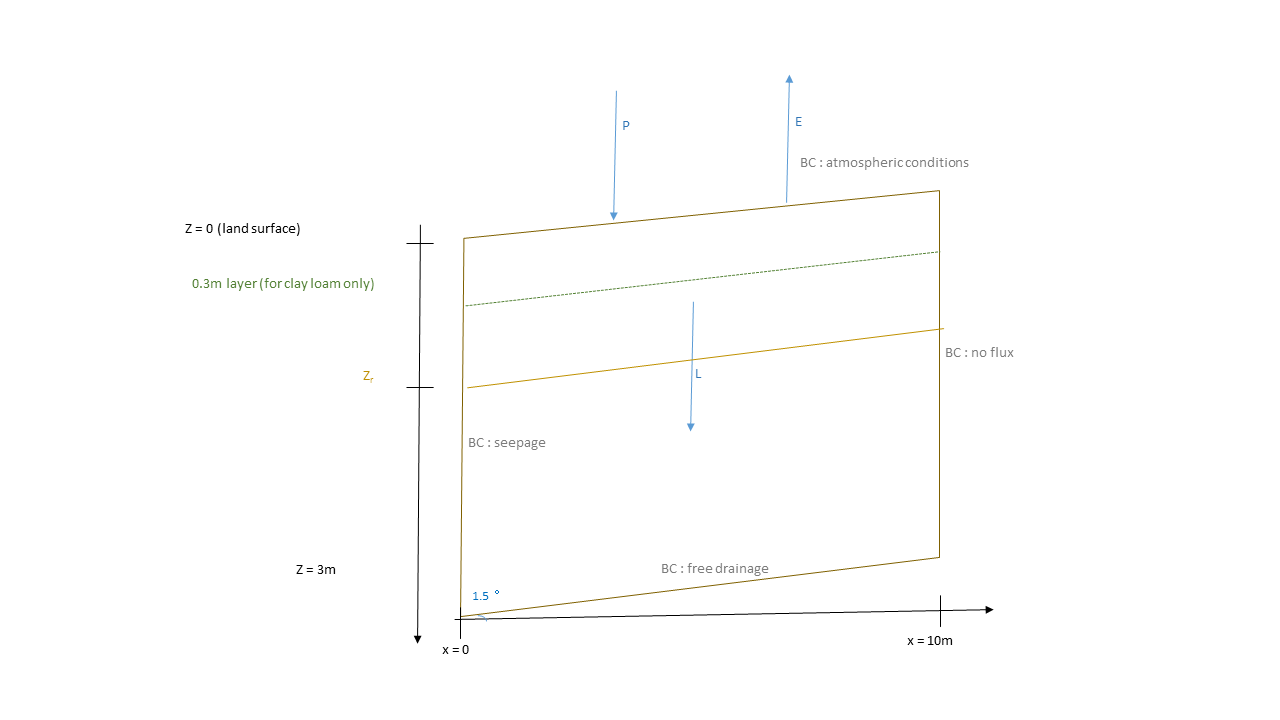
**Supplementary material**

**HYDRUS 2D setup**

HYDRUS 2D was used in this study as it is not possible to measure vertical water fluxes directly in the soil. HYDRUS 2D was therefore calibrated against available data of soil water content, and the calibrated soil hydraulic parameters were then used as inputs into the suggested modelling framework, thereafter referred to as Shallow Subsurface Modelling Framework (SSMF).

The HYDRUS 2D profile was setup according to the available soil water content data of the Sunjia catchment (Figure SM1). The soil hydraulic parameters were different in the clay loam profile between the upper layer (0-0.3m) and the remaining depth of the profile (0.3-3m). The groundwater table was measured at 3m.



**Figure SM1** HYDRUS 2D profile setup. BC stands for Boundary condition. In the clay loam profile.

The results shown in the main body of this study are the values found at x=5m, in order to minimize the effects of the lateral boundary conditions.

**Soil hydraulic data and calibration**

The following is only relevant for the clay loam texture, as a synthetic dataset of soil hydraulic parameters (reported in Table 1 of the main body) was used for the loamy sand texture. This allows for a more realistic study especially in the context of the Chinese red soils.

Soil water content time series were available at 0.4 and 0.8m, and at 6 locations along the slope for the period of study (23-10-2012 until 31-12-2013).

The soil was sampled and analysed by standard methods in October, 2010. The Ks was measured by the falling head method. Soil texture was determined by sedimentation method in the laboratory. The soil water retention curves were determined by a combination of the sand box method (0, -30, and -60 water potential) and pressure chamber (-100, -330, -1000, -3000 and -15000 water potential) at 0.05, 0.2, 0.4 and 0.8m depth, and provided the boundaries for the intervals of calibration of Richards’ equation in HYDRUS 2D within the 10’000 Monte-Carlo simulations. The values are reported in Table SM1.

**Table SM1** Range of the Mualem- van Genuchten parameters in the two layers of the clay loam profile for the calibration of Richards’ equation in HYDRUS 2D.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | (m3/m3) | (m3/m3) | (-) | (-) | *α*(1/m) | (m/d) |
| 0-0.3m | [0.001;0.12] | [0.35;0.48] | [1.05;1.54] | 0.5 | [0.001;0.12] | Lgn(-0.76,1.24) |
| 0.3-3m | [0.07;0.47] | [0.37;0.5] | [1.05;1.90] | [0.001;0.12] | [0.001;0.27] | [0.02;0.39] |

The prior distributions were assumed to be uniform for all the parameters except for in the layer 0-0.3m where a lognormal distribution was fitted, based on the measured soil hydraulic properties.

The results of the calibration of HYDRUS 2D are reported in Figure 4 of the main body. 10’000 Monte-Carlo simulations did not allow for a perfect fit with the data. However, the overall dynamics were captured. The calibrated time series were used in this study solely to represent realistic values for the conditions in the Sunjia catchment, therefore no further calibration was performed.

We report in Table SM2 the laboratory analysis results performed in 2012 in the peanut plots in Sunjia CZO.

**Table SM2** Laboratory results for the peanut upper- mid- and lower- slope plots (U.S, M.S., and L.S. respectively): sand, silt and clay contents (in %), bulk density (BD, in g/cm3), saturated hydraulic conductivity (Ks, in mm/min) and soil organic matter (SOM, in g/kg).

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Depth (cm) | Plot | Sand 1-0.05mm% | | Silt 0.05—0.002mm% | Clay <0.002mm% | BD(g/cm3) | Ks(mm/min) | SOM (g/kg) |
| 0-10 | Peanut (U.S.) | | 48.1 | 23.3 | 28.6 | 1.3 | 2.8 | 10.6 |
| 10-20 | Peanut (U.S.) | | 46.6 | 24.8 | 28.6 | 1.6 | 0.1 | 8.8 |
| 20-40 | Peanut (U.S.) | | 48.0 | 27.0 | 25.0 | 1.5 | 0.0 | 5.7 |
| 40-60 | Peanut (U.S.) | | 40.4 | 21.5 | 38.1 | 1.4 | 0.1 | 3.8 |
| 60-80 | Peanut (U.S.) | | 41.6 | 22.4 | 36.0 | 1.4 | 0.0 | 3.4 |
| 80-100 | Peanut (U.S.) | | 33.8 | 27.8 | 38.4 | 1.4 | 0.1 | 2.9 |
| 0-10 | Peanut (M.S.) | | 47.3 | 24.7 | 28.0 | 1.4 | 1.5 | 9.1 |
| 10-20 | Peanut (M.S.) | | 48.2 | 21.8 | 29.9 | 1.5 | 0.6 | 6.1 |
| 20-40 | Peanut (M.S.) | | 43.7 | 25.3 | 31.0 | 1.5 | 0.0 | 4.2 |
| 40-60 | Peanut (M.S.) | | 47.4 | 23.7 | 28.9 | 1.5 | 0.2 | 3.7 |
| 60-80 | Peanut (M.S.) | | 42.8 | 25.2 | 31.9 | 1.4 | 0.1 | 3.5 |
| 80-100 | Peanut (M.S.) | | 40.8 | 22.3 | 36.8 | 1.4 | 0.1 | 3.9 |
| 0-10 | Peanut (L.S.) | | 50.4 | 22.7 | 26.9 | 1.4 | 0.4 | 10.8 |
| 10-20 | Peanut (L.S.) | | 52.8 | 20.8 | 26.5 | 1.5 | 0.5 | 8.8 |
| 20-40 | Peanut (L.S.) | | 49.7 | 22.3 | 28.0 | 1.4 | 0.6 | 7.7 |
| 40-60 | Peanut (L.S.) | | 46.7 | 25.7 | 27.6 | 1.5 | 0.0 | 3.7 |
| 60-80 | Peanut (L.S.) | | 44.8 | 27.7 | 27.6 | 1.5 | 0.0 | 3.3 |
| 80-100 | Peanut (L.S.) | | 43.4 | 28.1 | 28.5 | 1.4 | 0.1 | 2.8 |