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Corrigendum to "The global water resources and use model WaterGAP v2.2d: model description and evaluation" published in Geosci. Model Dev., 14, 1037–1079, 2021

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This corrigendum was written in order not only to reflect feedback we have received since the original paper was published but also to update the code and model output description. In particular, some typos, errors in wording, and references to figures present in the original manuscript submission are corrected (Sects. 1, 3, 4, 5); the description of the calculation of runoff is now written in an unambiguous way (Sect. 2); and a number error in Table 6 of the original paper, which was introduced during the production process, is corrected. Furthermore, the model code is now available open access and model output driven by an additional climate forcing is now available (Sect. 7).

1 Unit correction

The unit for the land-cover-specific degree-day factor D_F (Sect. 4.3.3) is not $\mathrm{mm\,d^{-1}\,°C}$ but $\mathrm{mm\,d^{-1}\,°C^{-1}}$.

2 Explicit description for runoff from land

The description of the variable runoff from land R_l (Eq. 18 in Sect. 4.4.3) is ambiguous. Actually, Eq. (18) describes a part of R_l, the soil water outflow, which forms together with the soil water overflow and the urban runoff (see the sentences after Eq. 18) the total runoff. To be unambiguous, Sect. 4.4.3 starting after the sentence "$E_{\mathrm{pot,max}}$ is set to $15\ \mathrm{mm\,d^{-1}}$ globally" and until "R_l is partitioned into fast surface and subsurface runoff" is replaced by the following:

Runoff from land R_l (Eq. 15) is calculated as

$$R_l = R_1 + R_2 + R_3, \tag{18a}$$

where R_1 is the runoff in urban areas and is calculated as

$$R_1 = \begin{cases} 0.5 P_{\mathrm{eff}} f_{\mathrm{urban}} & \text{for the urban land fraction,} \\ 0 & \text{otherwise.} \end{cases} \tag{18b}$$

Here f_{urban} is the fraction of urban areas of the grid cell (defined from MODIS data, Appendix C) and the amount of R_1 is subtracted from P_{eff} before calculating R_2 and R_3.

R_2 is the soil water outflow that occurs when addition of P_{eff} to the soil exceeds $S_{\mathrm{s,max}}$. It is calculated as

$$R_2 = \begin{cases} P_{\mathrm{eff}} + S_{\mathrm{s},t-1} - S_{\mathrm{s,max}} & (P_{\mathrm{eff}} + S_{\mathrm{s},t-1}) > S_{\mathrm{s,max}}, \\ 0 & \text{otherwise,} \end{cases} \tag{18c}$$

Table 6. Global-scale (excluding Antarctica and Greenland) water balance components for different time spans as simulated with WaterGAP 2.2d. All units in $km^3\,yr^{-1}$. Long-term average volume balance error is calculated as the difference between component 1 and the sum of components 2, 3, and 7.

No.	Component	1961–1990	1971–2000	1981–2010	1991–2016	2001–2016
1	Precipitation	111 388	111 582	111 616	112 052	112 559
2	Actual evapotranspiration[a]	70 734	71 604	71 979	72 225	72 328
3	Streamflow into oceans and inland sinks	40 659	40 009	39 678	39 930	40 357
4	Actual consumptive water use[b]	906	1023	1146	1238	1302
5	Actual net abstraction from surface water	1002	1108	1220	1304	1353
6	Actual net abstraction from groundwater	−96	−85	−74	−66	−50
7	Change of total water storage	−6	−31	−40	−104	−125
8	Long-term average volume balance error	0.34	0.23	0.11	0.03	0.01

[a] Including actual consumptive water use. [b] Sum of rows 5 and 6.

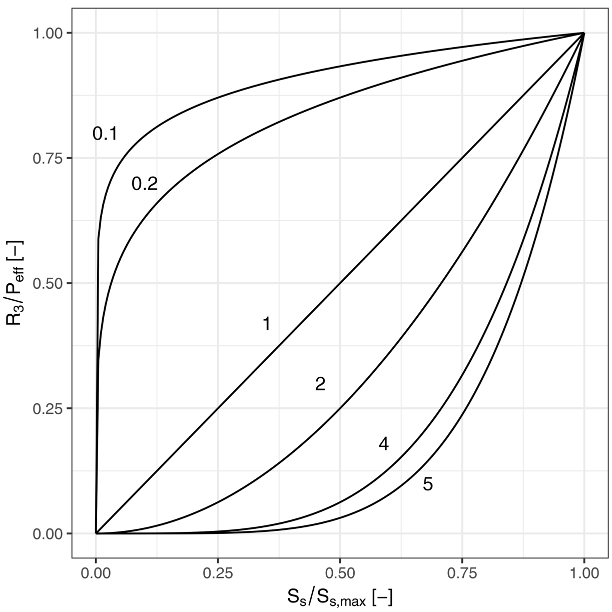

Figure 3. Relation between runoff from land R_3 as a fraction of effective precipitation P_{eff} and soil saturation $S_s/S_{s,max}$ for different values of the runoff coefficient γ in WaterGAP.

where $S_{s,t-1}$ is the soil water storage of the previous time step.

Finally, the runoff component R_3 is calculated according to Bergström (1995) as

$$R_3 = P_{eff}\left(\frac{S_s}{S_{s,max}}\right)^{\gamma}, \qquad (18d)$$

where γ is the runoff coefficient (–). This parameter, which varies between 0.1 and 5.0, is used for calibration (Sect. 4.9). Together with soil saturation, it determines the fraction of P_{eff} that becomes R_3 (Fig. 3).

Figure 3 of the original paper is updated accordingly to Fig. 3 in this corrigendum.

3 Parameter correction

In Sect. 4.6.3 the maximum storage depth of local lakes and that of local wetlands have been interchanged. The maximum storage depth of local lakes is 5 m, whereas the maximum storage depth of local wetlands is 2 m.

4 Correct reference to Supplement figures

In Sect. 4.8, the numbers to the figures in the Supplement have been wrongly referenced. The references to Figs. S2–S5 should be read as references to Figs. S8–S11.

5 Textual correction

The description of Fig. 11b in the first section of Sect. 7.2.1 should be read as “The global map of inter-annual variability of runoff production (Fig. 11b), here defined as the ratio of runoff in a 1-in-10 dry year to total renewable water resources, shows regions with relatively constant and relatively variable annual runoff generation, in bluish and yellow colors, respectively” (it was accidentally written as “reddish” instead of “yellow”).

6 Error in Table 6

Due to an oversight in the production process, an error appeared in Table 6 (Sect. 7.3). The 4009 $km^3\,yr^{-1}$ value should be replaced by 40 009 $km^3\,yr^{-1}$ such that the correct table is Table 6 in this corrigendum.

7 Updated code and model output availability

The WaterGAP model v2.2d as described in this paper was re-calibrated and run with an alternative climate forcing, the so-called GSWP3-W5E5 forcing from ISIMIP3a (Frieler et al., 2023), available for 1901–2019 (Lange et al., 2022). Furthermore, the source code for WaterGAP v2.2d is now publicly available. The "Code and data availability" section has been updated accordingly.

Code and data availability. The source code of WaterGAP 2.2d is publicly available online at https://doi.org/10.5281/zenodo.6902111 (Müller Schmied et al., 2022a). The model output data availability is described in Sect. 5. The standard model output is available online at https://doi.org/10.1594/PANGAEA.918447 (Müller Schmied et al., 2020) and https://doi.org/10.1594/PANGAEA.948461 (Müller Schmied et al., 2022b). For the latest papers published based on WaterGAP, we refer to http://www.watergap.de (Döll, 2020).

References

Bergström, S.: The HBV model, in: Computer models of watershed hydrology, edited by: Singh, V., 443–476, Water Resources Publications, Lone Tree, USA, 1995.

Döll, P.: The WaterGAP Website, available at: http://watergap.de, last access: 25 March 2020.

Frieler, K., Volkholz, J., Lange, S., Schewe, J., Mengel, M., Rivas López, M. R., Otto, C., Reyer, C. P. O., Karger, D. N., Malle, J. T., Treu, S., Menz, C., Blanchard, J. L., Harrison, C. S., Petrik, C. M., Eddy, T. D., Ortega-Cisneros, K., Novaglio, C., Rousseau, Y., Watson, R. A., Stock, C., Liu, X., Heneghan, R., Tittensor, D., Maury, O., Büchner, M., Vogt, T., Wang, T., Sun, F., Sauer, I. J., Koch, J., Vanderkelen, I., Jägermeyr, J., Müller, C., Klar, J., Vega del Valle, I. D., Lasslop, G., Chadburn, S., Burke, E., Gallego-Sala, A., Smith, N., Chang, J., Hantson, S., Burton, C., Gädeke, A., Li, F., Gosling, S. N., Müller Schmied, H., Hattermann, F., Wang, J., Yao, F., Hickler, T., Marcé, R., Pierson, D., Thiery, W., Mercado-Bettín, D., Forrest, M., and Bechtold, M.: Scenario set-up and forcing data for impact model evaluation and impact attribution within the third round of the Inter-Sectoral Model Intercomparison Project (ISIMIP3a), EGUsphere [preprint], https://doi.org/10.5194/egusphere-2023-281, 2023.

Lange, S., Mengel, M., Treu, S., and Büchner, M.: ISIMIP3a atmospheric climate input data (v1.0), ISIMIP Repository [data set], https://doi.org/10.48364/ISIMIP.982724, 2022.

Müller Schmied, H., Cáceres, D., Eisner, S., Flörke, M., Herbert, C., Niemann, C., Peiris, T., Popat, E., Portmann, F., Reinecke, R., Shadkam, S., Trautmann, T., and Döll, P.: The global water resources and use model WaterGAP v2.2d – Standard model output, PANGAEA [data set], https://doi.org/10.1594/PANGAEA.918447, 2020.

Müller Schmied, H., Cáceres, D., Eisner, S., Flörke, M., Herbert, C., Niemann, C., Peiris, T. A., Popat, E., Portmann, F. T., Reinecke, R., Shadkam, S., Trautmann, T., and Döll, P.: WaterGAP v2.2d, Zenodo [code], https://doi.org/10.5281/zenodo.6902111, 2022a.

Müller Schmied, H., Cáceres, D., Eisner, S., Flörke, M., Herbert, C., Niemann, C., Peiris, T. A., Popat, E., Portmann, F. T., Reinecke, R., Shadkam, S., Trautmann, T., and Döll, P.: The global water resources and use model WaterGAP v2.2d – Alternative model output driven with gswp3-w5e5, PANGAEA [data set], https://doi.org/10.1594/PANGAEA.948461, 2022b.