Florida International University
Department of Civil and Environmental Engineering

Homework 2

Optimization in Water Resources Engineering, Spring 2020
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1. (Adapted from McKinney and Savitsky, Basic optimization models for water and energy management, Revision 8, 2006). Consider the river system illustrated in Fig. 1. The system contains one reservoir (Toktogul reservoir in Kyrgyzstan) and two irrigated zones (one in Uzbekistan and one in Kazakhstan). Four different crops can be grown in each irrigation zone: cotton, wheat, rice, and Lucerne. The profit per hectare (ha) for each crop is shown in Table 1 along with the maximum crop areas and the crop water requirements. The capacity of the reservoir is 19,500 million m^3, and the dead storage capacity is 5,500 million m^3. The initial storage volume is 14,000 million m^3. Determine the optimal mix of crops to be grown by each of the countries if the ending storage in the reservoir must be 13,000 million m^3. What impact does the ending storage volume have on the solution?

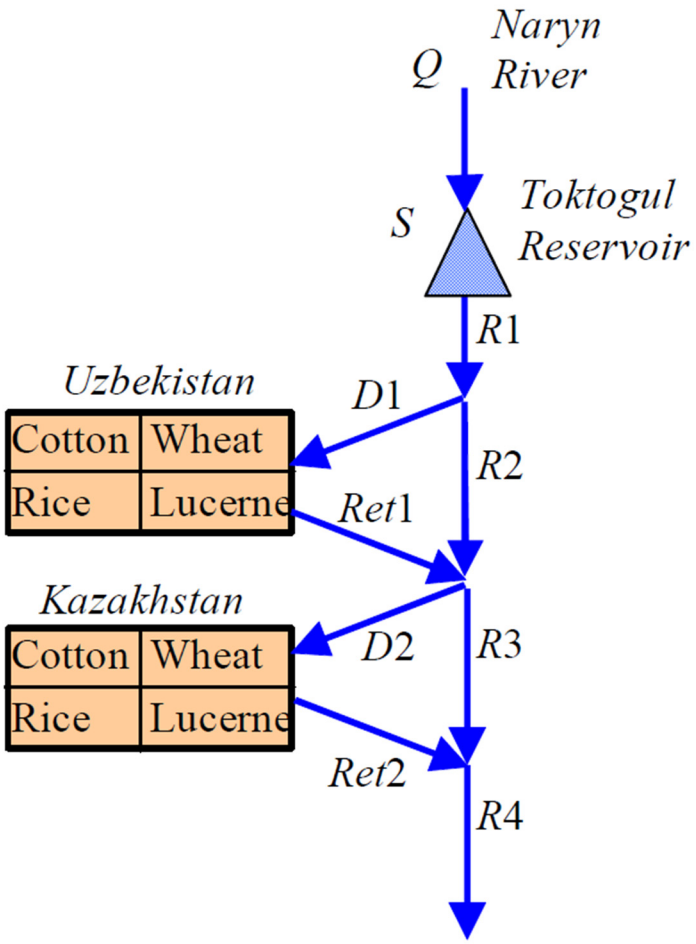

Fig. 1. River Network for Reservoir Operation

Table 1. Data for Reservoir Operation Problem

Crop water demands (mm per month)

Crop	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cotton	150	150	100	100	200	250	250	200	50	0	0	0
Wheat	0	0	0	100	300	300	0	0	200	0	0	0
Rice	0	0	0	450	700	800	800	700	50	0	0	0
Lucerne	0	0	0	50	200	350	350	250	50	0	0	0

Naryn River Inflow

Month	Inflow (Million m3)
Jan	386
Feb	346
Mar	416
Apr	713
May	1532
Jun	2373
Jul	2157
Aug	1431
Sep	798
Oct	582
Nov	487
Dec	420

Crop Profits

Crop	Profit ($/ha)
Cotton	350
Wheat	70
Rice	225
Lucerne	50

Maximum total area

Country	Area(ha)
Uzbekistan	2,000,000
Kazakhstan	2,000,000

Maximum area per crop

Crop	Uzbekistan (ha)	Kazakhstan (ha)
Cotton	500,000	65,000
Wheat	500,000	30,000
Rice	0	500,000
Lucerne	50,000	500,000

Return Flow Coefficient

Country	Coefficient
Uzbekistan	0.50
Kazakhstan	0.50