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Groundwater Recharge Rates and Surface Runoff Response to Land Use and Land Cover Changes in Semi-arid Environments

Steven Owuor (1,2), Klaus Butterbach-Bahl (1,2), Alphonce Guzha (3), Mariana Rufino (4), David Pelster (1), Eugenio Díaz-Pinés (2), Lutz Breuer (5,6), and Lutz Merbold (1)

(1) Mazingira Centre, International Livestock Research Institute (ILRI), 00100 Nairobi, Kenya, (2) Institute of Meteorology and Climate Research, Atmospheric Environmental Research (IMK-IFU). Karlsruhe Institute of Technology (KIT), Kreuzeckbahnstr. 19, 82467 Garmisch-Partenkirchen, Germany, (3) United States Forest Service, c/o CIFOR, World Agroforestry Centre, United Nations Avenue Gigiri, P.O. Box 30677 - 00100 Nairobi, Kenya, (4) Center for International Forestry Research (CIFOR). C/o World Agroforestry Centre, United Nations Avenue Gigiri, P.O. Box 30677 - 00100 Nairobi, Kenya, (5) Institute for Landscape Ecology and Resources Management (ILR), Research Centre for BioSystems, Land Use and Nutrition (iFZ), Justus Liebig University Giessen. Heinrich-Buff-Ring 26, 35392 Giessen, Germany, (6) Centre for International Development and Environmental Research (ZEU), Justus Liebig University Giessen, Germany

Conclusive evidence and understanding of the effects of land use and land cover (LULC) on both groundwater recharge and surface runoff is critical for effective management of water resources in semi-arid region as those heavily depend on groundwater resources. However, there is limited quantitative evidence on how changes to LULC in semi-arid tropical and subtropical regions affect the subsurface components of the hydrologic cycle, particularly groundwater recharge. In this study, we reviewed a total of 27 studies (2 modelling and 25 experimental), which reported on pre- and post-land use change groundwater recharge or surface runoff magnitude, and thus allowed to quantify the response of groundwater recharge rates and runoff to LULC. Restoration of bare land induces a decrease in groundwater recharge from 42 % of precipitation to between 6 and 12 % depending on the final LULC. If forests are cleared for rangelands, groundwater recharge increases by 7.8 $\pm$ 12.6 %, while conversion to cropland or grassland results in increases of 3.4 $\pm$ 2.5 and 4.4 $\pm$ 3.3 %, respectively.
Rehabilitation of bare land to cropland results in surface runoff reductions of between 5.2 and 7.3 %. The conversion of forest vegetation to managed LULC shows an increase in surface runoff from 1 to 14.1 % depending on the final LULC. Surface runoff is reduced from 2.5 to 1.1 % when grassland is converted to forest vegetation.
While there is general consistency in the results from the selected case studies, we conclude that there are few experimental studies that have been conducted in tropical and subtropical semi-arid regions, despite that many people rely heavily on groundwater for their livelihoods. Therefore, there is an urgent need to increase the body of quantitative evidence given the pressure of growing human population and climate change on water resources in the region.