

futureearth

research for global sustainability

Craig Starger

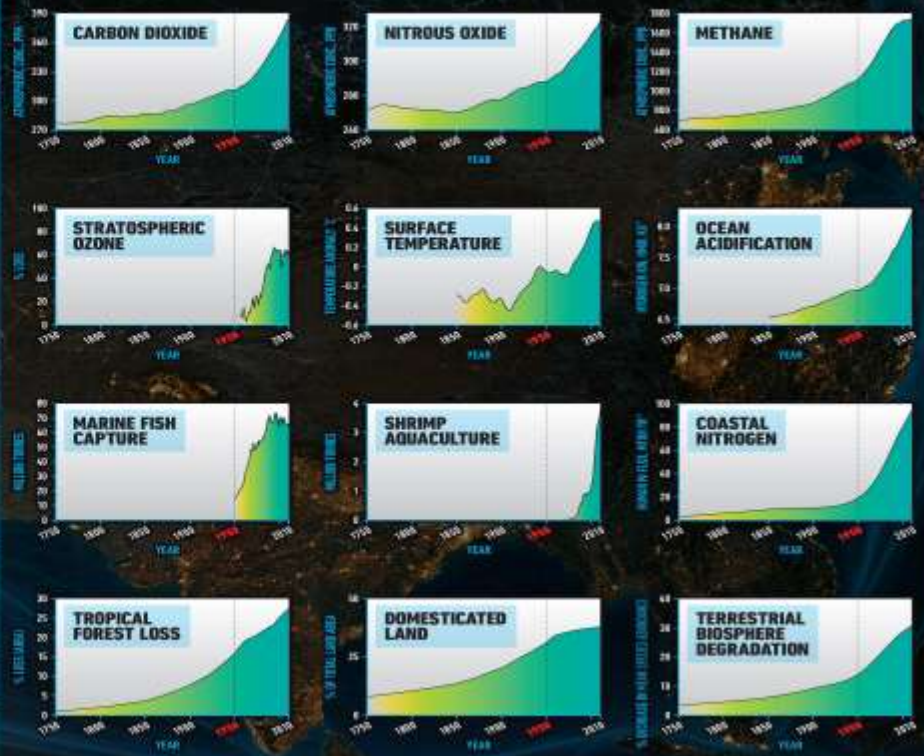
Future Earth Secretariat, Colorado Hub

THE GREAT ACCELERATION

SOCIO-ECONOMIC TRENDS



EARTH SYSTEM TRENDS

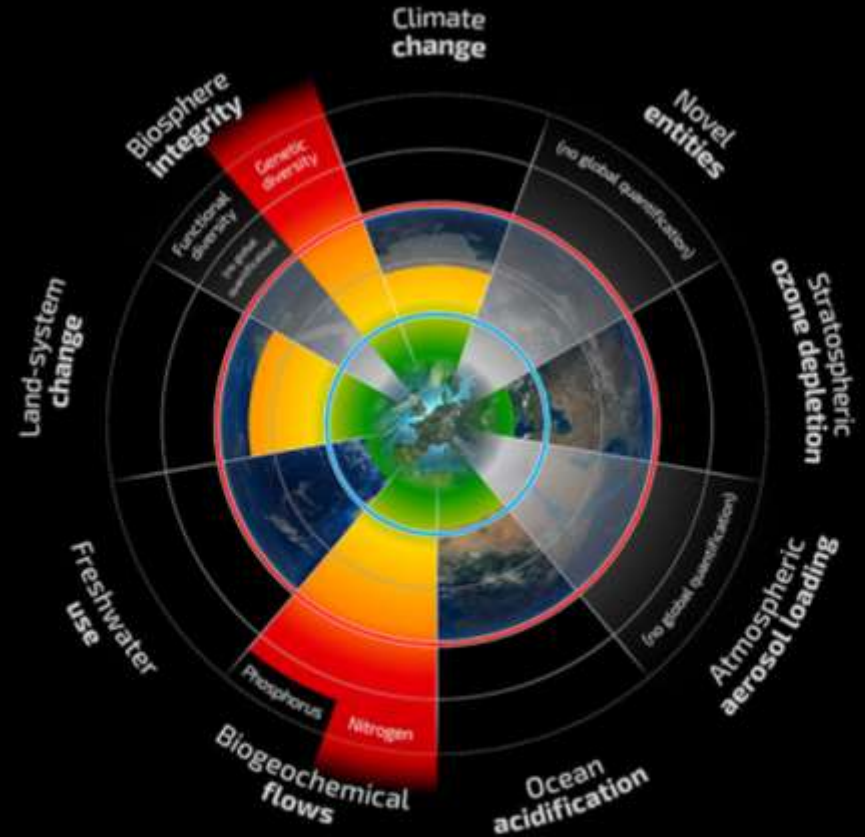


REFERENCE: Steffen, W., Broadgate, L., Deutsch, O., Gaffney, C. and Ludwig, C., The Trajectory of the Anthropocene: the Great Acceleration, *The Anthropocene Review*, 16 January 2015.

MAP & DESIGN: Félix Phérand-Deschênes / Globaia

Planetary Boundaries

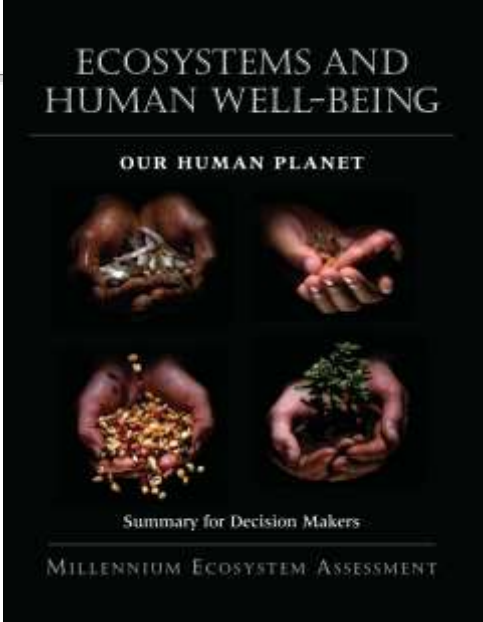
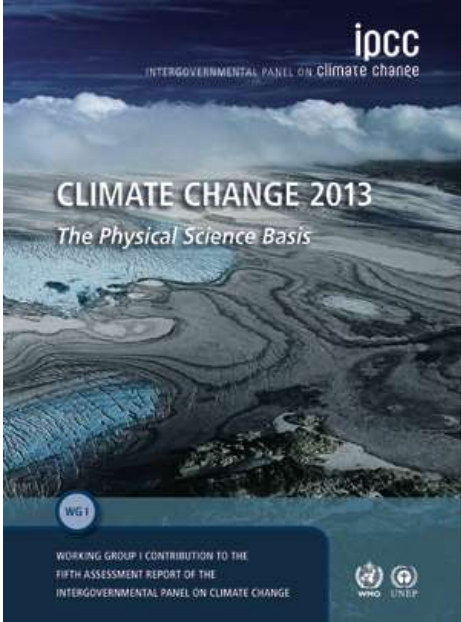
A safe operating space for humanity



- Beyond zone of uncertainty (high risk)
- In zone of uncertainty (increasing risk)
- Below boundary (safe)
- Boundary not yet quantified

Steffen et al.
2015, *Science*

Global assessments



Sustainable Development Goals



Future Earth



2013



**Earth System
Science Partnership**
2001

WCRP
World Climate Research Programme

Established
1980

**GLOBAL
IGBP
CHANGE**
International
Geosphere-Biosphere
Programme

1987



DIVERSITAS
1991



IHDP
International Human Dimensions Programme
on Global Environmental Change
1996



50,000+

Our networks reach 50,000 global sustainability researchers and people interested in this research



>20

National networks established, and many more in progress



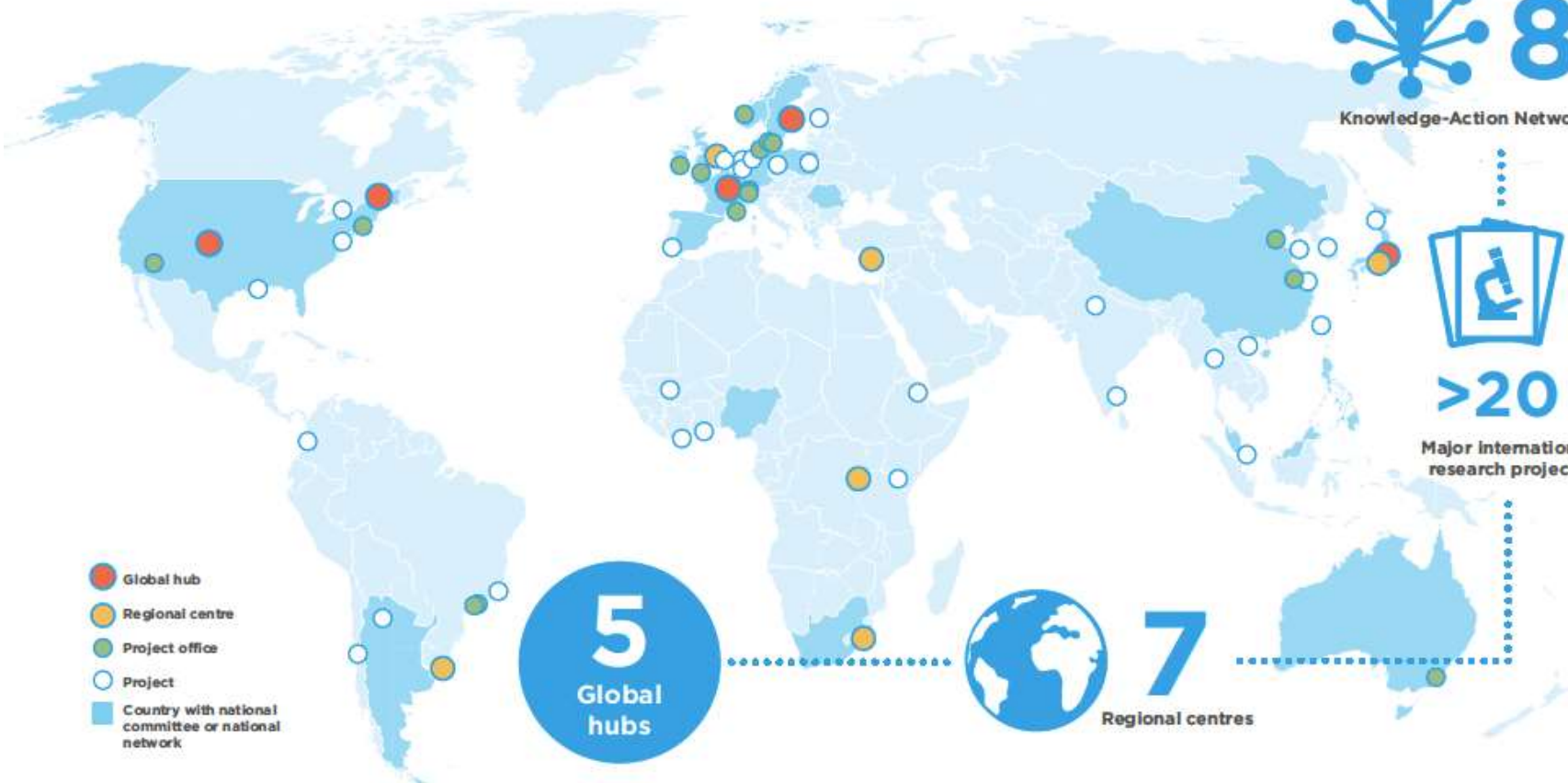
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Knowledge-Action Networks



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Major international research projects



-  Global hub
-  Regional centre
-  Project office
-  Project
-  Country with national committee or national network

5
Global hubs



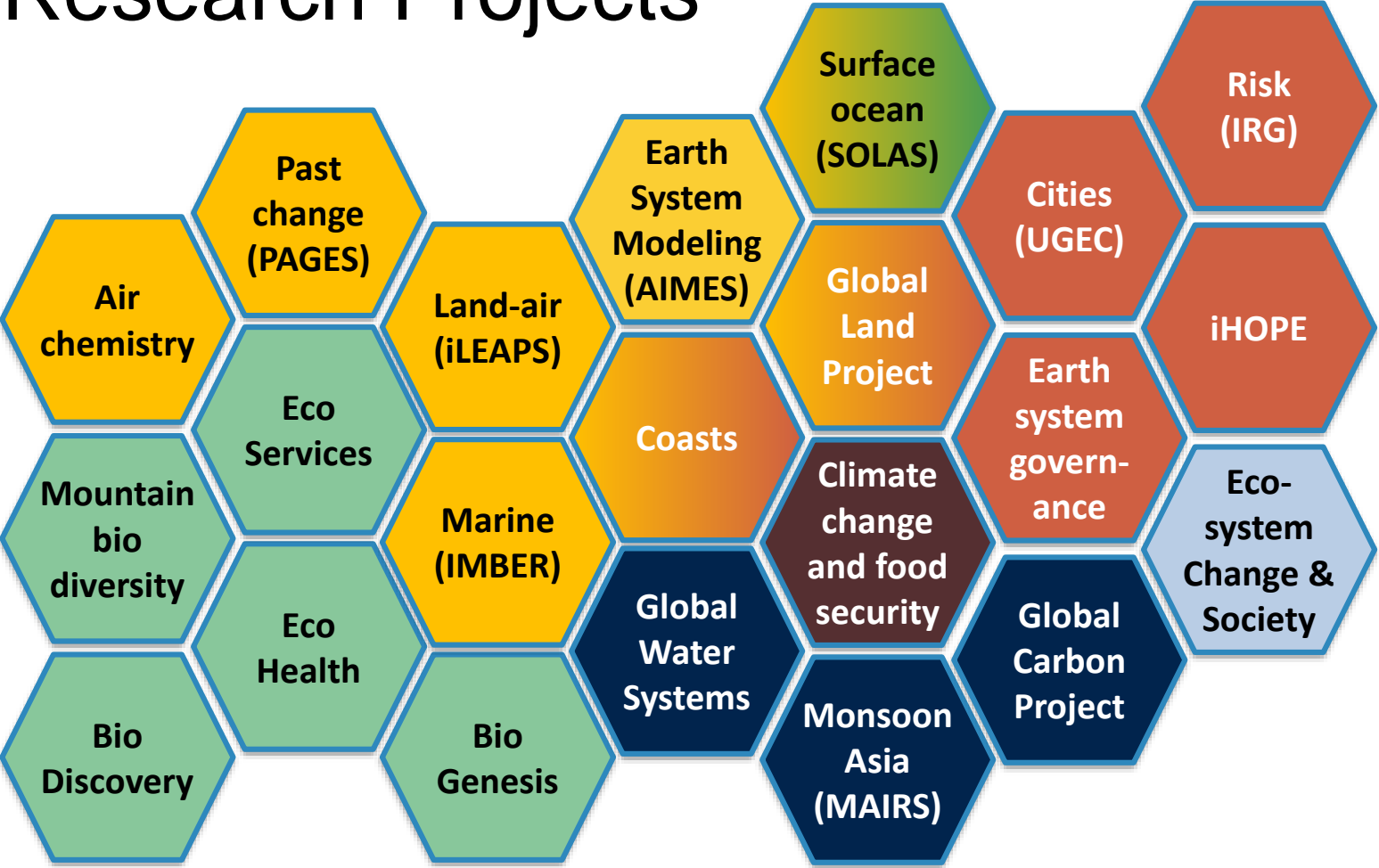
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Regional centres

Alliance creating Future Earth morphed into the Governing Council



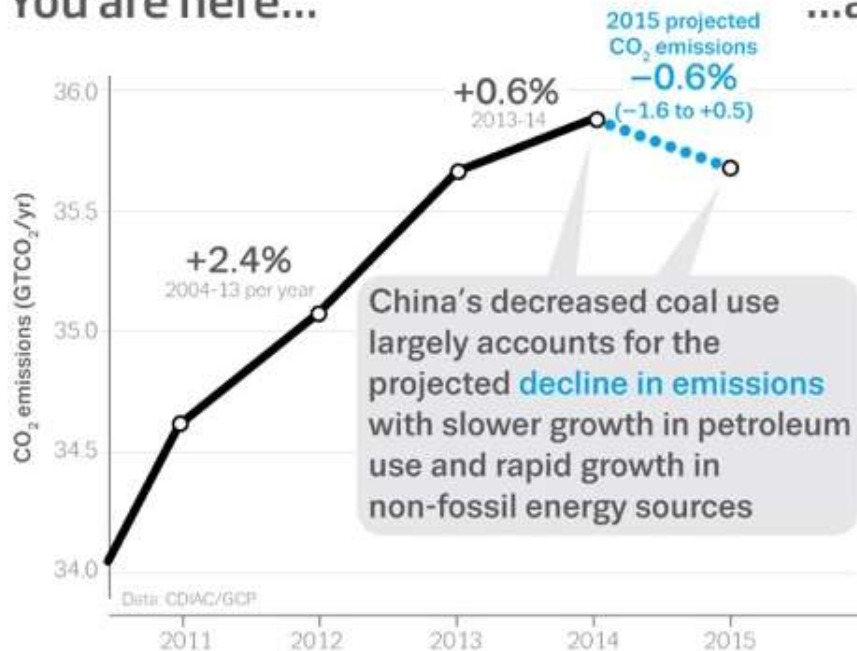
Research Projects



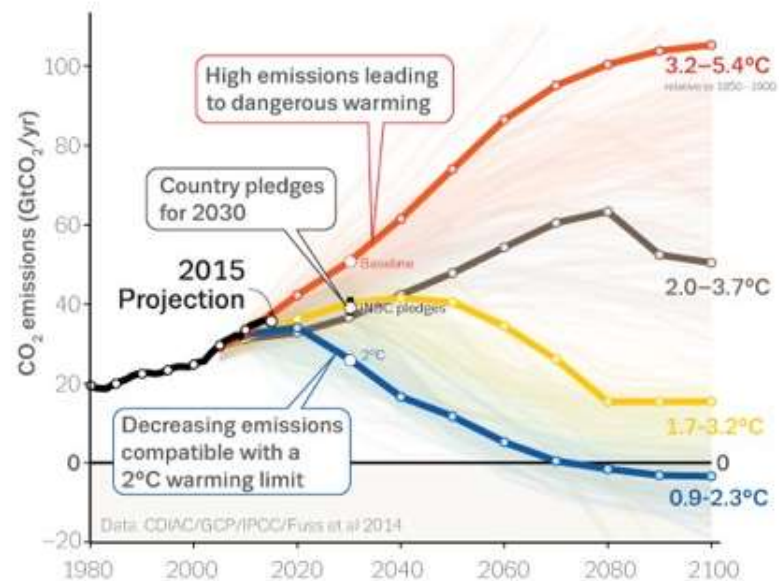
- WCRP
- IGBP
- Diversitas
- IHDP
- CGIAR
- ICSU
- ESSP

2015 Global Carbon Budget

You are here...



...a long way from near zero emissions...



Plant trait database (TRY)

LETTER

doi:10.1016/j.tree.2015.06.014

Plant functional traits have globally consistent effects on competition

Georgina Lambert^{1,2}, Daniel Johnson¹, David A. Coomes¹, Francis Hu¹, Robert M. Kouyama¹, Daniel C. Laughlin¹, Lourens Pretorius¹, Mark Venterweil¹, Chikito Velázquez^{1,2}, Erik Capoen^{1,3}, X. Huan⁴, Caroleusim¹, Sylvain Gauthier¹, Hiroaki Kamikawa^{1,2}, Yasuko Onoda¹, Joseph Petchenik^{1,2}, T. Fabian Rasse-Wagner^{1,2}, Jieping Sun¹, Gidon Shani¹, Natha Christian Wirth^{1,2,3}, Miguel A. Zavala¹, Hongsheng Zeng¹

Phenotypic traits and their associated trade-offs have been shown to have globally consistent effects on individual plant phenology functions^{1,2}, but how these effects scale up to influence competitive key drivers of community assembly in terrestrial vegetation, remained unclear^{3,4}. Here we use growth data from more than 1 million trees in over 1,800 plots across the world to show that three key functional traits—wood density, specific leaf area and maximum height—consistently influence competitive interactions that maximum growth of a species was correlated negatively with wood density in all biomes, and positively with its specific leaf area in most biomes. Low wood density was also correlated to a low ability to tolerate competition and a low competitive effect on neighbours, while high specific leaf area was correlated to a low competitive effect. Thus, traits generate trade-offs between performance with competition versus performance with competition, a fundamental ingredient in the classical hypothesis that the coexistence of plant species is enabled via differential in their resource-use strategies⁵. Competition within species is stronger than between species, but variation in trait distributions between species has little influence in weakening competition, a benefit of dissimilarity was detected for specific leaf area only, and only a weak benefit for maximum height. Our trait-based approach to modelling competition rules provides a possible avenue for the forest ecosystem of the world and their big biomes species composition.

Plant traits are considered fundamental drivers of community assembly and species diversity^{6,7}. The effects of traits on individual plant phenologies and functions are increasingly understood, and have been shown to be underpinned by well-known globally consistent trade-offs⁸. For instance, traits such as wood density and specific leaf area covary with biomass, the construction cost and specific

Key Results • Plant functional traits have globally consistent effects on competition. • Wood density, specific leaf area, and maximum height consistently influence competitive interactions. • Low wood density is correlated to a low ability to tolerate competition and a low competitive effect on neighbours. • High specific leaf area is correlated to a low competitive effect. • Traits generate trade-offs between performance with competition versus performance with competition. • A fundamental ingredient in the classical hypothesis that the coexistence of plant species is enabled via differential in their resource-use strategies. • Competition within species is stronger than between species. • Variation in trait distributions between species has little influence in weakening competition. • A benefit of dissimilarity was detected for specific leaf area only, and only a weak benefit for maximum height. • Our trait-based approach to modelling competition rules provides a possible avenue for the forest ecosystem of the world and their big biomes species composition.

NEWS & VIEWS

A trail map for trait-based stud

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ARTICLE

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The global spectrum of plant form and function

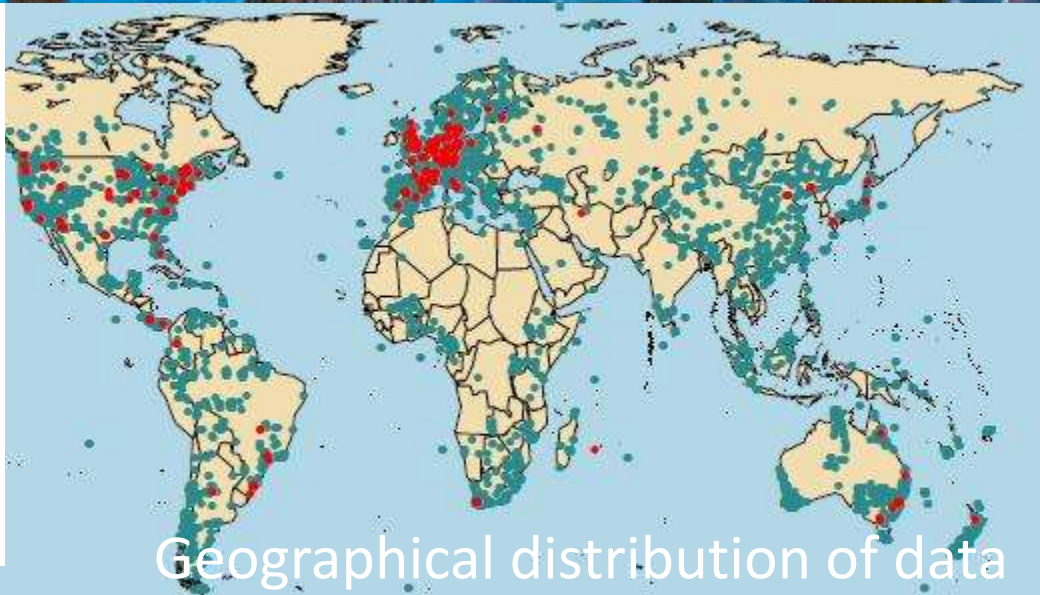
Sandra Diaz¹, Jens Kattge¹, Johannes I. C. Cornelissen¹, Jiri Wiegand¹, Sandra Lavorel¹, Stéphane Dray¹, Ryan Beer¹, Michael Köhlér¹, Christian Wirth^{1,2}, X. Huan³, Colin Prentice¹, Eric Garnier¹, André Barbault¹, Mark Westoby¹, Hendrik Poorter¹, Peter B. Reich^{1,4}, Angela Moles¹, John Drake¹, Andrew N. Gillieson¹, Amy E. Zanne¹, Steven Chazdon¹, G. Joseph Wright¹, David S. Schoener^{1,5}, Herwig Jacquet¹, Christopher Beckwith¹, Bruno Lavorel^{1,6}, Simon Pérez¹, Bill Shipley¹, Donald Ockinger¹, Fernando Casanoves¹, Julia A. Jongsomjit¹, Angela Götlicher¹, Valera Fialkowski¹, Seth Stippes¹, Miguel A. Zavala¹, Isaac J. Germino¹

Earth is home to a remarkable diversity of plant forms and life histories, yet comparatively few essential trait combinations have proved evolutionarily stable in today's terrestrial biomes. Here, by analysing worldwide variation in 16 major traits critical to growth, survival and reproduction within the largest sample of vascular plant species ever compiled, we found that occurrence of six-dimensional trait space is strongly constrained, including coordination and trade-offs. Three-quarters of trait variation is captured in a two-dimensional global spectrum of plant form and function. One major dimension within this plane reflects the size of whole plants and their parts, the other represents the leaf economic spectrum, which balances leaf construction costs against growth potential. The global plant trait spectrum provides a backbone for elucidating constraints on evolution, for functionally classifying species and ecosystems, and for improving models that predict future vegetation based on continuous variation in plant form and function.

Vascular plants are the main entry point for energy and matter into, and Earth's terrestrial ecosystems. Their diversification struggle for growth, survival and reproduction in very different areas has resulted in an extremely wide variety of form and function, both across and within habitats. In a long time, however, few have been able to predict the form and function of new plant species, and the underlying constraints on evolution are still unclear and remain controversial. Here, we use the largest sample of vascular plants ever compiled to quantify the global spectrum of plant form and function. We demonstrate that four alternative null hypotheses. We demonstrate that plant species reach a similar 'size' and 'shape' in a two-dimensional trait space. This trait space has been constrained geographically or taxonomically, and are not correlated to the global quantitative picture of essential traits. We therefore show which sections of the plane are occupied, and how diversity by different growth forms and plant economic groups. The design opportunities and limits indicated by shape and biomass of the functional plane of plant form and function provide a backbone to achieve a better understanding of the evolutionary trajectory from early plant form and function to today's plant form and function.

Key Results • Vascular plants are the main entry point for energy and matter into, and Earth's terrestrial ecosystems. • Their diversification struggle for growth, survival and reproduction in very different areas has resulted in an extremely wide variety of form and function, both across and within habitats. • In a long time, however, few have been able to predict the form and function of new plant species, and the underlying constraints on evolution are still unclear and remain controversial. • Here, we use the largest sample of vascular plants ever compiled to quantify the global spectrum of plant form and function. • We demonstrate that four alternative null hypotheses. • We demonstrate that plant species reach a similar 'size' and 'shape' in a two-dimensional trait space. • This trait space has been constrained geographically or taxonomically, and are not correlated to the global quantitative picture of essential traits. • We therefore show which sections of the plane are occupied, and how diversity by different growth forms and plant economic groups. • The design opportunities and limits indicated by shape and biomass of the functional plane of plant form and function provide a backbone to achieve a better understanding of the evolutionary trajectory from early plant form and function to today's plant form and function.

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Geographical distribution of data

Diaz et al Nature (2015)
Levine Nature (2015)
Kunstler et al Nature (2015)



8 Focal Challenges to society



Deliver water, energy, and food for all



Decarbonize socio-economic systems to stabilize the climate



Safeguard the terrestrial, freshwater and marine natural assets



Build healthy, resilient and productive cities



Promote sustainable rural futures to feed rising and more affluent populations



Improve human health through the improvement of human-environment interactions



Encourage sustainable and equitable consumption and production patterns



Increase social resilience to future threats

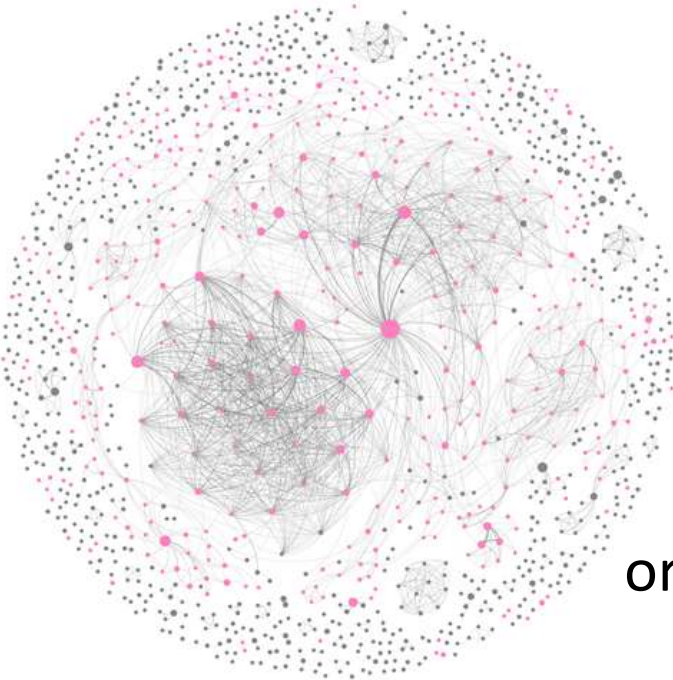
Knowledge Action Networks



Sources:
Photo: Fishing in the Mekong © Tan Someth Bunwath / WWF-
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