

Εθνικό Μετσόβιο Πολυτεχνείο
Σχολή Πολιτικών Μηχανικών

Ο ρόλος του πλέγματος νερού-ενέργειας και τροφίμων στην κοινωνική ευημερία

Γ.-Φοίβος Σαργέντης

<https://youtu.be/NnmsSdFKv-4>

Ιούλιος 2023



Artificial intelligence & 3D printing. Ο ρόλος του μηχανικού
Κλιματική αλλαγή
Μεταβαλλόμενα τοπία (πυρκαγιές, μεταβολές χλωρίδας)
Τοπίο και έργα υποδομής
Ο ρόλος του πλέγματος νερού-ενέργειας-τροφίμων

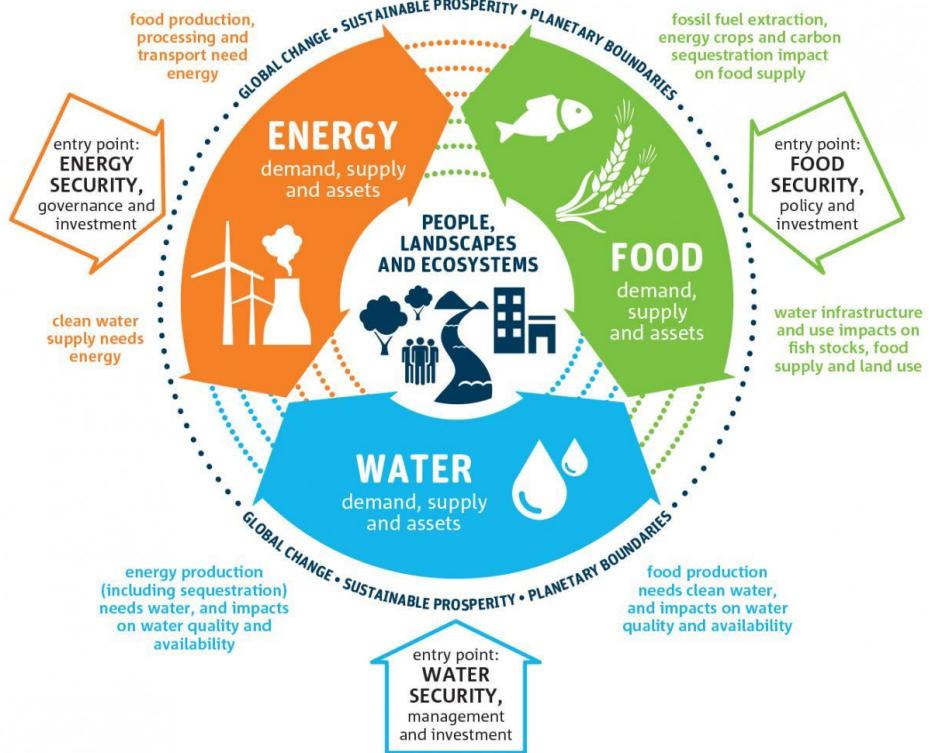
campingmovies

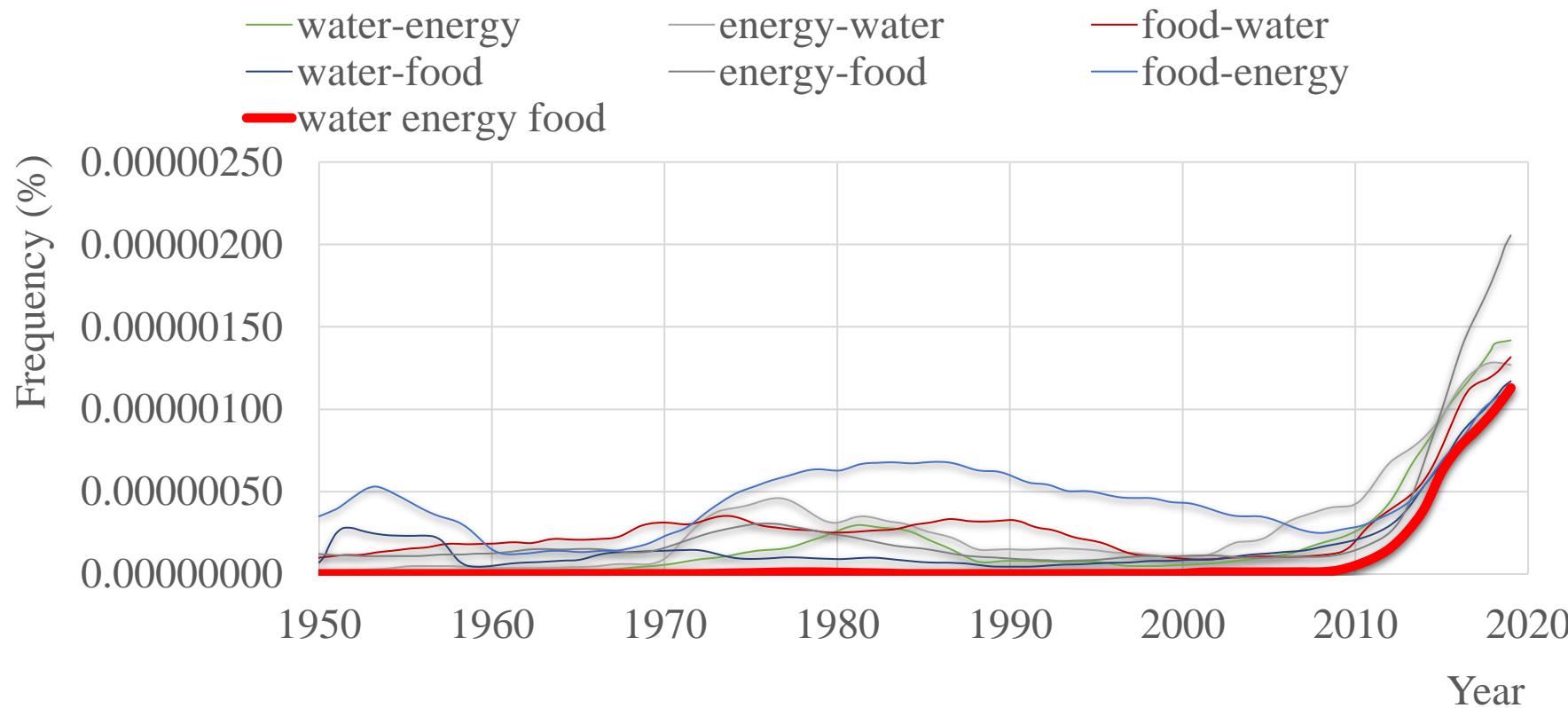
Βόρεια Εύβοια, κάμπινγκ Ροβιές
Κόστος διανυκτέρευσης 5 €/ημέρα

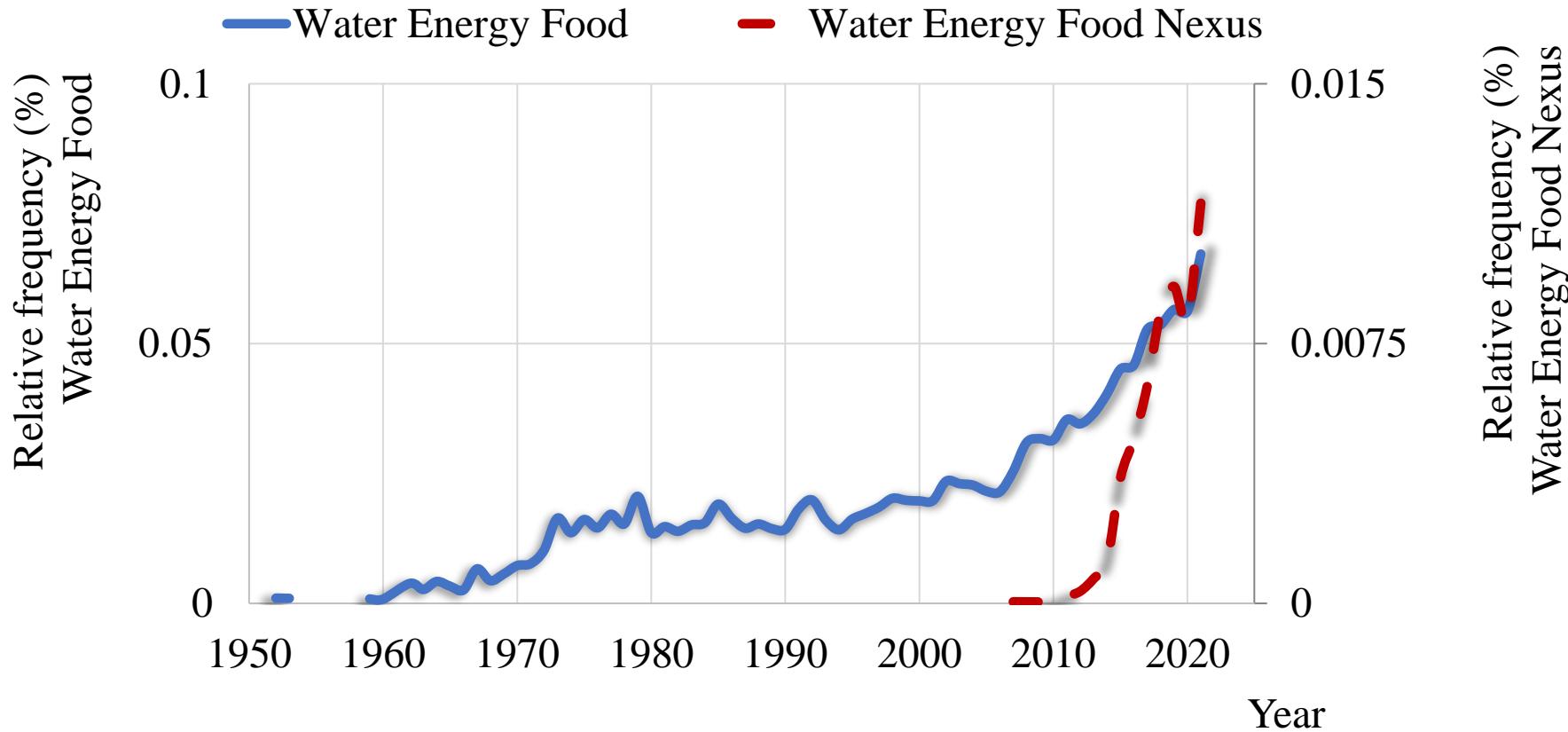
Δηλώσεις συμμετοχής
email: fivos@itia.ntua.gr
Προθεσμία υποβολής δηλώσεων: 31.5.2023 (Θέσεις περιορισμένες)

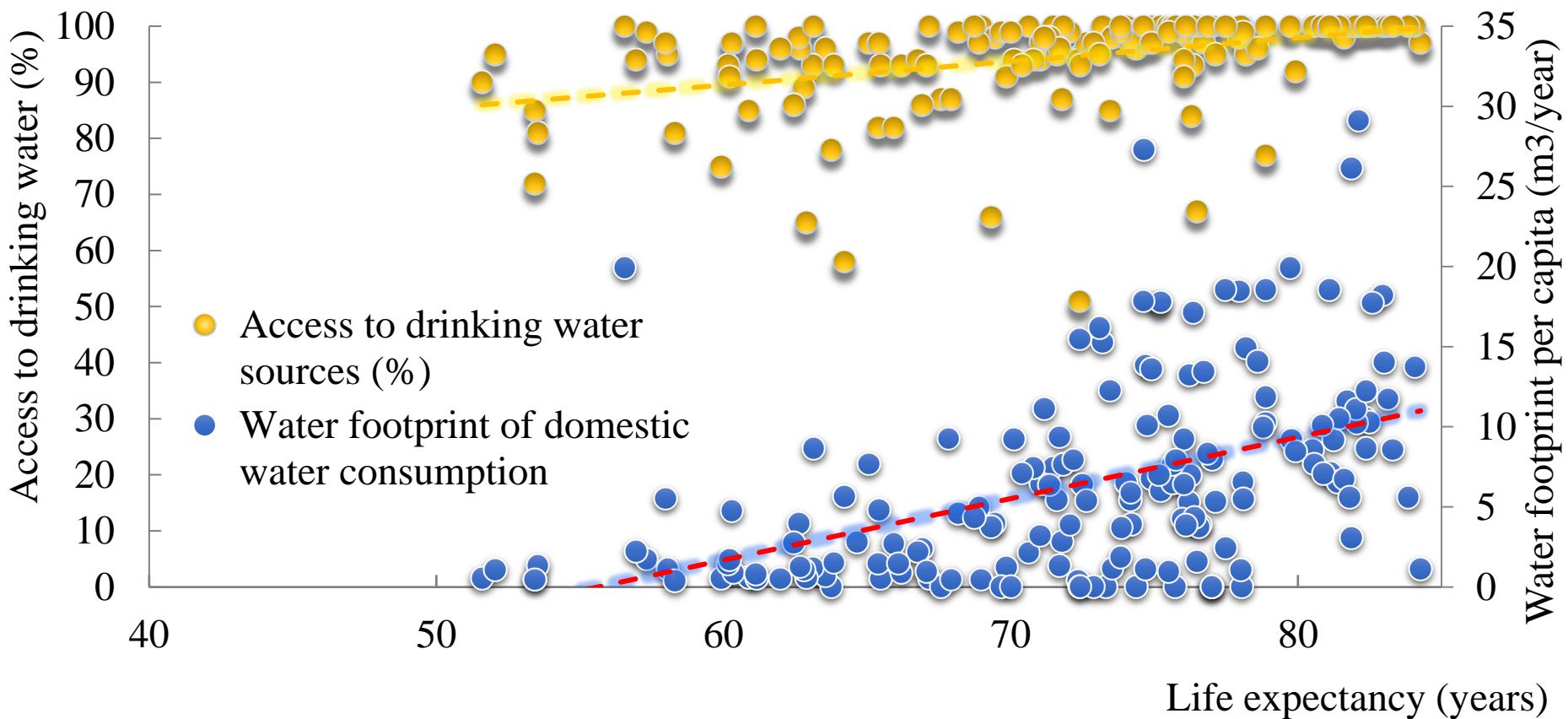


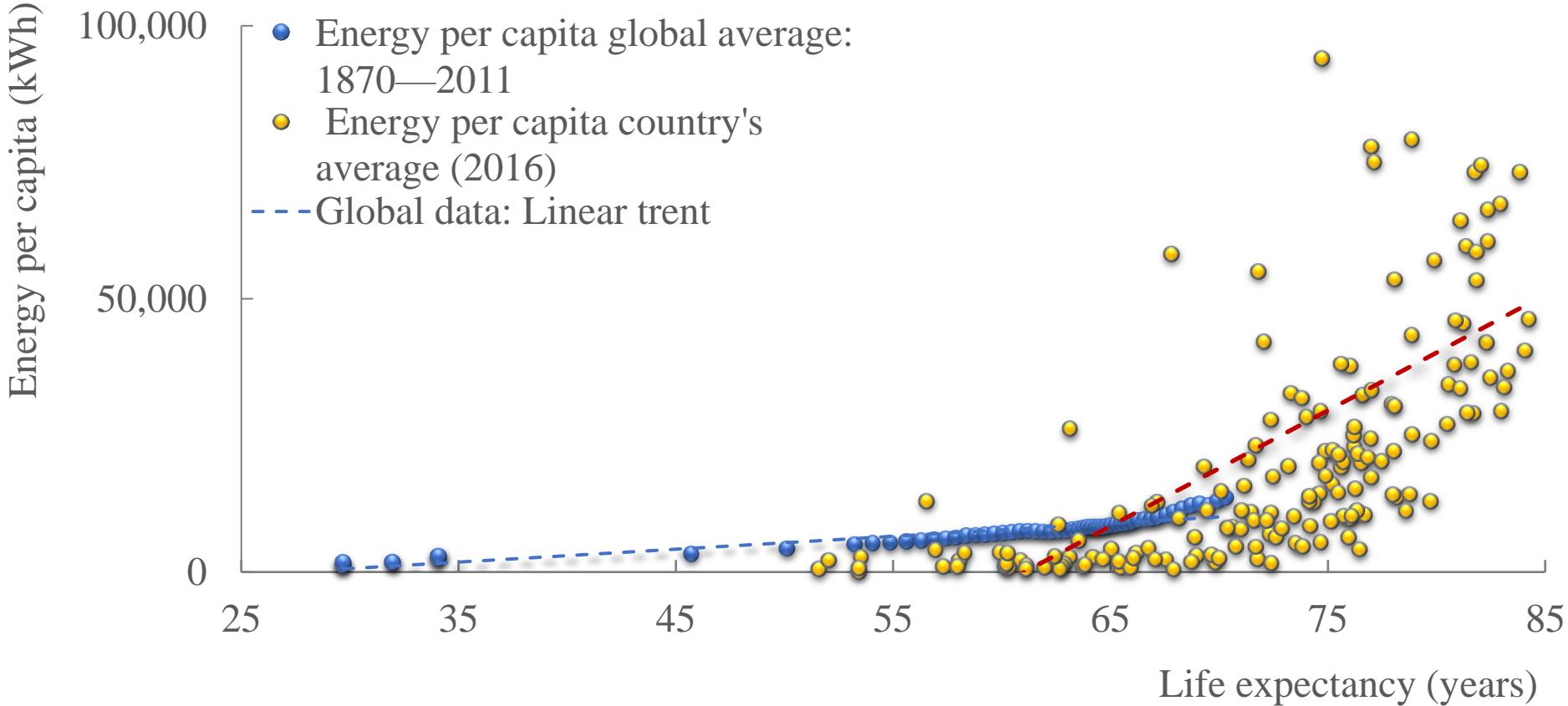
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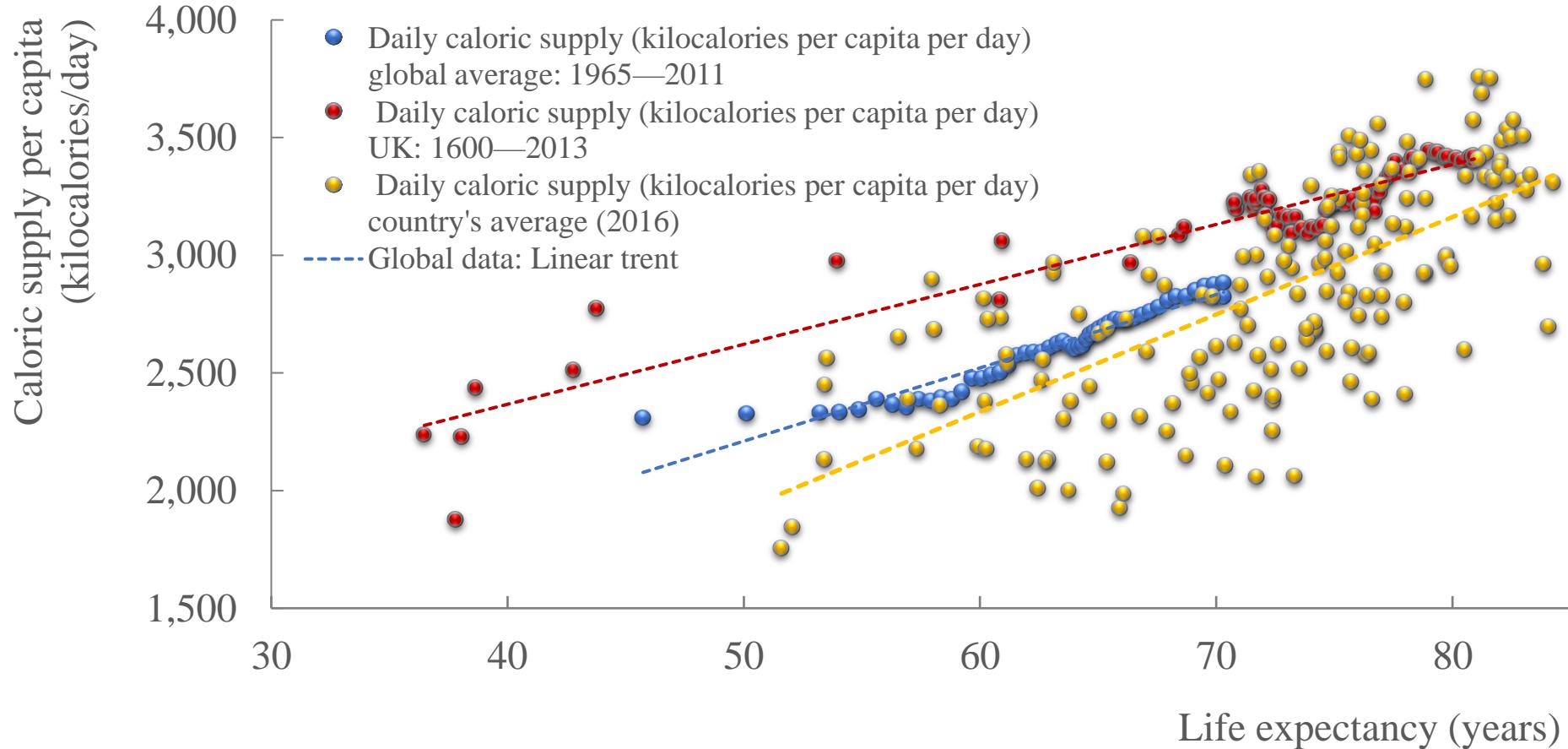


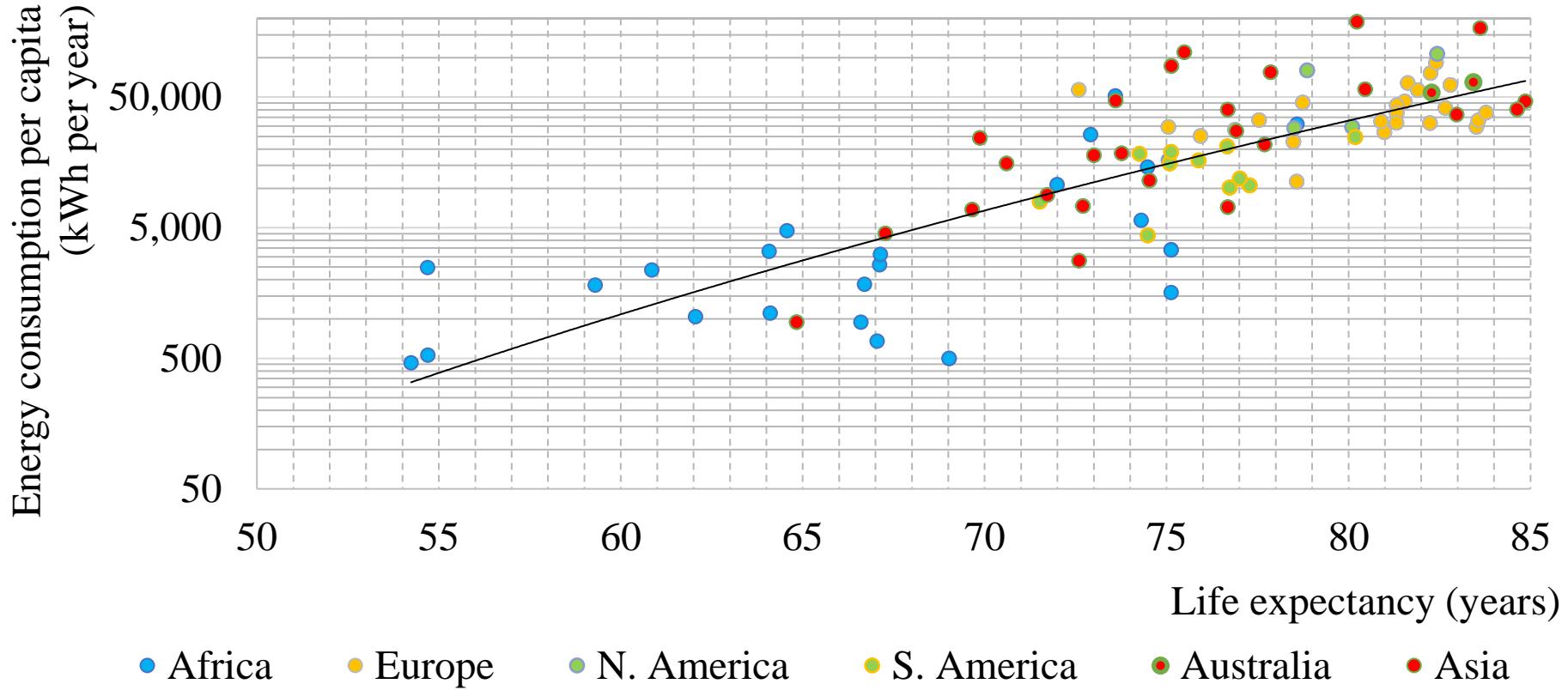


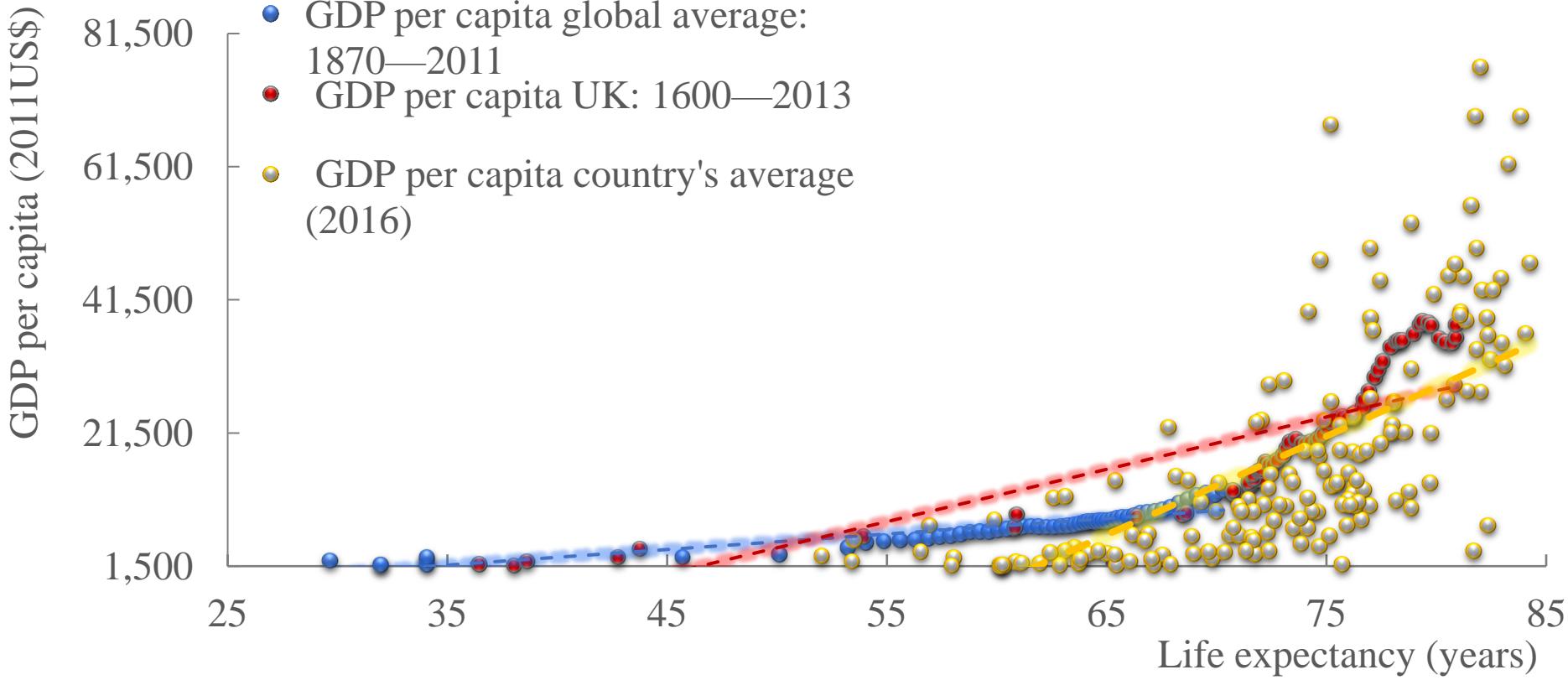








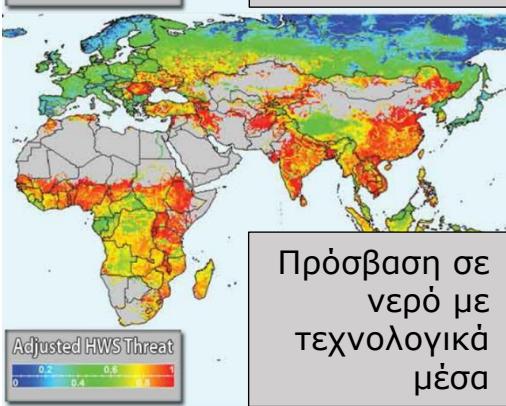
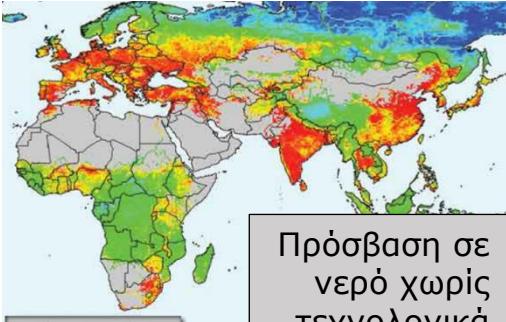




Ο ρόλος του νερού στην κοινωνική ευημερία

<https://youtu.be/F9WZxEUgVQg>

Νερό και υποδομές



10000 π.Χ.



3000 π.Χ.



Έτος 1



476 μ.Χ



1492 μ.Χ.

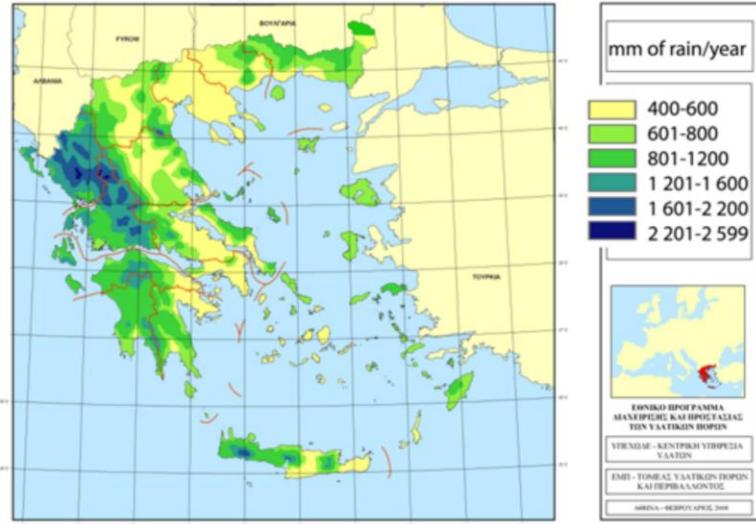


1789 μ.Χ.

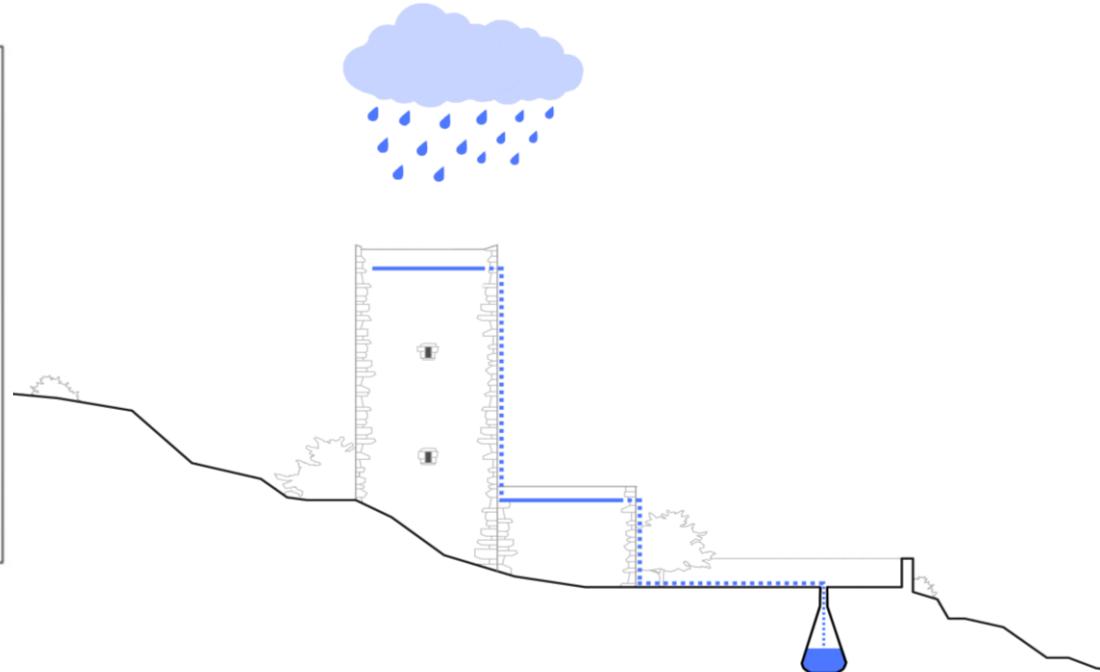


σήμερα

Νερό και υποδομές

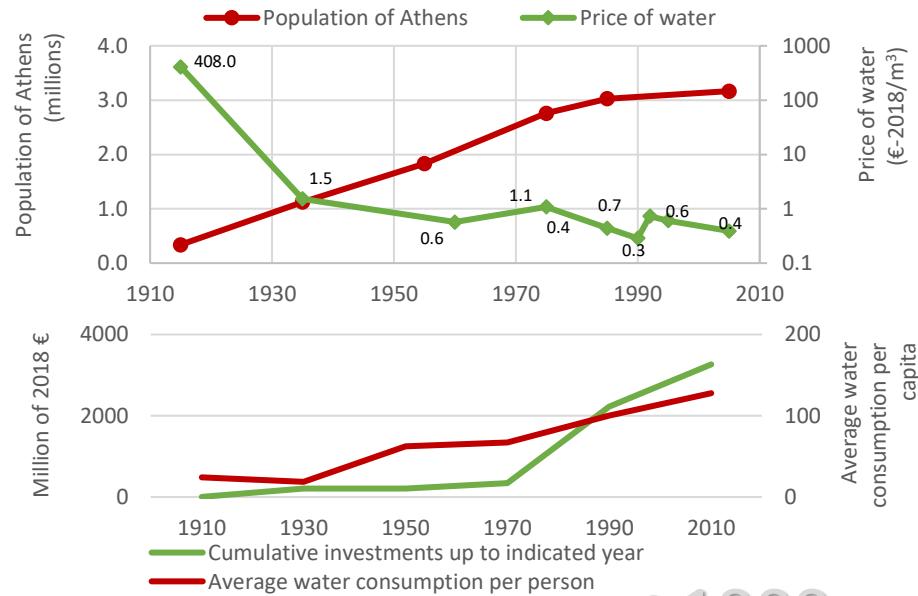
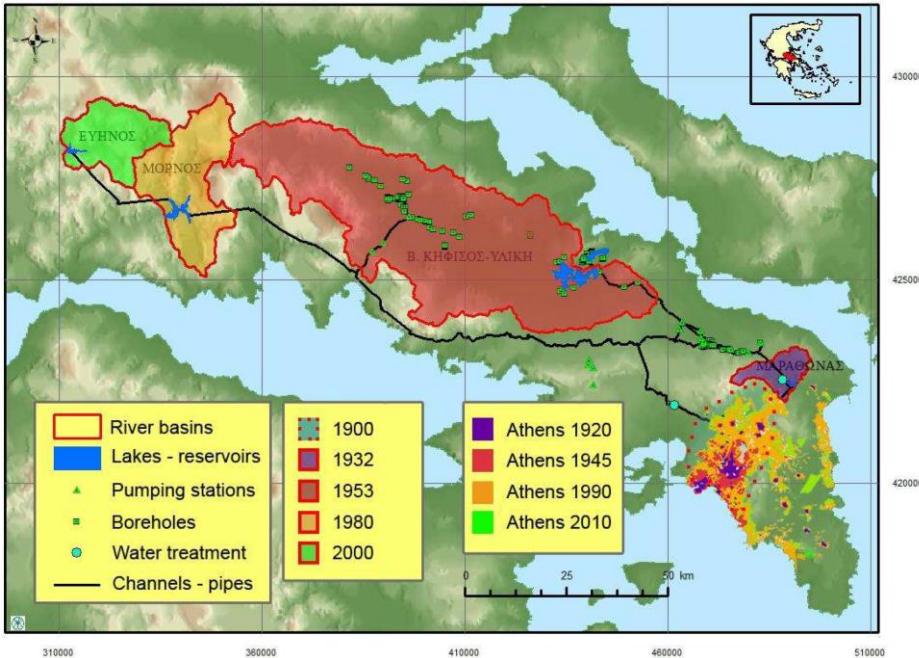


Koutsoyiannis, D.; Andreadakis, A.; Mavrodimou, R.; Christofides, A.; Mamassis, N.; Efstratiadis, A.; Koukouvinos, A.; Karavokiroς, G.; Kozanis, S.; Mamaïs, D.; Noutsopoulos, C. (2008). Εθνικό Πρόγραμμα Διαχείρισης και Προστασίας των Υδατικών Ρόπων [National Programme for Water Resources Management and Preservation]. <https://doi.org/10.13140/RG.2.2.25384.62727>



Iliopoulou, T.; Dimitriadis, P.; Siganou, A.; Markantonis, D.; Moraiti, K.; Nikolinakou, M.; Meletopoulos, I.T.; Mamassis, N.; Koutsoyiannis, D.; Sargentis, G.-F. Modern Use of Traditional Rainwater Harvesting Practices: An Assessment of Cisterns' Water Supply Potential in West Mani, Greece. *Heritage* 2022, 5, 2944-2954. <https://doi.org/10.3390/heritage5040152>

Νερό και υποδομές

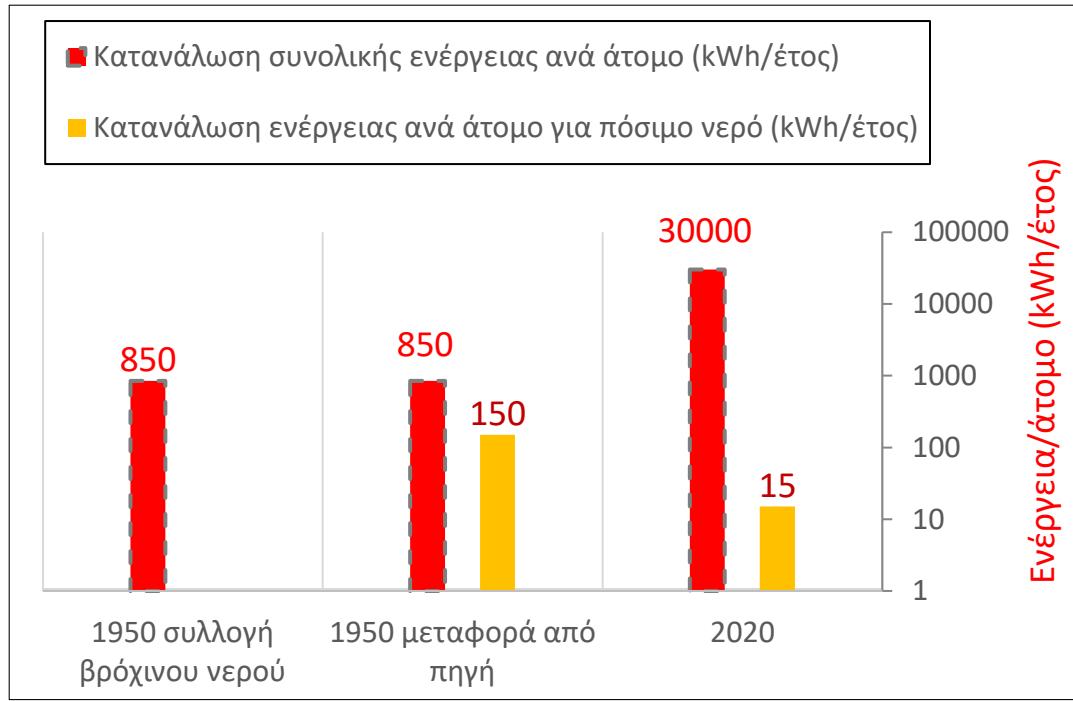
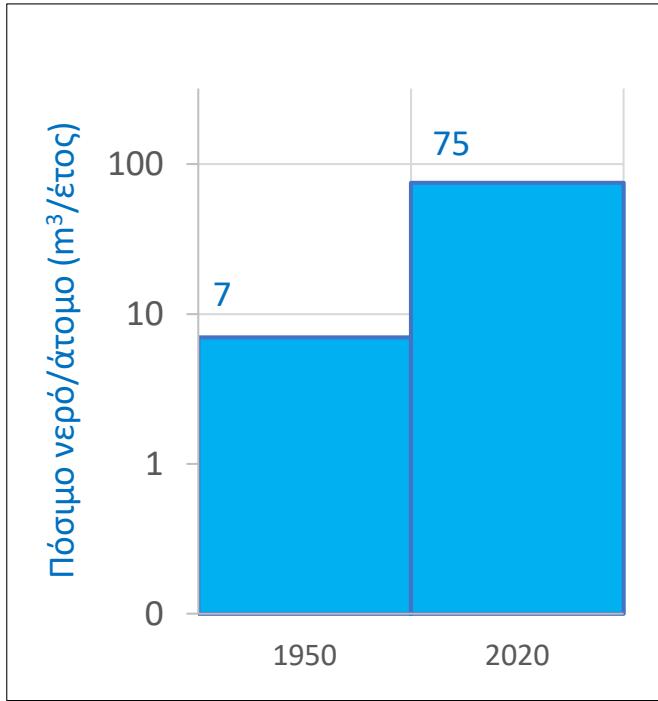


Πηγή: Sargentis, G.-F.; Ioannidis, R.; Karakatsanis, G.; Sigourou, S.; Lagaros, N.D.; Koutsoyiannis, D. The Development of the Athens Water Supply System and Inferences for Optimizing the Scale of Water Infrastructures. Sustainability 2019, 11, 2657. <https://doi.org/10.3390/su11092657>

~1900



Νερό και υποδομές



Πηγή: Σαργέντης Γ.-Φ. και Ν. Μαμάσης, Συλλογή νερού σε συγκροτήματα & κατοικίες – σχεδιασμός για μικρές κλίμακες, ΚΤΠΙΟ 6/2021, 75–80, 2021.

3 εκ. χρόνια πριν

10000 π.Χ.

3000 π.Χ.

Έτος 1

476 μ.Χ.

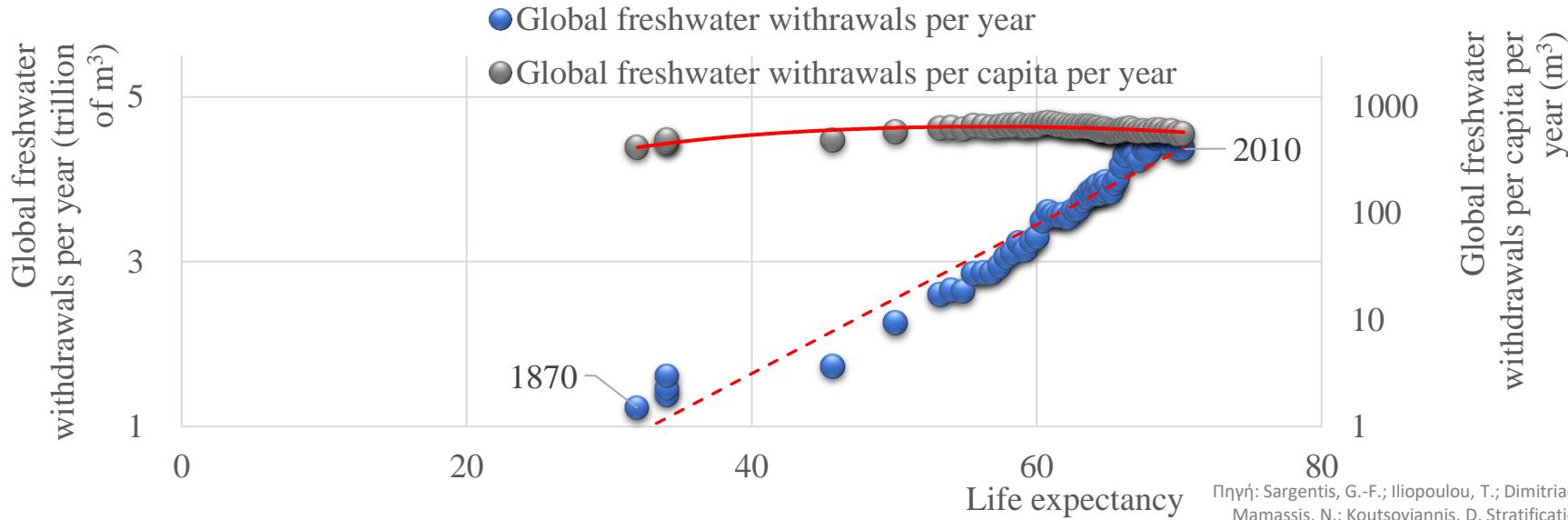
1492 μ.Χ.

1789 μ.Χ.

σήμερα



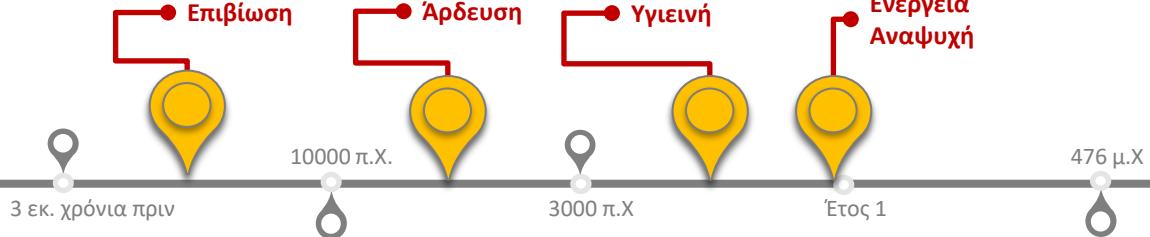
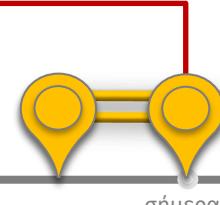
Οι χρήσεις του νερού στην ιστορία



Απολείψεις νερού για όλες τις χρήσεις παγκόσμιος μέσος όρος, data: 1870-2011

Πηγή: Sargentis, G.-F.; Iliopoulos, T.; Dimitriadis, P.; Mamassis, N.; Koutsoyiannis, D. Stratification: An Entropic View of Society's Structure. *World* 2021, 2, 153-174. <https://doi.org/10.3390/world2020011>

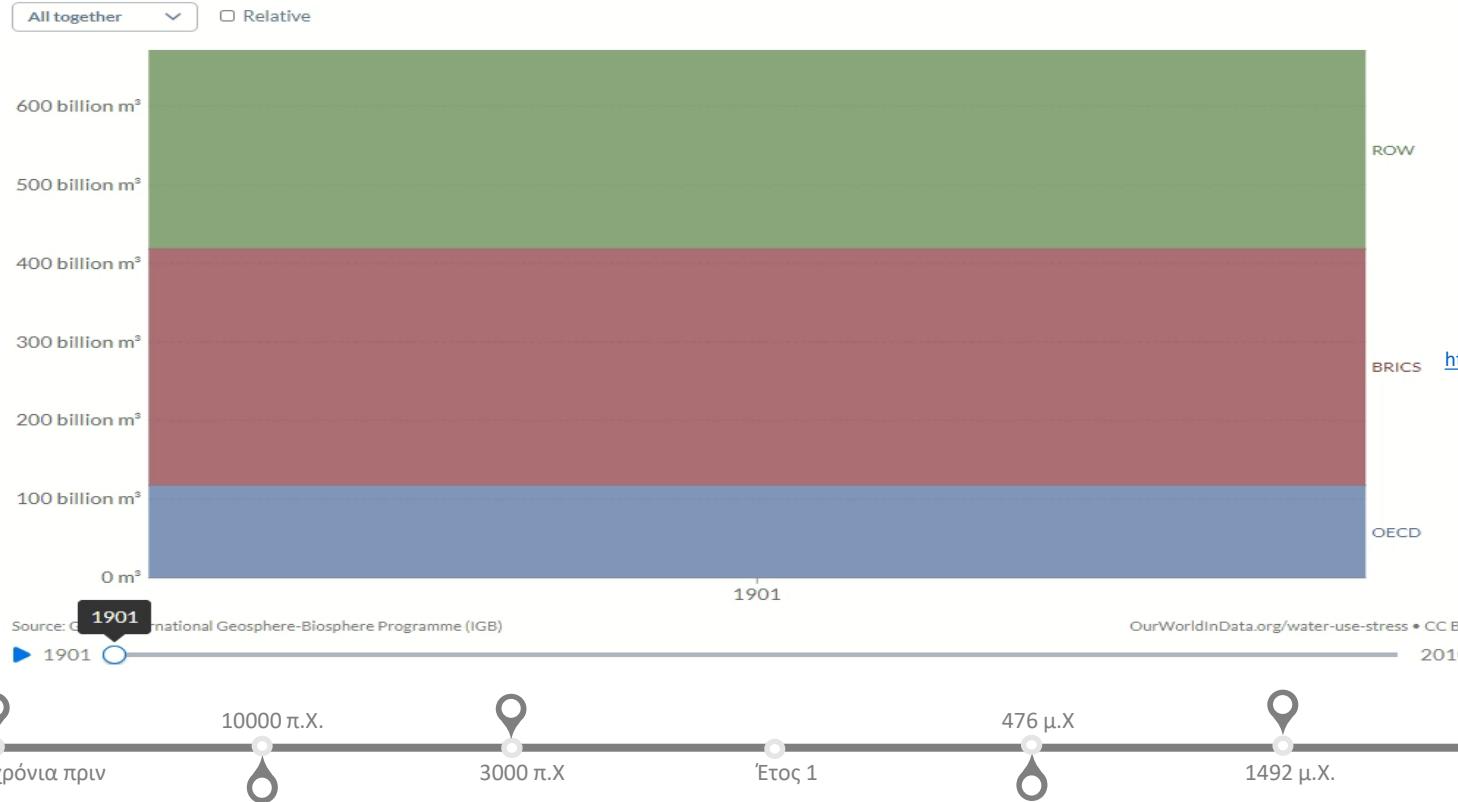
Global freshwater withdrawals
Το νερό που παίρνουμε για,
ύδρευση, άρδευση
βιομηχανική χρήση



Χρήση καθαρού νερού

Freshwater use by aggregated region, 1901

Global freshwater withdrawals for agricultural, industrial and domestic uses by aggregated regional groupings. OECD members are defined as countries who were members in 2010 and their membership was carried back in time. BRICS countries are Brazil, Russia, India, China and South Africa. ROW refers to the Rest of the World, excluding OECD and BRICS countries.



Πηγή:
<https://ourworldindata.org/grapher/freshwater-use-by-aggregated-region>

Global freshwater withdrawals
Το νερό που παίρνουμε για, ύδρευση, άρδευση βιομηχανική χρήση



σήμερα

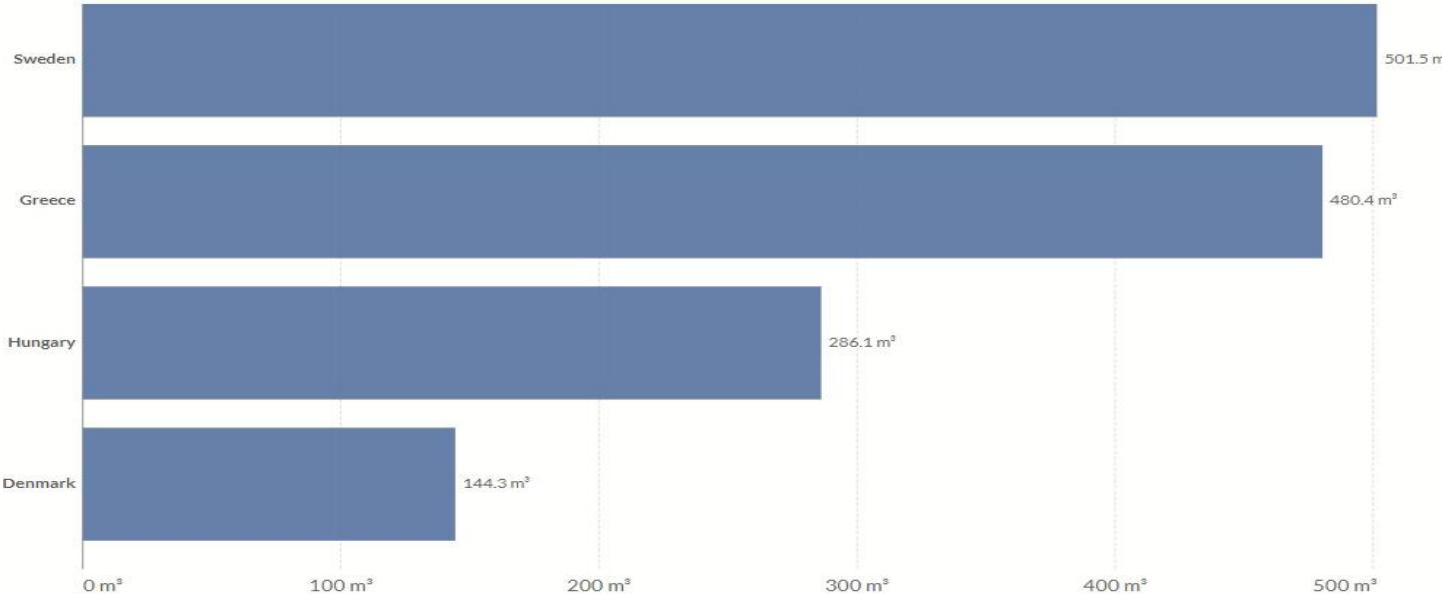
Χρήση καθαρού νερού/κάτοικο

Water withdrawals per capita, 1970

Total water withdrawals from agricultural, industrial and municipal purposes per capita, measured in cubic metres (m^3) per year.

Our World
in Data

+ Add country



Source: FAO Agriculture Organization of the United Nations - AQUASTAT

► 1970

OurWorldInData.org/water-use-stress • CC BY

2015

Πηγή:

[https://ourworldindata.org/
grapher/water-
withdrawals-per-capita](https://ourworldindata.org/grapher/water-withdrawals-per-capita)

Global freshwater
withdrawals

To νερό που
παίρνουμε για,
ύδρευση, άρδευση
βιομηχανική χρήση



3 εκ. χρόνια πριν

10000 π.Χ.



3000 π.Χ.

Έτος 1



476 μ.Χ.

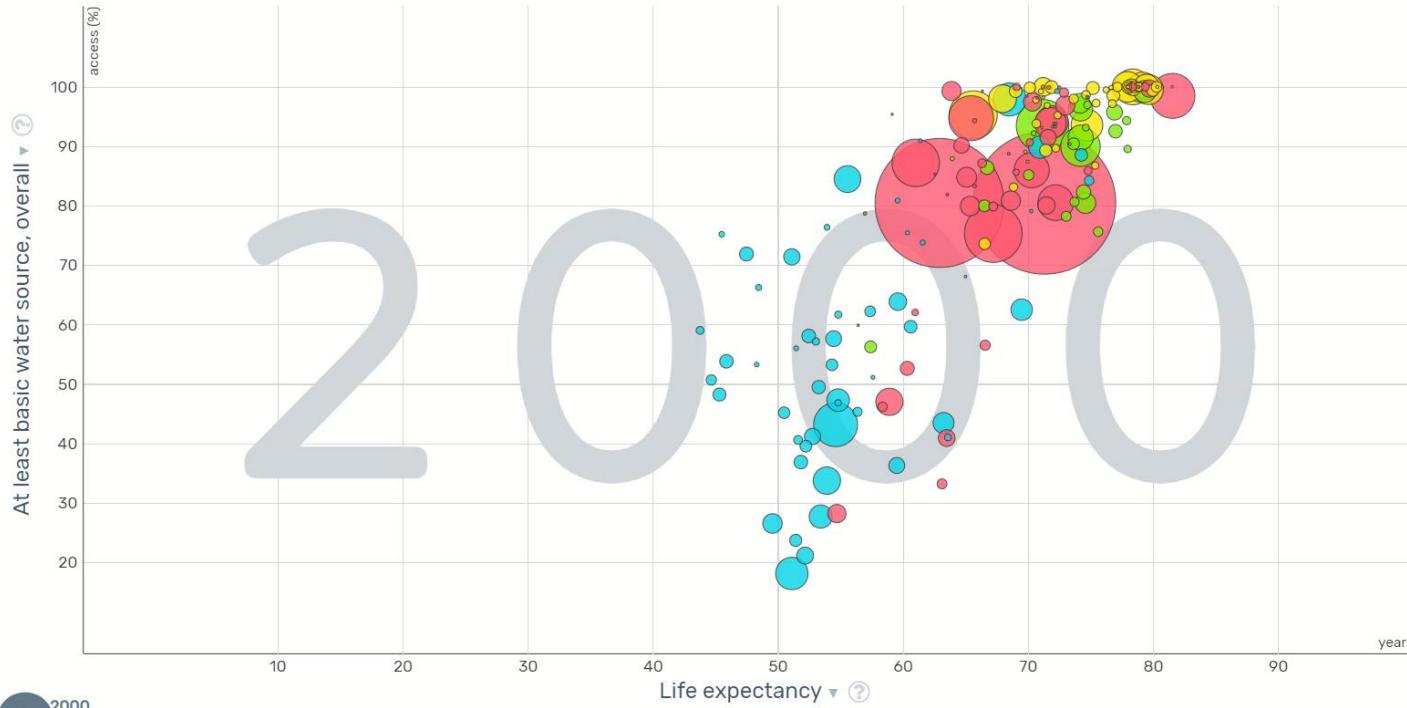


1492 μ.Χ.

1789 μ.Χ.

σήμερα

Προσδόκιμο ζωής και πρόσβαση σε καθαρό νερό



2000

3 εκ. χρόνια πριν

10000 π.Χ.

3000 π.Χ.

Έτος 1

476 μ.Χ.

1492 μ.Χ.

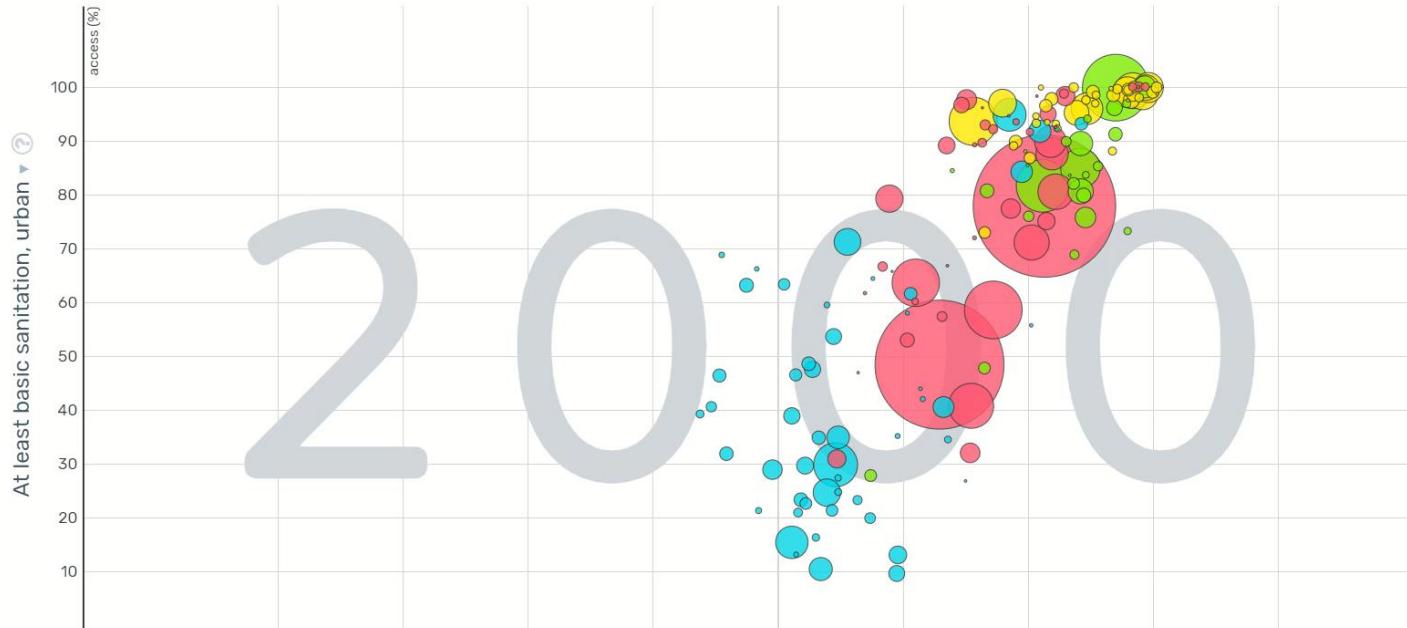
1789 μ.Χ.



σήμερα

Πηγή:
<https://www.gapminder.org/tools/>

Προσδόκιμο ζωής και έργα αποχέτευσης



2000

3 εκ. χρόνια πριν

10000 π.Χ.

3000 π.Χ.

Έτος 1

476 μ.Χ.

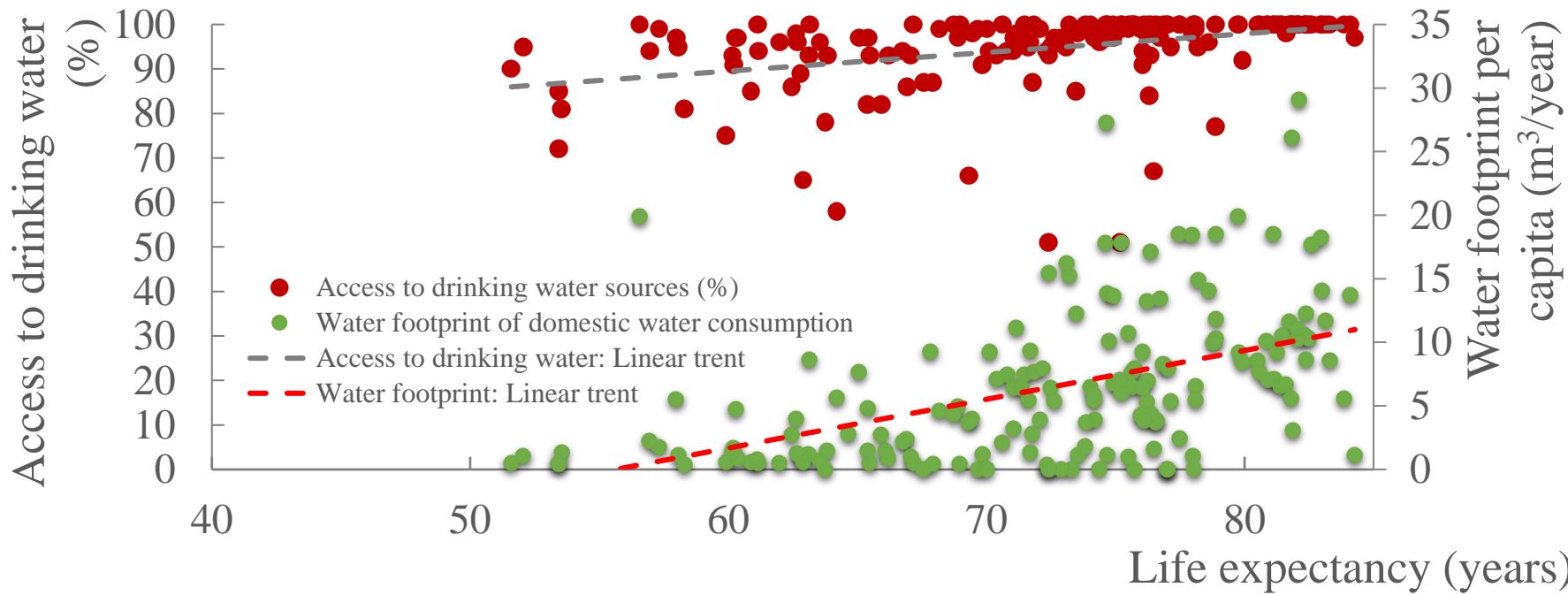
1492 μ.Χ.

1789 μ.Χ.



Πηγή:
<https://www.gapminder.org/tools/>

Προσδόκιμο ζωής και πρόσβαση σε καθαρό νερό



Πηγή:

Sargentis, G.F.; Lagaros, N.D.; Casella, G.L.; Koutsoyiannis, D. Threats in Water–Energy–Food–Land Nexus by the 2022 Military and Economic Conflict. *Land* 2022, 11, 1569.
<https://doi.org/10.3390/land11091569>



3 εκ. χρόνια πριν

10000 π.Χ.

3000 π.Χ.

Έτος 1

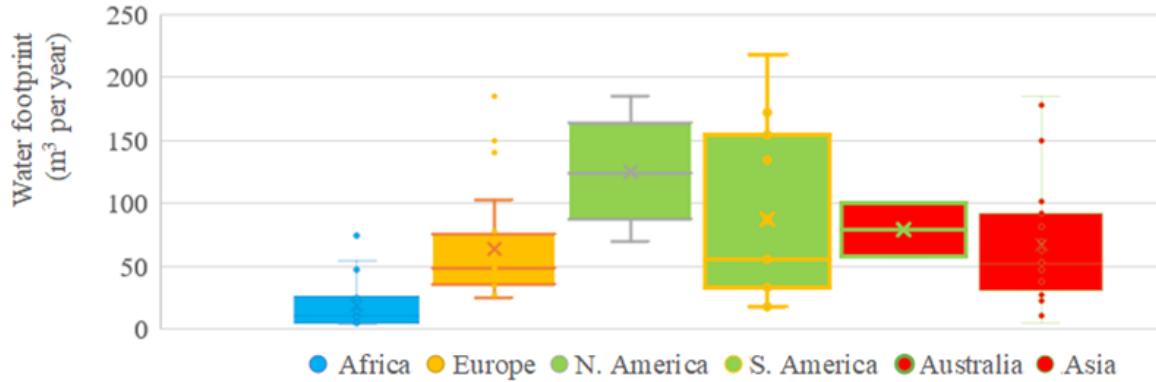
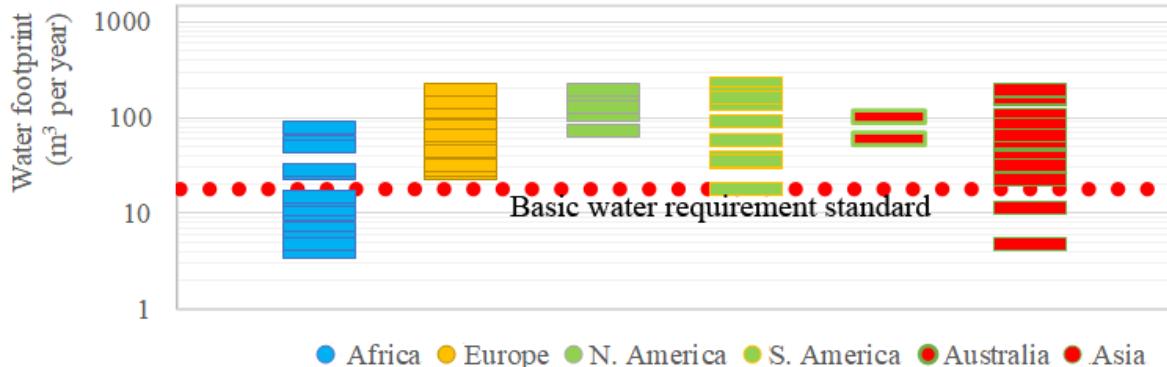
476 μ.Χ.

1492 μ.Χ.

1789 μ.Χ.

σήμερα

Χρήση καθαρού νερού



Πηγή:

Sargentis, G.F.; Lagaros, N.D.; Cascella, G.L.; Koutsoyiannis, D. Threats in Water–Energy–Food–Land Nexus by the 2022 Military and Economic Conflict. *Land* 2022, 11, 1569. <https://doi.org/10.3390/land11091569>

Ετήσια κατανάλωση νερού κατ' άτομο για οικιστικές χρήσεις (διάφορες χώρες, data: 2005)
Βασικές ανάγκες: 50lit/ημέρα (18m³ το χρόνο)

10000 π.Χ.

3000 π.Χ.

Έτος 1

476 μ.Χ.

1492 μ.Χ.

1789 μ.Χ.

σήμερα

3 εκ. χρόνια πριν

Πηγές

Σαργέντης Γ.-Φ. και Ν. Μαμάσης, Συλλογή νερού σε συγκροτήματα & κατοικίες– σχεδιασμός για μικρές κλίμακες, ΚΤΙΡΙΟ 6/2021, 75–80, 2021.

Koutsoyiannis, D. Scale of water resources development and sustainability: Small is beautiful, large is great, Hydrological Sciences Journal, 56 (4), 553–575, <https://doi.org/10.1080/02626667.2011.579076>, 2011.

Koutsoyiannis, D.; Andreadakis, A.; Mavrodimou, R.; Christofides, A.; Mamassis, N.; Efstratiadis, A.; Koukouvinos, A.; Karavokiros, G.; Kozanis, S.; Mamaïs, D.; Noutsopoulos, C. (2008). Εθνικό Πρόγραμμα Διαχείρισης και Προστασίας των Υδατικών Πόρων [National Programme for Water Resources Management and Preservation].
<https://doi.org/10.13140/RG.2.2.25384.62727>.

Iliopoulou, T.; Dimitriadis, P.; Siganou, A.; Markantonis, D.; Moraiti, K.; Nikolinakou, M.; Meletopoulos, I.T.; Mamassis, N.; Koutsoyiannis, D.; Sargentis, G.-F. Modern Use of Traditional Rainwater Harvesting Practices: An Assessment of Cisterns' Water Supply Potential in West Mani, Greece. Heritage 2022, 5, 2944–2954.
<https://doi.org/10.3390/heritage5040152>.

Πηγές

Sargentis, G.-F.; Defteraios, P.; Lagaros, N.D.; Mamassis, N. Values and Costs in History: A Case Study on Estimating the Cost of Hadrianic Aqueduct's Construction. *World* 2022, 3, 260-286. <https://doi.org/10.3390/world3020014>

Sargentis, G.-F.; Lagaros, N.D.; Cascella, G.L.; Koutsoyiannis, D. Threats in Water–Energy–Food–Land Nexus by the 2022 Military and Economic Conflict. *Land* 2022, 11, 1569. <https://doi.org/10.3390/land11091569>

Sargentis, G.-F.; Koutsoyiannis, D.; Angelakis, A.; Christy, J.; Tsonis, A.A. Environmental Determinism vs. Social Dynamics: Prehistorical and Historical Examples. *World* 2022, 3, 357-388. <https://doi.org/10.3390/world3020020>

Sargentis, G.-F.; Siamparina, P.; Sakki, G.-K.; Efstratiadis, A.; Chiotinis, M.; Koutsoyiannis, D. Agricultural Land or Photovoltaic Parks? The Water–Energy–Food Nexus and Land Development Perspectives in the Thessaly Plain, Greece. *Sustainability* 2021, 13, 8935. <https://doi.org/10.3390/su13168935>

Sargentis, G.-F.; Koutsoyiannis, D. The Function of Money in Water–Energy–Food and Land Nexus. *Land* 2023, 12, 669. <https://doi.org/10.3390/land12030669>

Sargentis, G.-F. Issues of Prosperity: Stochastic Evaluation of Data Related to Environment, Infrastructures, Economy and Society. Ph.D. Thesis, National Technical University of Athens, School of Civil Engineering, Athens, Greece, 2022.

Πηγές

Sargentis, G.-F.; Ioannidis, R.; Karakatsanis, G.; Sigourou, S.; Lagaros, N.D.; Koutsoyiannis, D. The Development of the Athens Water Supply System and Inferences for Optimizing the Scale of Water Infrastructures. *Sustainability* 2019, 11, 2657. <https://doi.org/10.3390/su11092657>.

Sargentis, G.-F.; Iliopoulou, T.; Dimitriadis, P.; Mamassis, N.; Koutsoyiannis, D. Stratification: An Entropic View of Society's Structure. *World* 2021, 2, 153-174. <https://doi.org/10.3390/world2020011>.

Sargentis, G.-F.; Lagaros, N.D.; Casella, G.L.; Koutsoyiannis, D. Threats in Water–Energy–Food–Land Nexus by the 2022 Military and Economic Conflict. *Land* 2022, 11, 1569. <https://doi.org/10.3390/land11091569>.

Sargentis, G.-F.; Dimitriadis, P.; Ioannidis, R.; Iliopoulou, T.; Fragedaki, E.; Koutsoyiannis, D. Optimal utilization of water resources for local communities in mainland Greece (case study of Karyes, Peloponnese), *Procedia Manufacturing*, Volume 44, 2020, Pages 253-260, ISSN 2351-9789, <https://doi.org/10.1016/j.promfg.2020.02.229>.

<https://ourworldindata.org/>.

<https://www.gapminder.org/tools/>.

Ο ρόλος της ενέργειας στην κοινωνική ευημερία

<https://youtu.be/DvJauWPnixY>

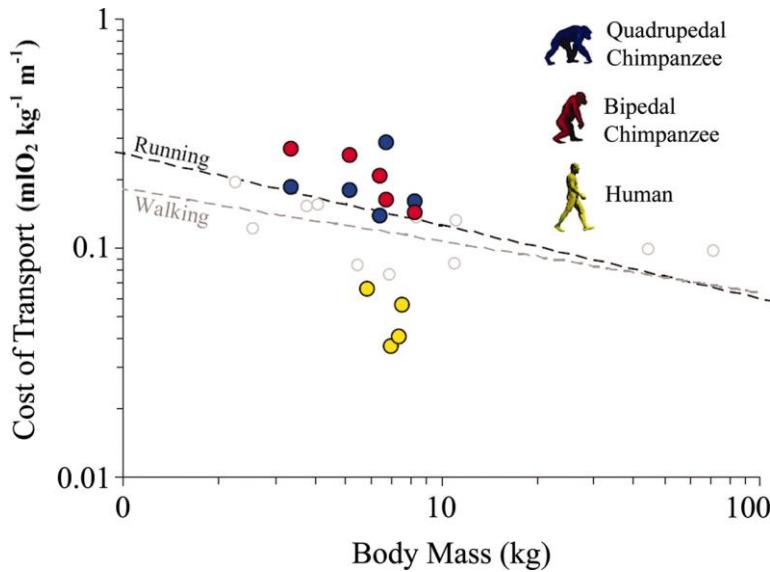
Ο ήλιος και η κατανομή της ενέργειάς



Πηγή: Sargentis, G.-F.; Siamparina, P.; Sakki, G.-K.; Efstratiadis, A.; Chiotinis, M.; Koutsoyiannis, D. Agricultural Land or Photovoltaic Parks? The Water–Energy–Food Nexus and Land Development Perspectives in the Thessaly Plain, Greece. *Sustainability* 2021, 13, 8935. <https://doi.org/10.3390/su13168935>

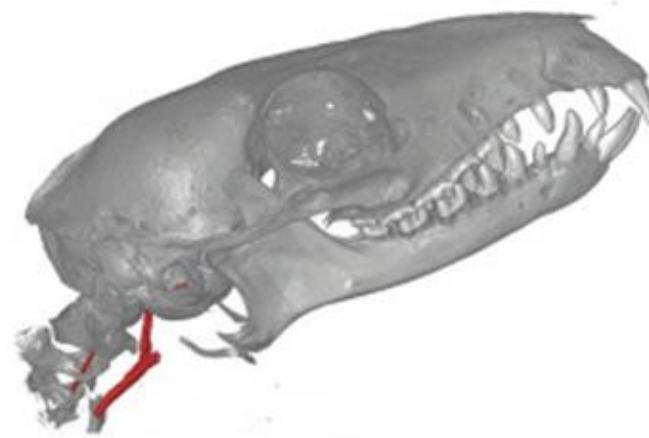
Εξέλιξη και ενεργειακή κατανάλωση

Η διαδικασία της εξέλιξης είναι διαδικασία βελτιστοποίησης της κατανάλωσης ενέργειας



- Το βάδην σε όρθια στάση εξοικονομεί ενέργεια

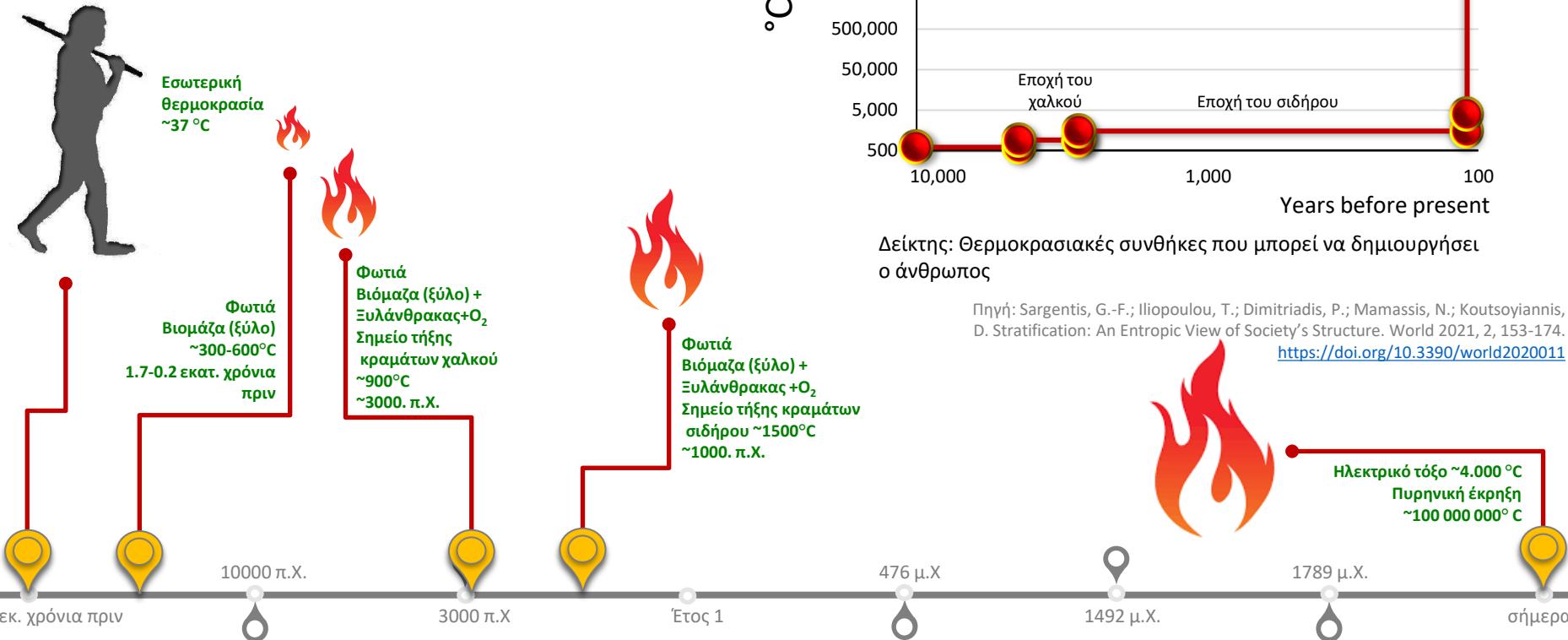
Michael D. Sockol, David A. Raichlen, Herman Pontzer. Chimpanzee locomotor energetics and the origin of human bipedalism, Proceedings of the National Academy of Sciences Jul 2007, 104 (30) 12265-12269; <https://doi.org/10.1073/pnas.0703267104>.



- Ο ανθρώπινος εγκέφαλος καταναλώνει λιγότερη ενέργεια από των ζώων

Boyer, D.M.; Harrington, A. R.; Scaling of bony canals for encephalic vessels in euarchontans: Implications for the role of the vertebral artery and brain metabolism, Journal of Human Evolution, Volume 114, 2018, Pages 85-101, ISSN 0047-2484, <https://doi.org/10.1016/j.jhevol.2017.09.003>.

Θερμοκρασιακές συνθήκες





3 εκ. χρόνια πριν

10000 π.Χ.

3000 π.Χ.

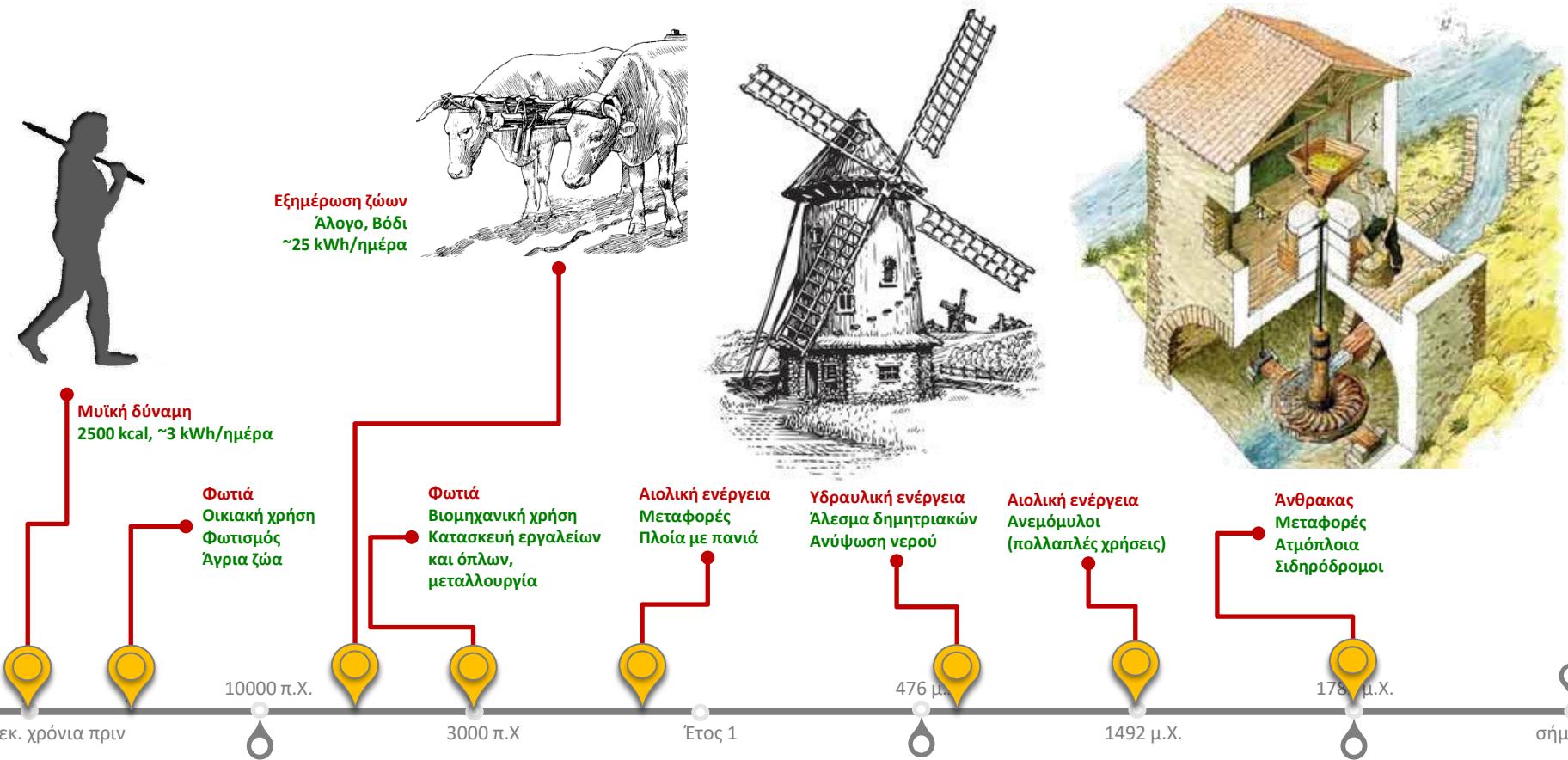
Έτος 1

476 μ.Χ

1492 μ.Χ.

σήμερα

Ενεργειακοί πόροι

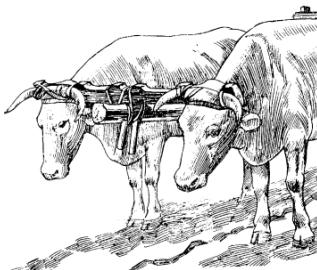


Ενεργειακοί πόροι και εγκατεστημένη ισχύς



50-90 W

Άλογο ~500 W
Βόδι: ~300 W



Πηγές:
Vaclav Smil, Conversion of Energy: People and Animals, Editor(s): Cutler J. Cleveland, Encyclopedia of Energy, Elsevier, 2004, Pages 697-705, ISBN 9780121764807 <https://doi.org/10.1016/B0-12-176480-X/00094-2>.
Astrid Kander, Paul Warde UNumber, Size and Energy Consumption of Draught Animals in European Agriculture, Working Paper, March 2009.

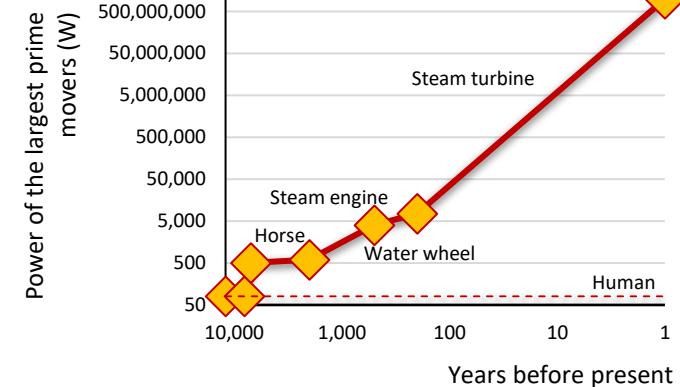


~60 000 W, 80 Hp

Ανεμόμυλοι-νερόμυλοι
~5 000 W

Smil, V. World History and Energy. In Cleveland, Encyclopedia of Energy; Cutler, J., Ed.; Elsevier: Amsterdam, The Netherlands, 2004.

Cutnell & Johnson. Physics
Third Edition. New York:
Wiley, 1995.



Δείκτης: Μέγιστη εγκατεστημένη ισχύς σε διάφορες ιστορικές περιόδους

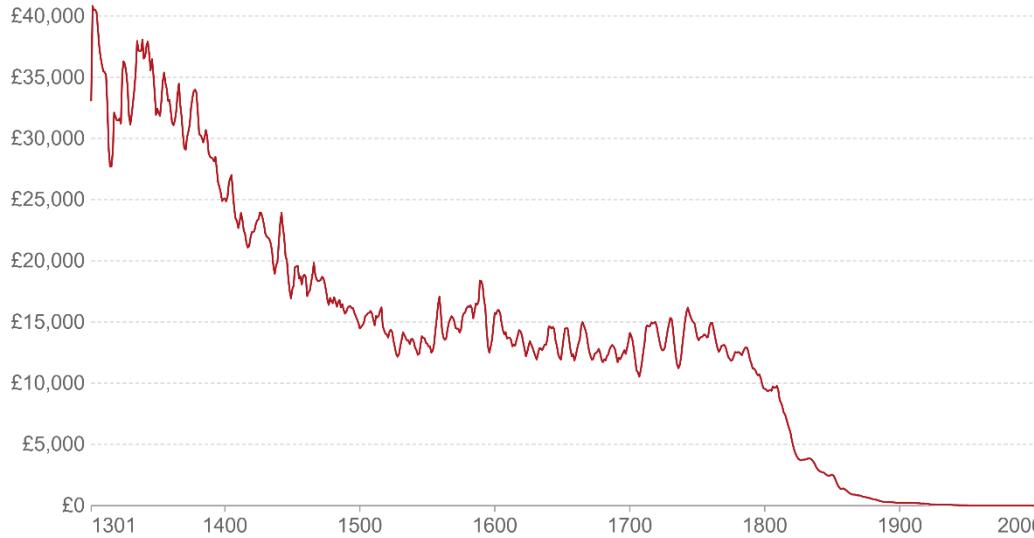
Πηγή: Sargentis, G.-F.; Iliopoulou, T.; Dimitriadis, P.; Mamassis, N.; Koutsoyiannis, D. Stratification: An Entropic View of Society's Structure. World 2021, 2, 153-174.
<https://doi.org/10.3390/world2020011>

Η εξέλιξη της αφθονίας των ενεργειακών πόρων

The price for lighting in the United Kingdom

Our World
in Data

The price per million lumen-hours in British Pound. 1 lumen-hour is equal to the luminous energy emitted in 1 hour by a light source emitting a luminous flux of 1 lumen. For comparison: a standard 100W incandescent light bulb emits around 1700 lumen.



Source: Fouquet and Pearson (2012)

Note: The price is adjusted for inflation and expressed in prices for the year 2000. Shown is a 5-year moving average.

Πηγή: <https://ourworldindata.org/grapher/the-price-for-lighting-per-million-lumen-hours-in-the-uk-in-british-pound>

3 εκ. χρόνια πριν

10000 π.Χ.

3000 π.Χ.

Έτος 1

476 μ.Χ

1492 μ.Χ.

1789 μ.Χ.

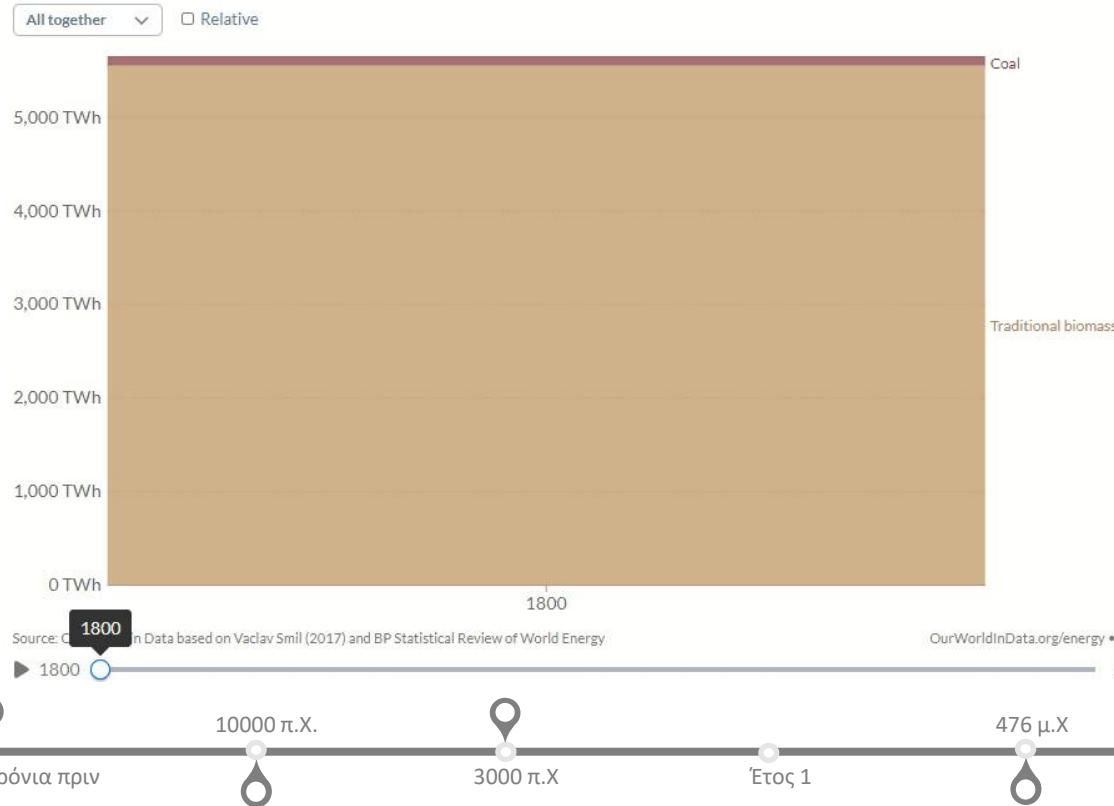
σήμερα

Ενεργειακή κατανάλωση τα τελευταία 200 χρόνια

Global primary energy consumption by source

Primary energy is calculated based on the 'substitution method' which takes account of the inefficiencies in fossil fuel production by converting non-fossil energy into the energy inputs required if they had the same conversion losses as fossil fuels.

Our World
in Data



Πηγή: <https://ourworldindata.org/grapher/global-energy-substitution>

Global energy consumption
Κατανάλωση ενέργειας

Τεχνολογία και αξιοποίηση των πόρων



1000 Β.Π.Χ.



3000 π.Χ.

Έτος 1

476 μ.Χ



1492 μ.Χ.

1789 μ.Χ.



σήμερα

3 εκ. χρόνια πριν

Τεχνολογία και αξιοποίηση των πόρων



3 εκ. χρόνια πριν

10000 π.Χ.

3000 π.Χ.

Έτος 1

476 μ.Χ.

1492 μ.Χ.

1789 μ.Χ.

σήμερα

Τεχνολογία και αξιοποίηση των πόρων



3 εκ. χρόνια πριν

100.000 π.Χ.

3000 π.Χ.

Έτος 1

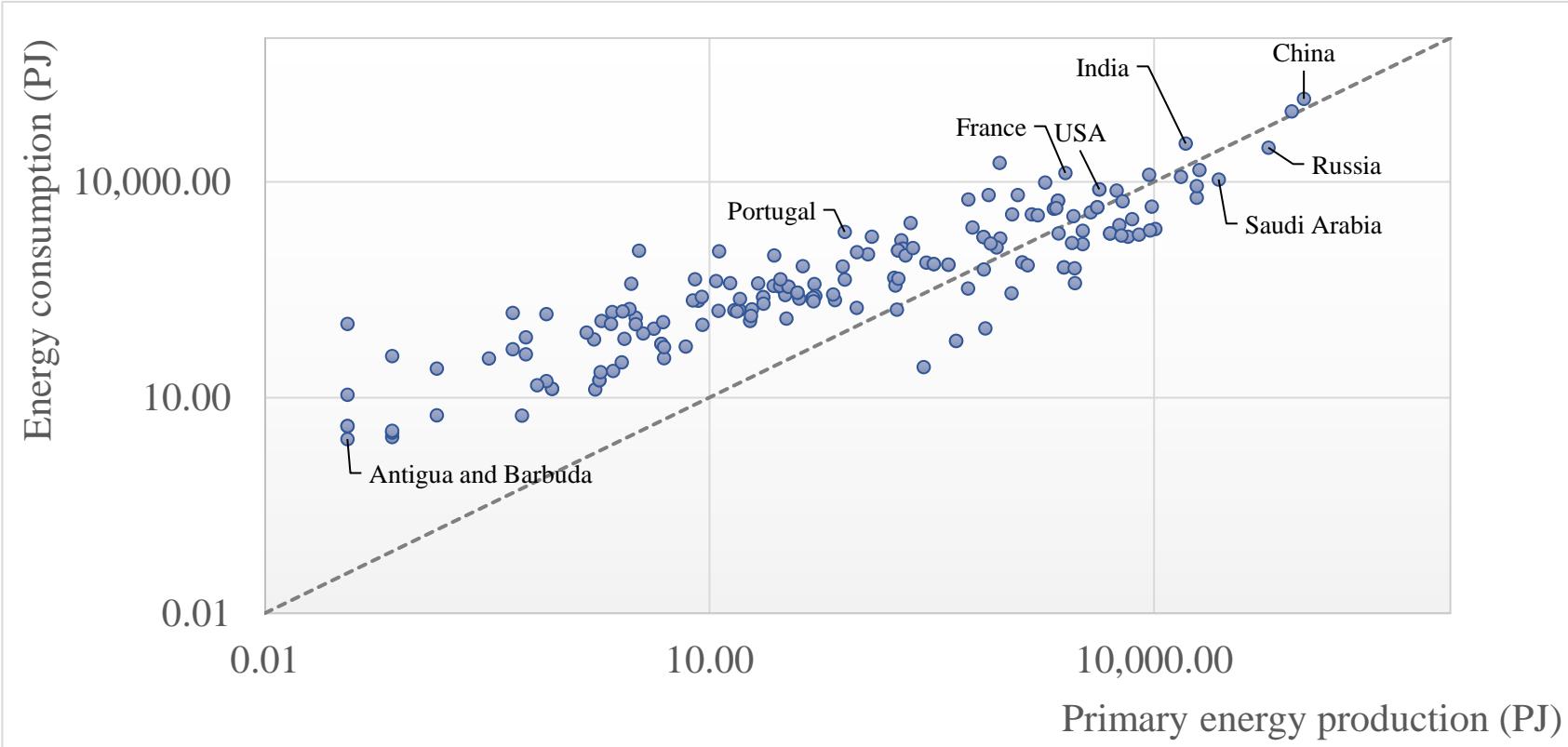
476 μ.Χ.

1492 μ.Χ.

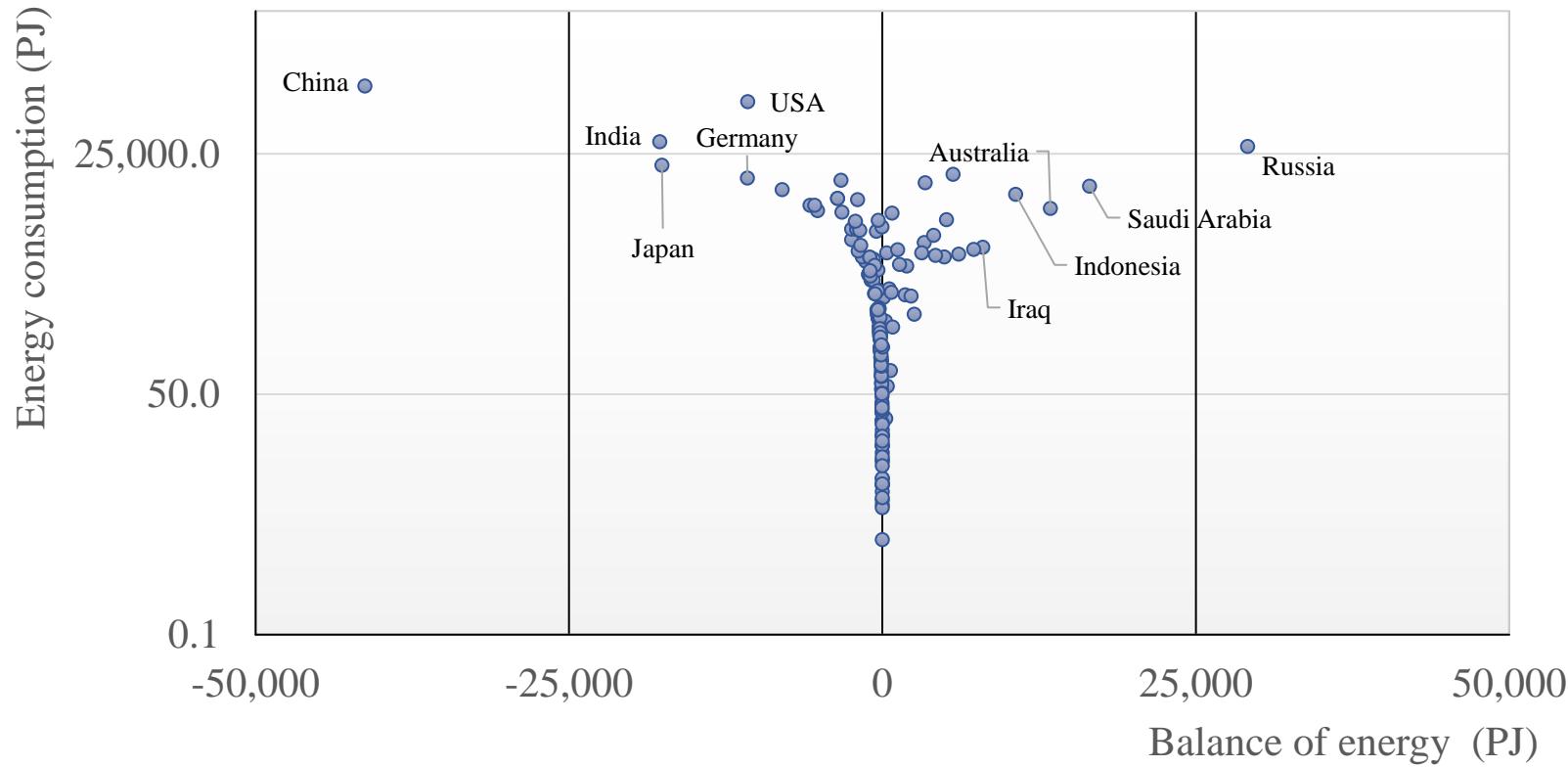
1789 μ.Χ.

σήμερα

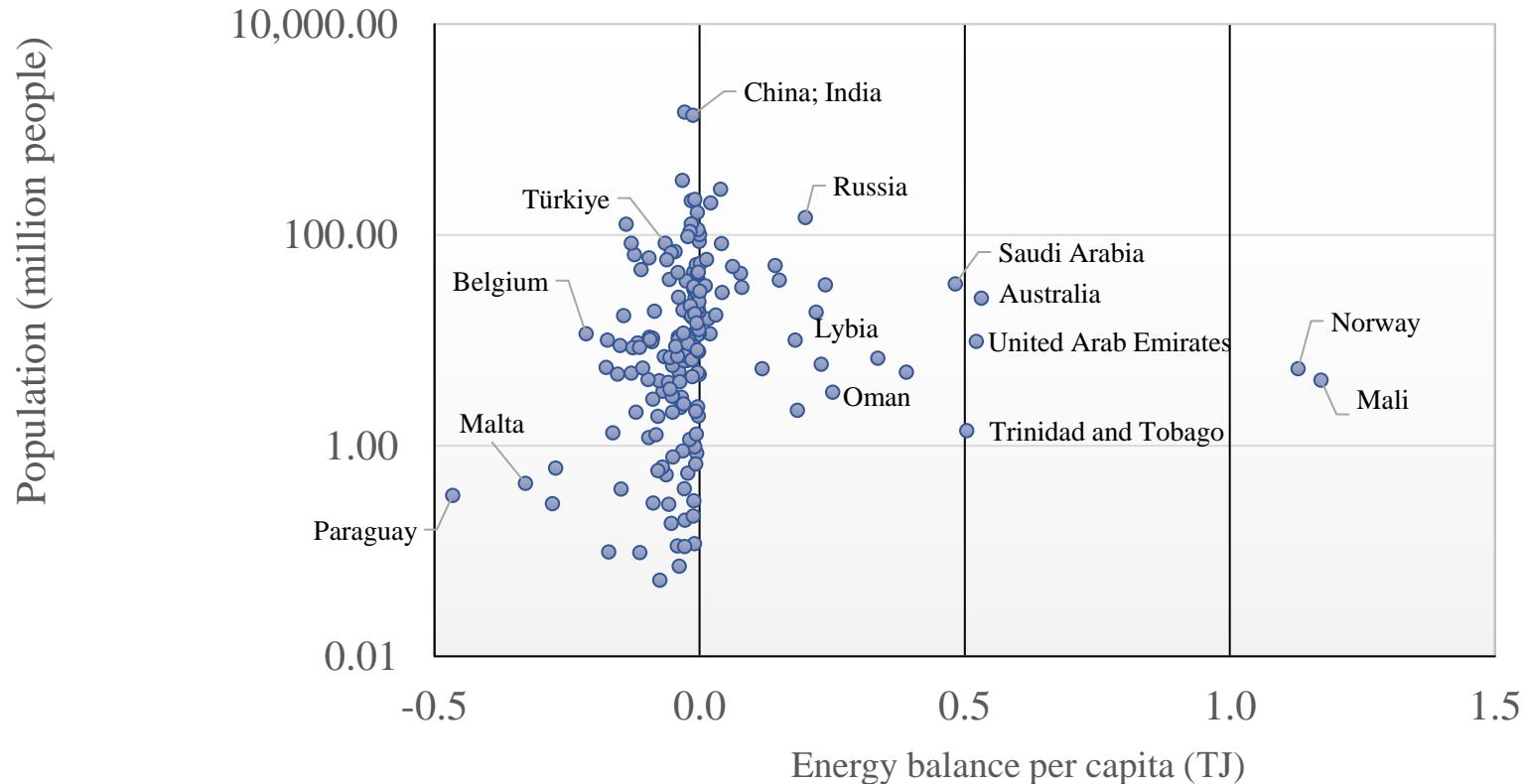
Παραγωγή-κατανάλωση ενέργειας



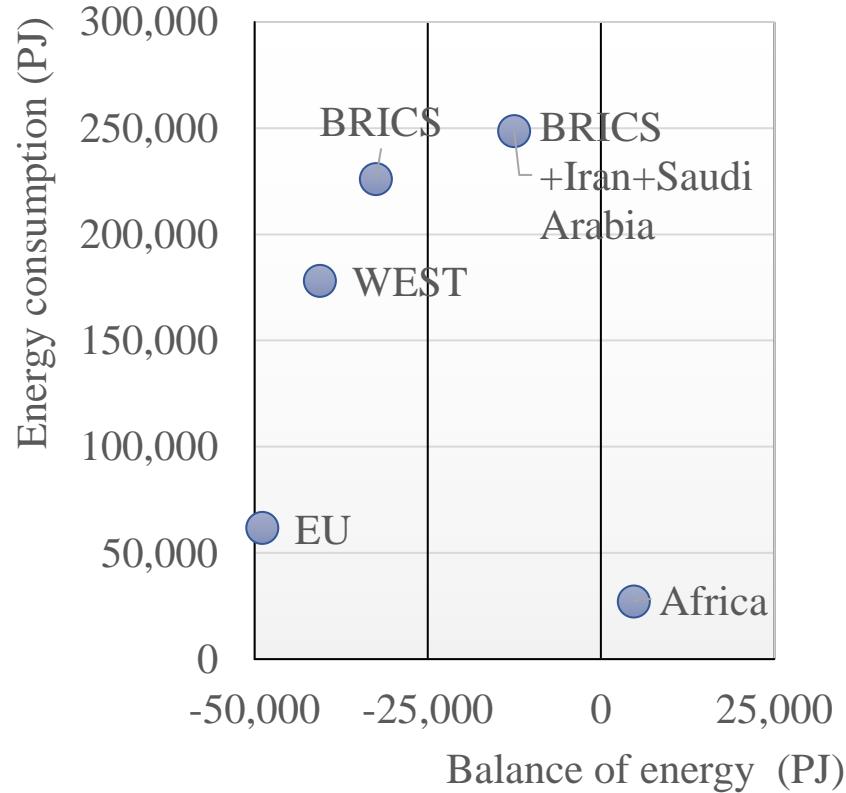
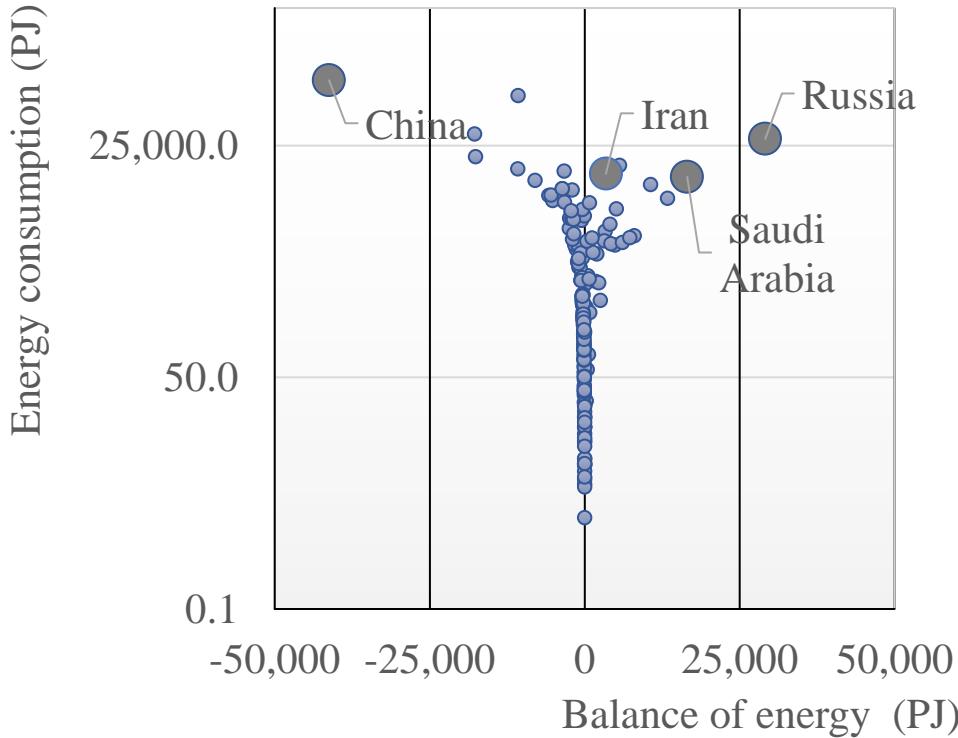
Ενεργειακή ισορροπία



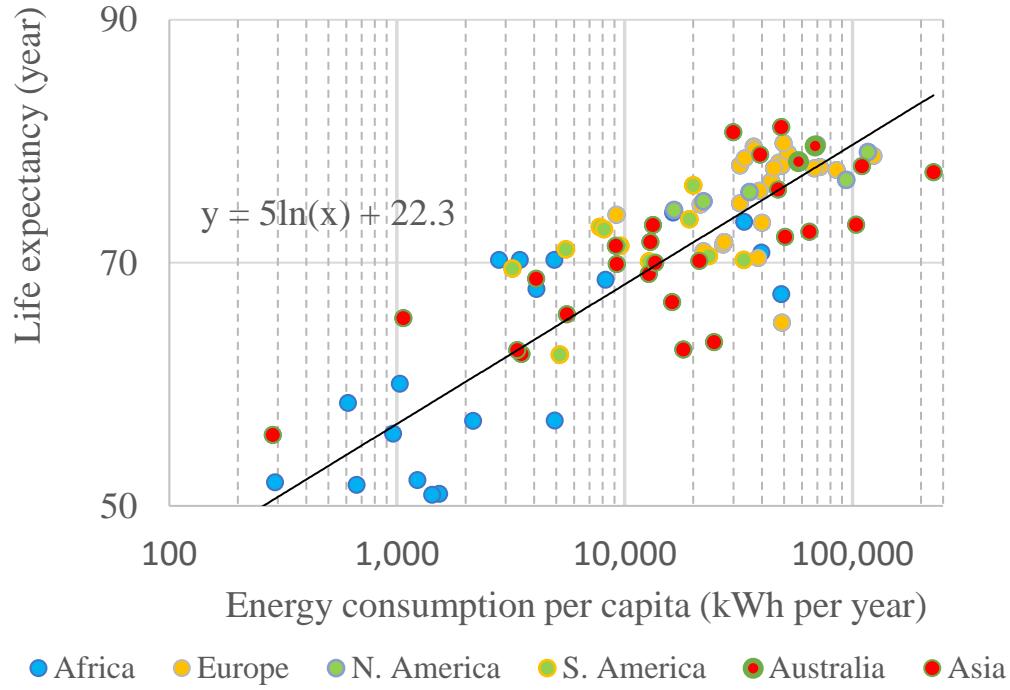
Ενεργειακή ισορροπία ανά κάτοικο



Ενεργειακά αθροίσματα



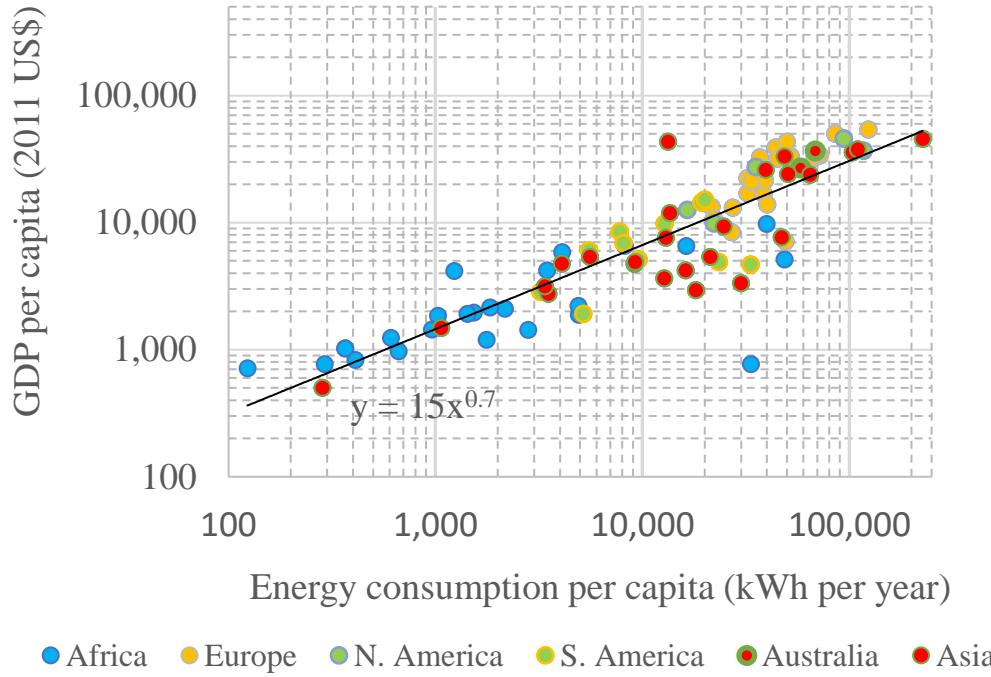
Ενέργεια και προσδόκιμο ζωής



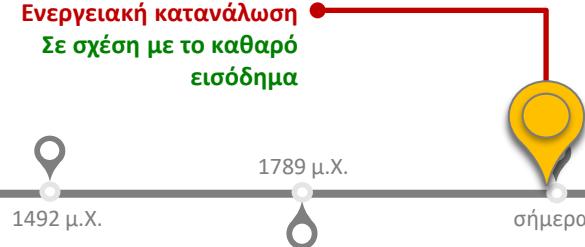
Πηγή:
Sargentis, G.F.; Lagaros, N.D.; Casella, G.L.;
Koutsoyiannis, D. Threats in Water–Energy–Food–
Land Nexus by the 2022 Military and Economic
Conflict. Land 2022, 11, 1569.
<https://doi.org/10.3390/land11091569>



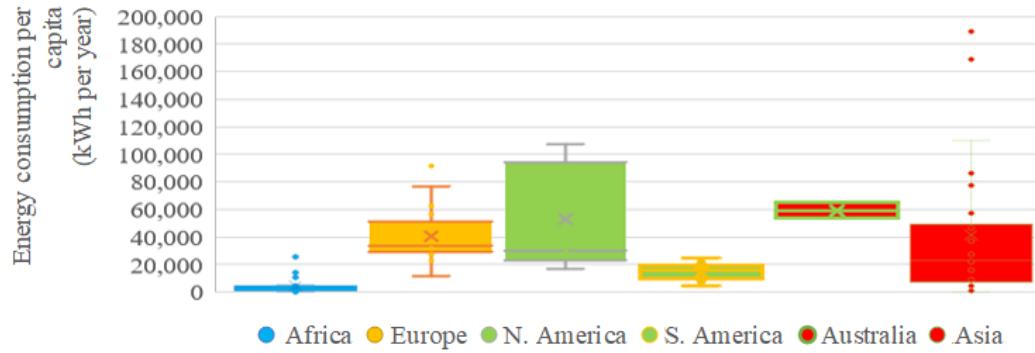
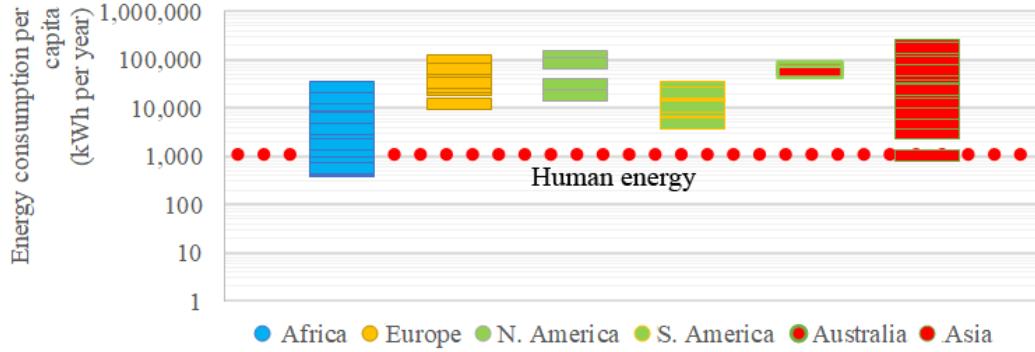
Ενέργεια και εισόδημα



Πηγή:
Sargentis, G.F.; Lagaros, N.D.; Casella, G.L.;
Koutsoyiannis, D. Threats in Water–Energy–Food–
Land Nexus by the 2022 Military and Economic
Conflict. Land 2022, 11, 1569.
<https://doi.org/10.3390/land11091569>



Κατανάλωση ενέργειας



Πηγή:
Sargentis, G.F.; Lagaros, N.D.; Casella, G.L.; Koutsoyiannis, D. Threats in Water–Energy–Food–Land Nexus by the 2022 Military and Economic Conflict. Land 2022, 11, 1569.
<https://doi.org/10.3390/land11091569>



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Πηγές

Sargentis, G.F.; Lagaros, N.D.; Cascella, G.L.; Koutsoyiannis, D. Threats in Water–Energy–Food–Land Nexus by the 2022 Military and Economic Conflict. *Land* 2022, 11, 1569. <https://doi.org/10.3390/land11091569>.

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<https://doi.org/10.1073/pnas.0703267104>.

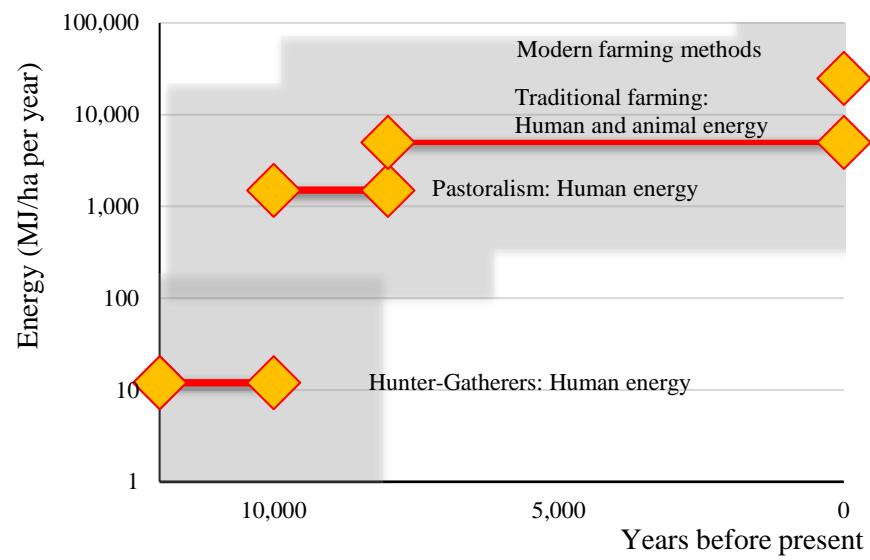
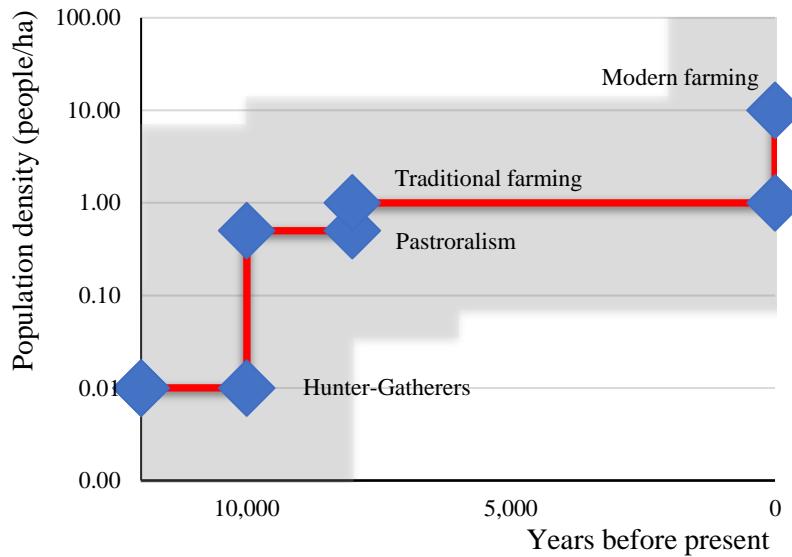
<https://ourworldindata.org/>.

Ο ρόλος των τροφίμων στην κοινωνική ευημερία

<https://youtu.be/4WgV6N7HAxo>

Τρόφιμα, ενέργεια και πύκνωση των ανθρώπων

Πηγή: Sargentis, G.-F.; Iliopoulou, T.; Dimitriadis, P.; Mamassis, N.; Koutsoyannis, D. Stratification: An Entropic View of Society's Structure. World 2021, 2, 153-174. <https://doi.org/10.3390/world2020011>



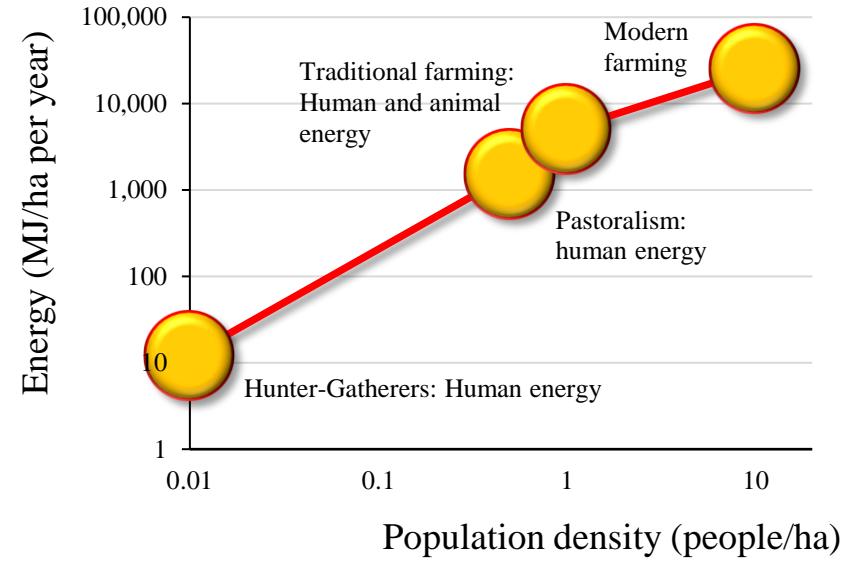
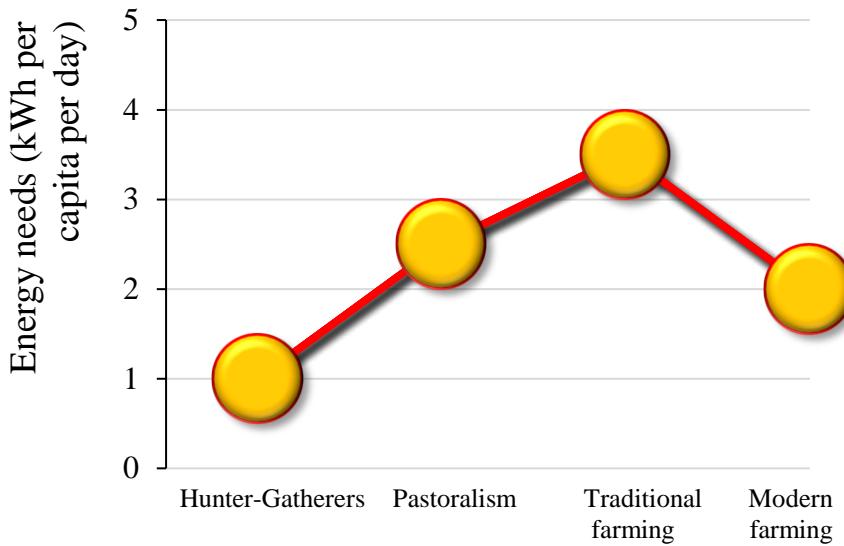
Τύποι γεωργικής καλλιέργειας, πυκνότητα πληθυσμού και ενεργειακές ανάγκες

Χρήση γης – Ενέργεια – Πυκνότητα πληθυσμού



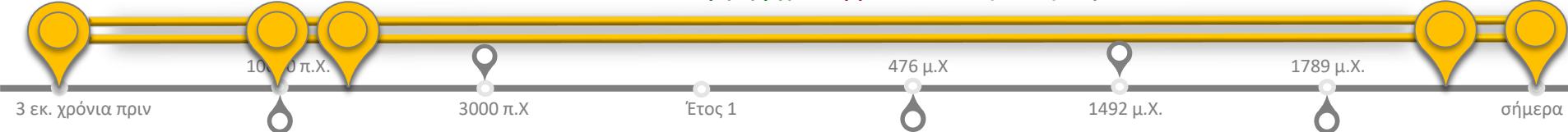
Τρόφιμα, ενέργεια και πύκνωση των ανθρώπων

Πηγή: Sargentis, G.-F.; Iliopoulou, T.; Dimitriadis, P.; Mamassis, N.; Koutsoyannis, D. Stratification: An Entropic View of Society's Structure. World 2021, 2, 153-174. <https://doi.org/10.3390/world2020011>



Τύποι γεωργικής καλλιέργειας, πυκνότητα πληθυσμού και ενεργειακές ανάγκες

Χρήση γης – Ενέργεια – Πυκνότητα πληθυσμού



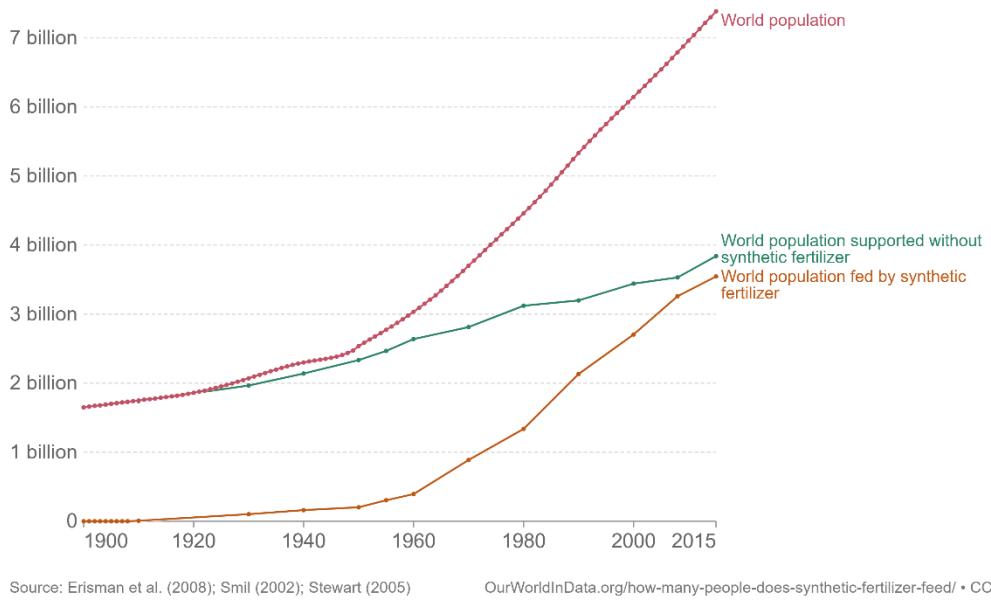
Τρόφιμα και λιπάσματα

Πηγή: <https://ourworldindata.org/grapher/world-population-with-and-without-fertilizer>



World population with and without synthetic nitrogen fertilizers

Estimates of the global population reliant on synthetic nitrogenous fertilizers, produced via the Haber-Bosch process for food production. Best estimates project that just over half of the global population could be sustained without reactive nitrogen fertilizer derived from the Haber-Bosch process.



Source: Erisman et al. (2008); Smil (2002); Stewart (2005)

OurWorldInData.org/how-many-people-does-synthetic-fertilizer-feed/ • CC BY



3 εκ. χρόνια πριν
10000 π.Χ.

3000 π.Χ.

Έτος 1

476 μ.Χ.
1492 μ.Χ.

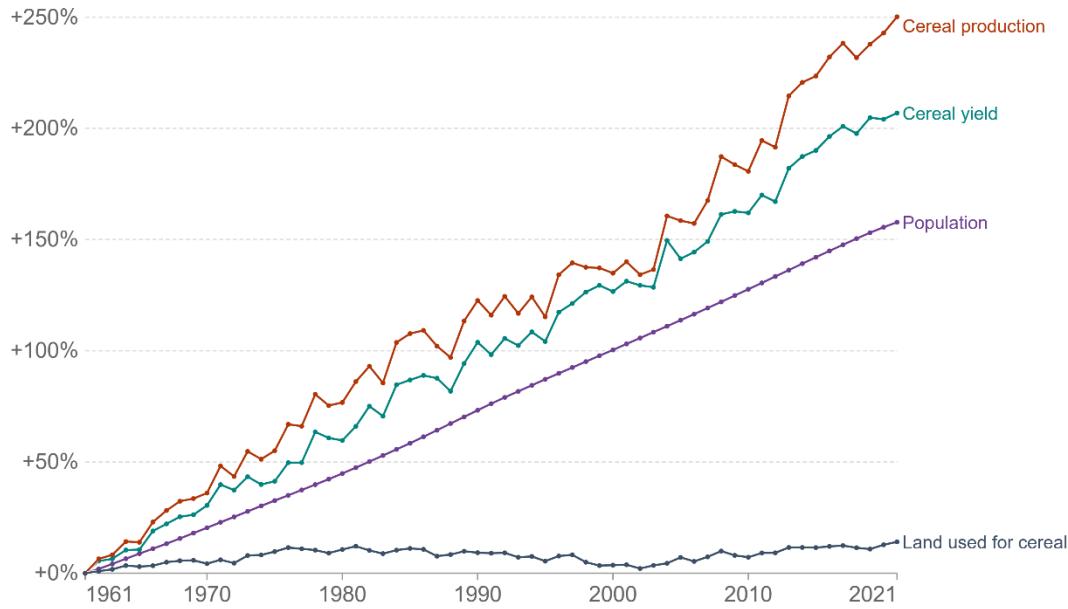
1789 μ.Χ.
σήμερα

Τρόφιμα και χρήσεις γης_1

Change in cereal production, yield, land use and population, World

All figures are indexed to the start year of the timeline. This means the first year of the time-series is given the value zero.

+250%



Source: Our World in Data based on World Bank; Food and Agriculture Organization of the United Nations
OurWorldInData.org/crop-yields • CC BY

Πηγές:

1. Food and Agriculture Organization of the United Nations
 2. <https://ourworldindata.org/yields-vs-land-use-how-has-the-world-produced-enough-food-for-a-growing-population>

1961



σήμερα

3 εκ. χρόνια πριν

10000 π.X.

3000

'Etoč 1

476 μ.X

1492 μV

1789 μ.X

σήμερα

Τρόφιμα και χρήσεις γης_2

Has the world passed peak agricultural land?

Agricultural land is the sum of cropland and pasture used for grazing livestock.

Our World
in Data

Πηγή:

<https://ourworldindata.org/grapher/global-peak-agricultural-land>

This is shown for three sources, which use different methods of estimation. While they disagree on how much land is used for agriculture, and the exact date that it peaked, they do all agree that we have passed the peak.

5 billion ha

4 billion ha

3 billion ha

2 billion ha

1 billion ha

0 ha

10,000 BCE

6,000 BCE

4,000 BCE

2,000 BCE

0

2020

HYDE 3.2 (Goldewijk et al.)
UN FAO
Taylor and Rising (2021)

Source: Taylor & Rising (2021); Food and Agriculture Organization of the United Nations; Goldewijk et al. (2017)
OurWorldInData.org/land-use • CC BY



1000 π.Χ.



3000 π.Χ.

Έτος 1

476 μ.Χ



1492 μ.Χ.

1789 μ.Χ.



σήμερα

3 εκ. χρόνια πριν

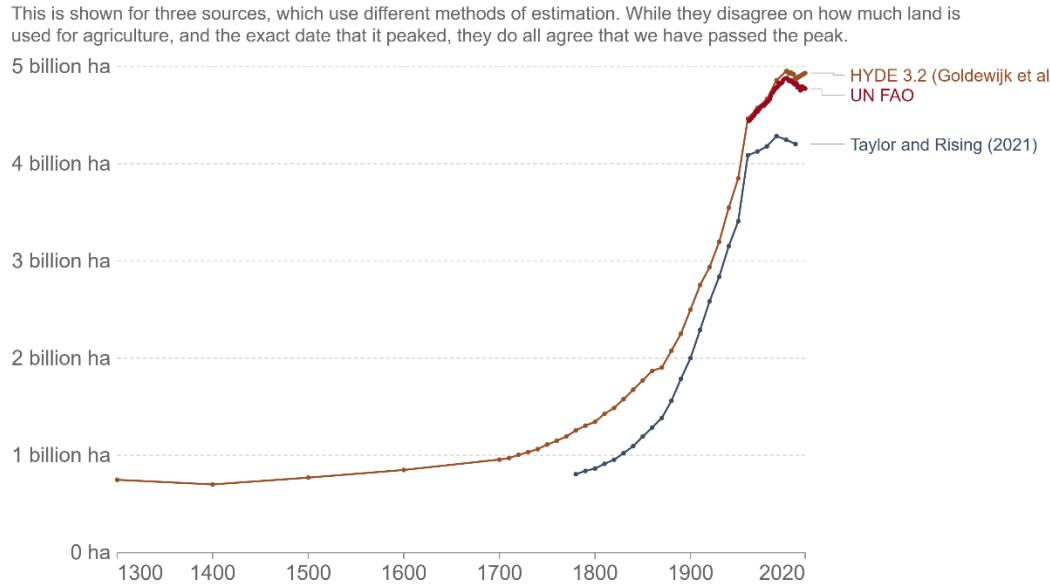
Τρόφιμα και χρήσεις γης_2

Has the world passed peak agricultural land?

Agricultural land is the sum of cropland and pasture used for grazing livestock.

Our World
in Data

Πηγή:
<https://ourworldindata.org/grapher/global-peak-agricultural-land>



Source: Taylor & Rising (2021); Food and Agriculture Organization of the United Nations; Goldewijk et al. (2017)
OurWorldInData.org/land-use • CC BY



1789 μ.Χ.



σήμερα

3 εκ. χρόνια πριν

10000 π.Χ.

3000 π.Χ.

Έτος 1

476 μ.Χ

1492 μ.Χ.

Τρόφιμα και χρήσεις γης_3

Agricultural land use per person

This dataset is showing estimates of the total agricultural land area – which is the combination of cropland and grazing land – per person. It is measured in hectares per person.

Our World
in Data

Πηγή:
<https://ourworldindata.org/grapher/total-agricultural-land-use-per-person>



Source: History Database of the Global Environment (HYDE)

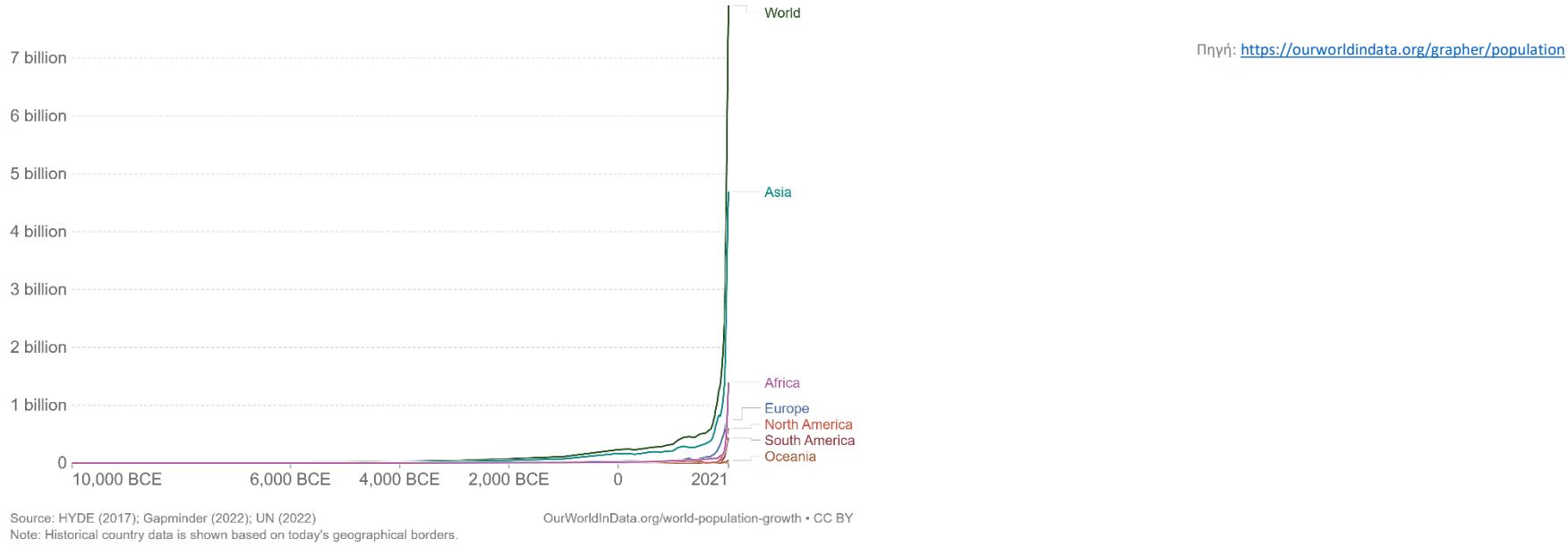
OurWorldInData.org/land-use • CC BY



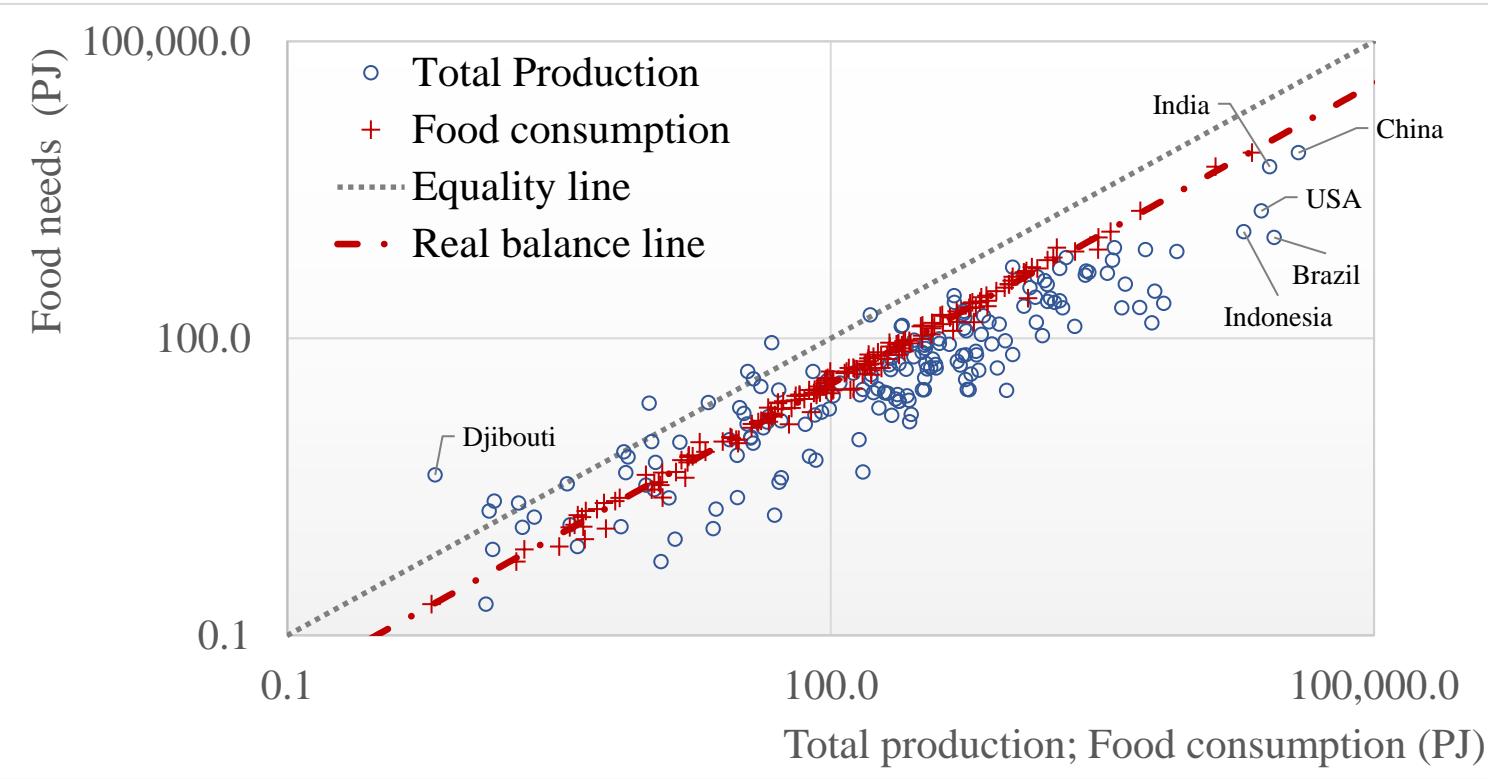
Η εξέλιξη του πληθυσμού

Population, 10,000 BCE to 2021

Our World
in Data



Διαθεσιμότητα των τροφίμων_1

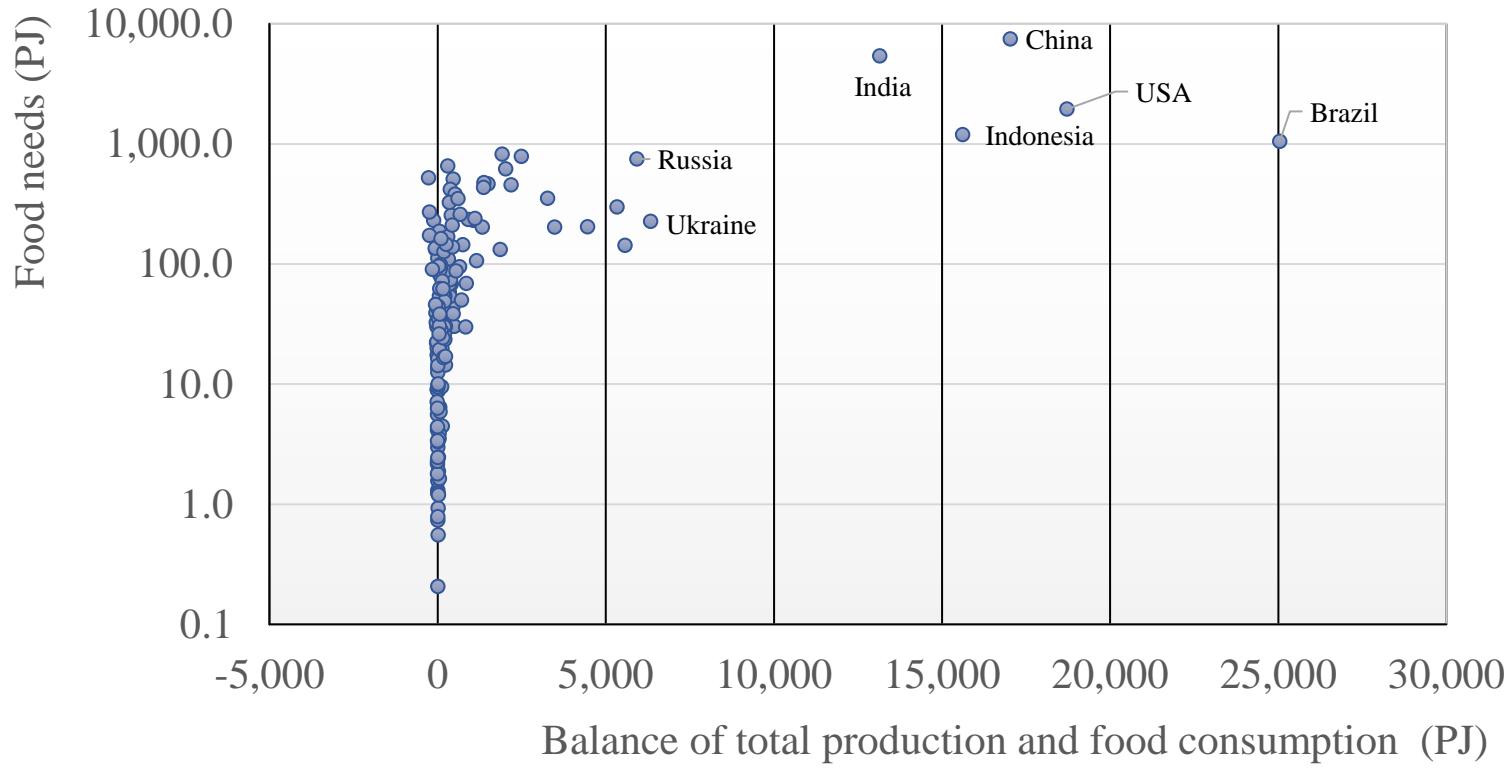


Πηγή: Sargentis, G.-F.; Koutsoyiannis, D. The Function of Money in Water–Energy–Food and Land Nexus. *Land* 2023, 12, 669.

<https://doi.org/10.3390/land12030669>



Διαθεσιμότητα των τροφίμων_2

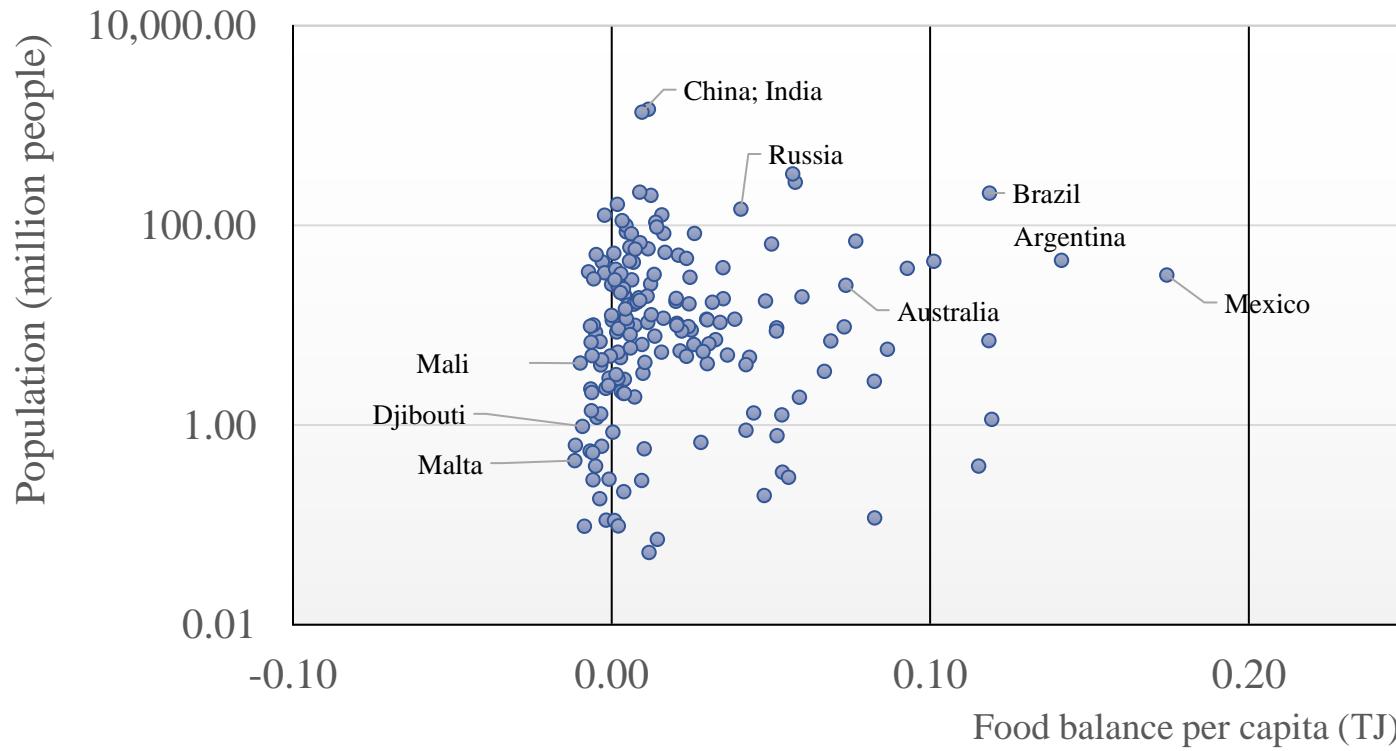


Πηγή: Sargentis, G.-F.; Koutsoyiannis, D. The Function of Money in Water–Energy–Food and Land Nexus. *Land* 2023, 12, 669.

<https://doi.org/10.3390/land12030669>.



Διαθεσιμότητα των τροφίμων_3



Πηγή: Sargentis, G.-F.; Koutsoyiannis, D. The Function of Money in Water–Energy–Food and Land Nexus. *Land* 2023, 12, 669.
<https://doi.org/10.3390/land12030669>.



Πηγές

Sargentis, G.-F.; Siamparina, P.; Sakki, G.-K.; Efstratiadis, A.; Chiotinis, M.; Koutsoyiannis, D. Agricultural Land or Photovoltaic Parks? The Water–Energy–Food Nexus and Land Development Perspectives in the Thessaly Plain, Greece. *Sustainability* 2021, 13, 8935. <https://doi.org/10.3390/su13168935>.

Sargentis, G.-F.; Iliopoulou, T.; Dimitriadis, P.; Mamassis, N.; Koutsoyiannis, D. Stratification: An Entropic View of Society's Structure. *World* 2021, 2, 153–174. <https://doi.org/10.3390/world2020011>.

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Sargentis, G.-F.; Koutsoyiannis, D.; Angelakis, A.; Christy, J.; Tsionis, A.A. Environmental Determinism vs. Social Dynamics: Prehistorical and Historical Examples. *World* 2022, 3, 357–388. <https://doi.org/10.3390/world3020020>.

<https://ourworldindata.org/>

Το χρήμα στο πλέγμα νερού-ενέργειας και τροφίμων

Παρουσίαση του paper: Sargentis, G.-F.; Koutsoyiannis, D. The Function of Money in Water–Energy–Food and Land Nexus. *Land* 2023, 12, 669.

<https://doi.org/10.3390/land12030669>

<https://youtu.be/3VQG7wiKBk4>

<https://youtu.be/UhJCsQXUwxg>

ΑΕΠ και ενέργεια



Data

This page in: English Español Français العربية 中文

GDP (current US\$)

Search data e.g. GDP, population, Indonesia



DataBank Microdata Data Catalog



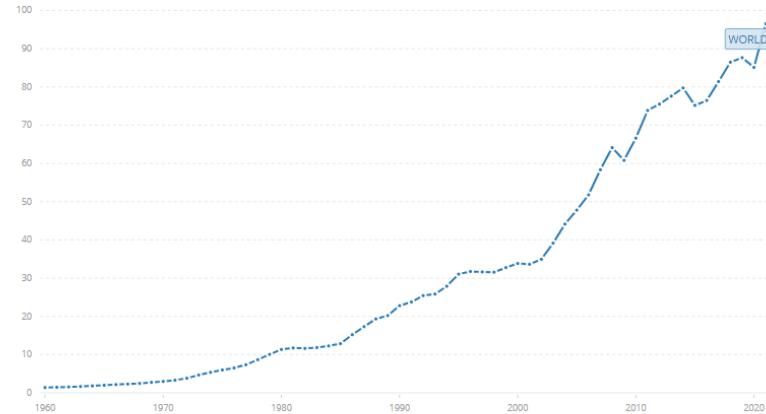
GDP (current US\$)

World Bank national accounts data, and OECD National Accounts data files.

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Line Bar Map

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 LABEL

1960 - 2021

GDP growth (annual %)



GDP (constant 2015 US\$)



GDP (constant LCU)

GDP: linked series (current LCU)

GDP, PPP (constant 2017 international \$)



GDP (current LCU)

GDP, PPP (current international \$)



GDP per capita growth (annual %)



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DataBank

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Thematic data tables from WDI

ΑΕΠ και ενέργεια

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GovData360

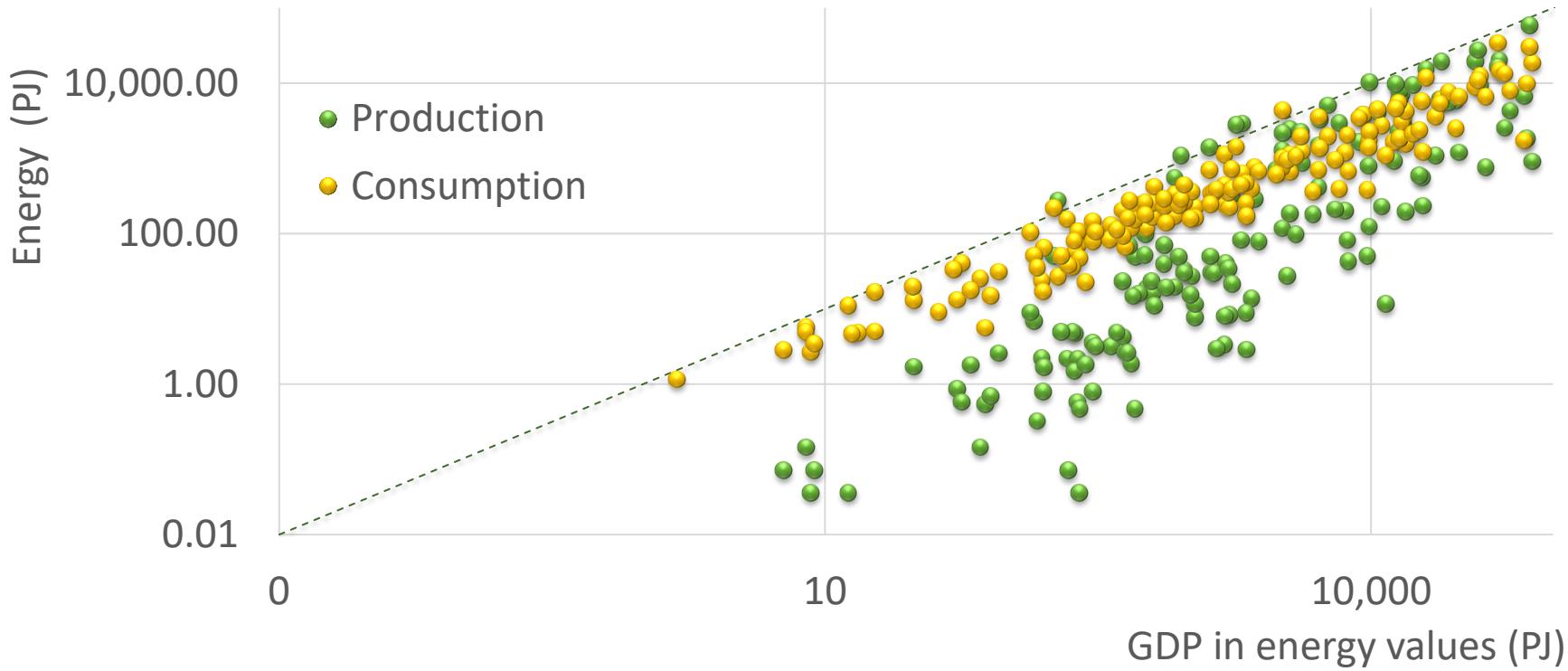
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Getting electricity: Price of electricity

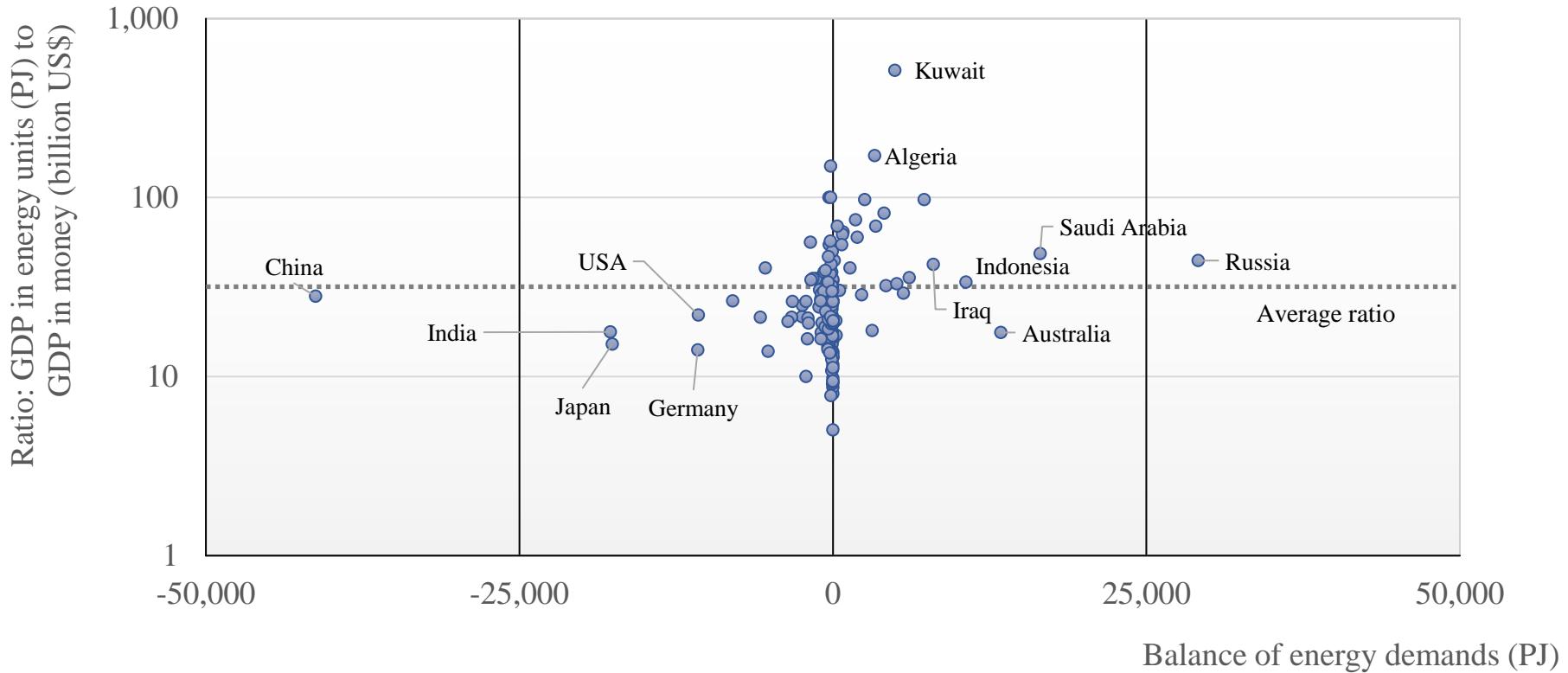
US cents per kWh (DB16-20 method... ▾)

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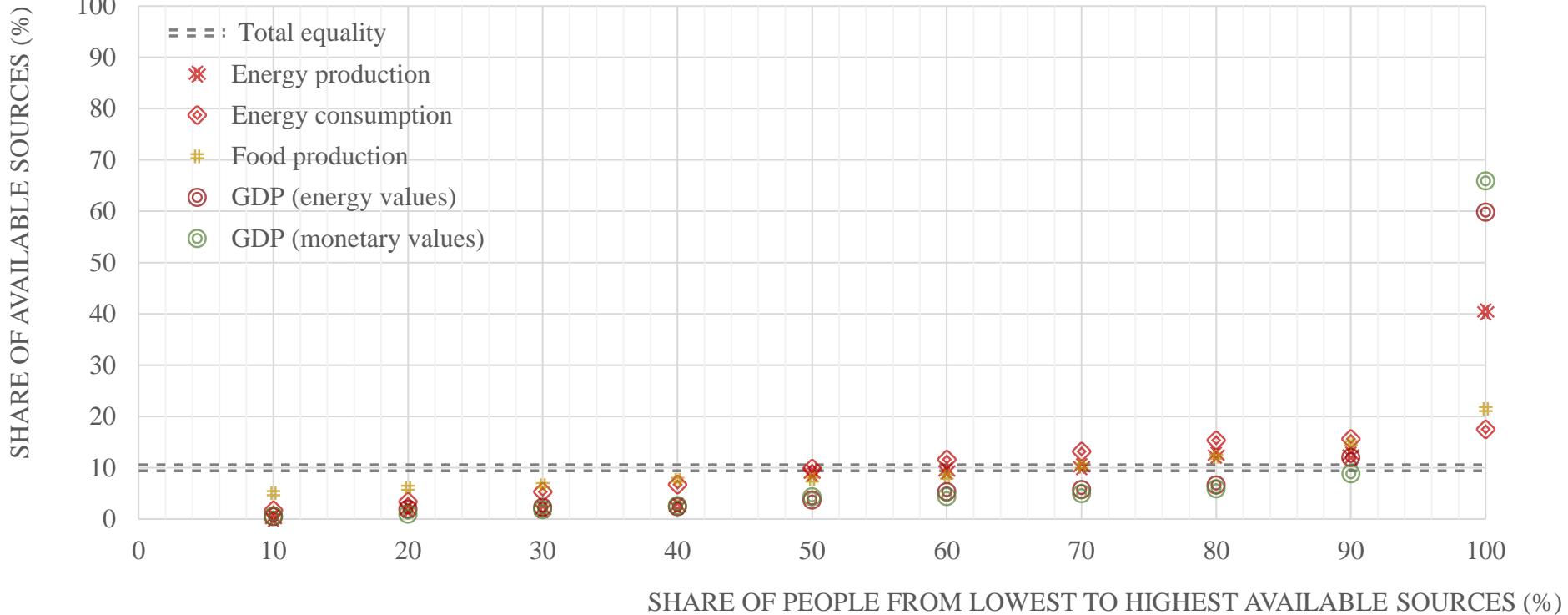
ΑΕΠ και ενέργεια



ΑΕΠ και ενέργεια



Οι ανισότητες στο πλέγμα



Οι ανισότητες στο πλέγμα

