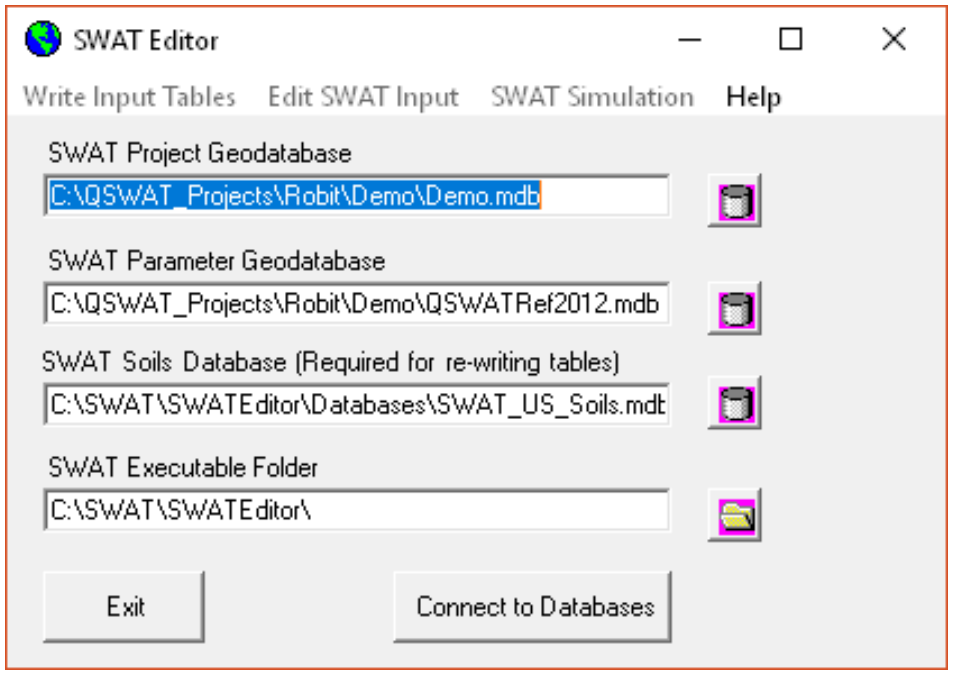
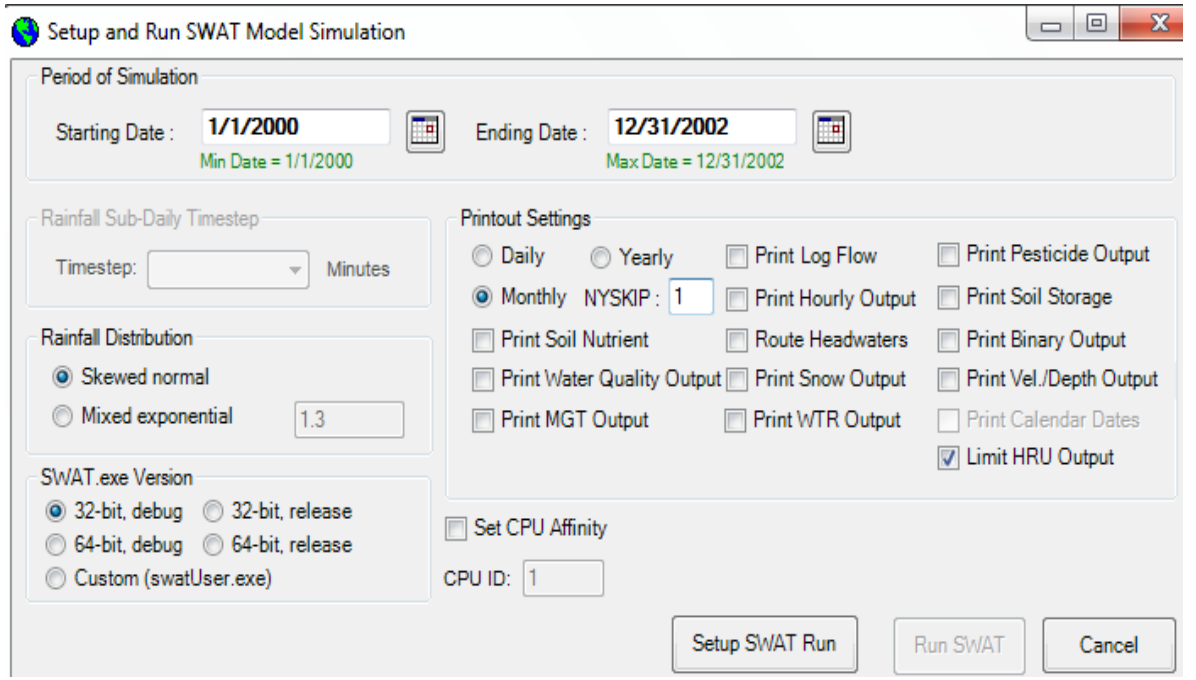
Chạy mô hình (QSWAT)

4



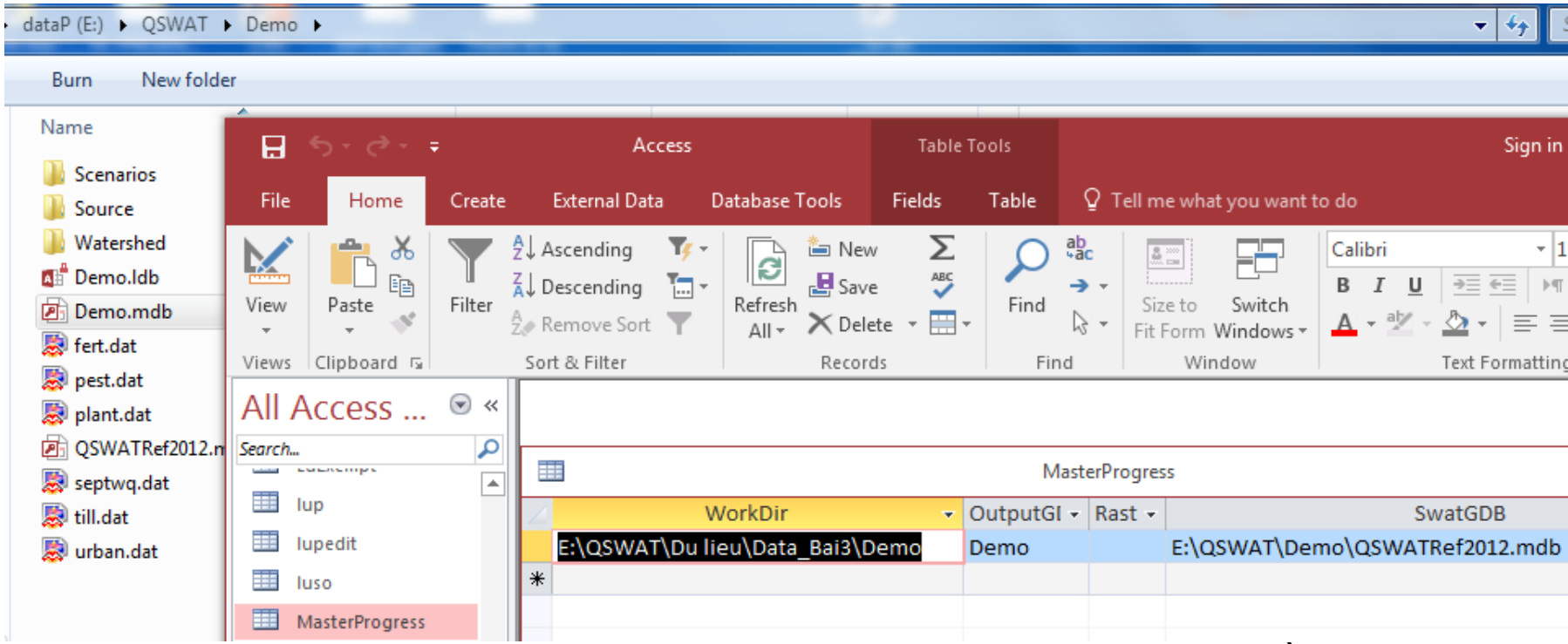


Nội dung thực hành

- Mở đồ án có sẵn (đã nhập dữ liệu thời tiết)
- Kết nối SWAT Editor với cơ sở dữ liệu của đồ án
- Chạy mô hình
- Cấu trúc dữ liệu đầu ra
- Đọc kết quả đầu ra
  - hru
  - sub
  - rch
- Kiểm tra kết quả đầu ra
  - Thủy văn
  - Xói mòn đất
  - Chu trình nitơ
  - Chu trình photpho
  - Sinh trưởng cây trồng
  - Tổn thất dinh dưỡng
  - Tóm tắt sử dụng đất/ lớp phủ đất
  - Quá trình trong dòng chảy
  - Điểm xả thải
  - Hồ chứa
- Lưu kịch bản chạy SWAT

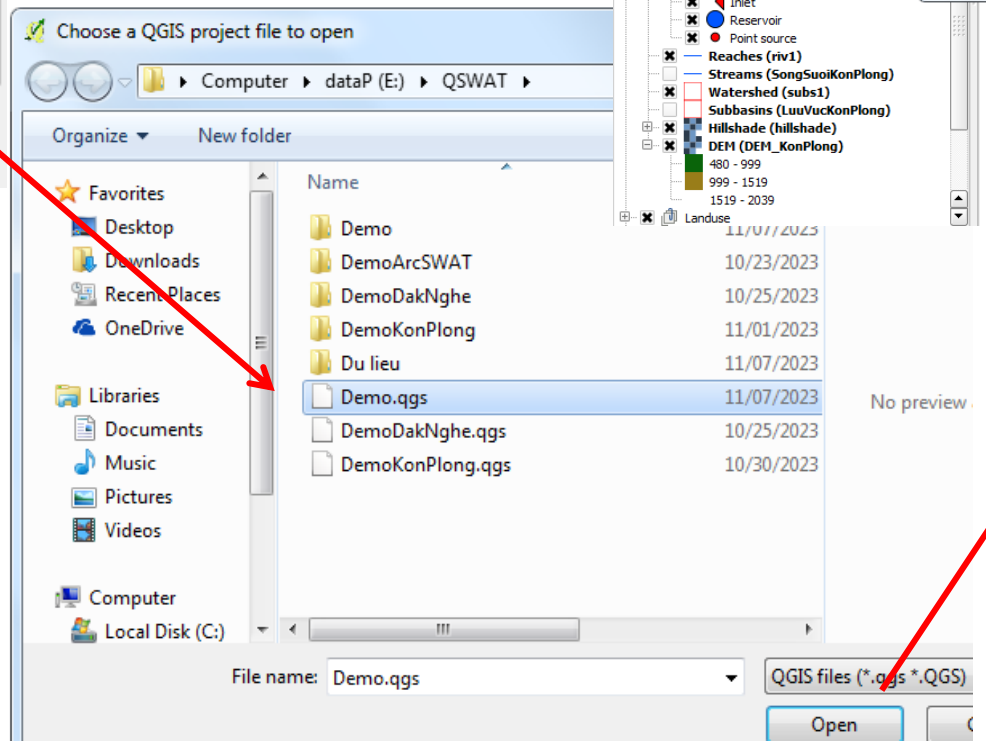
Mở đồ án có sẵn (đã nhập dữ liệu thời tiết)

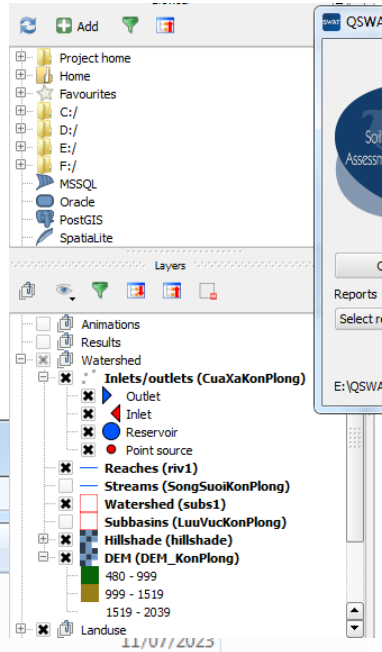
- Mở Demo.mdb của đồ án trong thư mục …\Demo.
- Mở bảng MasterProgress, cập nhật hai cột sau:
  - WorkDir: E:\QSWAT\Du lieu\Data_Bai4\Demo
  - SwatGDB: E:\QSWAT\Demo\QSWATRef2012.mdb
- Lưu lại chỉnh sửa.

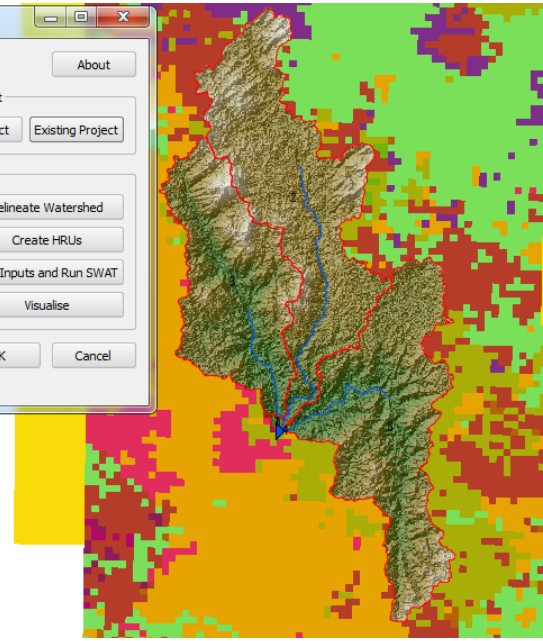


Mở đồ án có sẵn (đã nhập dữ liệu thời tiết)

- Mở QSWAT 1.9
- Click Existing Project để mở đồ án Demo

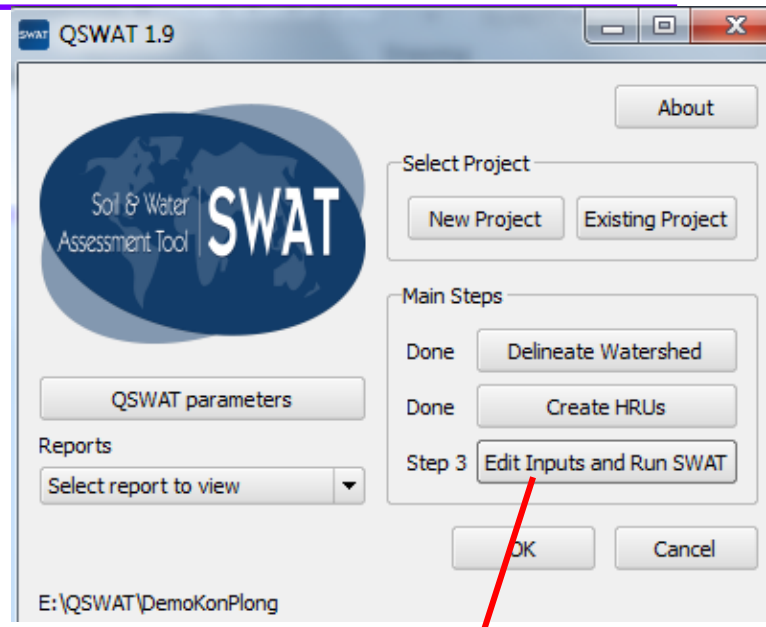


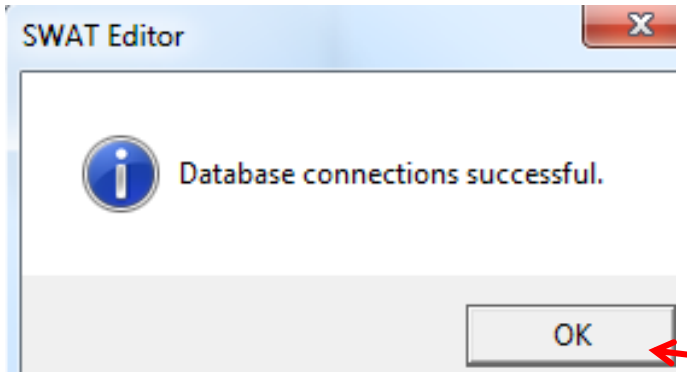


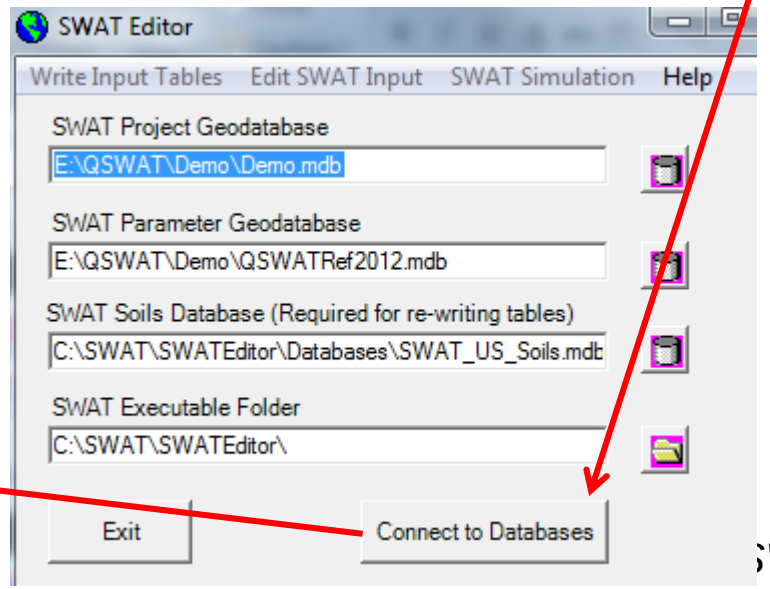


Kết nối SWAT Editor với cơ sở dữ liệu của đồ án

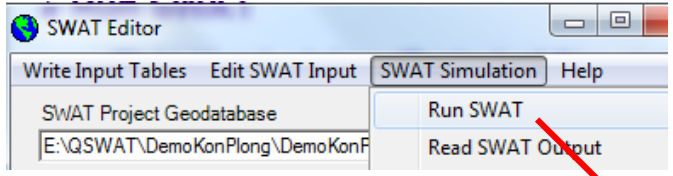
- Click Edit Inputs and Run SWAT
- Click Connect to Databases

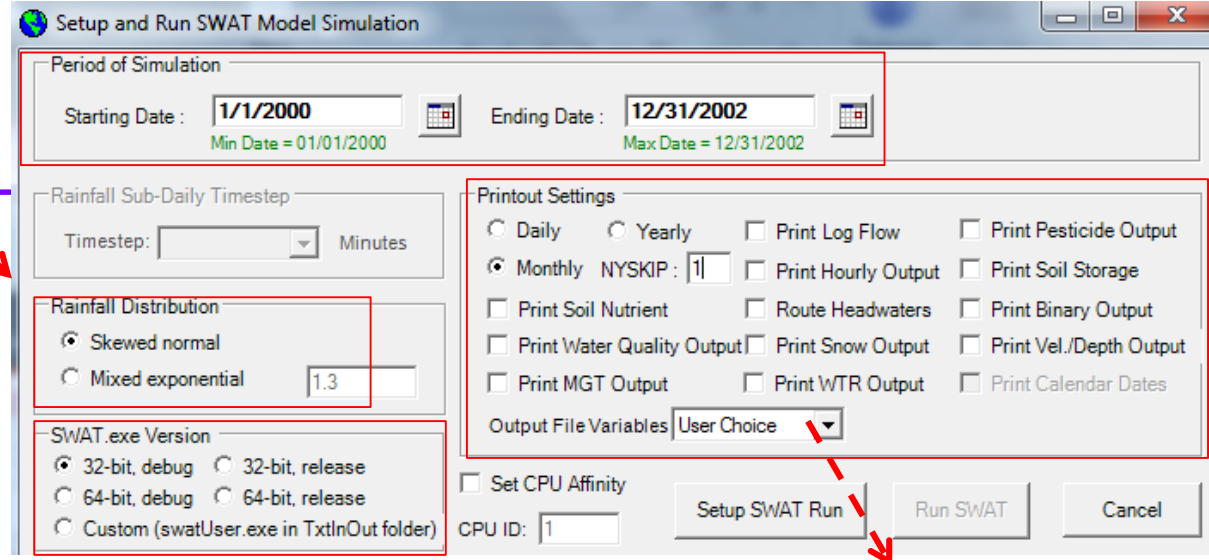


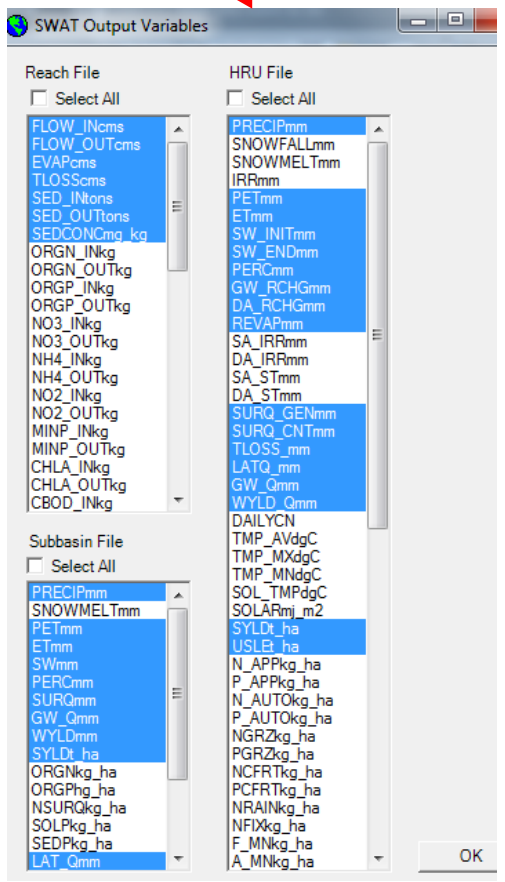




Chạy mô hình



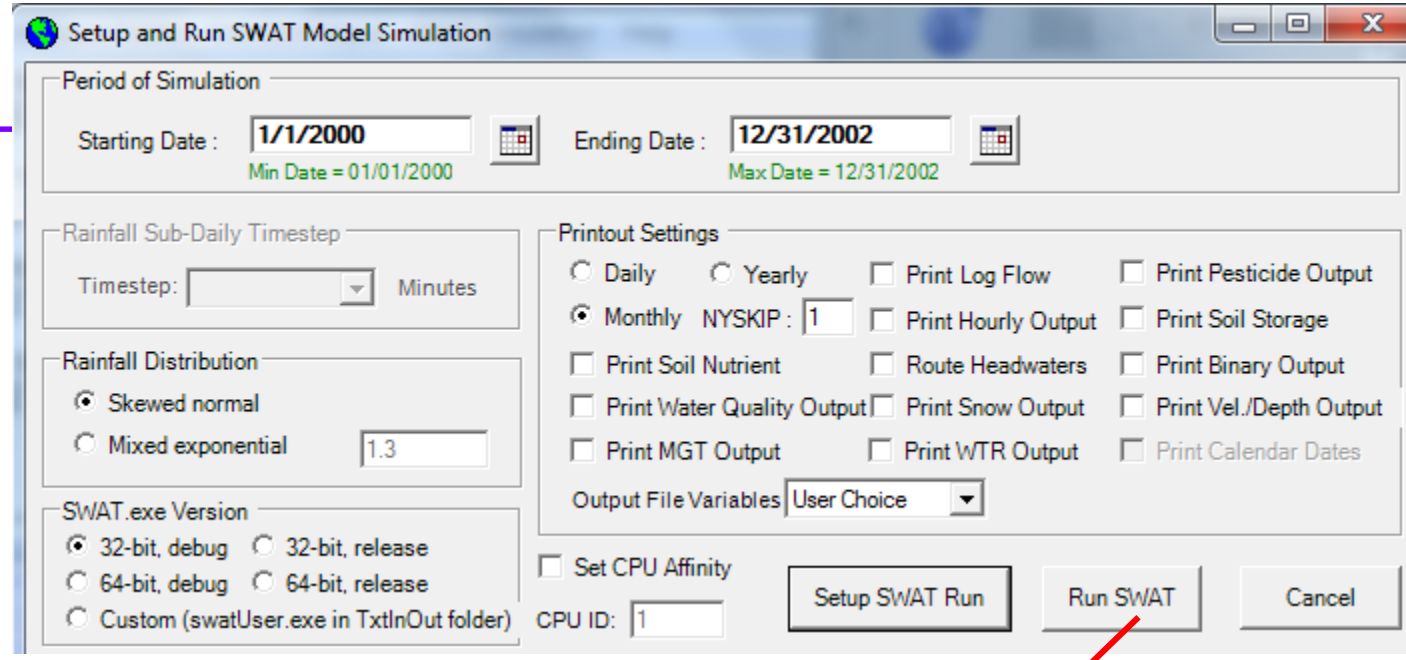


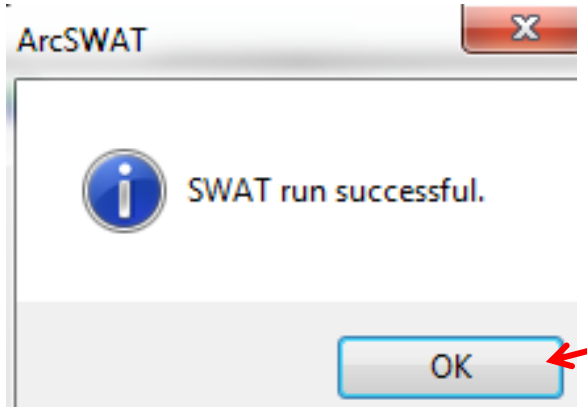


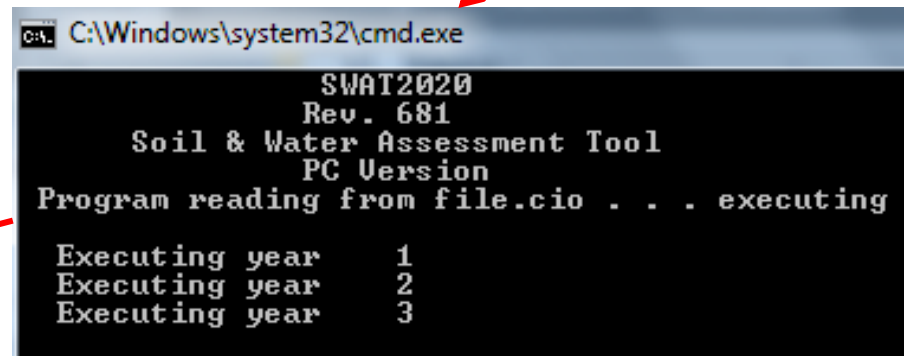
- **SWAT Simulation/ Run SWAT**
  - **Thời kì mô phỏng (Period of Simulation)**
    - **Starting/End Date: ngày bắt đầu/ kết thúc**
  - **Phân bố mưa (Rainfall Distribution)**
    - **Skewed normal: phân bố lệch**
    - **Mixed exponential: phân bố hàm mũ**
  - **Phiên bản SWAT (SWAT.exe Version)**
    - **debug/release/custom: in lỗi/ không in lỗi/ tùy biến**
  - **Thiết lập in ấn (Printout Settings)**
    - **Daily/Monthly/Yearly: tần suất ngày/ tháng/ năm**
    - **NYSKIP: số năm không in đầu ra**
    - **Output File Variables: Chọn biến đầu ra**
  - **Chia luồng áp lực CPU (Set CPU Affinity)**
  - **Click Setup SWAT Run**

Chạy mô hình

- Click **Run SWAT.**
- Đợi khi hoàn thành quá trình chạy mô hình, click **OK.**



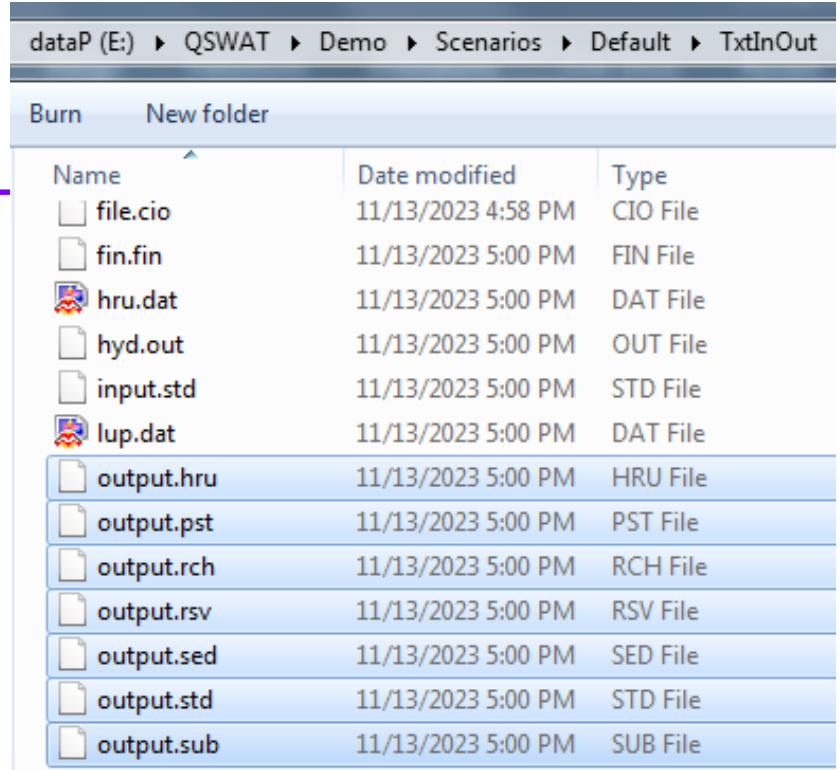




Cấu trúc dữ liệu đầu ra

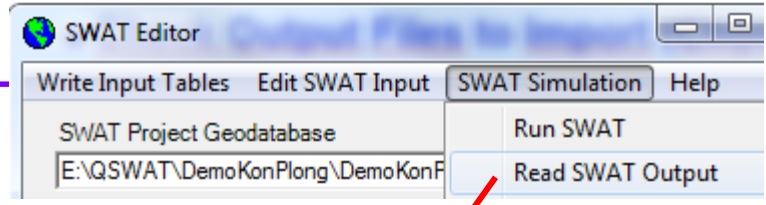
- Lưu vực → Open output.std
- Dòng chảy → output.rch
- Tiểu lưu vực → output.sub
- HRU → output.hru
- Chuyên đề:
  - Xói mòn/bồi lắng
  - Hồ chứa
  - Thuốc bảo vệ thực vật
  - Sử dụng nước
  - Ao, đất ngập nước
  - Mực nước
  - Tuyết
  - Xác bã thực vật
  - Ổ gà, hố trũng
  - Vận tốc dòng chảy
  - Chất lượng nước
  - Canh tác đất đai

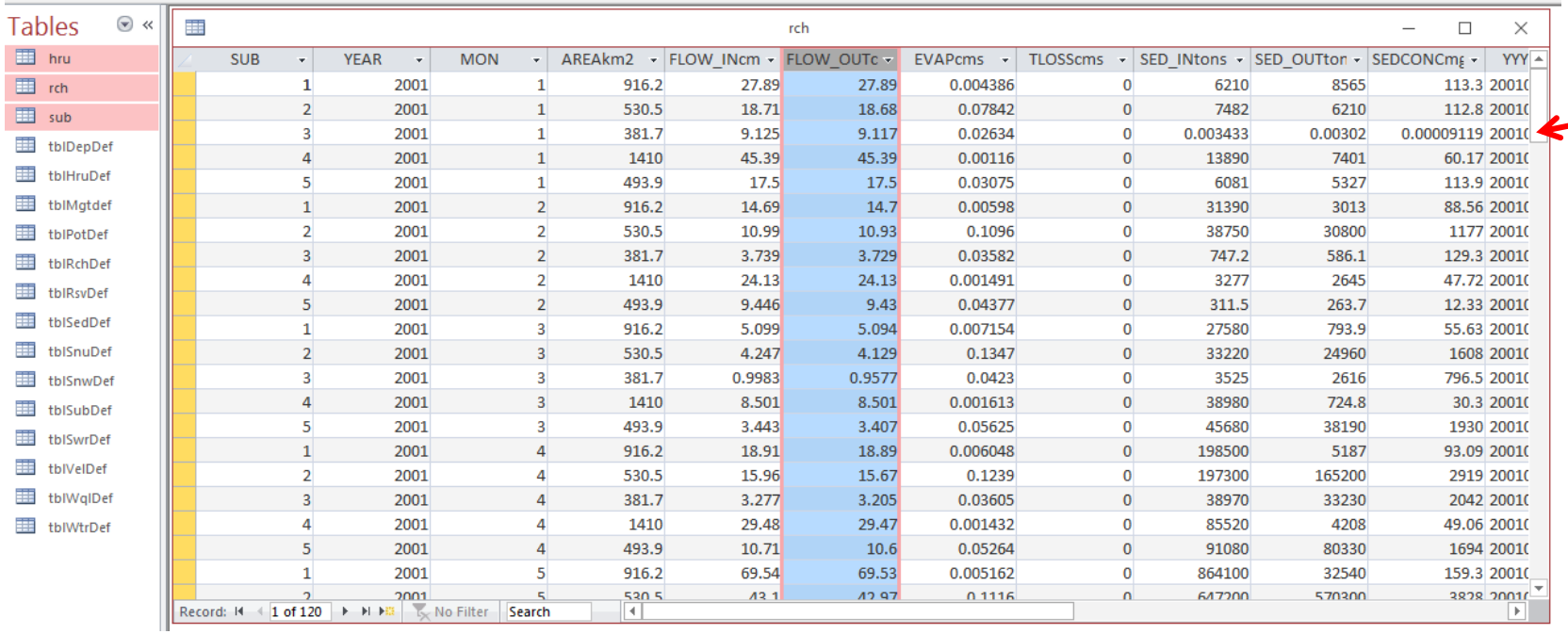
output.sed, output.rsv, output.pst, output.wtr, output.swr, output.dep, output.snw, output.snu, output.pot, output.vel, output.wql, output.mgt

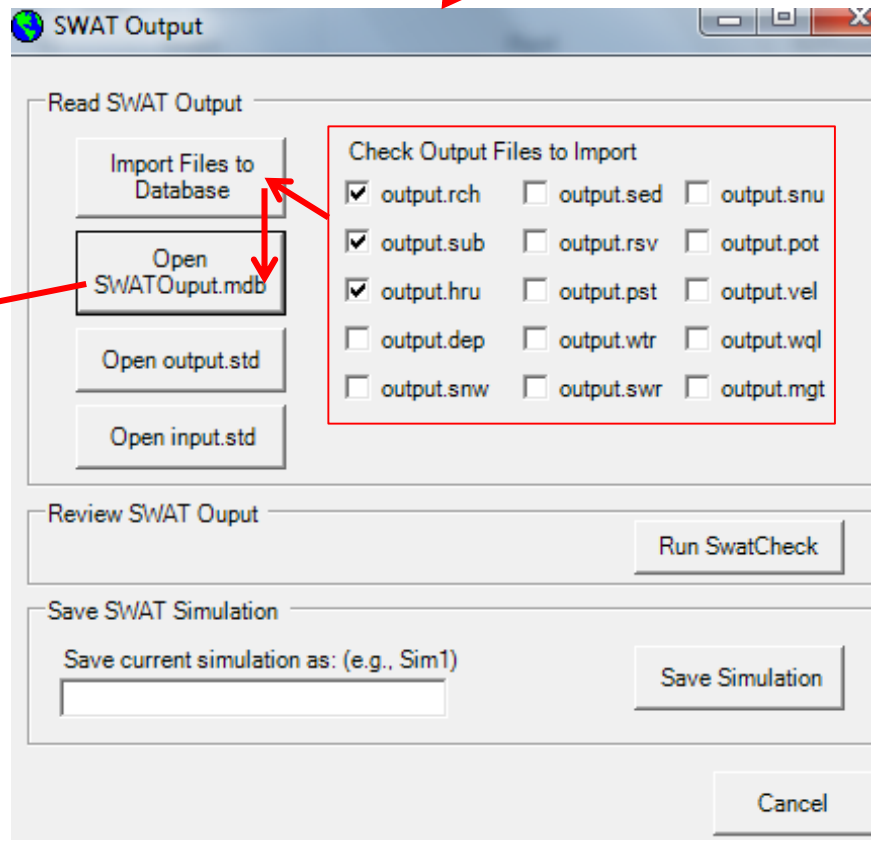


Đọc kết quả đầu ra

- **SWAT Simulation/ Read SWAT Output**
  - **Check Output Files to Import (Chọn tập tin đầu ra cần nhập)**
  - **Import Files to Database (Nhập tập tin đầu ra vào cơ sở dữ liệu)**
  - **Open SWATOutput.mdb (…\DemoKonPlong\Scenarios\Default\TablesOut) (Mở SWATOutput.mdb)**







Đọc kết quả đầu ra

- **SWATOutput.mdb**
  - **hru**

tblHruDef

Variable name	Definition
HRU	Hydrologic response unit number
SUB	Topographically-defined subbasin to which the HRU belongs.
MON	Daily time step: the julian date, Monthly time step: the month (1-12), Annual time step: 4-digit year, Average annual summary lines: number of years averaged together
AREA	Drainage area of the HRU (km2).
PRECIP	Total amount of precipitation falling on the HRU during time step (mm H2O).
PET	Potential evapotranspiration (mm H2O). Potential evapotranspiration from the HRU during the time step.
ET	Actual evapotranspiration (soil evaporation and plant transpiration) from the HRU during the time step (mm H2O).
SW_INIT	Soil water content (mm H2O). For daily output, this column provides the amount of water in soil profile at beginning of day. For monthly and annual output, this is the average soil water content for the time period. The amount of water in the soil profile at the beginning of the day is used to calculate daily curve number values.
SW_END	Soil water content (mm H2O). Amount of water in the soil profile at the end of the time period (day, month or year).
PERC	Water that percolates past the root zone during the time step (mm H2O). There is usually a lag between the time the water leaves the bottom of the root zone and reaches the shallow aquifer. Over a long period of time, this variable should equal groundwater recharge (PERC = GW_RCHG as time → ∞).
GW_RCHG	Recharge entering aquifers during time step (total amount of water entering shallow and deep aquifers during time step) (mm H2O).
DA_RCHG	Deep aquifer recharge (mm H2O). The amount of water from the root zone that recharges the deep aquifer during the time step. (shallow aquifer recharge = GW_RCHG - DA_RCHG)
REVAP	Water in the shallow aquifer returning to the root zone in response to a moisture deficit during the time step (mm H2O). The variable also includes water uptake directly from the shallow aquifer by deep tree and shrub roots.
SURQ_GEN	Surface runoff generated in HRU during time step (mm H2O).
SURQ_CNT	Surface runoff contribution to streamflow in the main channel during time step (mm H2O).
TLOSS	Transmission losses (mm H2O). Water lost from tributary channels in the HRU via transmission through the bed. This water becomes recharge for the shallow aquifer during the time step. Net surface runoff contribution to the main channel streamflow is calculated by subtracting TLOSS from SURQ.
LATQ	Lateral flow contribution to streamflow (mm H2O). Water flowing laterally within the soil profile that enters the main channel during time step.
GW_Q	Groundwater contribution to streamflow (mm H2O). Water from the shallow aquifer that enters the main channel during the time step. Groundwater flow is also referred to as baseflow.
WYLD	Water yield (mm H2O). Total amount of water leaving the HRU and entering main channel during the time step. (WYLD = SURQ + LATQ + GWQ – TLOSS – pond abstractions)
SYLD	Sediment yield (metric tons/ha). Sediment from the HRU that is transported into the main channel during the time step.
USLE	Soil loss during the time step calculated with the USLE equation (metric tons/ha). This value is reported for comparison purposes only.

Đọc kết quả đầu ra

- **SWATOutput.mdb**
  - **sub**

tblSubDef

Variable name	Definition
SUB	Subbasin number.
MON	Daily time step: the julian date, Monthly time step: the month (1-12), Annual time step: 4-digit year, Average annual summary lines: number of years averaged together
AREA	Area of the subbasin (km2).
PRECIP	Total amount of precipitation falling on the subbasin during time step (mm H2O).
PET	Potential evapotranspiration from the subbasin during the time step (mm H2O).
ET	Actual evapotranspiration from the subbasin during the time step (mm).
SW	Soil water content (mm). Amount of water in the soil profile at the end of the time period.
PERC	Water that percolates past the root zone during the time step (mm). There is potentially a lag between the time the water leaves the bottom of the root zone and reaches the shallow aquifer. Over a long period of time, this variable should equal groundwater percolation.
SURQ	Surface runoff contribution to streamflow during time step (mm H2O).
GW_Q	Groundwater contribution to streamflow (mm). Water from the shallow aquifer that returns to the reach during the time step.
WYLD	Water yield (mm H2O). The net amount of water that leaves the subbasin and contributes to streamflow in the reach during the time step. (WYLD = SURQ + LATQ + GWQ – TLOSS – pond abstractions)
SYLD	Sediment yield (metric tons/ha). Sediment from the subbasin that is transported into the reach during the time step.
LATQ	Lateral flow contribution to streamflow during timestep (mm H2O)

Đọc kết quả đầu ra

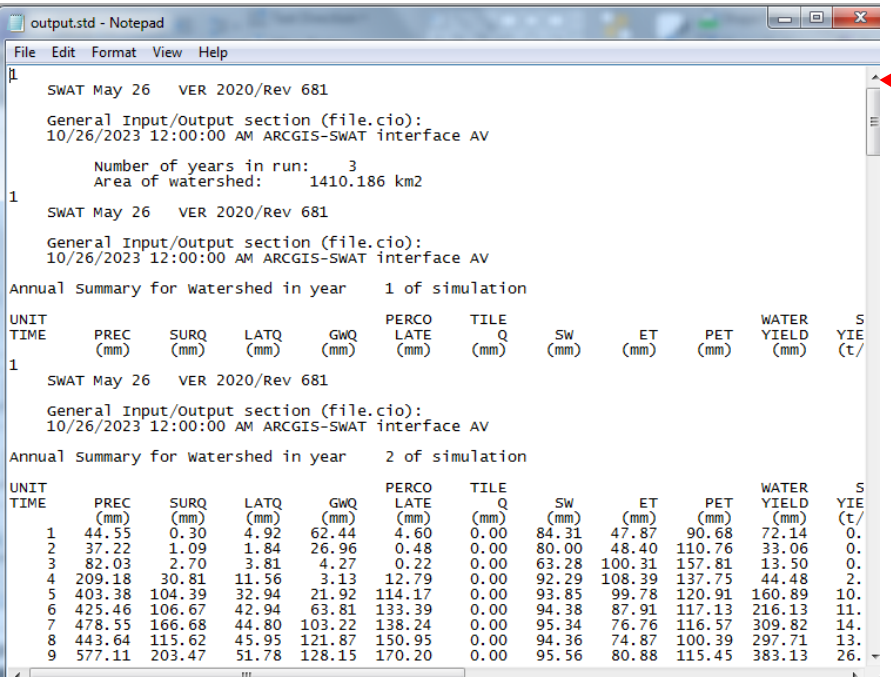
- **SWATOutput.mdb**
  - **rch**

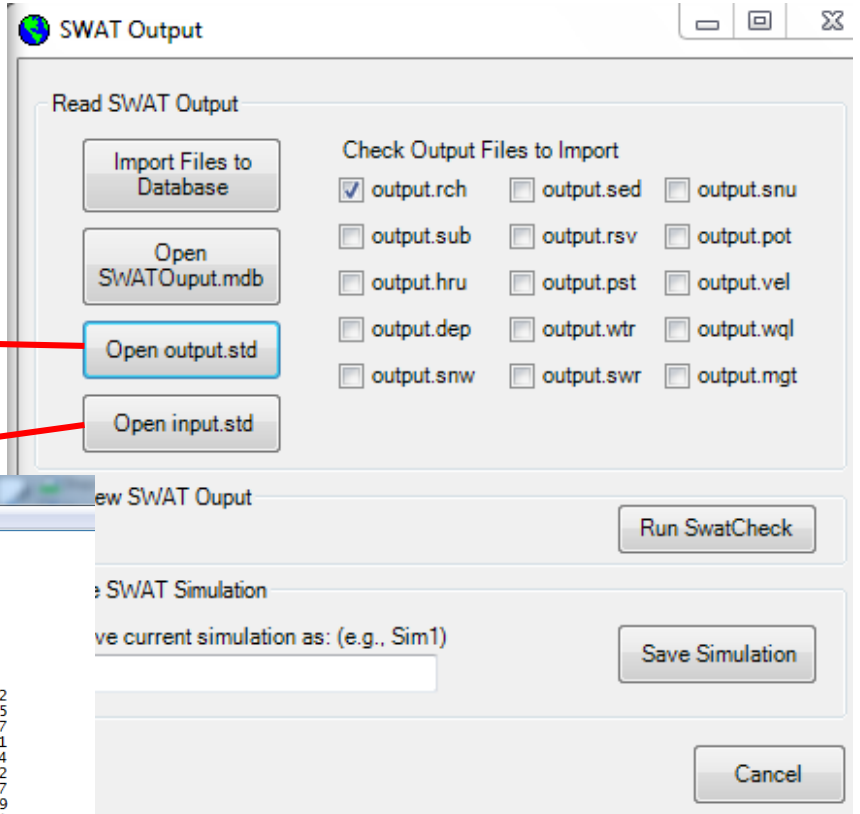
tblRchDef

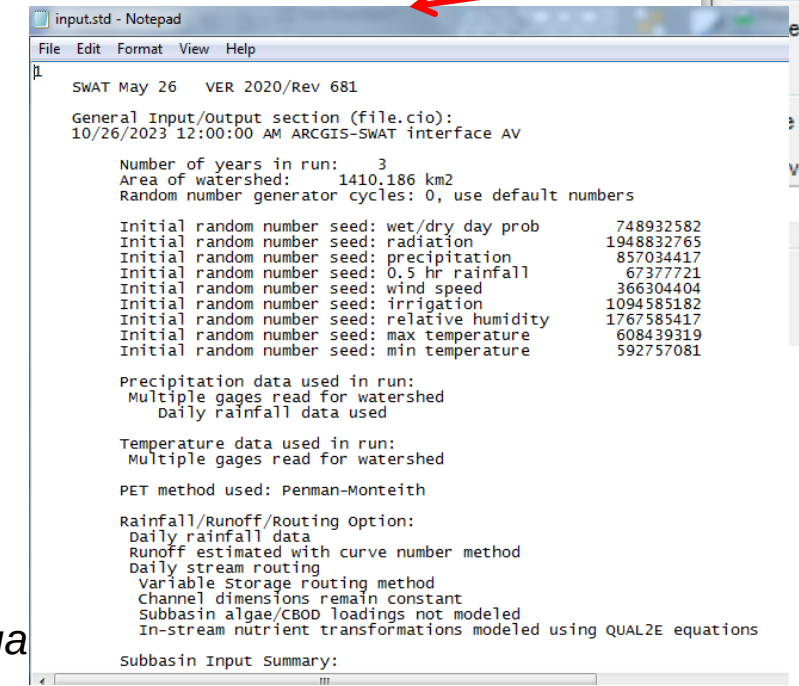
Variable name	Definition
RCH	Reach number.
MON	Daily time step: the julian date, Monthly time step: the month (1-12), Annual time step: 4-digit year, Average annual summary lines: number of years averaged together
AREA	Area drained by reach (km2).
FLOW_IN	Average daily streamflow into reach during time step (m3/s).
FLOW_OUT	Average daily streamflow out of reach during time step (m3/s).
EVAP	Average daily rate of water loss from reach by evaporation during time step (m3/s).
TLOSS	Average daily rate of water loss from reach by transmission through the streambed during time step (m3/s).
SED_IN	Sediment transported with water into reach during time step (metric tons).
SED_OUT	Sediment transported with water out of reach during time step (metric tons).
SEDCONC	Concentration of sediment in reach during time step (mg/L).

Đọc kết quả đầu ra

- Tập tin thống kê
  - Open output.std (Mở tập tin thống kê đầu ra)
  - Open input.std (Mở tập tin thống kê đầu vào)







output.std

Trung bình tháng, năm của từng năm

General Input/Output section (file.cio):
11/13/2023 12:00:00 AM ARCGIS-SWAT interface AV

Annual Summary for Watershed in year 2 of simulation

UNIT TIME	PREC (mm)	SURQ (mm)	LATQ (mm)	GWQ (mm)	PERCO LATE (mm)	TILE Q (mm)	SW (mm)	ET (mm)	PET (mm)	WATER YIELD (mm)	SED YIELD (t/ha)	NO3 SURQ (kg nutrient/ha)	NO3 LATQ (kg nutrient/ha)	NO3 PERC (kg nutrient/ha)	NO3 CROP (kg nutrient/ha)	N ORGANIC (kg nutrient/ha)	P SOLUBLE (kg nutrient/ha)	P ORGANIC (kg nutrient/ha)	TILENO3 (kg/ha)
1	44.55	0.62	5.45	76.43	7.80	0.00	59.52	37.79	82.43	90.64	0.17	0.00	0.02	0.17	0.00	0.19	0.00	0.02	0.00
2	37.22	2.30	1.83	33.36	0.41	0.00	56.55	35.93	100.92	40.86	0.21	0.00	0.00	0.01	3.83	0.20	0.00	0.03	0.00
3	82.03	5.50	2.88	5.64	0.00	0.00	38.57	91.05	148.21	17.20	0.31	0.77	0.14	0.00	54.36	0.44	0.00	0.05	0.00
4	209.18	48.10	8.59	4.33	16.35	0.00	68.84	103.02	127.47	51.19	1.30	0.04	0.02	0.01	8.44	1.53	0.00	0.19	0.00
5	403.38	139.44	25.76	26.75	136.25	0.00	70.04	93.14	109.76	182.96	4.78	0.00	0.01	0.31	1.40	4.34	0.01	0.54	0.00
6	425.46	149.27	35.87	76.58	163.00	0.00	70.86	74.79	106.14	267.95	7.78	0.00	0.02	0.63	0.46	4.76	0.01	0.59	0.00
7	478.55	209.19	38.92	124.92	167.64	0.00	71.89	62.56	104.91	360.99	5.81	0.04	0.05	1.41	0.00	4.99	0.01	0.70	0.00
8	443.64	157.53	40.03	147.80	183.45	0.00	70.45	63.26	89.89	370.42	10.05	0.12	0.12	2.84	0.00	6.76	0.03	1.15	0.00
9	577.11	260.18	41.80	155.11	201.70	0.00	72.19	67.68	103.80	440.13	11.70	0.05	0.11	2.62	0.00	9.61	0.03	1.30	0.00
10	250.39	57.75	32.14	163.87	108.49	0.00	70.31	60.54	93.39	292.69	4.46	0.02	0.07	1.38	0.00	3.90	0.01	0.51	0.00
11	297.50	117.39	25.47	134.77	109.60	0.00	73.22	42.86	63.75	259.36	6.83	0.01	0.07	1.71	0.00	4.92	0.01	0.62	0.00
12	75.75	21.20	14.35	112.98	28.82	0.00	66.33	26.05	52.91	185.20	4.03	0.01	0.04	0.45	0.00	1.75	0.00	0.23	0.00
2001	3324.76	1168.47	273.08	1062.56	1123.51	0.00	66.33	758.66	1183.59	2559.59	57.44	1.06	0.68	11.53	68.48	43.40	0.11	5.93	0.00

Trung bình tháng nhiều năm

AVE MONTHLY BASIN VALUES

MON	RAIN (MM)	SNOW FALL (MM)	SURF Q (MM)	LAT Q (MM)	WATER YIELD (MM)	ET (MM)	SED YIELD (T/HA)	PET (MM)
1	26.37	0.00	0.31	3.92	83.91	29.00	0.11	78.58
2	20.86	0.00	1.15	1.09	33.56	27.14	0.11	107.50
3	74.96	0.00	6.47	2.04	13.63	72.89	0.20	149.84
4	133.29	0.00	30.44	6.63	37.64	90.51	0.82	144.46
5	274.34	0.00	76.07	15.94	100.87	82.88	2.51	149.39
6	248.14	0.00	75.29	20.95	139.86	73.96	3.91	136.89
7	368.13	0.00	141.64	27.70	227.27	60.20	3.93	117.98
8	423.12	0.00	171.85	33.68	312.85	65.24	8.75	101.52
9	514.66	0.00	228.79	37.43	374.09	63.61	11.84	96.94
10	155.70	0.00	37.64	22.21	224.69	49.72	2.95	114.87
11	199.05	0.00	65.40	16.50	174.10	43.04	3.97	74.38
12	48.93	0.00	10.85	9.09	116.12	27.56	2.05	62.30

Trung bình nhiều năm

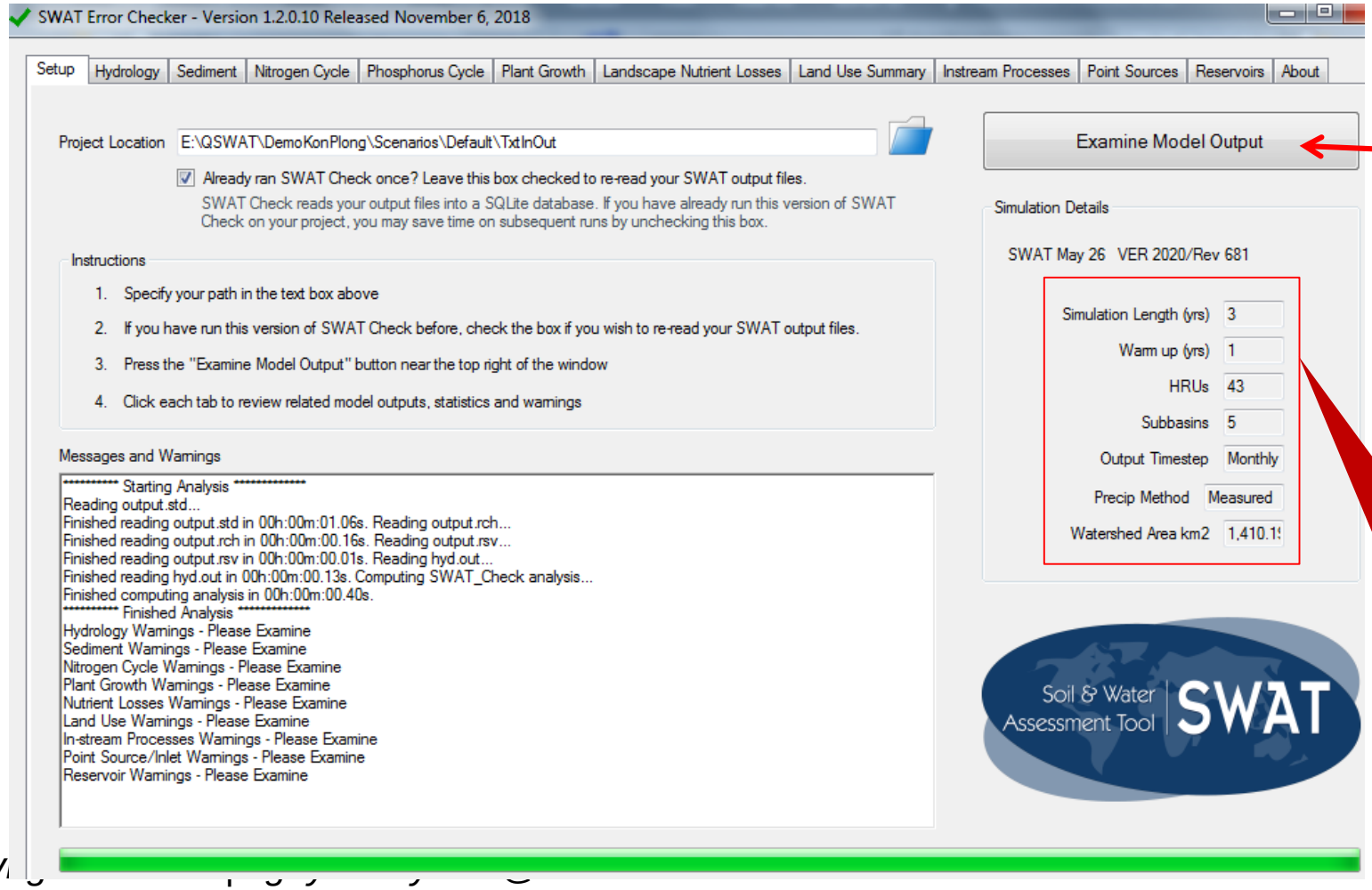
General Input/Output section (file.cio):
11/13/2023 12:00:00 AM ARCGIS-SWAT interface AV

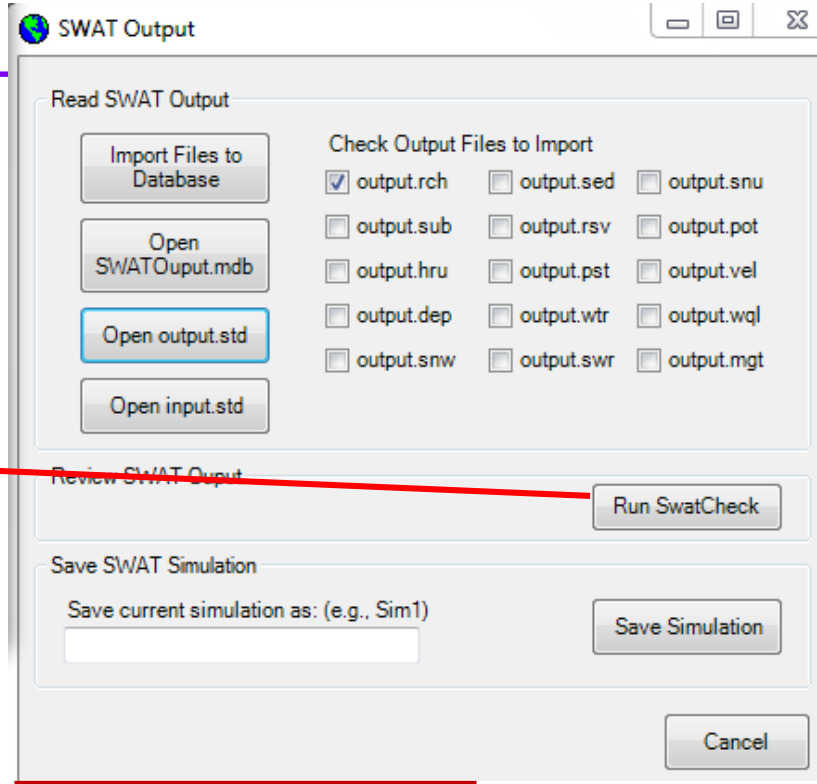
AVE ANNUAL BASIN VALUES

PRECIP = 2487.5 MM
SNOW FALL = 0.00 MM
SNOW MELT = 0.00 MM
SUBLIMATION = 0.00 MM
SURFACE RUNOFF Q = 845.90 MM
LATERAL SOIL Q = 197.17 MM
TILE Q = 0.00 MM
GROUNDWATER (SHAL AQ) Q = 749.43 MM
GROUNDWATER (DEEP AQ) Q = 44.60 MM
REVAP (SHAL AQ => SOIL/PLANTS) = 26.69 MM
DEEP AQ RECHARGE = 39.72 MM
TOTAL AQ RECHARGE = 794.38 MM
TOTAL WATER YLD = 1838.59 MM
PERCOLATION OUT OF SOIL = 764.48 MM
ET = 685.8 MM
PET = 1334.6MM
TRANSMISSION LOSSES = 0.00 MM
SEPTIC INFLOW = 0.00 MM
TOTAL SEDIMENT LOADING = 41.16 T/HA
TILE FROM IMPOUNDED WATER = 0.000 (MM)
EVAPORATION FROM IMPOUNDED WATER = 0.000 (MM)
SEEPAGE INTO SOIL FROM IMPOUNDED WATER = 0.000 (MM)
OVERFLOW FROM IMPOUNDED WATER = 0.000 (MM)

Kiểm tra kết quả đầu ra

- **Run SwatCheck (Chạy SWAT Check)**
- **Examine Model Output (Kiểm tra đầu ra của mô hình)**

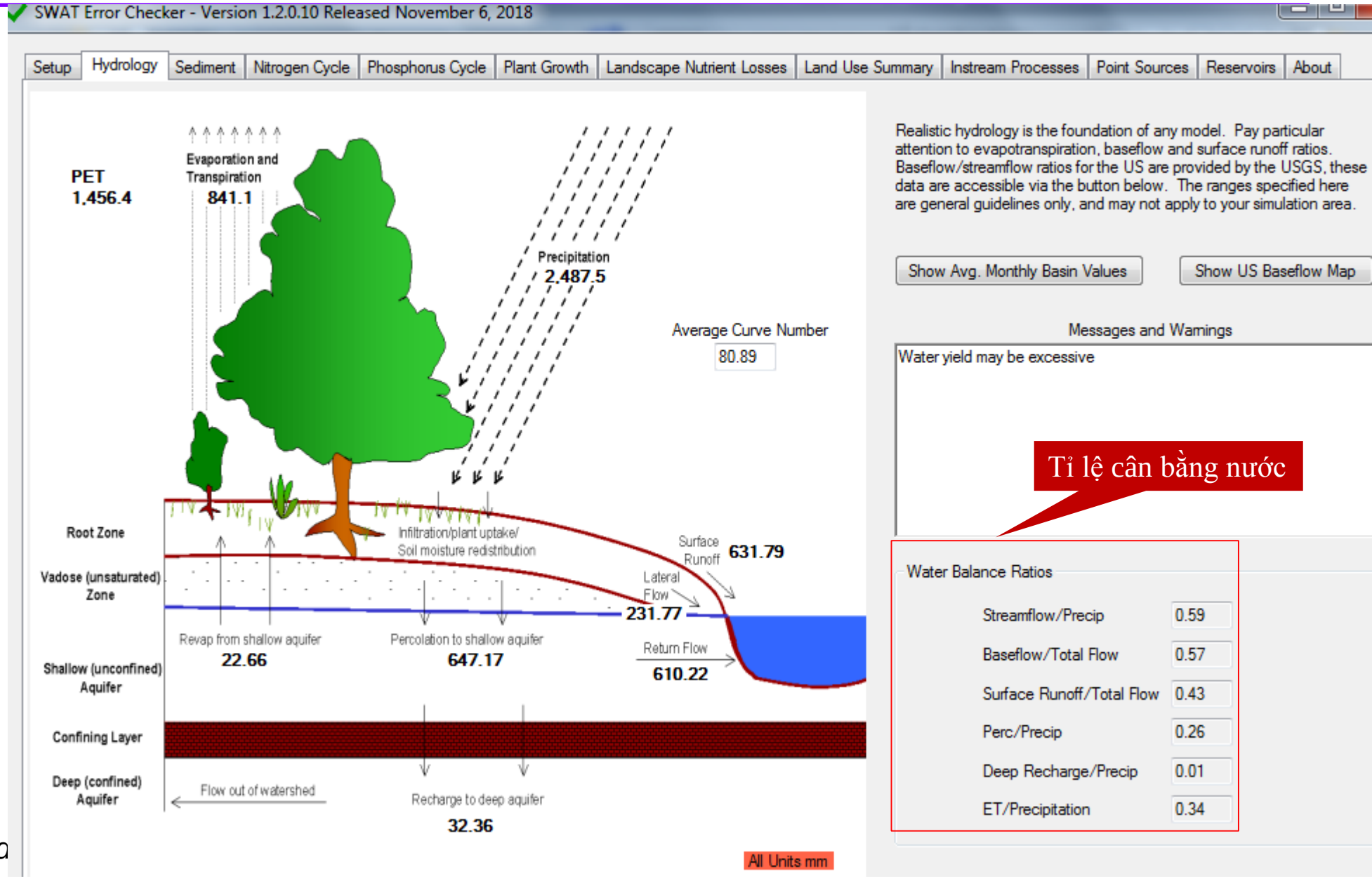




Số năm mô phỏng
Số năm không in đầu ra
Số HRU
Số tiểu lưu vực
Tần suất đầu ra
Số liệu mưa
Diện tích lưu vực

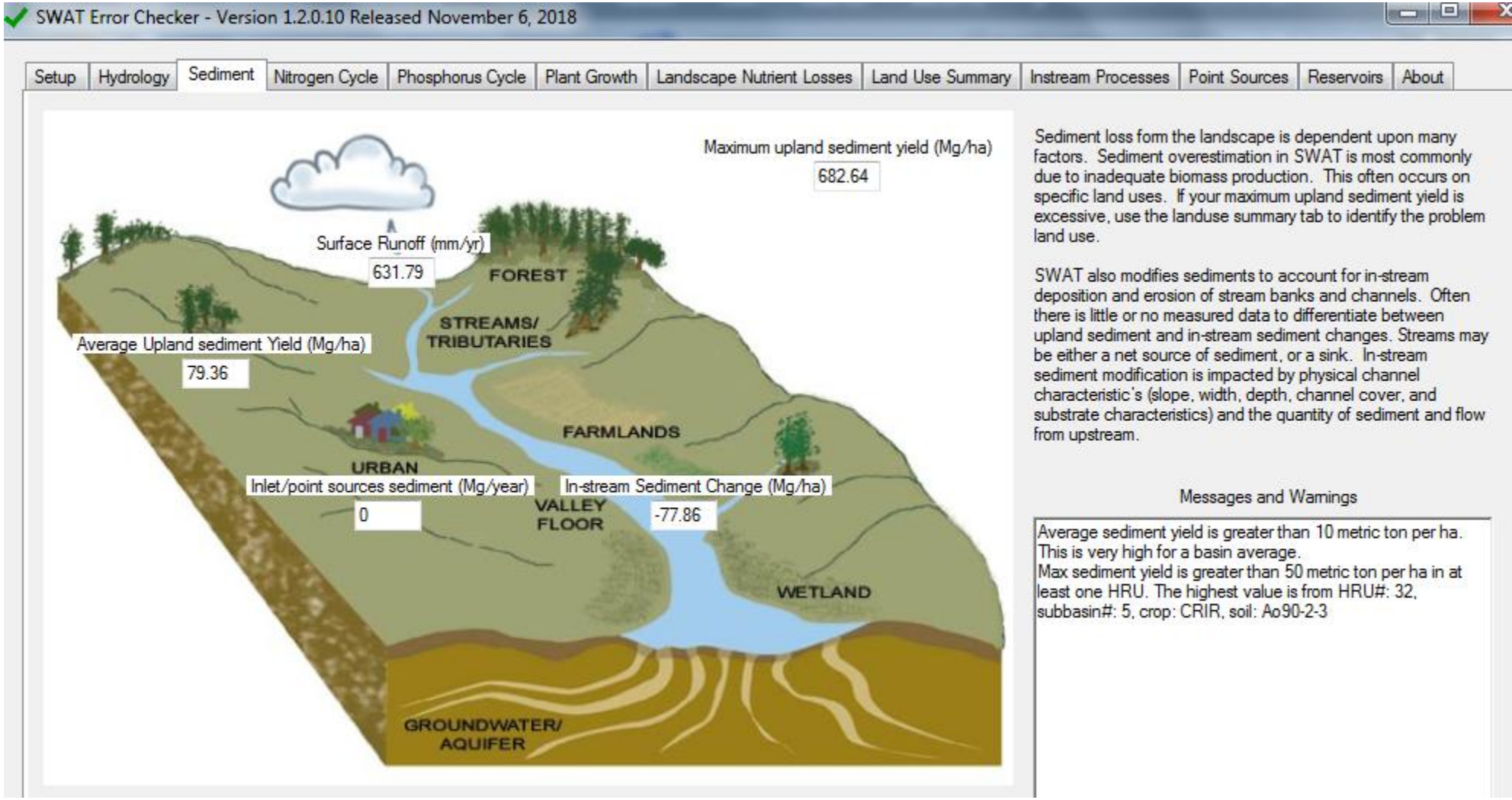
Kiểm tra kết quả đầu ra

- **Thủy văn**



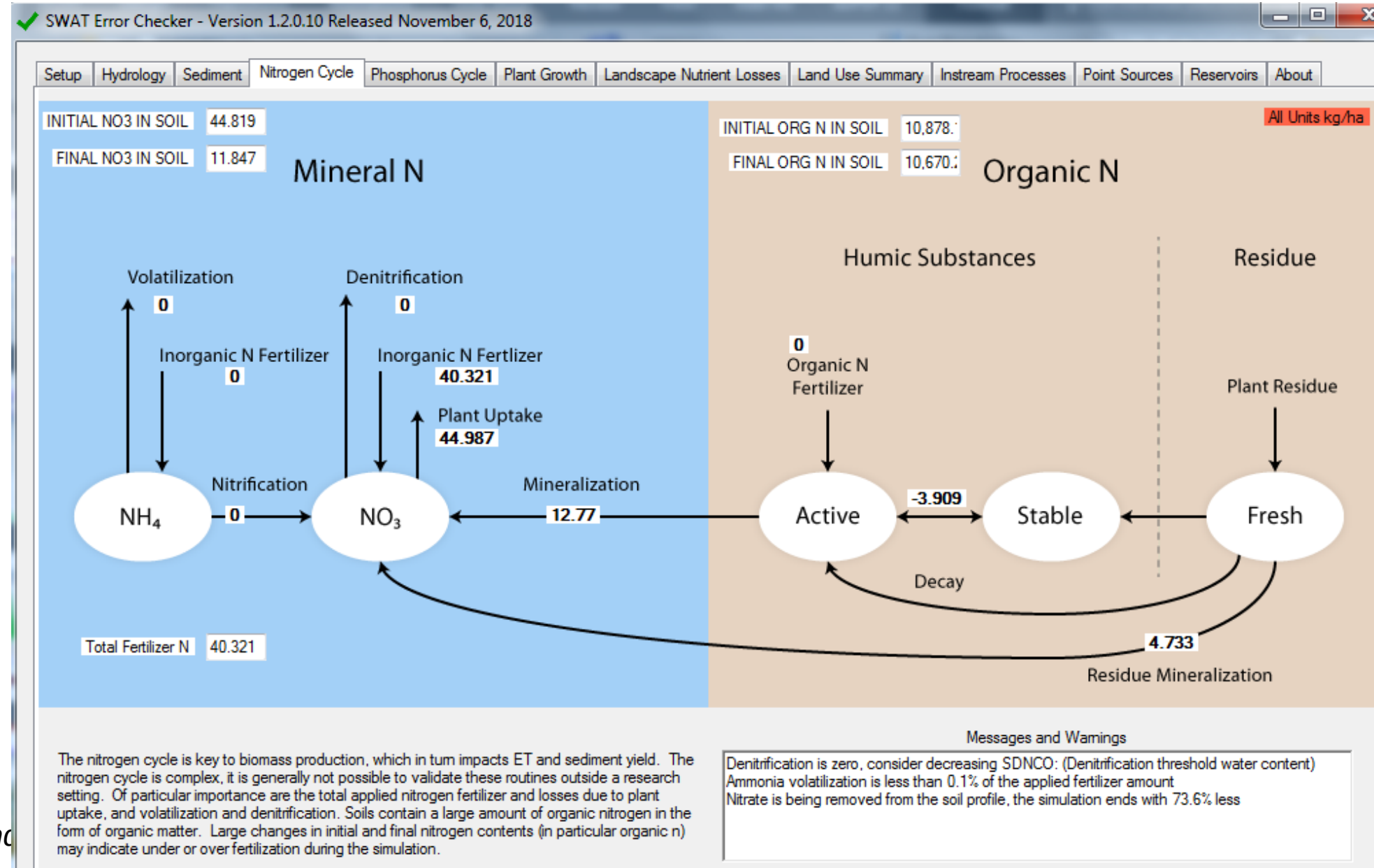
Kiểm tra kết quả đầu ra

- **Xói mòn đất**



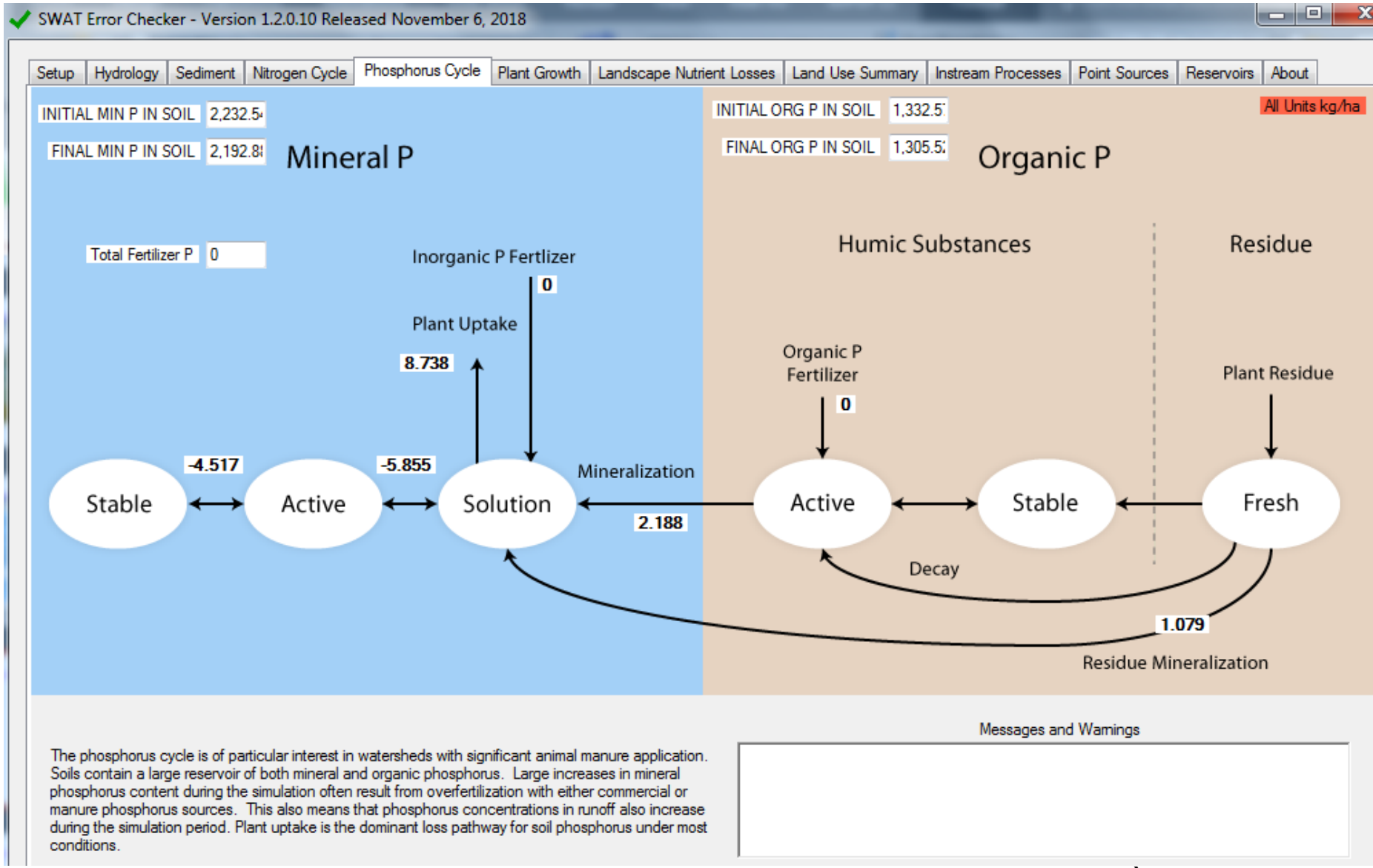
Kiểm tra kết quả đầu ra

- **Chu trình nitơ**



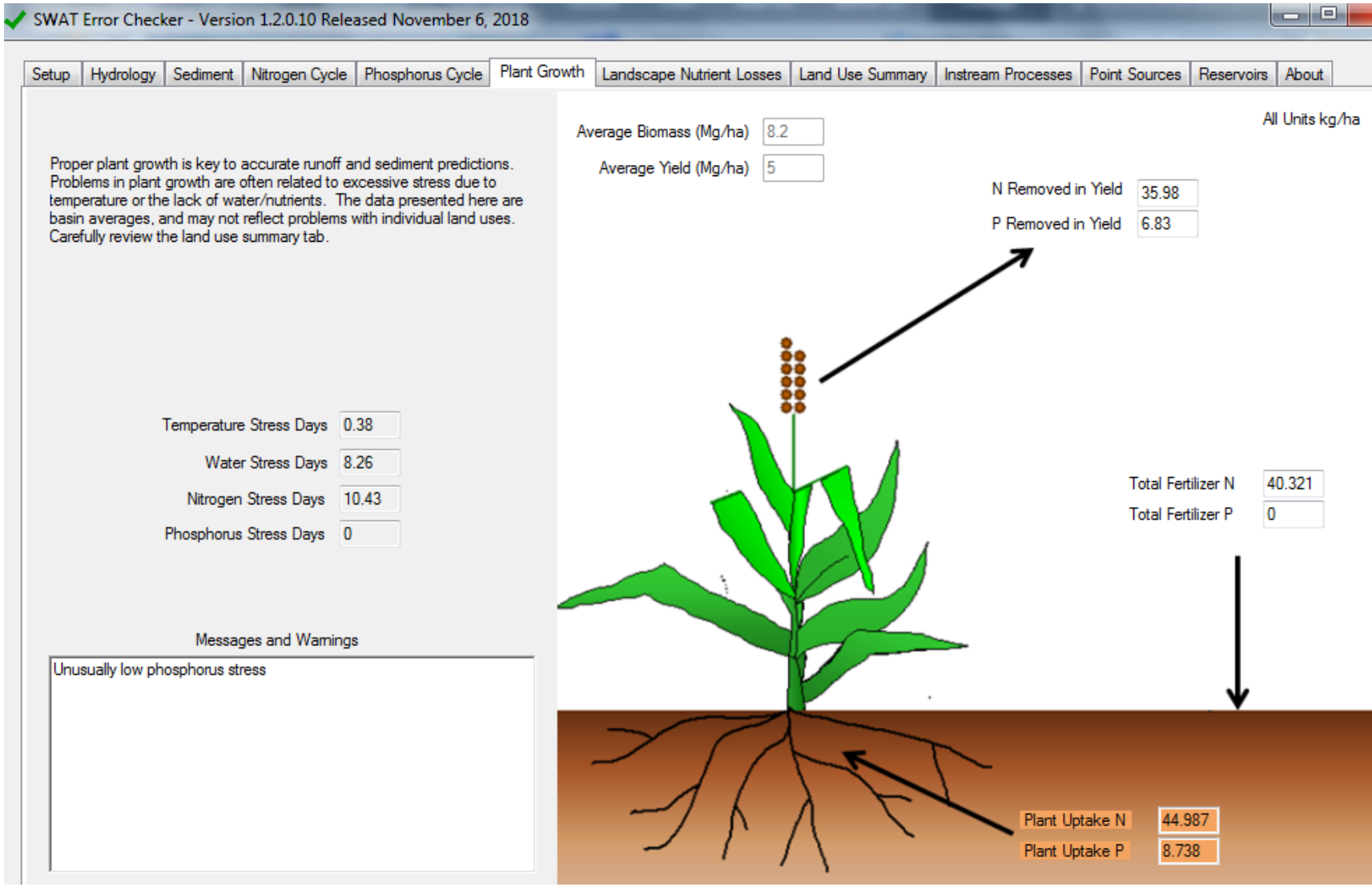
Kiểm tra kết quả đầu ra

- **Chu trình photpho**



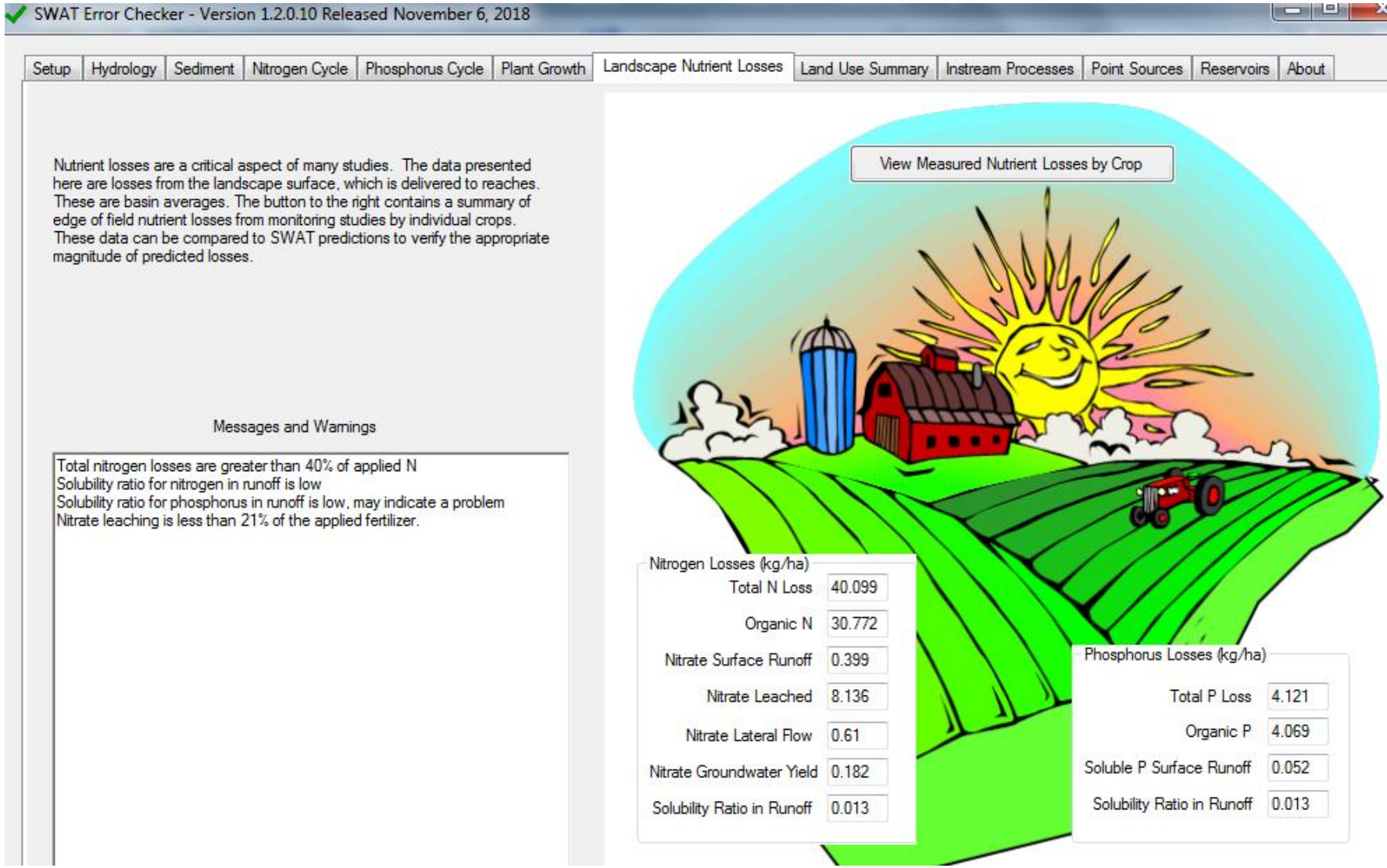
Kiểm tra kết quả đầu ra

- **Sinh trưởng cây trồng**



Kiểm tra kết quả đầu ra

- **Tổn thất dinh dưỡng**



Kiểm tra kết quả đầu ra

- **Tóm tắt sử dụng đất/ lớp phủ đất**

SWAT Error Checker - Version 1.2.0.10 Released November 6, 2018

Setup | Hydrology | Sediment | Nitrogen Cycle | Phosphorus Cycle | Plant Growth | Landscape Nutrient Losses | Land Use Summary | Instream Processes | Point Sources | Reservoirs | About

Summary By Reported Landuse

LULC	AREA km2	CN	AWC mm	USLE_LS	IRR mm	PREC mm	SURQ mm	GWQ mm	ET mm	SED th	NO3 kgh	ORGN
CRIR	325.48	84.32	93.52	5.15	0.00	2,550.76	1,003.15	831.91	711.87	263.72	3.34	
FODB	75.57	80.62	105.70	5.90	0.00	2,415.99	777.48	878.25	740.21	22.98	0.34	
FOEB	315.11	75.20	93.14	6.59	0.00	2,408.56	591.37	1,096.61	704.40	60.58	0.42	
FOMI	476.48	77.29	95.70	6.61	0.00	2,479.59	669.64	1,057.10	748.81	10.85	0.38	
SAVA	0.88	76.50	160.00	2.86	0.00	2,381.84	606.47	975.46	777.13	196.05	0.18	
WATR	216.75	92.00	93.56	5.15	0.00	2,550.70	0.00	0.00	1,472.40	0.00	0.00	

View HRU Level Warnings

Model errors are often isolated to a particular land use type. If the land use is relatively minor, these issues may go unnoticed at the basin outlet during calibration. Often, these minor land uses are the focus of scenario development, and errors become apparent after the investment of much calibration effort.

The table above contains a few important predictions summarized by land use. These should be reviewed carefully. The button to the right provides HRU level warnings, these data are provided only to help isolate problem HRUs within a particular land use. We do not recommend that these data be used during routine checking of model output.

Messages and Warnings

Crop CRIR: sediment yield may be too high
Crop CRIR: ET less than 31% of irrigation water + precip
Crop CRIR: surface runoff may be excessive
Crop FODB: sediment yield may be too high
Crop FODB: ET less than 31% of irrigation water + precip
Crop FODB: surface runoff may be excessive
Crop FOEB: sediment yield may be too high
Crop FOEB: ET less than 31% of irrigation water + precip
Crop FOMI: ET less than 31% of irrigation water + precip
Crop SAVA: sediment yield may be too high

Kiểm tra kết quả đầu ra

- **Quá trình trong dòng chảy**

SWAT Error Checker - Version 1.2.0.10 Released November 6, 2018

Setup | Hydrology | Sediment | Nitrogen Cycle | Phosphorus Cycle | Plant Growth | Landscape Nutrient Losses | Land Use Summary | Instream Processes | Point Sources | Reservoirs | About

In-stream processes may have a large impact on sediment and nutrient loads. It is difficult to gage appropriate values for these outputs. In-stream sediment change can be either positive or negative. Typically streams are a net sink for nutrients. Channel geomorphology can provide some guidance as to the net contribution of in-stream processes.

Show Detailed Reach Table

Sediment Budget

Upland Sediment Yield (Mg/ha)	79.36
Instream Sediment Change (Mg/ha)	-77.86
Channel Erosion (%)	
Channel Deposition (%)	98.11

Instream Nutrient Modification (%)

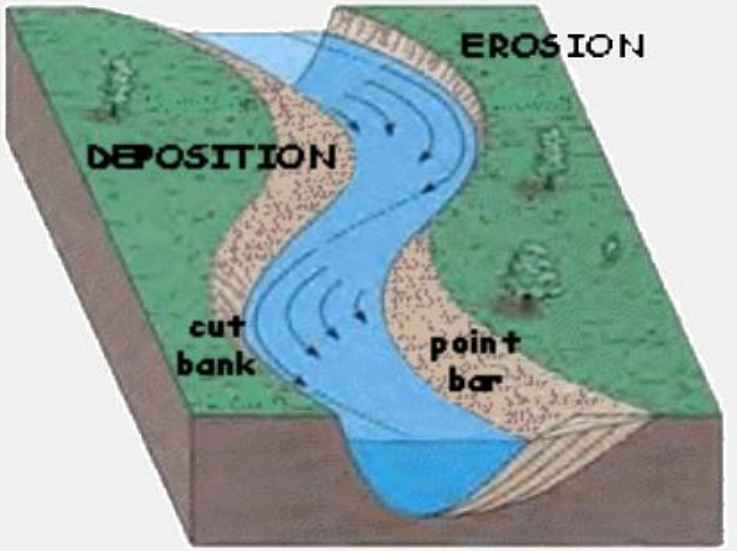
Total Nitrogen	
Total Phosphorus	

Instream Water Budget

Total Streamflow Losses (%)	0.29
Evaporation Loss (%)	0.29
Seepage Loss (%)	0

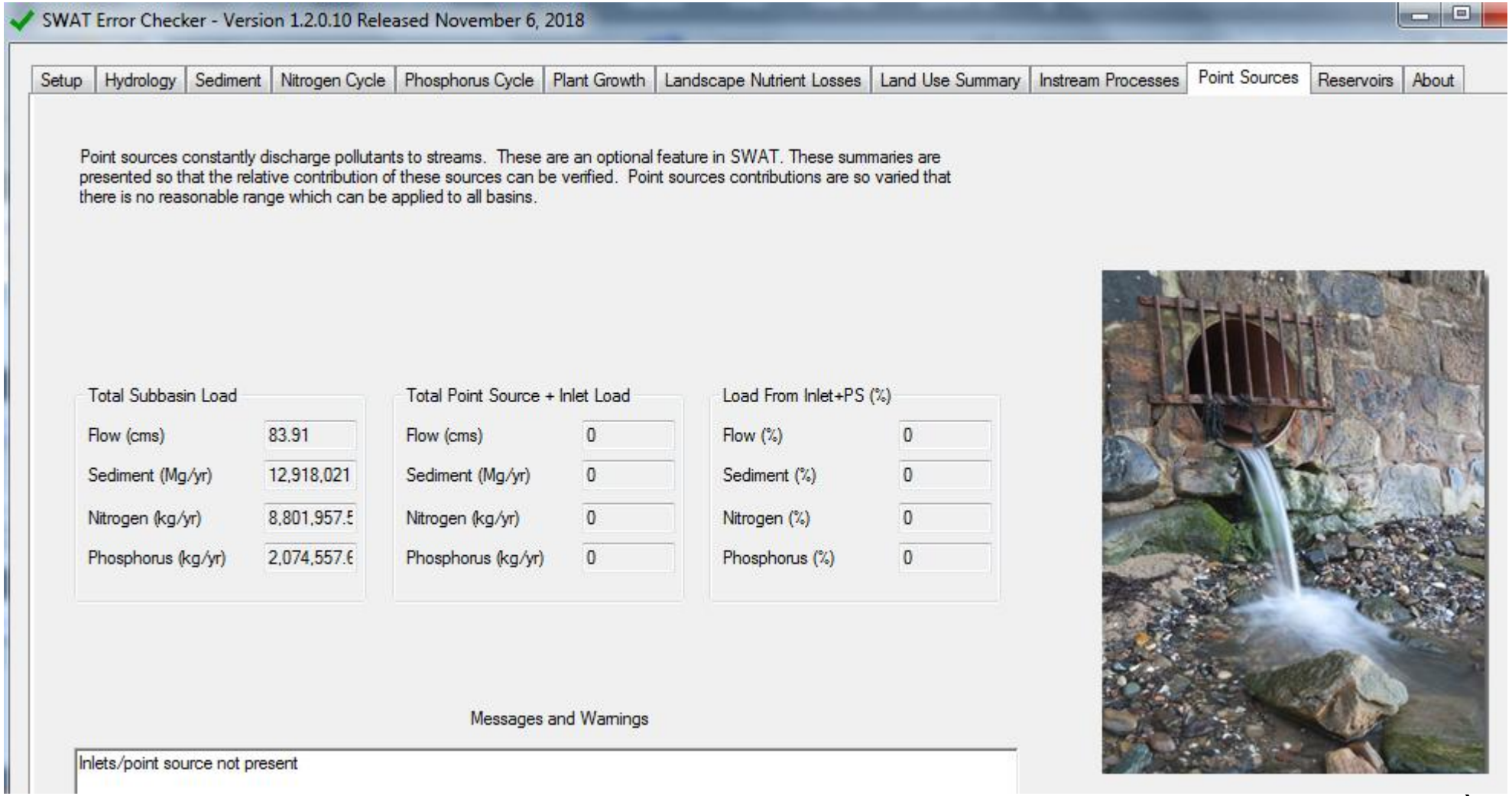
Messages and Warnings

More than 95% of sediment is deposited instream
Calculations could not be completed for this section because you did not print all reach output variables in File.CIO.



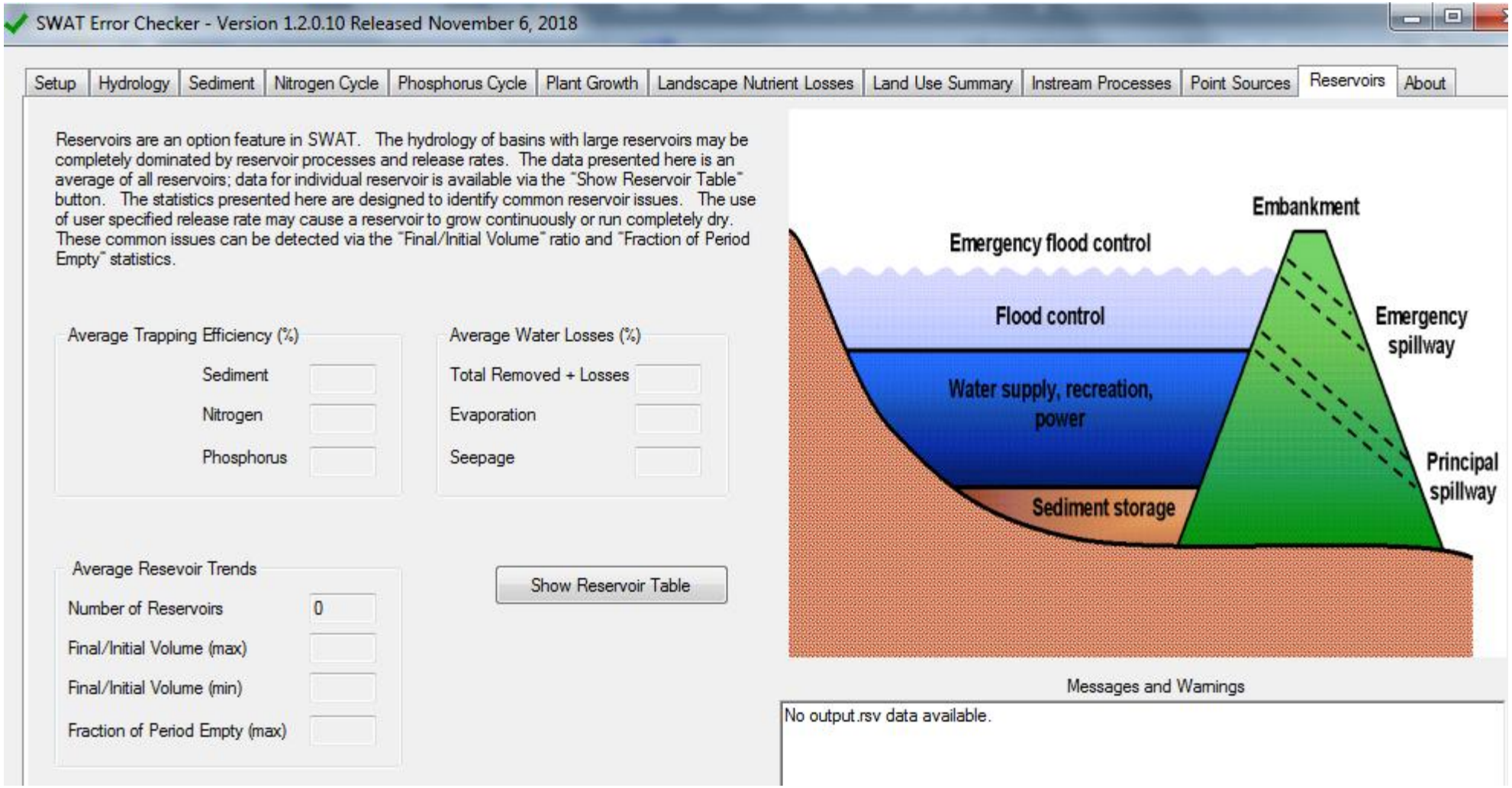
Kiểm tra kết quả đầu ra

- **Điểm xả thải**



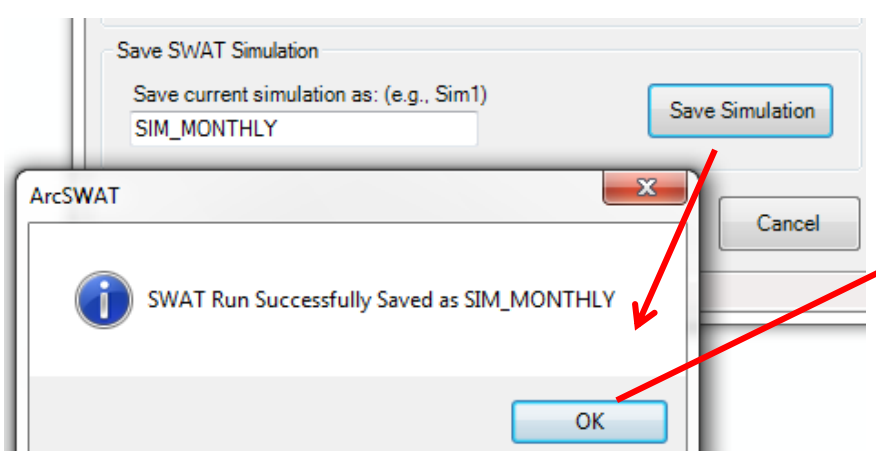
Kiểm tra kết quả đầu ra

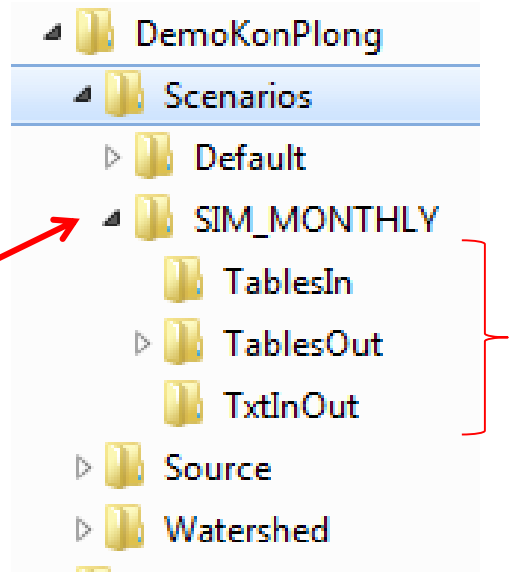
- **Hồ chứa**



Lưu kịch bản chạy SWAT

- Nhập tên kịch bản SIM_MONTHLY
- Click Save Simulation





Bảng đầu vào

Bảng đầu ra

Tập tin đầu vào, đầu ra

Bài tập kiểm tra

- Nhập lại số liệu thời tiết thành phần vào đồ án Demo sử dụng dữ liệu thời tiết trong thư mục Data_Bai4\ThoiTiet_Kiem Tra
  - pcp*: lượng mưa
  - tmp*: nhiệt độ không khí
- Chạy mô hình trong giai đoạn 1/1/2001 – 31/12/2002 với phân bố mưa là Skewed normal, in đầu ra theo ngày, NYSKIP = 0.
- Điền câu trả lời vào Google Form https://forms.gle/NtJqnNFQJ68UwXt57 cho các câu hỏi sau:
  1. Giá trị ET (mm) của HRU 4 thuộc tiểu lưu vực 4 trong ngày 02/01/2001 là bao nhiêu?
  2. Giá trị lượng mưa (mm) của tiểu lưu vực 5 trong ngày 01/02/2001 là bao nhiêu?
  3. Giá trị FLOW_OUT (m^3/s) của dòng chảy thuộc tiểu lưu vực 3 trong ngày 31/12/2001 là bao nhiêu?
  4. Giá trị SURQ (mm) trung bình năm 2001 trên lưu vực là bao nhiêu?
  5. Giá trị SED YIELD (tấn/ha) trung bình tháng 10 trên lưu vực là bao nhiêu?
  6. Giá trị GROUNDWATER (SHAL AQ) Q (mm) trung bình nhiều năm trên lưu vực là bao nhiêu?
  7. Giá trị tỉ lệ Baseflow/Total Flow trên lưu vực là bao nhiêu?
  8. Giá trị tải lượng bùn cát lớn nhất trên đất liền (tấn/ha) của lưu vực là bao nhiêu?