World Meteorological Organisation

DHMZ

SOUTH EAST EUROPE FLASH FLOOD GUIDANCE SYSTEM

WMO RAVI

Hydrological Forum 2016

Workshop on hydrological modeling, forecasting and warnings

September 19 -23, 2016, Oslo, Norway

What is Flash Flood

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 as the result of intense rainfall over a relatively small area”

A local hydrometeorological phenomenon that requires BOTH hydrological and meteorological expertise for real time forecasting/warning

Natural Causes of Flash Floods

- Intense rainfall from slow moving thunderstorms
- Convective rainfall
- Orographic rainfall in steep terrain
- Soil saturation or impervious land surfaces
- Hydraulic channel properties

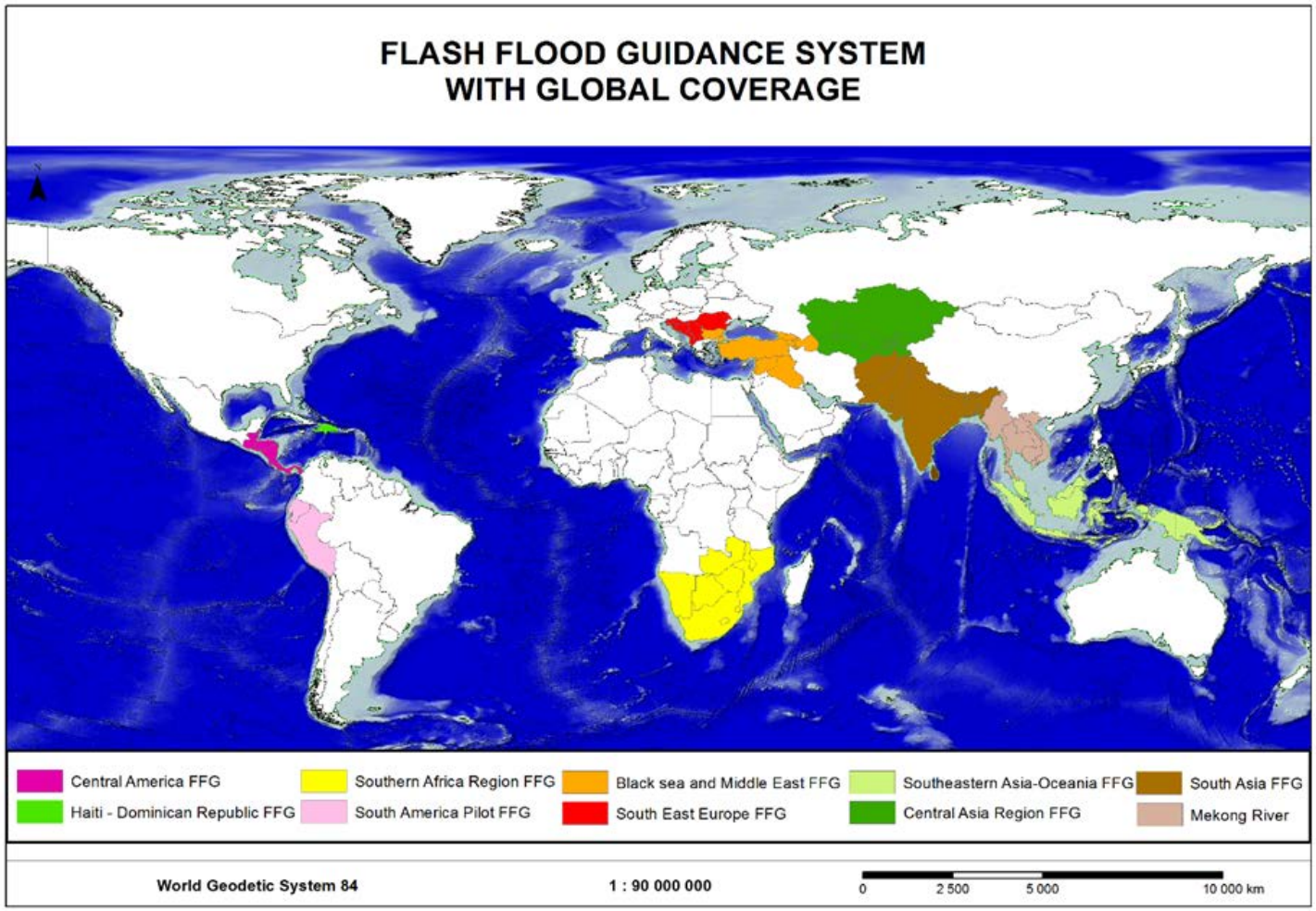
Why FFGS

- Flash floods have the **highest mortality rate** globally, highest number of deaths per people affected
- Frequency of occurrence of flash floods may increase due to climate variability and change
- No flash flood warnings exist for vast populated areas of the world
- Lack of local expertise and/or regional cooperation
- Insufficient in situ data in small regions
- Large-river flood-warning strategies ineffective for flash floods

The Goals

- Enhance NMHSs capacity to issue flash flood warnings and alerts
- Mitigate adverse impacts of hydro-meteorological hazards
- Enhance collaborations between NMHSs and Emergency Management Agencies/Rescue Directorate
- Generate flash flood early warning products by using state-of-the-art hydro-meteorological forecasting models
- Encourage regional developments and cooperation
- Support WMO Flood Forecasting Initiative

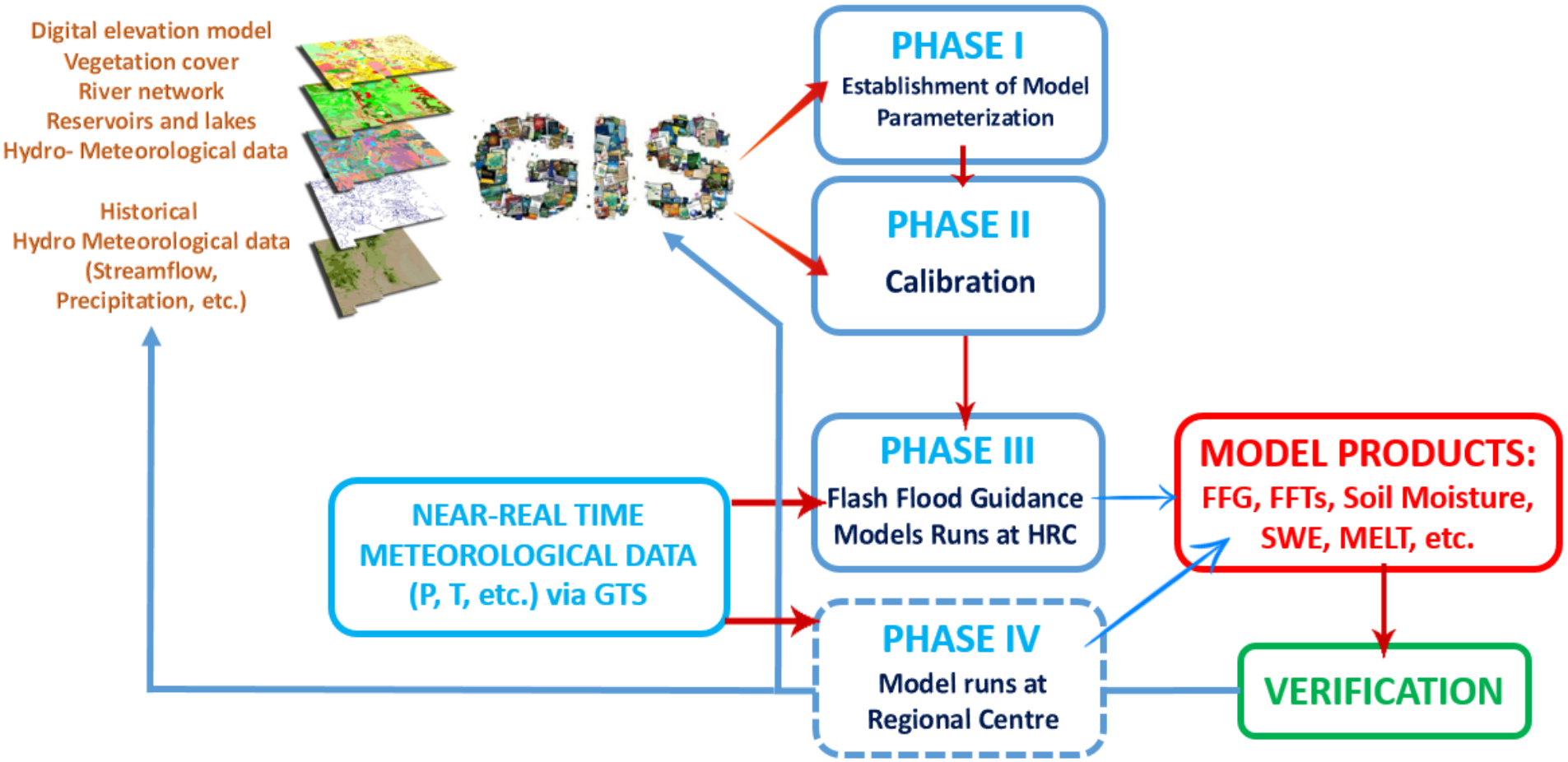
Global Coverage – Present State



Flash Flood Guidance System with global coverage enhances early warning capabilities of the NMHSs, currently covers 52 countries and more than two billion people around the world, saving lives and decreasing economic losses.

Established by the *Resolution 21*, XV WMO Congress 2007

System Developement



FFG System Technical components

DHMZ

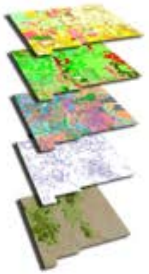
REAL-TIME PRECIPITATION INPUT
Satellite Rainfall
Radar/Gauge (as available)

RAINFALL DATA PROCESSING
Quality control
Merging
Bias adjustment
Basin precipitation

SNOW MODEL

AIR TEMPERATURE

SPATIAL GIS DATA ANALYSIS
Basin Delineation, Parameter estimation (Terrain, LULC, Soils, Streams)



FFG MODEL

SOIL MOISTURE MODEL

FORECASTER

FLASH FLOOD GUIDANCE

THRESHOLD RUNOFF MODEL

POTENTIAL EVAPOTRANSPIRATION (Climatological)

FLASH FLOOD THREAT

RAINFALL FORECASTS (ALADIN)

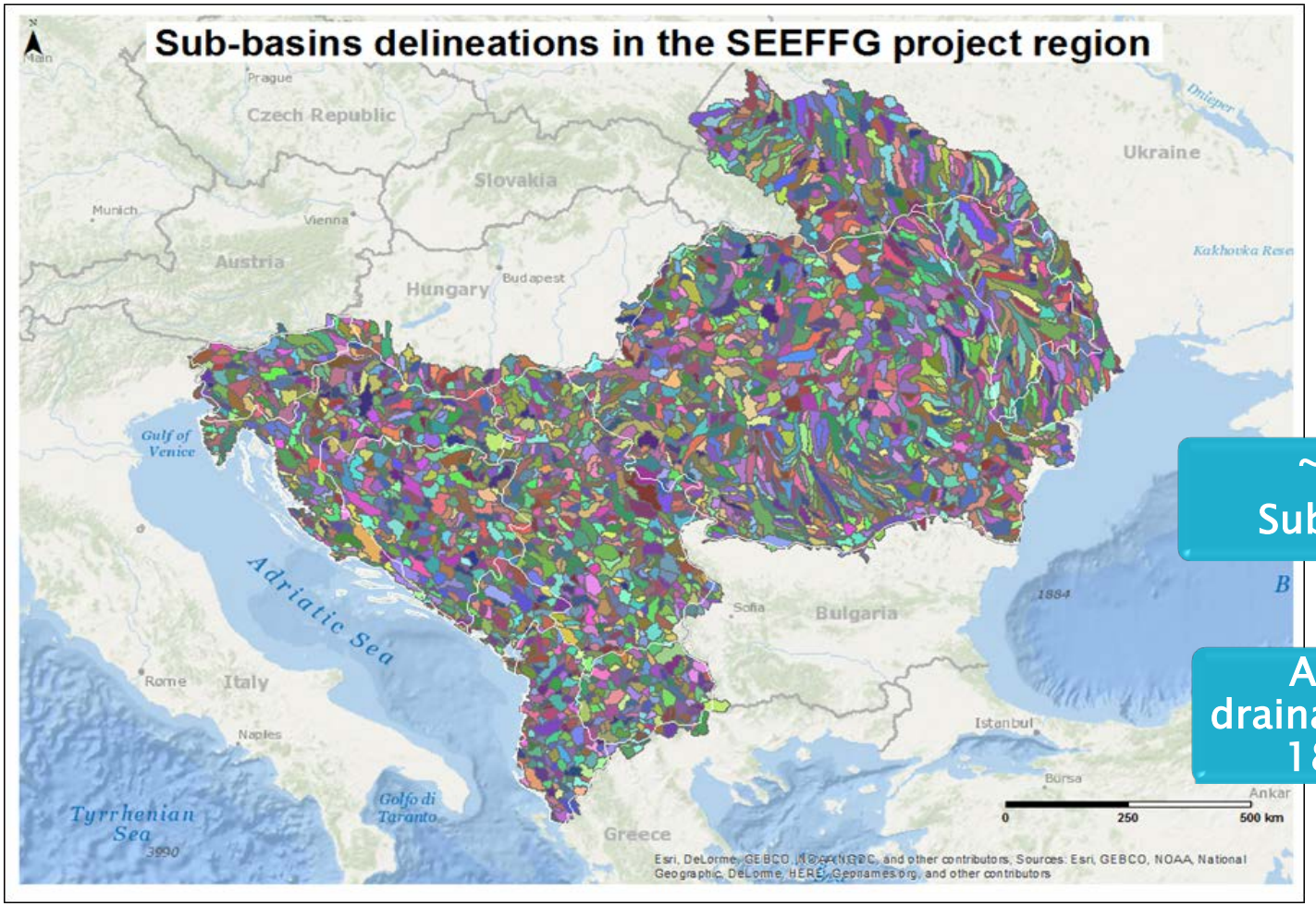
Background SEEFFGS

- **2009** — Memorandum of Understanding
- **2013** — Meeting for the Establishment of a SEEFFG, Turkey; SEE Countries Submitted Letter of Commitment
- **2015** — Steering Committee Meeting and Refresher Training, Macedonia
- **2015** — System Operational Training at the HRC, USA
- **2016** — Follow Up Operations Workshop SEEFFGS, Croatia
- **20→** — FUTURE…

World Meteorological Organisation

SEEFFGS – Area of Coverage

SEEFFGS – Sub-Basins



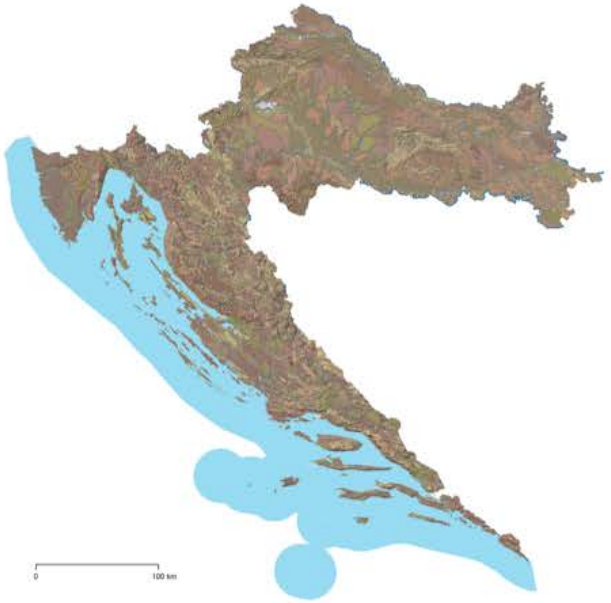
~ 3500 Sub-basins

Average drainage area of 185 km²

Historical Data – Croatia example

VEGETATION COVER

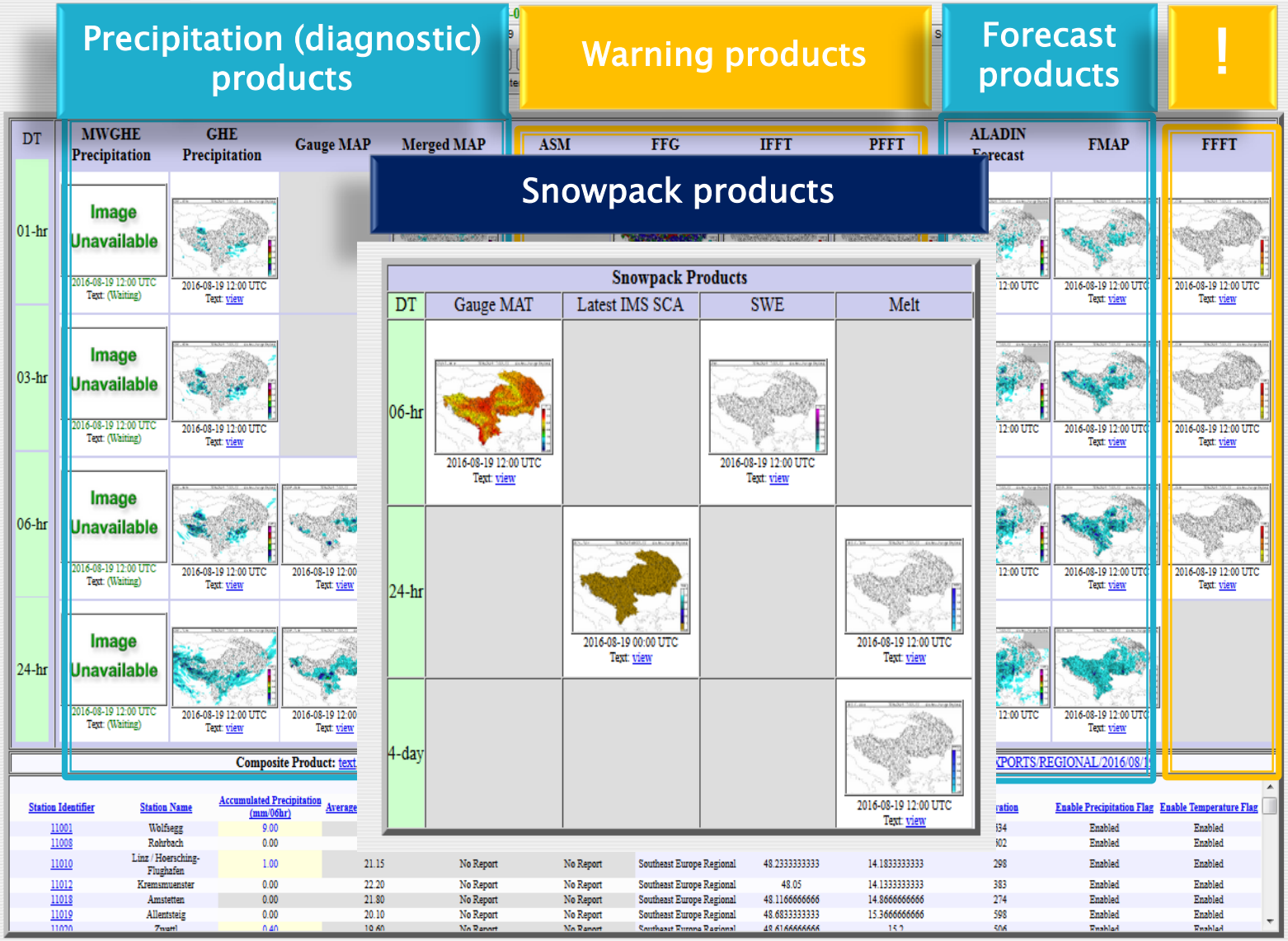
DIGITAL ELEVATION MODEL
AUTOMATIC HYDRO/METEO STATIONS



SOIL DATA

If required data were not provided by the participating countries, data from international organization were used

SEEFFG - Southeast Europe Flash Flood Guidance System



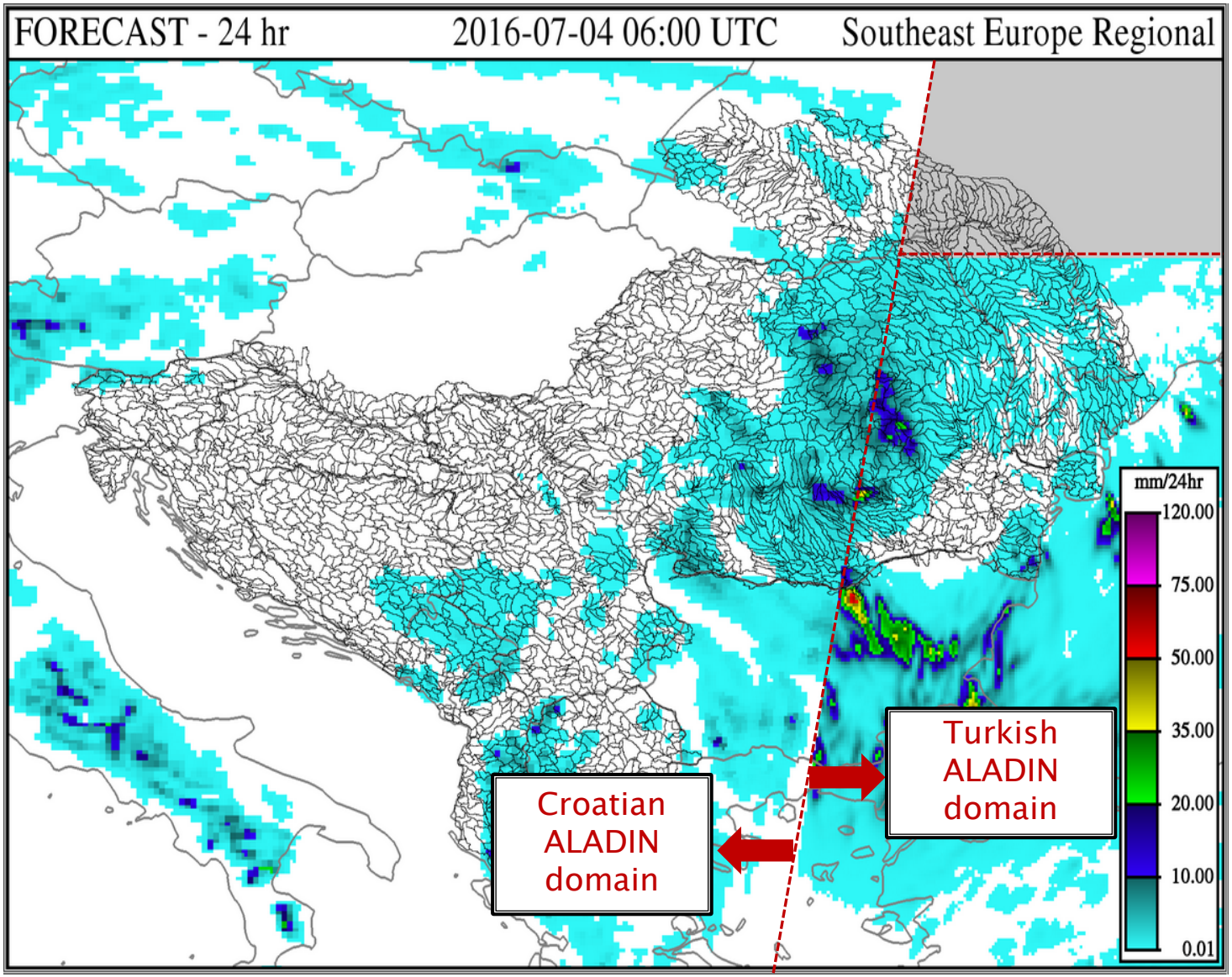
The forecaster interface – Main Product Console
All products are available on grapichal or text form

Aladin

- Currently NWPs in use for SEEFFGS:
  1. **ALADIN Croatia** - 8km resolution, runs 4 times per day (00, 06, 12, 18 UTC), produces forecast out to 72h
  2. **ALADIN Turkey** – 4.5 km resolution, runs 4 times per day (00, 06, 12, 18 UTC), produces forecast out to 72h

- SEEFFGS is using two coupled ALADIN forecasts, Croatian, which is the main NWP for the region, and Turkish, which is required because Croatian ALADIN domain does not cover the entire SEEFFG region.

- Aditional NWPs required (Coverage domain of entire SEEFFGS region, with better resolution, probabilistic NWPs, …), Radar incorporation


FORECAST - 24 hr
2016-07-04 06:00 UTC
Southeast Europe Regional
mm/24hr
120.00
75.00
50.00
35.00
20.00
10.00
0.01
Turkish ALADIN domain
Croatian ALADIN domain

May 2014: Flood and Flash Flood Events in SEE Region

- During this event, the SEEFFG System was under development but it showed quite accurate forecast. Now, after many experiences in operational work with the SEEFFG System, it proved to be valuable for disseminating warnings in this region, and highlighted a great opportunity for enhancement of collaboration with response agencies in the region.

B&H

Serbia

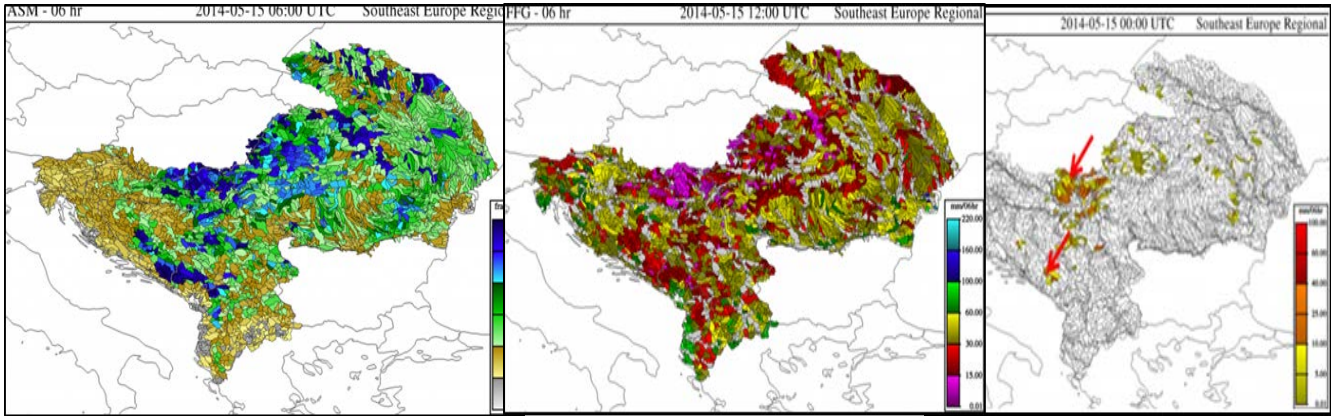
Croatia

Romania

79 casualities
(ISRBC, ICPDR)

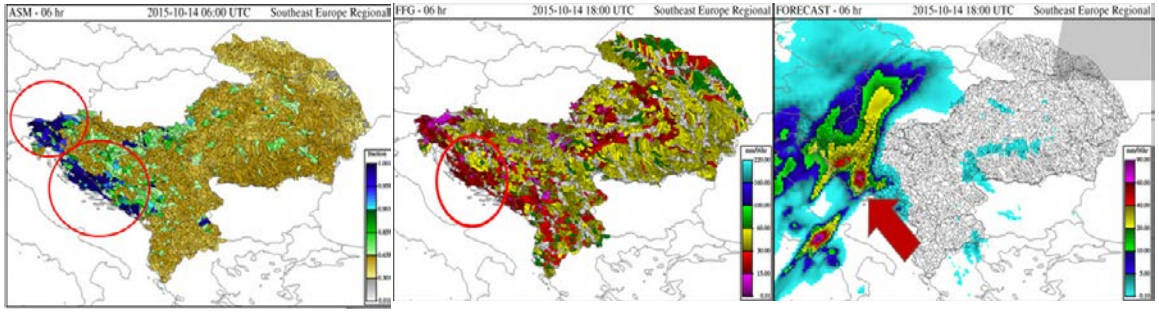
~ 3000 landslides

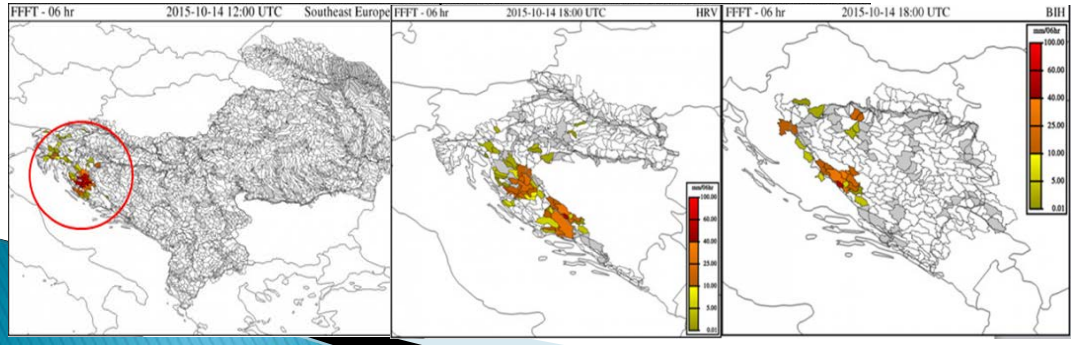
~ 3.3 billion EUR economic loss



October 2015: Flash Flood Event (100+ landslides) – Western part of SEE

- **SEEFFG system in this case was very precise and useful.** There were good indications of areas with flash flood threats, time frame was precise and it give forecasters that issued warning good help and support when they need to decide for what area to give warning.

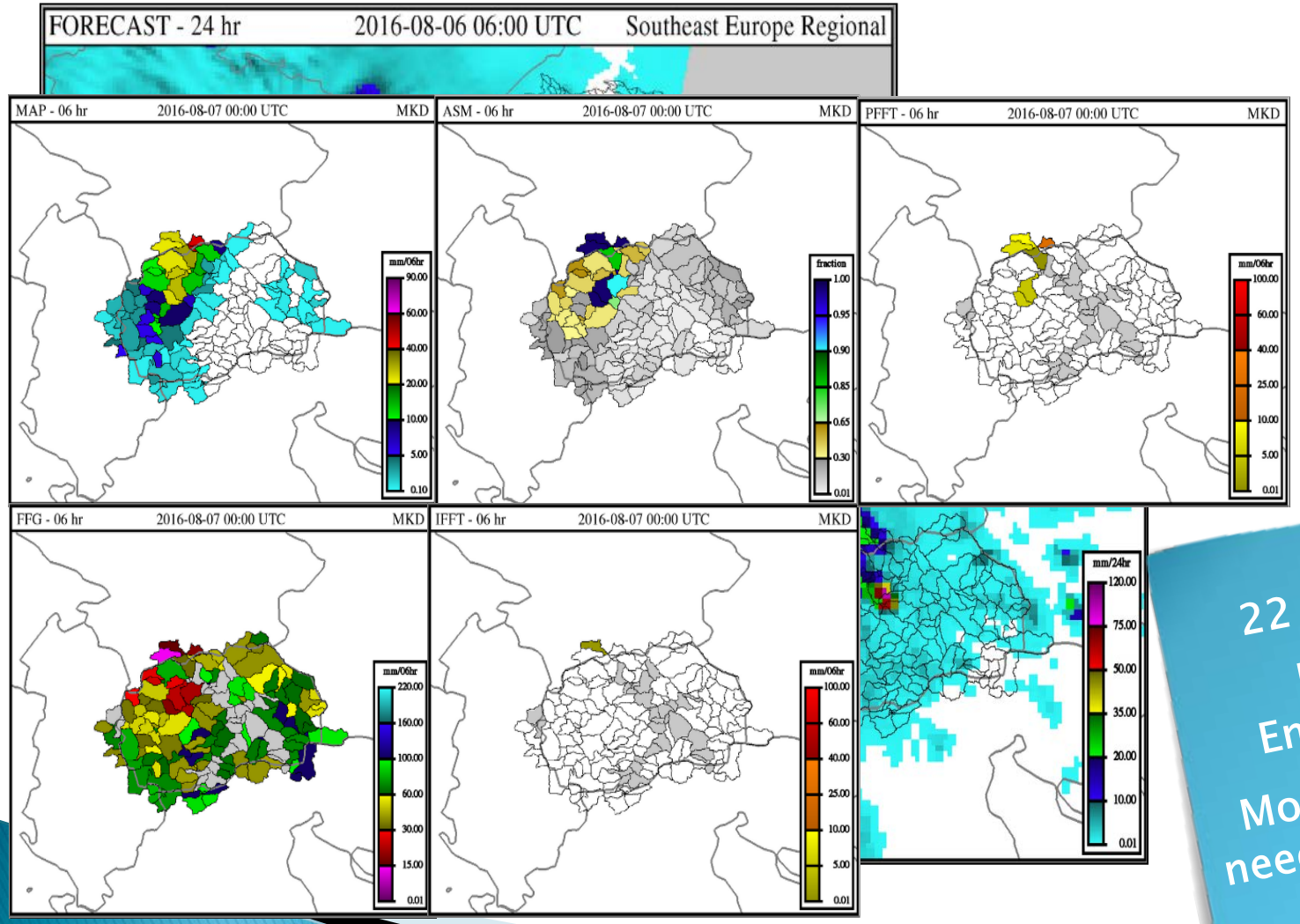




Croatia

B&H

August 2016: Flash Floods in The former Yugoslav Republic of Macedonia



August 6 08 UTC

22 causalities

Needs for Enhancements:

More NWP inputs needed for SEEFFGS

August 2016: Flash Floods in The former Yugoslav Republic of Macedonia

Flash Flood Warnings in SEE Region

COUNTRY	TYPE OF FF WARNING DISSEMINATION
ALBANIA	Daily natural risk bulletin on NMHS website
BOSNIA AND HERZEGOVINA	
CROATIA	Meteoalarm, Bulletin to NPRD in a case of an emergency, Hydroalarm under development
MOLDOVA	
MONTENEGRO	Meteoalarm
ROMANIA	
SERBIA	Meteoalarm, Hydroalarm, Operational Hydrometeorological Bulletin
SLOVENIA	Meteoalarm, Hydroalarm, Downloadable Audio clip, Video clips under developement
THE FORMER YUGOSLAV REP. OF MACEDONIA	

Verification

a = Hits
b = False alarms
c = Misses
d = Correct negatives

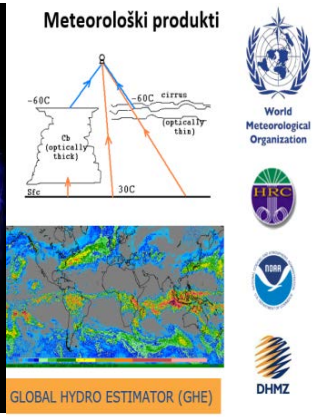
		EVENT OBSERVED		
		Yes	No	Total
EVENT FORECASTED	Yes	21 (a)	7 (b)	28
	No	1 (c)	113 (d)	114
	Total	22	120	142

Contingency table of flash flood warnings for Croatia in the period from 10th of October 2015 to 29th of February 2016

Hit Rate (POD): a/(a+c)	0.95
False Alarm Ratio (FAR): b/(a+b)	0.25
False Alarm Rate (POFD): b/(b+d)	0.058
Threat Score: a/(a+b+c)	0.72

Public Education

Successful response to FF warnings is most likely to occur when the people receiving the warning messages have been educated about the particular characteristics of the flash floods and are familiar with the extent of possible damage that could result.



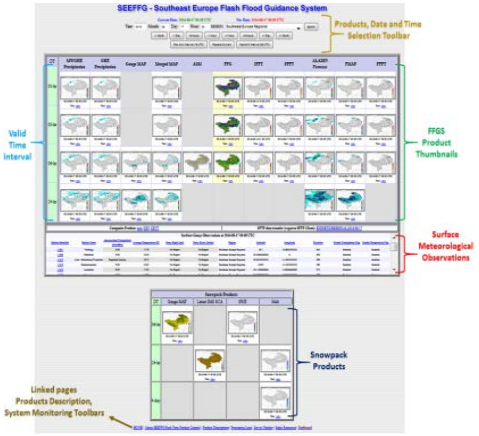
The exibition was visited by 83 000 + people

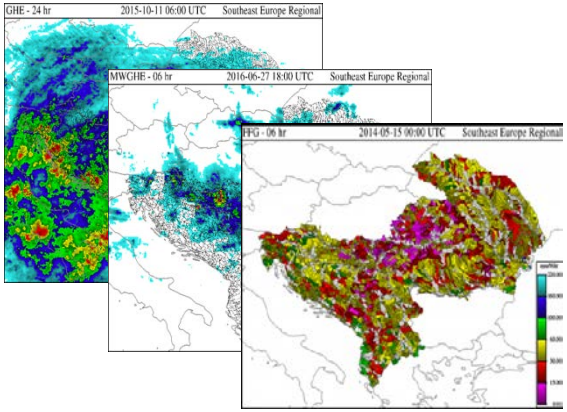
Best practice, effective flash flood awareness education campaigns will only be achieved within dynamic and diverse communities by applying a range of educational approaches

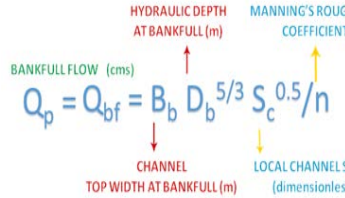
(presented in detail in SEEFFG User Guide)

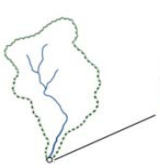
SEEFFGS User Guide

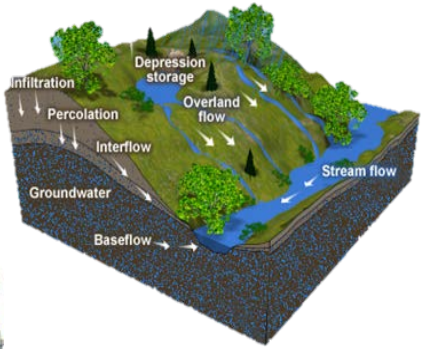
DHMZ

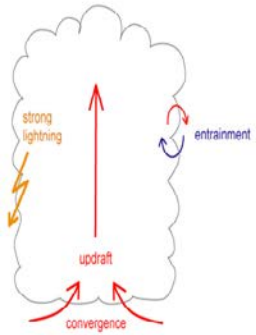


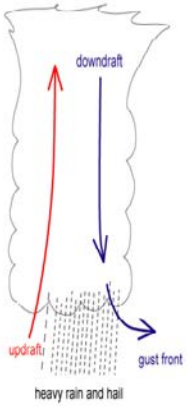


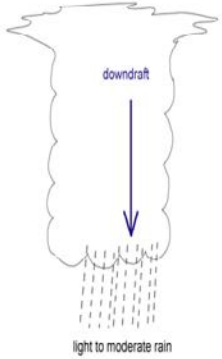












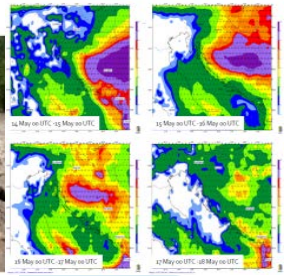
$$PoD = HR = \frac{a}{a+c}$$

$$FAR = \frac{b}{(a+b)}$$

$$CSI = \frac{a}{a+b+c}$$

a = Hits
b = False alarms
c = Misses
d = Correct negatives

		EVENT OBSERVED		
		Yes	No	Total
EVENT FORECASTED	Yes	a	b	a + b
	No	c	d	c + d
	Total	a + c	b + d	a + b + c + d = n



FFG brochure

NOAA FF and Flood Preparedness

El Paso County FF brochure

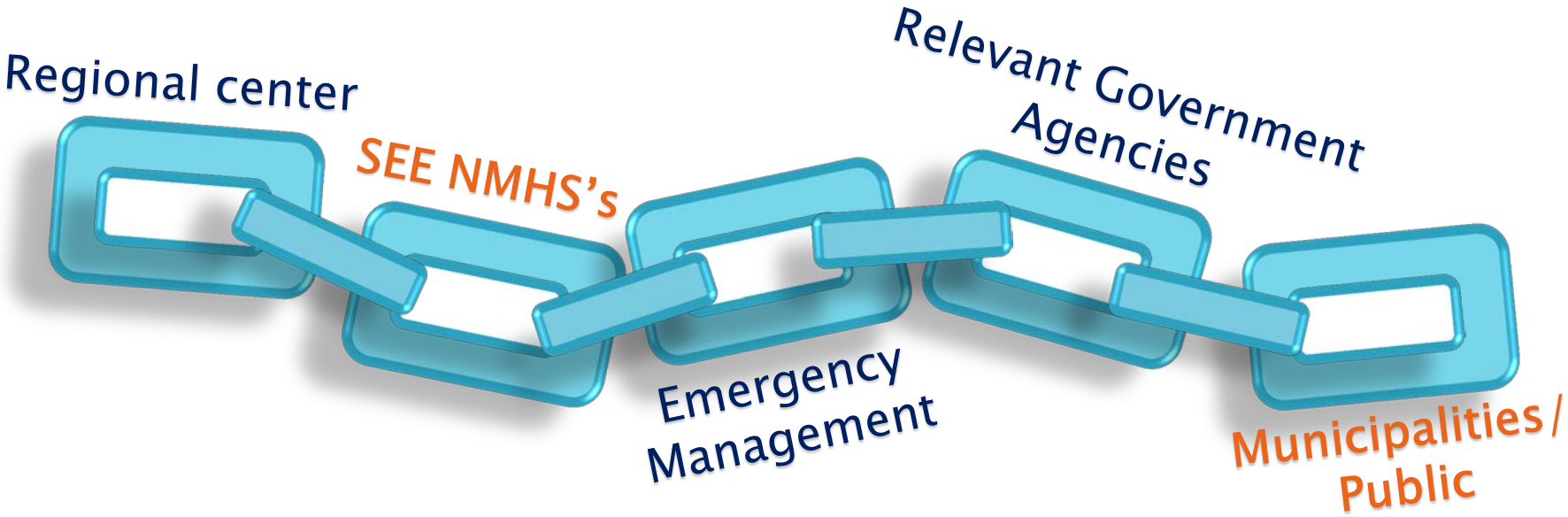
Future Plans

- Workshops - led by WMO certified trainers
  (eg. Croatia, autumn/winter 2016)

- It will ensure continuous training of operational forecasters and enhance flash flood forecasting and early warning capabilities

HYDROLOGIST ⟷ METEOROLOGIST

Conclusion



Each component in this process is critical to reduce the impacts of flash floods and provide essential lead times to aid decisions.

Failure of one component will lead to failure of the entire system to save lives and livelihoods

Jubach & Tokar (2016)

This is only way for establish an effective FF Early Warning System

SEEFEGS Family Credits