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 wetlands[1]) on NUTRIENT LEACHING AND RUN-OFF. It is based on 9 peer-reviewed synthesis research papers[2], 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 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 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)

[1] Described in the General Fiche.

[2] Research synthesis papers include a formal meta-analysis or systematic reviews with some quantitative results. Details can be found in the methodology section of the WIKI.

Ditches and ponds	1 (1)	0	0	1 (0)
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 the methodology section of this WIKI.*

2. IMPACTS

The main characteristics and results of the synthesis papers are summarised in **Table 2**. Summaries of the meta-analyses provide fuller 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.

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 Frenne, P;	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 and	Both grass strips and hedgerows increased P interception as well as surface and	75%

Reference	Population	Scale	Num. papers	Intervention	Comparator	Metric	Conclusion	Quality score
Nelissen, V; Pardon, P; Verheyen, K 2017		climate)				subsurface N interception	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	*Reviewers' note: We labelled the results for ditches as uncertain due to the lack of statistical testing.*	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	*Reviewers' note: We labelled the results for grassed buffer strips as uncertain due to the lack of statistical testing.*	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.