Supplement of Hydrol. Earth Syst. Sci., 25, 1727–1746, 2021
https://doi.org/10.5194/hess-25-1727-2021-supplement
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Supplement of

Hydraulic shortcuts increase the connectivity of arable land areas to surface waters

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Figure S1: Histogram of catchment statistics for study areas (blue) and all catchments in Switzerland containing arable land (grey). Catchment statistics were calculated only for catchment parts defined as arable land areas by the dataset BFS (2014). Relative road length (road length per arable land area) and relative water body length (water body length per arable land area) were derived from the dataset swissTLM3D (Swisstopo, 2010). Precipitation was derived from Kirchhofer and Sevruk (1992), and slope from Swisstopo (2018).

Table S1: List of catchment statistics calculated for finding explanatory variables for extrapolation to the national scale. Additionally, the datasets used for calculating those statistics are shown.

| Catchment statistic                                  | Data source                                                                 | Dataset used                                                                 |
|------------------------------------------------------|-----------------------------------------------------------------------------|------------------------------------------------------------------------------|
| Fraction of forests                                  | swissTLM3D (Swisstopo, 2010): TLM_BODENBEDECKUNG                            | OBJEKTART in [12,13]                                                        |
| Fraction of agricultural area                        | swissTLM3D (Swisstopo, 2010):                                              | (Total area) - (forests, water bodies, urban areas, traffic areas, and other non-agricultural areas) |
|                                                      | o TLM_BODENBEDECKUNG,                                                     |                                                                               |
|                                                      | o TLM_STRASSEN,                                                           |                                                                               |
|                                                      | o TLM_SIEDLUNGSNAME,                                                      |                                                                               |
|                                                      | o TLM_NUTZUNGSAREAL                                                      |                                                                               |
| Road density                                         | swissTLM3D (Swisstopo, 2010): TLM_STRASSEN                                | BELAGSART in [100,200]; BELAGSART = 100; BELAGSART = 200                     |
| (total; paved; unpaved)                              |                                                                            |                                                                               |
| Water body density (total; rivers; lakeshores)       | swissTLM3D (Swisstopo, 2010):                                             | Both datasets; TLM_FLIESSGEWAESSER only; TLM_STEHENDES_GEAWEasser only       |
|                                                      | o TLM_FLIESSGEWAESSER                                                   |                                                                               |
|                                                      | o TLM_STEHENDES_GEAWEasser                                               |                                                                               |
| Mean annual precipitation                            | Kirchhofer and Sevruk (1992)                                              | Mean annual precipitation depths 1951-1980                                    |
| Mean slope of agricultural areas                     | swissALTI3D (Swisstopo, 2018)                                             | Slopes as calculated by swisstopo, agricultural areas as defined above        |
| Area fractions (direct; indirect; not connected)     | Alder et al. (2015)                                                      | Fraction of total directly connected area; fraction of total indirectly connected area; fraction of total not connected area   |
S1.2. Examples of mapped structures

A1 - Storm drainage inlet shafts on or next to roads or farm tracks
Storm drainage inlet shafts on or next to roads or farm tracks were always considered as a potential shortcut in the connectivity model.

Figure S 2: Storm drainage inlet shaft with a gridded metal lid on a road in the study area Nürensdorf

Figure S 3: Lateral concrete storm drainage inlet shaft next to a road in the study area Molondin

Figure S 4: Storm drainage inlet shaft with a gridded metal lid on a road in the study area Oberneunforn
A2 - Strom drainage inlet shafts on fields

Storm drainage inlet shafts on fields are always considered as a potential shortcut in the connectivity model.

Figure S 5: Storm drainage inlet shaft with a metal grid lid in a field of the study area Meyrin

Figure S 6: Storm drainage inlet shaft with a concrete grid lid in a field of the study area Nürensdorf
B1 – Maintenance shafts on or next to roads

Maintenance shafts on or next to roads are considered a potential shortcut if they are located in an internal sink (only for shortcut definition B).

Figure S 7: Maintenance shaft with a metal lid with a pick hole next to a road in the study area Buchs

Figure S 8: Maintenance shaft with a concrete lid with a pick hole on a road in the study area Courroux
B2 – Maintenance shafts on fields

Maintenance shafts on fields are considered a potential shortcut if they are located in an internal sink (only for shortcut definition B).

Figure S 9: Damaged tile drainage maintenance shaft in a field in the study area Vufflens-la-Ville

Figure S 10: Tile drainage maintenance shaft in a field in the study area Molondin
C1 – Channel drains

Figure S 11: Channel drain on a road in the study area Clarmont

Figure S 12: Channel drain and inlet shaft with a metal grid lid on a road in the study area Lommiswil
Figure S 13: Ditch between a field and a road in the study area Meyrin
### S1.3. List of mapped structures

#### Table S 2: Types of mapped point features

| ID  | Description                  | Potential shortcut                                      |
|-----|------------------------------|---------------------------------------------------------|
| 1   | Inlet shaft                  | Yes                                                     |
| 2   | Maintenance shaft            | If lying in an internal sink (shortcut definition B)     |
| 3   | Other shaft                  | If lying in an internal sink (shortcut definition B)     |
| 4   | Stormwater tank              | If lying in an internal sink (shortcut definition B)     |
| 5   | Spillway                     | If lying in an internal sink (shortcut definition B)     |
| 6   | Pumping station              | No                                                      |
| 7   | House connection             | No                                                      |
| 8   | Other point object           | No                                                      |
| 9   | Unknown shaft                | If lying in an internal sink (shortcut definition B)     |
| 10  | Outfall                      | No                                                      |
| 11  | Infiltration structure       | If lying in an internal sink (shortcut definition B)     |
| 12  | Unknown object               | No                                                      |

#### Table S 3: Types of lids

| ID  | Description                      |
|-----|----------------------------------|
| 1   | Metal grid                       |
| 2   | Concrete lid with pick hole      |
| 3   | Concrete lid without pick hole   |
| 4   | Metal lid with pick hole         |
| 5   | Metal lid without pick hole      |
| 6   | Other lid type                   |
| 7   | Concrete grid                    |
| 8   | Concrete lid with lateral inlet  |
| 9   | Metal lid with lateral inlet     |
| 0   | Unknown lid type                 |

#### Table S 4: Types of line features mapped

| ID   | Description                              | Potential shortcut |
|------|------------------------------------------|--------------------|
| 1    | Drainage pipe                            | No                 |
| 2    | Tile drainage pipe                       | No                 |
| 3    | Other pipe                               | No                 |
| 4    | Channel drain                            | Yes                |
| 5    | Ditch                                    | Yes                |
| 6    | Sequence of channel drains & ditches      | Yes                |
| 7    | Stone wall                               | No                 |
| 8    | Earth wall                               | No                 |
| 9    | Hedge                                    | No                 |
| 10   | River                                    | No                 |
| 11   | Other line objects                       | No                 |
| 12   | Unknown line objects                     | No                 |
S1.4. Dates of field mapping and drone flights

Table S 5: Dates of field mapping and drone flights for each study area. In some areas a second drone flight had to be performed to ensure sufficient image quality.

| ID | Location          | Date field mapping | Date drone flights                  |
|----|-------------------|--------------------|------------------------------------|
| 1  | Böttstein         | 26.10.2017         | 26.10.2017                         |
| 2  | Ueken             | 25.10.2017         | 25.10.2017                         |
| 3  | Rüti b. R.        | 23.11.2017         | 23.11.2017                         |
| 4  | Romont            | 02.11.2017         | 03.11.2017                         |
| 5  | Meyrin            | 27.11.2017         | Usage of cantonal aerial images only |
| 6  | Boncourt          | 24.11.2017         | 24.11.2017; 07.06.2018              |
| 7  | Courroux          | 17.11.2017         | 17.11.2017                         |
| 8  | Hochdorf          | 29.09.2017         | 27.04.2018                         |
| 9  | Müswangen         | 21.09.2017         | 16.08.2018                         |
| 10 | Fleurier          | 24.05.2018         | 24.05.2018                         |
| 11 | Lommiswil         | 16.11.2017         | 16.11.2017                         |
| 12 | Illighausen       | 30.08.2017         | 07.12.2017                         |
| 13 | Oberneunforn      | 06.09.2017         | 01.11.2017; 19.04.2018              |
| 14 | Clarmont          | 09.11.2017         | 10.11.2017; 04.12.2017              |
| 15 | Molardin          | 02.11.2017         | 03.11.2017                         |
| 16 | Suchy             | 10.11.2017         | 08.11.2017                         |
| 17 | Vufflens          | 09.11.2017         | 08.11.2017; 24.08.2018              |
| 18 | Buchs             | 23.08.2017         | 09.08.2017; 17.08.2017              |
| 19 | Nürensdorf        | 18.09.2017         | 24.10.2017                         |
| 20 | Truttikon         | 20.09.2017         | 01.11.2017                         |
S1.5. Extrapolation to the national scale

In the following, mathematical details on the extrapolation of the local surface runoff connectivity model (L SCM) to the national scale are given. A schematic overview is given in the main part of this publication. Our model is using the area fractions of the national erosion connectivity model (NECM) to extrapolate the L SCM to the national scale, resulting in area fractions of a national surface runoff connectivity model (NSCM).

We defined the area fractions of model \( m \) and catchment \( c \) as follows:

\[
\mathbf{f}_m = \begin{pmatrix} f_{m,\text{dir},1} \\ f_{m,\text{indir},1} \\ f_{m,\text{nc},1} \end{pmatrix} = \begin{pmatrix} \frac{A_{m,\text{dir},c}}{A_{\text{tot},c}} & \cdots & \frac{A_{m,\text{dir},c}}{A_{\text{tot},c}} \\ \frac{A_{m,\text{indir},c}}{A_{\text{tot},c}} & \cdots & \frac{A_{m,\text{indir},c}}{A_{\text{tot},c}} \\ \frac{A_{m,\text{nc},c}}{A_{\text{tot},c}} & \cdots & \frac{A_{m,\text{nc},c}}{A_{\text{tot},c}} \end{pmatrix} \tag{S1}
\]

with: \( m: \) Model (either L SCM, NECM, or NSCM)
\( A_{m,\text{dir},c}: \) Directly connected agricultural area of model \( m \) in catchment \( c \) (ha)
\( A_{m,\text{indir},c}: \) Indirectly connected agricultural area of model \( m \) in catchment \( c \) (ha)
\( A_{m,\text{nc},c}: \) Not connected agricultural area of model \( m \) in catchment \( c \) (ha)
\( A_{\text{tot},c}: \) Total agricultural area in catchment \( c \) (ha)
\( f_{m,\text{dir},c}: \) Fraction of directly connected agricultural areas of model \( m \) in catchment \( c \) (-)
\( f_{m,\text{indir},c}: \) Fraction of indirectly connected agricultural areas of model \( m \) in catchment \( c \) (-)
\( f_{m,\text{nc},c}: \) Fraction of not connected agricultural areas of model \( m \) in catchment \( c \) (-)

The area fraction matrices \( \mathbf{f}_m \) underlie two boundary conditions (see main part). To ensure that extrapolation model meets these boundary conditions, we used a unit simplex transformation approach.

We performed a unit simplex inverse transformation to the area fraction matrices of the L SCM \( \mathbf{f}_{\text{LSCM}} \) and the NECM \( \mathbf{f}_{\text{NECM}} \) (3x20 matrices), resulting in the matrices \( \mathbf{z}_{\text{LSCM}} \) and \( \mathbf{z}_{\text{NECM}} \) (2x20 matrices).

\[
\mathbf{z} = \begin{pmatrix} \mathbf{z}_1^T \\ \mathbf{z}_2^T \end{pmatrix} = \begin{cases} \log^{-1}(\frac{f_{k}^T}{K}) + \log\left(\frac{1}{k-1}\right) & |k| = 1 \\ (1 - \sum_{k=1}^{K}(\frac{1}{k-1})) \cdot \log^{-1}(\frac{f_{k}^T}{K}) + \log\left(\frac{1}{k-1}\right) = \left(1 - \frac{1}{K^2}\right) \cdot \log^{-1}(\frac{f_{k}^T}{K}) & |k| = 2 \end{cases} \tag{S2}
\]

with: \( K = 3 \)

In order to model the difference \( \Delta \mathbf{z} \) (2x20 matrix) between the transformed L SCM and the transformed NECM (\( \Delta \mathbf{z} = \mathbf{z}_{\text{LSCM}} - \mathbf{z}_{\text{NECM}} \)), we tested the same list of nationally available catchment statistics that was already used before. For each of the two dimensions, we selected the variable that correlated best with \( \Delta \mathbf{z} \). Those were the fraction of directly connected areas \( f_{\text{NECM,dir}} \), and the fraction of indirectly connected areas \( f_{\text{NECM,indir}} \). Using these variables, we performed the following linear regression to describe \( \Delta \mathbf{z} \):

\[
\Delta \mathbf{z} = \mathbf{\hat{a}} + \mathbf{\hat{b}} \cdot \begin{pmatrix} f_{\text{NECM,dir}}^T \\ f_{\text{NECM,indir}}^T \end{pmatrix} + \varepsilon \tag{S3}
\]

For each of the catchments of the transformed national erosion connectivity model (\( \mathbf{z}_{\text{NECM}} \), 2xn matrix, \( n = 11'503 \)), this linear regression was used to calculate the transformed national surface runoff connectivity model (\( \mathbf{z}_{\text{NSCM}} \), 2xn matrix):
\[ z_{NSCM} = z_{NECM} + \Delta z \]  

Finally, using a unit simplex transformation, we transformed \( z_{NSCM} \) back, resulting in the area fraction matrix of the national surface runoff connectivity model \( f_{NSCM} \) (3xn matrix).

\[
f_{NSCM} = \begin{cases} 
  f_{NSCM,k} = \logit(z_{NSCM,k}) - \log\left(\frac{1}{K-k}\right) & |k = 1 \\
  f_{NSCM,k} = \logit\left(\frac{z_{NSCM,k}}{1 - \sum_{k=1}^{K-1} z_{NSCM,k}}\right) - \log\left(\frac{1}{K-k}\right) & |k > 1 
\end{cases}
\]  

This extrapolation model was run for each of the 100 area fractions matrices resulting from the Monte Carlo analysis that was performed on the local scale.

To address the uncertainty introduced by the selection of our study catchments, we bootstrapped the model 100 times. For each of the bootstrapping iterations 20 of our study catchments were resampled randomly.
S2. Results

S2.1. Occurrence of hydraulic shortcuts

Figure S15: Shaft density (ha\(^{-1}\)) on agricultural areas of the study catchments. For inlet shafts, colors show the drainage locations of the shafts. Abbreviations: WWTPs – waste water treatment plants, CSOs – combined sewer overflows.

Figure S16: Density of channel drains and ditches (m ha\(^{-1}\)) on agricultural areas of the study catchments. Colors show the drainage locations of the channel drains and ditches. Abbreviations: WWTPs – waste water treatment plants, CSOs – combined sewer overflows.
Table S 6: Linear regression of different catchment statistics with inlet shaft densities (ha$^{-1}$) per study area. $R^2$ equals the coefficient of determination, $m$ is the slope of the linear regression, and $p$ is the p-value.

| Catchment statistic | $R^2$  | $m$       | $p$       |
|---------------------|--------|-----------|-----------|
| Paved road density (m$^{-1}$) | 3.3E-01 | 5.7E+01 | 8.4E-03** |
| Unpaved road density (m$^{-1}$) | 6.3E-02 | -1.5E+01 | 2.8E-01   |
| Mean annual precipitation (mm yr$^{-1}$) | 4.9E-04 | -5.1E-05 | 9.3E-01   |
| Mean slope on agricultural areas (deg) | 8.3E-04 | -4.7E-03 | 9.0E-01   |
| Surface water body density (m$^{-1}$) | 4.4E-02 | -4.3E-05 | 3.7E-01   |
| Subsurface water body density (m$^{-1}$) | 6.2E-02 | 5.1E+02 | 2.9E-01   |

Table S 7: Linear regression of different catchment statistics with maintenance shaft densities (ha$^{-1}$) per study area. $R^2$ equals the coefficient of determination, $m$ is the slope of the linear regression, and $p$ is the p-value.

| Catchment statistic | $R^2$  | $m$       | $p$       |
|---------------------|--------|-----------|-----------|
| Paved road density (m$^{-1}$) | 3.7E-01 | 1.8E+02 | 4.6E-03** |
| Unpaved road density (m$^{-1}$) | 3.1E-02 | -3.2E+01 | 4.6E-01   |
| Mean annual precipitation (mm yr$^{-1}$) | 4.2E-03 | -4.5E-04 | 7.9E-01   |
| Mean slope on agricultural areas (deg) | 1.6E-02 | -6.2E-02 | 6.0E-01   |
| Surface water body density (m$^{-1}$) | 3.5E-02 | -1.2E-04 | 4.3E-01   |
| Subsurface water body density (m$^{-1}$) | 1.2E-01 | 2.2E+03 | 1.3E-01   |
Figure S 17: Fraction of inlet shafts per study area belonging to a certain landscape element

Figure S 18: Fraction of maintenance shafts per study area belonging to a certain landscape element
S2.2. Surface runoff connectivity: Study areas

S2.2.1. Example results for each study area

In the following, three example Monte Carlo analysis results (MC28, MC41, and MC40) are given for each of the study areas. The figures below correspond to Figure 5 in the main part of the article.
S2.2.2. Monte Carlo Results: Directly, indirectly, and not connected areas

Figure S 19: Left: Directly connected area per total agricultural area (-) as calculated by the Monte Carlo analysis for each study area. Right: Distribution of medians of directly connected area per total agricultural area (-) per study area and per Monte Carlo simulation.

Figure S 20: Indirectly connected area per total agricultural area (-) as calculated by the Monte Carlo analysis for each study area. Right: Distribution of medians of indirectly connected area per total agricultural area (-) per study area and per Monte Carlo simulation.
Figure S 21: Not connected area per total agricultural area (\(-\)) as calculated by the Monte Carlo analysis for each study area. Right: Distribution of medians of not connected area per total agricultural area (\(-\)) per study area and per Monte Carlo simulation.
### S2.2.3. Correlation of connectivity fractions with catchment statistics

Table S8: Correlation of catchment statistics with fractions of connected area connectivity. NECM: National erosion connectivity model, LSCM: Local surface runoff connectivity model.

| Variable                                              | Fraction directly connected \( f_{\text{NECM,dir}} \) (%) | Fraction indirectly connected \( f_{\text{NECM,indir}} \) (%) | Fraction not connected \( f_{\text{NECM,nc}} \) (%) |
|-------------------------------------------------------|----------------------------------------------------------|----------------------------------------------------------|-------------------------------------------------|
|                                                       | \( R^2 \) | Slope | \( P \)  | \( R^2 \) | Slope | \( P \)  | \( R^2 \) | Slope | \( P \)  |
| NECM: Directly connected agricultural area per total   | 0.71      | 1.0E+00 | < 0.001 *** | - | - | - | - | - | - |
| agricultural area \( f_{\text{NECM,dir}} \) (%)      |                                                       |                                                       |                                                       |                                                       |                                                       |                                                       |                                                       |                                                       |                                                       |
| NECM: Indirectly connected agricultural area per total | -         | -      | - | 0.52 | 6.0E-01 | < 0.001 *** | - | - | - |
| agricultural area \( f_{\text{NECM,indir}} \) (%)    |                                                       |                                                       |                                                       |                                                       |                                                       |                                                       |                                                       |                                                       |                                                       |
| NECM: Not connected agricultural area per total        | -         | -      | - | - | - | 0.26 | 4.0E-01 | < 0.001 *** | 0.022 * |
| agricultural area \( f_{\text{NECM,nc}} \) (%)       |                                                       |                                                       |                                                       |                                                       |                                                       |                                                       |                                                       |                                                       |                                                       |
| Surface water body density (\( m^2 \))                | 0.51      | 2.2E+02 | < 0.001 *** | 0.35 | -1.4E+02 | 0.006 ** | 0.14 | -7.6E+01 | 0.10 * |
| Paved road density (\( m^2 \))                        | 0.20      | -2.2E+01 | 0.049 * | 0.19 | 1.7E+01 | 0.053 | 0.04 | 6.5E+00 | 0.41 |
| Inlet shaft density (ha\(^{-1}\))                    | 0.07      | -1.3E-01 | 0.28 | 0.10 | 1.2E-01 | 0.17 | 0.00 | 1.0E-02 | 0.90 |
| Maintenance shaft density (ha\(^{-1}\))              | 0.15      | 4.0E+02 | 0.09 | 0.07 | -2.0E+02 | 0.27 | 0.07 | -1.8E+02 | 0.27 |
| Yearly rainfall (mm/year)                              | 0.10      | -5.2E-02 | 0.17 | 0.06 | 3.2E-02 | 0.28 | 0.04 | 2.0E-02 | 0.43 |
| Total road density (\( m^2 \))                        | 0.05      | 2.6E-01 | 0.35 | 0.05 | -2.0E-01 | 0.33 | 0.00 | -4.5E-02 | 0.80 |
| Subsurface waterbody density (\( m^2 \))              | 0.11      | -7.5E+00 | 0.14 | 0.04 | 3.3E+00 | 0.40 | 0.10 | 4.5E+00 | 0.18 |
| Fraction of agricultural area (-)                     | 0.00      | 2.6E+01 | 0.94 | 0.03 | -1.7E+02 | 0.48 | 0.03 | 1.7E+02 | 0.43 |
| Unpaved road density (\( m^2 \))                      | 0.15      | 4.4E-04 | 0.09 | 0.02 | -1.2E-04 | 0.55 | 0.18 | -3.2E-04 | 0.063 |
| Lake shore density (\( m^2 \))                        | 0.03      | 1.3E-02 | 0.49 | 0.02 | 7.7E-03 | 0.60 | 0.13 | -1.9E-02 | 0.13 |
| Slope on agricultural areas (°)                        | 0.04      | -5.8E+00 | 0.41 | 0.00 | 2.2E-01 | 0.97 | 0.09 | 6.0E+00 | 0.19 |
S2.2.4. Sensitivity analysis

Figure S 22: Sensitivity analysis for shortcut definition A. The y-axis shows the fraction of indirectly connected area per total connected area. The parameters were varied within the following bandwidths: Hedge infiltration [no; yes], infiltration width [6 m; 100 m], road carving depth [0 cm; 100 cm], sink depth [0 cm; 100 cm]

Figure S 23: Sensitivity analysis for shortcut definition B. The y-axis shows the fraction of indirectly connected area per total connected area. The parameters were varied within the following bandwidths: Hedge infiltration [no; yes], infiltration width [6 m; 100 m], road carving depth [0 cm; 100 cm], sink depth [0 cm; 100 cm]
Figure S 24: Influence of flow distance on Monte Carlo results. Distribution of medians of indirectly connected area per total connected area (\( \cdot \)) per study area and per Monte Carlo simulation for different flow distances. Left: Consideration of all flow distances. Right: Consideration of flow distances of smaller than 100 m, 100 to 200 m, 200 to 500 m, and larger than 500 m, respectively.
S2.2.5. Distribution of slope and wetness index

Figure S 25: Slope distribution (degrees) on different source area types

Figure S 26: Topographic wetness index distribution (-) on different source area types
S2.3. Surface runoff connectivity: Extrapolation to national level

S2.3.1. National area fractions

Figure S 27: Modelled area fractions by the NECM and the NSCM: Directly, indirectly, and not connected crop areas per total agricultural area, non-cropping area per total agricultural area, and indirectly connected crop area per total connected crop area for all catchments in Switzerland.

Table S 9: Statistics of modelled area fraction by the NECM and the NSCM. For the NSCM, the mean, the 5% quantile and the 95% quantile of the mean fractions resulting from the MC simulations is given. Additionally, the mean, the 5% quantile and the 95% quantile of the mean fractions resulting from the bootstrapping approach is given.

| Statistic | Fraction of directly connected crop area $f_{\text{crop,dir}}$ | Fraction of indirectly connected crop area $f_{\text{crop,indir}}$ | Fraction of not connected crop area $f_{\text{crop,nc}}$ | No crop area | Fraction of indirectly per total connected area $f_{\text{fracindir}}$ |
|-----------|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|-------------|---------------------------------------------------------------|
| NECM      | 6.7%                                                          | 16%                                                          | 27%                                                          | 50%         | 66%                                                          |
| NSCM: Mean (5% quantile; 95% quantile) of mean per MC simulation | 13% (6.9%; 18%)                                               | 17% (7.0%; 24%)                                               | 20% (8.8%; 36%)                                               | 50% (50%; 50%) | 54% (47%; 60%)                                               |
| NSCM: Mean (5% quantile; 95% quantile) of mean per bootstrap simulation | 14% (11%; 16%)                                               | 15% (13%; 17%)                                               | 21% (19%; 24%)                                               | 50% (50%; 50%) | 49% (42%; 55%)                                               |
Figure S 28: Mean area fractions reported by the NECM and distribution of the bootstrapped mean area fractions reported by the NSCM. Directly, indirectly, and not connected crop areas per total agricultural area, non-cropping area per total agricultural area, and indirectly connected crop area per total connected crop area for all catchments in Switzerland. The red squares report the means reported by the NSCM without using a bootstrapping approach. The black lines on the top of the plot indicate if the mean fraction reported by the NECM is significantly different from the distribution of means reported by the bootstrapping approach (**: p < 0.01, ns: not significant). Significance values were determined from the empirical cumulative distribution of the bootstrapped means.
Figure S 29: Fraction of crop area (arable land, vineyards, orchards, horticulture) per total agricultural area per catchment. Source of background map: Swisstopo (2010)
Figure S 30: Fraction of directly connected agricultural area per total agricultural area per catchment $f_{NSCM,dir}$.
Source of background map: Swisstopo (2010)

Figure S 31: Fraction of indirectly connected agricultural area per total agricultural area per catchment $f_{NSCM,indir}$.
Source of background map: Swisstopo (2010)
Figure S 32: Fraction of not connected agricultural area per total agricultural area per catchment $f_{NSCM, nc}$. Source of background map: Swisstopo (2010)

Figure S 33: Fraction of directly connected crop area per total agricultural area per catchment $f_{NSCM, crop, dir}$. Source of background map: Swisstopo (2010)
Figure S 34: Fraction of indirectly connected crop area per total agricultural area per catchment $f_{NSCM_{crop,dir}}$. Source of background map: Swisstopo (2010)

Figure S 35: Fraction of not connected crop area per total agricultural area per catchment $f_{NSCM_{crop,nc}}$. Source of background map: Swisstopo (2010)
Figure S 36: Fraction of indirectly connected crop area per total connected crop area $f_{NSCM, crop, fracindir}$. Source of background map: Swisstopo (2010)

Figure S 37: Difference between the fractions of directly connected agricultural area per total agricultural area reported by the NSCM and the NECM ($f_{NSCM, dir} - f_{NECM, dir}$). Source of background map: Swisstopo (2010)
Figure S 38: Difference between the fractions of indirectly connected agricultural area per total agricultural area reported by the NSCM and the NECM ($f_{NSCM, indir} - f_{NECM, indir}$). Source of background map: Swisstopo (2010)

Figure S 39: Difference between the fractions of not connected agricultural area per total agricultural area reported by the NSCM and the NECM ($f_{NSCM, nc} - f_{NECM, nc}$). Source of background map: Swisstopo (2010)
Figure S 40: Average difference in connectivity fractions of agricultural areas reported by the NSCM and the NECM:
\[ \Delta f_{\text{crop}} = \frac{(f_{\text{NSCM,dir}} - f_{\text{NECM,dir}}) + (f_{\text{NSCM,indir}} - f_{\text{NECM,indir}}) + (f_{\text{NSCM,nc}} - f_{\text{NECM,nc}})}{3}. \] The map shows data for all Swiss catchments in the valley zones, hill zones and lower elevation mountain zones. Grey areas represent higher elevation mountain zones that were excluded from the analysis. Study areas are marked with black lines. Source of background map: Swisstopo (2010)
Figure S 41: Difference between the fractions of directly connected crop area per total agricultural area reported by the NSCM and the NECM (f_{NSCM,crop,dir} - f_{NECM,crop,dir}). Source of background map: Swisstopo (2010)

Figure S 42: Difference between the fractions of indirectly connected crop area per total agricultural area reported by the NSCM and the NECM (f_{NSCM,crop,indir} - f_{NECM,crop,indir}). Source of background map: Swisstopo (2010)
Figure S 43: Difference between the fractions of not connected crop area per total agricultural area reported by the NSCM and the NECM ($f_{NSCM,crop,nc} - f_{NECM,crop,nc}$). Source of background map: Swisstopo (2010)

Figure S 44: Difference between the fractions of indirectly connected per total connected area reported by the NSCM and the NECM ($f_{NSCM,fracindir} - f_{NECM,fracindir}$). Source of background map: Swisstopo (2010)