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The open access environmental science journal

Highlights of 2016

Editor-in-Chief:
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Dear Colleague,

2016 saw *Environmental Research Letters* (ERL) celebrate it's 10th anniversary, and publish a special highlights collection to mark this milestone (**erl.iop.org/erl-10**). To complement this, we're honoured to present the journal's annual highlights, featuring 30 of the most innovative ground-breaking articles published in 2016. This special editor's selection includes research on environmental justice, ecology, extreme climate events, global food security, public health, as well as many articles documenting the increasing influence of anthropogenic effects on natural systems and the interventions required to help mitigate against these impacts.

Never before has the importance of ERL's vision been more evident, and our continued championing of values such as open science, cross-disciplinary approaches and impact-focussed research aimed at informing evidence-based policy more necessary. This remains critical to the safeguarding of our planet, and ERL is proud to serve the scientific community in striving to meet these shared goals. Our thanks to the journal's Editorial Board, authors, readers and supporters for making this possible.

Daniel M Kammen
Editor-in-Chief

Guillaume Wright
Executive Editor
Environmental Research Letters

To view these highlights online, please go to **erl.iop.org/highlights-2016**

Best article of 2016

This article has been awarded ERL's 'Best article of 2016', voted for by members of the ERL Editorial Board

Linking 'toxic outliers' to environmental justice communities

Mary B Collins, Ian Munoz and Joseph JaJa

Abstract
Several key studies have found that a small minority of producers, polluting at levels far exceeding group averages, generate the majority of overall exposure to industrial toxics. Frequently, such patterns go unnoticed and are understudied outside of the academic community. To our knowledge, no research to date has systematically described the scope and extent of extreme variations in industrially based exposure estimates and sought to link inequities in harm produced to inequities in exposure. In an analysis of all permitted industrial facilities across the United States, we show that there exists a class of hyper-polluters—the worst-of-the-worst—that disproportionately expose communities of color and low income populations to chemical releases. This study hopes to move beyond a traditional environmental justice research frame, bringing new computational methods and perspectives aimed at the empirical study of societal power dynamics. Our findings suggest the possibility that substantial environmental gains may be made through selective environmental enforcement, rather than sweeping initiatives.

2016 *Environ. Res. Lett.* **11** 015004

Featured on *environmentalresearchweb*
Super-polluter industrial facilities cause 90% of harm
environmentalresearchweb.org/cws/article/news/65429

Best early career article of 2016

VIDEO ABSTRACT

The nitrogen legacy: emerging evidence of nitrogen accumulation in anthropogenic landscapes

K J Van Meter, N B Basu, J J Veenstra and C L Burras

Abstract

Watershed and global-scale nitrogen (N) budgets indicate that the majority of the N surplus in anthropogenic landscapes does not reach the coastal oceans. While there is general consensus that this 'missing' N either exits the landscape via denitrification or is retained within watersheds as nitrate or organic N, the relative magnitudes of these pools and fluxes are subject to considerable uncertainty. Our study, for the first time, provides direct, large-scale evidence of N accumulation in the root zones of agricultural soils that may account for much of the 'missing N' identified in mass balance studies. We analyzed long-term soil data (1957–2010) from 2069 sites throughout the Mississippi River Basin (MRB) to reveal N accumulation in cropland of 25–70 kg ha^{-1} yr^{-1}, a total of 3.8 ± 1.8 Mt yr^{-1} at the watershed scale. We then developed a simple modeling framework to capture N depletion and accumulation dynamics under intensive agriculture. Using the model, we show that the observed accumulation of soil organic N (SON) in the MRB over a 30 year period (142 Tg N) would lead to a biogeochemical lag time of 35 years for 99% of legacy SON, even with complete cessation of fertilizer application. By demonstrating that agricultural soils can act as a net N sink, the present work makes a critical contribution towards the closing of watershed N budgets.

2016 *Environ. Res. Lett.* **11** 035014

Featured on *environmentalresearchweb*
Is missing nitrogen hiding out in plant roots?
environmentalresearchweb.org/cws/article/news/65321

Regional climate change and national responsibilities

VIDEO ABSTRACT

James Hansen and Makiko Sato

Abstract

Global warming over the past several decades is now large enough that regional climate change is emerging above the noise of natural variability, especially in the summer at middle latitudes and year-round at low latitudes. Despite the small magnitude of warming relative to weather fluctuations, effects of the warming already have notable social and economic impacts. Global warming of 2 °C relative to preindustrial would shift the 'bell curve' defining temperature anomalies a factor of three larger than observed changes since the middle of the 20th century, with highly deleterious consequences. There is striking incongruity between the global distribution of nations principally responsible for fossil fuel CO_2 emissions, known to be the main cause of climate change, and the regions suffering the greatest consequences from the warming, a fact with substantial implications for global energy and climate policies.

2016 *Environ. Res. Lett.* **11** 034009

Featured on *environmentalresearchweb*
James Hansen calls for fee on fossil fuels
environmentalresearchweb.org/cws/article/news/64181

A connection from Arctic stratospheric ozone to El Niño-Southern oscillation

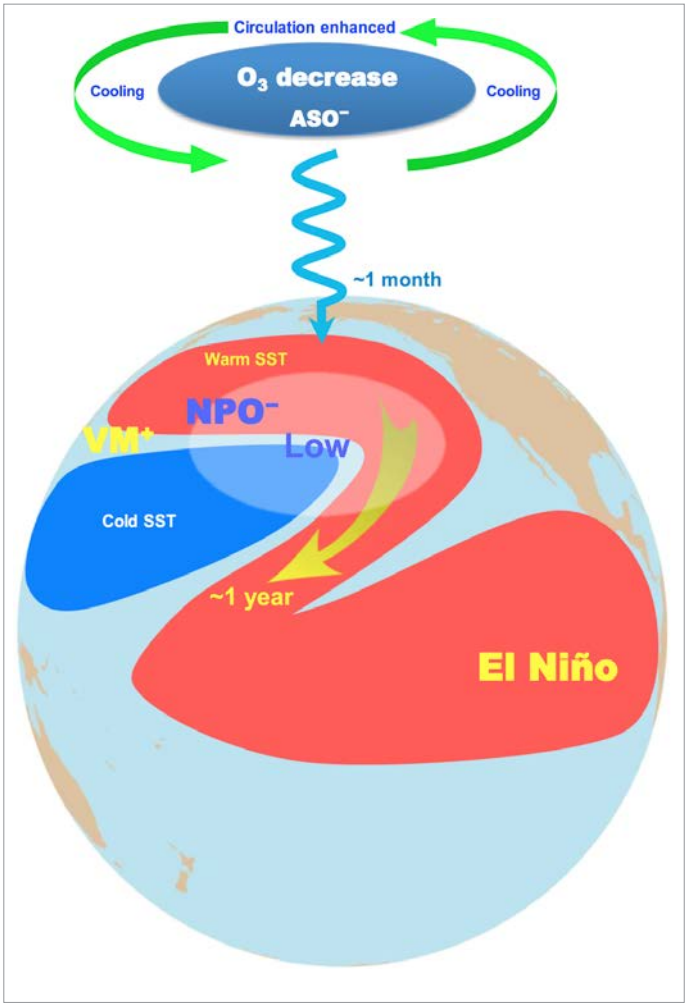
Fei Xie, Jianping Li, Wenshou Tian, Qiang Fu, Fei-Fei Jin, Yongyun Hu, Jiankai Zhang, Wuke Wang, Cheng Sun, Juan Feng, Yun Yang and Ruiqiang Ding

Abstract

Antarctic stratospheric ozone depletion is thought to influence the Southern Hemisphere tropospheric climate. Recently, Arctic stratospheric ozone (ASO) variations have been found to affect the middle-high latitude tropospheric climate in the Northern Hemisphere. This paper demonstrates that the impact of ASO can extend to the tropics, with the ASO variations leading El Niño-Southern Oscillation (ENSO) events by about 20 months. Using observations, analysis, and simulations, the connection between ASO and ENSO is established by combining the high-latitude stratosphere to troposphere pathway with the extratropical to tropical climate teleconnection. This shows that the ASO radiative anomalies influence the North Pacific Oscillation (NPO), and the anomalous NPO and induced Victoria Mode anomalies link to the North Pacific circulation that then influences ENSO. Our results imply that incorporating realistic and time-varying ASO into climate system models may help to improve ENSO predictions.

2016 *Environ. Res. Lett.* **11** 124026

Featured on *environmentalresearchweb*
Arctic stratospheric ozone could help predict El Niño
environmentalresearchweb.org/cws/article/news/67846



Transatlantic flight times and climate change

VIDEO ABSTRACT

Paul D Williams

Abstract

Aircraft do not fly through a vacuum, but through an atmosphere whose meteorological characteristics are changing because of global warming. The impacts of aviation on climate change have long been recognised, but the impacts of climate change on aviation have only recently begun to emerge. These impacts include intensified turbulence and increased take-off weight restrictions. Here we investigate the influence of climate change on flight routes and journey times. We feed synthetic atmospheric wind fields generated from climate model simulations into a routing algorithm of the type used operationally by flight planners. We focus on transatlantic flights between London and New York, and how they change when the atmospheric concentration of carbon dioxide is doubled. We find that a strengthening of the prevailing jet-stream winds causes eastbound flights to significantly shorten and westbound flights to significantly lengthen in all seasons. Eastbound and westbound crossings in winter become approximately twice as likely to take under 5 h 20 min and over 7 h 00 min, respectively. For reasons that are explained using a conceptual model, the eastbound shortening and westbound lengthening do not cancel out, causing round-trip journey times to increase. Even assuming no future growth in aviation, the extrapolation of our results to all transatlantic traffic suggests that aircraft will collectively be airborne for an extra 2000 h each year, burning an extra 7.2 million gallons of jet fuel at a cost of US$ 22 million, and emitting an extra 70 million kg of carbon dioxide, which is equivalent to the annual emissions of 7100 average British homes. Our results provide further evidence of the two-way interaction between aviation and climate change.

2016 *Environ. Res. Lett.* **11** 024008

Featured on *environmentalresearchweb*
Climate change will increase London to New York flight time
environmentalresearchweb.org/cws/article/news/64001

Arctic sea ice decline contributes to thinning lake ice trend in northern Alaska

Vladimir A Alexeev, Christopher D Arp, Benjamin M Jones and Lei Cai

Abstract

Field measurements, satellite observations, and models document a thinning trend in seasonal Arctic lake ice growth, causing a shift from bedfast to floating ice conditions. September sea ice concentrations in the Arctic Ocean since 1991 correlate well ($r = +0.69$, $p < 0.001$) to this lake regime shift. To understand how and to what extent sea ice affects lakes, we conducted model experiments to simulate winters with years of high (1991/92) and low (2007/08) sea ice extent for which we also had field measurements and satellite imagery characterizing lake ice conditions. A lake ice growth model forced with Weather Research and Forecasting model output produced a 7% decrease in lake ice growth when 2007/08 sea ice was imposed on 1991/92 climatology and a 9% increase in lake ice growth for the opposing experiment. Here, we clearly link early winter 'ocean-effect' snowfall and warming to reduced lake ice growth. Future reductions in sea ice extent will alter hydrological, biogeochemical, and habitat functioning of Arctic lakes and cause sub-lake permafrost thaw.

2016 *Environ. Res. Lett.* **11** 074022

Featured on *environmentalresearchweb*
Loss of Arctic sea ice thins Alaskan lakes
environmentalresearchweb.org/cws/article/news/66624

Review article – part of *Environmental Research Reviews*

Known unknowns: indirect energy effects of information and communication technology

Nathaniel C Horner, Arman Shehabi and Inês L Azevedo

Abstract

Background. There has been sustained and growing interest in characterizing the net energy impact of information and communication technology (ICT), which results from indirect effects offsetting (or amplifying) the energy directly consumed by ICT equipment. These indirect effects may be either positive or negative, and there is considerable disagreement as to the direction of this sign as well as the effect magnitude. Literature in this area ranges from studies focused on a single service (such as e-commerce versus traditional retail) to macroeconomic studies attempting to characterize the overall impact of ICT. *Methods*. We review the literature on the indirect energy effect of ICT found via Google Scholar, our own research, and input from other researchers in the field. The various studies are linked to an effect taxonomy, which is synthesized from several different hierarchies present in the literature. References are further grouped according to ICT service (e.g., e-commerce, telework) and summarized by scope, method, and quantitative and qualitative findings. *Review results*. Uncertainty persists in understanding the net energy effects of ICT. Results of indirect energy effect studies are highly sensitive to scoping decisions and assumptions made by the analyst. Uncertainty increases as the impact scope broadens, due to complex and interconnected effects. However, there is general agreement that ICT has large energy savings potential, but that the realization of this potential is highly dependent on deployment details and user behavior. *Discussion*. While the overall net effect of ICT is likely to remain unknown, this review suggests several guidelines for improving research quality in this area, including increased data collection, enhancing traditional modeling studies with sensitivity analysis, greater care in scoping, less confidence in characterizing aggregate impacts, more effort on understanding user behavior, and more contextual integration across the different levels of the effect taxonomy.

2016 *Environ. Res. Lett.* **11** 103001

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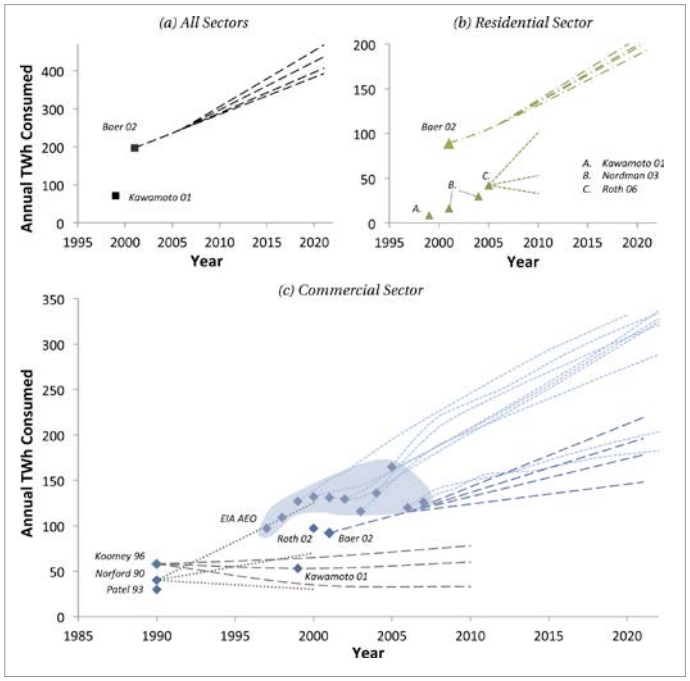
Sustainable computing needs careful thought
environmentalresearchweb.org/cws/article/news/67609



Poorest countries experience earlier anthropogenic emergence of daily temperature extremes

VIDEO ABSTRACT

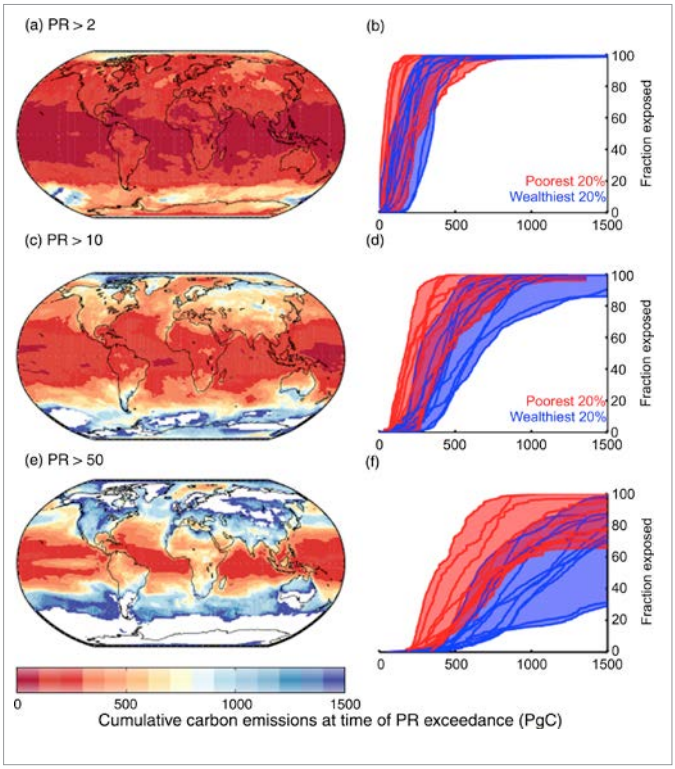
Luke J Harrington, David J Frame, Erich M Fischer, Ed Hawkins, Manoj Joshi and Chris D Jones

Abstract

Understanding how the emergence of the anthropogenic warming signal from the noise of internal variability translates to changes in extreme event occurrence is of crucial societal importance. By utilising simulations of cumulative carbon dioxide (CO_2) emissions and temperature changes from eleven earth system models, we demonstrate that the inherently lower internal variability found at tropical latitudes results in large increases in the frequency of extreme daily temperatures (exceedances of the 99.9th percentile derived from pre-industrial climate simulations) occurring much earlier than for mid-to-high latitude regions. Most of the world's people live at low latitudes, when considering 2010 GDP-PPP per capita; conversely the wealthiest population quintile disproportionately inhabit more variable mid-latitude climates. Consequently, the fraction of the global population in the lowest socio-economic quintile is exposed to substantially more frequent daily temperature extremes after much lower increases in both mean global warming and cumulative CO_2 emissions.

2016 *Environ. Res. Lett.* **11** 055007

Featured on *environmentalresearchweb*
Poorest fifth of world population will be first to experience more frequent temperature extremes
environmentalresearchweb.org/cws/article/news/65694



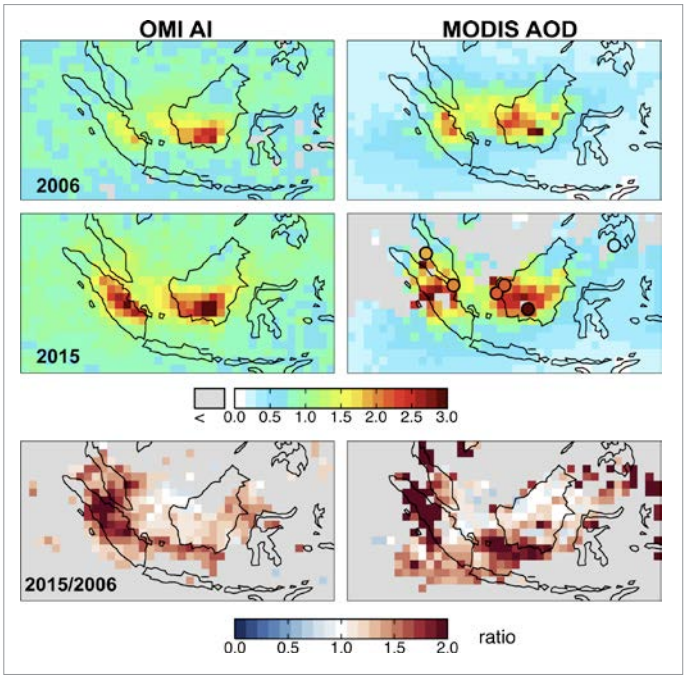
Public health impacts of the severe haze in Equatorial Asia in September–October 2015: demonstration of a new framework for informing fire management strategies to reduce downwind smoke exposure

Shannon N Koplitz, Loretta J Mickley, Miriam E Marlier, Jonathan J Buonocore, Patrick S Kim, Tianjia Liu, Melissa P Sulprizio, Ruth S DeFries, Daniel J Jacob, Joel Schwartz, Montira Pongsiri and Samuel S Myers

Abstract

In September–October 2015, El Niño and positive Indian Ocean Dipole conditions set the stage for massive fires in Sumatra and Kalimantan (Indonesian Borneo), leading to persistently hazardous levels of smoke pollution across much of Equatorial Asia. Here we quantify the emission sources and health impacts of this haze episode and compare the sources and impacts to an event of similar magnitude occurring under similar meteorological conditions in September–October 2006. Using the adjoint of the GEOS-Chem chemical transport model, we first calculate the influence of potential fire emissions across the domain on smoke concentrations in three receptor areas downwind—Indonesia, Malaysia, and Singapore—during the 2006 event. This step maps the sensitivity of each receptor to fire emissions in each grid cell upwind. We then combine these sensitivities with 2006 and 2015 fire emission inventories from the Global Fire Assimilation System (GFAS) to estimate the resulting population-weighted smoke exposure. This method, which assumes similar smoke transport pathways in 2006 and 2015, allows near real-time assessment of smoke pollution exposure, and therefore the consequent morbidity and premature mortality, due to severe haze. Our approach also provides rapid assessment of the relative contribution of fire emissions generated in a specific province to smoke-related health impacts in the receptor areas. We estimate that haze in 2015 resulted in 100 300 excess deaths across Indonesia, Malaysia and Singapore, more than double those of the 2006 event, with much of the increase due to fires in Indonesia's South Sumatra Province. The model framework we introduce in this study can rapidly identify those areas where land use management to reduce and/or avoid fires would yield the greatest benefit to human health, both nationally and regionally.

2016 *Environ. Res. Lett.* **11** 094023



A multi-model assessment of the co-benefits of climate mitigation for global air quality

Shilpa Rao, Zbigniew Klimont, Joana Leitao, Keywan Riahi, Rita van Dingenen, Lara Aleluia Reis, Katherine Calvin, Frank Dentener, Laurent Drouet, Shinichiro Fujimori, Mathijs Harmsen, Gunnar Luderer, Chris Heyes, Jessica Strefler, Massimo Tavoni and Detlef P van Vuuren

Abstract

We present a model comparison study that combines multiple integrated assessment models with a reduced-form global air quality model to assess the potential co-benefits of global climate mitigation policies in relation to the World Health Organization (WHO) goals on air quality and health. We include in our assessment, a range of alternative assumptions on the implementation of current and planned pollution control policies. The resulting air pollution emission ranges significantly extend those in the Representative Concentration Pathways. Climate mitigation policies complement current efforts on air pollution control through technology and fuel transformations in the energy system. A combination of stringent policies on air pollution control and climate change mitigation results in 40% of the global population exposed to PM levels below the WHO air quality guideline; with the largest improvements estimated for India, China, and Middle East. Our results stress the importance of integrated multisector policy approaches to achieve the Sustainable Development Goals.

2016 *Environ. Res. Lett.* **11** 124013

Featured on *environmentalresearchweb*
Climate mitigation set to help air pollution
environmentalresearchweb.org/cws/article/news/67927

Quantifying expert consensus against the existence of a secret, large-scale atmospheric spraying program

VIDEO ABSTRACT

Christine Shearer, Mick West, Ken Caldeira and Steven J Davis

Abstract

Nearly 17% of people in an international survey said they believed the existence of a secret large-scale atmospheric program (SLAP) to be true or partly true. SLAP is commonly referred to as 'chemtrails' or 'covert geoengineerings', and has led to a number of websites purported to show evidence of widespread chemical spraying linked to negative impacts on human health and the environment. To address these claims, we surveyed two groups of experts—atmospheric chemists with expertize in condensation trails and geochemists working on atmospheric deposition of dust and pollution—to scientifically evaluate for the first time the claims of SLAP theorists. Results show that 76 of the 77 scientists (98.7%) that took part in this study said they had not encountered evidence of a SLAP, and that the data cited as evidence could be explained through other factors, including well-understood physics and chemistry associated with aircraft contrails and atmospheric aerosols. Our goal is not to sway those already convinced that there is a secret, large-scale spraying program—who often reject counter-evidence as further proof of their theories—but rather to establish a source of objective science that can inform public discourse.

2016 *Environ. Res. Lett.* **11** 084011

Featured on *environmentalresearchweb*
Are chemtrails a con?
environmentalresearchweb.org/cws/article/news/65945

Modeling marine surface microplastic transport to assess optimal removal locations

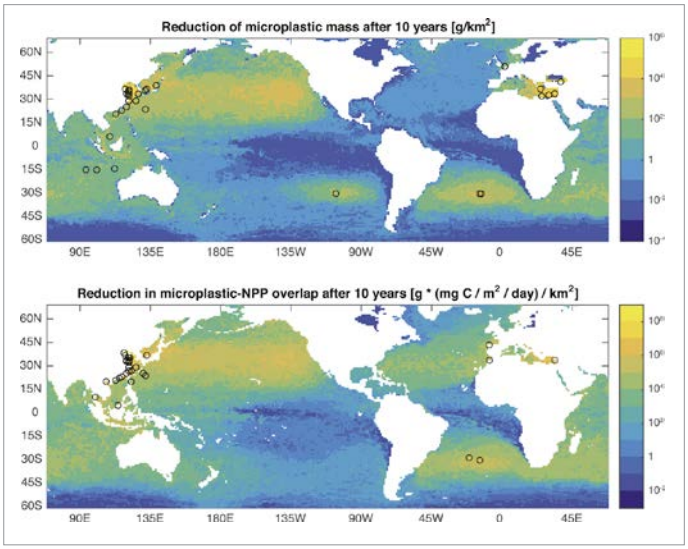
Peter Sherman and Erik van Sebille

Abstract

Marine plastic pollution is an ever-increasing problem that demands immediate mitigation and reduction plans. Here, a model based on satellite-tracked buoy observations and scaled to a large data set of observations on microplastic from surface trawls was used to simulate the transport of plastics floating on the ocean surface from 2015 to 2025, with the goal to assess the optimal marine microplastic removal locations for two scenarios: removing the most surface microplastic and reducing the impact on ecosystems, using plankton growth as a proxy. The simulations show that the optimal removal locations are primarily located off the coast of China and in the Indonesian Archipelago for both scenarios. Our estimates show that 31% of the modeled microplastic mass can be removed by 2025 using 29 plastic collectors operating at a 45% capture efficiency from these locations, compared to only 17% when the 29 plastic collectors are moored in the North Pacific garbage patch, between Hawaii and California. The overlap of ocean surface microplastics and phytoplankton growth can be reduced by 46% at our proposed locations, while sinks in the North Pacific can only reduce the overlap by 14%. These results are an indication that oceanic plastic removal might be more effective in removing a greater microplastic mass and in reducing potential harm to marine life when closer to shore than inside the plastic accumulation zones in the centers of the gyres.

2016 *Environ. Res. Lett.* **11** 014006

Featured on *environmentalresearchweb*
Where's best to clean up ocean plastic?
environmentalresearchweb.org/cws/article/news/63754



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European summer temperatures since Roman times

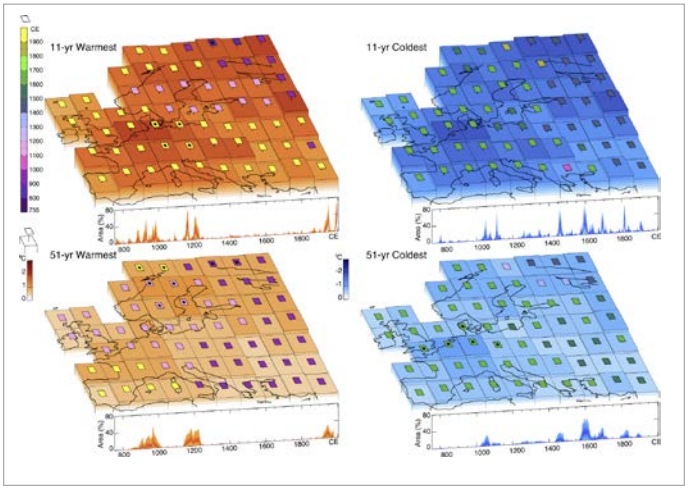
J Luterbacher *et al*

Abstract

The spatial context is critical when assessing present-day climate anomalies, attributing them to potential forcings and making statements regarding their frequency and severity in a long-term perspective. Recent international initiatives have expanded the number of high-quality proxy-records and developed new statistical reconstruction methods. These advances allow more rigorous regional past temperature reconstructions and, in turn, the possibility of evaluating climate models on policy-relevant, spatio-temporal scales. Here we provide a new proxy-based, annually-resolved, spatial reconstruction of the European summer (June–August) temperature fields back to 755 CE based on Bayesian hierarchical modelling (BHM), together with estimates of the European mean temperature variation since 138 BCE based on BHM and composite-plus-scaling (CPS). Our reconstructions compare well with independent instrumental and proxy-based temperature estimates, but suggest a larger amplitude in summer temperature variability than previously reported. Both CPS and BHM reconstructions indicate that the mean 20th century European summer temperature was not significantly different from some earlier centuries, including the 1st, 2nd, 8th and 10th centuries CE. The 1st century (in BHM also the 10th century) may even have been slightly warmer than the 20th century, but the difference is not statistically significant. Comparing each 50 yr period with the 1951–2000 period reveals a similar pattern. Recent summers, however, have been unusually warm in the context of the last two millennia and there are no 30 yr periods in either reconstruction that exceed the mean average European summer temperature of the last 3 decades (1986–2015 CE). A comparison with an ensemble of climate model simulations suggests that the reconstructed European summer temperature variability over the period 850–2000 CE reflects changes in both internal variability and external forcing on multi-decadal time-scales. For pan-European temperatures we find slightly better agreement between the reconstruction and the model simulations with high-end estimates for total solar irradiance. Temperature differences between the medieval period, the recent period and the Little Ice Age are larger in the reconstructions than the simulations. This may indicate inflated variability of the reconstructions, a lack of sensitivity and processes to changes in external forcing on the simulated European climate and/or an underestimation of internal variability on centennial and longer time scales.

2016 *Environ. Res. Lett.* **11** 024001

Featured on *environmentalresearchweb*
Europe's summers break 2000-year record
environmentalresearchweb.org/cws/article/news/64058



Attributing human mortality during extreme heat waves to anthropogenic climate change

VIDEO ABSTRACT

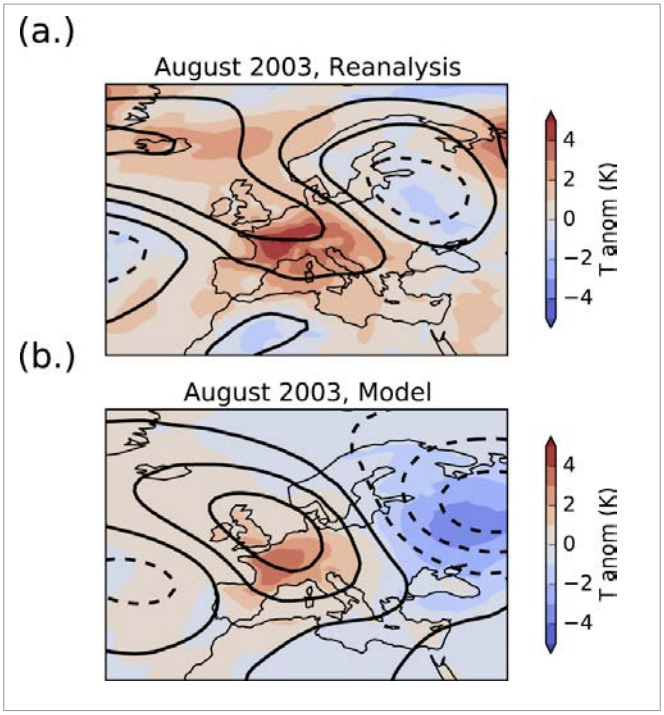
Daniel Mitchell, Clare Heaviside, Sotiris Vardoulakis, Chris Huntingford, Giacomo Masato, Benoit P Guillod, Peter Frumhoff, Andy Bowery, David Wallom and Myles Allen

Abstract

It has been argued that climate change is the biggest global health threat of the 21st century. The extreme high temperatures of the summer of 2003 were associated with up to seventy thousand excess deaths across Europe. Previous studies have attributed the meteorological event to the human influence on climate, or examined the role of heat waves on human health. Here, for the first time, we explicitly quantify the role of human activity on climate and heat-related mortality in an event attribution framework, analysing both the Europe-wide temperature response in 2003, and localised responses over London and Paris. Using publicly-donated computing, we perform many thousands of climate simulations of a high-resolution regional climate model. This allows generation of a comprehensive statistical description of the 2003 event and the role of human influence within it, using the results as input to a health impact assessment model of human mortality. We find large-scale dynamical modes of atmospheric variability remain largely unchanged under anthropogenic climate change, and hence the direct thermodynamical response is mainly responsible for the increased mortality. In summer 2003, anthropogenic climate change increased the risk of heat-related mortality in Central Paris by ~70% and by ~20% in London, which experienced lower extreme heat. Out of the estimated ~315 and ~735 summer deaths attributed to the heatwave event in Greater London and Central Paris, respectively, 64 (±3) deaths were attributable to anthropogenic climate change in London, and 506 (±51) in Paris. Such an ability to robustly attribute specific damages to anthropogenic drivers of increased extreme heat can inform societal responses to, and responsibilities for, climate change.

2016 *Environ. Res. Lett.* **11** 074006

Featured on *environmentalresearchweb*
Manmade climate change killed more than 500 Parisians in 2003 heatwave
environmentalresearchweb.org/cws/article/news/65523



Subnational distribution of average farm size and smallholder contributions to global food production

VIDEO ABSTRACT

Leah H Samberg, James S Gerber, Navin Ramankutty, Mario Herrero and Paul C West

Abstract

Smallholder farming is the most prevalent form of agriculture in the world, supports many of the planet's most vulnerable populations, and coexists with some of its most diverse and threatened landscapes. However, there is little information about the location of small farms, making it difficult both to estimate their numbers and to implement effective agricultural, development, and land use policies. Here, we present a map of mean agricultural area, classified by the amount of land per farming household, at subnational resolutions across three key global regions using a novel integration of household microdata and agricultural landscape data. This approach provides a subnational estimate of the number, average size, and contribution of farms across much of the developing world. By our estimates, 918 subnational units in 83 countries in Latin America, sub-Saharan Africa, and South and East Asia average less than five hectares of agricultural land per farming household. These smallholder-dominated systems are home to more than 380 million farming households, make up roughly 30% of the agricultural land and produce more than 70% of the food calories produced in these regions, and are responsible for more than half of the food calories produced globally, as well as more than half of global production of several major food crops. Smallholder systems in these three regions direct a greater percentage of calories produced toward direct human consumption, with 70% of calories produced in these units consumed as food, compared to 55% globally. Our approach provides the ability to disaggregate farming populations from non-farming populations, providing a more accurate picture of farming households on the landscape than has previously been available. These data meet a critical need, as improved understanding of the prevalence and distribution of smallholder farming is essential for effective policy development for food security, poverty reduction, and conservation agendas.

2016 *Environ. Res. Lett.* **11** 124010

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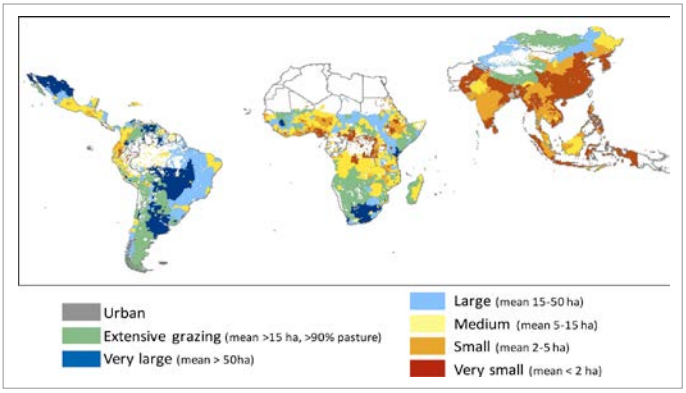
More than half of world's food calories produced by small farms
environmentalresearchweb.org/cws/article/news/67824



Review article – part of *Environmental Research Reviews*

VIDEO ABSTRACT

Evidence based review: positive versus negative effects of livestock grazing on wildlife. What do we really know?

Jennifer M Schieltz and Daniel I Rubenstein

Abstract

More than a quarter of earth's land surface is used for grazing domestic livestock. Livestock grazing is generally assumed to negatively affect wildlife, however, a number of studies have found positive impacts as well. We conducted an evidence-based review of the existing literature using a series of livestock- and wildlife-related search words to systematically query Google Scholar and Web of Science. A total of 807 sources were included in the final list, including 646 primary sources which reported original data. The majority of studies were conducted in North America (338) or Europe (123), with many fewer from Africa (57), Australia (54), Central/South America (43), or Asia (31). Most studies examined birds (330) and mammals (262), with fewer including reptiles (91) or amphibians (58). We extracted further information from studies that included mammals on positive, negative, and neutral effects of livestock grazing on mammals. We found that livestock change vegetation structure and cover in ways important to small mammals, while ungulates may be affected more by interference competition and changes in forage quantity and quality. Community-level total abundance of small mammals typically declines with grazing. Species richness of small mammals either declines or stays the same, as many studies found a change in species composition from ungrazed to grazed sites while the number of species remained similar. Individual species responses of small mammals vary. Voles, harvest mice, cotton rats, and shrews show consistently negative responses to grazing while deer mice, kangaroo rats, ground squirrels, and lagomorphs show positive or variable responses. In general, species adapted to open habitats are often positively affected by grazing, while species needing denser cover are negatively affected. Studies of wild ungulates are more variable in methodology and quality than those for small mammals. We found more negative ($n = 86$) than positive ($n = 34$) ungulate responses overall, however, most studies have been on browsers and mixed feeders, namely deer and elk, and there is little available data for other groups. Although data is limited, several of the grazing species in Africa may show a trend toward positive responses, suggesting possible facilitation. For a number of species, responses varied by season. We find a strong need for additional research on ungulates of varying diets and body sizes, especially in the developing world, and across longer time scales to examine possible tradeoffs between competition and facilitation from livestock.

2016 *Environ. Res. Lett.* **11** 113003

Featured on *environmentalresearchweb*
What do livestock mean for wildlife?
environmentalresearchweb.org/cws/article/news/67852

2 °C and SDGs: united they stand, divided they fall?

VIDEO ABSTRACT

Christoph von Stechow, Jan C Minx, Keywan Riahi, Jessica Jewell, David L McCollum, Max W Callaghan, Christoph Bertram, Gunnar Luderer and Giovanni Baiocchi

Abstract

The adoption of the Sustainable Development Goals (SDGs) and the new international climate treaty could put 2015 into the history books as a defining year for setting human development on a more sustainable pathway. The global climate policy and SDG agendas are highly interconnected: the way that the climate problem is addressed strongly affects the prospects of meeting numerous other SDGs and vice versa. Drawing on existing scenario results from a recent energy-economy-climate model inter-comparison project, this letter analyses these synergies and (risk) trade-offs of alternative 2 °C pathways across indicators relevant for energy-related SDGs and sustainable energy objectives. We find that limiting the availability of key mitigation technologies yields some co-benefits and decreases risks specific to these technologies but greatly increases many others. Fewer synergies and substantial trade-offs across SDGs are locked into the system for weak short-term climate policies that are broadly in line with current Intended Nationally Determined Contributions (INDCs), particularly when combined with constraints on technologies. Lowering energy demand growth is key to managing these trade-offs and creating synergies across multiple energy-related SD dimensions. We argue that SD considerations are central for choosing socially acceptable 2 °C pathways: the prospects of meeting other SDGs need not dwindle and can even be enhanced for some goals if appropriate climate policy choices are made. Progress on the climate policy and SDG agendas should therefore be tracked within a unified framework.

2016 *Environ. Res. Lett.* **11** 034022

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Some climate paths may harm sustainable development
environmentalresearchweb.org/cws/article/news/66004

The growing role of methane in anthropogenic climate change

M Saunois, R B Jackson, P Bousquet, B Poulter and J G Canadell

Abstract

Unlike CO_2, atmospheric methane concentrations are rising faster than at any time in the past two decades and, since 2014, are now approaching the most greenhouse-gas-intensive scenarios. The reasons for this renewed growth are still unclear, primarily because of uncertainties in the global methane budget. New analysis suggests that the recent rapid rise in global methane concentrations is predominantly biogenic-most likely from agriculture-with smaller contributions from fossil fuel use and possibly wetlands. Additional attention is urgently needed to quantify and reduce methane emissions. Methane mitigation offers rapid climate benefits and economic, health and agricultural co-benefits that are highly complementary to CO_2 mitigation.

2016 *Environ. Res. Lett.* **11** 120207

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Methane is rising and it's not clear why
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Interactions between sea-level rise and wave exposure on reef island dynamics in the Solomon Islands

Simon Albert, Javier X Leon, Alistair R Grinham, John A Church, Badin R Gibbes and Colin D Woodroffe

Abstract

Low-lying reef islands in the Solomon Islands provide a valuable window into the future impacts of global sea-level rise. Sea-level rise has been predicted to cause widespread erosion and inundation of low-lying atolls in the central Pacific. However, the limited research on reef islands in the western Pacific indicates the majority of shoreline changes and inundation to date result from extreme events, seawalls and inappropriate development rather than sea-level rise alone. Here, we present the first analysis of coastal dynamics from a sea-level rise hotspot in the Solomon Islands. Using time series aerial and satellite imagery from 1947 to 2014 of 33 islands, along with historical insight from local knowledge, we have identified five vegetated reef islands that have vanished over this time period and a further six islands experiencing severe shoreline recession. Shoreline recession at two sites has destroyed villages that have existed since at least 1935, leading to community relocations. Rates of shoreline recession are substantially higher in areas exposed to high wave energy, indicating a synergistic interaction between sea-level rise and waves. Understanding these local factors that increase the susceptibility of islands to coastal erosion is critical to guide adaptation responses for these remote Pacific communities.

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Wave erosion compounds damage of rising seas
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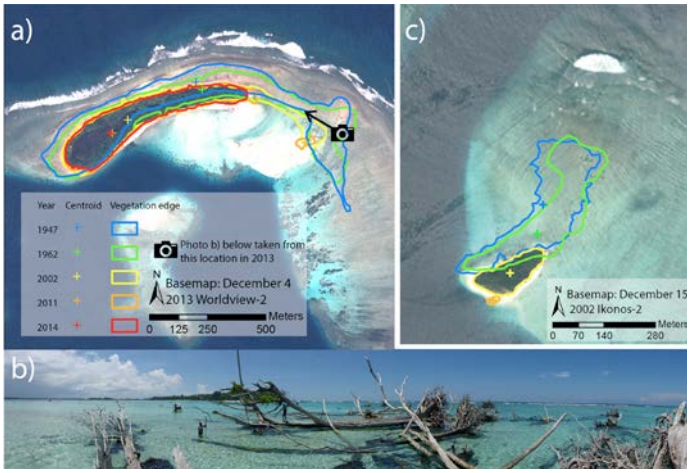

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Biomass offsets little or none of permafrost carbon release from soils, streams, and wildfire: an expert assessment

Benjamin W Abbott *et al*

Abstract

As the permafrost region warms, its large organic carbon pool will be increasingly vulnerable to decomposition, combustion, and hydrologic export. Models predict that some portion of this release will be offset by increased production of Arctic and boreal biomass; however, the lack of robust estimates of net carbon balance increases the risk of further overshooting international emissions targets. Precise empirical or model-based assessments of the critical factors driving carbon balance are unlikely in the near future, so to address this gap, we present estimates from 98 permafrost-region experts of the response of biomass, wildfire, and hydrologic carbon flux to climate change. Results suggest that contrary to model projections, total permafrost-region biomass could decrease due to water stress and disturbance, factors that are not adequately incorporated in current models. Assessments indicate that end-of-the-century organic carbon release from Arctic rivers and collapsing coastlines could increase by 75% while carbon loss via burning could increase four-fold. Experts identified water balance, shifts in vegetation community, and permafrost degradation as the key sources of uncertainty in predicting future system response. In combination with previous findings, results suggest the permafrost region will become a carbon source to the atmosphere by 2100 regardless of warming scenario but that 65%–85% of permafrost carbon release can still be avoided if human emissions are actively reduced.

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Experts predict vegetation growth in Arctic will not increase
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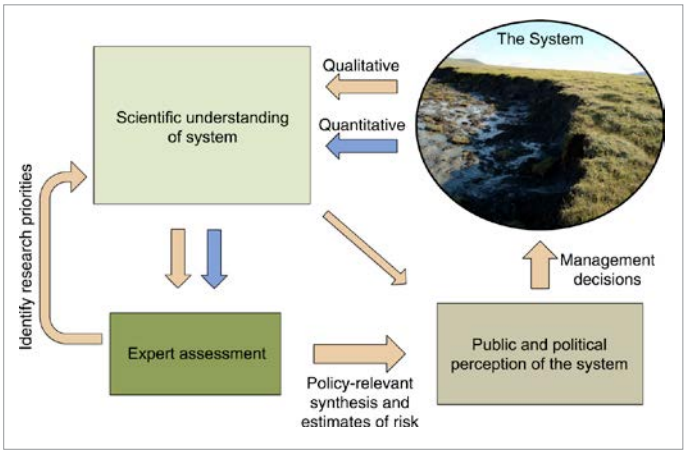

Running an open experiment: transparency and reproducibility in soil and ecosystem science

Ben Bond-Lamberty, A Peyton Smith and Vanessa Bailey

Abstract

Researchers in soil and ecosystem science, and almost every other field, are being pushed—by funders, journals, governments, and their peers—to increase transparency and reproducibility of their work. A key part of this effort is a move towards *open data* as a way to fight post-publication data loss, improve data and code quality, enable powerful meta- and cross-disciplinary analyses, and increase trust in, and the efficiency of, publicly-funded research. Many scientists however lack experience in, and may be unsure of the benefits of, making their data and fully-reproducible analyses publicly available. Here we describe a recent 'open experiments', in which we documented every aspect of a soil incubation online, making all raw data, scripts, diagnostics, final analyses, and manuscripts available in real time. We found that using tools such as version control, issue tracking, and open-source statistical software improved data integrity, accelerated our team's communication and productivity, and ensured transparency. There are many avenues to improve scientific reproducibility and data availability, of which is this only one example, and it is not an approach suited for every experiment or situation. Nonetheless, we encourage the communities in our respective fields to consider its advantages, and to lead rather than follow with respect to scientific reproducibility, transparency, and data availability.

2016 *Environ. Res. Lett.* **11** 084004

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Researchers make soil experiment data available in real time
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Review article – part of *Environmental Research Reviews*

Community-level climate change vulnerability research: trends, progress, and future directions

Graham McDowell, James Ford and Julie Jones

Abstract

This study systematically identifies, characterizes, and critically evaluates community-level climate change vulnerability assessments published over the last 25 years ($n = 274$). We find that while the field has advanced considerably in terms of conceptual framing and methodological approaches, key shortcomings remain in how vulnerability is being studied at the community-level. We argue that vulnerability research needs to more critically engage with the following: methods for evaluating future vulnerability, the relevance of vulnerability research for decision-making, interdependencies between social and ecological systems, attention to researcher / subject power dynamics, critical interpretation of key terms, and consideration of the potentially positive opportunities presented by a changing climate. Addressing these research needs is necessary for generating knowledge that supports climate-affected communities in navigating the challenges and opportunities ahead.

2016 *Environ. Res. Lett.* **11** 033001

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Vulnerability to climate change: what's happening at the community level?
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The spatially varying influence of humans on fire probability in North America

Marc-André Parisien, Carol Miller, Sean A Parks, Evan R DeLancey, François-Nicolas Robinne and Mike D Flannigan

Abstract

Humans affect fire regimes by providing ignition sources in some cases, suppressing wildfires in others, and altering natural vegetation in ways that may either promote or limit fire. In North America, several studies have evaluated the effects of society on fire activity; however, most studies have been regional or subcontinental in scope and used different data and methods, thereby making continent-wide comparisons difficult. We circumvent these challenges by investigating the broad-scale impact of humans on fire activity using parallel statistical models of fire probability from 1984 to 2014 as a function of climate, enduring features (topography and percent nonfuel), lightning, and three indices of human activity (population density, an integrated metric of human activity [Human Footprint Index], and a measure of remoteness [roadless volume]) across equally spaced regions of the United States and Canada. Through a statistical control approach, whereby we account for the effect of other explanatory variables, we found evidence of non-negligible human–wildfire association across the entire continent, even in the most sparsely populated areas. A surprisingly coherent negative relationship between fire activity and humans was observed across the United States and Canada: fire probability generally diminishes with increasing human influence. Intriguing exceptions to this relationship are the continent's least disturbed areas, where fewer humans equate to less fire. These remote areas, however, also often have lower lightning densities, leading us to believe that they may be ignition limited at the spatiotemporal scale of the study. Our results suggest that there are few purely natural fire regimes in North America today. Consequently, projections of future fire activity should consider human impacts on fire regimes to ensure sound adaptation and mitigation measures in fire-prone areas.

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Humans are heavily influencing fire in North America
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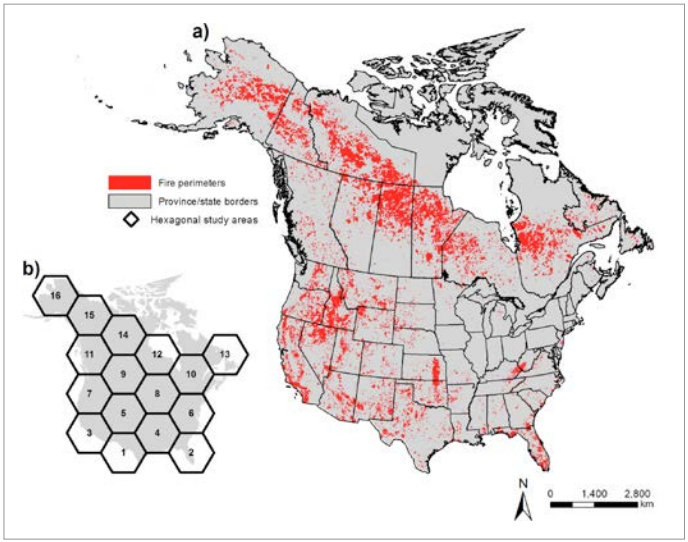

Simulating the Earth system response to negative emissions

C D Jones, P Ciais, S J Davis, P Friedlingstein, T Gasser, G P Peters, J Rogelj, D P van Vuuren, J G Canadell, A Cowie, R B Jackson, M Jonas, E Kriegler, E Littleton, J A Lowe, J Milne, G Shrestha, P Smith, A Torvanger and A Wiltshire

Abstract

Natural carbon sinks currently absorb approximately half of the anthropogenic CO_2 emitted by fossil fuel burning, cement production and land-use change. However, this airborne fraction may change in the future depending on the emissions scenario. An important issue in developing carbon budgets to achieve climate stabilisation targets is the behaviour of natural carbon sinks, particularly under low emissions mitigation scenarios as required to meet the goals of the Paris Agreement. A key requirement for low carbon pathways is to quantify the effectiveness of negative emissions technologies which will be strongly affected by carbon cycle feedbacks. Here we find that Earth system models suggest significant weakening, even potential reversal, of the ocean and land sinks under future low emission scenarios. For the RCP2.6 concentration pathway, models project land and ocean sinks to weaken to 0.8 ± 0.9 and 1.1 ± 0.3 GtC yr^{-1} respectively for the second half of the 21st century and to -0.4 ± 0.4 and 0.1 ± 0.2 GtC yr^{-1} respectively for the second half of the 23rd century. Weakening of natural carbon sinks will hinder the effectiveness of negative emissions technologies and therefore increase their required deployment to achieve a given climate stabilisation target. We introduce a new metric, the perturbation airborne fraction, to measure and assess the effectiveness of negative emissions.

2016 *Environ. Res. Lett.* **11** 095012

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Natural carbon sinks will weaken under low emissions
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Energy sector water use implications of a 2 °C climate policy

Oliver Fricko, Simon C Parkinson, Nils Johnson, Manfred Strubegger, Michelle TH van Vliet and Keywan Riahi

Abstract

Quantifying water implications of energy transitions is important for assessing long-term freshwater sustainability since large volumes of water are currently used throughout the energy sector. In this paper, we assess direct global energy sector water use and thermal water pollution across a broad range of energy system transformation pathways to assess water impacts of a 2 °C climate policy. A global integrated assessment model is equipped with the capabilities to account for the water impacts of technologies located throughout the energy supply chain. The model framework is applied across a broad range of 2 °C scenarios to highlight long-term water impact uncertainties over the 21st century. We find that water implications vary significantly across scenarios, and that adaptation in power plant cooling technology can considerably reduce global freshwater withdrawals and thermal pollution. Global freshwater consumption increases across all of the investigated 2 °C scenarios as a result of rapidly expanding electricity demand in developing regions and the prevalence of freshwater-cooled thermal power generation. Reducing energy demand emerges as a robust strategy for water conservation, and enables increased technological flexibility on the supply side to fulfill ambitious climate objectives. The results underscore the importance of an integrated approach when developing water, energy, and climate policy, especially in regions where rapid growth in both energy and water demands is anticipated.

2016 *Environ. Res. Lett.* **11** 034011

Vulnerability to shocks in the global seafood trade network

Jessica A Gephart, Elena Rovenskaya, Ulf Dieckmann, Michael L Pace and Åke Brännström

Abstract

Trade can allow countries to overcome local or regional losses (shocks) to their food supply, but reliance on international food trade also exposes countries to risks from external perturbations. Countries that are nutritionally or economically dependent on international trade of a commodity may be adversely affected by such shocks. While exposure to shocks has been studied in financial markets, communication networks, and some infrastructure systems, it has received less attention in food-trade networks. Here, we develop a forward shock-propagation model to quantify how trade flows are redistributed under a range of shock scenarios and assess the food-security outcomes by comparing changes in national fish supplies to indices of each country's nutritional fish dependency. Shock propagation and distribution among regions are modeled on a network of historical bilateral seafood trade data from UN Comtrade using 205 reporting territories grouped into 18 regions. In our model exposure to shocks increases with total imports and the number of import partners. We find that Central and West Africa are the most vulnerable to shocks, with their vulnerability increasing when a willingness-to-pay proxy is included. These findings suggest that countries can reduce their overall vulnerability to shocks by reducing reliance on imports and diversifying food sources. As international seafood trade grows, identifying these types of potential risks and vulnerabilities is important to build a more resilient food system.

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Where will fishing industry shocks hit hardest?
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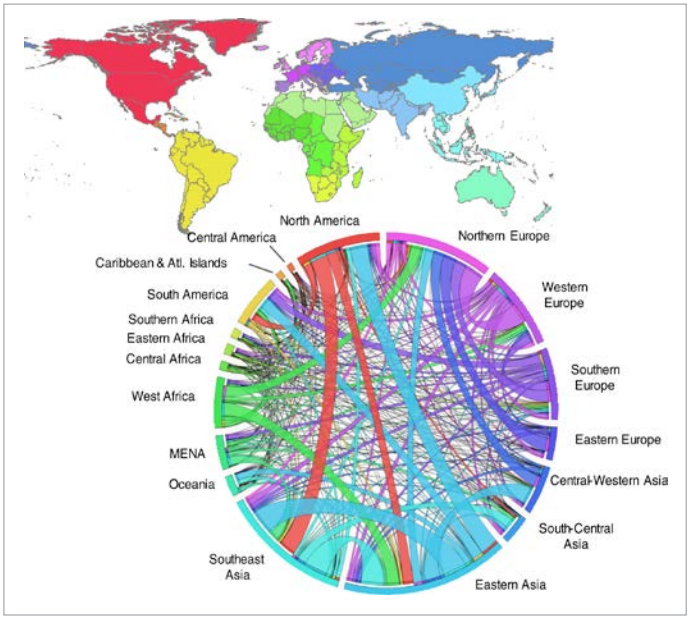

Humid tropical forest disturbance alerts using Landsat data

Matthew C Hansen, Alexander Krylov, Alexandra Tyukavina, Peter V Potapov, Svetlana Turubanova, Bryan Zutta, Suspense Ifo, Belinda Margono, Fred Stolle and Rebecca Moore

Abstract

A Landsat-based humid tropical forest disturbance alert was implemented for Peru, the Republic of Congo and Kalimantan, Indonesia. Alerts were mapped on a weekly basis as new terrain-corrected Landsat 7 and 8 images were made available; results are presented for all of 2014 and through September 2015. The three study areas represent different stages of the forest land use transition, with all featuring a variety of disturbance dynamics including logging, smallholder agriculture, and agroindustrial development. Results for Peru were formally validated and alerts found to have very high user's accuracies and moderately high producer's accuracies, indicating an appropriately conservative product suitable for supporting land management and enforcement activities. Complete pan-tropical coverage will be implemented during 2016 in support of the Global Forest Watch initiative. To date, Global Forest Watch produces annual global forest loss area estimates using a comparatively richer set of Landsat inputs. The alert product is presented as an interim update of forest disturbance events between comprehensive annual updates. Results from this study are available for viewing and download at http://glad.geog.umd.edu/forest-alerts and www.globalforestwatch.org.

2016 *Environ. Res. Lett.* **11** 034008

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Global Forest Watch system looks out for deforestation
environmentalresearchweb.org/cws/article/news/65205

Nitrogen fertilization challenges the climate benefit of cellulosic biofuels

Leilei Ruan, Ajay K Bhardwaj, Stephen K Hamilton and G Philip Robertson

Abstract

Cellulosic biofuels are intended to improve future energy and climate security. Nitrogen (N) fertilizer is commonly recommended to stimulate yields but can increase losses of the greenhouse gas nitrous oxide (N_2O) and other forms of reactive N, including nitrate. We measured soil N_2O emissions and nitrate leaching along a switchgrass (*Panicum virgatum*) high resolution N-fertilizer gradient for three years post-establishment. Results revealed an exponential increase in annual N_2O emissions that each year became stronger ($R^2 > 0.9$, $P < 0.001$) and deviated further from the fixed percentage assumed for IPCC Tier 1 emission factors. Concomitantly, switchgrass yields became less responsive each year to N fertilizer. Nitrate leaching (and calculated indirect N_2O emissions) also increased exponentially in response to N inputs, but neither methane (CH_4) uptake nor soil organic carbon changed detectably. Overall, N fertilizer inputs at rates greater than crop need curtailed the climate benefit of ethanol production almost two-fold, from a maximum mitigation capacity of -5.71 ± 0.22 Mg CO_2e ha^{-1} yr^{-1} in switchgrass fertilized at 56 kg N ha^{-1} to only -2.97 ± 0.18 Mg CO_2e ha^{-1} yr^{-1} in switchgrass fertilized at 196 kg N ha^{-1}. Minimizing N fertilizer use will be an important strategy for fully realizing the climate benefits of cellulosic biofuel production.

2016 *Environ. Res. Lett.* **11** 064007

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Nitrogen fertilizer risks cellulosic biofuel advantage
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Integrated crop water management might sustainably halve the global food gap

J Jägermeyr, D Gerten, S Schaphoff, J Heinke, W Lucht and J Rockström

Abstract

As planetary boundaries are rapidly being approached, humanity has little room for additional expansion and conventional intensification of agriculture, while a growing world population further spreads the food gap. Ample evidence exists that improved on-farm water management can close water-related yield gaps to a considerable degree, but its global significance remains unclear. In this modeling study we investigate systematically to what extent integrated crop water management might contribute to closing the global food gap, constrained by the assumption that pressure on water resources and land does not increase. Using a process-based bio-/agrosphere model, we simulate the yield-increasing potential of elevated irrigation water productivity (including irrigation expansion with thus saved water) and optimized use of *in situ* precipitation water (alleviated soil evaporation, enhanced infiltration, water harvesting for supplemental irrigation) under current and projected future climate (from 20 climate models, with and without beneficial CO_2 effects). Results show that irrigation efficiency improvements can save substantial amounts of water in many river basins (globally 48% of non-productive water consumption in an 'ambitious' scenario), and if rerouted to irrigate neighboring rainfed systems, can boost kcal production significantly (26% global increase). Low-tech solutions for small-scale farmers on water-limited croplands show the potential to increase rainfed yields to a similar extent. In combination, the ambitious yet achievable integrated water management strategies explored in this study could increase global production by 41% and close the water-related yield gap by 62%. Unabated climate change will have adverse effects on crop yields in many regions, but improvements in water management as analyzed here can buffer such effects to a significant degree.

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Better water management could halve food gap
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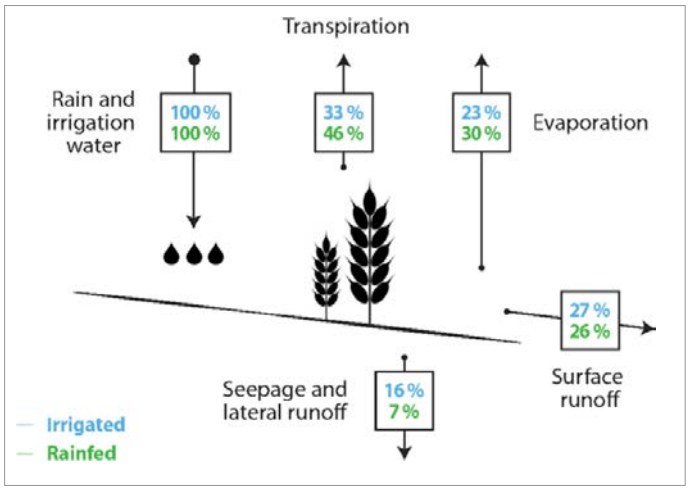

Spatially explicit global population scenarios consistent with the Shared Socioeconomic Pathways

B Jones and B C O'Neill

Abstract

The projected size and spatial distribution of the future population are important drivers of global change and key determinants of exposure and vulnerability to hazards. Spatial demographic projections are widely used as inputs to spatial projections of land use, energy use, and emissions, as well as to assessments of the impacts of extreme events, sea level rise, and other climate-related outcomes. To date, however, there are very few global-scale, spatially explicit population projections, and those that do exist are often based on simple scaling or trend extrapolation. Here we present a new set of global, spatially explicit population scenarios that are consistent with the new Shared Socioeconomic Pathways (SSPs) developed to facilitate global change research. We use a parameterized gravity-based downscaling model to produce projections of spatial population change that are quantitatively consistent with national population and urbanization projections for the SSPs and qualitatively consistent with assumptions in the SSP narratives regarding spatial development patterns. We show that the five SSPs lead to substantially different spatial population outcomes at the continental, national, and sub-national scale. In general, grid cell-level outcomes are most influenced by national-level population change, second by urbanization rate, and third by assumptions about the spatial style of development. However, the relative importance of these factors is a function of the magnitude of the projected change in total population and urbanization for each country and across SSPs. We also demonstrate variation in outcomes considering the example of population existing in a low-elevation coastal zone under alternative scenarios..

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