European Commission

SINGLE-IMPACT FICHE
LANDSCAPE FEATURES

IMPACT: SOIL EROSION

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Note to the reader: This fiche summarises the effects of Landscape features on SOIL EROSION. It is based on 12 synthesis papers[1], including from 11 to 300 primary studies.

1. WEIGHT OF THE EVIDENCE

CONSISTENCY OF THE IMPACT

Landscape features have a consistent significantly positive effect on soil erosion (i.e. decrease of soil erosion) compared to croplands or grasslands without landscape features.

The table below shows the number of synthesis papers with statistical tests reporting i) a significant difference between the Intervention and the Comparator, that is to say, a significant statistical effect, which can be positive or negative; or ii) a non-statistically significant difference between the Intervention and the Comparator. In addition, we include, if any, the number of synthesis papers reporting relevant results but without statistical test of the effects. Details on the quality assessment of the synthesis papers can be found in the methodology section of this WIKI.

- Buffer strips have a significantly positive effect on soil erosion (soil loss and run-off) compared to cropland or grassland without buffer strips, according to 3 synthesis papers; while 1 of those synthesis papers also reported a non-significant effect on run-off. Another 2 synthesis papers reported relevant results, but this evidence is not statistically tested.
- Field margins have a significantly positive effect on soil erosion compared to cropland or grassland without field margins, according to 2 synthesis papers.
- Hedgerows have a significantly positive effect on soil erosion (soil loss and run-off) compared to cropland or grassland without hedgerows, according to 3 synthesis papers; while 1 of those synthesis papers also reported a non-significant effect on run-off.
- Terraces have a significantly 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 a non-significant effect (depending on the type of terraces). Another synthesis paper reported relevant results, but this evidence is not statistically tested.
- Trees in group are studied in one synthesis paper where authors report relevant results on their effect compared to cropland or grassland without trees in group, but this evidence is not statistically tested.

Out of the 12 selected synthesis papers, 8 included studies conducted in Europe (see **Table 2**).

Table 1: Summary of effects. Number of synthesis papers reporting positive, negative or non-statistically significant effects on environmental and climate impacts. The number of synthesis papers reporting relevant results but without statistical test of the effects are also provided. When not all the synthesis papers reporting an effect are of high quality, the number of synthesis papers with a quality score of at least 50% is indicated in parentheses. The reference numbers of the synthesis papers reporting each of the effects are provided in **Table 3**. Some synthesis papers may report effects for more than one impact or more than one effect for the same impact.

				Statistically tested			Non-statistically tested
Impact	Metric	Intervention	Comparator	Significantly positive	Significantly negative	Non-significant	
Decrease soil erosion	Soil erosion	Buffer strips	No buffer strips	3 (2)	0	1 (0)	2 (0)
		Field margins	No field margins	2 (1)	0	0	0
		Hedgerows	No hedgerows	3	0	1	0
		Terraces	No terraces	4 (3)	0	1 (0)	1 (0)
		Trees in group	No trees in group or field copses	0	0	0	1 (0)

QUALITY OF THE SYNTHESIS PAPERS

The quality of each synthesis paper was assessed based on 16 criteria regarding three main aspects: 1) the literature search strategy and primary studies selection; 2) the statistical analysis conducted; and 3) the evaluation of potential bias. We assessed whether authors addressed and reported these criteria. Then, a quality score was calculated as the percentage of these 16 criteria properly addressed and reported in each synthesis paper. Details on quality criteria can be found in the methodology section of this WIKI.

[1] Synthesis research papers include either meta-analysis or systematic reviews with quantitative results. Details can be found in the methodology section of the WIKI.

2. IMPACTS

The main characteristics and results of the 12 synthesis papers are reported in **Table 2** with the terminology used in those papers, while **Table 3** shows the reference numbers of the synthesis papers reporting for each of the results shown in **Table 1**. Comprehensive information about the results reported in each synthesis paper, in particular about the modulation of effects by factors related to soil, climate and management practices, are provided in the **summaries of the synthesis papers** available in this WIKI.

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

Reference number	Population	Scale	Num. papers	Intervention	Comparator	Metric	Conclusion	Quality score
Ref4	Degradated landscape across several agroecology zones	Ethiopia	103	1) Contour bunds; 2) Terraces; 3) Vegetated contour bunds	No treatment, before treatment	Soil erosion, run-off	Fanya juu has the highest effect (−98%), followed by biological (−75%) and bunds (−74%) on soil erosion.	62%
Ref8	Grazed dairy systems	Global	83	Vegetation remants	Grazed dairy pasture without trees	Soil slope erosion	The effects reported are generally positive. Reviewers' note: We labelled the results as uncertain due to the lack of statistical testing.	38%
Ref12	Slope farmlands	China	81	Treatment under minimum soil disturbance practices (contour tillage with hedgerow or micro-basins tillage)	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%
Ref17	Cropland and Orchard	Global	121	1) Buffer strips; 2) Contour bunds, 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. However, hedgerows were effective in reducing soil erosion but were not effective in reducing run-off.	62%
Ref18	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%
Ref19	Croplands and cropland in sloppy areas	Indian tropics	83	Contour grass barrier	1) Bare land/fallow land; 2) Withour 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%
Ref20	Arable crops	Global (temperate climate)	60	1) Grass strips; 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%
Ref22	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. Reviewers' note: We labelled the results as uncertain due to the lack of statistical testing.	44%
Ref29	Cropland	Europe and Mediterranean	111	1) Buffer strips; 2) Contour bunds and 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%
Ref33	Agricultural fields	Global	73	Outflow from vegetated buffers	Inflow into vegetated buffers	Efficacy sediment mass retention	Vegetated buffers are generally effective in removing sediment from runoff. Buffer width, slope, and vegetation type are important factors for designing an effective buffer.	56%
Ref34	Croplands	Global	31	Outflow from grassed buffer strips (including vegetative filter strips, riparian buffer zones, and grass waterways).	Inflow into grassed buffer strips (including vegetative filter strips, riparian buffer zones, and grass waterways).	% of sediment removal	Authors found that 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%
Ref36	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 grassed buffer strips as uncertain due to the lack of statistical testing.	31%

Table 3: Reference numbers of the synthesis papers reporting for each of the results shown in **Table 1**.

				Statistically tested			Non-statistically tested
Impact	Metric	Intervention	Comparator	Significantly positive	Significantly negative	Non-significant	
Decrease soil erosion	Soil erosion	Buffer strips	No buffer strips	Ref17, Ref29 and Ref33		Ref29	Ref34 and Ref36
		Field margins	No field margins	Ref19 and Ref20			
		Hedgerows	No hedgerows	Ref12, Ref17 and Ref20		Ref17	
		Terraces	No terraces	Ref4, Ref17, Ref18 and Ref29		Ref29	Ref22
		Trees in group	No trees in group or field copses				Ref8

3. FACTORS INFLUENCING THE EFFECTS ON SOIL EROSION

Table 4: List of factors reported to significantly affect the size and/or direction of the effects on soil erosion, according to the synthesis papers reviewed.

Factor	Reference number
Buffer slope	Ref33 and Ref34
Buffer vegetation type	Ref33
Buffer width	Ref33 and Ref34
Field edge vegetation type	Ref19
Field edge width	Ref20
Geographical area	Ref18
Land use	Ref18
Slope	Ref18 and Ref19
Terrace type	Ref18

4. KNOWLEDGE GAPS

Table 5: Knowledge gap(s) reported by the authors of the synthesis papers included in this review.

Ref Num	Gap
Ref8	The number of publications supporting a given relationship between on-farm woody systems and ecosystem services was often relatively low.
Ref17	Due to a lack of detailed information about some of the influential factors and the types of SCTs 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.
Ref18	Other variables such as terrace age, size and management, which could possibly influence the efectiveness of terraces, were not considered due to insufficient data
Ref22	There is insufficient knowledge regarding design, construction and maintenance alternatives of terraces.
Ref33	The models would be greatly improved had there been enough information on buffer slope available in the literature.
Ref36	Long-term benefits remain questionable given the relatively short-termuse of this approach in P reduction and the lack of long-term experimental results.

5. SYNTHESIS PAPERS INCLUDED IN THE REVIEW

Table 6: List of synthesis papers included in this review. More details can be found in the summaries of the meta-analyses.

Ref Num	Author(s)	Year	Title	Journal	DOI
Ref4	Abera, W; Tamene, L; Tibebe, D; Adimassu, Z; Kassa, H; Hailu, H; Mekonnen, K; Desta, G; Sommer, R; Verchot, L	2020	Characterizing and evaluating the impacts of national land restoration initiatives on ecosystem services in Ethiopia	LAND DEGRADATION AND DEVELOPMENT, 31(1), 37-52.	10.1002/ldr.3424
Ref8	England, JR; OGrady, AP; Fleming, A; Marais, Z; Mendham, D	2020	Trees on farms to support natural capital: An evidence-based review for grazed dairy systems	SCIENCE OF THE TOTAL ENVIRONMENT, 704, 135345.	10.1016/j.scitotenv.2019.135345
Ref12	Jia, L; Zhao, W; Fu, B; Daryanto, S; Wang, S; Liu, Y; Zhai, R	2019	Effects of minimum soil disturbance practices on controlling water erosion in China's slope farmland: A meta-analysis	LAND DEGRADATION AND DEVELOPMENT, 30(6), 706-716.	10.1002/ldr.3258
Ref17	Xiong, M; Sun, R; Chen, L	2018	Effects of soil conservation techniques on water erosion control: A global analysis	SCIENCE OF THE TOTAL ENVIRONMENT, 645, 753-760.	10.1016/j.scitotenv.2018.07.124
Ref18	Chen, D; Wei, W; Chen, L	2017	Effects of terracing practices on water erosion control in China: A meta-analysis	EARTH-SCIENCE REVIEWS, 173, 109-121.	10.1016/j.earscirev.2017.08.007
Ref19	Mandal, D; Srivastava, P; Giri, N; Kaushal, R; Cerda, A; Alam, NM	2017	Reversing land degradation through grasses: a systematic meta-analysis in the Indian tropics	SOLID EARTH, 8(1), 217-233.	10.5194/se-8-217-2017
Ref20	Van Vooren, L; Reubens, B; Broekx, S; De Frenne, P; Nelissen, V; Pardon, P; Verheyen, K	2017	Ecosystem service delivery of agri-environment measures: A synthesis for hedgerows and grass strips on arable land	AGRICULTURE ECOSYSTEMS AND ENVIRONMENT, 244 32-51.	10.1016/j.agee.2017.04.015
Ref22	Wei, W; Chen, D; Wang, LX; Daryanto, S; Chen, LD; Yu, Y; Lu, YL; Sun, G; Feng, TJ	2016	Global synthesis of the classifications, distributions, benefits and issues of terracing	EARTH-SCIENCE REVIEWS, 159, 388-403.	10.1016/j.earscirev.2016.06.010
Ref29	Maetens, W; Poesen, J; Vanmaerck, M	2012	How effective are soil conservation techniques in reducing plot runoff and soil loss inEurope and the Mediterranean?	EARTH-SCIENCE REVIEWS, 115(1–2), 21-36.	10.1016/j.earscirev.2012.08.003
Ref33	Zhang, XY; Liu, XM; Zhang, MH; Dahlgren, RA; Eitzel, M	2010	Review of vegetated buffers and a meta-analysis of their mitigation efficacy in reducing nonpoint source pollution	JOURNAL OF ENVIRONMENTAL QUALITY, 39, 76-84.	10.2134/jeq2008.0496

Ref Num	Author(s)	Year	Title	Journal	DOI
Ref34	Liu, XM; Mang, XY; Zhang, MH	2008	Major factors influencing the efficacy of vegetated buffers on sediment trapping: A review and analysis	JOURNAL OF ENVIRONMENTAL QUALITY, 37(5), 1667-1674.	10.2134/jeq2007.0437
Ref36	Dorioz, JM; Wang, D; Poulenard, J; Trévisan, D	2006	The effect of grass buffer strips on phosphorus dynamics — a critical review and synthesis as a basis for application in agricultural landscapes in France	AGRICULTURE, ECOSYSTEMS AND ENVIRONMENT, 117(1), 4-21.	10.1016/j.agee.2006.03.029