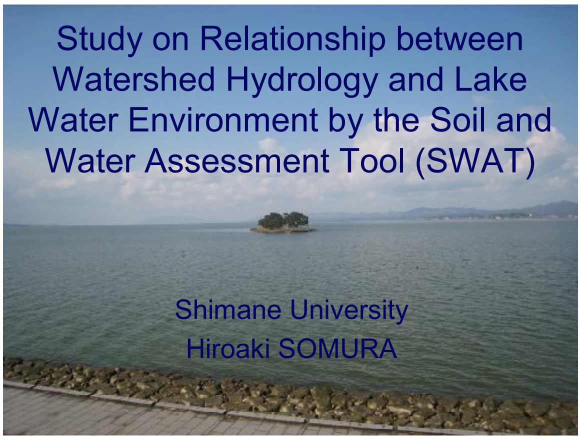
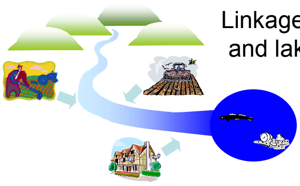


Study on Relationship between Watershed Hydrology and Lake Water Environment by the Soil and Water Assessment Tool (SWAT)

Shimane University
Hiroaki SOMURA

Background



Linkage of river basin environment and lake biodiversity / ecosystem

Rapid aging of the population resulting from the decline in the birthrate

Rough management in agriculture and forest

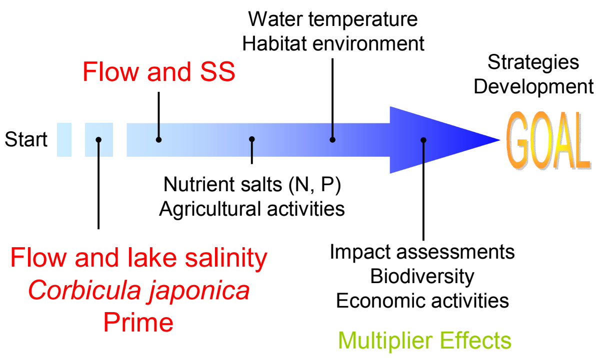
Watershed degradation
+
Global warming

Impact / damage to economic activities, water environment and biodiversity

Inside of forest (for example)

Rough management

Research Flow



About Lake Shinji: Why important?

1. Brackish lake: Delicate balance of saline and fresh water
2. Salinity level: 1/10 of sea water
3. Average water depth: 4.5m
4. The third largest brackish lake in Japan (79.1km^2)
5. 80 species of brackish water fish and shellfish
6. Annual catch of the clam is about 7,000t (40% of National total)
7. Sales amount of the clam is about 40 million dollars in the lake

Size: 2cm

http://www2.odn.ne.jp/shokuzai/Shijimi.htm

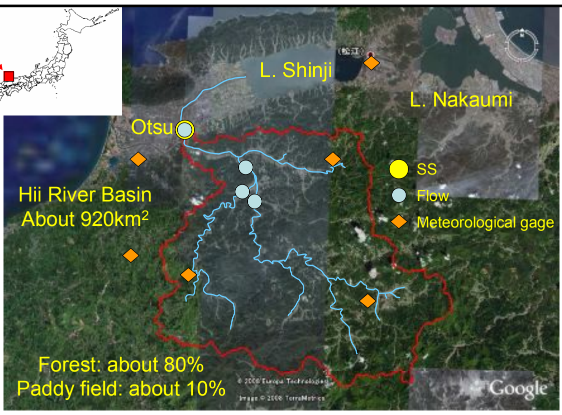
Corbicula japonica Prime,1864

Size: 5cm

http://fishing-forum.org/zukan/mashtml/M000712_1.htm

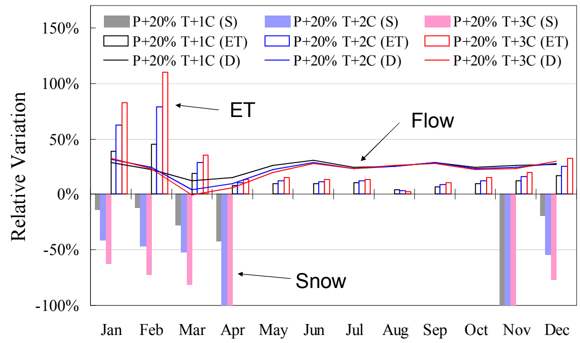
Gymnogobius taranetzi,1878

Impact of climate change on the Hii River basin and salinity in Lake Shinji

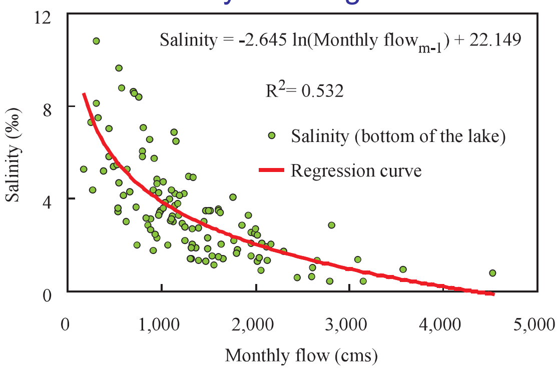


Location of the Study Area

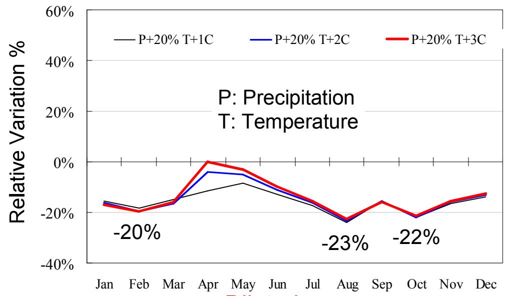
Impact of climate change in the basin



Relationship between salinity in Lake Shinji and monthly discharge at Otsu



Relative variations of salinity in Lake Shinji



Diluted

(For example)

Influence of lake salinity dilution against *Corbicula japonica* Prime

For adults of the clam:

Dilution under scenario conditions is not lethal

For eggs and larva of the clam:

Dilution during summer season may be critical and affect alternation of generations of the clam

The reproduction of the clam may be reduced by precipitation increase in the future

(From a view point of only salinity variation)

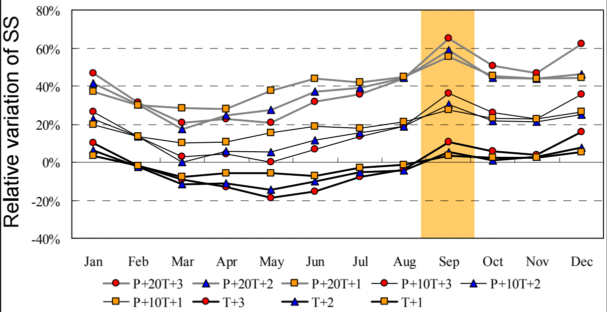
Impact of climate change on the SS load discharge from the Hii River Basin

Accumulation of SS on the Hii river bed

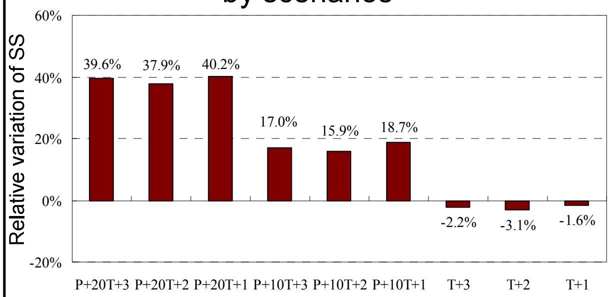
Efficient use of sediment

Monthly variations of SS by scenarios

Temperature variations did not have a significant effect, but precipitation have



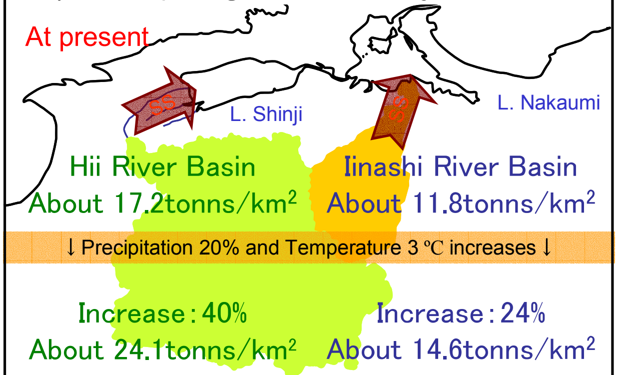
Difference of SS load discharge by scenarios



About 40% increase by precipitation increase 20%

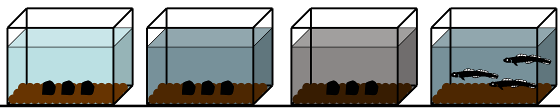
Annual SS load discharge

−Impact analysis against Lakes Shinji and Nakaumi−



Conclusions

1. Impacts of river hydrology on downstream lake salinity can be an important factor for benthic animals within the lake such as Gobies and *Corbicula japonica* Prime.
2. These species may also be affected by changes in nutrient input patterns from the river basin.



What is the SWAT model?

SWAT: Soil and Water Assessment Tool

Texas A&M University - Dr. Srinivasan
USDA-Agricultural Research Service – Dr. Jeff

A river, basin, or watershed scale model

Feature of the SWAT model

1. It is relatively easy to collect almost data sets
2. The model is a long-term yield model
3. Open source code
4. Both of point source and non-point source can be considered in a simulation
5. The model is not designed to simulate detailed, single-event flood routing

etc.

Overview of SWAT model

Simulation of the hydrology of a watershed can be separated into two major divisions.

•The land phase of the hydrologic cycle
•The water or routing phase of the hydrologic cycle

Reference : Neitch, 2001

Land Phase of the hydrologic cycle

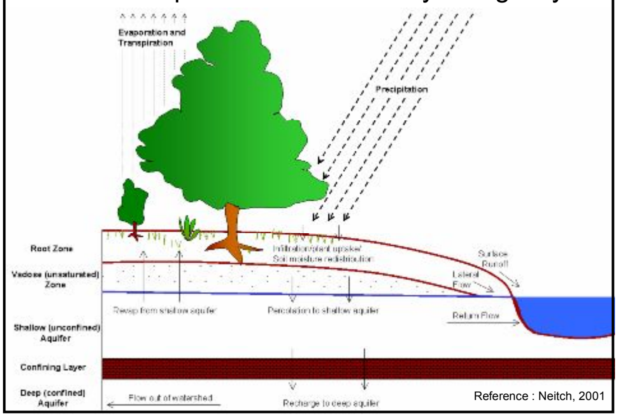
The hydrologic cycle as simulated by SWAT is based on the water balance equation

$$SW_t = SW_0 + \sum_{i=1}^{t} (R_{day} - Q_{surf} - E_a - W_{seep} - Q_{gw})$$

SW_t: final soil water content (mm)

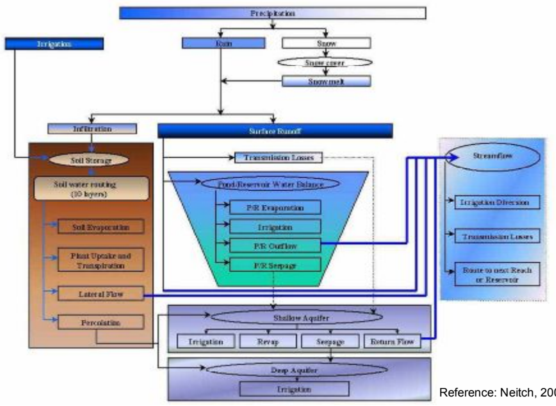
Reference : Neitch, 2001

Schematic representation of the hydrologic cycle



Reference : Neitch, 2001

Schematic of pathway available for water movement



Reference: Neitch, 2001

Surface Runoff

SWAT model provides two methods for estimating surface runoff

SCS Curve Number Method (1972)

The SCS runoff equation is an empirical model. The SCS curve number is a function of soil's permeability, land use, and antecedent soil water conditions

Green & Ampt Infiltration Method (1911)

The equation was developed to predict infiltration assuming excess water at the surface at all time. It requires precipitation data in small time increments

Potential Evapotranspiration

SWAT model offers three options for estimating potential evapotranspiration

1. Penman-Monteith Method
2. Priestley-Taylor Method
3. Hargreaves Method

The three PET methods vary in the amount of required inputs

Decision of PET method

- Penman-Monteith: Solar radiation, air temperature, relative humidity, and wind speed
- Priestley-Taylor: Solar radiation, air temperature, and humidity
- Hargreaves: temperature only

Land cover / Plant growth

SWAT utilizes a single plant growth model to simulate all types of land covers

The plant growth model is used to assess removal of water and nutrients from the root zone, transpiration, and biomass/ yield production

Erosion

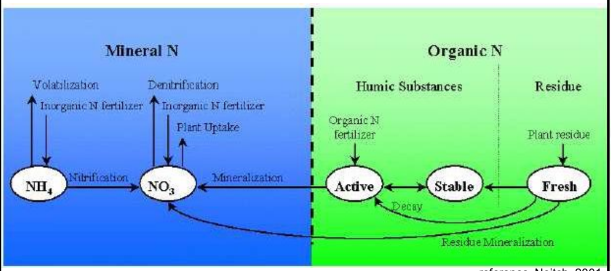
Erosion and sediment yield are estimated for each hydrologic response unit (HRU) with the Modified Universal Soil Loss Equation (MUSLE)

MUSLE: amount of runoff as an indicator of erosive energy

USLE: rainfall as an indicator of erosive energy

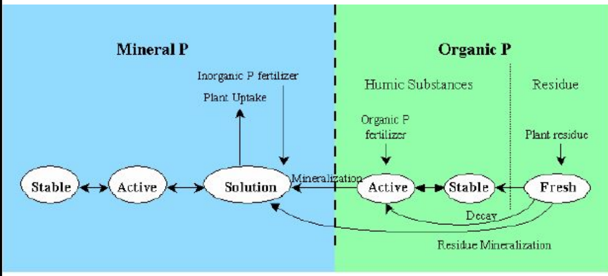
Nutrients: Nitrogen

SWAT tracks the movement and transformation of several forms of nitrogen and phosphorus in the watershed



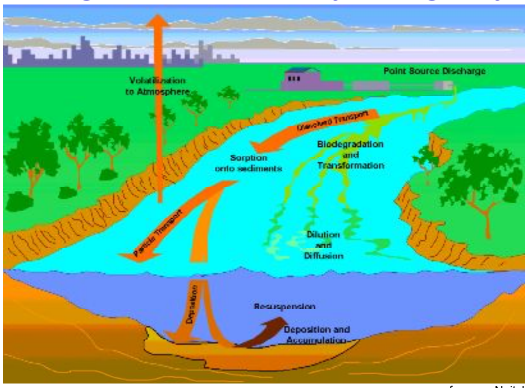
reference : Neitch, 2001

Nutrients: Phosphorus



reference : Neitch, 2001

Routing Phase of the Hydrologic cycle



reference : Neitch, 2001

Summary of Input data for SWAT

Minimum

- Precipitation
- Temperature
- Solar radiation
- Discharge

} Time series data

- Digital Elevation model
- GIS Land use data
- GIS soil type data

} GIS data

Another data

- Agricultural management data, water quality data etc

Procedure for calculation in the SWAT model

Watershed delineation and HRUs

DEM

Watershed delineation

Land Use

+

Soil Type

Grouping: Hydrologic Response Unit (HRU)

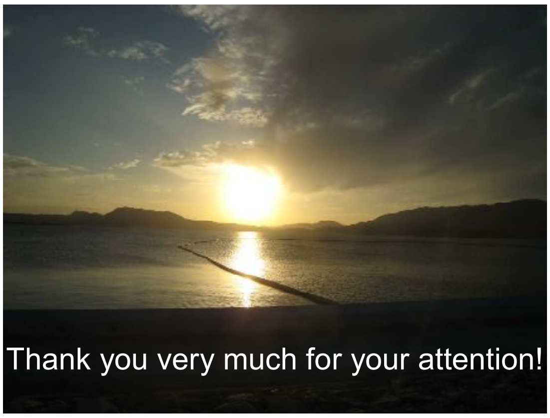
Input of Observed data

Weather data
Precipitation
Temperature
Humidity
Wind speed
Solar radiation

Another data
Agricultural activities
Fertilizer
Management

SWAT simulation

Results


Thank you very much for your attention!