Determination of a mean daily discharge values for Faleaseela River – implications for population water demand.

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Abstract
Faleaseela is a 10.1 km^2 catchment basin (Figure 1) to the southwest of Upolu Island. The stream's tributaries converge into a very stable artificial control weir on the edge of a moderately steep water fall. Data is collected by a mechanically operated Leupold & Stevens Type A stream flow recorder and converted to mean daily discharges using an empirical rating curve equation, $Q = ah^c$ where Q is the Mean Daily Discharge; h is the stage height; and c the exponential constant, and multiply a another constant value accounting for channel and flow characteristics. Mean daily discharges are applied to the determination of the total runoff volume for a period of 5–10 years. Comparative analysis of reticulation to the end users (population) against supply is an indicator for providing an effective strategy for the management of the resource at abstraction point. Some assumptions had to be made for the validity of the study: 1) the slightly falling trend in the average mean daily discharge through out the research period is a result of land clearance in critical parts of the catchment area, and 2) the point of abstraction is in close proximity with the measurement point, assumption of identical mean daily discharge values.

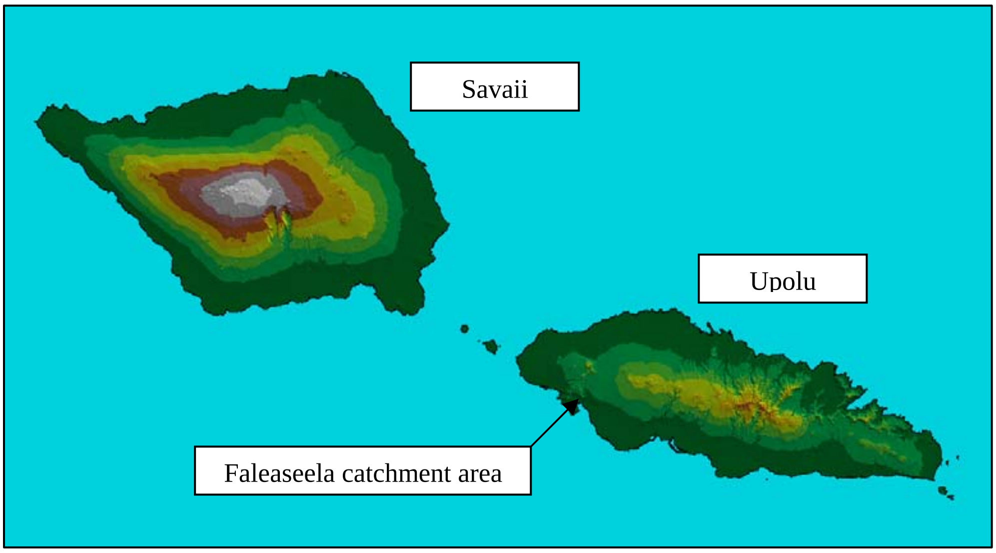

Figure 1: Location of Faleaseela catchment area (Source: Ministry of Natural Resources & Environment)

Introduction

During the dry season or close to its onset, perennial problems of water shortage are experienced in certain parts of Samoa. A generalized statement, observed only without clear scientific justifications. It is also extremely difficult to make a genuine assessment and

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planning if the resource cannot be quantified by our water users, mainly Samoa Water Authority (SWA), Electric Power Corporation and Ministry of Health.

Hydrological analyses should provide the answer. It is based on well-established principles of hydrodynamics, thermodynamics, and statistics. The central set-back is that these principles must be applied in a homogeneous, well sampled and fully understood natural environment.

The reason we have opted to use this ‘simple’ parametric approach, analysis that is performed by inter-comparison of hydrological data recorded at different locations and time. As opposed to the more complex deterministic, probabilistic and stochastic hydrological analyses. Note also that very little is provided on the temporal, spatial and regionalization of variables, but most the relationship and for planning purposes consumption rate – more of social variable in this respect.

Data collection

A flat-shaped artificial weir was constructed at Faleaseela River for flow control and a L/Stevens Type F to gauge the water level was also installed in 1975 (Methorology Division 1975-1979). A 5 year period was selected because of quality control. Runoff volume (m^3) was calculated using mean monthly discharge for the month (Table 1). Census data on population for Faleaseela and Lefaga district (Ministry of Finance 1981-2001) were used for demand versus supply projection and for future trend analysis (Table 2).

Years	**Runoff volume (m^3 x 10^6)**	**Average per month**	**Average per day**	**Average for 5 years**
1975	17.220	1.435	0.0472	14.5012
1976	11.700	0.975	0.0321	14.5012
1977	11.727	0.977	0.0321	14.5012
1978	17.099	1.425	0.0499	14.5012
1979	14.760	1.230	0.0404	14.5012

Table 1: Hydrological data (Source: Ministry of Natural Resources & Environment)

Census year	**1981**	**1986**	**1991**	**2001**
Lefaga & Faleaseela	3,776	3,747	4,044	4,508

Table 2: Total population of Lefaga & Faleaseela district (Source: Ministry of Finance)

Methodology and analysis

<u>Calculation of runoff volume</u>

The methodology is a parametric approach – estimating the average annual volume of runoff (m^3), from average mean daily discharge rates (m^3/s) From Table 1, the monthly and annual volume is computed as Average monthly runoff volume (m^3) = Mean daily discharge (m^3/s) times seconds/day times number of days in the month.

For example in January 1975, MDD is 1.373 m^3/s x 86,400 s/day x 31 days = 3.678 million m^3. Adding the 12 months in a year gives us 17.220 million m^3 annually. After the analysis the average annual runoff volume for the 5 year period is estimated at 14.5 million m^3 of water is available

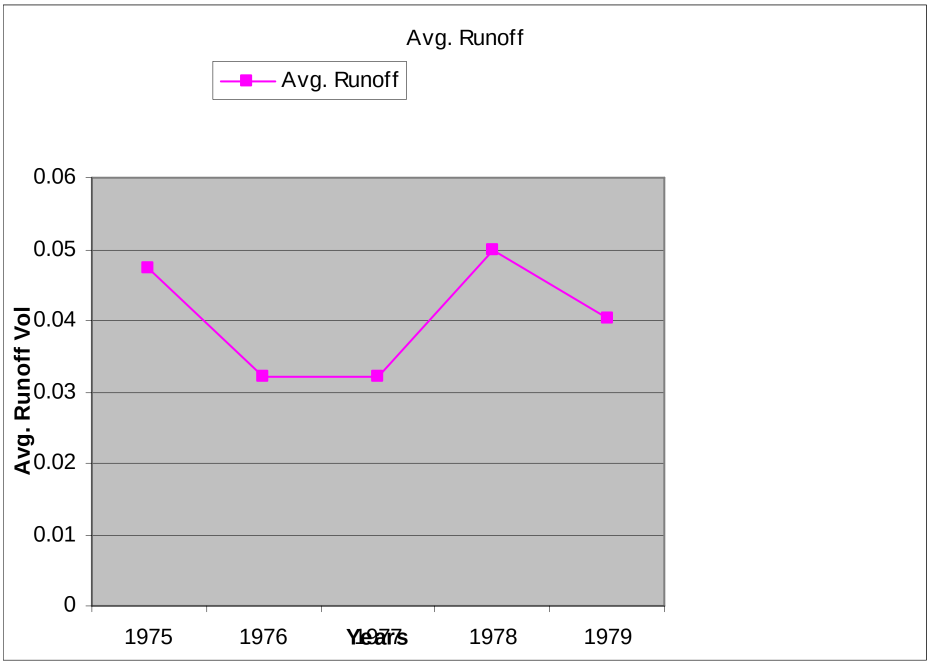

Figure 2: Average/day/month/ Runoff x 10^6 vs Years

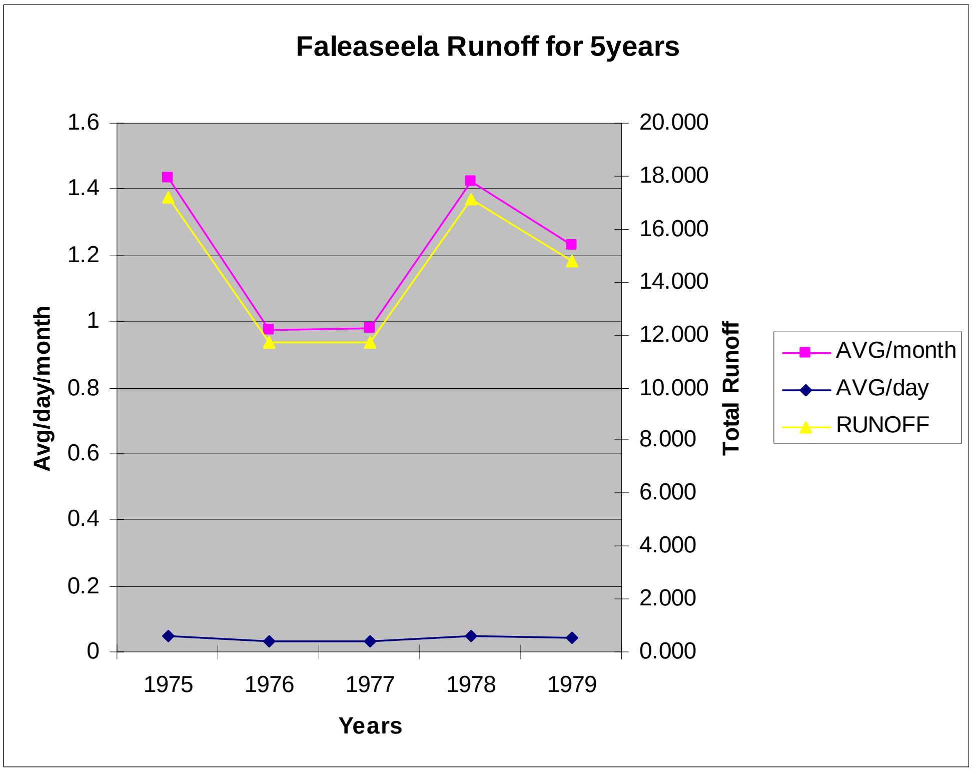

Figure 3: Graphical presentation of hydrological data

Graphical presentation of hydrological data

Figure 2 shows the average Runoff-Volume in cubic meters (m^3) computed per day for each year from 1975 to 1979 which gives a comparative value to plan abstraction on a daily basis and similarly for Figure 3 which shows the overlay of the 3 parameters - (1) ‘pink’ – average run-off volume in m^3 per month *point values on the left Y-axis*; (2) ‘black’ – average run-off volume per day in m^3 *point values on the left Y-axis* and the ‘yellow’ is the total run-off in m^3x10^6 *point values with the scale on the right. Y-axis* (Note: the different scales of the axes maybe similar but are not identical)

After the analysis the average annual runoff volume for the 5 year period is estimated at 14.5 million cubic meters of water is available

<u>Population growth and trend</u>
From Table 2, there has been very little population growth in the1980s however an 8% increase in 1991 then an 11% increase in 2001. The last two censuses depicted some significant increase in the population in the Lefaga & Faleaseela district

<u>Consumption rate</u>
For the purpose of the study some assumption had to be made on the abstraction rate: (1) there is no leakage within the reticulation system; and (2) the consumption rate (usage – shower, washing etc.) is equal to that of the abstraction rate.

Though, very little data exist on the SWA database on abstraction rate, so we have to undertake a special field exercise at the intake site. The value obtained is 18 liters per second or 0.5 million cubic meters is abstracted annually.

The consumption rate is 243 liters per day (pers. comm SWA) and is quite high in Samoa; about 40% of this amount is wastage, the rest is utilized for drinking, washing, shower etc. usage.

So in the final analysis an estimate is made on the quantity of the water resource (surface water) or run-off *less* the estimate of the water abstracted from the intake (consumption) leaving the incremental portion of surface water available.

Conclusion

1. The estimated average annual run-off volume for Faleaseela Catchment Area of $10km^2$ is 14.5 million cubic meters;
2. SWA abstract 0.5 million cubic meters annually or 18 liters per second;
3. The 2001 census with a population of 4,508 persons requires 0.4 million cubic metres per year or 80% of Saw's drawing rate;
4. If the trend of a 3% increase of population continue linearly every 5 years it shall project the district population in 2006 to be at 4,743 persons requires a .42 million cubic meters per year;
5. About 77% of the surface water still remain to be developed from Faleaseela;
6. The major problem is the demand is at the ceiling of the abstraction rate so SWA needs to develop a large intake and an increase abstraction rate to cope with the demand

Bibliography

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