



Using serious games and virtual worlds in pesticides transport teaching

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Teaching environmental scenarios, such as the availability and transport of pesticides in catchments, may fail with traditional lectures and tutorials due to the complex and synergic interplay of soil, landuse, compounds properties, hydroclimatic forcing and biogeochemical processes. To tackle and pedagogically enter into this complexity, virtual worlds (i.e. computer-based simulated environment) and serious games (i.e. applied games with added pedagogical value) can efficiently improve knowledge and know-how of the future water management stakeholders and scientists. We have developed an e-learning teaching unit using virtual catchments and serious games by gradually adapting the level of complexity depending of the targeted public. The first targeted group is farmers in continuing education centers. We developed a distributed pesticide transport tool in a virtual agricultural catchment to highlight the specific risks of off-site pesticide transport along crop growing season. Students of this first group can interactively define and combine climatic, land-use and soil type scenarios with different pesticides to experiment the components of worst-case situations and to propose best-management practices depending of the involved environmental compartments, i.e. atmosphere, soil, surface water or groundwater. For Master's degree students, we added a level of complexity by adding a specific module focusing on pesticide degradation using cutting-edge approaches. With the compound-specific isotope analysis (CSIA) module students are able to link the $^{13}\text{C}/^{12}\text{C}$ signature of pesticides to the ongoing dissipation processes within the catchment. By using and interpreting CSIA data, students can thus efficiently understand the difference between non-destructive (e.g. sorption) and destructive (e.g. bio and abiotic degradation) processes occurring in a catchment. This CSIA tool applied to a virtual agricultural catchment will also allow to distinguish the dilution effect from the degradation effect in complex agricultural catchments receiving pesticides. We anticipate our e-learning teaching unit based on serious game and virtual catchments will help future scientists and stakeholders to better understand and manage pesticides transport within catchments.