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1. Challenges of water management in South Korea

Annual mean precipitation of South Korea is around 1,300mm, with a high inter-annual and seasonal variability. Therefore, South Korea is highly susceptible to both floods and droughts.

Unfortunately, intensified impact of climate change aggravates water crisis over the country. Recently, we have experienced extreme droughts from 2013 to 2015 and floods in 2011, 2020.



< Annual mean precipitation (left) and monthly precipitation (right) >

2. How seasonal forecasts can help

The major goal of our study is to validate the Seasonal Forecasts whether it can suggest better water management (reservoir operation) performance in South Korea.



Skill assessment of Seasonal Precipitation Forecasts



From Seasonal Meteorological to Hydrological Forecasts



Assessing seasonal meteorological and hydrological forecasts across South Korea

3.1 Are Seasonal Precipitation Forecasts (SPFs) skillful?

ECMWF provides more skillful forecasts than other forecasting centres and it outperforms the climatology up to 2 months of lead times.



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	May	54	60	60	52	52	40	44	36	55	41	32	28	52	50	42	54	50	50	52	61	62	56	57
Wet	Jun	58	55	49	51	36	36	41	51	44	42	33	36	52	52	52	53	42	45	60	66	60	61	52
	Jul	54	44	48	42	42	40	50	31	32	26	25	25	52	56	46	41	40	40	38	40	46	41	40
	Aug	56	62	57	54	52	50	53	49	41	41	46	46	50	45	45	39	42	46	36	47	41	48	48
Wet-to-Dry	Sep	68	66	66	62	64	64	60	44	56	49	50	51	47	44	54	55	52	48	52	64	62	57	62
	Oct	60	68	70	66	66	76	50	60	56	56	53	65	71	55	70	63	55	56	57	41	48	48	55
vvet-to-Dry	Nov	57	61	65	46	63	55	57	57	48	51	50	45	70	66	64	57	60	66	53	55	52	48	52
Dry	Dec	70	62	52	52	51	46	46	53	31	34	56	57	53	55	52	50	57	48	45	55	54	46	50
		1 2 3 4 5 6 Lead time (months)						1	2 L	3 Lead time	4 e (months	5	6	1	2 L	3 .ead time	4 (months	5	6	1	2 L	3 .ead time	4 (months	5

< Overall skill (averaged chances of SPFs being more skillful than climatology) for 20 catchments and over 10 years (2011-2020) (a) before and (c) after bias correction, (b) represents Linear bias correction factors. >

SPFs show the highest skill during the Wet season of dry years, and better than climatology at all lead times.

The Dry season shows lower skill compared to climatology, however, the impact of bias correction is more significant during this season.

In general, the **skill** during the wet years is less skillful than during dry years.

For all lead times (month), the Wet season in dry years shows the highest level of skill.



< Overall skill of SPFs from ECMWF, averaged over 20 catchments for (a, b) entire years, wet (c, d) and dry (e, f) years. Top (bottom) row is before (after) bias correction. >



(a) SPFs are less skillful than climatology, except the forecasts from ECMWF with 1~2 months lead time. Therefore, **ECMWF** forecasts are the most skillful in South Korea.

(b) Bias correction (Linear scaling) factors show that there are **systematic seasonal** biases which overestimate (underestimate) the precipitation during the Dry (Wet) season.

(c) We also found that the application of **linear bias** correction has the potential to enhance forecast skill. The impact of bias correction is more evident during the Dry season.

Precipitation is the dominant driver of the Seasonal Hydrological Forecasts (SHFs) skill in South Korea.

Precipitation (red) contributes 90%, and temperature (blue), ET (orange) show similar level of contribution around 40% to the SHFs skill (CRPS).



The skill of Seasonal Precipitation Forecasts (SPFs) is directly mirrored into the Hydrological Forecasts skill

Both skills are generally coherent even in different seasons. In summary, improved precipitation forecasts lead to skillful hydrological forecasts.



(dashed lines) bias correction. >

4. Key Findings

- skill of **hydrological forecasts**.

5. What's next?

We plan to assess the value of seasonal forecasts for informing water management decisions. *Want to get in touch?* yongshin.lee@bristol.ac.uk

Try our Python based *SEAFORM* package to assess the skill of Seasonal Forecasts for your catchment of interest ! [SEAFORM, <u>https://github.com/uobwatergroup/seaform.git</u>]



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However, temperature plays more important role in the catchments with significant snow during the Dry season.

(There is no notable differences according to the lead times)

< Contribution rate (%) of each weather forcing (Prec.: red, ET: orange, Temp.: blue) to the skill of SHFs during all season (left) and Dry season (right) >

< Overall skill of SPFs (blue) and SHFs (red) before (solid lines) and after

• Seasonal Precipitation Forecasts provided by **ECMWF** are the **most skillful** in South Korea and linear bias correction was useful to improve the skill.

² Seasonal Precipitation Forecasts have the **highest skill** during the **Wet season** in dry years, thus, it might be mainly useful for anticipating dry years.

³ **Precipitation** is the **key variable** in Seasonal Hydrological Forecasts in South Korea, and the skill of **precipitation forecasts** is **directly propagated** into the

