

Appendix B: Description of attributes of entities in the WaterScope model.

Entity	Attribute	Method	Description
WaterUnit	id		Unique value for each water unit
	pemc		Present ecological management class
	wma		Identification number of Water Management Area (WMA)
	runoff		Natural mean annual runoff
	origRunoff		Runoff value at initialisation
	incomingWater		Water from upstream water units
	agricultureDemand		Water requirement of agricultural sector
	forestryDemand		Water requirement of forestry sector
	minesIndustryDemand		Water requirement of mining and industrial sector
	ruralDemand		Water requirement of rural sector
	urbanDemand		Water requirement of urban sector
	ecoReserve		Ecological reserve requirement
	ecoProp		Proportion of total runoff designated for ecological reserve requirement
	humanReserve		Human reserve requirement
	ruralReserve		Human reserve requirement of rural population
	urbanReserve		Human reserve requirement of urban population
	waterAvailable		Component of runoff that is available for use
	strategy		Water management strategy (i.e. scenario)
	strategyType		Strategy type (i.e. previous or most successful strategy)
	waterTransferredOut		Water transferred out of water unit
	waterTransferredIn		Water transferred into water unit
	recipient1 (2,3,4)		Downstream water unit that receives water from this water unit
	precipitation		Mean annual precipitation
	hydroIndex		Hydrological index value
	eisc		Ecological importance and sensitivity value
	efficiencyTime		Consecutive number of times water unit exceeds efficiency indicator threshold value
	humanTime		Consecutive number of times water unit exceeds human indicator

			threshold value
	ecoTime		Consecutive number of times water unit exceeds ecological indicator threshold value
	origPemc		PEMC value at initialisation
	timeStep		Number of time steps (years) since initialisation
	indicator		Indicator by which success of strategy is measured
		allocateAllPossibleWaterToSector	Gives all water needed to satisfy demand; if demand is more than water available, gives all water available.
		allocateMarketForces	Allocates water to each of the sectors in turn according to 'Market Forces' rule (i.e. in order of average economic productivity).
		allocateToWaterUser	Allocates an amount to water user proportional to its demand.
		allocateWaterToSector	Gives water to the WaterUser of the specified sector; if not enough water is available, gives all available.
		addDemand	Increases demand of a WaterUser.
		degrade	Adjusts ecological management class (PEMC) for degradation, based on withdrawal-to-availability ratio and ecological importance and sensitivity index, for water unit and recipient (downstream) water units.
		evaluateIndicator	Evaluates success of indicator and changes if it fails for 5 successive timesteps.
		flowIn	Releases water into water unit from donor (upstream) water units.
		flowOut	Releases water out of this water unit into recipient water units.
		getFlowRecipient	Finds recipient to which water flows downstream from this water unit. If there is more than one, selects the nearest of these.
		moveWaterFromAvailableToEcoReserve	Sets aside water for ecological reserve. If the amount required is greater than the actual water available, moves all available.
		removeWater	Takes an amount of water away from the available water pool. If the requested amount is more than the amount available, takes it all.
		restore	Adjusts ecological management class (PEMC) for restoration, based on withdrawal-to-availability ratio and ecological importance and sensitivity index, for water unit and recipient (downstream) water units.
		replenishRunoffClimateChangeNormal	Sets runoff equal to the greater of 0 and the change projected to occur due to climate change, multiplied by a random positive number drawn from a normal distribution around the mean.
		resetWaterUnitForNextStep	Resets variables at the beginning of the timestep.

		checkAndTransferTo	Before water is transferred to water unit, checks unmet demand of transfer recipient to see if it has changed since requesting transfer. Compares the updated unmet demand to the amount designated for transfer and transfers the lesser of the two.
		transferTo	Transfers requested amount of water to transfer recipient.
WaterUser	demand		Water requirement of water user
	sector		Water use sector
	waterAllocated		Water allocated to water user
	timeStep		Number of time steps (years) since initialisation
	demandExported		Demand exported by water user
	demandImported		Demand imported by water user
	waterConsumed		Water consumed by water user
		getDemandRecipientAllWMA	Finds recipient water unit within WMA to which water user can export excess demand.
		addDemandToWaterUser	Increases demand by amount that has been exported to this water user; water user immediately consumes this amount of water from the WaterUnit.
		export	WaterUser with excess demand exports demand to WaterUnit with available water.
		exportDemand	Adds amount of exported demand to recipient's demand, and subtracts same amount from donor water user's demand.
		resetWaterUserForNextStep	Resets variables at the beginning of the timestep.
		giveWater	Adds amount of exported water to water user's available water and water consumed.
WaterScape Message	amountTransferred		Amount of water transferred from donor to recipient
	origUnmetDemand		Unmet demand of recipient at time of transfer request
	transferRecipient		Water unit that receives transfer
	updatedUnmetDemand		Unmet demand of recipient at time of transfer
	wma		Identification number of water management area requesting transfer
CMA	wma		Identification number of water management area
	waterUnits		Water units within water management area of CMA's jurisdiction
	firstTimeStep		First time step (true or false)

	timeStep		Number of time steps (years) since initialisation
	status		Status of water availability (i.e. surplus or deficit)
		adjustDemandAgricultureBase	Adjusts demand of agricultural sector in each of its WaterUnits according to base growth projections.
		adjustDemandForestryBase	Adjusts demand of forestry sector in each of its WaterUnits according to base growth projections.
		adjustDemandMinesIndustryBase	Adjusts demand of mining and industry sector in each of its WaterUnits according to base growth projections.
		adjustDemandRuralBase	Adjusts demand of rural sector in each of its WaterUnits according to base growth projections.
		adjustDemandUrbanBase	Adjusts demand of urban sector in each of its WaterUnits according to base growth projections.
		adjustDemandAgricultureHigh	Adjusts demand of agricultural sector in each of its WaterUnits according to high growth projections.
		adjustDemandForestryHigh	Adjusts demand of forestry sector in each of its WaterUnits according to base growth projections.
		adjustDemandMinesIndustryHigh	Adjusts demand of mining and industrial sector in each of its WaterUnits according to high growth projections.
		adjustDemandRuralHigh	Adjusts demand of rural sector in each of its WaterUnits according to high growth projections.
		adjustDemandUrbanHigh	Adjusts demand of urban sector in each of its WaterUnits according to high growth projections.
		allocateCollectiveLearningEfficiency	Allocates water randomly, then allows agents to use efficiency indicator to choose allocation strategy in subsequent timesteps.
		allocateCollectiveLearningEfficiencyIndicator	Allocates water randomly, then allows agents to use efficiency indicator to choose allocation strategy in subsequent timesteps (used when all three indicators are distributed among agents).
		allocateCollectiveLearningEquity	Allocates water randomly, then allows agents to use equity indicator to choose allocation strategy in subsequent timesteps.
		allocateCollectiveLearningEquityIndicator	Allocates water randomly, then allows agents to use equity indicator to choose allocation strategy in subsequent timesteps (used when all three indicators are distributed among agents).
		allocateCollectiveLearningSustainability	Allocates water randomly, then allows agents to use sustainability indicator to choose allocation strategy in subsequent timesteps.

		allocateCollectiveLearningSustainabilityIndicator	Allocates water randomly, then allows agents to use sustainability indicator to choose allocation strategy in subsequent timesteps (used when all three indicators are distributed among agents).
		allocateCollectiveLearningIndicator	Allocates water randomly, then allows agents to use efficiency, equity, and sustainability indicators.
		allocateFortressWorld	Allocates water using Fortress World rule (proportional allocation).
		allocateMarketForces	Allocates water using Market Forces rule (preferential allocation, then to human and ecological Reserve).
		allWaterUnitsUsePolicyReform	Allocates water using Policy Reform rule (allocation to human and ecological Reserve, then preferential allocation).
		waterUnitsGetRandomStrategy	Randomly assigns allocation strategies to water units.
		getTransferDonor	Selects a surplus water unit from which to transfer water.
		getTransferDonorNearest	Selects the surplus water unit from which to transfer water with sufficient water available to meet recipient's unmet demand and that is nearest to the recipient.
		getTransferRecipientMaxDemand	Selects the water unit with the greatest demand from which to transfer water.
		getTransferRecipientMaxUnmetDemand	selects the water unit with the greatest unmet demand from which to transfer water.
		resetCMAForNextStep	Resets variables at the beginning of the timestep.
		deficitAlertFortressWorld	Sends a message to all other CMAs containing wma number and selected transfer recipient (water unit with maximum demand). The messages are delivered and processed asynchronously (as soon as received).
		deficitAlertMarketForces	Sends a message to all other CMAs containing wma number, selected transfer recipient (water unit with maximum demand), and amount requested (recipient's unmet demand). The messages are delivered and processed synchronously (at end of timestep).
		deficitAlertPolicyReform	Sends a message to all other CMAs containing wma number, selected transfer recipient (water unit with maximum unmet demand), and amount requested (recipient's unmet demand). The messages are delivered and processed synchronously (at end of timestep).
		transferMaxAvailable	Transfers all available water from the donor water unit, regardless of the requested amount, to selected recipient.
		transferToNearest	Transfers the lesser of the amount requested and the donor's available

			water to selected recipient.
		transferToNearestMaxAvailable	Transfers all available water from the donor water unit, regardless of the requested amount, to nearest of selected recipients.