



Environmental tipping points in landscape interventions

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Interventions are common in watersheds. These interventions can be either environmentally positive such as attempting to improve water quality from agriculture by installing best management practices (BMP's) or negative such as changing from a single to a double cropping system in semi-arid areas using irrigation. Although model predictions and plot experiments are very optimistic about the potential of many interventions, monitoring at the watershed scale are often less favourable with respect to these interventions. In some cases BMP's have increased the non-point source load. For example, in Ethiopia 30% of all erosion is caused by faulty installation of BMPs. In other parts of the world, double cropping has led to increased salinization or declining ground water tables depending on the source of the irrigation water.

In this presentation, we will highlight catchments from three very diverse regions: The New York City drinking water source watersheds in the Catskills, two rural watersheds in Ethiopia and an urbanizing watershed in Portugal. In the Catskills despite 50 million dollar spent over a 15 year period for watershed improvements, the amount of runoff, erosion and total nutrient loads have not been affected to any great extent. Only dissolved P losses were decreased significantly due to nutrient management practices in which manure was land applied in areas uphill without saturation excess runoff. In Ethiopia large scale terrace construction was only effective for reducing soil losses for a limited time span of two to three years. In the longer term, the terraces decreased runoff and increased interflow. Subsequently due to more subsurface flow, the bottom of the watershed became wetter and accelerated the formation of gullies. In Portugal increasing urbanization covering more than 30% of the watershed has not yet increased runoff to more than 10-20% of total precipitation.

In general, the hydrology and sediment and nutrient loads of watersheds are amazingly resilient to man-made interventions over a wide set of conditions. However, there are points where the balance tips (tipping points) and any additional small change will affect the hydrology greatly. For example, in Portugal, further increases in impermeable surfaces must increase runoff resulting in severe flooding downstream. Ethiopia is another example of a tipping point where well-meant BMP's installed in the upland resulted in gully erosion downstream. Other tipping points are a result of changing the watershed water balance by either importing water for irrigation or increasing evaporation by double cropping using ground water.