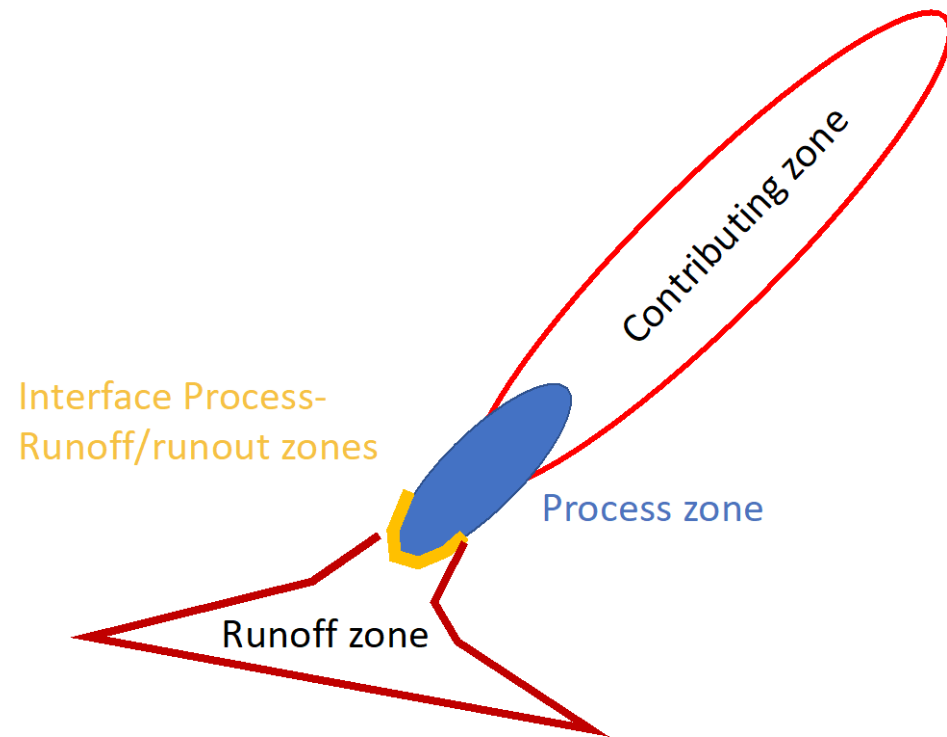




## Examples of nature-based solutions for sediment and flood control and methods for quantifying their impact

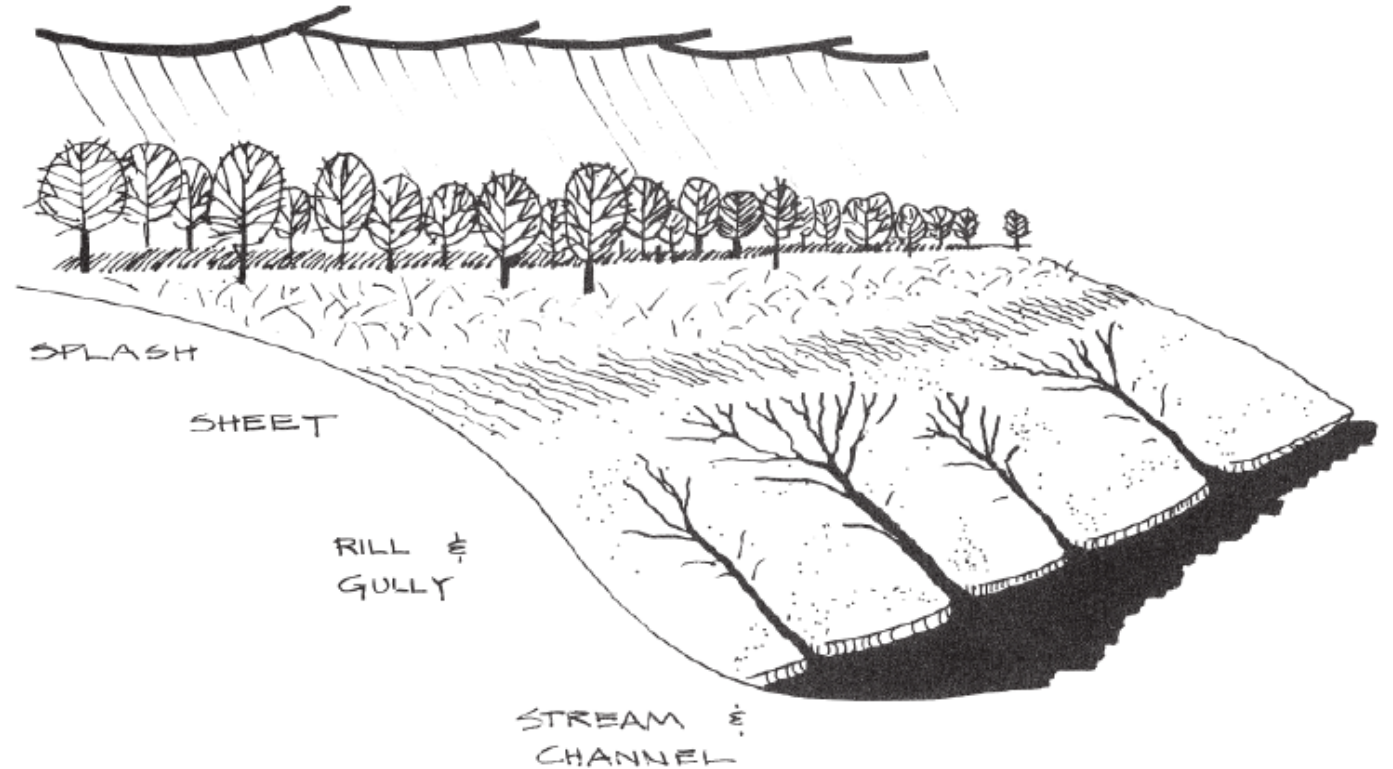
- Hochschule für Agrar-, Forst- und Lebensmittelwissenschaften, Abteilung Waldwissenschaften

# Zones of influence for sediment mobilisation



(Source: kwaard.net)

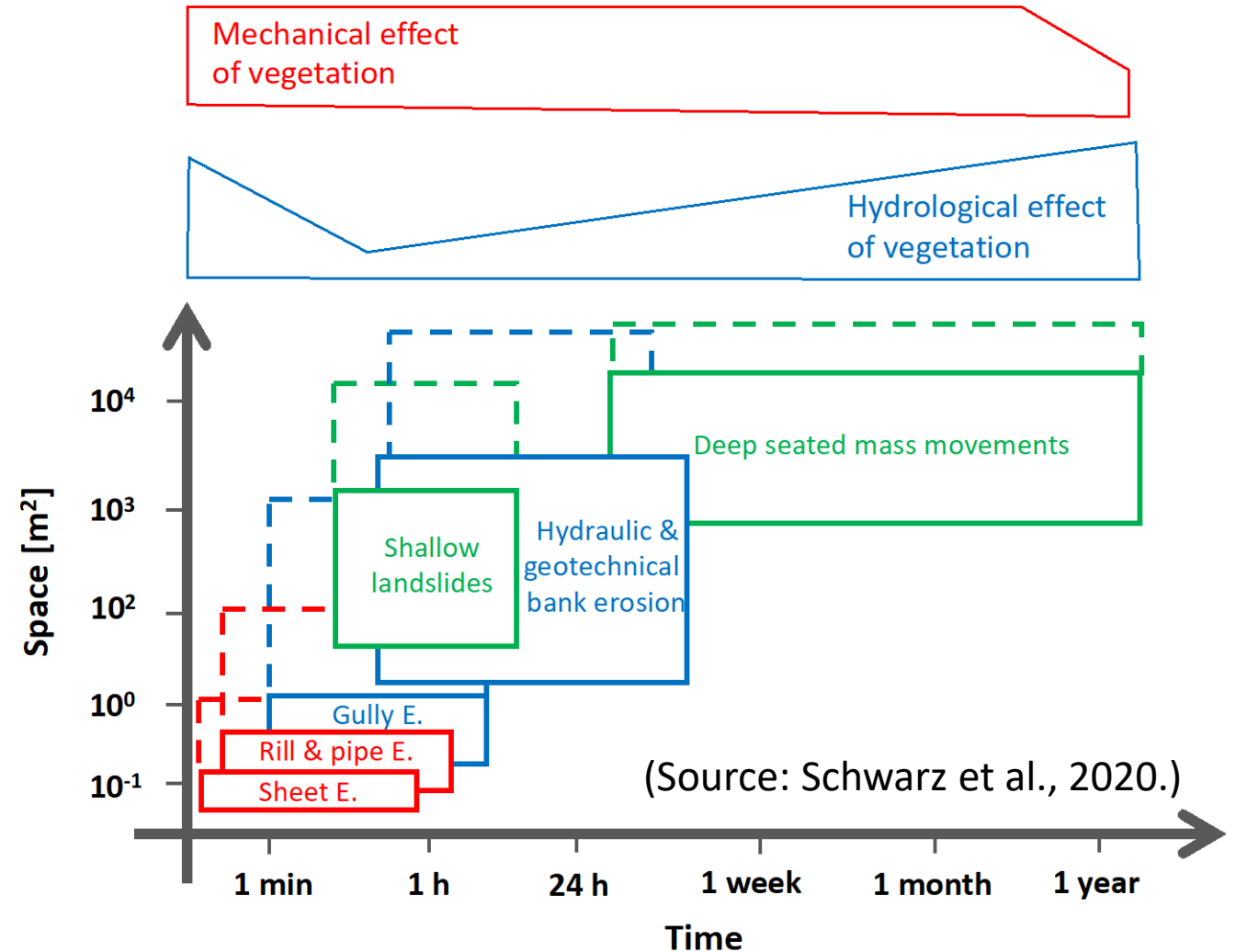
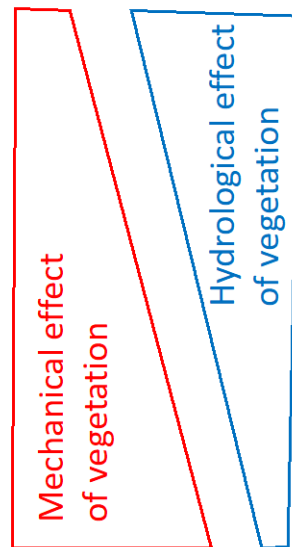
# Zones of influence for sediment mobilisation



Drawing: Evolution of soil erosion processes. (Source: Amangabara, 2014)

# Source of sediments (process zone): general concept

- ▶ Splash, rill and gully erosion
- ▶ Shallow landslides
- ▶ Hydraulic and geotechnical bank erosion
- ▶ Deep seated mass movement



# Water runoff: principal factors

- ▶ Precipitations
- ▶ Catchment geometry and morphology
- ▶ Soil and Land use

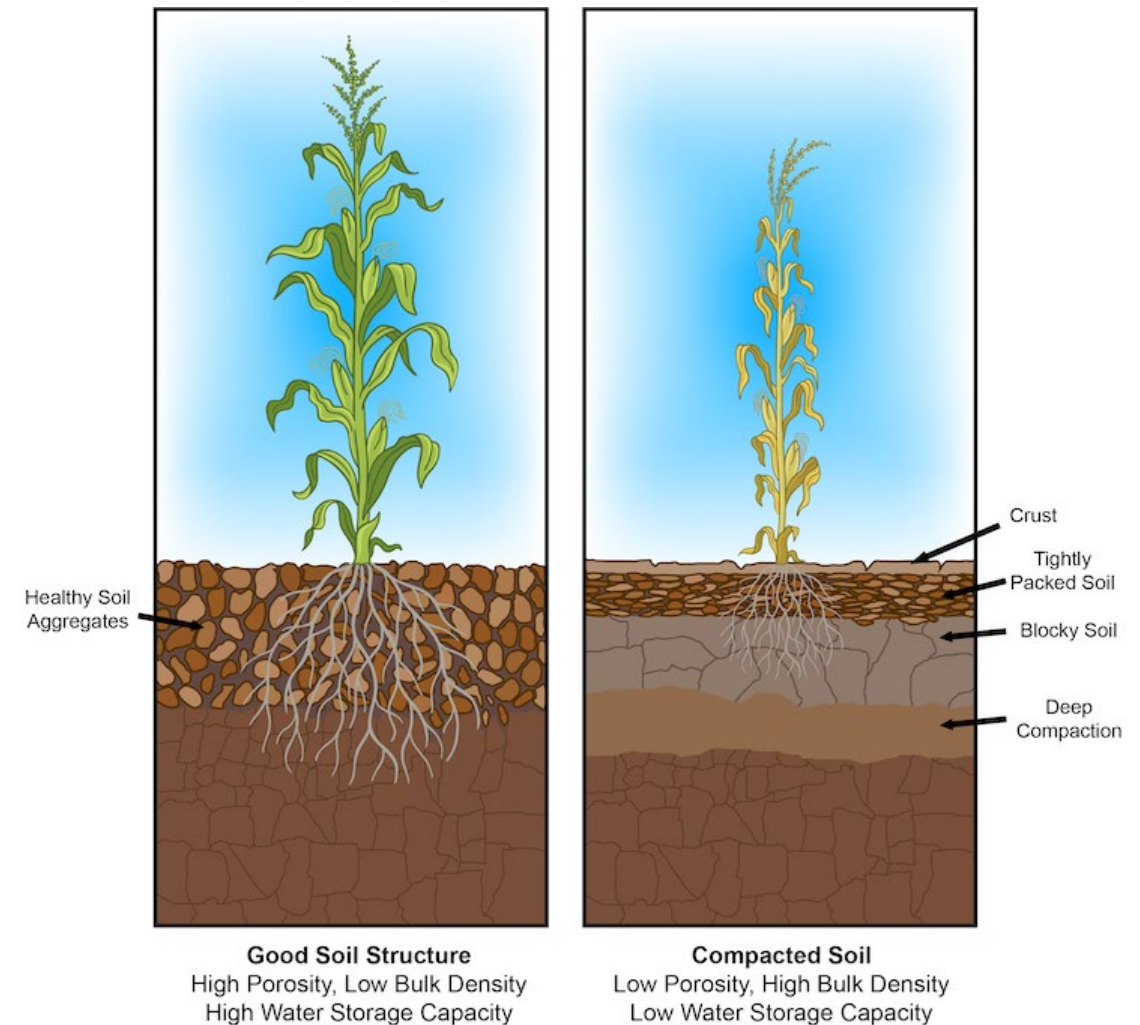


- ▶ “The reason for the recent increase in flooding events appears to be changes in land use, in the area of arable cropping, and the continued intensification of farming such as the use of **chemical fertilizers**, the decline in aggregate stability, the increase in the **size of fields** and **compaction** by farm vehicles.” (Boardman et al., 1994)

<https://doi.org/10.1016/B978-0-444-82012-9.50017-7>

# Water runoff: control measures

- ▶ Increasing infiltration and storage
- ▶ Interrupting connectivity
- ▶ **Conversion to organic farming:** “Fertility and soil biological activity should be maintained or increased through crop rotations, green manure cultivation, organic matter recycling and composting.” <https://doi.org/10.1016/j.catena.2018.02.024>
- ▶ By reducing the ploughing depth or by practicing no-till, the infiltration capacity and the storage capacity of soils increase compared to conventional agriculture (Alliaume et al., 2014).



# Rill & Gully erosion: models

- ▶ Event-based physical models are the most useful for the benefit/cost analysis and the planning of measures.

Source: Borrelli et al., 2021. Science of the total environment.

Lists of the top 25 most applied soil erosion prediction models according to the records reported in the GASEMT database.

Model	Records	%	References
RUSLE	507	17.1	(Renard et al., 1997)
USLE	412	13.9	(Wischmeier and Smith, 1978)
WEPP	191	6.4	(Laflen et al., 1991)
SWAT	185	6.2	(Arnold et al., 2012)
WaTEM/SEDEM	139	4.7	(Van Oost et al., 2000)
RUSLE-SDR	115	3.9	–
USLE-SDR	64	2.2	–
LISEM	57	1.9	(De Roo et al., 1996)
Customized approach	53	1.8	–
MUSLE	52	1.7	(Williams and Berndt, 1977)
MMF	48	1.6	(Morgan et al., 1984)
AnnAGNPS	47	1.6	(Young et al., 1989)
RHEM	44	1.5	(Nearing et al., 2011)
Unknown	36	1.2	–
Erosion 3D	29	1.0	(Schmidt, 1991)
EPIC	25	0.8	(Williams et al., 1983)
PESERA	23	0.8	(Govers et al., 2003)
USPED	22	0.7	(Mitasova et al., 1996)
GeoWEPP	20	0.7	(Renschler, 2003)
RUSLE2	20	0.7	(Foster et al., 2001)
EPM	19	0.6	(Gavrilovic, 1962)
STREAM	19	0.6	(Cerdan et al., 2002)
RUSLE/SEDD	16	0.5	(Ferro and Porto, 2000)
DSESYM	15	0.5	(Yuan et al., 2015)
EUROSEM	15	0.5	(Morgan et al., 1998)

# Rill erosion: control measures

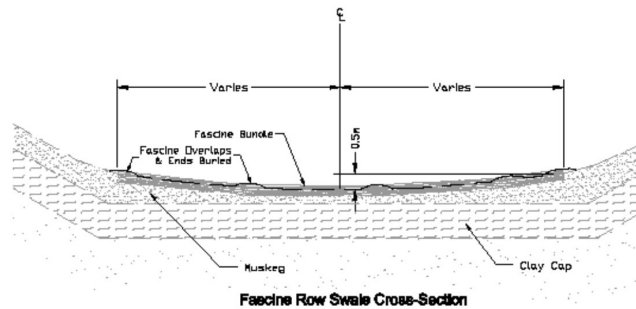
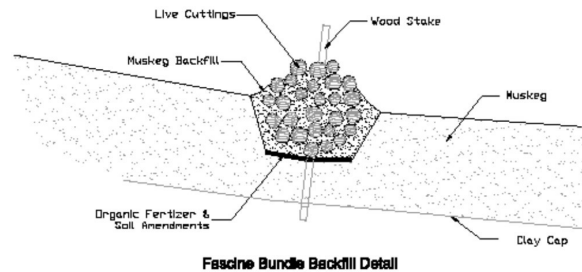
## Contour fascines used to control water and sediment runoff

Source: Frankl et al., 2018. Geomorphology.



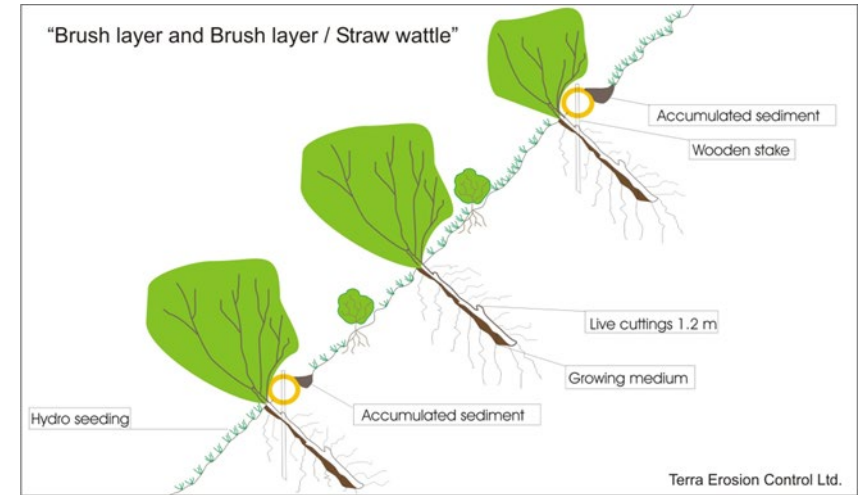
# Rill erosion: control measures

Contour fascines used to control water runoff in mine setting 2010 - 2014

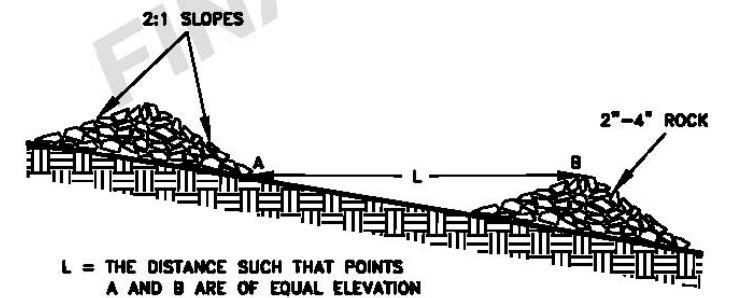


# Rill erosion: control measures

Combined straw wattle with brush layers,  
planting and seeding 2006 – 2008.

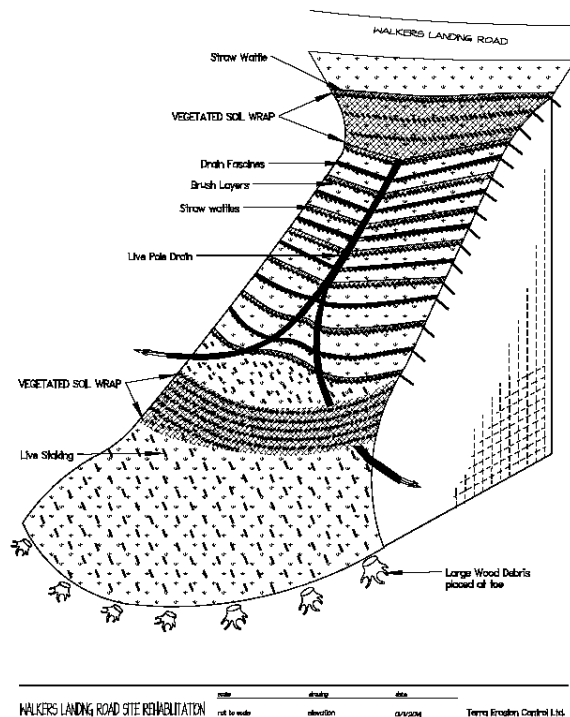


# Gully erosion: control measures



# Shallow landslides: control measures

Live pole drain system combined with brush layers, plantings and seeding to address ground seepage and slope failure. 2003 – 2014.



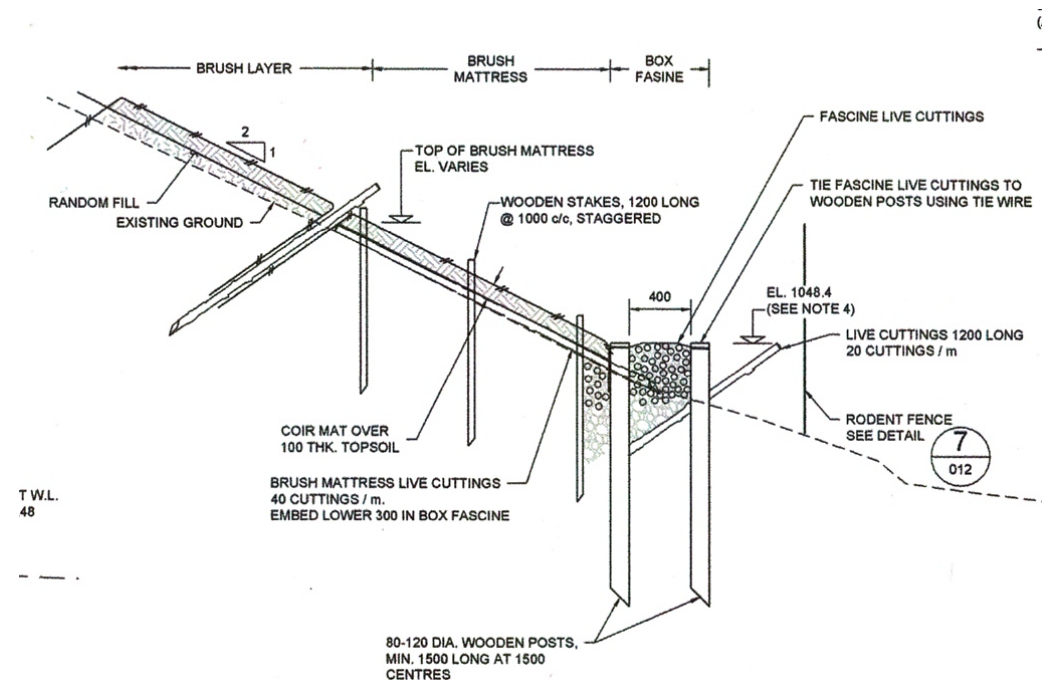
# Shallow landslides: control measures

- ▶ Spaced planted trees



# Bank erosion: control measures

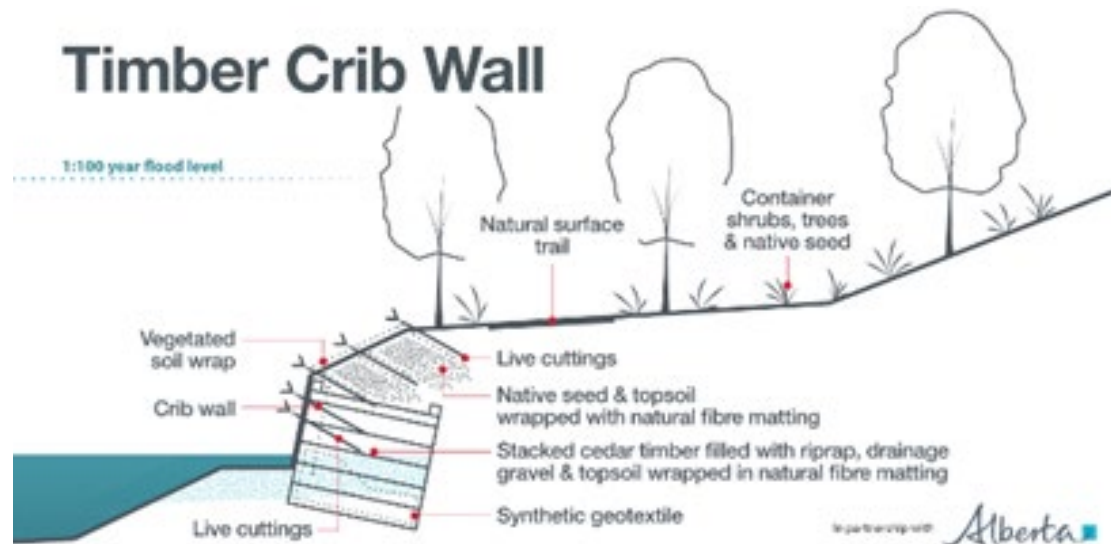
Primarily Vegetative Techniques:  
Combined toe fascine, brush mattress and vegetated soil wraps  
brush layers 2018 - 2021



# Bank erosion: control measures

Mixed Techniques:

Vegetated timber crib wall / vegetated soil wraps 2016 – 2020.



Photos: Terra Erosion Control / Keer wood Leidal.

# Bank erosion: BankforNET

BankforNET by **ecorisQ**

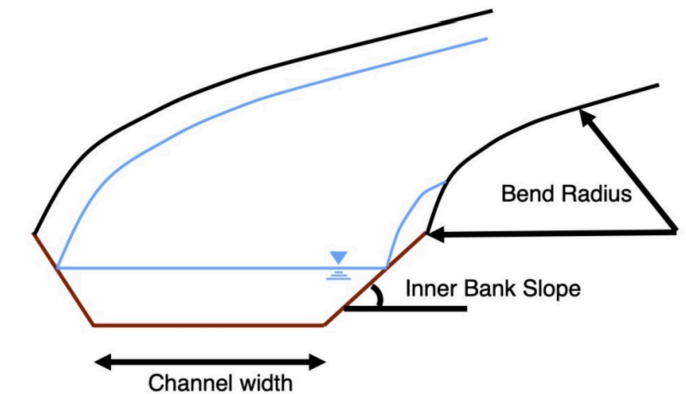


Input   Flow Height   Transport   Erosion

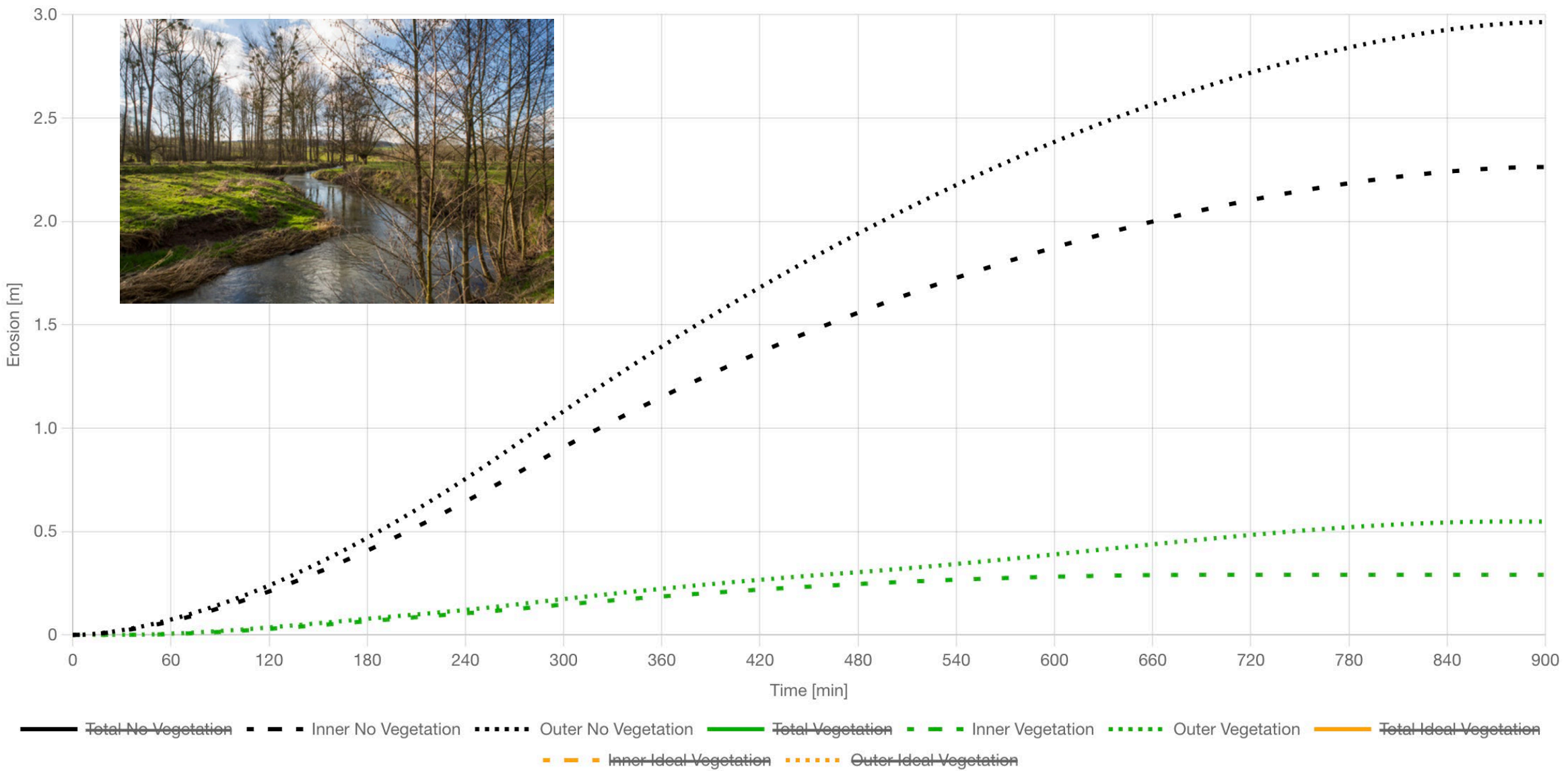
Channel Parameters ⓘ

Channel Width	4 m	Channel Slope	0.07 m/m
Inner Bank Slope	29 deg	Outer Bank Slope	29 deg
Bend Radius	100000 m	Manning Coefficient	0.05 m <sup>1/3</sup> /s
Inner Bank Height ⓘ	0.6 m	Outer Bank Height ⓘ	0.6 m

Channel Parameter Diagram



# Erosion



# Summary/conclusion

- Planning, design and construction of nature-based solutions involves many considerations:
  - Appropriate design for the site conditions.
  - Quantitative assessment of the performance of the structure.
  - Life cycle assessment of structure.
  - Downstream / down slope potential hazards.
  - Access to site and availability of live and inert material.
  - Fish windows to work instream.
  - Vegetation dormancy periods.
  - Availability of skill contractor and experience site supervisor.
  - Implementation and on-site supervision during construction.
  - On site monitoring.



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Thanks for your attention!