

MEMO : EN/INPA/DHL-3
SUBJECT: LIST OF PARAMETERS FOR WQ-ARM
TO : PASM-ELETRONORTE
FROM : JOHANNES SMITS
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INTRODUCTION

SINCE THE BEGINNING OF THIS PROJECT WQ-ARM HAS BEEN CHANGED IN MANY WAYS, NOT ONLY WITH RESPECT TO THE FORMULATIONS BUT ALSO WITH RESPECT TO THE NAMES OF PARAMETERS. MANY NAMES WERE CHANGED IN ORDER TO FIT INTO A MORE SYSTEMATIC (ENGLISH) NOMENCLATURE. NOW THE MODEL HAS REACHED ITS MORE OR LESS FINAL VERSION AT LEAST WITHIN THIS PROJECT, THE TIME HAS COME TO LIST AND EXPLAIN ALL THE PARAMETERS. SUCH A LIST WILL BE BASIC TO A MANUAL, WHICH IS TO APPEAR IN DUE TIME.

THE PARAMETERS HAVE BEEN LISTED BELOW ACCORDING TO A FEW PRINCIPLES. THE FIRST LEVEL OF DISTINCTION CONCERNS THE FUNCTION OF PARAMETERS IN THE MODEL. THE FUNCTIONS ARE: (1) INPUT, (2) VARIABLE, (3) PARAMETER, (4) OUTPUT, (5) PROGRAM COORDINATION. THE SECOND LEVEL OF DISTINCTION RELATES TO THE DISCIPLINE. THE DISCIPLINES ARE: (A) WATER QUALITY, (B) HYDROLOGY AND MASS TRANSPORT, (C) GEOMETRY, (D) THERMAL STRATIFICATION, (E) AUXILIARY. A THIRD LEVEL HAS BEEN FOUND IN THE TYPE OF PARAMETER: INTEGER, INTEGER ARRAY, REAL, REAL ARRAY. THE FOURTH AND FINAL LEVEL IS THE ALPHABETIC ORDER.

LIST OF PARAMETERS FOR WQ-ARM, MAIN PROGRAM (WQARM)

1. INPUT

A) WATER QUALITY

CAMP : AMMONIUM-N CONCENTRATION IN PRECIPITATION (MG N/L)
CNIP : NITRATE-N CONCENTRATION IN PRECIPITATION (MG N/L)
COPP : PHOSPHORUS CONCENTRATION IN PRECIPITATION (MG P/L)
CKL : REAERATION COEFFICIENT (S²/M².D)
CKLMIN : MINIMAL REAERATION CONSTANT (1/D)
DEPTHR : AVERAGE DEPTH OF RIVER NEAR THE DAM (M)
FAMR : FACTOR FOR AMMONIUM RELEASE FROM DEGRADING ORGANIC MATTER AT THE BOTTOM (1=NOT ACCELERATED COMPARED TO THE DEGRADATION ITSELF, >1=ACCELERATED FAMR TIMES)
FAN : RATIO OF ANAEROBIC AND AEROBIC DEGRADATION RATES (1-0)
FED : FRACTION OF DETRITUS CONTRIBUTING TO EXTINCTION (1-0)
FMOR : MULTIPLIER FOR MORTALITY RATE (1-0)
FOD1 : FRACTION OF LITTER IN PHYTO MASS (1-0)
FOPR : FACTOR FOR PHOSPHORUS RELEASE FROM DEGRADING ORGANIC MATTER AT THE BOTTOM (1=NOT ACCELERATED COMPARED TO THE DEGRADATION ITSELF, >1=ACCELERATED FAMR TIMES)
FREF : FRACTION OF REFRACTORY ORG. MATTER PRODUCED FROM SOD (1-0)
HVEG : AVERAGE HEIGHT OF VEGETATION (M)
GASVP : VOLUME PERC. OF GAS CAUGHT IN RIVER WATER AFTER SPILLWAY (%)
RCO1 : TEMPERATURE COEFFICIENT FOR RESPIRATION PHYTOPLANKTON (1/OC)
RDEBB : DENITRIFICATION RATE CONSTANT IN THE BOTTOM AT 20 OC (M/D)
RDET8 : DEGRADATION RATE CONSTANT OF DETRITUS AT 20 OC (1/D)
REAR : FRACTION OF MAXIMAL REAERATION AT THE SPILLWAY (1-0)
RNIT8 : NITRIFICATION RATE CONSTANT AT 20 OC (1/D)
ROD18 : DEGRADATION RATE CONSTANT OF PHYTO MASS (LITTER) AT 20 OC (1/D)
ROD28 : DEGRADATION RATE CONSTANT OF PHYTO MASS (FRESH) AT 20 OC (1/D)
RSAD : SEDIMENTATION/ADSORPTION RATE CONSTANT OF PHOSPHATE (M/D)
RS1 : SEDIMENTATION VELOCITY OF PHYTO MASS (M/D)
RS2 : SEDIMENTATION VELOCITY OF DETRITUS (M/D)
RSOD8 : DEGRADATION RATE CONSTANT OF ORGANIC MATTER AT THE BOTTOM AT 20 OC (1/D)
RVEG : INCORPORATION RATE CONSTANT OF PHYTO MASS INTO WATER (1/D)
SA1 : STOCH. CONSTANT FOR N IN PHYTO MASS (LITTER) (G N/G C)
SA2 : STOCH. CONSTANT FOR N IN PHYTO MASS (FRESH) (G N/G C)
SA3 : STOCH. CONSTANT FOR N IN PHYTOPLANKTON/DETRITUS (G N/G C)
SD : STOCH. CONSTANT FOR DENITRIFICATION (G N/G O₂)
SN : STOCH. CONSTANT FOR NITRIFICATION (G O₂/G N)
SOC : STOCH. CONSTANT FOR THE OXIDATION OF PHYTO MASS (G O₂/G C)
SODI : INITIAL AMOUNT OF ORG. MATTER IN THE BOTTOM (G O₂/M²)
SP1 : STOCH. CONSTANT FOR P IN PHYTO MASS (LITTER) (G P/G C)
SP2 : STOCH. CONSTANT FOR P IN PHYTO MASS (FRESH) (G P/G C)
SP3 : STOCH. CONSTANT FOR P IN PHYTOPLANKTON/DETRITUS (G P/G C)
TODI1 : TOTAL INITIAL PHYTO MASS BETWEEN LEVELS 0 AND H1 (G O₂/M²)
TODI2 : TOTAL INITIAL PHYTO MASS BETWEEN LEVELS H1 AND H2 (G O₂/M²)
TODI3 : TOTAL INITIAL PHYTO MASS BETWEEN LEVELS H2 AND HMAX (G O₂/M²)
BEXT() : BACKGROUND EXTINCTION COEFFICIENT FOR EACH MONTH (1/M)
CAMI() : AMMONIUM-N CONCENTRATION IN INFLOW FOR EACH MONTH (MG N/L)
CDETI() : DETRITUS CONCENTRATION IN INFLOW FOR EACH MONTH (MG O₂/L)

CNII() : NITRATE-N CONCENTRATION IN INFLOW FOR EACH MONTH (MG N/L)
 COPI() : INORGANIC-P CONCENTRATION IN INFLOW FOR EACH MONTH (MG P/L)
 COXI() : DISS. OXYGEN CONCENTRATION IN INFLOW FOR EACH MONTH (MG O2/L)
 DL() : AVERAGE DAYLENGTH FOR EACH MONTH (H)
 RCO2() : SPECIES SPECIFIC RESPIRATION COEFFICIENT PHYTOPLANKTON FOR EACH MONTH
 SEXT() : SPECIES SPECIFIC EXTINCTION COEFFICIENT PHYTOPLANKTON FOR EACH MONTH (L/(MG C.M))
 SIOP() : SPECIES SPECIFIC OPTIMAL PHOTOREACTIVE IRRADIATION INTENSITY AT 20 OC FOR EACH MONTH (W/M2)
 SVOL() : SPECIES SPECIFIC CELLULAR VOLUME PHYTOPLANKTON FOR EACH MONTH (U3)
 TIS() : DAILY AVERAGE PHOTOR. IRRADIATION INTENSITY FOR EACH MONTH, CORRECTED FOR REFLECTION AT THE WATER SURFACE (W/M2)

B) HYDROLOGY AND MASS TRANSPORT

DMAX : MAXIMAL VERTICAL DISPERSION COEFFICIENT IN EPILIMNION (M2/D)
 DMIN : MINIMAL VERTICAL DISPERSION COEFFICIENT IN HYPOLIMNION (M2/D)
 FDISP : RATIO OF HYPOLIMNION AND METALIMNION DISPERSION COEFFICIENTS
 FRICH : FRACTION OF DENSITY GRADIENT EPILIMNION IN RICH. NUMBER (1-0)
 HOUT1 : ELEVATION OF OUTLET 1 (TURBINES) (M)
 HOUT2 : ELEVATION OF OUTLET 2 (SPILLWAY) (M)
 HOUT3 : ELEVATION OF OUTLET 3 (OPTIONAL) (M)
 WIDTH : WIDTH OF RESERVOIR NEAR THE DAM (M)
 EVAP() : EVAPORATION FOR EACH MONTH (MM/MONTH)
 PREC() : PRECIPITATION FOR EACH MONTH (MM/MONTH)
 QIN(,) : INFLOW FOR EACH MONTH (1=TOTAL, 2=TOTAL EPIL., 3=TOTAL HYPOL.) (M3/S)
 QOUT(,) : OUTFLOW FOR EACH MONTH (1=TURBINES, 2=SPILLWAY, 3=OPTIONAL) (M3/S)
 WIND() : AVERAGE WINDSPEED AT 10 M HEIGHT FOR EACH MONTH (M/S)

C) GEOMETRY

AMAX : MAXIMAL SURFACE AREA OF RESERVOIR (KM2)
 AMIN : MINIMAL (INITIAL) SURFACE AREA OF RESERVOIR (KM2)
 EN : EXPONENT OF AREA-DEPTH AND VOLUME-DEPTH RELATIONS
 GAMMA : COEFFICIENT OF AREA-DEPTH AND VOLUME-DEPTH RELATIONS
 HMAX : MAXIMAL WATER LEVEL OR MAXIMAL DEPTH (M)
 DEPTH() : DEPTH FOR EACH MONTH (M)
 HEPI() : THICKNESS OF THE EPILIMNION FOR EACH MONTH (M)
 HHYP() : THICKNESS OF THE HYPOLIMNION FOR EACH MONTH (M)

D) THERMAL STRATIFICATION

TDAM() : AVERAGE TEMPERATURE OF OUTFLOW (ALL OUTLETS) FOR EACH MONTH (OC)
 TDEL() : TEMPERATURE DIFFERENCE BETWEEN EPILIMNION AND HYPOLIMNION FOR EACH MONTH (OC)
 TEPI() : EPILIMNION TEMPERATURE FOR EACH MONTH (OC)

E) AUXILIARY

IFILE : INDICATOR FOR OUTPUT UNIT NUMBER (=8 PRESENTLY)
 IIN : INDICATOR INFLOW DISTRIBUTION (1=COUPLED TO STRATIF,

0=NO COUPLING)

JSTART : FIRST YEAR OF COMPUTATIONS (LAST TWO DIGITS ONLY)

LOG : OPTION PARAMETER FOR OUTPUT (0=OXYGEN AND OXYGEN DEMANDS, 1=+ORG. MATTER IN BOTTOM AND PHYTO MASS, 2=+NUTRIENTS, 3=+TEMPERATURE, 4=+FLOWS, 5=+GEOMETRY)

MMAX : NUMBER OF MONTHS (MAXIMALLY 24)

MSTART : NUMBER OF THE FIRST MONTH OF COMPUTATIONS

NLEV : NUMBER OF LEVELS FOR SPECIFIC OUTPUT OXYGEN CONCENTRATION

DET : MAXIMAL TIMESTEP (D)

DET1 : MINIMAL TIMESTEP (D)

DEZ : THICKNESS OF LAYERS (M)

H1 : FIRST LEVEL FOR VARIATION OF PHYTO MASS DENSITY (M)

H2 : SECOND LEVEL FOR VARIATION OF PHYTO MASS DENSITY (M)

STAB : STABILITY FACTOR FOR DETERMINATION OF THE TIMESTEP (1-2)

ODEP() : LEVELS FOR SPECIFIC OUTPUT OXYGEN CONCENTRATION (M)

TEX() : TEXT FOR INPUT AND OUTPUT, AS WELL AS STORAGE OF CODE WORDS (STOP=STOP AFTER ONE RUN (MAXIMALLY 24 MONTHS), RIVE=INCLUDE RIVER MODEL, TEST=TEST RUN (ONLY 24 TIMESTEPS), HYDR=COMPUTE HYDRAULICS ONLY, GO=DO ANOTHER RUN FOR THE SAME RESERVOIR, NEW=DO A RUN FOR ANOTHER RESERVOIR, R2=INCLUDE RIVER MODEL WITH ARITHMETIC MEAN OXYGEN CONCENTRATION, R3=SAME WITH ARITHMETIC MEAN HYPOLIMNIC OXYGEN CONCENTRATION)

TEXT(,) : TEXT FOR INPUT AND OUTPUT

2. VARIABLES

A) WATER QUALITY

CGAS : EQUIL. OXYGEN CONC. IN WATER ENCLOSED IN GASBUBBLES (MG O2/L)

CGASI : INITIAL OXYGEN CONC. IN WATER ENCLOSED IN GASBUBBLES (MG O2/L)

CM : ARITHMETIC MEAN OXYGEN CONCENTRATION (MG O2/L)

CME : ARITHMETIC MEAN OXYGEN EPILIMNION CONCENTRATION (MG O2/L)

CMH : ARITHMETIC MEAN OXYGEN HYPOLIMNION CONCENTRATION (MG O2/L)

COU1 : OXYGEN CONCENTRATION IN OUTLET 1 (MG O2/L)

COU2 : OXYGEN CONCENTRATION IN OUTLET 2 (MG O2/L)

COU3 : OXYGEN CONCENTRATION IN OUTLET 3 (MG O2/L)

CWM : VOLUME AVERAGED MEAN OXYGEN CONCENTRATION (MG O2/L)

PAN : FRACTION OF VOLUME, WHICH IS ANAEROBIC

VAN : VOLUME OF ANAEROBIC WATER (M3)

CAM() : AMMONIUM-N CONCENTRATION IN EACH LAYER (MG N/L)

CDE() : DETRITUS CONCENTRATION IN EACH LAYER (MG O2/L)

CNI() : NITRATE-N CONCENTRATION IN EACH LAYER (MG N/L)

COD1() : SLOW DEGR. ORG. MATTER CONCENTRATION IN EACH LAYER (MG O2/L)

COD2() : FAST DEGR. ORG. MATTER CONCENTRATION IN EACH LAYER (MG O2/L)

COP() : INORGANIC-P CONCENTRATION IN EACH LAYER (MG P/L)

COX() : DISS. OXYGEN CONCENTRATION IN EACH LAYER (MG O2/L)

CPH() : PHYTOPLANKTON CONCENTRATION IN EACH LAYER (MG O2/L)

AM() : AVERAGE AMMONIUM CONCENTRATION IN OUTFLOW (MG N/L)

OC() : AVERAGE DISS. OXYGEN CONCENTRATION IN OUTFLOW AFTER REAERATION CAUSED BY THE SPILLWAY (MG O2/L)

OD1() : AVERAGE CONC. SLOW DEGR. ORG. MATTER IN OUTFLOW (MG O2/L)

OD2() : AVERAGE CONC. FAST DEGR. ORG. MATTER IN OUTFLOW (MG O2/L)

OD3() : AVERAGE CONC. DETRITUS (+PHYTOPLANKTON) IN OUTFLOW (MG O2/L)

SDD() : AMOUNT OF ORG. MATTER AT THE BOTTOM FOR EACH LAYER (G O2/M2)
 TOD() : AMOUNT OF PHYTO MASS IN STORE (NOT YET INCORPORATED) FOR EACH LAYER (G O2/M2)
 TODIO() : TOTAL INITIAL AMOUNT OF FRESH PHYTO MASS FOR EACH LAYER (G O2/M2)

B) HYDROLOGY AND MASS TRANSPORT

DISPO : VERT. DISP. COEFFICIENT UNDER UNSTRATIFIED CONDITIONS (M2/D)
 DISPE : VERT. DISP. COEFFICIENT EPILIMNION (M2/D)
 DISPH : VERT. DISP. COEFFICIENT HYPOLIMNION (M2/D)
 DISPT : VERT. DISP. COEFFICIENT THERMOCLINE (M2/D)
 QE : VERT. FLOW FROM EVAPORATION (M3/D)
 QP : VERT. FLOW FROM PRECIPITATION (M3/D)
 VH : VOLUME OF HYPOLIMNION (M3)
 VS : STORAGE VOLUME FROM WHICH LAYERS ARE GENERATED OR REMOVED (M3)
 DISPC() : VERT. DISP. COEFFICIENT (1=HYPOL., 2=EPIL., 3=THERM.) (M2/D)
 QI() : INFLOW FOR EACH LAYER (M3/D)
 QO() : OUTFLOW FOR EACH LAYER (M3/D)
 QV() : VERTICAL FLOW FOR EACH LAYER (M3/D)
 SQI() : TOTAL INFLOW (M3/D)
 SQO() : TOTAL OUTFLOW (M3/D)

C) GEOMETRY

VO : RESIDUAL VOLUME FOR Z=0 (M3)
 Z : VERTICAL COORDINATE (M)
 A() : SURFACE AREA BETWEEN LAYERS (M2)
 V() : VOLUME OF A LAYER (M3)
 VT() : ACCUMULATED VOLUME BELOW A LAYER (M3)

D) THERMAL STRATIFICATION

TMAT() : TEMPERATURE FOR EACH LAYER AND EACH MONTH (OC)

3. PARAMETERS

A) WATER QUALITY

AVEF : DEPTH AND TIME AVERAGED EFFICIENCY FOR THE USE OF PHOTOR. IRRADIATION IN THE PRIMARY PRODUCTION
 CREDs : CONCENTRATION OF REDUCED SUBSTANCES (FE, S, MN) (MG O2/L)
 CSAT : SATURATION CONCENTRATION OF OXYGEN (MG O2/L)
 CSATP : SATURATION CONC. OF OXYGEN AT AVERAGE HYDR. PRESSURE IN THE RIVER NEAR THE DAM (MG O2/L)
 CSPIL : DISS. OXYGEN CONC. IN WATER OUTLET2 BEFORE SPILLWAY (MG O2/L)
 EXT : TOTAL EXTINCTION COEFFICIENT (1/M)
 PDEB : RATE OF DENITRIFICATION IN THE BOTTOM OF A LAYER (G N/D)
 PDEN : RATE OF DENITRIFICATION IN A LAYER (G O2/D)
 PDET : RATE OF DETRITUS DEGRADATION OF A LAYER (G O2/D)
 PNIT : RATE OF NITRIFICATION IN A LAYER (MG N/D)
 PMOR : RATE OF MORTALITY PHYTOPLANKTON IN A LAYER (G O2/D)
 PPHY : RATE OF NET PRIMARY PROD. PHYTOPLANKTON IN A LAYER (G O2/D)
 POD1 : RATE OF DEGRAD. OF SLOW DEGR. ORG. MATTER IN A LAYER (G O2/D)
 POD2 : RATE OF DEGRAD. OF FAST DEGR. ORG. MATTER IN A LAYER (G O2/D)
 PSAD : NET RATE OF SEDIMENTATION/ADSORPTION OF PHOSPHATE IN A

PSE1 : LAYER (G P/D)
 : NET RATE OF SEDIM. OF SLOW DEGR. ORG. MATTER IN A LAYER
 (G O2/D)
 PSE2 : NET RATE OF SEDIM. OF FAST DEGR. ORG. MATTER IN A LAYER
 (G O2/D)
 PSED : NET RATE OF SEDIMENTATION OF DETRITUS IN A LAYER (G O2/D)
 PSOD : RATE OF SEDIMENT OXYGEN DEMAND OF A LAYER (G O2/D)
 PROD(I) : NET PRIMARY PRODUCTION RATE CONSTANT FOR EACH LAYER (1/D)
 RDEB : RATE CONSTANT FOR DENITRIFICATION IN THE BOTTOM (M/D)
 RDET : RATE CONSTANT FOR DETRITUS DEGRADATION (1/D)
 RKL : RATE CONSTANT FOR REAERATION (M/D)
 RPMAX : RATE CONSTANT FOR MAXIMAL GROSS PRIMARY PRODUCTION (1/D)
 RMOR : RATE CONSTANT FOR MORTALITY (1/D)
 RNIT : RATE CONSTANT FOR NITRIFICATION (1/D)
 ROD1 : RATE CONSTANT FOR DEGRADATION OF SLOW DEGR. ORG. MATTER (1/D)
 ROD2 : RATE CONSTANT FOR DEGRADATION OF FAST DEGR. ORG. MATTER (1/D)
 RREF : RATE CONSTANT FOR PRODUCTION REFRACTORY ORG. MATTER (1/D)
 RRES : RATE CONSTANT FOR RESPIRATION (1/D)
 RRESB : RATE CONSTANT FOR RESPIRATION AT 20 OC (1/D)
 RSOD : RATE CONSTANT FOR SEDIMENT OXYGEN DEMAND (1/D)
 SAS(I) : STOCH. CONSTANT FOR N IN SEDIMENT OXYGEN DEMAND OF EACH
 LAYER (G N/G O2)
 SPS(I) : STOCH. CONSTANT FOR P IN SEDIMENT OXYGEN DEMAND OF EACH
 LAYER (G P/G O2)
 TIOPT : SPECIES SPECIFIC OPTIMAL PHOTOR. IRRADIATION INTENSITY (W/M2)

B) HYDROLOGY AND MASS TRANSPORT

DENGR : DENSITY GRADIENT OF EPILIMNION (KG/M4)
 FGRAD : FRACTION OF DENSITY GRADIENT EPIL., RELATED TO EPIL. THICKNESS
 FRIVE : FRICTION VELOCITY AT WATER SURFACE (M/S)
 RDGR : AVERAGE VERTICAL RELATIVE DENSITY GRADIENT (1/M)
 RICHE : RICHARDSON NUMBER FOR EPILIMNION
 RICHT : RICHARDSON NUMBER FOR THERMOCLINE

4. OUTPUT

A) WATER QUALITY

OCO(I) : AVERAGE DISS. OXYGEN CONC. IN OUTFLOW BEFORE DAM (MG O2/L)
 OC1(I) : DISS. OXYGEN CONC. IN OUTFLOW BEFORE DAM OUTLET 1 (MG O2/L)
 OC2(I) : DISS. OXYGEN CONC. IN OUTFLOW BEFORE DAM OUTLET 2 (MG O2/L)
 OC3(I) : DISS. OXYGEN CONC. IN OUTFLOW BEFORE DAM OUTLET 3 (MG O2/L)
 OUTAM(I, J) : AMMONIUM-N CONC. FOR EACH LAYER AND EACH MONTH (MG N/L)
 OUTBOD(I, J) : BOD (5 DAYS, 20 OC) FOR EACH LAYER AND EACH MONTH (MG O2/L)
 OUTCM(I) : ARITHMETIC MEAN OXYGEN CONCENTRATION FOR EACH MONTH (MG O2/L)
 OUTCME(I) : ARITHMETIC MEAN OXYGEN EPIL. CONC. FOR EACH MONTH (MG O2/L)
 OUTCMH(I) : ARITHMETIC MEAN OXYGEN HYPOL. CONC. FOR EACH MONTH (MG O2/L)
 OUTCMW(I) : VOLUME AVERAGED MEAN OXYGEN CONC. FOR EACH MONTH (MG O2/L)
 OUTDE(I, J) : DETRITUS CONC. FOR EACH LAYER AND EACH MONTH (MG O2/L)
 OUTNI(I, J) : NITRATE-N CONC. FOR EACH LAYER AND EACH MONTH (MG N/L)
 OUTOD1(I, J) : SLOW DEGR. ORG. MATTER CONCENTRATION FOR EACH LAYER AND
 EACH MONTH (MG O2/L)
 OUTOD2(I, J) : FAST DEGR. ORG. MATTER CONCENTRATION FOR EACH LAYER AND

EACH MONTH (MG O2/L)
 OUTOP(,) : INORGANIC-P CONC. FOR EACH LAYER AND EACH MONTH (MG P/L)
 OUTOX(,) : DISS. OXYGEN CONC. FOR EACH LAYER AND EACH MONTH (MG O2/L)
 OUTPAN(,) : FRACTION OF VOLUME, WHICH IS ANAEROBIC, FOR EACH MONTH
 OUTPH(,) : PHYTOPLANKTON CONC. FOR EACH LAYER AND EACH MONTH (MG O2/L)
 OUTTOD(,) : AMOUNT OF PHYTO MASS IN STORAGE FOR EACH LAYER AND EACH MONTH (G O2/M2)
 OUTTON(,) : TOTAL-N CONC. FOR EACH LAYER AND EACH MONTH (MG N/L)
 OUTTOP(,) : TOTAL-P CONC. FOR EACH LAYER AND EACH MONTH (MG P/L)

B) HYDROLOGY AND MASS TRANSPORT

OUTDCE(,) : VERT. DISP. COEFFICIENT EPILIMNION FOR EACH MONTH (M2/D)
 OUTDCH(,) : VERT. DISP. COEFFICIENT HYPOLIMNION FOR EACH MONTH (M2/D)
 OUTDCT(,) : VERT. DISP. COEFFICIENT THERMOCLINE FOR EACH MONTH (M2/D)
 OUTQE(,) : VERT. FLOW FROM EVAPORATION FOR EACH MONTH (M3/(1000.S))
 OUTQI(,) : INFLOW FOR EACH LAYER AND EACH MONTH (M3/(1000.S))
 OUTQO(,) : OUTFLOW FOR EACH LAYER AND EACH MONTH (M3/(1000.S))
 OUTQP(,) : VERT. FLOW FROM PRECIPITATION FOR EACH MONTH (M3/(1000.S))
 OUTQV(,) : VERTICAL FLOW FOR EACH LAYER AND EACH MONTH (M3/(1000.S))
 SQI2(,) : TOTAL INFLOW FOR EACH MONTH (M3/S)
 SQO2(,) : TOTAL OUTFLOW FOR EACH MONTH (M3/S)

C) GEOMETRY

DEPTH0 : INITIAL DEPTH (M)
 HEPIO : INITIAL THICKNESS OF EPILIMNION (M)
 HHYPO0 : INITIAL THICKNESS OF HYPOLIMNION (M)
 OUTH(,) : DEPTH FOR EACH MONTH (M)

D) THERMAL STRATIFICATION

TEPIO : INITIAL TEMPERATURE OF EPILIMNION (OC)
 THYPO0 : INITIAL TEMPERATURE OF HYPOLIMNION (OC)
 THYPO(,) : TEMPERATURE OF HYPOLIMNION FOR EACH MONTH (OC)

E) AUXILIARY

NCCOUNT : NUMBER OF RUNS FOR THE SAME RESERVOIR
 NERROR : NUMBER OF ERROR (1=NUMBER OF LAYERS TOO BIG, 2=NO NET FILLING OF RESERVOIR IN FIRST TIMESTEP, 3=TIMESTEP DET TOO BIG, 4=NUMBER OF LAYERS HAS BECOME ZERO, 5=NUMBER OF MONTHS TOO BIG, 6=FAMR OR FOPR SMALLER THAN 1)
 IM(,) : TIME INDICATOR (YEAR AND MONTH)
 IOV(,) : PARAMETER FOR OVERFLOW (0=NO RESERVOIR OVERFLOW, *****=OVERFLOW)
 OXYDEP(,) : DISS. OXYGEN CONC. AT SELECTED LEVELS FOR EACH MONTH (MG O2/L)

5. PROGRAM COORDINATION

A) WATER QUALITY

IEUT : NUMBER OF LOWER LAYER IN EUPHOTIC ZONE
 IMOR : NUMBER OF LAYER BELOW WHICH PHYTOPLANKTON CAN NOT SURVIVE
 IR : REVERSED NUMBER OF LAYER (FOR PRODUCTION COMPUTATION)
 DHVEG : DIFFERENCE OF AVERAGE HEIGHT VEGETATION AND WATER LEVEL (M)
 FA : RATE MULTIPLIER DEGRADATION (1=AEROBY, FA=ANAEROBY)
 FD : RATE MULTIPLIER DENITRIFICATION (0=AEROBY, 1=ANAEROBY)

FN : RATE MULTIPLIER NITRIFICATION (1=AEROBY, 0=ANAEROBY)
 FS : RATE MULTIPLIER SEDIMENT./ADSORPTION (1=AEROBY, 0=ANAEROBY)
 FRAC1 : FRACTION OF PRIMARY PRODUCTION CONSUMING AMMONIUM-N
 FRAC2 : FRACTION OF PRIMARY PRODUCTION CONSUMING NITRATE-N
 PRODM : MAXIMAL NET PRIMARY PROD. RATE CONSTANT ON THE BASIS OF
 NUTRIENT AVAILABILITY (1/D)
 SODO : AMOUNT OF ORG. MATTER AT THE BOTTOM IN THE PRECEEDING
 TIMESTEP (G O2/M2)
 SUMC : TOTAL AMOUNT OF DISS. OXYGEN IN OUTFLOW (G O2/D)
 SUMC1 : TOTAL AMOUNT OF SLOW DEGR. ORG. MATTER IN OUTFLOW (G O2/D)
 SUMC2 : TOTAL AMOUNT OF FAST DEGR. ORG. MATTER IN OUTFLOW (G O2/D)
 SUMC3 : TOTAL AMOUNT OF DETRITUS AND PHYTOPLANKTON IN OUTFLOW (G O2/D)
 SUMC4 : TOTAL AMOUNT OF AMMONIUM IN OUTFLOW (G N/D)
 SUMOX : TOTAL AMOUNT OF DISS. OXYGEN IN RESERVOIR (G O2)
 TIZ1 : PHOTOR. IRRADIATION INTENSITY AT UPPER SIDE OF LAYER (W/M2)
 TIZ2 : PHOTOR. IRRADIATION INTENSITY AT LOWER SIDE OF LAYER (W/M2)
 BAM() : AMMONIUM-N CONCENTRATION INCREASE FOR EACH LAYER (G N/D)
 BDE() : DETRITUS CONCENTRATION INCREASE FOR EACH LAYER (G O2/D)
 BNI() : NITRATE-N CONCENTRATION INCREASE FOR EACH LAYER (G N/D)
 BOD1() : SLOW DEGR. ORG. MATTER CONC. INCREASE FOR EACH LAYER (G O2/D)
 BOD2() : FAST DEGR. ORG. MATTER CONC. INCREASE FOR EACH LAYER (G O2/D)
 BOP() : INORGANIC-P CONCENTRATION INCREASE FOR EACH LAYER (G P/D)
 BOX() : DISS. OXYGEN CONCENTRATION INCREASE FOR EACH LAYER (G O2/D)
 BPH() : PHYTOPLANKTON CONCENTRATION INCREASE FOR EACH LAYER (G O2/D)

B) HYDROLOGY AND MASS TRANSPORT

IOH1 : LAYER NUMBER OF OUTLET 1
 IOH2 : LAYER NUMBER OF OUTLET 2
 IOH2A : LAYER NUMBER OF OUTLET 2
 IOH3 : LAYER NUMBER OF OUTLET 3
 IOH3A : LAYER NUMBER OF OUTLET 3
 B1 : MASS TRANSPORT COEFFICIENT TO BE MULTIPLIED WITH C(I-1) (M3/D)
 B2 : MASS TRANSPORT COEFFICIENT TO BE MULTIPLIED WITH C(I) (M3/D)
 B3 : MASS TRANSPORT COEFFICIENT TO BE MULTIPLIED WITH C(I+1) (M3/D)
 CWIDTH : CONSTANT IN WIDTH OF GAUSSIAN DISTRIBUTIONS
 QTOT : TROUGHFLOW FOR A LAYER (M3/D)
 SUM1 : SUM OF ELEMENTS OF GAUSSIAN DISTRIBUTION OUTFLOW 1
 SUM2 : SUM OF ELEMENTS OF GAUSSIAN DISTRIBUTION OUTFLOW 2
 SUM3 : SUM OF ELEMENTS OF GAUSSIAN DISTRIBUTION OUTFLOW 3
 X1 : VARIABLE OF GAUSSIAN DISTRIBUTION OUTFLOW 1
 X2 : VARIABLE OF GAUSSIAN DISTRIBUTION OUTFLOW 2
 X3 : VARIABLE OF GAUSSIAN DISTRIBUTION OUTFLOW 3
 W1 : WIDTH OF GAUSSIAN DISTRIBUTION OUTFLOW 1 (M)
 W2 : WIDTH OF GAUSSIAN DISTRIBUTION OUTFLOW 2 (M)
 W3 : WIDTH OF GAUSSIAN DISTRIBUTION OUTFLOW 3 (M)
 GD1() : VERTICAL GAUSSIAN DISTRIBUTION OUTFLOW 1
 GD2() : VERTICAL GAUSSIAN DISTRIBUTION OUTFLOW 2
 GD3() : VERTICAL GAUSSIAN DISTRIBUTION OUTFLOW 3

C) GEOMETRY

AV : RECIPROCAL AVERAGE DEPTH BELOW LAYER I+1 (1/M)

D) THERMAL STRATIFICATION

IEP : INTEGER OF EPILIMNION THICKNESS (M)

IH : INTEGER OF DEPTH (M)
 IHY : INTEGER OF HYPOLIMNION THICKNESS (M)
 TAV : AVERAGE TEMPERATURE (OC)
 TE : TEMPERATURE OF EPILIMNION (OC)
 TH : TEMPERATURE OF HYPOLIMNION (OC)

E) AUXILIARY

IDATE : INITIAL DATE (YEAR AND MONTH)
 IDEP : REVERSED NUMBER OF LAYER
 IHYP : NUMBER OF UPPER LAYER OF HYPOLIMNION
 IHYP1 : NUMBER OF UPPER LAYER OF HYPOLIMNION PLUS 1
 IMAX : MAXIMUM NUMBER OF LAYERS
 IMAXT : THE ACTUAL NUMBER OF LAYERS
 IMAXT1 : THE ACTUAL NUMBER OF LAYERS PLUS 1
 IMAXT2 : THE ACTUAL NUMBER OF LAYERS MINUS 1
 IMAXTD : THE ACTUAL NUMBER OF LAYERS IN THE PRECEEDING TIMESTEP
 IMXT01 : THE ACTUAL NUMBER OF LAYERS IN THE PRECEEDING TIMESTEP PLUS 1
 M : NUMBER OF MONTH
 MMAX1 : NUMBER OF MONTHS PLUS 1
 MO : NUMBER OF PRECEEDING MONTH
 NIL : NUMBER OF INCORPORATED LAYERS OF PHYTO MASS
 NOUT : OUTPUT INDICATOR
 NP : NUMBER OF PARTIAL TIMESTEP
 NPT : NUMBER OF PARTIAL TIMESTEPS
 NT : NUMBER OF TIMESTEP
 NTR : NUMBER OF TIMESTEPS IN RUN
 DET2 : TIMESTEP CORRECTED FOR DISPERSION (D)
 DET3 : TIMESTEP CORRECTED FOR THROUGHFLOW (D)
 DET4 : TIMESTEP CORRECTED FOR PHYTOPLANKTON PROCESSES (D)
 DET5 : TIMESTEP CORRECTED FOR SEDIMENTATION (D)
 DETC : TIMESTEP CORRECTED FOR THROUGHFLOW AND DISPERSION (D)
 DETH : TIMESTEP CORRECTED FOR THROUGHFLOW AND DISPERSION (D)
 GO : CONTAINS CODE WORD FOR OPTION: ANOTHER RUN FOR SAME RESERVOIR
 HYDRAU : CONTAINS CODE WORD FOR OPTION: COMPUTE HYDROLOGY ONLY
 RIV : CONTAINS CODE WORD FOR OPTION: INCLUDE RIVER MODEL
 RIV2 : CONTAINS CODE WORD FOR OPTION: INCLUDE RIVER MODEL WITH CM
 RIV3 : CONTAINS CODE WORD FOR OPTION: INCLUDE RIVER MODEL WITH CMH
 RUN : CONTAINS CODE WORD FOR OPTION: ANOTHER RUN FOR ANOTHER RESER.
 TEST : CONTAINS CODE WORD FOR OPTION: NUMBER OF TIMESTEPS IS MMAX
 T : TIME (MONTH)
 IS() : PARAMETER FOR INCORPORATION OF LITTER (0=NOT YET, 1=ALREADY)
 TDR() : TIME ELAPSED SINCE DROWNING OF VEGETATION IN LAYER STARTED (D)

LIST OF PARAMETERS FOR WQ-ARM, SUBROUTINE RIVER (PART OF WQARM)

1. INPUT

A) WATER QUALITY

CAMI : AMMONIUM CONC. ADDITIONAL INFLOW (MG N/L)
CDETI : DETRITUS CONC. ADDITIONAL INFLOW (MG O2/L)
COXI : DISS. OXYGEN CONCENTRATION ADDITIONAL INFLOW (MG O2/L)
FAN : RATIO OF ANAEROBIC AND AEROBIC DEGRADATION RATES (1-0)
RDETB : DEGRADATION RATE CONSTANT OF DETRITUS AT 20 OC (1/D)
RNITB : NITRIFICATION RATE CONSTANT AT 20 OC (1/D)
ROD1B : DEGRADATION RATE CONSTANT OF SLOW DEGR. ORG. MATTER AT
20 OC (1/D)
ROD2B : DEGRADATION RATE CONSTANT OF FAST DEGR. ORG. MATTER AT
20 OC (1/D)
SA1 : STOCH. CONSTANT FOR N IN PHYTCMASS (LITTER) (G N/G C)
SA2 : STOCH. CONSTANT FOR N IN PHYTCMASS (FRESH) (G N/G C)
SA3 : STOCH. CONSTANT FOR N IN PHYTOPLANKTON/DETRITUS (G N/G C)
SN : STOCH. CONSTANT FOR NITRIFICATION (G O2/G N)
CAM() : AMMONIUM CONC. INFLOW FROM THE RESERVOIR FOR EACH MONTH
(MG N/L)
CDET() : DETRITUS CONC. INFLOW FROM THE RESERVOIR FOR EACH MONTH
(MG O2/L)
COD1() : SLOW DEGR. ORG. MATTER CONC. INFLOW FROM THE RESERVOIR
FOR EACH MONTH (MG O2/L)
COD2() : FAST DEGR. ORG. MATTER CONC. INFLOW FROM THE RESERVOIR
FOR EACH MONTH (MG O2/L)
COX() : DISS. OXYGEN CONCENTRATION IN INFLOW FROM THE RESERVOIR
FOR EACH MONTH (MG O2/L)

B) HYDROLOGY AND MASS TRANSPORT

AV() : COEFFICIENT IN RELATION AVERAGE VELOCITY/FLOW RATE (IOPV=0)
OR IN RELATION WIDTH/FLOW RATE (IOPV=1) FOR EACH REACH
BV() : EXPONENT IN RELATION AVERAGE VELOCITY/FLOW RATE (IOPV=0)
OR IN RELATION WIDTH/FLOW RATE (IOPV=1) FOR EACH REACH
QI() : INFLOW FROM THE RESERVOIR FOR EACH MONTH (M3/S)
QID(,) : INFLOW FROM DIFF. SOURCES FOR EACH REACH AND EACH MONTH (M3/S)
QIT(,) : INFLOW FROM TRIBUTARIES FOR EACH REACH AND EACH MONTH (M3/S)

C) GEOMETRY

NREACH : NUMBER OF REACHES
DAMKM : INITIAL DISTANCE AT THE DAM (KM)
AH() : COEFFICIENT IN RELATION AVERAGE DEPTH/FLOW RATE FOR EACH REACH
BH() : EXPONENT IN RELATION AVERAGE DEPTH/FLOW RATE FOR EACH REACH
RCHKM() : LENGTH OF EACH REACH (KM)

D) TEMPERATURE

TDAM() : AVERAGE TEMPERATURE OF INFLOW FROM RESER. FOR EACH MONTH (OC)

E) AUXILIARY

IFILE : INDICATOR FOR OUTPUT UNIT NUMBER (=8 PRESENTLY)
LOG : OPTION PARAMETER FOR OUTPUT (0=OXYGEN AND BOD, 1=+0D1, 0D2)

AND DET, 2=+HYDRAULICS, DEPTH AND RESIDENCE TIME)
 MMAX : NUMBER OF MONTHS (MAXIMALLY 24)
 DELKM : LENGTH OF A SEGMENT (PART OF A REACH) (KM)
 IOPD() : OPTION NUMBER FOR DIFF. SOURCES FOR EACH REACH (0=NO, 1=YES)
 IOPT() : OPTION NUMBER FOR TRIBUTARY FOR EACH REACH (0=NO, 1=YES)
 IOPV() : OPTION NUMBER FOR COMPUTATION AVERAGE VELOCITY FOR EACH REACH
 (0=FUNCTION FLOW RATE, 1=FUNCTION OF GEOMETRY)
 TEXT(,) : TEXT FOR INPUT AND OUTPUT

2. VARIABLES

A) WATER QUALITY

CAMR : AMMONIUM CONC. IN THE RIVER (MG N/L)
 CBODR : BOD (5 DAYS, 20 OC) IN THE RIVER (MG O2/L)
 CDETR : DETRITUS CONC. IN THE RIVER (MG O2/L)
 COD1R : SLOW DEGRAD. ORG. MATTER CONC. IN THE RIVER (MG O2/L)
 COD2R : FAST DEGRAD. ORG. MATTER CONC. IN THE RIVER (MG O2/L)
 COXR : DISS. OXYGEN CONCENTRATION IN THE RIVER (MG O2/L)
 CBOD() : BOD (5 DAYS, 20 OC) CONC. OF INFLOW FROM RES. FOR EACH MONTH
 (MG O2/L)

B) HYDROLOGY AND MASS TRANSPORT

QIR : FLOW RATE IN RIVER AT THE BEGINNING OF A REACH (M3/S)
 QIRT : FLOW RATE IN RIVER AT THE END OF A SEGMENT (M3/S)
 VEL : AVERAGE FLOW VELOCITY IN A SEGMENT (M/S)
 VELR : AVERAGE FLOW VELOCITY IN A REACH (M/S)

D) GEOMETRY

DEP : AVERAGE DEPTH IN A SEGMENT (M)
 DEPR : AVERAGE DEPTH IN A REACH (M)

3. PARAMETERS

A) WATER QUALITY

CSAT : SATURATION CONCENTRATION OF OXYGEN (MG O2/L)
 PDET : DETRITUS DEGRADATION IN A SEGMENT (MG O2/L)
 PNIT : NITRIFICATION IN A SEGMENT (MG N/L)
 PDD1 : DEGRADATION OF SLOW DEGR. ORG. MATTER IN A SEGMENT (MG O2/L)
 PDD2 : DEGRADATION OF FAST DEGR. ORG. MATTER IN A SEGMENT (MG O2/L)
 PREA : REAERATION IN A SEGMENT (MG O2/L)
 RDET : RATE CONSTANT FOR DETRITUS DEGRADATION (1/D)
 RK2 : RATE CONSTANT FOR REAERATION (1/D)
 RNIT : RATE CONSTANT FOR NITRIFICATION (1/D)
 ROD1 : RATE CONSTANT FOR DEGRADATION OF SLOW DEGR. ORG. MATTER (1/D)
 ROD2 : RATE CONSTANT FOR DEGRADATION OF FAST DEGR. ORG. MATTER (1/D)

4. OUTPUT

A) WATER QUALITY

CAMD(, ,) : AMMONIUM CONC. AT THE END OF EACH REACH FOR EACH MONTH

(MG N/L)
 CBODO(,,): BOD (5 DAYS, 20 OC) CONC. AT THE END OF EACH REACH FOR EACH MONTH (MG O2/L)
 CDETO(,,): DETRITUS CONC. AT THE END OF EACH REACH FOR EACH MONTH (MG O2/L)
 COD10(,,): SLOW DEGR. ORG. MATTER CONC. AT THE END OF EACH REACH FOR EACH MONTH (MG O2/L)
 COD20(,,): FAST DEGR. ORG. MATTER CONC. AT THE END OF EACH REACH FOR EACH MONTH (MG O2/L)
 COXD(,,): DISS. OXYGEN CONC. AT THE END OF EACH REACH FOR EACH MONTH (FINAL INDEX=1, CALCULATED ON THE BASIS OF OXYGEN CONC. IN INFLOW FROM RESERVOIR AT THE END OF A MONTH AND THE FLOW RATE OF THE SAME MONTH; FINAL INDEX=2, CALCULATED ON THE BASIS OF THE SAME CONCENTRATION BUT THE FLOW RATE OF THE FOLLOWING MONTH) (MG O2/L)

B) HYDROLOGY AND MASS TRANSPORT

FLOW(,) : FLOW RATE (DISCHARGE) AT THE END OF EACH REACH FOR EACH MONTH (M3/S)
 VELO(,) : AVERAGE FLOW VELOCITY IN EACH REACH FOR EACH MONTH (M/S)

C) GEOMETRY

DEPT(,) : AVERAGE DEPTH IN EACH REACH FOR EACH MONTH (M)
 DIST() : DISTANCE OF THE END OF EACH REACH TO THE DAM (KM)

E) AUXILIARY

IM() : TIME INDICATOR (YEAR AND MONTH)
 TIME(,) : RESIDENCE TIME FOR EACH REACH AND EACH MONTH (D)

5. PROGRAM COORDINATION

A) WATER QUALITY

COXB : DISS. OXYGEN CONCENTRATION IN THE RIVER (MG O2/L)
 FA : RATE MULTIPLIER DEGRADATION (1=AEROBY, 0=ANAEROBY)
 FO : RATE MULTIPLIER NITRIFICATION (1=AEROBY, 0=ANAEROBY)

B) HYDROLOGY AND MASS TRANSPORT

DQ : INCREASE FLOW RATE IN A SEGMENT DUE TO DIFF. SOURCES (M3/S)
 QIRT1 : THE FLOW RATE AT THE BEGINNING OF A SEGMENT (M3/S)

D) GEOMETRY

SUMD : SUM OF AVERAGE DEPTHS OF SEGMENTS IN A REACH (M)

E) AUXILIARY

IF : INDICATOR FOR OUTPUT UNIT NUMBER (=8 PRESENTLY)
 MMAX1 : NUMBER OF MONTHS (MAXIMALLY 24) PLUS 1
 MMAX2 : NUMBER OF MONTHS (MAXIMALLY 24) OR IDEM PLUS 1
 NR : NUMBER OF REACHES PLUS 1
 NS : NUMBER OF SEGMENTS
 T : RESIDENCE TIME REACH (S)