Climate Change Impact Assessment for Small Basins with 10-min Precipitation (P10M)

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Introduction & Motivation
Downscaling
GCM or Earth System Model (ESM)
Why up to 10 minute precipitation (P10M)?

Concentration time is sub-hourly for most of the small basins.
Study Area (Jinju)
Data Acquisition (ESM, Observation)

Abstraction of ESM precipitation for a interest weather station (Jinju)

Bias-correction of the abstracted ESM precipitation (daily)

Temporal downscaling of daily to P10M

Estimation of IDF from P10M data
Data Acquisition (ESM, Observation)
<table>
<thead>
<tr>
<th>Order</th>
<th>ESM name</th>
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<td>IPSL-CM6A-LR</td>
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<td>CanESM5</td>
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<td>MPI-ESM1-2-HR</td>
<td>12</td>
<td>INM-CM4-8</td>
<td>18</td>
<td>KACE-1-0-G</td>
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</table>
Bias-correction of the abstracted ESM precipitation (daily precipitation)
Quantile Delta Mapping of Daily Precipitation

\[ \hat{y}_{m,\text{fut}} = \frac{F^{-1}_0[F_{m,\text{fut}}(x_{m,\text{fut}})]]}{F^{-1}_{m,\text{base}}[F_{m,\text{fut}}(x_{m,\text{fut}})]]} \cdot x_{m,\text{fut}} = \delta \cdot x_{m,\text{fut}} \]
Annual Maximum Precipitation of Daily ESM Outputs/Obs

Jinju Station

Period: 1979-2015 (base), 2016-2100

Base Period: 1979-2015
P1 Period: 2016-2040
P2 Period: 2041-2070
P3 Period: 2071-2100
Temporal downscaling of daily to P10M
MPGA+NPD
Lee et al. (Under Review, Climate Dynamics)
Precipitation event extraction (PEE) from observations

M-day pseudo-population generation algorithm (MPGA)

1. Choose the first dry spell $DS_{*}^{(1)}$
   
   $DS_{*}^{(1)} = \text{DUnif}(DS_{1}^{(1)}, DS_{2}^{(1)}, \ldots, DS_{T}^{(1)})$

   $LR_{*}^{(1)} = \text{M-day} \times 144$ of 10 mins

2. Randomly select a rainfall event $E_{*}^{(1)}$
   
   $E_{*}^{(1)} = \text{DUnif}(E_{1}^{(1)}, E_{2}^{(1)}, \ldots, E_{T}^{(1)})$

   $LR_{*}^{(1)} = \text{M-day} \times 144$ of P10M

3. Select the following dry spell with KNNR as $DS_{*}^{(1)} = \text{KNN}(DS_{1}^{(1)}, DS_{2}^{(1)}, \ldots, DS_{T}^{(1)}, DS_{T+1}^{(1)}, \ldots, DS_{T+M-1}^{(1)})$
   
   $\text{dist} = |(EA_{*}^{(1)} - EA_{l}^{(1)})|$, $l = 1, \ldots, T$

4. Select the following well spell with KNNR as the step (3)

5. Repeat the steps (2) - (3) until $LR_{*}^{(1)}$ is filled

6. Repeat the steps (1) - (4) until all the population set is simulated
Verification of Temporal Downscaling to P10M

Annual Maximum Precipitation
Downscaled data

Downscaled P10M
Maximum for
SSP245
SSP585

Jinju Station
Future Period: 2016-20100
AMP mean and std of the downscaled P10M for 10min and 60min

(a) Base

10min

(b) SSP245

(c) SSP585

60min

AMP mean (mm)

AMP std (mm)

AMP mean (mm)

AMP std (mm)

 Năm

ACCESS-CM2
ACCESS-ESM1-5
ACCESS-ESM1-6
CNRM-CM6-1
CNRM-CM6-1
EC-Earth3
EC-Earth3
GFDL-ESM4
INM-CM4-8
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MRI-CGCM3
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MRI-ESM2-LR
NorESM2-LM
NorESM2-LM
UKESM1-0-LL
UKESM1-0-LL

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MIROC-ESL
MIROC6
MPI-ESM1-2-LL
MPI-ESM1-2-LL
MRI-CGCM3
MRI-CGCM3
MRI-ESM2-LR
MRI-ESM2-LR
NorESM2-LM
NorESM2-LM
UKESM1-0-LL
UKESM1-0-LL
Interquartile range (IQR) of mean AMP (unit: mm) for uncertainty

<table>
<thead>
<tr>
<th></th>
<th>Base</th>
<th>SSP245</th>
<th>SSP585</th>
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<tr>
<td>Temp. Downs</td>
<td>0.9404</td>
<td>0.6515</td>
<td>0.8434</td>
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<tr>
<td>ESMs</td>
<td>0.3495</td>
<td>8.8573</td>
<td>7.9498</td>
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4. Application

Estimation of IDF from P10M data
Base Period: 1979-2015
P1 Period: 2016-2040
P2 Period: 2041-2070
P3 Period: 2071-2100
Conclusion

- The current study proposed an enhancement of the temporal downscaling of ESM daily precipitation to P10M data for a small basin.

- Results indicate that the proposed temporal downscaling model (MPGA-NTD) can be suitable for temporally downscaling daily ESM precipitation data to P10M data.

- The IDF curves reflecting future climate scenarios, such as SSP245 and SSP585, can be used for the design of hydraulic structures for small basins, depending on their vulnerability and the lifespan of structures.
Thank you!!!