SOM and Ecosystem services – some thoughts

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SOM and ecosystem services

- Soil chemical/biological
  - Energy and C skeletons for soil biota
  - Nutrient supply – esp. N, P & S
  - Ion exchange/retention
- Soil physical
  - Soil aggregate formation and stabilization
  - Macro-porosity and pore size distribution
    - Infiltration vs runoff (erosion)
    - Water holding capacity
- Biological C sink

We can safely say **more** SOM is (almost) always better, but

How do we get there?

‘The Soil C dilemma: shall we hoard it or use it?’

Janzen (2006)

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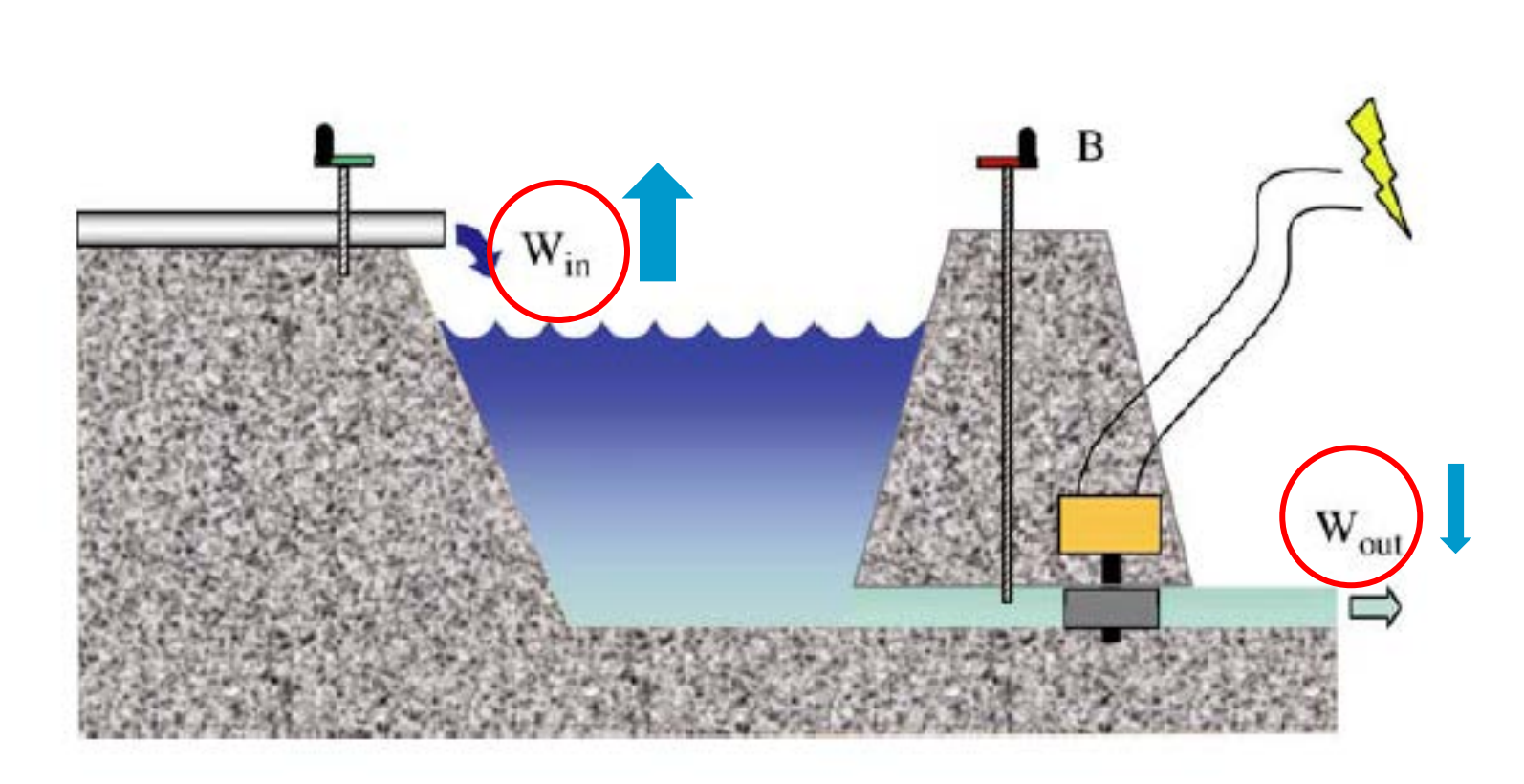
Requires organic matter degradation

Requires o.m. preservation

How to resolve the ‘dilemma’ ?



Increase C inputs, while reducing ‘unproductive’ respiratory losses

Trade-offs and caveats

- Agronomic production goal has been to **maximize** C **off-take** (thus **reducing** C inputs)
  - Breeding in favor of increasing harvest index (HI)
  - Crop residue use for forage and fuel
  - Fertilizer substitution for green manures/rotations

Thus increasing C inputs means either foregoing productivity potential (bad) or **finding 'niches' to increase C inputs without sacrificing yields**

Trade-offs and caveats

- Sequestration of C requires sequestration of N (and P)
  - 'universal' C:N ratios of mineral-associated SOM
    - Consistent with microbial products as the **dominant source** of stabilized SOM
  - Implies a relatively tightly-constrained demand for N (& P) need to **build** SOM

This means higher C inputs, alone, are not enough!

Greater N(&P) inputs and/or **reduced losses** are needed to satisfy **both** plant and SOM stabilization

The good news

- In the context of small-holder/subsistence agriculture, increasing **per ha yields** are broadly consistent with goals of increasing SOM
  - Usually 'baseline condition' is low
    - Soils depleted in SOM (far below saturation capacity)
    - Yields low – productivity well below site potential
    - Residues often already removed
- Moderate intensification of crop production (increased nutrient subsidies, improved plant varieties, improved cropping systems) can **both** increase yields **and** C inputs

The good news

- In general, we know the techniques that work (e.g. TSBF, ICRAF, others)
  - Avoided conversion of native ecosystems
  - Set-aside/rehab of degraded croplands & grasslands
  - Increase nutrient inputs to nutrient-deficient cropland/grazing land
  - Appropriate agroforestry systems
  - Tighter nutrient and water cycles – increase NUE & WUE
  - Elimination of 'non-productive' fallows
  - Reduced soil physical (tillage) disturbance

Barriers and Challenges

- Promoting SOM improvements share the same constraints as productivity/livelihood improvements (financial, labor, education, training, etc.), but in addition…
- SOM change is **slow**, many benefits are perceived only after several years
  - Requires long-term commitment and support
  - Requires tangible incentives in the short-term, i.e., positive yield responses, payments for ecosystem services, ??

Barriers and Challenges

- **Assessment** of programmatic success (enhancing SOM) is more challenging (than, e.g. yield improvement)
  - Slow changes, high spatial variability, other measurement issues
- Available modeling & measurement tools (e.g. CBP) can provide reasonable magnitude and direction of change
  - Dependent on capability to collect information on **local-scale** land use and management 'activity data', cheaply and efficiently – key priority
  - Needs support from **strategic** ground-based measurement and monitoring systems