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Local QdF (Flood-duration-Frequency) Modeling of the Oued Mina Catchment in the North-West of Algeria

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Abstract

The aim of this research paper is to develop a multi-duration and multi-frequency model that provides a more complete description of the basin's flood regime on both gauged and ungauged catchments in the range of observed and rare frequencies and answer the questions relevant to integrated river management. The approach adopted in this paper is based on the frequency analysis of multi-duration series using the exponential distribution. So, we have focused on the basic notions and concepts underlying the local QdF modeling of floods in the Oued Mina catchment in North-West Algeria. The local QdF modeling is directly drawn from statistical analysis of the average volume flow for multi-duration series, derived from annual hydrographs of the Oued El-Abtal station to the Exponential distribution, where the fittings of the series lead to the establishment of the relation between the average volume flow, the duration, and the return period. The developed QdF plot can be applied to estimate water availability over specific time intervals (aggregation periods) and across various return periods within the catchment. The obtaining QdF model would be useful in the study of the flooding in an ungauged catchment.

Keywords: *Average volume flow, Fitting, Flood prediction, QdF (Flood-duration-Frequency), Return period.*

1. Introduction

Floods are among the most significant natural hazards and affect almost all regions of the world. The study of floods has been the subject of several studies and research using different methods, such as flood frequency analysis (Hamed and Rao, 2000; Yahiaoui, 1997) and hydro-meteorological methods (Guillot and Duband, 1967; Magroume, 1992), such as GRADEX and AGREGEE. The accurate evaluation of river discharge and precipitation variability, along with the estimation of the frequency and magnitude of extreme hydrological events, represents a complex scientific challenge. This complexity arises from the profound influences of climate change and changes in land use and land cover, which substantially modify the dynamics and availability of water resources (Baran-Gurgul *et al.*, 2024). Hydrological modeling constitutes a fundamental scientific approach for simulating the movement and distribution of water within natural and managed environments. These models provide a quantitative framework for evaluating the effects of land-use transformations, climate variability, and extreme hydrometeorological events on hydrological processes. They serve as indispensable tools for formulating strategies for sustainable water resources management, flood risk mitigation, and environmental protection. The historical development and methodological advancements of hydrological modeling, from the 1950s to the present, are comprehensively examined in Singh's seminal work (Singh, 2018). In general, frequency analysis studies describe the flood event by its instantaneous peak flow. But when mapping a floodplain or designing a hydraulic structure, information about peak flow is essential yet insufficient (Di Baldassarre *et al.*, 2010). In addition, it is crucial to recognize that flood severity can be characterized by both its volume and its duration.

It is essential to give special attention to the concept of "duration" as a fixed parameter, since it plays a key role in many hydrological processes. The characterization of catchment flow, the assessment of water demand, and the evaluation of potential damage risks are all closely related to the temporal nature of hydrological events (Galea and Prudhomme, 1997). The conceptual foundations of the Flood-Duration-Frequency (QdF) model were introduced in the 1990s by Sherwood (1994), Balocki and Burges (1994) and Galea and Prudhomme (1997), who emphasized the role of duration in flood frequency analysis. These applications primarily address gauged catchments under non-stationary (Chen *et al.*, 2013; Cunderlik *et al.*, 2007) or stationary (Hachemi and Benkhaled, 2016) conditions, but the framework supports extension to ungauged areas via index-flood regionalization. QdF modeling also focuses on maximum instantaneous flows and on the analysis of characteristics related to different durations d to assign a frequency to the maximum average flow V_{CXd}.

The obtained QdF model can be used to construct probable flood hydrographs (Sauquet *et al.*, 2004), which can

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be used in the study of flood hazard.

The aim of this paper is to develop a local QdF model for the Oued Mina catchment in western Algeria by fitting the maximum flow series V_{CXd} of different durations d to the Exponential distribution, and determining the relationships between maximum flow, duration, and return period. The model QdF serves as a tool for flood hazard and vulnerability assessment.

2. Methodology

The methodology is applied to a specific catchment in western Algeria, selected due to its history of severe flooding (Lahlah, 2004) and representative semi-arid characteristics. The study area and available data are outlined in the following section.

2.1 Study area

The study has been conducted on the catchment of Oued Mina (Fig. 1), which is located in the North-Western part of Algeria, at about 300 km from Algiers, between 0° 20' and 1° 10' of East longitude and 34° 40' and 35° 40' of North latitude. The Oued Mina catchment drains an area of approximately 4900 km², and it is part of the large Chelif catchment. The stream of Oued Mina is the main tributary of Oued Chelif, with a distance of about 90 km between the Bakhada and Sidi M'Hamed Benaouda dams, with a South East-North West orientation (Touaibia *et al*., 2003; Ghernaouet and Remini, 2017). The study area was selected as a case study due to the severe flooding in Oued Rhiou, Relizane, caused by heavy rainfall in October 1993 (Lahlah, 2004).

The Oued Mina catchment is characterized by a dominance of tertiary marls (Eocene, Miocene and Oligocene) very sensitive to erosion in the north, whose soils are generally bare and oversaturated, and Jurassic (upper, lower and middle) in the south, subject to less severe erosion (ANRH, 2010) where nearly 50% of its surface is covered by vegetation of varying density (6% of forests are dominated by young Aleppo pine plantations, 32% by "pistacia, olea, tetraclinis" scrubland and 12% by cereals) (Ghernaouet and Remini, 2014).

The catchment of Oued Mina is characterized by a Mediterranean climate, semi-arid to arid, with hot, dry summers and cold, humid winters. Annual precipitation averages 278 mm with high spatial and temporal variability, leading to alternating high-and low-water periods (Meddi, 1996).

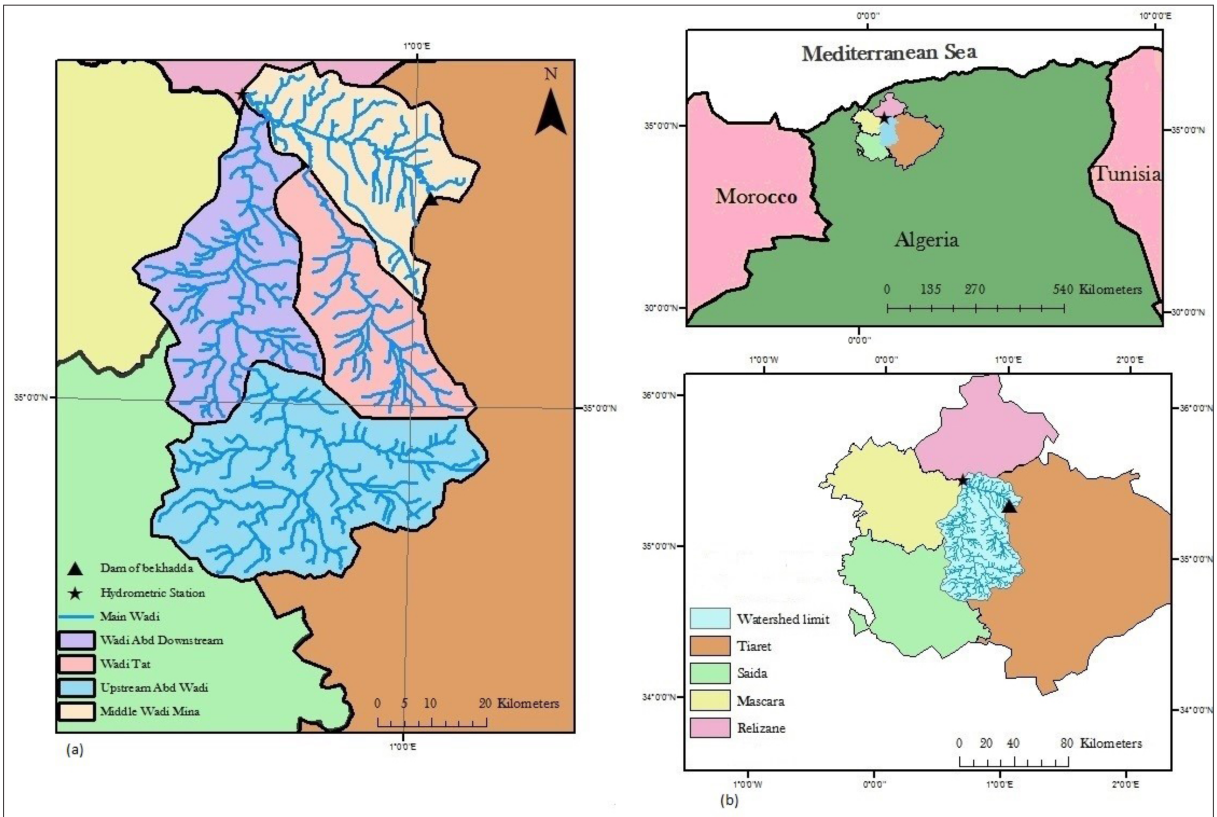


Figure 1. The Oued Mina catchment in North -West Algeria: (**a**) Hydrological network, sub-basin, and gauging station location; (**b**) Geographical location within Algeria.

The hydrometric data set used in this study was provided by the National Agency of Hydraulics Resources (ANRH) of Algiers. It consists of the records of instantaneous flood hydrographs recorded between 1953 and 2011 at the Oued El Abtal gauge station. The time series of annual maximum instantaneous discharge (Q_{IX}), which provides essential information for extreme event analysis, can be obtained (Fig. 2). This series has 57 observations, its mean and standard deviation are 309,65 m³/s and 242,80 m³/s, the min and max values are 31,85 m³/s and 962,65 m³/s, and the coefficient of skewness and kurtosis are respectively 1,06 and 3,15.

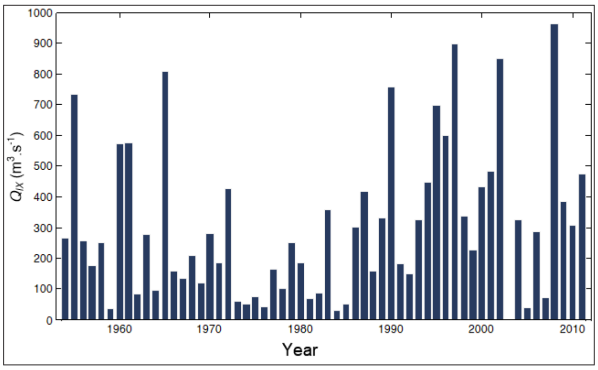


Figure 2. Annual instantaneous maximum discharges (QIX) in the Oued El Abtal station. *(Source: ANRH Algeria)*

By using the Wald-Wolfowitz test (Wald *et al.*, 1943), Mann-Whitney test (Mann *et al.*, 1947), Mann-Kendall test (Mann,1945 and Kendall,1938), and Grubbs test (Grubbs, 1949), the series of Q_{IX} is independent, homogeneous, stationary, and with no outlying values (Table 1).

Table 1. Sampling tests of the annual instantaneous maximum discharge series.

Type of the test	Calculated Value	Critical Value
Wald-Wolfowitz test for independence at 5%	1,314	1,960
Mann-Whitney test for homogeneity at 5%	1,770	1,960
Mann-Kendall test for stationarity at 5%	1,170	1,960
Grubbs test for outliers at 1%	2,692	3,538

These catchment characteristics and the validated Q_{IX} series provide the foundation for the QdF modeling approach. The materials and methods, including series extraction and distribution fitting, are detailed in the following section.

2.2. Material and method

2.2.1. Indices of the flood regime

The decision support system (DSS) was used (El Adlouni *et al.*, 2008), the curve of mean excess function (MFE) has a positive slope (Fig. 3), which implies that the underlying distribution is sub-exponential, so distributions considered in this section belong to the class D, which are represented by the Gumbel distribution, Gamma distribution, and Pearson Type III distribution. These include the method of moments (MOM), the maximum likelihood method (MLM), and the probability weighted moments method (PWM). These are practiced in fitting of distribution and compared by goodness-of-fit tests (Table 2 and Table 3). The main conclusion from the above analysis is that the Gamma distribution is the best model that will give a prediction estimation of the event's extreme.

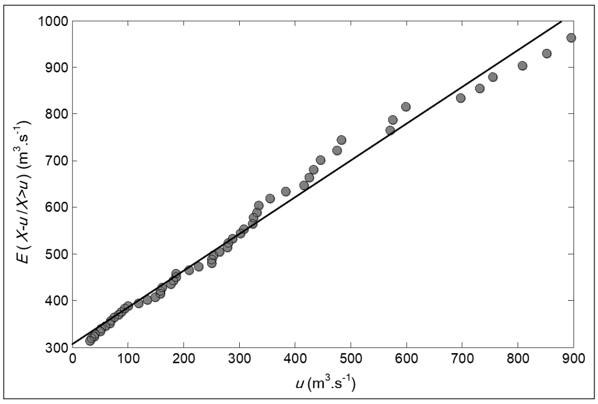


Figure 3. Mean excess function (MEF) for the annual instantaneous maxima peak flow series.

Table 2 shows the quantile estimates for the hydrometric station in the Oued Mina catchment using different distributions, and the following return periods were considered: 2, 5, 10, 20, 50, 100 and 1000 years. The results show the highest flow values. This result is due to several factors, including the geological nature of the region and the slope that facilitates the flow from elevations of 1933 meters to the lowest area, where the measuring station is located at an estimated elevation of 205 meters. We also note the vegetative cover and increased precipitation in this study area. These floods are characterized by irregular occurrence and strong destructive forces, so the engineer must design flood defense structures to withstand this force. Therefore, a suitable probability law for flood flows must be carefully chosen.

Table 2. Estimated Quantiles Q_{IXAT} for different return periods *T*.

Return period (Year)	Gumbel (MLM)	Gumbel (PWM)	Gumbel (MOM)	Gamma (MLM)	Gamma (MOM)	Pearson III (MOM)
2	264,67	268,76	269,18	246,75	248,21	266,78
5	460,88	485,56	483,74	475,39	474,05	491,13
10	590,80	629,11	625,79	**636.00**	632,02	634,60
20	715,41	766,80	762,06	971,20	784,65	767,39
50	876,71	945,03	938,44	991,62	981,38	932,82
100	997,58	1078,58	1070,61	1140,72	1127,58	1052,73
1000	1396,98	1519,89	1507,35	1626,37	1603,33	1430,91

The next step involves the estimation of goodness-of-fit. It is a different test which can be employed to determine the best theoretical probability distribution that can describe the annual instantaneous maxima peak flow series. So, the probability plot correlation coefficient test *(PPCC)*, Root Mean Square Deviation *(RMSD)*, and Kolmogorov-Smirnov *(KS)* were applied. Table 3 shows the results of the goodness-of-fit analysis. All the observed Kolmogorov–Smirnov values for the all distribution are less than 0,180 as theoretical value at 5% of significance and n = 57. The values of *PPCC* are near to 1, and all the values of *RMSD* are less than 1. Data analysis has shown that the goodness-of-fit of all distributions are accepted. To objectively distinguish between candidate distribution and select the most suitable one, we employed information criteria, such as the Akaike Information Criteria *(AIC)* (Akaike, 1974), and Bayesian Information Criteria *(BIC)* (Schwarz, 1979). Table 4 shows the distribution that yields the lowest AIC and BIC values, as these criteria penalize model complexity while rewarding goodness-of -fit.

Table 3. Goodness of fit test results

	PPC	*KS*	*RMSD*
Gumbel (MOM)	0,985	0,077	0,6244
Gumbel (PWM)	0,985	0,08	0,6499
Gumbel (MLM)	0,985	0,0753	0,4796
Gamma (MLM)	**0,989**	**0,056**	**0,1371**
Gamma (MOM)	0,98	0,06	0,1371
Pearson Type III (MOM)	0,988	0,081	0,1112

Table 4. Values of *AIC* and *BIC*

Probability Distribution	*AIC*	*BIC*
Gumbel (MOM)	776,13	780,22
Gumbel (PWM)	776,36	780,44
Gumbel (MLM)	775,18	779,27
Gamma (MLM)	**765,29**	**779,27**
Gamma (MOM)	765,31	769,4
Pearson Type III (MOM)	776,75	782,88

The use of the Gamma distribution is very suitable to fit the series of Q_{IX} (Fig. 4) because the lowest value of *AIC* corresponds to the Gamma distribution, as shown in Table 4, with parameter estimates *a* (scale) and *k* (shape), respectively equal to 1,58 and 0,05. Hence, the quantile of 10 years Q_{IXA10} is equal to 636 m^3/s, which is an important index of the flood regime of the catchment, high-lighting rapid, high-intensity floods, setting the stage for multi- duration QdF analysis.

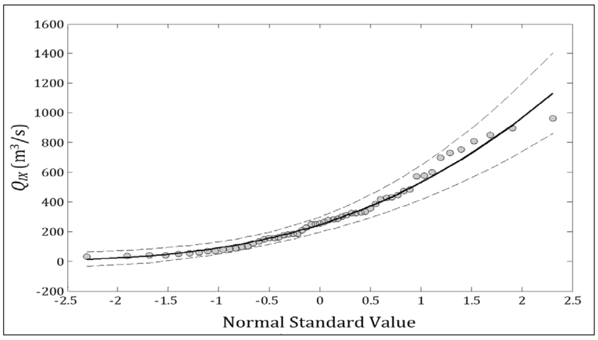


Figure 4. Observed and estimated flows at 95% confidence intervals for the Q_{IX} series.

According to the SOCOSE method of the French Technical Center for Rural Water and Forest Engineering (CTGREF, 1980), an observed flood hydrograph (Fig. 5) has two characteristics: the peak flow *Qs* and the duration ds during which half of *Qs* is continuously exceeded. For all observed flood hydrographs, the obtained data (*Qs*, *ds*) allow for drawing the mean between the ds and *Qs*. From the value of Q_{IXA10}, another index of the flood regime, *D* the duration of the characteristic flood of the catchment can be determined, which is approximately equal to 10 hours (Aichoune and Yahiaoui, 2024) (Fig. 6).

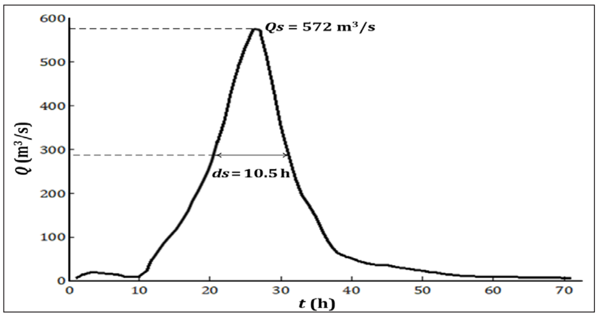


Figure 5. Flood hydrograph of 22 to 24 November 1959 recorded at Oued El Abtal station.

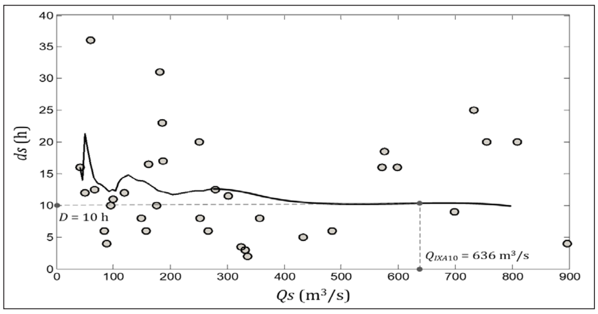


Figure 6. Estimation of the duration of the characteristic flood of the Oued Mina catchment.

With the V_{CXd} series extracted and the exponential distribution fitted using objective criteria (as detailed above), the key findings, including quantile estimates and the analytical QdF formulation, are presented and interpreted in the next section.

3. Results and Discussion

In this section, we present the main empirical results of the study, beginning with a description of the construction and fitting of the series of V_{CXd} by the exponential distribution, followed by a derived analytical formulation that provides a reliable tool for flood characterization in semi-arid catchments.

3.1. Construction and fitting of the series of V_{CXd}

The integration of the hydrograph *Q(t)* between t and *t+d* allows the volume of water *V* flowing for the duration *d*, where *D/2 ≤ d ≤ 5D*. Therefore, the corresponding characteristic average discharge rate is the volume V_{Cd} *(t)* flowing during this duration *d* is given by:

$$V_{Cd}(t) = \frac{1}{d}\int_{t}^{t+d} Q(\tau)\,d\tau \qquad (1)$$

By analyzing all annual hydrographs, it is possible to construct, for each duration d (incremented in one-hour time steps), a sequence of average discharges *Vcd(t)*. From this time series, the maximum annual value V_{CXd} can be extracted, representing the annual characteristic maximum mean discharge corresponding to extreme flood episodes of duration d (Guilard, 1998). For the Oued Mina catchment, 46 V_{CXd} series were generated for durations ranging from 5 to 50 hours (d = 5, 6, 7, …, 50 h). In this study, the analysis focused on the ten representative durations (d = 5, 10, 15, 20, 25, 30, 35, 40, 45, and 50 hours). The mean, standard deviation, coefficient of variation, skewness, and kurtosis of each V_{CXd} series are summarized in Table 5. All series are independent, homogeneous, and stationary and show no outliers or anomalies, as confirmed by statistical sampling tests. The use of the exponential distribution in this study is consistent with previous hydrological studies that applied QdF or related flood-frequency frameworks in similar climatic and hydrological contexts. This study showed that in semi-arid Mediterranean climates, flood variables often exhibit strong skewness and rapid tail decay, conditions under which the exponential distribution provides satisfactory fits, especially for duration-dependent flood metrics. Ketrouci and Meddi (2015), by applying QdF modeling to Algerian basins, reported that the exponential distribution performs well for V_{CXdT} and provides reliable estimates across multiple durations. Other studies (Javelle and Ouarda, 2002; 2003; Ouarda *et al.*, 2001; Merz *et al.*, 2003) also support this finding.

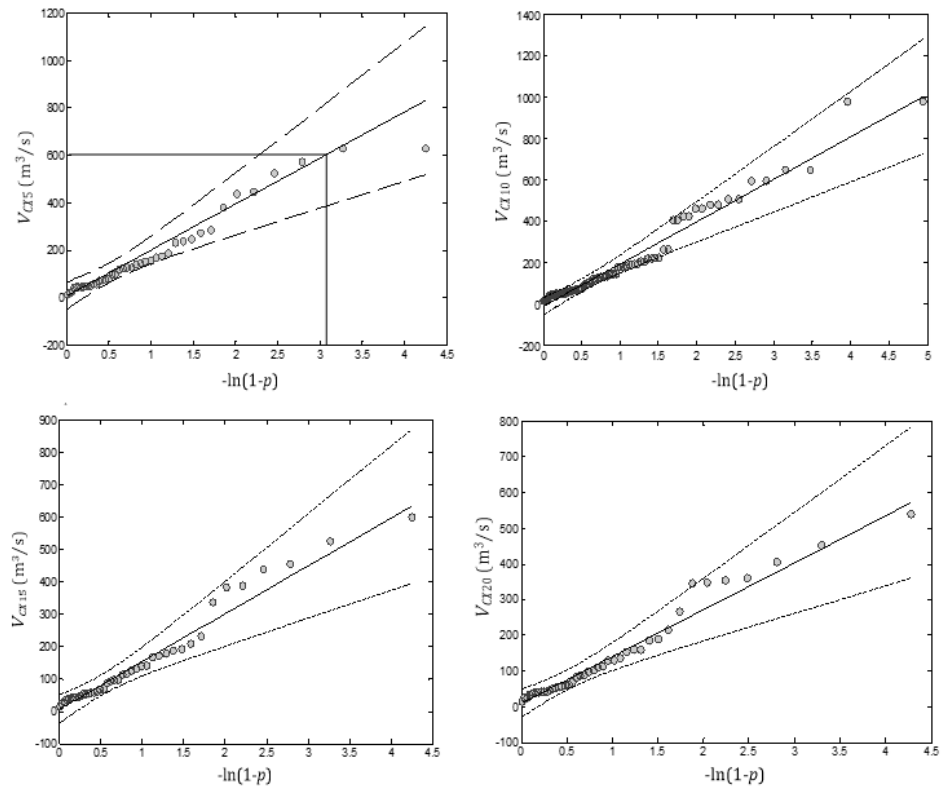
Table 5. Table 5. Principal characteristics of the maxima flow series *(VCXd)* of Oued Mina.

d (h)	Mean (m³/s)	Standard deviation(m³/s)	Variation	Skewness	Kurtosis
5	201,23	193,79	0,96	1,24	3,00
10	177,14	169,94	0,96	1,29	3,09
15	152,83	147,48	0,97	1,53	4,40
20	140,59	131,60	0,94	1,41	4,05
25	123,66	114,30	0,92	1,46	4,34
30	110,67	100,75	0,91	1,52	4,64
35	100,62	91,09	0,91	1,53	4,75
40	91,03	81,47	0,89	1,61	5,13
45	83,49	74,33	0,89	1,68	5,44
50	77,12	68,36	0,89	1,74	5,80

So, the exponential distribution was identified for fitting the V_{CXdT} series corresponding to durations *d* = 5, 10, 15, 20, 25, 30, 35, 40, 45, and 50 hours (Fig. 7).

The probability distribution function of the exponential distribution with two parameters m_d and a_d is given by:

$$F(x) = 1 - \exp\left(-\frac{x - m_d}{a_d}\right) \quad (2)$$



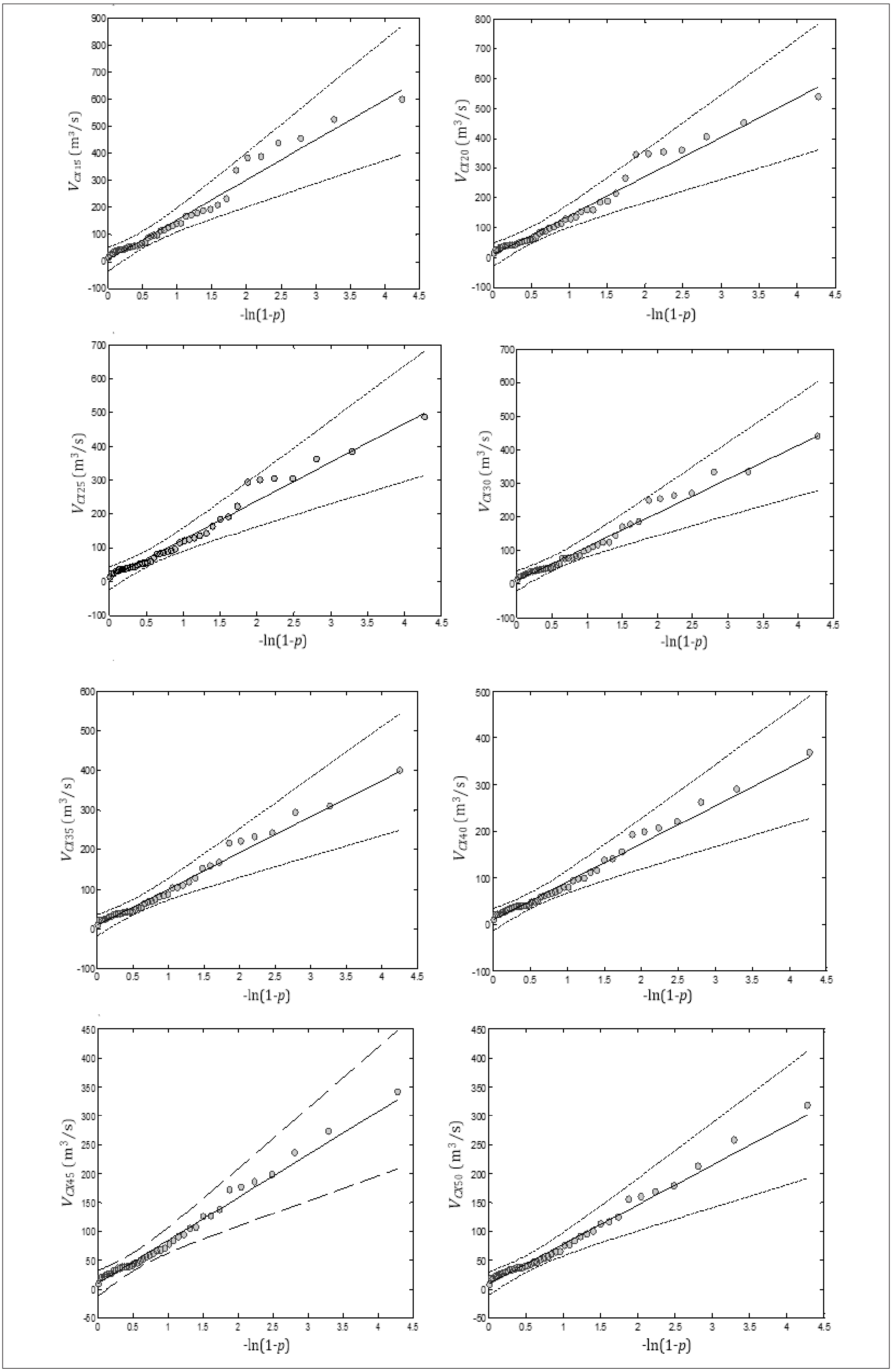


Figure 7. Figure 7. Fitting and confidence limits at 95 % of $_{VCXd}$ series (d = 5, 10 ..., 50 hours).

For the considered series of V_{CXd}, the parameters and are estimated by the method of moments, it was chosen for its simplicity unbiased estimation of location/scale in Exponential (small samples, n = 57), and robustness to outliers. This method performed well. It is recommended for Exponential in hydrological applications (Wilks, 2011). The results of estimation for the parameters and are given in the following table (Table 6). The results of the goodness-of-fit tests presented in Table 7 confirm the adequacy of the exponential distribution in modeling the V_{CXd} series for all considered durations. The Probability Plot Correlation Coefficient *(PPCC)* values are all greater than 0.98, indicating an excellent correlation between the observed and theoretical distributions. Moreover, the Kolmogorov–Smirnov *(KS)* statistics *(KS_{ob})* are systematically lower than the critical values *(KS_{th})* at the 5% significance level, which confirms that there is no significant difference between the empirical and theoretical distributions. Finally, the Root Mean Square Deviation *(RMSD)* values are very small and tend to decrease with increasing duration, suggesting a progressively better fit for longer flood durations. These results demonstrate that the exponential distribution provides a statistically reliable representation of the flood discharge behavior across all tested time scales.

Table 6. Estimated position and scale parameters for each V_{CXd} series.

d (h)	m_d (m³/s)	a_d (m³/s)
5	7,44	193,79
10	7,20	169,94
15	5,35	147,48
20	8,99	131,60
25	9,35	114,30
30	9,92	100,75
35	9,52	91,09
40	9,56	81,47
45	9,16	74,33
50	8,76	68,36

Table 7. Goodness of fit tests.

d(h)	5	10	15	20	25	30	35	40	45	50
PPCC	0,980	0,986	0,985	0,985	0,988	0,990	0,993	0,994	0,995	0,995
KS_{ob}	0,103	0,142	0,109	0,092	0,082	0,081	0,092	0,096	0,094	0,093
KS_{th}	0,210	0,210	0,210	0,207	0,207	0,207	0,210	0,207	0,207	0,207
RMSD	0,214	0,464	0,214	0,177	0,166	0,152	0,150	0,142	0,138	0,142

PPCC is the Probability Plot Correlation Coefficient (Filliben, 1975, Vogel, 1986, Kim *et al.*, 2010) KS_{ob} and KS_{th} are the observed and theoretical Kolmogorov-Smirnov values (Massey, 1951) and *RMSD* is the Root Mean Square Deviation (NERC, 1975). So, the theoretical quantile V_{CXdp} of probability p is estimated for the Exponential distribution fitted with the method of moments is given by:

$$V_{cxdp} = m_d - a_d \ln(1-p) \quad (3)$$

Therefore, in term of return period *T*, the estimated quantiles V_{CXdT} is expressed as (Table 8):

$$V_{CXdT} = m_d + a_d \ln T \quad (4)$$

Table 8. Estimated quantiles V_{CXdT}

d(h)	*T* = 2	*T* = 5	*T* = 10	*T* = 20	*T* = 50	*T* = 100	*T* = 500	*T* = 1000
5	141,77	319,34	453,67	587,99	765,56	899,89	1211,78	1346,11
10	128,52	317,51	460,48	603,45	792,44	935,41	1267,37	1410,34
15	107,57	242,71	344,94	447,17	582,30	684,53	921,89	1024,12
20	100,20	220,79	312,00	403,22	523,80	615,02	826,82	918,04
25	88,58	193,32	272,54	351,77	456,51	535,73	719,69	798,92
30	79,76	172,07	241,91	311,75	404,06	473,90	636,05	705,89
35	72,66	156,13	219,27	282,42	365,88	429,03	575,64	638,78
40	66,03	140,68	197,16	253,63	328,28	384,75	515,87	572,34
45	60,68	128,79	180,31	231,83	299,93	351,45	471,08	522,60
50	56,14	118,78	166,16	213,54	276,17	323,55	433,57	480,95

3.2. V_{CXDT} Formulation

The equation (3), obtained by fitting the V_{CXd} series to the Exponential distribution, is represented in (Fig. 6) as astraight line on the semi-logarithmic plane. For the considered V_{CXd} series with durations d = 5, 10, 15, 20, 25, 30, 35, 40, 45, and 50 hours, all the fitted straight lines intersect at a common point (Fig. 8). This point of intersection can be determined graphically and is located approximately at the coordinates that can be determined graphically; $\ln(1-p_0) = -0{,}0154$ and V_{CX0} = 10,45 m³/s.

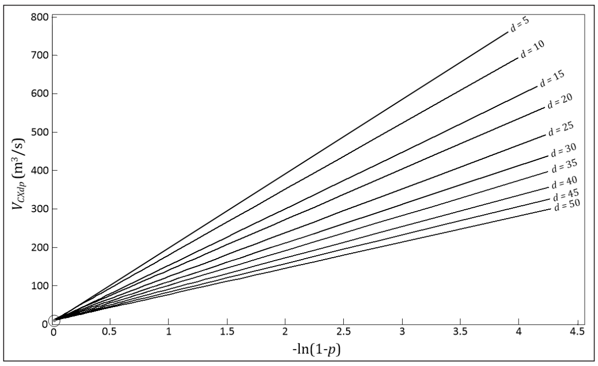


Figure 8. Straight lines of fittings of V_{CXd} series (d = 5, 10, 15, . . ., 50 hours).

It is possible to provide a continuous formulation of the quantiles V_{CXdT}. According to equation (3):

$$V_{CX0} = m_d - a_d \ln(1 - p_0) \quad (5)$$

And so, the difference between equation (3) and (5) gives gives an equation that depends only on the scale paramete a_d:

$$V_{CXdp} = a_d \left(\ln(1 - p_0) - \ln(1 - p)\right) + V_{CX_0} \quad (6)$$

a_d has a polynomial tendency of the second degree versus the duration d (Fig. 9) with a coefficient of determination R^2 = 0.999 expressed as:

$$a_d = 0.0461 d^2 - 5.2783 d + 218.11 \quad (7)$$

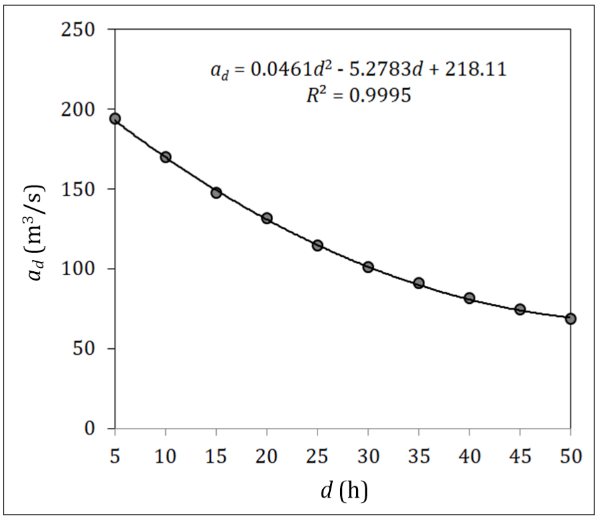


Figure 9. Polynomial tendency of a_d versus the duration d.

Thus, V_{CXdT} formulation as a quantile of flood depending on the duration d and the return period T is giving by:

$$V_{CXDT} = (0.0461\ d^2 - 5.2783\ d + 218.11) \times (\ln(T) - 0.0154) + 10.45 \quad (8)$$

It should be noted that Equation (8) provides a correction to the values of V_{CXdT} previously estimated using Equation (4) for different duration values. This analytical expression (Eq. 8) provides several advantages over discrete quantile tables (Table 5). It enables estimation of V_{CXdT} for any duration d and any return period T, slightly refines the discrete estimates by enforcing the observed convergence property, and facilitates the direct construction of smooth QdF curves (Fig.10). Interpretation of the QdF curves reveals key aspects of the catchment's flood regime: for short durations (e.g, 5-10 hours), discharges rise sharply with increasing return period, reflecting the torrential nature confirmed by Q_{IXA10} = 636 m³/s and d =10 hours. For longer durations, the curves flatten, indicating that extreme events are dominated by brief, intense peaks rather than sustained high flows. This pattern aligns with the semi-arid hydrology, where floods are typically flash-driven by connective storms (Meddi, 1996). Compared with traditional peak-flow analysis, this QdF model provides superior integration of magnitude, duration, and frequency, aligns with prior Algerian studies (Ketrouci and Meddi, 2015; Yahiaoui *et al.*, 2011; Hachemi and Benkhaled, 2016), and enhances applicability to ungauged sites through potential regionalization. The model's robustness supports advanced applications, such as probabilistic hydrograph generation and vulnerability assessments, which are crucial for mitigating risks in rapidly urbanizing semi-arid basins.

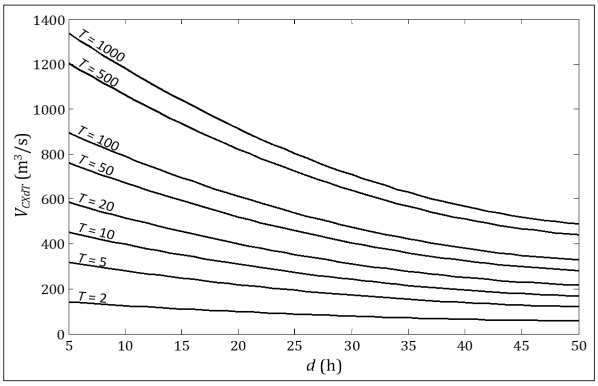


Figure 10. Flow-duration-Frequency (QdF) in V_{CX} curves of Oued Mina.

Compared with traditional peak-flow analysis, this QdF model offers superior integration of magnitude, duration, and frequency, aligns with prior Algerian studies, and enhances applicability to ungauged sites. In summary, the robust exponential fit and the derived analytical formulation provide a reliable tool for flood characterization in semi-arid catchments. The main conclusion of this study is presented in the following section.

4. Conclusion

The local QdF modeling is derived from statistical analysis of the average volume flow of the V_{CXdT} across multiple durations in the Oued Mina catchment. This methodology is based on fitting the Exponential statistical model. This selection is grounded in consistency with established QdF literature and hydrological principles, rather than subjective judgment. Previous studies have shown that flood quantiles expressed as mean discharges or volumes over fixed durations are adequately represented by parsimonious exponential-type models, particularly within the QdF framework (Javelle *et al.*, 2003).

These authors demonstrated that the Exponential distribution yields stable parameter estimates and satisfactory goodness-of-fit across multiple durations, especially when sample sizes are limited. Similar conclusions were reported in semi-arid Mediterranean catchments, where duration-dependent flood variables exhibit strong positive skewness and rapid tail decay (Ketrouci and Meddi, 2015). For this work, the *PPCC* values (0,980 and 0,995) indicate a strong correlation between observed and theoretical data, while the KS observed values remain below the critical thresholds confirming the model's adequacy. The *RMSD* values decrease with increasing duration, suggesting improved performance for longer aggregation periods. Overall, these results confirm the reliability of the exponential distribution for modeling the V_{CXd} data for *QdF* analysis. Therefore, the Oued Mina catchment's high quantile Q_{IXA10} = 636 m^3/s discharge values and the short flood duration (*D* = 10 hours) make it highly vulnerable to rapid torrential flooding.

Hence, the modeling of the flood regime is a major challenge in this case for predicting the extreme event. Moreover, the V_{CXd} series was constructed, and by fitting it to the exponential distribution, the following results were obtained: an analytical formula that gives the relationship of the characteristic extreme flow as a function of the duration and the return period. From the trend analysis, Construction of the QdF curves characterizing the Oued Mina catchment enables us to obtain finalized results integrating the great flows. It represents one of the most widely used hydrological tools in the management of water resources (Ketrouci, and Meddi, 2015; Ketrouci *et al.*, 2012; Hachemi and Benkhaled, 2016; Yahiaoui *et al.*, 2011) and they make it possible to carry out a frequency analysis of floods in a catchment area and flood forecasting for gauged or ungauged basins. Our findings could be valuable and can be helpful to decision makers to improve flood risk strategy in this region for protecting the lives of people and property. The increasing probability of flood occurrence is expected to pose substantial challenges to effective flood management. Accordingly, it is essential to reinforce mitigation and adaptation strategies to enhance human resilience within the Oued Mina catchment.

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Conflicts of interest

The authors declare no conflict of interest.

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