Supplementary material

Supplementary tables

Table S1: Forcing data used for EcH₂O-iso

| Forcing dataset(s) | Source | Temporal coverage | Notes |
|-----------------------------|--|------------------------|-----------------------------------|
| Precipitation | Interpolated using an inverse distance- weighted algorithm and five nearby (<10 | Prior to July 2014 | c.f. Capell et al. (2012) |
| | km) gauges | | |
| |) 544543 | | |
| | Up to three automated weather stations in the | | |
| | catchment | July 2014 onwards | - |
| Minimum and maximum | ERA-interim climate reanalysis | Prior to July 2014 | See Dee et al. (2011) |
| air temperature | | | |
| | Up to three automated weather stations in the | July 2014 onwards | - |
| | catchment | | |
| Mean air temperature, | Balmoral weather station ~5 km away | Prior to July 2014 | See Met Office (2017) |
| relative humidity and | | | |
| windspeed | | | |
| | Up to three automated weather stations in the | July 2014 onwards | - |
| | catchment | | |
| Short- and long-wave | ERA-interim climate reanalysis | Full simulation period | See Dee et al. (2011) |
| radiation | | | |
| Isotopic (δ ² H) | ISCO 3700 sampler at catchment outlet | Full simulation period | Daily bulk samples were |
| composition of | | | collected and preserved |
| precipitation | | | under a layer of paraffin. A |
| | | | Los Gatos DLT-100 was |
| | | | used for isotope analysis |
| | | | (δ^2 H precision: ±0.4‰). |

Table S2: The sampling ranges and 90%-spread calibrated ranges of soil, vegetation and channel parameters identified as sensitive in this application of EcH2O-iso. Additional information on parameter definitions can be found at: https://ech2o-iso.readthedocs.io/en/latest/Setup.html

| Parameter | Sampling range [90 | % spread calibrated ra | inge] | |
|--|---|---|---|---|
| Soil | Peat | Peaty gley | Podzol | Ranker |
| Air entry pressure (m) | 0.01-0.45 | 0.01-0.1 | 0.01-0.1 | 0.05-0.2 |
| | [0.05-0.41] | [0.03-0.09] | [0.02-0.09] | [0.06-0.17] |
| Brooks-Corey lambda (-) | 3.0-8.0 | 3.0-8.0 | 3.0-8.0 | 3.0-8.0 |
| | [3.1-7.8] | [4.9-7.8] | [4.1-7.0] | [3.4-7.4] |
| Soil L1 depth (m) | 0.05-0.15 | 0.05-0.15 | 0.05-0.15 | 0.05-0.15 |
| | [0.05-0.13] | [0.05-0.14] | [0.06-0.13] | [0.06-0.14] |
| Soil L2 depth (m) | 0.05-0.20 | 0.05-0.20 | 0.05-0.20 | 0.05-0.20 |
| | [0.05-0.19] | [0.07-0.18] | [0.06-0.20] | [0.06-0.19] |
| Total soil depth (m) | 0.5-40.0 | 0.5-40.0 | 0.5-10.0 | 0.5-5.0 |
| | [0.7-36.4] | [1.1-27.2] | [1.7-8.3] | [0.7-4.6] |
| Saturated horizontal hydraulic | 1.0×10 ⁻⁵ -1×10 ⁻² | 1.0×10 ⁻⁵ -1.0×10 ⁻³ | 1.0×10 ⁻⁵ -1.0×10 ⁻³ | 1.0×10 ⁻⁶ -1.0×10 ⁻⁴ |
| conductivity (ms ⁻¹) | [1.6×10 ⁻⁵ -3.6×10 ⁻³] | [2.2×10 ⁻⁵ -8.5×10 ⁻⁴] | [4.6×10 ⁻⁴ -9.1×10 ⁻⁴] | [1.2×10 ⁻⁶ -8.2×10 ⁻⁵] |
| Anisotropy (-) | 1.0×10 ⁻³ -1.0 | 1.0×10 ⁻³ -0.6 | 1.0×10 ⁻³ -0.6 | 1.0×10 ⁻³ -0.6 |
| | [1.6×10 ⁻³ -0.85] | [1.8×10 ⁻³ -0.35] | [1.3×10 ⁻³ -0.53] | [1.1×10 ⁻³ -0.22] |
| Conductivity exponential decay constant | 1.0-5.0 | 1.0-5.0 | 1.0-5.0 | 1.0-5.0 |
| (m ⁻¹) | [1.2-4.8] | [1.9-4.6] | [1.5-4.9] | [1.3-4.7] |
| Porosity (m ³ m ⁻³) | 0.8-0.98 | 0.7-0.9 | 0.4-0.7 | 0.4-0.6 |
| | [0.81-0.93] | [0.74-0.89] | [0.50-0.69] | [0.42-0.57] |
| Porosity exponential decay constant (m ⁻¹) | 5.0-10.0 | 5.0-10.0 | 3.0-5.0 | 0.5-1.0 |
| | [5.4-9.7] | [5.5-9.3] | [3.2-4.9] | [0.6-1.0] |
| Vegetation | Pre-existing pine | Heather | Sphagnum | Molinia grass |
| LAI $(m^2 m^{-2})$ | 2.0-4.0 | 1.4-2.0 | 2.0-3.5 | 1.0-3.0 |
| | [2.2-3.8] | [1.5-2.0] | [2.1-3.4] | [1.2-2.8] |
| Maximum canopy water storage (m LAI ⁻¹) | 3.0×10 ⁻⁴ -3.0×10 ⁻³ | 5.0×10 ⁻⁴ -2.0×10 ⁻³ | 1.0×10 ⁻³ -1.0×10 ⁻² | 1.0×10 ⁻⁴ -5.0×10 ⁻⁴ |
| | [3.5×10 ⁻⁴ -2.7×10 ⁻³] | [5.4×10 ⁻⁴ -1.7×10 ⁻³] | [1.2×10 ⁻³ -7.9×10 ⁻³] | [1.4×10 ⁻⁴ -4.7×10 ⁻⁴] |
| Maximum stomatal conductance (ms ⁻¹) | 3.3×10 ⁻³ -8.1×10 ⁻³ | 5.2×10 ⁻³ -6.6×10 ⁻³ | 1.3×10 ⁻² -1.8×10 ⁻² | 6.4×10 ⁻³ -1.5×10 ⁻² |
| | [3.6×10 ⁻³ -7.9×10 ⁻³] | [5.3×10 ⁻³ -6.5×10 ⁻³] | [1.3×10 ⁻² -1.8×10 ⁻²] | [6.6×10 ⁻³ -1.4×10 ⁻²] |
| Stomatal sensitivity to light (-) | 200-500 | 200-500 | 200-500 | 200-500 |
| | [213-452] | [223-442] | [220-496] | [222-479] |
| Stomatal sensitivity to vapour pressure | 1.0×10 ⁻³ -3.0×10 ⁻³ |
| deficit (-) | [1.9×10 ⁻³ -2.9×10 ⁻³] | [1.1×10 ⁻³ -2.9×10 ⁻³] | [1.1×10 ⁻³ -2.9×10 ⁻³] | [1.1×10 ⁻³ -2.8×10 ⁻³] |
| Soil water potential (-MPa): | | | | |
| Causing complete stomatal | 1.5-6.0 | 1.5-6.0 | 1.5-6.0 | 1.5-6.0 |
| closure | [1.8-5.8] | [1.8-5.7] | [1.8-5.6] | [1.6-5.8] |
| No longer limiting stomatal conductance | 0.1-1.0 | 0.1-1.0 | 0.1-1.0 | 0.1-1.0 |

| | [0 14 0 05] | [0 20 0 0 0] | [0 22 0 20] | [0,14,0,02] |
|--|-------------|--------------|-------------|-------------|
| | [0.14-0.95] | [0.20-0.96] | [0.22-0.89] | [0.14-0.92] |
| Minimum temperature of comfort (°C) | -5.03.0 | -5.03.0 | -5.03.0 | -6.03.0 |
| | [-5.03.1] | [-4.83.2] | [-4.83.3] | [-5.83.1] |
| Optimal temperature (°C) | 10.0-25.0 | 15.0-25.0 | 10.0-18.0 | 12.0-18.0 |
| | [11.0-24.2] | [15.3-24.4] | [10.3-17.3] | [12.2-17.2] |
| Maximum temperature of comfort (°C) | 35.0-42.0 | 40.0-45.0 | 38.0-42.0 | 30.0-40.0 |
| | [35.4-41.4] | [40.5-44.8] | [38.1-41.7] | [31.7-39.1] |
| Light attenuation coefficient (-) | 0.3-0.6 | 0.3-0.6 | 0.3-0.6 | 0.3-0.6 |
| | [0.33-0.58] | [0.36-0.58] | [0.39-0.60] | [0.33-0.58] |
| Vertical root distribution exponential | 10.0-20.0 | 27.0-40.0 | 27.0-100.0 | 6.0-10.0 |
| decay constant (m ⁻¹) | [10.9-19.5] | [28.1-39.2] | [32.5-82.8] | [6.6-10.0] |
| Channel | | | | |
| Channel resistance to groundwater | 0.01-0.05 | | | |
| seepage (-) | [0.01-0.04] | | | |
| Manning's n | 1.0-50.0 | | | |
| | [4.8-49.1] | | | |



Figure S1: Summary of natural pinewood regeneration. After Summers (2018) and Summers et al. (2008).



Figure S2: Time series of observed and simulated volumetric water content (VWC) at sites not shown in Figure 3. 90% spread of simulations are from the 30 behavioural model runs.



Figure S3: Time series of observed and simulated soil water (SW) and deeper groundwater (DW) isotopes at sites not shown in Figure 3. 90% spread of simulations are from the 30 behavioural model runs.



Figure S4: Time series of observed and simulated evapotranspiration (ET) and transpiration (Tr) at sites not shown in Figure 3. 90% spread of simulations are from the 30 behavioural model runs.



Figure S5: Time series of observed and simulated net radiation (CNR) at sites not shown in Figure 3. 90% spread of simulations are from the 30 behavioural model runs.

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