water

MDPI

Evaluating the Impacts of IWRM Policy Actions on Demand Satisfaction and Downstream Water Availability in the Upper Awash Basin, Ethiopia

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I. Detail specification of scenarios based on existing water development and management trend, IWRM concept, National policies and strategies as well as stakeholders perspectives is presented in Table S1.

Table S1. Scenarios descriptiona and representation in WEAP.

<table>
<tr><th rowspan="2">Scenarios</th><th rowspan="2">Target</th><th rowspan="2" colspan="3">Details</th><th colspan="2">Demand Side Savings (DSS) (%)</th></tr>
<tr><th>LSS</th><th>SSS</th></tr>
<tr><td>Reference scenario: Existing state of water management</td><td>Baseline</td><td colspan="3">This is the 'business as usual' scenario which assumes the present water use and management trend, which will continue in the future (2016–2040) given the increasing demand for water overtime and the current supply management fashion</td><td>-</td><td>-</td></tr>
<tr><td>Irrigation expansion scenario: Review of existing basin development strategy (irrigation expansion to the maximum potential)</td><td>Implementation of irrigation expansion plans</td><td colspan="3">Current irrigation practice + A total irrigation expansion by 70% from the existing within the Upper Awash basin (20% for SSS; 50% for LSS)</td><td>-</td><td>-</td></tr>
<tr><td rowspan="5">Comprehensive demand management scenario: Set of alternative Demand Side Management options (DSM) based on IWRM principles, National water policy and stakeholders views</td><td rowspan="5">Total Reduction in demand by 30% for LSS and 9% for SSS</td><td rowspan="5">Efficiency improvement</td><td rowspan="2">Change of irrigation method (15% for LSS)</td><td>Sprinkler</td><td>12%</td><td>-</td></tr>
<tr><td>Drip</td><td>3%</td><td>-</td></tr>
<tr><td rowspan="2">Conveyance system improvement (10% for LSS and 2% for SSS)</td><td>Unification of supply networks</td><td>4%</td><td>2%</td></tr>
<tr><td>Canal lining</td><td>6%</td><td>-</td></tr>
<tr><td colspan="2">Sub total</td><td>25% saving</td><td>2% saving</td></tr>
</table>

		Economic instruments	Increase in water price + Tiered pricing system (5% for LSS and 2% for SSS)	100% increase for SSS	-	2%
				300% increase for MSS	-	-
				400increase for % LSS	5%	-
			Subtotal		**5% saving**	**2% saving**
		Revision of water right regulation measures	Legalization (5% for SSS)	0% unlicensed use	-	5%
			Subtotal		**-**	**5% saving**
Users Preferences Scenario: Based on the preferences of primary stakeholders (Particularly, the majority small-scale irrigators)	Reduction in demand 10% LSS and 6% SSS	Economic instruments	Increase in water price + Tiered pricing system	100% increase for SSS	-	2%
				300% increase for MSS	-	-
				400increase for % LSS	5%	-
		Change in water right regulation measures: Control of illegal diversion (15%)	Legalization	0% unlicensed use	%	4%
			Restricted water use (Quota limit)	-	5%	-
		Subtotal			**10% saving**	**6% saving**

Note: SSS = Small-scale irrigation schemes, MSS = Medium-scale irrigation schemes, LSS = Large-scale irrigation schemes

II. Hydrology: Water Balance of the Upper Awash basin

Water balance for the upper Awash basin has been done for the period 2016 to 2040 based on analysis of historical observed climate data for the years 1970–2008 and resultant runoff prediction. The WEAP model provided information about inflows and outflows on a monthly basis for each of the catchments and their respective land use classes based on the hydrologic conditions of the base year. The current accounts year considered was from January to December 2008, which represents a 'normal' year hydrologic condition. Figure S1 demonstrates water balances for two catchments (most upstream and downstream) of the Upper Awash basin. Inflow is described as precipitation, and added to it is decrease in soil moisture. Outflows include evapotranspiration, surface runoff, interflow, base flows, flow to ground water and increases in soil moisture. WEAP uses Penman-Montieth equation for calculating evapotranspiration based on FAO recommendation [1]. Figure S2 also indicates seasonal water balance where much of the inflows and outflows are going on during the months from June to September.

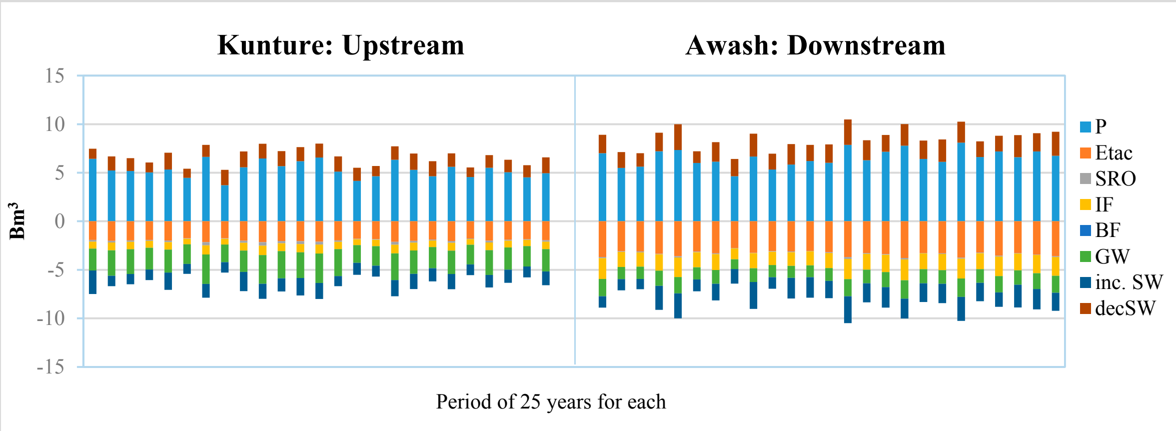

Figure S1. Annual water balance calculations for two irrigated catchments of the Upper Awash Basin.

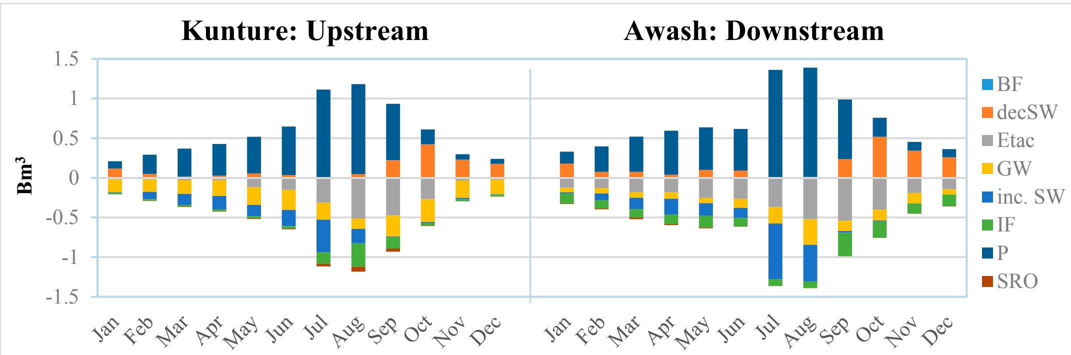

Figure S2. Monthly average water balance calculations for two irrigated catchments of the Upper Awash Basin.

III. Flow variability of the Upper Awash River Basin based on streamflow data at Kunture station

Illustration of the Variability of monthly streamflow patterns over the years is presented for all the months in Figure S3. Spearman rank correlation was used to analyze the existing trend of the monthly flows over the years. The results indicate that there is no significant trend for all the months and annually except in the case of June (Table S2).

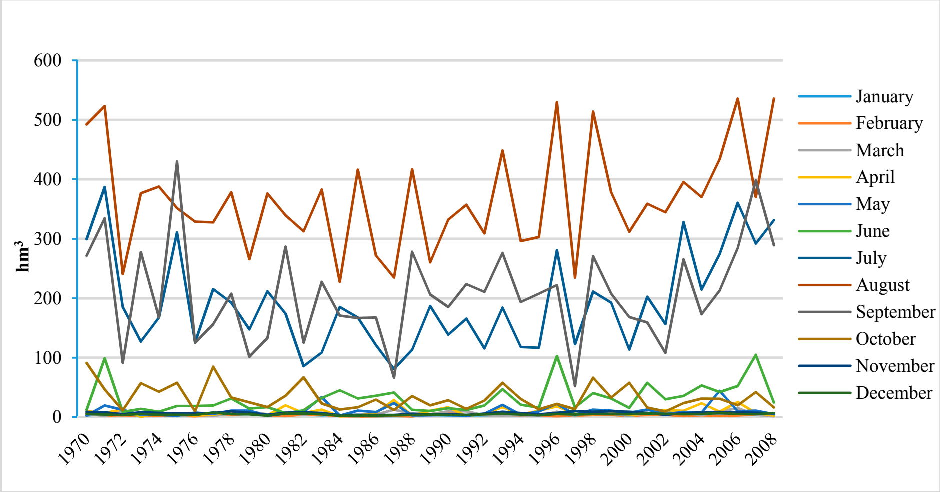

Figure S3. Historical stream flow for all months (1970–2008).

Table S2. Spearman Coefficient (R_s).

Month	R_s
January	0.096
February	0.021
March	0.107
April	0.172
May	0.227
June	0.479
July	0.147
August	0.251
September	0.139
October	−0.223
November	0.120
December	0.346

Reference

1. Allen, R.; Pereira, L.; Raes, D.; Smith, M. Guidelines for computing crop water requirements-fao irrigation and drainage paper 56, fao-food and agriculture organisation of the united nations, rome (http://www.Fao.Org/docrep) arpav (2000), la caratterizzazione climatica della regione veneto, quaderni per. *Geophys.* **1998**, *156*, 178.