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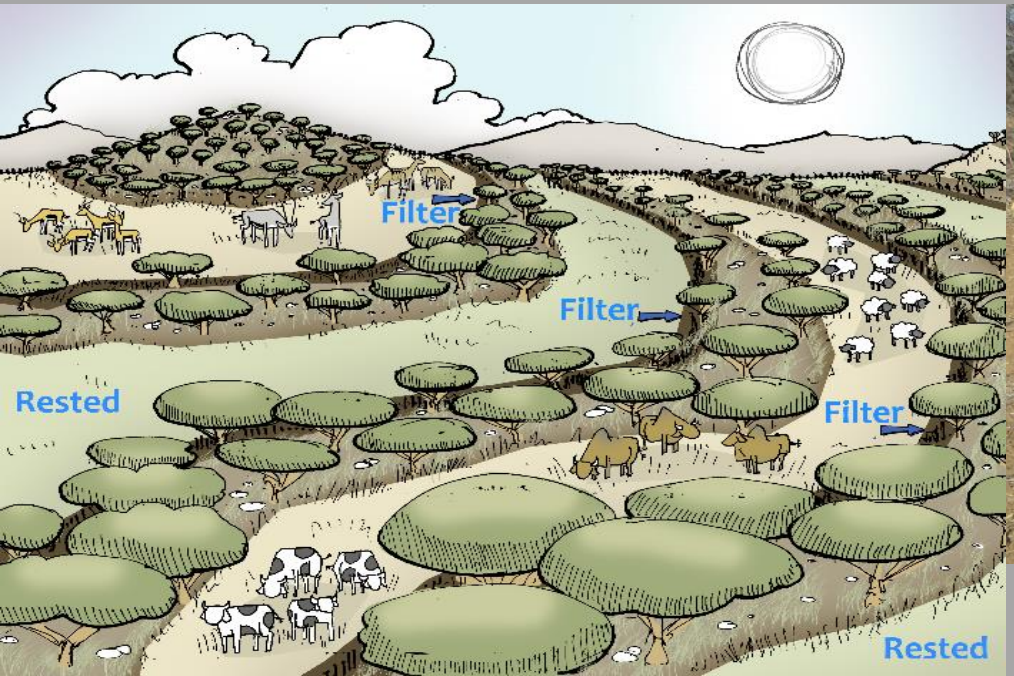
BUSH
BIOMASS UTILISATION BY SUSTAINABLE HARVEST

CONTOURS AND MINERALS PROTOCOL FOR INTEGRATED BIOSYSTEMS REGENERATING EARTH (CAMPFIBRE)

Ibo Zimmermann (NUST) and Johan Bruwer (AIRE)



Drawing by Duif Keyser

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Bush encroachment is a symptom of rangeland degradation, not its cause

Nature uses bushes to try repairing water and nutrient cycles. They will eventually self-thin, if given a chance

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Condition of most Namibian rangelands

- Most of Namibia's rangelands are degraded
- Water and nutrient cycling have been disrupted
- Much water runs off bare soil instead of infiltrating
- and evaporates instead of growing organic matter
- Exposed soils get hot and bake soil microbes

Some mulch

No mulch

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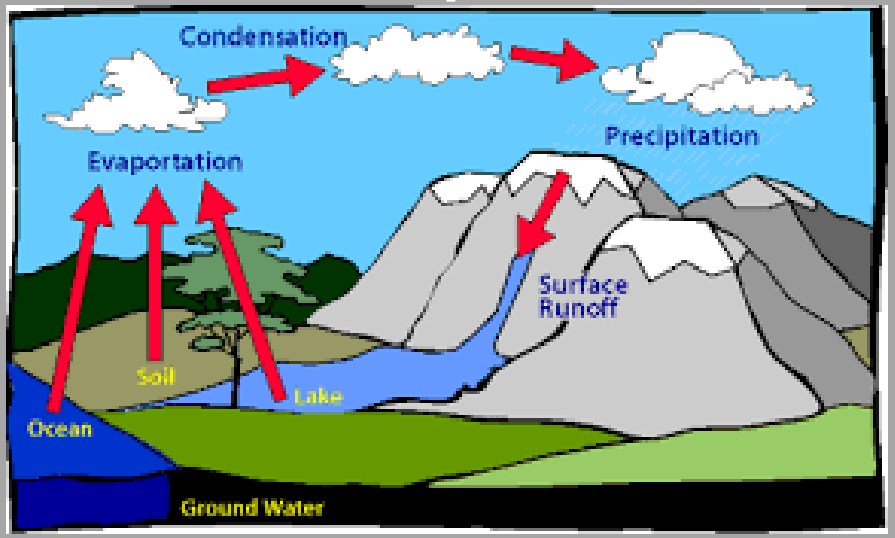
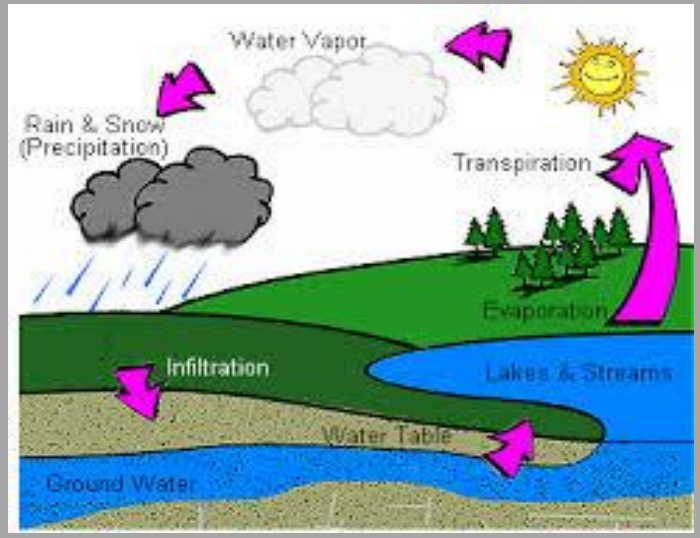
Instead of high runoff and evaporation …



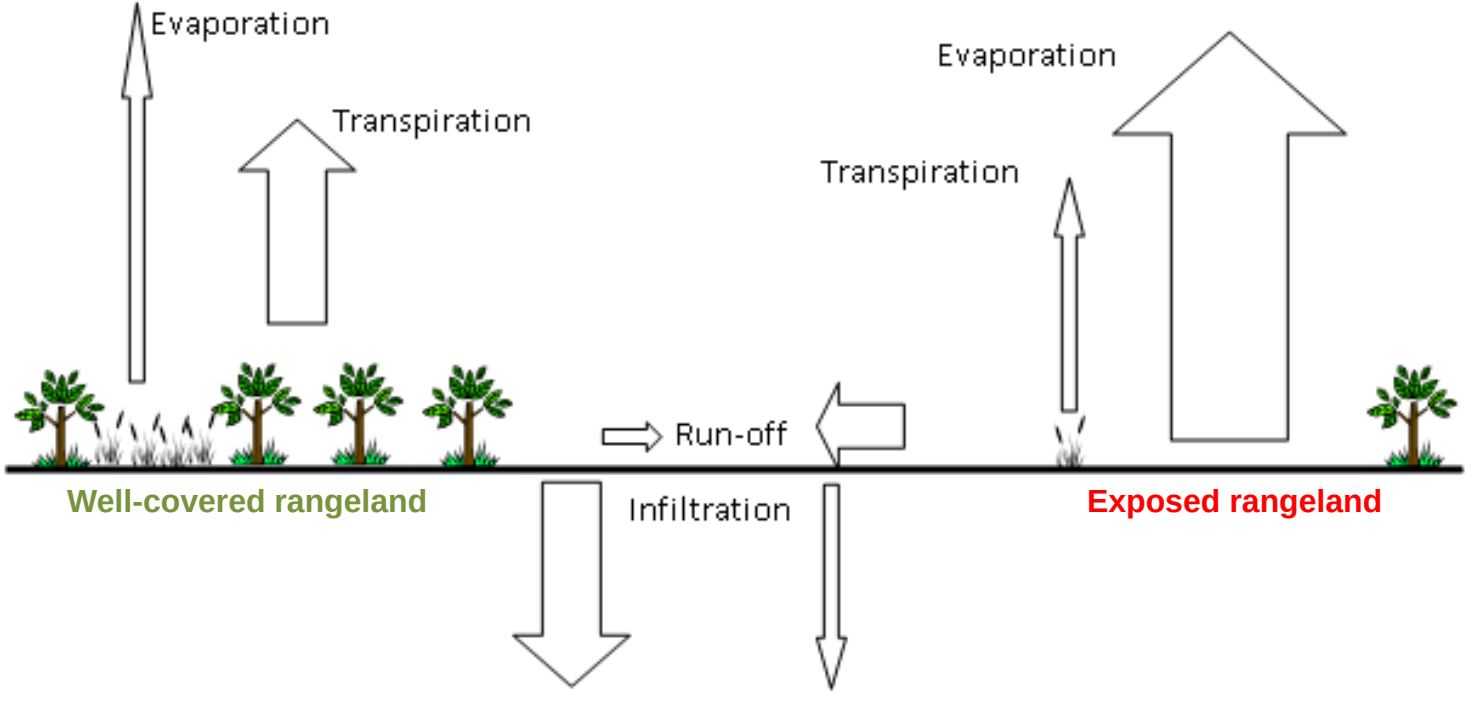
Poor water cycle

… we need more infiltration & transpiration

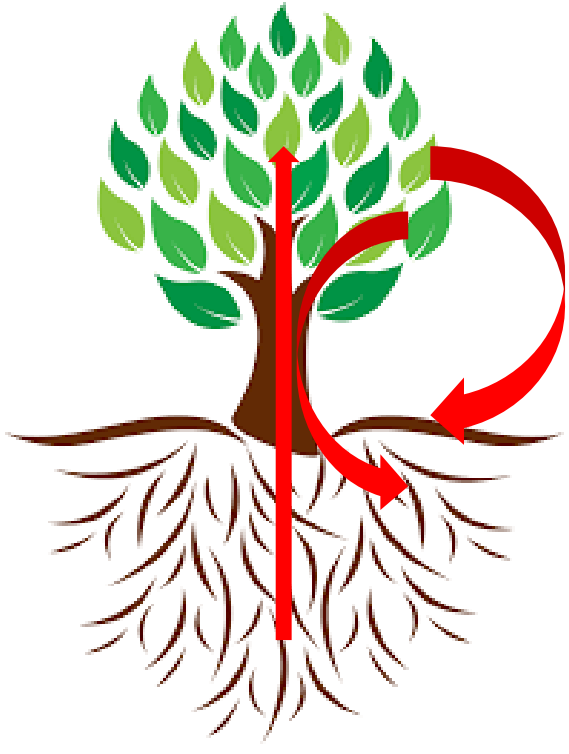


Effective water cycle

BUSHES AND GRASSES ENHANCE WATER CYCLE



Bushes as fertility pumps



Root uptake through xylem, to feed leaves and branches

Leaf fall, to feed soil microbes

Root exudates through phloem, to feed soil microbes

Brief history of rangeland use

- For 1st half of 20th Century, Namibian rangelands supported a thriving dairy industry,
- which disrupted water and nutrient cycling,
- and was then replaced by beef industry,
- further degrading the rangeland
- now subjected to biomass offtakes

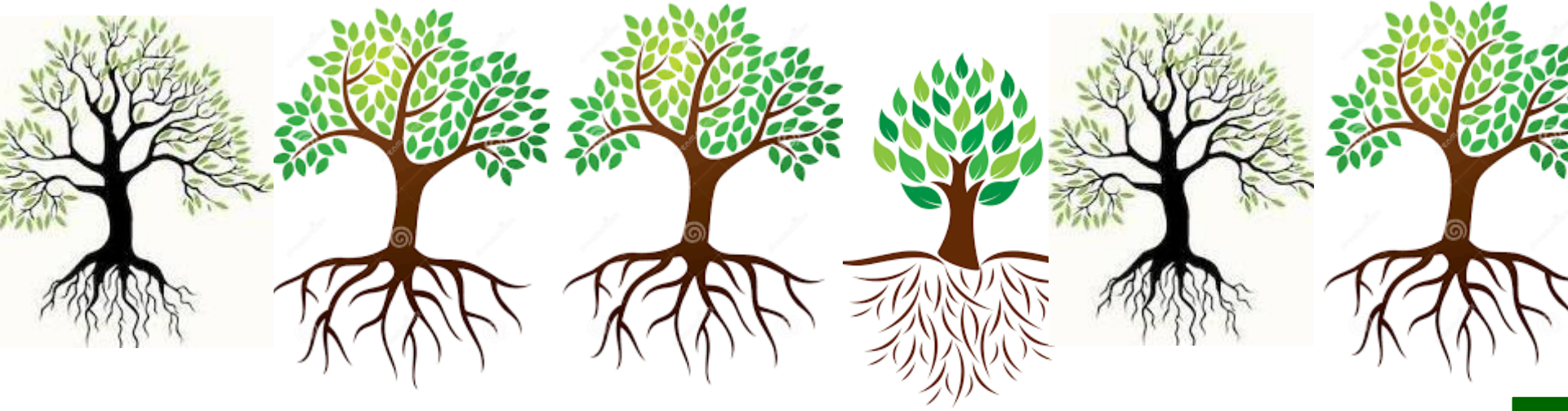
Disruption of mineral cycle by export of cattle or milk and imbalanced replacement such as through lick

When cattle are sold

Minerals provided by lick mainly Na, Cl, N & P

Disruption of mineral cycle by export of wood and usually zero replacement

If wood is harvested from the rangeland, then even more minerals are removed



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If rangeland products are sold, their minerals fail to cycle

Order of magnitude offtake rates from Namibian rangeland

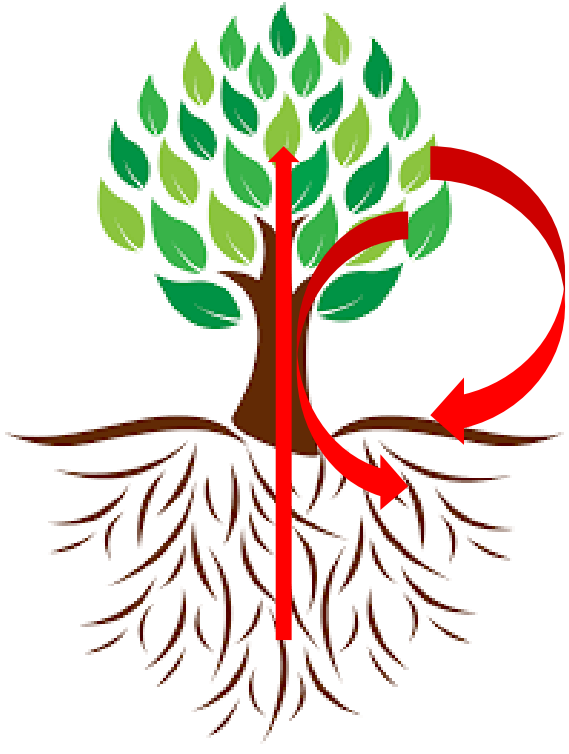
Milk - 100 kg/ha/a

Beef – 10 kg/ha/a

Hay – 1000 kg/ha/a

Wood – 1000 kg/ha/a

Elements that cycle through atmosphere and those that don't



C, H, O, N and some S can cycle through the atmosphere, even from far away

Mineral elements need to cycle more locally through soil, water and organisms, including Ca, Mg, K, P, most S, Fe, Mn, Zn, Cu, B, Co, Mo, Se

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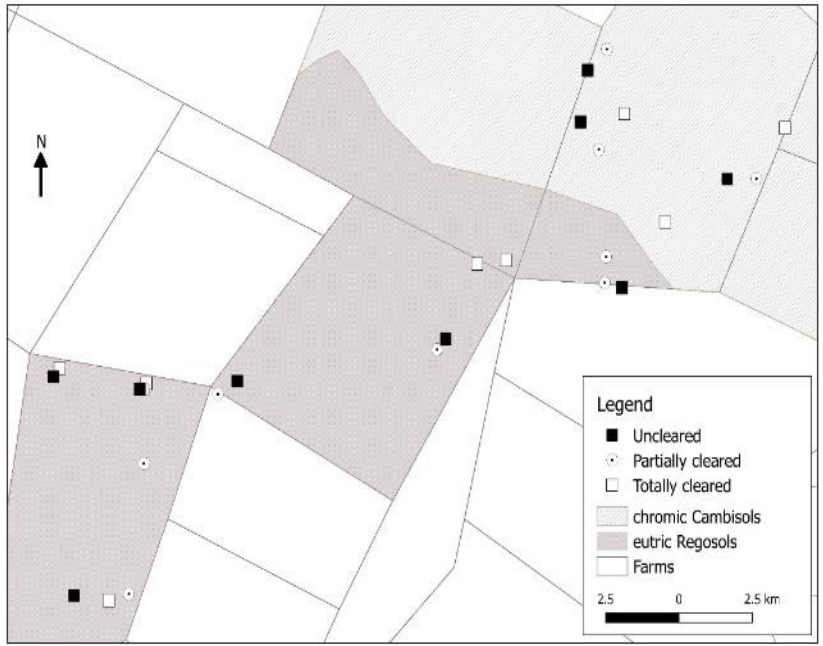
BUSH BIOMASS UTILISATION BY SUSTAINABLE HARVEST

Study on soil fertility in Namibia's Thornbush Savanna



A study at CCF sampled soil from 27 sites, over 2 soil types, 9 from each of:

- Totally debushed

- Partially debushed

- Uncleared land

(Zimmermann et al. 2017)

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Soil bioassay with monocot and dicot

By Fogu Aron

Barley

By Beckser Shipingana

Moringa oleifera

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Findings from bioassay

- Although barley grew taller than moringa,
- they had similar pattern of emergence, survival and growth.
- Therefore they were standardized and combined for some analyses.
- Eutric Regosol was more fertile than Chromic Cambisol, as expected

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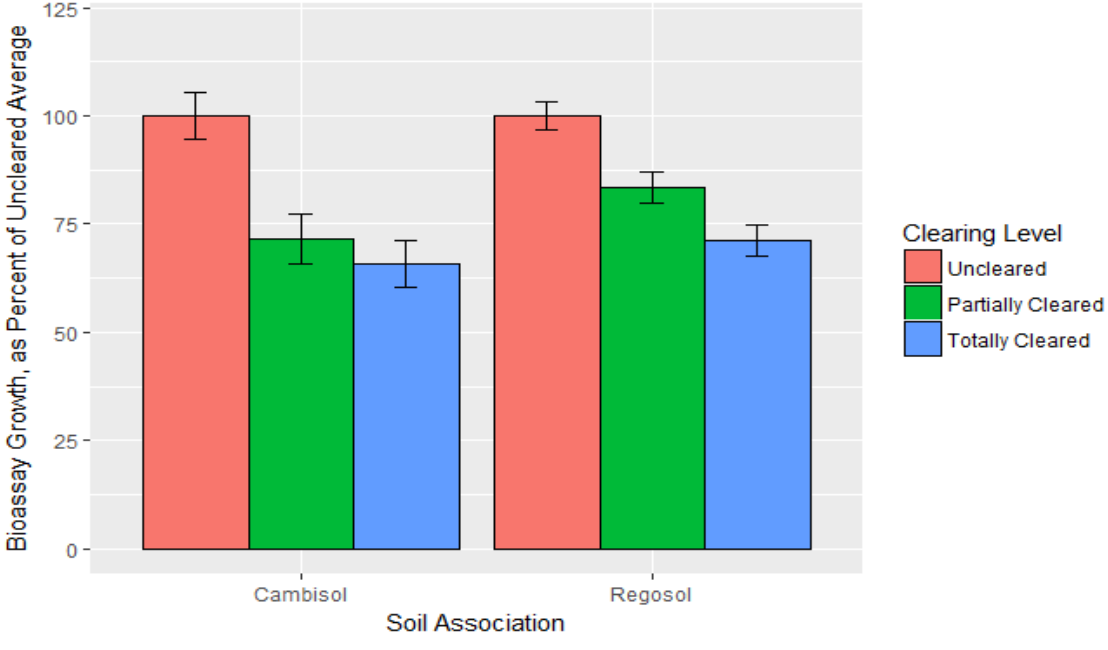
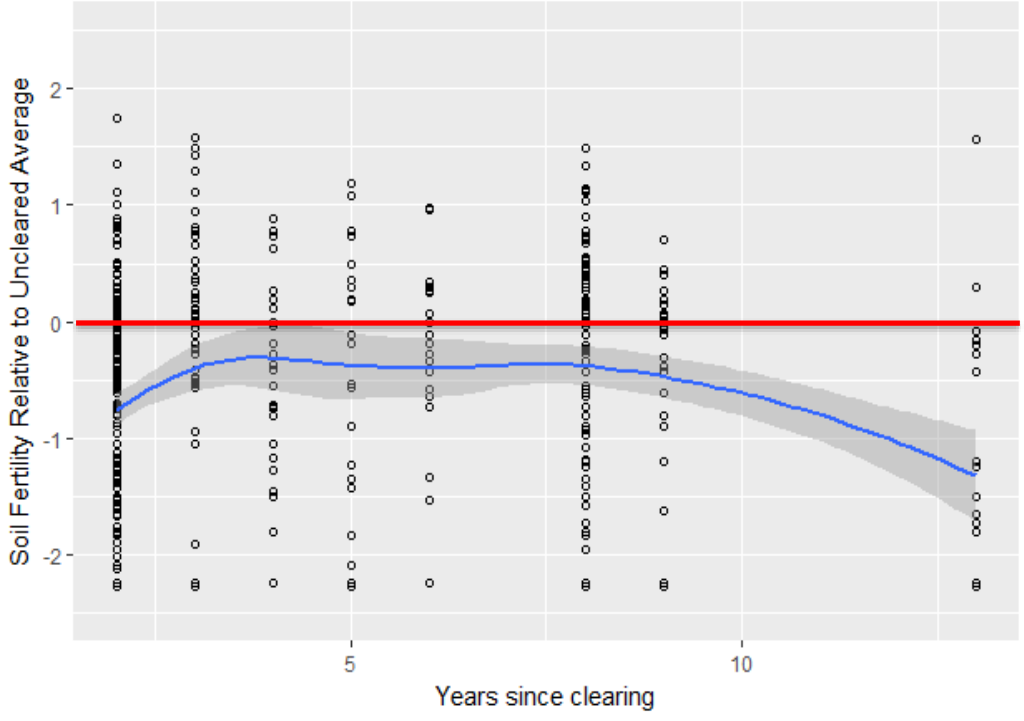
Results of relative heights attained in bioassay



Mean seedling growth at five weeks as %s of the mean from uncleared sites, to represent relative fertility in soil with different levels of debushing on each soil association. Error bars represent standard errors.

Results of seedling growth ovet time since debushing



Noisy data, less clear than for level of debushing

Uncleared average

Debushed average

Discussion on likely rate of fertility decline

- Soil fertility would decline more quickly if hay were also harvested from debushed land (not done at CCF)
- Fertility would regenerate quicker if leaves and fine twigs of harvested bushes were left on the ground (not done at CCF, all harvested wood is compressed into bush blocks)
- Fertility also probably regenerates more slowly at CCF because they apply arboricide on stumps of cut bushes

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Discussion on fertility regeneration by bushes

- Credit for bushes regenerating soil fertility goes to:
- Annual leaf fall that feeds arthropods & other fauna,
- Termites that feed on fallen twigs and branches,
- Biological soil crusts that develop under bushes,
- Rapid turnover of fine roots & associated fungi,
- Root exudates that feed beneficial microbes

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Conclusions on soil bioassay at CCF

- Soil fertility declines as level of debushing increases
- Regeneration of soil fertility by regrowing bushes is a slow process, not yet evident even 13 years after debushing

Recommendations from soil bioassay at CCF

- Return minerals to the soil
- Such as suitably processed ash or biochar if bush is burnt for energy
- Or provide ocean minerals such as kelp as lick,
- for animals to spread over rangeland in dung and urine

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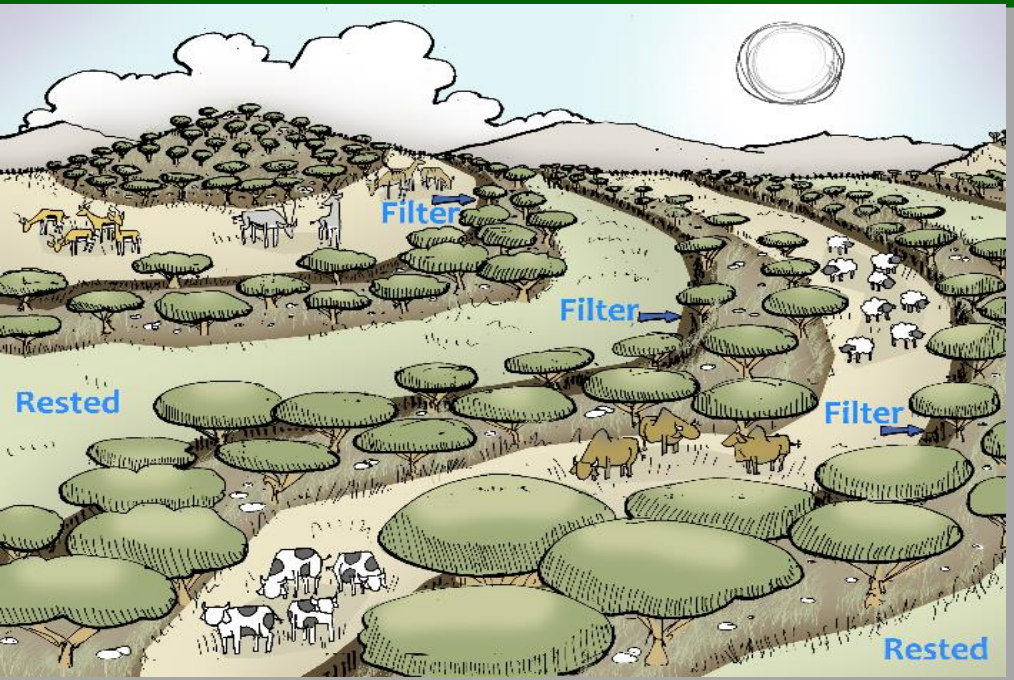

Drawing by Duif Keyser

CAMPFIBRE aims at regenerating water and nutrient cycles, while integrating circular economy enterprises through synergistic resource flows, the latter to be addressed in next presentation by Johan Bruwer

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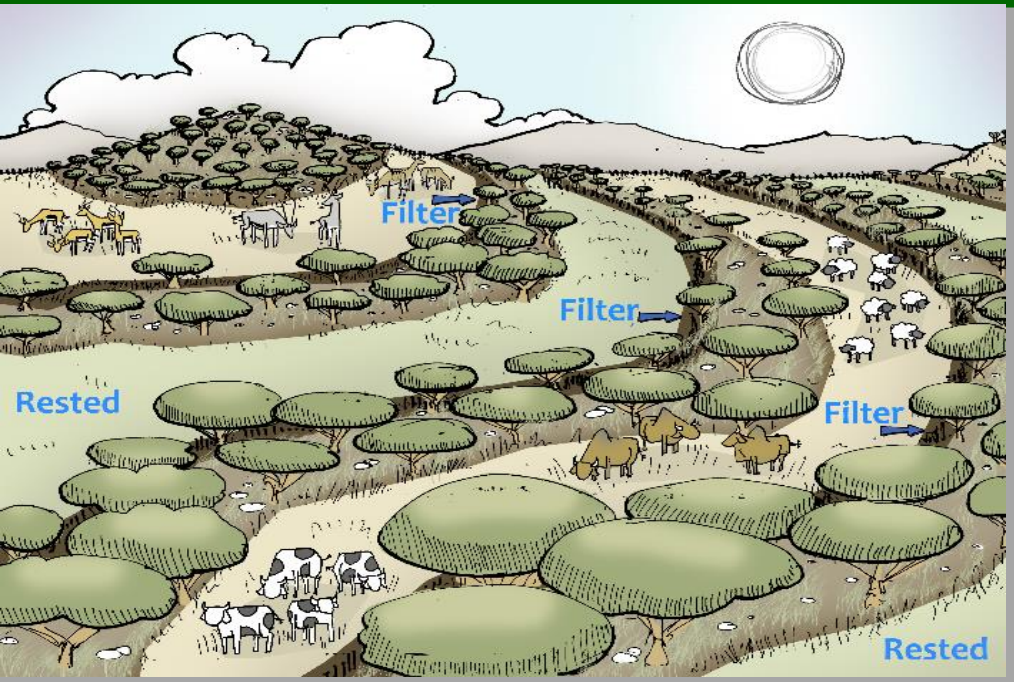

Drawing by Duif Keyser

If bushes are harvested along contour strips, then uncleared strips infiltrate rainwater, grow fertility and break wind, while cleared strips produce abundant grass if provided with sufficient rest as part of an appropriate grazing strategy

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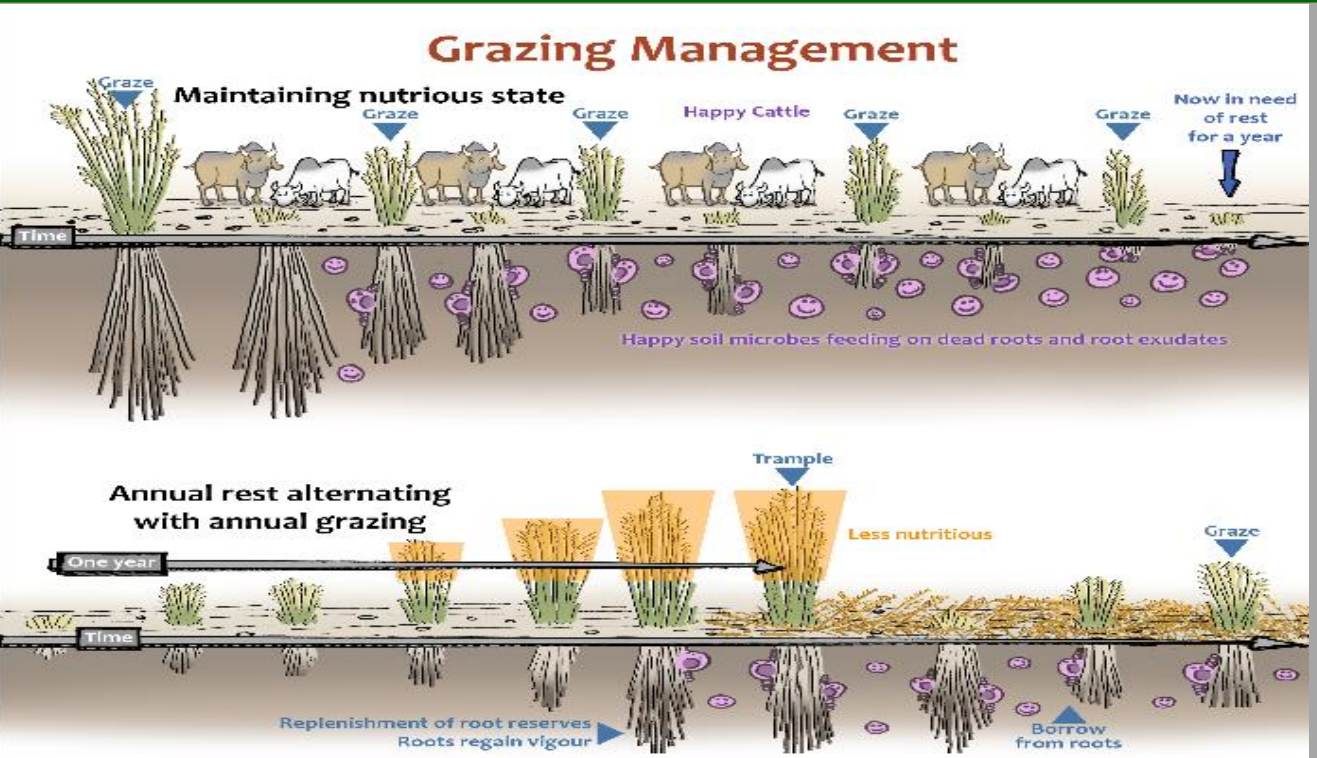
Grazing management must provide sufficient rest for grazed grasses to regrow, e.g. alternating year-long grazing and rest



Year-long rest allows grass to recover nutrients released by microbes during pulses of rain early in the rainy season, and replenish root reserves late in the rainy season

(Fynn et al. 2017)

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CONTOURS AND MINERALS PROTOCOL FOR INTEGRATED BIOSYSTEMS REGENERATING EARTH (CAMPFIBRE)

If bush filters are built from cut branches along contour, they cool the soil, trap seeds and mulch, and encourage a dense growth of grass underneath, which slows runoff, enhancing infiltration of rainwater into soil

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CONTOURS AND MINERALS PROTOCOL FOR INTEGRATED BIOSYSTEMS REGENERATING EARTH (CAMPFIBRE)

Bush filters along contour imitate the natural, self-reinforcing pattern of banded vegetation

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Even in 2019 drought, grass grew well and was less heavily grazed under old bush filter

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CONTOURS AND MINERALS PROTOCOL FOR INTEGRATED BIOSYSTEMS REGENERATING EARTH (CAMPFIBRE)

Series of bush filters support each other at gully head

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Gentle flow of water slowed and spread by dense grass in bush filter behind

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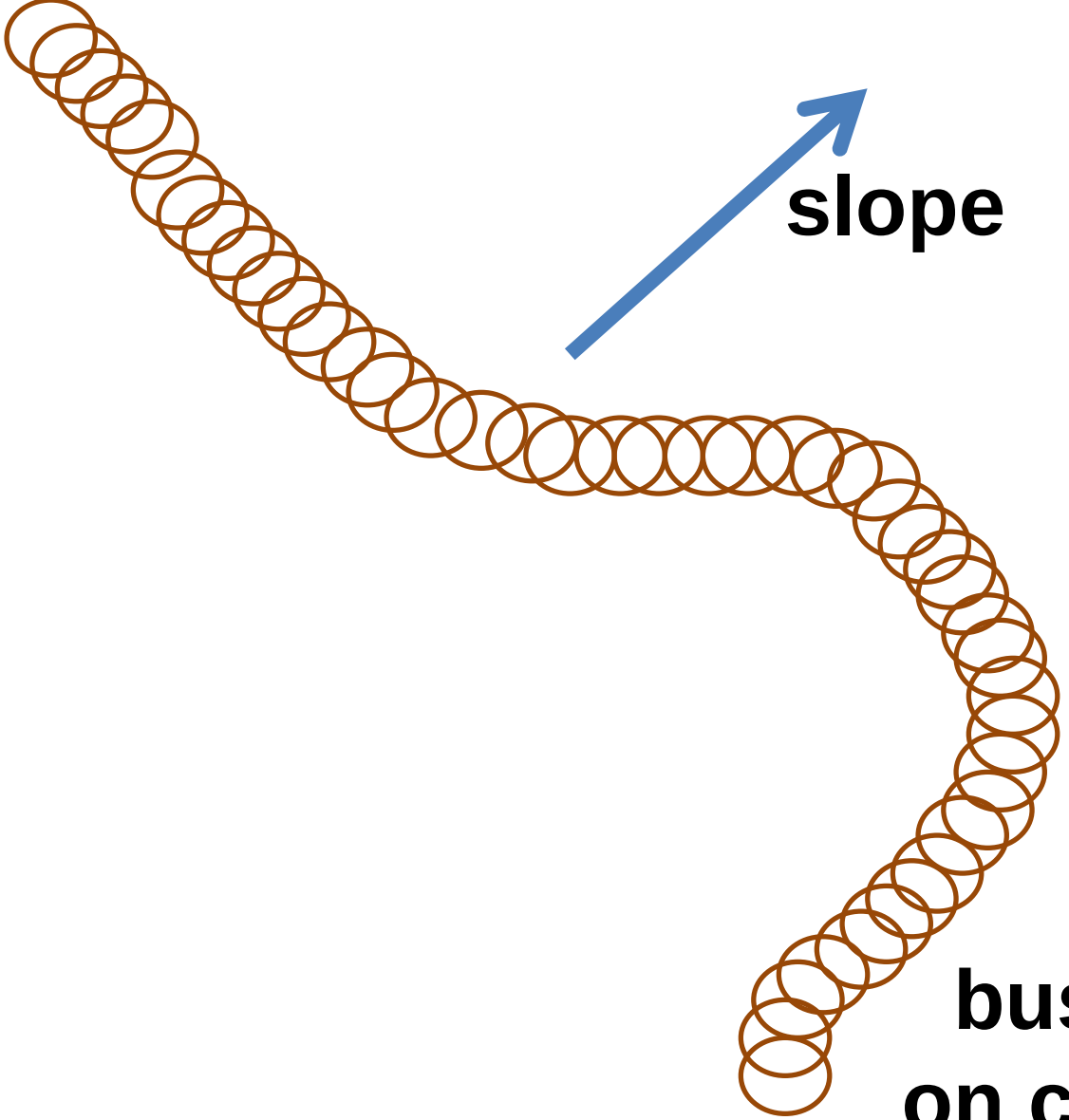
Bush filters become self reinforcing over time, by growing more dense vegetation where most water spilled through, as illustrated

by the following 9 slides



bush filter on contour

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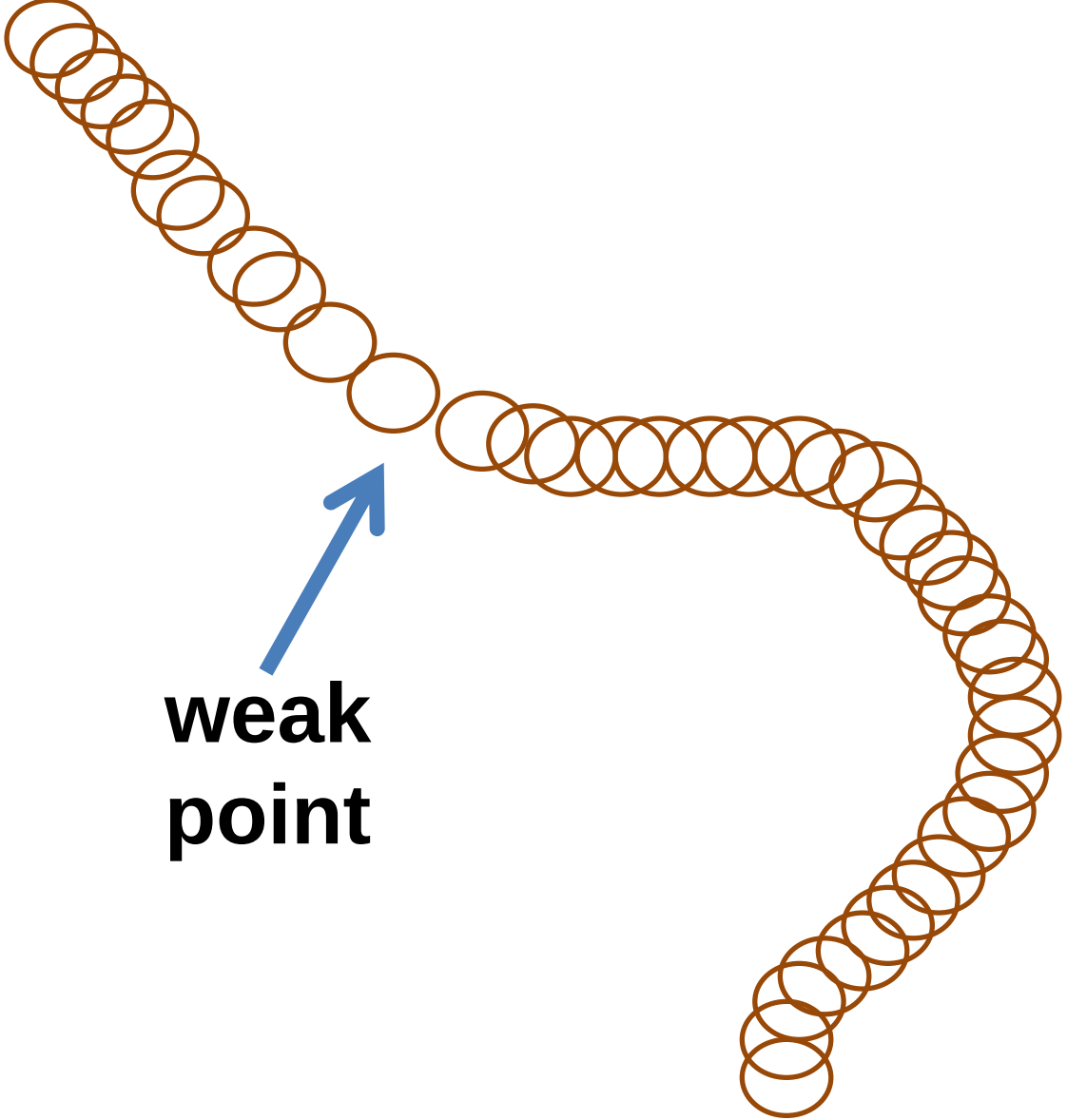

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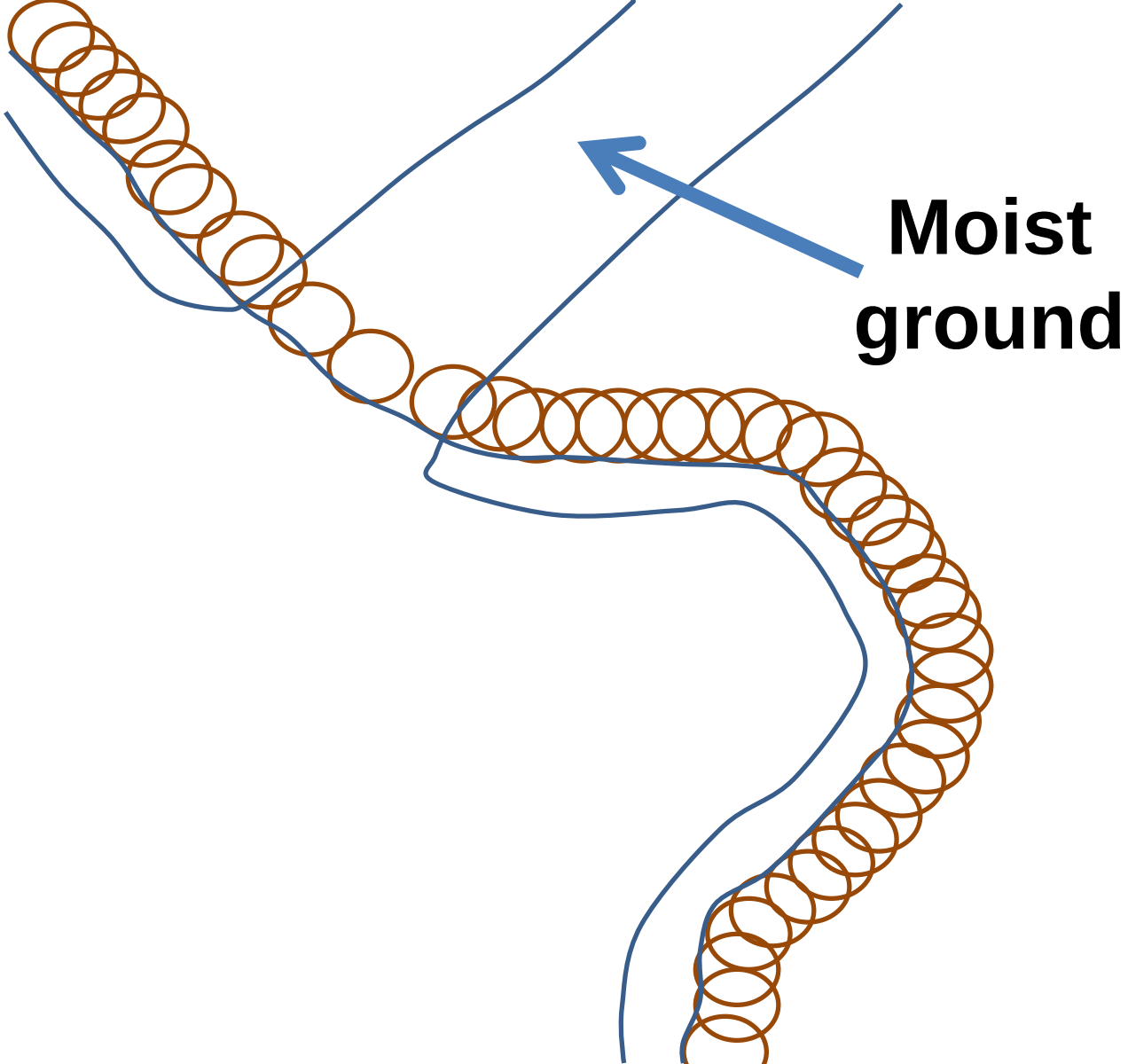

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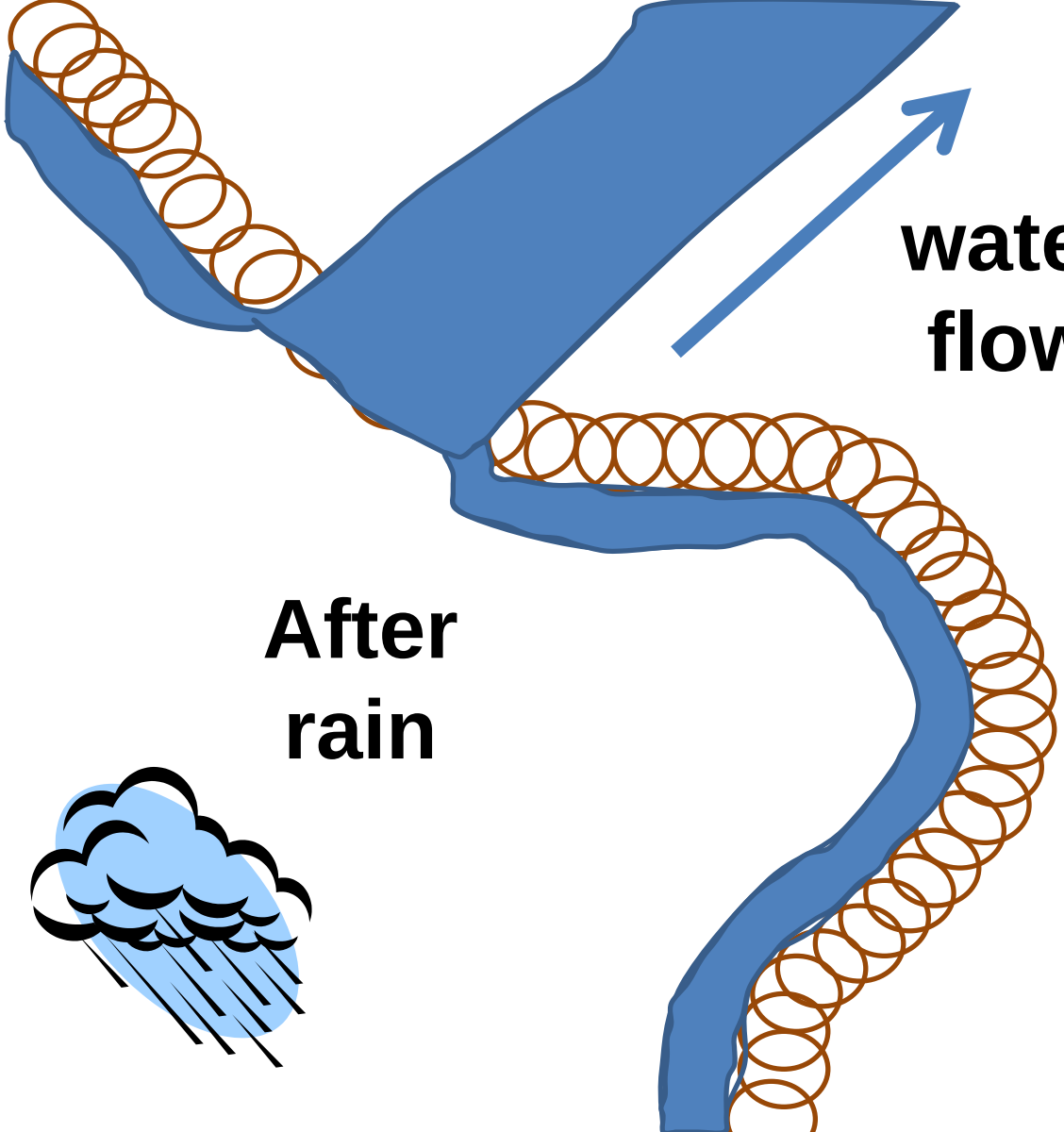

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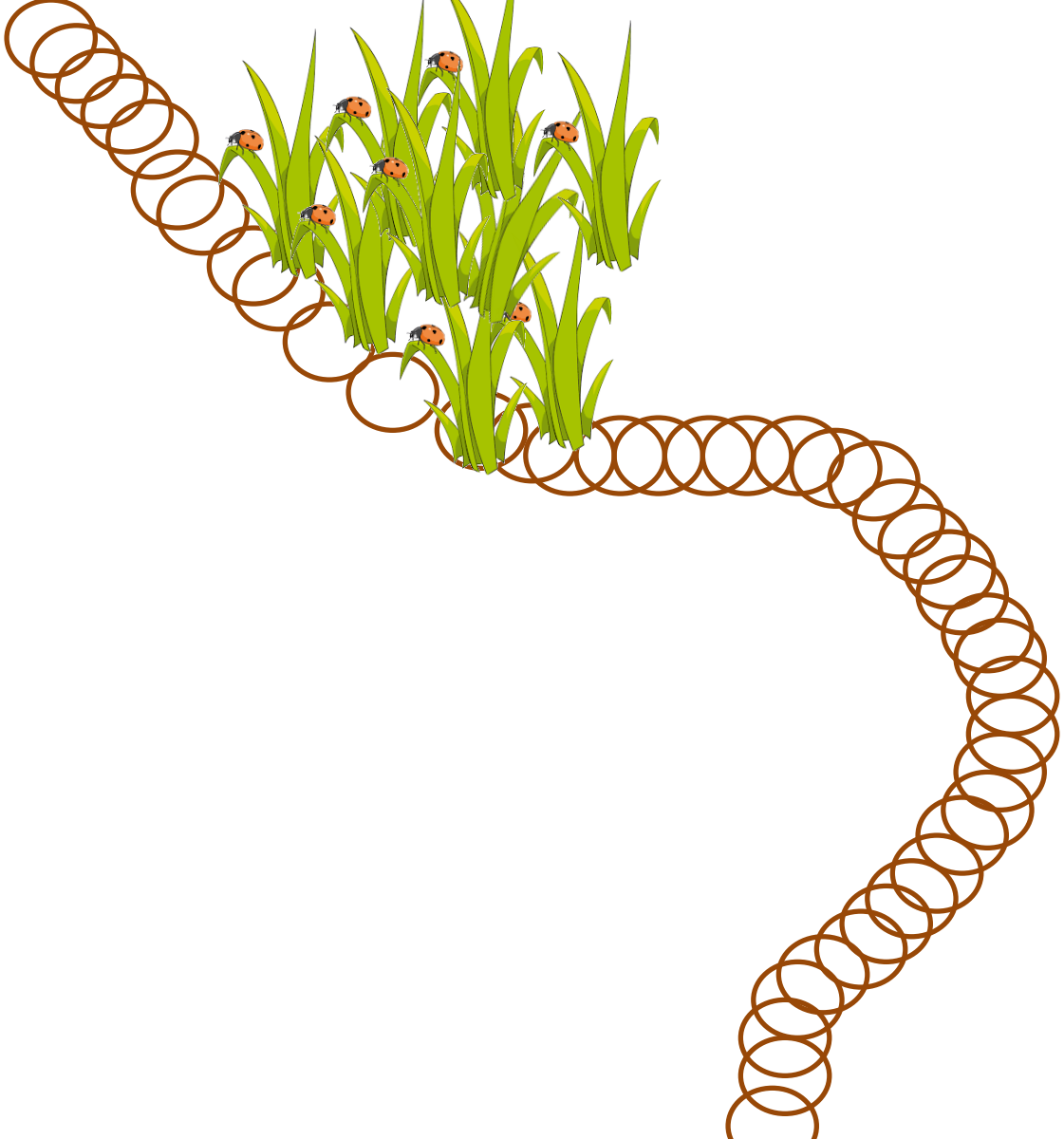

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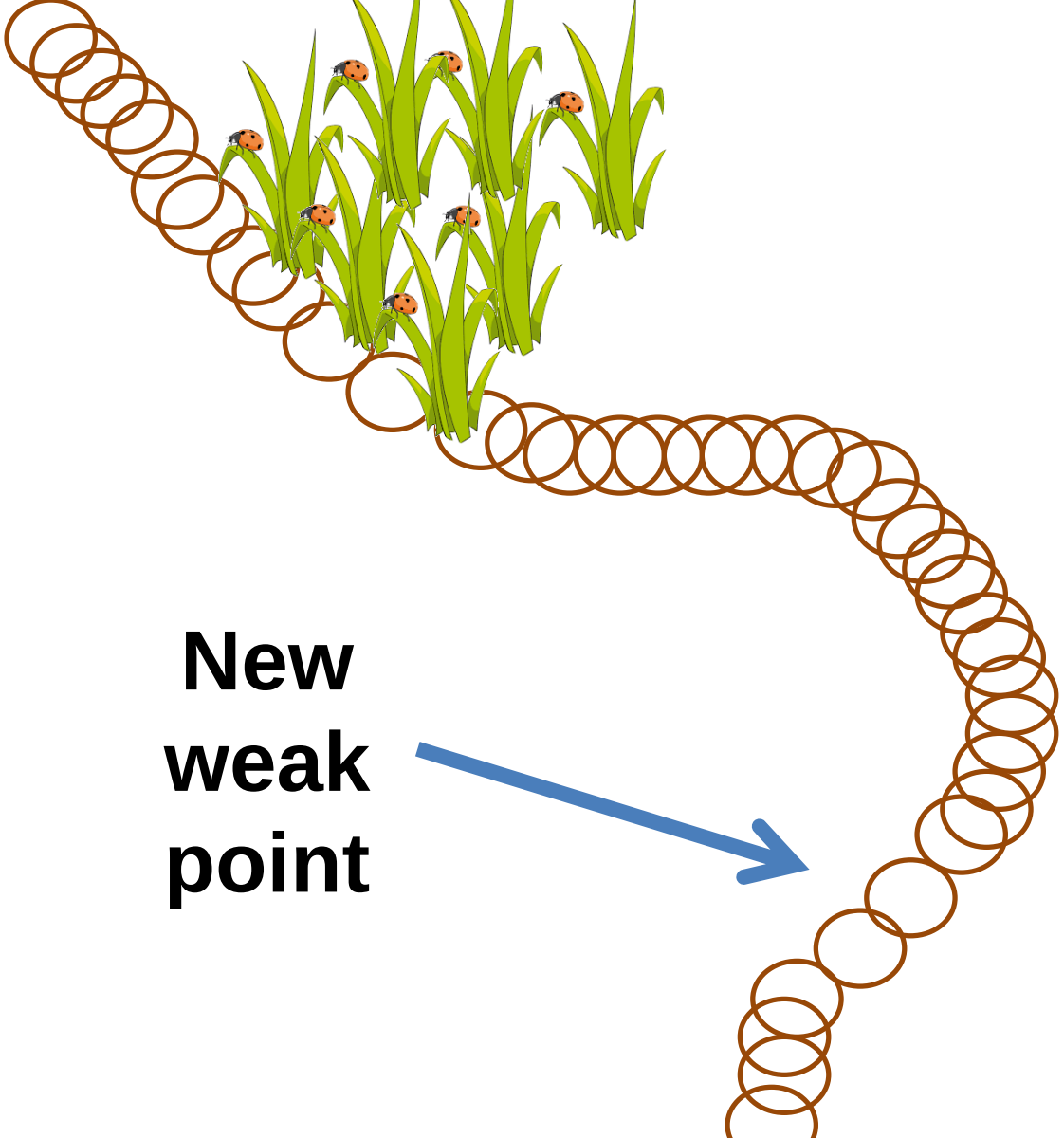

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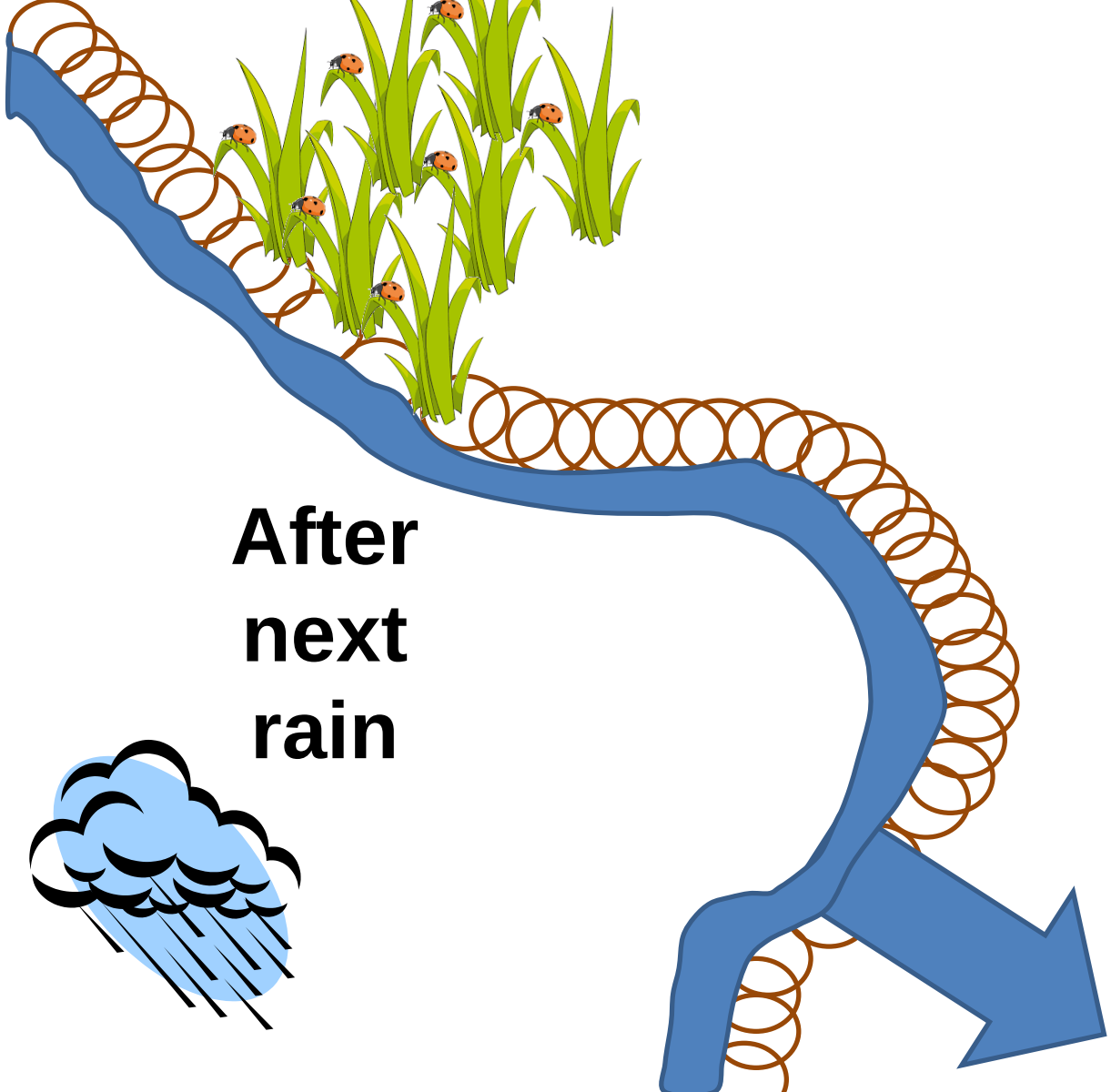

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Lusher grass

below weak point

of contour ditch

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In following season, water started spilling at a new weak point, where dense grass then grew to self heal the system

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Old bush filters attract termites that puff up the soil underneath, which ponds rainwater over a wide strip on the upper side and eventually infiltrates to support abundant growth of grass

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If the grass seed bank is depleted by decades of continuous grazing, then grass seeds can be sown in cleared strips and along bush filters

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Contour furrow for perennial grass seed

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Grass seed is sown in contour furrow …

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… and covered with light bush filter

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Time to cool off

Thank you