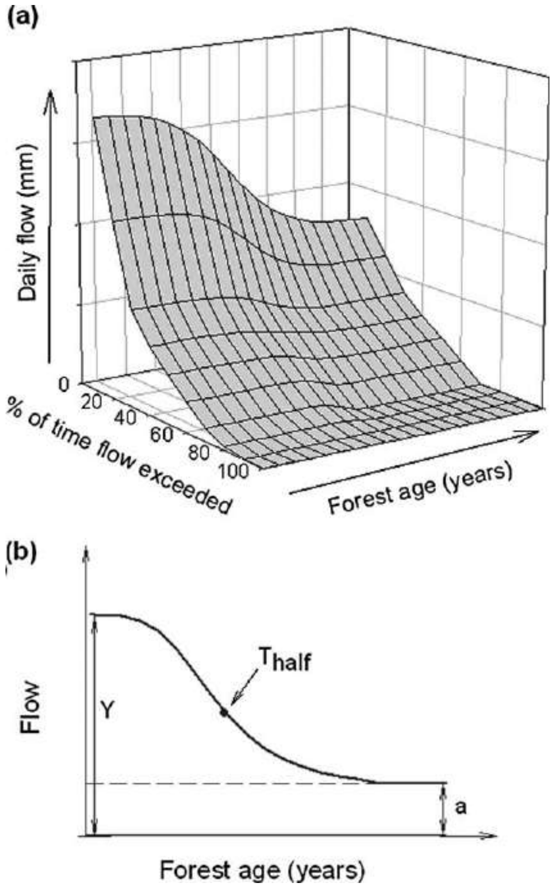

Fig. 2. (a) Schematic of the change in the FDC over time, and (b) definition of model parameters.

2.2. Zero flow day analysis

A notable feature of Fig. 1 is the increase in the number of zero flow days. A similar approach to Eq. (2), using an inverse sigmoidal function was employed to assess the impact of afforestation on the number of zero flow days per year (N_{zero}). In this case, the left hand side of Eq. (2) is replaced by N_{zero}, and b and S are constrained to negative as N_{zero} decreases as rainfall increases, and increases with plantation growth:

$$N_{\mathrm{zero}} = a + b(\Delta P) + \frac{Y}{1 + \exp\left(\frac{T - T_{\mathrm{half}}}{S}\right)} \tag{3}$$

For the average pre-treatment condition $\Delta P = 0$ and $T = 0$, N_{zero} approximately equals a. Y gives the magnitude of change in zero flow days due to afforestation, and S describes the shape of the response. For the average climate condition $\Delta P = 0$, $a + Y$ becomes the number of zero flow days when the new equilibrium condition under afforestation is reached.

2.3. Statistical analyses

The coefficient of efficiency (E) (Nash and Sutcliffe, 1970; Chiew and McMahon, 1993; Legates and McCabe, 1999) was used as the 'goodness of fit' measure to evaluate the fit between observed and predicted flow deciles (2) and zero flow days (3). E is given by:

$$E = 1.0 - \frac{\sum_{i=1}^{N}(O_i - P_i)^2}{\sum_{i-1}^{N}(O_i - \bar{O})^2} \tag{4}$$

where O are observed data, P are predicted values, and $\bar{O}$ is the mean for the entire period. E is unity minus the ratio of the mean square error to the variance in the observed data, and ranges from $-\infty$ to 1.0. Higher values indicate greater agreement between observed and predicted data as per the coefficient of determination (r^2). E is used in preference to r^2 in evaluating hydrologic modelling because it is a measure of the deviation from the 1:1 line. As E is always $< r^2$ we have arbitrarily considered $E > 0.7$ to indicate adequate model fits.

It is important to assess the significance of the model parameters to check the model assumptions that rainfall and forest age are driving changes in the FDC. The model (2) was split into simplified forms, where only the rainfall or time terms were included by setting $b = 0$, as shown in Eq. (5), or $Y = 0$ as shown in Eq. (6). The component models (5) and (6) were then tested against the complete model, (2).

$$Q_{\%} = a + \frac{Y}{1 + \exp\left(\frac{T - T_{\mathrm{half}}}{S}\right)} \tag{5}$$

and

$$Q_{\%} = a + b\Delta P \tag{6}$$

For both the flow duration curve analysis and zero flow days analysis, a t-test was then performed to test whether (5) and (6) were significantly different to (2). A critical value of t exceeding the calculated t-value