# Appendix A

**Table A1 |** Main equations, variables, and parameters of improved WALRUS (Revised from Brauer *et al*. (2014b)). The subscript 1 represents the variable belonging to paddy fields, while subscript 2 represents the variable belonging to dry farmland

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **States** | **Paddy field** | **Dry farmland** | **Unit** |
| *d*V | Storage deficit |  |  | mm |
| *d*G | Groundwater depth |   |  | mm |
| *h*Q | Level quickflow reservoir |   |  | mm |
| *h*S | Surface water level |  | mm |
|  | **Dependent variables** |
| *W* | Wetness index |   |  |  |
| *β* | Evapotranspiration reduction factor |  |  |  |
| *d*V,eq | Equilibrium storage deficit |   |  | mm |
|  | **External fluxes: input** |
| *P* | precipitation |  | mm/h |
| *Ir*1 | Irrigation water to paddy field |  |  | mm/h |
| *ET*pot | Potential evapotranspiration | *ET*pot1  | *ET*pot2 | mm/h |
| *ET*pot3 | Potential evapotranspiration surface water |  | mm/h |
| *Q*obs | Observed runoff |  | mm/h |
| *f*XG | Seepage(up/down)/extraction |  | mm/h |
|  | **External fluxes: output** |
| *ET*act | Actual evapotranspiration |   | mm/h |
| *Q* | Modeled runoff |  | mm/h |
|  | **Internal fluxes** |
| *P*S | Precipitation into surface water reservoir |   | mm/h |
| *P*r | Precipitation into residual area |  | mm/h |
| *P*V | Precipitation into vadose zone |  |  | mm/h |
| *P*Q | Precipitation into quickflow reservoir |  |  | mm/h |
| *Ir*V1 | Irrigation water into vadose zone of paddy field |  |  | mm/h |
| *Ir*Q1 | Irrigation water into quickflow reservoir of paddy field |  |  | mm/h |
| *In*1 | Infiltration rate of the quickflow reservoir into the vadose zone in the paddy field when *h*Q1>0 |  |  | mm/h |
| *ET*Q1 | Actual evapotranspiration from the quickflow reservoir of the paddy field when *h*Q1>0  |  |  | mm/h |
| *ET*V | Actual evapotranspiration vadose zone |  |  | mm/h |
| *ET*r | Actual *ET* residential area |  | mm/h |
| *ET*S | Actual *ET* surface water |  | mm/h |
| *f*GS | Groundwater drainage/surface water infiltration |  |  | mm/h |
| *f*QS | Quickflow |  |  | mm/h |
| *f*rS | Residential drainage |   | mm/h |
| *f*G12 | Groundwater flow between the paddy field and dry farmland |  | mm/h |
|  | **Model parameters** |
| *c*w | wetness index parameter | *c*w1 | *c*w2 | mm |
| *c*v | vadose zone relaxation time | *c*v1 | *c*v2 | h |
| *c*G | groundwater reservoir constant | *c*G1 | *c*G2 | mm h |
| *c*G3 | groundwater exchange constant between paddy field and dry farmland |  | mm h |
| *c*Q | Quickflow reservoir constant | *c*Q1 | *c*Q2 | h |
|  | **Supplied parameters** |
| aS | surface water area fraction |  |  |
| ar | residential area fraction |  |  |
| aG | groundwater reservoir constant | aG1 | aG2=1- aS - ar - aG1 |  |
| α | runoff coefficient of residential area |  |  |
| cD | channel depth |  | mm |
|  | **User defined function with defaults** |
| W(dV) | wetness index |  |  |  |
| β(dv) | evapotranspiration reduction factor |  |  |  |
| dv,eq(dG) |  |   |  | mm |
| Q(hs) |  |   | mm/h |
|  | **Parameters for default functions** |
| ζ1 | curvature ET reduction function | ζ11 | ζ12 |  |
| ζ2 | translation ET reduction function | ζ21 | ζ22 | mm |
| b | pore size distribution parameter | b1 | b2 |  |
| φae  | air entry pressure | φae1 | φae2 | mm |
| θS | soil moisture content at saturation | θS1 | θS2 |  |
| cS | surface water parameter: bankfull Q |  | mm/h |
| xs | stage–discharge relation exponent |  |  |
|  | surface water level to start pump drainage |  | mm |
| hQ,min1 | lower limit of appropriate water level for the paddy field |  | mm |
| hQ,max1 | upper limit of appropriate water level for the paddy field |  | mm |
| hQ,flood1 | maximum submergence-tolerant water level for rice growth |  | mm |