



Central Asia Regional Flash Flood Guidance System: Introduction to CARFFGS, Design Philosophy, and FFGS Products

Hydrologic Research Center
15 SEPTEMBER 2015

CARFFG Steering Committee Meeting
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Ari Posner – Land Slides/EOS Data Evaluation

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Cris Spencer – IT Engineering/Programming

Jason Sperflage – IT Systems Engineering



What Do We Call Flash Floods

WORLD METEOROLOGICAL ORGANIZATION (WMO):

“ A flood of short duration with a relatively high peak discharge ”

AMERICAN METEOROLOGICAL SOCIETY (AMS):

“ A flood that rises and falls quite rapidly with little or no advance warning, usually the result of intense rainfall over a relatively small area ”

A local hydrometeorological phenomenon that requires:

1. BOTH Hydrological and Meteorological expertise for real time forecasting/warning
2. Knowledge of local up to the hour information for effective warning

*Usually, flow crest is reached within **6 hours** of causative event
(Only consider < **2000km²**).*

Natural Causes of Flash Floods

- Intense rainfall from *slow moving* thunderstorms or tropical systems
- Orographic rainfall in *steep* terrain
- Soil *saturation or impervious* land surfaces
- Hydraulic *channel* properties
- Sudden release of impounded water
(natural dam or human-made dam)

The Need

Flash Floods are very significant disasters globally ...

- Highest number of deaths per people affected

... **BUT** there are no discernible trends for loss reduction

- No flash flood warnings for vast populated areas of the world
- Lack of local expertise and of regional cooperation
- Little in situ data in small regions
- Large-river flood-warning strategies ineffective for flash floods

Large River Flooding vs. Flash Flooding

LRF

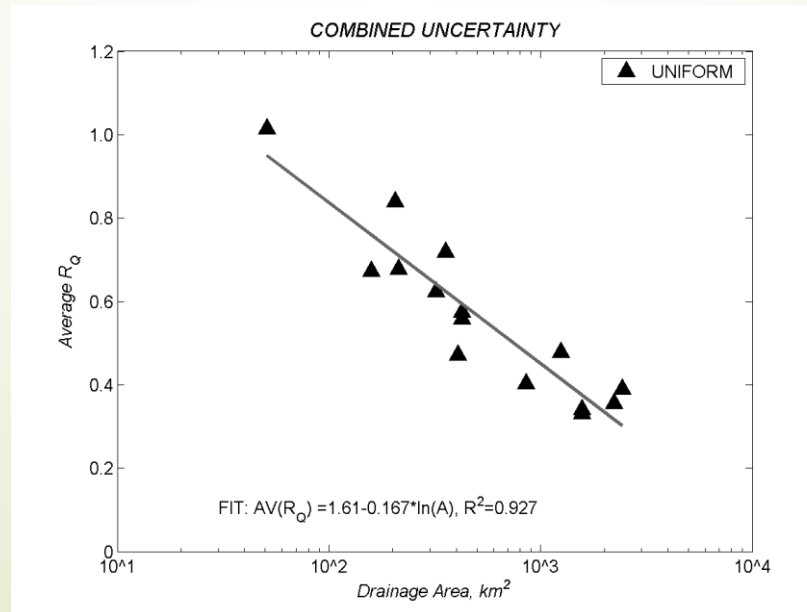
- *Catchment response affords long lead times*
- *Entire hydrographs can be produced with low uncertainty with good quality data*
- *Local information less valuable*
- *A hydrologic forecasting problem primarily*
- *Affords time for coordination of flood response and damage mitigation*

FF

- *Catchment response is very fast and allows very short lead times (< 12hrs)*
- *Prediction of occurrence is of interest*
- *Local information is very valuable*
- *A truly hydro-meteorological forecasting problem*
- *Coordination of forecasting and response is challenging over short times (Careful Planning Needed)*

Operational Approaches for Flash Flood Warning

1. Site Specific (data rich catchments with special forecast interests)
2. Area-wide modeling with remotely sensed data and global datasets
 - 2a. Flash Flood Guidance (data sparse regions for public watches and warnings of flash flood occurrence)
 - 2b. Full Distributed Hydrograph Modeling (in regions with good data when entire hydrographs are needed) (High Uncertainty on smaller scales)



5 BASINS
3 LOCATIONS/BASIN
27 EVENTS/LOCATION

Importance of Soil Water on Flash Flooding in addition to rainfall rate

Example from south-central United States – Summer Convection

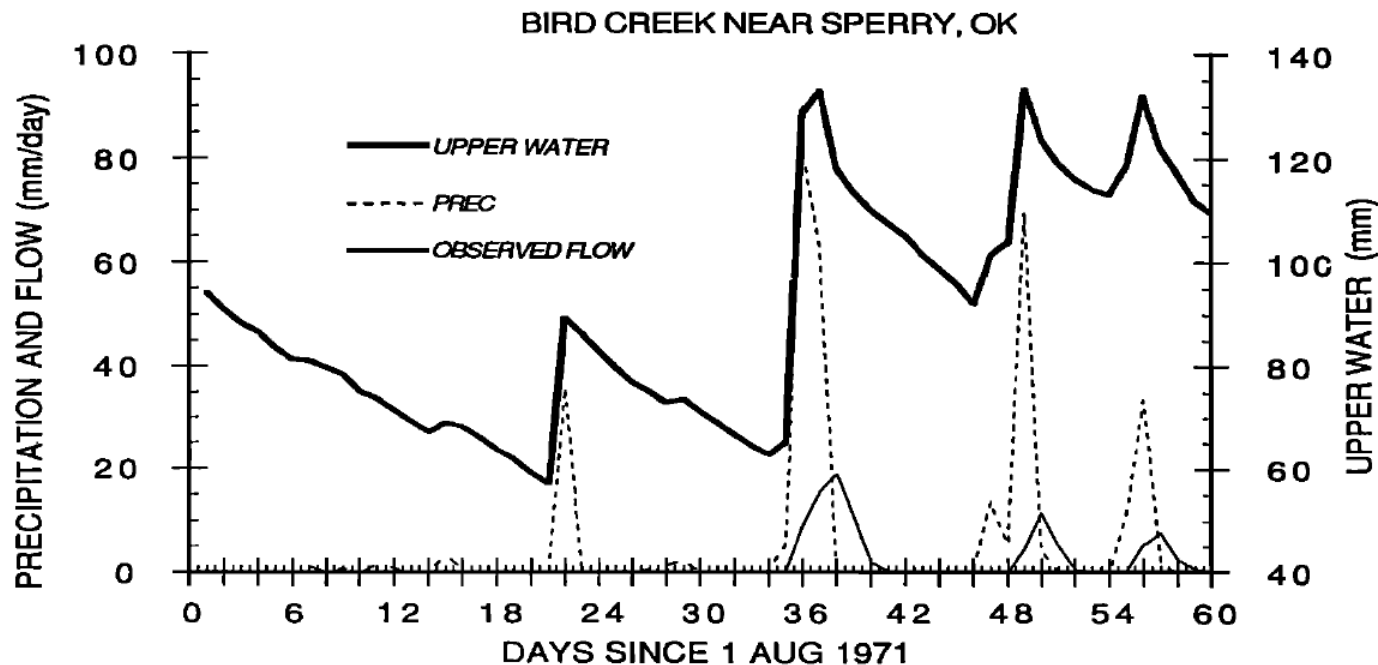
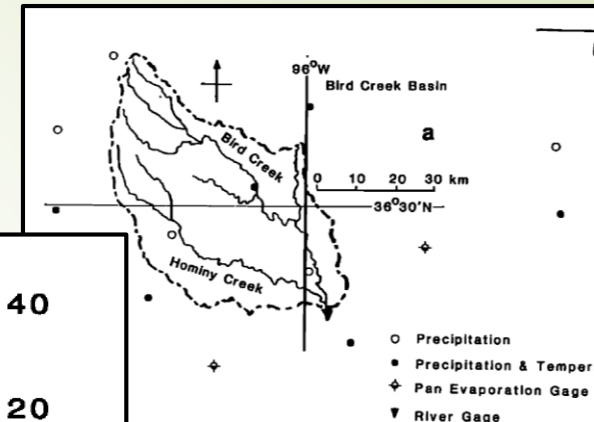
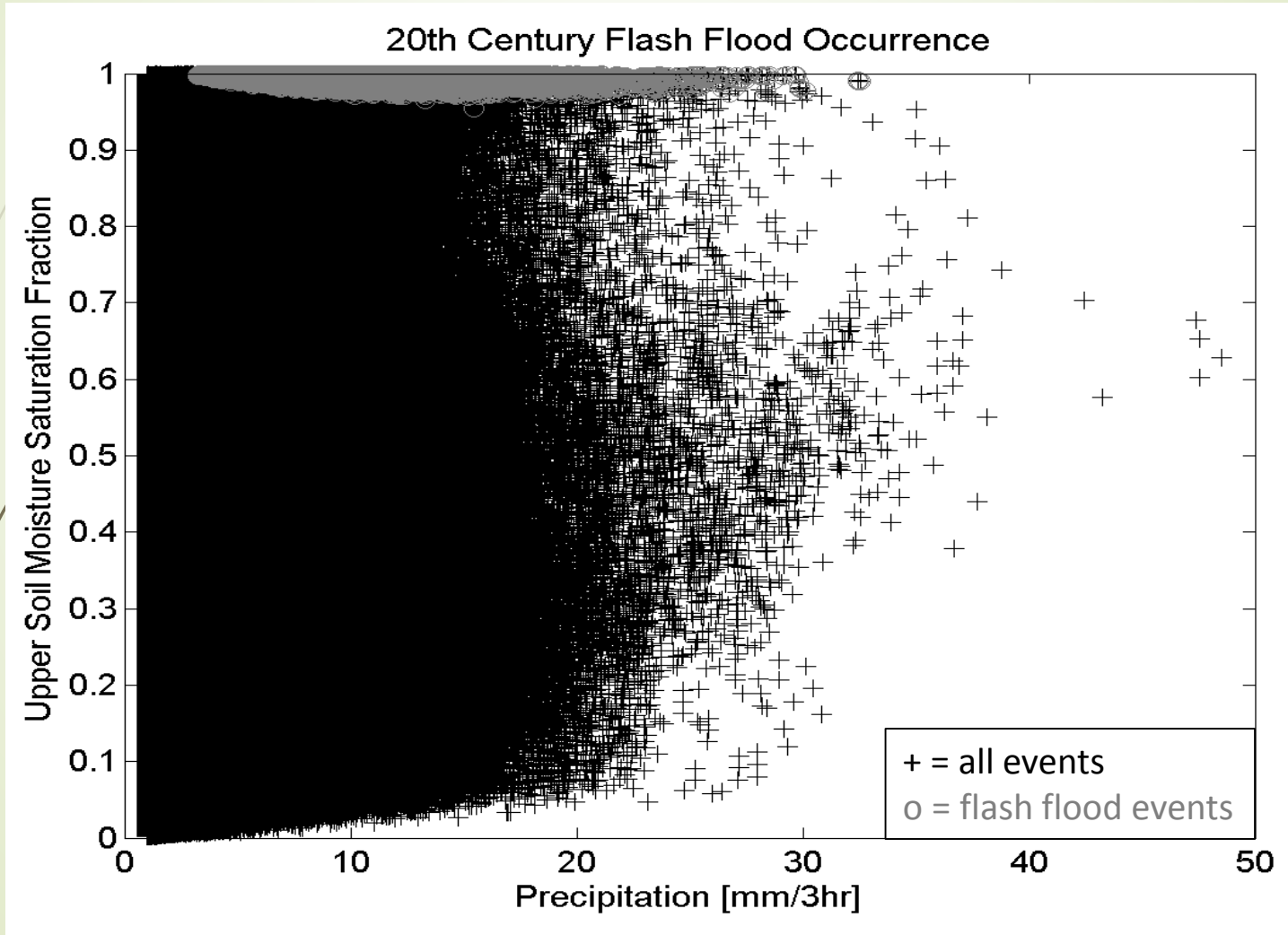


Figure 2. Daily values of rainfall rate (dashed line), flow rate (solid line), and upper soil water (heavy solid line) for Bird Creek near Sperry, Oklahoma, for August and September 1971. Rainfall and flow rates are in millimeters per day and are read on the left ordinate axis. Upper water is in millimeters and is read on the right ordinate axis. Upper water capacity is 135 mm.

Georgakakos et al.
WRR 31(3), 210-220,
1995.

Importance of Soil Water on Flash Flooding in addition to rainfall rate

Example from southwestern United States – Winter Mediterranean Rain



Modrick & Georgakakos
JHRS 3, 312-336, 2015

Examples of Soil Texture and Infiltration Rates

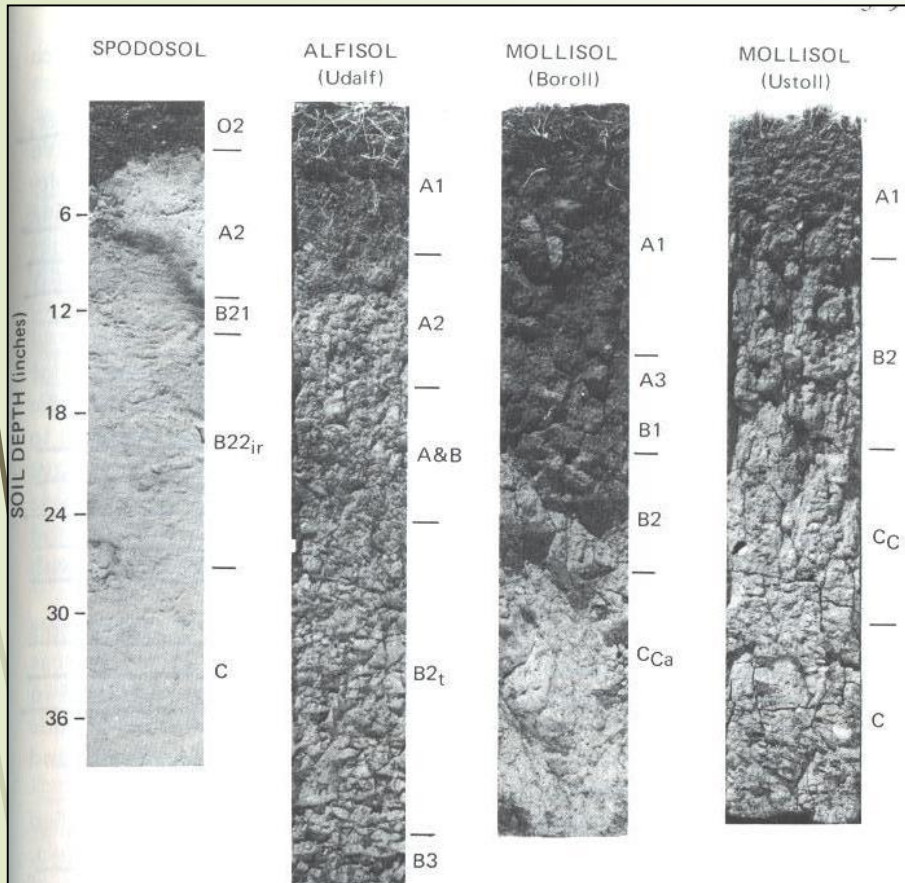


FIGURE 12:8. Monoliths of profiles representing four soil orders. The suborder names are also shown (in parentheses). Note the spodic horizons in the Spodosol characterized by humus (h) and iron (ir) accumulation. In the Alfisol is found the illuvial clay horizon B2_t. The thick dark surface horizon (mollic epipedon) characterizes both Mollisols. Note that the zone of calcium accumulation (C_{Ca}) is higher in the Ustoll, which has developed in a dry climate.

Profile	Depth (cm)	Horizon Description	Upper Limit Infiltration Rate (cm/day)
RP-1	10	A/B	5,760
	40	C/Bt Clay in fractures	26
	80	C/Bt Clay in fractures	19
RP-2	40	Bt2	9
	80	Cox/t Saprolite with clay in fractures	55
RP-3	40	Cox/t Saprolite with clay in fractures	180
	80	Cox/t Saprolite with clay in fractures	160
RP-4	10	Bw/C Disturbed horizon	14,400
C-1	10	Bt	60
	120	Saprolite	180
	300	Saprolite	85
C-2	50	Bt	85

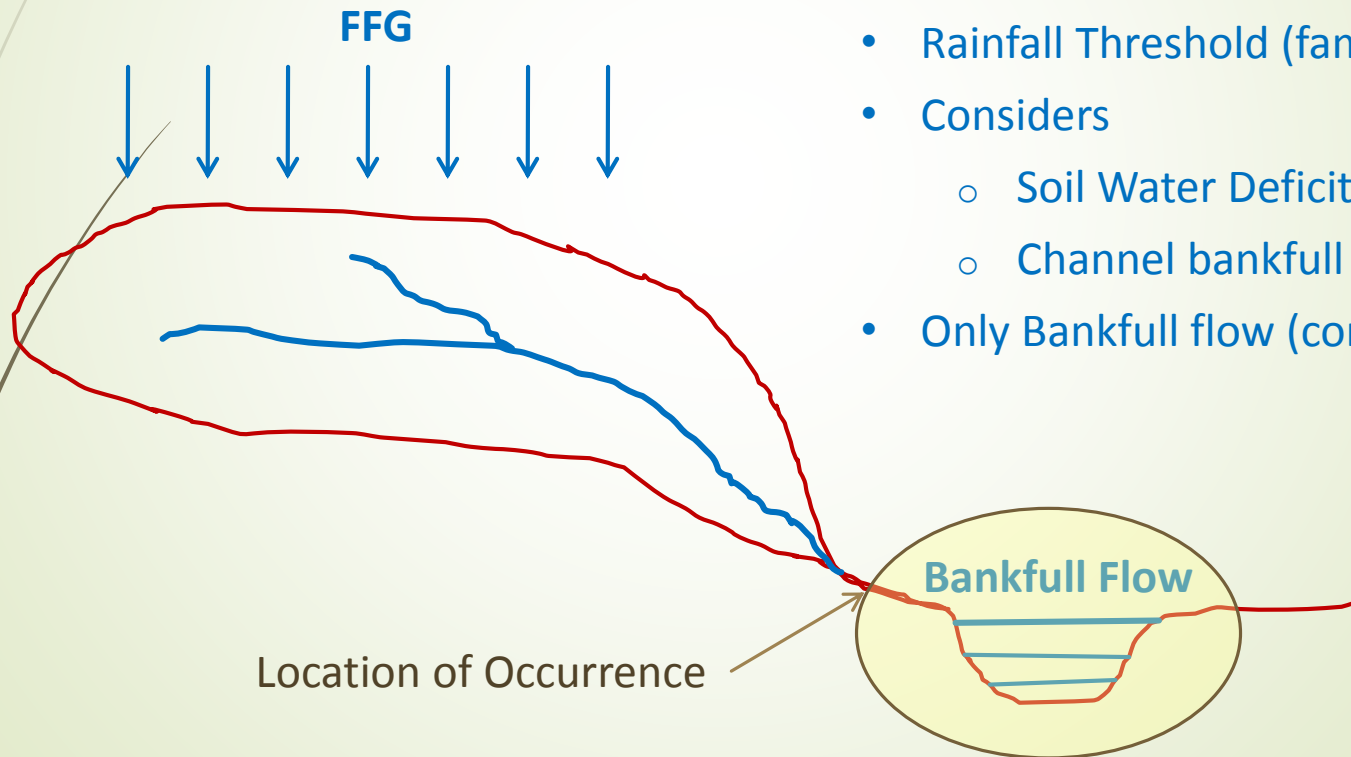
Harmon, R.,S., (ed.) 2005: The Rio Chagres, Panama. Springer, The Netherlands.

**Maximum Daily Rainfall Observed:
187 cm/day – Reunion Island**

Soils can infiltrate significant precipitation rates and amount.

FFG Fundamental Concepts

Flash Flood Guidance (FFG): defines the amount of **rainfall** of a given duration and over a given catchment that is just enough to cause **flooding conditions** at the outlet of the draining stream

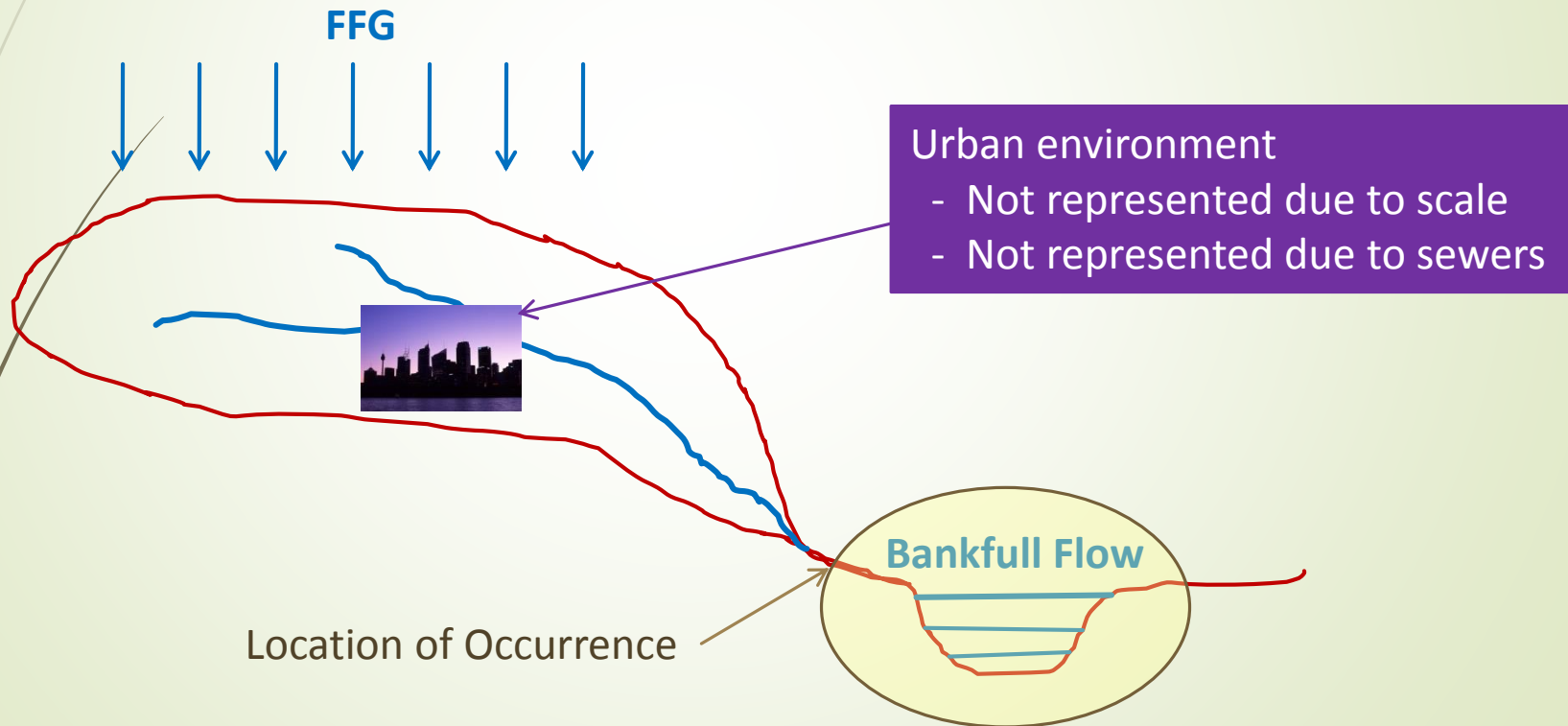


- Rainfall Threshold (familiar concept)
- Considers
 - Soil Water Deficit
 - Channel bankfull storage
- Only Bankfull flow (conservative)

Threshold exceedance concept to estimate occurrence only!

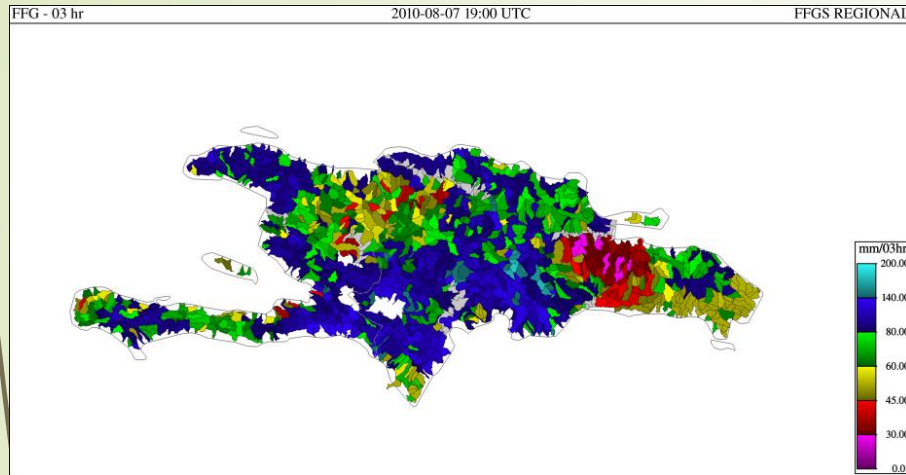
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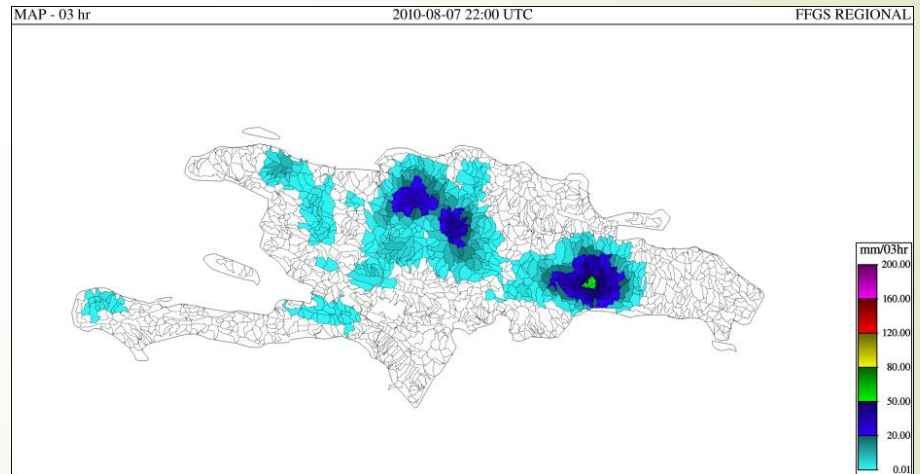
Threshold exceedance concept to estimate occurrence only!

Regional Application of Flash Flood Guidance

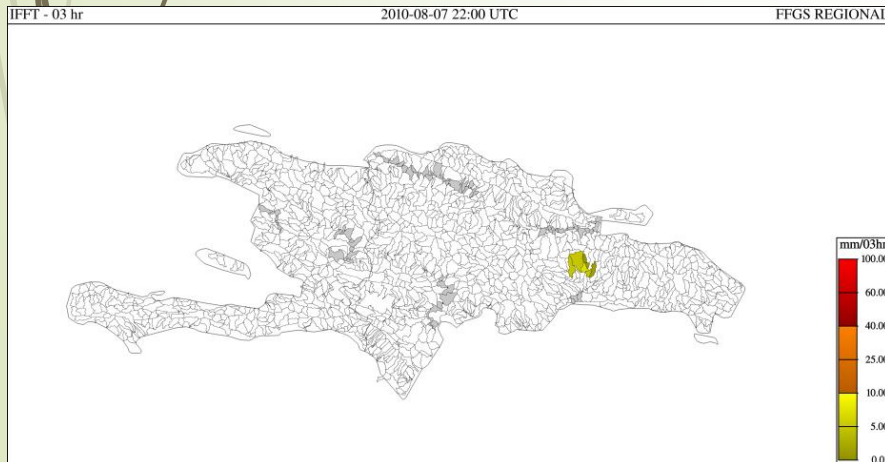


(1) Current Estimate of FFG for small watersheds

(2) Compare with precipitation (obs or forecast)



(3) Identify areas with $P > FFG$



[Example of the HDRFFG System]

The Global Initiative for Flash Floods

The **Hydrologic Research Center (HRC)** has signed a joint Memorandum of Understanding to implement regional flash flood guidance systems worldwide with:

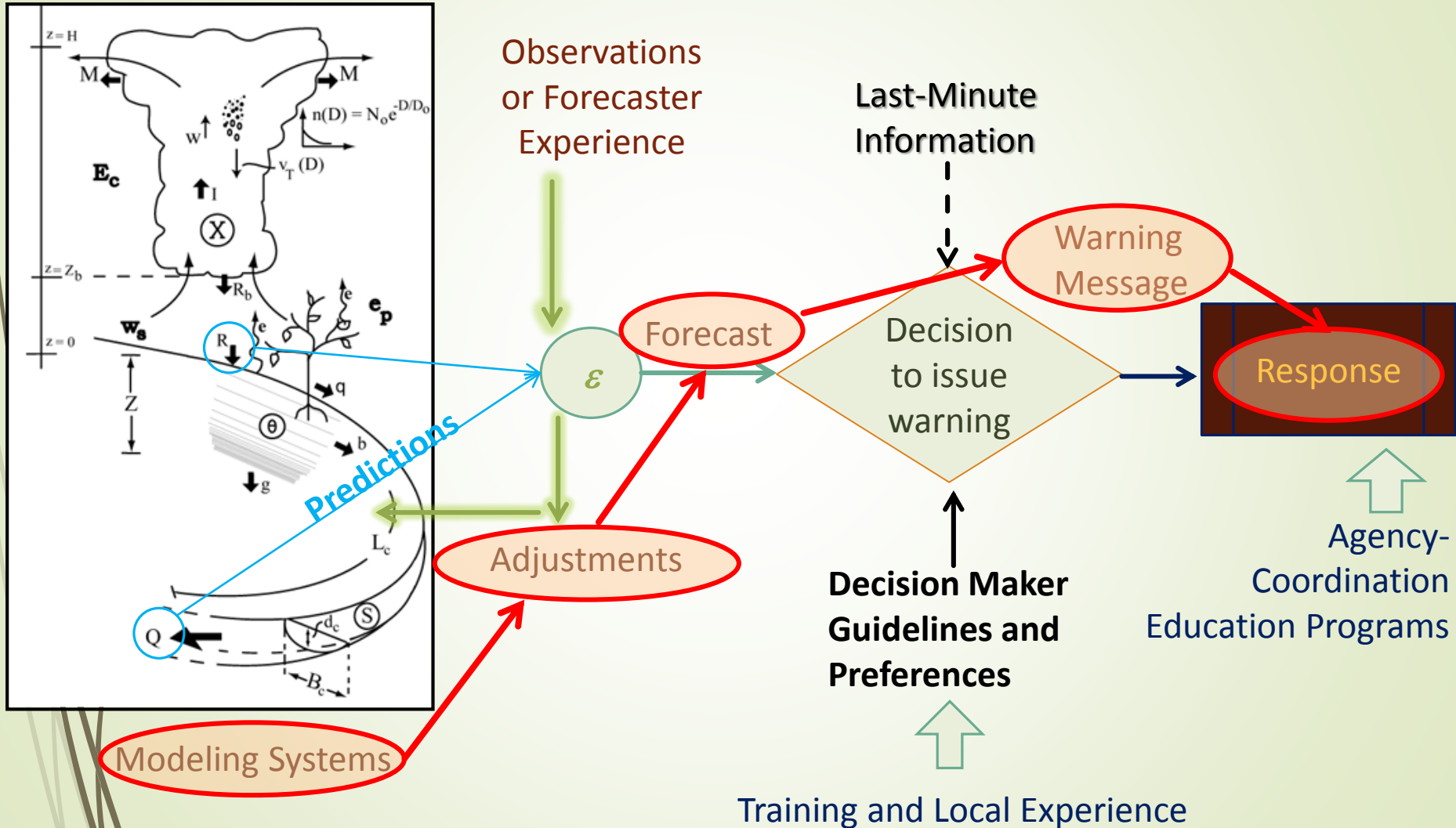
the United Nations – World Meteorological Organization (WMO)

the U.S. Agency for International Development/Office of U.S. Foreign Disaster Assistance (USAID/OFDA)

and the U.S. National Oceanic and Atmospheric Administration (NOAA).

http://www.wmo.int/pages/prog/hwrrp/flood/ffgs/index_en.php

Integrated Systems for Real-Time Warning



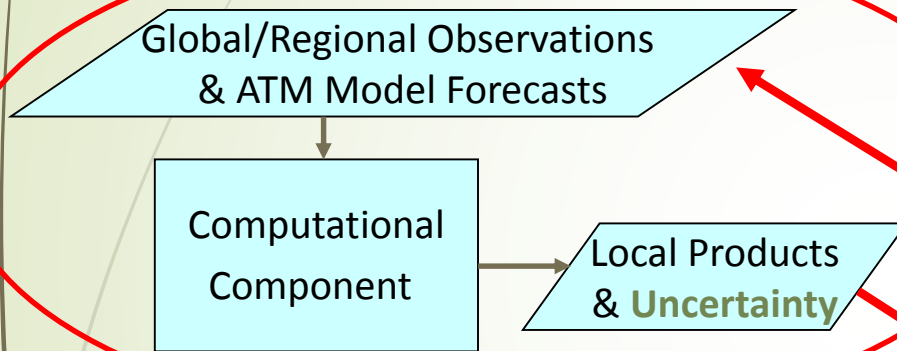
FFG Research and Development History

- ❑ **1970-1988:** US NWS Produces **FFG statistically** for each River Forecast Center. Also, **research** in adaptive site specific FF prediction systems.
- ❑ **1988-1993:** IIHR/HRC develop **physically consistent FFG formulations based on GIS** and create the first operational codes for US NWS
- ❑ **1993-2005:** HRC continues **research** in various aspects of the FFG process and system (sparsely gauged basins and uncertainty issues, forcing and models). The development of **prototype regional systems** using FFG is proposed and accepted in work plan of **WMO CHy Working Group on Applications (2002-2003)**
- ❑ **2004:** The **Central America Flash Flood Guidance System becomes operational** (serves 7 countries in CA)
- ❑ **2008:** WMO, USAID, NOAA, HRC sign a quad-part Memorandum of Understanding to collaborate in the development of a global flash flood guidance system (currently in second 5-year phase)
- ❑ **2015:** Begin development for Central Asia Regional System

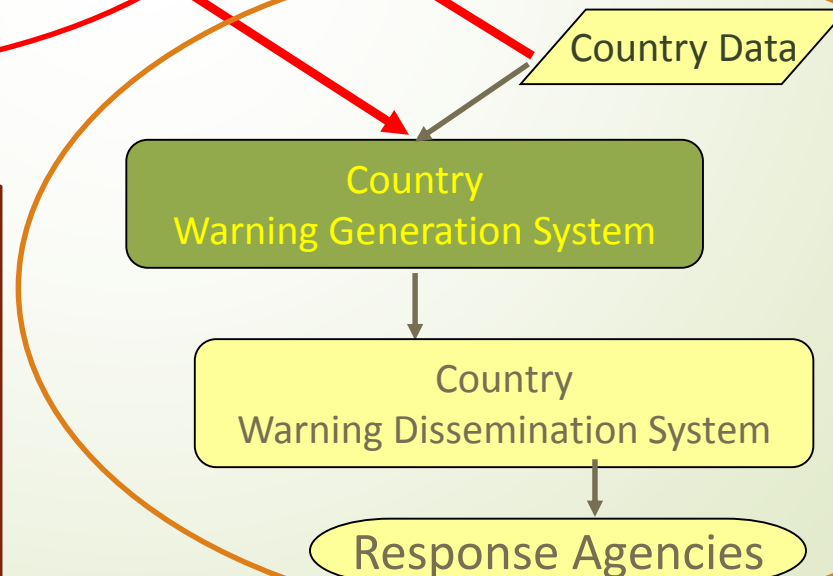
Flash Flood Guidance Systems

From Global Data and Regional Hydrometeorology to Country Data and Warnings

Regional Center: Computational Core



Country NMHS: Adjustments and Warning Core



Decisions are made with multiple datasets and under uncertainty.

There is a need to modify the products of the regional system by country forecasters and have capability for estimating consequences to local flash flood potential.

Introduction to FFGS Products

Flash Flood Guidance System Forecaster Interface

FFGS forecaster interface was designed to provide visual overview of current (and historical) system products. [Example of the BSMEFFG System]


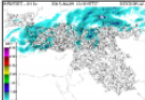
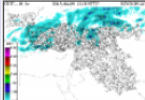

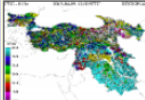
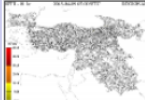

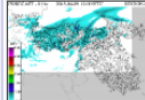



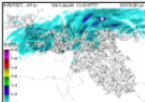
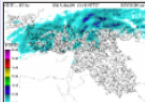


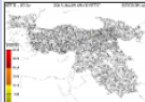
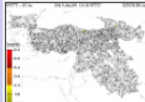
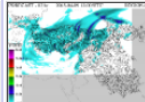
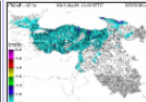
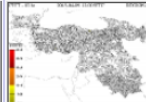
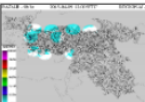
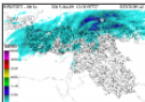
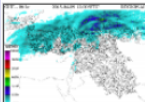

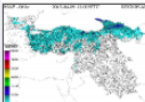
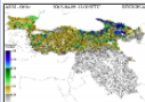
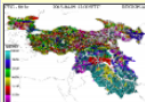
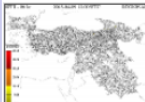
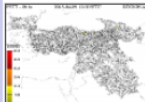
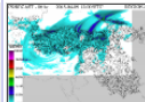


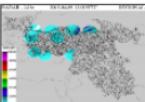
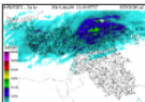
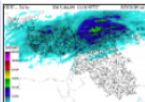

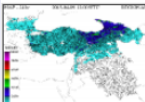
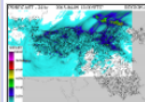
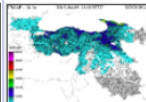
BSMEFFG - Black Sea Middle East Flash Flood Guidance System

Current Date: 2015-04-28 18:56 UTC Nav Date: 2015-04-09 12:00 UTC

Year: 2015 Month: 04 Day: 09 Hour: 12 REGION: REGIONAL Submit

-1 Month -1 Day -6 Hours -1 Hour +1 Hour +6 Hours +1 Day +1 Month

Prev 6-hr Interval (06 UTC) Reset to Current Next 6-hr Interval (18 UTC)

DT	RADAR Precipitation	MWGHE Precipitation	GHE Precipitation	Gauge MAP	Merged MAP	ASM	FFG	IFFT	PFFT	ALADIN Forecast	FMAP	FFFT
01-hr	 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view		 2015-04-09 12:00 UTC Text: view		 2015-04-09 12:00 UTC Text: view	 2015-04-09 07:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view
03-hr	 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view		 2015-04-09 12:00 UTC Text: view		 2015-04-09 12:00 UTC Text: view	 2015-04-09 09:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view
06-hr	 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view
24-hr	 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view					 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view	

Composite Product: [text](#), [CSV](#), [CSV/T](#)

SFTP data transfer (requires SFTP Client): [EXPORTS/REGIONAL/2015/04/09](#)

Surfmet Gauge Observations at 2015-04-09 12:00 UTC

Station Identification Station Name Accumulated Precipitation (mm/6hr) Average Temperature (C) Snow Depth (cm) Snow Cover (Index) Region Latitude Longitude Elevation Enable Precipitation Flag Enable Temperature Flag

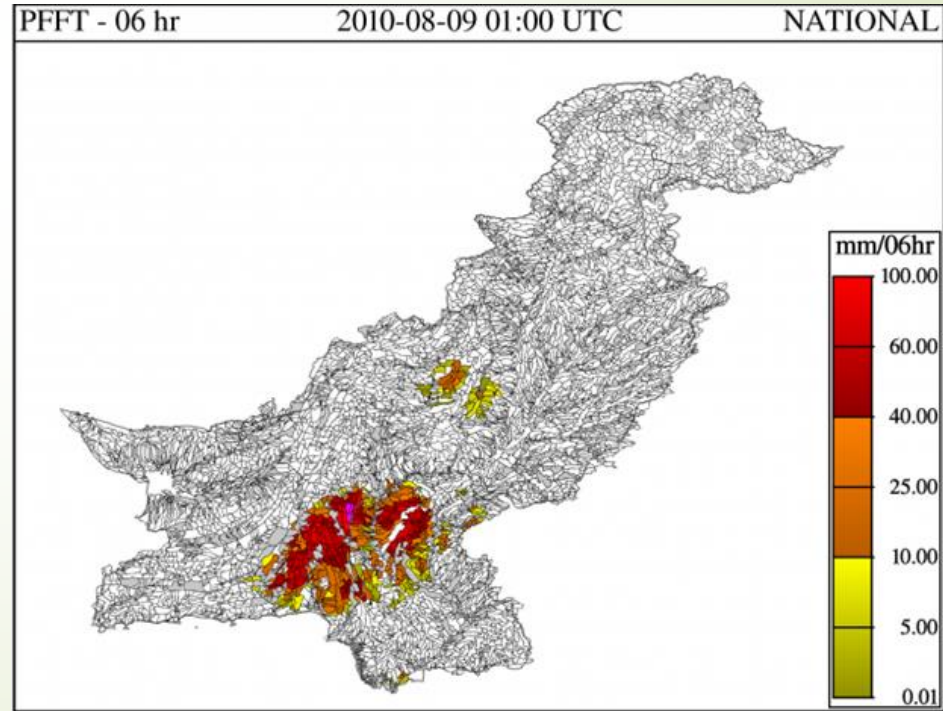
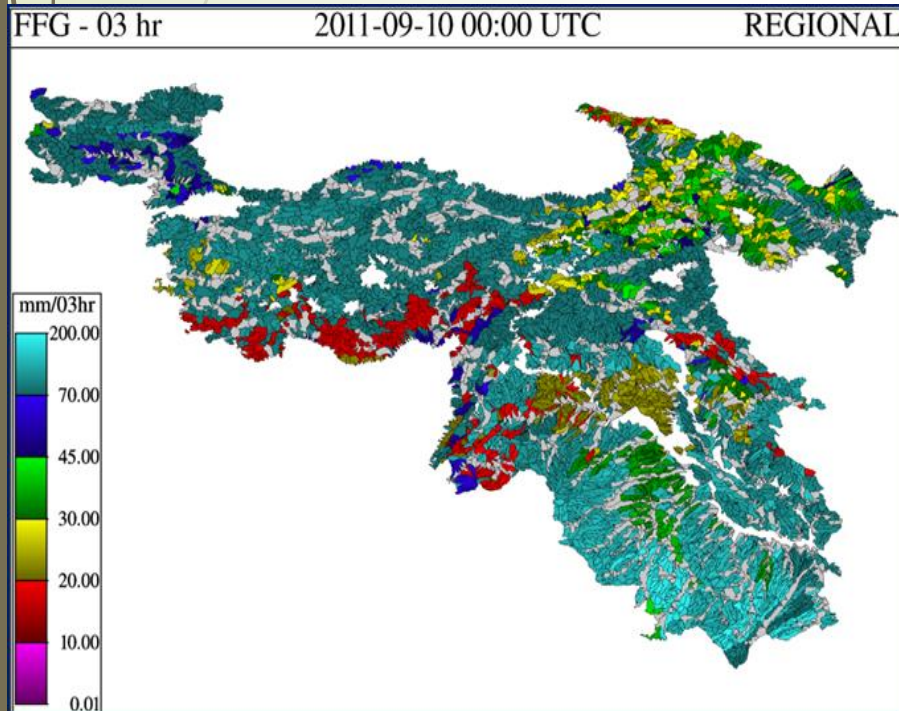
FFG System Products

DIAGNOSTIC

Flash Flood Guidance
Average Soil Moisture
Observed Precipitation

PROGNOSTIC

Forecast Precipitation (FMAP)
Flash Flood Threat

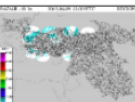
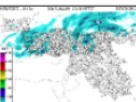
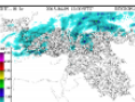

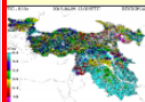
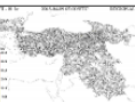
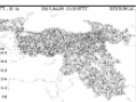
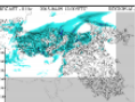
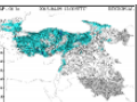
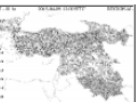

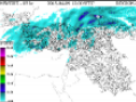
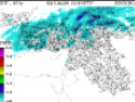


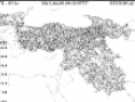

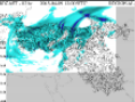


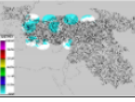
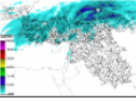
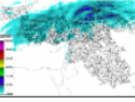

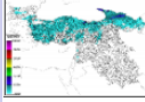
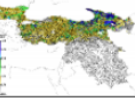

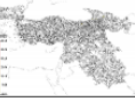
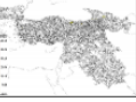
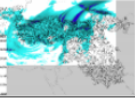
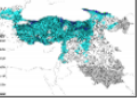
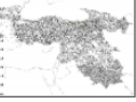
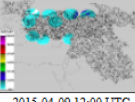
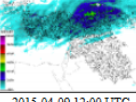
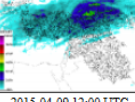

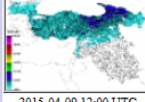
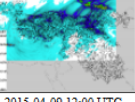
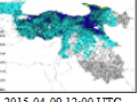


Flash Flood Guidance System Forecaster Interface

Diagnostic Products: ASM, FFG, Merged MAP

BSMEFFG - Black Sea Middle East Flash Flood Guidance System

Current Date: 2015-04-28 18:56 UTC Nav Date: 2015-04-09 12:00 UTC
 Year: 2015 Month: 04 Day: 09 Hour: 12 REGION: REGIONAL Submit
 -1 Month -1 Day -6 Hours -1 Hour +1 Hour +6 Hours +1 Day +1 Month
 Prev 6-hr Interval (06 UTC) Reset to Current Next 6-hr Interval (18 UTC)

DT	RADAR Precipitation	MWGHE Precipitation	GHE Precipitation	Gauge MAP	Merged MAP	ASM	FFG	IFFT	PFFT	ALADIN Forecast	FMAP	FFFT
01-hr	 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view		 2015-04-09 12:00 UTC Text: view		 2015-04-09 12:00 UTC Text: view	 2015-04-09 07:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view
03-hr	 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view		 2015-04-09 12:00 UTC Text: view		 2015-04-09 12:00 UTC Text: view	 2015-04-09 09:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view
06-hr	 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view
24-hr	 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view					 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view	

Composite Product: [text](#), [CSV](#), [CSVt](#)

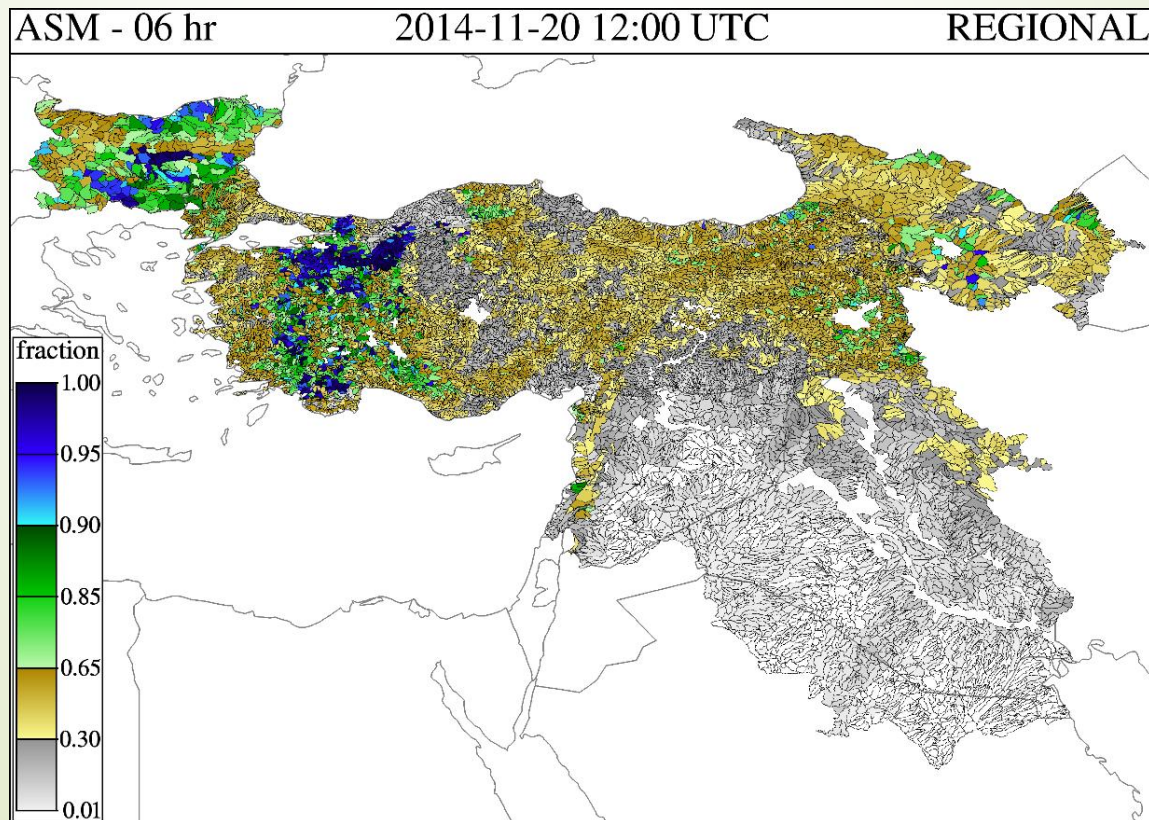
SFTP data transfer (requires SFTP Client): [EXPORTS/REGIONAL/2015/04/09](#)

Surfmet Gauge Observations at 2015-04-09 12:00 UTC

Station Identif...	Station Name	Accumulated Precipitation (mm/06hr)	Average Temperature (C)	Snow Depth (cm)	Snow Cover (Index)	Region	Latitude	Longitude	Elevation	Enable Precipitation Flag	Enable Temperature Flag
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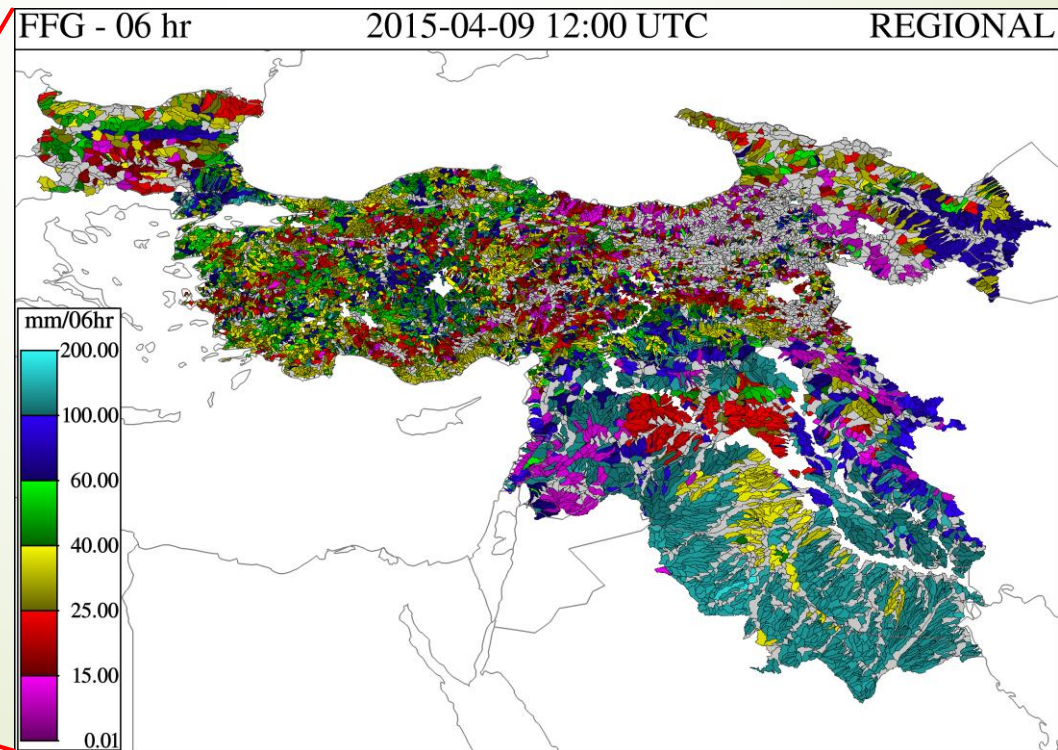
ASM

Average Soil Moisture (ASM) product provides an estimate of current soil water in the upper soil depth, expressed as a fraction of saturation, based on hydrologic modeling of soil water content. ASM reflects history of prior precipitation. The upper soil depth is most indicative for flash flood production.

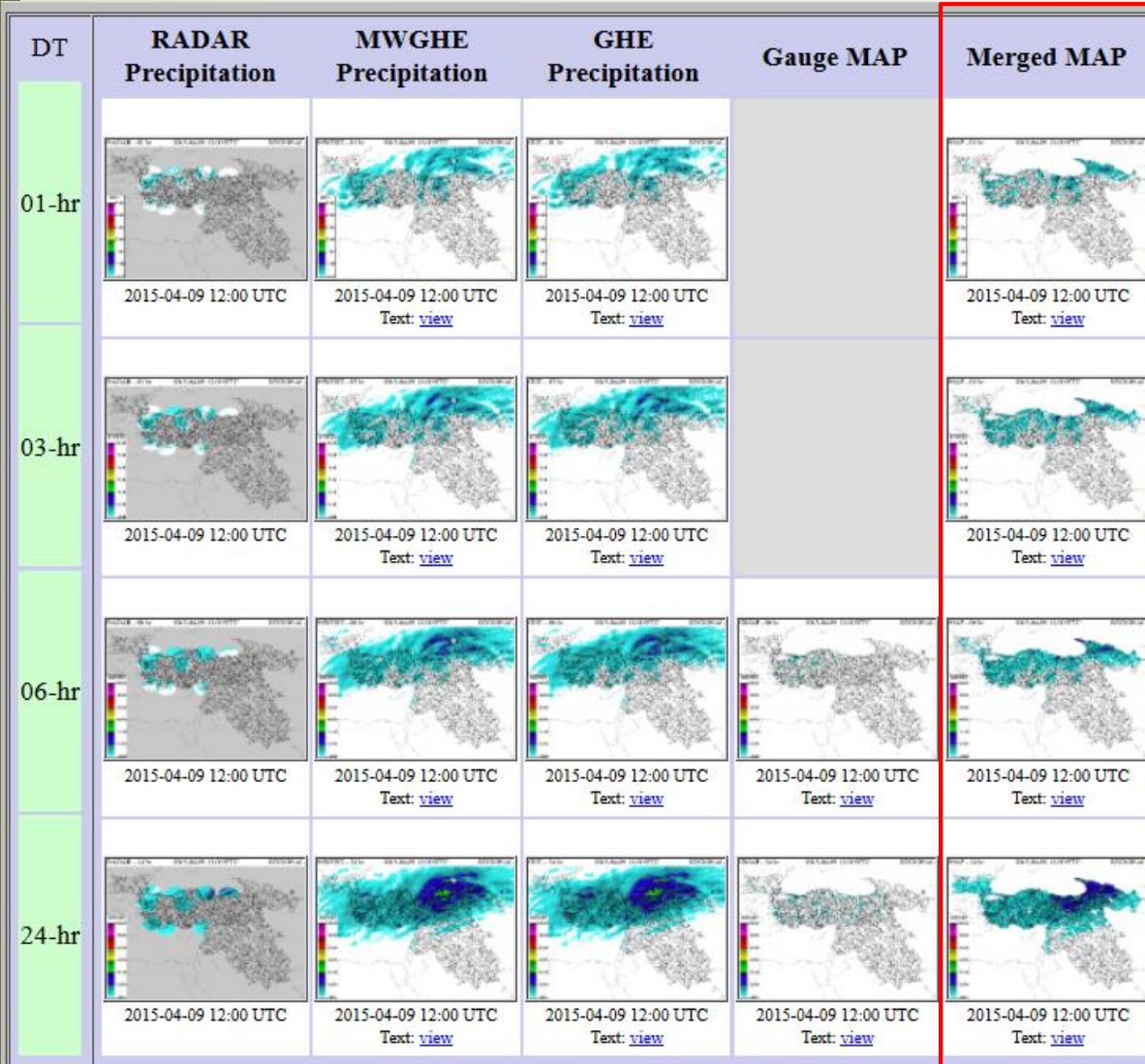


FFG

Flash Flood Guidance (FFG) is an estimate of the amount of rainfall of a given duration over a given small watershed which is enough to produce bankfull flow in the stream channel at the outlet of the watershed. The system interface provides current FFG values for durations of 1-, 3-, and 6-hours.



Observed Precipitation



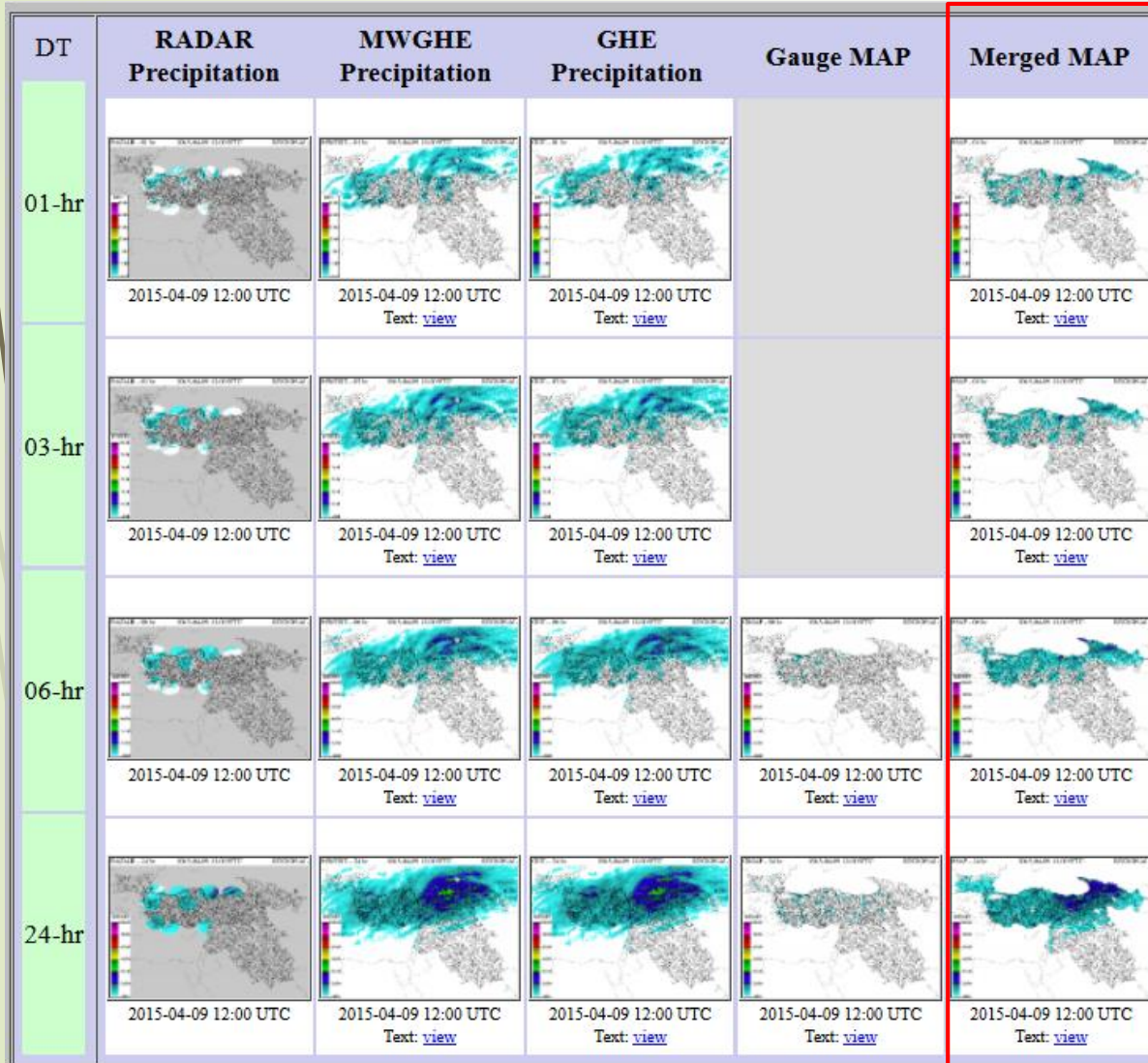
GHE: Global HydroEstimator

MWGHE: Microwave-adjusted GHE

Gauge MAP

Accumulation over the past 1-, 3-, 6- and 24-hours.

Merged MAP



Merged MAP is the *best estimate* of Mean Areal Precipitation over each small watershed for each duration (1-, 3-, 6-, 24-hr)

Flash Flood Guidance System Forecaster Interface

Prognostic Product: Forecast Precipitation and FMAP

BSMEFFG - Black Sea Middle East Flash Flood Guidance System

Current Date: 2015-04-28 18:56 UTC Nav Date: 2015-04-09 12:00 UTC

Year: 2015 Month: 04 Day: 09 Hour: 12 REGION: REGIONAL

DT	RADAR Precipitation	MWGHE Precipitation	GHE Precipitation	Gauge MAP	Merged MAP	ASM	FFG	IFFT	PFFT	ALADIN Forecast	FMAP	FFFT
01-hr		 Text: view	 Text: view		 Text: view		 Text: view	 Text: view	 Text: view		 Text: view	 Text: view
03-hr		 Text: view	 Text: view		 Text: view		 Text: view	 Text: view	 Text: view		 Text: view	 Text: view
06-hr		 Text: view	 Text: view	 Text: view	 Text: view	 Text: view	 Text: view	 Text: view	 Text: view		 Text: view	 Text: view
24-hr		 Text: view	 Text: view	 Text: view	 Text: view						 Text: view	

Composite Product: [text](#), [CSV](#), [CSVt](#)

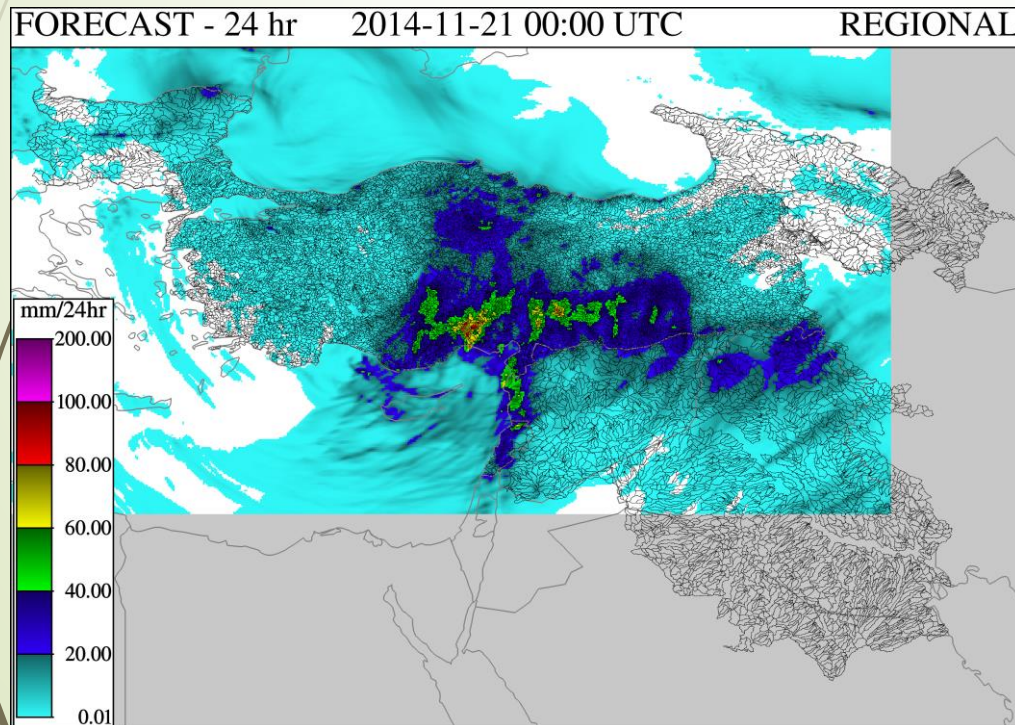
SFTP data transfer (requires SFTP Client): [EXPORTS/REGIONAL/2015/04/09](#)

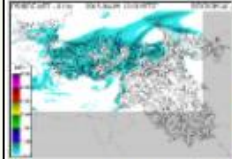
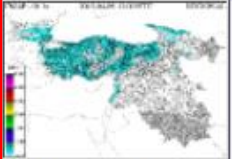
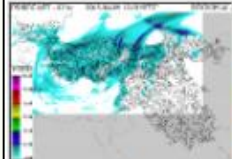
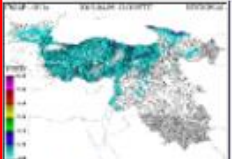
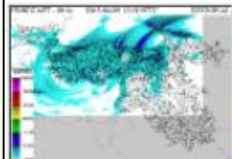
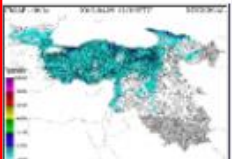
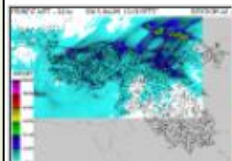
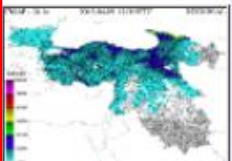
Surfmet Gauge Observations at 2015-04-09 12:00 UTC

Station Identif...	Station Name	Accumulated Precipitation (mm/06hr)	Average Temperature (C)	Snow Depth (cm)	Snow Cover (Index)	Region	Latitude	Longitude	Elevation	Enable Precipitation Flag	Enable Temperature Flag
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FMAP

If a forecast precipitation product is available, the system ingests forecast precipitation estimates to calculate forecast MAP (FMAP) for each small watershed for forecast lead times of 1-, 3-, 6-, and 24-hours.



ALADIN Forecast	FMAP
 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view
 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view
 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view
 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view

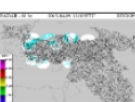
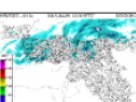
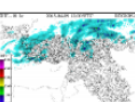


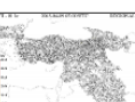
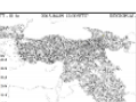
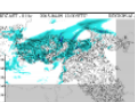

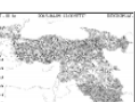

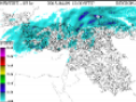
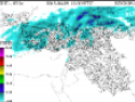


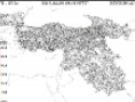

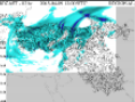


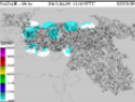
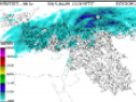
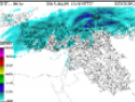


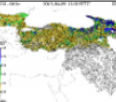



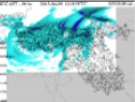


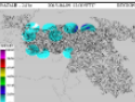
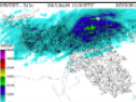
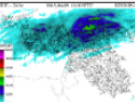
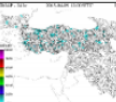
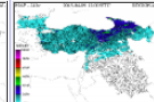
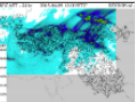
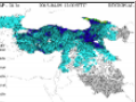
Flash Flood Guidance System Forecaster Interface

Prognostic Products: Flash Flood Threat

BSMEFFG - Black Sea Middle East Flash Flood Guidance System

Current Date: 2015-04-28 18:56 UTC Nav Date: 2015-04-09 12:00 UTC

Year: 2015 Month: 04 Day: 09 Hour: 12 REGION: REGIONAL

DT	RADAR Precipitation	MWGHE Precipitation	GHE Precipitation	Gauge MAP	Merged MAP	ASM	FFG	IFFT	PFFT	ALADIN Forecast	FMAP	FFFT
01-hr	 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view		 2015-04-09 12:00 UTC Text: view		 2015-04-09 12:00 UTC Text: view	 2015-04-09 07:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view
03-hr	 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view		 2015-04-09 12:00 UTC Text: view		 2015-04-09 12:00 UTC Text: view	 2015-04-09 09:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view
06-hr	 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view
24-hr	 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view	 2015-04-09 12:00 UTC Text: view					 2015-04-09 12:00 UTC	 2015-04-09 12:00 UTC Text: view	

Composite Product: [text](#), [CSV](#), [CSVt](#)

SFTP data transfer (requires SFTP Client): [EXPORTS/REGIONAL/2015/04/09](#)

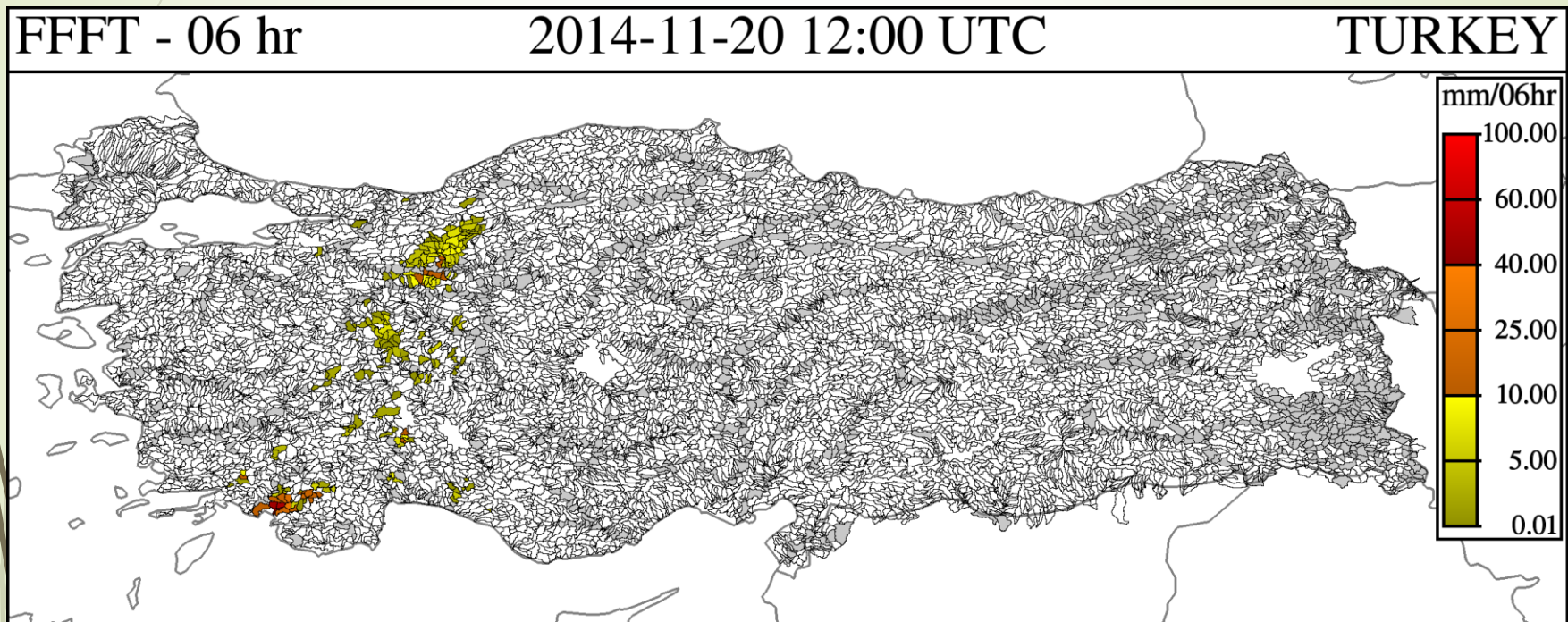
Surfmet Gauge Observations at 2015-04-09 12:00 UTC

Station Identif...	Station Name	Accumulated Precipitation (mm/06hr)	Average Temperature (C)	Snow Depth (cm)	Snow Cover (Index)	Region	Latitude	Longitude	Elevation	Enable Precipitation Flag	Enable Temperature Flag
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Flash Flood Threat (FFT) Products

Flash Flood Threat (FFT) products indicate the watersheds where precipitation exceeds the Flash Flood Guidance (FFG) value, based on observed, persisted, or forecast precipitation.

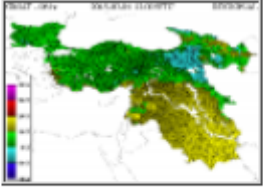

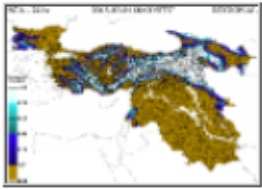
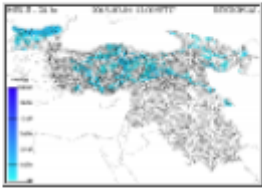

FFTs indicate watersheds where the potential for flash flooding is increased.



*FFT products are ***not*** intended to be used for automatic warning generation. Rather these serve as indicators of regions of potential concern. The role of operational forecasters in evaluating the current situation (observed and forecast precipitation) in these regions is **critical**.*

Flash Flood Guidance System Forecaster Interface

Informational Products: Snow Products

Snowpack Products				
DT	Gauge MAT	Latest IMS SCA	SWE	Melt
06-hr	 <p>2015-03-01 12:00 UTC Text: view</p>		 <p>2015-03-01 12:00 UTC Text: view</p>	
24-hr		 <p>2015-03-01 00:00 UTC Text: view</p>		 <p>2015-03-01 12:00 UTC Text: view</p>
4-day				 <p>2015-03-01 12:00 UTC Text: view</p>

Observations

- (1) Gauge MAT
based on real-time temperature stations
- (2) IMS Snow Cover
satellite observation of snow extent (daily)

Model Output

- (3) SWE
model estimated Snow Water Equivalent
- (4) Snow Melt
melt from snow pack; this contributes to soil water model

Flash Flood Guidance System Forecaster Interface

Informational Products: Real-time gauge data

Composite Product: [text](#), [CSV](#), [CSV2](#)

SFTP data transfer (requires SFTP Client): [EXPORTS/REGIONAL/2015/04/09](#)

Surfmet Gauge Observations at 2015-04-09 12:00 UTC

Station Identifier	Station Name	Accumulated Precipitation (mm/06hr)	Average Temperature (C)	Snow Depth (cm)	Snow Cover (Index)	Region	Latitude	Longitude	Elevation	Enable Precipitation Flag	Enable Temperature Flag
15502	Vidin	0.00	14.40	No Report	No Report	BULGARIA	43.9942	22.8525	31	Enabled	Enabled
15525	Lovech	0.00	8.50	No Report	No Report	BULGARIA	43.1631	24.7006	220	Enabled	Enabled
15549	Razgrad	0.10	7.35	No Report	No Report	BULGARIA	43.5661	26.5078	346	Enabled	Enabled
15552	Varna	0.00	11.60	No Report	No Report	BULGARIA	43.2125	27.9522	39	Enabled	Enabled
15600	Murgash	0.10	-3.85	50.00	8.00	BULGARIA	42.8333	23.6683	1687	Enabled	Enabled
15614	Sofia	0.00	7.60	No Report	No Report	BULGARIA	42.6553	23.3847	586	Enabled	Enabled
15615	Musala	8.00	-12.20	No Report	No Report	BULGARIA	42.1797	23.5866	2925	Enabled	Enabled

BSMEFFG - Black Sea Middle East Flash Flood Guidance System

Current Date: 2015-04-28 19:20 UTC

Nav Date: 2015-04-09 12:00 UTC

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Station Identifier	15615
Station Name	Musala
Region	BULGARIA
Latitude	42.1797
Longitude	23.5866
Elevation (m)	2925
Agency	Bulgaria
Type	SYNOP
Precipitation Enabled Flag	Enabled
Temperature Enabled Flag	Enabled

Reported Surfmet Gauge Observations from Station '15615' within the past 30 days

Station Identifier	Observation Date & Time	Precipitation (mm/06hr)	Temperature (C)	Snow Depth (cm)	Snow Cover (Index)
15615	2015-04-09 12:00:00+00	8.00	-12.20	No Data	No Data
15615	2015-04-09 06:00:00+00	9.00	-13.65	999.00	9.00
15615	2015-04-09 00:00:00+00	3.00	-14.25	No Data	No Data
15615	2015-04-08 18:00:00+00	8.00	-13.95	No Data	No Data
15615	2015-04-08 12:00:00+00	6.00	-12.20	No Data	No Data
15615	2015-04-08 06:00:00+00	12.00	-15.50	999.00	9.00
15615	2015-04-08 00:00:00+00	7.00	-13.55	No Data	No Data
15615	2015-04-07 18:00:00+00	8.00	-12.25	No Data	No Data
15615	2015-04-07 12:00:00+00	4.00	-11.95	No Data	No Data
15615	2015-04-07 06:00:00+00	0.00	-14.05	999.00	9.00
15615	2015-04-07 00:00:00+00	0.00	-14.30	No Data	No Data
15615	2015-04-06 18:00:00+00	0.00	-9.70	No Data	No Data
15615	2015-04-06 12:00:00+00	0.20	-6.60	No Data	No Data
15615	2015-04-06 06:00:00+00	5.00	-6.80	999.00	9.00
15615	2015-04-06 00:00:00+00	4.00	-6.95	No Data	No Data
15615	2015-04-05 18:00:00+00	5.00	-7.50	No Data	No Data
15615	2015-04-05 12:00:00+00	2.00	-6.85	No Data	No Data

Real-time gauge report are critically important for:

- gauge MAP product
- real-time temperature (MAT)
- dynamic precipitation bias adjustment

Preliminary Forecaster Interface Design for CARFFG System

CARFFG Real-Time Product C... x +

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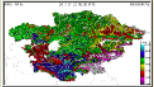



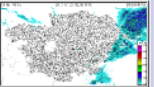




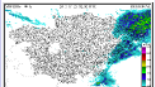
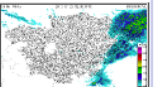


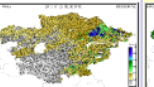
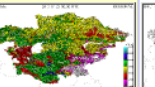


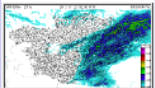
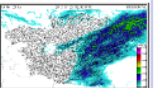

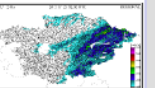
CARFFG - Central Asia Regional Flash Flood Guidance

Current Date: 2015-09-14 03:04 UTC Nav Date: 2015-04-27 02:00 UTC

Year: 2015 Month: 04 Day: 27 Hour: 02 REGION: REGIONAL Submit

-1 Month -1 Day -6 Hours -1 Hour +1 Hour +6 Hours +1 Day +1 Month

Prev 6-hr Interval (00 UTC) Reset to Current Next 6-hr Interval (06 UTC)

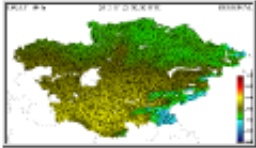

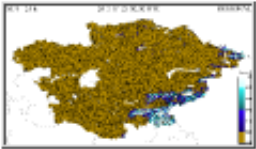


DT	MWGHE Precipitation	GHE Precipitation	Gauge MAP	Merged MAP	ASM	FFG	IFFT	PFFT
01-hr	 2015-04-27 02:00 UTC Text view	 2015-04-27 02:00 UTC Text view		 2015-04-27 02:00 UTC Text view		 2015-04-27 00:00 UTC Text view	 2015-04-27 01:00 UTC Text view	 2015-04-27 00:00 UTC Text view
03-hr	 2015-04-27 02:00 UTC Text view	 2015-04-27 02:00 UTC Text view		 2015-04-27 02:00 UTC Text view		 2015-04-27 00:00 UTC Text view	 2015-04-26 21:00 UTC Text view	 2015-04-27 00:00 UTC Text view
06-hr	 2015-04-27 02:00 UTC Text view	 2015-04-27 02:00 UTC Text view	 2015-04-27 00:00 UTC Text view	 2015-04-27 02:00 UTC Text view	 2015-04-27 00:00 UTC Text view	 2015-04-27 00:00 UTC Text view	 2015-04-27 00:00 UTC Text view	 2015-04-27 00:00 UTC Text view
24-hr	 2015-04-27 02:00 UTC Text view	 2015-04-27 02:00 UTC Text view	 2015-04-27 00:00 UTC Text view	 2015-04-27 02:00 UTC Text view				

Composite Product: [text](#) [CSV](#) [CSVt](#) SFTP data transfer (requires SFTP Client): [EXPORTS/REGIONAL/2015/04/27](#)

Surfnet Gauge Observations at 2015-04-27 00:00 UTC

Station Identifier	Station Name	Accumulated Precipitation (mm/06hr)	Average Temperature (C)	Region	Latitude	Longitude	Elevation	Enable Precipitation Flag	Enable Temperature Flag
No reports for region	No reports for region	No reports for region	No reports for region	No reports for region	No reports for region	No reports for region	No reports for region	No reports for region	No reports for region

Preliminary Forecaster Interface Design for CARFFG System

Snowpack Products				
DT	Gauge MAT	Latest IMS SCA	SWE	Melt
06-hr	 <p>2015-04-27 00:00 UTC Text: view</p>		 <p>2015-04-27 00:00 UTC Text: view</p>	
24-hr		 <p>2015-04-27 00:00 UTC Text: view</p>		 <p>2015-04-27 00:00 UTC Text: view</p>
4-day				 <p>2015-04-27 00:00 UTC Text: view</p>

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Introduction to CARFFG System and System Products

THANK YOU
for your kind attention

Production of Surface Runoff and Flash Flooding

Various processes lead to the production of surface runoff and possible flash flooding:

- **SATURATION FROM BELOW** – ALL RAIN INFILTRATES
(DOMINANT FOR MOST SOILS)
- **INFILTRATION CONTROLLED** – RAIN RATES IN EXCESS OF
INFILTRATION CAPACITY
(CLAY SOILS)
- **COMBINED** – HETEROGENEOUS AREAS AND PROFILES