



REPUBLIC OF SLOVENIA
MINISTRY OF THE ENVIRONMENT AND SPATIAL PLANNING
SLOVENIAN ENVIRONMENT AGENCY

FLASH FLOOD FORECASTING AND EARLY WARNING IN SLOVENIA

Sašo Petan

Hydrological Forecast Department,
Slovenian Environment Agency (ARSO)

SLOVENIAN ENVIRONMENT AGENCY (ARSO)

Body of the Ministry for the Environment and Spatial Planning

100% governmental institution, 5 Offices

The principle tasks of the Meteorological and Hydrological Offices:

Continuous monitoring, analyzing and forecasting of weather and hydrological conditions of rivers and the sea in Slovenia

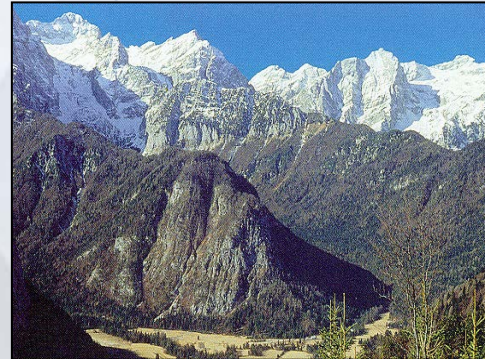
Issuing warnings on extreme/dangerous weather, weather related and hydrological phenomena

SOME FACTS ABOUT SLOVENIA



FOUR MAJOR EUROPEAN GEOGRAPHIC REGIONS MEET IN SLOVENIA – SIGNIFICANT IMPACT ON WEATHER AND CLIMATE.

The Alps (N and NW)



The Pannonian plain (E and NE)



Area and Altitude:

20 273 km²

0 to 2864 m a.s.l., average of 557 m

Major river catchments:

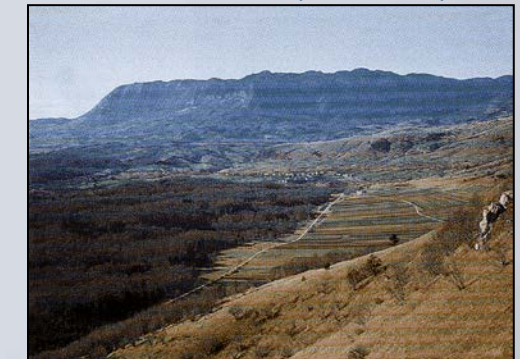
Sava, Drava, Mura, Kolpa – Black Sea RB

Soča, Adriatic rivers – Adriatic Sea RB

The Mediterranean (SW)

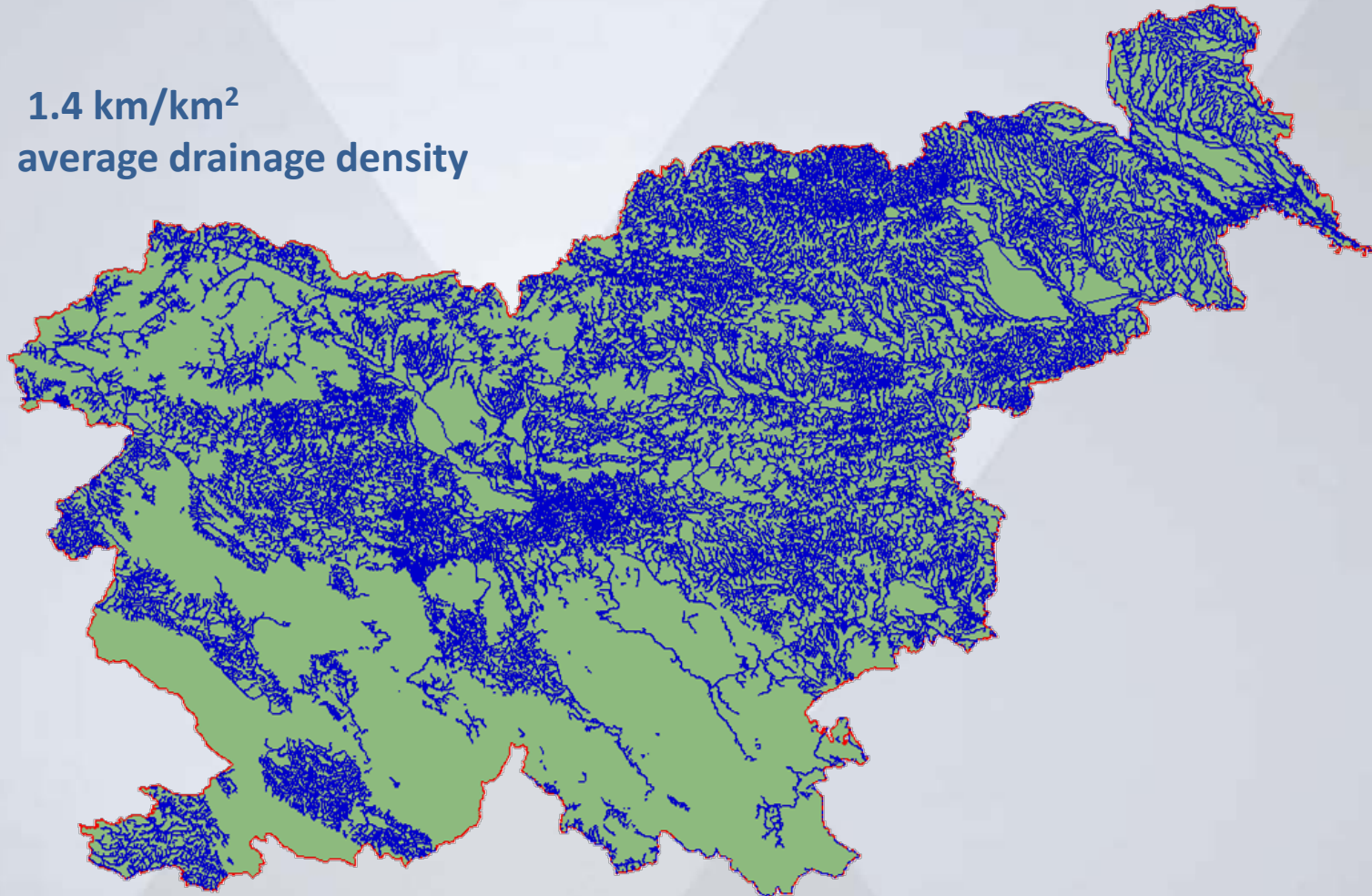


The Dinaric Karst (S and SW)



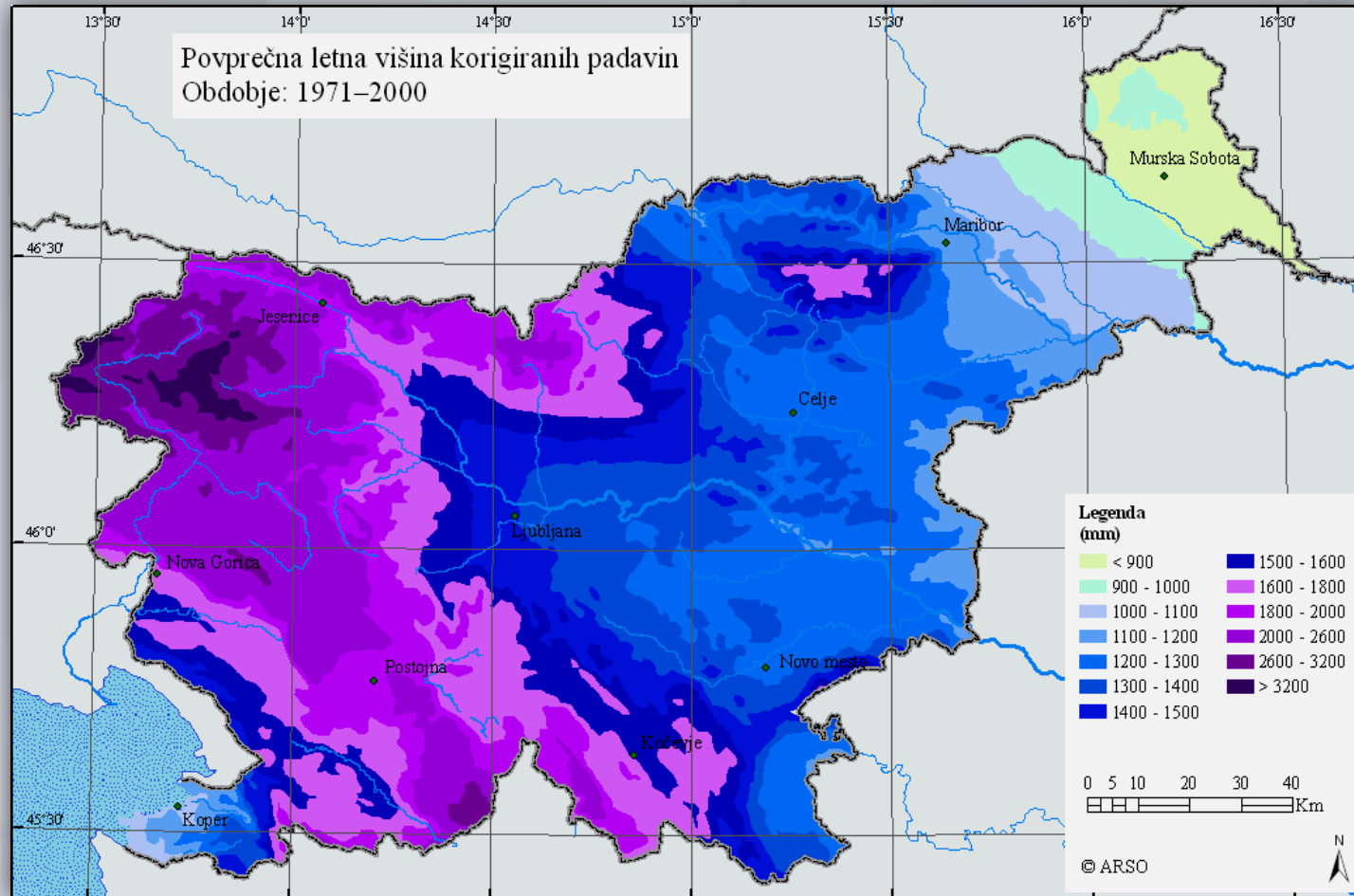
THE RIVER NETWORK OF SLOVENIA

1.4 km/km²
average drainage density



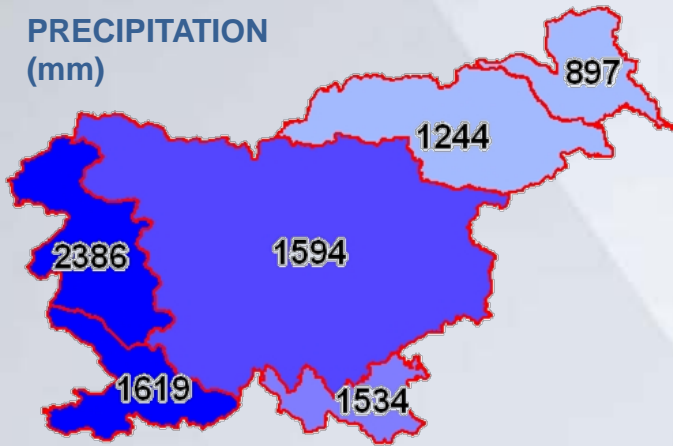
PRECIPITATION MAP OF SLOVENIA

average annual values in the 1971–2000 period

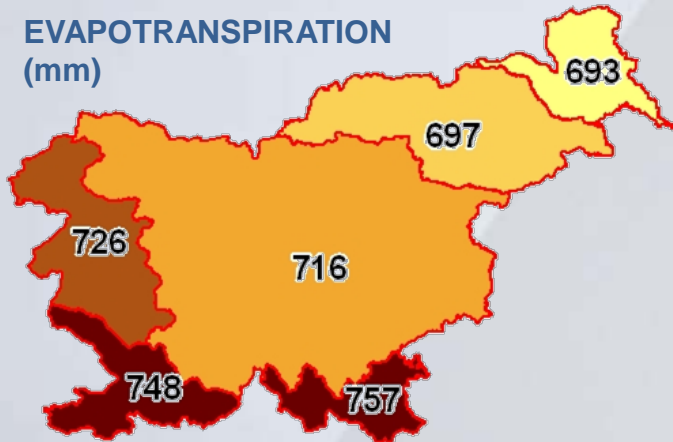


ELEMENTS OF THE WATER BALANCE

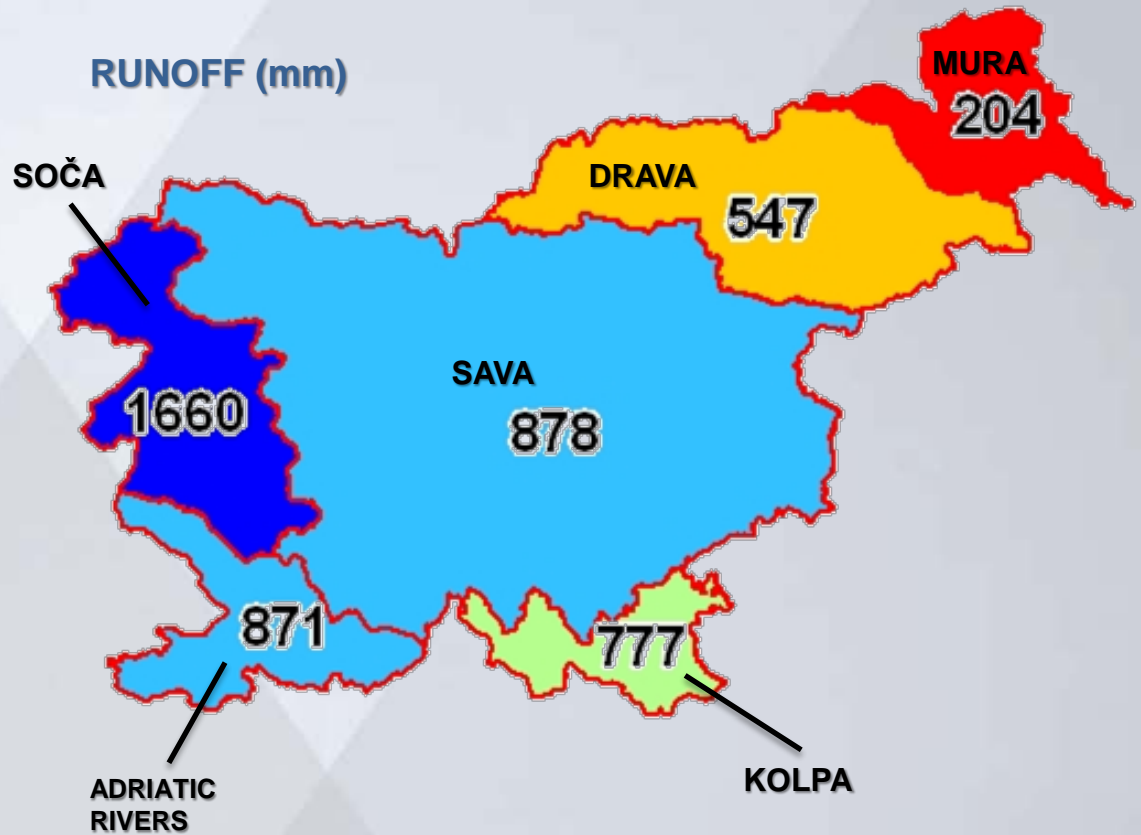
PRECIPITATION
(mm)



EVAPOTRANSPIRATION
(mm)



RUNOFF (mm)



FLASH FLOODS IN 2014

Polhov Gradec, Aug & Sep 2014



Poljanska dolina, Oct 2014



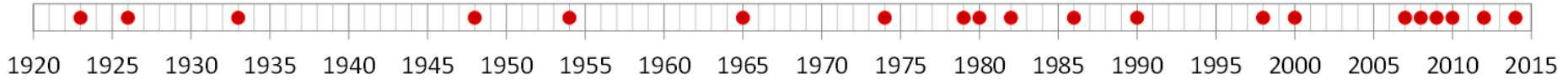
Planina, Feb & Nov 2014



Bač, Nov 2014



FLOODS IN SLOVENIA



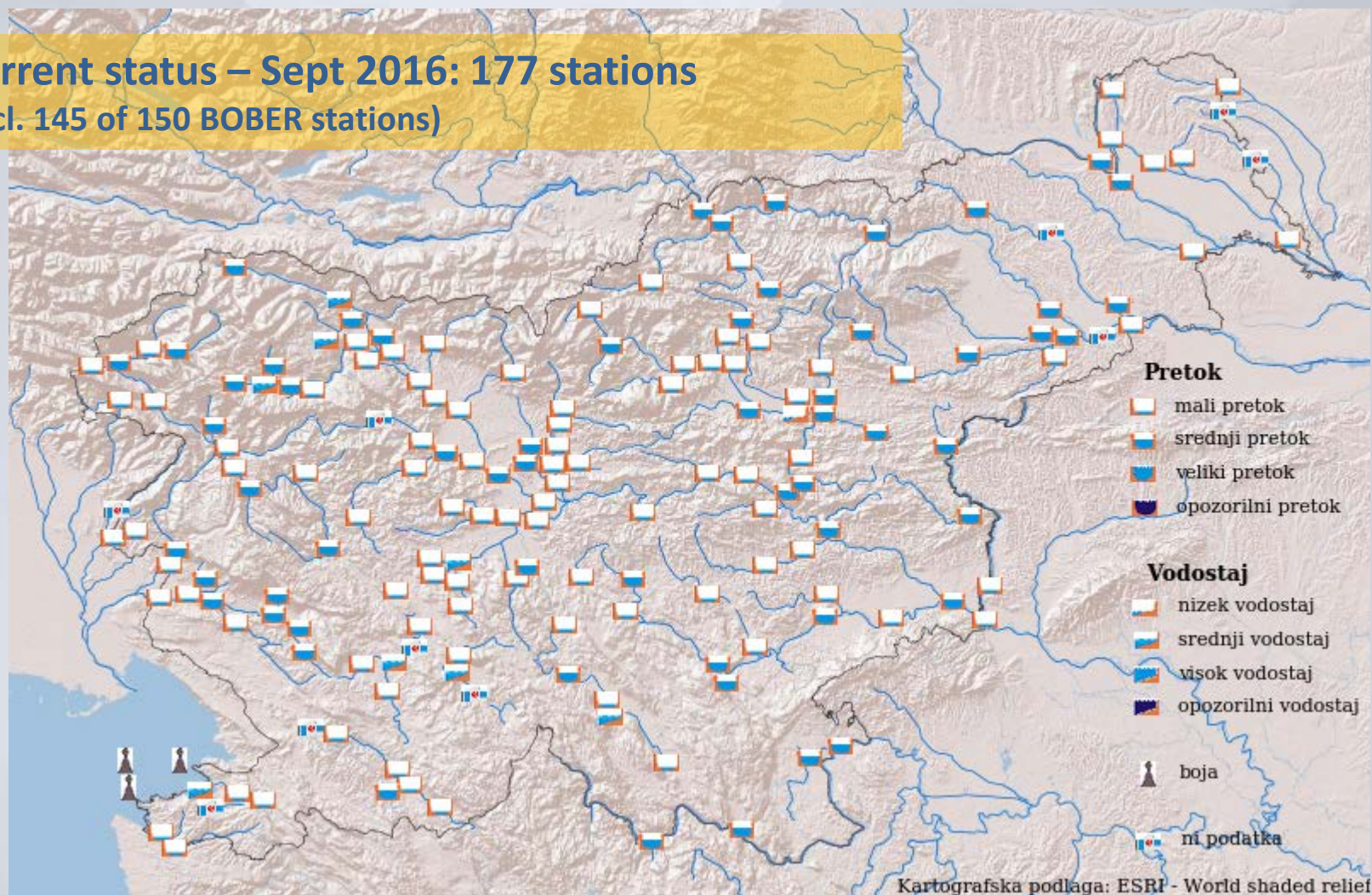
Better Observations for Better Environment Response (BOBER)

Upgrading the system for monitoring and analysing the state of the water environment in Slovenia:

- 281 upgraded / new **measuring stations** throughout Slovenia
- additional **weather radar**
- upgraded **computer infrastructure** in the Computer Centre
- **forecasting systems** developed for the state of the Slovenian rivers, the sea dynamics, the underground water in alluvial aquifers and drought monitoring

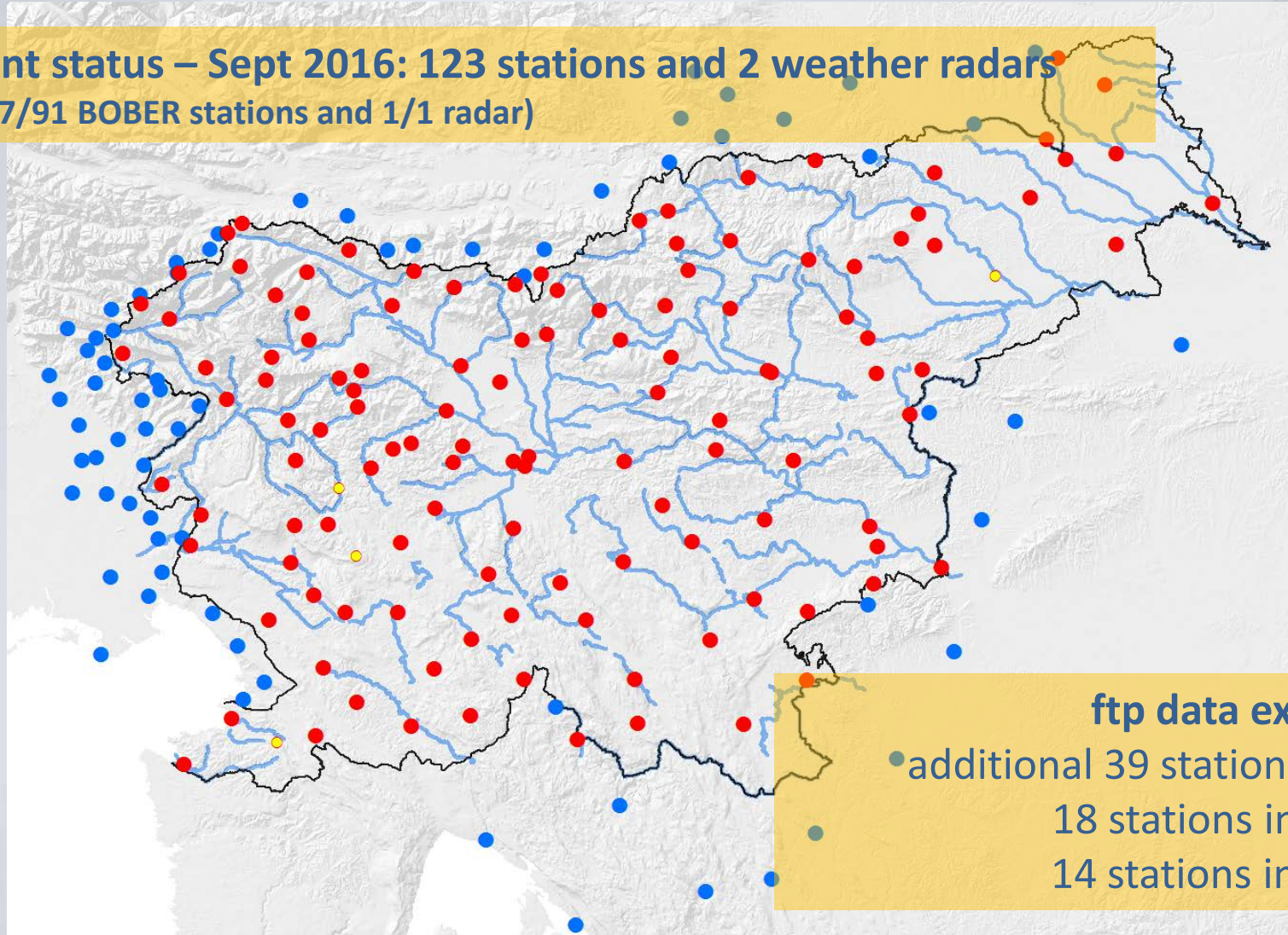
HYDROLOGICAL OBSERVATIONS IN REAL-TIME

Current status – Sept 2016: 177 stations
(incl. 145 of 150 BOBER stations)



PRECIPITATION OBSERVATIONS IN REAL-TIME

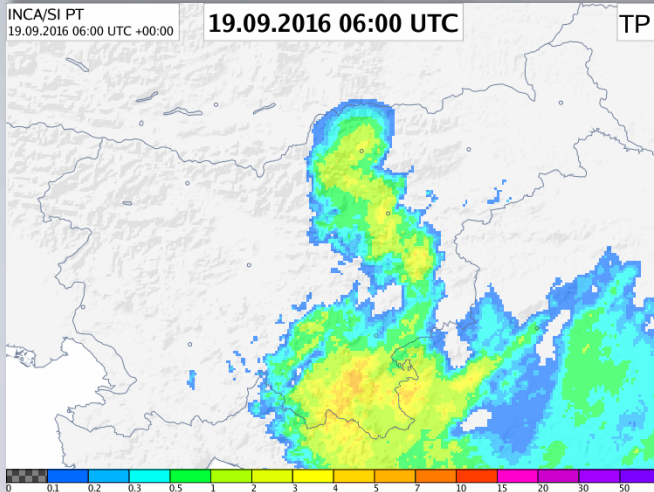
Current status – Sept 2016: 123 stations and 2 weather radars
(incl. 87/91 BOBER stations and 1/1 radar)



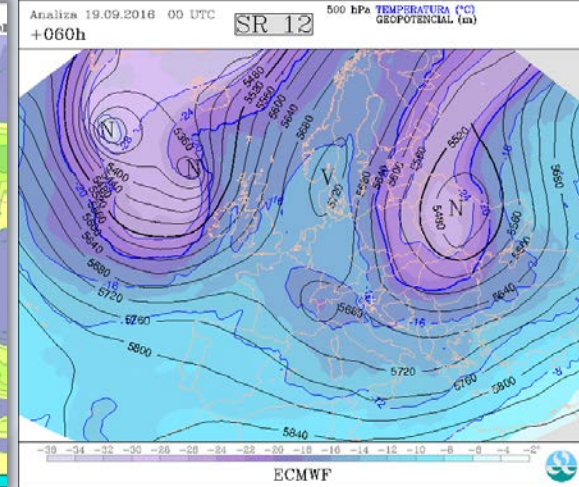
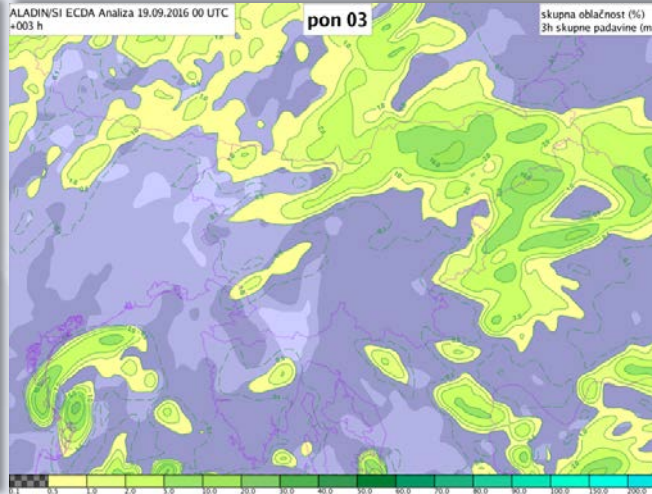
ftp data exchange:
● additional 39 stations in Italy
18 stations in Austria
14 stations in Croatia

INCA AND NWP MODELS

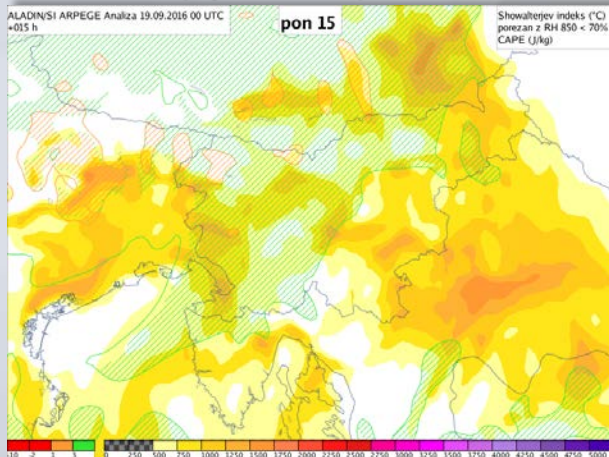
INCA-CE (up to +12h)



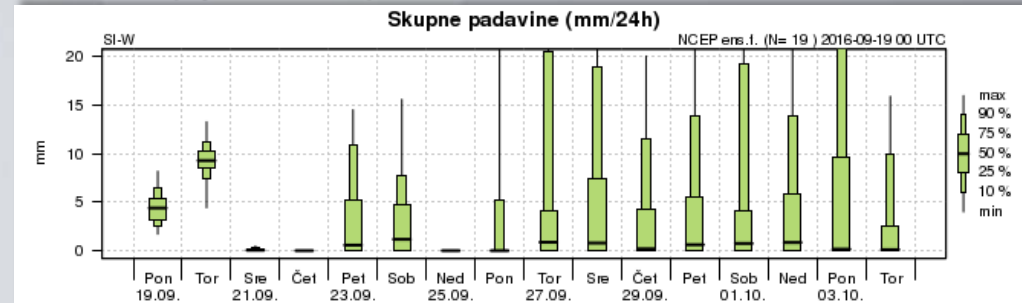
Aladin ECDA (up to +72h) + LAEF Ensemble ECMWF (up to +240h)



Aladin AR (up to +72h)



NCEP Ens (up to +384h)



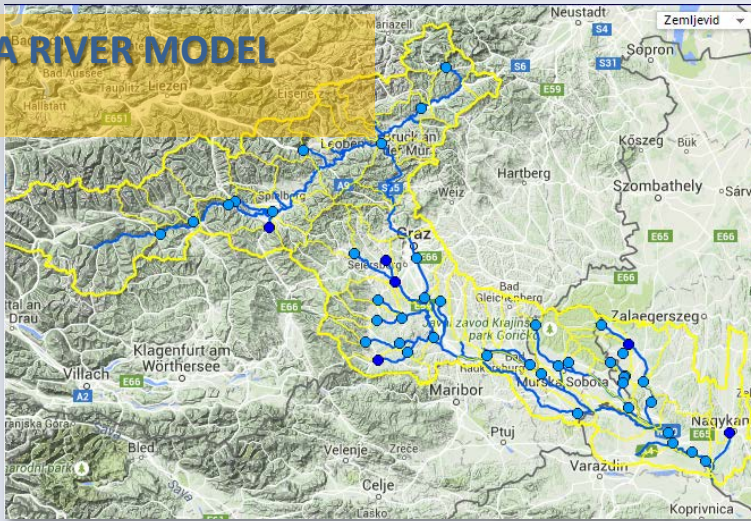
THE HYDROLOGICAL FORECASTING SYSTEM (HFS) OF ARSO



HIDROLOŠKO STANJE IN NAPOVED



MURA RIVER MODEL
2006



SAVA AND SOČA RIVER MODELS
2011



SLOVENIA MODEL
2014



Boundary conditions on the transboundary rivers:

Drava – EFAS forecast

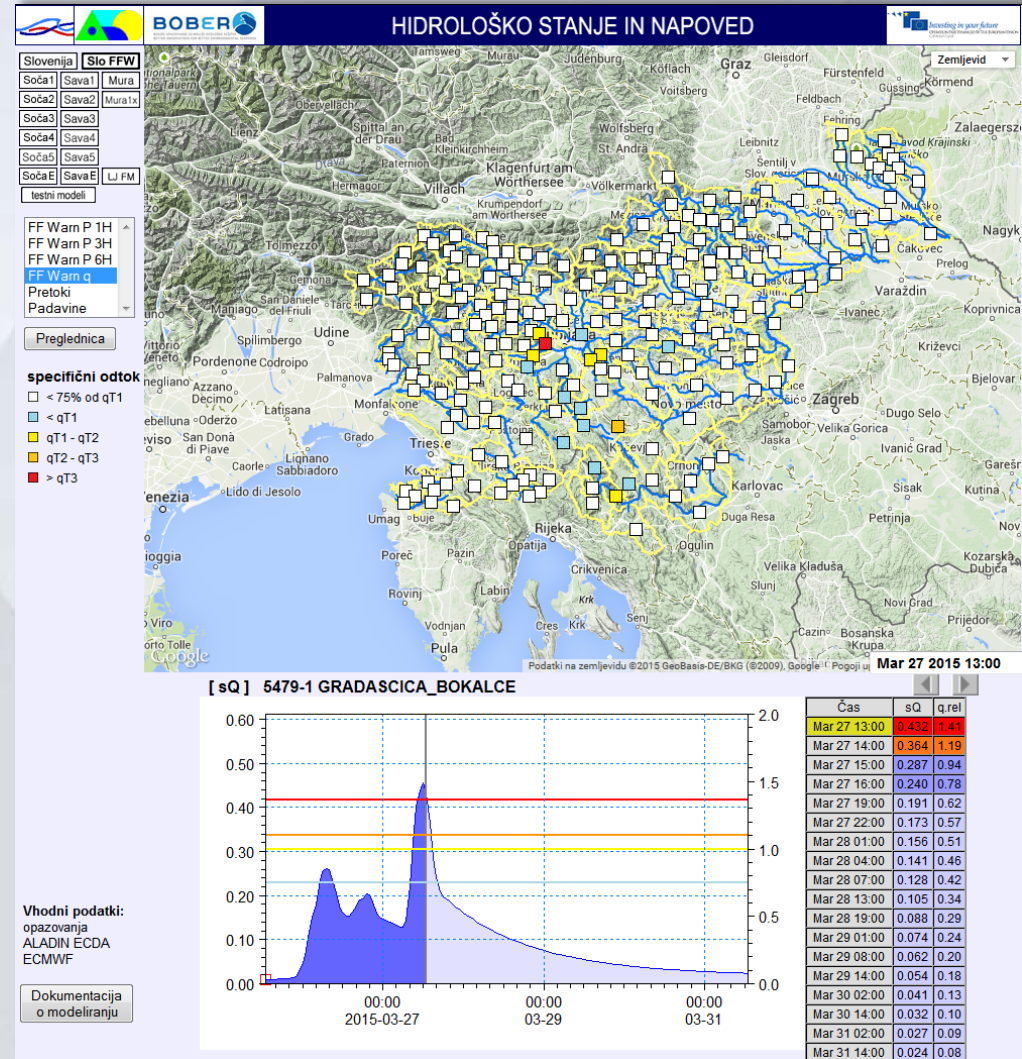
Mura – Mura model forecast

HFS WARNING PRODUCTS

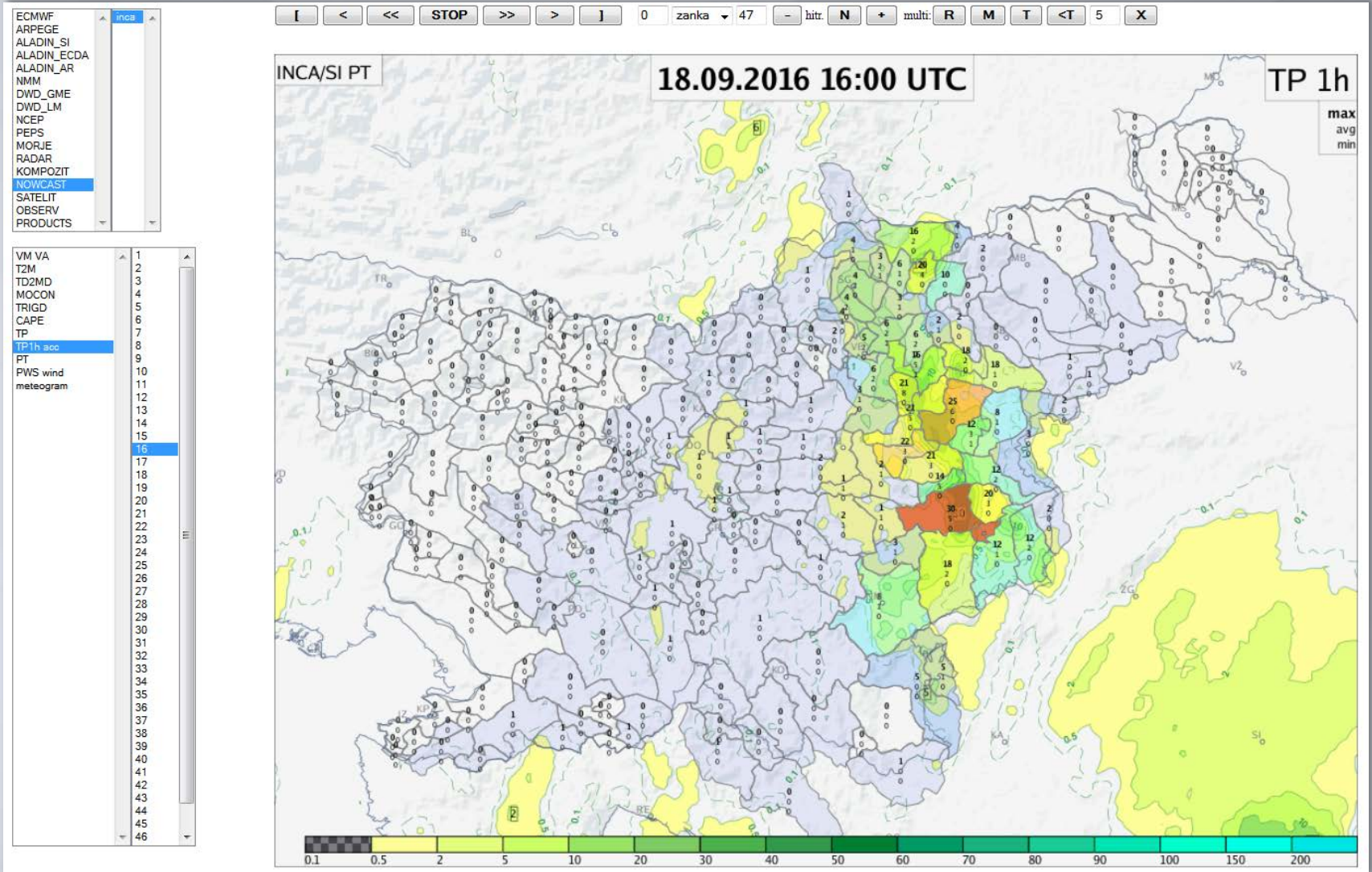
Statistically derived thresholds:

- 1h cumulative rainfall [mm]
- 3h cumulative rainfall [mm]
- 6h cumulative rainfall [mm]

Catchment specific runoff
[m³/s/km²]



INCA & HFS COMBINED



EFAS Flash Flood information

EFAS Flash Flood Notification for Slovenia - Podravska Region

Written by Michaela Mikulickova
Monday, 02 May 2016 06:34

EFAS Flash Flood Notification*

Country(ies): **Slovenia**
Region(s): **Podravska Region**
Earliest predicted peak: **Monday 2nd of May 2016 12:00**
Percent of affected area susceptible to landslides: very high **21%**, high **25%**, moderate **46%**
Forecast date: **2016-05-01 12 UTC**
Comment: -

This is the only notification you will receive for this event! Please follow the evolution of the event on EFAS.

EFAS forecaster on duty






Michaela Mikulicková
Tel: +421-2-59415106, 59415244
e-mail: michaela.mikulickova@shmu.sk
Slovak Hydrometeorological Institute (SHMU)

* indicating a high probability of extreme precipitation and potential flash flooding

- ▶ Search
- ▶ Partners list
- ▶ Contact us

New Bulletin ON-LINE

June - July 2016



-  **Adding new people to alerts**
1 month 19 hours ago
-  **real time hydrographs are out of date**
5 months 4 days ago
-  **Which met model is used in flood prob layers?**
5 months 5 days ago
-  **Problem with service status alert?**
11 months 3 weeks ago
-  **Flood Probability Layers**
11 months 3 weeks ago

[More Topics >](#)

JOINT RESEARCH CENTRE

EFAS forecasting Service OK

Forecasts available from 2009-05-01 to 2016-09-18 (12 UTC)

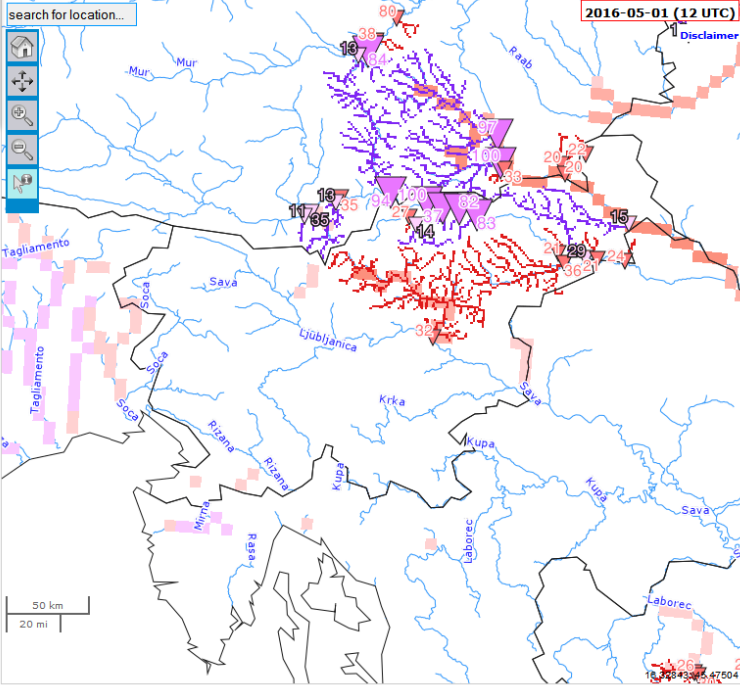
Utilities ▾ Partners Forum Search Partners list Contact us

hidrolosko.opozorilo Log out

<< full screen opacity << [0.3] >> Print screenshot

search for location...

2016-05-01 (12 UTC) Disclaimer



Contact: EFAS Team


Select layers

2016-05-01 12 UTC

- Flood summary layers (0/11)
- Hydrological layers (3/6)
- Meteorological layers (0/8)
- Init. Conditions layers (0/11)
- Background layers (2/6)
- Flash flood layers (2/2)
- Reporting Points
- Affected Drainage Area

Affected Drainage Area

Legend



Description
Drainage area affected by the forecasted heavy precipitation and potential flash floods. Red/Purple = drainage area affected with a high probability to exceed a 5/20 year return period magnitude.

SEE Flash Flood Guidance System

SEEFFG - Southeast Europe Flash Flood Guidance System

Current Date: 2016-09-19 08:16 UTC Nav Date: 2016-05-01 12:00 UTC
 Year: 2016 Month: 05 Day: 01 Hour: 12 REGION: Slovenia

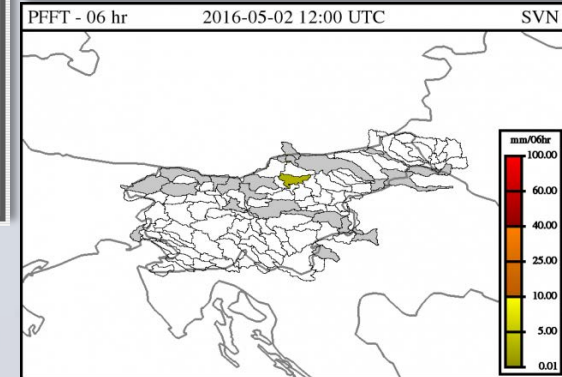
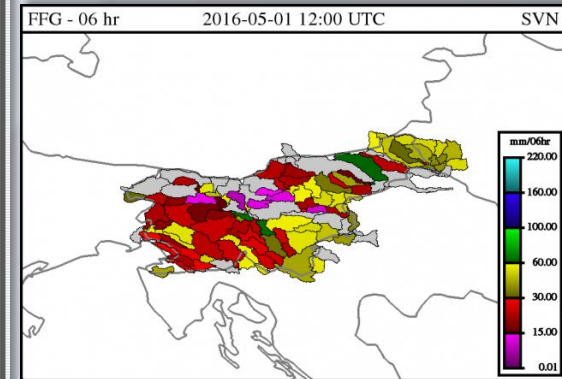
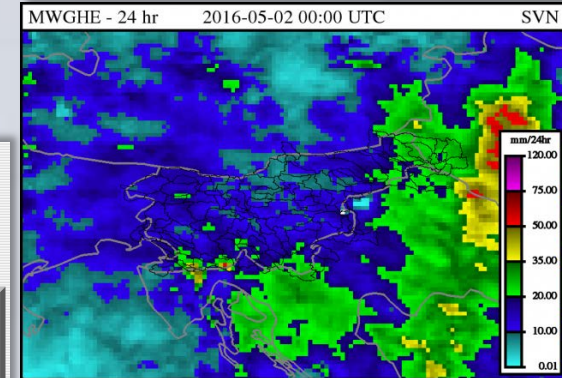
| DT | MWGHE Precipitation | GHE Precipitation | Gauge MAP | Merged MAP | ASM | FFG | IFFT | PFFT | ALADIN Forecast | FMAP | FFFT |
|-------|---|---|---|---|---|---|---|---|---|---|---|
| 01-hr | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 07:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View |
| 03-hr | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 09:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View |
| 06-hr | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View |
| 24-hr | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View | 2016-05-01 12:00 UTC Text View |

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

SFTP data transfer (requires SFTP Client): [EXPORTS:SVN/2016.05.01](#)

Surfnet Gauge Observations at 2016-05-01 12:00 UTC

| Station Identifier | Station Name | Accumulated Precipitation (mm/96hr) | Average Temperature (C) | Snow Depth (cm) | Snow Cover (Index) | 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 | No reports for region | No reports for region |



METEOROLOGICAL and HYDROLOGICAL FORECASTERS

Integrated hydro-meteorological activities:

- 24/7 meteorological, daily hydrological service (on call)
- daily consultations at specified hours (9:00 and 13:00)
- common operation and communication strategies in emergency situations
- harmonized warning thresholds for intensive rainfall and flood hazard – coloured warnings
- meteorological data and forecasts available for hydrological forecasting through common database and local network

SKILLED AND EXPERIENCED FORECASTERS

Assess if the event is:

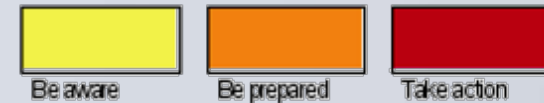
- unusual
- dangerous
- likely - less or more
- locally limited or may affect wider area



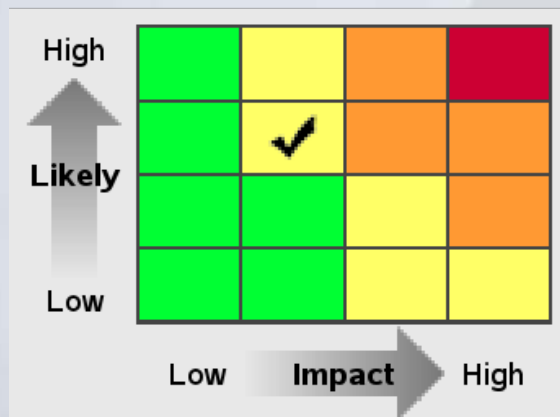
Assess the possible **impact**,
consider **vulnerability**
and **respond**



Present, report, share
i.e. colours



Weather Impact Matrix



WARNINGS: text, graphics, multimedia

REPUBLIKA SLOVENIJA
 MINISTRSTVO ZA OKOLJE IN PROSTOR
 AGENCIJA REPUBLIKE SLOVENIJE ZA OKOLJE

Vojkova 1b, 1000 Ljubljana

T: 01 478 40 00
 F: 01 478 40 52
 E: gp.arso@gov.si
 www.arso.gov.si

FAX Za: **Republiška uprava za zaščito in reševanje, Center za obveščanje RS**
 fax: 471-32-82, 471-32-81

Od: Oddelek za hidrološko prognozo
 tel: +386(0)1 478 41 47
 fax: +386(0)1 478 40 52

Datum: 14. 10. 2015 ob 8:00

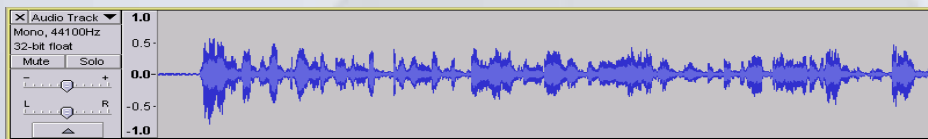
OPOZORILO

Zaradi močnih nalivov bodo danes dopoldne hitreje naraščali hudourniki in reke v Vipavski dolini, na Goriškem, na območju Idrijsko-Cerkljanskega hribovja ter v jugovzhodni Sloveniji. Pri tem lahko pride do razlivanja na izpostavljenih mestih ob vodotokih.

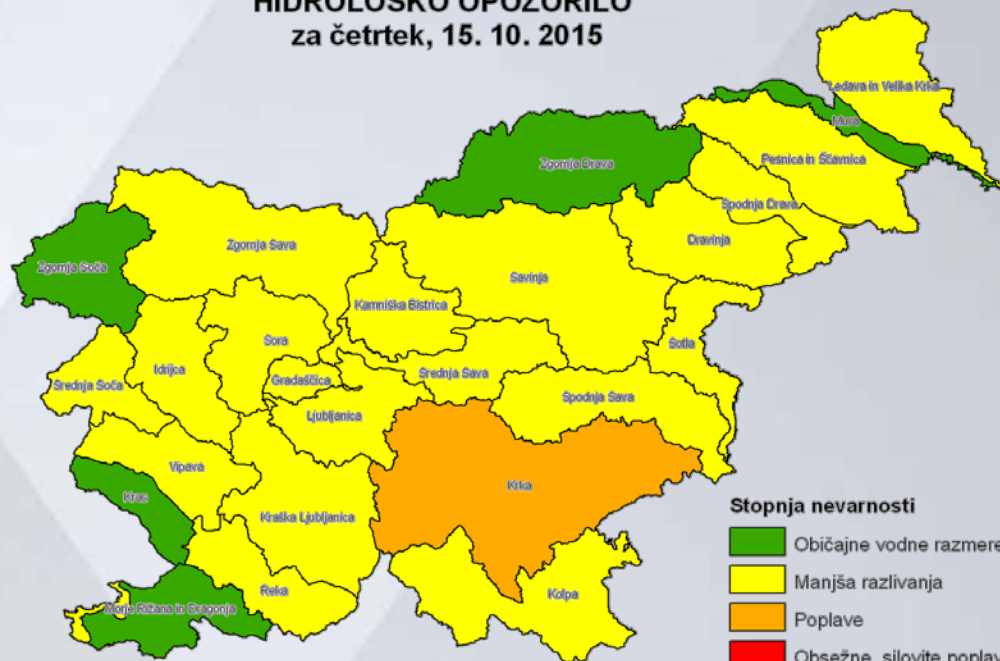
Danes tekom dneva bodo reke po državi močneje naraščale, zvečer in v noči na četrtek lahko pride do razlivanja manjših vodotokov v jugozahodni, osrednji in jugovzhodni Sloveniji. V četrtek bodo reke še naraščale, do razlivanja v nekoliko večjem obsegu lahko pride zlasti na porečju Krke.

Danes dopoldne, med 9. in 12. uro, bo gladina morja ob slovenski obali zaradi visokega plimovanja in južnega vetra povišana. Ob tem lahko morje poplavi nižje predele obale.

Lep pozdrav,
 Hidrološka prognoza



HIDROLOŠKO OPOZORILO za četrtek, 15. 10. 2015



Stopnja nevarnosti

- Običajne vodne razmere
- Manjša razlivanja
- Poplave
- Obsežne, silovite poplave

Urad za hidrologijo in stanje okolja
 Sektor za analize in prognoze površinskih voda
 Oddelek za hidrološke prognoze

REPUBLIKA SLOVENIJA
 MINISTRSTVO ZA OKOLJE IN PROSTOR
 AGENCIJA REPUBLIKE SLOVENIJE ZA OKOLJE

Izdano: 14. 10. 2015 ob 8:00

| year | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|-----------------|------|------|------|------|------|------|------|
| issued warnings | 114 | 32 | 125 | 118 | 234 | 74 | 72 |

WARNING, DATA AND FORECAST DISSEMINATION

Authorities (national EWS):

Ministry of Defence,
Administration for Civil Protection and Disaster Relief

Media and general public:

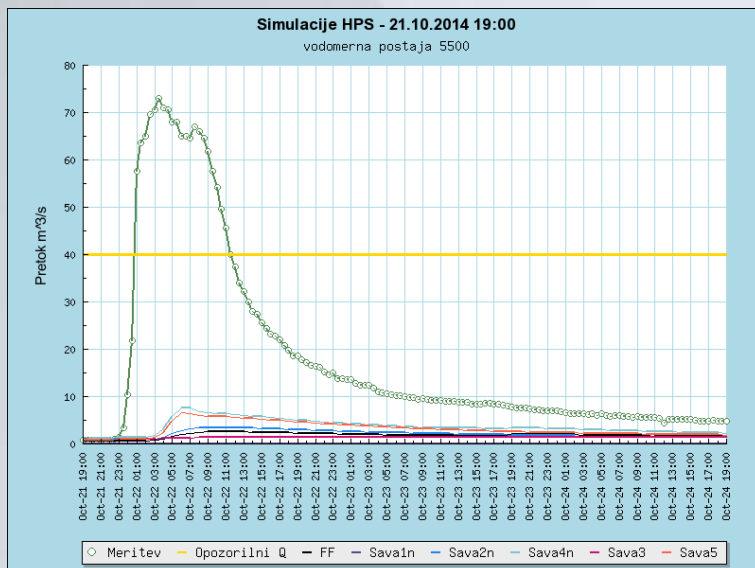
Radio and TV stations, teletext, newspapers

Neighbouring countries (bilateral agreements):

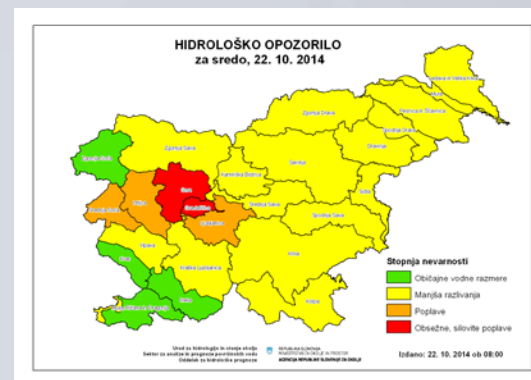
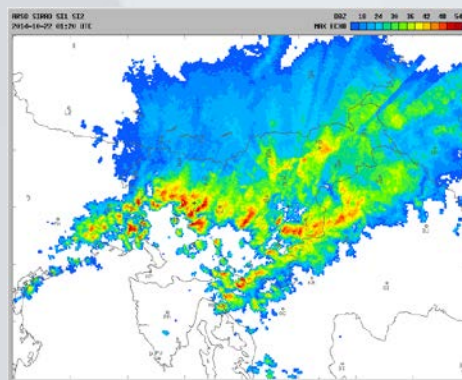
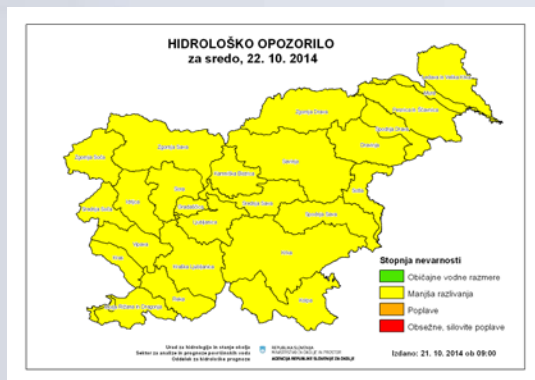
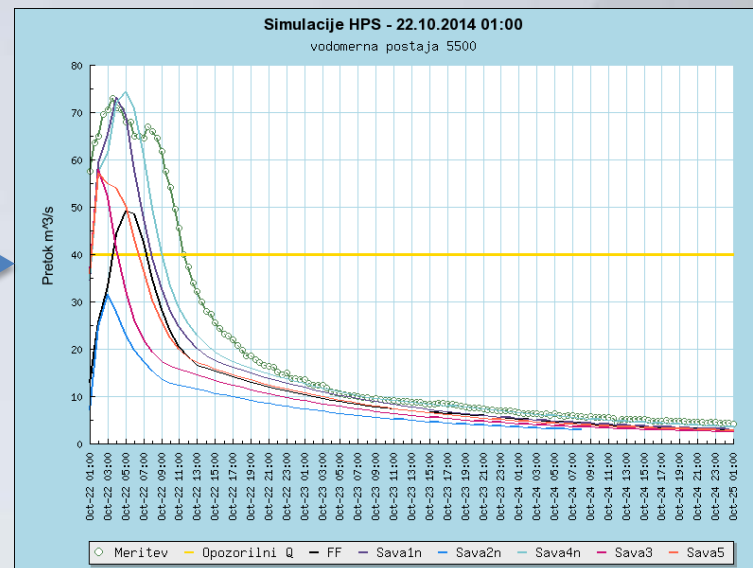
Authorities in Croatia, Italy and Hungary (and Austria)

**ARSO website, meteo.si, MeteoAlarm,
ftp, e-mail, fax, telephone communication**

Flash flood event on Sora and Gradaščica, 22 Oct 2014



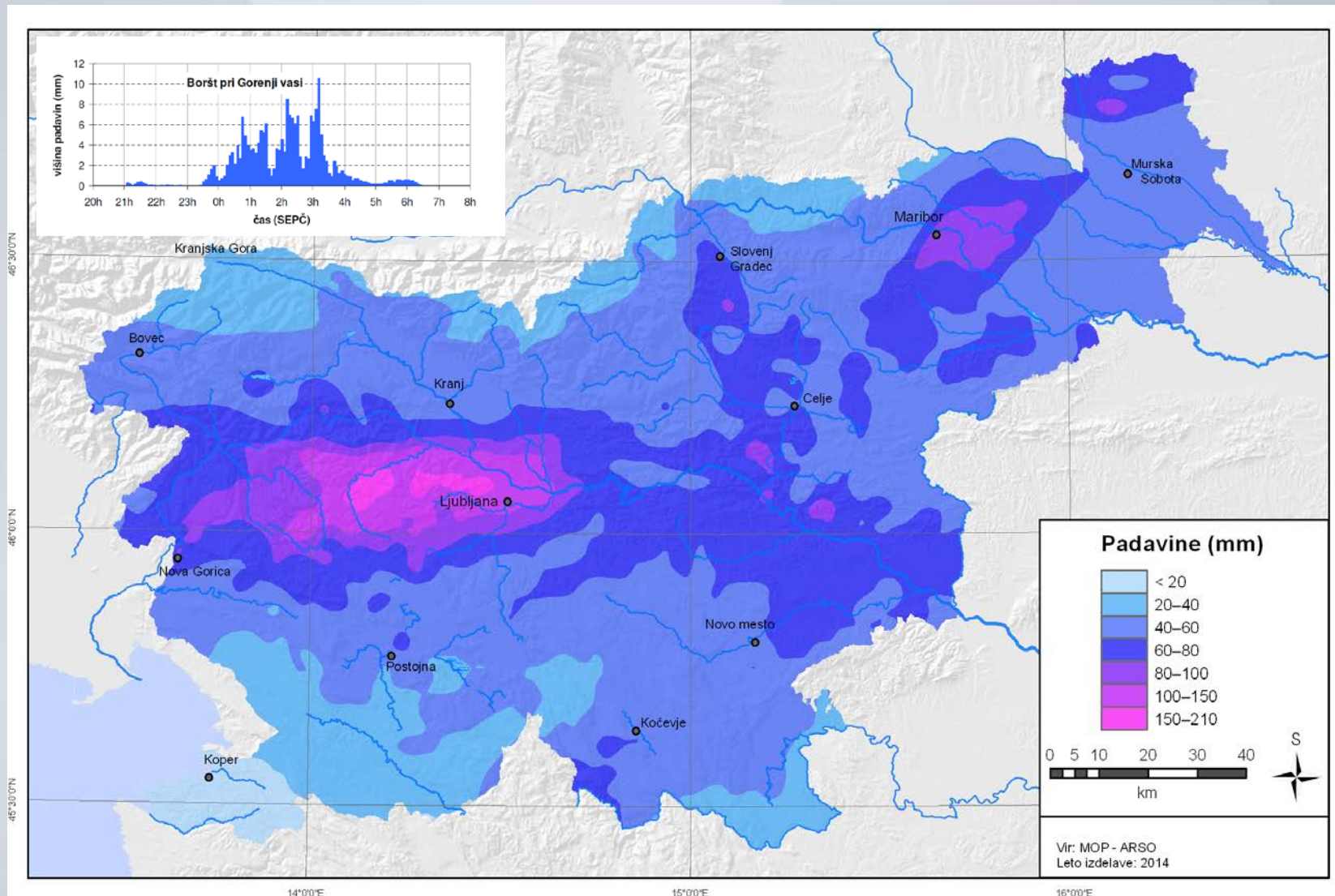
+6h



Yellow warning for small river flooding 21 oct 2014 09:00

Red warning 22 oct 2014 08:00

Flash flood event on Sora and Gradaščica, 22 Oct 2014



CONCLUSION

(Flash) Flood forecasting and warning issues in Slovenia:

- establishing full 24/7 hidrometeorological service
- communicating event uncertainties with the end users, media and general public
- general flood and flood warning awareness
- EWS warning products update
- Modern media and community presence (tweeter, YT, FB)





REPUBLIC OF SLOVENIA
MINISTRY OF THE ENVIRONMENT AND SPATIAL PLANNING
SLOVENIAN ENVIRONMENT AGENCY

Thank you for your attention!