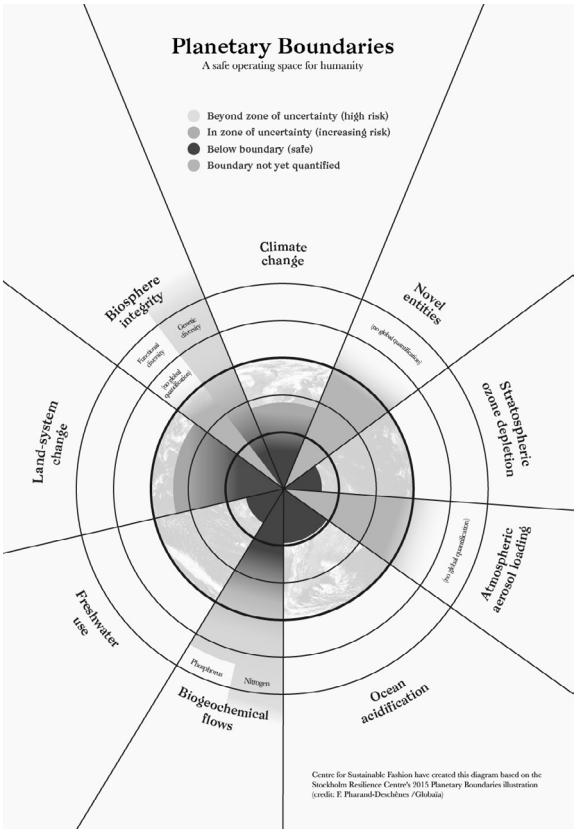
Not everything here on Earth is endless, we live on a finite planet, yet around us we can see that things are growing and accelerating. Are there limits to how fast or how much we can produce and throw away? Are we already pushing into uncertain territory? The Planetary Boundaries[1] framework is one way a fashion professional could seek an overview of the Earth System, its boundaries, and which have already been exceeded.

The fashion industry is affected by Earth systems, and affects them also, in a multitude of ways - for example through the use of natural materials or the pollution produced by industry. The impacts of even a single product are likely to be many and far-reaching, especially as supply chains are often complex and international in the fashion industry. Assessing these impacts may be difficult, and even knowing where to start may be a challenge as there is a wealth of publications, from books to websites to podcasts to scientific articles and so on, discussing aspects of sustainability.

There are initiatives which bring together scientific literature, for example in the area of climate change, the Intergovernmental Panel on Climate Change (IPCC) brings together work of many scientists and publishes regular assessments of climate change. The IPCC has reported that "warming of the climate system is unequivocal"[2] and "human influence on the climate system is clear."[3] Climate change and associated impacts such as reducing Arctic sea ice extent are relatively well-known, so what are the other processes within the Earth System that a fashion professional may be interested in looking at, when considering anthropogenic activities and sustainability?

The idea of Planetary Boundaries was conceived in 2009, when 28 scientists led by Will Steffen of Australian National University and Johan Rockström of the Stockholm Resilience Center came together to investigate, using science-based analysis, which environmental processes regulate the stability of the Earth system, and what their boundary positions might be.[4] Within the boundary positions lies the "safe operating space" for humanity. We are living in the Holocene geological epoch, which has proven accommodating for humans and supported development of our societies; perturbing the Earth System outside these conditions could cause a shift outside the stable Holocene environmental state.[5] This has prompted talk of the Anthropocene, a new era brought by on since the Industrial Revolution.



Nine Planetary Boundaries are included:

- Stratospheric ozone depletion
- Biosphere integrity
- Introduction of novel entities
- Climate change
- Ocean acidification
- Freshwater use
- Land system change
- Biogeochemical flows
- Atmospheric aerosol loading

[1] *Stockholm Resilience Centre, Planetary Boundaries Research. Available at:* stockholmresilience.org/research/planetary-boundaries.html *(Accessed January 3rd 2017)*

[2] *Intergovernmental Panel on Climate Change (IPCC) (2014), Climate Change 2014 Synthesis Report Summary for Policymakers. Available at:* ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf *(Accessed December 15th 2017)*

[3] *Intergovernmental Panel on Climate Change (IPCC) (2014), Climate Change 2014 Synthesis Report Summary for Policymakers. Available at:* ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf *(Accessed December 15th 2017)*

[4] *Rockström, J., W. Steffen, K. Noone, Å. Persson, F. S. Chapin, III, E. Lambin, T. M. Lenton, M. Scheffer, C. Folke, H. Schellnhuber, B. Nykvist, C. A. De Wit, T. Hughes, S. van der Leeuw, H. Rodhe, S. Sörlin, P. K. Snyder, R. Costanza, U. Svedin, M. Falkenmark, L. Karlberg, R. W. Corell, V. J. Fabry, J. Hansen, B. Walker, D. Liverman, K. Richardson, P. Crutzen, and J. Foley. 2009. Planetary boundaries:exploring the safe operating space for humanity. Ecology and Society 14(2): 32. [online] URL:* ecologyandsociety.org/vol14/iss2/art32/

[5] *Steffen et al. 2015. Planetary Boundaries: Guiding human development on a changing planet. Science Vol. 347 no. 6223*

Two of these, climate change and biosphere integrity, have been designated "core" planetary boundaries due to their fundamental importance. Four of the boundary levels - climate change, biosphere integrity, land system change, biogeochemical flows - have been exceeded.[6] Functional diversity (within the biosphere integrity boundary), novel entities, and atmospheric aerosol loading have not had Planetary Boundaries identified yet, but are included due to their importance in looking at anthropogenic perturbations to the Earth System.

The boundaries are set by determining values of a set of control variables for the processes, for example, atmospheric CO_2 concentration and energy imbalance at the top of the atmosphere, for climate change. The boundaries are set at "safe" distances from dangerous levels or global thresholds.[7]

As shown in the graphic, the control variable values are in or beyond the zone of uncertainty for many of the Planetary Boundaries. For some processes global-level boundaries have not been quantified yet. For three processes, the control variables are within the boundaries.

The graphic provides a snapshot of the processes included in the Planetary Boundaries framework and the control variable values compared to the boundary positions. It also shows that there are key processes for which the authors are unable to determine whether we are outside the safe operating space. This snapshot will give you an idea of what processes regulate the stability of the Earth System, from an environmental perspective, and where we are with respect to the safe operating space for humanity.

There are nuances and full explanations about Planetary Boundaries which cannot be included in this factsheet; for a full understanding of the concept, methodology and results (and consideration of global vs regional scales) please refer to the peer-reviewed publications. There is also a Planetary Boundaries for Business article.[8]

The Planetary Boundaries framework was first published in 2009 in Ecology and Society[9] and Nature[10] journals, and an update was published in 2015 in Science.[11] Some information published online or in the media may not have been reviewed by an expert at all, so it may have no independent verification.

The Planetary Boundaries framework is not complete in that not all processes have control variable values to compare to boundary positions, and will evolve as new scientific investigations bring to light new processes, control variables and quantifications. It does not tell policymakers what laws or guidelines to put in place. It does not consider non-environmental areas of sustainability such inequality.

As a fashion professional, your work likely touches upon many of the processes in the Planetary Boundaries framework. Think about whether the framework has illuminated processes you weren't aware of before. Consider the manufacturing and transport in your supply chains, the end of life of your products, the way you deliver services, your office-based operations. Which Planetary Boundaries processes do you influence? During your career, what improvements would you like to make to your environmental impacts and what effect could that have?

Further reading

stockholmresilience.org/research/planetary-boundaries.html

stockholmresilience.org/download/18.6d8f5d4d14b32b2493577/1459560273797/SOS%20for%20Business%202015.pdf

nature.com/news/we-must-set-planetary-boundaries-wisely-1.10694

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[6] Steffen et al. 2015. Planetary Boundaries: Guiding human development on a changing planet. Science Vol. 347 no. 6223

[7] Thresholds have a specific meaning in this framework, see Rockström et al. 2009

[8] http://stockholmresilience.org/download/18.6d8f5d4d14b32b2493577/1459560273797/SOS%20for%20Business%202015.pdf

[9] Rockström, J., W. Steffen, K. Noone, Å. Persson, F. S. Chapin, III, E. Lambin, T. M. Lenton, M. Scheffer, C. Folke, H. Schellnhuber, B. Nykvist, C. A. De Wit, T. Hughes, S. van der Leeuw, H. Rodhe, S. Sörlin, P. K. Snyder, R. Costanza, U. Svedin, M. Falkenmark, L. Karlberg, R. W. Corell, V. J. Fabry, J. Hansen, B. Walker, D. Liverman, K. Richardson, P. Crutzen, and J. Foley. 2009. Planetary boundaries:exploring the safe operating space for humanity. Ecology and Society 14(2): 32. [online] URL: ecologyandsociety.org/vol14/iss2/art32/

[10] Johan Rockström, Will Steffen, Kevin Noone, Åsa Persson, F. Stuart Chapin III, Eric F. Lambin, Timothy M. Lenton, Marten Scheffer, Carl Folke, Hans Joachim Schellnhuber, Björn Nykvist, Cynthia A. de Wit, Terry Hughes, Sander van der Leeuw, Henning Rodhe, Sverker Sörlin, Peter K. Snyder, Robert Costanza, Uno Svedin, Malin Falkenmark, Louise Karlberg, Robert W. Corell, Victoria J. Fabry, James Hansen, Brian Walker, Diana Liverman, Katherine Richardson, Paul Crutzen & Jonathan A. Foley, A safe operating space for humanity, Nature 461, 472–475 (24 September 2009)

[11] Steffen et al., Planetary boundaries: Guiding human development on a changing planet, Science 13 Feb 2015, Vol. 347, Issue 6223