Supporting Information S1

Using Darcy's law and the Dupuit approximation, the groundwater flow rate toward the riparian zone can be formulated as [1]:

$$q(\mathrm{WT}) = K_s \frac{H_0^2 - h^2}{2L} \quad \textbf{(S1)}$$

where K_s is [L T^{-1}] is the saturated hydraulic conductivity of the aquifer system; L [L] is the distance from the background to the riparian zone; H_0 [L] and h [L] is the groundwater elevation in the background and the riparian zone, respectively (Fig. 1). Assuming the depth of the aquifer to be D [L], equation S1 can be transferred to:

$$\begin{aligned} q(\mathrm{WT}) &= K_s \frac{H_0^2 - h^2}{2L} \\ &= K_s \frac{(D - WT_0)^2 - (D - WT)^2}{2L} \\ &= K_s \frac{WT_0^2 - 2D \times WT_0 - WT^2 + 2D \times WT}{2L} \\ &= -\frac{K_s}{2L} WT^2 + \frac{D \times K_s}{L} WT + \frac{K_s \times WT_0^2 - 2D \times WT_0}{2L} \end{aligned} \quad \textbf{(S2)}$$

where WT_0 [L] is the water table depth at the background region; and WT [L] is the water table depth in the riparian zone. Thus, we can simply write equation (S2) as:

$$q(\mathrm{WT}) = a_1 \times WT^2 + a_2 WT + a_3$$

with the coefficients $a_1 = -K_s / 2L$, $a_2 = D \times K_s / L$, and $a_3 = \frac{K_s \times WT_0^2 - 2D \times WT_0}{2L}$.

If the aquifer is depth enough ($D \gg WT_0, D \gg WT$), then equation S1 can be further simplified as:

$$
\begin{aligned}
q(\mathrm{WT}) &= K_s \frac{H_0^2 - h^2}{2L} \\
&= K_s \frac{(D-WT_0)^2 - (D-WT)^2}{2L} \\
&= K_s \frac{[(D-WT_0)+(D-WT)][(D-WT_0)-(D-WT)]}{2L} \\
&\approx \frac{D \times K_s}{L}(WT - WT_0)
\end{aligned}
\quad \textbf{(S3)}
$$

Supporting Information S2

In shallow water table environments, S_y can be calculated using the depth-compensated method proposed by Loheide et al. [2]**:**

$$
S_y = \theta_s - [\theta_R + \frac{\theta_s - \theta_R}{[1+(\alpha|WT|)^n]^m}] \quad \textbf{(S4)}
$$

where WT [L] is water table depth, θ_s and θ_R are saturated and residual soil moisture (dimensionless), α (m^{-1}), n (dimensionless) and m (dimensionless) are empirical coefficients. To obtain the S_y value of the study area, soil samples at three depth ranges (0-0.5 m, 0.5-1.0 m and 1.0-1.5 m below the ground) were collected. The soil moisture curve of the soil samples was determined using a pressure plate extractor (Daiki-3404; Daiki Rika Kogyo Co., Ltd, Saitama, Japan) to obtain important parameters used in the van Genuchten model, and the properties of the soil samples were analyzed using a Mastersizer 2000 laser diffractometer (Malvern Panalytical, Malvern, UK). The parameters for the silt loam soil at our site are estimated as follows: $\theta_s = 0.38$ m^3 m^{-3}, $\theta_r = 0.16$ m^3 m^{-3}, $\alpha = 0.85$ m^{-1}, $n = 1.23$, and $m = 0.19$.

The S_y value calculated using the Loheide method was given in Fig. S1, as well as that calculated using the minimum RSS method. The result indicated that the Loheide method is suitable for determination of S_y during water table declining periods, and may overestimate the values of S_y for water rising periods.

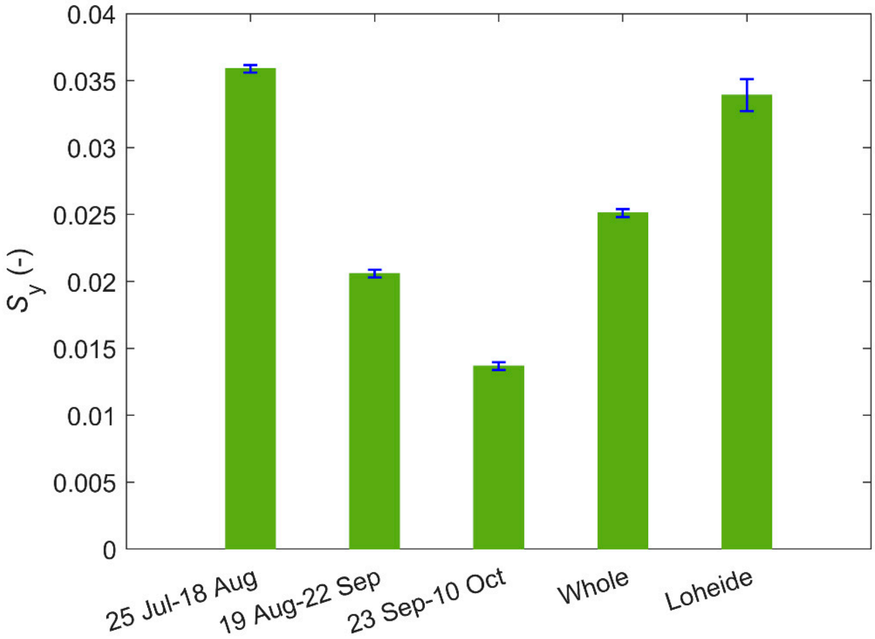

Figure S1. Comparisons of estimated S_y values by different methods

References

1. Harr, M.E. Groundwater and Seepage. McGraw-Hill, New York, 1962; p. 315.
2. Loheide, S. P.; Butler Jr, J. J.; Gorelick, S. M. Estimation of groundwater consumption by phreatophytes using diurnal water table fluctuations: a saturated-unsaturated flow assessment. Water Resour. Res. 2005, 41, W07030, doi:10.1029/2005WR003942.