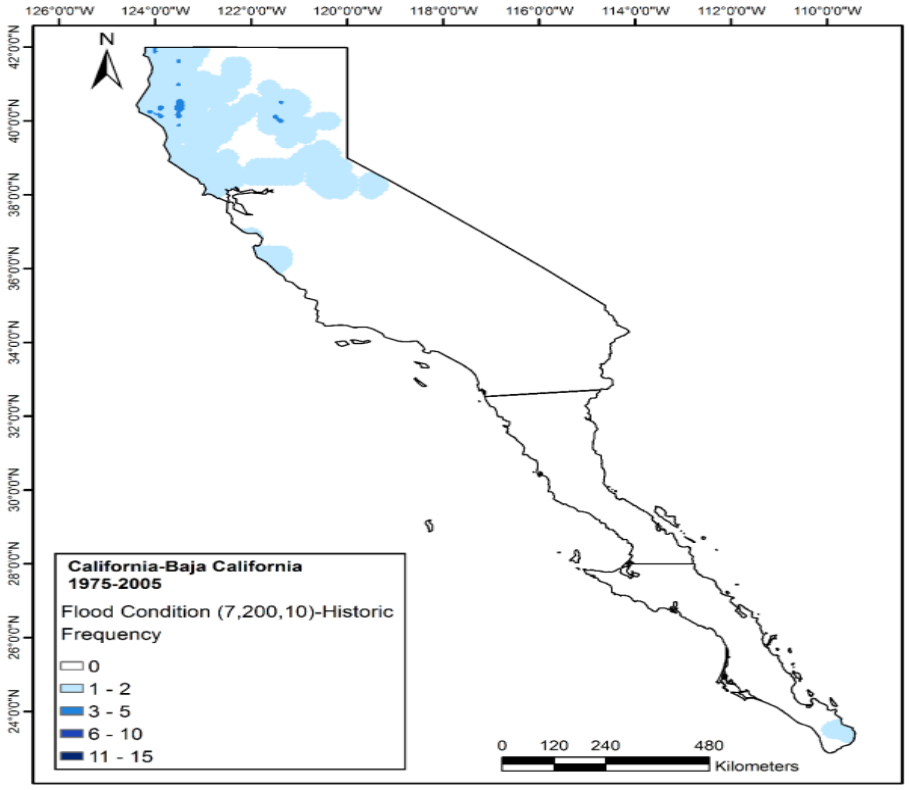
Records of historic flooding conditions in California.

	Region	Year	Precipitation (mm)	Duration (Day)	Return period (years)
	California	1909	1,458	20	12,000
1	North of Los Angeles	1933-1934	300	7	
2	Santa Ana River basin	February (4-7) 1937	200	4	450
3	Los Angeles	1938	254	5	
4	California (Shasta County)	December 1955	390	1	
5	California-Wester Nevada	1986	740	10	
6	California-Calistoga	1986	740	10	1,000
7	California-Sacramento	1986	250	11	
8	Northern California-Sierra Nevada	1996-1997	760	16	

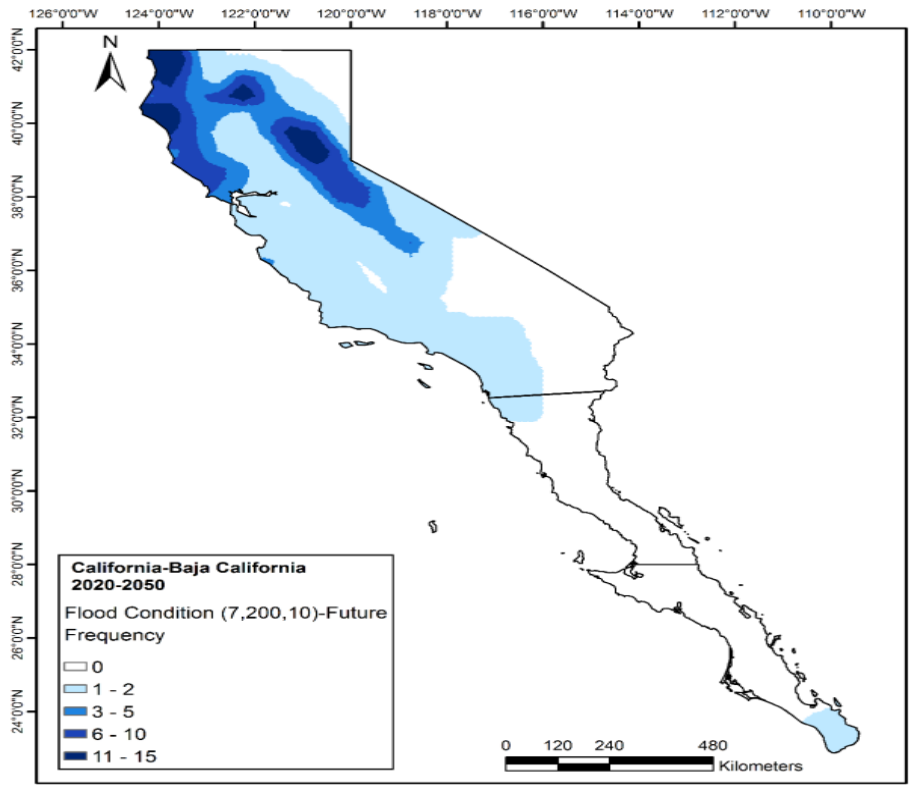
California Results- Flood analysis

Flood condition: 7 days rainfall, more than 200 mm, min 10 mm/d

Historic (1975-2005)



Future (2020-2050)

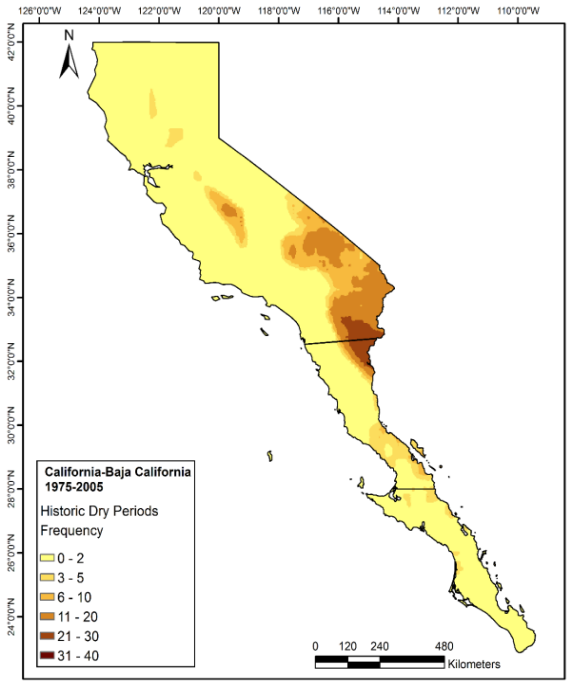


California Results- Dry periods

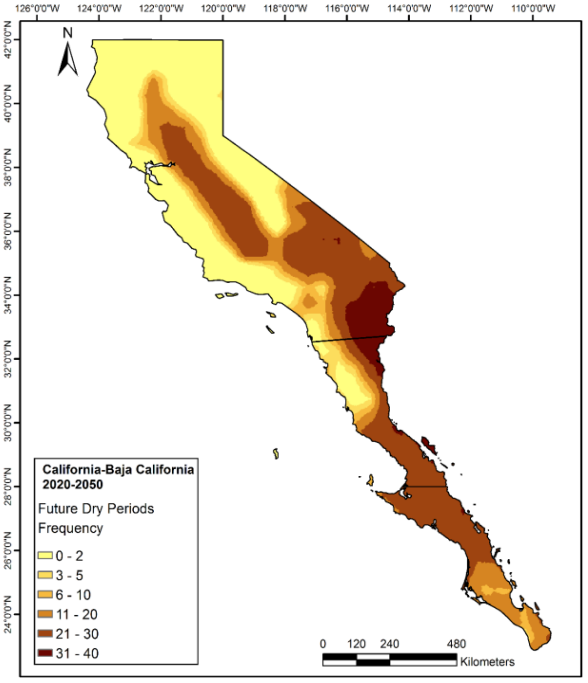
Period Length > 60 days
precipitation < 2 mm/day **.and.** max temperature > 30° C

Frequency of dry periods increased from 0-2 to 30–40 times

Historic (1975-2005)



Future (2020-2050)

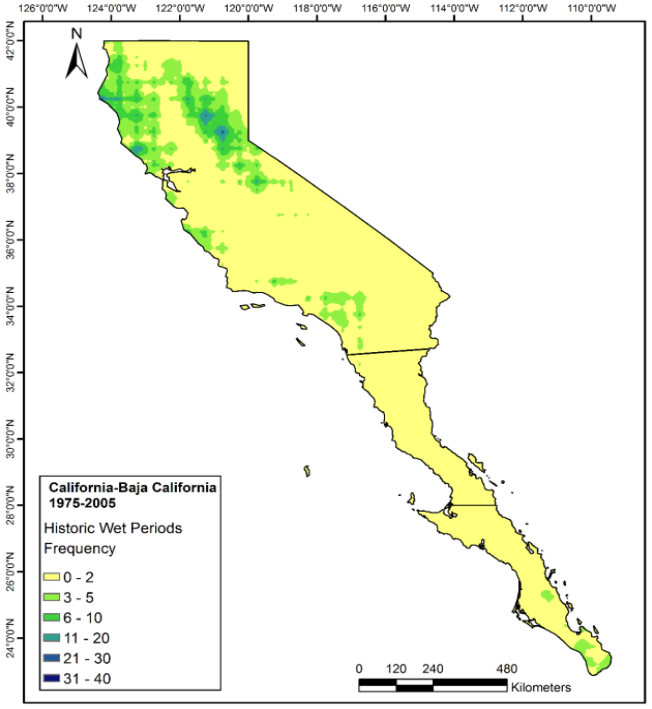


California Results- Wet periods

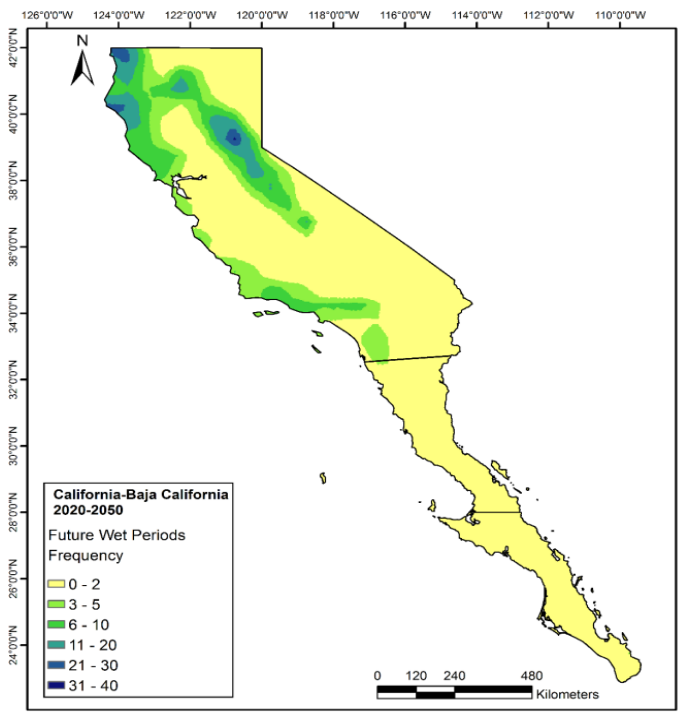
Period Length > 2 days, Precipitation > 50 mm day^{-1}

Frequency of wet periods: 0-2 to 31 – 40 times

Historic (1975-2005)



Future (2020-2050)



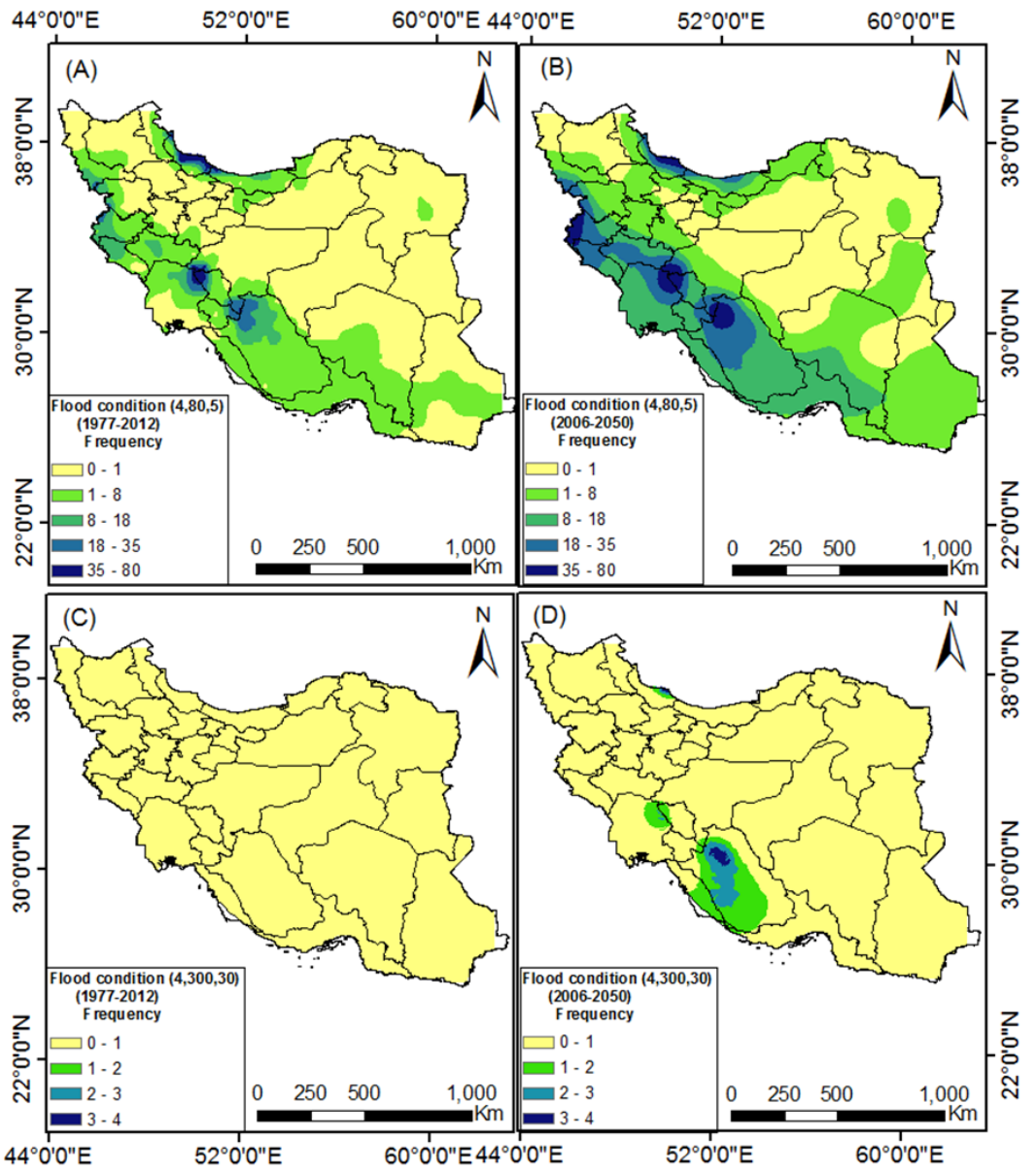
Iran Floods

Table 1

Reference criteria to study extreme floods.

province	date	Duration precipitation day	Total precipitin mm	Damage	
				Fatalities	Buildings
Golestan	11 August	2	140		4,000 buildings
East Azerbaijan	April 14 to April 17, 2017	2	55	42 deaths	-
Kurdistan		3	53	5 deaths	
Golestan	September 2, 2016	1	68	4 deaths	900
Ilam	October28 ,2015	3	325	9	
Lorestan			121		-
Tehran	19 July 2015	1	34	30 people injured	-
Mazandaran	19 and 20 July 2015	2	166.1		-
Qazvin	30 March 2015	1	31.1	77 people injured	-
Sistan	30 January 2017	4	118	1 death	-
Fars	13 February 2017	6	360	-	-

Iran Floods


(A)
(B)
(C)
(D)
N
44°0'0"E
52°0'0"E
60°0'0"E
38°0'0"N
30°0'0"N
22°0'0"N
Flood condition (4,80,5)
(1977-2012)
Frequency
0 - 1
1 - 8
8 - 18
18 - 35
35 - 80
Flood condition (4,80,5)
(2006-2050)
Frequency
0 - 1
1 - 8
8 - 18
18 - 35
35 - 80
Flood condition (4,300,30)
(1977-2012)
Frequency
0 - 1
1 - 2
2 - 3
3 - 4
Flood condition (4,300,30)
(2006-2050)
Frequency
0 - 1
1 - 2
2 - 3
3 - 4
0 250 500 1,000
Km

Frequency of 150 consecutive days where rainfall < 2 mm and for the 1977-2012 period and 2006-2050