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Chairpersons: Theano Iliopoulou, Serena Ceola

Violent land terrain alterations and their impacts on water management; Case study: North Euboea

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1. Introduction – Area of Interest

Abstract: **North Euboea** is a place with high topographic relief, covered mostly by wild forests, with a lot of small rivers receiving high amounts of rainfall.
After 2017 a severe **disease** started to eliminate plane trees (Platanus orientalis), which were growing on the riverbanks stabilizing the flow of water.
One more dramatic event which severely impacted North Euboea was the **wildfire** that occurred in August 2021 and burnt 52,900 ha.
Both events drastically changed the land terrain, causing various impacts on the area's watersheds. In this vein, we try to investigate the changes in the water flow and inspect the **combined effects** of these landscape alterations on water management.

2. Plane Trees Disease (I)

- Ceratocystis platani is an invasive fungal pathogen, which causes a fatal disease of plane trees.

- The Ceratocystis is believed to originate from the USA [1].

- In 2003, it was first found in southwest Greece, and until 2011 has spread in west/northwest Greece, while nowadays, traces are found allover the country. [https://www.tovima.gr/2022/06/09/society/ta-platania-kindyneyoun-me-afanismo/; access date: 21/04/2023]

- The Ceratocystis has a devastating effect in the riparian vegetation and is spreading over short and long distances mainly due to human activities, such as the use of terracing machinery and cutting tools [2].

Before 2017 in central Greece (Euboea).

After the impact of the disease in same area.

3. Plane Trees Disease (II)

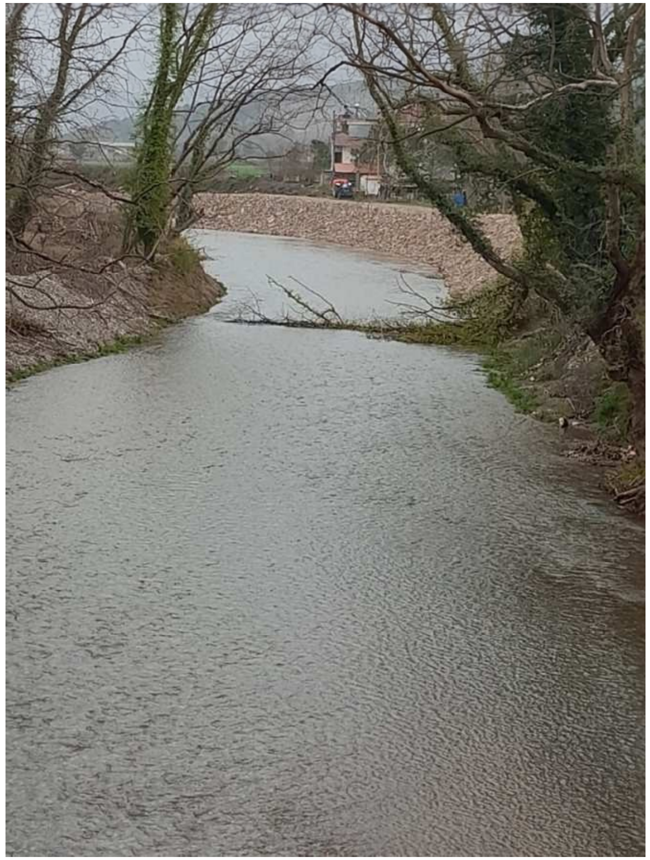
In terms of flood risk management, some high-impact issues are:

- A permanent effect to the landscape and vegetation of the area around the river.

- Most plane trees grow along rivers, and thus, the effect to the floodplain and river roughness coefficients could be large.

- The sedimentation load may increase.

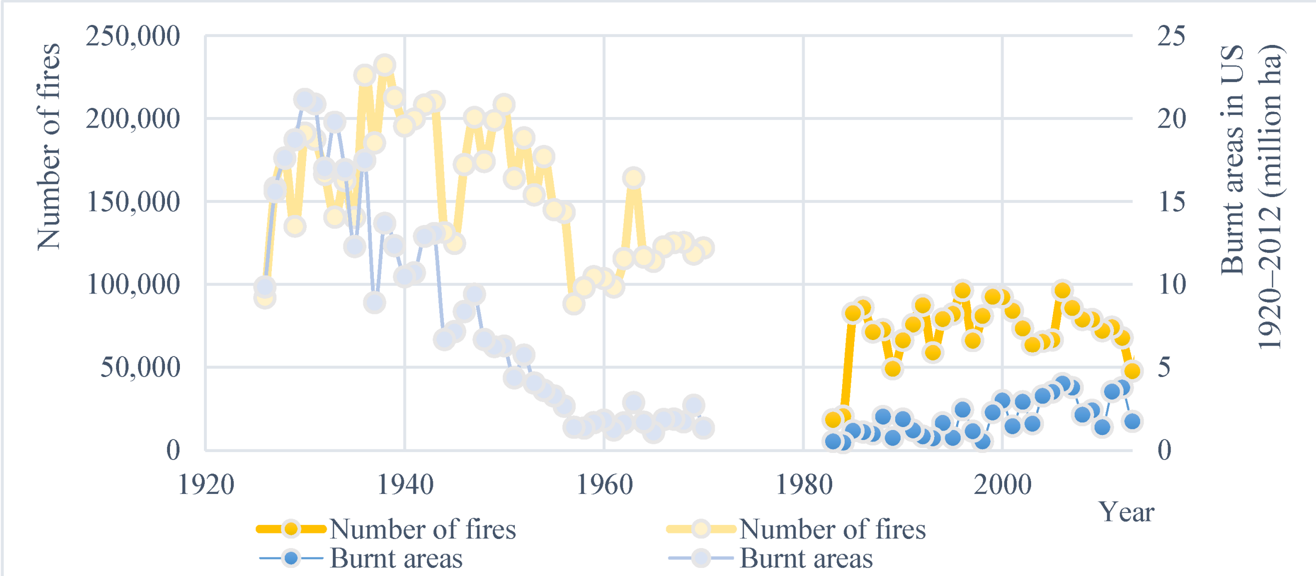
Photos from Euboea illustrating the high-impacts to landscape, roughness and sedimentation.

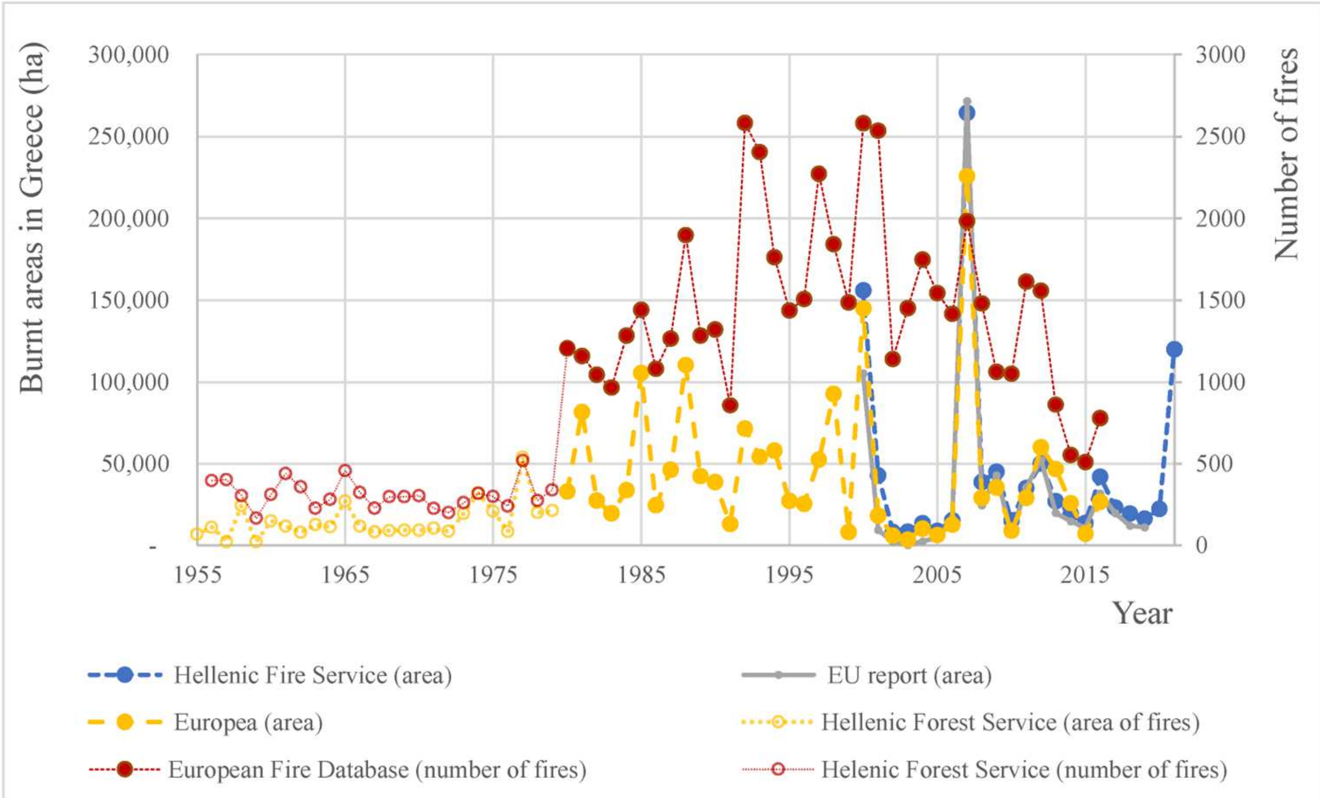


4. Wildfire (I)

The number of wildfires and burnt areas have significantly decreased over the last decades in the USA, as compared to previous decades dating back to the 1920 [3].

The number of wildfires and burnt areas over the last decade have reached the same low levels of the period 1950-1980 in the European Union and Greece, as compared to the high-variability period of 1980-2015 [3], with one exception in 2018 in Greece, where a devastating fire occurred but with indications of arson action [https://en.wikipedia.org/wiki/2018_Attica_wildfires].

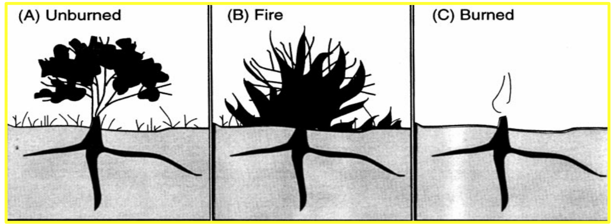




5. Wildfire (II)

In terms of flood risk management, some high-impact issues are:

- An effect to the landscape and vegetation of the river basin.
- The floodplain roughness coefficient could highly decrease.



- The sedimentation load may increase.
- Wildfires do not leave permanent effects, since burnt vegetation grows back eventually [4].

Photos from Euboea's wildfires in 2021 illustrating the high impact to landscape, roughness and sedimentation.

6. Sensitivity analysis (I)

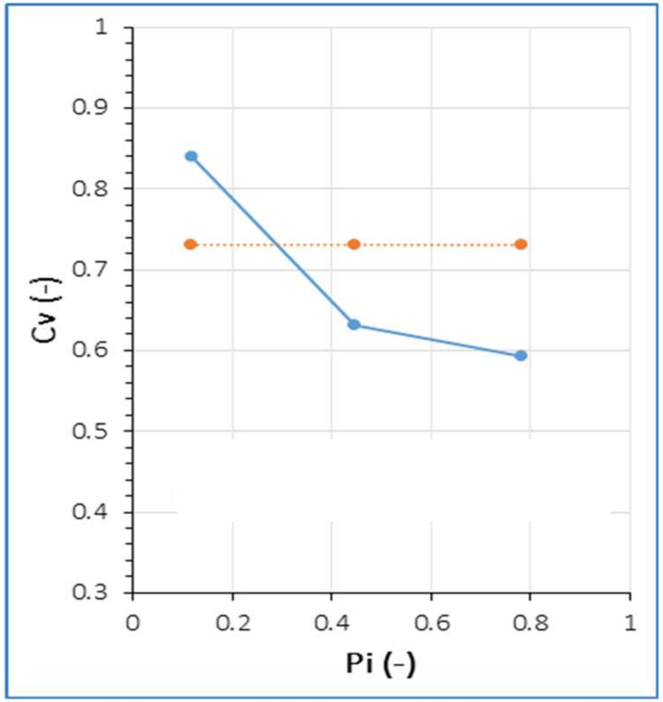
Although the above effects (disease and wildfire) are of different nature, they both have an hydrological impact in the area of interest, and therefore they can be initially analyzed using the same tools. The variability of the most important hydrological parameters is estimated based on the rational rainfall-runoff method [5], a post-fire-flood methodology [6], and through a Monte-Carlo sensitivity analysis [7]:

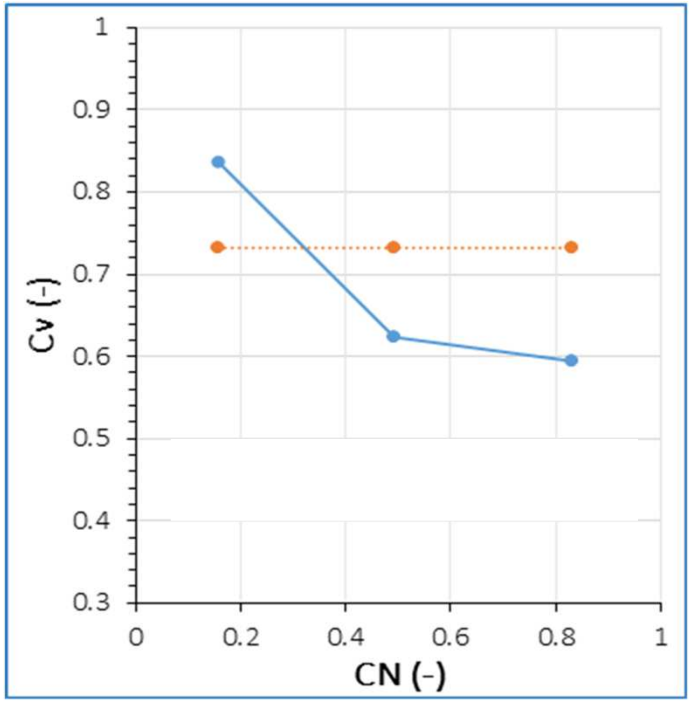
Parameters	Symbols and measurement units	Minimum value	Maximum value	Resolution step
Burnt area over the total area of the river basin	Pi (-)	0	1	0.1
Streamflow coefficient	Cn (-)	0	1	0.01
Return period	T (years)	10	1000	10
Precipitation scale	k (h)	0.5	24	0.5
Area of the river basin	A (km^2)	0.5	10000.5	100
Parameters that depend on the intensity of wildfire. [6]	a (-)	[-8.31, -7.33, -6.55, -3.25]		
	b (-)	[+36.17, +29.26, +22.63, +11.32]		
Parameter that depend on the soil moisture conditions. [6]	d (-)	[0, -7, +7]		
Parameter that depends on the area percentage of the river basin that is greater or smaller than the elevation of 160 m.	λ (mm/h)	[579, 445]		

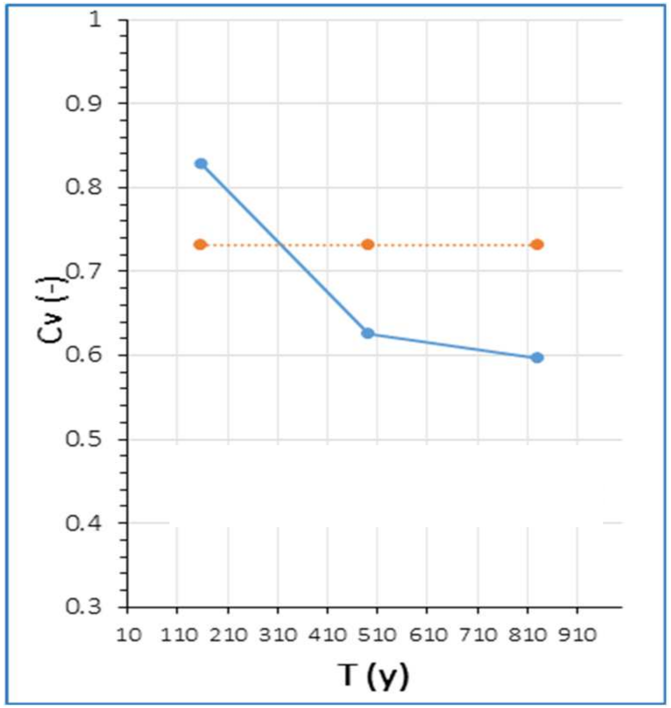
7. Sensitivity analysis (II)

Results include the group averages of the coefficient of variability (Cv) of streamflow for three equally weight values (with blue colour) and for the total sample (with orange colour) of each parameter. [5]

The Monte-Carlo method is applied assuming each input and output parameter is randomly varied according to a uniform distribution of 1000 values, with upper and low limits the maximum and minimum values indicated in the previous Table.

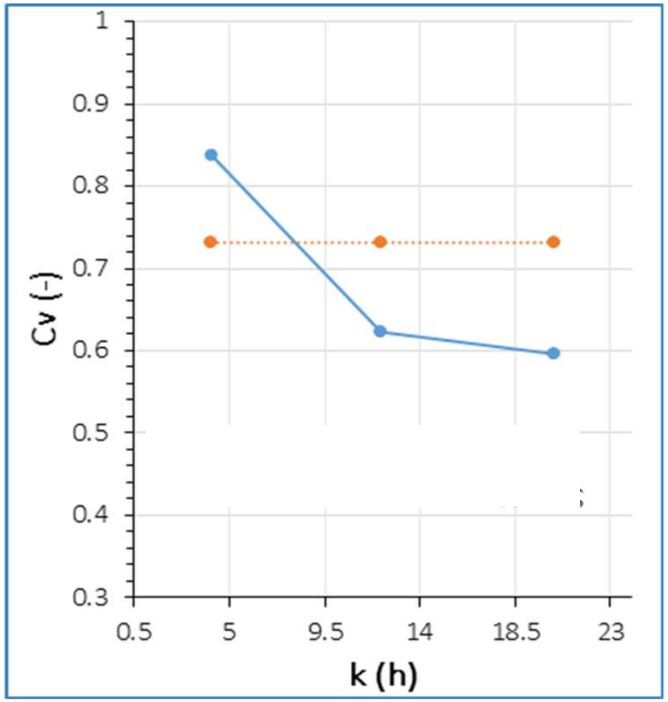


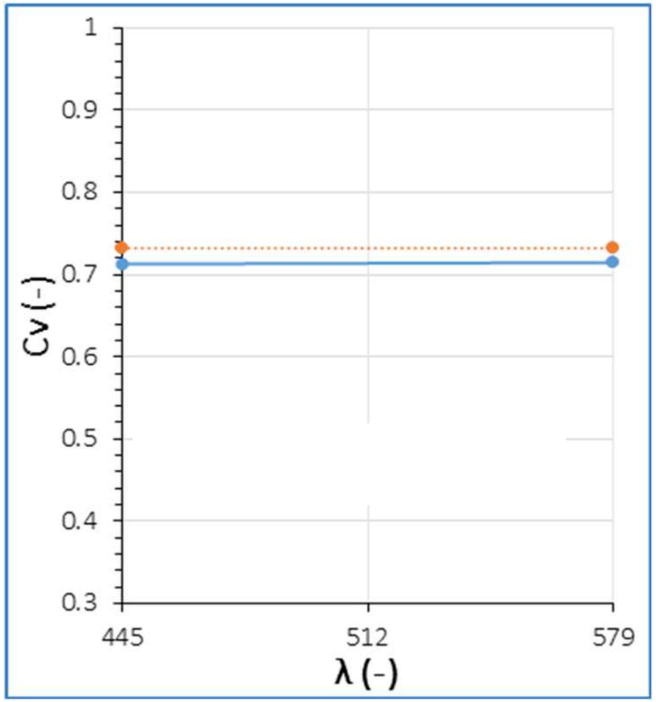


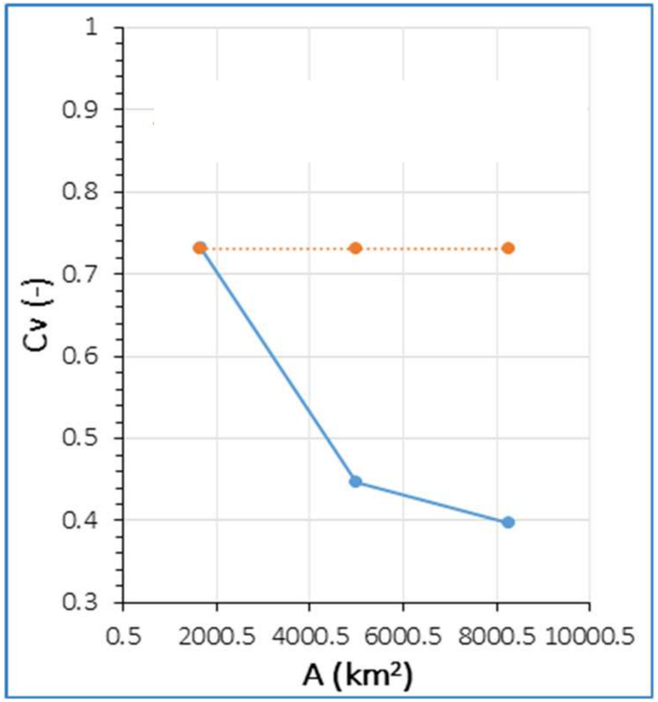


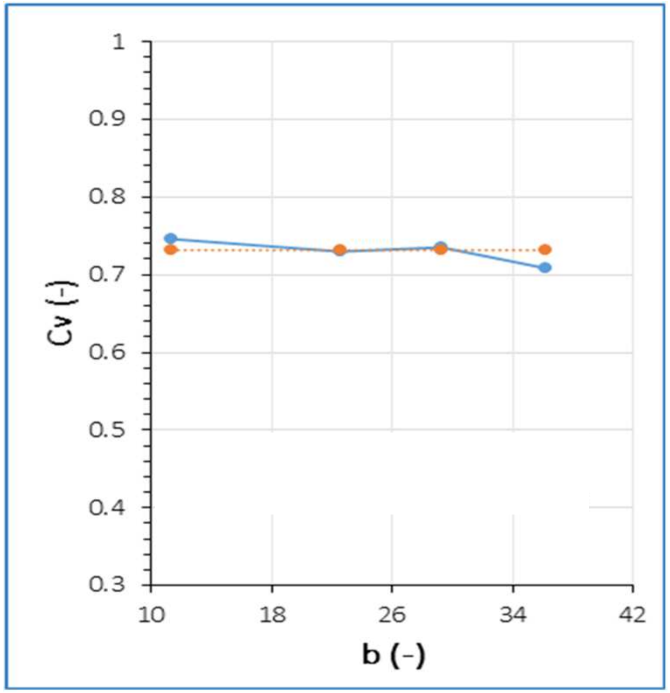
8. Sensitivity analysis (III)

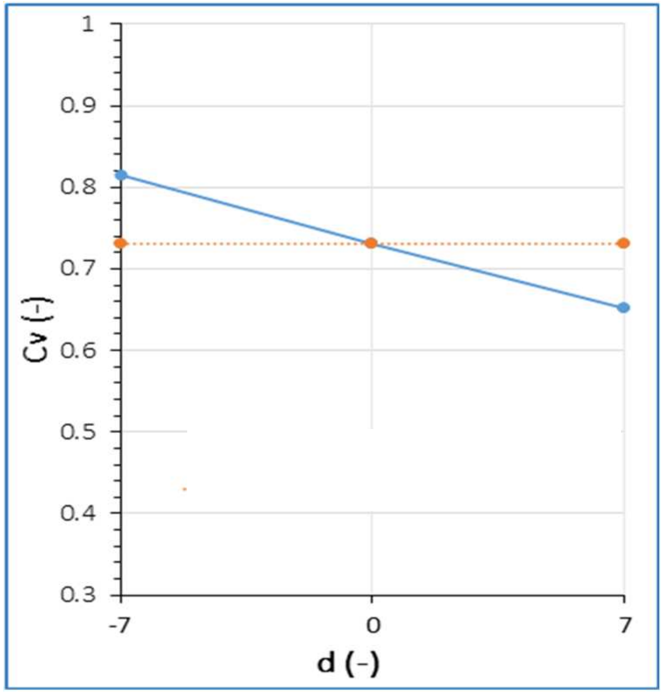
The larger the variability the stronger the impact of the parameter to the streamflow compared to the rest group values (blue colour) and to the rest parameters from the total sample (orange colour). [5]











9. Comments and Conclusions

Both effects (wildfires and tree-disease) have a strong impact to the landscape-vegetation, roughness (floodplain and river), and sedimentation load.

The wildfire is most dangerous at the immediate post-fire seasons, while the tree-disease have a slower but permanent impact.

Both effects can be initially analyzed using the same methods such as the rational rainfall-runoff model, and a post-fire-flood model.

A sensitivity analysis is performed for the above models through a Monte-Carlo method to determine the variability and impact of the input and output parameters of the models.

It is shown that the highest impact to the streamflow is from the burnt/disease-area percentage (in terms of the equivalent effects in the vegetation of the area), streamflow coefficient, return period, and precipitation scale, followed by the soil-moisture conditions, and parameters related to the basin area and the intensity of the wildfire/disease (in terms of the equivalent effects in the vegetation of the area).

Please share any comments or questions through the platform or through email at pandim@itia.ntua.gr.

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