11. APPENDICES

Appendix A New data objects added to *ACRU2000* in this project

Table A1 Definition of the general data objects in *ACRUSalinity*

Class Name	Abbreviation	Definition	Remark
DSalinityOption	SALINITY	An option whether the hydrosalinity module is to be executed in a particular simulation	Input
DReservoirSalinityOption	RESSALINITY	An option whether the reservoir salt budget routine is to be executed in a particular simulation	Input

Table A2 Definition of data objects that belong to non-irrigated areas

Class Name	Abbreviation	Definition	Remark
DActualQuickflowDepth	AQFLDE	Depth of the generated stormflow that leaves non-irrigated land on the same day	Internal
DBaseflowSalinity	BFLOSA	TDS concentration of baseflow release from non-irrigated areas	Output
DBaseflowSaltLoad	BFLSL	The salt load associated with the baseflow releases from non-irrigated areas	Output
DGeneratedSaltLoad	GENSL01	The salt load generated in the topsoil horizon of non-irrigated areas	Output
DGeneratedSaltLoad	GENSL02	The salt load generated in the subsoil horizon of non-irrigated areas	Output
DGeneratedSaltLoad	GENSLGW	The salt load generated in the groundwater store of non-irrigated areas	Output
DGroundwaterSalinity	GWSA	TDS concentration of the groundwater store in non-irrigated areas	Output

Table A2 Continued

Class Name	Abbreviation	Definition	Remark
DInitialSalinity	INISUBSSA	TDS concentration of the soil moisture of the subsoil horizon in non-irrigated areas at the start of a simulation	Input
DInitialSalinity	INITOPSSA	TDS concentration of the soil moisture of the topsoil horizon in non-irrigated areas at the start of a simulation	Input
DInitialSaltLoad	INISUBSSL	Salt load of the soil moisture of subsoil horizon in non-irrigated areas at the start of a simulation	Output
DInitialSaltLoad	INITOPSSL	Salt load of the soil moisture of the topsoil horizon in non-irrigated areas at the start of a simulation	Output
DPercSaltConc	PERCSA01	TDS concentration of percolation water from the topsoil to subsoil in non-irrigated areas	Output
DPercSaltConc	PERCSA02	TDS concentration of percolation water from the subsoil to groundwater store in non-irrigated areas	Output
DPercSaltLoad	PERCSL01	Salt load associated with percolation water from the topsoil to the subsoil in non-irrigated areas	Output
DPercSaltLoad	PERCSL02	Salt load associated with percolation water from the subsoil to the groundwater store in non-irrigated areas	Output
DQuickflowSalinity	QFLOSA	TDS concentration of the quickflow from non-irrigated areas	Output
DQuickflowSaltLoad	QFLOSL	The salt load associated with quickflow from non-irrigated areas	Output
DRainfallSalinity	RSALIN	TDS concentration of the rain falling on non-irrigated areas	Input

Table A2 Continued

Class Name	Abbreviation	Definition	Remark
DRainfallSaltLoad	RFLSL	Salt load associated with the rain falling on non-irrigated areas	Output
DRunoffSalinity	RUNOSA	TDS concentration of runoff water from non-irrigated areas	Output
DRunoffSaltLoad	RUNOSL	The salt load associated with runoff water from non-irrigated areas	Output
DSaltFluxRecord	SALTFL01	Salt load associated with the topsoil moisture in non-irrigated areas	Output
DSaltFluxRecord	SALTFL02	Salt load associated with the subsoil moisture in non-irrigated areas	Output
DSaltFluxRecord	SALTFLGW	Salt load associated with the groundwater store in non-irrigated areas	Output
DSaltInput	SALTINP	Total salt input to non-irrigated areas	Output
DSaltSat	SALTSAT01	The salt saturation value of the topsoil horizon in non-irrigated areas	Input
DSaltSat	SALTSAT02	The salt saturation value of the subsoil horizon in non-irrigated areas	Input
DSaltSat	SALTSATGW	The salt saturation value of groundwater store in non-irrigated areas	Input
DSubsoilSalinity	SUBSSA	TDS concentration of the subsoil horizon in non-irrigated areas	Output
DSurfaceSaltFluxRecord		Salt load associated with surface flows	Internal
DTopsoilSalinity	TOPSSA	TDS concentration of the topsoil horizon in non-irrigated areas	Output
DUptakeRateConstant	SALTUPT01	The rate of salt generation in the topsoil horizon of non-irrigated areas	Input
DUptakeRateConstant	SALTUPT02	The rate of salt generation in the subsoil horizon of non-irrigated areas	Input
DUptakeRateConstant	SALTUPTGW	The rate of salt generation in the groundwater store of non-irrigated areas	Input

Table A2 Continued

Class Name	Abbreviation	Definition	Remark
DUpwardSaltFlux	UPSF02	Salt load associated with upward water movement from the subsoil horizon to the topsoil horizon in non-irrigated areas	Output
DUpwardSaltFlux	UPSF02	Salt load associated with upward water movement from the subsoil horizon to the topsoil horizon in non-irrigated areas	Output

Table A3 Definition of data objects that belong to irrigated areas

Class Name	Abbreviation	Definition	Remark
DBaseflowSalinity	BFLOSA	TDS concentration of baseflow releases from irrigated areas	Output
DBaseflowSaltLoad	BFLSL	The salt load associated with the baseflow releases from irrigated areas	Output
DGeneratedSaltLoad	GENSL01	The salt load generated in the topsoil horizon of irrigated areas	Output
DGeneratedSaltLoad	GENSLGW	The salt load generated in the groundwater store of irrigated areas	Output
DGroundwaterSalinity	GWSA	TDS concentration of the groundwater store in irrigated areas	Output
DInitialSalinity	INITOPSSA	TDS concentration of the soil moisture of topsoil horizon in irrigated areas at the start of a simulation	Input
DIrrigationWaterSalinity	IRRWASA	TDS concentration of the applied irrigation water	Input
DIrrigationWaterSaltLoad	IRRWASL	Salt load associated with the applied irrigation water	Output
DPercSaltConc	PERCSA01	TDS concentration of percolation water from the topsoil to the subsoil in irrigated areas	Output

Table A3 Continued

Class Name	Abbreviation	Definition	Remark
DPercSaltLoad	PERCSL01	Salt load associated with percolation water from the topsoil to the subsoil in irrigated areas	Output
DQuickflowSalinity	QFLOSA	TDS concentration of the quickflow from irrigated areas	Output
DQuickflowSaltLoad	QFLOSL	The salt load associated with quickflow from irrigated areas	Output
DRainfallSaltLoad	RFLSL	Salt load associated with the rain falling on irrigated areas	Output
DRunoffSalinity	RUNOSA	TDS concentration of runoff water from irrigated areas	Output
DRunoffSaltLoad	RUNOSL	The salt load associated with runoff water from irrigated areas	Output
DSaltFluxRecord	SALTFL01	Salt load associated with the topsoil moisture in irrigated areas	Output
DSaltFluxRecord	SALTFLGW	Salt load associated with the groundwater store in irrigated areas	Output
DSaltInput	SALTINP	Total salt input to irrigated areas	Output
DSaltSat	SALTSAT01	The salt saturation value of the topsoil horizon in irrigated areas	Input
DSaltSat	SALTSATGW	The salt saturation value of the groundwater store in irrigated areas	Input
DTopsoilSalinity	TOPSSA	TDS concentration of the topsoil horizon in irrigated areas	Output
DUptakeRateConstant	SALTUPT01	The rate of salt generation in topsoil horizon of irrigated areas	Input
DUptakeRateConstant	SALTUPTGW	The rate of salt generation in the groundwater store of irrigated areas	Input
DUpwardSaltFlux	UPSF01	Salt load associated with upward water movement from the topsoil horizon to surface flow (quickflow) in irrigated areas	Output

Table A4 Definition of data objects that belong to the reservoir component

Class Name	Abbreviation	Definition	Remark
DAbstractionSaltLoad	ABSRSL	The salt load associated with the water abstracted from the reservoir for irrigation, domestic and other uses	Output
DInflowSaltLoad	INFSL	The salt load associated with the total inflow to a reservoir	Output
DInitialSalinity	INIRESSA	TDS concentration of the water stored in a reservoir at the start of a simulation	Input
DInitialSaltLoad	INIRESSL	Salt load of the water stored in a reservoir at the start of a simulation	Output
DNormalflowSalinity	NORMFLSA	TDS concentration of the legal flow releases from the reservoir	Output
DNormalflowSaltLoad	NRMLFLSL	Salt load associated with the legal flow releases from the reservoir	Output
DOutflowSalinity	OUTFSA	Average TDS concentration of the total outflow from the reservoir	Output
DOutflowSaltLoad	OUTFSL	Salt load associated with the daily total outflow from a reservoir	Output
DRainfallSalinity	RSALIN	TDS concentration of the rain falling on a reservoir surface	Input
DReservoirEvapVol		The daily volume of evaporated water from a reservoir surface	Internal
DReservoirSalinity	RESSA	TDS concentration of the water stored in a reservoir	Output
DResInflowSalinity	RESINFSA	Average TDS concentration of the total inflow to a reservoir	Output
DSaltFluxRecord	SALTFLRES	Salt load associated with the water stored in a reservoir	Output
DSaltInput	SALTINP	Total salt input to a reservoir	Output
DSeepageSalinity	SEEPAGESA	TDS concentration of seepage water from a reservoir	Output

Table A4 Continued

Class Name	Abbreviation	Definition	Remark
DSeepageSaltLoad	SEEPAGESL	Salt load associated with seepage water from a reservoir	Output
DSpillwayflowSalinity	OFLSA	TDS concentration of an overflowing water from the reservoir	Output
DSpillwayflowSaltLoad	OVERFLSL	Salt load associated with an overflowing water from the reservoir	Output

Table A5 Definition of data objects that belong to impervious areas (adjunct and disjunct impervious areas)

Class Name	Abbreviation	Definition	Remark
DImperviousAreaSaltLoad	RUNOSL	The salt load stored in adjunct or disjunct impervious areas	Output
DRainfallSalinity	RSALIN	TDS concentration of the rain falling on adjunct and disjunct impervious areas	Input

Table A6 Definition of data objects that belong to the channel

Class Name	Abbreviation	Definition	Remark
DOutflowSaltLoad	OUTFSL	Salt load associated with the daily total outflow from a channel reach	Output
DSaltFluxRecord		The daily total salt load inflowing to a channel reach	Internal
DWaterOutflow	OUTFLV	The daily volume of water outflowing from a channel reach	Output

Appendix B Main data objects used in *ACRUSalinity* from the hydrological modules of *ACRU*

Class Name	Definition
DActualIrrigApplic	The quantity of irrigation water applied to the field, excluding the various losses
DArea	Area of a component such as catchment area or impervious area
DBaseflowDepth	Baseflow depth in irrigated or non-irrigated areas
DChannelOutflow	Depth of water outflowing from a particular channel reach
DDamActualSeepage	Daily seepage loss from a reservoir
DDamCatchmentPercent	Percentage of the total catchment area being simulated that is contributing its flow to the reservoir
DDamDraftQuantity	The daily quantity of water abstracted from a reservoir
DDamNormalFlowRelease	The quantity of water released for downstream users (legal flow releases)
DDamOption	An option about the existence and location of a reservoir in a catchment
DDamRainfall	The quantity of rain falling on a reservoir surface
DDamSpillwayFlow	The quantity of water outflowing from a reservoir through the spillway
DEffectiveRainfall	The quantity of rain infiltrated to the topsoil of irrigated or non-irrigated areas
DImpervAreaRunoff	The quantity of runoff water from impervious areas
DIrrigMonth	The month in which irrigation takes place
DIrrigReturnflowOption	An option whether an irrigation return flows upstream or downstream of an internal reservoir
DNetArea	The area of a particular component
DQuickflowDepth	The depth of quickflow from irrigated or non-irrigated area
DSaturatedFlow	The quantity of percolated water from one layer to an underlying layer in irrigated or non-irrigated areas
DWaterFluxRecord	The quantity of water on a particular component, for example in reservoir and soil horizons of irrigated or non-irrigated areas

Appendix C Major component objects used in *ACRUSalinity* from the hydrological modules of *ACRU*

Class Name	Definition
CClimate	The component (physical feature) that represents the general climate of an area
CIrrigatedArea	The component representing irrigated areas
CLandSegment	The component that represents non-irrigated areas, or in some cases a sub-catchment
CChannel	The component that represents a stream or river
CDam	The component representing a reservoir
CImperviousArea	The component representing total impervious areas
CAdjunctImperviousArea	The component that represents adjunct impervious areas
CDisjunctImperviousArea	The component that represents disjunct impervious areas
CReach	The component that represents an inflow or outflow reach, for example, a river or reservoir reach

Appendix D Some of the factors and their magnitude resulting in the spatial variation of salinity betweens Sub-catchments 1 and 12

Factors affecting salinity		Sub-catchment No.	
		1	12
Mean annual precipitation (mm)		1107	945
Mean annual evaporation (mm)		1503.7	1588.6
Irrigated area as percentage of the total area		0	5
Impervious area as percentage of the total area	Adjunct	0.015	0.028
	Disjunct	0.198	0.045
Elevation (m)		2123.6	1684.6
Slope (%)		26.5	11.3
Depth of A-horizon (m)		0.22	0.26
Depth of B-horizon (m)		0.22	0.38
Porosity (m/m)	Topsoil	0.438	0.432
	Subsoil	0.420	0.413
Drained upper limit (m/m)	Topsoil	0.229	0.225
	Subsoil	0.244	0.256
Wilting point (m/m)	Topsoil	0.138	0.137
	Subsoil	0.147	0.171

Appendix E Sensitivity analysis of the major *ACRUSalinity* input parameters

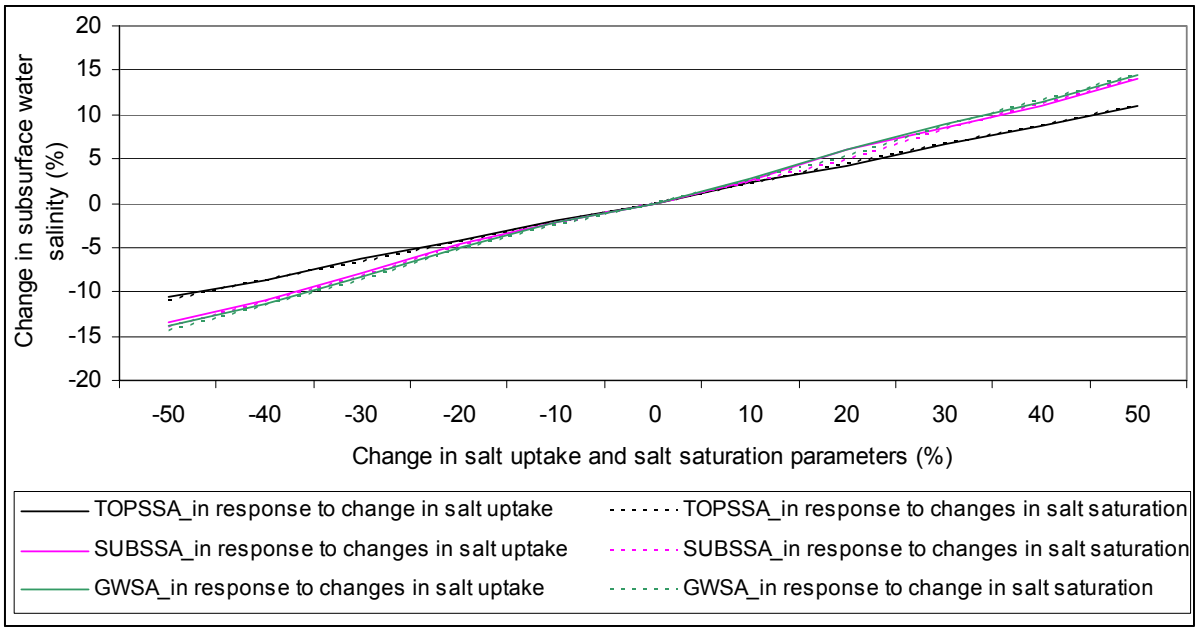


Figure E1 The impact of changes in salt uptake and salt saturation parameter values on subsurface water salinity

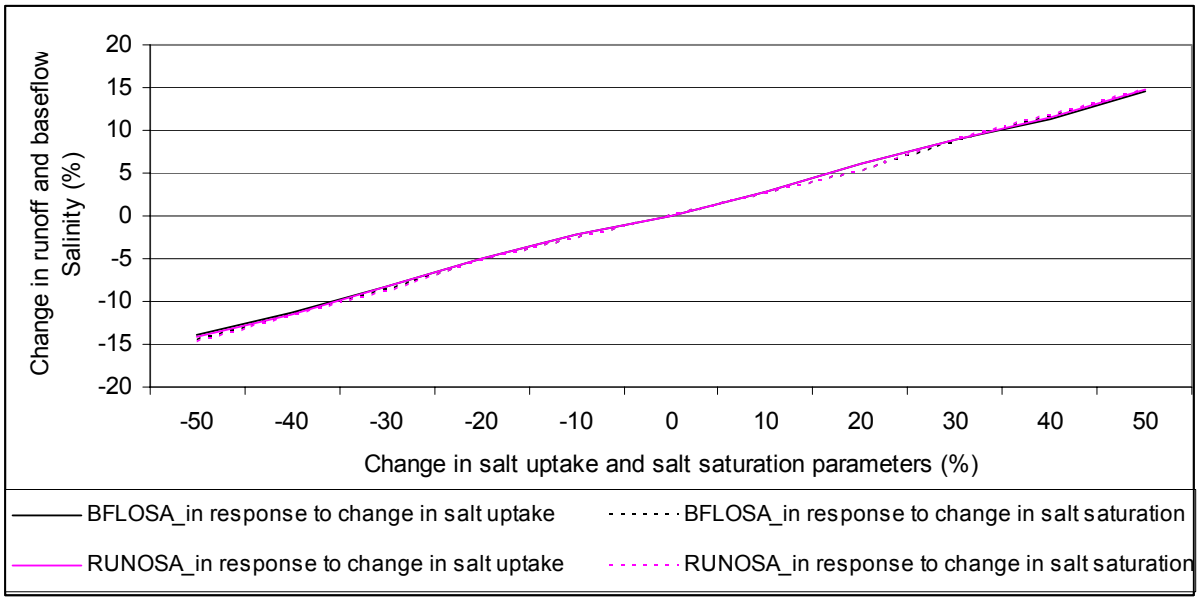


Figure E2 The impact of changes in salt uptake and salt saturation parameter values on runoff and baseflow salinity

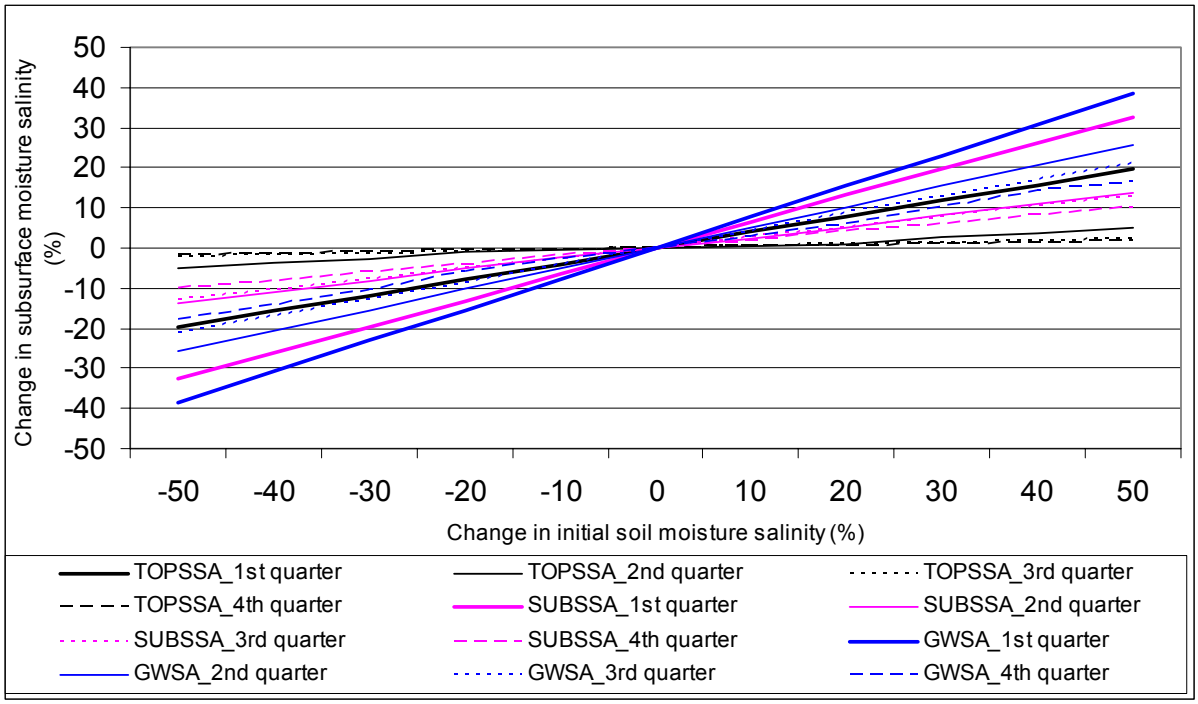


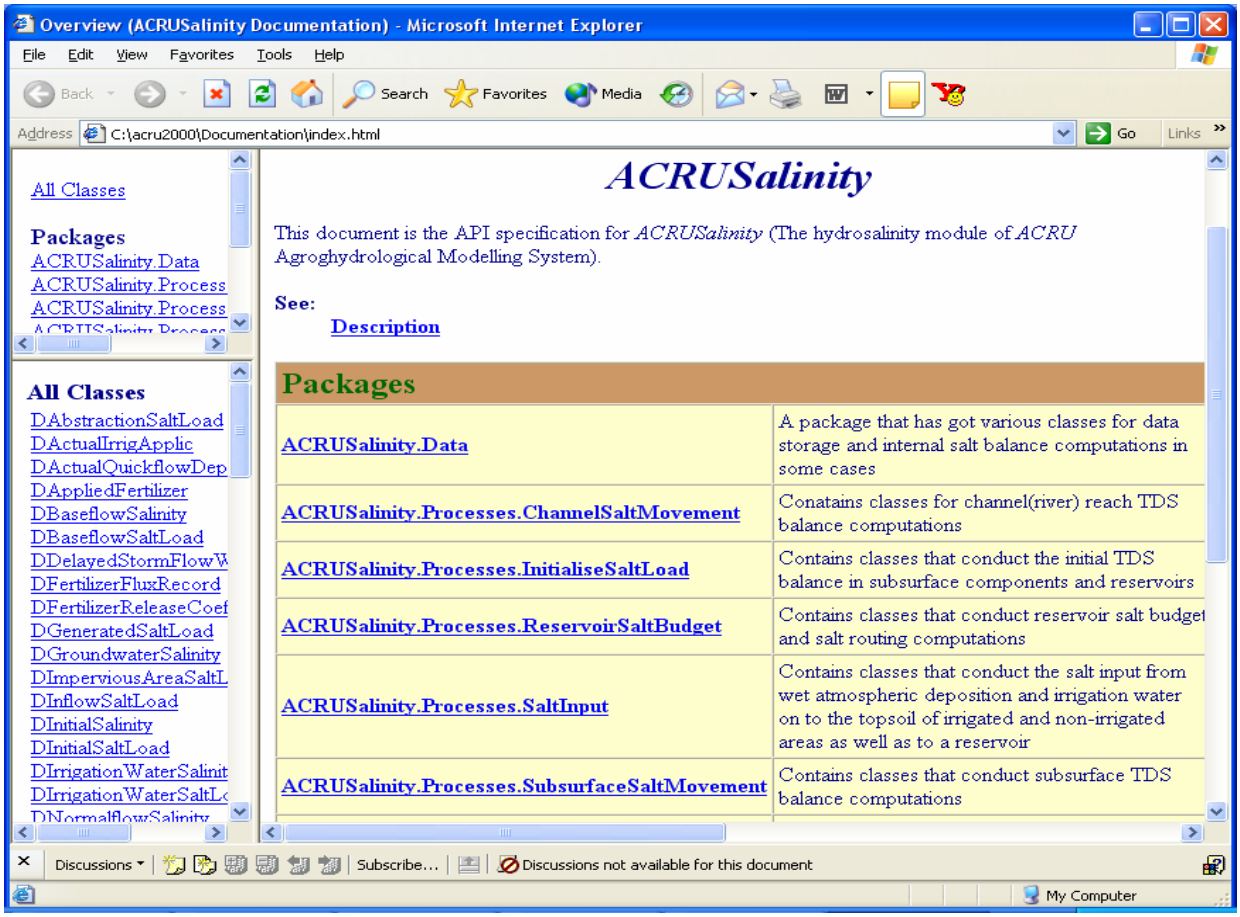
Figure E3 The impact of changes in initial soil moisture salinity value on subsurface water salinity

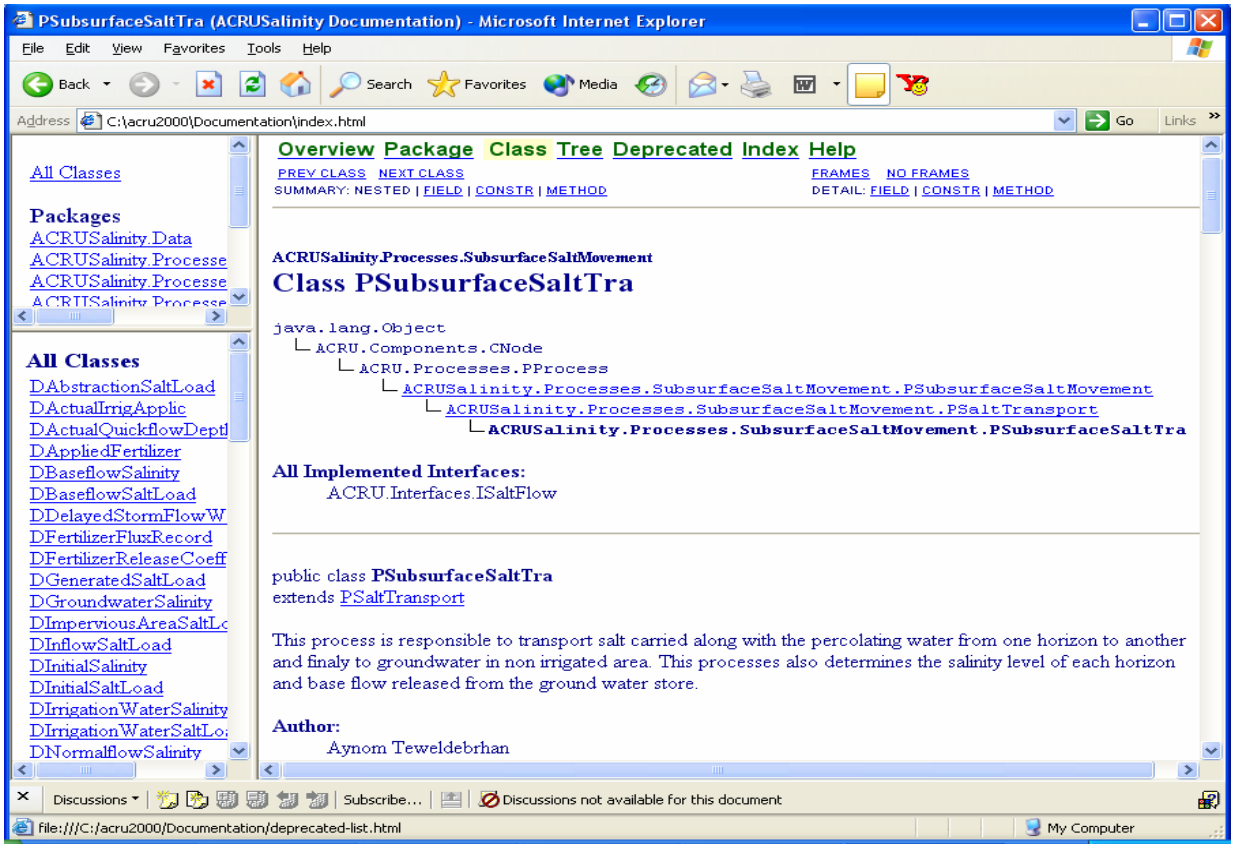
Appendix F GENSTAT output of the regression analysis for determination of the salt uptake rate constant for the Upper Mkomazi Catchment

```
***** Regression Analysis *****

 Response variate: changeInCwithTime
     Fitted terms: ChangeInC


*** Summary of analysis ***

            d.f.  s.s.        m.s.        v.r.        F pr.
Regression  1     15.001      15.0006     52.51       <.001
Residual    14    3.999       0.2857
Total       15    19.000      1.2667

Change      0     -0.001      *

Percentage variance accounted for 0.0
Standard error of observations is estimated to be 0.534


*** Estimates of regression coefficients ***

            estimate    s.e.        t(14)       t pr.
ChangeInC   0.0003401   0.0000469   7.25        <.001
```

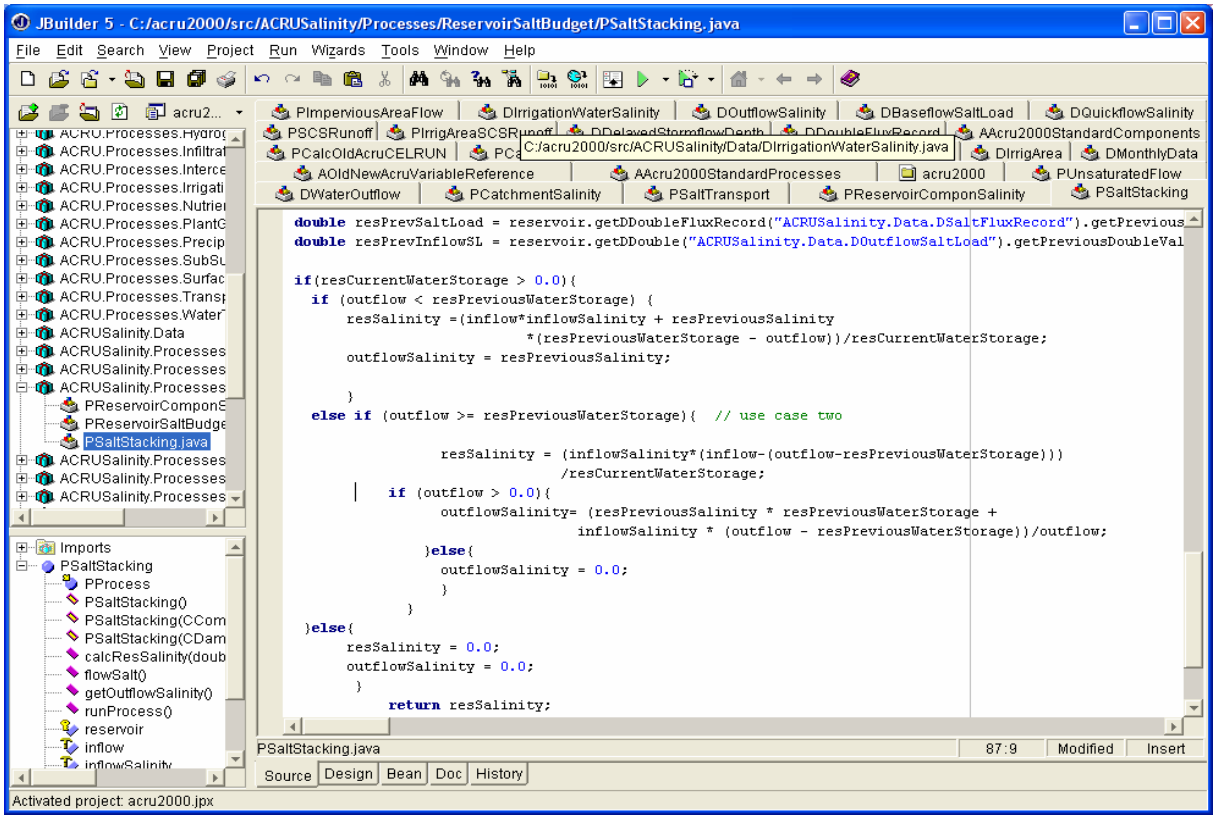
NB. changeInCwithTime represents the difference in TDS concentration between successive days over the time interval (in days), and changeInC represents the difference between the maximum soil TDS concentration and the observed TDS concentration for the day

Appendix G API specification of *ACRUSalinity*

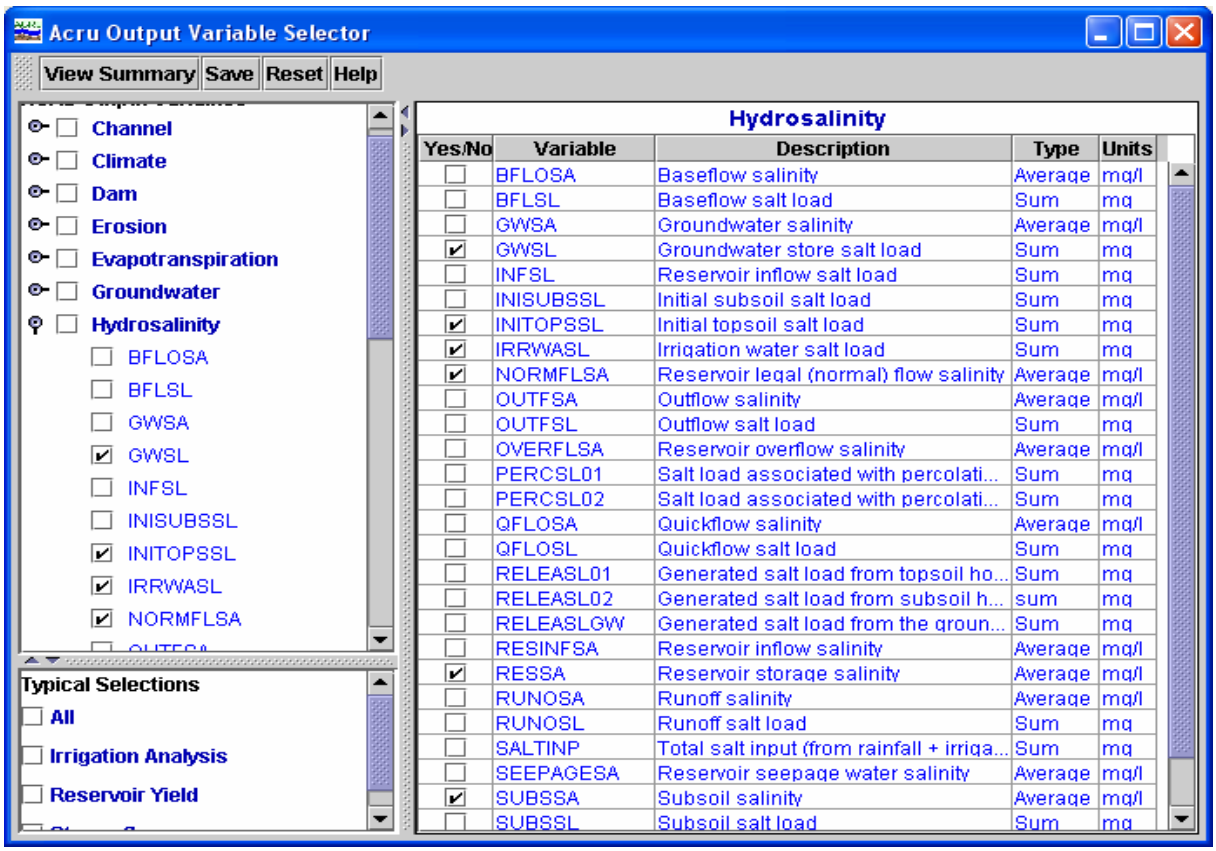




Appendix H A sample Java code and packages in *ACRUSalinity*



Appendix I *ACRUSalinity* output variables in the output variable selector of *ACRU*



Yes/No	Variable	Description	Type	Units
☐	BFLOSA	Baseflow salinity	Average	mg/l
☐	BFLSL	Baseflow salt load	Sum	mg
☐	GWSA	Groundwater salinity	Average	mg/l
☑	GWSL	Groundwater store salt load	Sum	mg
☐	INFSL	Reservoir inflow salt load	Sum	mg
☐	INISUBSSL	Initial subsoil salt load	Sum	mg
☑	INITOPSSL	Initial topsoil salt load	Sum	mg
☑	IRRWASL	Irrigation water salt load	Sum	mg
☑	NORMFLSA	Reservoir legal (normal) flow salinity	Average	mg/l
☐	OUTFSA	Outflow salinity	Average	mg/l
☐	OUTFSL	Outflow salt load	Sum	mg
☐	OVERFLSA	Reservoir overflow salinity	Average	mg/l
☐	PERCSL01	Salt load associated with percolati...	Sum	mg
☐	PERCSL02	Salt load associated with percolati...	Sum	mg
☐	QFLOSA	Quickflow salinity	Average	mg/l
☐	QFLOSL	Quickflow salt load	Sum	mg
☐	RELEASL01	Generated salt load from topsoil ho...	Sum	mg
☐	RELEASL02	Generated salt load from subsoil h...	sum	mg
☐	RELEASLGW	Generated salt load from the groun...	Sum	mg
☐	RESINFSA	Reservoir inflow salinity	Average	mg/l
☑	RESSA	Reservoir storage salinity	Average	mg/l
☐	RUNOSA	Runoff salinity	Average	mg/l
☐	RUNOSL	Runoff salt load	Sum	mg
☐	SALTINP	Total salt input (from rainfall + irriga...	Sum	mg
☐	SEEPAGESA	Reservoir seepage water salinity	Average	mg/l
☑	SUBSSA	Subsoil salinity	Average	mg/l
☐	SUBSSL	Subsoil salt load	Sum	mg