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The Effect of Soil Erosion on Agricultural Productivity

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Abstract

There is little doubt that soil erosion has and will continue to have a detrimental effect on global soil resources. The depletion of the soil has led to major instability and undoubtedly contributed to the collapse of relatively advanced societies in the past, such as the isolated civilizations of Easter Island and Iceland. Evidence suggests that the fall of the Mayan civilization was related to problems of soil erosion, while in ancient China soil degradation was found to be one of the decisive factors leading to the relocation of population centers. Archaeological evidence also points to severe soil erosion in Greece during ancient Greek times, which may have contributed significantly to the collapse of Greek civilization. According to some scientists, erosion of topsoil threatens modern civilizations as well.

Although the problem has received much attention recently, hardly any quantitative information on the effect of erosion on agricultural productivity exists. The quantitative information derived at the plot scale is scattered and incoherent, and no quantitative information at the regional or national level (i.e. the level relevant for food production) exists. Inferences made from the synchronicity of soil erosion events and societal changes are therefore not based on quantitative assessments of the impact of soil erosion on agricultural productivity, nor are analogies between the collapse of ancient societies and the risks facing modern society. For this reason, the extent to which soil erosion is indeed a significant threat to the agricultural productivity of modern societies is an important subject for debate.

The research presented here reports of statistical analysis of both plot and regional

scale with respect to the erosion-productivity relationship. A meta-analysis of plot scale experiments shows that the different methodologies used for the erosion-productivity assessments bear part of the responsibility for the incoherence of the outcomes. At the plot scale, the effect of soil erosion on crop growth has been assessed in numerous experiments where erosion was either simulated by artificial desurfacing, or where productivity losses in strongly eroded areas were compared with losses from less eroded areas. A systematic overestimation of the effects may apply to the first category of experiments, which make up a large part of the research results. Correcting for this overestimation reveals that under intensive, mechanized agriculture yield reductions at the field scale are of the order of only 4% for each 0.1 m of soil loss. Given the fact that the removal of 0.1 m of soil required either long time-spans, or very high erosion rates, this number makes it highly unlikely that erosion may pose a serious threat to food production in modern societies within the coming centuries.

An empirical analysis of the relationship between erosion and productivity for modern agriculture at the regional scale, also shows no agreement with previous assumptions concerning the importance of the impact of erosion on agricultural productivity either. The results of this analysis converge with the corrected plot-scale findings of approximately 4% per 0.1 m of soil loss.