# ISSUES CONCERNING OCCURRENCE OF FLOODS ON THE VEDEA RIVER

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**ABSTRACT**. **Aspects of flood occurrence on the Vedea River**. This study addresses several aspects of floods on the Vedea River, located in the Central Romanian Plain, located between Olt and Argeş rivers. Data recorded in the most important hydrological stations (Buzeşti, Văleni, Alexandria) along the Vedea River were used, for a period of 40 years (1970-2009). Flood generating conditions, their typology and parameters were analyzed. Cavis software developed by specialists from INHGA Bucharest was employed, in order to draft the flood hydrographs and calculate the floods parameters. Also, we calculated the multi-annual and seasonal frequencies of flood occurrence. There are two main conclusions emerging from specific analysis. First, the most floods occur in late winter and early spring while the least are specific to autumn season. Second conclusion is that the highest flash floods recorded along the Vedea River are associated to heavy rainfall periods and they occurred in late spring and early summer.

**Keywords**: highflood, frequency, Cavis software,Vedea River.

## 1. INTRODUCTION

Although aspects on the floods on the Vedea River itself have not been analyzed, some studies covering the whole country (Mustăţea, A 2005), the Romanian Plain (Haraga St., Niţulescu, M.1973) or only of the large river in southern Romania as Olt (Dumitrescu, V. 1976) or Ialomiţa (Lăzărescu, D., Ţuca, I. 1976) were made. Some authors studied exceptional highfloods as case studies: 1972 (Trufaş, V. and Vrabie, C. 1973, Diaconu, C., Lăzărescu D., Mociorniţa, C., 1972), 1975 (Zăvoianu, I., Podani, M. 1977).

Located in the central part of the Romania Plain, between the Olt and Arges rivers (Teleorman Plain), Vedea springs from Piedmond Cotmeana (Morăreşti). The superior course of the river goes through the lower hills while the middle and inferiour course flows through the plains. It crosses the counties of Arges, Olt and Teleorman, having a total length of 224 km. After passsing through Pietroşani village it flows into the Danube River.

Vedea Basin was the sbject of many points of view papers: morphologically (Vâlsan,G 1914,1917), hydrological characteristics (Mociorniţa,C. and Popovici, V.1979, Zaharia,L. 1993, 2004) or impact of deforestation and environmental pollution (Marin,I. 1997).

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Since the Vedea River was less studied, both in terms of water issues and aspects of floods occurrence, we considered appropriate to study in this paper the floods generating conditions, their frequency and floods hydograph characteristics.

## 2. DATA AND METHODS

### 2.1. Data

Hourly and daily data from the three main hydrological stations along the Vedea River (Buzeşti, Văleni and Alexandria) were used in order to identify the highest floods in the area. The period considered covered 40 years (1970-2009).

Data were provided by the Vedea and Argeş Water Branch

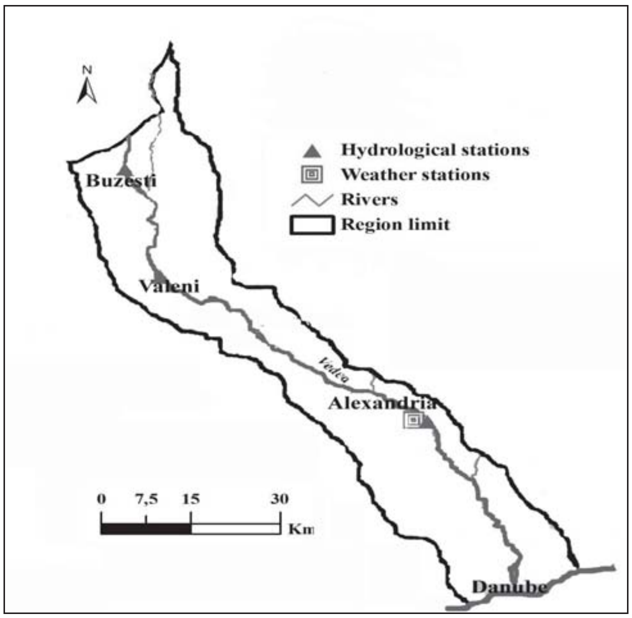


**Fig 1.** ***Vedea River***

### 2.2. Methods

In order to draw the flood hidrograph and to calculate the parameters of the singular floods the CAVIS softwere developed by researchers in the National Hydrology and Water Management Institute in Bucharest was employed. The separation of singular floods from composite floods was made using the same application.

CAVIS softwere is an application developped under Windows, with two main modules: *input data management module* and *calculation of singular flood wave specific elements module*.

Parameters of the flood waves: maximum discharge flow of direct flow *(QmaxV* (m3/s)), maximum discharge of the flood - *Qmax* (m3/s), the discharge at *t* moment Q(t), the base discharge of the flood flow at *t* moment *Qb(t),* time of growth-*Tc* (hours), time of decreasing *Td* (hours), total time of the flood *Tt* (hours), initial base flood discharge flow *Qbi* (m3/s), final discharge flow of the flood *Qbf* (m3/s), minimum and maximum threshold variation of the basic flow *Qbmin, Qbmax,* maximum discharge of direct flow *QmaxV* (m3/s), maximum discharge flow of the flood *Qmax* (m3/s), the growth volume *of* direct flow *WcV* (mil. m3), the growth volume of the flood *Wc* (mil. m3), the decrease volume of the direct flow *WdV* (mil. m3), the decreasing volume of the flood *Wd* (mil. m3);

- total volume of the direct flow *WtV* (mil. m3), computed as:

$$WtV = WcV + WdV$$

- total volume of flood *Wt* (mil. m3):

$$Wt = Wc + Wd$$

- shape coefficient of the direct flow hydrograph ( $\gamma_V$):

$$\gamma_V = WtV / (QmaxV \bullet Tt)$$

- shape coefficient of the flood ( $\gamma$ ):

$$Gamma = Wt / (Qmax \bullet Tt)$$

-*HsV*(mm) elapsed layer (layer drained volume equivalent) of direct flow, computed as:

$$HsV = WtV / S$$

-*Hs* (mm) - layer drained since the flood beginning, computed with:

$$Hs = Wt / S$$

There are five models available with this softwere one can choose from, in order to determine the flow of single flood :

-constant model $Qb(t) = Qbi;$

- model with constant slope $Qb(t) = Qb(t- \Delta t) + \Delta Qbc$

- concave model:

$$Qb(t) = \begin{cases} Qb(t-\Delta t) - \Delta Qbd, t \in [QbiTime, QmaxTime] \\ Qb(t-\Delta t) + \Delta Qbc, t \in (QmaxTime, QbfTime] \end{cases}$$

- recursive model: $Qb(t) = A \cdot Q(t) + (1 - A) \cdot Qb(t - \Delta t)$

- generalized-model

$$Qb(t) = \begin{cases} Qb(t-\Delta t) - \Delta Qbd, t \in [QbiTime, QbminTime] \\ Qb(t-\Delta t) + \Delta Qbc, t \in (QbminTime, QbmaxTime] \\ Qb(t-\Delta t) - \Delta Qbd, t \in (QbmaxTime, QbfTime] \end{cases}$$

where

-*QmaxTime*, *QbiTime*, *QbfTime*, *QbminTime*, *QbmaxTime* – is the time of *Qmax*, *Qbi*, *Qbf*, *Qbmin* şi *Qbmax*;

-$\Delta Qbc$, $\Delta Qbd$ – increase or decrease the rate of basic discharge flow;

*A* – coefficient; $\Delta t$ – time step.

To make delimitation of the monowave flood from a multiwaves flood, an exponential realtion is used , both for growth and decreasing periods of the flood. It suggests the input and the output of water in the hydrographic basin.

For the growth branch:

$$Qb\ (t) = Q\,(t - \Delta t) \cdot e^{Ac}$$

For the decreasing branch:

$$Qb\ (t) = Q\,(t - \Delta t) \cdot e^{-Ad}$$

where:

- *Ac* is the power of the basic exponential function (Euler number with an approximate value e = 2,71828).

## 3. RESULTS

Flash floods are considered as risk phenomena due to the destroying force they develop. It is manifested by a sudden increase of the flow of the river in a short period of time. They are caused by melting snow, heavy rains or the combination of both causes.

Both peak flow and flood duration depend on the physical and geographical conditions that generate flow: amount, duration and intensity of rainfall, basin slope, area and topography as well as geology *(Fig.2).*

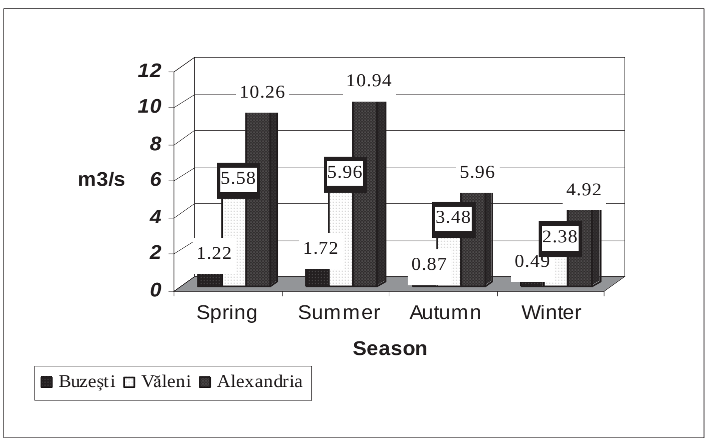


**Figure 2.** ***Seasonal average flow***

Generally, topography influences the flood parameters by its features: massiveness, slope and altitude. However, in the analyzed region, low slopes of the relief gives the flow a little speed. It affects the time for concentration and propagation of the flood. On the other hand, the high rate of infiltration allows partially the absorption of the rain water and causes the mitigation of the flood volume. In addition to this, as a result of high temperature regime, intense evaporation adds, especially during the warm season (April-September).

Analyzing seasonal flood frequency it was revealed that most floods occured in spring (40.19%) and winter (37.25%). The lowest frequency was specific to summer (12.37%) and autumn with only 9.80% of total flood occurred on the Vedea River( *Table 1*,*Fig.3*).

**Table 1.** ***Frequency of seasonal floods occurred on the Vedea River***

| Nr crt | Hydrometric station | Season | | | |
|---|---|---|---|---|---|
| | | Spring | Summer | Autumn | Winter |
| 1. | Buzeşti | 8 | 14 | 4 | 3 |
| 2. | Văleni | 12 | 13 | 4 | 4 |
| 3. | Alexandria | 18 | 14 | 5 | 3 |
| 4. | Total | 38 | 41 | 13 | 10 |
| 5. | Frequency | 37.25% | 40.19% | 12.73% | 9.80% |

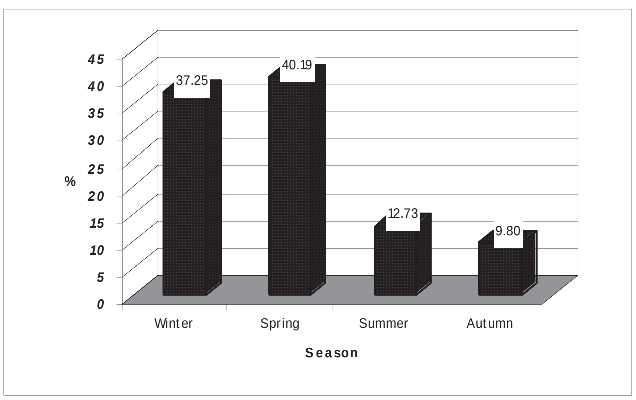


**Figure 3.** ***Frequency of seasonal floods***

An analysis of the floods produced along the Vedea River highlights that the most numerous winter floods were recorded at Alexandria station (18 floods), while during spring the numbers of floods recorded were equal at Alexandria and Buzeşti stations (14 cases).

Summer and autumn floods had the lowest frequencies (5 and respectively, 3 cases). During autumn, floods are diminished due to the small amounts of rainfall associated with summer drought.

Another issue of this study was the analyze of the floods typology according to the type of the hydrograph. Thus, 73 monowave flood events representing 71.56% of the total number of floods, and 29 multiwaves floods, representing 28.43% of the total number of floods occurred on the Vedea River, were identified *(Table2*).

***Table 2. The total duration of the floods occurred on the Vedea River***

| Nr. crt. | River | Hydrometric station | Number of flood duration in hours | | | |
|---|---|---|---|---|---|---|
| | | | 0-5 h | 5-12 h | 12-100 h | 100-450 h |
| 1 | Vedea | Văleni | 1 | 8 | 16 | - |
| | | Buzeşti | - | 1 | 28 | 2 |
| | | Alexandria | 1 | 4 | 22 | 4 |

The highest number of simple floods (32 out of 73) was recorded at Alexandria observation point located in the lower part of the river, where the plain is wide and floods are diminishing due to existing facilities along the River. The most numerous multiwave floods were identified at Văleni station, located on the middle course of the Vedea River, 12 out of 29 (*Fig.4*).

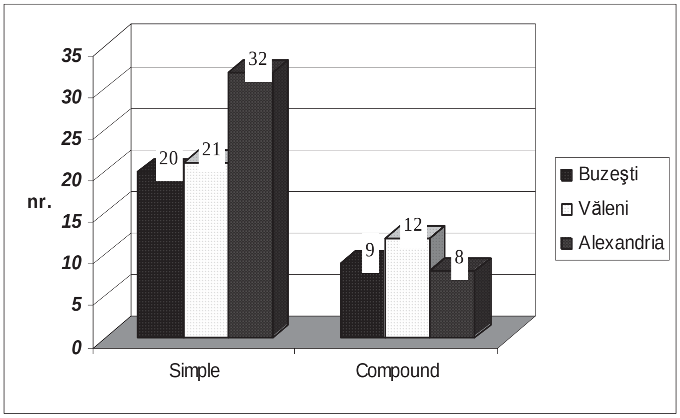


**Figure 4.** ***Types of floods according to the hydrograph***

Considering the suddeness, generally floods are classified as slow, fast or torrential (Loat, R.Petrascheck, A., 1997).

Most floods occurring on the Vedea River belong to the slow category (72 floods), specific to low areas, and have a relatively long growth time, resulting in significant water flows and volumes. A large number of such floods were recorded at Văleni station, and the lowest at Buzeşti station. At Buzeşti, where characteristic are the fast and torrential floods were specific generally with the growth time less than 12 hours.

The most important aspects of floods occurred on the Vedea River are those that analyze the characteristic elements of the flood. For a better illustration we chose the largest flood flow at each station. Thus, the flood recorded at the Alexandria station in 1972, that recorded at Buzeşti station in 1995, and that recorded at Văleni station in 2005. (*Table 3*)

At Buzeşti station, during 23-24 may 1995 flood, the maximum discharge flow was 345 $m^3/s$ and it was 3.75 times higher than danger threshold (92 $m^3/s$) *(Fig.5).*

At Alexandria, in 1972, during the flood occured from 4 till 13 october 1972, the highest historical discharge flow was recorded (935 $m^3/s$). It was more than 2 times higher than danger threshold (462 $m^3/s$).

At Văleni station, the danger threshold (807 $m^3/s$) was not reached during the highest flood recorded from 2 till 5 july 2005.

The total water volume of each of the three highfloods varies from 14.04 mil.$m^3$, at Buzeşti, and 83.48 mil. $m^3$, at Văleni, up to 373.86 mil. $m^3$ at Alexandria.

Considering flood time parameters, one can see that at Buzeşti, time of growth and time of decreasing are almost similarly (15h and respectively, 17 h), while at Alexandria in 1995, where, because of the multiwave characteristic, the time of growth (118h) was longer compared to that of decrease (86 h). The total time of the highfloods also varied very much in the area, from 32 h at Buzeşti till 204 h, at Alexandria.

**Table 3.** ***The characteristic elements of the great flood of waves***

| Nr. crt. | Characteristic elements | Hydrometric station Buzeşti | Hydrometric station Văleni | Hydrometric station Alexandria |
|---|---|---|---|---|
| 1. | Year | 1995 | 2005 | 1972 |
| 2. | F (m) | 495 | 1724 | 3246 |
| 3. | Qmax ($m^3/s$) | 345 | 751 | 935 |
| 4. | Wc (mil. $m^3$) | 3.2 | 2.9 | 213 |
| 5. | Wd (mil. $m^3$) | 10.8 | 60.5 | 160.8 |
| 6. | Wt(mil. $m^3$) | 14.0 | 83.4 | 373.8 |
| 7. | Hs (mm) | 28.3 | 48.4 | 118.7 |
| 8. | Gamma | 0.35 | 0.44 | 0.56 |
| 9. | Qbi ($m^3/s$) | 0.96 | 5.16 | 12.5 |
| 10. | Qbf ($m^3/s$) | 24.4 | 63.5 | 153.5 |
| 11. | Tc (h) | 15 | 18 | 118 |
| 12. | Td (h) | 17 | 51 | 86 |
| 13. | Tt (h) | 32 | 69 | 204 |

Analysis of the specific features of flood waves has revealed the occurence of the highest floods at Alexandria station, located in the lower course of Vedea River. The station is located about 40 km before the river flows into the Danube, and the flow rate is high, after collecting all the tributaries. The duration of the floods is long since the slope of the river is reduced and the area of the basin is large (3246 $km^2$).

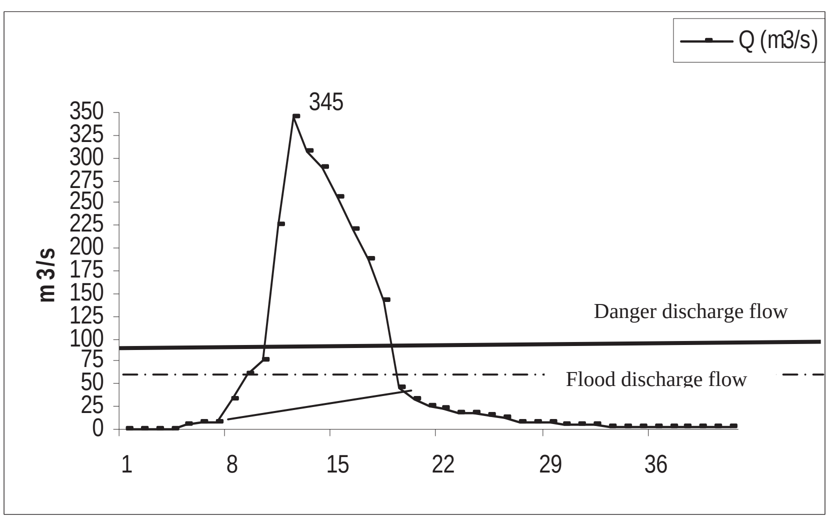


**Figure 5.** ***1995 flood hydrograph station hidromertica Buzesti-Vedea***

## 4. CONCLUSIONS

The conclusions to be drawn from the study of floods occurred on the Vedea River during the analyzed period are the following:

- most floods occur in winter and spring seasons when the huge amounts of precipitations cause higher flow rates.
- simple floods are much more numerous than compound floods (more than double).
- in terms of duration, most are slow, similarly to other plain area;
- the most important floods were recorded at Alexandria located downstream;
- The highest floods that occurred in the analized period of 40 years were recorded in 1972, 1995 and 2005.

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