Auteurs :
- Julie Cornet,animator and trainer, Compagnie du Code
- Anne-Cécile Orgerie, research fellow, CNRS à l'IRISA
- Martine Olivi, research fellow, Inria

Activity 02.2 : Quel lien peut-on faire entre performance environnementale et usage ?

As we have seen, the digital energy footprint is growing by about 6% per year, which is equivalent to a doubling every 12 years. How is this footprint distributed between countries, given that there are currently around 5 billion people connected to the Internet on earth (source: site www.internetlivestats.com, consulted on 15/12/2021), i.e. more than half the world's population? This is what we will see in the next activity.

Capsule slide	Related text
Environmental performance and use of the Internet : any thoughts ? In this sequence, we will analyse the global situation using two indicators: the ecological footprint and the percentage of Internet users among the population. Previously, we have been focused on the evolution of the quantities over time. Now we will look at their geographical distribution at a specific moment. We will see how we can visualize and compare these two indicators on the same graph and we will see what conclusions we can draw.	**Environmental performance and use of the Internet : any thoughts ?** In this sequence, we will analyse the global situation using two indicators: **the ecological footprint *** and **the percentage of Internet users among the population.** Previously, we have been focused on the evolution of the quantities over time. Now we will look at their geographical distribution at a specific moment. We will see how we can visualise and compare these two indicators on the same graph and we will see what conclusions we can draw. * **The ecological footprint** is an indicator that measures human demand on natural capital.More specifically, it estimates the land and sea area, as well as the amount of water needed to provide for/to meet the needs of a person,

Capsule slide	Related text
	a city or a country consumes and to absorb the wastes it generates. The Ecological Footprint is expressed in global hectares (gha), i.e. hectares with productivity equal to the average productivity. Sources: Ecological footprint, Wikipedia Empreinte écologique, GreenWashing Economy
Context of the activity **Let's use a representation and statistical analysis tool** The following plot will give you an opportunity to compare some countries according to two parameters: • **on the x-axis:** the percentage of Internet users • **on the y-axis:** the ecological footprint per person. The ecological footprint per person is computed as the global ecological footprint of a nation [1] divided by its total population. Match the name of each country with the dots indicating its position on the plot. [1] the biological productive surface needed to sustain itself, measured in global hectares (gha).	**Let's use a representation and statistical analysis tool** The following plot will give you an opportunity to compare some countries according to two parameters: • **on the x-axis:** the percentage of Internet users • **on the y-axis:** the ecological footprint per person. The ecological footprint per person is computed as the global **ecological footprint** of a nation [1] divided by its total population. Match the name of each country with the dots indicating its position on the plot. [1] the biological productive surface needed to sustain itself, measured in global hectares (gha).

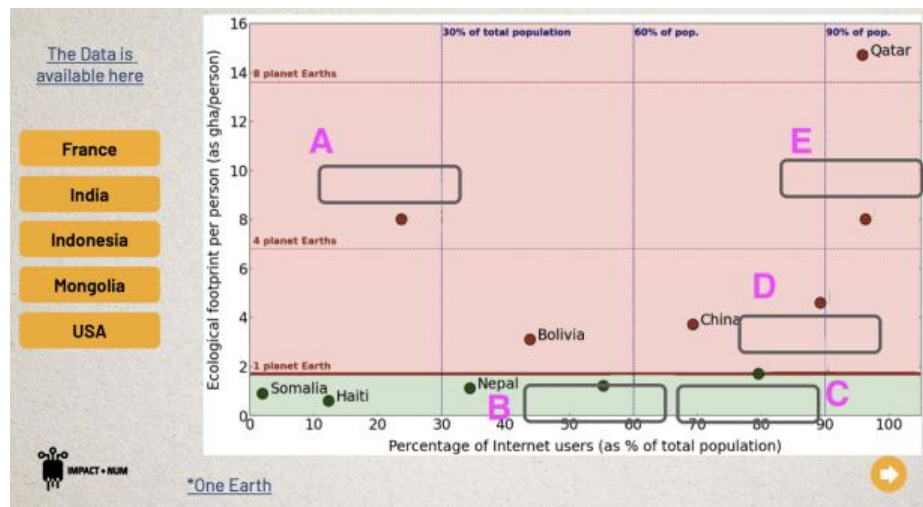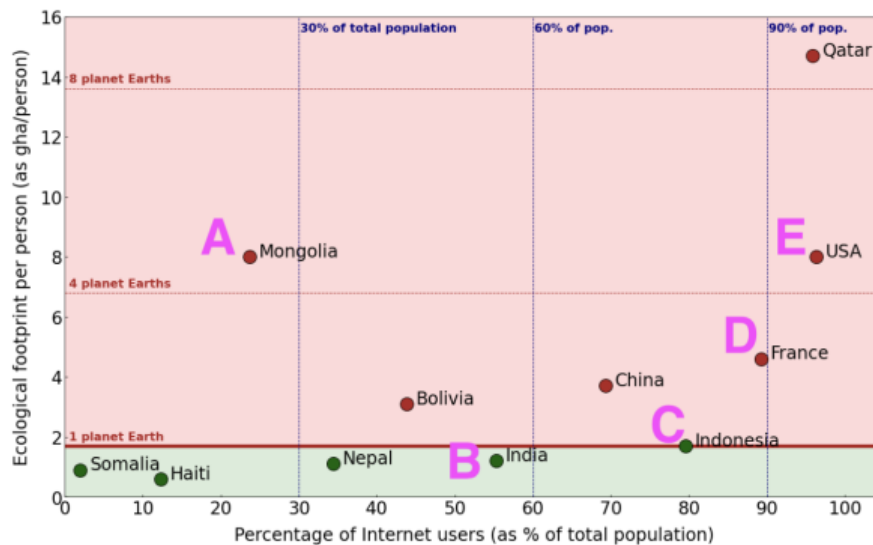| Capsule slide	Related text
Before starting the activity, check the data below: • percentage of Internet users by country, • ecological footprint : click on "ECOLOGICAL FOOTPRINT PER PERSON" and then on a country to see the data at the bottom of the page. Then position the countries in the graph The box with the country turns green once it is correctly placed!	**Information** Before starting the activity, check the data below: • **percentage of Internet users by country,** • **ecological footprint:** click on "ECOLOGICAL FOOTPRINT PER PERSON" and then on a country to see the data at the bottom of the page. **Then position the countries in the graph.** **The box with the country turns green once it is correctly placed!**
	To complete the graph, see the data for the corresponding countries below: **(France, India, Indonesia, Mongolia, USA)** A B C D E *** One Earth** *When clicking on "One Earth"* **The biocapacity** of a bioproductive area refers to its capacity to produce a continuous supply of renewable resources and to absorb the waste resulting from their consumption. Biocapacity is measured in global hectares (hag) as the ecological footprint.

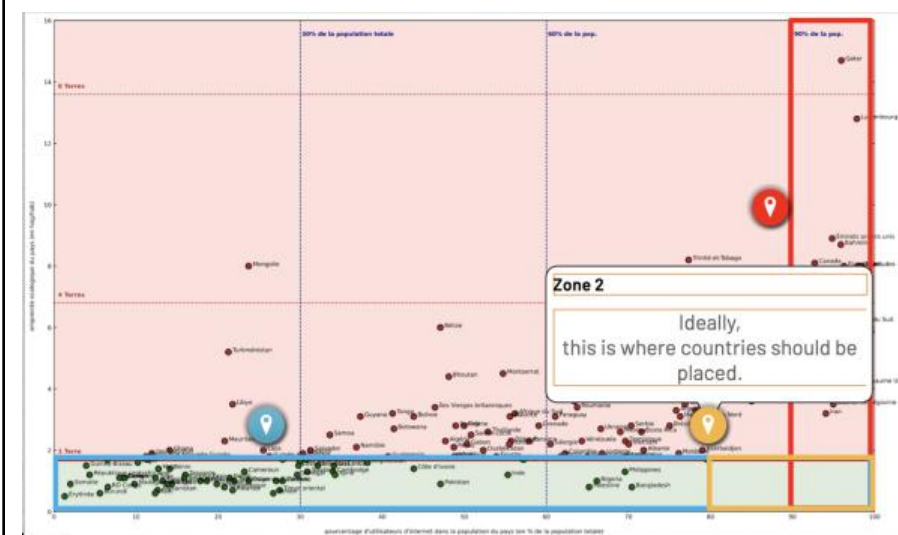| Capsule slide	Related text
	If we divide the earth's biocapacity by the number of inhabitants, we get the biocapacity per person, which is currently 1.7 hag. In other words, the earth can only provide 1.7 global hectares per person. This allows us to assess the "**amount of Earth**" needed by a person, according to his or her ecological footprint. For example, if his footprint is 3.4 hag, then he consumes twice his "Earth budget", so he is living on credit. Source : L'empreinte écologique, wwf
	A – Mongolie **B – Inde** **C – Indonésie** **D – France** **E – USA**

| Capsule slide	Related text
We hope now that this kind of plot has no secrets for you now! With few countries, we can already see that countries with the biggest percentage of Internet users have a very high ecological footprint, while the countries with a very low ecological footprint are poorly connected to the Internet. But what we would like is for all countries to be well connected (90%) with an ecological footprint smaller than one earth. Let's see what happens when we display all of the countries.	**We hope now that this kind of plot has no secrets for you now!** With few countries, we can already see that countries with the biggest percentage of Internet users have a very high ecological footprint, while the countries with a very low ecological footprint are poorly connected to the Internet. But what we would like is for all countries to be well connected (90%) with an ecological footprint smaller than one earth. Let's see what happens when we display all of the countries.
Click on the icons for more information on the ecological footprint and its links to internet use.	The graph identifies three particularly interesting areas on the ecological footprint and its links with internet use.
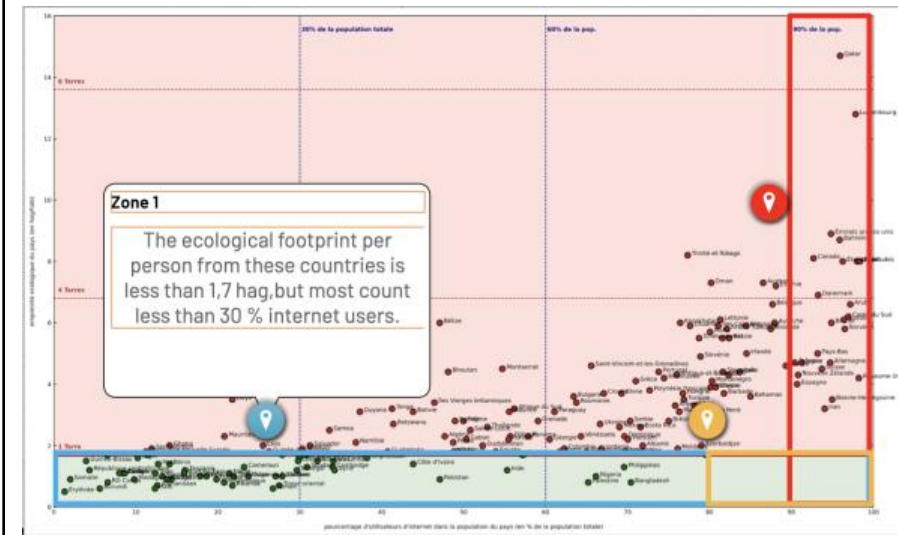
Capsule slide	Related text
	Zone 1 (rectangle at bottom of graph: ecological footprint < 1.7 hag → < 1 earth): The ecological footprint per person from these countries is less than 1,7 hag, but most count less than 30 % internet users.
	Zone 2 (bottom right of the plot, the intersection of Zone 1 and Zone 3): Ideally this is where countries should be placed.

| --- | --- |
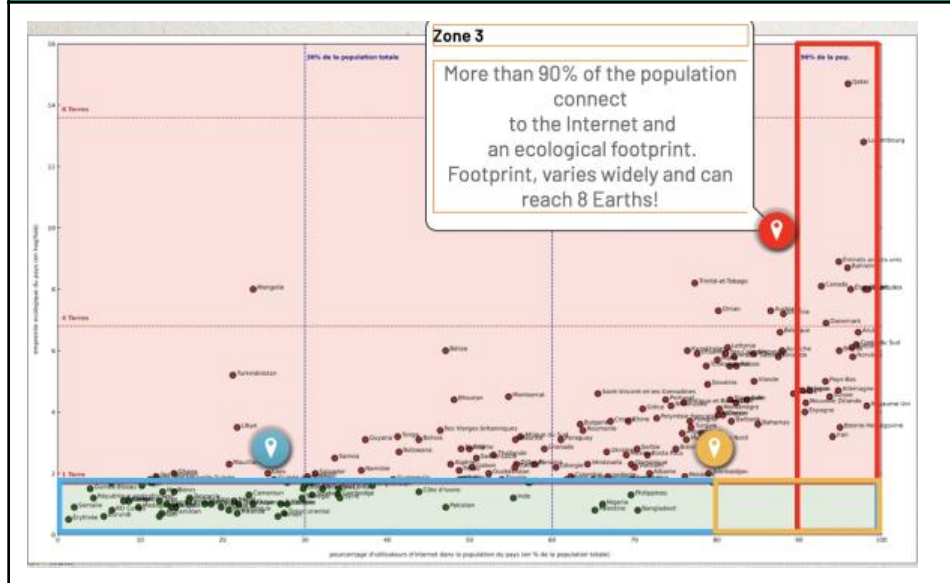
Zone 3 (rectangle on the right of the graph: % of internet users > 90%):

More than 90% internet connections and a highly variable ecological footprint, which can reach 8 Earths!

Capsule slide	Related text
	Conclusion **The resulting distribution of countries is typical.** A similar plot is obtained if we choose the HDI (Human Development Index) as an indicator instead of the percentage of internet users. As Gaël Giraud [1] points out, no country is in the target zone, the magic square at the bottom right. The most developed countries must learn how to reduce their ecological footprint, while those with a reasonable footprint must learn how to develop without increasing it. There is much debate about the relevance of the indicators used to measure human development, of which technology is a part, and the impact of humans on nature. Even imperfects, those available highlight the scale of inequalities in the world. Source : [1] Conférence STEEP de Gael Giraud (22'), 2019 [accessed on: 16/12/2021]

If you wish to go deeper into certain concepts

The Digital technology: concepts and definitions to make it more ecological introduces the concepts of efficiency vs. sobriety, digital sobriety, low-tech for a responsible or eco-responsible digital.

The «Digital ecology» – how computer science and digital technology can accompany an ecological transition helps to understand how IT and digital technology can support the ecological transition.

The Calculation and estimates of the positive impacts of digital technology for the transition attempts to shed light on these issues and to weigh the possibility of a "net balance" between direct negative environmental impacts and indirect positive impacts.

For those of you who know how to code in Python, we have provided the code that displayed the graph so that you can modify it. Follow the 2nd activity of the sequence: Your turn to code! ➡

Conclusion

Indicators are important for designing and evaluating policies to ensure the sustainable development of societies, but they are imperfect and reductive [1]. Correlations are often sought, such as GHG emissions and GDP, or well-being and GDP. But it is important to remember that there are spurious correlations [2]. Here, numerical tools are indispensable, but they must be used with rigour and transparency [3]. Research must be reproducible and peer-reviewed.

At our level, it is important to train ourselves to think critically and to build our opinions on well-founded facts. This is essential to contribute positively to democratic debates and to the choices of society.

[1] Joseph E. Stiglitz, Amartya Sen, Jean-Paul Fitoussi. Report of the Commission on the Measurement of Economic Performance and Social Progress [online], 2009 [accessed on 15/12/2021]
[2] To get a Nobel Prize, eat chocolate! 2020. journal-decoder.fr. [accessed 15/12/2021]
[3] David Louapre © Amazing Science. How to read a scientific study. 30/04/2019. [accessed 15/12/2021]

📝 Bonus activity: Your turn to code

The graph from the previous activity ("link between environmental performance and Internet use") was developed in Python. For those who know how to code in this language, we provide below the Jupyter notebook which contains the code that displayed the graph (a document that contains text and executable Python code). You can for example :

- Modify the values for a country,
- Add countries,
- build a similar graph with other indicators (some sources with different indicators are proposed under the notebook),
- ...

Warning

- If the Jupyterlite tool that displays the notebook does not work, you can try using a different browser like Firefox or Chrome (recent version).
- Otherwise, here is the link to the Jupyter notebook repository on github :
  https://github.com/inrialearninglab/NotebookImpactNum.

For inspiration, here are some sources with different indicators you can use:

- **GDB :** List of countries by GDP (PPP) per capita — Wikipédia (2021)

- **Happiness :** World Happiness Report (2019)

- **IDH : Human Development Index —** Wikipédia

- **List of countries by smartphone penetration** — Wikipédia

- **The ecological footprint and biocapacity**

Credits :

Authors : • Julie Cornet, animator and trainer, Compagnie du Code • Anne-Cécile Orgerie, research fellow, CNRS à l'IRISA • Martine Olivi, research fellow, Inria	A co-production of Class'Code / Inria
Pedagogical team : • Laurence Farhi, Tatiana Khomenko, Inria Learning Lab • Sophie de Quatrebarbes, S24B for Class'Code	With the support of the Minister of National Education, Youth and Sport and UNIT. UNIT MINISTÈRE DE L'ÉDUCATION NATIONALE, DE LA JEUNESSE ET DES SPORTS Liberté Égalité Fraternité
Graphismes : • Illustrations : Mikaël Cixous, 4 minutes 34 • Photographies of Guillaume Clémencin : Nicolas Ledu	
This resource was produced as part of the Mooc Environmental impacts of digital technologies under licence CC BY 4.0 FR 2021 www.fun-mooc.fr	