SINGLE-IMPACT FICHE
LANDSCAPE FEATURES

IMPACT: SOIL EROSION

Data extracted in October 2021

Note to the reader: This fiche summarises the impact of five landscape features (buffer strips, field margins, hedgerows, terraces, and trees in group[1]) on SOIL EROSION. It is based on 12 peer-reviewed synthesis research papers[2], each of them including from 11 to 300 individual studies.

1. WEIGHT OF THE EVIDENCE

- CONSISTENCY OF THE IMPACT:
  Landscape features have a consistent positive effect on soil erosion (i.e. decrease of soil erosion) compared to croplands or grasslands without landscape features (see **Table 1**):

- Buffer strips have a positive effect on soil erosion (soil loss and run-off) compared to cropland or grassland without buffer strips, according to 3 synthesis papers reviewed, while 1 of those synthesis papers also reported no effect on run-off. Another 2 synthesis papers reported relevant results, but without statistical test of the effects and they are labelled as uncertain. Details are provided below in Table 2 and in the summary reports.
- Field margins have a positive effect on soil erosion compared to cropland or grassland without field margins, according to the 2 synthesis papers reviewed.
- Hedgerows have a positive effect on soil erosion (soil loss and run-off) compared to cropland or grassland without hedgerows, according to 3 synthesis papers reviewed, while 1 of those synthesis papers also reported no effect on run-off.
- Terraces have a positive effect on soil erosion compared to cropland or grassland without terraces, according to 4 synthesis papers, while 1 of those synthesis papers also reported no effect (depending on the type of terraces). Another synthesis paper reported relevant results, but without statistical test of the effects and it is labelled as uncertain. Details are provided below in Table 2 and in the summary reports.
- Trees in group have an uncertain effect compared to cropland or grassland without trees in group. The only 1 synthesis paper reviewed reported relevant results, but without statistical test of the effects and it is labelled as uncertain. Details are provided below in Table 2 and in the summary reports.

All the 12 reviewed synthesis papers include data collected in Europe (see **Table 2**).

Table 1. Summary of effects. The effect with the higher score is marked in bold and the cell coloured. The numbers between parentheses indicate the number of synthesis papers with a quality score of at least 50%. Details on quality criteria can be found in the next section. Some synthesis papers reported more than one landscape feature or more than one result for the same landscape feature.

Impact	Intervention	Positive	Negative	No effect	Uncertain*
Decrease of soil erosion	Buffer strips	**3 (3)**	0	1 (1)	2 (0)

[1] Described in the General Fiche.

[2] Research synthesis papers include a formal meta-analysis or systematic reviews with some quantitative results →.

	Field margins	**2 (2)**	0	0	0
	Hedgerows	**3 (3)**	0	1 (1)	0
	Terraces	**4 (3)**	0	1 (1)	1 (0)
	Trees in group	0	0	0	**1 (0)**

* Number of synthesis papers that report relevant results but without statistical test comparison of the intervention and the control.

QUALITY OF THE SYNTHESIS PAPERS: *The quality score summarises 16 criteria assessing the quality of three main aspects of the synthesis papers: 1) the literature search strategy and studies selection; 2) the statistical analysis; 3) the potential bias. Details on quality criteria can be found in this document →.*

As shown in the "Quality score" in **Table 2,** the quality level ranges from 31% to 81%. The least frequently satisfied quality criteria were "Number of studies at each step", "Individual effect sizes", "Dataset available" and "Publication bias analysed".

2. IMPACTS

The main characteristics and results of the synthesis papers are summarised in **Table 2**. Detailed results of each synthesis study are reported in the summary reports →.

Table 2. Main characteristics of the synthesis papers reporting impacts of landscape features on soil erosion. The references are ordered chronologically with the most recent publication date first.

Reference	Population	Scale	Num. papers	Intervention	Comparator	Metric	Conclusion	Quality score
Abera, W; Tamene, L; Tibebe, D; Adimassu, Z; Kassa, H; Hailu, H; Mekonnen, K; Desta, G; Sommer, R; Verchot, L 2020	Degradated landscape across several agroecology zones	Ethiopia	103	1) Contour bunds; 2) Terraces; 3) Vegetated contour bunds (all classified as terraces)	No treatment; before treatment	Soil erosion, run-off	The vegetated contour bud Fanya juu has the highest effect (-98%), followed by biological (-75%) and bunds (-74%) on soil erosion.	62%
England, JR; OGrady, AP; Fleming, A; Marais, Z; Mendham, D 2020	Grazed dairy systems	Global	83	Vegetation remants (trees in group)	Grazed dairy pasture without trees	Soil slope erosion	Authors report a positive effect of trees in group and field copses reducing erosion. *Reviewers' note: We labelled the results as uncertain due to the lack of statistical testing.*	38%
Jia, L; Zhao, W; Fu, B; Daryanto, S; Wang, S; Liu, Y; Zhai, R 2019	Slope farmlands	China	81	Treatment under minimum soil disturbance practices (contour tillage with hedgerow or micro-basins tillage) (hedgerows)	Control under conventional tillage	Sediment production; run-off	Overall, minimum soil disturbance practices (contour tillage with hedgerow) reduced sediment yield and run-off significantly compared with conventional tillage.	81%
Xiong, M; Sun, R; Chen, L 2018	Cropland and Orchard	Global	121	1) Buffer strips; 2) Contour bunds, terraces (terraces); 3) Hedgerows	No soil conservation techniques	Soil loss, run-off	Buffer strips, terraces and contour bunds were effective in reducing soil erosion and run-off.	69%

Reference	Population	Scale	Num. papers	Intervention	Comparator	Metric	Conclusion	Quality score
							However, hedgerows were effective in reducing soil erosion but were not effective in reducing run-off.	
Chen, D; Wei, W; Chen, L 2017	Croplands in China	China	46	Terraces	Non-terraced land	Run-off; sediments	The results confirmed that terracing significantly and positively affected water erosion control.	75%
Mandal, D; Srivastava, P; Giri, N; Kaushal, R; Cerda, A; Alam, NM 2017	Croplands and cropland in sloppy areas	Indian tropics	83	Contour grass barrier (terraces)	1)Bare land/fallow land; 2) Without grass barrier	Run-off, soil loss	The overall result of the meta-analysis showed that infiltration capacity increased approximately 2-fold after planting grasses across the slopes in agricultural fields, which reduced the runoff by 45% and the transported soil by 59% compared to control (no grass). The use of grass barriers was effective and efficient for decreasing soil and water loss on sloppy croplands in tropical and subtropical regions of India.	44%
Van Vooren, L; Reubens, B; Broekx, S; De Frenne, P; Nelissen, V; Pardon, P; Verheyen, K 2017	Arable crops	Global (temperate climate)	60	1) Grass strips (field margins); 2) Hedgerows	1) No grass strips; 2) No hedgerows	Soil sediment interception	Grass strips and hedgerows are very effective in increasing soil sediment interception.	75%
Wei, W; Chen, D; Wang, LX; Daryanto, S; Chen, LD; Yu, Y; Lu, YL; Sun, G; Feng, TJ 2016	Human-made terraces world wide (including crops of rice, grain, coffee, potato, viticulture or ancient cultivation)	Global	300	Terraces	No terraces	Run-off; soil erosion	This global synthesis suggested that diverse terracing practices played a positive role in ecosystem services provisions, particularly erosion control, followed by runoff reduction.	44%
Maetens, W; Poesen, J; Vanmaerck, M 2012	Cropland	Europe and Mediterranean	111	1) Buffer strips; 2)Terraces and contour bunds (all classified as terraces)	Conventional practices	Run-off; soil erosion	Buffer strips are effective in reducing soil loss. Terraces were not effective in reducing runoff and soil loss, while contour bunds were effective in reducing both of them.	31%
Zhang, XY; Liu, XM; Zhang, MH; Dahlgren, RA; Eitzel, M 2010	Agricultural fields	Global	73	Outflow from vegetated buffers (buffer strips)	Inflow into vegetated buffers	Efficacy sediment mass retention	Vegetated buffers are generally effective in removing sediment from runoff. Buffer width, slope, and	56%

Reference	Population	Scale	Num. papers	Intervention	Comparator	Metric	Conclusion	Quality score
							vegetation type are important factors for designing an effective buffer.	
Liu, XM; Mang, XY; Zhang, MH 2008	Croplands	Global	31	Outflow from grassed buffer strips (including vegetative filter strips, riparian buffer zones, and grass waterways) (buffer strips)	Inflow into grassed buffer strips (including vegetative filter strips, riparian buffer zones, and grass waterways).	% of sediment removal	Vegetated buffers in the studies exhibited an excellent potential for sediment removal. *Reviewers' note: We labelled the results as uncertain due to the lack of statistical testing.*	38%
Dorioz, JM; Wang, D; Poulenard, J; Trévisan, D 2006	Cultivated land	France	11	Grass buffer strips	No buffer strips and before buffers strips	Run-off; sediment retention	*Reviewers' note: We labelled the results for buffer strips as uncertain due to the lack of statistical testing.*	31%

3. KNOWLEDGE GAPS

England et al., 2020

The number of publications supporting a given relationship between on-farm woody systems and ecosystem services was often relatively low.

Xiong et al., 2018

Due to a lack of detailed information about some of the influential factors and the types of soil conservation techniques (SCT) in this study, as well as the substantial variation in study conditions, the environmental and experimental factors controlling the variability in the efficiency of each SCT could not be clearly identified in this study.

Chen et al., 2017

Other variables such as terrace age, size and management, which could possibly influence the effectiveness of terraces, were not considered due to insufficient data.

Wei et al., 2016

There is insufficient knowledge regarding design, construction and maintenance alternatives of terraces.

Zhang et al., 2010

Although models captured a reasonable amount of variance in buffer removal efficacy, the model predictions contain uncertainty. First, the model is an oversimplification of a complex set of processes. Second, the environmental settings and management scenarios of the studies vary considerably. Finally, the models would be greatly improved had there been enough information on buffer slope available in the literature.

Dorioz et al., 2006	Long-term benefits remain questionable given the relatively short-term use of this approach in phosphorus reduction and the lack of long-term experimental results.

4. SYSTEMATIC REVIEW SEARCH STRATEGY

Keywords	Different searches were conducted with the following search strings: 1) TS= ("terrac*" OR "contour bund*" OR "level bench*" OR "level ditch*" OR "fish-scale pit*" OR "dry-stone wall*" OR "dry stone wall*" OR "stone wall*" OR "earth wall*" OR "dry wall*" OR "dry-wall*" OR "rubble wall*") AND TS= ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TS= (agric* OR cultiv* OR crop* OR farm*) or TITLE-ABS-KEY: ("terrac*" OR "contour bund*" OR "level bench*" OR "level ditch*" OR "fish-scale pit*" OR "dry-stone wall*" OR "dry stone wall*" OR "stone wall*" OR "earth wall*" OR "dry wall*" OR "dry-wall*" OR "rubble wall*") AND TITLE-ABS-KEY: ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TITLE-ABS-KEY: (agric* OR cultiv* OR crop* OR farm*) 2) TS= ("ditch*" OR "earth bund*" OR "open-channel" OR "intermittent W/4 stream" OR "small W/4 stream") AND TS= ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TS= ("agric*" OR "cultiv*" OR "crop*" OR "farm*") or TITLE-ABS-KEY: ("ditch*" OR "earth bund*" OR "open-channel" OR "intermittent near/4 stream" OR "small near/4 stream") AND TITLE-ABS-KEY: ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TITLE-ABS-KEY: ("agric*" OR "cultiv*" OR "crop*" OR "farm*") 3) TS= ("pond*" OR "soda pan*" OR "reedbed*" OR "small W/4 lake*" OR "small W/4 wetland*") AND TS= ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TS= ("agric*" OR "cultiv*" OR "crop*" OR "farm*") or TITLE-ABS-KEY: ("pond*" OR "soda pan*" OR "reedbed*" OR "small near/4 lake*" OR "small near/4 wetland*") AND TITLE-ABS-KEY: ("meta-analy*" OR "systematic* review*" OR "evidence

	map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TITLE-ABS-KEY: ("agric*" OR "cultiv*" OR "crop*" OR "farm*") 4) TS=(("strip*" OR "margin*" OR "hedge*" OR "edge*" OR "border*" OR "band*" OR "line*" OR "verge*" OR "row*") near/3 ("flower*" OR "vegetat*" OR "tree*" OR "shrub*" OR "plant*" OR "grass*" OR "filter*" OR "buffer*" OR "wooded" OR "riparian" OR "field*" OR "wildlife" OR "seminatural" OR "semi-natural" OR "semi natural")) AND TS=("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TS= ("agric*" OR "cultiv*" OR "crop*" OR "farm*") merged with TS= ("margin strip*" OR "windbreak*" OR "shelterbelt*" OR "hedgerow*" OR "road verge*" OR "riparian buffer*" OR "riparian vegetation" OR "riparian woodland*" OR "buffer zone*" OR "riparian zone*" "vegetated filter strip*") AND TS=("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TS= ("agric*" OR "cultiv*" OR "crop*" OR "farm*") or TITLE-ABS-KEY: (("strip*" OR "margin*" OR "hedge*" OR "edge*" OR "border*" OR "band*" OR "line*" OR "verge*" OR "row*") W/3 ("flower*" OR "vegetat*" OR "tree*" OR "shrub*" OR "plant*" OR "grass*" OR "filter*" OR "buffer*" OR "wooded" OR "riparian" OR "field*" OR "wildlife" OR "seminatural" OR "semi-natural" OR "semi natural")) AND TITLE-ABS-KEY: ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TITLE-ABS-KEY: ("agric*" OR "cultiv*" OR "crop*" OR "farm*") merged with TITLE-ABS-KEY: ("margin strip*" OR "windbreak*" OR "shelterbelt*" OR "hedgerow*" OR "road verge*" OR "riparian buffer*" OR "riparian vegetation" OR "riparian woodland*" OR "buffer zone*" OR "riparian zone*" "vegetated filter strip*") AND TITLE-ABS-KEY: ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TITLE-ABS-KEY: ("agric*" OR "cultiv*" OR "crop*" OR "farm*") 5) TS=(("patch*" OR "islet*" OR "island*" OR "remnant*" OR "group*" OR "copse*" OR "coppice*") near/3 ("flower*" OR "vegetat*" OR "tree*" OR "shrub*" OR "grass*" OR "forest*" OR "wooded" OR "field*" OR "wildlife" OR "seminatural" OR "semi-natural" OR "semi natural")) AND TS=("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TS= ("agric*" OR "cultiv*" OR "crop*" OR "farm*") merged with TS=("woodland creation*" OR "mid-field islet*" OR "environmental island*" OR "refuge*" OR "scattered tree*" OR "shading tree*") AND TS=("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TS= ("agric*" OR "cultiv*" OR "crop*" OR "farm*")

	or TITLE-ABS-KEY: (("patch*" OR "islet*" OR "island*" OR "remnant*" OR "group*" OR "copse*" OR "coppice*") W/3 ("flower*" OR "vegetat*" OR "tree*" OR "shrub*" OR "grass*" OR "forest*" OR "wooded" OR "field*" OR "wildlife" OR "seminatural" OR "semi-natural" OR "semi natural")) AND TITLE-ABS-KEY: ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TITLE-ABS-KEY: ("agric*" OR "cultiv*" OR "crop*" OR "farm*") merged with TITLE-ABS-KEY: ("woodland creation*" OR "mid-field islet*" OR "environmental island*" OR "refuge*" OR "scattered tree*" OR "shading tree*") AND TITLE-ABS-KEY: ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TITLE-ABS-KEY: ("agric*" OR "cultiv*" OR "crop*" OR "farm*") 6) TS= ("landscape feature*" OR "landscape characteristic*" OR "green infrastructure*" OR "landscape connectivity" OR "landscape diversity" OR "landscape element*" OR "landscape fragment*" OR "landscape mosaic*" OR "landscape structure*" OR "nature-based feature*" OR "linear feature*") AND TS= ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TS= ("agric*" OR "cultiv*" OR "crop*" OR "farm*") or TITLE-ABS-KEY: ("landscape feature*" OR "landscape characteristic*" OR "green infrastructure*" OR "landscape connectivity" OR "landscape diversity" OR "landscape element*" OR "landscape fragment*" OR "landscape mosaic*" OR "landscape structure*" OR "nature-based feature*" OR "linear feature*") AND TITLE-ABS-KEY: ("meta-analy*" OR "systematic* review*" OR "evidence map" OR "global synthesis" OR "evidence synthesis" OR "research synthesis") AND TITLE-ABS-KEY: ("agric*" OR "cultiv*" OR "crop*" OR "farm*")
Search dates	No time restrictions
Databases	Web of Science and Scopus, run in October 2021
Selection criteria	The main criteria that led to the exclusion of a synthesis paper were when the paper: 1) does not deal with any landscape feature; 2) does not synthetise pairwise comparisons on the effect of landscape features; 3) does not include results for cropland or grassland; 4) deals with agroforestry; 5) is either a non-systematic review, a non-quantitative systematic review, or a meta-regression without mean effect sizes; 6) is not written in English. Synthesis papers that passed the relevance criteria were subject to critical appraisal carried out on a paper-by-paper basis. The search returned 244 synthesis papers potentially relevant for the practice object of our fiche. From the 244 potentially relevant synthesis papers, 136 were excluded after reading the title and abstract, and 74 after reading the full text according to the above-mentioned criteria. Finally, 34

	synthesis papers were selected for landscape features, from which 12 were relevant for this impact.