4.14. Water supply and demand forecasting 2000-2020

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In any river basin, and particularly one which is perennially water-short, it is important to have reliable estimates of both likely water supply and demand by different sectors. With this information, it is possible both to contemplate new water-resources development and to adjust allocations between sectors as demand patterns change.

The Zayandeh Rud basin has been water short for many years, and this has resulted in a program of water resources development from 1952 onwards (Momtazpur 1995). By 2010, almost all potential water resources will have been developed, including three trans-basin diversion tunnels, the Chadegan Reservoir and several smaller springs and other local water sources. Once that stage of development is complete, the focus in the basin will be primarily one of allocation between different sectors so as to continue to match supply and demand into the future.

In this section, we examine demands for water at three separate times: 2000, representing present supply and demand, and 2010 and 2020 as future projections.

4.14.1. Water supply

Planned water supplies for 2000 totaled 1,487 MCM, consisting of 900 MCM of natural inflow and 587 MCM from two diversion tunnels from the Kuhrang River (table 4.19).

Projected water resource developments comprise an additional tunnel from Kuhrang providing another 280 MCM, and local springs and other sources totaling 150 MCM. This means that before 2010 the total water planned for the basin will be 1,917 MCM. This figure appears to represent the maximum available water for the basin for the foreseeable future (figure 4.46).

Figure 4.46. Planned water supplies for Zayandeh Rud, 2000-2020.

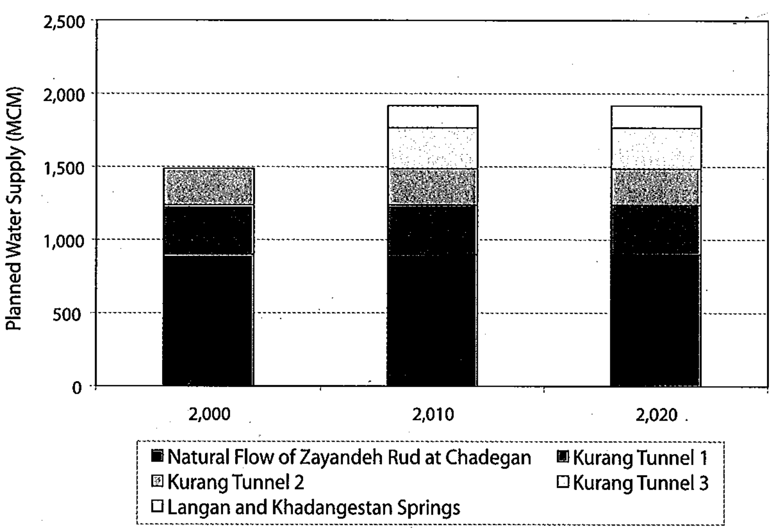

Table 4.19. Supply and demand estimates for Zayandeh Rud, 2000.

WATER BALANCE FOR ZAYANDEH RUD, ESFAHAN - YEAR 2000			
Supply Estimations	mcm	%	Source/assumption
Natural Flow of Zayandeh Rud at Chadegan	900	61	based on historic average
Kurang Tunnel 1	337	23	Ministry of Energy
Kurang Tunnel 2	250	17	Ministry of Energy
Kurang Tunnel 3	0		Ministry of Energy
Langan and Khadangestan Springs	0	0	Ministry of Energy
Total Supply	1487		
Demand Estimations			
Urban Areas			
Greater Esfahan	210		275 1/day/person for 2,100,000 people
Supply for Other cities near river	0		
Total Urban Supply	210	14	
Return flows from urban areas	-105	-7	50% return flow
Industry	100	7	Master Plan Organization
Agriculture	1500	101	100,000 ha at 1,500 mm/ year divrsion
Return flows from agriculture	-300	-20	20% return flow
Enviaronment Demand	0	0	None
Transbasin Deversion	34	2	Ministry of Energy
Evaporation	74	5	5% of total river flow
Total Demand	1513		
Deficit	-26	-2	

4.14.2. Water Demands in 2000

Table 4.20 also summarizes the main demands for water in 2000. These cover normal demands for urban, industrial and agricultural use, including an allowance for return flows from urban areas (50 percent) and agriculture (20 percent). Substantial volumes of wastewater are used to irrigate forests around cities and industrial plants so that return flows are lower than is normal for urban and industrial areas.

In addition, there is a trans-basin diversion out of the basin to Yazd, currently at 34 MCM but planned to rise to 80 MCM, and to Kashan which is under development and will take 45 MCM. Environmental requirements for the Gavkhouni Swamp have been set at 70 MCM per year, but in 2000 this was not included in the water budget. These allocations are fixed and will not change in the future. Evaporation losses from the reservoir and other places within the basin are estimated at 5 percent of total supply.

It can be seen that even in 2000, water demand exceeds supply by some 26 MCM, although this is probably within the error of estimation of both supply and demand.

4.13.3. Projection of future demands for water

There are many different possibilities for projection of demand for water between different sectors in the basin. To do this, we have adopted a set of increasingly complex scenarios and examined the implications for growth in the basin. The scenarios are as follows:

Scenario 1:	All sectors grow by 2 percent a year
Scenario 2:	All sectors grow by 1 percent a year
Scenario 3:	Urban demand increases by 2.5 percent a year, other sectors by 1percent a year
Scenario 4:	Urban demand grows by 2.5 percent, industry by 1 percent, and agriculture is adjusted to balance total supply and demand in the basin

These scenarios all assume that water supply is at a planned level. Two additional variations on scenario 4 were therefore developed:

Scenario 4a:	Scenario 4 with a 10 percent shortfall in water supply
Scenario 4b:	Scenario 4 with a 20 percent shortfall in water supply

The results of the first three scenarios are summarized in table 4.20.

Table 4.20. Water supply and demand projections with growth for all sectors.

	2000			2010			2020		
Scenario	Supply	Demand	Surplus/ Deficit	Supply	Demand	Surplus/ Deficit	Supply	Demand	Surplus/ Deficit
1	1,487	1,513	-26	1,917	1,984	-67	1,917	2,323	-406
2	1,487	1,513	-26	1,917	1,844	73	1,917	1,999	-82
3	1,487	1,513	-26	1,917	1,865	52	1,917	2,051	-134

These three scenarios all anticipate growth in all sectors, although Scenario 3 assumes a higher growth rate for urban areas than for other sectors. While Scenarios 2 and 3 show a modest surplus in 2010 when all water resources are developed, all three Scenarios are in deficit by 2020 and continue to get worse into the future.

To try to balance out supply and demand, agriculture was selected as the sector, which has to give up water, partly because it is the largest user of water in the basin, and because other sectors have higher priorities for human health and welfare.

Scenario 4 balances out supply and demand by treating agriculture as a residual. Table 4.21 examines the impact on agriculture of these changes.

Table 4.21 shows that with an increase in basin supplies of 430 MCM per year, agriculture will gain an additional 172 MCM in 2010, but this will shrink to 118 MCM over current levels by 2020.

However, in the event that water supplies drop to less than 90 percent of the planned supply—an event expected at least once every 3 years—then agriculture will never receive current levels of water allocation despite the increased supply at basin level. When water

Table 4.21. Impact of changed water allocations on agricultural water availability.

Scenario	2000			2010			2020		
	Basin supply	supply to agri-culture	Change from 2000	Basin supply	supply to agri-culture	Change from 2000	Basin supply	supply to agri-culture	Change from 2000
4	1,487	1,200	0	1,917	1,372	172	1,917	1,318	118
4a	1,338	1,032	-168	1,736	1,190	-20	1,726	1,136	-64
4b	1,190	891	-309	1,534	1,108	-192	1,534	954	-246

supplies fall to less than 80 percent of that planned, then the share to agriculture is much less than at current levels.

It is unclear to what extent there are effective mechanisms to apportion shortfalls in water at basin level, either between sectors or within the agricultural sector. Experience at present is that all sectors take as much water as they can up to the extractive limit. The result is that the environment is the main sufferer, as is shown by very low flows, or even dry conditions, at Varzaneh whenever supplies fall below the planned level.

These projections overall do not allow for large growth in the Zayandeh Rud basin. Scenario 4, considered the most realistic from a hydrologic and social point of view, allows for a population growth rate of only 20 percent per decade, industrial demand of less than 1 percent a year, and fixed allocations for environment and trans-basin diversions. There is really only a very limited opportunity for increasing supplies to agriculture, and only if supplies are at or above planned levels. Whenever these conditions are not met, then agriculture is the main loser in the struggle to obtain sufficient water in the Zayandeh Rud.

It is in this context of shrinking water supplies predicted for agriculture in the Zayandeh Rud basin that we can move on to the assessment of different scenarios for the future, and the water availability projects they entail.