China’s contribution to Indus Forum (2013-): Changes of observation and projection in climate, runoff and flood/drought over Indus River Basin
Remarkable Importance for China: “One Zone and One Road” Strategy
1, Indus River Studies linking to Global Program
The Global Programme of Research On Climate Change Vulnerability, Impacts and Adaptation

PROVIA

PROGRAMME OF RESEARCH ON CLIMATE CHANGE VULNERABILITY, IMPACTS AND ADAPTATION

(The Global Programme of Research On Climate Change Vulnerability, Impacts and Adaptation)

CLICC

Country Level Impacts of Climate Change
PROVIA
PROGRAMME OF RESEARCH ON CLIMATE CHANGE VULNERABILITY, IMPACTS AND ADAPTATION
4th Adaptation Futures Conference 2016
Adaptation Practice and Solutions
Joint conference and exhibition hosted by

Welcome to Rotterdam in May 2016
http://www.adaptationfutures2016.org/
[China]

21 January 2016
CL ICC Process

1. A focus on communication of the scientific evidence available in countries

2. Provision of a common toolkit connecting institutions, policies and plans, nationally and internationally, and related network/forum

3. Consistency and transparency enabling the potential to compare impacts in different countries

4. A capacity building aspect alongside development of products and information sharing
2. research results:
Changes of observation and projection in climate, runoff and flood/drought over Indus River Basin
Larger Asian River Basins

Simulation and Projection of temperature, precipitation and runoff in the Asian Larger Rivers based on ensembles of the CMIP5 climate models and CCLM regional model
Work package II (2015): Changes of observation and projection in climate, runoff and flood/drought over Indus River Basin
Projections of future changes: climate change scenarios

- **Emission scenario**: A1B
- **GCM**: ECHAM5, MPI-ESM-LR
- **SD/RCM**: CCLM 1/2°
- **Bias correction**: EDCDF approach (Gudmundson et al., 2012)
- **GCM/RCM Bias correction**: 21 selected GCMs (CMIP5)
- **Statistical downscaling**

- **RCP 2.6**
- **RCP 4.5**
- **RCP 8.5**
Improvement of climate model: to get accurately climate variables

Bias correction

EDCDF (Equidistant Cumulative Distribution Functions) adjusts the CDF of the datasets for projection period on the bias between the model and observation cumulative distribution functions (CDFs)
(1)

GCM multi-model ensemble (resolution: 1° × 1°)

Bias correction and statistical downscaling

Downscaled GCM (resolution: 0.5° × 0.5°)

1 bias correction
2 calculate the climate state (30 years), resolution: 0.5° × 0.5°
3 interpolate the climate state to GCM grid resolution (1°×1°), x denotes the results
4 calculate the weight coefficient \( r \) (temperature: \( GCM - x \), precipitation: \( GCM/x \))
5 interpolate the weight coefficient to a high spatial resolution (0.5°×0.5°)
6 add \( r \) to observed grid temperature data or multiply \( r \) by observed grid precipitation data

(2)

CCLM (Regional Climate Model, resolution: 0.46° × 0.46°)

Bias correction

Bias corrected CCLM
Hydrological model WASA

- Semidistributed, process-oriented and conceptual approaches

- Previous applications in other catchments in Central Asia
  Duethmann et al. (2014), *WRR*, 50(3)
  Duethmann et al. (2013), *HESS*, 17(7)

- Glacier geometry changes
  • Elevation changes: Δh-approach
    Huss et al. (2010), *HESS*, 14(5)
  • Glacier volume estimate based on Glabtop2
  • Area changes in the past: derived from two glacier inventories
Hydrological model: **SWIM** *(Soil and Water Integrated Model)*
Annual Temperature for the period 1961-2005

(a. observation; b. simulation; c. difference of simulation-observation; d. scatter plot of temperature-elevation dependence of simulation and observation)
Anomaly of Tem and Pre. for the period 1961-2005

(a) Temperature (°C)

(b) Precipitation (mm)

the observation and CCLM-simulation
Anomaly of Tem and Pre. for the period 1961-2005

The observation and CCLM-simulation
Result 1: Future changes in climate

Near term: 2016-2035

Changes of annual mean temperature (a~f) and precipitation (g~i) during 2016-2035 under 2.6, 4.5, 8.5 scenarios relative to 1986-2005 in the Indus River Basin (Bold line denotes 0 isoline)
Mid-21st century: 2046-2065

Changes of annual temperature (a-f) and precipitation (g-i) during 2046-2065 under 2.6, 4.5, 8.5 scenarios relative to 1986-2005 in the Indus River Basin (Bold line denotes 0 isoline)
Late-21st century: 2081-2100

Changes of annual mean temperature (a-f) and precipitation (g-i) during 2081-2100 under 2.6, 4.5, 8.5 scenarios relative to 1986-2005 in the Indus River Basin (Bold line denotes 0 isoline)
Comparison of probability density of summer temperature (a, b) and monsoon precipitation (c, d) for the periods 2046-2065(a,c) and 2081-2100(b,d) under RCP2.6, RCP4.5, RCP8.5 and the baseline period 1986-2005 over the Indus River Basin.
Result 2: Future changes in runoff

Near term: 2016-2035

Spatial distribution of runoff depth during 2016-2035 scenarios relative to 1986-2005 under 2.6, 4.5 and 8.5 scenario (Bold line denotes 0 isoline)
Spatial distribution of runoff depth during 2046-2065 scenarios relative to 1986-2005 under 2.6, 4.5 and 8.5 scenario (Bold line denotes 0 isoline)
Late-21st century: 2081-2100

Spatial distribution of runoff depth during 2081-2100 scenarios relative to 1986-2005 under 2.6, 4.5 and 8.5 scenario (Bold line denotes 0 isoline)
Result 3: Future changes in flood/drought distribution over Indus River Basin for the period of 2016-2035 compared with 1986 to 2005 mean under 2.6, 4.5 and 8.5 scenario

Near term: 2016-2035

Downscaled GCM

CCLM

RCP 2.6
RCP 4.5
RCP 8.5
Mean Flood/drought distribution over Indus River Basin for the period of 2046-2065 compared with 1986 to 2005 mean under 2.6, 4.5 and 8.5 scenario
Late-21st century: 2081-2100

Mean flood/drought distribution over Indus River Basin for the period of 2081-2100 compared with 1986 to 2005 mean under 2.6, 4.5 and 8.5 scenario.
The 27-year (1979-2005) averaged wind field at 850 hpa for the monsoon period over South Asia; the red line represents the wind speed (units: m/s); the color bar represents the wind direction (units: degree); zero degree is set to be west wind
The 27-year (1979-2005) averaged wind field at 850 hpa for winter and spring over South Asia; the red line represents the wind speed (units: m/s); the color bar represents the wind direction (units: degree); zero degree is set to be west wind.
Conclusion remarks

- Relative to baseline period (1986-2005), mean annual temperature (2015-2050) has a consistent increasing over the whole basin with greatest changes in the Upper Indus Basin under all three RCP scenarios. Changes of mean annual precipitation (2015-2050) are not distinct, but it has a significant spatial variation.

- Relative to baseline period (1986-2005), summer temperature (2015-2050) has a consistent increasing over the whole basin. Significant increasing changes are shown in the Upper Indus Basin. Further melting of glaciers will occur in the future across the source region.

- Except the weak increasing in spring precipitation (2015-2050) under RCP4.5 scenario, all scenarios have a decreasing trend. But the increasing of spring precipitation and winter precipitation at high altitudes will contribute to the accumulation of the glaciers and water resources. Summer precipitation almost increases over the whole Basin. It will increase the risk of flooding.

- The frequency and intensity of extreme temperature events and extreme precipitation events will increase under RCP scenarios during 2015-2050.