Title and Objective

Estimation of submarine groundwater and TP flux near the intertidal zone by the budget analysis using the marine observation data

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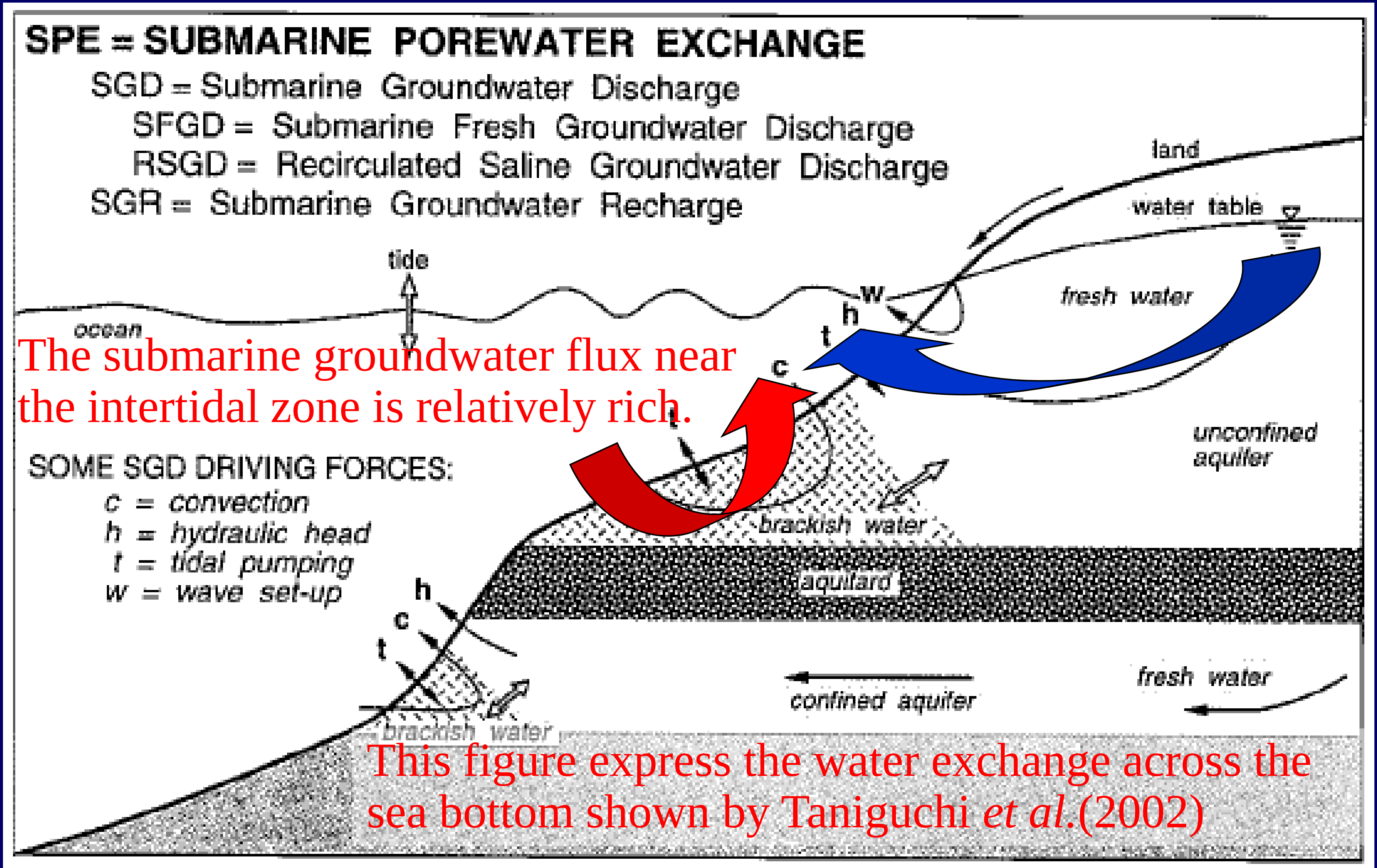
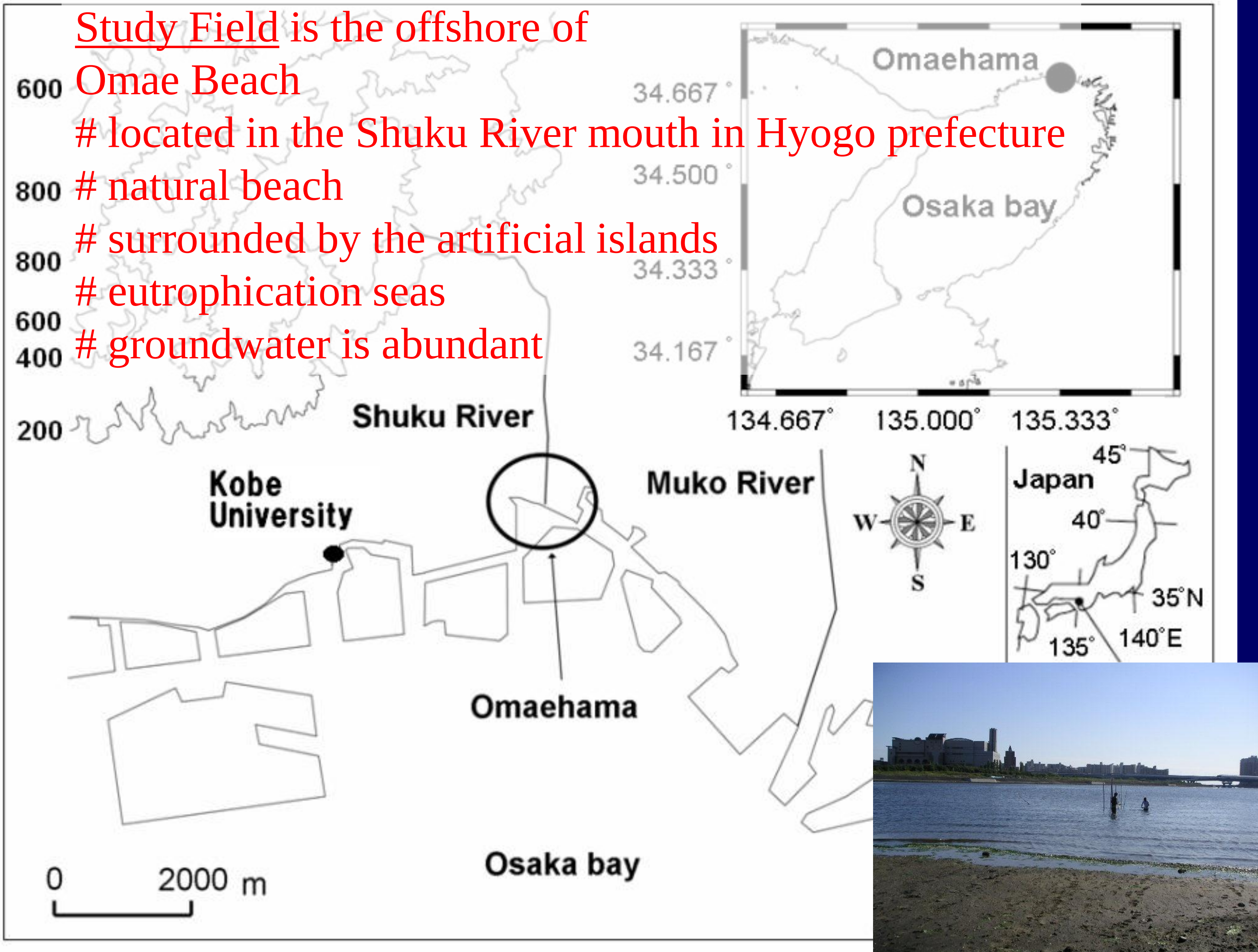
Because we don’t have the estimation method of SGW flux which specially correspond with the marine environment.



SFG and RSG, and not only discharge but also recharge are considered in this study.

Study Field is the offshore of Omae Beach

- # located in the Shuku River mouth in Hyogo prefecture
- # natural beach
- # surrounded by the artificial islands
- # eutrophication seas
- # groundwater is abundant

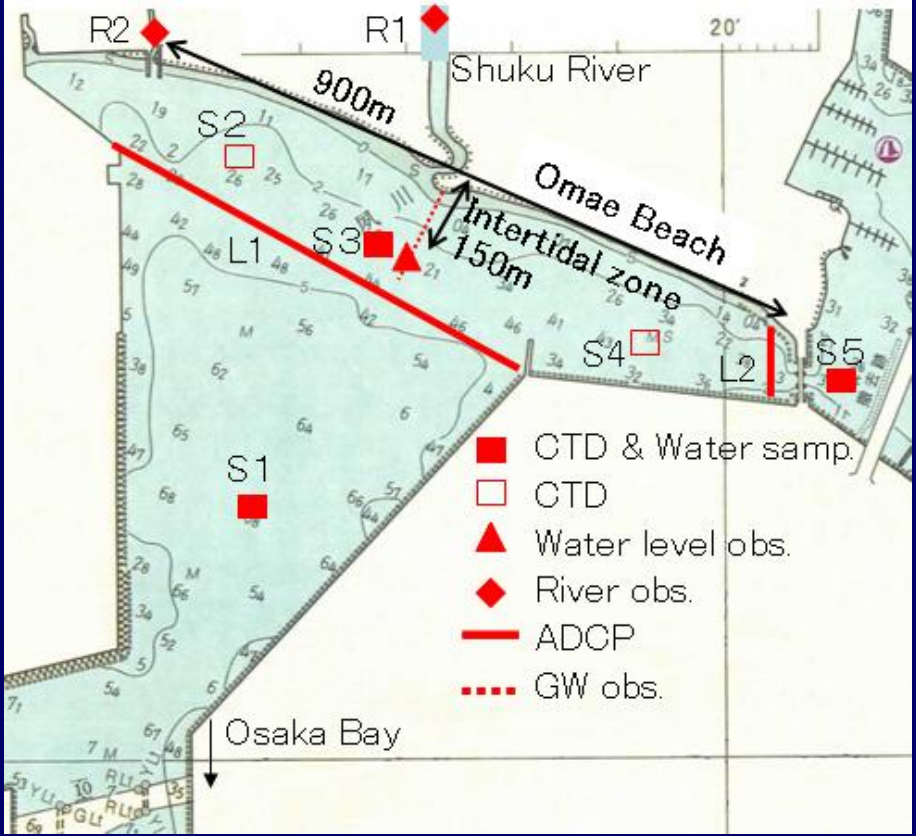


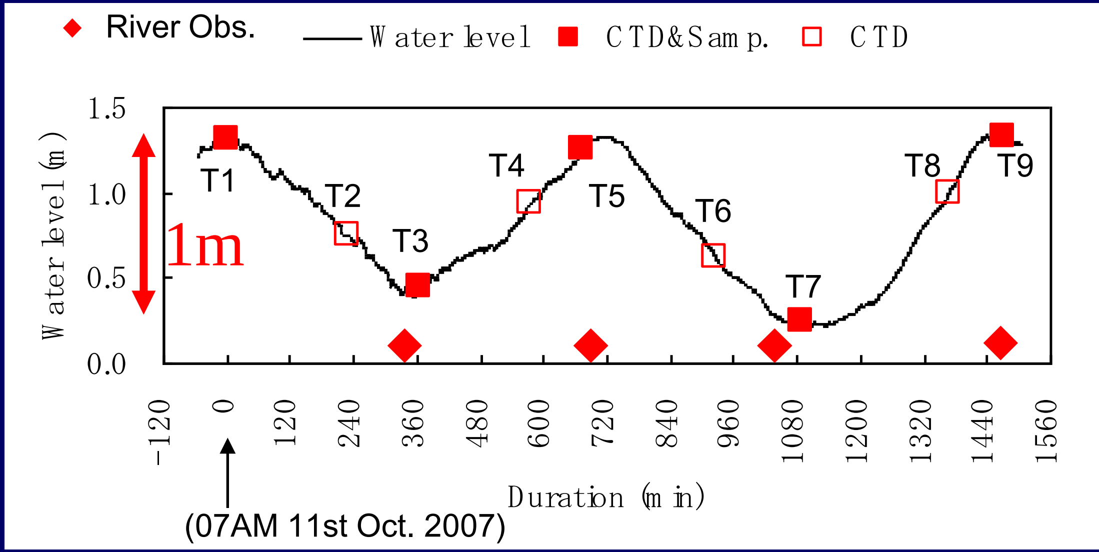
Field observations were carried out in October 11 and 12, 2007.

Water level was recorded at offshore of the intertidal zone.

Salinity obs. And Water sampling (in the sea surface and near the bottom) were done in high tide, mean level and low tide.

River obs. were done in high and low tide.

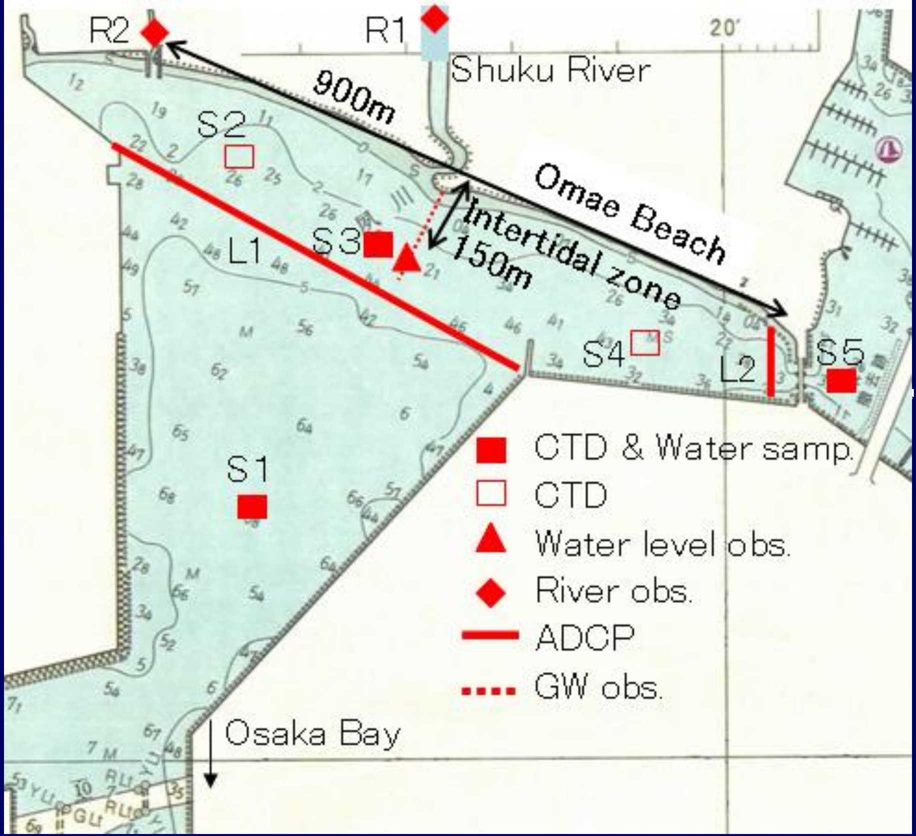


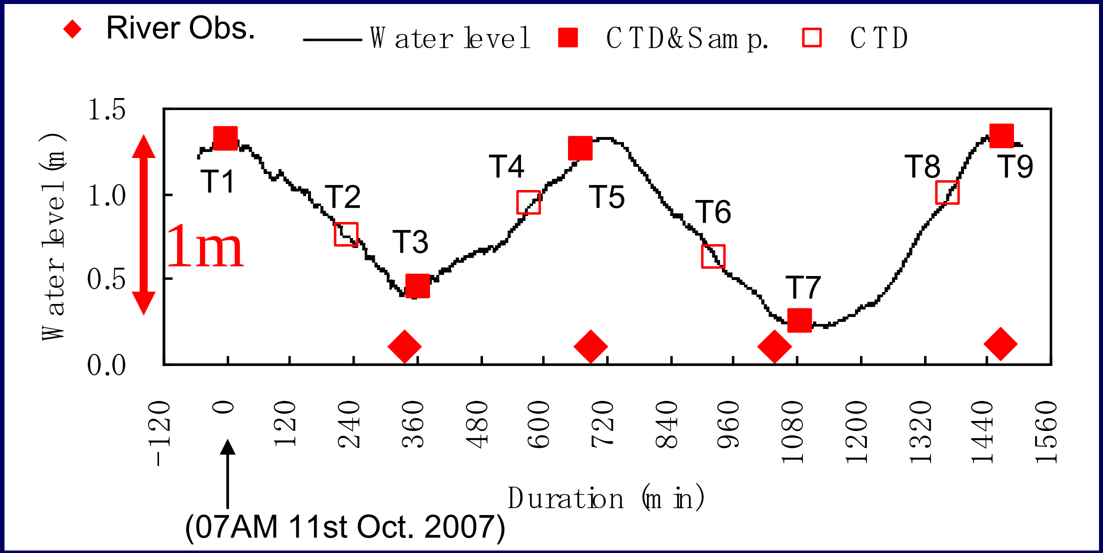


River Obs.

CT (Sal.&Temp.)

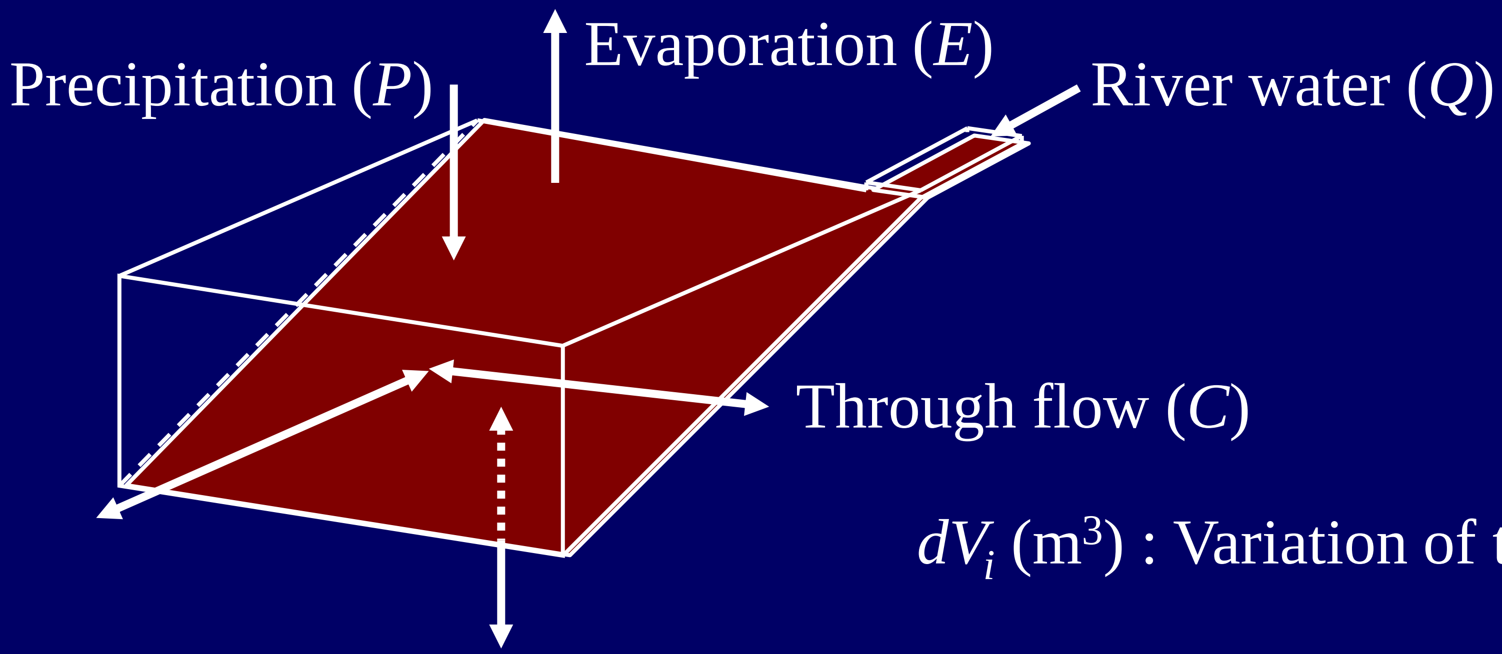
Length of the coastline of Omae Beach : 900m
Length of the inter-tidal zone : 150m
Surface area of the box : 1860×10^2 m^2
Water depth of the box : 0 to 5 m





Budgets of the box which is surrounded by L1, L2 and Omae beach were estimated for every span of the observation, T1-T2, T2-T3 and so on.

Water budget of the box is represented by $dV_i = Q + P - E + C + G$



dV_i (m^3) : Variation of the volume

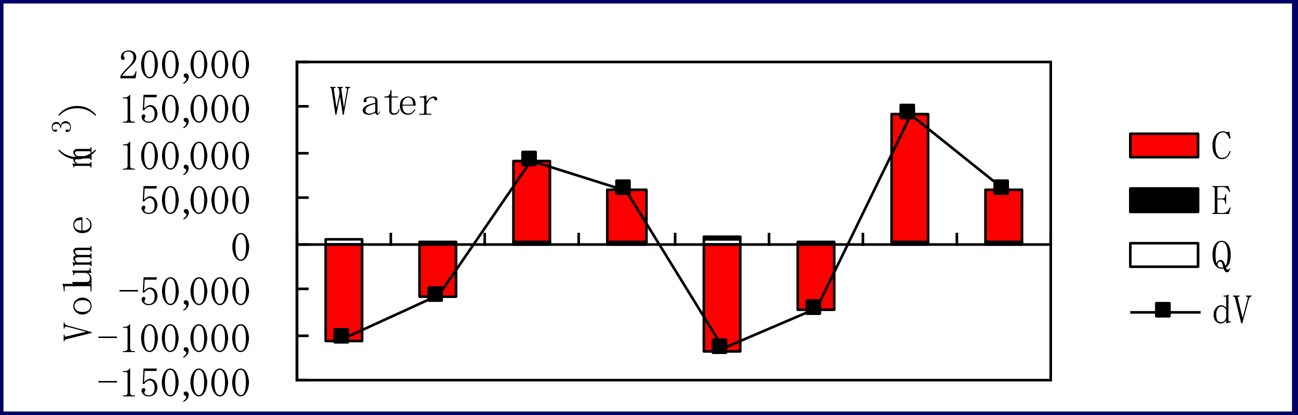
Submarine Groundwater (*G=Fresh+Recirculation*)

If G extremely smaller than C, G can be neglected

and C can be counted by $C = dV_i - Q - P + E$.

Water budget

Through flow speed
 : ~ 0.3 cm/s
 >> reasonable



Salt budget

$$d(V_i * S_i) \fallingdotseq C * S_x$$

> Variation of the salt volume in the box can be accounted by through flow.

TP budget

$$d(V_i * TP_i) - Q * TP_q - C * TP_x = unknown$$

> TP doesn't balanced.

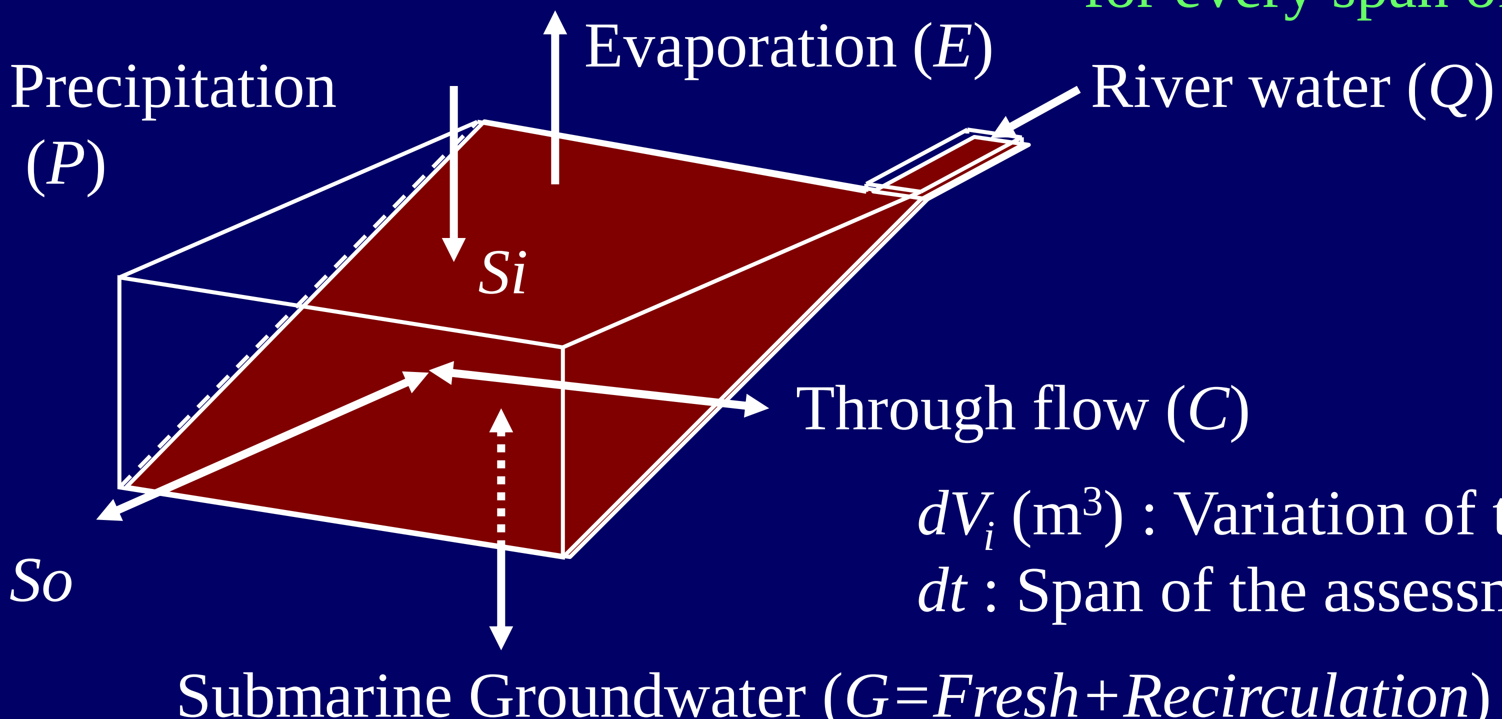
At first, through flow
which correspond with salinity in outside of the box is estimated.

$$dV_i(m^3) = Q + P - E + C_{est}$$

$$C_{est}(m^3/s) = U \times A \times dt$$

$$U(m/s) = a \times S_o + b$$

U : Through flow speed
A : Area of the boundary cross section
So : Salinity in outside of the box
a, *b* : coefficients
in minimum error
for every span of observation



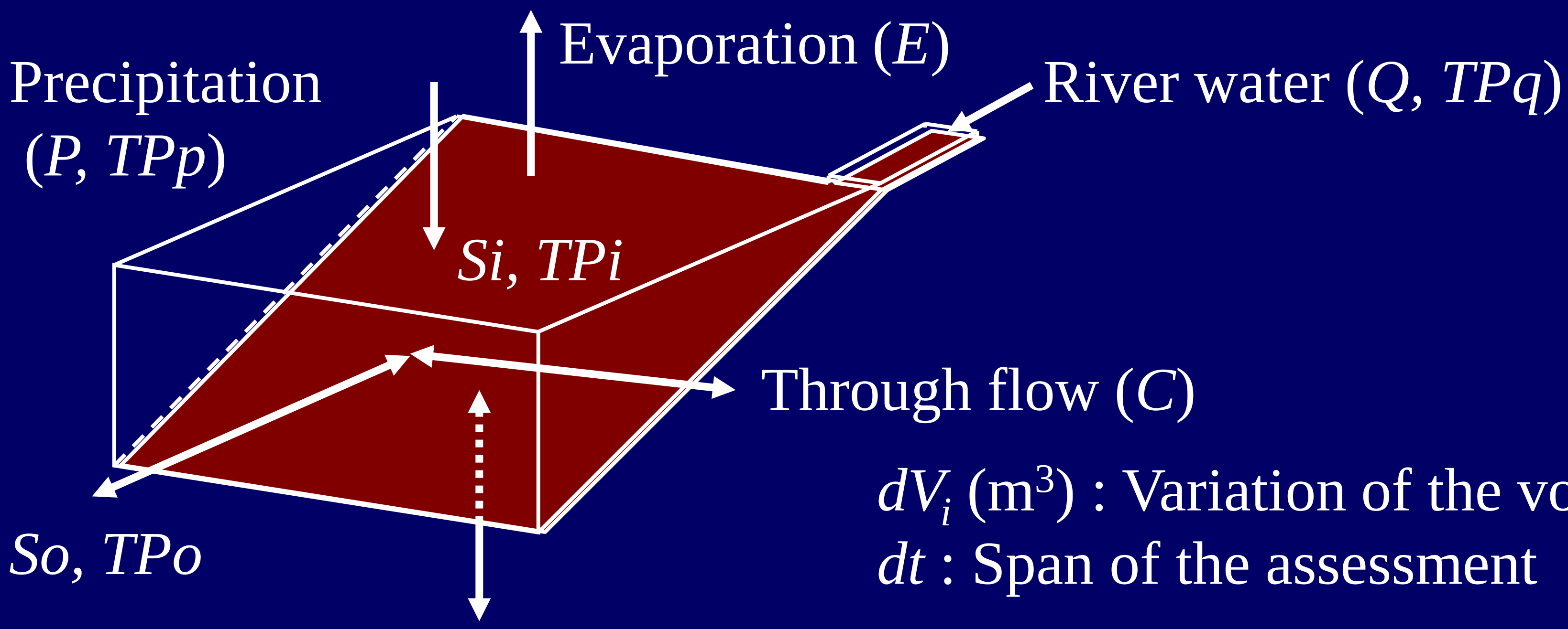
dV_i (m^3) : Variation of the volume
dt : Span of the assessment

Then, SGW is counted as the difference in observation and estimation.

$$G = dV_i - Q - P + E - C_{est})$$

$$TP_g = d(V_i * TP_i) - Q * TP_q - C_{est} * TP_x$$

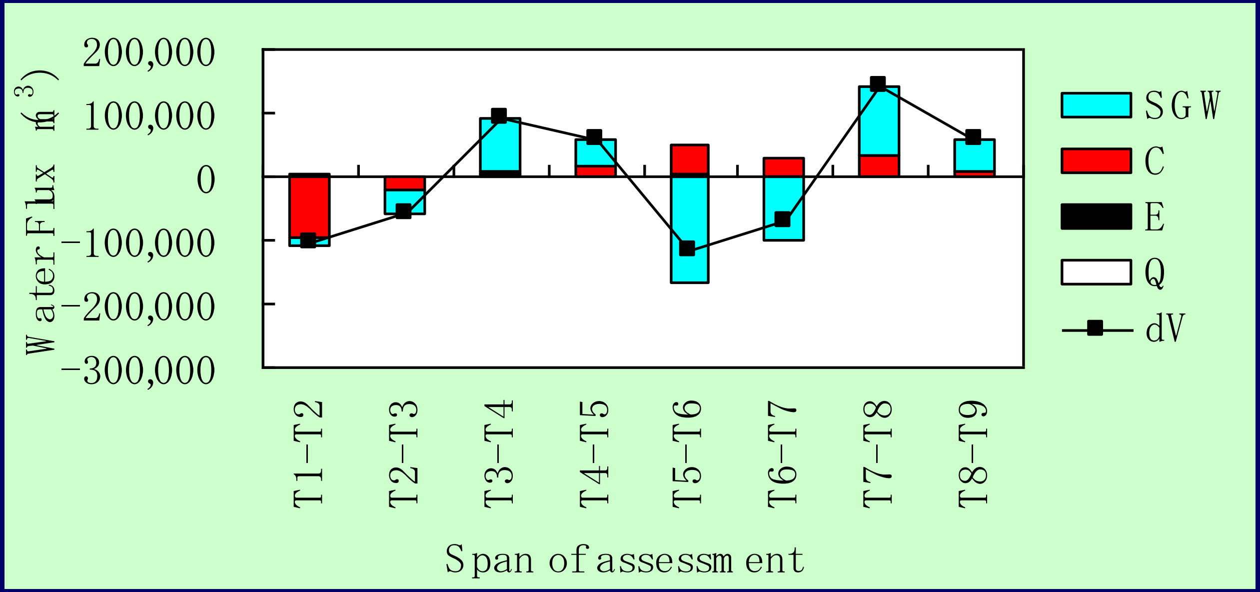
TPg includes fresh and recirculation groundwater and release form pore water.



dV_i (m^3) : Variation of the volume

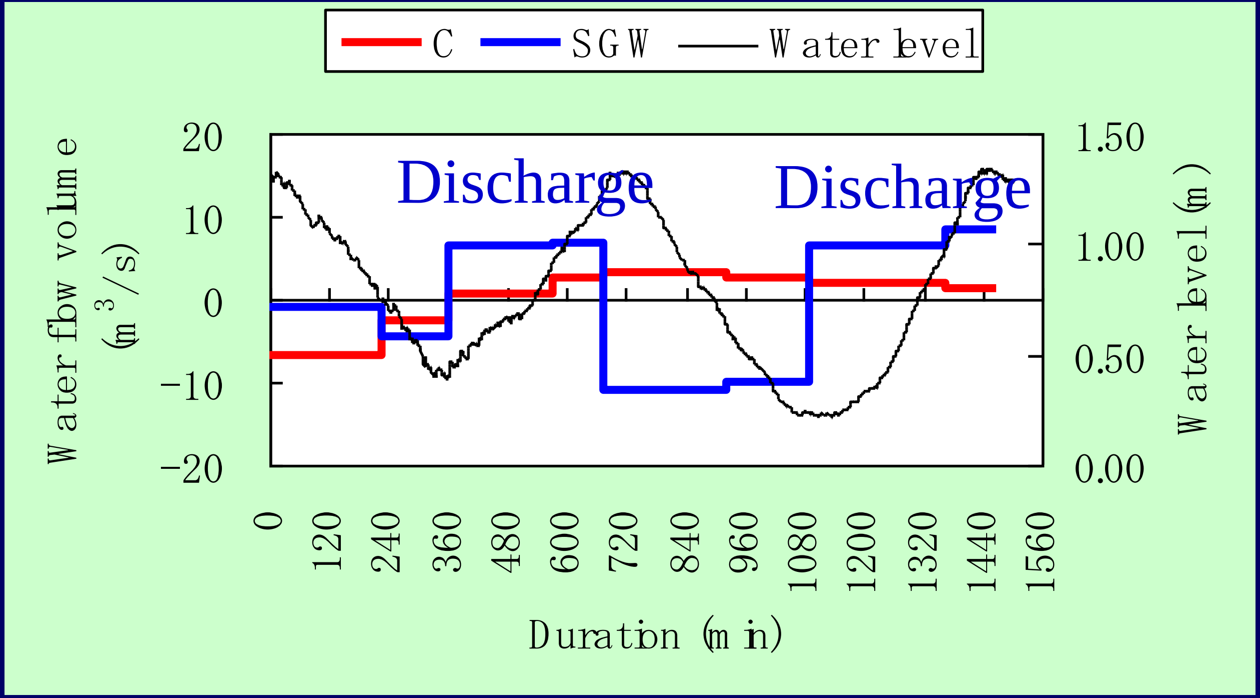
dt : Span of the assessment

Results of water budget



SGW discharged during flood tide. It agrees with the general opinion.

Discharge / Recharge : 90 %

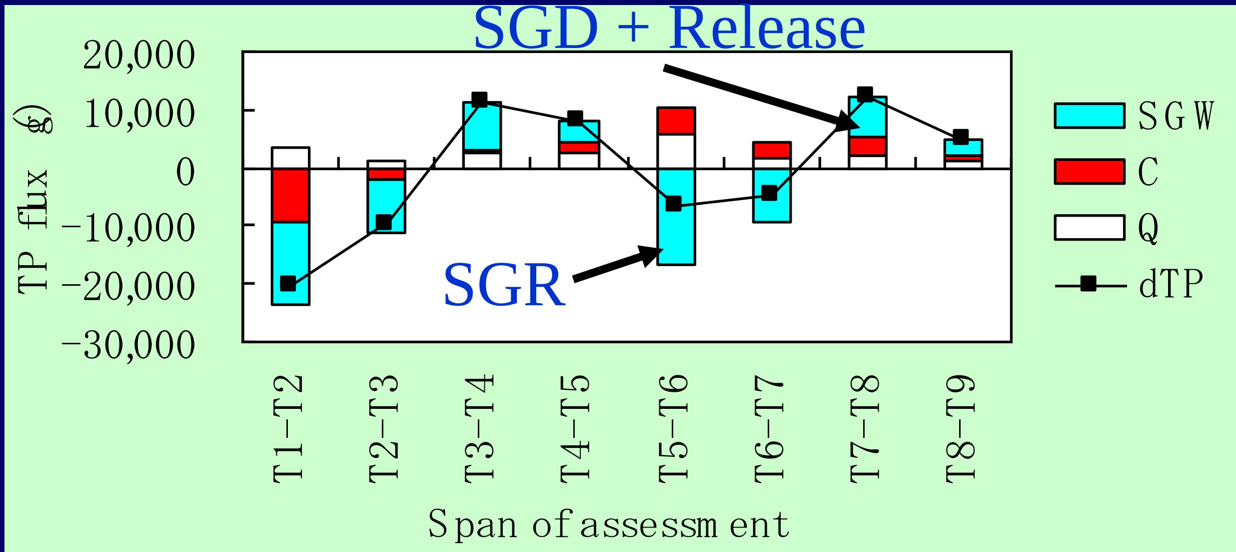


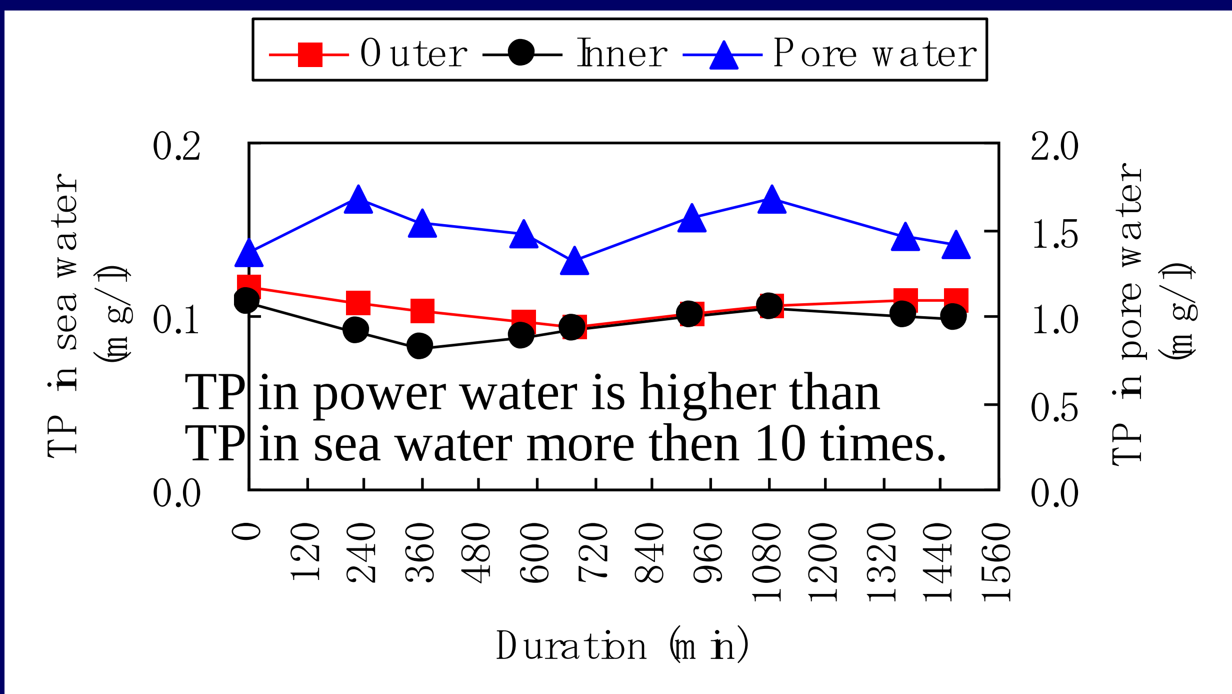
Speed of Through flow : ~ 0.2 cm/s

SGW : -6 ~ 4.5 ×10^{-3} cm/s (-510 ~ 390 cm/day)

It is 10 times of points observation by seepage meter.

Results of TP budget





TP inflow from
Sea bottom / Outside
: 160%

SGW
Discharge / Recharge
: 43 %
Speed
: 200 ~ 300 $mg/m^2/day$
Several times of
the general value
of release speed.

Summary

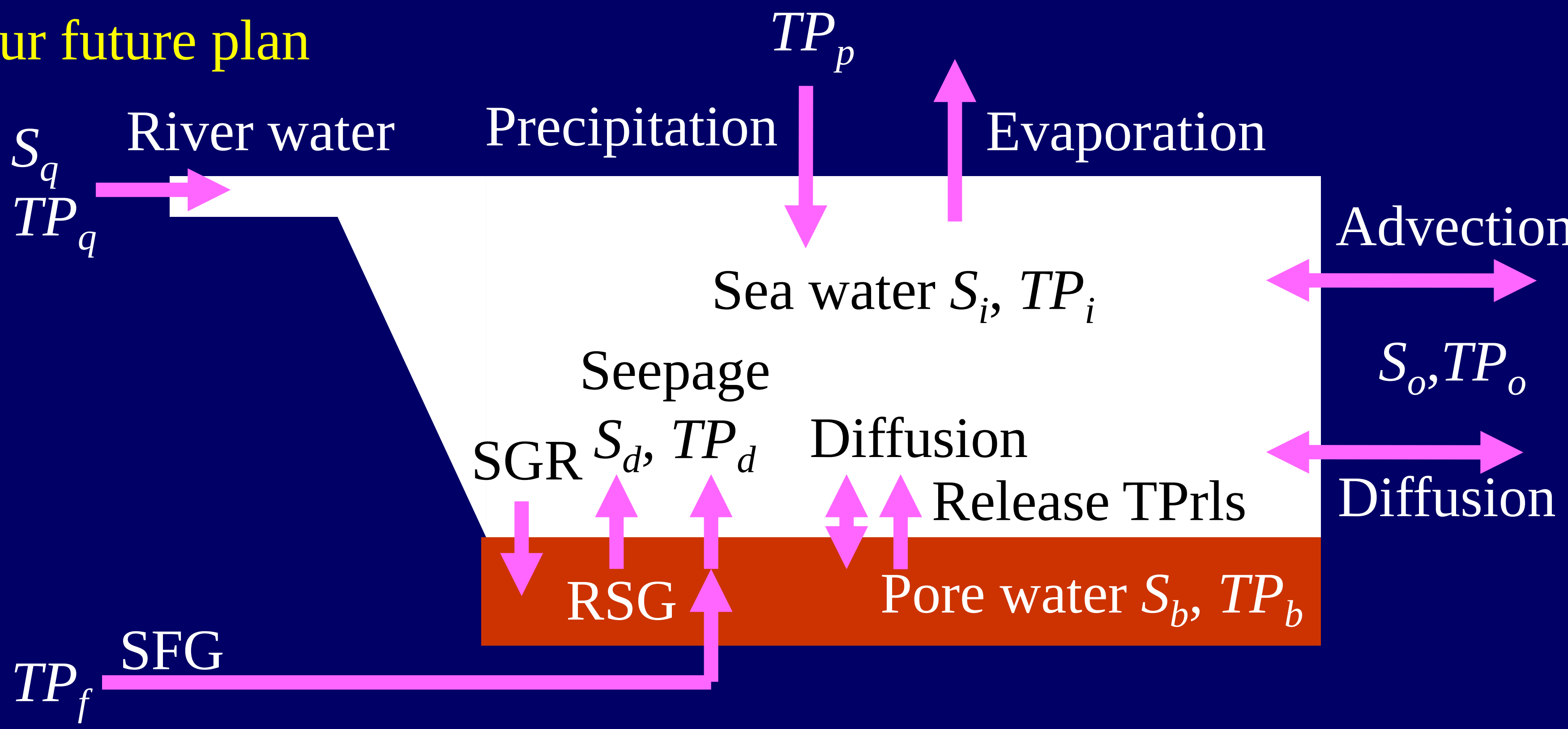
Variation of TP volume in the inter tidal zone of Omae Beach could not be accounted by through flow only.

Through flow which correspond with salinity in outside of the box was estimated. Then SGW and TP exchange across the sea bottom were estimated.

TP inflow from the bottom is 16 times of from outside the zone.

Not only release but also SGW have grate impact for this zone.

Our future plan



To make the model of submarine groundwater exchange.
It is separated into Submarine Fresh Groundwater (SFG),
Recirculated Saline Groundwater (RSG),
Submarine Groundwater Recharge (SGR)
and Release from pore water by diffusion process.

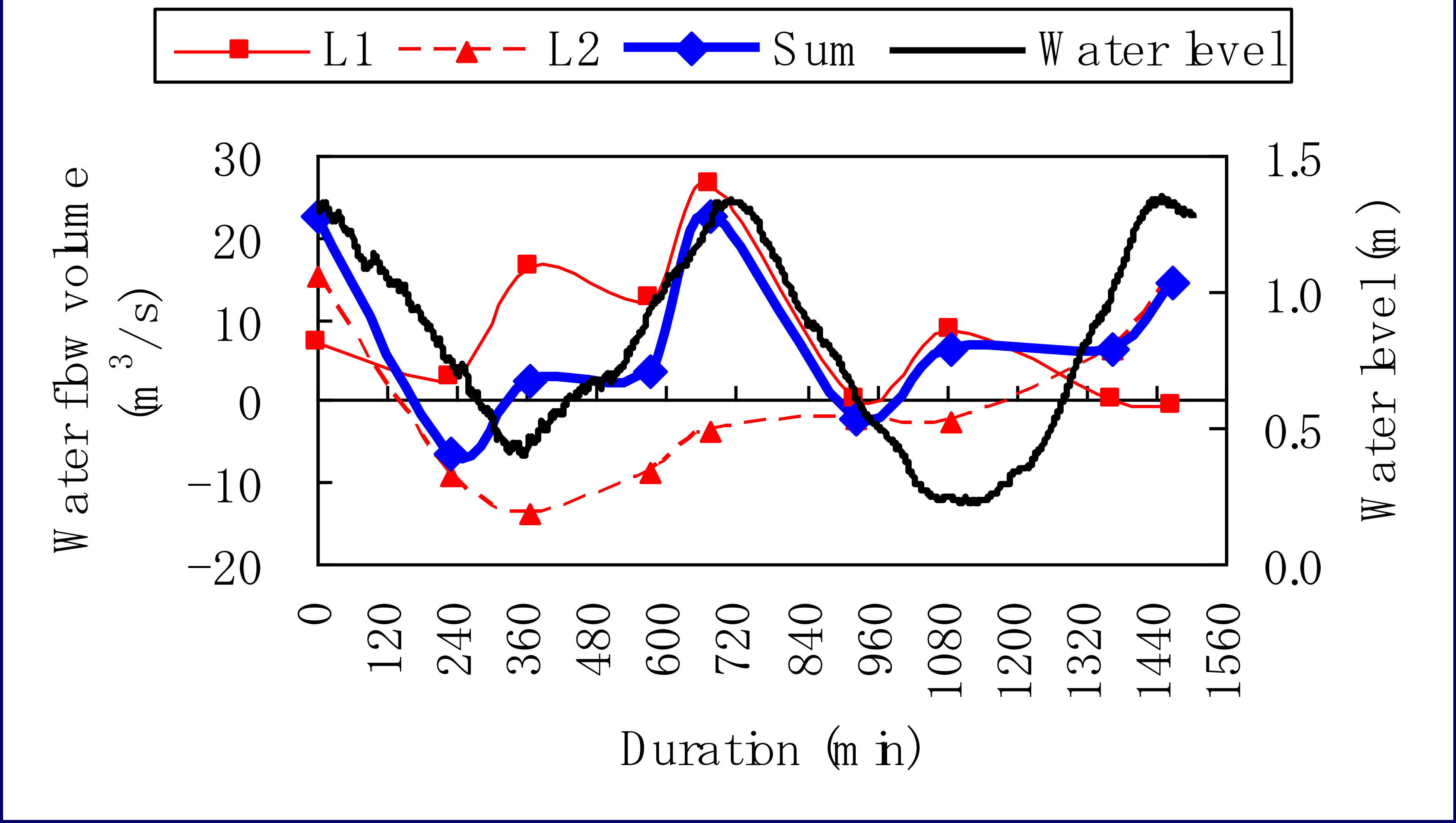
To clarify the material cycling in seawater quantitatively
and the impact of SGW on marine environment.

The present methods of SGW estimation

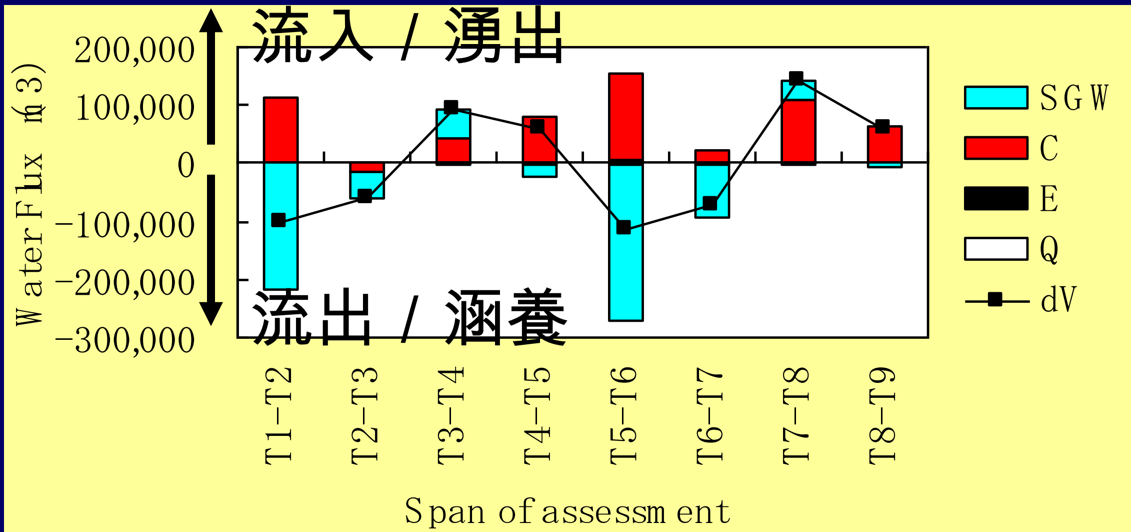
Estimation by the hydraulic gradient (Onodera *et al*., 2007)
Estimation by Radon isotope observation in the sea (Burnett *et al*., 2003)
>> These can estimate fresh water only.
Estimation by seepage and the seabed temperature observation (Taniguchi and Iwakawa, 2001)
>> It is direct measurement but is at points, therefore is weak in the spatial estimation.
Estimation by the numerical simulation model of groundwater flow (Thompson *et al*., 2007)
>> It is under development.

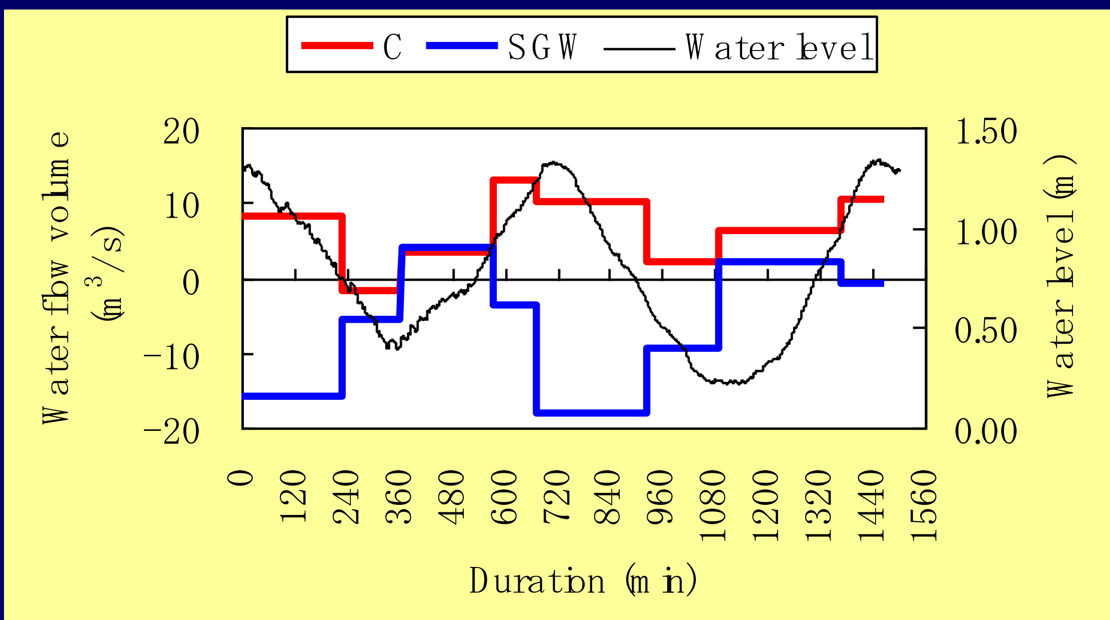
those results correspond or not to the marine conditions is unknown.
>> Estimation method by marine data is needed.
Marine environment can be analyzed at the same time.
The past condition can be estimated by the observed data.

- ADCP流量を再検討
- 水位変動とADCP流量の変動傾向が概ね一致
  →定性的には評価可能



結果





- 低潮～上げ潮時に湧出
  （既知の知見と一致）
- 海底への涵養量が推定出来た
  （確立された涵養量観測推定手法はない）

地下水湧出流速推定値は、シーページメーターによる実測に比べ１～２桁大きい

↓

ADCPデータを使用しない方法を検討

通過流：～0.4 cm/s　地下水：-10～2 ×10^{-3} cm/s (-840～180