The 11th AIM International Workshop

Land surface dependent Water balance modeling of Korea

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H.C. Jung, Y. Matsuoka
(Kyoto University, Japan)

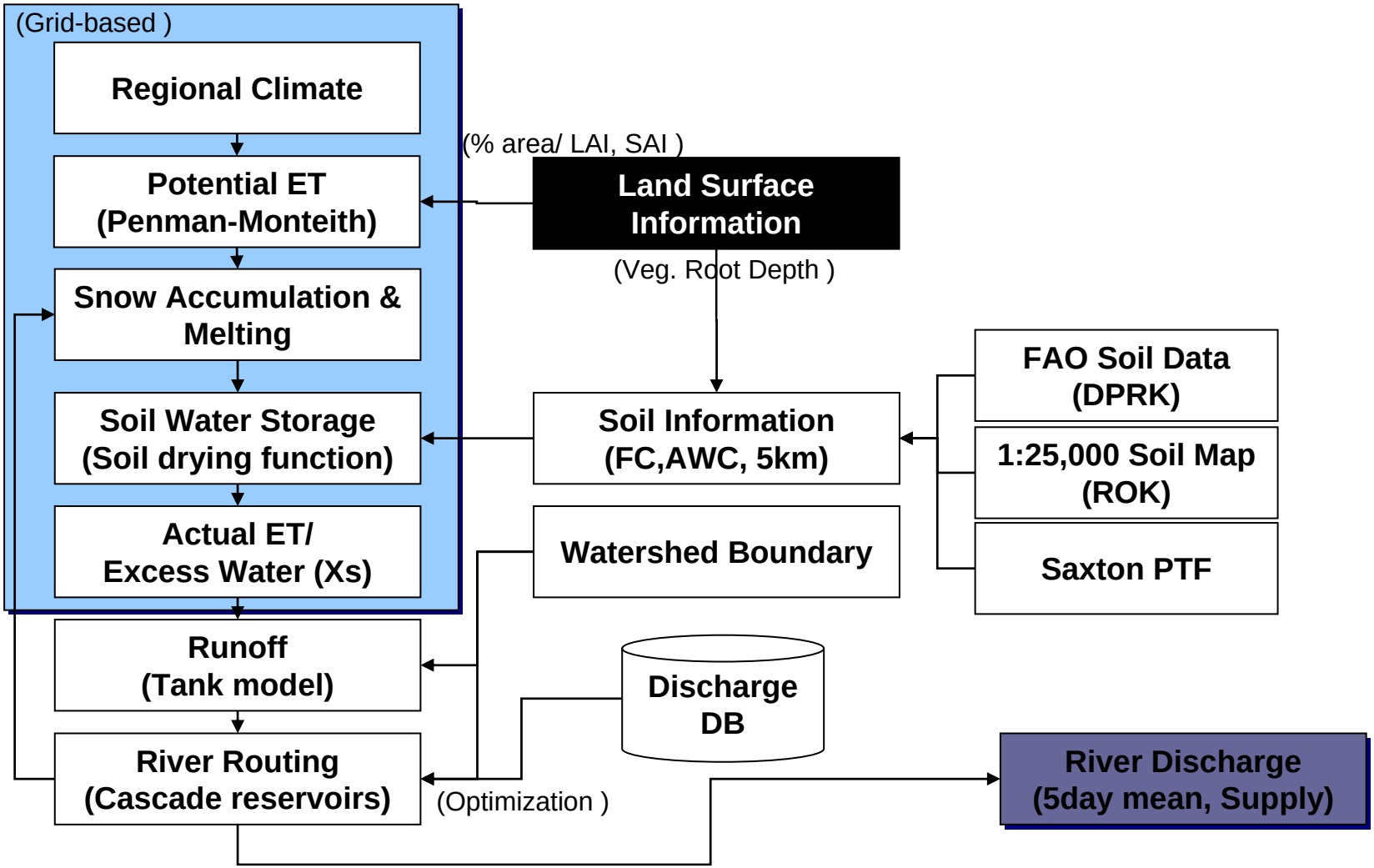
Objectives

1. The effects of land use and land cover on the climate will accelerate warming by deforestation and change the future impacts on the water balance and ecosystems by a complicated interplay of land surface energy balance including soil moisture, rainfall, snow, albedo etc.
2. To define, describe and quantify the relative and absolute importance of potential climate change to the hydrology, water resources and ecosystem, land surface database were parameterized and land surface dependent potential evapotranspiration models were developed

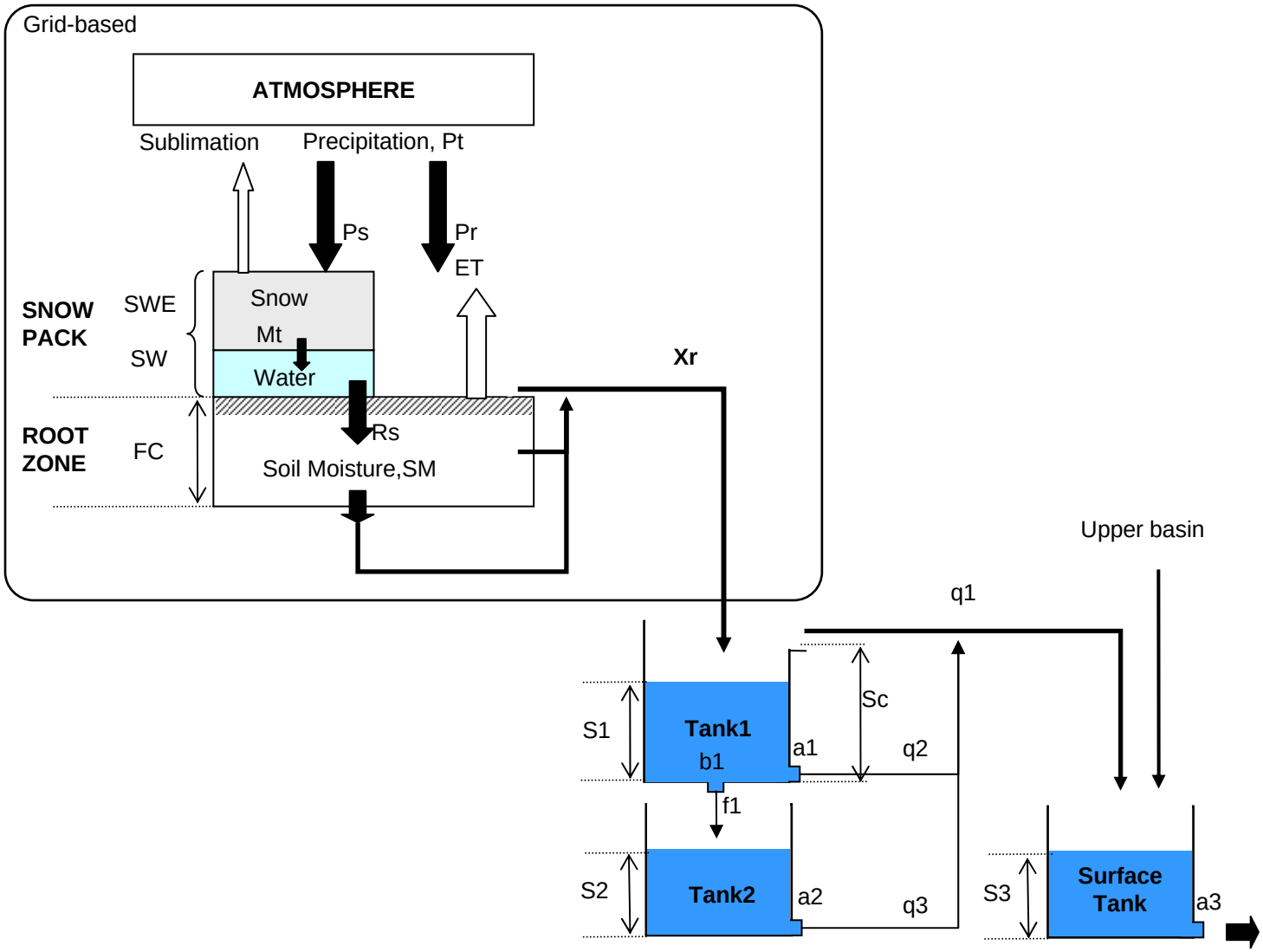
Contents of presentation

- The core of the research consists of development of
  1. Land surface database
     - Land use and cover data
     - Leaf Area Index
     - Soil pedon data and Water holding capacity
  2. Hydro database
     - Basin and river network delineation with GIS
     - Water level DB gathering and converting to discharge
  3. Surface dependent PET model test
     - Shuttleworth and wallace(SW) model
     - Penman Monteith(PM) model
     - FAO 24 style PM model

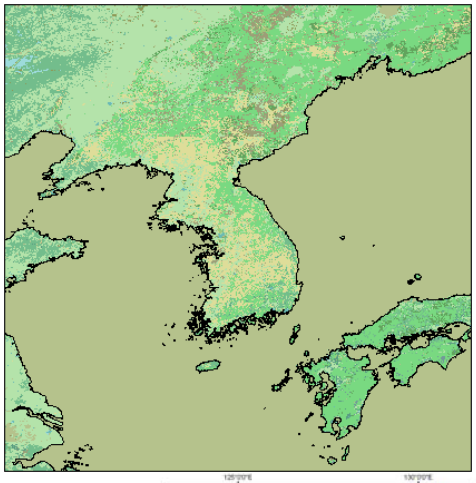
Conceptual diagram of hydrologic impact assessment with land surface heterogeneity



Water Balance and Hydrologic model

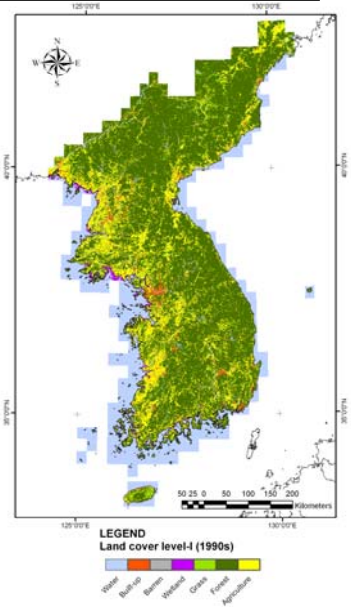


Construction of Land surface database : Land Cover and Land Use

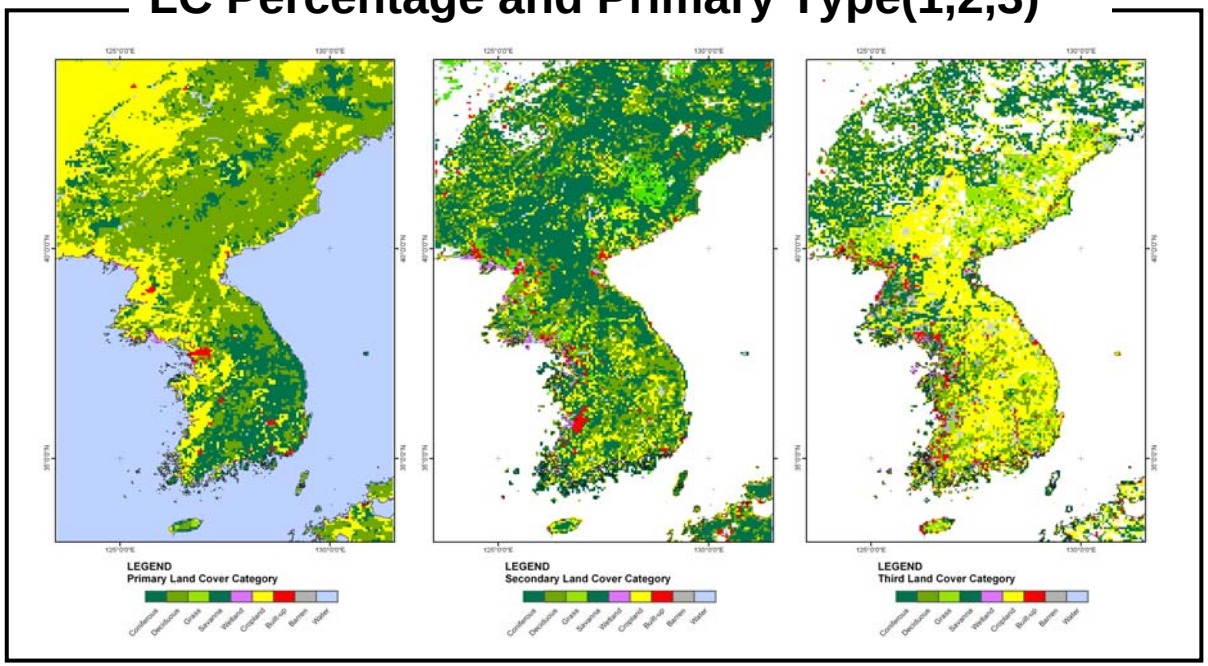


Global and Local database of LC :

1. 30 m Landsat LC, 7classes, K.pen. (area)
2. 5m LU, 23 classes, ROK (attribute)
3. IGBP 1km LC (attribute, DPRK)



LC Percentage and Primary Type(1,2,3)

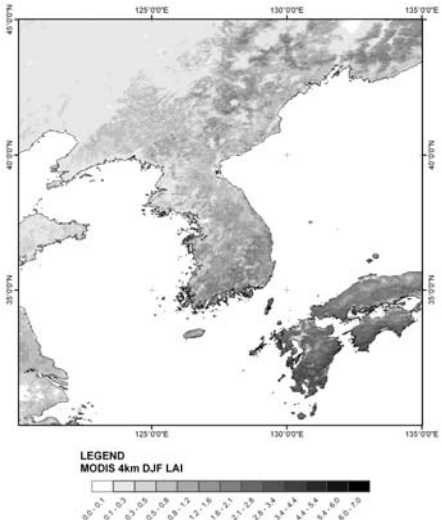


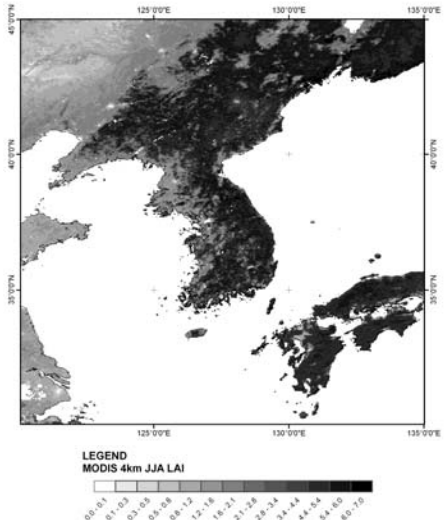
Construction of Land surface database : Leaf Area Index

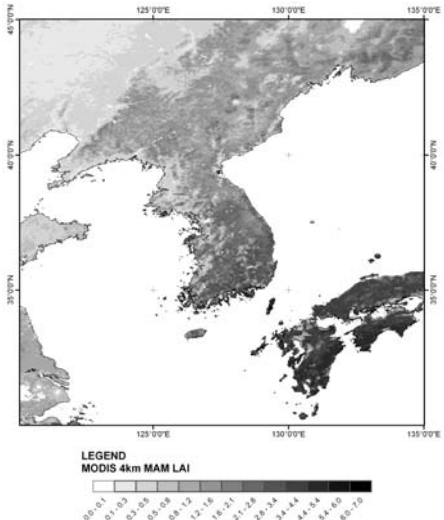
Monthly LAI data from MODIS satellite images :

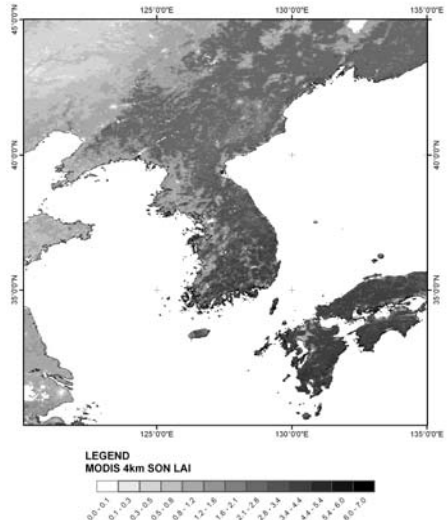
1. 6 year (2000~2006), 4 km, + LC % Data
2. mean monthly LAI for LC types by latitude

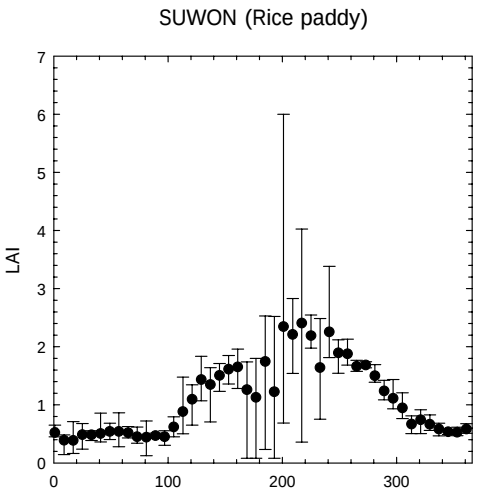
LC TYPE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Coniferous Forest (30-40N)	1.3	1.4	1.3	2.2	4.0	4.9	5.0	4.6	3.9	3.2	1.7	1.4
Coniferous Forest (40-50N)	1.3	1.3	1.2	1.4	2.4	4.9	5.0	4.2	3.4	1.6	1.2	1.2
Deciduous Forest (30-40N)	0.7	0.7	0.6	1.4	3.8	6.0	5.6	5.3	4.6	3.0	1.1	0.8
Deciduous Forest (40-50N)	0.8	0.8	0.6	0.9	1.9	5.0	5.2	4.4	3.8	1.5	0.9	0.8
Agriculture	0.2	0.2	0.3	0.3	0.4	0.9	1.9	2.4	2.0	0.7	0.3	0.2

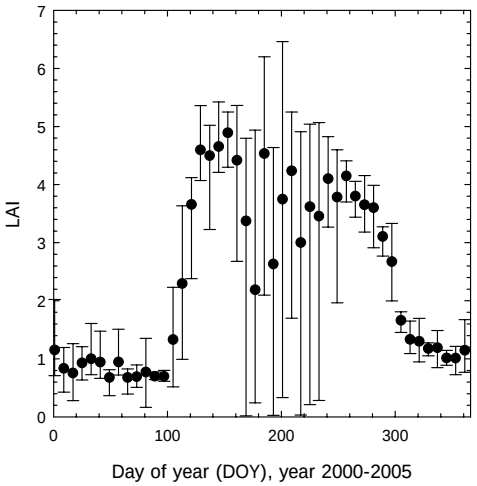


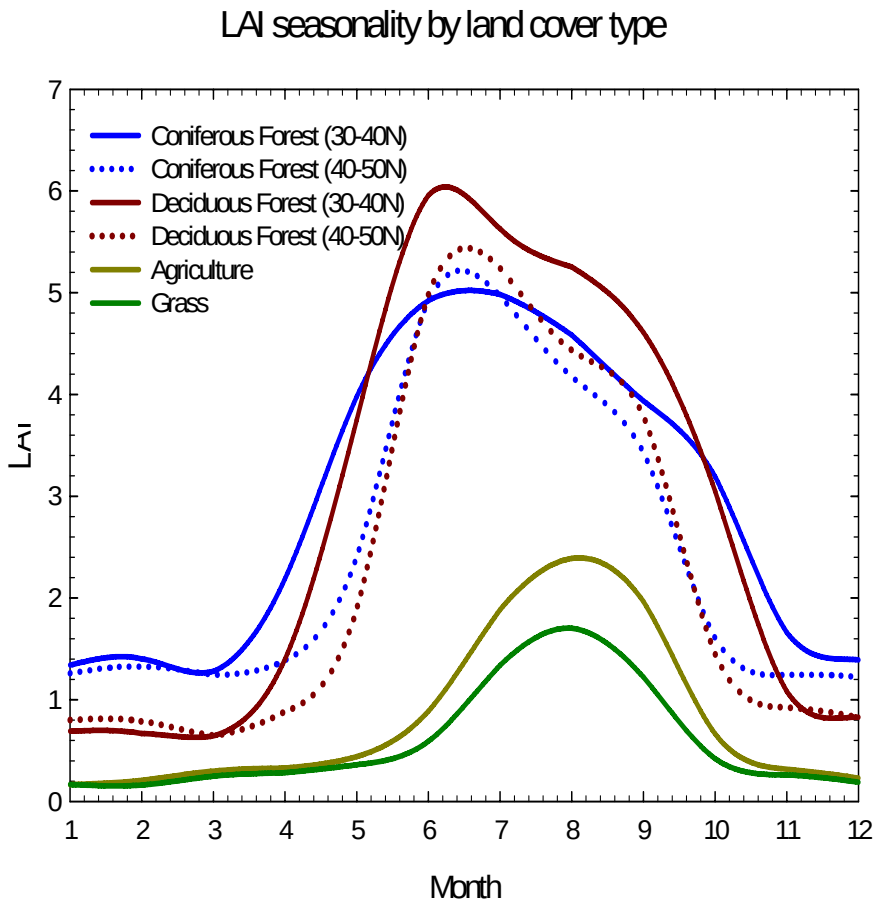


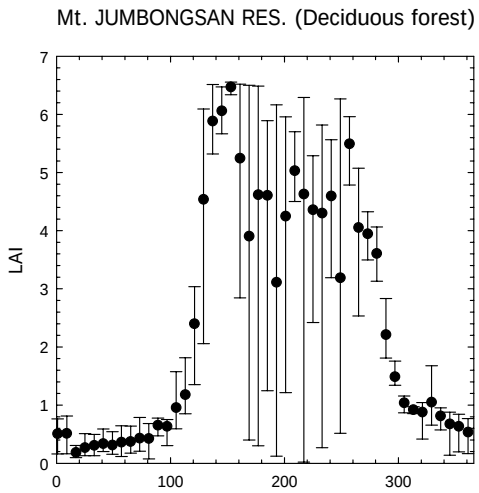


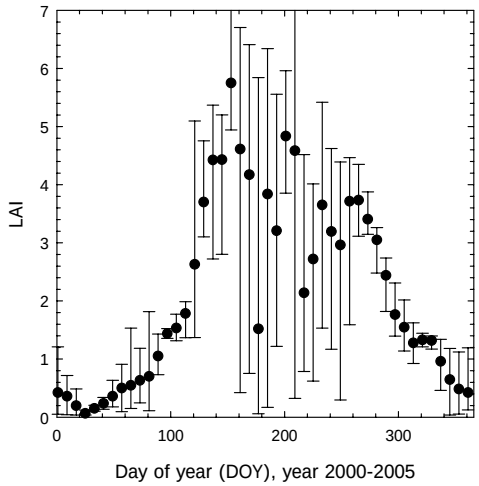










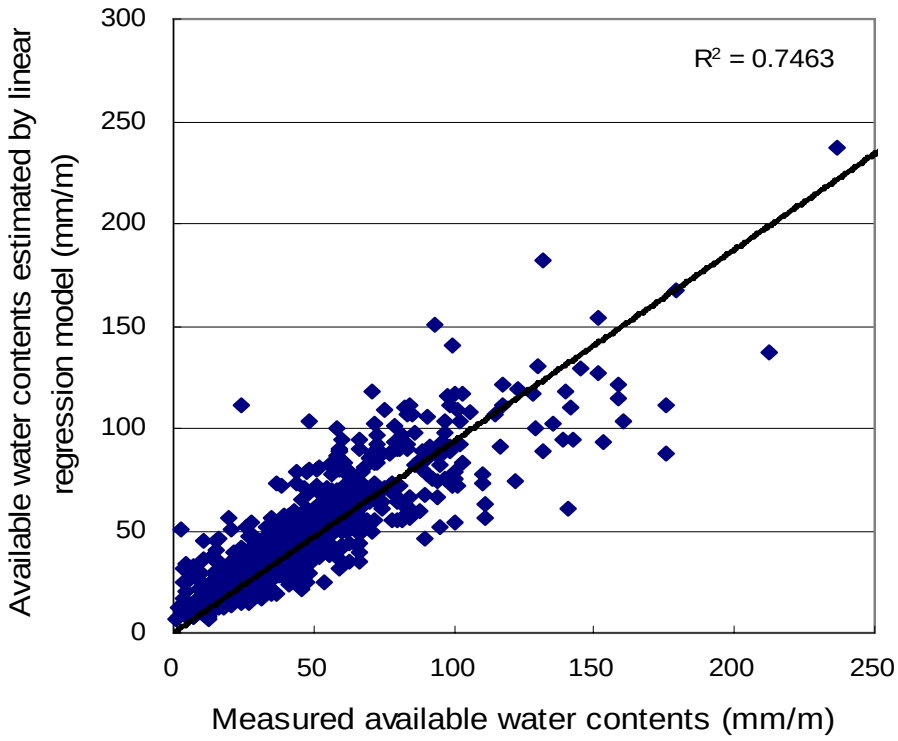


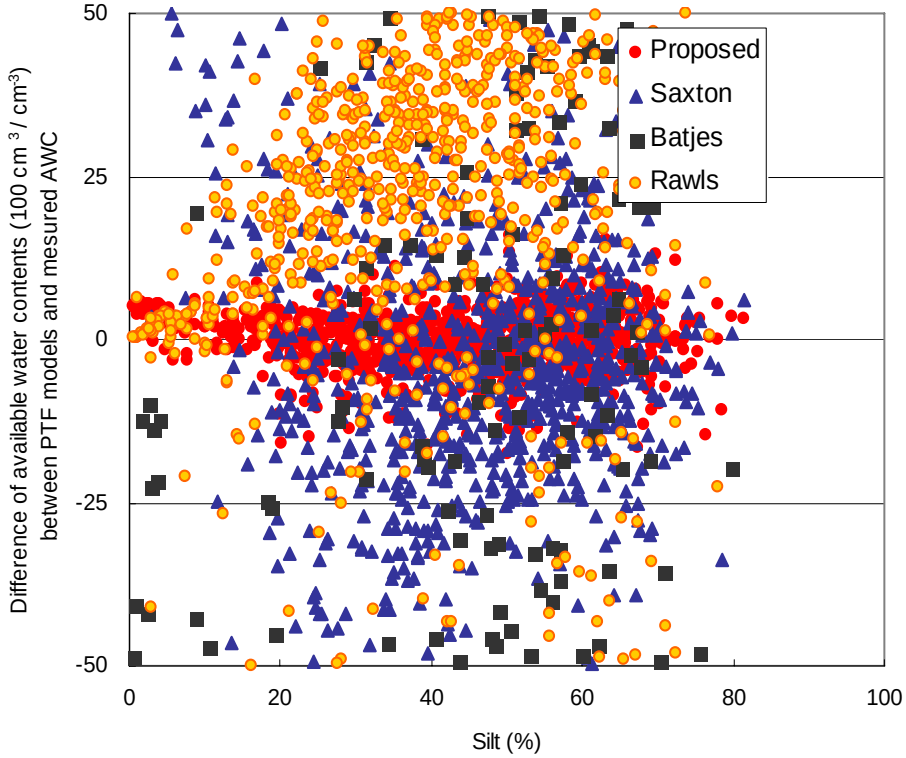
Seasonality of LAI by land cover type and location

Construction of Land surface database : Soil pedology and Water holding capacity

Linear regressions for prediction of soil water contents at FC and WP by the stepwise multi-linear linear regression

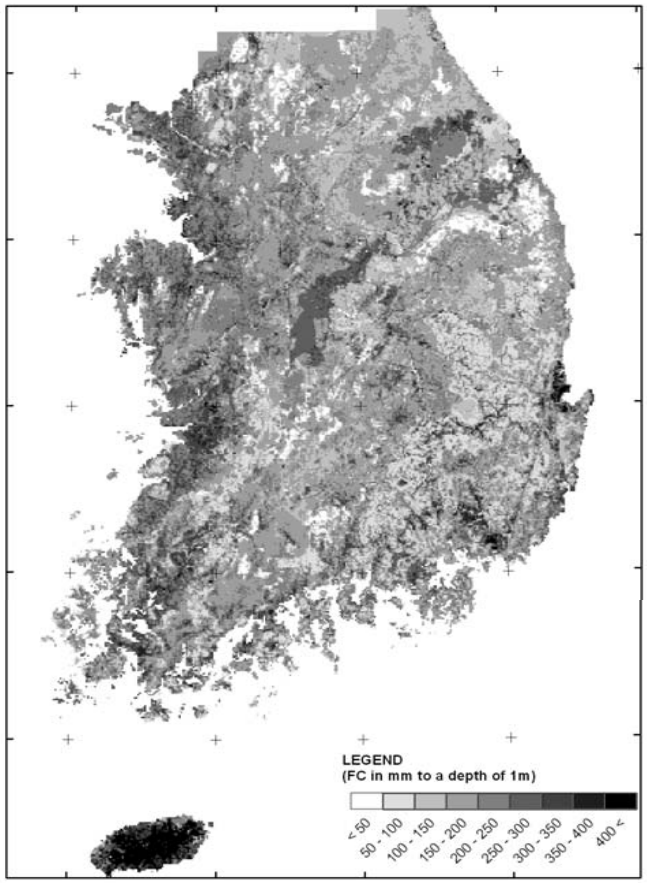
$\Theta_f = 42.5080 - 0.3510P_{sand} - 0.1030\ P_{silt} + 1.9231P_{om}$	(n=1006, r^2=0.717)
$\Theta_w = 1.5515 + 0.0754P_{silt} + 0.2732\ P_{clay} + 1.3544P_{om}$	(n=1006, r^2=0.664)

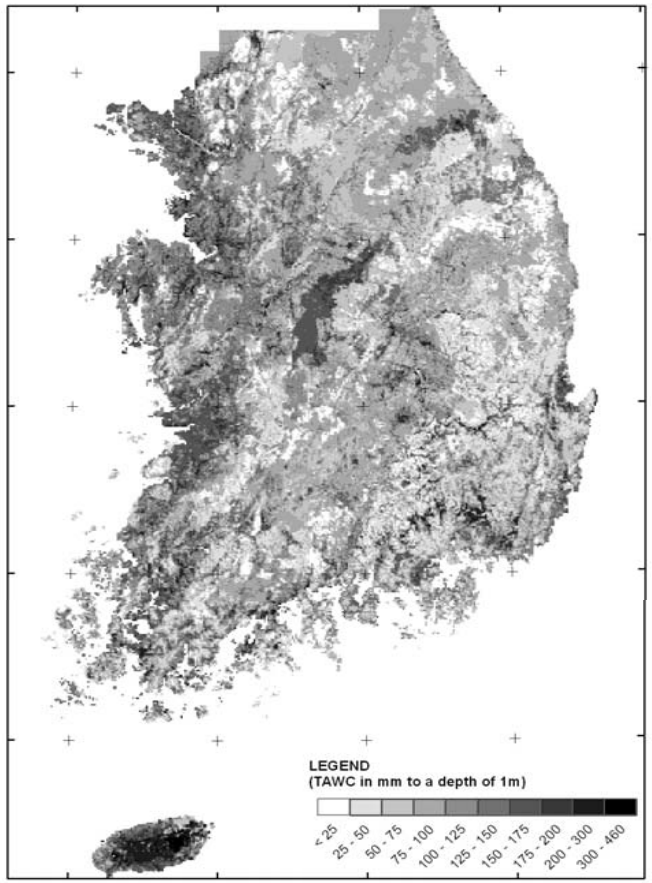




Comparison of available water contents estimated by proposed PTF model results.

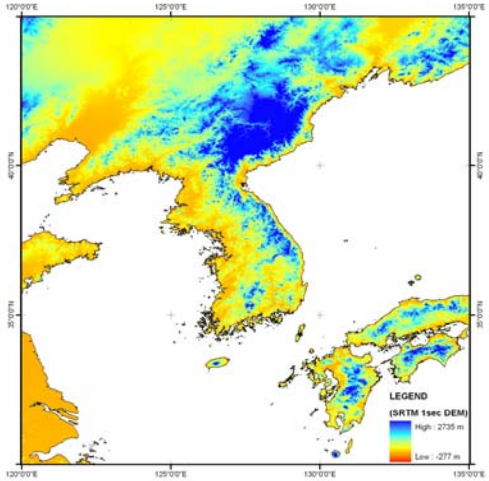
Total available water capacity and field capacity of the soil in Korea for 100㎝ depth





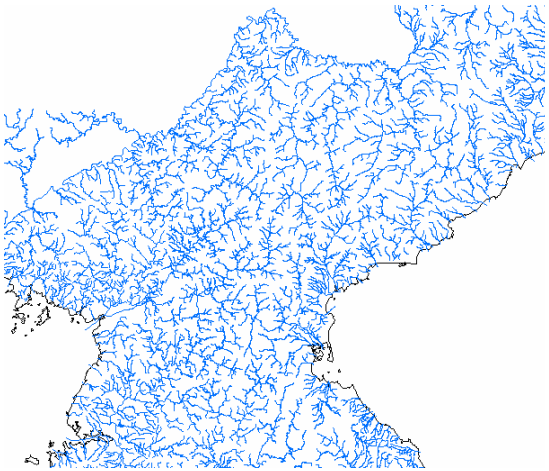
$$TAWC = \sum_{j=1}^{n} [AWC_j \cdot t_j \cdot (1 - s_j)]$$

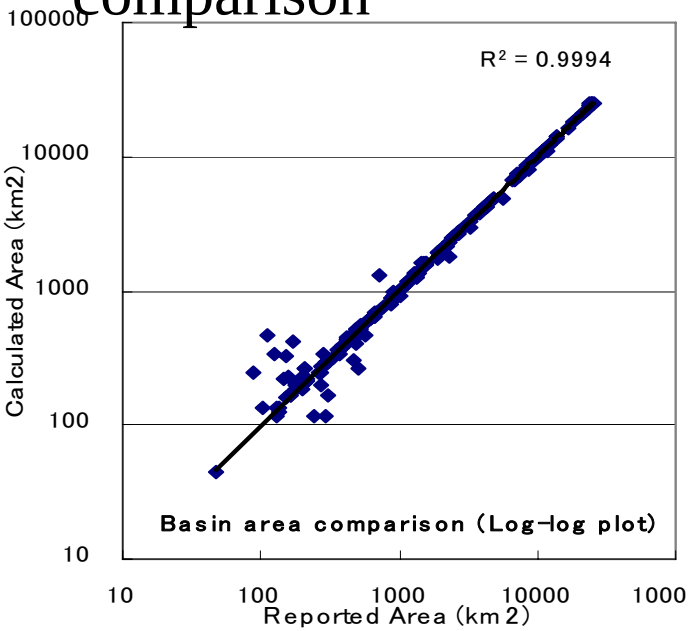
Construction of Hydro database : Basin delineation of Korean peninsula

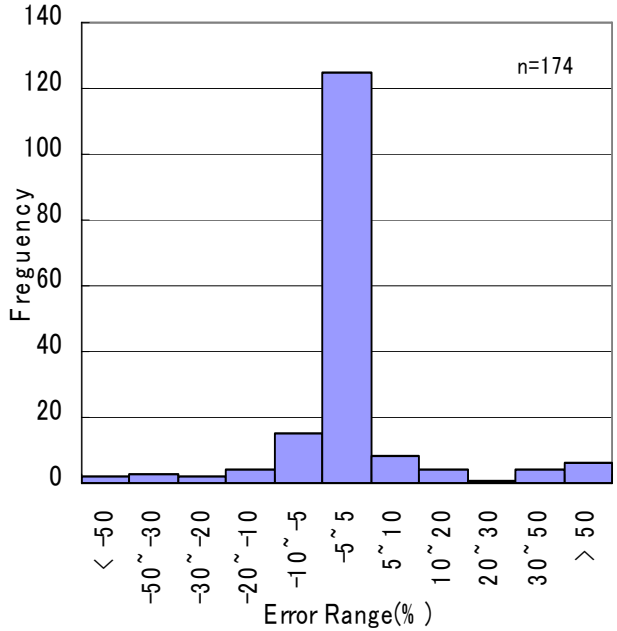


GIS based Hydro-Network and Basin DB :

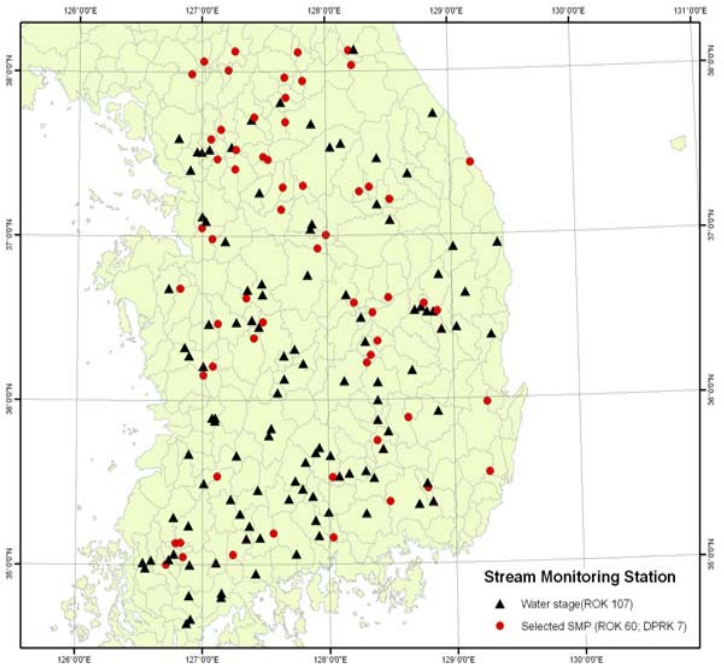
1. SRTM 3sec DEM
2. 1:25,000 rivernet for stream burning
3. National basin map of ROK
4. 177 stream monitoring station for area comparison





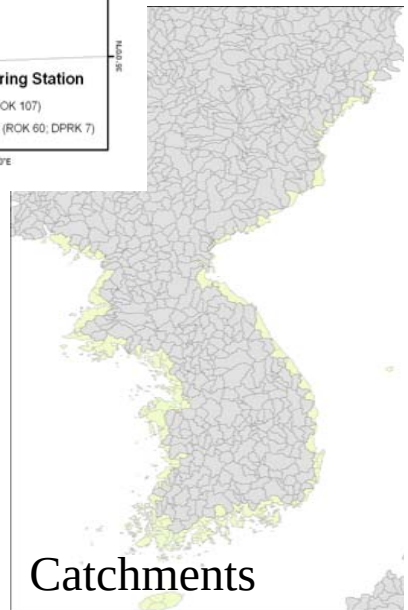


Construction of Hydro database : Discharge DB and Watershed delineation

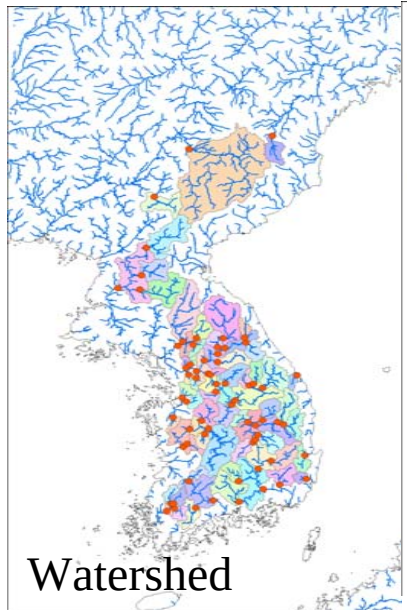


GIS based Hydro-Network and Basin DB :

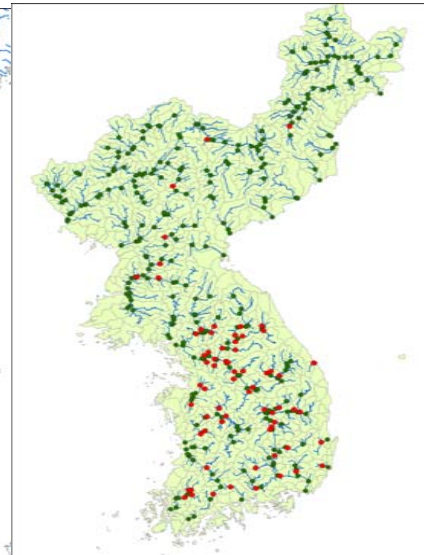
1. ROK- 60 station, daily water level
2. DPRK- GRDC monthly 7station
3. more than 5 year records for optimzation



Catchments



Watershed



HydroNet

Comparison of land surface dependent PET between PM and SW Model (10yr mean)

- *Penman-Monteith* (PM)

$$c_t L_v \rho_w E_{ps} = \frac{\Delta R_n + c_p \rho D_a / r_a}{\Delta + \gamma + \gamma (r_c / r_a)}$$

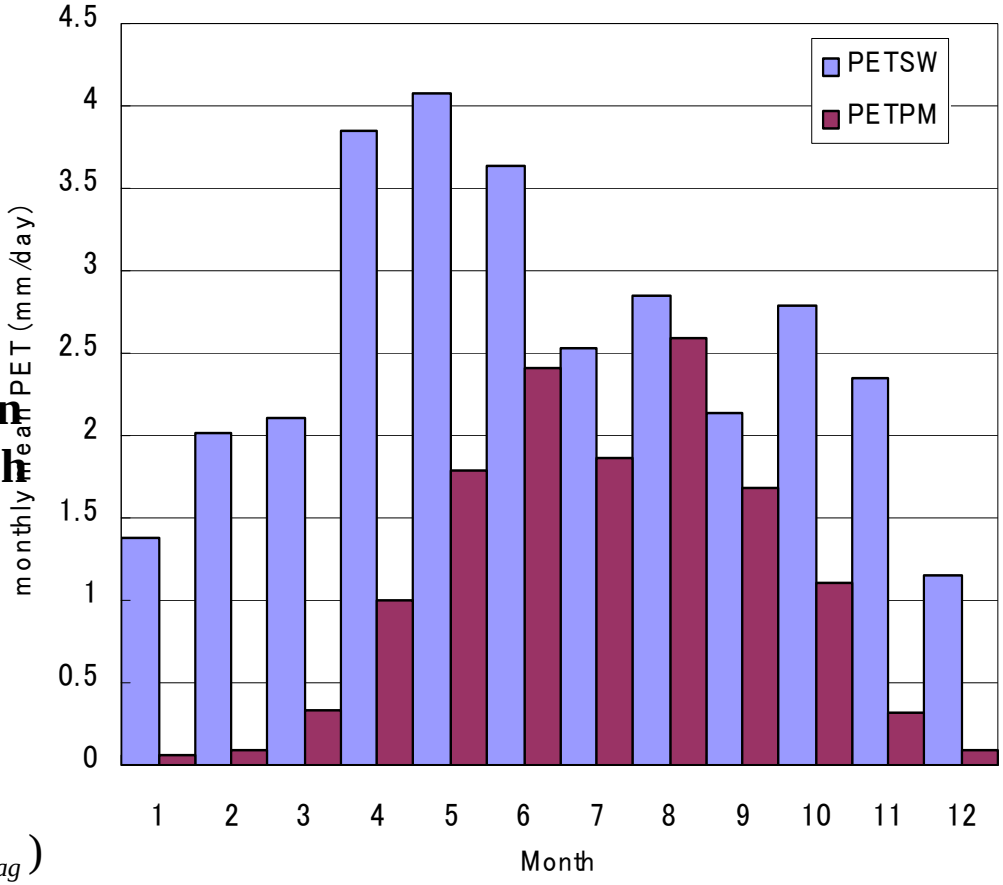
- *Shuttleworth and Wallace* (SW)

-Dividing Transpiration and Evaporation
- More accurate and theoretical approach

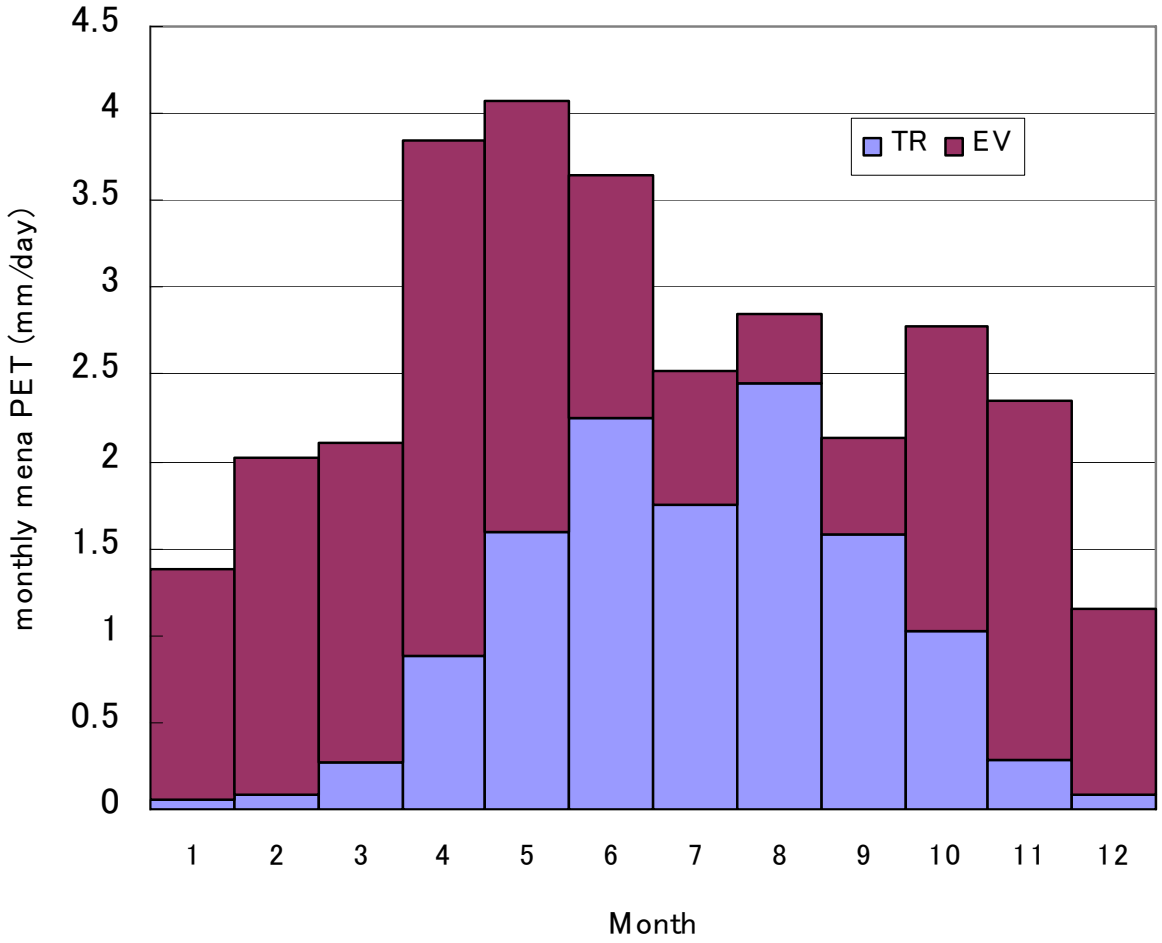
$$c_t L_v \rho_w E_{ps} = C_c M_c + C_g M_g$$

$$M_c = \frac{\Delta R_n + (c_p \rho D_a - \Delta r_{ac} R_g)/(r_{aa} + r_{ac})}{\Delta + \gamma + \gamma r_{sc}/(r_{aa} + r_{ac})}$$

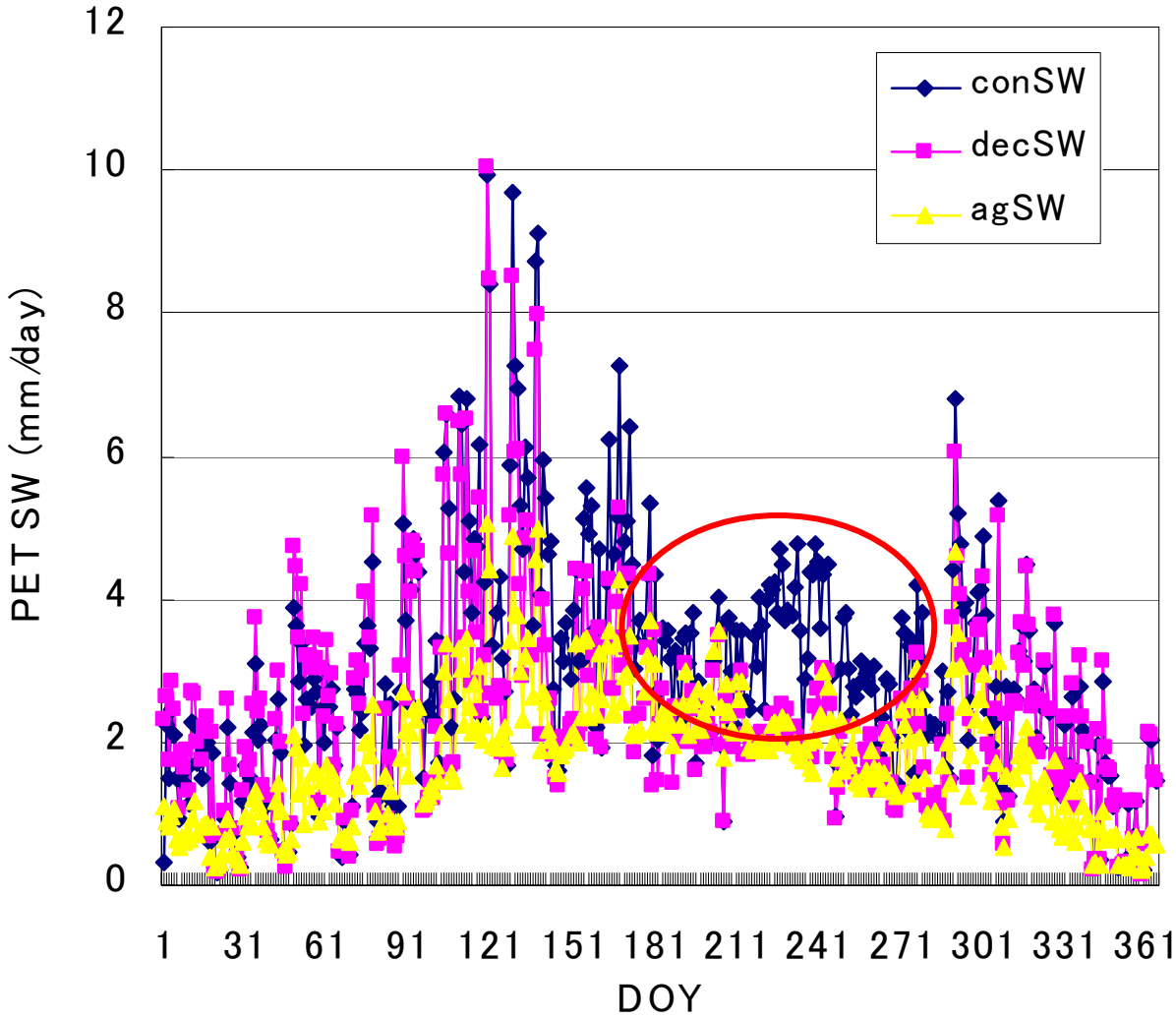
$$M_g = \frac{\Delta R_n + [c_p \rho D_a - \Delta r_{ag}(R_n - R_g)]/(r_{aa} + r_{ag})}{\Delta + \gamma + \gamma r_{sg}/(r_{aa} + r_{ag})}$$



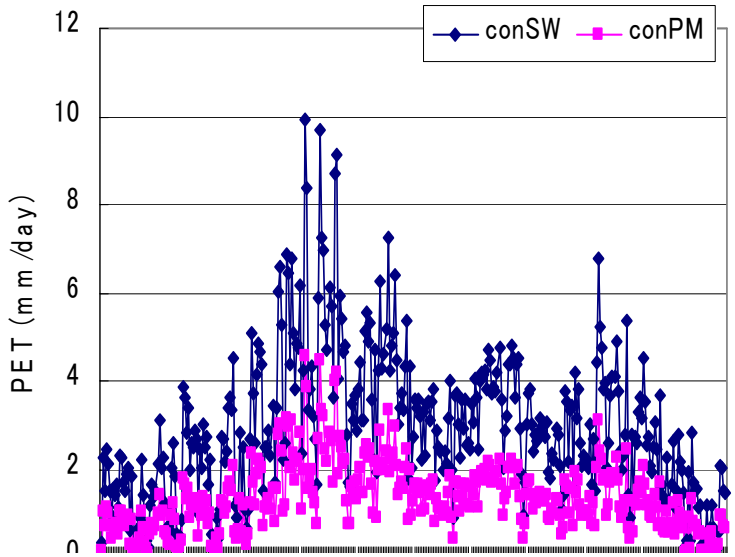
Ratio of Transpiration and Evaporation at deciduous forest-dominant basin by SW model



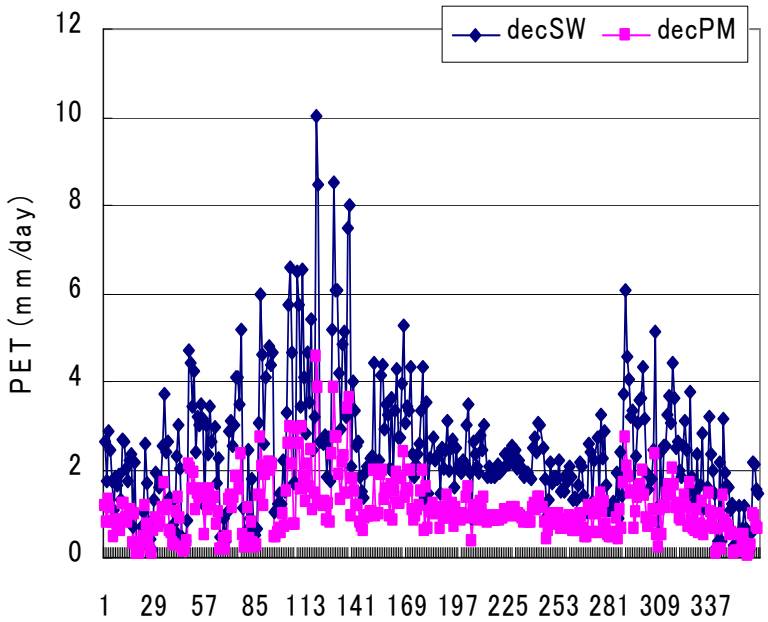
PET by land cover type using SW model



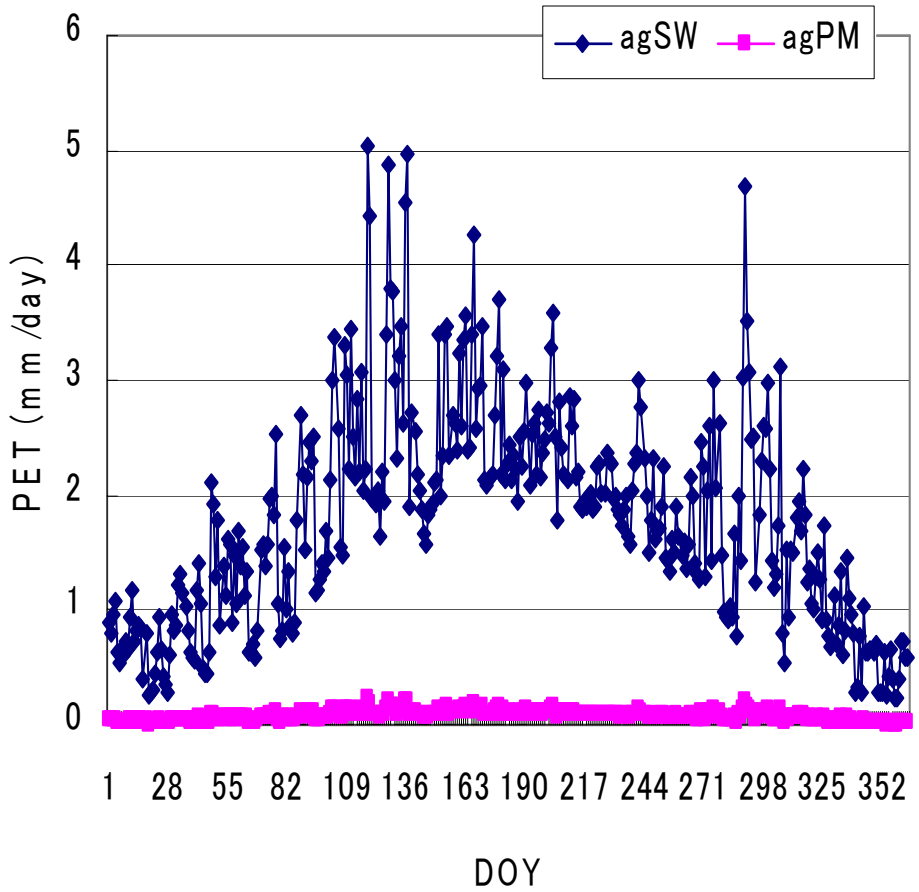
Coniferous



Deciduous Forest



Agriculture Forest



Thanks !