



**ADVANCES IN  
FOREST FIRE  
RESEARCH**

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# The weather circulation analysis over Adriatic region of Croatia in warm period 1981-2013

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## Abstract

The most frequent natural hazard in the Adriatic region are the forest fires, which are strongly affected by weather conditions. This is particularly stressed in the last two decades, when large fires occurred. Furthermore, the season has been expanded and large fires appeared also in early summer and early autumn, which was not so common before. In order to explain such a behaviour, an analysis of the atmospheric circulation patterns has been performed. The results reveal that the frequency of weather types connected to dry and warm conditions has been increased, and frequency of weather types with wet weather has been reduced. This is especially pronounced in June and September. Additionally, a change of number of days with precipitation has been observed, with less days with smaller precipitation and more days with larger precipitation. This can lead to additional drying of the fuel. The risk- and fire-managers should be aware of these trends in the future.

*Keywords: forest fires, atmospheric circulation, weather types, climate change*

## 1. Introduction

Most frequent natural hazards on the Adriatic region are forest fires. They strongly depend upon weather conditions such as dry and warm periods, which are connected with weather types and atmospheric circulation.

A large number of forest fires appeared in 2000s. They occurred not only on the coast, but for the first time in the mountain region as well. Furthermore, since 2005 the most dangerous fires appeared at the end of August and first part of September, which was not common before. Recently – particularly in 2012 - fires became more frequent in interior parts also.

In order to find a possible explanation of such behaviour, an analysis of the upper atmosphere circulation was done for warm season for period 1981-2013.

Additionally, the analysis of mean monthly number of days with precipitation has been performed also.

## 2. The atmospheric circulation

There are seven main atmospheric circulations patterns in upper atmosphere: upper atmospheric ridge (R), non-gradient field (NG), front side of the ridge (FR), upper through (TR), back side of the upper through or north-west stream (NW), west-stream (W), front side of upper through or south-west stream (SW).

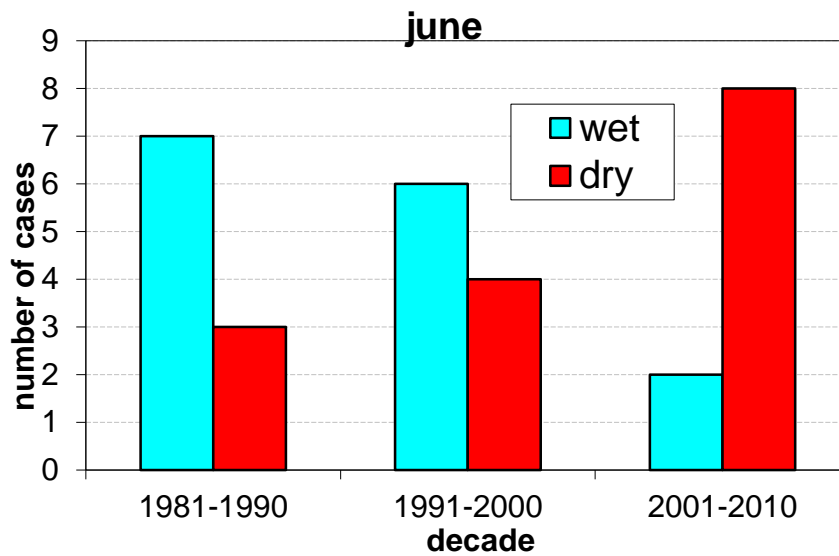
First three types are associated with relatively dry and warm weather, which could be connected with an increased number of forest fires. North-west stream brings cold air with local showers or thunderstorms. West stream is characterized by moderate temperatures and precipitation, while south-west stream and upper through usually cause more precipitation.

The analysis is done for Adriatic coast for years 1981-2013 for period May to October. Charts of mean monthly circulation AT 500 hPa on the Northern hemisphere (Deutscher Wetterdienst and European Centre for Medium-Range Weather Forecast) were used. The weather pattern typing is done manually.

### 3. Results

Most frequent situations are north-west and west stream with relative frequency about 25%, the same as non-gradient field and the upper ridge (although the upper ridge is most common in July and August, and very rare - with only one case - in September). Frequency of upper through is about 15%, mostly in September. The southwest stream, which brings more rain, has the frequency 6%, and is most common in September. This distribution of weather circulation pattern is expected.

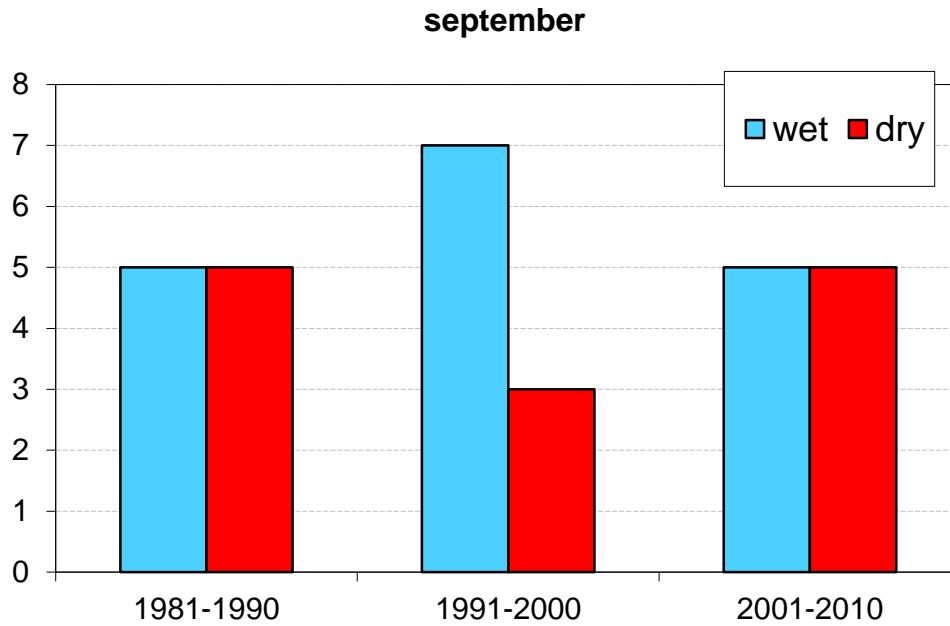
A further analysis showed that in May and June the non-gradient field and upper ridge mean monthly circulation has appeared more frequently since 2000. In July the distribution of patterns is dispersed. The west and north-west stream were most frequent in August, the west stream particularly in the first decade.



|      |    |    |    |    |    |    |    |    |    |    |
|------|----|----|----|----|----|----|----|----|----|----|
| 80's | TR | NW | NW | W  | W  | SW | SW | W  | NW | W  |
| 90's | W  | NG | W  | R  | TR | W  | W  | R  | W  | R  |
| 00's | TR | R  | FR | NW | NW | NW | W  | NG | NW | NG |

Figure 1. The frequency of relatively dry (filled red) and wet (filled blue) weather types in June, for period 1981-2010.

Finally, in September and October the most frequent types are north-west stream, upper through and - particularly in October - southwest stream. However, since 2005 non-gradient field appeared more often, characterized by less precipitation.



|      |    |    |    |    |    |    |    |    |    |    |
|------|----|----|----|----|----|----|----|----|----|----|
| 80's | W  | NG | NW | SW | R  | W  | W  | TR | NG | NW |
| 90's | NW | W  | W  | TR | TR | TR | NW | W  | NG | W  |
| 00's | TR | TR | TR | NW | SW | NG | W  | NW | NG | NW |

*Figure 2. The frequency of relatively dry (filled red) and wet (filled blue) weather types in September, for period 1981-2010.*

To estimate the potential influence of such a distribution to the precipitation regime on the Adriatic, an analysis of number of days with precipitation has been conducted also. The goal of such analysis is to provide the information about the distribution of precipitation events, and its possible trends.

A mean number of days with precipitation greater than 1mm, 10 mm, 20 mm and 50 mm is calculated for individual months (May, June, July, August, September and October). Data are based on 63 climatological stations on the Adriatic, for period 1981-2013.

A simple and preliminary analysis reveals that the number of days with smaller precipitation is generally found to be decreasing towards the end of the observed period. Meanwhile, number of days with larger precipitation thresholds is significantly increasing. This feature is observed for both June and September.

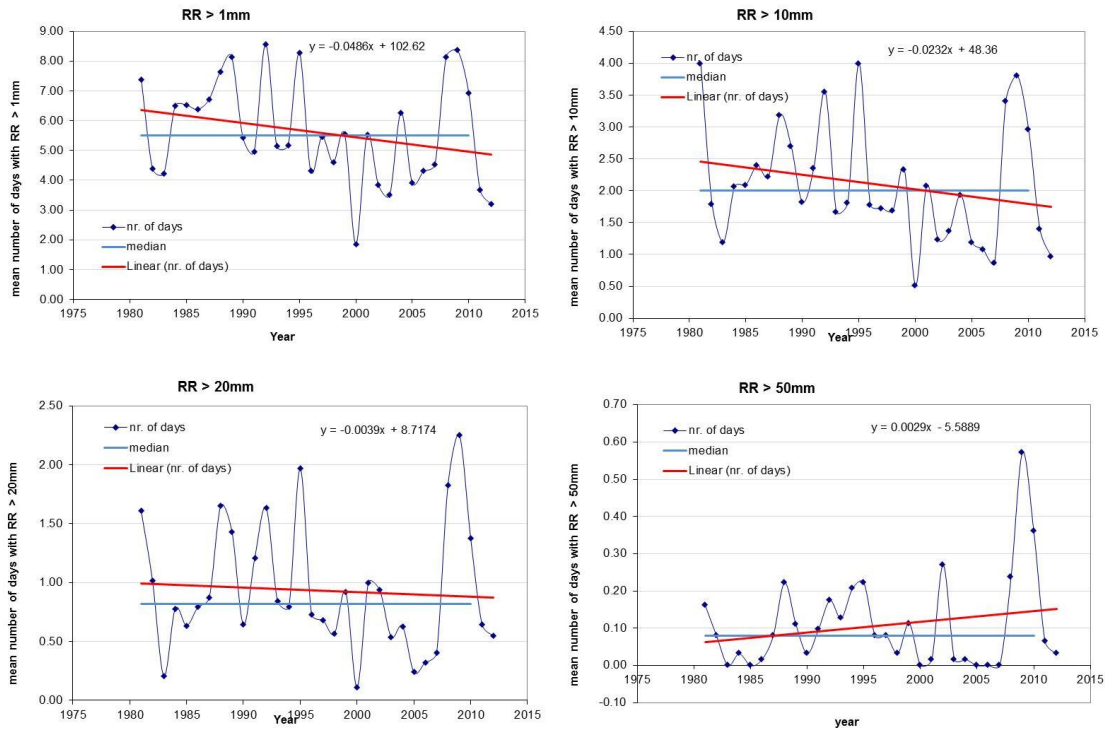


Figure 3.: Mean number of days with precipitation bigger than 1mm, 10 mm, 20 mm and 50 mm, for June (period 1981.-2013.), with corresponding linear trends.

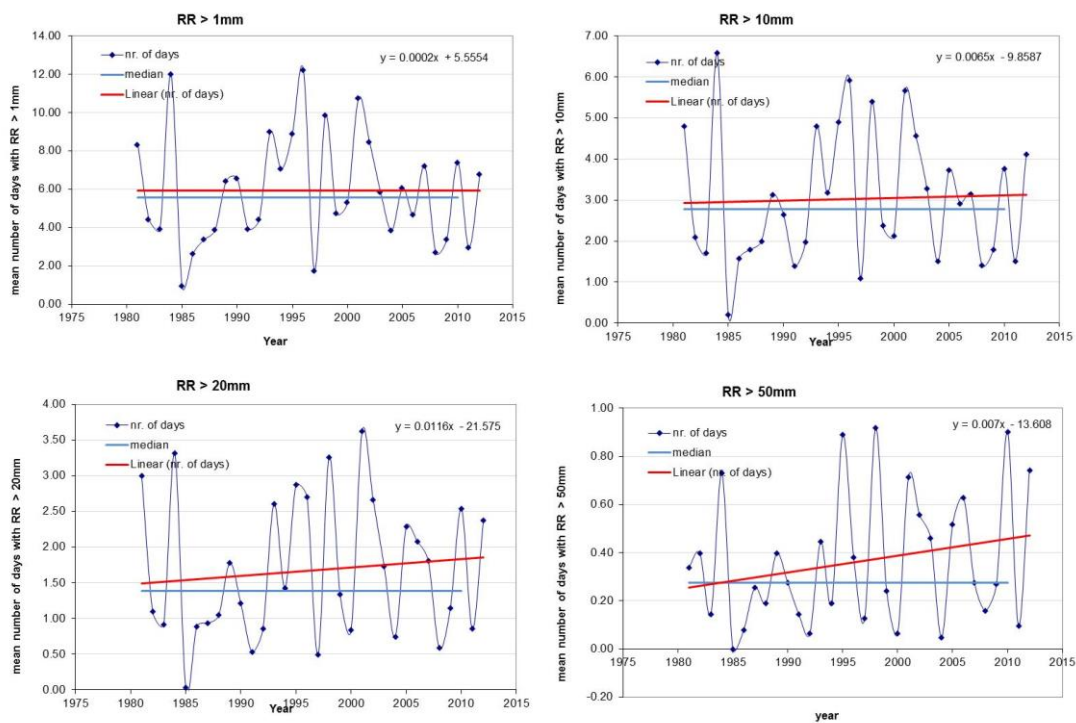


Figure 4.: Mean number of days with precipitation bigger than 1mm, 10 mm, 20 mm and 50 mm, for September (period 1981.-2013.), with corresponding linear trends.

Such trends, caused by changes of weather types, are not desired in hydrological and agrometeorological (silvometeorological) sense. Decrease of frequency of days with smaller precipitation and increase of frequency of days with larger (extreme) precipitation eventually leads to

prolonged dry spells on a wider area, and to the lack of water. This reflects significantly on the fuel condition.

#### **4. Conclusions**

To summarize, these possible changes of atmospheric circulation in the last decade can be connected to more frequent weather conditions associated with high forest fire risk, particularly in May, June and September. So, the risk- and fire-managers should be aware of more probable such weather circulation pattern in the Adriatic region in the future.