

CAVERTI: Communicating and Visualizing Erosion- Associated Risks to Infrastructure

Caspar Hewett, Carolyn Simpson and John Wainwright



Higher

Risk of Soil Erosion

Lower

CAVERTI:



Communicating and Visualizing Erosion-Associated Risks to Infrastructure

Asset protection

NERC SCIENCE OF THE ENVIRONMENT

Risks to Infrastructure

Deposition of silt in River Gaunless



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Communicating and Visualizing Erosion-Associated Risks to Infrastructure

Asset protection

NERC SCIENCE OF THE ENVIRONMENT

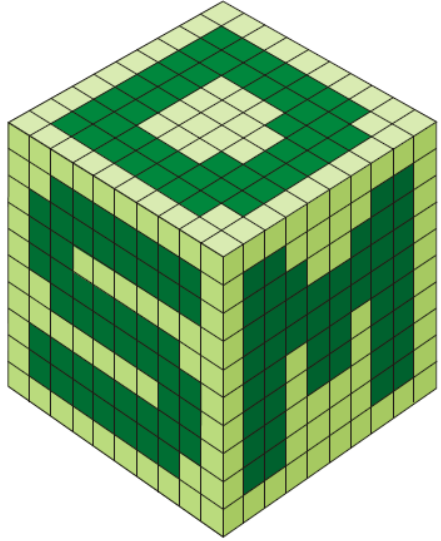


Erosion exposing high pressure gas main, Brancepeth Beck

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Communicating and Visualizing Erosion-Associated Risks to Infrastructure



DECISION
SUPPORT
MATRIX

Participatory Action Research

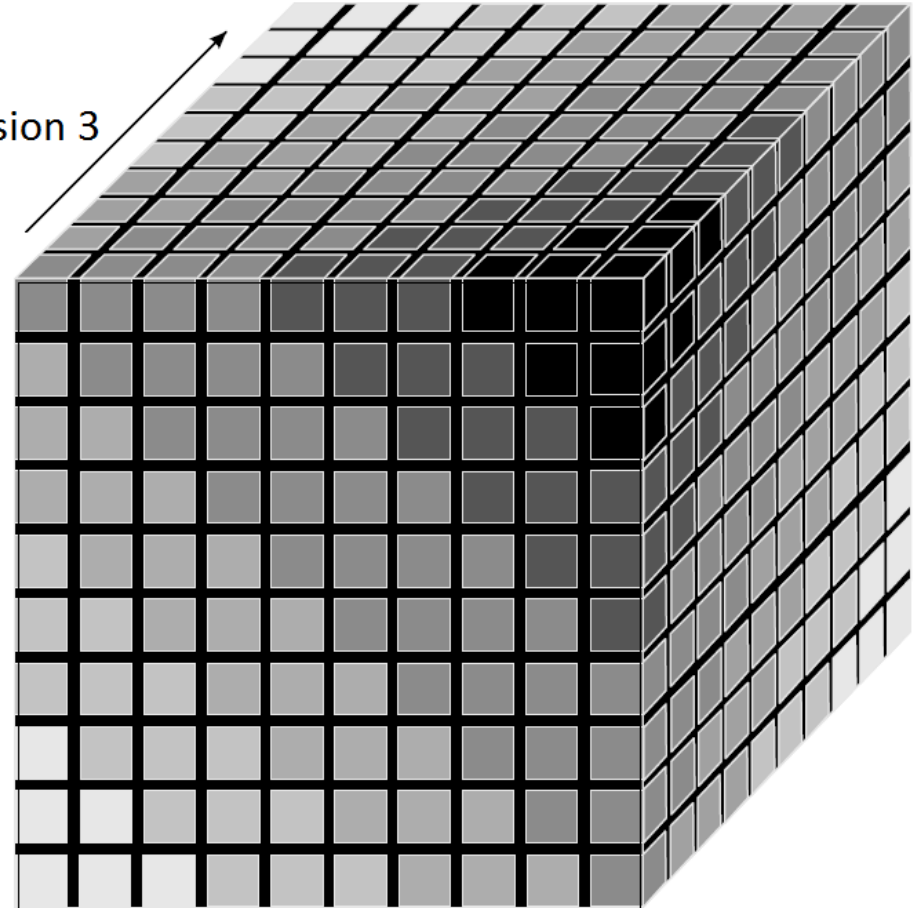
Co-production of knowledge and tools

Researchers and stakeholders

Visualization and Communication of risk

Dimension 2

Dimension 3

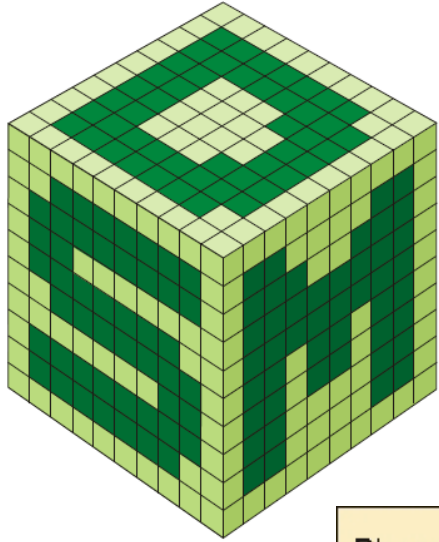


Dimension 1

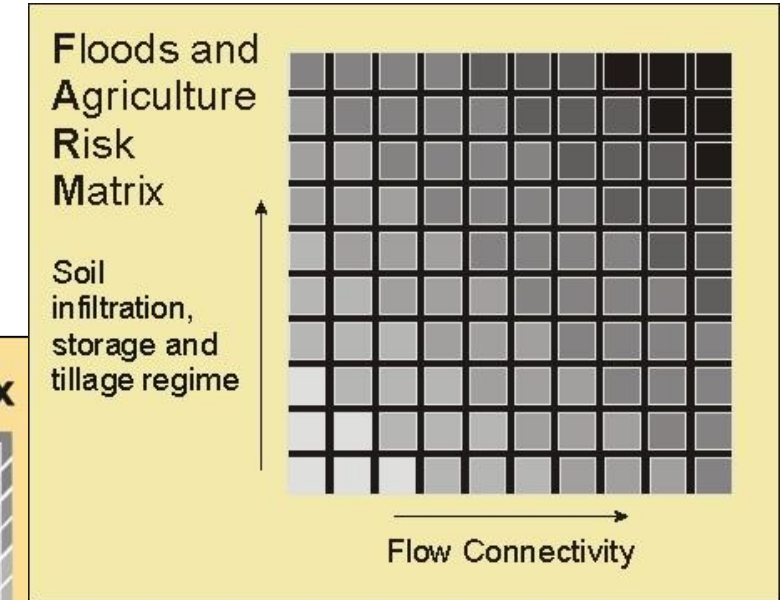
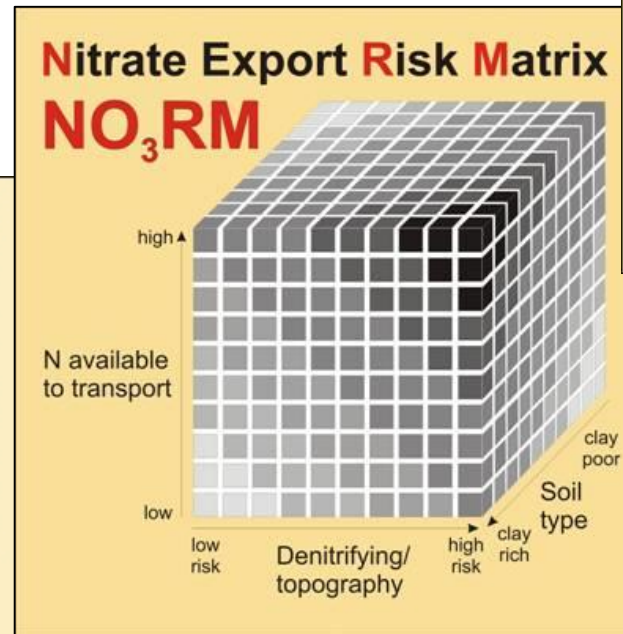
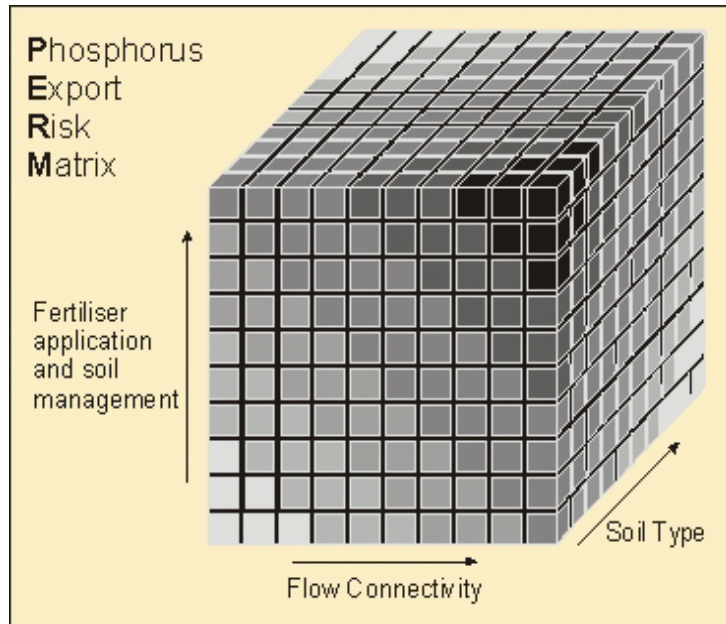
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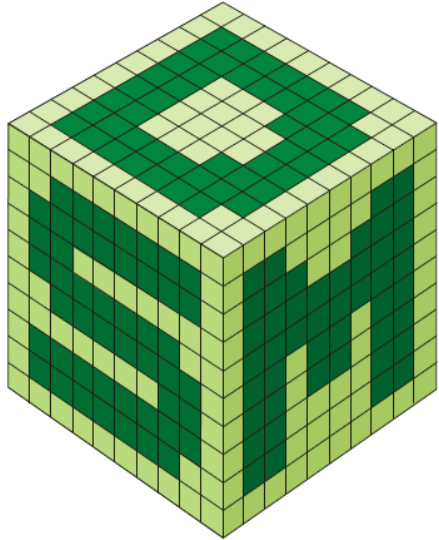
DECISION
SUPPORT
MATRIX



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Nitrate Export Risk Matrix

TheNORM.xls [Compatibility Mode]

File Home Insert Page Layout Formulas Data Review View

A1

	A	B	C	D
1		Risk Loss Assessment for Flow Connectivity		
3	Nitrate		Q1 Crop Cover	
4	available to		50 - 75% protection from crop cover	
5	transport		Q2 Land Drains	
6			partially operating land drains	
7			Q3 Point sources such as muck heap, slurry lagoon, silage clamp	
8			Partial containment but far from receiving waters	
9			Q4 Livestock access to waterways	
10			river fenced with livestock drinking bays	
11			Q5 Tramlines	
12			low density tramlines across hillslope, large distance from ditches	
13		Q6 Tyre tracks and roads		
14		low density		
15				
16				
17				
18				
19				
20				

Flow connectivity

Return to Welcome Next

Welcome NORM Examples NORM 1 **NORM 2** Flow Connectivity Low Risk

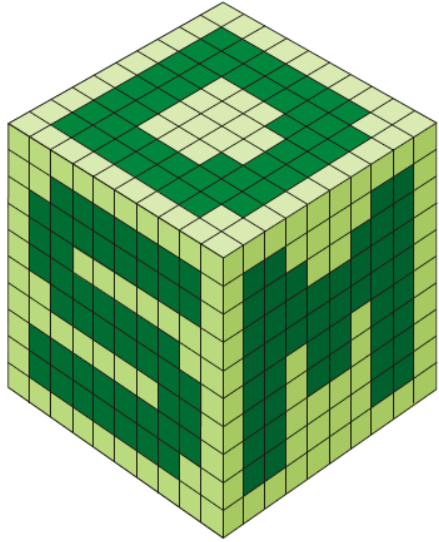
Ready

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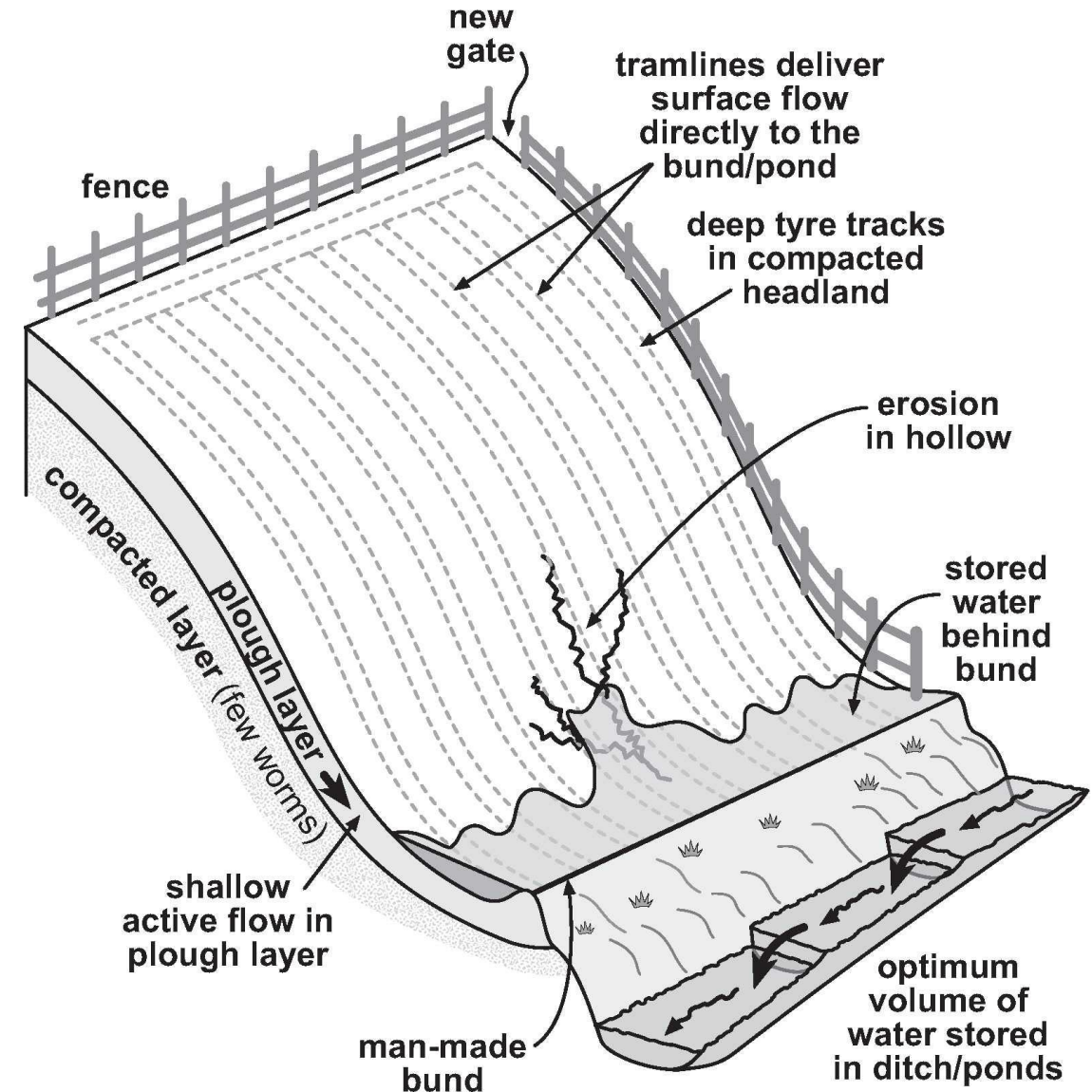
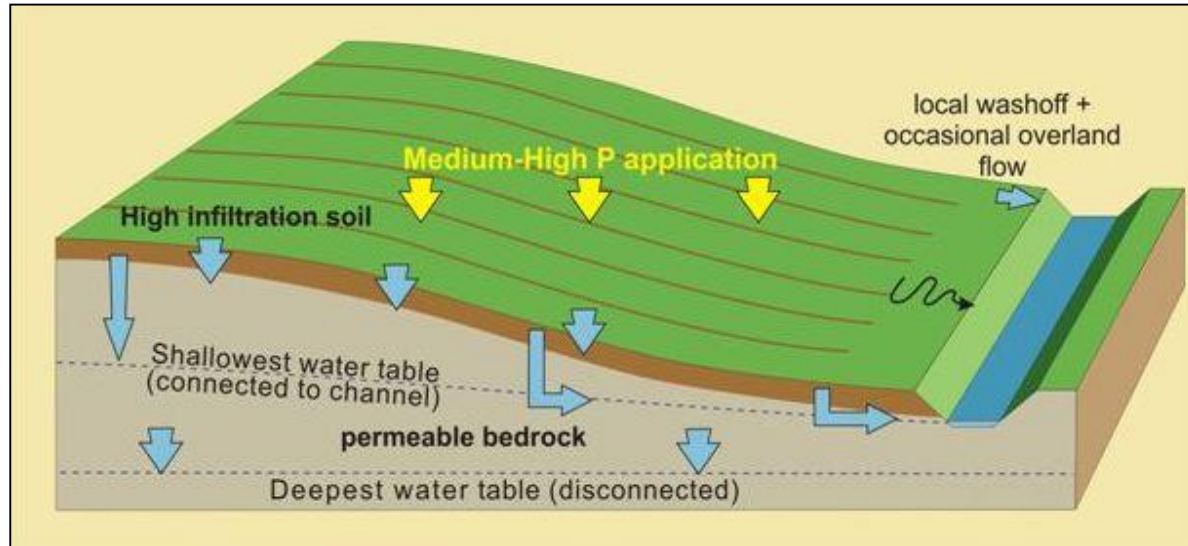
CAVERTI:



Communicating and Visualizing Erosion-Associated Risks to Infrastructure



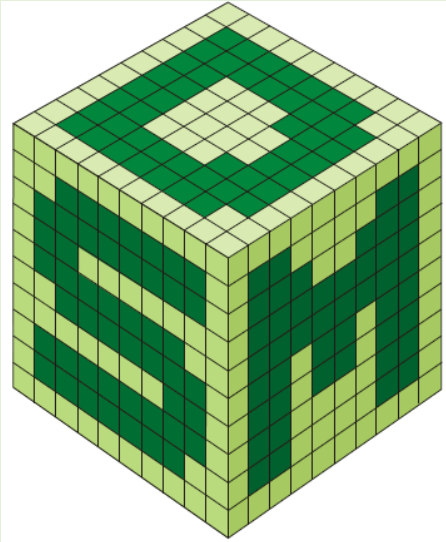
DECISION
SUPPORT
MATRIX



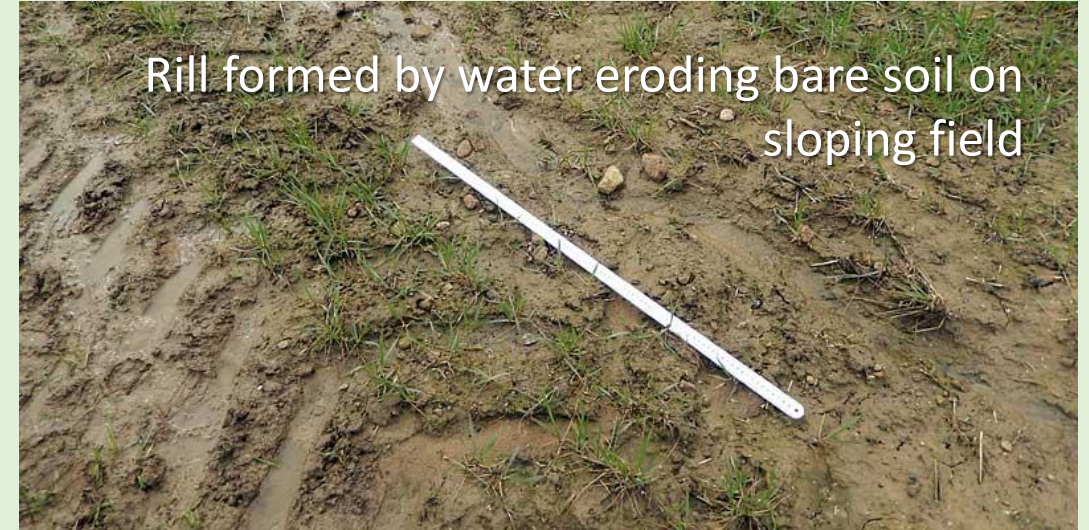
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Rill formed by water eroding bare soil on sloping field

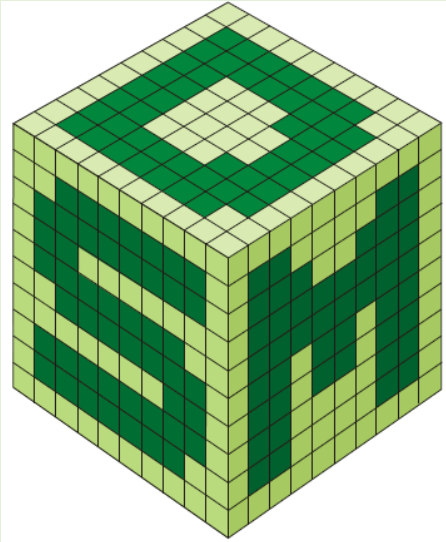


Rills formed on sloping field, high risk of further soil loss in heavy rainfall



Heavy rainfall event causing soil erosion and runoff via tramlines

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MATRIX



Rapid runoff of soil from fields through gap in hedge



Soil deposition and flooding causing road closure



Soil deposition in woodland and on adjacent farmland

Slope

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CAVERTI Tool

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[Risk Summary](#)[Interventions](#)

Slope

Slope is a baseline risk factor for soil erosion occurring as result of heavy rainfall events; in general steeper longer slopes are more susceptible to soil erosion. Whilst you are unable to alter field slope in order to reduce this risk, this tab aims to help indicate the susceptibility of land to soil erosion based upon gradient and length of slope.

In the tick boxes provided:

Please select the slope type (A - D) that currently resembles your land of interest. As slope cannot be altered, please repeat your 'current' answer for your potential scenario.

A: Steep long slope (1:3 - 1:7)

B: Steep short slope (1:3 - 1:7)

C: Moderately steep slope (1:7 - 1:20)

D: Level to gently sloping (1:20 or more)

Current:

Potential:

☐ A

☒ B

☐ C

☐ D

☐ A

☐ B

☒ C

☐ D

Current

Potential

Higher

Risk of Soil Erosion

Lower

Next

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	C: Moderately steep slope (1:7 - 1:20)	D: Level to gently sloping (1:20 or more)
Current:	<input type="radio"/> A	<input checked="" type="radio"/> B
Potential:	<input type="radio"/> A	<input checked="" type="radio"/> C

Current

Higher Lower

Potential

Next



A: Steep long slope (1:3 - 1:7)



B: Steep short slope (1:3 - 1:7)



C: Moderately steep slope (1:7 - 1:20)



D: Level to gently sloping (1:20 or more)

Slope

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A: Steep long slope (1:3 - 1:7)



B: Steep short slope (1:3 - 1:7)

Current:

☐ A

☒ B

☐ C

☐ D

Potential:

☐ A

☐ B

☒ C

☐ D

Current

↓

Higher

Risk of Soil Erosion

Lower

↑

Potential

Next

Soil Type

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Soil Type

Soil type can be a major limiting factor in the type of crop that can be grown on land, the rate at which rain water infiltrates through the soil, and how easily soil can be detached and moved via runoff. Whilst you are unlikely to be able to alter the soil type, this tab aims to help indicate the susceptibility of different soil types to erosion as a result of heavy rainfall events.

In the tick boxes provided:

Please select the most widespread soil type (A - D) currently in your land of interest. As soil type cannot be altered, please repeat your 'current' answer for your potential scenario.

(Image source: www.soil-net.com - please see [credits](#)).



A: Heavy / clay



B: Light / silt-sand



C: Medium loam



D: Chalk

Current: ☐ A ☒ B ☐ C ☐ D
Potential: ☐ A ☐ B ☒ C ☐ D

Current



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Soil Structure

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[Risk Summary](#) [Interventions](#)

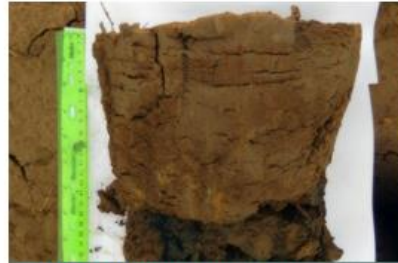
Soil Structure

Soil structure can greatly influence the risk of soil erosion occurring as a result of heavy rainfall events. Soils with a poor structure, such as compacted, poorly aerated soils are more likely to be prone to waterlogging. As rainwater cannot readily infiltrate through compacted soil, soil erosion and runoff is more likely to occur.

In the tick boxes provided:

Please select the soil structure (A - D) that currently represents your land of interest. If there is 'potential' to improve soil structure on your land select the lower risk option that applies.

(If a lower risk option is not applicable simply repeat your current answer for your potential scenario).



A: Highly compacted, poor structure



B: Slightly compacted, massive structure



C: Fissured soil with good organic matter



D: Good soil structure, well aerated

Current: ☐ A ☐ B ☐ C ☐ D
Potential: ☐ A ☐ B ☐ C ☐ D

Higher Risk of Soil Erosion Lower

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Crop Cover

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Crop Cover

A well-established crop can help protect the soil surface from rain drops which detach soil from the land during heavy rainfall events. Crops also provide a rough surface to help slow down any runoff that may arise, helping soil deposit back on the land. The roots of crops also help bind soil together improving soil structure and stability.

In the tick boxes provided:

Please select the crop cover option (A - D) that 'currently' resembles your land of interest and a 'potential' lower risk option you might consider for that location.

(If a lower risk option is not applicable simply repeat your current answer for your potential scenario).



A: No winter cover crop



B: Winter cover crop



C: Fallow / rough grass



D: Woodland / plantation

Current: ☐ A ☐ B ☐ C ☐ D
Potential: ☐ A ☐ B ☐ C ☐ D

Higher Risk of Soil Erosion Lower

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Tramlines

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Tramlines

For sloping fields, the risk of soil erosion occurring as a result of heavy rainfall events is greatly increased under the up-downslope formation of tramlines; bare soil in these tramlines is particularly susceptible to rill formation. Rills are small channels that form on the soil surface when sediment is detached by runoff; these channels act as a pathway to move soil down slope and can be the predominant source of soil lost from sloping fields in heavy rainfall events.

In the tick boxes provided:

Please select the tramline arrangement (A - D) that 'currently' resembles your land of interest and a 'potential' lower risk option you might consider for that location. [If your land is level please select from options C or D only].

(If a lower risk option is not applicable simply repeat your current answer for your potential scenario).



A: Up / downslope - rills in tramlines



B: Up / downslope - no rills in tramlines



C: Across slope - ponding water in tramlines



D: Across slope - no ponding water in tramlines

Current: ☒ A ☐ B ☐ C ☐ D
Potential: ☐ A ☐ B ☐ C ☒ D



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Gateway Position

Gateway Position

Heavy traffic accessing gateways has the potential to create bare soil at field entrances, resulting in poor ground condition. Gateways located adjacent to main roads and surface water drainage systems at the base of sloping fields are likely to be at higher risk for conveying runoff, resulting in sedimentation and flooding. It may be worth considering whether gateway position can be altered to reduce risk and/or improve surfacing at access points to minimise the creation of bare soil and wheel ruts.

In the tick boxes provided:

Please select the gateway description (A - D) that 'currently' resembles your field of interest, and a 'potential' lower risk option you might aim for.

(If a lower risk option is not applicable simply repeat your current answer for your potential scenario).

NOTE: If your land is level, please select from the options C or D only.



Current: ☐ A ☒ B ☐ C ☐ D

Potential: ☐ A ☐ B ☐ C ☒ D



Land Drainage

Land Drainage

Maintaining land drains, ditches and pipe outlets can help ensure the field drainage system is working efficiently; where soils are saturated and rainwater can not infiltrate through the soil, the risk of surface water runoff and soil erosion occurring in heavy rainfall events is likely to be higher.

In the tick boxes provided:

Please select the land drainage characteristic (A - D) that currently resembles your field of interest and a 'potential' lower risk option you might work towards for that location.

(If a lower risk option is not applicable simply repeat your current answer for your potential scenario).



A: Waterlogged areas, prone to runoff



B: Waterlogged areas, runoff less common



C: Damp patches, slowly draining



D: Mostly dry, freely draining

Current: ☐ A ☐ B ☒ C ☐ D
Potential: ☐ A ☐ B ☒ C ☐ D



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Field Boundaries

Field Boundaries

Maintaining field boundaries and enhancing those across slopes is likely to help reduce the risk of soil erosion occurring as a result of heavy rainfall events; well planned and maintained field boundaries with few gaps can help intercept and slow the rate of runoff, reduce soil loss and aid deposition within the field boundary.

In the tick boxes provided:

Please select the field boundary (A - D) that currently resembles your land of interest, and a 'potential' lower risk option you might consider for that location. [If you have a variety of field boundary types, select the boundary type most commonly found across slopes, if you have sloping land].

(If a lower risk option is not applicable simply repeat your current answer for your potential scenario).



A: Fence and / or a grass margin



B: Grass margin and / or sparse hedge



C: Maintained hedge with few or no gaps



D: Dry-stone wall (maintained, no gaps)

Current:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	A	B	C	D
Potential:	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
	A	B	C	D

Higher Risk of Soil Erosion Lower

Previous

Next

Current



Higher	Risk of Soil Erosion	Lower
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Potential

Risk Factor	Current	Potential
Slope	High	Medium
Soil Type	High	Medium
Soil Structure	High	High
Crop Cover	Very high	Medium
Tramlines	Very high	Low
Gateways	Very high	Low
Drainage	High	Medium
Boundaries	Very high	Medium
Overall Risk	High	Medium

Risk Factor	Interventions to help mitigate risk of soil erosion and erosion-associated risks to infrastructure
Slope	<p>As you can not alter slope, manage other risks factors where possible, especially where your baseline risk of erosion is high owing to a relatively steep or long slope.</p> <p>Break up slopes with across slope buffer features that will help slow runoff and intercept soil whilst offering benefits for wildlife: e.g. beetle banks, in-field grass strips (minimum 3m wide).</p> <ul style="list-style-type: none"> • http://www.cfeonline.org.uk/campaign-themes/arable/ (also see boundaries options below).
Soil Type	<p>As you can not alter soil type, manage other risk factors where possible, especially where your baseline risk of erosion is high owing to a heavy clay or very light sandy and loamy soils. Check the optimum cropping regime for your soil type:</p> <ul style="list-style-type: none"> • http://www.landis.org.uk/soilscapes/
Soil Structure	<p>Avoid soil compaction by using dual or flotation tyres on farm vehicles to help spread the load over a large area.</p> <p>To encourage top-soil stability apply organic manures; avoid over-deep working of the land and over-deep cultivation.</p> <p>Use minimal cultivation techniques for susceptible soils e.g. by ploughing and rolling in one operation with the crop sown at right-angles to the direction of rolling.</p> <p>A variety of manuals are available to help assess your soil structure and optimise soil organic matter which can improve drainage and crop yields. For guidance and links to other information see:</p> <ul style="list-style-type: none"> • https://www.gov.uk/soil-management-standards-for-farmers • http://www.soilassociation.org/whatisorganic/organicfarming/organicmatter • https://www.gov.uk/managing-soil-types

Risk Factor	Interventions to help mitigate risk of soil erosion and erosion-associated risks to infrastructure
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	• https://www.gov.uk/managing-soil-types
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Risk Factor	Interventions to help mitigate risk of soil erosion and erosion-associated risks to infrastructure
Crop Cover	<p>Limit the area and duration for which soil surface is left bare over winter by sowing autumn crops; sow crops early to help them establish and form deeper roots. Sowing winter cover crops can help minimise the risk of nitrate leaching and also help improve soil fertility.</p> <p>Incorporate conservation management in your crop cover choice:</p> <ul style="list-style-type: none"> • http://www.kingscrops.co.uk/ <p>If an area is particularly susceptible to soil erosion and can not be improved by changes in husbandry or cropping, consider sowing permanent grass or planting a woodland. Help towards costs of planting and materials may be available from the Woodland Trust Morewoods scheme or from the Forestry Commission through Countryside Stewardship woodland capital grants:</p> <ul style="list-style-type: none"> • http://www.woodlandtrust.org.uk/get-involved/plant-trees/on-farms/ • https://www.gov.uk/government/publications/guide-to-countryside-stewardship-woodland-capital-grants-2015/guide-to-countryside-stewardship-woodland-capital-grants-2015
Tramlines	<p>If safe to do so (in relation to the risk of farm vehicles tipping), carry out cultivations that will create tramlines across slope, avoiding the creation of up/downslope tramlines.</p> <p>Avoid access when the soil is wet.</p> <p>Shift the tramline pattern to avoid repeat compaction of land in tramlines / tracks.</p>
Gateways	<p>If road safety and security requirements are met, situate gateways at the top of any sloping fields. Also consider surfacing access gateways with hardcore and filling in wheel ruts. If a site is particularly susceptible to run-off consider installing a sediment trap to collect surface water and intercept soil:</p> <ul style="list-style-type: none"> • http://www.demonstratingcatchmentmanagement.net/wp-content/uploads/2013/01/Intercepting-diffuse-pollution-pathways-.pdf <p>Install interceptor ditches (silt traps) to channel surface-water away from areas prone to erosion (e.g. areas frequently accessed by farm machinery, and at the base of long steep slopes) or away from areas with connectivity to water courses, roads or drains (e.g. potentially at gateways).</p>

Risk Factor	Interventions to help mitigate risk of soil erosion and erosion-associated risks to infrastructure
Drainage	<p>Identify areas where drainage efficiency could be improved:</p> <ul style="list-style-type: none"> • http://www.swarmhub.co.uk/sub_soils.php?id=2604 <p>Follow best practice guidelines for maintaining field drains, ditches and outlets in efficient working condition to minimise ponding and run-off:</p> <ul style="list-style-type: none"> • https://www.gov.uk/manage-water-on-land-guidance-for-land-managers#drainage-and-water-levels <p>Reduce run-off by increasing surface drainage by using subsoilers or mole ploughs:</p> <p>Consider constructing a farm wetland to manage run-off, protect the water-environment and improve ecological condition:</p> <p>http://www.wwt.org.uk/conservation/saving-wetlands-and-wildlife/influencing-action/guidance/constructed-farm-wetlands/</p>
Boundaries	<p>Where possible, plant up field boundaries with hedges which when established and if well maintained, help increase infiltration rates, slow run-off and intercept soil:</p> <ul style="list-style-type: none"> • http://www.hedgeline.org.uk/farm-environment-schemes.htm <p>Use permanent grass buffer strips both within fields and between fields to reduce field erosion, and alongside ponds or water courses to help intercept sediments and nutrients or pesticides.</p> <p>Encourage regeneration of trees and shrubs to stabilise borders adjacent to flowing water.</p>

Conclusion

Visualization and communication tools co-developed by researchers and stakeholders are the best means of ensuring that mitigation measures are undertaken across the landscape to reduce soil erosion.

The CAVERTI tool has proven to be an effective means of encouraging farmers and land owners to act to reduce erosion, providing multiple benefits from protecting local infrastructure to reducing pollution of waterways.