European Journal of Social Sciences Studies
ISSN: 2501-8590
ISSN-L: 2501-8590
Available on-line at: www.oapub.org/soc

DOI: 10.46827/ejsss.v11i2.1976 Volume 11 | Issue 2 | 2025

NATURE-BASED SOLUTIONS AIMED AT SAVING NON-RENEWABLE RESOURCES; THUS, LIMITING THE NEGATIVE EXTERNALITIES THEIR EXPLOITATION CAN ENTAIL: ONLINE INFORMATIVE AND EDUCATIONAL DOCUMENTS

Aldo Tommaso Marrocco[i]
Professor, Former Science Teacher,
"Istituto Comprensivo G. Toniolo",
Pisa, Italy

Abstract:
The article presents free online documents on the negative externalities observed as a consequence of non-renewable natural resources exploitation. Some of the documents presented deal with studies aimed at mitigating such negative externalities. Water is a declining basic resource; its mismanagement results in, e.g. aquifer depletion, soil salinisation, and reservoir siltation. Some documents presented, inter alia, deal with water saving in agriculture, aquifer recharge, and the importance of forests in generating rainfall. The exploitation of fossil fuels is associated with negative externalities, including climate change and armed conflicts. Some documents suggest the utilisation of biomasses for bioenergy, and describe the strategy used in Sweden where a part of the forest residues is used for this purpose. Some residues are left in the forest where they assist regeneration and biodiversity; over time they naturally decay and release CO_2 into the atmosphere. The CO_2 emitted by forest residues harvested and then utilised for bioenergy is offset by the avoided emissions from fossil fuels they replace. In Sweden, the use of fossil heating fuel has dropped by more than 90%, and in case of wildfires the previous removal of forest residues results in less dangerous fires. In Nauru, mining phosphate fertilisers resulted in an environmental devastation of the forest and of the reef surrounding the island, and left the land uncultivable. With less people employed in farming and fishing, their physical activity declined dramatically, while people switched from natural to processed food. Unsurprisingly, this resulted in very high levels of obesity and diabetes, and many other related health adverse effects. Several documents deal with best practices in the management of phosphorus fertilisers, considered a non-renewable resource, and nitrogen fertilisers whose production is so energy intensive. A good management of these resources may also reduce marine eutrophication and hypoxia.

[i] Correspondence: email aldo_marrocco@yahoo.it

Аннотация:
В статье представлены бесплатные онлайн-документы о негативных внешних эффектах, наблюдаемых в результате эксплуатации невозобновляемых природных ресурсов. Некоторые из представленных документов посвящены исследованиям, направленным на смягчение таких негативных внешних эффектов. Вода является сокращающимся основным ресурсом; неправильное управление ею приводит, например, к истощению водоносных горизонтов, засолению почв и заиливанию водохранилищ. Некоторые представленные документы, в частности, касаются экономии воды в сельском хозяйстве, пополнения водоносных горизонтов и важности лесов для получения осадков. Эксплуатация ископаемых видов топлива связана с негативными внешними эффектами, включая изменение климата и вооруженные конфликты. В некоторых документах предлагается использовать биомассу для получения биоэнергии и описывается стратегия, применяемая в Швеции, где часть лесных остатков используется для этих целей. Часть остатков оставляют в лесу, где они способствуют восстановлению и биологическому разнообразию; со временем они естественным образом разлагаются и выделяют CO_2 в атмосферу. Выбросы CO_2, образующиеся при заготовке и последующем использовании лесных остатков для получения биоэнергии, компенсируются выбросами ископаемого топлива, которое они заменяют. В Швеции использование ископаемого топлива для отопления сократилось более чем на 90 %, а в случае лесных пожаров предшествующая уборка лесных остатков приводит к снижению опасности возгорания. На Науру добыча фосфорных удобрений привела к экологическому опустошению рифа, окружающего остров, леса и оставила землю неплодородную. Поскольку в сельском хозяйстве и рыболовстве было занято меньше людей, их физическая активность резко снизилась, а люди перешли с натуральной пищи на обработанную. Неудивительно, что это привело к очень высокому уровню ожирения и диабета, а также ко многим другим негативным последствиям для здоровья. В нескольких документах рассматриваются передовые методы управления фосфорными удобрениями, которые считаются невозобновляемым ресурсом, и азотными удобрениями, производство которых требует больших затрат энергии. Правильное управление этими ресурсами может также уменьшить морскую эвтрофикацию и гипоксию.

Riassunto:
L'articolo presenta documenti online gratuiti sulle esternalità negative conseguenti allo sfruttamento di risorse naturali non rinnovabili. Alcuni dei documenti presentati riguardano studi volti a mitigare tali esternalità negative. L'acqua è una risorsa di base sempre più scarsa; la sua cattiva gestione comporta, ad esempio, esaurimento delle falde acquifere, salinizzazione del suolo ed insabbiamento dei bacini idrici. Alcuni documenti presentati riguardano, tra l'altro, risparmio idrico in agricoltura, ricarica delle falde acquifere ed importanza delle foreste nel generare precipitazioni acquose. Lo

sfruttamento dei combustibili fossili è associato ad esternalità negative, tra cui il cambiamento climatico e conflitti armati. Alcuni documenti suggeriscono produrre bioenergia dalle biomasse e descrivono la strategia utilizzata in Svezia, dove una parte dei residui forestali viene utilizzata a questo scopo. Qui, alcuni residui vengono lasciati nella foresta dove contribuiscono alla sua rigenerazione ed alla biodiversità; col tempo si decompongono naturalmente e rilasciano CO_2 nell'atmosfera. La CO_2 emessa dai residui forestali raccolti e poi utilizzati per produrre bioenergia è compensata evitando emissioni dei combustibili fossili. In Svezia, l'uso di combustibili fossili per il riscaldamento è diminuito di oltre il 90%. Inoltre, eventuali incendi forestali qui sono meno gravi grazie alla rimozione preventiva di una parte dei residui. A Nauru, l'estrazione di fertilizzanti fosfatici ha provocato la devastazione della foresta, della barriera corallina che circonda l'isola ed ha lasciato la terra incoltivabile. Con meno persone impiegate in agricoltura e pesca, l'attività fisica della popolazione è molto diminuita; al contempo, si è passati dagli alimenti naturali a quelli trasformati. Non sorprende che questo abbia portato livelli elevatissimi di obesità e diabete, nonchè molti altri effetti negativi sulla salute. Diversi documenti trattano le migliori pratiche nella gestione dei fertilizzanti a base di fosforo, considerato una risorsa non rinnovabile, nonchè di azoto la cui produzione è molto energivora. Una buona gestione di queste risorse può anche ridurre eutrofizzazione marina ed ipossia.

Keywords: online educational documents, resource curse, fertilisers, agroforestry, groundwater, rainfall, fossil fuels, bioenergy

1. Aims of the teaching unit

The article and the documents quoted hereafter are aimed at increasing information and awareness about the externalities associated with the mismanagement of natural resources. Several experiences deal with the mitigation of such externalities.

2. Materials and methods

The paper presents educational and informative documents downloadable for free from the internet. They consist of text, images, videos and graphs, and can be used by teachers with the method felt as most appropriate.

The subject is very complex and, for a more in-depth study, “Evaluating Web Pages: Questions to Consider: Categories” (46) may help to select additional reliable literature.

3. Introduction

The exploitation of natural resources, including water, fossil fuels, metals and other minerals, enabled the development of our society. But, especially in certain countries, resource mismanagement has led to negative externalities, with most of the population not benefiting from the wealth. This is the so-called Resource Curse.

A video of the Assistant Professor Bhuiyan I.H. deals with the Resource Curse theory (76).

De Morais R.M., a human rights defender discusses the abuses suffered by the Angolan population during a war that lasted 27 years, with the diamond trade playing a pivotal role (74 video). Sadly, according to the author, *where there are natural resources, there is the likelihood of finding more poverty, with the local population that does not benefit from such resources*.

According to "Natural Resources and Violent Conflict", developing countries whose economies are highly dependent on primary commodities are significantly exposed to a higher risk of poor governance and violent conflict (75 figure 1.1). *In some cases, legal or illegal revenues generated by the exploitation of natural resources have financed devastating conflicts in many countries*.

Again, according to the World Bank document (75), the resource curse is not a destiny, however. The document explains several mechanisms, and provides some ideas on the measures that the international community may take in order to help countries in the control of illicit activities related to resources.

4. Water, the growing need for a declining basic resource

"The Global Groundwater Situation: Overview of Opportunities and Challenges" describes several situations observed worldwide, where water abstraction is exceeding recharge. For instance, several aquifers in Mexico are exhibiting an annual decline between 1.79 and 3.3 metres. Whereas the water tables in some Southern Korean industrial cities have dropped by 10-50 metres in 30 years. In some Indian residential areas, the groundwater tables are falling at an annual rate of 7-10 ft. (36).

Groundwater depletion is causing acute problems of subsidence in several cities, drying up of natural springs, collapse of wetland ecosystems, or results in seawater intrusion into coastal aquifers (36).

Agriculture accounts for 72% of the global freshwater withdrawals. Availability and quality of water are quickly declining as a consequence of mismanagement, pollution, population growth, economic development, and climate change (20).
The 2050 agriculture may need to produce almost 50% more food, feed and biofuel than in 2012, which will require more water (25 / 26 page 46).

According to an USGS document, Saudi Arabia was planning to grow wheat in its desert areas, using for irrigation *fossil* water. In fact, the *limited rainfall in that area implies*

that the aquifer is not recharged, thus making this groundwater a non-renewable resource. As a consequence, according to the hydrologists, this production could only go on 50 years (86). Nowadays, the plan has changed, and the local farmers are encouraged to engage in alternative sustainable agricultural activities.

According to professor Stern R., of the University of Texas, the water of the Ogallala Aquifer, underlying eight states, has enabled the transformation of an arid area into the largest US agricultural region (15 video).

But the low rainfall in this arid region results in a limited recharge rate of the aquifer, as compared to the 26 cubic kilometres per year water withdrawal. Over time, this may lead to the exhaustion of the aquifer, and *turn again the region to the dry wasteland it once was* (15).

According to the video, using more efficient irrigation techniques, planting crops that require less water, injecting freshwater into the aquifer, and saving and recycling water are necessary to preserve the Ogallala aquifer (15).

4.1 International water disputes

According to "What Causes Water Conflict?", as shown in the first graph of the document (25), worldwide water-related conflicts are increasing. When different countries and communities share scarce water resources, rising demand and unsustainable management may trigger conflicts.

"Editor's Pick: 10 Violent Water Conflicts" discusses situations where droughts or water resources mismanagement, in already water-stressed countries, may cause, e.g. a decline in rural incomes, thus providing incentives for joining armed groups (42). This document also provides an example of two co-riparian countries that, despite tensions, work together in their mutual interest, thus sharing the waters equitably.

"Interstate Dam Disputes Threaten Global Security" examines the situation in the Middle East, in East Africa, and in South and Southeast Asia. According to the US document, when a state builds a dam, downstream riparian countries can be adversely affected. This may contribute to both domestic and international tensions, which in the past have pushed countries to the brink of war, which suggests the importance of robust, clear and equitable water-sharing agreements (41).

4.2 Soil salinisation

Two documents deal with the accumulation of salts in cultivated soils, a growing global problem that is implying a loss of agricultural soils, unless actions are taken. Typically, in irrigated soils, the water undergoes evapotranspiration, while the mineral salts it contains do not evaporate and remain in the soil, over time accumulating in such amounts that many crops can no longer grow there (22 Chapter 7 / 21 video). The video shows a salinised field.

The salts that accumulate during the irrigation season can be leached by rainfall, *but this does not occur in dry climates where evaporation prevails over the percolation process*

(24). Table 1 of this 2010 document shows the global distribution of salt-affected soils by geographic area, with a total 12,781.3 million hectares.

4.3 Role of agricultural soil management in water infiltration

According to "Gravel Mulch as an Effective Tool for Salinity Management in Orchards of Salt-affected Arid Regions", gravel mulching reduces runoff and evaporation of soil moisture and increases water infiltration (23). Images and text help to understand how terracing, mulch and windbreaks combined reduce the need for irrigation, thus contributing to preventing soil salinisation.

Two videos (28 / 29) show how soil management may also result in higher infiltration and reduced runoff. A soil under conventional tillage exhibited an infiltration rate of 3.1 inches per hour. Conversely, under continuous no-till management, thanks to different soil structure, the infiltration rate observed is 50.4 inches per hour (29 video).

According to "Soil Health Demonstration: Rainfall Simulator", the better infiltration and the lower runoff observed in reduced-till and no-till soils also imply a lower loss of nutrients (28 video).

Two videos show how, e.g. cereal grains or soybean seeds, or potatoes are planted in no-tilled soils. Here, cover crops are roller crimped and left on the soil as a mulch; subsequently, just narrow trenches are dug where the seeds must be placed (39 / 30).

A video discusses the pros and cons of no-till farming, as compared to conventional farming methods (89).

4.4 Techniques aimed at improving underground water recharge

In monsoonal areas, such as India, most of the annual rainfall is concentrated in about 100 hours of heavy downpour, *which are not enough for the water to infiltrate into the soil and recharge the aquifer.* This suggests that the recharge rates need to be increased and that *only a mass popular action on a regional scale may counteract the aquifer depletion*. In West India, 300,000 wells were modified so that rainwater could be diverted to them (36).

An Indian educational video shows a recharge pit used to store underground the rainwater that falls on the roof of a building and on surrounding areas. The pit should be deep enough to reach a porous layer of soil. The use of recharge pits may contribute to increasing the underground water level, while contributing to mitigating floods (37).

"Incentivizing groundwater recharge through payment for ecosystem services (PES)" deals with a Japanese city, where about one million people depend on groundwater for their water supply. Here, as a consequence of increased water consumption and decreased recharge, this resource was depleting (40).

For this reason, the farmers were encouraged to grow again rice in abandoned paddy fields. Thanks to recharge rates as high as 100-200 mm/day, these rice fields satisfy 13% of the total water demand. The farmers were paid for this ecosystem service, and organic farming has been promoted to achieve the best results in terms of water quality (40).

According to "The effect of trees on preferential flow and soil infiltrability in an agroforestry parkland in semiarid Burkina Faso", tree planting in dry areas is often discouraged, due to their water consumption. But the positive impacts of trees on water infiltration are overlooked (38). In fact, thanks to a higher soil organic matter content, roots, and faunal activity observed beneath trees, water infiltration in their close vicinity is largely increased. While increasing groundwater recharge, this results in a reduced runoff.

"Trees, forests and water: Cool insights for a hot world" shows the effect of tree cover on rainfall infiltration and groundwater recharge (36 figure 3). We can observe that, with a scarce tree cover on the soil, both runoff and evaporation from the soil are huge, with limited water infiltration and groundwater recharge. Conversely, a dense forest limits strongly both runoff and evaporation from the soil, but the huge amount of transpired water limits the groundwater recharge. An intermediate tree density has the potential to provide the best results with regard to infiltration and hence groundwater recharge, which also may help mitigate flooding.

4.5 Forests generate rainfall

The rainfall is determined by the condensation of moisture generated by evaporation from the ocean and evapotranspiration from the continents. The natural forests, thanks to the huge area of all the leaves of its trees, provide a lot of evapotranspiration. Subsequently, the condensation of the water vapour to liquid creates a drop in air pressure that sucks in more air from the coast (34 video / 33).

According to an FAO document, 70% of the vapour generated over the continents comes from plants (31). The reduction in rainfall experienced in the southern Brazil in recent years has been associated with deforestation.

"The largest river on Earth is actually in the sky" helps to visualise how the water rises from the forest soil to the leaves of the trees and then to the atmosphere. The video also deals with the need to protect the natural habitat (32 video).

According to "Why we need a new economics of water as a common good", even the precipitation in a large country relies on water evaporated elsewhere. The deforestation, e.g. in the Congo Basin and Brazil, results in reduced rainfall in neighbouring countries (27). The situation may worsen if deforestation continues, and an international governance framework is necessary to avoid a catastrophe.

"The Nile Basin waters and the West African rainforest: Rethinking the boundaries" shows the moist air masses that, from the sea, reach the Ethiopian Highlands, with the West African rainforest adding extra moisture (45 graphical abstract). The rainfall originating from such moisture-laden air masses provides most of the freshwater supply to several African countries.

The deforestation of the West African rainforest results in a reduced amount of moisture, which in turn reduces the amount of rainfall and modifies its timing, thus implying adverse effects on the Nile water flow. This river basin is among the most water-

stressed regions of the world, with a quickly growing population and a declining water per capita availability. This situation may contribute to international tensions over the management of the water needed for food security (45 figure 2).

Over time, many water agreements have been signed between the riparian countries regarding the utilisation of the Nile waters. *But, such agreements should also involve the states of the West African rainforest region, from where moisture-laden air masses arrive* (45). An appropriate form of collaboration could consist of transregional payments for ecosystem services.

In the absence of sufficient climate action, the World Bank estimates that, by 2050, 216 million people may be forced to move due to the impacts of climate change (44). Conversely, again according to "Acting on Internal Climate Migration", if appropriate measures are taken, this number could be reduced to 44 million people.

4.6 Making the best use of the water that accumulates in reservoirs

According to "The European mountain cryosphere: a review of its current state, trends, and future challenges", among the consequences of climate change, the volume of the alpine glaciers is forecast to shrink by up to 90% of their volume. The snow season will be much shorter than it is today. By the end of the century, the amount of water available in the snow is projected to decline by 80-90% at an elevation of 1,500 metres above sea level (54). This will imply significant impacts on water availability downstream with consequences for drinking water, irrigation, and hydropower production.

According to "All dams are temporary" (47), without intervention, the majority of reservoirs may gradually fill up with sediments carried by the river. The video shows an US reservoir built in the 1950s, whose storage capacity nowadays is reduced by 30% as a consequence of sand and silt deposition.

According to a 2004 study reviewed in "Sustainable sediment management in reservoirs and regulated rivers: Experiences from five continents" (49), the *global storage capacity of the existing reservoirs is decreasing at such a rate that it will be halved by 2100. A reservoir is built to store water for flood control, irrigation, and the generation of electricity*. Consequently, the more sediment replaces water, the less value the reservoir provides. In addition, the value that such sediments could have for the downstream environment is lost because they remain trapped in the reservoir. The video examines *several methods aimed at preventing silting, or at removing the silt accumulated in the reservoir* (47).

The sediments trapped in reservoirs can be considered as resources out of place (49). Many coastal areas rely on sediment supply for their own maintenance. For instance, the Mississippi River delta has lost 4,800 km^2 as a consequence of a reduced sediment supply.

Reforestation, controlled grazing, and terracing are techniques aimed at reducing the erosion of the watershed upstream of the dam, and hence the amount of sediment entering the reservoir. Or, when the river waters are sediment-laden, they can be by-

passed directly downstream without entering the reservoir. These and other techniques are described in the document, that has a video, animations, and links to case studies (48).

5. Externalities consequent to fossil fuels use: the climate change

The atmospheric CO_2 concentration has increased from approximately 278 ppm in 1750 to 417 ppm in 2022 (62). At the beginning, the increase was mainly caused by carbon released into the atmosphere from deforestation and other land use change activities. From around 1950, the emissions from fossil fuels became the dominant source of anthropogenic emissions into the atmosphere.

A document of the Intergovernmental Panel on Climate Change deals with projections on future global climate (61). The last part of the document contains FAQs and answers; FAQ 4.3 deals with climate change and regional patterns.

Figure 4.2 (61) shows, *under different emissions scenarios, graphs on global change in temperature, precipitations, mean sea level*, and the September Arctic sea ice area. Figures 4.3 and 4.8 show, respectively, the projections up to 2100 of atmospheric CO_2 concentration and the global surface ocean pH; the document also discusses the acidification of the ocean.

Globally, around 2050, net zero CO_2 emissions should be reached to limit warming to 1.5°C (63). At the same time, even the emissions of other climate forcers, such as methane, need to be strongly reduced. This mitigation pathway implies, inter alia, energy-demand reductions with lower use of goods that imply high greenhouse gas emissions, decarbonisation of electricity and other fuels. *Some sources of black carbon should be limited,* for the impact on snow and ice loss (63).

According to the National Oceanic and Atmospheric Organisation, *black carbon, while it remains in the air, absorbs sunlight, thus contributing to warming the atmosphere and affecting the formation of clouds and rain patterns. Black carbon covering ice and snow contributes to accelerating their melting* (64 video). *Black carbon is also emitted from forest fires.*

According to "What happens if we 'burn all the carbon'? carbon reserves, carbon budgets, and policy options for governments", the combustion of the proven reserves of fossil fuels might result in the generation of 4,777 Gt of CO_2 (65). *This would lead very close to RCP8.5, which is the worst of the IPCC emissions scenarios*.

Investments in oil and gas fields are continuing because the investors, while recognising the possibility that governments might restrict fossil fuels use, do not believe this will happen soon (65). The document discusses policies that could convince investors in fossil fuels that governments are serious about climate change. For instance, *governments might use financial instruments that hold themselves accountable for achieving their policy objectives, e.g. the issue of bonds linked to specific targets. These latter could be a reduction in CO_2 emissions or a renewable energy deployment, where the government itself is committed and incentivised to prioritise and actively pursue the objectives* (65).

5.1 Sea level rise

"Sea Level Projection Tool" is a 2021 NASA map based on the assessment presented in the IPCC Sixth Assessment Report. It provides the projections for 2100 for any location anywhere in the ocean, according to the *different scenarios that depend on future greenhouse gas emissions* (58).

Notoriously, melting glaciers and thermal expansion increase the volume of sea water. In addition, according to "The Secret of Sea Level Rise: It Will Vary Greatly By Region", other factors may exert a local influence (59). For instance, changes in the prevailing winds can push water toward or away from the coast. The loss of ice, e.g. from Greenland, implies a gravitational weakening that causes the sea water to move away, thus resulting in a locally lowered sea level.

In some geographic areas, in addition to sea level change, the ground is subsiding, e.g. due to oil and gas extraction (59 / 60).

5.2 Some examples of environmental pollution linked with fossil fuels extraction

According to a USGS document, at the end of the productive lifetime of an oil well, it is supposed to be properly shut down, sealed, and the surrounding area returned as much as possible to the conditions before drilling. But this does not always occur, particularly in the past. More than 117,000 abandoned oil wells have been identified in the US, and up to 800,000 more are supposed to exist (83). This may result in safety and environmental problems. For instance, an abandoned well can emit greenhouse gases into the atmosphere or may cause water contamination.

An image in "Scientists Map Where Orphan Wells Pose Threats to Aquifers" shows how an old and deteriorated oil well may pollute air and water (84). "Study Shows 14,000 Unplugged Oil and Gas Wells in Gulf of Mexico" deals with the environmental damage and economic difficulties posed by abandoned offshore oil wells (90).

"Nigeria: Oil pollution in the Niger Delta" shows farmers and fishermen hit by an ecological disaster, with oil continuously seeping through leaky pipes since decades, thus poisoning soil and water. At the same time, open gas flaring pollutes the air (53 video).

According to "The human health implications of crude oil spills in the Niger delta, Nigeria: An interpretation of published studies", besides damaging human health, oil spills reduced soil fertility, killing plants or reducing yields (52).

The quality of food crops was also worsened. The household's food security was strongly reduced, with a 24% increased prevalence of underweight children in the areas affected by oil spills (52 table 7).

5.3 Fossil fuels, weapons, and conflicts

Again, in Nigeria, according to a document published by the US Army War College Press, the *economic benefits that oil has provided to the corrupt government have not been enjoyed by the entire population* (51). Oil industry activities displaced many residents, destroyed

fisheries and agricultural lands. This has resulted in large areas of social instability in the Niger Delta, with insurgents damaging pipelines and attacking governmental forces.

According to "Global arms trade and oil dependence", oil-dependent economies are likely to supply weapons to oil-rich countries in order to reduce the risks of instability in these latter. In fact, armed conflicts in oil-rich countries may result in insecurity in oil supply and growing prices, which in turn imply adverse effects on oil-dependent countries (55).

In some cases, *oil-exporting countries, besides buying weapons, use their wealth in subsidising extremist and terrorist groups that operate outside their borders* (51).

A 2022 document of the United Nations Security Council Counter-Terrorism Committee deals with the *use of the proceeds from illegal exploitation of natural resources to finance armed groups and terrorist activities* (50). This may occur, for instance, in the Middle East with oil and gas. Elsewhere, charcoal or other natural resources, such as precious metals and minerals, timber and wildlife have been exploited to finance terrorist activities.

In 2021, as much as 45% of the Russian federal budget was constituted by revenues from oil and natural gas, with Europe remaining a major market for these oil products (57). A link from "Energy Fact Sheet: Why does Russian oil and gas matter?" may provide information in this regard (57> A 10-Point Plan to Reduce the European Union's Reliance on Russian Natural Gas).

"Fossil Fuels are fuelling war" is a 2022 document of Greenpeace that deals with the links between the oil industry and conflicts in the Middle East, Sudan and Russia (56). According to the document, in order to help for both peace and climate crisis, the countries need to reduce their dependency on fossil fuels; just shifting from a supplier of oil and gas to another might not substantially modify the situation. *Differently from fossil fuels, renewable energy is based on infrastructures that are largely delocalised, which are less likely to feed the formerly mentioned geopolitical power struggles and inequality*.

5.4 Producing energy from forest residues, while reducing the potential for wildfires gravity

A 2021 document of the International Energy Agency entitled "Net Zero by 2050" discusses how to reduce emissions and give the world a chance of limiting the global temperature rise to 1.5°C (65). This implies a huge decline in the use of coal, oil and gas, without further investment in new fossil fuel supply, and with bioenergy among the key solutions. *For this latter, advanced bioenergy feedstocks are used that do not require land for being produced, and include forest residues and waste from agriculture*.

According to Peterson D., biologist for the U.S. Forest Service (67 video), *the single most important factor in determining the potential gravity of forest fires is the amount of fuel*. This latter is constituted by all the living and dead vegetation existing between the trees, which can easily burn. A reduced amount of fuel in the forest may result in less

dangerous fires. *Large blocks of forest with fuels greatly reduced, as shown in the video, help to slow down a fire easily*.

According to Hobby T., a forest economist and agrologist, in the past, the California forest underwent poor management. As a consequence, nowadays there are *overgrown forests with an excess of biomass that may constitute a ladder fuel, which has increased the susceptibility to catastrophic fires as compared to the past*, when the native Americans were there (68 video).

"Ladder fuels and wildfires" shows the importance of removing tightly-spaced vegetation and dead timber under larger trees to eliminate the possibility of a walking grass fire reaching into the crown of a large tree (69 video).

According to "Reusing Wood Waste For A Carbon Negative Bioeconomy" (68), for every tonne of biomass taken out of the forest we can get about 1.7 barrels of oil equivalent. Thanks to the gasification technology we can get, e.g. hydrogen, methane and aviation fuel, thus replacing fossil fuels with this renewable resource.

"The effectiveness of vegetation management practices for prevention and control of bark beetle infestations in coniferous forests of the western and southern United States" is a review study (43). Figures 1/6/8/9 show the consequences and progression of these catastrophic infestations. While reducing fire risk, thinning the forest results in fewer trees attacked by the beetle (43 table 4). Figure 2 shows the forest before and after the thinning operation.

Overcrowded forests are weakened by drought and higher temperatures; here, the competition for water is amplified. Insufficient moisture compromises the trees' ability to produce resin, so important in expelling bark beetles, as shown in the image. Thinning the forest can reduce the competition for water, thus resulting in healthier trees and improved situation of the Californian forests (70).

In Sweden, forest biomass is used for bioenergy. Small trees and bushes, discarded wood and stumps that result from thinning vegetation, tops and branches resulting from felling the trees are harvested for bioenergy use. Several images of the document show how the activity is carried out in the forest (2).

Not all the forest residues are harvested, some of them are left in the forest to assist in its own regeneration. The residues left in the forest, over time, naturally decay and release CO_2 into the atmosphere (2 page 55). *Whereas, the CO_2 emitted by the forest residues harvested and then utilised for bioenergy is offset by the avoided emissions from fossil fuels they replace; in case of wildfire, their previous removal results in less dangerous fires* (2 / 67 / 68).

In Sweden, while developing technology and market for forest bioenergy, in-depth studies have been carried out on, e.g. environmental sustainability for soil, water, nutrients and biodiversity. For instance, slash should not be taken from dry, steep or very wet sites and, at a national level, the harvest of 50 per cent of the slash should not be exceeded (2).

A part of the formerly mentioned forest residues contributes to the soil carbon pool. Leaves and needles play an important role in the growth of the following tree

generation because they contain more nitrogen than the stem wood. When the vegetation is thinned, the small birds are less protected, which should also be seriously considered. Old broad-leaf trees, bushes carrying berries, and some dead coarse wood contribute in promoting biodiversity. In some cases, the ash resulting from burning the wood is spread on the forest floor to increase fertility; this is primarily done in locations where acidification is to be countered (2).

Thanks to this management, in Sweden and other Nordic countries, the forests are less affected by natural disturbances than in North America and Siberia. The document widely discusses the potential for bioenergy of European forests, and Russian and Canadian boreal forests. Interestingly, in European forests, and even more so in the boreal forests of Canada and Russia, there is a large potential for bioenergy *while reducing CO_2 emissions* (2).

According to "Bioenergy from boreal forests: Swedish approach to sustainable wood use", energy security concerns and environmental problems convinced the Swedes to develop bioenergy (2). The public support has been strong, with the *government adopting the carbon tax, which is considered the most important factor in making bioenergy more competitive with fossil fuels*.

Two graphs in "Carbon Taxation in Sweden" show, respectively, how this tax has developed between 1991 and 2023, and how the real GDP and CO2eq emissions have changed in this country (1). *While increasing the taxation on fossil fuels, the Swedish government has reduced labour taxes* and implemented temporary aid schemes for conversion to renewable heating. According to this governmental document, Sweden is committed to reaching *no net emissions of greenhouse gases by 2045,* and here the use of fossil heating fuel has already dropped by more than 90%.

5.5 Getting energy from organic waste originating from agriculture, households and the food industry

According to "Current state and future of biogas and digestate production", many European countries are facing huge problems of overproduction of organic waste originating from agriculture, households and the food industry. This implies the chance of producing biogas through the anaerobic digestion of such organic waste, *thus reducing the dependency on imported fossil fuels*. Biogas is mostly constituted by methane, which, once purified, can be injected into the natural gas grid (71). The process also produces digestate, a nutrient-rich material that can be used as a fertiliser.

Different materials, including wood that has undergone a delignification process, can be digested together; mixing materials with different C/N ratios may imply a positive synergy. The document discusses the factors involved in the process and the life cycle assessment according to materials and bioreactors used (71).

An Italian study deals with a promising strategy aimed at enhancing biogas yield from the organic fraction of municipal solid waste, which included leaves, grass, and woody materials originating from private yards and public green space (85). Thanks to a

microorganism, *Bjierkandera adusta*, woody residues have been efficiently delignified, with lignin degraded into materials available for subsequent anaerobic digestion.

"How does a biogas plant work? Anaerobic Digestion explained" is the title of a German video. The plant utilises the organic fraction of municipal solid waste produced by the community (3).

"Turning Animal Waste in Energy in Viet Nam" shows livestock farmers building small biogas plants, according to a programme aimed at properly disposing of animal waste while producing renewable energy and reducing CO_2 emissions (81).

According to "Stubble burning: Effects on health & environment, regulations and management practices", the burning of stubble is recognised as an important global contributor to air pollution. This is particularly true for South Asia; here, in 2012, air pollution caused 5 million victims (72). After harvesting crops, large amounts of stubble remain in the fields and are burned in order to quickly clear the soil for the next planting. This Indian study describes the composition of these emissions, which include gases and particles known for affecting climate and human health. The numerous numerical data provided by the document, the images of the graphical abstract, and figure 1 may help to understand the size of the problem.

As an alternative, e.g. the stubble could be incorporated into the soil to restore fertility. Or the stubble can be used as a feedstock for bioethanol or biogas production, thus reducing the formerly mentioned toxic emissions, and the dependency on imported fossil fuels (72). The use of agricultural waste for energy, differently from the utilisation of edible materials for the same purpose, does not contribute to the food crisis.

According to a 2014 study reviewed in this document (72), an efficient use of agricultural stubble might fulfil as much as 17% of the total Indian energy demand.

According to a document of the International Energy Association, the materials available for sustainable biogas production are largely underutilised; conversely, their full utilisation could cover 20% of global gas demand. They include crop and livestock waste, forestry residues, municipal solid waste and wastewater. A graph compares the actual production and the potential (82).

According to a document of the Pennsylvania State University, the earliest digestion plants were built before 1900. Nowadays, millions of low-technology farm-based digesters exist (73). *Notoriously, many technologies used for the energy transition imply the utilisation of critical metals; conversely, a key factor in the success of many European digesters is the simplicity of their design*.

6. Fertilisers mismanagement may lead to negative externalities

In Nauru, 80% of the surface of the island underwent strip mining aimed at the extraction of phosphate rock. This left the mined land uncultivable, which *has amplified the dependency of the island on the imports of food* (5). The degradation of the forest had an impact on water and air quality, soil erosion, and the potential as a tourist destination.

Even the reef surrounding the island, once a rich food source, as a consequence of pollution from the shipping lines and industry, underwent significant degradation (7). Thanks to the sale of phosphate Nauru became a very rich country but, without having saved or invested effectively the money, when the mine became exhausted this small country underwent a financial collapse (8).

With less people employed in farming and fishing, the level of physical activity underwent a dramatic decline. At the same time, the traditional Nauruan diet based on fish, fruit and vegetables switched to imported energy-dense and nutrient-poor processed foods (6 / 8). Unsurprisingly, nowadays, we observe a particularly high level of obesity and the highest level of people suffering from type 2 diabetes in the world, with many of them affected by blindness and amputations. Here, high levels of heart and kidney disease are also observed (6 figures 2-3-4 / 8).

"Nauru National Assessment Report For The Third International Conference On Small Island Developing States" discusses the very many challenges and vulnerability suffered by Nauru (5). For instance, according to this 2013 document, the need is felt to strengthen the cultural level, including writing and reading in Nauruan language. *Nauru also suffers a lack of environmental, health and nutrition awareness programmes in schools*.

A video summarises the events that led the Nauruans into this situation (9).

6.1 Environmental impacts and energy consumption linked to chemical fertilisers

According to a 2007 IPCC document, the fertiliser industry utilises about 1.2% of global energy, with 90% of it used for producing ammonia (78).

"Dead Zone in the Gulf of Mexico" shows the low oxygen areas around the world, where fish cannot live (10 video and transcript). The Dead Zone of the Gulf of Mexico, for instance, in some years is as large as the New Jersey State. The fertilisers not utilised by crops, which end up in the river and finally in the sea, play an important role in this disaster. Such nutrients stimulate an overgrowth of algae, which then decompose, thus depriving marine animals of oxygen and causing those that cannot escape to die.

According to the Australian Institute of Marine Science, as a consequence of fertiliser use and increased erosion, large amounts of nutrients are discharged into the coastal waters of the Great Barrier Reef (11). This causes algal blooms that may increase the availability of food and survival of the crown-of-thorn starfish larvae; consequently, more adults will develop (11 / 12). These latter are a major cause of the decline of the reef because, annually, an adult can consume up to 10 square metres of coral. This animal may reach a 80 cm diameter and has toxic spines 4 cm long which deter predators, and can lay up as many as 200 million eggs.

6.2 Nature-based solutions aimed at making the most of nutrients, while mitigating the pollution

Ores of phosphate rock may contain various toxic metals and radionuclides, which cause water pollution when the ore is mined, and soil pollution when the fertiliser is applied

(87). Phosphorus is the most critical element in plant fertilisation because it is non-renewable, and should be used very efficiently, e.g. limiting run-off, recovering and reusing bio-wastes. Figure 1 (87) shows the biogeochemical cycle of phosphorus.

"Phosphorus Management: Best Management Practices for Minimizing Phosphorus Loss from Agricultural Soils" and "Surface Water Impacts – Effects of cover crops on surface water quality" study the relations between the loss of phosphorus from agricultural fields and no-till techniques, cover crops use, terraces and contouring (13 / 14).

According to "Agroforestry as an approach to minimizing nutrient loss from heavily fertilized soils: The Florida experience", *trees used in agroforestry, thanks to their deep roots can remove from the soil more nutrients than shallow-rooted crops can, which reduces the loss of nutrients from the fields* (17). Alley cropping also may reduce surface runoff and wind erosion, thus contributing to a better use of nutrients.

According to "Leaf Litter Decomposition and Nutrient Dynamics Associated with Common Horticultural Cropland Agroforest Tree Species of Bangladesh", the litter fallen from the trees provides a significant amount of nutrients to the soil (16). Agroforestry can play an important role in cycling nutrients while contributing to sustainable soil fertility.

"Basics of Agroforestry" shows how trees, shrubs, crops and eventually livestock properly combined, may support a high productivity for a long time. The different root systems and their different size enable an efficient use of nutrients and water (18 video). Figure 1 of "Phosphorus price spikes: A wake-up call for phosphorus resilience" shows the high price volatility of this element, which suggests the need to do the most with it, thus reducing waste and enhancing food security (19).

Among the important functions of pulses, there is the fixation of atmospheric nitrogen, which is then made available to other plants. *This reaction, differently from industrial energy-intensive processes, occurs in root nodules where rhizobia bacteria are hosted*. The pulses can solubilise phosphate ions from minerals, such as calcium and iron phosphates, thus making this element available to the plant (4 video / 79 video).

According to an FAO document, pulses included as a rotation crop with cereals, can save up to 88-350 kilograms of nitrogen per hectare (80).

"Healthy low nitrogen footprint diets" deals with diets that, while being healthy, exhibit a reduced environmental burden (77). *A shift towards plant-based diets has the potential to reduce the proportion of nitrogen applied to soils*. In wealthy countries, a reduction in the consumption of meat and protein, which nowadays are above the recommended levels, while being more environmentally sustainable, can provide health benefits (77 tables 1 and 2).

Reducing food waste also plays an important role towards sustainability (77). According to "Utilizing the Eutrophication in Bioresources Recovery and Biogas Production – A Case Study in Egypt", many species of microalgae can remove nitrogen and phosphorus from wastewater, thus mitigating eutrophication. The nutrients are then recovered within the algal biomass that is harvested for biogas generation; this is

particularly important for phosphorus, a non-renewable resource that could be depleted within 100 years (88). The simplified flow diagram in figure 1 shows the process.

Conflict of Interest Statement
The author declares no conflicts of interest.

About the Author(s)
The author is a former middle school teacher, and has written about 80 educational papers starting 38 years ago. Areas of interest: Health, Environment and Peace Education, and Prevention of Natural Disasters. The author has a University Degree in Biology.

References

1) Government Offices of Sweden, (2023). Carbon Taxation in Sweden. https://www.government.se/contentassets/419eb2cafa93423c891c09cb9914801b/230323-carbon-tax-sweden---general-info.pdf
2) International Renewable Energy Agency, (2019). Bioenergy from boreal forests: Swedish approach to sustainable wood use. https://www.irena.org/publications/2019/Mar/Bioenergy-from-boreal-forests-Swedish-approach-to-sustainable-wood-use
3) Renergon Biogas, (2020). How does a biogas plant work? Anaerobic Digestion explained. https://www.youtube.com/watch?v=ehNEtJtaFR8
4) FAO, (2016). Soils and Pulses: symbiosis for life. https://www.youtube.com/watch?v=dLxoGaRrrtU
5) Government of Nauru, (2013). Nauru National Assessment Report For The Third International Conference On Small Island Developing States (SIDS). https://wedocs.unep.org/bitstream/handle/20.500.11822/8426/Nauru.pdf?sequence=3&amp%3BisAllowed=
6) Gill T. *et al.*, (2002). Obesity in the Pacific: Too Big To Ignore. https://iris.who.int/bitstream/handle/10665/207524/9822039255_eng.pdf?isAllowed=y&sequence=1#:~:text=Many%20Pacific%20Island%20countries%20and,food%20is%20afforded%20higher%20status
7) McLennan A.K. and Ulijaszek S.J., (2014). Obesity emergence in the Pacific islands: why understanding colonial history and social change is important. https://pmc.ncbi.nlm.nih.gov/articles/PMC10271720/
8) The global diabetes community. "I have seen so many funerals for such a small island": The astonishing story of Nauru, the tiny island nation with the world's highest rates of type 2 diabetes. https://www.diabetes.co.uk/in-depth/i-have-seen-so-many-funerals-for-such-a-small-island-the-astonishing-story-of-

nauru-the-tiny-island-nation-with-the-worlds-highest-rates-of-type-2-diabetes/

9) Brut America, (2020). The Story of Nauru: The "Country that Ate iIself". https://www.bing.com/videos/riverview/relatedvideo?q=nauru%20diabetes%20&mid=33A2221355857B9C66B833A2221355857B9C66B8&ajaxhist=0

10) National Oceanic and Atmospheric Administration. Dead Zone in the Gulf of Mexico. https://oceantoday.noaa.gov/deadzonegulf/

11) Australian Institute of Marine Science. Nutrients. https://www.aims.gov.au/research-topics/environmental-issues/water-quality/nutrients

12) Australian Institute of Marine Science. Crown-of-thorns starfish. https://www.aims.gov.au/research-topics/marine-life/crown-thorns-starfish

13) Chakraborty D. and Prasad R. (2023). Phosphorus Management: Best Management Practices for Minimizing Phosphorus Loss from Agricultural Soils. https://www.aces.edu/blog/topics/crop-production/phosphorus-management-best-management-practices-for-minimizing-phosphorus-loss-from-agricultural-soils/

14) Sharpley A.N. and Smith S.J. Surface water impacts – Effects of cover crops on surface water quality. https://www.swcs.org/static/media/cms/CCCW3surface_79CEC411D2D30.pdf

15) Stern R., (2020). The Ogallala Aquifer. https://www.youtube.com/watch?v=UgdtglTjQr4

16) Hasanuzzaman Md and Hossain M., (2014). Leaf Litter Decomposition and Nutrient Dynamics Associated with Common Horticultural Cropland Agroforest Tree Species of Bangladesh. https://onlinelibrary.wiley.com/doi/10.1155/2014/805940

17) Nair V.D. and Graetz D.A., (2004). Agroforestry as an approach to minimizing nutrient loss from heavily fertilized soils: The Florida experience. https://it.search.yahoo.com/yhs/search?hspart=sz&hsimp=yhs-011&p=Agroforestry+as+an+approach+to+minimizing+nutrient+loss+from+heavily+fertilized+soils%3A+The+Florida+experience&type=type80058-1890191675&gdpr=1&param1=3897452938

18) Agripreneurship Academy, (2021). Basics of Agroforestry. https://www.youtube.com/watch?v=jLZ0KtNx354

19) Brownlie W.J. *et al.*, (2023). Phosphorus price spikes: A wake-up call for phosphorus resilience. https://www.frontiersin.org/journals/sustainable-food-systems/articles/10.3389/fsufs.2023.1088776/full#F1

20) United Nations, (2023). World Food Day 2023. https://www.unwater.org/news/world-food-day-2023#:~:text=Agriculture%20accounts%20for%2072%25%20of,water%20resources%20under%20increasing%20stress.

21) Dr. Griffiths S., (2017), Salinization. https://www.youtube.com/watch?v=tYKZUUNCPHk
22) FAO, (1985). Irrigation Water Management: Training Manual No. 1 - Introduction to Irrigation. https://www.fao.org/4/r4082e/r4082e00.htm#Contents
23) Korsandi F. (2021). Gravel Mulch as an Effective Tool for Salinity Management in Orchards of Salt-affected Arid Regions. https://www.fao.org/fileadmin/user_upload/GSP/GSAS21/GSAS21_presentations/PS4-2_06_Khorsandi.pdf
24) Aringhieri R., (2010). The Salt Problem In Soil: An Overview. https://eqa.unibo.it/article/view/3801/3227
25) Michel D., (2024). What Causes Water Conflict? https://www.csis.org/analysis/what-causes-water-conflict
26) FAO, (2017). The future of food and agriculture – Trends and challenges. https://openknowledge.fao.org/bitstreams/2e90c833-8e84-46f2-a675-ea2d7afa4e24/download
27) Rockström J. *et al.*, (2023). Why we need a new economics of water as a common good. https://www.researchgate.net/publication/369472648_Why_we_need_a_new_economics_of_water_as_a_common_good
28) USDA, (2020). Soil Health Demonstration: Rainfall Simulator. https://www.youtube.com/watch?v=MJqMBPAo0fQ
29) USDA, (2020). Soil Health Demonstration: Infiltration. https://www.bing.com/videos/riverview/relatedvideo?&q=ater+infiltration+runoff+no-till&&mid=C5F71CF6F33E00642DADC5F71CF6F33E00642DAD&mmscn=mtsc&aps=35&FORM=VRDGAR
30) Silva E., (2015). Advances using the roller-crimper for organic no-till in Wisconsin. https://www.bing.com/videos/riverview/relatedvideo?&q=no-till+corn+roll+crimp&&mid=9150392FB4370C445D809150392FB4370C445D80&mmscn=mtsc&aps=96&FORM=VRDGAR
31) FAO, (2025). Flying Rivers – how forests affect water availability downwind and not just downstream. https://www.fao.org/in-action/forest-and-water-programme/news/news-detail/en/c/1190278/
32) Gillespie I., (2023). The largest river on Earth is actually in the sky. https://www.youtube.com/watch?v=tm6VSkm_ko8
33) Makarieva A.M. and Gorshkov V.G., (2014). The Biotic Pump: Condensation, atmospheric dynamics and climate. https://it.search.yahoo.com/yhs/search?hspart=sz&hsimp=yhs-011&p=%28PDF%29+The+Biotic+Pump%3A+Condensation%2C+atmospheric+

dynamics+and+climate&type=type80058-1890191675&gdpr=1&param1=3114286080

34) ISO Training Institute, (2017). What is the BIOTIC PUMP of Ecosystem | Biotic Pump of Nature | Ecology Biodiversity | global warming. (Video) https://www.bing.com/videos/riverview/relatedvideo?q=he+Biotic+Pump%3a+Condensation%2c+atmospheric+dynamics+and+climate.&mid=1770787BC53468465EB41770787BC53468465EB4&FORM=VIRE

35) Shah T. *et al.*, (2000). The Global Groundwater Situation: Overview of Opportunities and Challenges. https://www.researchgate.net/publication/227366540_The_Global_Groundwater_Situation_Overview_of_Opportunities_and_Challenges

36) Ellison D. *et al.*, (2017). Trees, forests and water: Cool insights for a hot world. https://www.researchgate.net/publication/313479082_Trees_forests_and_water_Cool_insights_for_a_hot_world

37) Bodhaguru, (2012). Science - Environment - How to recharge underground water – English. https://www.youtube.com/watch?v=sH8XmG1Bvz8

38) Tobella A.B. *et al.*, (2014). The effect of trees on preferential flow and soil infiltrability in an agroforestry parkland in semiarid Burkina Faso. https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2013WR015197

39) Sarahtroisi, (2015). No-Till Potatoes. https://www.youtube.com/watch?v=Xkqi6DXQwsU

40) International Water Management Institute. Incentivizing groundwater recharge through payment for ecosystem services (PES). https://gripp.iwmi.org/natural-infrastructure/water-storage/incentivizing-groundwater-recharge-through-payment-for-ecosystem-services-pes/

41) Noa Tann, (2018). Interstate Dam Disputes Threaten Global Security. https://www.americansecurityproject.org/perspective-interstate-dam-disputes-threaten-global-security/

42) Detges A. *et al.*, (2017). Editor's Pick: 10 Violent Water Conflicts. https://reliefweb.int/report/world/editor-s-pick-10-violent-water-conflicts

43) Fettig C.J. *et al.*, (2007). The effectiveness of vegetation management practices for prevention and control of bark beetle infestations in coniferous forests of the western and southern United States. https://www.researchgate.net/publication/42814136_The_Effectiveness_of_Vegetation_Management_Practices_for_Prevention_and_Control_of_Bark_Beetle_Infestations_in_Coniferous_Forests_of_the_Western_and_Southern_Unites_States

44) World Bank, (2021). Groundswell Part 2: Acting on Internal Climate Migration. https://openknowledge.worldbank.org/entities/publication/2c9150df-52c3-58ed-9075-d78ea56c3267

45) Gebreyohannis Gebrehiwot *et al.*, (2018). The Nile Basin waters and the West African rainforest: Rethinking the boundaries. https://wires.onlinelibrary.wiley.com/doi/10.1002/wat2.1317
46) Cornell University Library, (last updated 2024). Evaluating Web Pages: Questions to Consider: Categories. https://guides.library.cornell.edu/evaluating_Web_pages
47) Practical Engineering, (2025). All Dams Are Temporary. https://nebula.tv/videos/practical-engineering-all-dams-are-temporary
48) International Hydropower Association, (2022). Sediment management strategies. https://www.hydropower.org/sediment-management/sediment-management-strategies
49) Kondolf G.M. *et al.*, (2014). Sustainable sediment management in reservoirs and regulated rivers: Experiences from five continents. https://agupubs.onlinelibrary.wiley.com/doi/full/10.1002/2013EF000184
50) United Nations Security Council, (2022). Concerns Over the Use of Proceeds from The Exploitation, Trade, And Trafficking of Natural Resources for the Purposes of Terrorism Financing. https://www.un.org/securitycouncil/ctc/sites/www.un.org.securitycouncil.ctc/files/files/documents/2022/Jun/cted_cft_trends_alert_june_2022.pdf
51) Clayton K. S. Chun Dr., (2010). Do Oil Exports Fuel Defense Spending? https://press.armywarcollege.edu/monographs/607
52) Ordinioha B. and Seiyefa Brisibe S., (2013). The human health implications of crude oil spills in the Niger delta, Nigeria: An interpretation of published studies. https://pmc.ncbi.nlm.nih.gov/articles/PMC3644738/
53) DW News, (2012). Nigeria: Oil pollution in the Niger Delta | Global 3000. https://www.youtube.com/watch?v=3A-tLtqM8YU
54) Benistom M. *et al.*, (2018). The European mountain cryosphere: a review of its current state, trends, and future challenges. https://www.researchgate.net/publication/323500517_The_European_mountain_cryosphere_a_review_of_its_current_state_trends_and_future_challenges
55) Bove V. *et al.*, (2018). Global arms trade and oil dependence. chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://core.ac.uk/download/pdf/151213464.pdf
56) Greenpeace, (2022). Fossil Fuels are fuelling war. https://www.greenpeace.org/international/story/52988/fossil-fuels-are-fuelling-war/
57) International Energy Agency, (2022). Energy Fact Sheet: Why does Russian oil and gas matter? https://www.iea.org/articles/energy-fact-sheet-why-does-russian-oil-and-gas-matter
58) NASA, (2021). Sea Level Projection Tool. https://sealevel.nasa.gov/ipcc-ar6-sea-level-projection-tool

59) Lemonick M., (2010). The Secret of Sea Level Rise: It Will Vary Greatly By Region. https://e360.yale.edu/features/the_secret_of_sea_level_rise_it_will_vary_greatly_by_region?source=post_page----------
60) Woods Hole Oceanographic Institution, (2025). Sea Level Rise. https://www.whoi.edu/know-your-ocean/ocean-topics/climate-weather/sea-level-rise/
61) Lee J.Y. *et al.*, (2021). Future Global Climate: Scenario-based Projections and Near-term Information. https://www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Chapter04.pdf
62) Friedlingstein P. *et al.*, (2023). Global Carbon Budget 2023. https://essd.copernicus.org/articles/15/5301/2023/
63) Intergovernmental Panel on Climate Change. Mitigation pathways compatible with 1.5°C in the context of sustainable development. https://www.ipcc.ch/sr15/chapter/chapter-2/
64) National Oceanic and Atmospheric Organisation, (2013). Black Carbon. https://www.youtube.com/watch?v=ColNlsqErZM
65) International Energy Agency, (2021). Net Zero by 2050 A Roadmap for the Global Energy Sector. https://www.iea.org/reports/net-zero-by-2050
66) Parker K.M.A. and Mainelli M.R., (2024). What happens if we 'burn all the carbon'? carbon reserves, carbon budgets, and policy options for governments. https://pubs.rsc.org/en/content/articlelanding/2024/ea/d3ea00107e
67) US Forest Service, (2019). Understanding Fuels: Forest Fire Science. https://www.youtube.com/watch?v=7gjxG_kN6x8
68) Hobby T., (2024). Reusing Wood Waste For A Carbon Negative Bioeconomy. https://www.youtube.com/watch?v=v3fKiAuciCU
69) Bergeleen S., (2021). Ladder fuels and wildfires. https://www.youtube.com/watch?v=lMCeHraoa3k
70) US Forest Service, (2018). When the wells run dry. https://www.govinfo.gov/content/pkg/GOVPUB-A13-PURL-gpo106460/pdf/GOVPUB-A13-PURL-gpo106460.pdf
71) Comparetti *et al.*, (2013). Current state and future of biogas and digestate production. https://www.researchgate.net/publication/280882276_Current_state_and_future_of_biogas_and_digestate_production.
72) Abdurrahman M.I. *et al.*, (2020). Stubble burning: Effects on health & environment, regulations and management practices. https://www.sciencedirect.com/science/article/pii/S2666765720300119#bib0126
73) Pennsylvania State University, (updated 2023). A Short History of Anaerobic Digestion. https://extension.psu.edu/a-short-history-of-anaerobic-digestion

74) De Morais R.M., (2019). Trading Human Rights for Diamonds in Angola. Video https://www.youtube.com/watch?v=pvU23BDx18M
75) The World Bank, (2003). Natural Resources and Violent Conflict. https://documents1.worldbank.org/curated/en/578321468762592831/pdf/282450Natural0resources0violent0conflict.pdf
76) Bhuiyan I.H., (2024). What is Resource Curse | Resource Curse Theory | Relevance and Criticisms. https://www.youtube.com/watch?v=bUxGzvVQnXM&t=18s
77) Leite J.C., (2020). Healthy low nitrogen footprint diets. https://pmc.ncbi.nlm.nih.gov/articles/PMC7063699/
78) IPCC, (2007). Fertilizer Manufacture. https://archive.ipcc.ch/publications_and_data/ar4/wg3/en/ch7s7-4-3-2.html
79) FAO, (2015). What are pulses and why are they important crops for food security. https://www.youtube.com/watch?v=aPdqJEs_-zg
80) FAO, (2016). Soils And Pulses Managing Soils for Sustainable Pulse Production. https://openknowledge.fao.org/server/api/core/bitstreams/723639ba-4145-440c-97b1-29c81b90b9ed/content
81) Asian Development Bank, (2011). Turning Animal Waste in Energy in Viet Nam. https://www.youtube.com/watch?v=S7M-rV-T_Fk
82) International Energy Association, (2020). Outlook for biogas and biomethane: Prospects for organic growth. https://www.iea.org/reports/outlook-for-biogas-and-biomethane-prospects-for-organic-growth
83) USGS, (2023). Plugging the Gaps: How the USGS is working to fill in data gaps for Orphaned Oil and Gas Wells. https://www.usgs.gov/news/featured-story/plugging-gaps-how-usgs-working-fill-data-gaps-orphaned-oil-and-gas-well
84) Pskowski M. (2025). Scientists Map Where Orphan Wells Pose Threats to Aquifers. https://insideclimatenews.org/news/04052025/scientists-map-where-orphan-wells-pose-threats-to-aquifers/
85) Semeraro B. *et al.*, (2021). Bio-Delignification of Green Waste (GW) in Co-Digestion with the Organic Fraction of Municipal Solid Waste (OFMSW) to Enhance Biogas Production. https://www.mdpi.com/2076-3417/11/13/6061
86) USGS, (2016). The EarthView: Saudi Wheat Experiment Relied on Fossil Water. https://www.usgs.gov/news/science-snippet/earthview-saudi-wheat-experiment-relied-fossil-water
87) Gupta D.K. *et al.*, (2014). Role of phosphate fertilizers in heavy metal uptake and detoxification of toxic metals. https://www.researchgate.net/profile/Dharmendra-Gupta/publication/260373964_Role_of_phosphate_fertilizers_in_heavy_metal_uptake_and_detoxification_of_toxic_metals/links/5af9a4950f7e9b026bf74ac5/R

ole-of-phosphate-fertilizers-in-heavy-metal-uptake-and-detoxification-of-toxic-metals.pdf

88) Khalil M.M. *et al.*, (2022). Utilizing the Eutrophication in Bioresources Recovery and Biogas Production – A Case Study in Egypt. https://www.jeeng.net/Utilizing-the-Eutrophication-in-Bioresources-Recovery-and-Biogas-Production-A-Case,155082,0,2.html

89) Ag PhD, (2017). Farm Basics #1029 The Pros and Cons of No-Till (Air Date 12-24-17). https://www.bing.com/videos/riverview/relatedvideo?&q=ater+infiltration+runoff+no-till&&mid=301FDABE25274E3FC958301FDABE25274E3FC958&&FORM=VRDGAR

90) Loomis R., (2023). Study Shows 14,000 Unplugged Oil and Gas Wells in Gulf of Mexico. https://www.nrdc.org/bio/rebecca-loomis/study-shows-14000-unplugged-oil-and-gas-wells-gulf-mexico