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EC-Earth Global Climate Projections

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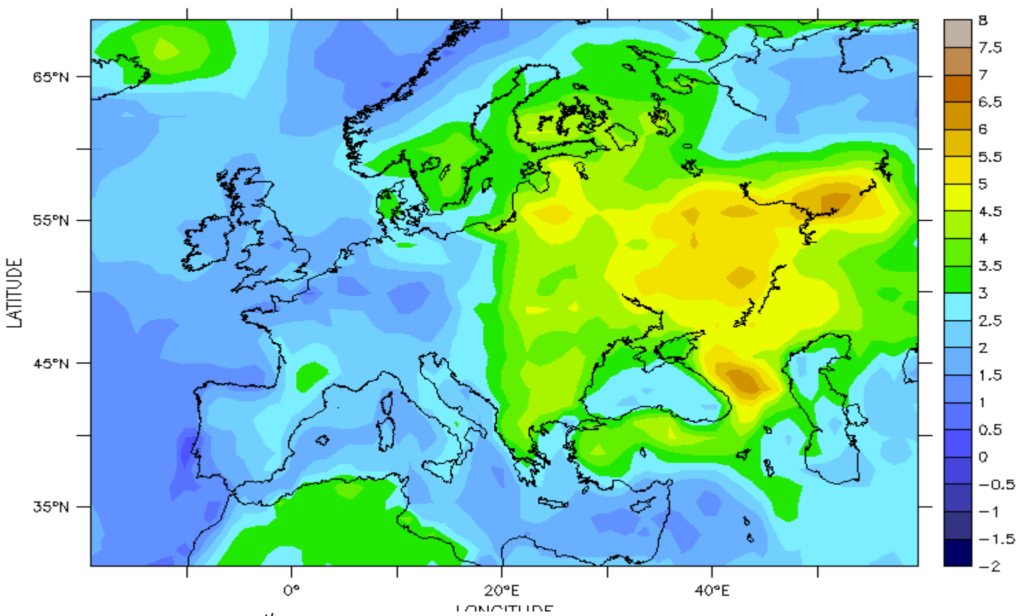
Met Éireann is part of a European consortium who recently completed a suite of global climate simulations using the EC-Earth atmosphere, ocean and sea-ice coupled model. The data are available at a resolution of approximately 130km and will be available for consideration by the IPCC for the AR5 report. As well as this, UCD is working in collaboration with Met Éireann to downscale the data to a much finer grid (4km resolution) over Ireland.

The data will be readily available to everyone and it is hoped that some of the agricultural community would like to use it in their research.



Projected change in the 99th percentile of daily maximum of 2m temperature for the period 2071-2100 relative to the period 1971-2000 (representative of changes in extremes of daily maximum temperatures).

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EC-Earth website: http://ecearth.knmi.nl/

Accessing data: One full dataset is already available on the BADC server. See http://badc.nerc.ac.uk/home/ and it comes under CMIP5 experiments. Our other datasets will be uploaded over the coming weeks. These datasets are on a 130 km grid with 3 hourly output of a large set of meteorological parameters including temperature, precipitation, wind, humidity for the years 1850-2100. We will have 14 such simulations where each was run for 2 different future forcings (rcp4.5 and rcp8.5 as defined by the IPCC).

Explaining spring barley yields in 2011

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Ireland has globally high cereal yields with, over the last decade or so, the highest average wheat and second highest average barley yields in the world. Despite this history of high yields the 2011 season produced some of the highest yields on record; on average across all the cereals, yields were up 13% on 2010 yields.

The 2011 season had a very harsh winter but frosts did not penetrate the soil to sufficient depth to affect structure apart from in the very surface layers of the soil. This may well have improved seedbed structure for spring crops which in combination with plentiful soil moisture and good drilling conditions resulted in good plant stands.

Average temperatures were well above the norm from the start of the year until May providing very good conditions for leaf and tiller formation. Monitoring of spring barley crops showed that this resulted in crop canopy sizes and ear numbers significantly above those achieved in 2010. From June until harvest, the period during which grain filling takes place, temperatures were well below normal and solar radiation was close to average. Good levels of solar radiation promote good rates of growth. In 2011 this, in combination with low temperatures which prolonged grain filling, allowed crops to fully fill the high grain numbers set during the favourable spring growing conditions.

Meteorological trends affecting grass growth. A study in the South of Ireland

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Meteorological factors influence grass growth over the course of the growing season, making grass budgeting at farm level challenging. Meteorological trends from 1982 to 2010 at the Animal and Grassland Research and Innovation Centre, Teagasc Moorepark, Fermoy, Co. Cork were examined and factors having the greatest influence on grass growth were determined. A regression analysis of meteorological factors and grass growth rates was performed in SPSS. The analyses indicated an increase in annual air temperature of approximately 0.5ºC, but this was not statistically significant; the number of data points would be considered small for climate analysis. A significant increase in mean temperature was shown in June, while maximum temperature significantly increased in June and decreased in December. Significant monthly increases in soil temperature at 50 mm occurred in April, May, June and September; and in soil temperature at 100 mm from April to September. Soil temperature least square regression lines had very steep slopes compared to air temperatures, suggesting soil temperatures are increasing faster. Average annual precipitation showed a small but not significant negative trend, however, a significant increase was shown in July. Significant increases in sunshine hours were observed in February, March, April, June, August and December, while significant increases in solar radiation were in March, April, June and August. There was a positive significant annual trend in evapotranspiration and monthly significant increases in October and November. When considering the regression analysis, the meteorological factors having the greatest effect on grass growth in the January to April period were evapotranspiration and soil temperature at 100 mm; in the May to mid June period it was soil temperature at 50 mm; in the mid June to August period they were maximum and minimum daily temperature, evapotranspiration and sunshine hours; and in the September to December period evapotranspiration, minimum and mean daily temperature had the greatest effect. As expected, temperature had a big influence on herbage production in all seasons and evapotranspiration also played a key role. These results suggest that it may be possible to use meteorological data to predict grass growth to assist farmers with grazing management.

Soil moisture deficit as a predictor of grass field trafficability

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Soil compaction is a serious threat to the productivity of agricultural enterprises. While the increased size of farm vehicles has led to greater pressures exerted upon agricultural soils, it is the soil moisture content at the time of trafficking which remains the most significant determinant of the extent of deformation incurred. The purpose of this study was to determine the compaction incurred by a single pass of a tractor and loaded slurry tanker at various soil moisture deficits (SMD), on well, moderate and poorly drained soils. This study aims to determine threshold SMD values beyond which slurry spreading is likely to cause significant levels of compaction. SMD has the advantages of being a proxy for volumetric water content, and of being predictable for various drainage classes using weather data. Treatments of a single pass by a Landini Vision 105 tractor and a fully loaded single axle 2000 gallon slurry tanker (combined weight of 18.4 tonnes) were conducted on well, moderate and poorly drained grassland soils at predicted SMDs of 0, 5, 10 and 20 mm. Changes in bulk density and shear strength were used as indicators of compaction, and rut profiles were taken to indicate surface deformation in the form of wheel tracks, a common symptom of soil compaction. Grass yield samples were also taken as a measure of the loss in productivity occurring as a result of compaction. Measurements were taken on the day of trafficking, and at subsequent 30 day intervals. This study is ongoing, with detailed results and analysis to be forthcoming.

Modelling Topographic Wetness Index using GIS to account for the effect of slope and landscape position when using the hybrid Soil Moisture Deficit model

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A farm-scale Decision Support System (DSS) for sustainable nutrient management is being developed to provide farmers with advice on minimising nutrient loss from land spread organic and mineral fertilisers. Within the DSS, the Hybrid Soil Moisture Deficit Model (SMD; *Schulte et al. 2005*) is used to assess when slurry spreading is 'safe' and will not pose a risk of water pollution. The Hybrid SMD model assumes a flat field scenario where the only input of water is from rainfall, and "drainage" is not defined, thus could be any combination of leaching or runoff. This work is establishing whether a Topographic Wetness Index (TWI) derived from Digital Elevation Model (DEM) data can be accurately calculated, and then combined with the Hybrid SMD model to better predict the presence of gravity moveable water at a given time. GIS modelling has calculated TWI for the two hydrological sub-catchments located at Johnstown Castle, Wexford and Lyons Estate, Dublin. TWI was calculated using three different flow accumulation algorithms; D8 *[O'Callaghan&Mark, 1984],* Dinfinity *[Tarboton, 1997],* and Multiple Flow Direction *[Quinn et al., 1991; Freeman, 1991]* at a resolution of 20 metres and 40 metres using SAGA GIS. Successfully linking TWI and the hybrid SMD model will result in improving the DSS by providing more accurate predictions of when there is a transport vector to link pollution sources and environmental targets to better define 'safe' slurry spreading periods.

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Farmer evaluation of slurry spreading conditions compared to predictions using the Hybrid Soil Moisture Deficit model

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A Sustainable Nutrient Management Decision Support System (SNM-DSS) has been designed to assist farmers in preventing water pollution by reducing coincidence of land spreading with nutrient transport processes. The aim of this study was to evaluate whether the output of the HSMD model, a core component of the SNM-DSS, corresponds to farmer opinion of when it is safe to spread slurry. A mobile phone text message survey was conducted in cooperation with 175 farmers. Farmers were sent SMS messages with questions related to slurry management issues (trafficability, weather forecast, storage limitations and nutrient efficiency). SMD was calculated for each farm location using interpolated weather data provided by Met Éireann. Storage limitations were found to encourage farmers to spread slurry almost 50% of the time. Trafficability and weather forecast tended to prevent farmers from spread when the soil was wetter than field capacity. On the other hand they would expect a more efficient nutrient uptake by plants in drier conditions. The correlation of farmer opinion of slurry spreading opportunities and SMD predictions highlighted the potential of the HSMD model for predicting when slurry spreading will be optimum for plant uptake and reducing nutrient loss from land surface.

Net Ecosystem Exchange of Carbon Dioxide in Two Newly Established Biomass Crops

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Land-use change to biomass crop production has been identified as a means of mitigating greenhouse gas (GHG) emissions through the substitution of fossil fuels and the enhancement of carbon storage in soil and vegetative reservoirs. However, the size of this potential terrestrial carbon sink is unknown, as are the GHG emissions associated with biomass crop cultivation. The aim of this research was to investigate the carbon balance implications of establishing biomass crops by assessing ecosystem-scale carbon fluxes in newly established stands of *Miscanthus × giganteus* and Reed Canary Grass (RCG; *Phalaris arundinacea*) using the eddy covariance technique. This micrometeorological method provides a direct measure of net ecosystem carbon dioxide exchange across the canopy-atmosphere boundary. RCG demonstrated superior carbon sink strength in the early establishment phase however, by year 3, the annual rate of carbon uptake in *Miscanthus* was comparable to that of RCG at over 3.5 t C ha^{-1}. Disparities in the temporal pattern of ecosystem carbon accumulation during the growing season were explained by phenological differences between the crops, in particular, timing of crop emergence, canopy closure and senescence. These results highlight the potential of biomass crops to reduce the carbon intensity of agricultural activities in Ireland by enhancing carbon sinks in the terrestrial biosphere.

Nitrous Oxide emissions from Grasslands

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We report on a field investigation of N_2O emissions which was part of the PhD thesis of Dr. Rashid Rafique, at University College Cork. The work involved a 2.5 year field sampling program at eight different farms in the South Ireland. N_2O fluxes were determined using the manual chamber technique. Environmental data of rainfall, soil temperature and soil moisture were also collected. Management data including stocking density, fertilizer and slurry applications along with soil data were also reported. Nitrous oxide fluxes were found to be a function of N application rate and timing; soil moisture, soil temperature, stocking density, grazing periods and silage cutting periods. Annual fluxes were found to range from 2 ± 3.51 to 12.55 ± 2.83 kg N_2O-N ha^{-1} yr^{-1}, which corresponded to an emission factor (EF) range of 1.3% to 3.4%, exceeding the IPCC default EF of 1%. Annual fluxes increased significantly beyond an N application rate of ~ 300kg N ha^{-1} yr^{-1} such that the ~5kg flux at an N application rate of 300kg increased to ~10 kg at an application rate of 400kg N ha^{-1} yr^{-1}. Hourly fluxes were found to increase linearly from a soil temperature of ~2^{O}C to ~ 12^{O}C, above which the hourly fluxes varied little. Maximum hourly fluxes were observed at a water filled pore space (WFPS) range of 60 to 80%. Fluxes for intensive grazing farms were significantly higher than those on extensive farms. Fluxes from brown podzol soils were significantly higher than those from gley soils. Fluxes increased immediately after silage cutting and after (short) grazing periods. Significantly more research is required on N_2O fluxes before Ireland can move to a Tier 2 N_2O inventory estimate.