Application of Flood Forecasting and Analysis Model (IFAS) for Wadi Flash Flood

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Flood early warning and timely evacuation is important for reducing loss of life and property against flash floods in Wadi systems. Forecasting the magnitude of flood event is useful to support evacuation during a flood. ICHARM has been studying flood forecasting and analysis models, including Integrated Flood Analysis System (IFAS) to help such action.
IFAS is an all-in-one package for flood forecasting. It contains GIS functions to create a rainfall-runoff model with interfaces to import rainfall data and display output results effectively in a short period of time. Simulation engine is based on a tank model which calculates river discharge. IFAS can utilize globally-available topographical datasets in case local information is insufficient for model creation, and import not only ground-based rainfall data but also satellite-based rainfall data (i.e., GSMaP, 3B42RT). Satellite-based rainfall includes bias, therefore several types of bias correction techniques are connected to IFAS, such as GSMaP-IF2, a bias correction function using ground observed rainfall developed by JAXA. IFAS is also extremely cost-effective; the software is downloadable for free at the ICHARM website.

Flood forecasting systems based on IFAS have been applied to some basins in the Asian regions, such as the Solo river basin in Indonesia or the Indus river basin in Pakistan. Along with practical use, IFAS can be a very useful training tool to learn about flood forecasting and warning, because the system lets the user experience a series of tasks necessary for the purpose on the interface, including the preparation of a runoff analysis model, the execution of runoff calculation and the presentation of its results, and the development and operation of a flood forecasting and warning system. ICHARM has provided IFAS training sessions for the development and operation of a flood forecasting and warning system for over 1,000 river engineers, researchers and students from about 50 countries. Up to recent years, IFAS has been mainly applied to relatively wet Asian countries. However, it is now expected to use its capacity for a wider range of areas and climate zones. In fact, an IFAS training session, “Training Workshop on Warning Systems and Geographical Information Systems (GIS) Courses,” was hosted by the UNESCO Cairo Office on December 15-16, 2015, for engineers of Egypt, Sudan, Yemen and Jordan. This was the first case of large-scale IFAS training ever held for African engineers and drew a great deal of media attention.

Applicability of IFAS on flush flood forecasting was tested in Gash Wadi on upper Nile and Samail Wadi in Oman. Flush floods occur at Kassala point in Sudan, Gash Wadi. Most of catchment area of Kassala is in Eritrea, then GSMaP is useful for simulation at Kassala. Several flood peaks in 2010 were simulated properly by IFAS even with no ground observatory. Also, bias corrected GSMaP using ground observed rainfall was applied to simulation on Samail Wadi in Oman and showed good performance. These result suggests effectiveness of IFAS on flush flood forecasting in insufficiently-gauged area in Wadi systems.

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Campas El Gouna, Egypt

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Objectives

Flood early warning and timely evacuation is important for reducing loss of life and property against flash floods in Wadi systems

Applicability of IFAS (Integrated Flood Forecasting System) on flush flood forecasting was tested

1. Wadi Gash (upper Nile)
2. Wadi Samail (Oman)

Bias corrected GSMaP (Satellite based rainfall by JAXA) was applied

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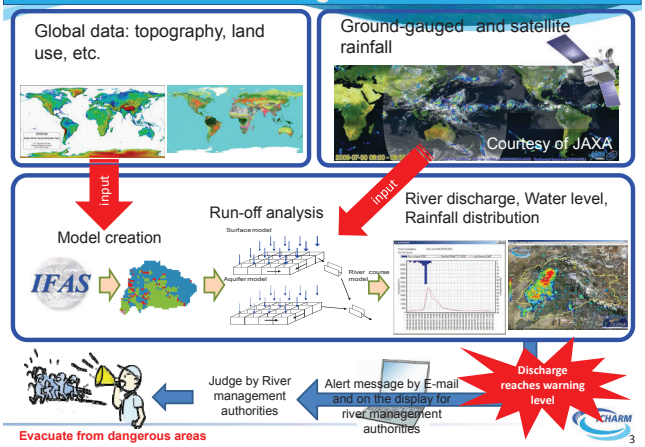
IFAS for flood forecasting



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Application of IFAS for flood forecasting system

Country	Basin (Area)	Installment	Model	Project	Remarks
Indonesia	Solo (16,100km²)	January 2013	IFAS	ADB	
Pakistan	Indus (400,000km²)	June 2014	IFAS + RRI	UNESCO	Phase Ⅱ (2016-)
Philippines	Cagayan (27,280km²)	June	IFAS	ADB	
Malaysia	Kelantan (11,900km²)	2015	IFAS	JST-JICA SATREPS	
Vietnam	Thai Bin (27,200km²)	2015	IFAS	JICA	

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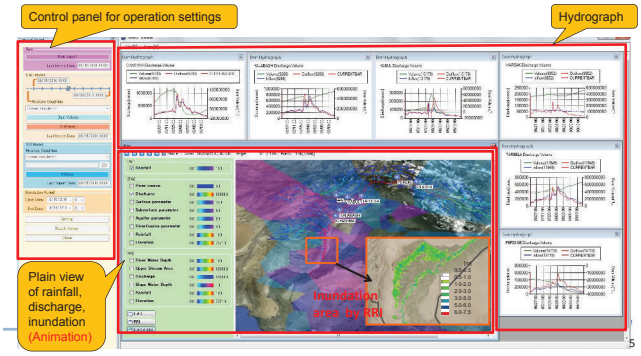
User friendly display of Indus-IFAS

INPUT DATA :
- Rainfall data (ground- gauges, GSMaP and forecasted)
- Real-time observed discharges

OUTPUT DATA:
- Rainfall distribution maps
- Hydrographs at specified locations
- Inundation extents in mid-low Indus



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IFAS training

More than 1000 participants from 50 countries

ASEAN, IFAS training（JICA）

Arab region Wadi flush flood training（UNESCO）

October 5-9, 2015
AHA center (Jakarta, Indonesia)

December 15-16, 2016
GUC (Egypt, Cairo)

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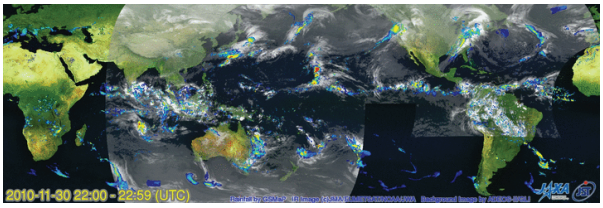
Satellite based rainfall by JAXA

GSMaP_NRT : Near realtime product
(0.1 degree grid, hourly, 4 hours delay)
GSMaP_MVK : Standard product
(0.1 degree grid, hourly, 3-4 days delay)
GSMaP_Gauge : Gauge adjusted product
(0.1 degree grid, hourly, 3-4 days delay)



World rainfall map from GSMaP

Data:(http://sharaku.eorc.jaxa.jp/GSMaP/index.htm) made by JAXA

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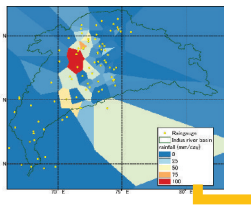
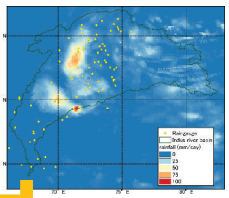
Bias correction of satellite rainfall（GSMaP_IF2、JAXA）

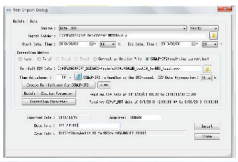
Ground

GSMaP_NRT

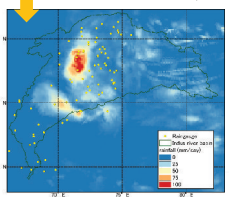


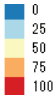


Setting on IFAS



Corrected GSMaP（GSMaP_IF2）





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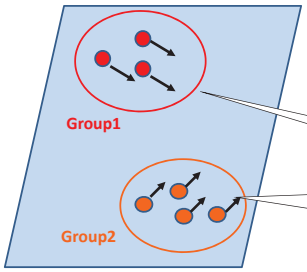
GSMaP-IF2 (JAXA, NTT-DATA)

Geo-location correction (Shift)

✓Geo-location error in GSMaP is corrected based by shifting based on the comparison between GSMaP rainfall pattern and ground rainfall pattern.

GSMaP accumulated rainfall



Correlation and Difference

Station ID	*Ground*	*GSMaP*
000001	*30*	*10*
000002	*100*	*50*
000003	*20*	*7*
…	*…*	*…*

Geo-location errors are corrected in each defined group separately.

Courtesy of JAXA

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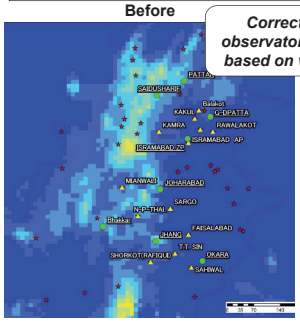
GSMaP-IF2 (JAXA, NTT-DATA)

Rainfall correction (Scale & Offset)

Formula

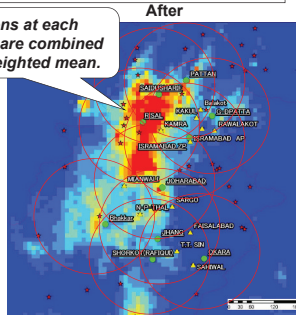
High Rainfall : *(Corrected rainfall) = (Original rainfall) * (Scale factor) * (Weight)*
Small Rainfall : *(Corrected rainfall) = (Original rainfall) + (Offset factor) * (Weight)*

Before



Corrections at each observatory are combined based on weighted mean.

After



Courtesy of JAXA

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Application to Wadi Gash

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Wadi Gash (Sudan)

Basin area (upper Nile, blue):
about 250 thousands km2
Basin area upper Kassala, red):
about 21 thousands km2
Population of Kassala:
about 400,000 (2009)
Estimated rainfall:
600 mm/year

Source: Urgent capacity development for managing natural disaster risks of flash floods, 2015

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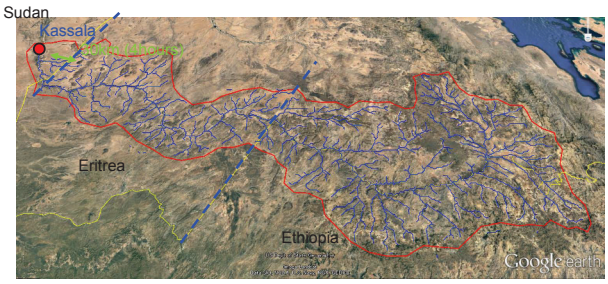
IFAS simulation area



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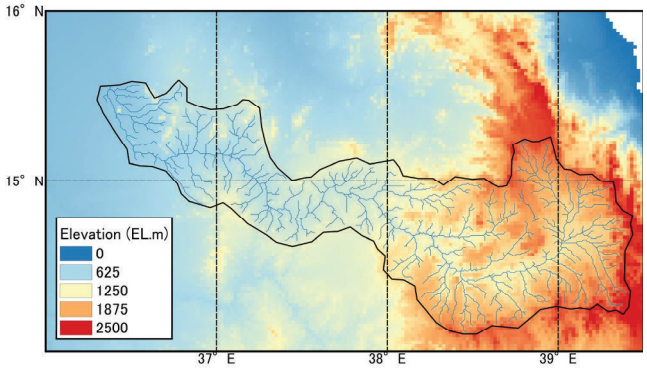
River course model



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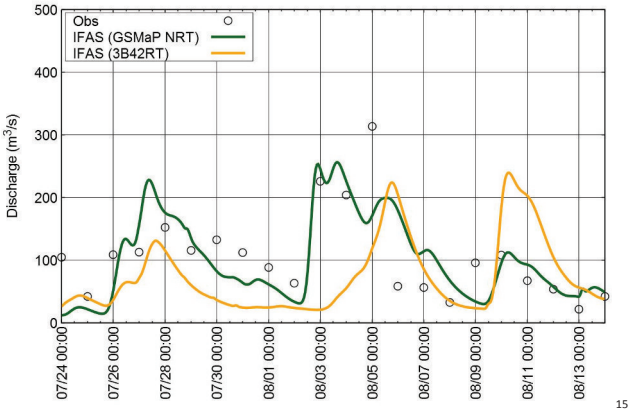
IFAS simulation result (July 24- Aug 14, 2010)



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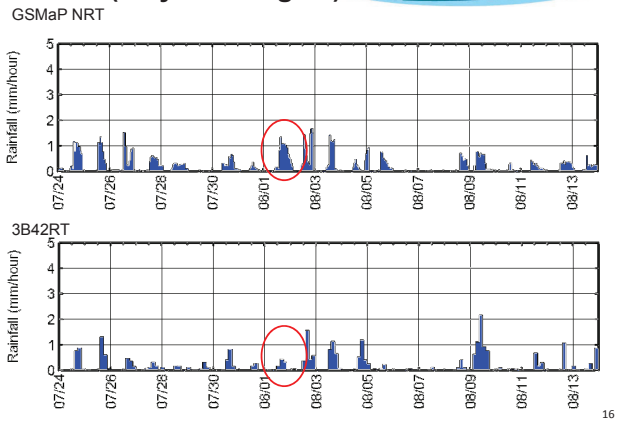
Rainfall (July 24- Aug 14)



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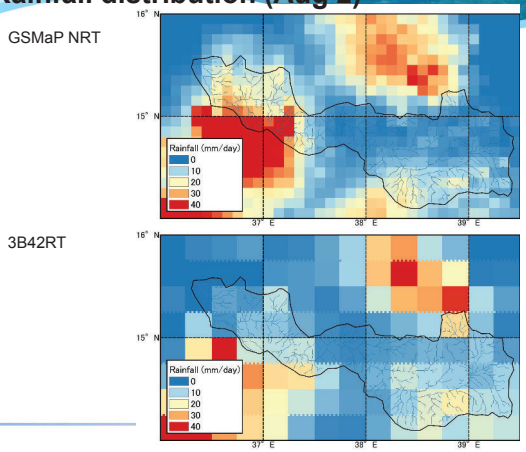
Rainfall distribution (Aug 2)



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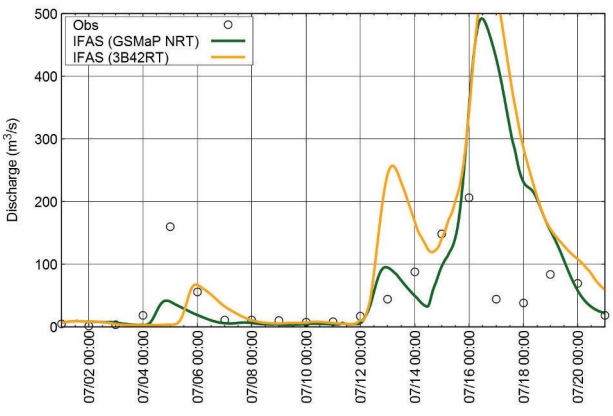
IFAS simulation result (July 1- July 21)



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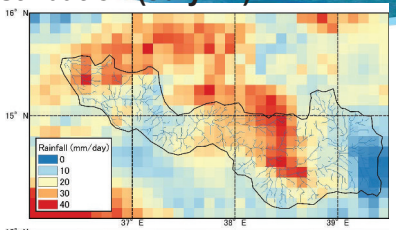
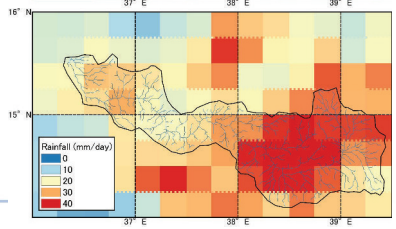
Rainfall distribution (July 14)

GSMaP NRT



3B42RT



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Application to Wadi Samail

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Wadi Samail (Oman)

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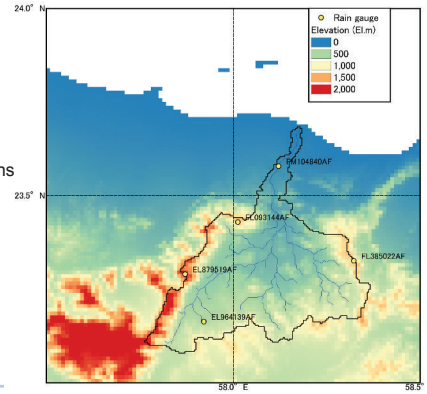
IFAS simulation model for Wadi Samail

Basin area:
about 1,700 km2

Rain gauges: 5 stations



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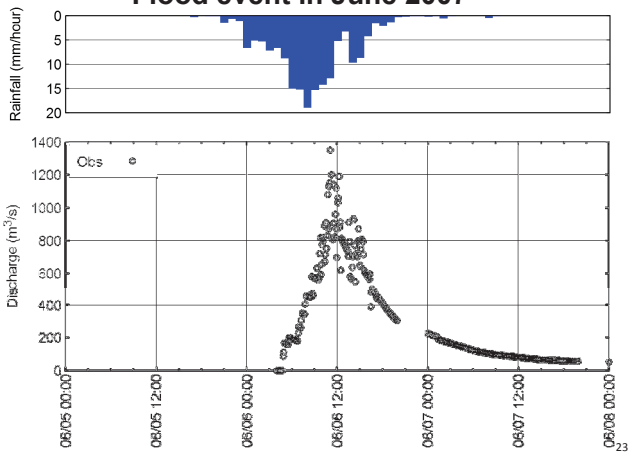
Flood event in June 2007



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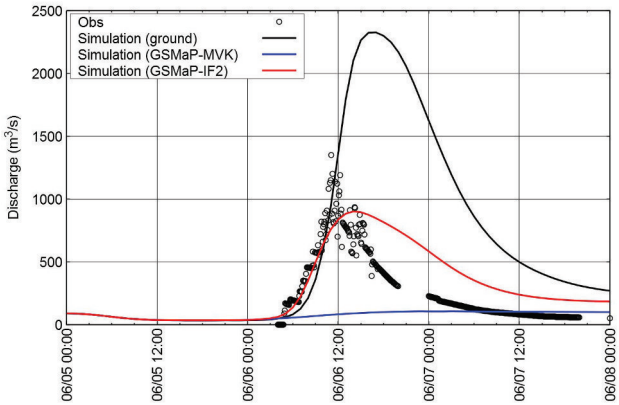
Simulation (Default parameter)



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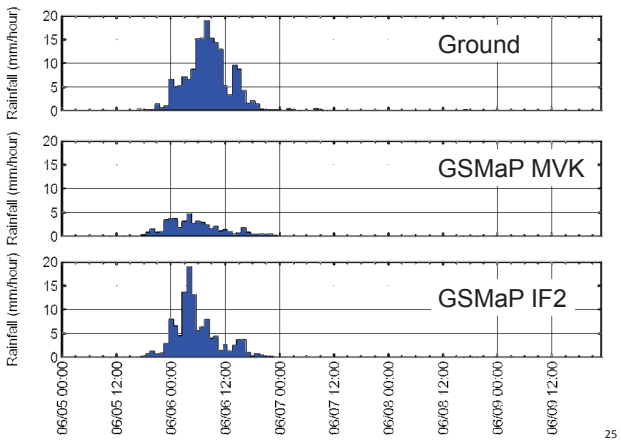
Basin average rainfall



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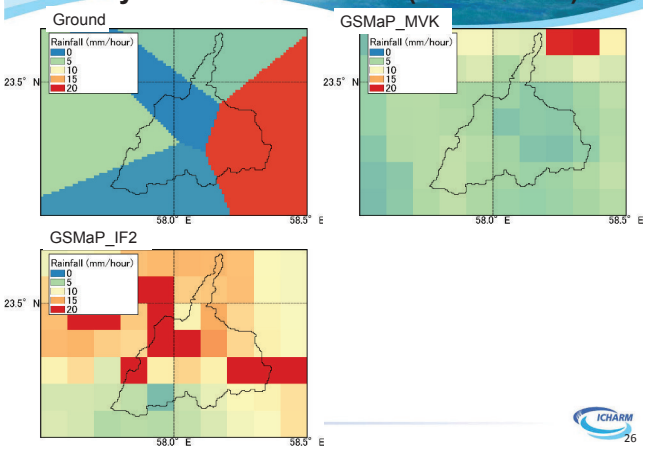
Daily rainfall distribution (June 6 4:00)



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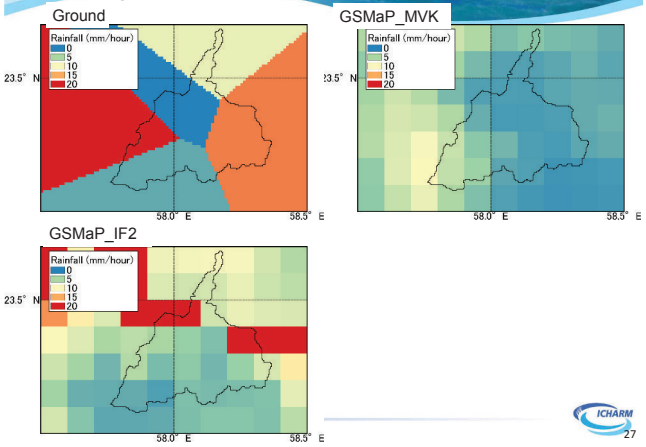
Daily rainfall distribution (June 6 5:00)



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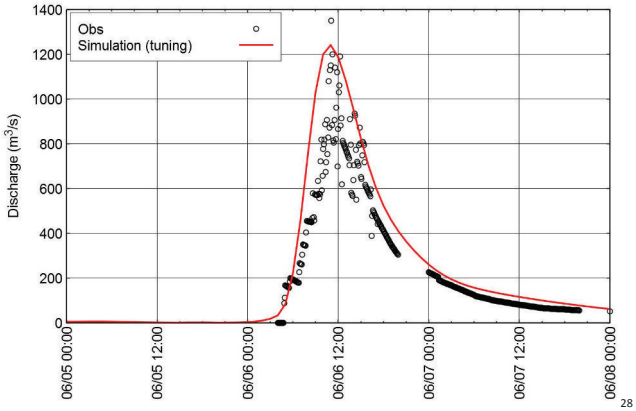
Simulation (Calibration, GSMaP-IF2)



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Summary

- ICHARM has been studying flood forecasting and analysis models, including Integrated Flood Analysis System (IFAS)
- Result suggests usefulness of IFAS on flush flood forecasting in insufficiently-gauged area in Wadi systems
- Bias correction technique of satellite based rainfall was effectively applied

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