

SINGLE-IMPACT FICHE

LANDSCAPE FEATURES



IMPACT: NUTRIENT LEACHING AND RUN-OFF

Data extracted in October 2021

Note to the reader: This fiche summarises the impact of five landscape features (buffer strips, ditches and ponds, field margins, hedgerows, and small wetlands¹) on NUTRIENT LEACHING AND RUN-OFF. It is based on 9 peer-reviewed synthesis research papers², including from 11 to 140 individual studies.

1. WEIGHT OF THE EVIDENCE

- **CONSISTENCY OF THE IMPACT:**

Landscape features have a consistent positive effect on nutrient leaching and run-off (i.e. decrease of nutrient leaching and run-off) compared to cropland or grassland without landscape features (see **Table 1**):

- Buffer strips have an overall positive effect on nutrient leaching and run-off compared to cropland or grassland without buffer strips. 4 out of 5 synthesis papers reviewed reported a positive effect. The other 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.
- Ditches and ponds were analysed together in 1 synthesis paper that reported a positive effect on nutrient leaching and run-off compared to cropland or grassland without ditches or ponds. Another synthesis paper reported relevant results for ditches, 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.
- Field margins have a positive effect on nutrient leaching and run-off compared to cropland or grassland without field margins, according to the only synthesis paper reviewed.
- Hedgerows have a positive effect on nutrient leaching and run-off compared to cropland or grassland without hedgerows, according to the only synthesis paper reviewed.
- Small wetlands have a positive effect on nutrient leaching and run-off compared to cropland or grassland without constructed small wetlands, according to the only synthesis paper reviewed.

The 9 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 parenthesis 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 results for two landscape features or more than one result for the same landscape feature.

Impact	Intervention	Positive	Negative	No effect	Uncertain*
Decrease nutrient leaching and run-off	Buffer strips	4 (4)	0	0	1 (0)
	Ditches and ponds	1 (1)	0	0	1 (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	1 (1)	0	0	0
Hedgerows	1 (1)	0	0	0
Small wetlands	1 (1)	0	0	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 of the 9 synthesis papers retrieved ranged from 25% to 94%. The least frequently satisfied quality criteria were: “Number of studies at each step”, “Individual effect sizes”, “Dataset available”, “Heterogeneity of results analysed” 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 nutrient leaching and run-off. The references are ordered chronologically with the most recent publication date first.

Reference	Population	Scale	Num. papers	Intervention	Comparator	Metric	Conclusion	Quality score
Shen, W; Li, S; Mi, M; Zhuang, Y; Zhang, L 2021	Croplands	Global	92	Effluent concentration from ditches (ditches)	Influent concentration into ditches	Total nitrogen (TN)	Based on this statistical analysis, ditches and ponds effectively reduce total nitrogen, and the general removal rate is 38.7%.	50%
Carstensen, MV; Hashemi, F; Hoffmann, CC; Zak, D; Audet, J; Kronvang, B 2020	Pilot and full-scale field studies on drainage mitigation measures in croplands	Global	42	Outflow from 1) Free water surface constructed wetlands; 2) denitrifying bioreactors (all classified as small wetlands)	Inflow from 1) Free water surface constructed wetlands; 2) denitrifying bioreactors	1) Nitrogen removal efficiency; 2) Total phosphorous removal efficiency	Data analysis showed that the load of nitrate was substantially reduced by drainage mitigation measures. As well, mitigation measures mainly acted as sinks of total phosphorus, but occasionally, also as sources.	94%
Valkama, E; Usva, K; Saarinen, M; Uusi-Kamppa, J 2019	Field studies where water run-off comes from agricultural fields for grass or cereal production, natural pasture or feedlots	Global	46	Buffer zone (buffer strip)	No buffer zone	Nitrate-N surface run-off, Total-N surface run-off, Nitrate-N groundwater	Buffer zones more effectively reduced N in groundwater than in surface runoff, despite the large variation of results across the studies.	75%
Van Vooren, L; Reubens, B; Broekx, S; De	Arable crops	Global (tempe rate)	60	1) Grass strips (field margins); 2) Hedgerows	1) No grass strips; 2) No hedgerows	1) P interception; 2) surface	Both grass strips and hedgerows increased P interception as well	75%

Reference	Population	Scale	Num. papers	Intervention	Comparator	Metric	Conclusion	Quality score
Frenne, P; Nelissen, V; Pardon, P; Verheyen, K 2017		climate)				and subsurface N interception	as surface and subsurface N interception.	
Land, M; Graneli, W; Grimvall, A; Hoffmann, CC; Mitsch, WJ; Tonderski, KS; Verhoeven, JTA 2016	Croplands	Northern hemisphere	93	Outflow load from constructed wetlands (small wetlands)	Inflow load into constructed wetlands	Total nitrogen (TN); total phosphorus (TP)	Restored and created wetlands remain appropriate and potentially sustainable ecological engineering approaches for removing nutrients from treated wastewater and urban and agricultural runoff.	94%
Dollinger, J; Dagès, C; Bailly, JS; Lagacherie, P; Voltz, M 2015	Cropland	Global	140	Outflow from ditches	Inflow into ditches	Nutrients mitigation power	<i>Reviewers' note: We labelled the results for ditches as uncertain due to the lack of statistical testing.</i>	25%
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 nitrogen mass retention; efficacy phosphorus mass retention	Vegetated buffers are effective for removing N and P.	56%
Mayer, PM; Reynolds, SK; McCutchen, MD; Canfield, TJ 2007	Landscapes with N anthropogenic inputs	Global	45	Riparian buffers effluent (buffer strips)	Riparian buffers influent	Nitrogen removal	Riparian buffers of various types are effective at reducing nitrogen in riparian zones, especially nitrogen flowing in the subsurface.	56%
Dorioz, JM; Wang, D; Poulenard, J; Trévisan, D 2006	Cultivated land	France	11	Grass buffer strips	No buffer strips and before buffers strips	Total phosphorus retention; dissolved phosphorus retention	<i>Reviewers' note: We labelled the results for grassed buffer strips as uncertain due to the lack of statistical testing.</i>	31%

3. KNOWLEDGE GAPS

Shen et al., 2021 In addition to the factors presented in this study, many other factors may also influence the total nitrogen removal rate, such as substrate material. Due to the lack of statistical data, this study did not elaborate on all these factors.

Land et al., 2016 Most studies are from Europe and North America; the size distribution of included wetlands may also be biased; most studies of nutrient removal in wetlands have been made during the years following wetland restoration or creation.

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	<p>Different searches were conducted with the following search strings:</p> <p>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*)</p> <p>or</p> <p>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*)</p> <p>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*")</p> <p>or</p> <p>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*")</p> <p>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*")</p> <p>or</p> <p>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*")</p> <p>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</p>
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"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 "researchsynthesis") 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 "researchsynthesis") 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 "researchsynthesis") 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 "researchsynthesis") 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

	<p>synthesis" OR "evidence synthesis" OR "research synthesis") AND TITLE-ABS-KEY: ("agric*" OR "cultiv*" OR "crop*" OR "farm*")</p> <p>merged with</p> <p>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*")</p> <p>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*")</p> <p>or</p> <p>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*")</p>
Search dates	No time restrictions
Databases	Web of Science and Scopus, run in October 2021
Selection criteria	<p>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 synthesise 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.</p> <p>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 9 were relevant for this impact.</p>