1. CATCHMENT YIELD ESTIMATION

For any hydrological study, specially the design of the roads, dams or any other hydraulic structures, the availability of streamflow data is very much needed, in order to compute the required catchment yield and the design floods for the construction of any other hydraulic structures. The used method in this case is usually the frequency analyses of the time series of the annual observed floods if such data are available.

If the stream flow is not observed in the catchment or if the observations are not available, then estimation is required. In this case, the methodology will include at the first stage, the collection of the relevant hydro-meteorological data. These data were collected through the Client, from different authorities. These collected data were stored in the computer taking into account adequate criteria to preserve statistical independence between adjacent events.

For the purpose of designing dams, roads, or any other hydraulic structures, if the flow of streams is not observed, the water level and/or flow monitoring for each site is not a practicable way. The flood magnitudes can generally be estimated after the maximum events from peak flood marks using slope-area method, or, by using the empirical methods in generating the design flood from the measured rainfall observations.

In fact, and as mentioned earlier, this normally needs the continuous rainfall recording in order to know the short duration rainfall needed to draw the intensity-duration-frequency (IDF) curves representative to the area. Even if the records of the short duration rainfall are not available as

the case existing in Yemen, the maximum daily rainfall records can be used in order to generate the rainfall of the shorter durations, using Hershfeild's method with the use of some of the experience of the hydrologist.

The slope-area method, can also be used, based on the cross-sectional area of the river/stream at its crossing water surface up to the flood marks, if the bed slope roughness characteristics of the river/wadi and the historic high flood levels (high flood marks) obtained from field investigations are known. These data are applied for the very popular Manning's formula which, will be discussed later, to estimate the discharge. But, the accuracy of this method is much dependable on the estimation of the roughness coefficient, which needs either measurement or a good experience for accurate estimation. The field visit to the site could show those marks after a flood event occurs. In the following pages the most popular empirical methods being used for the determination of catchment yield and design floods will be discussed.

9.1 Case when the Observations are Available

9.1.1 Hydrograph

The ultimate aim of many computational techniques in engineering hydrology is the derivation of river discharges, and it might appear that once these are obtained the hydrologist's work is done. However, whether they are gained indirectly from considerations of other hydrological variables, or from river discharge measurements, the discharge data are only samples in time of the behavior of the river. The hydrologist then must assess the worth of the data and their representativeness over the

period for which the information is required, usually the expected life of a water engineering project.

A hydrograph is defined as a graph showing stage, flow, velocity, or other property of water with respect to time. The gauging station can usually give the water level or the stage of the water in the wadi/river. In order to convert the water level records to discharge data a rating curve relating the water level to discharge should be used.

With an adjusted and well-measured rating curve, the daily gauge readings can be converted directly to runoff volumes. A typical set of such daily runoff figures is presented graphically in figure (14). Such a presentation is called a hydrograph. Although figure (14) shows a hydrograph with a time base of many months, hydrographs for smaller catchments can have time bases of days or even hours.

Fig. (14): Daily Streamflow Hydrograph [m3/s]