



Three months' worth of rain fell on the region in just a few days, causing Sava and Kolubara rivers to burst their banks and sweep into people's homes.

SERBIA FLOODS 2014

Worst flooding in over a century

www.hidmet.gov.rs
www.meteoalarm.rs

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Introduction

- ❑ Every year, disasters related to meteorological, hydrological and climate hazards cause significant loss of life, and set back economic and social development by years, if not decades.
- ❑ Extreme rainfall during April and May 2014 cause in parts of Serbia worst flooding in over a century.
- ❑ The disaster has made evident a number of vulnerabilities of the Serbian population and economy that – in view of climate change – deserve special attention and require the reduction of disaster risks.

Content:

- **Synoptic situation;**
- **NWP products;**
- **RHMSS Warning Activities;**
- **Overview of total amount of rainfall;**
- **Hydrological situation during May 2014;**
- **SERBIA worst affected areas;**
- **Emergency situation in Serbia;**
- **Concluding remarks.**

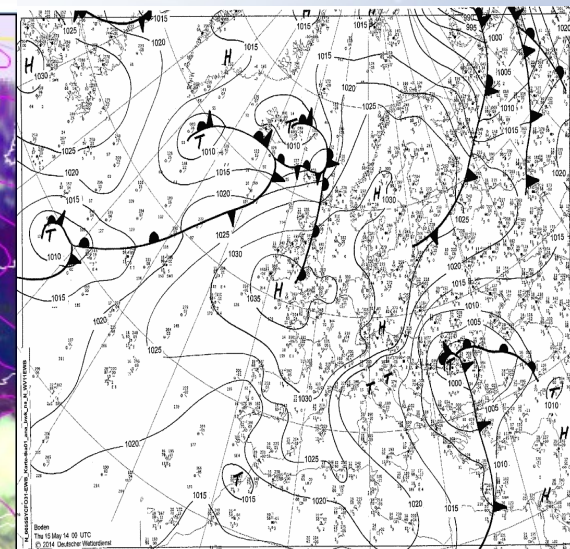
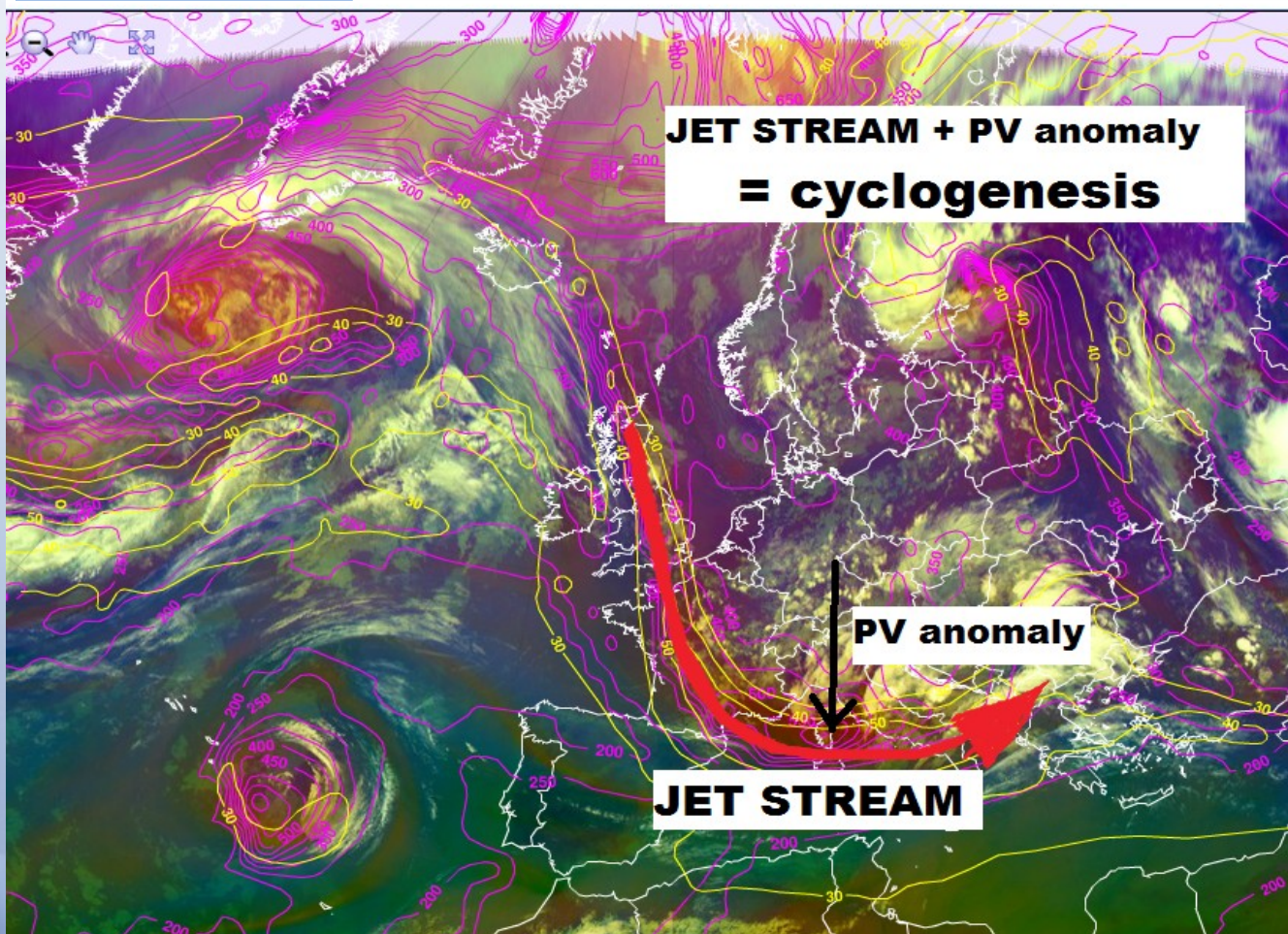




Synoptic situation

On 13 May, a low-pressure area formed over the Adriatic Sea, as polar air from Central Europe penetrated into the Mediterranean basin. The cold polar air mass met with humid subtropical air, leading to strong low pressure development.

13 May 2014

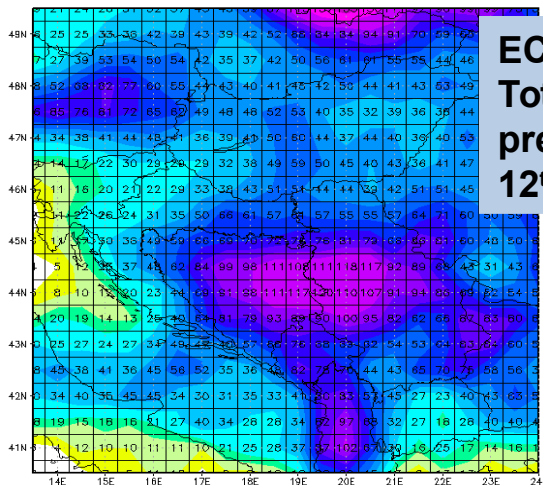


On 14 May, the low moved over the Balkans, becoming stationary. As a result, extremely heavy rain fell within the region - Serbia and the North of Bosnia-Herzegovina were most affected.



NWP products

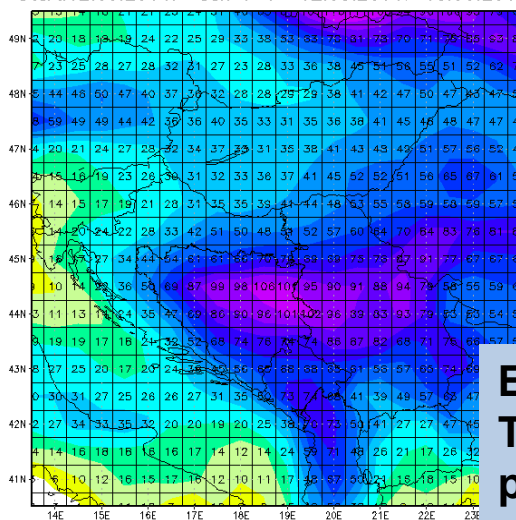
ECMWF EPS Control Ukupne nedeljne padavine (mm)
Start:12.05.2014. dan 1-7 12.05.2014.-18.05.2014.



**ECMWF EPS Control
Total weekly
precipitation for
12th -18th May 2014**

In performing a wide range of tasks in short to medium range weather forecasts and seasonal to long-term climate prediction, RHMSS in its forecasting operative work utilise the products and data of WMO Global Producing Centres, EUMETSAT, as well as data and products from its own NWP and climate model suits. Most of them predicted extreme rainfall in central Balkans.

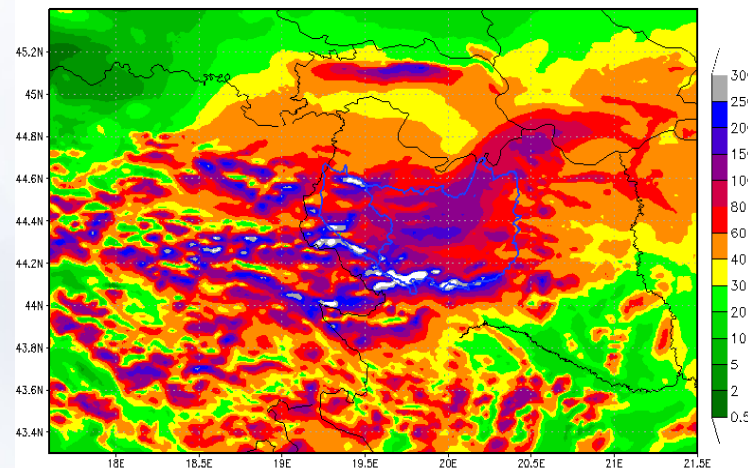
ECMWF EPS median Ukupne nedeljne padavine (mm)
Start:12.05.2014. dan 1-7 12.05.2014.-18.05.2014.



**ECMWF EPS median
Total weekly
precipitation for
12th -18th May 2014**

WRF-NMM 3.5.1 Padavine (mm/24h)

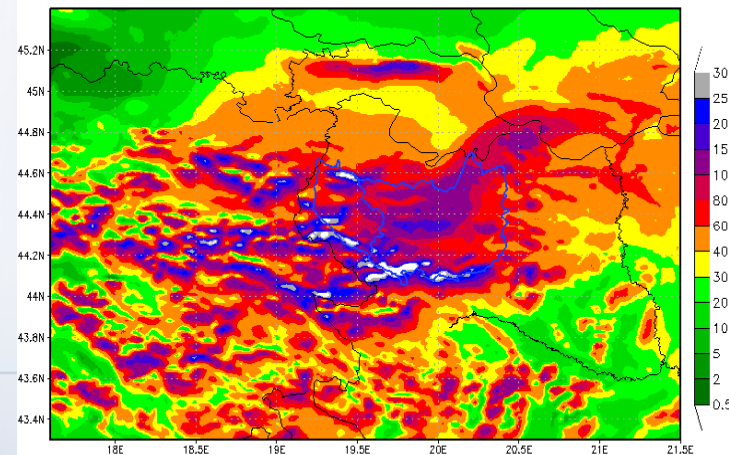
Start:14.05.2014. 00UTC Valid:14.05.2014. 00 UTC - 15.05.2014. 00 UTC



**WRF-NMM Daily precipitation for
15th and 16th May**

WRF-NMM 3.5.1 Padavine (mm/24h)

Start:14.05.2014. 00UTC Valid:14.05.2014. 00 UTC - 15.05.2014. 00 UTC





Meteo alarm

RHMSS – Center for hyd-met early warning and alerts is primary national authority and official source for issuing warning and alerts

Responsibility: early warning and alerts on the hydro-meteorological hazards

Green - no risk,
Yellow - the weather is potentially dangerous,
Orange - the weather is dangerous and
Red - the weather is very dangerous.

Прогноза времена за Србију

Прогноза времена
 011 2542 184
 prognoza@hidmet.gov.rs

Република Србија

Метео аларм - Прогнозиране метеоролошке појаве за датум: 14.05.2014.

* Важи од: 10:12 12.05.2014, за: 14.05.2014.

Изабери датум: 12.05.2014. ::: 13.05.2014. ::: 14.05.2014. :::

Бачка:		
Банат:		
Срем:		
Београд:		
Западна Србија:		
Шумадија:		
Поморавље:		
Источна Србија:		
Југоисточна Србија:		
Југозападна Србија:		
Косово и Метохија:		

Кликни регион на слици или назив региона за више детаља

Colour coded map in combination with special symbols for dangerous meteorological elements and phenomena provides a quick overview forecast of dangerous meteorological elements and phenomena.

For the universality of weather warning system we use the logic of European MeteoAlarm with the same graphic and colour symbols.

Four levels of risk are identified. Each colour represents one level of the risk.

Warnings issued for extreme precipitations on 12 May for 14 May 2014!



Operational Bulletin for Sector for Emergency Management Weather Forecast with warnings and level of awareness on country level

Date of issuing: 12.05.2014. y 12:00
Validity: from 12.05.2014. to 21.05.2014.

Date	Forecast	Warning	Prob. (%)
12.05.2014. Monday	Mostly cloudy with scattered showers and isolated thunderstorms. Becoming partly sunny in northwestern parts at first from the middle of the day. Northwestern winds light to moderate, in the evening and during the night becoming southeastern. Maximum temperatures between 15°C and 20°C.	ISOLATED THUNDERSTORMS The weather may be hazardous	60
13.05.2014. Tuesday	Partly sunny in the morning. Then becoming mostly cloudy with scattered showers and thunderstorms in the afternoon. In the western and central parts isolated hailstorms with damaging winds in the late afternoon and evening. Southern and southeastern winds light to moderate, in the evening and during the night becoming northwestern. Minimum temperatures between 8°C and 13°C. Maximum temperatures from 20°C to 25°C.	ISOLATED HAILSTORMS WITH SEVERE WIND GUSTS The weather is danger	90
14.05.2014. Wednesday	Colder and cloudy with heavy precipitations. In most places between 30 and 50 mm of rain, in western parts locally more. Northwestern winds moderate to strong, in the evening and during the night with gusts over 60km/h. Minimum temperatures between 7°C and 12°C. Maximum temperatures from 10°C in northwestern parts to 18°C in southeastern parts.	EXTREME RAINFALL (more than 40mm/12h) The weather is very danger	90
		WIND GUSTS OVER 60km/h The weather may be hazardous	80
15.05.2014. Thursday	Cold and cloudy with heavy precipitations. In most places between 30 and 50 mm of rain. In high mountains snow and snow cover formation, locally blizzard conditions. Northwestern winds moderate to strong, in northern parts and in the mountains with gusts over 60km/h. Temperatures between 7°C nad 12°C.	EXTREME RAINFALL (more than 40mm/12h) The weather is very danger	90
		WIND GUSTS OVER 60km/h The weather may be hazardous	90



16.05.2014. Friday	Cold and cloudy with rain. In high mountains snow with increasing snow cover. Northwestern wind moderate to strong, in the afternoon gradually weakened. Minimum temperatures from 4 to 7°C. Maximum temperatures between 8 and 13°C.	PRECIPITATIONS – LOCALLY MORE THAN 20mm/12h The weather may be hazardous	90
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Weather forecast from 17.05.2014. to 21.05.2014.

Partly sunny and warmer with isolated showers in the mountains.

The weather is very danger – Very dangerous weather phenomena with such intensity that can cause great damage and be dangerous to the safety of people and animals.

The weather is danger – Dangerous weather phenomena with such intensity that can cause great damage and be dangerous to the safety of people and animals.

The weather may be hazardous – Weather phenomena that are predicted are not uncommon, but caution is required if you plan activities that are exposed to meteorological risks.

No warnings – No meteorological hazards.

Impacts according of warning and level of awareness (example):

EXTREME RAINFALL (more than 40mm/12h)

Causing flooding, problems in all the activities of agricultural production, significant problems in traffic and transportation, the risk of landslides and mudslides, damage to property, endangering the lives of people and animals.

Gust wind ≥ 17 m/s (≥ 60 km/h)

Possible damage of properties, problems in transportation (cars veer on road), forest damage, damage of trees in parks and individual trees (some twigs broken from trees, some branches break off trees), problems in civil engineering construction works - especially works with cranes, indirect impact on the safety of people and animals, makes already existing dangerous security situations more complicated (forest and other fires, environmental disasters, disturbance of rescue actions). Impacts apply to facilities built of hard materials, facilities that are well maintained on healthy trees and the like.



Republic Hydrometeorological Service of Serbia

Bulletin of Warning



Republic Hydrometeorological Service of Serbia
Center for hydrometeorological system of early warning and alerts
WARNING OF IMPACTS EXTRAORDINARY OR HAZARD PHENOMENA
For Sector for emergency management

Date of issuing: 13 May 2014.

Validity period from: 00:00 May 14. 2013 to: 00:00 May 15. 2013.

Region	District	Level of awareness	Phenomena
Backa	Severno Backi	The weather is potentially dangerous	Heavy precipitations (more than 30mm/24h)
	Zapadno Backi		
	Juzno Backi		
Banat	Severno Banatski	The weather is potentially dangerous	Heavy precipitations (more than 30mm/24h)
	Srednje Banatski		
	Јужно Банатски		
Srem	Sremski	The weather is dangerous	Heavy precipitations (more than 40mm/24h)
Belgrade	Belgrade city	The weather is dangerous	Heavy precipitations (more than 40mm/24h)
West Serbia	Macvanski	The weather is very dangerous	Extreme rainfall (more than 40mm/12h)
	Kolubarski		
Sumadia	Sumadijski	The weather is very dangerous	Extreme rainfall (more than 40mm/12h)
Pomoravlje	Podunavski	The weather is very dangerous	Extreme rainfall (more than 40mm/12h)
	Branicevski		
	Pomoravski		
East Serbia	Borski	The weather is very dangerous	Extreme rainfall (more than 40mm/12h)
	Zajecarski		
Southeast Serbia	Rasinski	The weather is dangerous	Heavy precipitations (more than 40mm/24h)
	Nisavski		
	Toplicki		
	Pirotski		
	Jablanicki		



Warning messages

Time of issuing:

12.05.2014. u 11.00 h

On Wednesday (14.05.) and Thursday (15.05.) heavy rainfall is expected in most parts of Serbia, from 30 to 50mm/24h, locally in western and central parts more than 40mm/12h. On Wednesday evening gusts of northwestern winds will become greater than 60km/h in northern parts, also in the mountains, where the snow is expected and the formation of snow cover with possible blizzard conditions.



Kopaonik, 16 May 2014
Snow depth: 61 cm

- **Extremely warnings for:**
 - **Emergency services (services for monitoring and notification)**
 - **Ministry of Internal Affairs, Department for Protection and Rescue**
 - **Serbian Government,**
 - **Media (radio and TV stations)**
 - **Local authority and public utilities**

Ways of notification:

on briefing, by fax (special bulletins), by phone, by E-mail, Website, FTP, SMS.

For more information visit www.meteoalarm.rs

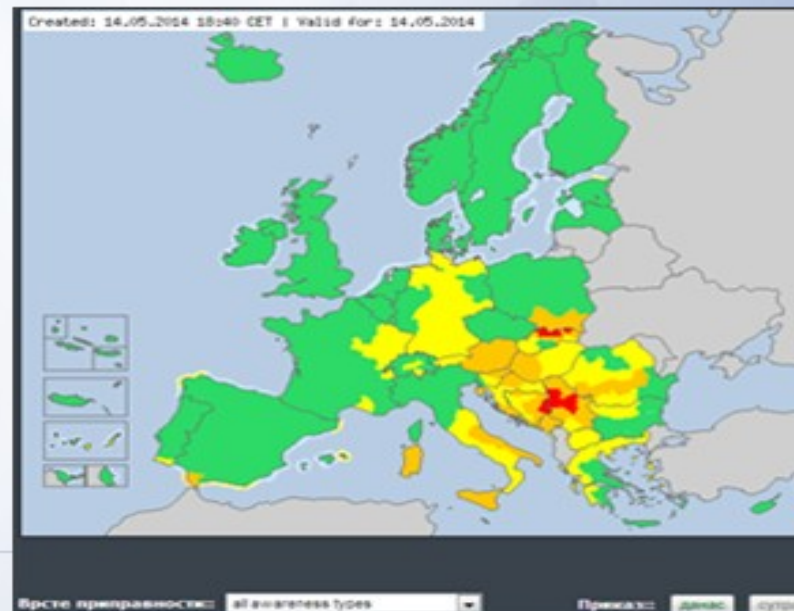
Forecaster: Slobodan Sovilj
phone: +381 11 2542 184



MMS	13.05.	14.05.	15.05.	16.05.	17.05.	18.05.	TOTAL
Loznica	0	50	110	53	6	0	218,6
Vajjevo	6	38	108	44	3,2	3	202,1
Belgrade	0,2	21	108	45	16	0	190,2
Smederevska Palanka	8	22	96	30	1,7	6,5	164,3
Novi Sad	0	0,3	87	31	27	2	147,5
Sremska Mitrovica	0	6	69	29	23	0,1	126,8
Zlatibor	10	38	37	21	3	7	115,9
Ćuprija	6	23	40	35	0,9	6	111,3
Niš	2,2	2	75	26	4	2,1	111,2
Kopaonik	1,2	7,1	37	49	4	8,1	106,8
Kraljevo	11	27	48	12	1,9	5	104,9
Kragujevac	6,4	21	41	28	1	5,4	102,7
Zrenjanin	0	2	68	19	12	0,1	101,1
Požega	7	39	27	11	3	7	94
Crni Vrh	2	29	50	10	2,3	0,4	93,7
Banatski Karlovac	0	0,7	59	25	2,8	0,3	88,2
Veliko Gradište	3	7	51	23	4	0,1	88
Zaječar	2	30	30	8	12	0,2	82,6
Sjenica	7	34	19	4,8	9	5,5	79,3
Kikinda	0	2	42	28	6	0,9	78,5
Negotin	0,7	18	41	13	0,2	3	75,5
Leskovac	4	2,6	42	13	5	2,3	68,4
Palić	0	5	27	22	3,5	3	60
Vranje	0	23	29	5,9	1	1,1	60
Kruševac	4	17	18	20	0,4	0,2	59,6
Sombor	0	0	25	12	13	2	52,3
Kuršumlija	11	2,2	18	6	1	9	47,2
Dimitrovgrad	1,1	14	16	0,4	9	5	45,5

What finally happened?

The warning was adequate for the most parts of Serbia. At some stations in the western and central parts dropped even more rainfall than predicted, locally more than 200mm/72h (although it has been given the highest level of alert).





Republic Hydrometeorological Service of Serbia

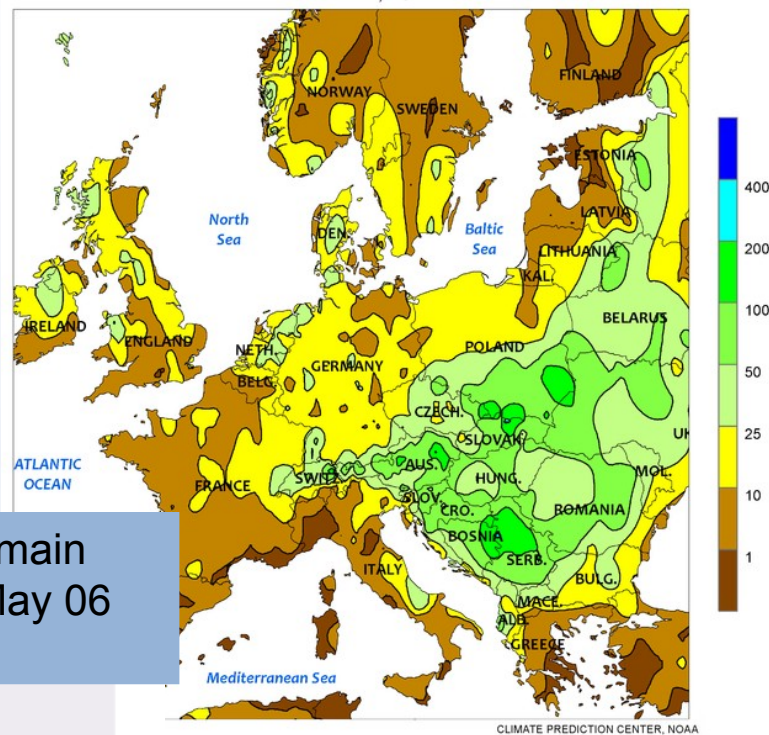
Overview of total amount of rainfall from 12 to 18 May 2014



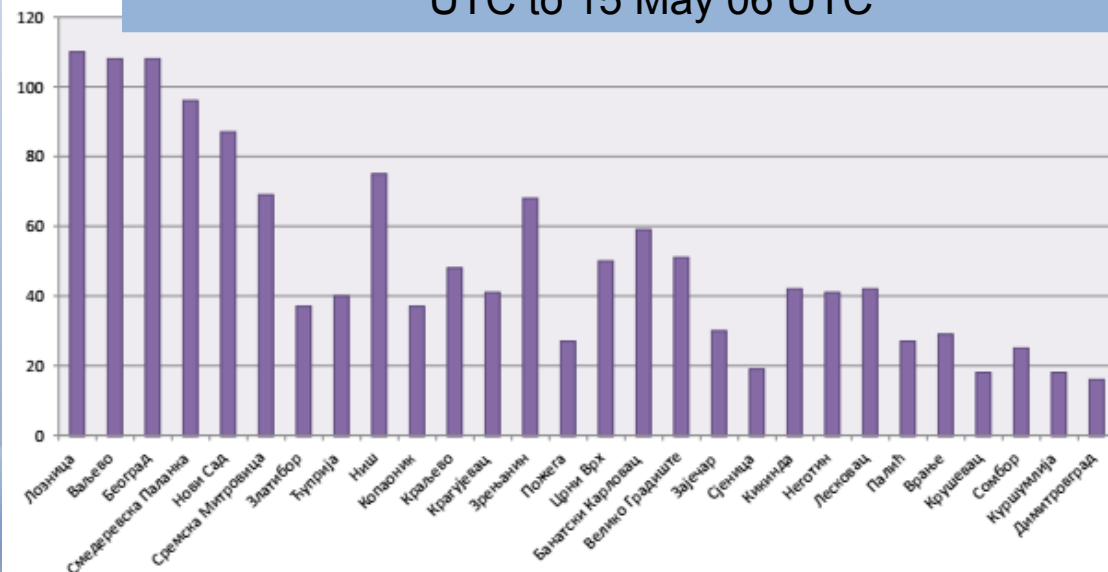
The maximum daily rainfall ever recorded at some meteorological stations!

- Loznica 110 mm/24h
- Valjevo 108 mm/24 h
- Beograd 108 mm/24h

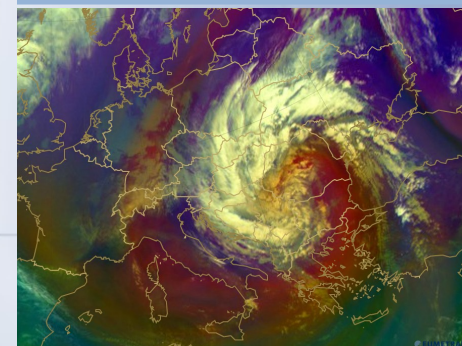
(average monthly rainfall in may for the period 1981-2010 for western parts of Serbia is between 70 and 80mm and for Belgrade about 58mm!)



Total amount of 24 hours precipitation at main meteorological stations in Serbia from 14 May 06 UTC to 15 May 06 UTC



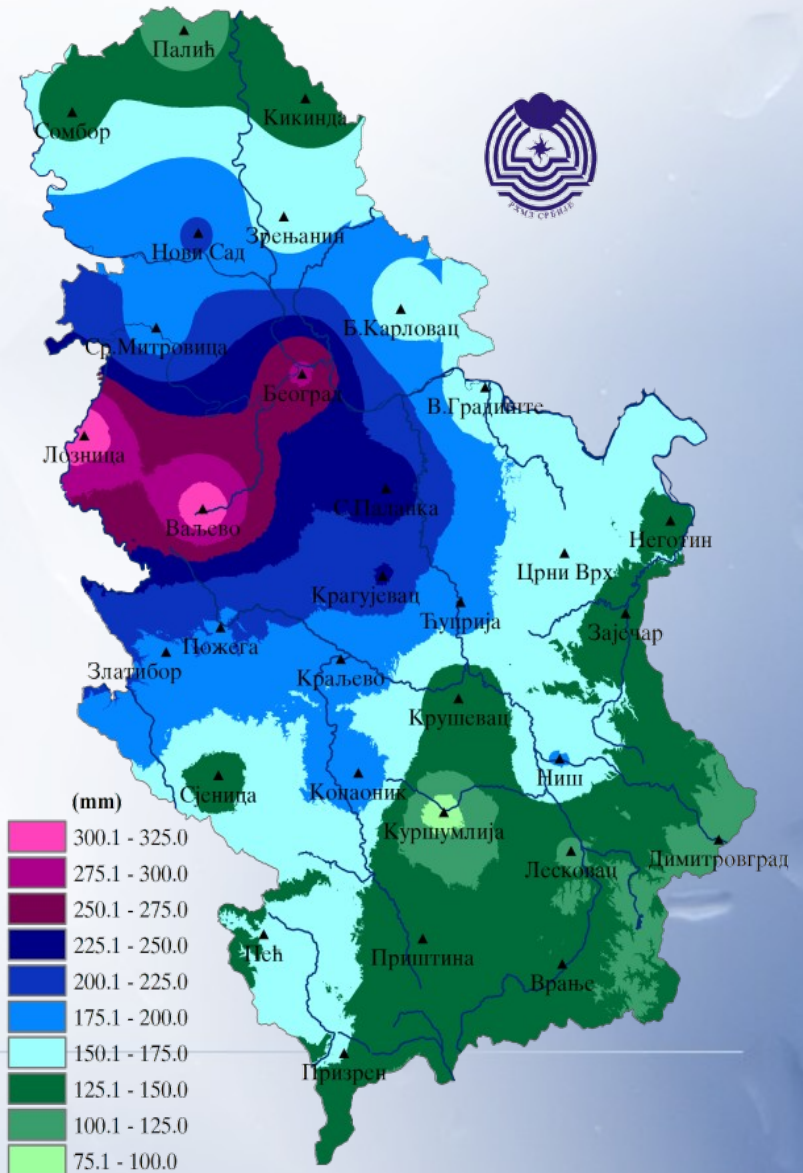
Europe Total Precipitation 11-17 May 2014





The greatest historical monthly precipitation totals during May since the beginning of the measurements on the main meteorological stations were exceeded on 9 stations in the period between the 1st and 31st of May 2014

MMS	Precipitation amount 1 - 31.5. 2014	The highest precipitation amount for May before 2014	Year of highest amount for May
NOVI SAD	201.9	175.7	1987
LOZNICA	314.6	218.6	1938
S.MITROVICA	189.0	184.9	1939
VALJEVO	317.6	213.2	1957
BELGRADE	278.5	191.7	1900
KRAGUJEVAC	227.0	169.7	1970
S.PALANKA	238.2	164.7	1929
ZLATIBOR	195.6	172.5	1956
POZEGA	199.4	177.9	1980

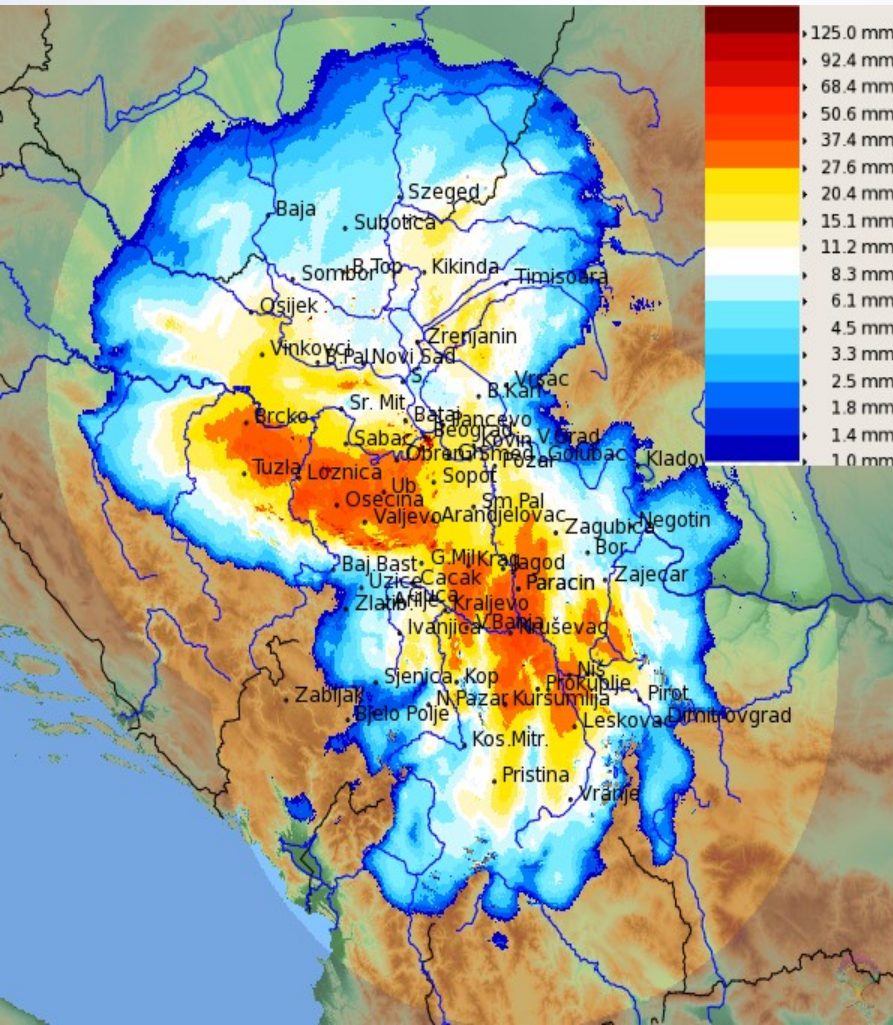


The precipitation totals for May on met stations Loznica, Valjevo and Belgrade are three to four time higher than the average values for May!



Radar data

The estimate of precipitation totals on Marshall-Palmer relation $Z = 200 \cdot R^{1.6}$ for stratiform precipitation for 15th of May 2014 using Gematronik radar from the locations on Fruska Gora and Jastrebac.

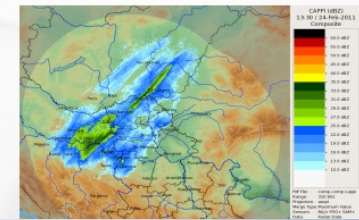


Modernization of the State meteorological radar centers network (Centers of the RHMSS and hail suppression Centers of the Ministry for interior-responsible for DRM)



Gematronic S band	3 (hail supp.)
Mitsubishi S band	10 (hail supp.)
MRL 5	X/S band 1 (RHMSS)
LAWR	X band 1 (RHMSS)

New Gematronik S band – dual polarization radar at Jastrebac mountain operational from October 2013 (RHMSS)



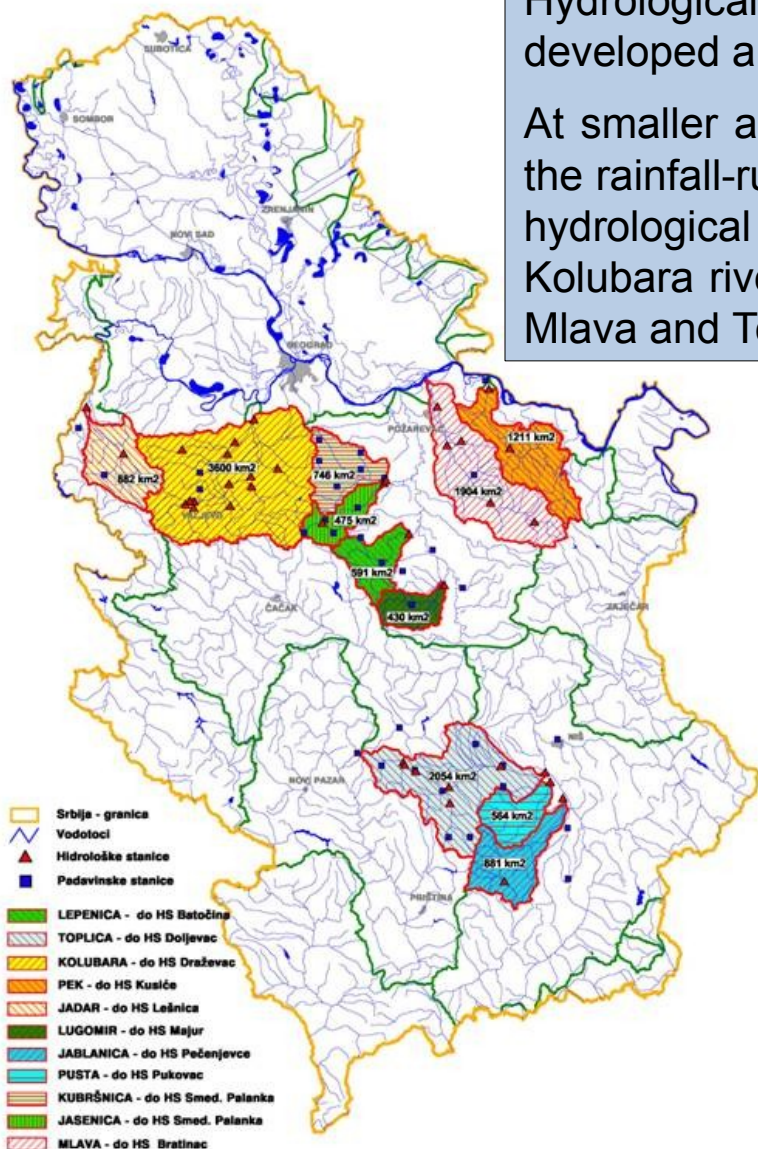
With the installation of new radar at Jastrebac (2013) all parts of Serbia are covered with Doppler Radars (Gematronik) with Rainbow software which is one of the most comprehensive, state-of-the-art sensor management system for multi-radar network management, data analysis and display available today. However, three Gematronik radars installed between 2000 and 2002 in Vojvodina need software update to utilize their full potential.



Hydrological situation

Hydrological forecasting models, early warnings and alerts are developed and introduced in operational practice.

At smaller and medium water flows, models based on the analysis of the rainfall-runoff process are used, along with the adapted well-known hydrological forecasting models, such as the TANK model for the Kolubara river and the HBV model for the Jadar, Kubrsnica, Jasenica, Mlava and Toplica river.



Due to extreme precipitation in the period 13-16 May 2014, there was a sudden and significant increase of water levels in the medium and small catchments in western, south-western, central and eastern Serbia. The highest increases were recorded in the Sava River, the Kolubara River, the Tamnava River; in the Jadar River and other tributaries of the Drina River; in the upper flow of the Zapadna Morava River with its tributaries; in the Velika Morava River with its tributaries; in the Mlava River and the Pek River. The water levels of these rivers surpassed the irregular flood defence limits and new historical maximums have been recorded.



Why did flooding occur?

During the first three weeks of May 2014, total rainfall has already exceeded the amount of 250 mm in central and western parts of Serbia (Loznica 286.9mm, Belgrade 266.2mm, Valjevo 262.9mm)

But also....

April 2014 ranked as the first with the highest precipitation amount in Serbia. Precipitation sums registered in most of Serbia were considerably above the average, especially over western and southwestern parts. Record-breaking daily precipitation totals were observed in Valjevo, B.Karlovac and Kopaonik Mountain.



Daily and cumulative precipitation in Valjevo

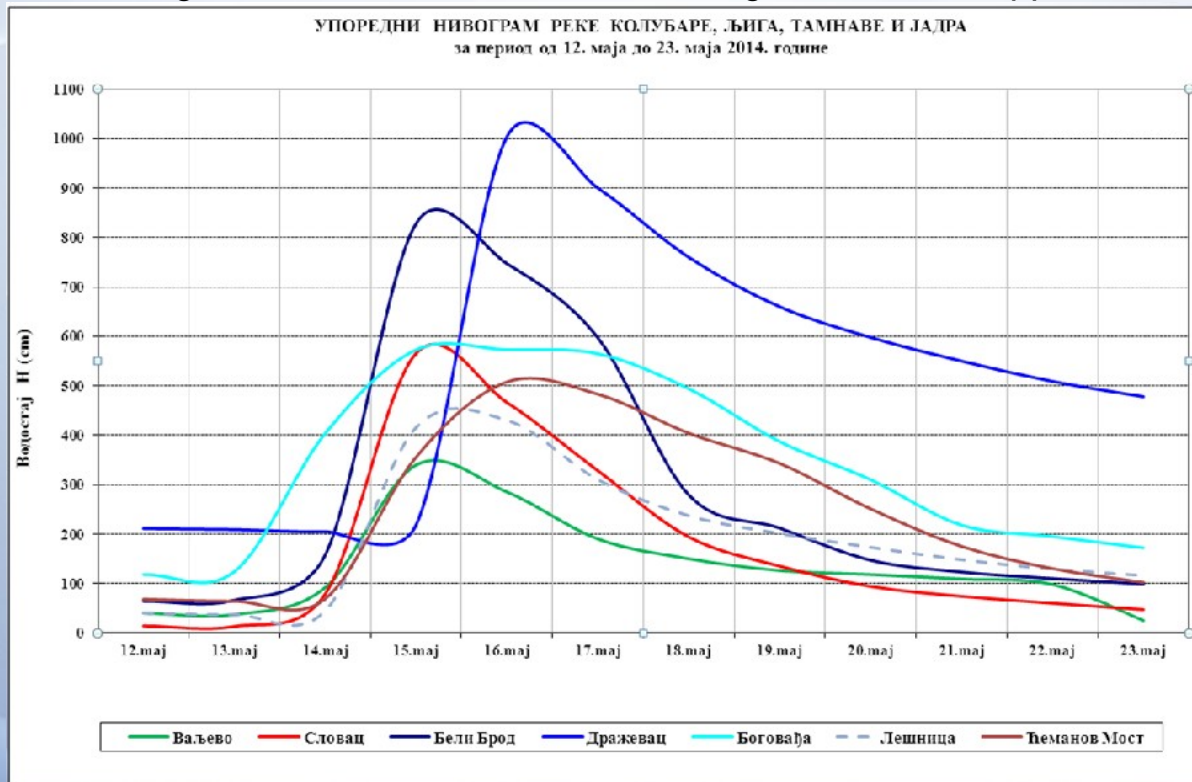




Example: Hydrological situation in the Kolubara catchment in May 2014



At the end of the second and in the middle of the third decade of April 2014, due to two episodes of rain, two waves were recorded of moderate and major water level increase. Water levels were decreasing in the period from 27 April to 2 May, after which the third wave ensued, lasting from May 3 to 7. After that, the water levels of the entire Kolubara catchment were stagnating in the period from 10 to 13 May. In the evening hours of May 13 the water levels of the upper flow of the Kolubara River increased, moderately at first, and more significantly later on. At the Valjevo, Slovac and Beli Brod hydrological stations the maximum water level was recorded on May 15. At the most downstream hydrological station Drazevac the water level suddenly increased on May 14/15, rising in the course of 24 hours from $H = 219$ cm to $H = 1005$ cm, which has been the last registered value, since the measuring instrument stopped working due to immersion in water.



At the Bogovadja hydrological station on the Ljig River the water level suddenly started to rise on 13/14 May, and the maximum height of $H = 637$ cm (a new historical maximum) was registered on 15/16 May, with the increase amplitude reaching $\Delta H = 449$ cm.

At the Cemanov Most hydrological station on the Tamnava River a major increase in water level was registered on 14/15 May, and the maximum height of $H = 507$ cm (a new historical maximum) was measured on 15/16 May, with the increase amplitude reaching $\Delta H = 439$ cm. At the Ub hydrological station on the Ub River a major increase in water level was registered on 13/14 May, and the maximum height of $H = 540$ cm (a new historical maximum) was measured on 15 May, with the increase amplitude reaching $\Delta H = 496$ cm.



SERBIA Worst affected areas:

Šabac and Obrenovac, municipalities of Ub, Krupanj, Svilajnac and Paraćin

Three immediate and direct effects of heavy precipitations:

1. High intensity flash floods resulting in the total destruction of houses, bridges and sections of roads (in western parts of Serbia, particularly in Krupanj);
2. Widespread flooding of both urban areas (particularly in Obrenovac) and rural areas (Šabac area);
3. Widespread landslides (Krupanj, Bajina Bašta).

The combination of heavy rainfall, high soil saturation before the intense rains began and the presence of unstable soils in hilly areas, caused the subsequent occurrence of landslides. These landslides occurred in both inhabited and uninhabited areas and generated destruction of houses, roads, bridges and other infrastructure works.



Obrenovac



SERBIA Worst affected areas:

Šabac and Obrenovac, municipalities of Ub, Krupanj, Svilajnac and Paraćin

The city of **OBRENOVAC** was hit hardest by the floods, with an estimated 90% of the town flooded. During the night between 15 and 16 May, nearby Kolubara river, collecting waters from southerly mountains, suddenly rose several meters above its banks and flooded the city. The entire city was evacuated, around 24000 people in total. During 18 May, the water level dropped.

Peak flood waters hit **ŠABAC** on 18 May, but the embankments survived, strengthened by efforts of army and several thousands volunteers. Flood waters on the Sava river reached 6.3 m, the highest on record, endangering Šabac and Sremska Mitrovica on the left bank.

Further east, along the valleys of Morava and Mlava rivers, city centers of Paraćin, Petrovac na Mlavi, Svilajnac and Smederevska Palanka were flooded.



Krupanj

In **KRUPANJ** in western Serbia, located in a valley of several small rivers, torrents, mudslides and landslides devastated the infrastructure and destroyed dozens of houses. Because of road damages, the town was completely inaccessible for three days, and the road to Loznica was cut only in 18 May. Electricity was cut for almost whole municipality. Around 500 houses were seriously damaged and at least 20 houses are completely uninhabitable. Part of the village of Rebelj in Valjevo municipality was annihilated by landslides. In the Drina river valley, on the border with Bosnia, heavy rain activated landslides, cutting off several villages and closing roads. At Mali Zvornik, a giant hill threatened to slide into the river and cut its flow, endangering that town and Zvornik across the river.



SERBIA Worst affected areas:

Šabac and Obrenovac, municipalities of Ub, Krupanj, Svilajnac and Paraćin

Fourteen bodies were recovered from the worst-hit Serbian town of Obrenovac, 30 kilometers southwest of the capital, Belgrade. The largest thermoelectric power plant in Serbia, TPP Nikola Tesla, which supplies close to 50% of electricity in Serbia, lies in the vicinity of Obrenovac, but was saved from danger. However, flood waters filled the largest coal field of RB Kolubara with 210 million cubic meters of water, and its pumping out is expected to take months. Further east, TPP Kostolac, which supplies 11% of electricity in Serbia, was threatened by floods from the Mlava, but the water had not breached the innermost ring of defenses. **From August 2014, RHMSS daily issue two Extraordinary bulletins for SEM to forecast weather conditions and warnings with level of awareness in the Mlava and Kolubara catchment for five days ahead.**



The flooded area match with regions with the highest level of warning!

Flooded area



18 May 2014



Republic Hydrometeorological Service of Serbia



The Serbian government declared an emergency situation
(the Official Gazette of the Republic of Serbia No 52 from 15 May 2014)



- The government established “Flood Emergency Headquarters” within the Sector for Emergency Management in The Ministry of Interior ;
- Important activities of the Serbian Red Cross ;
- On 16th May the Ministry of Foreign Affairs established its Crises Response Team Tasked with coordinating the activities related to relief and donations from abroad.



**The meeting of the Republican Headquarters for
Emergency Situations, 15 May 2014.**



23 May 2014



The Serbian government abolished at its session, at the proposal of the Staff for Emergency Situations, the emergency situation in the territory of the Republic of Serbia which has been in force since 15 May due to floods that hit our country.

Because of the flooding, some 32,000 people were evacuated from their homes, out of which 25,000 were from Obrenovac. The majority of evacuees found accommodation with relatives, but some 5,000 required temporary shelters in camps established by the Government and the Serbian Red Cross. The disaster resulted in 51 casualties, of which 23 were due to drowning.

Assessment of disaster effects

The assessment revealed that the total effects of the disaster in the 24 affected municipalities amounts to EUR 1,525 million, of which EUR 885 million (57% of the total effects) represent the value of destroyed physical assets, and EUR 640 million (43% of the total) refer to losses in production. The European Union, the United Nations and the World Bank – on the basis of an inter-agency agreement subscribed in 2008 – provided financial and expert support to conduct the assessment.



<http://reliefweb.int/report/serbia/serbia-floods-2014>

REPORT from [Government of Serbia](#), [World Bank](#), [European Union](#), [UN Country Team in Serbia](#)



Belgrade, 18 July 2014 - The Serbian parliament adopted the **Law on eliminating consequences of floods** and this special law (*lex specialis*) which will be valid one year and will apply in all the cities and municipalities that were damaged by the May floods in Serbia.

The law regulates the tasks related to the elimination of consequences of floods and landslides in the areas hit by the May floods.

The main achievements within governmental administration reform and the implementation of the National Programme for the Integration of the Republic of Serbia in the European Union during the last decade:

- Improved legal and institutional framework of the RHMSS;
- Enhanced capacity of the RHMSS to support DRR and adaptation to climate change, participation in governmental disaster risk and climate change activities and structures;
- Established of the operational national Climate Watch System as part of MHEWS and further development of the meteorological, climate and hydrological services;
- Enhanced infrastructure and capacity of the RHMSS to support WMO RA VI RCC Network-SEEVCCC operations and research functions;
- Enhanced Regional and International Cooperation and Partnership.





- Natural disasters, particularly storms and floods, becoming more frequent and severe because of climate change.

- Adaptation is a response measure promoted by the UNFCCC (United Nations Framework Convention on Climate Change) and Early Warning Systems are one way of reducing vulnerability and enhancing adaptive capacity to weather events and climate change.

- Flooding in May 2014 shows unquestionable need for further strengthening international and regional cooperation and also improvement of meteorological, climate and hydrological services.



**THANK YOU FOR YOUR
ATTENTION!**