Understanding how SWAT models phosphorus

In general, phosphorus (P) pools and processes are somewhat coarse in the SWAT model. It does not help that at times the naming convention of these pools and flows can be unintuitive and misleading, and this was identified as a need to be addressed in SWAT in a UM-led SWAT workshop in 2014. This short description of the pools and flows should clarify what is going on inside SWAT. More detailed information about the governing equations and processes can be found in the SWAT model documentation (http://swat.tamu.edu/documentation/).

- At the field level (HRU), SWAT models phosphorus in six ***pools*** (three organic and three inorganic):
    1. Inorganic pools
        - Solution: this portion of P is taken up by plants and in rapid equilibrium with the active pool
        - Active: this portion of P is in rapid equilibrium with the solution pool and slow equilibrium with the stable pool.
        - Stable: this portion of P is relatively unavailable
    2. Organic pools
        - Fresh: this portion of P is associated with crop residue and microbial biomass. It can be transformed to the inorganic solution pool or into soil humus pools.
        - Active: this portion of P is associated with soil humus and can mineralize to the inorganic solution pool. It also maintains a slow equilibrium with the stable pool.
        - Stable: this portion of P is associated with soil humus as well, but does not mineralize as quickly as the active pool.
- At the field level (HRU), SWAT currently ***outputs*** four forms of phosphorus export:
    1. Sediment P: the P attached to sediment particles eroding from fields in overland flow
    2. Organic P: the P present in organic matter traveling from fields in overland flow
    3. Soluble P: the P export that is not sediment-attached or organic and traveling in overland flow
    4. Tile P: the soluble P exported through subsurface drains
- These four forms of phosphorus exported from fields are summed at the reach (or river) level and called “mineral” phosphorus and “organic” phosphorus as follows:

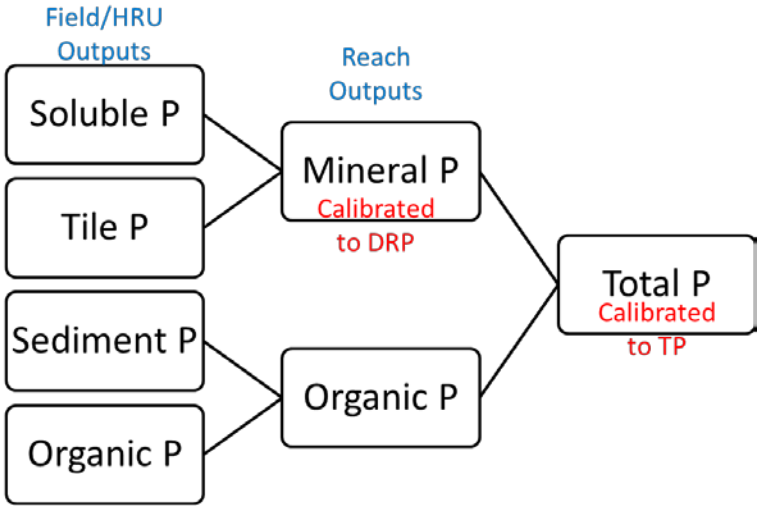

Figure 1: Aggregation of field-level export of P to two pools in the reach, mineral P and organic P.

- In our SWAT models, the “mineral” phosphorus pool is calibrated to measured dissolved reactive phosphorus (DRP) in the river, whereas total P (TP) is calibrated to the sum of the “mineral” and “organic” phosphorus pools (see Figure 1). It is important to note the nomenclature issue that the organic P pool at the reach level is different than the organic P exported from the field/HRU.
- See additional figures to better understand the cycling among soil P pools (Figure 2) and the how these pools contribute to phosphorus losses from farm fields (Figure 3).

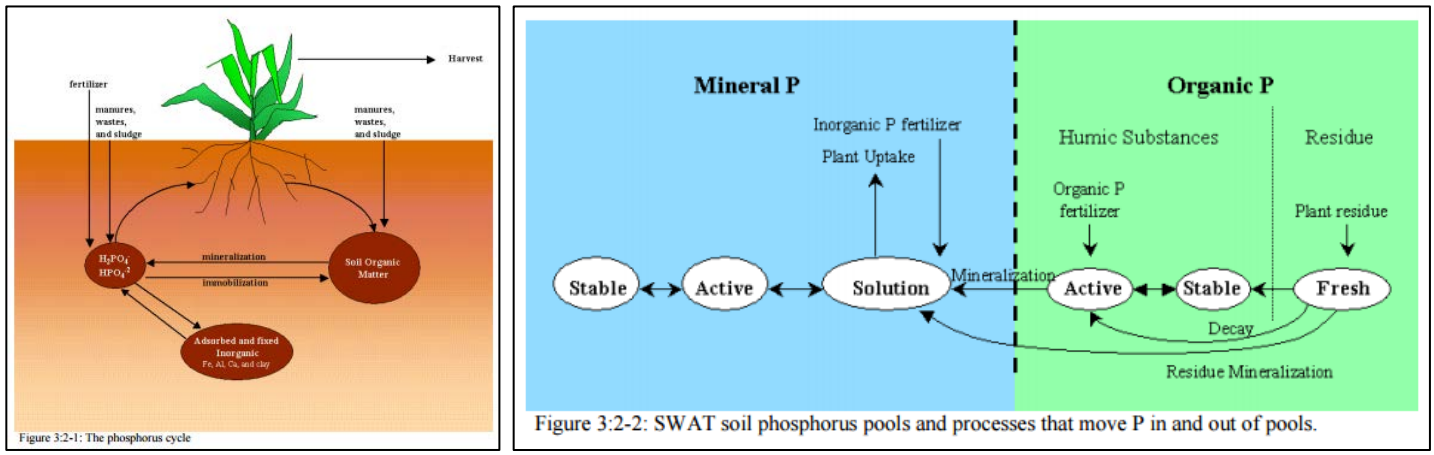

Figure 2: Soil phosphorus pool diagrams from the SWAT theoretical documentation (pp. 207 & 208). Left: The phosphorus cycle as modeled in SWAT; Right: SWAT soil phosphorus pools and processes.

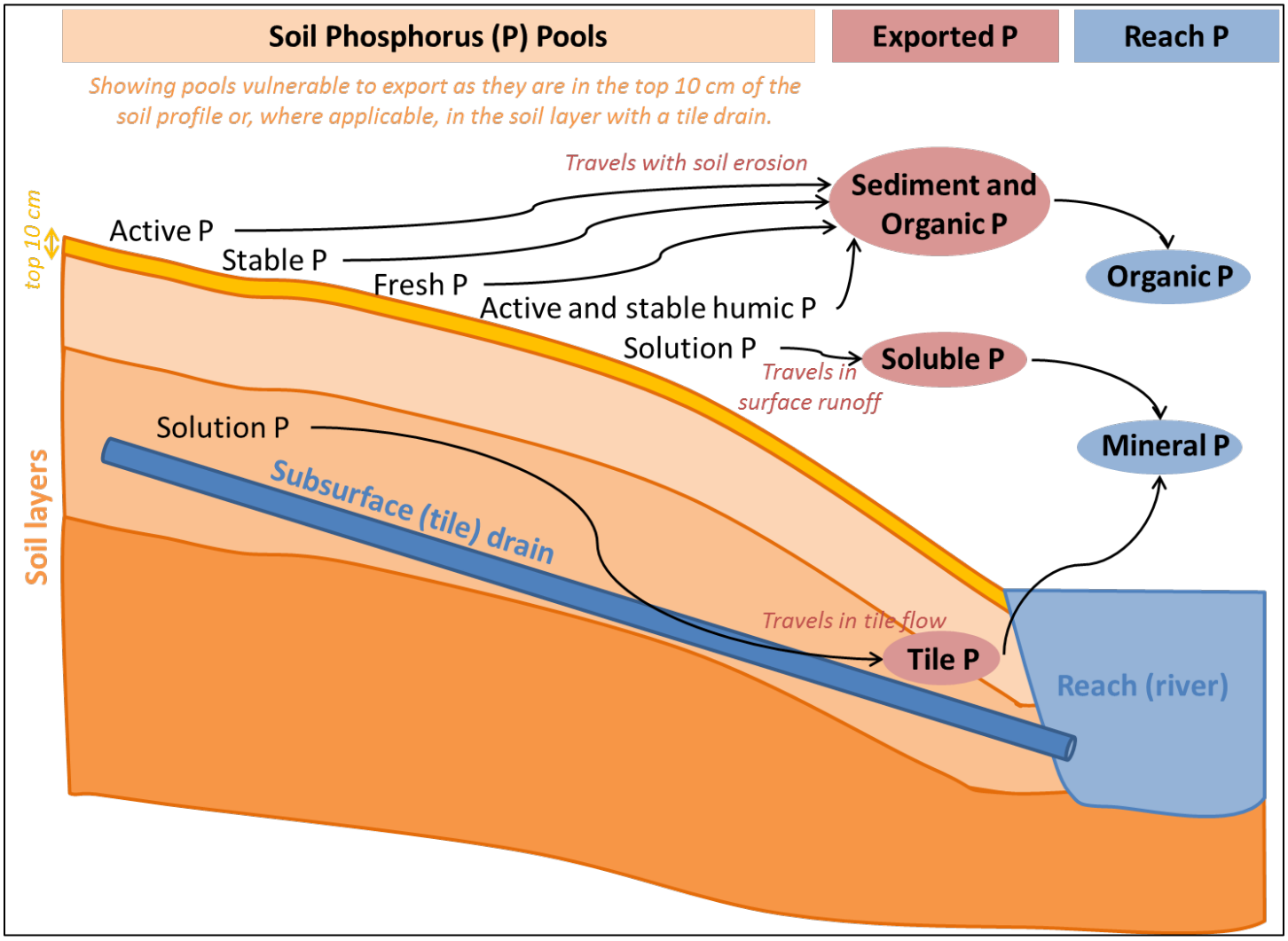

Figure 3: We put this together to demonstrate how soil phosphorus pools contribute to field-level export and ultimately the river/reach. This figure maintains the SWAT naming conventions.