

# Selected Environmental and Sustainability-Related Aspects of the Conflict in Ukraine

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## 1. Introduction

This letter is an update and continuation of the previously published article and book, where ecological and health-care-related aspects of the Ukraine conflict were discussed along with some peace initiatives. Environment is one of the most important dimensions of sustainability. The conflict in Ukraine has thwarted ecological policies and triggered armed conflicts in different parts of the world. The war itself is damaging for the environment having global repercussions, worsening energy and food supply. As food prices rise, some nations are likely to cope by converting forests to fields [1-3].

### 1. 1. Fossil Fuels and Nuclear Energy

Certain environmentalists and grassroots act in accordance with the interests of companies and governments selling fossil fuels. Most evident is this tendency in regard to low-dose low-rate ionizing radiation, comparable with the natural radiation background, whereas the overestimation of medical and environmental side effects of nuclear energy contributed to its strangulation, supporting appeals to dismantle nuclear power plants [NPPs] [4]. Health risks and environmental damage are maximal for coal and oil, lower for natural gas and much lower for the nuclear energy. The same ranking applies to the greenhouse gas emissions [5, 6]. Nuclear power is a large-scale sustainable energy source; it is devoid of unpredictability of wind and solar energy, uses fuels with high energy density, which facilitates transportation. The nuclear fuel cycle holds potential for economic and environmental optimization [6]. Hopefully, the nuclear fission will be in future replaced by fusion, which is intrinsically safer. The fusion should offer a source of safe, clean power generation, with a plentiful supply of raw materials [7, 8]. Durable peace and international cooperation are needed for this and other large-scale projects.

In the long run, nonrenewable fossil fuels will become increasingly expensive, contributing to the population growth in the fuel-producing countries and poverty elsewhere. Uranium

prices may grow as well; but the cost of nuclear power depends only to a small extent on the fuel cost. Uranium is produced in diverse regions while major reserves of oil and gas are concentrated in a small number of countries [6]. Chernobyl accident has been exploited to strangle nuclear energy [4, 9]. But it would be a speculation to claim that there was intention. At least, negligence and disregard for written instructions were among the causes of the accident [10-12]. One can await everything from people devoid of religion and morality. Escalation of conflicts contributes to the boosting of fossil fuel prices. By analogy with the Chernobyl accident, the war damage and shutdown of the Zaporozhe NPP [the largest in Europe] has enhanced demands for fossil fuels. The weightiest consideration against NPPs is that they are potential war targets. Military threats are arguments against the use of nuclear power for electricity production. The boosting of fossil fuel prices seems to be one of the motives to unleash the war in Ukraine and of the threats to use nuclear weapons.

The fossil fuel supply is not endless. External supplies of energy e.g. for agriculture will probably not last long especially for countries that will not be able to afford the next leap in oil prices [13]. The exaggeration of medical and environmental side effects of nuclear energy contributes to its strangulation [4, 14]. Escalation of conflicts contributes to the elevation of prices for oil and natural gas. The Green initiatives including campaigns to dismantle nuclear power stations, the limits of growth appeal and anti-globalization [15] are self-damaging activities partly sponsored from abroad. The campaign for nuclear disarmament is largely a campaign for unilateral disarmament. Cui bono? The environmental movement is foundering on new economic realities. The environmentalism rested largely on a foundation of economic prosperity; and when the prosperity is threatened, the attitude must change [16]. It is obviously unfavorable for the economy to redesign technologies, to which billions have been invested, in order to conform to ecological requirements; whereas in less democratic societies the environment protection is not so effective.

tively implemented. Therefore, some industries and modern technologies flee to countries with less stringent standards and less legalistic traditions [17].

## 1. 2. Sustainability, Ethics and Religion

Another topic that needs completion is ethics and religion that are closely related with sustainability and environment protection. Anti-religious propaganda in the former Soviet Union [SU] was efficient. Atheism has been accepted after 1917 not only due to the propaganda, but also because religiosity was not as deeply ingrained as it is sometimes believed. Faithful people belonged predominantly to the middle class that was largely destroyed by Bolsheviks. Soviet propaganda claimed great successes in tearing people away from religion [18]. In Ukraine, especially in the western regions, which belonged to Poland and escaped the anti-religious activities of the 1920-1930s, the situation was different. Even in the Soviet part of Ukraine, Bolsheviks were alarmed by religious revival in the late 1920s. Closing and demolition of churches, repressions of clergy and parish activists were implemented [19]. Then followed the famine (1932-1933) contributed by the Soviet policies [20]. During the German governance (1941-1944), churches in Ukraine were full, weddings and baptism being usual practices [21]. The antireligious campaign by Nikita Khrushchev met obstacles in the Ukraine [22].

The recent religious revival in Russia seems to be partly insincere and superficial, being a matter of fashion, and lately also of policy: religion has been incorporated into the official ideology. Some surveys reported high percentages of self-identification with Orthodox Christianity; but the knowledge of Scriptures remains at a low level [23]. If a child goes to church, he or she may retain the faith lifelong despite scientific education. The acquisition of beliefs from within by an adult seems to be improbable. Preparing the end of the communist regime, the Party and military functionaries, so-called Nomenklatura, sent their children to theological academies, some students being transferred from Marxism-Leninism faculties.

The hypothesis is proposed here that a majority of today's churchgoers, priests and church officials in Russia are atheists or agnostics, habitually supporting the Soviet-time vision of the "West" as perpetual threat [24-27]. The politicization is illustrated by a paradox: the concept of Orthodoxy is broader than that of faith; some atheists designate themselves as Orthodox. Besides, superstitions are sometimes mixed up with religious beliefs, which is named "dvoeverie - dual faith" or orthodox-heathen syncretism [28]. The interest of broad public to the supernatural contributed to the religious revival [29, 30]. This tendency seems to be exploited in view of abundant mystical TV shows and films. The communist propaganda named such policies "odurmanivanie - mass mystification". Admittedly, the efficacy of these efforts is limited because the Soviet-nurtured materialism and atheism are deeply ingrained. After an upsurge in the 1990s, the number of young people attending Orthodox services is again declining [31]. Other behaviors propagated by Russian media are promiscuity and de facto reproductive

coercion. For example, popular mystical serials "Gadalka" [Fortune teller] and "Slepaia" [Blind] depict unexpected and unintended pregnancies both in and out of wedlock as natural and unavoidable while contraception is mentioned rarely.

In the Episode 306 of the latter serial a gynecologist at a husband's request surreptitiously replaced contraceptive pills by vitamins, which was presented as a good deed. Risks associated with abortions and oral contraceptives are systematically exaggerated. Evidently, the propaganda follows policies aimed at the birth rate elevation. Some church officials, endorsing the Ukraine war, engage in moralizing or "norm entrepreneurship", opposing to birth control and sex education, depicting childbearing as a duty [32-34]. This is understandable from the military- and geopolitical standpoint but counterproductive in view of the overpopulation in many regions of the world including certain subjects of the Russian Federation e.g. Caucasus [RF]. The same activists fail to recognize, or even discuss, the high incidence of rape in RF [34]. Of note, ~75% of rapes in the Moscow province are perpetrated by migrants [35]. The anti-abortion campaigners should learn what it means to grow up as undesired child, and what unwanted pregnancies imply for a female victim of reproductive coercion [36].

The declared reason of the "special military operation", started February 2022, was the anti-separatist activity of Ukraine in the Donbas since 2014. Apparently, this activity was exaggerated by the media. Counteracting separatism within national borders is justifiable, exemplified by Russian anti-separatist operations in the North Caucasus (1994-2009). The Ukraine voted for independence (~83%) in the 1991 referendum. The pro-independence vote varied from 95% in the west of the country to 76.5 % in the Donetsk area and 54% in Crimea [37]. The 1991 borders of Ukraine were recognized by all nations including RF. The Ukraine war, having undermined the principle of internationally agreed status quo, has triggered conflicts in different parts of the world. Recent referendums in occupied territories were met with skepticism, as the residents voted for unification with RF to avoid trouble because they did not believe that the situation will be reverted.

The Soviet-trained collectivism has influenced referendums, elections and opinion polls. Almost everybody voted the ruling party in the former SU. Admittedly, a majority of residents in the southern and eastern parts of the country are Russian-speaking and many people were disappointed that their region had not become a part of RF. Some Russian-speaking areas may become parts of RF if people really want it. A workable solution must be found by means of negotiations. The question is, however, whether there are responsible negotiating partners. The history of the 20th century demonstrated that European leaders sometimes took short-sighted decisions. The main thing is to avoid a large-scale war. Consequences would be unfavorable for both sides, as it was 100 years ago.

Psychological aspects of the war in Ukraine have been discussed previously [2, 38]. Vladimir Putin's saying "If a fight

is [perceived as] inevitable, you must strike first” may be a trace of juvenile ways of defending against bullies related to an intergenerational traumatic chain [39]. According to some analyses, the prevalence of family violence in RF during last decades has been 45-70 times higher than, for example, in the United Kingdom and France. As per the recent report, about 40% of all serious violent crimes in RF are committed within families; 14% of children are subjected to physical abuse, 2 million are regularly beaten by parents while 10% of them lose their lives as a result, reviewed in [40]. According to other sources, 40% of children are beaten in their families; 31% of children experience sexual abuse and 41% suffer cruel punishments [41, 42].

Yet in 2017 Vladimir Putin has signed into law an amendment decriminalizing some forms of domestic violence [43]. Physical abuse was described in Putin’s biographies [39, 44-46]. Defensive behaviors may include attacking weaker persons and submitting to dominant ones [47]. The latter seems to be reflected by relationships of Vladimir Putin with Ramzan Kadyrov, the head of Chechen Republic, who is a dominant personality. There has been a stereotype of “chechenophobia” in Russia [48]. Reportedly, Putin studies Sufism and is sympathetic to this Islamic teaching [49]. The influential ideologist Alexandr Dugin worked on interpretations and conceptualizations of Sufism [50]. The most important topic in this connection is the inter-ethnic difference in birth rate and migrations [51], which is avoided by Russian media and officials today. In November 2022, Putin awarded the Soviet-era medal for mother heroines to Kadyrov’s wife, who has fourteen children. According to the Wikipedia, Kadyrov has three wives. Chechnya receives considerable federal funding.

Ramzan Kadyrov declared the war in Ukraine “Big Jihad” and urged Russian Muslims to fight the satanic democracy and demons. He urged to lay waste to Ukraine and backed calls to wipe cities “off the face of the Earth” [52]. The Quran contains numerous injunctions regarding unbelievers: “Smite at their neck at lengths; when ye have thoroughly subdued them, bind a bond firmly on them” (47:4). It is not permitted to a Muslim to kill another Muslim (2:84; 4:92), but with regard to unbelievers’ other recommendations are given: “Fight them on until there prevails faith in Allah altogether and everywhere” (8:39). About responsibility for murder, it is commented: “It is not ye who slew them, it was Allah” (8:17).

Contradictions between the Quran and modern legislation can be found: “The law of equality is prescribed: the free for the free, the slave for the slave, the woman for the woman” (2:178) [53]. It can be understood that, instead of a criminal, an innocent from his kinship may be killed, woman for the woman, etc. Jihad, the holy war, is considered to be a religious duty. To be objective, positive tendencies in the modern Islamic literature should be pointed out: condemnation of terrorism, promotion of business ethics, of good-neighbor relations, disapproval of arrogant attitude towards supposed sinners and unbelievers. Undoubtedly, Islam promotes many universal moral values.

Calls for punishments can also be found in the Old Testament: “And thine eye shall not pity; but life shall go for life, eye for eye, tooth for tooth, hand for hand, foot for foot” [Deuteronomy 19:21]. The words eye and tooth, used allegorically, can be understood differently in various cultures, so that the concept might perpetuate conflicts. Admittedly, the “eye for eye” principle can be seen as a limiting of retribution. Confessional differences should not be exaggerated; but throughout the history religious teachings and fanaticism have sometimes contributed to wars. Conflicting laws and injunctions cannot be valid at the same time and place. Considering the unpredictability and compromise-resistance of terrorists with religious motives, such motives should be regarded by the justice system as aggravating circumstances [54]. This must pertain also to appeals for war and violence using religious vocabulary, noting that war propaganda is prohibited by the international law [55].

Outside religion, it is hard to see how the notion what is right and wrong should provide a motive for doing right [56]. According to a widespread opinion, morals have no materialistic foundations worth respecting [57, 58]. Should the power in Europe shift to Russia, it would come along with losses of some moral values. Disregard for laws and regulations, corruption and collectivism would come instead. The quality of many services and products will decline: spoiled foods on sale, antibiotics in milk, falsified beer and wine, impolite service, wrong price tags in shops, misquoting of legal codes by civil servants in their correspondence, backdating of official letters, embezzlement of registered correspondence, various types of misconduct in the healthcare [59].

### 1. 3. The Healthcare

An autocratic or military management style discourages criticism. In the healthcare, attributes of this style include a paternalistic attitude to patients and bossy management. Disregard for the principle of informed consent and compulsory treatments are deemed permissible [60]. For example, abortions and gynecological manipulations were sometimes performed in a harsh manner, especially in women deemed socially unprotected or “immoral”. Endocervical ectopies [pseudo-erosions] have been routinely cauterized without cytological tests; at the same time, Pap-smears have been performed infrequently and not up to the international standards, cervical cancer being diagnosed relatively late [61].

Considering the breast cancer incidence, millions of women in the former SU have undergone Halsted or Patey procedures with resection of pectoralis muscles without sufficient indications; details and references are in the book [59]. Psychiatry has been discussed previously [62, 63]. The following features of Russian healthcare should be pointed out: comparatively low life expectancy and survival rates in different diseases, medical science not repelling falsification, inefficient medications advertised and prescribed, invasive procedures applied without indications [59, 64-66]. Experts understood obsolescence of certain instructions but preferred not to voice their opinions.

## 2. Conclusion

The nuclear threats and declarations of jihad [52, 67] have appeared against the background of Soviet atheism, while religious vocabulary is misused for political purposes. It can be reasonably assumed that many church officials supporting the war in Ukraine are atheists acting in accordance with political trends. The above-mentioned ideologist Alexander Dugin opined: "Every civilization has the right to decide about... death, good and evil" [68]. Indeed, some terrorists made such decisions. A preferred alternative would be a leadership centered in developed parts of the world, based on the principles of mercy, modesty and forgiveness, aimed at preservation of human life and health.

## References

- Jargin, S. V. (2023). The War in Ukraine: Social and Medical Perspective. *International Journal of Business and Management (IJBM)*, 2(1), 32-65.
- Jargin, S. (2023). Book Review: Jargin SV. *The Conflict in Ukraine*. Nova Science Publishers, 2023.
- Jargin, S. V. (2023). Sustainability and religion-related aspects of the conflict in Ukraine.
- Jargin, S. V. (2023). The overestimation of medical consequences of low-dose exposure to ionizing radiation. Cambridge Scholars Publishing.
- Markandya, A., & Wilkinson, P. (2007). Electricity generation and health. *The Lancet*, 370(9591), 979-990.
- Jargin, S. V. (2023). Sustainability and religion-related aspects of the conflict in Ukraine.
- Smith, C. L., & Ward, D. (2007). The path to fusion power. *Philosophical Transactions: Mathematical, Physical and Engineering Sciences*, 945-956.
- Duffy, D. M. (2010). Fusion power: a challenge for materials science. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 368(1923), 3315-3328.
- Jaworowski, Z. (2010). Observations on the Chernobyl Disaster and LNT. *Dose-Response*, 8(2), dose-response.
- Beliaev, I. A. (2006). Chernobyl. Death shift. Moscow: Izdat.
- Semenov, A. N. (1995). Chernobyl'desiat'let spustia: Neizbezhnost' ili sluchainost'. Moscow: Energoatomizdat.
- Mould, R. F. (2000). Chernobyl record: the definitive history of the Chernobyl catastrophe. CRC Press.
- Paehlke, R. C. (1989). Environmentalism and the future of progressive politics.
- Jargin, S. V. (2021). The overestimation of medical consequences of low-dose exposures: Cui bono?. *Environmental Disease*, 6(3), 101-107.
- Schreurs, M., & Papadakis, E. (2019). *Historical dictionary of the green movement*. Rowman & Littlefield Publishers.
- Drake, B. A. (2013). *Loving nature, fearing the state: environmentalism and antigovernment politics before Reagan*. University of Washington Press.
- Garcia-Johnson, R. (2000). *Exporting environmentalism: US multinational chemical corporations in Brazil and Mexico*. MIT Press.
- Pospielovsky, D. V. (1988). *History of Soviet Atheism in Theory and Practice and The Believer*. Springer.
- Freeze, G. L. (2012). Subversive Atheism: From Antireligious Campaign to Religious Revival in Ukraine in the 1920s. In *State Secularism and Lived Religion in Russia and Ukraine* (pp. 27-62). Oxford University Press & Woodrow Wilson Center.
- Bezo, B., & Maggi, S. (2015). Living in "survival mode:" Intergenerational transmission of trauma from the Holodomor genocide of 1932-1933 in Ukraine. *Social Science & Medicine*, 134, 87-94.
- Buss, G. (1987). The bear's hug: religious belief and the Soviet State: [1917-86]. Hodder and Stoughton.
- Еленський, В. Є. (2012). The Revival before the Revival: Popular and Institutionalized Religion in Ukraine on the Eve of the Collapse of Communism.
- Andreeva, L. A., & Andreeva, L. K. (2010). Religioznost'studencheskoy molodezhi. Opyt sopostavleniya s religioznost'yu rossiyan [Religiosity of Students. The Experience of Comparison with the Religiosity of Russians]. *Sotsiologicheskie issledovaniya-Sociological Studies*, 9, 95-98.
- Voslensky MS. *Nomenklatura: The Soviet ruling class*. Garden City, NY: Knopf Doubleday Publishing Group; 1984.
- Netburn, D. (2022). A spiritual defense of the war in Ukraine? Putin's patriarch is trying. *Los Angeles Times*, 29.
- Vyshinsky AY. For peace and friendship, among the peoples, against the instigators of a new war. Speech delivered at the plenary session of the General Assembly of the United Nations, 18 Sept. 1947. Moscow: Foreign Languages Publishing House; 1948.
- Snyder, T. (2018). *The Road to Unfreedom: Russia, Europe, America*. Crown.
- Jargin, S. V. (2023). Sustainability and religion-related aspects of the conflict in Ukraine.
- Jargin, S. V. Selected religion-related and psychological aspects of the war in Ukraine.
- Mitrofanova, A. V. (2006). Politicheskoe pravoslavie" i problema religioznosti ["Political Orthodoxy" and the Problem of Religiosity]. *Filosofiya i obshchestvo*, (1), 78-95.
- Павлюткин, И. В. (2020). La dynamique religieuse des modèles en Russie. Résultat époustoufflant. *Социология и управление*, 6(3), 153-183.
- Stoeckl, K. (2016). The Russian Orthodox Church as moral norm entrepreneur. *Religion, State & Society*, 44(2), 132-151.
- Jargin, S. V. (2023). Sustainability and religion-related aspects of the conflict in Ukraine.
- Erofeeva, L. V. (2013). Traditional Christian values and women's reproductive rights in modern Russia—is a consensus ever possible?. *American Journal of Public Health*, 103(11), 1931-1934.
- IuA, S. (2019). Determinants of crime by migrants in conditions of a megapolis. In *Actual problems of migrations. Proceedings of an interuniversity scientific and practical conference*. Domodedovo: Ministry of Internal Affairs of the Russian Federation (pp. 73-76).
- Jargin, S. V. (2021). Reproductive and sexual coercion:

- The role of alcohol, social and demographic conditions. *J Addiction Prevention*, 9(1), 1-5.
37. Sneider, D. (1990). Independent Ukraine may seal Soviet fate. *The Christian Science Monitor: Chronicle of the Soviet coup*, 1992.
  38. Jargin, S. (2023). Book Review: Jargin SV. *The Conflict in Ukraine*. Nova Science Publishers, 2023.
  39. Ihanus, J. (2022). Putin, Ukraine, and fratricide. *Clio's psyche.*, 28(3), 300-311.
  40. Jargin, S. V. (2023). Sustainability and religion-related aspects of the conflict in Ukraine.
  41. Agafonova, S. V., Beschastnova, O. V., Dymova, T. V., & Ryabichkina, T. V. (2022). *Preduprezhdenie zhestokogo obrashhenija s det'mi [Prevention of child abuse]*. Astrakhan: Sorokin.
  42. Tinkova, E. L. (2016). *Katilevskaia IuA. Osobennosti viktimnogo povedenia detei i podrostkov, podverghshihsia zhestokomu obrashheniu [Special features of victim behavior of children and adolescents subjected to cruel treatment]*. Stavropol: Pedagogical Institute.
  43. Walker, S. (2017). Putin approves legal change that decriminalises some domestic violence. *The Guardian*, 7.
  44. Baker, P., & Glasser, S. (2005). *Kremlin rising: Vladimir Putin's Russia and the end of revolution*. Simon and Schuster.
  45. Ressler, N. (2017). *Putin po Freud'u: tainoe i yavnoe [Putin according to Freud: hidden and obvious]*. Moscow: Algorithm.
  46. Volkan, V., & Javakhishvili, J. D. (2022). Invasion of Ukraine: Observations on leader-follower's relationships. *The American Journal of Psychoanalysis*, 82(2), 189-209.
  47. Lopes, B. C. (2013). Differences between victims of bullying and nonvictims on levels of paranoid ideation and persecutory symptoms, the presence of aggressive traits, the display of social anxiety and the recall of childhood abuse experiences in a Portuguese mixed clinical sample. *Clinical psychology & psychotherapy*, 20(3), 254-266.
  48. Khlebnikov P. *Razgovor s varvarom [Conversation with a barbarian]*. Moscow: Detective-Press; 2003.
  49. Mukhin, A. A. (2015). *Vladimir Putin. Who is mister P?* Moscow: Algorithm.
  50. Knysh, A. (2022). Studying Sufism in Russia: From ideology to scholarship and back. *Der Islam*, 99(1), 187-231.
  51. Jargin, S. V. (2021). Environmental damage and overpopulation: demographic aspects. *J Environ Stud*, 7(1), 4.
  52. Stewart, W. (2022). Vladimir Putin's Chechen warlord Ramzan Kadyrov declares Ukraine war a 'Big Jihad'News.com. au. *New York Post*.
  53. Ali YA. *The meaning of the Holy Qur'an*. Beltsville: Amana; 1999.
  54. Cimbala, S. J. (2016). *Arms for uncertainty: nuclear weapons in US and Russian security policy*. Routledge.
  55. CCPR. Human Rights Committee Office of the High Commissioner for Human Rights United Nations General Comment No. 11. Prohibition of propaganda for war and inciting national, racial or religious hatred (Art. 20); 29 July 1983.
  56. Mitchell, B. (1980). *Morality, religious and secular: The dilemma of the traditional conscience*. Oxford University Press.
  57. Oakeshott, M. (1993). *Morality and politics in modern Europe: The Harvard lectures*. Yale University Press.
  58. Jargin, S. V. Selected religion-related and psychological aspects of the war in Ukraine.
  59. Sergei, V. J. (2020). *Misconduct in medical research and practice*. Nova Science Publishers.
  60. Mikirtichan, G. L., Kaurova, T. V., & Pestereva, E. V. (2022). *Introduction to bioethics*. St. Petersburg Pediatric Medical University.
  61. Jargin, S. V. (2016). Treatment of gonorrhoea in Russia: Recent history. *Global Journal of Dermatology & Venereology*, 4(1), 1-5.
  62. Jargin, S. (2015). Gilyarovskiy and Gannushkin psychiatric hospitals in Moscow. *Hektoen Int J*.
  63. Jargin, S. V. (2011). Some aspects of psychiatry in Russia. *International Journal of Culture and Mental Health*, 4(2), 116-120.
  64. *Wisevoter Cancer Survival Rates by Country* Accessed December 14, 2023.
  65. Jargin, S. V. (2022). Surgery without sufficient indications: an update from Russia. *Journal of Surgery*, 10(1), 9.
  66. Jargin, S. V. (2023). Overtreatment of Supposedly Radiogenic Cancer and Precancerous Lesions. *Cancer Screen Prev*.
  67. Light, F. (2022). Kadyrov says Russia should use low-yield nuclear weapon. *Reuters* October, 1, 2022.
  68. Dugin, M. G. A. (2023). Ich plädiere für eine Vielfalt der Zivilisationen. *RT DE*, 28.

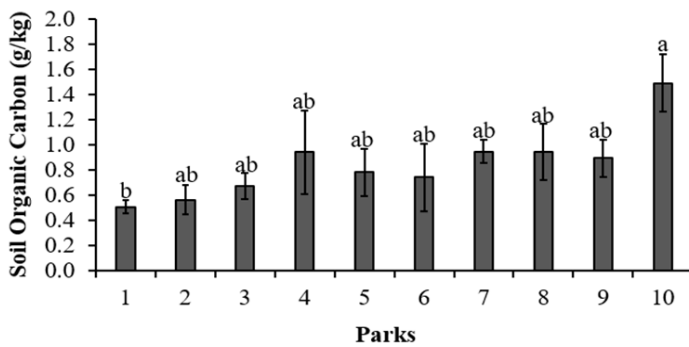


Figure 4: Soil Organic Carbon of the various parks in JOSTUM. Vertical bars represent means; error bars represent standard error of the means; means with the same alphabet are not significantly different ( $P > 0.05$ ) from each other [Tukey-HSD post hoc]. Parks legend: 1: Forestry, 2: Fishery, 3: NASS, 4: FST, 5: Engineering; 6: VET, 7: Science, 8: Science Extension; 9: Student Union, 10: NUBESS.

#### 4. Discussion

Trees species have been shown to promote the growth of herbaceous species in sub-tropical grasslands by increasing the nitrogen content available to herbaceous plants [24]. That might underpin the large numbers of herbaceous species found in the various parks in the study area and the rich species diversity recorded. Numerous environmental factors interact and affect the abundance of trees and herbaceous species. These complex interactions include rainfall, temperature, soil nutrient, soil texture/structure etc. JOSTUM parks are in guinea savanna ecological zone with moderate rainfall, which supports herbaceous growth. Poor nutrient/soil quality have been shown to promote the distribution of grasses, while trees species grow in nutrient rich and quality soils [25, 26]. Furthermore, canopy gaps have been highlighted to affect herbaceous biomass, diversity, and soil physical properties [27].

JOSTUM parks have a rich mix of small to moderate-sized trees species, thereby allowing suitable canopy gaps for growth of herbaceous species. Consequently, parks with large canopy gaps such as VET and SU, had the highest effective species diversity. Also, family poaceae was the most abundant in the studied parks, taking advantage of the canopy gaps [17]. The highest herbaceous biomass/litter biomass, herbaceous/litter TSC and herbaceous/litter  $SCO_2E$  were recorded in NUBESS and Student Union parks respectively. Those parks recorded the highest species occurrence frequencies as well. Accordingly, that could be attributed to their high species diversity and high number of grasses with large vegetative parts that have been designated to sequester more carbon than other herbaceous species [28].

The processes affecting the spatial and temporal fluxes in soil carbon ought to be evaluated to properly highlight the variation of SOC in the studied parks and account for the significant difference observed between NUBESS and Forestry parks. For instance, spatial and vertical distribution of SOC have been reported to vary between climatic zones and biomes [29]. Furthermore, vegetation and soil texture were

revealed to significantly influence spatial pattern of SOC distribution [30]. Although the studied parks fall within the same climatic zone, the effects of vegetation and soil texture need to be assessed to understand their roles in variation of SOC between some of the parks. Furthermore, the significant difference in SOC between some parks could be because of the disparity in species richness/composition and its effect on biomass accumulation and soil organic carbon sequestration [31, 32].

#### 5. Conclusion

The carbon credit potentials of 1532 herbs belonging to 68 species and 20 plant families were evaluated in Joseph Sarwuan Tarka University Makurdi parks. The total herbaceous biomass, TSC, and  $SCO_2E$  of all parks were 0.75 kg, 0.37 kg, and 1.37 kg respectively; while the total litter biomass, TSC and  $SCO_2E$  were 0.46 kg, 0.23 kg, and 0.85 kg respectively. The average SOC of JOSTUM parks was 0.85 g kg<sup>-1</sup>. JOSTUM parks are a good repository of  $SCO_2E$  and SOC, which is indicative of their carbon credit potentials and can be properly utilized for biodiversity conservation and climate change mitigation.

#### References

- Komolafe, E. T., Chukwuka, K. S., Obiakara, M. C., & Osunubi, O. (2020). Carbon stock and sequestration potential of Ibodi monkey forest in Atakumosa, Osun state, Nigeria. *Trees, Forests and People*, 2, 100031.
- Environmental Protection Agency (EPA) (2002). EPA Year in Review 2020. EPA Publication Number: 100K2100.
- Perkins-Kirkpatrick, S. E., Stone, D. A., Mitchell, D. M., Rosier, S., King, A. D., et al. (2022). On the attribution of the impacts of extreme weather events to anthropogenic climate change. *Environmental Research Letters*, 17(2), 024009.
- Pörtner, H. O., Roberts, D. C., Adams, H., Adler, C., Aldunce, P., et al. (2022). Climate change 2022: impacts, adaptation and vulnerability. IPCC.
- Sedjo, R., & Sohngen, B. (2012). Carbon sequestration in forests and soils. *Annu. Rev. Resour. Econ.*, 4(1), 127-144.
- Lal, R. (2008). Carbon sequestration. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 363(1492), 815-830.
- Beer, C., Reichstein, M., Tomelleri, E., Ciais, P., Jung, M., et al. (2010). Terrestrial gross carbon dioxide uptake: global distribution and covariation with climate. *Science*, 329(5993), 834-838.
- Akpa, S. I., Odeh, I. O., Bishop, T. F., Hartemink, A. E., & Amapu, I. Y. (2016). Total soil organic carbon and carbon sequestration potential in Nigeria. *Geoderma*, 271, 202-215.
- Yang, Y., Tilman, D., Furey, G., & Lehman, C. (2019). Soil carbon sequestration accelerated by restoration of grassland biodiversity. *Nature communications*, 10(1), 718.
- Ghosh, B. N., Meena, V. S., Alam, N. M., Dogra, P., Bhattacharyya, R., et al. (2016). Impact of conservation practices on soil aggregation and the carbon management

- index after seven years of maize–wheat cropping system in the Indian Himalayas. *Agriculture, Ecosystems & Environment*, 216, 247-257.
11. Pereira, P., Bašić, F., Bogunovic, I., & Barcelo, D. (2022). Russian-Ukrainian war impacts the total environment. *Science of The Total Environment*, 837, 155865.
  12. Belucio, M., Santiago, R., Fuinhas, J. A., Braun, L., & Antunes, J. (2022). The impact of natural gas, oil, and renewables consumption on carbon dioxide emissions: european evidence. *Energies*, 15(14), 5263.
  13. Deng, L., Yuan, H., Xie, J., Ge, L., & Chen, Y. (2022). Herbaceous plants are better than woody plants for carbon sequestration. *Resources, Conservation and Recycling*, 184, 106431.
  14. Besar, N. A., Suardi, H., Phua, M. H., James, D., Mokhtar, M. B., et al. (2020). Carbon stock and sequestration potential of an agroforestry system in Sabah, Malaysia. *Forests*, 11(2), 210.
  15. Gratani, L., Varone, L., & Bonito, A. (2016). Carbon sequestration of four urban parks in Rome. *Urban Forestry & Urban Greening*, 19, 184-193.
  16. Mexia, T., Vieira, J., Príncipe, A., Anjos, A., Silva, P., et al. (2018). Ecosystem services: Urban parks under a magnifying glass. *Environmental research*, 160, 469-478.
  17. Thomas, O., Stephen, O. E., Aondofa, A. B., & Felicia, I. E. Carbon credit assessment and importance value indices of trees in urban parks: a case study of benue state secretariat, makurdi.
  18. Thomas, O., Stephen, O. E., Aondofa, A. B., & Felicia, I. E. Carbon credit assessment and importance value indices of trees in urban parks: a case study of benue state secretariat, makurdi.
  19. DeClerck, F. A., Barbour, M. G., & Sawyer, J. O. (2006). Species richness and stand stability in conifer forests of the Sierra Nevada. *Ecology*, 87(11), 2787-2799.
  20. Dossa, E. L., Fernandes, E. C. M., Reid, W. S., & Ezui, K. (2008). Above-and belowground biomass, nutrient and carbon stocks contrasting an open-grown and a shaded coffee plantation. *Agroforestry Systems*, 72, 103-115.
  21. Labata, M. M., Aranico, E. C., Tabaranza, A. C. E., Patricio, J. H. P., & Amparado Jr, R. F. (2012). Carbon stock assessment of three selected agroforestry systems in Bukidnon, Philippines. *Advances in Environmental Sciences*, 4(1), 5-11.
  22. Pearson, T., Walker, S., & Brown, S. (2013). Sourcebook for land use, land-use change and forestry projects.
  23. Black, A. C., Evans, D. D., White, J. L., Ensminger, E. L., & Clark, E. F. (1965). *Methods of soil analysis* Amer. Soc. Agro. Inc. Madison Wisconsin, USA, 6, 2013.
  24. Bernardi, R. E., de Jonge, I. K., & Holmgren, M. (2016). Trees improve forage quality and abundance in South American subtropical grasslands. *Agriculture, Ecosystems & Environment*, 232, 227-231.
  25. Eneji, I. S. (2014). Sequestration and carbon storage potential of tropical forest reserve and tree species located within Benue State of Nigeria. *Journal of Geoscience and Environment Protection*, 2(02), 157.
  26. Ben-Shahar, R. (1991). Abundance of trees and grasses in a woodland savanna in relation to environmental factors. *Journal of Vegetation Science*, 2(3), 345-350.
  27. Garg, S., Joshi, R. K., & Garkoti, S. C. (2022). Effect of tree canopy on herbaceous vegetation and soil characteristics in semi-arid forests of the Aravalli hills. *Arid Land Research and Management*, 36(2), 224-242.
  28. Atsbha, T., Desta, A. B., & Zewdu, T. (2019). Woody species diversity, population structure, and regeneration status in the Gra-Kahsu natural vegetation, southern Tigray of Ethiopia. *Heliyon*, 5(1).
  29. Sitaula, B. K., Bajracharya, R. M., Singh, B. R., & Solberg, B. (2004). Factors affecting organic carbon dynamics in soils of Nepal/Himalayan region—a review and analysis. *Nutrient cycling in Agroecosystems*, 70, 215-229.
  30. Yang, Y., Mohammad, A., Feng, J., Zhou, R., & Fang, J. (2007). Storage, patterns and environmental controls of soil organic carbon in China. *Biogeochemistry*, 84, 131-141.
  31. Bhalawe, S., Jadeja, D. B., Tandel, M. B., Gayakvad, P., Parmar, M. R., Prajapati, V., & Behera, L. K. (2015). Non-Destructive Approach for Biomass Estimation and Carbon Mitigation in Different Land Use Systems. *Trends in Biosciences*, 8(15), 3785-3790.
  32. Kumar, B. M. (2011). Species richness and aboveground carbon stocks in the homegardens of central Kerala, India. *Agriculture, ecosystems & environment*, 140(3-4), 430-440.