

administrative units of the country. For the study, daily rainfall from 300 locations for the period 1960 to 2015 and daily temperature from 30 locations for the period 1974 to 2015 were obtained from the Kenya Meteorological Department. Combined approaches to missing data-imputation were used. The Statistical Downscaling Model was applied to reconstruct the daily data sets using NCEP predictors while satellite-derived values obtained from NOAA were used to calibrate the observed station records for improved accuracy on estimating the missing observations. A Generalized Additive Model (GAM) in R environment was applied to derive the relationships and trends of rainfall and temperature over the period and to test the capability of GAM to predict the spatial distribution of the historical climatic data across all the Sub-counties in Kenya. This model is expected to become a valuable tool for operational forecasters and decision makers in the natural resource-based economic sector of Kenya. It can generate more accurate and area-specific climatic information and provide information required by policy makers to initiate effective adaptation and mitigation measures against impacts of climate change. It has application in County integrated land use planning and management of forests and agriculture, among other sectors.

Harvesting of old-growth Boreal Forest decrease soil carbon stock

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The Boreal Forest is a vast region, consisting of diverse ecosystem types with different carbon dynamics and vulnerability to climate change, exposed to various intensities of forest management. There are large uncertainties among scientists on the contribution of boreal forest management to climate change mitigation, and disagreements among stakeholders whether bio-economy or conservation is the winning concept. The most appropriate mitigation actions will be decided by current forest conditions and climate change impacts, socio-economic state and regional policy for mitigation actions. Therefore, mitigation strategies need to be adapted to regional conditions to meet objectives regarding carbon as well as other forest management objectives. This study focus on the effects on soil carbon in old-growth boreal forests in northern Sweden after a first regeneration cut. This was done by empirically quantifying soil carbon stock in the humus layer and down to 20 cm in the mineral soil at 14 paired sites of adjacent old-growth and younger stands. The younger stands had been established after clear cutting of old-growth forests similar to the one at the adjacent site 15-55 years ago. Results indicate a reduction of soil carbon after a final harvest. This temporary or permanent carbon debt needs to be considered when assessing the climate benefit of turning old growth forests into managed forests.

Changes in the rate of shrub coverage in native forests within the Mesopotamian Espinal Region of Argentina: using remote sensing for analysis / Evolución del nivel arbustización en bosques nativos del espinal mesopotámico: utilización de sensores remotos para su análisis

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Monitorear la evolución de los cambios ocurridos sobre los recursos naturales es una prioridad a nivel mundial. Los modelos de cambio y cobertura de la tierra, y su facilidad en la predicción, son una herramienta potente de análisis espacial. El objetivo del trabajo consistió en determinar y explicar los cambios sobre el nivel de arbustización en bosques nativos del Espinal Mesopotámico, con la finalidad de predecir el nivel de degradación y ajustar la carga animal. El estudio se realizó en el Área Natural Protegida "El Carayá" ubicada en Entre Ríos (Argentina). El estado del bosque nativo se determinó en los años 2012 y 2018, a través de puntos georreferenciados con GPS. Se cuantificó el nivel de arbustización en cinco clases, y utilizaron dos imágenes satelitales Landsat. El modelo Markov fue utilizado para determinar las predicciones. El 36% (3.775 ha) del "El Carayá" se mantuvo estable en relación con el nivel de arbustización durante el período evaluado. El porcentaje restante, presentó cambios notables debido a la dinámica sucesional característica de estos ecosistemas. En el año 2027 se espera que la superficie sin cambios sea del 33%. La dinámica sucesional en la cobertura de arbustivas propia de los bosques nativos, estuvo influenciada por la variación estacional del clima, la intervención antrópica a través de la limpieza química y la implementación de un sistema de pastoreo rotativo intensivo. Este trabajo permitió definir y ajustar la capacidad de carga de los diferentes ambientes teniendo en cuenta los potenciales cambios sobre la arbustización de los bosques nativos.

Calculations of socio-economic efficiency of environmental forestry measures including reforestation activities considering climate change and forests disasters in the Czech Republic

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The first experimental socio-economic efficiency evaluation of environmental forestry operations in the landscape under the Rural Development Programme (RDP) in the Czech Republic is presented. The efficiency evaluation is based on environmental operations costs provided by the Ministry of Agriculture for all the Czech Republic in years 2015-2017, considering the future socio-economic improvements of the respective environmental landscape ecosystem services' socio-economic values (both market and non-market) expressed by their differences. The socio-economic efficiency represents a relationship between public financial inputs into the forestry environmental measures on one hand, and enhancement of respective landscape ecosystems services' socio-economic values on the other hand. The main landscape ecosystems such as forestland, grassland, arable land, and solid soil cover were included, and valued by the methodology created by the research team, and certified in the Czech Republic in 2018. The following main services were included: production service (both market and non-market), game management and hunting, hydrological services, soil protection services, air protection – CO₂ sequestration services, health-hygienic (recreational services), cultural-educational services (based on nature-protection service closely related to biodiversity, important in educational, scientific and institutional points of view). The results show that the selected forestry measures within the RDP significantly improve the given landscape services' socio-economic values within the Czech Republic and that all measures' value benefits are higher than the public funds invested.

Dicyandiamide as an alternative for mitigating nitrous oxide emissions from nitrogen fertilizer used on eucalyptus / Uso da dicianodiamida como alternativa para a mitigação da emissão de óxido nitroso proveniente da adubação nitrogenada do eucalipto

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O uso de inibidor de nitrificação (IN) concomitantemente à adubação nitrogenada constitui uma alternativa para a mitigação da emissão de óxido nitroso (N₂O) do solo. O objetivo do estudo foi avaliar o potencial do IN dicianodiamida (DCD) em reduzir a emissão de N₂O do solo proveniente da adubação nitrogenada do

eucalipto. O experimento foi conduzido em povoamento de *Eucalyptus urograndis* cultivado em Latossolo Vermelho argiloso. Os tratamentos foram: controle (C), ureia (U) e ureia com DCD (U-DCD), aplicados 10 e 120 dias após plantio (DAP), correspondendo à adubação de base (13 kg N ha^{-1}) e cobertura (33 kg N ha^{-1}), respectivamente. O fluxo de N_2O foi avaliado durante 247 dias pelo método da câmara estática fechada. O fluxo de N_2O do solo variou de 1,5 a $1030,8 \mu\text{g N m}^{-2} \text{ h}^{-1}$, com picos concentrados entre 15 e 65 DAP, seguidos de valores basais até o final do período de avaliação. A emissão acumulada (EA) de N_2O do solo do tratamento C, U e U-DCD foi de 2,93, 5,53 e $3,29 \text{ kg N ha}^{-1}$, respectivamente. No entanto, embora a U apresente EA duas vezes maior que o controle e que a U-DCD tenha reduzido a emissão de N_2O do solo fertilizado com U em 40,5%, os tratamentos não apresentaram diferença significativa entre si, possivelmente devido ao elevado coeficiente de variação entre as repetições (3). Neste sentido, conclui-se que o inibidor de nitrificação dicianodiamida não foi eficiente em reduzir a emissão de N_2O do solo nas condições edafoclimáticas deste estudo.

Nitrous oxide emissions in an area of mixed eucalyptus and acacia plantations in Northern Mato Grosso, Brazil / Emissões de óxido nitroso em área de plantio misto de eucalipto e acácia no norte Mato-grossense

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O eucalipto é a espécie florestal mais plantada no Brasil e para explorar seu máximo potencial produtivo, é necessária a reposição de nutrientes, sobretudo nitrogênio (N), principal fonte de emissão de óxido nitroso (N₂O). Plantios mistos de eucalipto com leguminosas arbóreas fixadoras de nitrogênio, surge como uma alternativa sustentável de fornecer N e reduzir as emissões de N₂O. O objetivo do estudo foi avaliar o efeito do plantio misto de *Eucalyptus urograndis* (*E. urophylla* x *E. grandis*) e *Acacia mangium* na redução das emissões de N₂O. Foi realizado na Embrapa Agrossilvipastoril, Sinop-MT e foram avaliados cinco tratamentos: monocultivo de eucalipto com fertilização nitrogenada (E+N), sendo aplicado 190 kg ha^{-1} de ureia; monocultivo de eucalipto sem fertilização nitrogenada (E); monocultivo de acácia (A); plantio misto com 67% eucalipto e 33% acácia (67E:33A); plantio misto com 50% eucalipto e 50% acácia (50E:50A). O delineamento experimental foi blocos casualizados, com três repetições. As coletas foram realizadas em 2016 e 2017, em período de seca e chuva. Foram instaladas câmaras estáticas para coleta de gases e as amostras foram analisadas por cromatografo gasoso. No período seco, os maiores valores de emissões de N₂O foram $5,44 \mu\text{g N m}^{-2} \text{ h}^{-1}$, não apresentando diferença significativa entre os tratamentos. No período de chuva, a emissão foi superior à seca e os maiores valores foram no E+N, com emissões de $189,49 \mu\text{g N m}^{-2} \text{ h}^{-1}$, sendo superior aos demais tratamentos. Plantio misto de eucalipto com acácia tem potencial de mitigação de emissões de N₂O, comparado a monocultivos fertilizados com N.

B4t: ESTIMATION OF STATUS AND CHANGE IN FOREST CARBON POOLS BASED ON INVENTORY DATA: GOING BEYOND TREE CARBON

Combretum-Terminalia vegetation accumulates more carbon stocks in the soil than the biomass along the elevation ranges of dryland ecosystem in Southern Ethiopia

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Dryland ecosystems including Combretum-Terminalia vegetation cover a wider area in the tropics. These resources are believed to greatly contribute to climate change mitigation in dryland ecosystems. Therefore, the objective of this study was to investigate biomass and soil carbon stocks of Combretum-Terminalia vegetation along the elevation ranges. A total of 60 nested sample plots of $20 \text{ m} \times 20 \text{ m}$ were laid systematically along lower, middle and higher elevation ranges, representing 20 plots for each elevation. Within each nested sample plot of woody species, litter and soil samples (0-15, 15-30 cm layers) were collected. The total carbon stocks (biomass plus soil) significantly ($p < 0.05$) differed among the three studied elevation ranges. The biomass carbon stocks were significantly different between middle and higher elevations but both of them significantly ($p < 0.05$) differed from lower elevation, and also showed a decreasing trend from lower to higher elevations. However, inconsistency trends were observed for organic carbon and litter along the elevation ranges. It was concluded that the woodland ecosystem has a potential to accumulate higher carbon stocks in the soil than the biomass and significantly vary along elevations.

Quantification of soil organic and inorganic carbon stocks in Gambari Forest Reserve, Nigeria

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Soil carbon is the largest carbon pool in the terrestrial biosphere and contains organic carbon and inorganic carbon components. Inorganic carbon has not been considered in estimation of soil carbon stock. Assessment of both carbon components is required to understand the effects of land use on soil carbon stock. Therefore, this study was conducted to quantify organic and inorganic carbon among soil aggregates of selected land use types in Gambari Forest Reserve. Four ($30 \text{ m} \times 30 \text{ m}$) plots were randomly demarcated on each land use; Natural Forest, Plantation Forest and Cultivated Land. Soil core samples were collected to depths of 0-15, 15-30 and 30-45cm in the sub-plots of $8 \text{ m} \times 8 \text{ m}$ established at four corners and centre of each plot. Soil core samples were oven dried at 1050C to constant weight and 100 g of soil sample was sieved into five aggregate sizes (> 2 , 2-1, 1-0.5, 0.5-0.05, $< 0.05 \text{ mm}$) and total carbon content was determined by Loss-in-Ignition method at 5000C for 4 hours. Walkley Black method was used to determine soil organic carbon and inorganic carbon was computed from each aggregate fractions. Data collected were analyzed using descriptive statistics. Aggregates $> 2.0 \text{ mm}$ had the highest total carbon content at three depths in Plantation Forest and Cultivated Land while 1.0 mm had the highest carbon content at three depth in Natural Forest. Soil organic and inorganic carbon decreased with increase in soil depths in the three land use type. Land use and aggregates determined the distribution pattern of soil organic and inorganic carbon.