O 1. WILDFIRES FORECAST PERFORMANCE (WFP) IN ALBANIA DURING THE SUMMER SEASON 2017

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ABSTRACT: Albania is characterized by a Mediterranean climate, with dry and warm or hot summers. Like other Mediterranean countries, Albania is repeatedly threatened by wildfires causing frequently ecological, economic losses, even sometimes threatening the human lives. The wildfire risk forecast is one of the key risk mitigation measures, which helps to safeguard the human properties and lives from natural hazards. The Wildfire Risk Forecast is a daily procedure conducted by the National Centre for Forecast and Monitoring of Natural Hazards (NCFMNH), which is part of the Institute of Geosciences, Energy, Water and Environment (IGEWE) of Albania. The risk forecast is issued and disseminated in a daily basis to the General Directorate of Civil Emergencies, including wildfire occurrence probability (risk) by country's administrative unit (prefecture). The wildfires risk forecast, since 2016, is based on the fire weather index of the European Forest Fires Information System (EFFIS). The study aims to evaluate the accuracy of the wildfire risk forecasts issued during the 2017 summer season, calculating and analyzing results of the Wildfires Forecast Performance (WFP) for each Prefecture, and draw recommendations for possible improvement of forecast. The study proved high accuracy for the "High Risk Level" forecast alerts, and for the "Very Low Risk Level" forecast alerts. But on the other side, the study suggests that the accuracy for the "Moderate Risk Level" and "Low Risk Level" could be improved if other threasholds would be used to devide the levels.

Keywords*: Wildfires, forecast, risk, natural hazard*

1. INTRODUCTION

Albanian territory is often affected by wild-land fires which result in significant economic and ecological losses differing from year to year. Thus, building an accurate assessment system that forecast the risk of forest fires over the country in order to enable the notification of the level of risk for fires over the country is of key importance.

Several forest fire danger rating systems are built with this purpose, worldwide. One of the most used fire danger rating system is The Canadian FWI system which was the first subsystem developed in the CFFDRS (Van Wagner, 1987, Van Wagner and Pickett, 1985).Even though Canadian FWI is specifically calibrated to describe the fire behaviour in a standard jack pine stand Pinus banksiana typical of the Canadian forests (Van Wagner 1974), the index has successfully been used in countries where vegetation is dissimilar to Canada (Taylor and Alexander 2006) such as Australia (Cruz and Plucinski 2007), New Zealand, and Malaysia (Taylor and Alexander 2006). Given those results the Fire Weather Index module of the CFFDRS has been adapted for use in several countries.

The Fire Weather Index (FWI) is currently being used by the European Forest Fire Information System (Camia et al. 2006), which is developed in the framework of the Copernicus Emergency Management Services to monitor and forecast fire danger in Europe (Di Giuseppe et al. 2016).Nevertheless, the FWI algorithms in EFFIS have been slightly changed to the original FWI System of the CFFDRS in order to better suit the remarkable differences in day length in European Union when going from the Mediterranean to the Boreal countries (Lopez et al., 2002; San-Miguel-Ayanz et al., 2003). Besides, EFFIS uses medium-range (1–10-day lead time) weather forecasts, instead of observations, to extend the advance warning.

The Centre for Forecasting and Monitoring of Natural Hazards (CFMNH), in Institute of Geosciences, Water and Environment (IGEWE), started to provide information about the Forest Fire Risk, in the summer of 2011, delivering daily information on the upcoming risk of fires for the following day. Beginning the year 2016 the FWI index delivered by EFFIS have been used in order to define the daily fire risk forecasts for each prefecture in Albania. Anyway, in order to comply with the categories of the Meteoalarm platform, CFMNH rates the Fire Danger into four levels of risk, unlike EFFIS which rates the Danger in six classes. Table one shows the respective thresholds used for each level of risk by EFFIS and by CFMNH. As seen in the table, CFMNH uses the same thresholds as EFFIS in order to

determine the two lower levels, while, for the two upper levels CFMNH uses the EFFIS thresholds of two gathered levels for each. That is, CFMNH "Moderate Risk" level corresponds to EFFIS "Moderate" and "High" and CFMNH "High Risk" level corresponds to EFFIS "Very High" and "Extreme".

Table 1: IGEWE vs. EFFIS Fire Danger Classes

EFFIS Fire Danger Classes	FWI ranges
Very low	< 5.2
Low	5.2 - 11.2
Moderate	11.2 - 21.3
High	21.3 - 38.0
Very high	38.0 - 50.0
Extreme	>= 50.0

CFMNH Fire Danger Classes	FWI ranges
No Risk	< 5.2
Low Risk	5.2 - 11.2
Moderate Risk	11.2 – 38.0
High Risk	>= 38.0

This study aims to evaluate the Wild-fires Forecast Performance (WFP) in Albania during the summer season 2017, while using these thresholds, and contribute to improvement of the forecast with recommendations and suggestions for the future.

2. METHODOLOGY

The relationship between the FWI values and fire occurrence was investigated by several studies. In most of them was found moderate to high correlations between FWI values and fires occurrence, Stocks B. J. (1971), by Gillet et al. (2004), Dimitrakopoulos et al. (2011) and Bedia et al. (2012). While, studies that investigated the correlation between FWI values and burned area found poor to moderate correlation between them, Harrington et al. (1983) and Dimitrakopoulos et al. (2011).

Given those findings, the Wildfire Forecast Performance in this study, was evaluated only investigating the fire occurrence over the prefectures of Albania. The fire occurrence was investigated on each level of risk according the forecasts conducted each day during the summer. It consisted of two steps. The first step was assessment of the Prefecture Hit Probability (PHP) which was conducted for each level of forecast alert following [Formula 1]. In the second step, the revealed PHP values were assembled in three categories, using the threasholds as shown in the table 2, rating the Wildfire Forecast Performance (WFP) as "VERY GOOD", "GOOD" or "BAD".

$$\text{PHP}_{\text{Level}} = \sum_{i=0}^{n} \frac{n^0\text{Hits}}{n^0\text{Alerts}} \text{ x } 100\% \qquad [1]$$

Where:
PHP - refers to the Prefecture Hit Probability
Nr. of HITs - refers to the number of the prefectures exposed to the respective level of risk affected by fires.
Nr. of Alerts - refers to the number of alerts of the respective level of risk.

Table 2. Shreasholds of PHP used for categorising theWildfire Forecast Performance

	PHP	WFP	PHP	WFP	PHP	WFP
High Risk	70% - 100%	**VERY GOOD**	50 % -70 %	**GOOD**	>50 %	**BAD**
Moderate Risk	50% - 70%		40 % – 50 % 70 % - 80 %		>40 % <80%	
Low Risk	20% - 40%		10 % - 20 % 40 % – 50 %		< 50%	
Very Low Risk	0 – 10%		10 % - 20 %		< 20%	

Additionally, the Average quantitity of Fires per Hits (AFH) was calculated per each Level of risk, in order to better understand the fire occurrence, taking into account that in many cases more than one Fire per Hit Occurred. All evaluations were conducted for each Prefecture, in a month duration basis.

3. RESULTS

The results are shown in two subsections, the first one, containing the basic findings of the study, and the second one, containing additional information with data on number of forecast alerts issued by level, number of fires occurred by level, and number of HITS by level.

3.1. Wildfire Forecast Performance

3.1.1. June

Wildfire Forecast Performance of "High Risk Level" forecasts, during June, was rated as "VERY GOOD" due to considerably high value of Prefecture Hit Probability (PHP 70%). The average quantity of fires occurring per prefecture (Average Fires per Hit) appeared considerably high as well with an average value of 1.5 Fires per Hit, showing as such, a good relationship with the respective level (see table 3).

The "Moderate Risk Level" forecasts appeared to have a "BAD" Wildfire Forecast Performance given the low values of Prefecture Hit Probability (PHP 14%). The average number of Fires per Hit was 1.18, a value that was in line with the level of forecast.

The "Low Risk Level" and the "Very Low Risk Level" forecasts indicated respectively "GOOD" and "VERY GOOD" Wildfire Forecast Performance. The respective values of PHP were 10% and 4%, revealing that 90% and 96% of the alerted prefectures in respectively "Low Risk Level" and "Very Low Risk Level" reported no fires. In all cases, only one fire per hit was reported, on average, which was in line with forecast levels.

3.1.2. July

During July, Wildfire Forecast Performance of "High Risk Level" forecasts was ranked as "VERY GOOD" with a considerably high value of Prefecture Hit Probability (PHP 70%). The average quantity of fires occurring per prefecture (Average Fires per Hit) appeared significantly high (1.72 fires/hit) which was in accordance with with the level of forecast.

"Moderate Risk Level" forecasts appeared to have a "VERY GOOD" Wildfire Forecast Performance due to a moderate value of Prefecture Hit Probability (42%). Even though, the number of fires per Hit, in average terms, appeared significantly high (1.66 fires/hit), which should preferably be lower in this level of risk.

The Wildfire Forecast Performance of "Low Risk Level" and "Very Low Risk Level" forecasts were ranked as "VERY GOOD" and "GOOD" owing to low PHP values (respectively 27% and 20%). The PHP value of "Very Low Risk Level" forecasts were reported somehow high which caused WFP to step from "VERY GOOD" to "GOOD" level. The fires occurrence was high in both levels, specifically in "Very Low Risk Level" (2.7fires/hit), which was actually inconsistent with respective level.

3.1.3. August

Wildfire Forecast Performance of "High Risk Level" forecasts, during August, was rated as "GOOD" with a slightly higher Prefecture Hit Probability, much lower as compared to the previous months (PHP 55%). The average quantity of fires occurring per prefecture (Average Fires per Hit) was high in accordance with respective level (1.56 fires/hit).

"Moderate Risk Level" forecasts appeared as "GOOD" with a slightly low Prefecture Hit Probability (45%). The quantity of fires per prefecture was moderate in line with respective level (AHF, 1.35 fires/hit).

Wildfire Forecast Performance of "Low Risk Level" and "Very Low Risk Level" forecasts appeared as "GOOD" and "VERY GOOD" respectively, with Prefecture Hit Probability values of 10% and 0%. In all cases, only one fire per hit was reported, in line with the respective level.

3.2. Distribution of Forecast alerts and Fires by Level

A total of 360 forecast alerts were delivered during June, of which, a share of 53.6% indicated "High Risk Level" or "Moderate Risk Level" with the highest percentage indicating "Moderate Risk Level" (52%). On the other side, a total of 44 fires were registered over the country, of which, a share

of 75% occurred in "High Risk Level" and "Moderate Risk Level" prefectures according to the forecast alerts; while most of them (59%) occurred in "Moderate Risk Level" ones (see table 4 and graph 1).

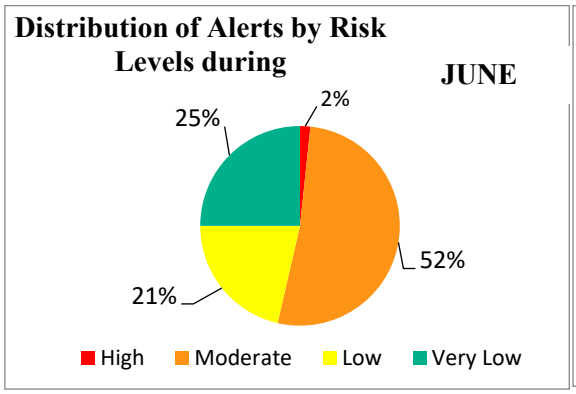
Table 3. Prefecture Hit Probability, Wildfire Forecast Performance and Average Fires per HIT

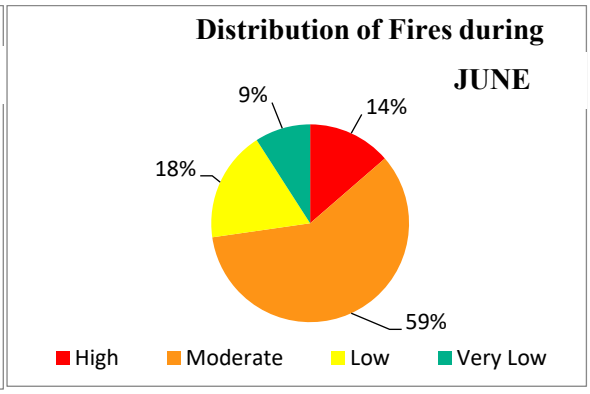
	JUNE			JULY			AUGUST		
	PHP	**WFP**	**AFH**	**PHP**	**WFP**	**AFH**	**PHP**	**WFP**	**AFH**
High Risk	**70%**	Very good	1.50	**70%**	Very good	1.72	**55%**	Good	1.56
Moderate Risk	**14%**	Bad	1.18	**42%**	Good	1.66	**45%**	Good	1.35
Low Risk	**10%**	Good	1.00	**27%**	Very good	1.83	**10%**	Good	1.00
Very Low Risk	**4%**	Very good	1.00	**20%**	Good	2.67	**0%**	Very good	-

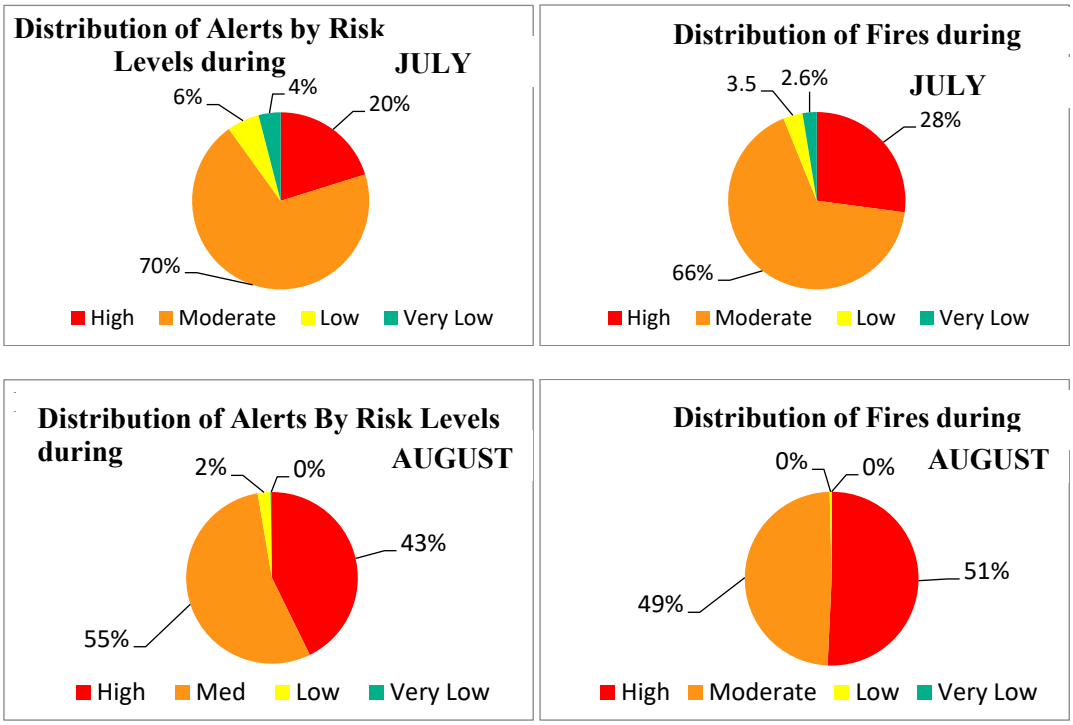
Table 4. Number of forecasts issued for each level of Risk, Fires occurrence, registered HITS

		JUNE	JULY	AUGUST
High Risk	Alerts	6	75	159
	Fires	6	86	137
	Hits	4	50	88
Moderate Risk	Alerts	187	260	203
	Fires	26	207	132
	Hits	22	125	98
Low Risk	Alerts	77	22	9
	Fires	8	11	1
	Hits	8	6	1
Very Low Risk	Alerts	90	15	1
	Fires	4	8	0
	Hits	4	3	0
TOTAL	Alerts	360	372	372
	Fires	44	312	270

A total of 372 forecast alerts were issued during July, of which, a share of 90% indicated "High Risk Level" and "Moderate Risk Level" with the highest percentage indicating "Moderate Risk Level" (70%). Meanwhile, a total of 312 fires were registered countrywide, of which, a share of 94% occurred in "High Risk Level" and "Moderate Risk Level" prefectures; while most of them (66%) occurred in "Moderate Risk Level" prefectures (see table 4 and graph 1).
During August, a total of 372 alerts were issued. A share of 97% of forecast alerts indicated "High Risk Level" and "Moderate Risk Level" with almost the same percentage amongst these two levels (respectively 43% and 55%). A total of 270 fires were registered, of which, a share of 51% occurred in "High Risk Level" prefectures and a share of 49% in "Moderate Risk Level" prefectures (see table 4 and graph 1).







Graph 1. The distribution of alerts by forecast risk levels and distribution of fire occurrence on monthly basis

4. CONCLUSIONS

- A high accuracy for the alerts of "**High Risk Level"** has been observed during the three months the study was conducted, with Prefecture Hit Probability, peeking in June and July to 70% and with Wldifire Forecast Performance rating as "VERY GOOD" for those months but "GOOD" for August. The number of the prefectures exposed to the "High Risk Level" consisted a normal share to the total. It was very low in June, significantly high in July and very high in August.
- A significantly varying accuracy for the "**Moderate Risk Level"** forecasts has been observed, with Prefecture Hit Probability varying from very low in June to low in July and August and Wildfire Forecast Performance rating as "BAD" for June and "GOOD" for July and August. The number of the prefectures exposed to this level of risk was very high, peeking in July with a share of 70% to the total of forecast alerts.
- A varying accuracy for the "**Low Risk Level"** forecasts has been observed with Prefecture Hit Probability varying from 10% in June and August to 27% in July and Wldifire Forecast Performance rating as "GOOD" for June and August and "VERY GOOD" for July.The quantity of the prefectures exposed to this level of risk was significantly low during all the season, exceptionally during July and August.
- A very high accuracy for the "**Very Low Risk Level"** forecasts has been observed, explicitly during June and August, whith Prefecture Hit Probability of 4% and 0% respectively to 20% in July and Wldifire Forecast Performance rating as "VERY GOOD" for June and August and "GOOD" for July. The number of the prefectures exposed to this risk level consisted a normal share to the total. It was significantly high in June, low in July and almost null in August.

5. RECOMMENDATIONS

A great number of prefectures exposed to Moderate level of risk should not be considered as satisfactory. Another study should be conducted aiming to define better levels of risk thresholds. Furthermore, an improved risk level division is expected to bring a more balanced exposure by risk level as well as a revised accuracy for forecasts related to "Moderate Risk Level" and "Low Risk Level".

Even though the affected area does not show significant correlation with FWI Index, according to literature, other studies on this topic should include an analysis on the relationship between forecast alerts and areas that have literally caught fire.

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