Scientific Bulletin of Politehnica University of Timişoara

Transactions on HYDROTECHNICS

Volume 64 (78), Issue 1, 2019

Selection Between Different Locations for Dam Construction Considering Reservoir Capacity

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Abstract: Choosing the right location for a dam construction is one of the most important factors for a complex water management arrangement. In order to make a good choose for the location it's imperative to take into consideration water demands for the present and for the future. Runoff flow, direct rainfall, catchment characteristics, climatic data, site geology topography, tectonic outlines, evaporation are olso important factors.

Keywords: Reservoir, dam, location.

1. INTRODUCTION

In the last hydrological years many parts of the word was subjected to a drastic drought condition, which caused several problems for the region population, as the available water resources are not satisfying water demands for humans and livestock consumption, agriculture, etc.

Therefore, the water resources management became one of the most important targets of the World's Governments and in order to satisfy water management of the area, investigations and studies started for water harvesting through the construction of different sizes of reservoirs everywhere possible, that aims in collection of excess rainfall water and in conservation of the eroded soil, in addition to ground water recharge.

Considering that, the main purpose of the dam construction in that area is to collect the biggest amount of water, it is recommended to choose the location where result the biggest designed reservoir volume.

In order to make a good selection is recommended to compare the locations considering all important factors:

- Integrated complex water management factors (development of the area for the next 25 year)
- Purpose of the water management scheme (irrigation, water supply, agreement, etc.)
- Satisfying water demands for the present and for the future.

2. STUDY CASE

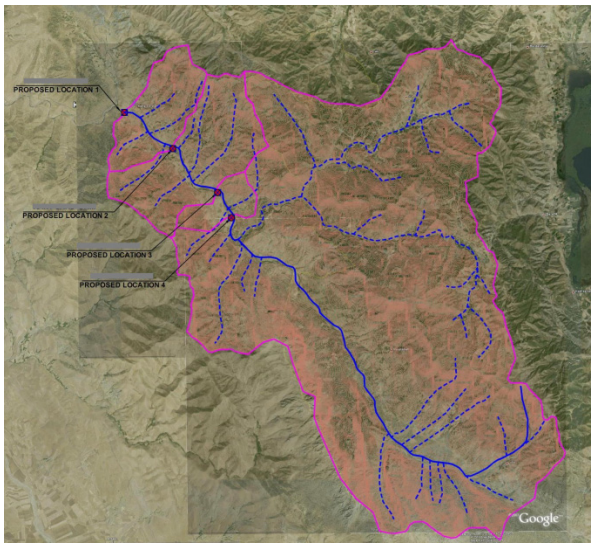

Figure 1. Catchment Areas on Google Image[2]

Table 1: Proposed Dam's Locations

Name	Catchment Area (km2)	Longest Path (km)
Location 1	188.91	25.78
Location 2	179.44	23.38
Location 3	162.59	20.76
Location 4	159.06	19.54

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Catchment characteristics

The flow delineation at the catchment area is related to topographic maps of the largest available scale up to the proposed hydraulic structure, as shown in Figure 1. [3]

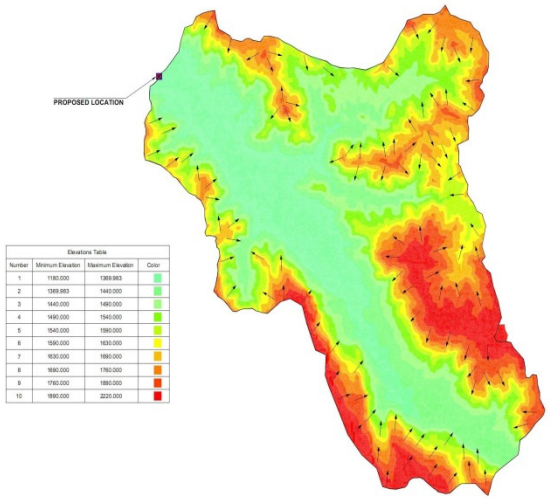

Figure 2. Catchment Area Flow Delineation[2]

Runoff Estimation

The runoff discharge is used to optimize the reservoir volume, and for yield management

There isn't runoff discharge data available at the dam site. A monthly rainfall runoff discharge estimation for the proposed dam would be calculated based on SCS (Soil Conservation Service); this method depends on the average daily rainfalls, soil used, and soil cover complex and land slope for the catchments area has been used to generate the monthly and then the annual runoff volume.

The runoff curve number CN is a function of land use, antecedent soil moisture, and other factors affecting runoff and retention in a watershed and its values are presented in Table 1 below.

Table 2: Runoff Curve Numbers

Land Use Description	Hydrology Soil Group			
	A	B	C	D
Cultivated land :				
Without conservation treatment	72	81	88	91
With conservation treatment	62	71	78	81
Pasture or range land:				
Poor Cover	68	79	86	89
Good Cover	39	61	74	80
Meadow:				
Good Condition	30	58	71	78
Woods or forest land:				
Thin stand, poor cover, non-much	45	66	77	83
Good Cover	25	55	70	77
Farmsteads	59	74	82	86
Roads	74	84	90	92

The curve number is a dimensionless number defined such that $0 \leq CN \leq 100$. For impervious and water surface CN=100, for natural surface $CN \leq 100$

Figure 2 presents the land use description for catchment area and Table 2 presents the estimated area and CN according to the plants.

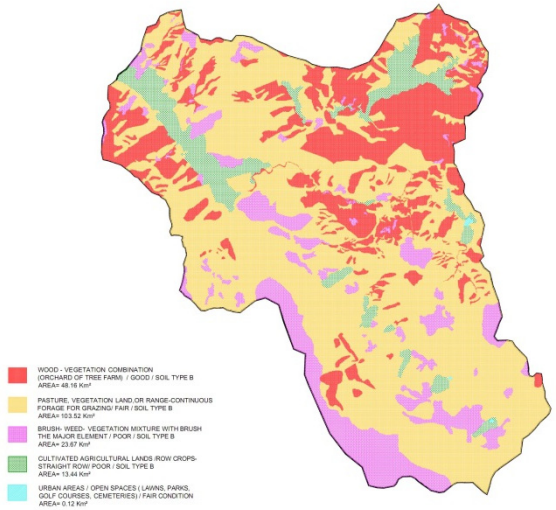

Figure 3. Land Use Description[2]

Table 3: Calculated CN and Ia for Catchment Area

Land use	Area (Km2)	%	CN
Woods - vegetations cover combination (orchard of tree farm) / Good / Soil Type B	48.16	25.5%	58
Pasture, vegetations, or range-continuous forage for grazing/ Fair / Soil Type B	103.52	54.8%	69
Brush- weed- grass mixture with brush the major element / Poor / Soil Type B	23.67	12.5%	67
Cultivated agricultural lands /Row crops- Straight row/ Poor/ Soil Type B	13.44	7.1%	81
Urban areas / Open spaces (lawns, parks, golf courses, cemeteries) / Fair condition/ Soil Type B	0.12	0.1%	69

Reservoir Management and Potential Yield

The purpose of reservoir management is to control operations to obtain the maximum possible economic benefit from reservoir based on available information about rainfall, runoff, and region needs.

Reservoir management is a method to optimize the water storage by producing a proper quantity of water released from reservoir.

Table 4, Table 5, Table 6, Table 7 shows a summary of potential yield for different dam capacities. The best Capacity-Yield option for the dams, in percentage of yield over the capacity as indicated in Figure 4, Figure 5, Figure 6, Figure 7.

Table 4: Potential Yield for location (1).

Capacity (m3)	Yield (m3/Year)	Yield/Capacity (%)
35,000,000	15,656,250	44.73
33,000,000	15,406,250	46.69

30,000,000	15,062,500	50.21
27,000,000	14,375,000	53.24
25,000,000	13,875,000	55.50
23,000,000	13,468,750	58.56
20,000,000	12,656,250	63.28
17,000,000	11,925,000	70.15
15,000,000	11,281,250	75.21
13,000,000	10,542,500	81.10
10,000,000	8,823,375	88.23
9,000,000	8,096,875	89.97
8,000,000	7,276,875	90.96
7,000,000	6,295,000	89.93
6,000,000	5,310,000	88.50
5,000,000	4,321,875	86.44
3,000,000	2,290,625	76.35
2,000,000	1,303,125	65.16
1,000,000	386,875	38.69

Table 5: Potential Yield for location (2)

Capacity (m3)	Yield (m3/Year)	Yield/Capacity (%)
20,000,000	12,537,500	62.69
17,000,000	11,850,000	69.71
15,000,000	11,175,000	74.50
13,000,000	10,406,250	80.05
11,000,000	9,556,250	86.88
10,000,000	8,893,750	88.94
9,000,000	8,156,250	90.63
8,000,000	7,437,500	92.97
7,000,000	6,487,500	92.68
5,000,000	4,450,000	89.00
3,000,000	2,381,250	79.38
1,000,000	428,125	42.81

Table 6: Potential Yield for location (3)

Capacity (m3)	Yield (m3/Year)	Yield/Capacity (%)
12,000,000	9,081,250	75.68%
11,000,000	8,587,500	78.07%
10,000,000	8,068,750	80.69%
9,000,000	7,456,250	82.85%
8,000,000	6,746,125	84.33%
7,000,000	6,005,313	85.79%
6,500,000	5,590,625	86.01%
6,000,000	5,171,388	86.19%
5,000,000	4,250,000	85.00%
3,000,000	2,400,000	80.00%
1,000,000	461,875	46.19%

Table 7: Potential Yield for location (4)

Capacity (m3)	Yield (m3/Year)	Yield/Capacity (%)
12,000,000	8,893,750	74.11%
11,000,000	8,396,875	76.34%
10,000,000	7,918,750	79.19%
9,000,000	7,264,688	80.72%
8,000,000	6,625,000	82.81%
7,000,000	5,898,813	84.27%
6,500,000	5,535,625	85.16%
6,000,000	5,128,969	85.48%
5,500,000	4,712,469	85.68%
5,000,000	4,294,594	85.89%
4,000,000	3,418,750	85.47%
3,000,000	2,429,500	80.98%
1,000,000	473,125	47.31%

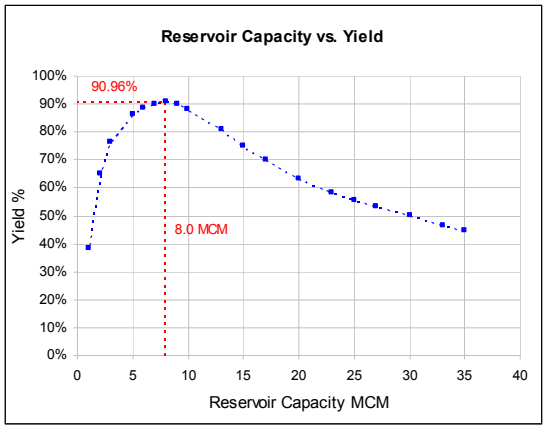

Figure 4. Reservoir Capacity vs. Yield for location (1)

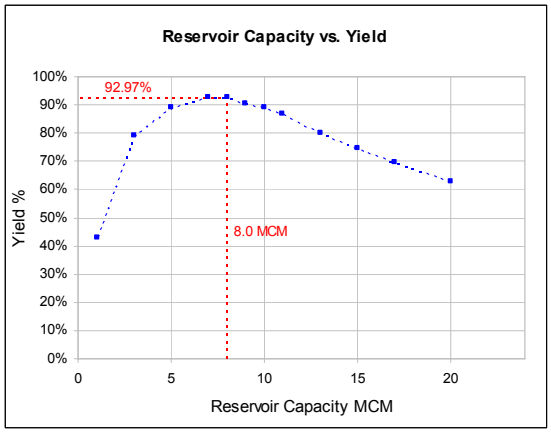

Figure 5. Reservoir Capacity vs. Yield for location (2)

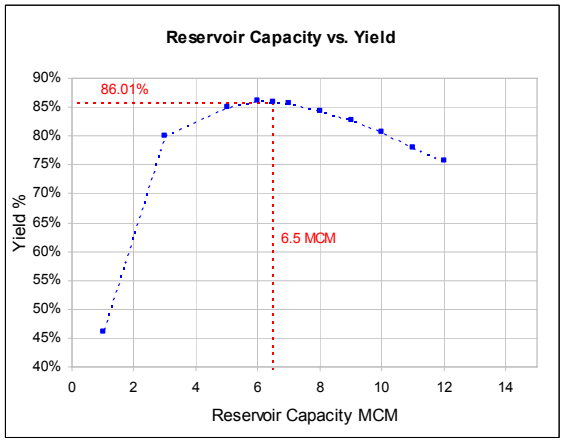

Figure 6. Reservoir Capacity vs. Yield for location (3)

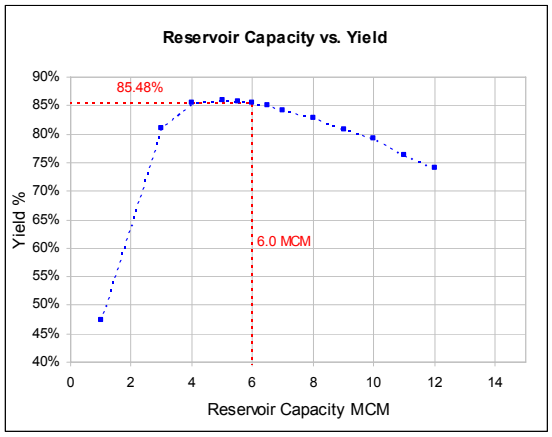

Figure 77 Reservoir Capacity vs. Yield for location (4)

3. RESULTS AND CONCLUSIONS

Four options are studied in order to select the proper location of dam considering reservoir volume, yield, dam height, dam length,.

The inflow runoff is predicted for all options and 2-yr runoff volume varies from 10-13 MCM for all proposed dam locations. The flood peak flow is predicted for different return periods for each dam location and the difference between predicted values is about 14m3/sec for 200-yr return period and 13.9m3/sec for 1000-yr return period.

Reservoir management plan mainly depends on the dam site properties area-capacity relationship. Reservoir volumes for dams' location are presented as follows;

-for locations 1 and 2 the volume is 8.0 MCM,
-for locations 3 it is 6.5 MCM,
-for location 4 it is 6.0MCM.

The area capacity curves for each location is drawn and the spillway height is derived as well. The approximate dam axis length for each location is listed as follows:

Earthfill dam with impervious clay core:

Location (1) → 223.5m at 25.92m Spillway Crest Height

Location (2) → 640.5m at 21.33m Spillway Crest Height

Location (3) → 637.7m at 20.87m Spillway Crest Height

Location (4) → 737.7m at 19.18m Spillway Crest Height

Comparisons between dams' locations and options are performed in order to find the proper location based on reservoir capacity and average annual yield volume as presented in Figure 8.

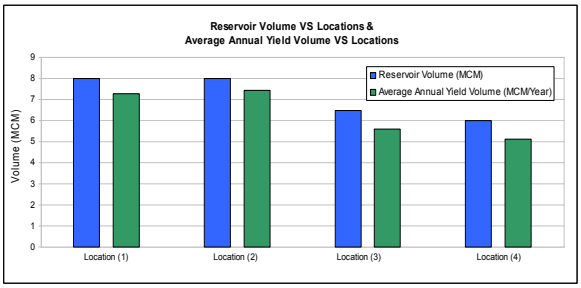

Figure 8. Comparison between Proposed Dams Locations versus Reservoir Volume & Average Annual Yield.

As shown in Figure 8, dam location (1) and dam location (2) have the largest dam's capacities respect to other proposed locations and location (2) gives slightly higher yield than location (1).

4. RECOMMENDATIONS

In order to select a proper location for the dam between the first two locations, the cost benefit analyses or discounted net income is one of the most important factors. The cost benefit analyses shooed take in consideration all the important factors for the entire water management scheme from the dam to the final user.

REFERENCES

[1] Applied Hydrology, Ven Te Chow, McGraw-Hill Book Co., International Edition, 1988.

[2] Preliminary Study Report- Kany Sard Dam

[3] http://age-web.age.uiuc.edu/classes/abe455/CN Table from EFH (2-3).pdf