Figure 1. Map of the potential snow glide distance (m) modelled with the Spatial Snow Glide Model of Leitinger et al. (2008).

Figure 2. Correlation of the cumulative measured snow glide distances (cm) versus the difference of the $^{137}$Cs and RUSLE soil erosion rate (t ha$^{-1}$ yr$^{-1}$) for the grassland sites (dots, n=10) and the Alnus viridis sites A1N, A2N (squares, n=2). Y-error bars represent the error of both the $^{137}$Cs and RUSLE estimates. X-error bars represent the standard deviation of replicate snow glide measurements at one site. Solid line represents a linear regression and the dotted lines the 95% confidence interval.

References


Factors Affecting Water Dynamics and Their Assessment in Agricultural Landscapes

K. Sakadevan$^1$, M.L. Nguyen$^{1,2}$

$^1$Soil and Water Management & Crop Nutrition Section, International Atomic Energy Agency, PO Box 100, 1400 Vienna, Austria

$^2$PO Box 125-122, St Heliers, Auckland 1740, New Zealand

The intensification and extension of agriculture have contributed significantly to the global food production in the last five decades. However, intensification without due attention to the ecosystem services and sustainability of soil and water resources contributed to land and water quality degradation such as soil erosion, decreased soil fertility and quality, salinization and nutrient discharge to surface and ground waters. Land use change from forests to crop lands altered the vegetation pattern and hydrology of landscapes with increased nutrient discharge from crop lands to riverine environment. Global climate change will increase the amount of water required for agriculture in addition to water needed for further irrigation development causing water scarcity in many dry, arid and semi-arid regions. The water and nutrient use efficiencies of agricultural production systems are still below 40% in
many regions across the globe. Nitrogen (N) and phosphorus (P) fertilizer use in agriculture have accelerated the cycling of these nutrients in the landscape and contributed to water quality degradation. Such nutrient pollution has a wide array of consequences including eutrophication of inland waters and marine ecosystems. While intensifying drought conditions, increasing water consumption and environmental pollution in many parts of the world threatens agricultural productivity and livelihood, these also provided opportunities for farmers to use improved land and water management technologies and practices to make agriculture resilient to external shocks.

The authors within the Soil and Water Management & Crop Nutrition Section, International Atomic Energy Agency have recently reviewed major factors and drivers that affect water dynamics and nutrient pollution in agricultural landscapes (Sakadevan and Nguyen, 2015). The manuscript has been approved for publications in “Sustainable Agricultural Reviews”. A summary of the review is presented in this article.

The paper highlighted that water flux is the main driver of nutrient pollution and is influenced by land use (vegetation), soil physical and chemical characteristics and climate change. While fertilizer N and P for agriculture increased by 10 and 14% respectively between 2010 and 2015, crop nutrient use efficiencies (25-65% and 10-30% for N and P respectively) were still low leading to losses of N and P from agricultural landscapes. Fertilizer and manure application together with legume cropping contributed almost 60% N and 69% P to surface water systems in agricultural landscapes.

The low crop water productivity and nutrient use efficiency could jeopardize agricultural productivity and the quantity and quality of surface and ground water in agricultural landscapes. Improved agricultural management practices that incorporate efficient fertilizer and water use and conservation agricultural practices are important for sustainable agricultural production and water resources protection. Research has identified the mechanisms controlling water dynamics under different land use, land management practices and agro-ecological regions, but the science is far from having a clear understanding of these mechanisms at different spatial scales (from farm to landscape scales). Although a number of techniques based on ground measurements, modelling approaches and remote sensing have been used to identify and characterize water dynamics and the associated water quantity and quality at field and landscape levels, it has been a challenge to integrate water and nutrient dynamics from farm to landscape scale.

In recent years the concept of ecohydrology combining all aspects of ecosystem functions such as evapotranspiration, vegetation, climate change, groundwater dynamics, runoff and stream flow in land and water management. Its application has rapidly grown to solve some of the critical issues in land and water management related to water quantity and quality in agricultural landscapes. Ground based soil-water sensors and isotopic techniques are currently being used at landscape scale for developing the technology and algorithms for monitoring and data processing. These are fundamental research efforts and further improvements are important in this area.

While direct relationship between land use, evapotranspiration and daily fluctuations in water and nutrient flux have been documented, more attention need to be given to unravelling the relationship between land use (vegetation), hydrology and landscape response under changing climate across different agro-eco regions. Techniques that use stable isotopes of $^{18}$O, $^2$H and $^{15}$N play an important role for assessing the dynamics of water and their relationship to land use and land management practices. Capabilities to extrapolate water and nutrient use efficiency information from plant and farm to landscape level will remain a future priority for research. Further information is required on the spatial variability and heterogeneity on factors controlling water and nutrient fluxes and the impact of climate change at these scales. The application of satellite based remote sensing data for water quantity and quality assessment has proven to be an important step forward, but methods and approaches need to be improved for obtaining linear relationship between spectral signatures of the image and water quantity and quality parameters to be investigated.

Reference