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Ecosystem services sustainable management at the agricultural frontier in Brazil

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This study address sustainable land management to preserve ecosystem services at the agricultural frontier, Upper Xingu Basin, MT, Brazil, we applied a conceptual tool designed to support policy making to manage five selected soil functions and demands. In this study, we implemented an Interdisciplinary GIS Based Multi-model Approach to understand how land use change due to agricultural expansion and intensification are affecting soils functions at the arch of deforestation. Encompassing two large Brazilian Biomes, the tropical rain forest and Cerrado (savannah), the study area of ~170.000km^2 has undergone extensive changes in land use and land cover since the late 1970. In only 40 years has already lost 30 % of its natural vegetation, which was replaced mainly by pastures for cattle raisin. Since the early 2000, a new cycle started and currently the Xingu Upper basin is under and increased agriculture intensification process (e.g. double cropping) to produce corn and soybean for the international market. Land tenure is dominated by medium to large farms (100 to >1000 ha), and 33 % of the area belongs to an Indigenous Land known as Xingu Park. Average farmers are family farmers and/or family business farmers, still original settlers from 30/40 years ago with strong German background and highly technified. Average soybean yield is about 3.6 ton of grains ha^{-1}. According to stakeholders, the main limiting factor for agriculture is infrastructure and absence of government. The lack of support affects markets and international trading with high costs for stocking and distribution of soybean production. Most of the land for agricultural production is rain fed; irrigation is still not common due to lack of electricity. Traditionally, soybean producers adopt Direct Seeding Mulch-Based Cropping System (soybean -corn) drive by market prices. As

proxys for foil indicator for supply, we used a 2015 land use map derived from remote sensing data. Demand was expressed as annual productivity (kg/ha/y) from census data spatialized by land use type. Evapotranspiration as the proxy for water availability and water yield for demands. For Biodiversity indicator we used Indigenous Land and Conservation Units as suppliers and Legal Reserve and Permanent Protection Areas as demand (legal instruments). Nutrient Cycling supply was mapped base on Base saturation of 0-30 cm of almost 400 soil profiles and demand by average fertilizer application (NPK) spatialized by land use . Carbon storage and GHG Seq. Carbon sequestration were derived from field measurements spatialized by land use and demands by field carbon sequestration measurements and policy (Zero illegal deforestation target). Our result show that this approach can be applied to a range on landscapes and is a useful tool for decision-making and policy implementation and support.

Keywords: Land use; planning; ecosystem services; policies; water.

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