Assessment of Hydro-Meteorological Data in the Karak Plateau, Jordan

*Ibrahim M. Oroud***

ABSTRACT

The present paper evaluates the consistency and validity of archived hydro-meteorological data in the Karak Plateau. Maximum annual one day precipitation data for 53 years were obtained and assessed from a first class meteorological station along with archived flood records of four major wadies draining the plateau. To assess the archived flood record., a spatially distributed transient model with a resolution of 1 km^2 in
one of the catchment areas was run on a daily time basis to simulate rainfall runoff dynamics

The results have shown significant deviations in the hydro-meteorological record. For instance, the maximum annual one day precipitation value as archived by the Department of Meteorology during the 53 year period was 108 mm/day, whereas the actual value was 136.5 mm/day. Likewise, archived hydrological measurements of the four wadies in the plateau were inconsistent with the precipitation events and suffered serious errors. The spatially distributed model was able to simulate rainfall runoff dynamics adequately and reproduced the major floods that took place during the simulation period.

The poor quality of hydro-meteorological data brings the question of the validity of such records for planning and management of water resources of the plateau. These inconsistent records have far reaching ramifications that influence decisions concerning the construction of dams, bridges and culverts. Results presented in this paper call for an urgent need to reconstruct the archived hydro-meteorological data for better management of water resources in the country.

Keywords: hydro-meteorological data, annual maximum precipitation, dams in Jordan, spatially distributed modeling, flood prediction.

1. Introduction

Being located in a subtropical zone, Jordan suffers from severe water shortages where precipitation is quite scarce and variable. The average annual precipitation in the country as a whole is around 90 mm, with the percentage of area receiving more than 200 mm of annual precipitation is restricted to less than 10% of the country (Ministry of Water and Irrigation, 2014: MoWI). This precipitation, though very meager, suffers from substantial inter-annual and intra seasonal variability, with the coefficient of annual variation exceeding 60%

in the arid zones of the country. Besides the inauspicious climatic conditions, two additional problems arise: rapid population growth and projected climatic changes towards warmer and drier conditions which combine to exacerbate Jordan's water predicament. The population of Jordan has increased from close to less than a million people near the beginning of the second half of the 20th Century (Oroud and Al-Rousan, 2004) to a current value of 9.5 million people as of mid 2015(Bureau of Statistics, 2015). Average annual water per capita in the country has dropped from more than 500 m^3 in the early 1970's to less than 120 m^3 at the present time (Ministry of Water and Irrigation, 2014). This trend will decline further in the near future due to the continuous population growth, rapid depletion of underground water

aquifers and drier and warmer conditions as projected by Climate Models and the recent precipitation trend (Zhang et al., 2005; IPCC, 2007; Oroud, 2008; Menzel et al., 2009; Sowers et al., 2011).

To face natural and anthropogenic water challenges, Jordan sought plans to maximize the utilization of its limited water resources. Numerous water dams were established on the main creeks and ephemeral wadies throughout the country to collect intermittent flooding water following intense rainy events. Karak Plateau which has large water resources and agricultural potentials is of particular importance. The Ministry of Water and Irrigation is planning to establish several dams on the main wadies draining this plateau. Such projects demand accurate data to insure adequate planning to accommodate the flood volume because serious pitfallswere noted in the planning of the Mujib Dam *which* receives most of its water from the Karak Plateau. This dam suffers from two serious problems: very small storage capacity and the large flux of sediments accumulating in the body of the dam. Inadequate understanding of watershed fluvial processes in terms of precipitation- runoff/sediment dynamics are aggravated further by the lack and/or incorrect data gathering/archiving techniques. Accurate hydro-meteorological observations and archiving are of significant importance for proper planning and construction of engineering projects such as roads, culverts, bridges and water dams (e.g., Farhan, 1986; 1999). Water scarcityin Jordan is a major hindrance towards economic and social development.

The present study will investigate the record of annual maximum daily precipitation data as archived by the Department of Meteorology (2014) and the flood record of some wadies in the Karak Plateau as archived by the MoWI. The main goal is to establish the coherence and validity of hydro-meteorological records as these data are the core that have been implemented and will be usedfor future engineering projects for the

Plateau. A spatially distributed transient model with a grid resolution of one km^2 and a temporal resolution of one day was implemented to simulate rainfall- runoff dynamics for a watershed situated within the Plateau. The expected results of this investigation would help decision makers to reconsider the quality of hydro-meteorological data throughout the country.

2. The Study Area

The Karak Plateau covers the mountainous area extending from Wadi Hasa in the south to Wadi Mujib in the north, with a total area close to 1800 km^2. Elevation within the plateau increases southward and reaches around 1370 m above mean sea level in Jebil Dhabab (Fog Mountain) southwest of Mazar town. Figure 1 shows the geographic location of the plateau along with the main topographic features and wadi drainage systems. Elevation of the plateau decreases gradually towards the east, but drops steeply towards the Dead Sea escarpment. The western parts are highly dissected by wadies which formed deep canyons. The plateau is covered mainly with red terra-rosa soil which is clearly depicted on the satellite image by its dark tone, making it easily discernible (see figure 1). This soil is usually deep and suitable for agricultural practices.

Average annual temperature ranges from ≈14 ^{o}C in the highlands close to Mazar town to 16°C near Rabba and Serfa. Average annual precipitation falling on the plateau varies from 240 mm in the southeastern parts to about 350 mm northwest of Rabba town. A large fraction of precipitation in the southern parts of the plateau occurs in the form of snow that increases its efficiency and compensates for its reduced amount compared to the northern parts. Average precipitation volume falling on the plateau area is approximately 500 million m^3 year^{-1}. This indicates that the plateau has large blue water and agricultural potentials. According to Koppen classification, the climate of the plateau is temperate (Csa) with warm dry summers and cool wet

winters. The dryness index[i] (e.g., Budyko, 1974; Mc-Mahon et al., 2013), of the plateau is within the range of 3.3 to 4 which implies that the climate of the plateau sustains rain-fed agriculture, and has good grazing

potentials if well managed. Being located in this transitional climate zone, the plateau is prone to drought episodes, causing failure to rain-fed crops.
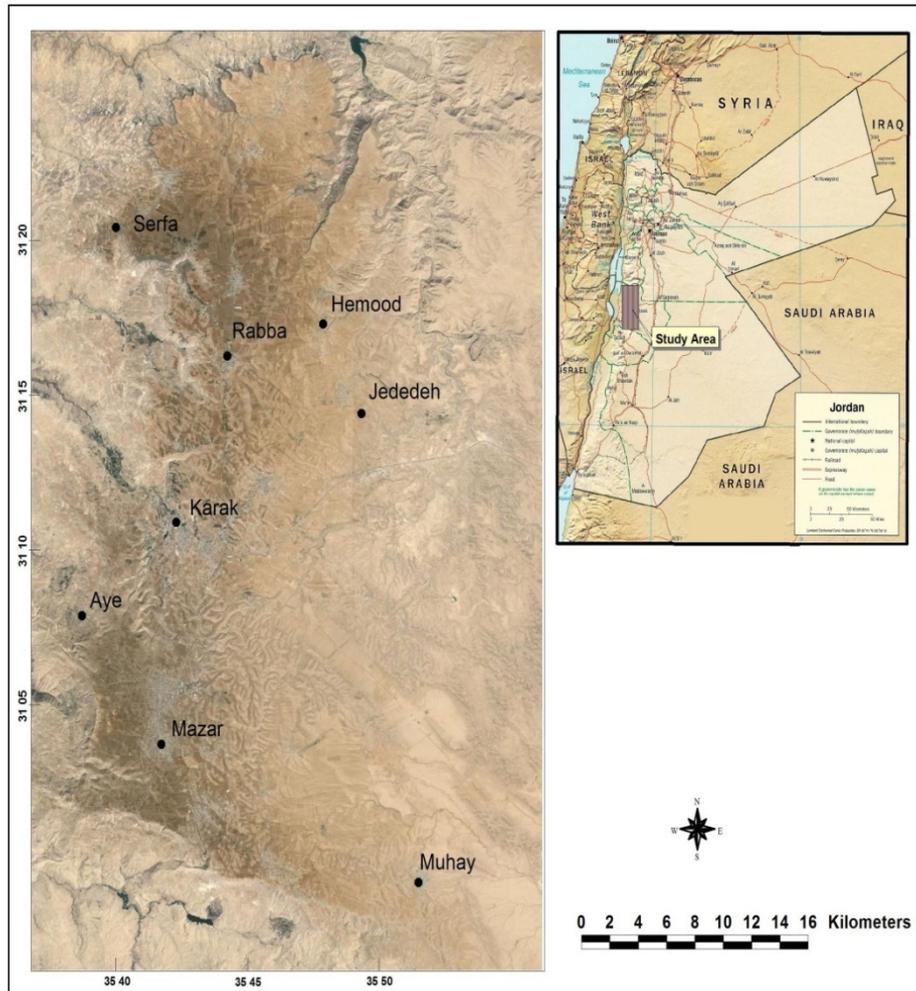

Figure 1: Karak Plateau and its relative location in Jordan

3. Methods of Investigation

The method of investigation consisted of using archived hydro-meteorological data, collecting relevant newspapers data, and establishing relevant theoretical and numerical analyses. A brief description of the methods of investigation is presented below. The daily meteorological data, purchased from the Department of Meteorology, Jordan, were used in this investigation.

3.1. Meteorological Data

Precipitation is measured in several stations situated within the plateau and is reported by the Ministry of Water and Irrigation, by the Ministry of Agriculture, and the Department of Meteorology. The only station which provides reliable, consistent and shorter than one day precipitation record is the Rabba station which is operated by the Department of Meteorology. This station is located

at 31° 16' N, and 35° 45' E, with an elevation of 920 m above mean sea level. All meteorological data in this station were collected at three or six hourly intervals. The archived precipitation data consisted of annual maximum daily precipitation and cover the period from1961 through 2014. The collected data in this station are usually double-checked for consistency by the Climate Division at the Meteorology Department. Precipitation data are routinely collected at 6 hourly intervals, and daily precipitation is recorded at 0800 O'clock local time and ascribed as the daily total for the previous day.

Two Theoretical Extreme Value Distributions, the Gumbel and the Log-Pearson type III distributions, were used to establish the consistency of the archived maximum annual one day precipitation data reported by the Department of Meteorology. These distributions are widely used (e.g., Shaw, 1983; Solomon and Cordery,1984; Chow et al., 1988; Dingman, 1992; Mc Bean and Rovers, 1998) in hydro-meteorological investigations of extreme events and to predict return periods of certain magnitudes.

3.2. *The Flooding Record*

The flood record is obtained from archives collected by the Ministry of Water and Irrigation, Jordan, for four wadies (Mujib, Numera, Karak, and Bin Hammad) draining the Karak Plateau. This record extends for the four wadies from 1990 through 2011. There is some cessation of the record for some wadies.

A spatially distributed transient model with a resolution of 1×1 km^2 and a daily time step was built to simulate precipitation-runoff dynamics in the Numera catchment to establish the coherence and consistency of the flood record in this catchment. The model was run for three continuous years, September, 1996 through August, 1999 to match the existing relevant meteorological data and the archived flood record of that catchment. Detailed description and parameterizations of this model were presented elsewhere (Oroud, 2015a, 2015b).

3.3. *Newspaper Reports*

Relevant flood damages in the study area as reported in two daily newspapers, Al-Rai and Al-Dustoor were gathered during the three year simulation period. These reports serve to examine the adequacy of the archived flood records and also to establish the adequacy of the model in generating flood events. Although newspapers information are qualitative, they provide an excellent account of the extent of damages caused by these flooding events given the facts that flood archives were inconsistent with precipitation events.

4. *Analysis of Archived Meteorological Data*

Table 1 shows the statistical properties of the archived annual daily maximum precipitation as compiled by the DM. The record shows that the one day maximum precipitation in Rabba for the period 1961 through 2014 ranged from a minimum of 20 mm day^{-1} to a maximum of 108 mm day^{-1}.

Table 1. Statistical properties of annual maximum daily precipitation in Rabba meteorological station

Parameter	Value
Minimum (mm day^{-1})	20
Maximum (mm day^{-1})	108
Median (mm day^{-1})	49
Average (mm day^{-1})	54.01
Standard deviation (mm day^{-1})	22.43
Coefficient of variation (-)	*0.415*
Skewness (-)	0.70

The above table is based on the premise that the archived annual maximum daily data is correct! These

data are normally implemented for planning and construction of dams, culverts and bridges. Unfortunately, there are serious problems with the archived meteorological record. Precipitation data in first class meteorological stations, like the Rabba station, are routinely observed at 6 hourly intervals, 0200, 0800, 1400, and 2000, local time. Total daily precipitation is recorded at 0800 local time (MoWI, 1998), and this total is ascribed as the actual daily total (24 hours) for the previous day. In other words, the value recorded at 0800 O'clock is assumed to be the total precipitation amount and being ascribed for the previous day regardless of the storm duration.

The 24 hour maximum precipitation should be based on the duration of the storm rather than setting an artificial time divide as is routinely done in the DM and MoWI, as this would certainly lead to serious errors, with adverse impacts on engineering projects. An example of this serious reporting error is presented in Table 2. During the period March 22/23, 1991, southern Jordan was under the influence of a steady state thunderstorm which caused massive flooding in Karak, Tafieleh and Shoubak areas. Maximum annual daily precipitation reported for Rabba station on the 24th of March, 1991 was 88.1 mm. Table 2(taken from 6 hourly data compiled by the DM, Jordan) shows however, that the maximum daily precipitation for the 24 hour period of that date was actually 136.5 mm rather than 88.1 mm.

Table 2. The six hourly precipitation data as observed in Rabba on the 22 and 23 of March, 1991

Time (local time)	0200	0800	1400	20000	Total
Precipitation 22/3/1991	0	0	18.2	5.2	23.4
Precipitation 23/3/1991	7.2	41.2	64.6	23.5	136.5

As observed from Table 2, the DM reported maximum annual daily precipitation at 0800 O'clock local time on the 24th of March as 88.1. The obtained value is the sum of precipitation recorded at 1400 and 2000, respectively (64.6+23.5=88.1). On the other hand, when considering the duration of the storm, the actual 24 hour precipitation value (7.2+41.2+64.6+23.5=136.5) is obtained. In fact, the precipitation of that storm stopped at about 1530 on the 23 of March, 1991 which would increase the maximum annual daily precipitation value to about 141.7 mm. Reported precipitation for Tafieleh and Shoubak for that date showed similar mistakes. The annual maximum daily precipitation for that storm would have been much higher than the 136.5 mm reported in Rabba had the values for Karak city and its surroundings been taken into consideration. Figure 2 shows the spatial distribution of total precipitation reported on the 23 and 24 of March, 1991 in the Karak Plateau. During that storm, Karak (CE0004), Ain Bisas (CE0002), Aye (CA0004) and Southern Mazar(CD0013) reported 245, 177, 245, and 185mm, respectively compared to Rabba which reported a total of 160 mm of precipitation during that period. The stations presented in Figure 2 do not record precipitation at time scales shorter than one day. Unfortunately, additional short duration precipitation data for other events for Rabba station could not be secured from the DM because of administrative restrictions on data and their astronomical price tag. At any rate, the annual maximum daily precipitation presented above brings into question the validity of data archived by the Department of Meteorology which are implemented for engineering

projects. Such records had substantial influence on the calculated return period and other design issues (e.g., Chow, 1964; Benson, 1968; Singh et al., 2012).
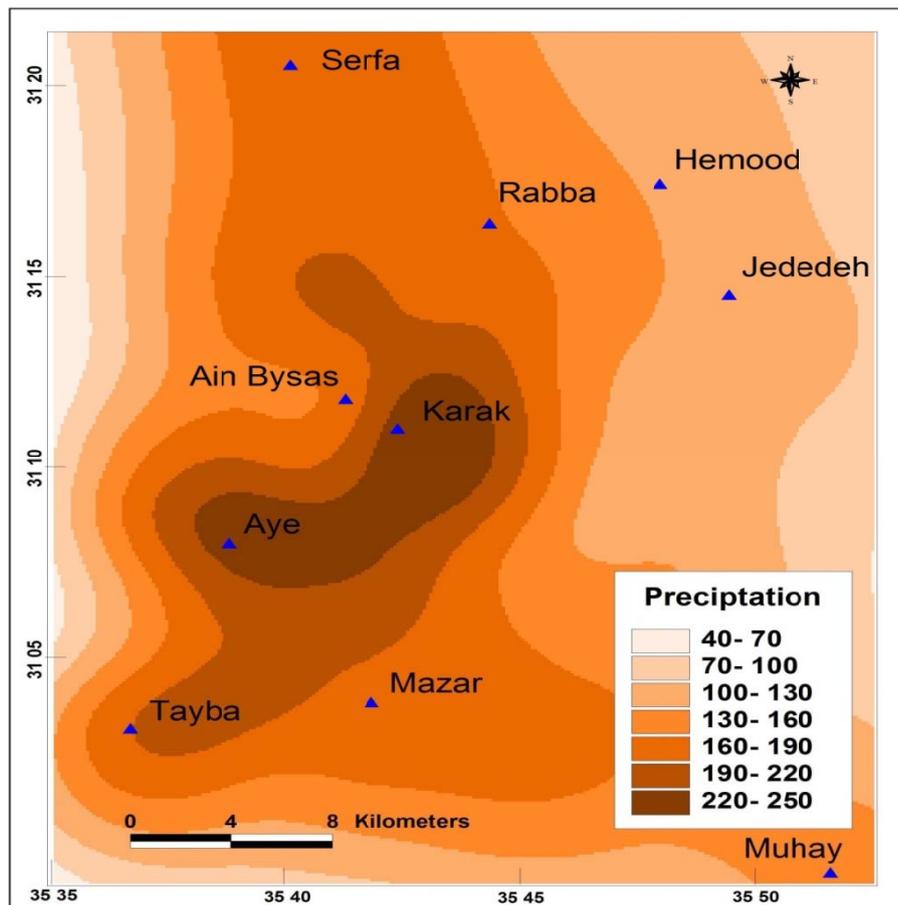

Figure 2: Spatial distribution of precipitation over the Karak Plateau during the period between 22 and 23 of March, 1991

5. Theoretical Analysis

The archived and corrected annual maximum daily precipitation data sets were analyzed using the Gumbel and the Log-Pearson type III distributions. These distributions are widely used in the prediction of extreme value events such as daily precipitation and flooding (e.g., Shaw, 1983; Mc Bean, 1998), as they provide excellent fit to time series of these events. The purpose of this analysis is to provide an independent check of the coherence and consistency of collected annual maximum daily precipitation data.

The frequency analysis for a particular return period maybe expressed using the following form (Chow et al., 1988),

$$X_T = \bar{X}(1 + CvKT) \tag{1}$$

where X_T is maximum value for a given return period, $\bar{X}$ is the mean of maximum annual one day precipitation series, CV and KT are the coefficient of variation and the frequency factor which depend upon the return period.

For the Log-Pearson type III, the frequency factor is

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expressed as (Chow et al., 1988),

$$KT = \frac{2}{Cs}\left[\left[\left(z - \frac{Cs}{6}\right)\frac{Cs}{6} + 1\right]^3 - 1\right] \tag{2}$$

where Cs is the skewness coefficient of the series, and z is the normal z score corresponding to an exceedance of a return period (p) (p= 1/T).

For the Gumbel distribution, the frequency factor is written as (e.g., Chow et al., 1988),

$$KT = -\frac{\sqrt{6}}{\pi\left[0.5772 + Ln\left[Ln\left(\frac{T}{T-1}\right)\right]\right]} \tag{3}$$

The z value corresponding to a given exceedance probability is calculated using the following form (e.g.,

Sing et al., 2012),

$$z = w - \left[\frac{2.515517 + 0.802853w + 0.010328w^2}{1 + 1.432788w + 0.189269w^2 + 0.001308w^3}\right] \tag{4}$$

where w is calculated as,

$$w = \left[Ln\left(\frac{1}{p^2}\right)\right]^{0.5}, \tag{5}$$

Table 3 shows the corrected and uncorrected compiled annual maximum daily precipitation data and their corresponding values as calculated with the Gumbel and the Log Pearson's distributions. Figure 3a shows a plot of archived data using the Gumbel method (e.g., Hammer and Mackichan, 1981).

Table 3. Stochastic nature of archived and corrected record of annual Maximum daily precipitation in Rabba station

| Parameter	Corrected	Archived
Minimum (mm day^{-1})	20	20
Maximum (mm day^{-1})	136.5	108
Median (mm day^{-1})	49	49
Average (mm day^{-1})	54.92	54.01
Standard deviation (mm day^{-1})	24.72	22.43
Coefficient of variation (-)	*0.450*	*0.415*
Skewness (-)	1.099	0.7
Kurtosis (-)	1.163	-0.34

Table 4. Observed (archived and corrected) versus theoretically derived annual one day maximum precipitation values

Log Pearson's Method		Gumbel's Method		Precipitation (mm day^{-1})		Return Period (year)
Corrected	Archived	Corrected	Archived	Corrected	Archived	
20.97	20.73	14.32	17.15	20	20	1.01
49.80	49.94	50.86	50.31	49	49	2
66.90	66.05	67.81	65.70	68	68	4
72.03	70.74	72.70	70.14	77	77	5
87.63	84.58	87.16	83.27	92	91	10
103.17	97.86	101.03	95.86	100	99.8	20
108.22	102.08	105.43	99.85	108	100	25
118.99	110.92	114.64	108.21	123	104	40
124.17	115.10	118.99	112.16	135	108	50
140.63	128.11	132.44	124.37	-	-	100
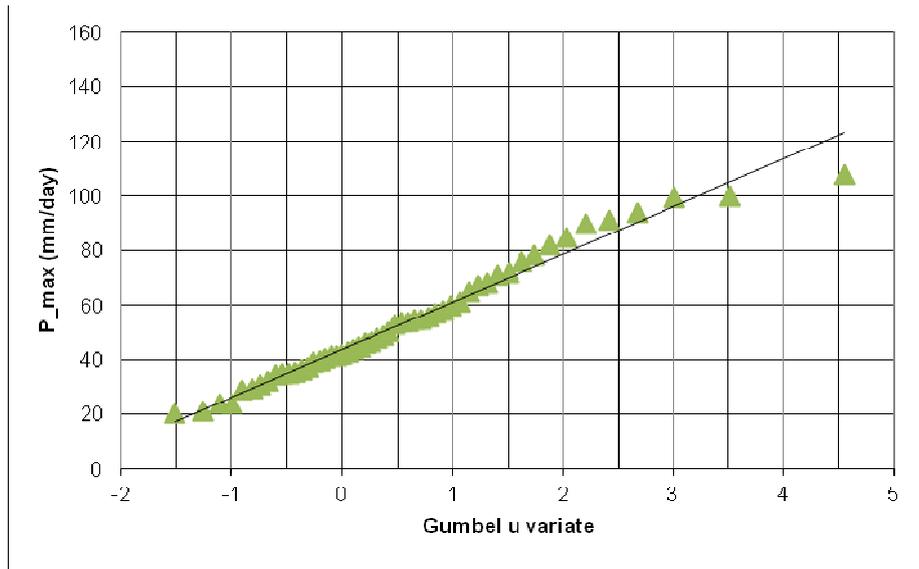
a

Figure 3: a. Archived annual daily maximum precipitation versus the Gumbel Distribution
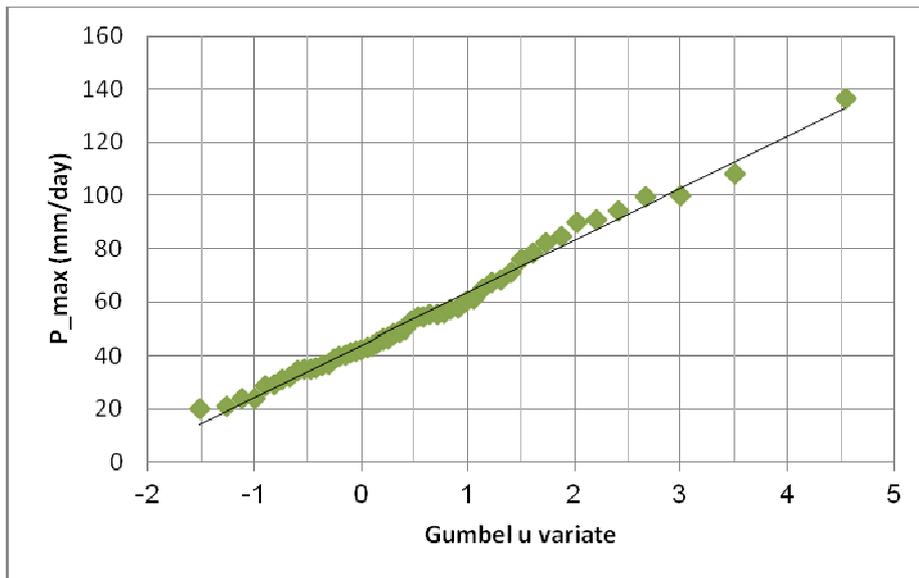
b

Figure 3: b. Corrected annual daily maximum precipitation versus the Gumbel Distribution

Figure 3b, and Table 4 show that there is an excellent fit, particularly the Pearson Type III distribution, between observed and the theoretically derived annual one day maximum precipitation at the lower end but deviate substantially at the smaller return periods. The deviation at the upper end indicates that the archived data suffer from a serious reporting error. Furthermore, the reporting procedure does influence the statistical properties such as the mean, the skewness, and the coefficient of variation which in turn influence the theoretically derived values.
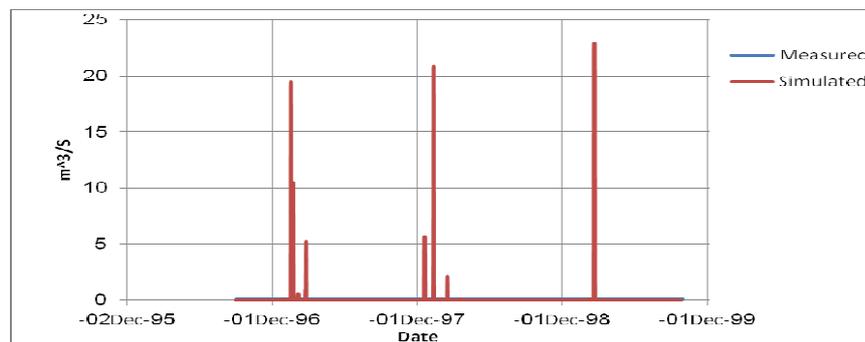
6. The Archived Flood Record

The records of flooding as archived by the Ministry of Water and Irrigation of the Mujib, Karak, Wadi Bin Hammad and Numera are used to examine their consistency and coherence. Inspection of the flood record for the four Wadies shows that the archived records suffer from serious inconsistencies. For instance, during the severe storm that took place during March 22 trough 23 of 1991, massive flooding took place in all wadies draining the Karak plateau and newspapers reported substantial damage in the southern Ghore area, yet average daily discharges of Wadi Mujib, Wadi Karak, Wadi Numera and Wadi Bin Hammad for the 22, 23, 24, 25 of March, 1991 as provided by flooding records archived by the Ministry of Water and Irrigation, were 0.038, 0.274, 0.061, and 0.19 m^3/second!. Other major precipitation events over the plateau which caused massive flooding never appeared in the flood record of these wadies. There are many other inconsistencies that could be cited between major precipitation events and the archived discharges of the four wadies.

To extend the discussion further, a spatially distributed transient model with a resolution of 1×1 km^2 was constructed to examine the archived flooding reported for Wadi Numera which drains parts of the Karak Plateau (Oroud, 2015). The catchment covers an area of about 100 km^2 and receives, on average around 26 million m^3 annually. The average annual precipitation of the catchment area ranges from around 300 mm in the highlands to less than 80 mm near the Dead Sea shoreline.

The simulation covered the period, September 1, 1996 through end of September, 1999 to match the archived data for Wadi Numera as reported by the Ministry of Water and Irrigation.

The maximum daily discharge at the outlet of Wadi Numera near the southern Dead Sea during the three year simulation period, September, 1996 through August, 1999 was 0.09 m^3 /s, which indicated that the maximum total daily discharge during that period was less than 8000 m^3 day^{-1}. The model was able to simulate several flooding events during the simulation period, and these events were verified from the flood damage reported in daily newspapers. Figure 4a shows simulated versus archived discharges at the outlet of the Numera catchment area, and Figure 4.b shows daily precipitation during the simulation period. It is clear that the archived record did not show any flooding during the three year period which is inconsistent with precipitation events. On the other hand, the model simulated several flooding events during the run period. For instance, the simulation model produced large flooding events on the following dates: February, 23, 1997, January, 11, 1998, and January, 19, 1999. These flooding events were checked against newspapers reports for the dates when floods occurred and caused damage to roads and agricultural lands in the Numera catchment and in the southern Ghore area. The absence of any significant changes in the archived stream discharge during the simulation period is a clear example of the absence of real measurements, and the more likely scenario is that runoff in the four catchments was based on guessing.

4.a
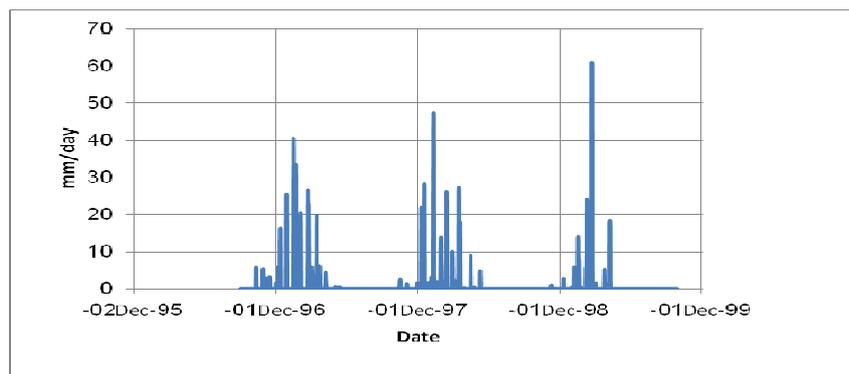
4.b

Figure 4: a. Simulated versus archived flood discharges at the outlet of the Numera catchment area. 4.b Daily precipitation during the simulation period

7. Discussion and Conclusion

The archived meteorological and hydrological data were not carefully constructed as large deviations were observed in both records. The archiving of the annual maximum daily precipitation data suffers from a serious error that affected the record substantially. The archived largest one day maximum precipitation value was 108 mm/day whereas a value obtained from a continuous recording of the storm that took place on March, 22/23 of March, 1991 was 136.5 mm/day. The very large difference would lead to serious errors in calculating flood volume and in estimating the magnitude of flood at different return periods with substantial adverse planning ramifications. The flood records of wadies, at least in the Karak Plateau, suffer also from serious errors, and archived flood data cannot be used for planning and management of water resources in the Karak Plateau area.

Inconsistent meteorological and flood records have repeatedly led to serious failures of many engineering projects in the country such as dams, bridges, and culverts. Numerous bridges and culverts failed to accommodate flood volumes and collapsed after very short periods of their constructions. A clear example is a bridge constructed at the entrance of Karak beneath the Karak Castle. The bridge was completed in early 1990 and collapsed in March, 1991, after one year of its

construction (Alrai Newspaper, end of March issues, 1991). Many examples of failed culverts and bridges can be cited throughout the country.

Much more costly projects are not exceptions, and the Mujib and Wala Dams are clear examples of these planning failures. As an example, the maximum storage capacity design of both the Wadi Walla and the Mujib dams were seriously underestimated, being 8 and 36 million m^3, respectively. During their operation period which started around 10 years ago, the volume of overflow during flooding periods was quite substantial which cannot be tolerated in a country that suffers from severe water shortages. As a measure to rectify the serious storage deficiency of the Wala Dam, the Ministry of Water and Irrigation (MoWI) implemented in 2014 a plan to increase the capacity of this dam from 8 M m^3 to 25 M m^3.

The circumstances of the Mujib dam are complicated further by the large flux of sediments deposited in the main body of the dam which continuously diminishes its already small storage capacity. A study conducted in 2008 by Margane et al., 2008, after five years of dam operation, showed that the sediment thickness in some parts of the Mujib dam exceeded 14 meters. This sedimentation problem has gravely reduced the dam's effective capacity from 36 Million m^3 in 2003 to less than 28 Million m^3 in 2014 (MoWI, 2014). As a result of

its small capacity and the rapid accumulation of sediments, the dam has experienced repeated overflow that would exacerbate further as time passes due to continuously diminishing capacity. High levels of **"unexpected"** precipitation volumes were the given justifications by the MoWI personnel for the failure of the dam to accommodate the repeated large flooding during the operation period, 2003 through end of May 2014. Archived precipitation data do not show any serious increase in daily precipitation during the operation of the Mujib dam.

There is a serious problem in reconstructing meteorological data in Jordan. The Department of Meteorology has a long tradition of adhering to strict policy of disseminating archived meteorological data, and in order to stop the trickling of such data, they impose an astronomical price tag which makes it almost impossible to acquire. This peculiar policy has caused serious problems to engineering constructions with substantial adverse economic ramifications. Thus, it is urgently needed to reconstruct maximum precipitation data and establish reliable hydrological measuring stations to amend the ensued errors and avoid further poor and very costly planning. Unfortunately, such erroneous **"records"** are routinely utilized in the construction of dams, culverts, and bridges. It is no wonder then that constructed dams in Jordan suffer from serious problems. As with the flooding records, wadies in the Karak Plateau should be considered simply as ungauged watersheds and should be dealt with as such when planning for dams or other engineering constructions.

NOTES

(1) The dryness index (Φ) is a measure of the ratio of potential evaporation to precipitation in an area; when ϕ is < 1 then the region has ample water resources; when Φ between 2 and 5 then the climate is semiarid, permitting dry-fed agriculture; a value between 5 and 10 indicates that the climate is relatively arid but lands there could be used under controlled conditions for grazing purposes. If $\Phi>10$ and less than 20, then the climate is arid with very little potential for forage; when Φ exceeds 20 then the climate is hyper-arid and vegetation occurs mainly along wadi courses, over fluvial fans, and in deep areas where flood water collects.

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تقييم المعلومات الجوية والهيدرولوجية في هضبة الكرك

إبراهيم العرود*

ملخص

عالجت الورقة الحالية مدى صلاحية البيانات المطرية والفيضانات التي تزودها كل من دائرة الأرصاد الجوية الأردنية ووزارة المياه والري اعتمادا على بيانات المطر اليومية لثلاثة وخمسين عاما من محطة جوية أساسية، وبيانات الفيضانات لأربعة أودية رئيسية، الموجب، الكرك، ابن حماد والنميرة لمدة عشرين سنة. ومن أجل تقييم الفيضانات فقد تم بناء نموذج هيدرولوجي ديناميكي بقدرة تمييزية مكانية مقدارها كيلومتر مربع واحد وبفاصل زمني مقداره يوم واحد لمحاكاة الفيضانات لأحد الأحواض سابقة الذكر لمعرفة صلاحية بيانات الفيضانات المؤرشفة. وقد أظهرت النتائج انحرافات وأخطاء فادحة وخطيرة في البيانات المطرية لدائرة الأرصاد الجوية، فقد كانت أكبر كمية مطر يومي مسجلة من قبل دائرة الأرصاد الجوية في محطة أرصاد الربة/ الكرك هي 108 ملم/اليوم بينما كانت فعليا لعاصفة مطرية حدثت يومي 22 و23 آذار، 1991، 136.5 ملم/اليوم. كما أظهرت النتائج أن بيانات الفيضانات المسجلة لدى وزارة المياه والري للأودية الأربعة سابقة الذكر تعاني من أخطاء جسيمة، فقد كانت أكبر كمية تدفق فيضاني خلال الفترة 1990 ولغاية 2010 في وادي النميرة، مثلا، 90 لترا/ الثانية. ولا تختلف بيانات الأودية الأخرى عن هذه "القيمة" الغريبة. وقد أظهر النموذج الهيدرولوجي توافقا ممتازا بين المطر اليومي والفيضانات، وكانت أعلى كمية فيضان تمت محاكاتها لوادي النميرة خلال الفترة 1996 –2002 هي 23 متر مكعب/الثانية، أي أكبر من أعلى قيمة فيضان مسجلة لدى وزارة المياه والري بمقدار 255 ضعفا؟ وقد تم التأكد من بيانات النموذج عند مقارنة بيانات الفيضانات التي أنتجها النموذج مع التقارير الصحفية للأضرار التي خلفتها تلك الفيضانات في منطقة الأغوار الجنوبية.

إن الأخطاء الجسيمة في البيانات المطرية والفيضانات التي توردها المؤسسات الرسمية تثير تساؤلات عميقة عن مدى صلاحية مثل هذه البيانات للتخطيط وإدارة الموارد المائية في الأردن. إن اعتماد مثل هذه البيانات في السابق كان لها تأثيرات مادية مكلفة جدا وتصميمية خطيرة على الجسور والسدود المائية التي تم إنشاؤها على الأودية التي تصرف مياه هضبة الكرك وفي كافة أرجاء الأردن الذي يعاني من شح مائي شديد في موارده المائية. إن جسامة الأخطاء الواردة في بيانات دائرة الأرصاد الجوية ووزارة المياه والري تستدعي إعادة النظر بشكل عاجل بهذه البيانات التي يؤدي استعمالها إلى هدر مالي هائل وسؤ تخطيط المرافق المائية الحيوية، وخير دليل على ذلك صغر سعة كل من سد الموجب ووادي الواله وانهيار الكثير من الجسور والعبارات بعد فترة وجيزة من انجازها؟

الكلمات الدالة: تقييم المعلومات الجوية، المعلومات الهيدرولوجية، هضبة الكرك.