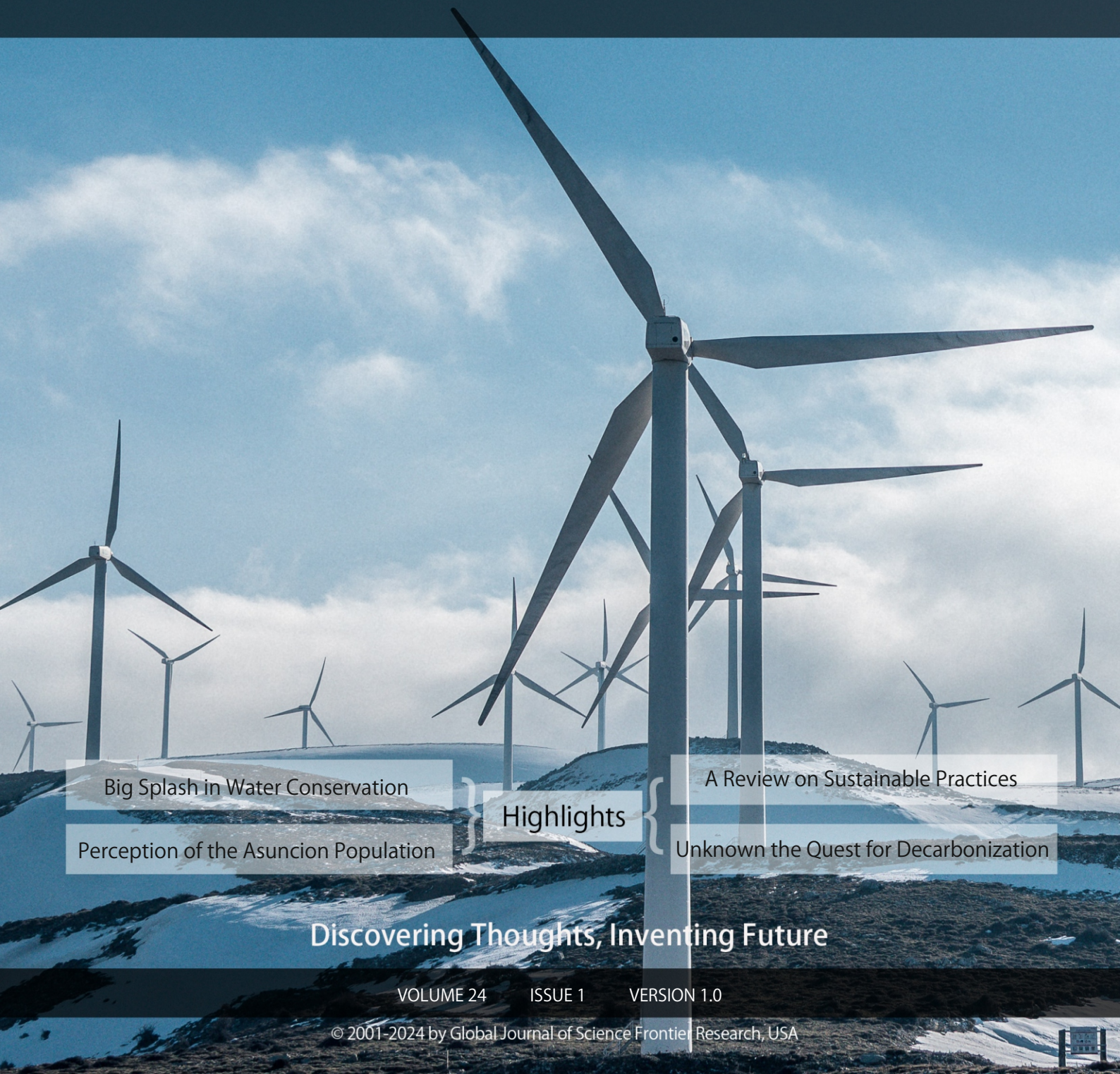
Online ISSN : 2249-4626
Print ISSN : 0975-5896
DOI : 10.17406/GJSFR

Global Journal

of Science Frontier Research: H

Environment & Earth Science



Big Splash in Water Conservation

Perception of the Asuncion Population

Highlights

A Review on Sustainable Practices

Unknown the Quest for Decarbonization

Discovering Thoughts, Inventing Future

VOLUME 24 ISSUE 1 VERSION 1.0

Global Journal of Science Frontier Research: H
Enviornment & Earth Science

Global Journal of Science Frontier Research: H
Enviornment & Earth Science
Volume 24 Issue 1 (Ver. 1.0)

Open Association of Research Society

Incorporation No.: 0423089
License No.: 42125/022010/1186
Registration No.: 430374
Import-Export Code: 1109007027
Employer Identification Number (EIN):
USA Tax ID: 98-0673427

Global Journals Inc.

*(A Delaware USA Incorporation with "Good Standing"; **Reg. Number: 0423089**)*
Sponsors: Open Association of Research Society
Open Scientific Standards

Publisher's Headquarters office

Global Journals® Headquarters
945th Concord Streets,
Framingham Massachusetts Pin: 01701,
United States of America
USA Toll Free: +001-888-839-7392
USA Toll Free Fax: +001-888-839-7392

Offset Typesetting

Global Journals Incorporated
2nd, Lansdowne, Lansdowne Rd., Croydon-Surrey,
Pin: CR9 2ER, United Kingdom

Packaging & Continental Dispatching

Global Journals Pvt Ltd
E-3130 Sudama Nagar, Near Gopur Square,
Indore, M.P., Pin:452009, India

Find a correspondence nodal officer near you

To find nodal officer of your country, please email us at *local@globaljournals.org*

eContacts

Press Inquiries: *press@globaljournals.org*
Investor Inquiries: *investors@globaljournals.org*
Technical Support: *technology@globaljournals.org*
Media & Releases: *media@globaljournals.org*

Pricing (Excluding Air Parcel Charges):

Yearly Subscription (Personal & Institutional)
250 USD (B/W) & 350 USD (Color)

Editorial Board

Global Journal of Science Frontier Research

Contents of the Issue

Global Journal of Science Frontier Research: H
Environment & Earth Science
Volume 24 Issue 1 Version 1.0 Year 2024
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

A Review on Sustainable Practices in Scientific Research

By Patrick Penndorf

Abstract- Many sustainable practices to reduce footprints in scientific research have been described. Plenty were proven to reduce environmental impacts while not affecting data quality. However, many scientists struggle with initiating change due to a lack in sustainability orientated education. A thorough understanding of sustainable practices is urgently needed to enable efficient and safe implementation. Therefore, the focus of this review is to provide a comprehensive collection and discussion of practices in chemical, biochemical, biologic and medical laboratories. Amongst others, strategies to reduce plastic waste, lessen energy consumption, reducing footprints when handling equipment and optimizing protocols or procurement will be included.

GJSFR-H Classification: *FOR Code: 0502*

AREVIEWONSUSTAINABLEPRACTICESINSCIENTIFICRESEARCH

Strictly as per the compliance and regulations of:

A Review on Sustainable Practices in Scientific Research

Patrick Penndorf

Abstract- Many sustainable practices to reduce footprints in scientific research have been described. Plenty were proven to reduce environmental impacts while not affecting data quality. However, many scientists struggle with initiating change due to a lack in sustainability orientated education. A thorough understanding of sustainable practices is urgently needed to enable efficient and safe implementation. Therefore, the focus of this review is to provide a comprehensive collection and discussion of practices in chemical, biochemical, biologic and medical laboratories. Amongst others, strategies to reduce plastic waste, lessen energy consumption, reducing footprints when handling equipment and optimizing protocols or procurement will be included. To enable scientists in different circumstances to benefit from this review, both simple, low effort steps and actions at larger scale will be discussed. Similarly, this review will address opportunities for bottom-up approaches by individual scientists and top-down approaches that require entire groups or institutions to participate. Additionally, benefits of sustainable practice such as reduced expenses, increased safety and optimized workflows are described because of their importance to motivate and justify change. In essence, this review should raise awareness by compiling the plethora of sustainable practices available. Furthermore, it should equip researchers with the knowledge and tools to incorporate sustainable practices whether they are driven by passion, regulation or workflow optimization.

I. Introduction

To drive change safely, a thorough understanding of the specific processes involved is essential. However, one major limitation for the advance of sustainable practices is that many approaches are not published after peer review. This is in part due to the fact that sustainable practices aim at keeping research outcomes unaffected, thereby not generating new knowledge. Secondly, changes have to be tailored to individual circumstances, thus, making generalization difficult.

Nevertheless, impactful examples have been demonstrated, such as an 11-fold reduction in footprints by reusing labware[1] and a 43 kg reduction in plastic waste within a single month in a microbiology group adopting minimizing as a design principle[2]. Also, a range of informative guides have been published[3–6].

Although a footprint in scientific research cannot be avoided due to the need of specific reagents, sterile work environments, and repeated replication, investigating options for sustainable practices is required to limit the steady growth of environmental pollution.

Growing awareness and increasing initiative are restricted by the lack of sustainability orientated education. Not just practical training but also the knowledge of alternative actions is missing. As a result, worries about potential process impairments prevail. Existing educational resources are often limited on a particular field. Furthermore, most are focused on a limited set of actions.

Therefore, this review covers sustainable opportunities in multiple fields such as chemical, medical, biochemical and even dry lab work. It offers both, general considerations as well as concrete actions alongside their benefits in reducing expenses, enhancing efficiency or improved cooperation. In essence, this review aims to equip scientists with a comprehensive understanding of what sustainable actions precisely entail. In the first third of this work, options for individual scientists are compiled. Later, actions that involve groups as well institutes and thus, address other professions are discussed as well (see figure 1).

II. Practices for Individual Researchers

a) Reducing Plastic Waste

The issue of plastic waste stands as a prominent concern within many laboratories. Given the requirement of sterile work environments, plastic products are often the preferred choice. This is exacerbated by the low production costs and feasibility of large-scale manufacturing, which diminishes the incentive for recycling, despite existing recycling routes[7,8]. The COVID pandemic demonstrated the substantial use of plastic waste, with the major portion of about 97% being incinerated[9–11]. Nevertheless, plastic lab ware is of high quality and purity due to the stringent requirements e.g., ensuring transparency, theoretically making them valuable in recycling processes.

To provide a memorable framework to lessen waste, the 3R framework—reduce, reuse, recycle—was established[12] and further expanded to encompass rethink, reject and repair within the 6R framework[13]. In essence, one should be incentivized to reject practices that prevail due to convenience. Afterwards, one can identify alternatives through rethinking common approaches. This ultimately leads to reducing

Author: *e-mail: penndorf.pa@gmail.com*

is not feasible, motivating recycling. How these principles can be translated into actionable steps, was addressed before[13].

i. *Reducing and Reusing*

As shown in table 1, reduction can be implemented by using reusable materials like glass or by revising experimental designs to decrease number and minimize size of consumables. Studies in running laboratories indicate that such measures can result in a substantial reduction of up to 69% in plastic waste which in turn reduce expenses significantly[2,14].

Reusing emerges as another powerful approach in reducing carbon footprints. In fact, reusing plastic articles can in some cases reduce impacts more strongly than the use of glassware[1]. For instance, optimizing pipetting sequences by adding solvents first, reusing tubes as containers for frequently needed solutions, or implementing tip washing procedures can significantly limit plastic waste[2]. Notably, these protocol optimizations not only reduce operational time but also decrease error frequencies due to heightened researcher awareness and better adherence to protocols. Reusing tips during noncontaminating procedures is also possible but should be considered meticulously given that repetition of experiments is even more costly.

ii. *Alternative Approaches*

The type of plastic an article is made of can significantly alter its footprint. Lately, it was demonstrated that with proper reuse and recycling schemes in place, opting for deep well-plates made out of Polypropylene instead of Polystyrene can reduce footprints by about 70%[15].

Moreover, recent innovations such as pipette washing machines or technology like acoustic droplet ejection, which avoid the need for disposable tips entirely, have emerged[16].

In summary, it was shown that the reduction in plastic waste is achievable without compromising data quality or sterility, while resulting in cost savings[1,2]. Nevertheless, proper experimental planning offers further opportunities.

b) Experimental Design and Conduct

While data generation remains of highest priority, adopting a sustainable approach motivates workflows optimization without affecting experimental outcomes (see table 2).

i. *Planning and Preparation*

Although being an upfront investment of time, a comprehensive review of existing literature is instrumental in preventing unnecessary duplication. Of note, the goal is not to entirely avoid duplication but to motivate through interaction with previously published work. Unnecessary duplication not only goes along with a carbon footprint but also wastes times, energy and financial resources. Although it might feel less industrious to read than doing experiments, the long-term benefit can be substantial.

Of note, initiating collaborations or outsourcing experiments to core facilities proves advantageous, circumventing resource-intensive and time-consuming method establishment while fostering expertise and international cooperation.

ii. *Experimental Design and Strategizing*

Time constraints and limited experience can often lead to suboptimal experimental design. As common practice in rodent focused research, statistical planning before starting a project can enhance power and thus, significance of results. As a result, this might offer opportunities to reduce sample sizes through optimized experimental design[17–19].

Outlying entire long term experimental plans will help with avoiding unnecessary experiments that are conducted because of missing perspective. Above that, it helps to deal with negative emotions when a series of experiments yields unsatisfying outcomes. Of note, long term planning also focuses on size and scope of preliminary experiments directed at initial hypothesis. Thus, initially variable and lean approaches are certainly welcome but require long-term planning to be of maximal value.

As widely appreciated, controls are crucial in every experiment. However, they should be chosen according to future research orientation. For instance, a control involving a painkiller may be valuable, but without understanding the painkiller's mechanism, subsequent studies may require additional experiments to account for analgesic effects.

iii. *Reviewing Experimental Conduct*

Once a research framework is established, a close examination of current protocols and methods is useful. Exploring alternative analytical routes using combination techniques such as Liquid chromatography–mass spectrometry or non-invasive methods, for example, Near-infrared spectroscopy and Raman spectroscopy can enhance analysis without compromising samples[20,21]. This extends to considering the use of alternative chemicals for tasks like mounting slides or fixing samples, which also provide more safety for researchers[22–25]. Exchanging solvents and adjusting reagent quantities can yield substantial benefits, especially in the context of expensive chemicals or antibodies[26,27]. By the same token, reuse of materials such as nucleic acid extraction columns after regeneration is possible without carryover contamination as previously demonstrated[28].

Importantly, conscientiously archiving and sharing negative results contributes can minimize unnecessary repetition while providing useful information that is often forgotten later on.

Changes, like titrating antibodies to lower concentrations while changing incubation times, demonstrate how a focus on sustainability can simultaneously reduce environmental footprints, cut expenses, and improve data quality[29]. Other specific examples especially evolving around analytical methods such as chromatography, enable reduced running times, higher efficiency and reduction of handling toxic chemicals [27,30].

c) Green Chemistry

Apart from the possibility to distill back solvents, few chemicals and reagents can be reused or even recycled, thus, being discarded on landfills[31,32]. Consequently, the concept of green chemistry emerged, aiming to mitigate environmental footprints. Numerous strategies, such as the 12 principles of green chemistry and other reviews offer a roadmap for making chemical research more sustainable[21,33]. In essence, these principles evolve around the conscious choices of chemicals, synthesis routes that reduce the use of environmentally impactful chemicals, and the avoidance of energy-intensive steps. Of note, exchanging solvents and alternative methods such as solid phase microextraction or optimizations for chromatography well reviewed elsewhere[27,34].

While an immediate overhaul of experimental setups may not always be feasible, it is worth educating on these topics to enable future change. Materials for involving such topics in courses and lectures has been created and published[35,36].

Nevertheless, it should be noted that there is no complete standardization of vocabulary and life cycle calculations. As a result solutions need to be chosen according to current circumstances, and undoubtedly a degree of subjectivity remains[37,38].

d) Computational Biology

The environmental impact of computational approaches often goes overlooked, despite the significant energy consumption with more than 15kg of CO_2-equivalents for simulating a Satellite Tobacco Mosaic Virus for 100ns depending on the tool used[39–41]. Recently, useful principles and guides have been published to address this concern[42,43]. In general, the assessment of carbon footprints is of great importance, as these metrics offer a comprehensive understanding of the environmental impact and serve as a means to raise awareness. Various publicly available tools are designed to facilitate impact assessments, even for complex and energy-intensive tasks like training deep learning models[44,45].

While overarching actions, such as increasing code efficiency, implementing checkpoints, and conscious chose of both software and hardware, can be applied universally, tailored solutions have been developed for specific applications. Examples include optimizations in whole genome regression and neuroimaging studies[46,47]. Undoubtedly, the development of more sustainable practices is urgently needed given the ubiquitous importance of modern computation versus outdated ways of operation.

e) Avoiding Paper use

Reducing paper is trivial but often avoided given that printed materials provide a unique sensory experience. However, the adoption of digital solutions allows for convenient features such as highlighting, text searching, copy-pasting, bookmarking. Thereby functionality and handling to find notes even after long time periods are greatly enhanced. Additionally, sharing and forwarding becomes much easier. As addressed in table 3, when the use of printed materials is unavoidable, considerations should include opting for recycled paper, printing on both sides of the sheet, or utilizing already used sheets to minimize environmental impacts.

f) Reducing Water Consumption

Efforts to enhance the sustainability of laboratories with respect to water usage are often closely linked to considerations of energy consumption. However, minimizing water use is possible by employing mechanical force or allowing impurities to soak during cleaning procedures. However, addressing water usage in laboratories remains a complex issue, influenced by geographical location.

Nevertheless, for many cleaning steps, tap water should be preferred, especially for the initial washing phase, as it is significantly less energy-intensive compared to using distilled or otherwise treated water and the feasibility given the large awareness of the issue[48]. Additionally, using ice consciously is beneficial given the energy costs for cooling down water.

g) Lessen Energy usage

Since electricity costs are often not paid by research groups themselves, energy consumption is not of particular importance for many scientists. However, energy conserving practices often come with other benefits. Conscientious practice such as shutting the sashes on fume hoods or turning off machines can increase life times, for example, by avoiding unnecessary filter clotting[49]. Furthermore, trivial but inconvenient practices such as reducing the time doors of fridges and freezers are left open reduces frost accumulation that makes defrosting necessary. Even more importantly, this practice prevents the accumulation of ice-crystals on lids which cause unwanted air-exchange. The result can be temperature variances within the freezer and additional burden on compressors that become more likely to fail due to overload.

As mentioned in table 3, maintaining a well-organized cloud system for experimental data and

ensuring tidy inboxes can enhance efficiency and reliability in finding data. If data is stored on a cloud, every additional backup should be made on hard drives to lessen energy consumption but also to ensure proper data security.

Another often overlooked source of energy consumption stems from the use of artificial intelligence and search engines. Of course, it is not possible to avoid the use of these technologies, however, preventing unnecessary use is certainly valuable.

h) Personal Engagement

Quantifying one's own footprint is essential not only to provide much needed data but also to be able to monitor improvement. Although it is not easy, resources such as a tool that helps to calculate emissions exist[50].

Participating in conferences and meetings often is a highlight of academic work, but comes at a considerable carbon footprint[51,52]. While travel is traditionally deemed essential for professional success[53,54], evidence suggests that the benefits of frequent travel are limited[51]. Nevertheless, there are multiple avenues to address this issue, such as merely reducing flight frequency or implementing incentives to discourage excessive travel[55].

Moreover, also journal clubs and talk series can be designed more sustainably. For instance, opting for local colleagues instead of inviting speakers from foreign countries or transitioning entirely to online meetings is possible. Even if it involves using more interactive online software, these solutions can pave the way for new ways of exchange. For larger events that are mostly held in person, hybrid formats should be considered as a way to alleviate sustainable impacts but also allow scientists from disadvantaged backgrounds to participate.

If scientists present their work at conferences or their local institute, addressing sustainable practices is a great way to raise awareness and inspire colleagues. Thereby, it is easy to connect with like-minded scientists who may be hesitant to express their interest or seek advice. Furthermore, open sharing can lead to collaborative initiatives, including opportunities such as funding or invitations to publish papers on the topic.

Still, it remains crucial to extend consideration beyond personal travel, especially in research scenarios that involve the movement of patients or samples[52,56]. Nevertheless, such decisions can often not be made by a single individual but require the consent of an entire group.

III. Group Focused Actions

The effective and safe implementation of sustainable practices relies on individual researchers taking actions that are well integrated into the overall activities of their group.

a) Internal Communication & Integration

Openly planning and discussing sustainable practices during lab meetings is crucial, not only to raise awareness but also to guarantee their proper implementation.

Furthermore, it can contribute to a strong feeling of unity by working on a common goal.

To start such discussions, it is feasible to animate team members to share the changes they learned about or already implemented in their protocols during their presentations. It is important to openly acknowledge the challenges that arise with change no matter how big enthusiasm might be. To ensure that sustainability remains an actively discussed topic even after successful implementation, dedicating a few minutes at the beginning or end of each meeting for exchanging new opportunities is often feasible. For very ambitious groups, planning entire sustainability meetings once every quarter is possible to ensure buy-in from all members, especially new ones.

Objections to attempted change should be handled with care and understanding. Given that sustainability is often considered a threat to established practices, proper communication and education are crucial. Changes should not be made unless a strategy is crafted that ensures that potential impairments in workflows are detected and readily reversable. Additionally, understanding priorities of superiors and addressing benefits beyond environmental protection can prove powerful. A rejection might demotivate and intimidate, but often it needs some time until decision makers open up to new approaches given they carry responsibility for overall success.

b) Optimizing Procurement

According to a recent study, procurement could contribute to more than 50% of the carbon footprint of a laboratory, particularly due to the substantial impact of scope 3 emissions, i.e., the emission in part caused by producers and shipments[57]. While the selection of products must align with the needs of scientific endeavors, ordering practices can be designed to be more sustainable (see table 4).

Establishing a robust management system is a first step that will also benefit laboratory operations greatly. The goal is to ensure that reagents and consumables are ordered only when necessary, but thereby guaranteed to be available when needed. Such systems are available as commercial software, relatively easy to code or even manageable as an Excel sheet. These systems can be integrated to monitor the location of reagents, significantly reducing search times for researchers. Even in underfunded settings, where priorities evolve around opting for the cheapest option, these systems can contribute to this end. The avoidance of ordering when items are still available as well as reinforcing choosing options with the smallest necessary

volume while saving on delivery fees when ordering in bulk help cutting expenses. Furthermore, merely reducing ordering frequency by incentivizing long term planning and collecting order potentially across groups can reduce fees and footprints.

Undoubtedly, procurement strategies can only effectively be changed when feasible alternative exists. Although scientists have other priorities than comparing products, and deciding to order new articles always comes at a certain risk, sustainability should act as a motivator to at least monitor potential beneficial alternatives until change becomes possible. In fact, many companies have already adopted practices, such as reducing packaging or utilizing eco-friendly delivery methods e.g., shipping polymerases without cooling or oligos in powder form. Decisions can be based on the provider's location thereby reducing delivery times and minimizing reliance on supply chains. Some providers offer take-back programs or engage in other sustainable practices, making them preferable choices.

Reading life cycle analyses for products may require considerable effort and is highly dependent on specifics. By the same token, caution is needed, as green washing and carbon offsetting remain problematic practices. As a solution, information by initiatives and certification programs offer guidance for choosing more sustainable products.

c) Using Equipment Sustainably

As mentioned before, groups often do not pay for the energy consumption themselves but in many cases parts of their grants are deducted from the institute for those expenses. Therefore, conscious choices for less energy machines can help to partially reclaim those. However, a plethora of other benefits goes along with sustainable practices as well.

i. *Choosing the Right Equipment*

When acquiring new machines, special care should be taken given that many companies offer equipment that reduces reagent use, has optimized components or even makes use of alternative working procedures (see table 5). For instance, for mass spectrometers this could be reduced nitrogen consumption. For chromatography this could mean a reduced inner diameter of the columns. More advanced changed could involve switching to hydrogen as a more sustainable carrier gas for GC/MS or even alternative cooling mechanism and refrigerants for freezers[58]. Indeed, the various models available can be overwhelming at first but conversations with salespeople can help. Often, these interactions can also inform about new methods that are dedicated to certain experimental questions. Of note, in cases of sterilizers, ovens and incubators capacity is an important factor to be considered.

However, it is not always feasible to replace, for example, water baths with more efficient alternatives. Then, proper use can be important, for example, by using covers to prevent evaporation of the heated water. Finally, addressing equipment that is not used anymore is advised. This can involve repairing old machines or selling machines on the secondary market. At this point it should be also mentioned that buying secondhand machines with proper refurbishment-certification can improve finances. Of note, also programs to donate machines with laboratories in developing countries can be explored. Nevertheless, how long a machine will be in action depends on it operation.

ii. *Operating Machines Effectively*

Operating machines sustainably fundamentally refers to increasing lifetime and reducing unnecessary expenses.

Given the rise of very complex softwares and hardwares proper operation and maintenance often require sa deeper understanding than the limited set of functions a single researcher needs would require. Indeed, the stressful settings in which scientists work makes general introduction often appear sufficient. Investing in more elaborate introductions should avoiding damages that occur by accident and adequate handling when incidents happen[59]. Ordering engineers when issues are irreparable goes along with high prices and also long waiting times and thus, downtime of machines. Furthermore, often seldomly used features can offer improvements for certain experiments and analyses.

Ensuring proper use of fume hoods, contributes to ensure protections of researchers health[60]. Additionally, maximizing use of samples and test resins, for example, in mass spectrometry target plates or deep well plates, should be prioritized above convenience. Without doubt, settings and resulting running times should be considered in detail but have to be optimized for every piece of equipment and experiment individually. Still, they offer opportunities for improving sample integrity, while potentially reducing reagent and energy consumption.

d) Reducing Energy and Water Consumption

Another way to reduce electricity consumption is reducing the operating times of machines. In turn, this will also reduce wearing off components and thereby save on expenses and downtime. Especially for sterilizers, it was shown that energy requirements can be reduced significantly, about 26% in one case when completely turned off in times they are not in use[61,62]. Therefore, it is often useful to create an energy plan and make everybody aware of which machine can be turned off and under which conditions. Also, how different features are used such as settings when scanning with modern high resolution microscopes or the holding temperature of PCR cyclers are factors to be considered.

Efforts to reduce water expenses in machines are often not immediately apparent and more difficult to implement, but they play a crucial role in promoting sustainability. One effective strategy involves implementing close cycle cooling, particularly in cases of condensers. These alternatives can significantly decrease water consumption and contribute to resource conservation. Additionally, installing low-flow aerators on faucets is a straightforward yet impactful step. Lowflow aerators control the flow of water from faucets, reducing the overall water usage without compromising functionality.

Furthermore, actions mirroring those taken at home can adopted. Those include using multi-plugs to completely shut down equipment when not in use, turning off lights, and running dishwashers at full capacity.

Moreover, optimizing the settings of freezers from -80°C to -70°C is a frequently discussed practice that allows for remarkable savings on energy. Various initiatives work on list for samples that did not suffer from such a change, especially given that -70°C was the common operating temperature a few years ago. While a detailed discussion is not feasible at this point, open discussions should be had given that some “buffer” in case of failure can be avoided by proper monitoring while regulations for the storage of certain samples must be addressed on other levels. Still, best practices include defrosting and cleaning of filters and compressors that will contribute to longer lifetimes and lower energy consumption as well. Proper organization of samples remains key to ensure time efficient workflows. Especially in academic research environments, proper planning early on will also enable to only keep selected samples instead of losing track of contents because of retaining every specimen without clear organization.

e) Handling Waste Properly

Handling waste in laboratories is a critical aspect, ensuring both the safety of researchers and the protection of the environment downstream.

Theoretically is required to be familiar with all chemicals used, and general introduction are given. Still, clearly pointing out that these practices should protect the health of researchers and nature is crucial to provide an intelligible motivation that goes beyond a mere rule. Then, motivating scientists to create their own guides and overviews of how consumables and chemicals should be treated can offer a much more powerful and efficient way to have every member engaged with the topic.

Given that chemical-related incidents are the most common in harming scientists, making best practice a habit is essential[59]. Preventing evaporation is an insightful example. Finishing work due to stress is often of higher priority, thus, chemicals are handled wherever feasible, thereby endangering colleagues as well. Even when working in hoods, evaporation poses danger to scientists in case they do not adhere to best practices but more importantly, chemicals still freely dissipate into nature.

Nudging is a simple but often helpful way to boost adherence to best practice (see table 6). Labeling waste bins and centonates with easily graspable visual explanation or articles helps differentiate where specific types of waste should be disposed while serving as a constant reminder. Ensuring proper separation is crucial because failures can render entire fractions of waste unrecyclable.

Reusing old flasks or containers and participating in takeback programs offered by some companies, offer further options. In contrast, addressing the proper handling of items such as cooling packs, animal bedding, and Styrofoam is more challenging. While composting and recycling is possible, initiation often falls to individual groups.

Old pipettes and broken glass can be repaired through university facilities and technicians. Lab coats can easily be reused. Although it often needs a responsible person to take care, these practices often involve not more than proper organization within a particular group.

f) Improving Organization

Sustainability should be implemented without causing too much pressure on individual members. To do so laying out a strategy can be of tremendous value. As discussed before, that means open communication (see table 7). Additionally, implementing features from "Smart-Labs," that aim to connect software and hardware to improve processes such as database operation, monitoring, or ensuring access to information at any time can help. These systems can approximate footprints, monitor energy consumption, and prevent catastrophic sample losses by alerting to freezer failures. Tracking and organizing samples and experimental outcomes contributes to a well-structured data system, allowing insights even years after experiments were conducted. While these changes may initially seem technological and involve costs, the long-term efficiency gains make them valuable investments for laboratory sustainability.

Optimizing lab space utilization is valuable both in terms of monetary aspects especially for facilities while facilitating a safer and more efficient workflow for individual scientists. Insufficient space or too long distances between workspaces can cause avoidable accidents that might impair results or prevent data acquisition entirely. However, some of these changes have to be approved by other groups or even the entire institute.

IV. Institute-Wide Changes

Sustainability is a multifaceted topic, and it is essential for both grassroots initiatives and top-down approaches to complement each other, as discussed elsewhere[63]. Currently, grassroots initiatives are more prevalent, however, the significance of top-down approaches should not be underestimated.

a) Leveraging Governance

Institutes play a crucial role in promoting sustainability by issuing guidelines and regulations that can create a much needed framework for sustainable actions. These changes could even be enforceable, thus providing a strong momentum. As included in table 8, guidelines are essential to facilitate buy-in from superiors and overcoming inertia, especially considering the novelty of the topic.

These guidelines can include proper waste separation with providing necessary bins and infrastructure. Institutes often also have control over electricity and air conditioning as discussed below. Of note, making laboratories report about their use of energy, water or waste generation is an easy way to raise awareness and collect valuable data.

Without doubt, establishing such guidelines can be challenging due to the variability of techniques used in laboratories and the difficulty to not hinder research. Still, institutes and universities optimize towards more sustainable actions also outside the laboratory. These processes can be used to initiate support for scientific endeavors as well. A remarkable example is the Laboratory Efficiency Assessment Framework that was developed at the University College London. Of note, a number of other universities share their sustainability guidelines that were created by scientists, such as the University of Pennsylvania Green Labs program or the Sustainable Labs by the Sustainability Office from Havard University.

Whatever steps are taken, institutes adapting strategies early will benefit when political regulations and enforcements are introduced. How well these new regulations will be received might also depend on how these are introduced internally and how easily staff can adopt.

b) Internal Communication and Strategizing

Institutional communication is vital even if often considered trivial. Clearly stating values and priorities can happen in dedicated meetings, through newsletters, or specifically organized get-togethers. Making such activities focused on providing value to and listening to challenges that occur when implementing sustainable practices can foster a sense of community engagement. Educational resources can be created internally or by cooperating with external initiatives that often come with a plethora of experiences. Offering support for projects evolving around assessing footprints and drafting solutions allows for excellent insights into current circumstances. An outstanding example is the University of British Columbia providing a plethora of financial support for such projects to engage and use their human resources.

c) Enhancing Organizations Structurally

However, learning about sustainability is often demanding. Establishing roles like green lab experts or sustainability managers can accumulate expertise and provide positions with the necessary recognition, capacity, and judgment to drive change. While such roles are still relatively new and clear requirements are difficult to establish, they come with the needed variability to help groups individually. Their role can involve screening, evaluating, and advancing sustainable actions. By the same token, they can also help to combat the challenge of high turnover rates and personnel that is often encountered in scientific environments[64].

Regarding future benefits, sustainability efforts can contribute to branding and attracting new talent, showcasing engagement and responsible action. As mentioned before, the University of British Columbia is a great example that is famously known for its commitment to sustainability.

Although less common, institutes have the ultimate authority to establish guidelines for sustainable procurement, influencing the choices made by researchers and administrators. As mentioned above, creation often requires effort but will serve as a scaffold for the entire institute thereby aligning with future requirements.

While the scope of this review may not cover cafeterias, addressing ways to reduce their environmental footprint and waste generation is an additional aspect worth considering.

d) Selecting Third Parties Carefully

Handling third parties that provide electricity, take care of waste and are responsible for refurbishment or construction of laboratories plays a role in sustainable conduct as well.

While it is the responsibility of scientists to appropriately separate waste, institutes can play a vital role in educating their researchers on proper waste separation. Furthermore, selecting a third-party waste management service that ensures proper handling is necessary to ensure that waste is actually recycled downstream. Of note, effective recycling but also mitigates potential dangers to overall health associated with improperly treated waste are resulting[65,66].

Designing and planning new laboratories with sustainable practices in mind, or choosing a 3rd party that has expertise in this area, is beneficial. These measures should include commonly known aspects such as efficient laboratory design. Above that, they might comprise also less obvious measures, for

example, where and how to incorporate emergency power systems. Of course, one essential aspect in such planning includes the setting ventilation and heating systems.

e) Addressing HVAC

The Heating, Ventilation, and Air Conditioning (HVAC) systems in laboratories are often overlooked by scientists due to limited experience and expertise in this field. However, optimized strategies in HVAC management as summarized in table 9, can significantly contribute to reducing the overall environmental footprint, with potential reductions of up to 50%[67]. Institutes or specialized technicians have the opportunity to adjust and decrease air flows in laboratory spaces, particularly with the capabilities of modern systems that allow for close monitoring and variation. Merely adjusting air flow has been shown to yield reductions in energy consumption of about 18% by Kitzberger et al.[68]. Air conditioning should regularly be reviewed given that levels are seldomly reported or changed.

Furthermore, the organization of freezers and the set temperature in these rooms are crucial considerations for ensuring their proper functioning. Freezers should be orientated so that exhausted air can easily dissipate. Temperatures at different locations within a room should be closely controlled given that extreme temperatures can lead to a higher probability of freezer failures. Although best practices have to be guided by individual circumstances, paying attention to avoiding obvious blunders can often reduce unnecessary footprints significantly.

V. Discussion

The numerous actions can be taken in the pursuit of environmental protection also enable cost savings, time preservation, enhanced workflows, or in some cases improved data quality (see figure 2). The key is to choose initial steps that align with the scientist's experience and that can be effectively integrated into current circumstances. Informing and involving the entire team or institute is crucial, as colleagues may harbor more passion for sustainability than initially apparent.

Even if far-reaching changes are not immediately feasible, initiating discussions, openly communicating, and refining current training practices hold significant potential, although they may initially seem less tangible[69].

Scientists and staff should not be overwhelmed by the multitude of possibilities but start small with clear goals and manageable expectations. Changing habits takes time, and unforeseen challenges will arise. However, with experience, approaches and understanding will evolve.

Although many examples of successful implementation of sustainable practices are not formally published in papers, internet searching will provide a multitude of insights. By the same token, many initiatives can be found that offer help, guidance and shared experiences.

Nevertheless, is important to refine the current apprehension of sustainability. In a research context, sustainability must be implemented beyond merely political or ideological agendas. Sustainability orientated thinking offers a new perspective combining environmental, societal, psychological and economical aspects. It is an approach that maintains the ultimate goals of science but emphasizes the rather hidden opportunities to increase efficiency. Sustainability is not an obligation, it is an opportunity, both for better preserving our ecosystems and further optimizing scientific workflow.

Table 1: A Summary of Options to Reduce Waste

Choosing providers that avoid unnecessary packaging or opt for more easily degradable solutions like paper
Reducing plastic waste in the laboratory can be achieved by: • Using alternatives such as glass or metal items for flasks, dishes, serological pipettes and weighing boards • Minimizing the size of consumables (especially tubes, serological pipettes, pipette tips) • Pouring solutions where precises volumes are not decisive (e.g., washing steps) • Reusing Falcon tubes, potentially after rinsing, especially for frequently used solutions • Reusing pipette tips, tubes where cross-contamination is not an issue
Precise calculation and bulk preparation of reagents and solutions
Conscious use of gloves
Making use of take-back programs for plastic items, including Styrofoam

Table 2: A Summary of Options for Improving Experimental Conduct and Design

Proper experimental planning can be achieved by: • Leveraging existing literature to avoid redundant experiments • Robust statistical planning (especially power analysis) help reduce sample sizes and enhance statistical validity • Carefully chosen experimental conditions with proper controls • Reviewing consumable utilization ahead of conduct (including material, size and number of consumables) • Preparation procedures (e.g., optimizing pipetting schemes and master-mixes to reuse tips and tubes) • Adopting safer and more benign alternatives for commonly used reagents in experiments (e.g., DNA staining solutions, microscopic slide mounting agents, lysing agents, or protease inhibitors) • Alternative experimental approaches (e.g., using Supercritical fluid chromatography (SFC) to avoid organic solvents needed in HPLC) • Consider potential for downstream use or regeneration (e.g., regeneration of nucleic acid extraction columns)
Implementing strategies and frameworks to ensure best practices (e.g., handling pipettes upright when pipetting)
Awareness of toxicity of reagents in use for proper handling and discarding (e.g., including closing lids to avoid evaporation)
Initiating collaboration with • Colleagues in co-preparation of solutions, sharing of samples or co-use of machines (e.g., water baths) • Other groups to share equipment • Core facilities or partners to avoid unnecessary establishment of new methods
Implementing the 12 rules of Green Chemistry, including
• Conscious solvent and reagent selection (according to safety, LCA and impact assessment, e.g., Ethanol instead of Acetonitrile) • Optimize procedures by using catalyzers and reducing resource-intensive processes like heating or distillation • Using renewable feedstock and designing products for degradation
Refining computational experiments by: • Adapting practices that reduce running times and optimize code efficiency • Measuring carbon footprints (and potential reductions) • Considering relocating computational tasks to energy-efficient data centers • Planning to run jobs during times of low demand • Implementing check pointing strategies to streamline computational processes and reduce unnecessary energy consumption • Storing only essential data for regenerating large datasets, reducing energy demands and use hard drives instead of cloud-storage only • Avoiding using screensavers to minimize needless energy consumption • Selecting energy-efficient hardware especially when buying anew

Table 3: A Summary of Sustainable Practice to Reduce Paper, Water and Energy use

Paper
• Transition to digital sources like electronic lab journaling and online publications
• When printing is necessary, using recycled paper and opt for double-sided printing on previously used paper
Water
• Minimize water use, for example by soaking steps and mechanical cleaning
• Consciously discern water types (tap, distilled, double distilled etc.)

• Use only as much ice as needed
Energy
• Regularly organizing and cleaning digital inboxes to prevent unnecessary data storage
• Maintain a tidy system for experimental data, avoiding unnecessary duplication and keeping a safety copy securely stored on a hard drive
• Exercise caution with AI technologies and use of search engines due to their potential high energy consumption
• Evaluate the necessity of video in online meetings and switch to audio-only when possible to minimize data and energy usage
• keep laboratory fume hood sashes shut and turn machines off when not in use (e.g., water baths)

Table 4: A Summary of Changing Procurement and Purchasing Processes to be More Sustainable

Planning orders carefully by: • Creating an internal system to track chemical inventory and consumable supplies to minimize unnecessary orders • Collaborating with other laboratories or facilities to collect orders
Choosing products consciously by: • Procuring items in quantities aligned with future usage • Emphasizing sustainable packaging practices, favoring minimal material usage and biodegradable materials where possible • Opting for specific shipping methods and alternatives to conventional cooling methods (e.g., when ordering polymerases without cooling or oligos dry) • Thoroughly evaluating feasible alternatives based on certifications, life cycle analyses, and sustainability practices
Choosing the optimal supplier • Preferring local suppliers to reduce transportation-related emissions and dependency on global supply routes • Preferring certified suppliers and articles • Exploring take-back programs and consider second - hand purchases to enhance sustainable procurement practices

Table 5: A Summary of Actions for Sustainable use of Equipment

Choose instruments with reference to • lifetime (e.g., photomultiplier tubes have longer lifetimes) • capacity (e.g., volume of sterilizers & autoclaves) • components (using low-boiling-point solvents in air-cooled condensers to reduce energy consumption)
Running equipment that • minimizes reagent use (e.g., Nitrogen consumption in MS or HPLC columns with smaller inner diameter to reduce solvent consumption and waste creation) • enables change to more sustainable alternatives (Hydrogen as carrier gas instead of He in GC/MS) • enables internal reuse (e.g., automated recycling of the mobile phase for example after absorption of the impurities)
Making a conscious choice about what methodology to use (e.g., wet vs dry blotting, on site analysis, high throughput analysis, combination techniques such as LC-MS)
Exercising best practices (e.g., not let elution fractions from chromatography columns evaporate or using all spots on matrix array plates for MS, putting as many samples on one microscopy slide as possible)
Being aware of the robustness of methods (e.g., ability to reuse TLC capillaries after rinsing)

Reducing energy use by: • Developing an energy plan, i.e., when to turn on and off individual machines • Using strategies like multi-plugs to turn off ovens and water baths during inactivity or employing smart plugs for automated on/off cycles • Considering carefully how you use equipment (e.g., the holding temperature of PCR-cyclers or settings including scanning area in microscopy) • Modifying freezer temperatures, such as increasing from -80 to -70 • Using covers for water baths and replace oil baths with more efficient alternatives like metal heating blocks or efficient oil pumps • Operating dishwashers and autoclaves only at full capacity • Consciously choosing levels for the A/C set-up
Reducing water use by • Implementing low-flow aerators to conserve water • Using closed-cycle cooling systems and waterless liquid-cooled condensers with low-boiling-point solvents as an alternative to single-pass cooling methods

Table 6: A Summary of Sustainable Practices that Optimize Waste Treatment

Making sure that evaporating waste is handled properly (e.g., stored in a hood or closed container)
Using old jerry cans/flasks/container as waste containers (or already contaminated tubes)
Create a plan how to handle cooling packs, animal bedding, Styrofoam etc
Establishing education and indication systems (e.g., exhaustive stickers on waste bins, using and a database with necessary educational resources)
Repairing broken glassware and old pipettes

Table 7: A Summary of Changes for Internal Organization to Align with Sustainability as a Priority

Exploring "Smart-Lab" innovations to monitor and quantify lab processes (e.g., monitoring old freezers to control failures or assess energy consumptions)
Have open conversations and discussion in lab meetings
Reusing Labcoats
Freeing and optimizing use of lab-space by:
• Only buying/installing equipment that is certainly needed • Promoting the use of spacing or energy saving alternatives e.g. ventilated storage cabinets instead of fume hoods for storage • Encouraging the removal of unused equipment

Table 8: A Summary of Possibilities to Include Sustainability in Institute Governance

Creating clear guidelines, regulations or position papers
Creating a position for a Sustainability Manager/Green Lab Expert
Conscious assessment of space use and encouraging shared utilization of equipment
Consciously choosing 3rd parties (e.g., for waste treatment or power providers)
Initiating conversations with cafeteria staff to explore ways to mitigate their carbon footprint

Table 9: A Summary of Practices to Optimize HVAC in a Sustainable Fashion

Adjusting and decreasing air flow within laboratory spaces during periods of inactivity at night or during vacations
Prioritizing smart design principles when constructing new laboratories (e.g., including proper insulation, strategic window and vent placement, strategic placement and employment of emergency power systems)
Precisely reviewing and setting A/C levels
Organizing freezer placement and air conditioning systems properly to ensure efficient air circulation
Removing or replacing energy inefficient equipment (e.g., sucking pumps)

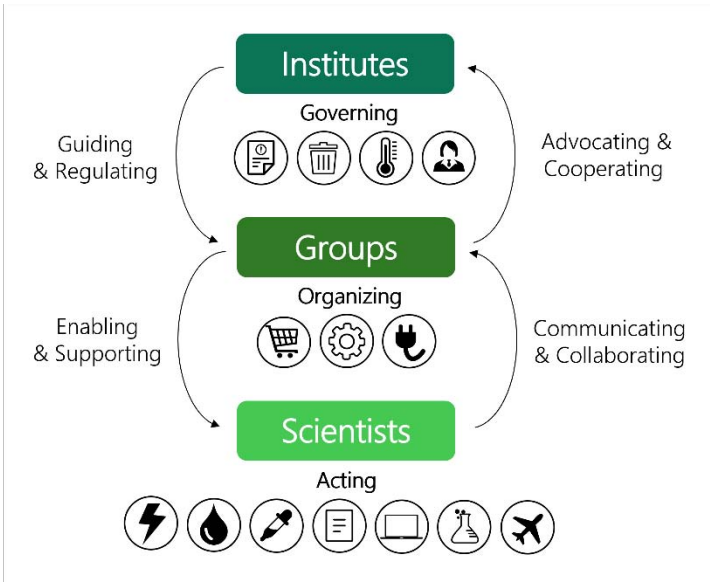


Figure 1: Sustainable actions within a research environment need to be implemented on multiple levels. Institutes play a pivotal role by providing guidance and regulations for research groups. Beyond governance, they are responsible for organizing third-party involvement in waste processing or HVAC management. The appointment of a green labs manager can be beneficial in coordinating these efforts. Research groups and Principal Investigators are essential in implementing these guidelines while their voice in advocating for further sustainable changes is often required. Groups need to organize purchasing, machine handling, energy consumption, and internal practices, facilitating discussions and enabling scientists to adopt sustainable practices. Individual scientists have a range of sustainable options to implement, including reducing energy, water, chemical, paper, and plastic consumables, and optimizing experimental strategies in both dry and wet lab research. Additionally, individual actions like opening sharing practices during meetings or talks and reducing international travel help to minimize environmental footprints. Effective communication of these actions and collaboration within groups are crucial to ensure the safe implementation of changes and gain support from superiors

Figure 2: Sustainable practices implemented reduces environmental impact by enhancing efficiency and effectiveness of laboratory processes. For instance, establishing sustainability positions institutes and laboratories well for the future, where regulations may be introduced, and applications for funding may include the establishment of sustainable practices. Adhering to the principle of reduction in sustainability often results in decreased expenses, stemming from reduced consumption of consumables, chemicals, and energy. Choosing more benign reagents and chemicals inherently enhances safety. Reviewing laboratory processes and optimizing machine operations not only increases efficiency but also fosters improved teamwork, as sustainable changes require awareness and participation from all team members. Proper planning and optimization of experimental strategies and protocols can elevate data quality and increase statistical robustness. Although these benefits can be considered separately, benefiting one actor will reinforce their commitment and support for the establishment of sustainable practices at other levels

References Références Referencias

1. Farley, M. & Nicolet, B. P. Re-use of laboratory utensils reduces CO2 equivalent footprint and running costs. *PloS one 18,* e0283697; 10.1371/journal.pone.0283697 (2023).
2. Alves, J. *et al.* A case report: insights into reducing plastic waste in a microbiology laboratory. *Access Microbiology 3,* 173; 10.1099/acmi.0.000173 (2021).
3. Freese, T. *et al.A guidebook for sustainability in laboratories* (2023).
4. Farlie, F. *et al.* Sustainability in the IVF laboratory: recommendations of an expert panel. *Reproductive biomedicine online 48,* 103600; 10.1016/j.rbmo.2023.103600 (2024).
5. Leak, L. B., Tamborski, J., Commissaris, A. & Brophy, J. A. N. Forging a path toward a more sustainable laboratory. *Trends in biochemical sciences 48,* 5–8; 10.1016/j.tibs.2022.09.001 (2023).
6. Lopez, J. B. & Badrick, T. Proposals for the mitigation of the environmental impact of clinical laboratories. *Clinical chemistry and laboratory medicine 50,* 1559–1564; 10.1515/cclm-2011-0932 (2012).
7. Lange, J.-P. Managing Plastic Waste—Sorting, Recycling, Disposal, and Product Redesign. *ACS Sustainable Chem. Eng. 9,* 15722–15738; 10.1021/acssuschemeng.1c05013 (2021).
8. Tsuchimoto, I. & Kajikawa, Y. Recycling of Plastic Waste: A Systematic Review Using Bibliometric Analysis. *Sustainability 14,* 16340; 10.3390/su142416340 (2022).
9. Aragaw, T. A. & Mekonnen, B. A. Understanding disposable plastics effects generated from the PCR testing labs during the COVID-19 pandemic. *Journal of hazardous materials advances 7,* 100126; 10.1016/j.hazadv.2022.100126 (2022).
10. Al Qahtani, S., Al Wuhayb, F., Manaa, H., Younis, A. & Sehar, S. Environmental impact assessment of plastic waste during the outbreak of COVID-19 and integrated strategies for its control and mitigation. *Reviews on environmental health 37,* 585–596; 10.1515/reveh-2021-0098 (2022).
11. Celis, J. E. *et al.* Plastic residues produced with confirmatory testing for COVID-19: Classification, quantification, fate, and impacts on human health. *The Science of the total environment 760,* 144167; 10.1016/j.scitotenv.2020.144167 (2021).
12. Howes, L. Can Laboratories Move Away from Single-Use Plastic? *ACS central science 5,* 1904–1906; 10.1021/acscentsci.9b01249 (2019).
13. Penndorf, P. & Jabs, J. A new approach to making scientific research more efficient - rethinking sustainability. *FEBS letters 597,* 2371–2374; 10.1002/1873-3468.14736 (2023).
14. Kilcoyne, J., Bogan, Y., Duffy, C. & Hollowell, T. Reducing environmental impacts of marine biotoxin monitoring: A laboratory report. *PLOS Sustain Transform 1,* e0000001; 10.1371/journal.pstr.0000001 (2022).

15. Ragazzi, I., Farley, M., Jeffery, K. & Butnar, I. Using life cycle assessments to guide reduction in the carbon footprint of single-use lab consumables. *PLOS Sustain Transform* **2,** e0000080; 10.1371/journal.pstr.0000080 (2023).
16. Guo, Q. *et al.* A review on acoustic droplet ejection technology and system. *Soft matter 17,* 3010–3021; 10.1039/d0sm02193h (2021).
17. Arifin, W. N. & Zahiruddin, W. M. Sample Size Calculation in Animal Studies Using Resource Equation Approach. *The Malaysian journal of medical sciences: MJMS 24,* 101–105; 10.21315/mjms2017.24.5.11 (2017).
18. Bonapersona, V., Hoijtink, H., Sarabdjitsingh, R. A. & Joëls, M. RePAIR : a power solution to animal experimentation. *bioRxiv,* 864652; 10.1101/864652 (2019).
19. Bonapersona, V., Hoijtink, H., Sarabdjitsingh, R. A. & Joëls, M. Increasing the statistical power of animal experiments with historical control data. *Nature neuroscience 24,* 470–477; 10.1038/s41593020-00792-3 (2021).
20. Bakkalci, D., Farley, M., Kessler, F. & Cheema, U. Charting our sustainability journey within the Division of Surgery and Interventional Science at University College London. *Environmental Sustainability 6,* 427–432; 10.1007/s42398-02300288-3 (2023).
21. Anastas, P. T. Green Chemistry and the Role of Analytical Methodology Development. *Critical Reviews in Analytical Chemistry 29,* 167–175; 10.1080/10408349891199356 (1999).
22. Rezoana, R. *et al.* The hazardous effects of formalin and alcoholic fixative in mice: A public health perspective study. *Saudi journal of biological sciences 29,* 3366–3371; 10.1016/j.sjbs.2022.02.019 (2022).
23. Bourzac, K. M., LaVine, L. J. & Rice, M. S. Analysis of DAPI and SYBR Green I as Alternatives to Ethidium Bromide for Nucleic Acid Staining in Agarose Gel Electrophoresis. *J. Chem. Educ. 80,* 1292; 10.1021/ed080p1292 (2003).
24. Kandyala, R., Raghavendra, S. P. C. & Rajasekharan, S. T. Xylene: An overview of its health hazards and preventive measures. *Journal of oral and maxillofacial pathology : JOMFP 14,* 1–5; 10.4103/0973-029X.64299 (2010).
25. Rahman, M. A. *et al.* Alcoholic fixation over formalin fixation: A new, safer option for morphologic and molecular analysis of tissues. *Saudi journal of biological sciences 29,* 175–182; 10.1016/j.sjbs.2021.08.075 (2022).
26. López-Lorente, Á. I. *et al.* The ten principles of green sample preparation. *TrAC Trends in Analytical Chemistry 148,* 116530; 10.1016/j.trac.2022.116530 (2022).
27. Mohamed, H. M. Green, environment-friendly, analytical tools give insights in pharmaceuticals and cosmetics analysis. *TrAC Trends in Analytical Chemistry 66,* 176–192; 10.1016/j.trac.2014.11.010 (2015).
28. Siddappa, N. B., Avinash, A., Venkatramanan, M. & Ranga, U. Regeneration of commercial nucleic acid extraction columns without the risk of carryover contamination. *BioTechniques 42,* 186, 188-92; 10.2144/000112327 (2007).
29. Whyte, C. E., Tumes, D. J., Liston, A. & Burton, O. T. Do more with Less: Improving High Parameter Cytometry Through Overnight Staining. *Current protocols 2,* e589; 10.1002/cpz1.589 (2022).
30. Shaaban, H. New insights into liquid chromatography for more eco-friendly analysis of pharmaceuticals. *Analytical and bioanalytical chemistry 408,* 6929–6944; 10.1007/s00216-016972 6-2 (2016).
31. Ozben, T. & Fragão-Marques, M. Chemical strategies for sustainable medical laboratories. *Clinical chemistry and laboratory medicine 61,* 642–650; 10.1515/cclm-2022-1157 (2023).
32. Glover, R. T., Booth, G. S. & Wiencek, J. R. Opportunities for recycling in an automated clinical chemistry laboratory produced by the comprehensive metabolic panel. *American journal of clinical pathology 160,* 119–123; 10.1093/ajcp/aqad031 (2023).
33. Armenta, S., Garrigues, S. & La Guardia, M. de. Green Analytical Chemistry. *TrAC Trends in Analytical Chemistry 27,* 497–511; 10.1016/j.trac.2008.05.003 (2008).
34. Yabré, M., Ferey, L., Somé, I. T. & Gaudin, K. Greening Reversed-Phase Liquid Chromatography Methods Using Alternative Solvents for Pharmaceutical Analysis. *Molecules (Basel, Switzerland) 23;* 10.3390/molecules23051065(20 18).
35. Zuin, V. G., Eilks, I., Elschami, M. & Kümmerer, K. Education in green chemistry and in sustainable chemistry: perspectives towards sustainability. Green Chem. *23,* 1594–1608; 10.1039/D0GC03313H (2021).
36. O'Neil, N. J., Scott, S., Relph, R. & Ponnusamy, E. Approaches to Incorporating Green Chemistry and Safety into Laboratory Culture. *J. Chem. Educ. 98,* 84–91; 10.1021/acs.jchemed.0c00134 (2021).
37. Čuček, L., Klemeš, J. J. & Kravanja, Z. A Review of Footprint analysis tools for monitoring impacts on sustainability. *Journal of Cleaner Production 34,* 9–20; 10.1016/j.jclepro.2012.02.036 (2012).
38. Reyes, K. M. D., Bruce, K. & Shetranjiwalla, S. Green Chemistry, Life Cycle Assessment, and Systems Thinking: An Integrated Comparative-Complementary Chemical Decision-Making Approach. *J. Chem. Educ. 100,* 209–220; 10.1021/acs.jchemed.2c00647 (2023).

39. La Guardia, M. de & Armenta, S. *Green Analytical Chemistry. Theory and Practice* (Elsevier Science, Saint Louis, 2014).
40. Grealey, J. *et al.* The Carbon Footprint of Bioinformatics. *Molecular biology and evolution 39;* 10.1093/molbev/msac034 (2022).
41. Freitag, C. *et al.* The real climate and transformative impact of ICT: A critique of estimates, trends, and regulations. *Patterns (New York, N.Y.)* **2,** 100340; 10.1016/j.patter.2021.100340 (2021).
42. Lannelongue, L., Grealey, J., Bateman, A. & Inouye, M. Ten simple rules to make your computing more environmentally sustainable. *PLoS computational biology 17,* e1009324; 10.1371/journal.pcbi.1009324 (2021).
43. Lannelongue, L. *et al.* GREENER principles for environmentally sustainable computational science. *Nature computational science 3,* 514–521; 10.1038/s43588-023-00461-y (2023).
44. Lannelongue, L., Grealey, J. & Inouye, M. Green Algorithms: Quantifying the Carbon Footprint of Computation. Advanced science (Weinheim, BadenWurttemberg, Germany) *8,* 2100707; 10.1002/advs.202100707 (2021).
45. Bouza, L., Bugeau, A. & Lannelongue, L. How to estimate carbon footprint when training deep learning models? A guide and review, 2023.
46. Mbatchou, J. *et al.* Computationally efficient wholegenome regression for quantitative and binary traits. *Nature genetics 53,* 1097–1103; 10.1038/s41588021-00870-7 (2021).
47. Souter, N. E. *et al.Ten recommendations for reducing the carbon footprint of research computing in human neuroimaging* (2023).
48. Abou Assi, R., Ng, T. F., Tang, J. R., Hassan, M. S. & Chan, S. Y. Statistical Analysis of Green Laboratory Practice Survey: Conservation on NonDistilled Water from Distillation Process. *Water 13,* 2018; 10.3390/w13152018 (2021).
49. Aldred Cheek, K. & Wells, N. M. Changing Behavior Through Design: A Lab Fume Hood Closure Experiment. *Front. Built Environ. 5;* 10.3389/fbuil.2019.00146 (2020).
50. Mariette, J. *et al.* An open-source tool to assess the carbon footprint of research. *Environ. Res.: Infrastruct. Sustain. 2,* 35008; 10.1088/2634450 5/ac84a4 (2022).
51. Wynes, S., Donner, S. D., Tannason, S. & Nabors, N. Academic air travel has a limited influence on professional success. *Journal of Cleaner Production 226,* 959–967; 10.1016/j.jclepro.2019.04.109 (2019).
52. Achten, W. M., Almeida, J. & Muys, B. Carbon footprint of science: More than flying. *Ecological* Indicators 34, 352–355; 10.1016/j.ecolind.2013.05.025 (2013).
53. Nursey-Bray, M., Palmer, R., Meyer-Mclean, B., Wanner, T. & Birzer, C. The Fear of Not Flying: Achieving Sustainable Academic Plane Travel in Higher Education Based on Insights from South Australia. *Sustainability 11,* 2694; 10.3390/su1109 2694 (2019).
54. Kreil, A. S. Does flying less harm academic work? Arguments and assumptions about reducing air travel in academia. *Travel Behaviour and Society* **25,** 52–61; 10.1016/j.tbs.2021.04.011 (2021).
55. Görlinger, S., Merrem, C., Jungmann, M. & Aeschbach, N. An evidence-based approach to accelerate flight reduction in academia. *npj Clim. Action* **2**; 10.1038/s44168-023-00069-y (2023).
56. Chuter, R. *et al.* Towards estimating the carbon footprint of external beam radiotherapy. *Physica medica: PM : an international journal devoted to the applications of physics to medicine and biology: official journal of the Italian Association of Biomedical Physics (AIFB) 112,* 102652; *10.1016/j.ejmp.2023.102652 (2023).*
57. Paepe, M. de, Jeanneau, L., Mariette, J., Aumont, O. & Estevez-Torres, A. *Purchases dominate the carbon footprint of research laboratories* (2023).
58. Berchowitz, D. & Kwon, Y. Environmental Profiles of Stirling-Cooled and Cascade-Cooled Ultra-Low Temperature Freezers. *Sustainability 4,* 2838–2851; 10.3390/su4112838 (2012).
59. Nasrallah, I. M., El Kak, A. K., Ismaiil, L. A., Nasr, R. R. & Bawab, W. T. Prevalence of Accident Occurrence Among Scientific Laboratory Workers of the Public University in Lebanon and the Impact of Safety Measures. *Safety and health at work 13,* 155–162; 10.1016/j.shaw.2022.02.001 (2022).
60. Mathew, P. A., Sartor, D. A., Bell, G. C. & Drummond, D. Major energy efficiency opportunities in laboratories—Implications for health and safety. *J. Chem. Health Saf. 14,* 31–39; 10.1016/j.jchas.2007.01.002 (2007).
61. McGain, F., Moore, G. & Black, J. Hospital steam sterilizer usage: could we switch off to save electricity and water? *Journal of health services research & policy 21,* 166–171; 10.1177/1355819615625698 (2016).
62. McGain, F., Moore, G. & Black, J. Steam sterilisation's energy and water footprint. *Australian health review: a publication of the Australian Hospital Association 41,* 26–32; 10.1071/AH15142 (2017).
63. Winter, N. *et al.* The paradox of the life sciences: How to address climate change in the lab: How to address climate change in the lab. *EMBO reports 24,* e56683; 10.15252/embr.202256683 (2023).
64. Dobbelaere, J., Heidelberger, J. B. & Borgermann, N. Achieving sustainable transformation in science - green grassroots groups need nurturing from the top. *Journal of cell science 135;* 10.1242/jcs.259645 (2022).
65. Fazzo, L. *et al.* Hazardous waste and health impact: a systematic review of the scientific literature.

Environmental health: a global access science source 16, 107; 10.1186/s12940-017-0311-8 (2017).
66. Ghulam, S. T. & Abushammala, H. Challenges and Opportunities in the Management of Electronic Waste and Its Impact on Human Health and Environment. *Sustainability 15,* 1837; 10.3390/su 15031837 (2023).
67. Ni, K. *et al.* Carbon Footprint Modeling of a Clinical Lab. *Energies 11,* 3105; 10.3390/en11113105 (2018).
68. Kitzberger, T., Kotik, J. & Pröll, T. Energy savings potential of occupancy-based HVAC control in laboratory buildings. *Energy and Buildings 263,* 112031; 10.1016/j.enbuild.2022.112031 (2022).
69. Durgan, J., Rodríguez-Martínez, M. & Rouse, B. Green Labs: a guide to developing sustainable science in your organization. *Immunology and cell biology 101,* 289–301; 10.1111/imcb.12624 (2023).

Global Journal of Science Frontier Research: H
Environment & Earth Science
Volume 24 Issue 1 Version 1.0 Year 2024
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Chasing the Unknown the Quest for Decarbonisation

By Miguel Schloss

Summary & Introduction- Isn't it noteworthy that an agreement reached in the1990'sto combat climate change has triggered to this day so much conflict (with strong deniers of the existence of the problem and militant supporters of the need to address the issue)? Are the temperature increases over the last decade an indication that global warming is finally catching up with us? Or are the paltry changes in our energy matrixes and policies an indication of failure of the decarbonization effort, or the inherent limitations of human endeavors to address emerging global issues? Perhaps both obviously contradictory postures may signal that the discussion has become overly ideologized, and thus impervious to proper diagnoses that provide technically sound answers for effective response to the issue.

GJSFR-H Classification: *TD885.5*

Strictly as per the compliance and regulations of:

Chasing the Unknown the Quest for Decarbonisation

Miguel Schloss

I. Summary & Introduction

"*Everything should be made as simple as possible, but not simpler.*" (A. Einstein).

Isn't it noteworthy that an agreement reached in the1990'sto combat climate change has triggered to this day so much conflict (with strong deniers of the existence of the problem and militant supporters of the need to address the issue)? Are the temperature increases over the last decade an indication that global warming is finally catching up with us? Or are the paltry changes in our energy matrixes and policies an indication of failure of the decarbonization effort, or the inherent limitations of human endeavors to address emerging global issues? Perhaps both obviously contradictory postures may signal that the discussion has become overly ideologized, and thus impervious to proper diagnoses that provide technically sound answers for effective response to the issue.

The current discussion is loaded with partial and often poorly thought-out responses. Economic problems would be solved with more efficiency and growth; environmental concerns with more incentives and market signals – or others may argue for more controls, if not downright banning of coal, gas and any form of hydrocarbons, and their substitution by renewables to decidedly reduce emissions.[1] Everyone in love with their own answers and solutions. The time is ripe to put questions to the forefront, subjecting answers and solutions to scrutiny and review of evidence. As long as we maintain our infatuation with questions and not answers, there is hope. After all, responses are transitory; the questions, permanent.

Similarly, the empirical evidence of greenhouse emissions is equally unclear, leading to unsettled discussions whether investments and policy actions will lead to internationally agreed goals. The following article summarizes the main statistical trends, to disentangle the different outcomes and range of projection, and identify possible causes and courses of action to achieve more effective results.

II. The Record

"Dig the Well Before You Are Thirsty." 未雨绸缪 (Chinese Proverb)

All things considered; indications are that we are reaching the warning points of crossing 400 ppm carbon in the air. This suggests that we are already exceeding the yearly average temperature threshold of + 1.5 c, and upper ranges of 2.4 c above pre-industrial levels. Moreover, of all countries, just four explain over half of the CO2 dischargers, and emitters concentrate on large economies — i.e., China, the US, the EU27, India, Russia and Japan, which discharge over 65% of global fossil emissions. While this does not provide a full answer to all problems that must be addressed, these numbers alone, already put some perspective on where to concentrate attention to achieve global impact. This should avoid the temptation to deal with the myriad of issues that may deflect from achieving tangible and much needed overall progress.

Temperatures; Global Warming

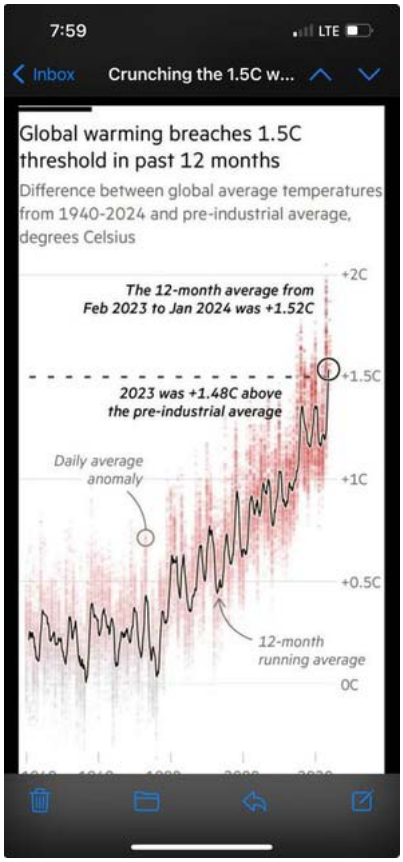


Figure 1

Author: President, Surinvest Ltda. and member of Bretton Woods Committee; former Executive Director of Transparency International and Director of Corporate Planning of World Bank.
e-mail: m.schloss@sur-invest.com

CO2 emissions by country

#	Country	Share of world
1	China	29.18%
2	United States	14.02%
3	India	7.09%
4	Russia	4.65%

An interesting contrast in outcomes can be seen between major emerging and developed economies. In India and China, heavy reliance on coal and higher electricity demand following the post pandemic economic recovery pushed emissions significantly higher, offsetting reductions in other economies.

Emissions rose more than 7% last year in India, where a weaker monsoon season drove hydropower output lower. In China, emissions from energy combustion rose by 5.2% to 12.6 billion tons—by far the largest on a global scale despite the country's leading position in the deployment of clean-energy technology. The agency's report refers to emissions from all uses of fossil fuels for energy purposes and industrial processes.

On the other hand, in advanced economies, emissions fell 4.5% to a 50-year low last year, supported by a stronger deployment of renewables and energy-efficiency measures, but also weaker industrial production and milder weather in some regions resulting in lower energy demand.

According to the International Energy Agency (IEA), electricity generation from renewable sources and nuclear power in those economies reached 50% of total generation. Renewables alone accounted for 34% of electricity output, while the share of coal fell to a historic low of 17%.

In the European Union, emissions from energy combustion fell by almost 9% in 2023 driven by a surge in renewables generation and drop in both coal and gas generation, despite economic growth of around 0.7%. In the U.S., emissions fell 4.1% on higher electricity generation from renewables and gas rather than coal, in spite of economic growth of 2.5%.

Still, the deployment of clean-energy sources remains heavily concentrated in advanced economies, and to a lesser extent China. Increasing attention will be required to enhance investment and deployment in emerging economies. It is there where economic growth, industrialization (in part stemming from a migration of industries from OECD to emerging economies) and growing economic "catch up" is bound to take place. As a result, the bulk of energy growth will be in non-OECD countries (particularly China and India), which by mid-century may well lead energy demand worldwide.

In thousands of purchasing power parity (PPP) per person

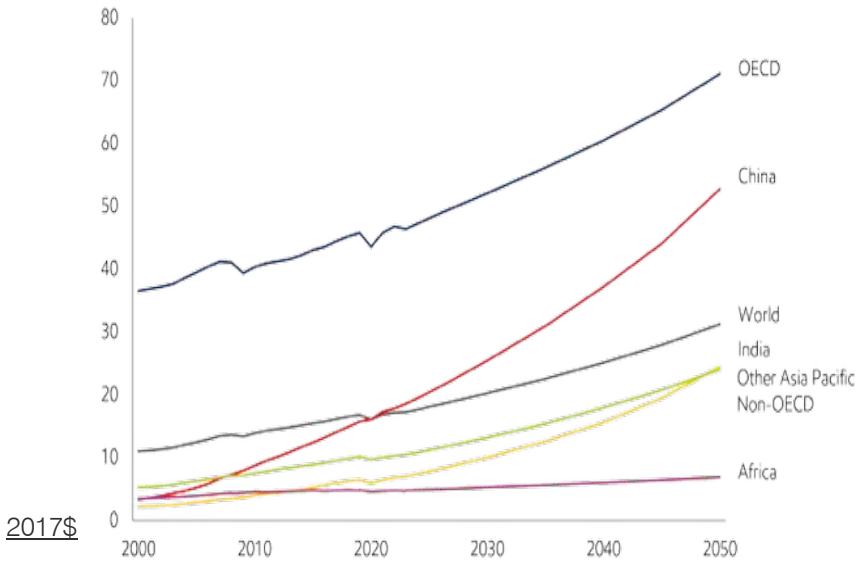


Figure 2

Primary energy demand – Quadrillion Btu

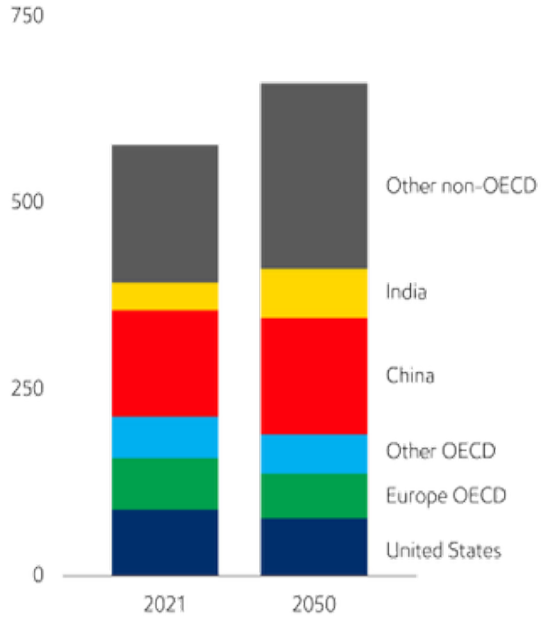


Figure 3

This will put an entirely different perspective on the energy and environment perspective. As a billion more people move towards greater prosperity, we may well see emissions decline as a variety of low-carbon solutions advance. However, achieving net-zero emissions, as aspired in the international agreements, seems rather unlikely, requiring adoption of constructive policies that can facilitate new technologies, including market-driven policies, more in line with institutional capabilities of emerging economies.[2]

As the bulk of growth is bound to concentrate in emerging economies, it will become an increasingly critical for success and sustainability of the decarbonization effortto focus on the need to provide the reliable, affordable energy that drives economic prosperity and better living standards, while reducing greenhouse gas emissions.

This will inevitably still include oil and natural gas, which will still be required to drive critically needed economic growth in the developing world, particularly as some industrial activity may bound to migrate to emerging as part of narrowly understood environmental concerns, which may be bound to remain unchanged from a global perspective, and emissions for such activities may just migrate to emerging economies.

As a result, demand for energy-intensive activities (mainly industry and electricity generation) is bound to continue to grow globally, and is likely going to remain by far the largest share of energy consumption globally by mid-century:

Global Primary energy demand – Quadrillion Btu

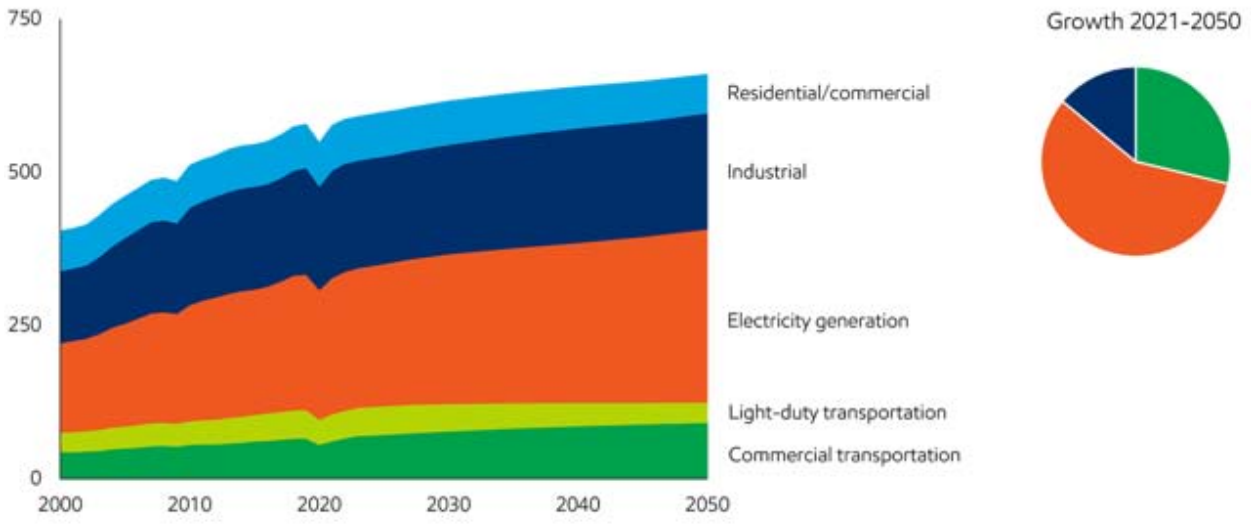


Figure 4

Short of major technological breakthrough. Renewables are going to continue growing, though from a still small base (and coal decline), leaving hydrocarbons still as the major (though with a larger share of lower emitting gas) as the predominant share of energy supply.

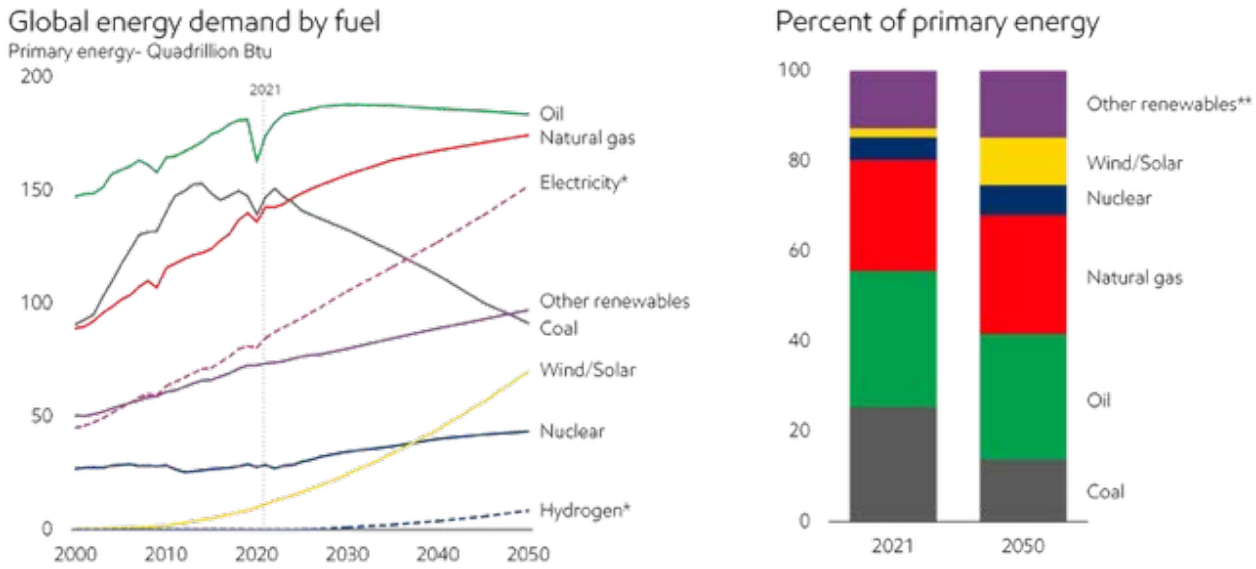


Figure 5

Every day, billions of people around the world benefit from the ability to heat and cool their homes, cook their food, access medical equipment and modern medicine, and travel for work and pleasure. Affordable and reliable energy is at the core of every key measure of human development – elevating living standards, life expectancy, education, and income per person. Yet for billions of more people, modern living conditions are still far out of reach.

In developing countries, such as India, gross domestic product (GDP) per person is only about $2,000 per year1, and many people earn far less and lack access to basic necessities, including clean drinking water, heat, and cooking fuel. This challenge will only grow as the world's population increases from about 8 billion people today to nearly 10 billion in 2050 – a rate of about 1 million people every six days. And just as human progress has been fueled by higher energy use, further expansion of economic prosperity will depend on increased access to abundant, affordable energy.

In other words, energy use and economic development are inseparable. Where there is energy poverty, there is poverty. And where energy availability rises, living standards rise as well. Economic development and the integration of emerging economies have to go hand-in-hand to generate greater world prosperity, including meeting increasing energy needs to fuel much needed economic expansion.

Between now and 2050, developing countries will see GDP per capita more than double, driving higher demand for energy. Meeting that demand with lower-emission energy options is vital to making progress toward society's environmental goals. At the same time, failing to meet demand would prevent developing nations from achieving their economic goals and their citizens from living longer, more fulfilling lives, and constrain economic expansion, including in developed economies.

The critical question is how that growing energy demand will be met. Renewable energy continues to hold great promise, and we see wind and solar providing 11% of the world's energy supply in 2050, five times today's contribution. Other lower- emission options, such as bio fuels, carbon capture and storage, hydrogen, and nuclear, will also play important roles. And even with this unprecedented rise in lower-emission options, oil and natural gas are still projected to meet some 52-54% of the world's energy needs in 2050.

As lower-emission options grow, the world's energy-related CO2 emissions may well decline 25% by 2050. That's a major change as these emissions rose by 10% over the past decade. While the progress is substantial, larger reductions are needed to keep global warming from exceeding 2° Celsius, according to the United Nations Intergovernmental Panel on Climate Change (IPCC).

The world will thus need to dramatically scale up lower-emission solutions – beyond the current trajectory – that preserve the advantages of today's energy system while significantly and efficiently reducing emissions. Doing this will require policy support from governments, significant advances in technology to reduce costs, and ultimately, market-driven solutions to incentivize emission reductions in a manner that is more

in line with institutional capabilities with public sectors around the word, and efficiency and skills to be provided by private sectors.

III. Powering Human Progress, While Reducing Emissions

"It's not the size of the dog in the fight, it's the size of the fight in the dog" (Mark Twain)

Energy use and improved living standards thus go hand in hand. One can't have one without the other, and powering human progress to increase standards of living will have to embed reducing emissions, but in an efficient manner.

When China's per capita GDP was around $2,000, its energy use was low – about 36 million British thermal units (MMBtu) per person per year, deep in the realm of energy poverty. By 2021, when per capita GDP passed $11,000, China's energy use had risen to 101 MMBtu per person, well above the global average.

In contrast with China, Africa's energy use per person has remained at a low 27 MMBtu for the past two decades, and its per capita GDP has only risen by about $500 during that time. Areas that remain mired in energy poverty struggle to raise the living standards of their people.

As we look ahead to 2050, how much more energy must the world produce to meet the needs of 2 billion additional people and a global economy that has doubled in size? About 15% more, with nearly all of it going toward meeting the higher living standard of a developing world with a larger population. Contrast that with the developed world, where there will be little population growth, and greater efficiency is projected to cause energy use to decline across all sectors of the economy.

But all energy types are needed to raise living standards and reduce emissions:

- Energy from solar and wind is projected to more than quintuple, from 2% of the world's supply to 11%. Coal will increasingly be displaced by lower-emission sources of electricity production – not just renewables but also natural gas, which has about half the carbon intensity of coal. Overall, electricity use may grow 80% by 2050.
- Oil and natural gas are projected to still make up more than half of the world's energy supply. The utility of oil and natural gas in meeting the world's needs remains unmatched. They are energy dense, portable, available, and affordable — and serve as essential raw materials for many products we use today. Given that oil and natural gas are projected to remain a critical component of a global energy system through 2050, sustained investments are essential to offset depletion as production naturally declines by 5-7% per year.
- Oil use is expected to decline significantly in personal transportation but will remain essential for the industrial processes and heavy-duty transport like shipping, long-haul trucking, and aviation that underpin economic growth. Even if every new passenger car sold in the world in 2035 were an electric vehicle, oil demand in 2050 would still be 85 million barrels per day, the same as it was around 2010.
- Natural gas use is projected to increase by more than 20% by 2050 given its utility as a reliable and lower-emissions source of fuel for electricity generation, hydrogen production, and heating for both industrial processes and buildings.

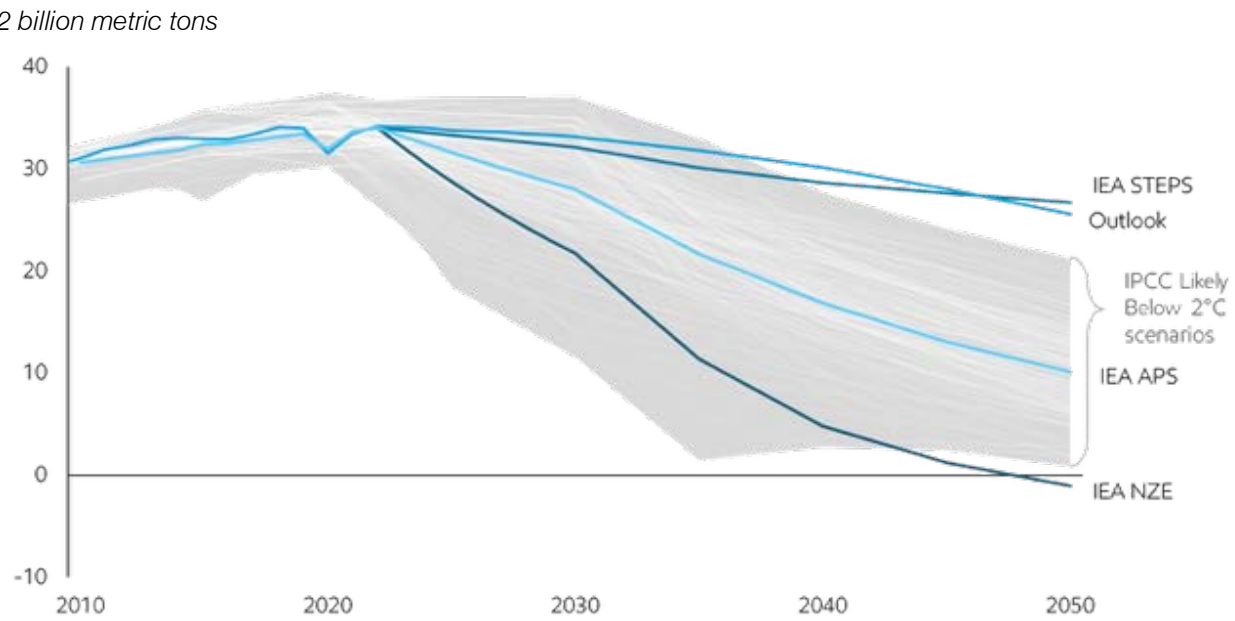
IV. Adding all up: Where's the Problem?

"El papel aguanta mucho" (Spanish expression to denote that on paper everything is possible).

We are flooded with an overdose of reports, so extensive and elegantly crafted that it is difficult to distill what they are conveying, distinguishing the fundamental from the trivial, and what to conclude. In the process, we seem to have lost a clear and unapologetic sense of: (i) whether and where we are (or aren't) making progress; (ii) why, and ultimately (iii) what needs to be done.

After all, the above projections ae based on assumptions of the degree of introduction of renewables on the supply side, and consumer adoption on the market demand side. The declining costs of solar and wind technologies has certainly helped the adoption of such technologies, but their heavy location and weather dependence still limits their load factor capabilities, and with it the continuing need of traditional technologies to serve the needs of industry and urban centers that need high reliabilities to respond to major market requirements.[3]

It should thus not be surprising that the range of projections of global energy-related emissions remains high, even assuming compliance with international pledges and agreements, as can be observed in the following graph of generally accepted projections from different sources:



Source: IEA World Energy Outlook 2023, IPCC Sixth Assessment Report

Figure 6

Broadly speaking, views of the future path of the world's energy system and emission levels can be grouped into three categories.

- Society's Current Trajectory
  - Generally Presented Global Outlooks tend to be grounded on views of energy demand and supply through 2050 on observable trends in population, economic development, policy, technology and consumer preferences.
  - The International Energy Agency's Stated Energy Policies Scenario (STEPS) that reflects a sector-by-sector assessment of current policy in place or announced by governments around the world.
- Paris-Aligned Scenarios
  - The U.N. Intergovernmental Panel on Climate Change's (IPCC) database contains 311 scenarios defined as pathways with a 67% likelihood of limiting peak warming to below 2°C throughout the 21st century. These are labelled IPCC Likely below 2°C scenarios.
  - The International Energy Agency's Announced Pledges Scenario (APS)1 assumes that all aspirational targets announced by governments are met on time and in full, including their long-term net zero and energy access goals.
- Net zero by 2050
  - The International Energy Agency's Net-Zero Emissions by 2050 Scenario (NZE)1 is an aggressive pathway that assumes all necessary changes in policy, technology and human behavior occur for the global energy sector to reach net-zero CO_2 emissions by 2050.

It is important to note that according to the U.N. Environment Program Emissions Gap Report the current Nationally Determined Contributions (NDCs) to emissions reductions that countries have pledged to make by 2030 are not yet within a Likely Below 2°C pathway. It further states that G20 members as a group do not have policies in place to achieve their current NDCs.

All considered, the projections are based on fairly mechanical criteria, and that in the majority of countries, accountability for results, institutional competencies to regulate effectively the transition and incentives prevailing in the private sector remain generally weak, and thus conditions for compliance with estimated agreed goals may be still rather lose to provide much credence to such (even wide ranging) projections.

Crisp assessments are thus needed on where priorities should be placed, what is being done in these economies to seek tangible decarbonization results impacting globally, and at least pose probing questions on whether the current record shows if countries and sectors are on the right track, and if not, what corrective actions may be needed to assure genuine progress towards the international goals. Without clear responses to these questions, it is unlikely to identify steps to contribute to achieve proper global impact.

Such approach should facilitate where progress is made, and where not, which policies and actions are taken, and what this can tell us of successful or failing policies. This may help move the discussion towards much needed transparency, and the build-up of accountability for improvements. A valid discussion on increasing temperatures and greenhouse gas emissions

can be engaged to assess whether sufficient progress, is being made, and a more disciplined approach to focus on results, the build-up of proper analytic underpinnings of what polices and actions work, and which ones not, to define a more discerning contribution to the subject.

V. Its Half-Time - Poising to Achieve Genuine Decarbonisation

"A man will fight harder for his interests than for his rights" (Napoleon).

Improved outcomes over the current record are far from trivial. All indications are that we may be seeing "tipping points" (or points of no return) in action, such as sustained melting of the Greenland, Arctic and Antarctic ice masses, Pacific islands going under water, the dieback of the Amazon and other forests with no other plausible explanations than human caused climate change. Scientific consensus is sparce, but one them is that planetary tipping points represent one of the gravest threats. In the absence of clear frameworks, four areas merit specific attention:

- Through regulatory and/or institutional compulsion: quite aside of the institutionally-intensive requirements of such processes to manage these types of changes, they tend to demand increasing costs and time, and are difficult or burdensome to manage, particularly in emerging economies, and thus hard to see how they could contribute to tangible outcomes in the foreseeable term solution of the issue, as they probably may be a rather taxying and burdensome avenue.
- Through enabling pricing and/or taxation policies reflecting energy scarcity and/or "pricing" carbon emissions, as successfully done in Chile and a growing number of countries,[4] and the face-out of chlorofluorocarbons (CFCs pursuant to the Montreal Protocol to stem ozone depletion) in essence "internalizing" external costs to reflect societal harm and align incentives to minimize the latter, as in the EU, with its emissions trading system and national carbon taxes. For such policies to work, it is indispensable to have a working private sector and enabling conditions that further the development of enterprises capable to respond to such policy environment.[5]
- Through proactive management of transformative policy, such as tax credits, focused policies like the Inflation Reduction Act aimed at supporting renewable energy incentive opportunities to help US businesses manage and reduce their energy costs and improve security by enhancing renewable infrastructure providing public sector support for decarbonized sources of energy supply, or the European Union measures to cut off Russian gas. Within five years they have been instrumental in reducing Russian gas as a percentage of total gas piped in to Europe, and new facilities for changing energy matrix. Such policy, inevitably depends on significant public sector resources (which in times of fiscal constraints, is bound limit sustainability) and management inputs for appropriate resource allocations. Overall, the EU is now introducing its ambitious supply-side measures through industrial plans to enhance competitiveness of Europe's net-zero industry to accelerate the transition to climate neutrality by scaling up its manufacturing capacity for the net-zero technologies and products.
- Mobilization of financial and technical resources (with public policy, legal, engineering, project management and a wide range of other skills) to achieve net zero goals. Public and private sector entities across the globe will need approximately $3.8 trillion in additional annual investment flows [equivalent to 3.8 percent of global GDP through 2030.[6] But only a fraction of this capital is currently being deployed. Even when viewed with a wider lens that considers funding such as transition finance, expected needs still outweigh flows by 66%.[7]

In sum, with the significant cost reductions, and increased adoption of renewables, the case the case for them has already been made. The promise of lowered aggregate CO2 emissions and consequent mastering of climate change is, however, far from materialized.

VI. Conclusion – The Road to Perfection

"Let's build a city, with a tower that reaches heavens"; ריעונמצעלהנבנהבה, מימשהדעיגמשלדגמסע(Genesis 11)

Readers expecting a methodological tight analysis and conclusive results will surely be disappointed. For the time being, there is no alternative than to dig deeper and experiment systematically on the subject. The world is messy; perfection is the enemy of the good, and partial evidence and aggregate statistical information on overall outcomes are informative. Under the circumstances, there is no alternative but to admit that technical expertise is and will continue to be a key ingredient for success in a wide range of pending issues – from policy formulation to technological innovation.

Over recent years there have been plenty of turbulence around the economy. We had the pandemic, wars, climate disasters (all with considerable externalities), but we have witnessed remarkable resilience and imagination. While we have plenty to worry about, despite multiple (and complex) shocks and tight financial constraints, growth and development are firmly in positive territory, as is the levelling of emissions and improvements in energy matrixes around much of

the world. But the problems are not gone, and we have a long and complex road ahead.

We recognize one-size-fits-all does not fit all. The pace and speed of consolidation will vary depending on country circumstances, so will also the balance between mobilizing revenue and improving spending efficiency. In the interest of international stability, to face this adjustment, we cannot forget that the burden should not fall on the most vulnerable people.

All this will require foundational reforms, strengthening governance, cutting red tape, improving access to capital, combating corruption. These factors are all essential for growth, and even more so are productivity-enhancing structural reforms and investment in human capital, the green and the digital transition. With artificial intelligence already upon us, coordination on global rules is as important as having the technology and the skills to tap into it.

Although, all this may sound formidable, strictly speaking, for millennia, the universe went through major changes, causing human beings to migrate, changing their survival practices by adapting themselves to their changing environment. The Bible's recording of the ambitious construction, and subsequent disastrous fall of the Tower of Bible may well be one such event. As human beings keep developing, beyond a certain point they need to rethink the underlying ways of living, materials they use and other ways of developing. It may well climate change and associated problems we are starting to face may be a manifestation of this problem – i.e., the need to adjust our modes of living, construction and even the surrounding environment we create to adapt and live in a world operating at much larger scale.

In fact, Galileo in his principle of similitude had already defined the issue by showing that size and strength do not increase or decrease at the same ratio, and that beyond certain scales structures and practices need to be recast.[8] It is not inconceivable that this principle goes beyond structural engineering, and could apply just as well to human development, and that climate change is another manifestation of human beings having developed with technologies beyond the capabilities of nature to keep responding to population growth and associated increased availability of materials, without adjustments in the modes of living and practices for further development.

With such major change in hoe to conceive further development, it is easy to see the conflict between neither climate change deniers and asserters as the underlying facts seem so unclear:

- Climate change deniers refuse to believe that there is a problem, and thus oppose any policy or investments to counter the trend of temperature increases;
- Asserters, refuse to understand the implications of the scale (requiring an annual increase of investments of the order noted above to achieve the net zero target), and complexity of technological changes to operate in a world with significantly different energy feedstock.

Accordingly, a more agnostic and eclectic approach may be necessary — avoiding the fanatics on both sides, to achieve a balanced and viable investment framework while undertaking the necessary adaptation measures, within the scale of what is absorbable — some of this is already taking place spontaneously to get us out of the current bind and achieve longer-term sustainable results. Resisting reforms and/or adaptation just involves digging ourselves deeper into the existing problems we are getting into. Changing the energy matrix within what is absorbable with the current knowledge, while at the same adapting to the warming environment through migration, construction of defenses for increased water levels, etc. Seem to provide a viable option to address development under emerging conditions.[9]

At the same time, a more integrated approach to the issue needs to be undertaken to seek more effective answers to overcome inherent limitations of renewables (such as their lack of reserve capacity and heavy location-and climate-dependence). This will require greater attention and complementary investments in energy storage and transmission to overcome their low load-factor conditions and location constraints, and further diversification and technical development to seek enhanced security in emerging conditions.

In the end, more economically-driven analyses are necessary for proper policy formulation, to capture the varying institutional and contextual conditions that need to be properly integrated in the above-mentioned policy options for enhanced outcomes.

References Références Referencias

1. Miguel Schloss; Global Journal of Science Frontier Research (Environment & Earth Science) (USA) May 2023: "Aligning Interests or Precipitating Energy Transition" https://www.sur-invest.com/ Downloads Publications/Global Journal MS 10 June 2021.pdf. Miguel Schloss; Oil, Gas & Energy Law Intelligence (OGEL-U.K.), Feb. 2023 "Changing the Conversation on Energy Transition — Aligning Interests or Mandating Actions to Combat Climate Energy Transition in Unsettled Times.
2. Geoffrey Heal; Endangered Economics; Columbia University Press, 2017 https://www.thriftbooks.com/w/endangered-economies-how-the-neglect-of-nature-threatens-our-prosperity_geoffrey-heal/11610560/#edition=11182883&idiq=34742655. Miguel

Schloss; Editorial Acade ´mica Española: “Cambiando la conversacio´nenerge´tica”, 2023.
3. Miguel Schloss: Global Journal of Science Frontier Research (Environment & Earth Science) (USA) Dec. 2023: “Energy Transition in Unsettled Times”. Miguel Schloss "The Elephant in the Room; Preaching or Working on Climate Change"; the Global Journal of Science Frontier Research (Sept 2023)) https://globaljournals.org/GJSFR_ Volume23/2-The-Elephant-in-the-Room.pdf.; “Decarbonizing Energy – with Speed, Wisdom and Balance”. “Mapping Carbon Neutrality in Uncharted Territory – Governance & Policy Implications for the Mining Sector” Generis Publishing, 2023.
4. Ministerio de Energía, Chile (2023); Planificación energética de largo Plazo (2023) https://energia.gob.cl/pelp.
5. The Economist; Oct 1, 2023: “How carbon prices are taking on the world” https://www.economist.com/finance-and-economics.
6. The Bretton Woods Committee; The Role of Multilateral Banks in Closing the Climate and Energy Transition Finance Gap https://www.brettonwoods.org/sites/default/files/documents/CFPTTemplate_Final_Digital_1.pdf
7. Bretton Woods Committee (Oct. 2023) https://www.brettonwoods.org/article/decarbonizing - energy-with-speed- wisdom-and-balance; “Essay on Combating Believers and Deniers on Energy Transition”; Oil, Gas & Energy Law Intelligence (Sep. 2023) https://twitter.com/ogeltdm/status/1709529533534134459.
8. Alessandro Casaburo, Giuseppe Petrone, Francesco Franco, Sergio De Rosa; A Review of Similitude Methods for Structural Engineering” Appl. Mech. Rev. May 2019; https://doi.org/10.1115/1.4043787.
9. Abraham Lustgarten: “On the Move: The Overheating Earth and the Uprooting of America”. Farrar, Straus and Giroux, 2024.

This page is intentionally left blank

Global Journal of Science Frontier Research: H
Environment & Earth Science
Volume 24 Issue 1 Version 1.0 Year 2024
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

"Drip by Drip: How Small Changes Can Make a Big Splash in Water Conservation"

By Robert Kurek

Abstract- Discover simple yet impactful strategies to conserve water in your daily life and protect our planet's most precious resource. From easy household tips to innovative technologies, learn how you can make a difference, one drop at a time. Join the movement to preserve our water for future generations.

Keywords: *savingwater, savingenergy, savingstips.*

GJSFR-H Classification: *LCC: TD345*

Strictly as per the compliance and regulations of:

"Drip by Drip: How Small Changes Can Make a Big Splash in Water Conservation"

Robert Kurek

Abstract- **Discover simple yet impactful strategies to conserve water in your daily life and protect our planet's most precious resource. From easy household tips to innovative technologies, learn how you can make a difference, one drop at a time. Join the movement to preserve our water for future generations.**

Keywords: savingwater, savingenergy, savingstips.

I. "The State of our Water: Understanding the Urgency"

Water is essential for all life on Earth, yet its availability and quality are increasingly threatened by human activities and environmental degradation. In this chapter, we delve into the current state of our water resources, highlighting the urgency of the conservation efforts needed to safeguard this precious resource for future generations.

Across the globe, water scarcity is becoming a pressing issue, exacerbated by factors such as population growth, climate change, pollution, and unsustainable water management practices. According to the United Nations, over 2 billion people currently live in countries experiencing high water stress, with projections indicating that this number will only rise in the coming decades.

Furthermore, the quality of our water sources is under threat from pollution stemming from industrial runoff, agricultural practices, urban development, and improper waste disposal. Contaminants such as pesticides, heavy metals, pharmaceuticals, and microplastics pose significant risks to both human health and ecosystems, highlighting the critical need for comprehensive water management and pollution control measures.

In light of these challenges, there is an urgent need for collective action to address the state of our water resources. This requires not only improved water governance and policy frameworks but also individual and community-level efforts to reduce water consumption, protect water sources, and promote sustainable water use practices.

By understanding the urgency of the situation and recognizing the interconnectedness of water with human health, economic prosperity, and ecological well-being, we can galvanize efforts to conserve and protect our water resources. Together, we must work towards a future where clean, safe, and accessible water is available to all, ensuring the sustainability and resilience of our planet for generations to come.

II. "Every Drop Counts: Practical Tips for Water Conservation at Home"

Conserving water at home is not only crucial for reducing water bills but also for preserving our planet's most precious resource. In this chapter, we explore practical tips and strategies that individuals can implement to minimize water waste and promote sustainability within their households.

One of the most effective ways to save water at home is by investing in water-saving products and technologies. Companies like Neoperl offer a wide range of innovative solutions designed to maximize water efficiency without compromising performance. Products such as faucet aerators, showerheads, and flow regulators are easy to install and can significantly reduce water consumption in the kitchen, bathroom, and throughout the home.

In addition to using water-saving products, simple behavioral changes can also make a big difference in water conservation. For example, fixing leaky faucets and pipes, turning off the tap while brushing teeth or washing dishes, and taking shorter showers can all help minimize water waste. Installing low-flow toilets and using water-efficient appliances like dishwashers and washing machines further contribute to reducing water usage.

Furthermore, outdoor water conservation is essential, particularly in regions prone to drought or water scarcity. Implementing practices such as xeriscaping, mulching, and collecting rainwater for irrigation can help maintain beautiful landscapes while minimizing water consumption.

By incorporating these practical tips and utilizing water-saving products from companies like Neoperl, individuals can play a significant role in conserving water resources and promoting sustainability at home. Every drop saved not only contributes to lower water bills but also helps protect the environment for future generations.

Author: e-mails: robertkurek.com, Robert.k@robertkurek.com

Fig.1: Drinking Water Filtration System for Domestic usage

III. "Innovative Solutions: Technologies Revolutionizing Water Conservation"

In the face of mounting water scarcity and environmental challenges, innovative technologies are playing a pivotal role in revolutionizing water conservation efforts. In this chapter, we explore some of the cutting-edge solutions that are transforming the landscape of water management and sustainability.

One of the most promising advancements in water conservation technology is the development of smart water meters and monitoring systems. These devices utilize sensors and data analytics to provide real-time insights into water usage, detect leaks, and optimize irrigation practices. By empowering users with actionable information, smart water meters enable more efficient water management and significant reductions in water waste.

Another groundbreaking technology making waves in water conservation is the emergence of advanced filtration and purification systems. From membrane-based filtration to ultraviolet disinfection, these systems are capable of removing contaminants and impurities from water sources, ensuring access to safe and clean drinking water for communities around the world.

Additionally, the integration of Internet of Things (IoT) technology and artificial intelligence (AI) into water infrastructure holds tremendous potential for improving efficiency and sustainability. IoT-enabled sensors and smart networks enable remote monitoring and control of water systems, allowing for proactive maintenance, optimized resource allocation, and reduced water losses.

Furthermore, innovations in water-efficient appliances and fixtures are helping to minimize water consumption in homes and businesses. High-efficiency toilets, low-flow showerheads, and water-saving faucets are just a few examples of products that are revolutionizing water use practices and promoting conservation on a daily basis.

By harnessing the power of these innovative technologies, we can address the challenges of water scarcity, improve water quality, and build a more sustainable future for generations to come. From smart meters to advanced filtration systems, these solutions are paving the way towards a world where every drop of water is valued and preserved.

IV. "Water-Wise Landscaping: Cultivating Gardens that Thrive with Less Water"

In a world where water scarcity is becoming increasingly prevalent, water-wise landscaping offers a sustainable solution for maintaining beautiful outdoor spaces while conserving precious water resources. In this chapter, we explore the principles and practices of water-wise landscaping, empowering individuals to create gardens that thrive with less water.

At the heart of water-wise landscaping is the concept of designing landscapes that are well-adapted to their local climate and conditions. By selecting native and drought-tolerant plant species that are suited to the natural rainfall patterns of the region, homeowners can

reduce the need for irrigation and create resilient gardens that require minimal water inputs.

In addition to plant selection, water-wise landscaping also involves thoughtful design and maintenance practices that optimize water efficiency. This includes incorporating features such as mulch, which helps retain soil moisture and suppress weed growth, as well as using permeable paving materials that allow rainwater to infiltrate into the ground rather than running off into storm drains.

Furthermore, efficient irrigation systems play a crucial role in water-wise landscaping, ensuring that water is delivered directly to the root zone of plants where it is needed most. Drip irrigation, soaker hoses, and smart irrigation controllers are all effective tools for minimizing water waste and maximizing the effectiveness of watering practices.

By embracing the principles of water-wise landscaping, homeowners can create gardens that not only conserve water but also provide habitat for wildlife, support biodiversity, and enhance the beauty and value of their properties. With careful planning and attention to detail, cultivating gardens that thrive with less water is not only achievable but also rewarding and environmentally responsible.

V. "Community Action: Mobilizing for Change and Ensuring Sustainable Water Practices"

Community action plays a vital role in mobilizing for change and ensuring the adoption of sustainable water practices on a broader scale. In this chapter, we explore the power of collective action and community engagement in addressing water conservation challenges and promoting long-term sustainability.

At the heart of community action for water conservation is raising awareness and educating individuals about the importance of water stewardship and the impact of their daily choices on water resources. Through outreach programs, workshops, and educational campaigns, communities can empower residents to take proactive steps to reduce water consumption, minimize pollution, and protect local water sources.

Furthermore, community-based initiatives such as water conservation competitions, neighborhood clean-up events, and tree-planting drives can foster a sense of collective responsibility and camaraderie among residents, inspiring them to work together towards common goals. By harnessing the power of community engagement, local organizations and grassroots movements can mobilize resources, build partnerships, and drive meaningful change in water management practices.

In addition to raising awareness and fostering community engagement, community action also involves advocating for policy changes and infrastructure investments that support sustainable water practices. By working collaboratively with local governments, businesses, and other stakeholders, communities can advocate for the implementation of water-saving measures, such as water-efficient building codes, green infrastructure projects, and incentives for water conservation technologies.

Ultimately, community action is essential for creating a culture of sustainability and ensuring that sustainable water practices are integrated into the fabric of society. By coming together to address water conservation challenges, communities can make a significant impact on the health of local ecosystems, the resilience of water supplies, and the well-being of future generations.

Fig. 2: Saving Water is Crucial for Future Generations

VI. Conclusion

Embark on a journey towards sustainability by implementing practical water-saving strategies and embracing energy-efficient practices in your daily life. From utilizing innovative technologies to fostering community action, there are countless ways to make a meaningful impact on water conservation and energy efficiency. By joining the movement to save water and energy, you're not only safeguarding our planet for future generations but also creating a brighter, more sustainable future for all. Every drop saved and every watt conserved makes a difference – together, let's pave the way towards a greener, more resilient world. Start today, and be the change our planet needs.

Global Journal of Science Frontier Research: H
Environment & Earth Science
Volume 24 Issue 1 Version 1.0 Year 2024
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

Perception of the Asunción Ppopulation on Climate Change, Paraguay

By Claudia Patricia Caballero Chávez
Universidad Nacional de Asunción

Summary- Climate change is a highly complex global conflict that implies unequal environmental, social and economic consequences, which is why it is presented as one of the great challenges of today's society. To meet the climate change goals of reducing greenhouse gas emissions, changes in social structures are necessary that require the participation of the general public. This article analyzes the perceptions of Asunción society about climate change, through the application of the survey questionnaire with open and close questions. The results show that seven out of ten people in Asunción have heard about climate change, they largely indicated the impacts of climate change such as high temperatures, these perceptions are related to increases in average temperature in the region. The population of Asunción perceives that climate change is already occurring in the country; the majority pointed to citizens as responsible for applying the solutions.

Keywords: *asunción, climate change, causes, impacts, risk perception.*

GJSFR-H Classification: *FOR Code: 160804*

Strictly as per the compliance and regulations of:

Perception of the Asunción Ppopulation on Climate Change, Paraguay

Percepción de la Población Asuncena Sobre el Cambio Climático, Paraguay

Claudia Patricia Caballero Chávez

Resumen- El cambio climático es un conflicto global de amplia complejidad que implica desiguales consecuencias ambientales, sociales y económicas, por lo que se presenta como uno de los grandes desafíos de la sociedad actual. Para el cumplimiento de los objetivos de cambio climático de reducir las emisiones de gases de efecto invernadero, son necesarios cambios en las estructuras sociales que requieren la participación del público en general. Este artículo analiza las percepcionesde la sociedad asuncena sobre el cambio climático, a través de la aplicación del cuestionario de encuestas con preguntas abiertas y cerradas. Los resultados muestran que siete de cada diez asuncenos han escuchado sobre el cambio climático, indicaron en gran parte los impactos del cambio climático como las altas temperaturas, estas percepciones están en relación con los aumentos de la temperatura mediaen la región. La población asuncena percibe que el cambio climático ya está ocurriendo en el país, la mayoría señaló a la ciudadanía como responsable de aplicar las soluciones. Sin embargo, existe una preocupación por el cambio climático impulsado por la percepción de peligro para las personas distantes geográfica y temporalmente, lo que dificulta la adopción de acciones para mitigar el cambio climático y para adaptarse reactiva o proactivamente al cambio climático.

Palabras clave: asunción, cambio climático, causas, impactos, percepción al riesgo.

Summary- Climate change is a highly complex global conflict that implies unequal environmental, social and economic consequences, which is why it is presented as one of the great challenges of today's society. To meet the climate change goals of reducing greenhouse gas emissions, changes in social structures are necessary that require the participation of the general public. This article analyzes the perceptions of Asunción society about climate change, through the application of the survey questionnaire with open and close questions. The results show that seven out of ten people in Asunción have heard about climate change, they largely indicated the impacts of climate change such as high temperatures, these perceptions are related to increases in average temperature in the region. The population of Asunción perceives that climate change is already occurring in the country; the majority pointed to citizens as responsible for applying the solutions. However, there is concern about climate change driven by the perception of danger to geographically and temporally distant people, making it difficult to take action to mitigate climate change and to reactively or proactively adapt to climate change.

Keywords: asunción, climate change, causes, impacts, risk perception.

I. Introducción

El cambio climático es un problema global de múltiples dimensiones e incertidumbres, por lo que se plantea como uno de los mayores desafíos de la sociedad actual [1-4] ya que abarca a la física del sistema climático, el desarrollo económico, las políticas internacionales, las amenazas a la diversidad de la vida del planeta y sus desiguales consecuencias sociales, ambientales y económicas[2].

La Convención Marco de las Naciones Unidas sobre el Cambio Climático, en su artículo 1 define el cambio climático como "cambio de clima atribuido directa o indirectamente a la actividad humana, que altera la composición de la atmósfera mundial y que se suma a la variabilidad natural del clima observada durante períodos de tiempo comparables"[5].

Para el cumplimiento de los objetivos de cambio climático de reducir las emisiones de gases de efecto invernadero (GEI), son necesarios cambios en las estructuras sociales que requieren la participación del público en general[6]. Las formas en que los individuos, las sociedades y las políticas respondan al cambio climático dependen en muchos casos de las percepciones sobre sus causas, consecuencias e implicaciones más amplias[7]. Es necesario conocer cómo es probable que el público responda a los impactos de los cambios climáticos porque esas respuestas pueden atenuar o amplificar los impactos[8].

Se ha desarrollado de forma activa el estudio de las percepciones públicas del cambio climático, tanto a nivel internacional[6, 8, 9, 10, 11, 12, 13] como en Latinoamérica[3, 4, 14, 15, 16, 17] y algunos estudios en Paraguay [18, 19].

Author: Universidad Nacional de Asunción, Facultad de Ciencias Agrarias. San Lorenzo, Paraguay. e-mail: claucaballeropy@gmail.com

Autor/a(es)	Título	Método utilizado	Unidades de observación	Principales resultados
Leiserowitz, 2005	American Risk Perceptions: Is Climate Change Dangerous?	Cuestionario de encuesta por correo electrónico con preguntas cualitativas y cuantitativas.	Público estadounidense	La mayoría demuestran una alta conciencia del cambio climático global, una fuerte creencia de que es real, y la preocupación, sin embargo, no consideran al cambio climático como un peligro inminente o de alta prioridad.
Whitmarsh, 2008	Are flood victims more concerned about climate change than other people? The role of direct experience in risk perception and behavioral response	Entrevista cualitativa semi-estructurada. Cuestionario de encuesta postal con preguntas cualitativas y cuantitativas	Ciudadanos de Somerset y Hampshire, Inglaterra afectados y no afectados por las inundaciones	Las víctimas de las inundaciones difieren muy poco de otros participantes en su comprensión y respuesta al cambio climático
Leiserowitz, 2006	Climate change risk perception and policy preferences: the role of affect, imagery, and values	Entrevista semiestructurada. Codificación y categorización de preguntas abiertas	Público estadounidense	La combinación del afecto, imagen afectiva y teoría cultural explican la percepción al riesgo. Los efectos del cambio climático se perciben lejanos y es un problema que se desea sea resuelto por alguien más.
Lorenzoni *et al*., 2006	Cross-National Comparisons of Image Associations with "Global Warming" and "Climate Change" Among Laypeople in the United States of America and Great Britain	Cuestionario de encuesta por correo electrónico cualitativas y cuantitativas. Codificación y categorización de preguntas abiertas	Ciudadanos de EE.UU. y Gran Bretaña	Aunque se reconoce la amenaza del cambio climático, se la ve como relativamente distante en el espacio y en el tiempo.
Bord *et al*., 1998	Public perceptions of global warming: United States and international perspectives	Cuestionario de encuesta a través del correo	Público estadounidense y comparación con otros estudios internacionales	El calentamiento global cuando se incluye en listas de otros problemas ambientales y sociales, tiende a reflejar la menor preocupación y apoyo
Akerlof *et al*., 2013	Do people 'personally experience'global warming, and if so how, and does it matter?	Cuestionario de encuesta a través del correo con preguntas abiertas y cerradas	Ciudadanos de Michigan, EEUU	La mayoría no creen que han experimentado el calentamiento global. Los que señalaron creer que habían experimentado describieron con frecuencia los cambios en el tiempo, cambios en las estaciones, los registros de los últimos datos confirman la evidencia.
Spence *et al*., 2011	Perceptions of Climate change and willingness to save energy related to flood experience	Cuestionario de encuesta con preguntas cerradas.	Ciudadanos de Reino Unido	Las experiencias de inundación reportadas tuvieron una relación significativa con las percepciones relacionadas con el cambio climático
Soares y Gutiérrez, 2011	Vulnerabilidad social, institucionalidad y percepciones sobre el cambio climático: un acercamiento al municipio de San Felipe, Costa de Yucatán	métodos cuantitativos y cualitativos: encuesta, entrevistas semiestructuradas y observaciones	Ciudadanos de San Felipe, Costa de Yucatán, México	El cambio climático lo asocian principalmente al cambio de la temperatura; un elevado porcentaje de personas jamás ha recibido capacitación sobre cambio climático
Urbina, 2015	La Percepción Social del Cambio Climático	Recopilación de varias investigaciones	Ciudadanos de México	Está cada vez más presente el asunto del cambio climático, pero no

Autor/a(es)	Título	Método utilizado	Unidades de observación	Principales resultados
	en el ámbito urbano			necesariamente se perciben con claridad sus causas y efectos. Un aspecto de gran relevancia es la explicable, aunque errónea adjudicación de responsabilidad a las causas y vulnerabilidad ante los efectos.
López *et al*., 2015	Percepción de la población costera de Jalisco, México, sobre el cambio climático	Encuesta con preguntas abiertas y cerradas	Población costera de Jalisco, México,	La mayoría percibe un aumento en la temperatura y conoce el término "cambio climático". Sin embargo, pocos consideran que sus efectos afectarán su vida cotidiana. Este hecho puede dificultar las acciones locales y regionales para la adaptación y mitigación del cambio climático.
Retamal *et al.,* 2011	Percepción al cambio climático y a la gestión del agua: aportes de las estrategias metodológicas cualitativas para su comprensión	Recopilación de varias investigaciones		El uso de metodologías mixtas para el estudio de la percepción al cambio climático y la gestión integrada del agua se constituye en investigación-acción, ya que permite sugerir en qué variables se deben hacer los mayores esfuerzos
Vignola *et al*., 2010;	Estudio de la percepción y actitudes de la población costarricense sobre Cambio Climático	Cuestionario de encuesta con preguntas abiertas y cerradas	Población costarricense	Existe un sentido de importancia general sobre el tema, pero no se ha observado un sentido de urgencia. Perciben el tema de cambio climático como algo muy lejano, lo que limita el nivel de responsabilidad de los mismos como una parte importante en las acciones para enfrentar el cambio climático
Olmos *et al*., 2013	Percepción de la población frente al cambio climático en áreas naturales protegidas de Baja California Sur, México	Cuestionario de encuesta con preguntas cerradas. Grupos focales.	Habitantes de las siete ANP en BCS, México.	La mayor parte de la población conoce el significado de cambio climático y que los efectos que perciben son reducción en la superficie forestal por cambio en uso de suelos, reducción de la actividad pesquera por cambios en las condiciones del mar, efectos negativos en el hato ganadero y frecuencia e intensidad de huracanes, aumento en sequías, falta de agua y reducción en la actividad ecoturística por cambios en las playas
Salas, 2009	Percepción del cambio climático por una comunidad ganadera en los humedales del sur del Paraguay	Entrevistas a referentes del área.	Habitantes de Isla Umbú, del Departamento de Ñeembucú, Paraguay.	Los principales efectos del Cambio Climático son sobre la infraestructura, los sistemas productivos, los aspectos sociales y ambientales. las principales limitaciones para enfrentar el Cambio Climático, entre las que sobresale el tema de información como el más relevante, pero al mismo tiempo el más deficiente. Han podido identificar acciones para enfrentar las nuevas condiciones ambientales.
Breuer *et al*., 2017	Percepción y observación de las variaciones en el	Encuestas con preguntas cerradas, entrevistas abiertas y grupos focales	Agricultores, consultores y técnicos de	La mayoría identificaron cambios en el clima en la zona donde llevan a cabo sus actividades productivas.

Autor/a(es)	Título	Método utilizado	Unidades de observación	Principales resultados
	régimen pluviométrico en Itapúa y Alto Paraná		Itapúa y Alto Paraná, Paraguay.	Específicamente, los agricultores detectaron un aumento en el volumen de la precipitación a través de los años, lo que concuerda con los resultados del análisis de los datos pluviométricos observados.

Alrededor de la mitad de las ciudades capitales de la región de América Latina y el Caribe presentan vulnerabilidad significativa al cambio climático, siendo la ciudad de Asunción incluida en la categoría de "riesgo extremo" [(20)]. La ciudad de Asunción y las ciudades aledañas son pródigas de asimetrías que provocan desigualdades, debido a que son el principal polo de atracción de servicios (salud, educación y fuentes de empleo), provocando un acelerado y desordenado crecimiento poblacional en una modesta extensión del territorio nacional, en donde se reproducen las inequidades sociales y los conflictos socioambientales [(21)] reflejadas en miles de personas establecidas precariamente en áreas inundables, provocando un aumento de la vulnerabilidad a los cambios climáticos.

La inundación es uno de los problemas socioambientales más serios en la ciudad de Asunción [(22)], las zonas ribereñas se ven afectadas por las crecidas del rio Paraguay, con más de 25 kilómetros de costas que han sido ocupadas para asentamientos y emprendimientos públicos y privados. De acuerdo con el Precenso Nacional 2011-2012 el 14% de las viviendas en Asunción están en las zonas inundables con una ocupación espacial de 1650ha a lo largo del río Paraguay.

Las personas que habitan en lugares reconocidos como físicamente vulnerables a los impactos del cambio climático, por ejemplo, zonas inundables, podrían tener una mayor percepción al riesgo personal[(23)].Destacar los vínculos entre los eventos locales y el cambio climático, debería dar como resultado un mayor reconocimiento de sus peligros, lo que puede alentar al público a involucrarse en el tema y a tomar medidas para mitigar los impactos[(24)].Mientras no se experimente de una manera más directa o se relacione el cambio climático con eventos locales, será difícil que se tomen acciones por parte de la población local [(15, 19)].El presente trabajo presenta una aproximación a la percepción del cambio climáticoa la población de la ciudad que habitaen Asunción, además de indagar si existe discrepancias entre los afectados por las inundaciones y los no afectados.

II. Materiales y Métodos

a) Área de Estudio

Geográficamente la ciudad de Asunción, capital del Paraguay, está comprendida entre los paralelos 25º 15' y 25º 20' de latitud sur y entre los meridianos 57º 40' y 57º 30' de longitud oeste, es la ciudad más poblada del país. Está situada sobre la orilla izquierda del río Paraguay, que la separa al noroeste de la región Occidental y al sur del territorio argentino, frente a la confluencia de los ríos Pilcomayo y Paraguay; rodeada por el departamento Central, con el que limita al norte, este y sur [(25)] (Figura 1).

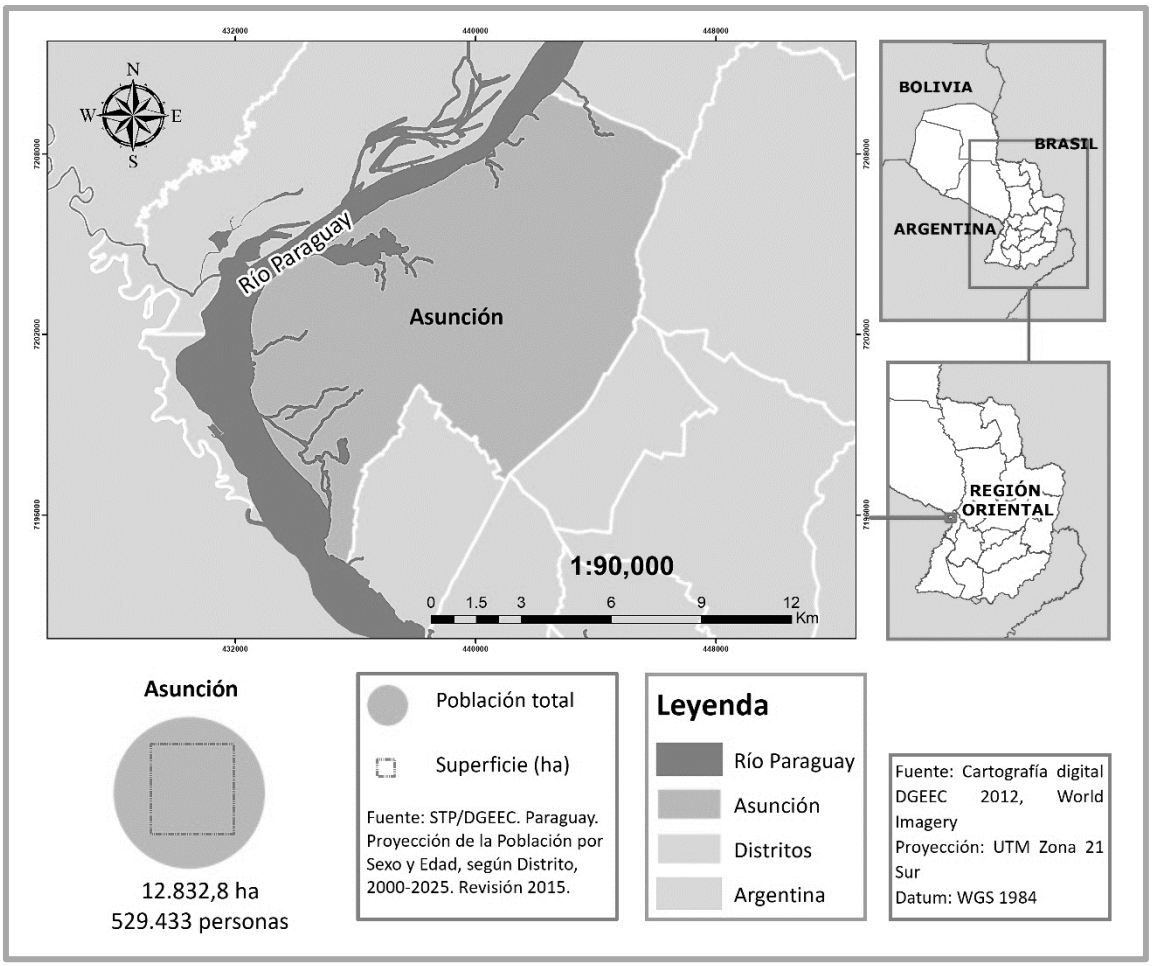


Figura 1: Ubicación del Area de Estudio

b) Abordaje Cuantitativo: Aplicación del Cuestionario a la Población Asuncena

i. *Características del diseño Muestral*

Se decidió aplicar el cuestionario en la ciudad de Asunción debido a que presenta la más alta densidad poblacional del país.

Los datos de la cantidad de viviendas precensadas de los 68 barrios de Asunción y los mapas de los diferentes barrios de Asunción, fueron provistos por la Dirección General de Estadística, Encuestas y Censos de acuerdo con el Precenso Nacional 2011-2012. El marco muestral estuvo compuesto por las viviendas de la ciudad de Asunción, donde la unidad de observación fue toda persona mayor de 18 años residente de la vivienda seleccionada al momento de realizar la encuesta, pertenecientes a todos los niveles socio económicos.

En primer lugar, se dividió la ciudad de Asunción en dos zonas, la zona inundable y la zona no inundable, para investigar si la experiencia de las inundaciones afecta el conocimiento, las actitudes o el comportamiento en relación con el cambio climático[6, 10]. Las inundaciones adoptan diversas formas y abarcan una gama de experiencias [10].

En la Figura 2, se observa la zona inundable en Asunción, y se define como aquellas áreas ribereñas donde ocurren las inundaciones fluviales, que son "fenómenos naturales debido a la crecida natural de un río que condicionan la formación de planicies aluviales, cercano a los cursos de agua periódicamente inundables" [22] pudiendo alcanzar hasta una altura de 10m (cota 64) del río Paraguay en la ciudad de Asunción.

Figura 2: Zona Inundable de la Ciudad de Asunción

La estrategia muestral adoptada para el presente estudio fue el diseño probabilístico y se caracteriza porque cada unidad que compone la población tiene la misma posibilidad de ser seleccionado[26], una elección de sus elementos al azar ayuda a asegurar que la muestra no tiene un sesgo o un prejuicio en contra de algún grupo en particular o grupos de la población [27].

El tamaño de la población son la cantidad de viviendas precensadas en la ciudad de Asunción, en la zona inundable corresponde a 18351, y 111425 en la zona no inundable de acuerdo con el Precenso Nacional 2011-2012. Posteriormente, se procedió a la elección del nivel de confianza del tamaño de la muestra. La elección de un nivel de confianza de un 95% para construir el intervalo de confianza es una convención estadística basada en parte por la tradición. Esto significa que se establece un estándar en el cual, el 95% de las veces se estará en lo cierto y un 5% de las veces en lo incorrecto. El tamaño de este intervalo de valores aumenta con el aumento del error estándar del promedio. También, es usual elegir el tamaño de la muestra de forma tal que el error estándar del promedio sea un 5%. Se ha utilizado para la determinación del tamaño de la muestra la siguiente ecuación directa [28]:

$$n = \frac{Z^2.\mathrm{N}.\mathrm{p}.\mathrm{q}}{(\mathrm{N}-1)\,e^2 + Z^2.\mathrm{p}.\mathrm{q}}$$

Donde:

n = Tamaño de la muestra.
N = Universo muestral (Tamaño de la Población). Zona inundable = 18351. Zona no inundable = 111425.
Z = Coeficiente o nivel de confianza = 1,96 (para un nivel de confianza de 95%).
e = Error muestral = 5%.
p = Probabilidad de éxito = 0,5.
q = Probabilidad de fracaso = 0,5.

De esta manera, el tamaño de la muestra resultó en 383 y 376 elementos a estudiar, correspondientes a las zonas no inundable e inundable, respectivamente. Luego, para cada zona, se definió el tamaño muestral en proporción al tamaño de la población de cada barrio (Figura 3).

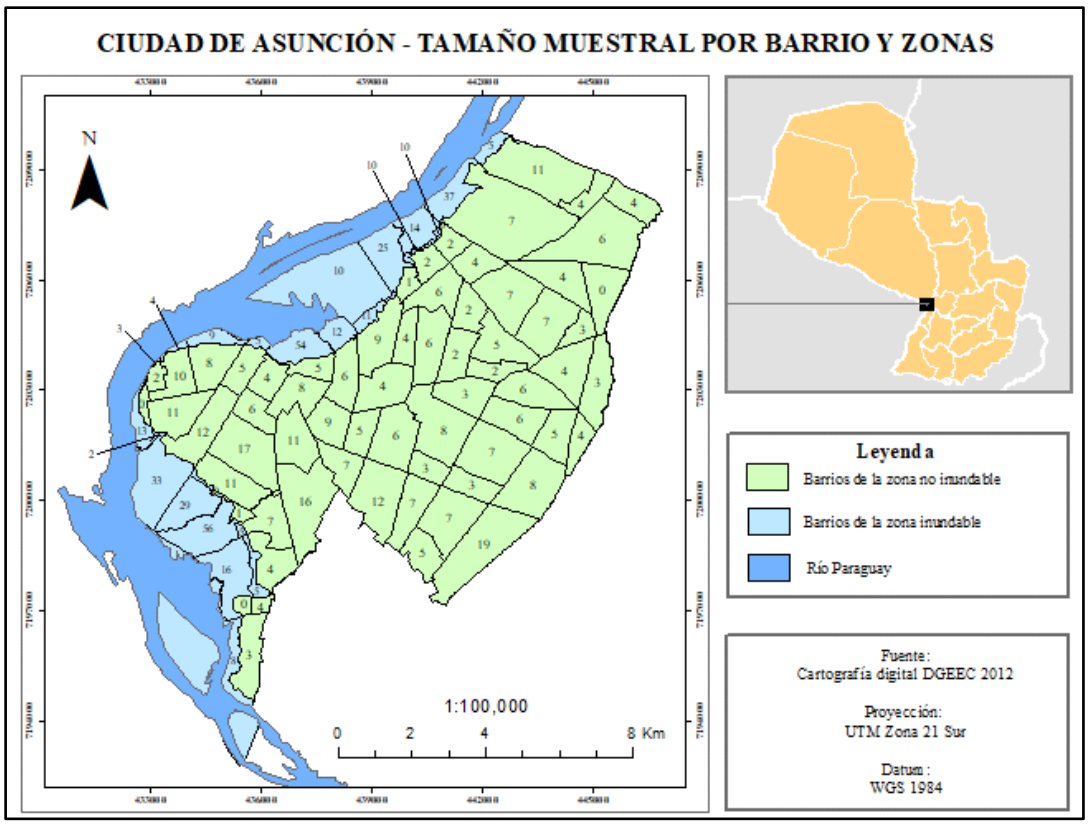


Figura 3: Tamaño Muestral de la Población de Asunción Por Barrios y Zonas

ii. *Construcción del Instrumento*

El instrumento adoptado, el cuestionario, fue diseñado a partir de la revisión de estudios previos similares desarrollados en otros países [9, 11, 14, 17]. y se construyeron preguntas referidas a las diferentes categorías presentadas.

Categorías		Dimensiones de análisis	Unidades de observación	Abordaje y técnicas	Instrumentos
C1	Clima	Entendimiento sobre el clima Conocimiento de la diferencia entre tiempo atmosférico y clima	Grupos de población de la ciudad de de Asunción.	Cuantitativo/Análisis de escalas de valoración.	Cuestionario de encuestas.
C2	Cambio Climático	Conocimiento y creencias sobre el cambio climático	Grupos de población de la ciudad de de Asunción.	Cuantitativo/Análisis de escalas de valoración.	Cuestionario de encuestas.
C3	Causas	Conocimiento de las causas del cambio climático	Grupos de población de la ciudad de de Asunción.	Cualitativo/testimonios y narraciones. Cuantitativo/escalas de valoración.	Cuestionario de encuestas.
C4	Impactos	Conocimiento de los impactos del cambio climático	Grupos de población de la ciudad de de Asunción.	Cualitativo/testimonios y narraciones. Cuantitativo/escalas de valoración	Cuestionario de encuestas.

C5	Riesgos	Pensamiento asociativo al cambio climático y cercanía percibida de los impactos	Grupos de población de la ciudad de de Asunción.	Cualitativo/testimonios y narraciones. Cuantitativo/escalas de valoración.	Cuestionario de encuestas.
C6	Actitudes	Preocupación por el cambio climático Prioridad del cambio climático frente a otros temas Responsabilidad frente al cambio climático	Grupos de población de la ciudad de de Asunción.	Cualitativo/testimonios y narraciones. Cuantitativo/escalas de valoración.	Cuestionario de encuestas.

Se llevó a cabo la aplicación de la encuesta piloto a cinco personas en el área de estudio para validar, pulir y ajustar el instrumento a las condiciones locales.

iii. *Trabajo de Campo*

Debido a la alta densidad del tamaño muestral (n= 729), ajustar el tiempo en recolectar la información en un periodo mínimo posible y la necesidad de recursos humanos que actúen como facilitadores de la información, se presentó una propuesta de proyecto de extensión universitaria en la Facultad de Ciencias Agrarias de la Universidad Nacional de Asunción, para que los estudiantes de las diferentes carreras pudieran realizar el trabajo de campo como encuestadores, dicha actividad tuvo como fin incentivar a los estudiantes a participar en dicho estudio ya que podrán interactuar con los informantes, conocer y explorar la realidad social, y adquirir experiencia como facilitadores de la información. Cerca de 66 estudiantes interesados fueron seleccionados para llevar a cabo la actividad, posteriormente la investigadora realizó la capacitación a los estudiantes sobre diversos temas: conceptos básicos sobre el cambio climático, los objetivos de la investigación, capacitación sobre el instrumento, análisis y técnicas de aplicación del cuestionario.

El trabajo de campo se llevó a cabo entre el 23 de abril y el 4 de mayo de 2018. La investigadora indicó a los encuestadores los barrios donde debían recolectar la información y brindó los materiales pertinentes para realizar el trabajo de campo (carpetas, mapas, cuestionarios, bolígrafos y remeras).

Cada facilitador debía encontrar los informantes con las características requeridas para contestar el instrumento. En cada vivienda se ubicó un solo informante mayor de 18 años que accediera y dispusiera de alrededor de 20-30 minutos para responder a las preguntas del cuestionario. Si la persona que recibió al facilitador estuvo incapacitada física, mental o afectivamente para responder la encuesta, se reemplazó por otra persona de la vivienda o de una vivienda contigua. Si el informante tuvo alguna duda al momento de responder, el facilitador, repitió la pregunta y añadiendo la frase "¿cuál de estas respuestas es la más parecida a su opinión?". Antes de despedirse del encuestado, el facilitador se cercioró que la encuesta haya estado totalmente completa.

La insistencia en el anonimato y confidencialidad de las respuestas fue la estrategia adoptada para disminuir el "error de no respuesta".

Cada encuestador aplicó entre 10 a 20 cuestionarios a la población objeto de estudio. En total se lograron encuestar a 667 personas en el área de estudio. Se tabuló la información correspondiente a 262 en la zona inundable, dado que no se logró completar la mayor parte del cuestionario debido al posterior rechazo a continuar por parte del informante para 8 encuestas. De la misma manera cabe destacar que varias áreas fueron eliminadas por encontrarse en zonas muy inseguras que ponían en riesgo la integridad de los encuestadores, por lo cual 106 cuestionarios no fueron aplicados en la zona inundable. Por otro lado, en la zona no inundable se logró entrevistar a más personas dando un total de 405 encuestados.

iv. *Análisis de los Datos*

Para la verificación de los datos, teniendo en cuenta aquellos encuestados que brindaron algún número telefónico, se eligieron al azar diez encuestas para corroborar al menos una pregunta del cuestionario.

Finalmente, los datos cuantitativos de la encuesta se cargaron en Excel, luego se importaronal programa estadístico SPSS 18 para su posterior análisis e interpretación de resultados. Debido a que tres preguntas eran abiertas, se realizó un análisis de contenido inductivo con dos codificadores independientes para reducir las categorías de los datos cualitativos [9, 12].

III. Resultados y Discusión

a) Conocimiento General Sobre el Cambio Climático

Considerando la pregunta que indagaba si los encuestados habían escuchado o no sobre el cambio climático, el calentamiento global o que el clima está cambiando con respecto al pasado, el 71,5% respondió afirmativamente, y el 28,5% señaló no haber escuchado sobre el tema.

Esta estadística resulta muy similar con los porcentajes encontrados en las encuestas aplicadas a

la población mexicana, donde siete de cada diez expresaron haber escuchado sobre el cambio climático [14]. Sin embargo, otros estudios señalan porcentajes mayores, la encuesta aplicada a estadounidenses en el 2001, el 82% respondió afirmativamente [9], mientras que otra encuesta realizada en el 2007 señala un aumento con cerca del 97% [29], por otro lado, la encuesta aplicada en España en el 2012, el 97,5% afirmaron haber escuchado sobre el cambio climático [30].

Es probable que exista aún una escasa cobertura sobre el tema en los medios de difusiones locales. Paraguay adoptó un compromiso mediante la Ley N°251/93 en donde aprueba el Convenio sobre Cambio Climático adoptado durante la Conferencia de las Naciones Unidas sobre Medio Ambiente y Desarrollo (la Cumbre para la Tierra). De acuerdo con la Convención Marco de las Naciones Unidas sobre el Cambio Climático en su artículo 6, invoca a generar educación, formación, sensibilización al público, acceso del público a la información, participación del público y la cooperación internacional, por lo tanto, es esencial la implementación de la comunicación social, bien por mandato de la Convención de Cambio Climático, o bien por su naturaleza y funcionalidad[5].

Se hallaron diferencias marcadas entre zonas, cinco de cada diez encuestados en la zona inundable manifestó haber escuchado sobre el cambio climático (el 53,1%), sin embargo, en mayor proporción en la zona no inundable, donde ocho de cada diez encuestados señaló haber escuchado sobre el tema (83,5%).

En la Figura 4, se observa el porcentaje de la población encuestada que ha manifestado escuchar sobre el tema, teniendo en cuenta los barrios y las zonas inundable y no inundable. Cabe destacar que aquellos barrios que figuran 0%, en la zona inundable, no se aplicaron los cuestionarios (n=114), como se mencionó anteriormente, debido al posterior rechazo a continuar por parte del informante con el cuestionario (n=8) y/o por tratarse de zonas muy inseguras que ponían en riesgo la integridad de los encuestadores (n=106).

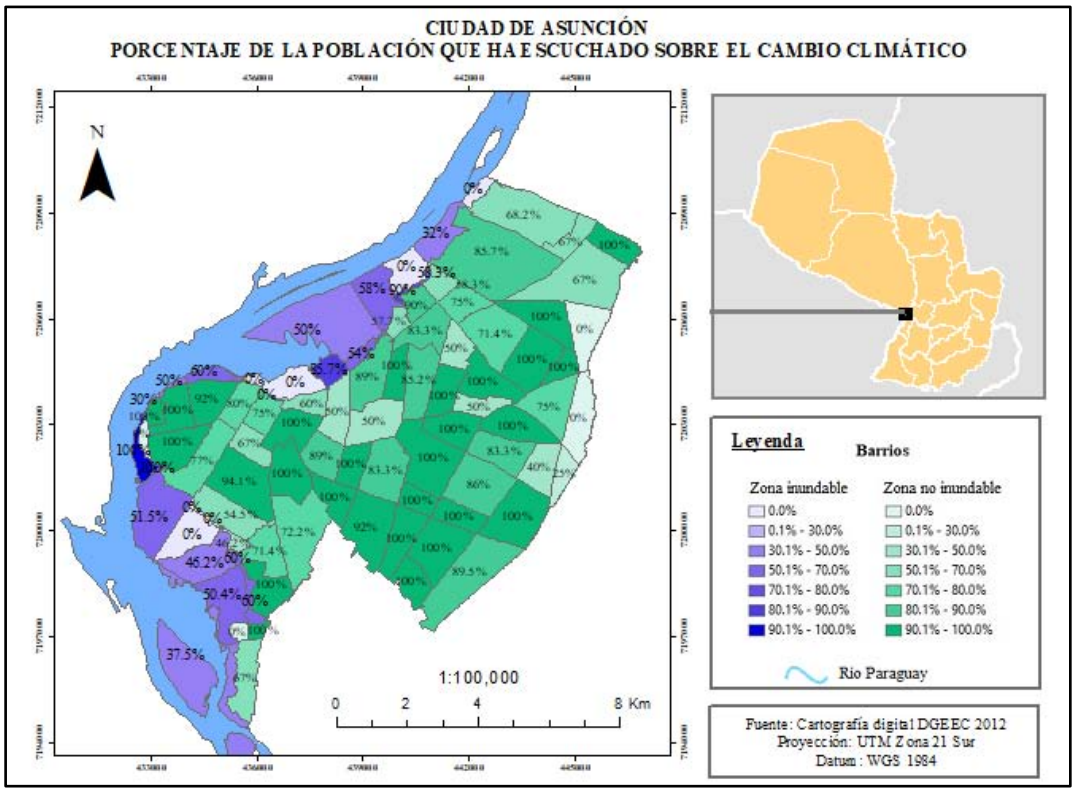


Figura 4: Porcentaje de la población que ha escuchado sobre el cambio climático, calentamiento global o que el clima está cambiando con respecto al pasado, por barrios y zonas

A continuación, se muestran los porcentajes de personas encuestadas que afirman haber escuchado sobre el cambio climático en función de su nivel de educación formal (Figura 5). Puede apreciarse que hay un salto brusco entre los porcentajes registrados en los encuestados *sin estudios* (que son los que declaran haber escuchado sobre el cambio climático en menor proporción) y los que han realizado estudios *primarios*. Y también hay un salto apreciable, entre éstos últimos y los que poseen estudios de enseñanza *secundaria*y *terciaria*. Se observan que aquellos que poseen educación *universitaria* mayormente han afirmado haber escuchado sobre el tema.

Por otro lado, de los encuestados que manifestaron no haber escuchado sobre el cambio climático resaltan en primer lugar aquellos que señalaron estar *sin actividad / en paro*con el 52,1%, seguido de *trabaja en casa / ama de casa* (37,4%) y *trabaja por cuenta propia* (27,4%).

Estos resultados coinciden con el estudio realizado en la población española, el reconocimiento del concepto es mayor entre las personas activas que entre las inactivas y aumente también con el nivel de estudios, esto podría indicar que, tanto el sistema educativo como el entorno laboral, constituyen ambientes socializadores de información relativa al cambio del clima o los problemas ambientales[30].

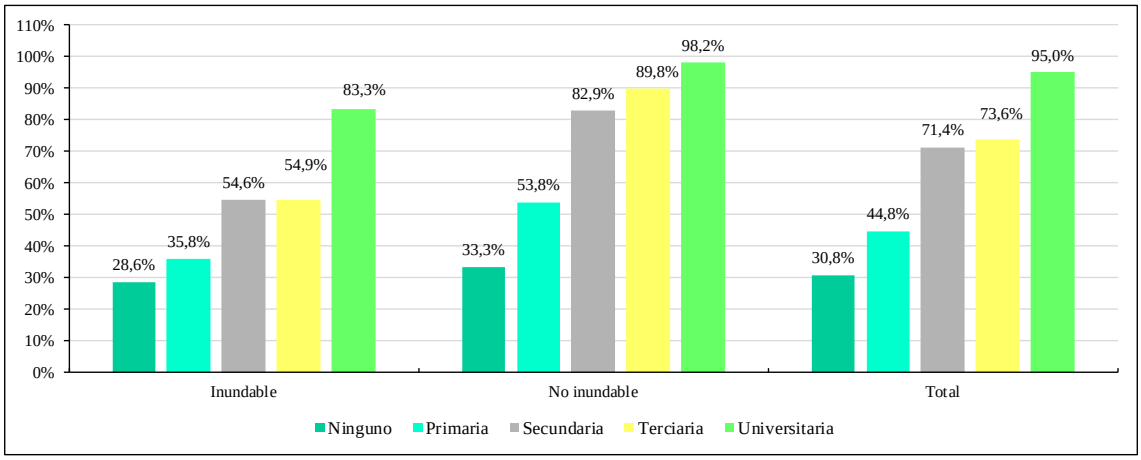


Figura 5: Porcentaje de la población objeto de estudio con conocimiento sobre el cambio climático distribuidos por educación formal y zona

Considerando los que afirman haber escuchado previamente los conceptos en función de la edad (Figura 6) los porcentajes más altos son en el tercer y cuarto intervalo de edad analizados (41 a 50 y 51 a 60 años). Estos resultados difieren notablemente con la población española, donde la población más joven (menores de 25 años y de 25 a 44 años) fueron quienes reconocieron más el concepto de cambio climático[30].

Se distinguen marcadas diferencias cuando se consideran las subpoblaciones por zona y edad, siendo aún más notorio en los dos primeros intervalos de edad. El 43,4% de la población más joven (18 – 30 años) de la zona inundable, manifestó haber escuchado al respecto, mientras que un porcentaje mayor se observó en la zona no inundable, con el 90,5%. De la misma manera se observan acentuadas diferencias en la población de 31 a 40 años, en la zona inundable, solo el 48,8% señaló haber escuchado sobre el tema y en mayor proporción en la zona no inundable, con el 85,1%.

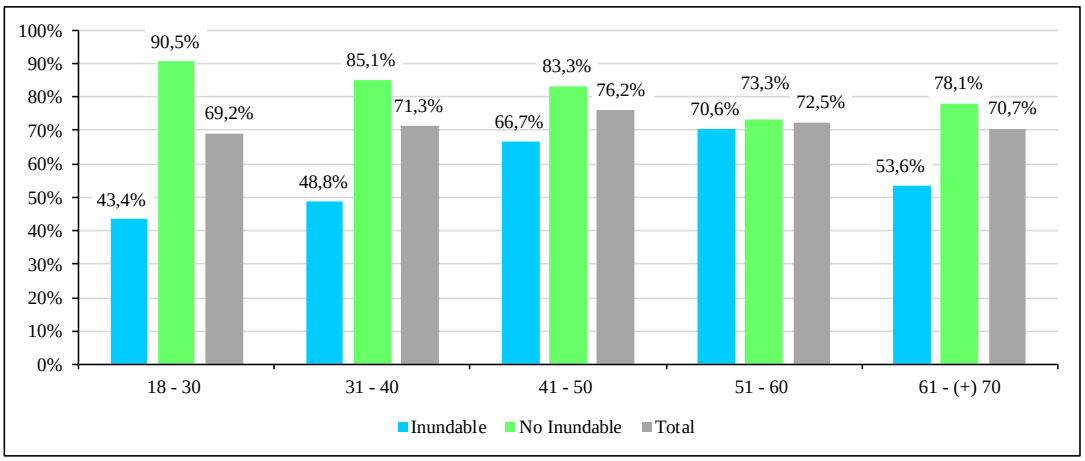


Figura 6: Porcentaje de la población objeto de estudio con conocimiento sobre el cambio climático distribuidos por edad y zona

A continuación, se presentan los resultados obtenidos del 71,5% (n= 477) de la población encuestadaque señalaron haber escuchado sobre el cambio climático, calentamiento global o que el clima está cambiando con respecto al pasado, considerando

el 53,1% de la zona inundable (n=139) y el 83,5% de la zona no inundable (n=338).

i. *Clima vs Tiempo Atmosférico*

Los fenómenos atmosféricos con escalas temporales que corresponden al día a día, generalmente se consideran relacionados con el tiempo, mientras que los fenómenos atmosféricos con escalas de tiempo más largas se consideran con relación al clima [31] conforme a la Organización Meteorológica Mundial el período de promedio habitual utilizado es de 30 años [32, 33].

Para el indicador de conocimiento sobre la definición de clima y tiempo atmosférico, se tuvieron en cuenta tres frases (Tabla 1), con respuestas de verdadero, falso y no sabe/no contesta. Se puede observar que la mayoría de los encuestados consideraron correctamente como falso que el clima del planeta es el mismo desde hace millones de años (79,5%), teniendo en cuenta la subpoblación, la gran mayoría de la zona no inundable (81,4%) considera como falsa dicha frase y la zona inundable en menor proporción (74,8%). Aunque ocho de cada diezreconocieron que el clima y el tiempo son dos conceptos diferentes, el 74% refieren al clima como cambiante dentro de la semana cuando por definición el clima es el promedio de 30 años[33].

Debido a que el sistema experiencial es sensible a los cambios en el entorno inmediato [34], el "tiempo" es la manera cotidiana en que muchos individuos perciben y posiblemente le dan sentido al "clima" [12].

Se han detectado confusiones bastante generalizadas a nivel mundial entre el clima y el tiempo[35, 36]. Estas confusiones entorpecen la representación apropiada de las causas del cambio climático, y la gran significancia de pequeños incrementos en la temperatura promedio del clima del planeta, no del tiempo atmosférico [36], a la vez dificulta la adecuada interpretación del cambio a nivel global y la valoración de su potencial amenaza [35].

Tabla 1: Conocimiento Sobre Clima y Tiempo Atmosférico

Frase		Zona		Total
		Inundable	No inundable	
Hablar del clima es lo mismo que hablar del tiempo	Verdadero	35,3%	39,1%	37,9%
	Falso	53,2%	52,4%	52,6%
	No sabe/No contesta	11,5%	8,6%	9,4%
Dentro de la semana el clima cambia	Verdadero	75,5%	73,4%	74,0%
	Falso	15,8%	20,4%	19,1%
	No sabe/No contesta	8,6%	6,2%	6,9%
El clima del planeta es el mismo desde hace millones de años	Verdadero	10,8%	10,1%	10,3%
	Falso	74,8%	81,4%	79,5%
	No sabe/No contesta	14,4%	8,6%	10,3%

ii. *Causas del Cambio Cimático*

Al consultarles a través de una pregunta abierta a la población asuncena, acerca de cuáles consideraban las posibles causas que contribuyen al cambio climático, en la Figura 7, se presentan las más citadas (un individuo pudo haber citado más de una de las causas que se han codificado). Se identificaron un total de 26 categorías distintas sobre las causas del cambio climático.

El 46,5% señaló a la *deforestación* siendo la causamás citada, seguido de la *contaminación* (30,2%), las *actividades humanas* (13%), los *procesos industriales* (8%), *mal manejo de los residuos sólidos / basuras* (7,1%) y *mal uso de los recursos naturales* (6,1%), el resto de las causas señaladas en la Figura 10, fueron nombradas en menos del 6%.

En México [14] y Estados Unidos [8] la principal causa nombrada fue la contaminación. Sin embargo, en Colombia [37] y Costa Rica [17]la deforestación fue la causa más señalada al igual que el presente estudio, probablemente debido a que hubo mayor difusión en los medios al respecto. Según el informe de la FAO, la deforestación en Paraguay es de alrededor de 180.000 hectáreas por año y esto se mantuvo constante durante el período 1990-2010[38].

Por otro lado, en la representación de la sociedad asuncena del cambio climático, los encuestados señalaron que hay una relación causal entre el *deterioro de la capa de ozono* y el cambio climático (2,5%), esta confusión se ha encontrado en investigaciones anteriores [4,8, 9, 10, 12, 14, 17,30]. Se ha extendido la creencia de asociar ambos fenómenos, como la “teoría de la cultura común”, donde el “deterioro” producido en esa capa facilitaría una penetración añadida de las radiaciones solares, que calentarían en exceso el planeta, siendo esta creencia bautizada como “el gran malentendido” [30]. Dicha confusión es en parte porque el deterioro de la capa de ozono está científicamente bien establecido, es fácil de imaginar y recordar, y ha sido vinculado al cambio

climático incluso por fuentes de información populares [39].

Considerando las subpoblaciones, en la zona inundable la *deforestación* fue la causa más mencionada (48,5%) seguido de la *contaminación* (23,7%) y el *mal manejo de los residuos sólidos / basuras* (13%), en la zona no inundable la *deforestación* también fue la causa más mencionada, pero en menor proporción (45,1%), sin embargo, la *contaminación* fue mayormente citada (32,9%), seguido de las *actividades humanas* (13,3%).

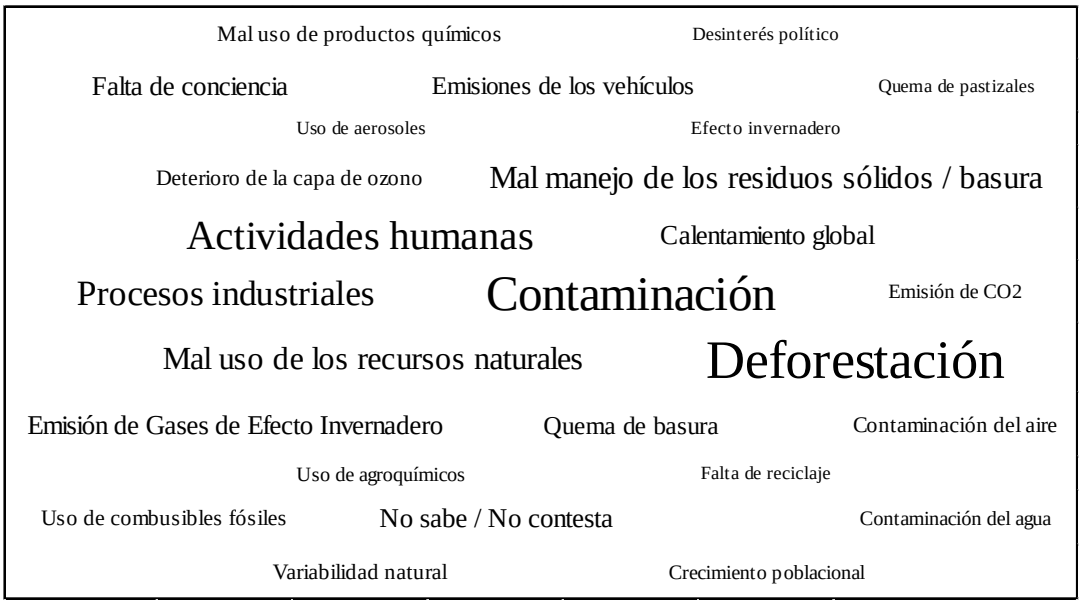


Figura 7: Principales Causas del Cambio Climático Mencionadas

Gran parte de los encuestados reconoce como principal causa del cambio climático a las actividades humanas (89,1%) (Tabla 2), en concordancia con los obtenidos en Costa Rica (91%)[17], estos resultados fueron mayores que los presentados en diferentes investigaciones, por ejemplo, en Colombia (68,9%) [37], España (64,4%) [30], en Australia (54%)[40], y en menor porcentaje en Estados Unidos, alrededor del 50% de los estadounidenses señalan a las actividades humanas como laprincipal causa del cambio climático [41].

Considerando las subpoblaciones, en la zona no inundable hay un mayor reconocimiento con el 91,1% frente a la zona inundable con el 84,2% (Tabla 2).

Tabla 2: Principales Causas del Cambio Climático

Ocurre principalmente por:	Zona		Total
	Inundable	No inundable	
Causas naturales	12,9%	8,6%	9,9%
Actividades del hombre	84,2%	91,1%	89,1%
Ninguna de las anteriores, el cambio climático no está ocurriendo	1,4%	0,3%	0,6%
Otros	0,7%	0,0%	0,2%
No sabe/No contesta	0,7%	0,0%	0,2%

iii. *Impactos del Cambio Climático*

La percepción de impactos del cambio climático implica la asignación de probabilidades a eventos de los cuales se desconoce la frecuencia probable, intensidad y capacidad adaptativa para ajustarse a los mismos [17]. De acuerdo con el paradigma de la percepción del riesgo [42], en esos contextos los individuos asignan probabilidades a impactos de acuerdo a emociones, experiencias y conocimiento sobre un riesgo dado.

Al consultarles a través de una pregunta abierta, cuáles consideraban los impactos del cambio climático, en la Figura 8, se presentan los más citados (un individuo puede haber citado más de uno de los impactos que se han codificado) se identificaron un total de 37 categorías distintas sobre los impactos del cambio climático.

Existe una percepción de que la distribución de la temperatura ha sufrido un cambio, además de un aumento general de las temperaturas de acuerdo a varias investigaciones, Costa Rica [17], México [4, 14,15], Chile [43], Colombia [37], España [30], Australia [40], Estados Unidos [13, 29, 41]. Esto se corrobora en las respuestas de la encuesta aplicada, donde el *aumento de la*

temperatura / más calor/ calor extremo / calor todo el año fueron expuestas por parte de los encuestados en mayor porcentaje (32,7%) y con los resultados obtenidos en los incrementos de las tendencias de las temperaturas en la región.

En segundo lugar, los impactos señalados por la población asuncena estuvieron relacionados con el incremento de la precipitación, como *inundaciones* (20%), *tormentas/tormentasintensas* (5,2%) y *más lluvias/lluvias intensas* (4,8%).

Figura 8: Impactos del Cambio Climático Mencionados

Considerando las subpoblaciones, cuando se les preguntó acerca de los impactos del cambio climático, los encuestados de la zona inundable no fueron más propensos a mencionar a las inundaciones en su respuesta, además de manifestar en menor porcentaje que los efectos del cambio climático son catastróficos (Tabla 3). En la zona inundable desconocen en mayor proporción los impactos del cambio climático (9,4%).

Tabla 3: Principales impactos del cambio climático mencionados por zona

Impactos mencionados	Zona		Total
	Inundable	No inundable	
Aumento de la temperatura / Calor extremo / Calor todo el año / Más calor	25,9%	35,6%	32,7%
Inundaciones	20,1%	19,8%	19,9%
Enfermedades / Problemas de salud	14,4%	15,4%	15,3%
Sequías	7,9%	12,7%	11,1%
Terremotos / Huracanes / Tsunamis / Tornados	7,9%	8,3%	8,0%
Derretimiento de los polos / glaciares	3,6%	7,7%	6,5%
Cambios bruscos de temperatura	6,5%	6,0%	6,1%
Cambios en el clima	5,0%	6,8%	6,1%
Pérdida / alteración de la fauna y flora	10,1%	4,5%	6,1%
No sabe / No contesta	9,4%	3,6%	5,2%
Tormentas / Tormentas intensas	5,0%	5,3%	5,2%
Lluvias intensas / Más lluvias	4,3%	5,4%	4,8%
Cambios en las estaciones del año	5,0%	4,5%	4,6%
Desastres naturales	1,4%	5,6%	4,4%

b) Información Requerida Sobre el Cambio Climático

Al consultarles sobre cómo consideraban su conocimiento sobre el cambio climático, se les preguntó qué tanta información necesitaría para mejorar sus conocimientos al respecto, un porcentaje alto de la población en estudio (74,8%) considera que necesita de *mucha más* o *algo más* de información. Los datos de encuestas en otras sociedades indicaron valoraciones menores, por ejemplo, en Costa Rica el 71% señaló necesita de *mucha más* a *algo más* de información[17], y en menor proporción en Australia donde el 58% manifestó querer aumentar su conocimiento [40].

Teniendo en cuenta las zonas, se observa que hubo una mayor proporción de encuestados de la zona inundable que señalaron necesitar *mucha más* o *algo más* información (77,7%) que en la zona no inundable (73,7%) (Figura 9). La experiencia, en este caso, los eventos locales como las inundaciones, podría motivar posiblemente a las personas a buscar información adicional para mejorar su comprensión [10].

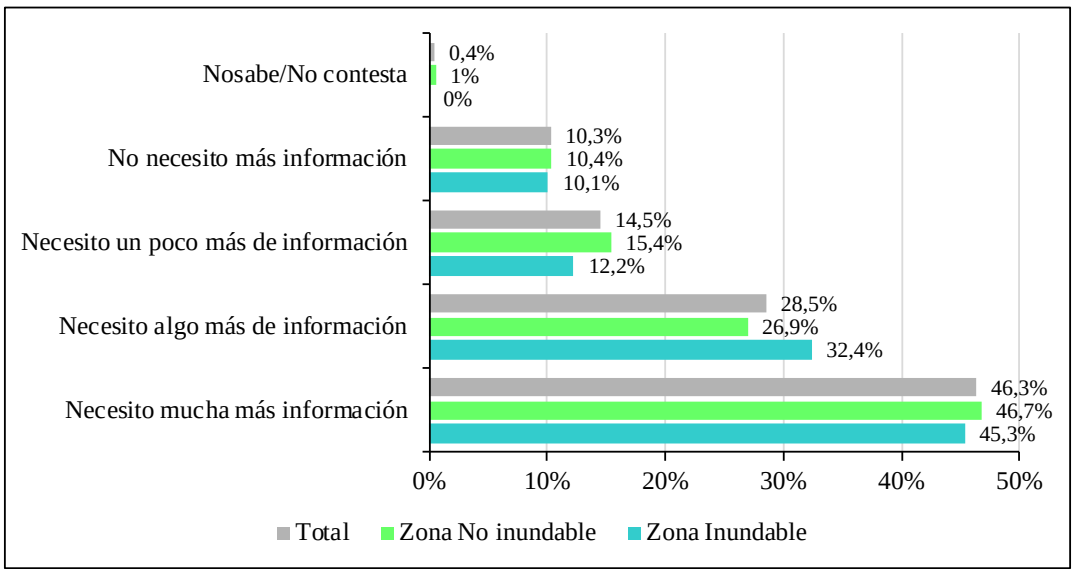


Figura 9: Niveles de Información Requerida Sobre el Cambio Climático

El 69,2% de la población asuncena afirmó ante la frase "la mayoría de los científicos señalan que el cambio climático está sucediendo". Sin embargo, el 16,1% señaló no saber al respecto y el 12,3% manifestó que existe "un gran desacuerdo entre científicos sobre si el cambio climático está sucediendo o no está sucediendo" (Figura 10). No existieron diferencias marcadas en las zonas inundable (68,4%) y no inundable (69,6%). La percepción pública sobre el consenso entre la comunidad científica presenta sus diferencias, por ejemplo, el 94% de los costarricenses [17] y solo el 49% los estadounidenses [41] reconocen que la comunidad científica afirma sobre la existencia del cambio climático.

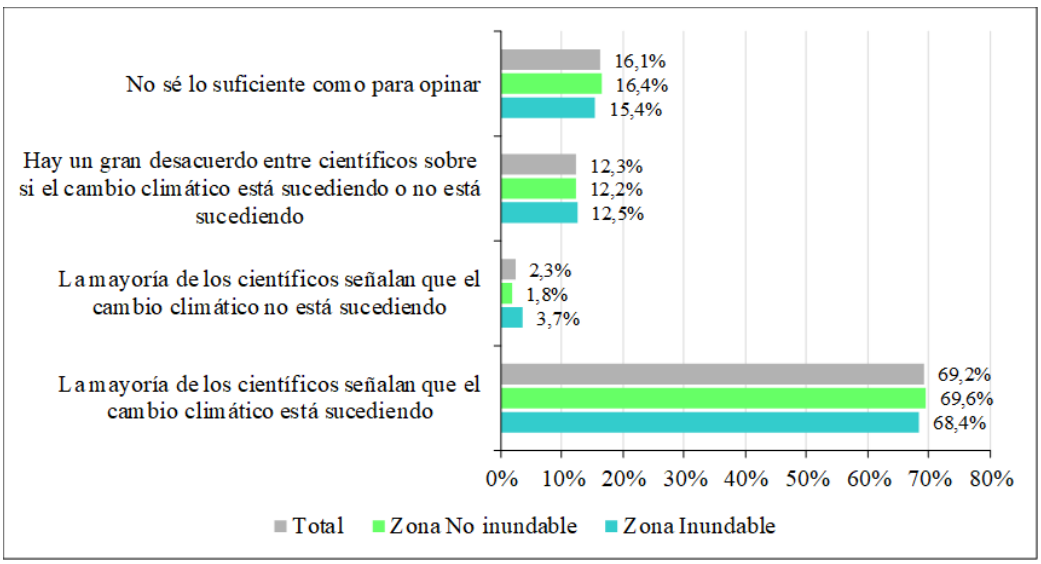


Figura 10: Percepción sobre el consenso científico sobre el cambio climático por zona

La posición de consenso se articula en la declaración del Panel Intergubernamental sobre el Cambio Climático (IPCC): "la influencia humana ha sido la causa dominante del calentamiento observado desde mediados del siglo XX" [(1)]. Varios científicos han llevado a cabo una recopilación de investigaciones que han utilizado diferentes enfoques sobre los niveles de acuerdo en el seno de la comunidad científica en materia de cambio climático, siete de los cuales fueron publicados por los autores[(44)], de acuerdo a sus hallazgos entre el 90% y 100% está de acuerdo en que los humanos son responsables del cambio climático, y el mayor consenso fue entre los científicos que publican en temas relacionados con el clima (97%). Además, las declaraciones conjuntas de 11 organismos científicos internacionales (Academia Brasiliera de Ciências; Royal Society of Canada; Chinese Academy of Sciences; Academié des Sciences, France; Deutsche Akademie der Naturforscher Leopoldina, Germany; Indian National Science Academy; Accademia dei Lincei, Italy; Science Council of Japan; Russian Academy of Sciences; Royal Society, United Kingdom; National Academy of Sciences, United States of America) que han expresado de forma pública y explícita su reconocimiento del cambio climático como fenómeno real causado principalmente por la acción humana[(45)].

Esos posicionamientos parecen haber tenido poco impacto en la percepción pública relativa al consenso científico [(30)] ya que si los propios científicos tienen un cierto grado de duda o rechazo al respecto (aunque sea muy bajo), para mucha gente significa que la urgencia puede diferirse hasta que la incerteza quede resuelta antes de introducir cambios sustantivos en sus formas de vida [(36)]. Sin embargo, una comprensión precisa del consenso científico, y la capacidad de reconocer los intentos de socavarlo, son importantes para la alfabetización pública del clima[(44)]. La comprensión pública del consenso científico es como una "creencia de acceso" que influye en otras creencias importantes (es decir, está ocurriendo, es causada por el hombre, es un problema grave y tiene solución) y apoyo para la acción[(46)].

c) Percepción del riesgo al cambio climático

i. *Pensamiento asociativo*

Refiere al pensamiento asociativo quela población asuncena ha revelado respecto a la palabra “cambio climático”.

La Figura 11, muestra las principales respuestas que se obtuvieron al indicarles a la población asuncena que mencionaran palabras, frases o imágenes que vienen a su mente cuando piensan en cambio climático. Representan los códigos de concepto o palabras citados durante ese ejercicio de pensamiento asociativo (un individuo puede haber citado más de uno de los conceptos que se han codificado). Las respuestas espontáneas han sido agrupadas en “asociaciones primarias” y, posteriormente, en “grandes temas” (por ejemplo: “una zona sin árboles” y “tala de árboles” se codificó como “deforestación”). Se identificaron un total de 37 categorías distintas sobre las asociaciones con el cambio climático.

La mayoría de las asociaciones válidas registradas (más del 55% del total de las respuestas) hacen referencia a los impactos del cambio climático: el 17,4% señaló *altas temperaturas* / *calor* / *más calor* / *calor extremo*, asociaciones con las precipitaciones como *inundaciones, tormentas* y *más lluvias* alcanzaron el 21,2%. Se debe considerar que las percepciones públicas del riesgo no solamente son influenciadas por descripciones científicas y técnicas, sino también por una variedad de factores sociales y psicológicos, incluyendo la experiencia personal, el afecto y la emoción, la imaginación [(47)].

Otras imágenes asociativas fueron *caos* / *catástrofes* / *destrucciones* (12,6%), *derretimiento de los polos* / *glaciares* (6,3%), *sequías* (4,2%). Las asociaciones con elementos causales del cambio climático constituyen alrededor del 15% del total: *deforestación* (6%), *destrucción del planeta* / *de la naturaleza* (5,2%) y *contaminación* en general alcanza el 4,8%. Mientras que el 3,3% expresó algún sentimiento negativo como *sufrimiento* / *susto* / *miedo* / *confusión* / *vergüenza*y *peligro*. Posiblemente esto puede dar una idea de la carga emocional que están adquiriendo las cuestiones ligadas al desajuste del clima [(35)].

A la vista de los resultados obtenidos, parece claro que la gente cuando oye hablar del cambio climático, lo primero que le viene a la mente son, ante todo, sus consecuencias.

Un hallazgo importante es que solo el 1,3% asoció el cambio climático con enfermedades y/o problemas en la salud. Sin embargo, es probable que los impactos en la salud humana sean uno de los mayores peligros del cambio climático para las sociedades humanas, especialmente para los países en desarrollo [(9, 12)].La Organización Mundial de la Salud estima que las tendencias de aumento de temperatura y precipitación debidas al cambio climático antropogénico de las últimas décadas ya cobran más de 150000 vidas al año[(48)].Los efectos sobre la salud pueden ser: directos, debido a cambios en la temperatura y la precipitación y al acaecimiento de olas de calor, inundaciones, sequías e incendios; e indirectos, por perturbaciones ecológicas relacionadas con el cambio climático, como malas cosechas o alteraciones en los patrones de los vectores de enfermedades, o por respuestas sociales al cambio climático, como el desplazamiento de poblaciones tras prolongadas sequías [(32)]. De acuerdo a la Segunda y Tercera Comunicación Nacional de Cambio Climático de Paraguay [(49, 50)] señalan a la salud humana entre los ámbitos estratégicos clave, puesto que es uno de los

sectores más vulnerables a los efectos del cambio climático en la región, debido a que existen afecciones estrechamente ligadas a los efectos de la variabilidad climática sobre ellas, como el caso del Dengue, enfermedad que se ha convertido en epidemia en el Paraguay desde el año 2009 y otras afecciones como el Zika y la Chikungunya, transmitidos por el mismo vector (Aedes Aegypti), así también como las Infecciones Respiratorias Agudas (IRAs) y Enfermedades Diarreicas Agudas (EDAs).

Por otro lado, el 6,7% manifestaron no saber al respecto, incluso después de haber afirmado haber escuchado la palabra cambio climático, lo cual puede deberse a la "deseabilidad social", de manera que los entrevistados modelan sus respuestas en función de lo que se consideran socialmente conveniente o normal, o en función de lo que perciben que busca el encuestador con sus preguntas [35].

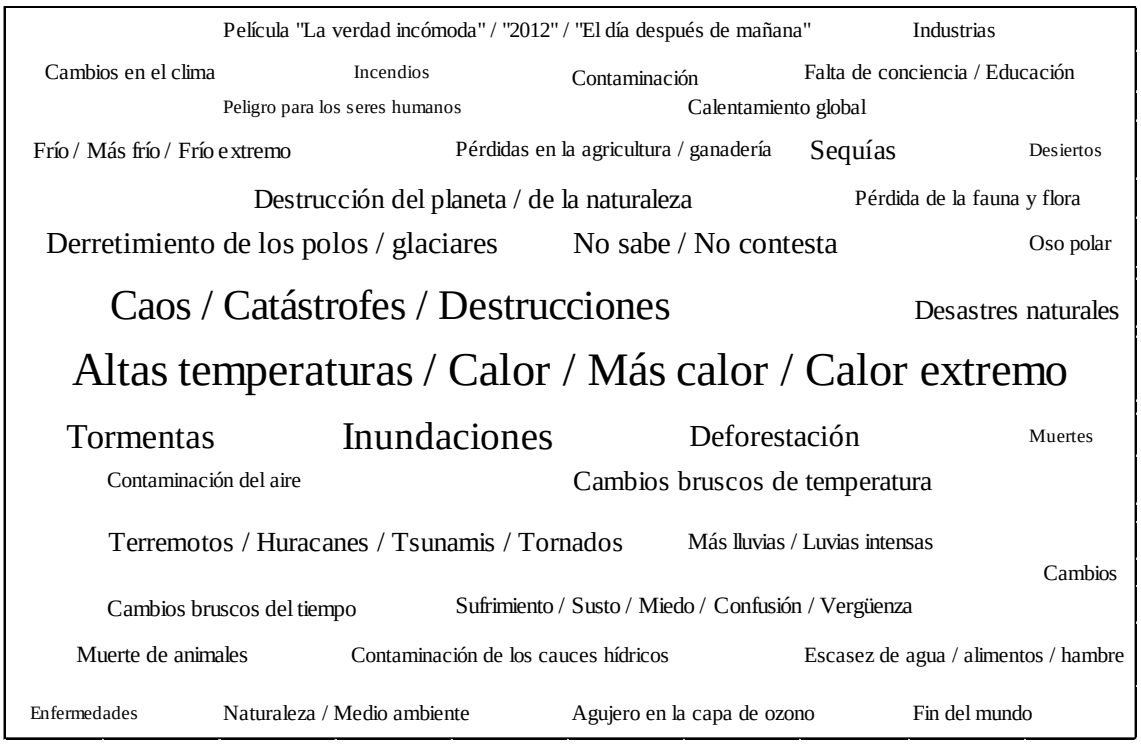


Figura 11: Recurrencia de Palabras, Frases o Imágenes Asociadas con el Cambio Climático

Analizando el pensamiento asociativo según las subpoblaciones, la zona no inundable asocia en mayor medida con el *aumento de temperatura*, que en la zona inundable (Tabla 4). No existió una mayor tendencia a asociar a las *inundaciones* con el cambio climático en la zona inundable, sin embargo, fueron más propensos a asociar con fenómenos como *catástrofes, tormentas, destrucciones de planeta*, así también, asociaron en mayor porcentaje *más lluvias / luvias intensas*que en la zona no inundable.

Tabla 4: Principales Asociaciones con el Cambio Climático Mencionados

Asociaciones con el cambio climático más mencionadas	Zona		Total
	Inundable	No inundable	
Altas temperaturas / Calor / Más calor / Calor extremo	13,6%	19,0%	17,4%
Caos / Catástrofes / Destrucciones	13,6%	12,1%	16,8%
Inundaciones	10,1%	10,1%	10,1%
Tormentas	8,6%	7,1%	7,5%
No sabe / No contesta	6,5%	6,8%	6,7%
Derretimiento de los polos / glaciares	5,0%	7,1%	6,3%
Deforestación	4,3%	6,5%	5,9%
Destrucción del planeta / de la naturaleza	6,5%	4,7%	5,2%
Contaminación en general	5,0%	4,7%	4,8%
Sequías	4,3%	4,1%	4,2%
Terremotos / Huracanes / Tsunamis / Tornados	5,0%	3,8%	4,2%
Frío / Más frío / Frío extremo	2,8%	3,8%	3,6%
Más lluvias / Luvias intensas	6,5%	2,4%	3,6%

ii. *Cercanía Percibida de los Impactos*

Para conocer en qué medida la población de Asunción reconoce la realidad del cambio climático, se ha pedido a las personas encuestadas su opinión sobre si está ocurriendo, si ocurrirá en los próximos años (rango 10 a 100 años) o nunca. Los resultados obtenidos indican que la mayoría percibe que el cambio climático ya está ocurriendo en el país (88,3%) (Figura 12), este resultado fue similar con los obtenidos en otras investigaciones, en España el 90,1% [30] en Costa Rica el 90,3% [17], y en Chile el 86,6%[51] afirman que el cambio climático está ocurriendo, sin embargo, otros estudios muestran más escepticismo al respecto, en Estados Unidos entre el 50% y 66% [29, 41] y en Australia el 63% señalan que el cambio climático está sucediendo[40]. Por otro lado, el 10,3% de la población en estudio indicó que entre 10 años o más de 50 años este fenómeno empezará a afectar a la población.

Teniendo en cuenta la subpoblación, en la zona no inundable, el 89,9% afirmó que el cambio climático está afectando al país y en menor proporción en la zona inundable, con el 84,2%.

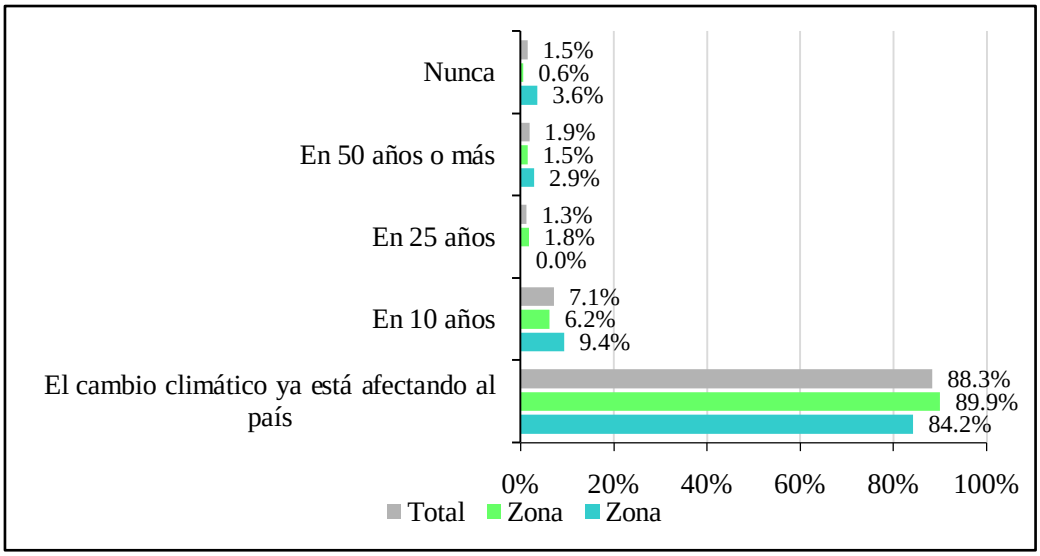


Figura 12: Percepción Acerca de la Ocurrencia del Cambio Climático

Con la intención de comprobar si en la población asuncena se reproduce el distanciamiento subjetivo ante los riesgos que implica el cambio climático que se detecta de forma sistemática y reiterada en estudios realizados sobre otras sociedades y, de ser así, en qué grado se produce y qué componentes o dimensiones presenta. La literatura científica muestra un alto grado de consenso al respecto [9, 11, 12, 14, 17, 30, 40, 41]. En esta línea, distinguen cuatro variaciones básicas en la expresión de este distanciamiento subjetivo[6]:

- Un alejamiento espacial o geográfico del potencial de amenaza: la población percibe que los riesgos climáticos son o serán mayores para quienes viven en otros territorios, lejanos y caracterizados por un menor nivel de desarrollo; el cambio climático es contemplado como una amenaza global, cuyas consecuencias ubicuas son difíciles de vincular con el territorio concreto que se habita.
- Un aplazamiento en el tiempo: se cree que serán más vulnerables quienes vivan en un futuro más bien a largo plazo.
- Un desapego social: son o serán otras personas, otros grupos sociales u otras comunidades las que padecerán en mayor grado las consecuencias.
- La incertidumbre social que se expresa en las dudas persistentes sobre la existencia real del cambio climático.

Se les consultó sobre cuán preocupados estaban sobre los impactos del cambio climático en los diferentes niveles de cercanía considerando además a los recursos naturales (Figuras 13).

Si se contemplan los niveles de cercanía como *usted, su familia ysu comunidad, la población mundial, las futuras generaciones y los recursos naturales,* considerando el grado de preocupación *mucho* y *medianamente*, los resultados confirman y refuerzan los patrones de distanciamiento subjetivo espacial, temporal y social (Figura 13). Por lo tanto, la preocupación por el cambio climático parece estar impulsado principalmente por la percepción de peligro para las personas distantes geográfica y temporalmente[9, 11].

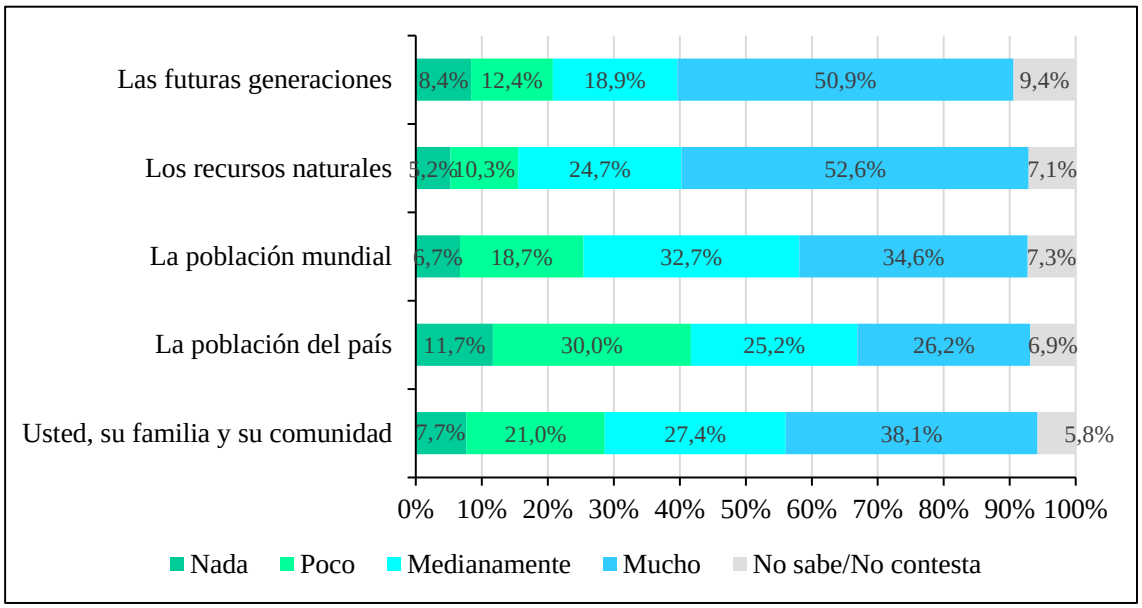


Figura 13: Preocupación por los Impactos del Cambio Climático Considerando los Diferentes Niveles de Cercanía y los Recursos Naturales

Considerando las subpoblaciones, teniendo en cuenta*usted y su familia*en la zona inundable manifestaron en su mayoría estar más preocupada por los impactos del cambio climático (μ=3,4), mientras que en la zona no inundable fue menor la preocupación (μ=3,2). Esta diferencia podría deberse por la mayor exposición y vulnerabilidad a los riesgos de los eventos meteorológicos extremos por parte de los encuestados en la zona inundable. Probablemente las personas que tienen experiencia directa con fenómenos que puedan estar relacionados con el cambio climático probablemente se preocuparán más por el problema[6].

d) Preocupación Ante el Cambio Climático

El 77,5% de la población encuestada señaló estar *muy preocupada* (39,3%) y *preocupada* (38,2%) por el cambio climático (Figura 14). Estos resultados fueron levemente inferiores que en Chile (80%)[51], y en Costa Rica (86%) [17], donde indicaron en mayor porcentaje de la población preocupación por el cambio climático. Sin embargo, en menor medida, el 58% del público estadounidense indicó estar preocupada al respecto [41].

Considerando las subpoblaciones, se hallaron diferencias, el 81,2% de la zona inundable señaló estar

muy preocupada (44,9%) y *preocupada* (36,2%) y en menor porcentaje la zona no inundable con el 76% indicó estar *muy preocupada* (37%) y *preocupada* (39,1%). Estos resultados coinciden con los obtenidos en el Reino Unido, donde aquellos que informaron experiencias de inundaciones expresaron más preocupación por el cambio climático[6]. Al respecto, los autores señalan que los eventos localmente relevantes, como las inundaciones, presentan oportunidades significativas para involucrar a las personas con el cambio climático, aumentar la preocupación y estimular la acción.

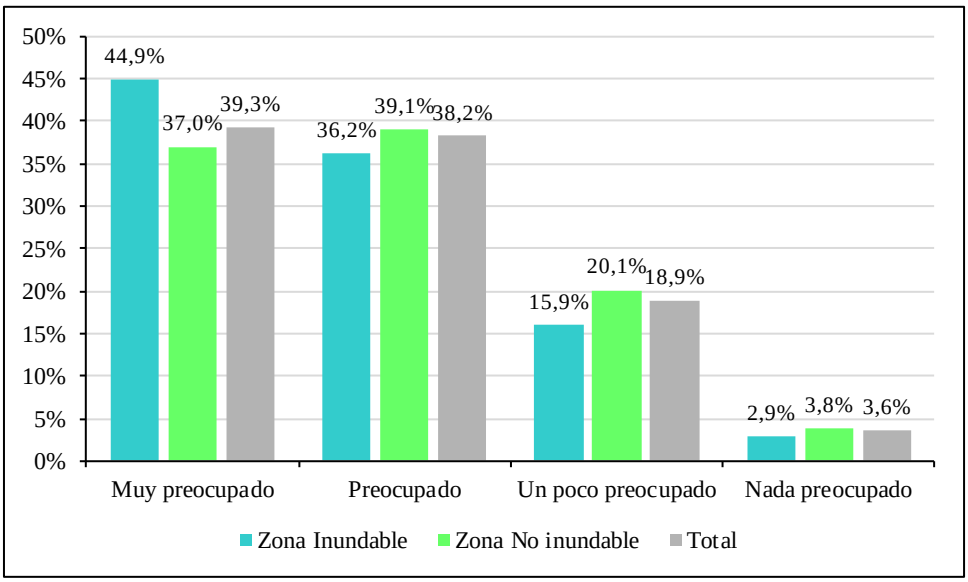


Figura 14: Preocupación por el Cambio Climático por Zonas

Por otro parte, considerando el grado de preocupación por el cambio climático con relación a la educación formal, en general existe una mayor preocupación cuanto más alto nivel educativo se posee, el 79,5% de las personas que reconocieron estar *muy preocupada* y *preocupada* tienen educación universitaria, seguido de educación secundaria (78,5%), educación primaria (74,5%). Quienes en mayor medida expresaron estar *nada preocupado* por el cambio climático fueron con educación primaria (6,4%).

e) *Prioridad del Cambio Climático en Relación Con Otros Temas*

Para analizar la presencia del cambio climático en la percepción de las personas, se les consultócuáles eran, a su parecer, los tres temas más importantes por discutir en el país de una lista predeterminada de siete temas (Figura 29).

Indicaronla *educación* (74,4%), la *salud* (73%), la *seguridad ciudadana* (58,1%) y *empleo* (45,7%) como los principales temas más a discutir en el país, sin embargo, el*cambio climático* ocupó el quinto lugar (21,8%).

Las cuestiones como la economía, la educación, la atención a la salud y ambientales(por ejemplo, aire limpio, agua limpia, expansión urbana), se entienden más fácilmente como de relevancia local directa, debido a que el cambio climático global aún no se percibe como una preocupación local significativa[9, 11]. Aunque los asuntos ambientales sean identificados y evaluados en el dominio de la ciencia, es necesario que esta información se incorpore al sentido común para que sean asumidos como tales[36].

Esta jerarquización se encuentra en función de las necesidades socioeconómicas de la gente [52], que le otorga mayor valor subjetivo a aquello de lo que más carece o cree carecer[53]. La forma de atender las necesidades es también una construcción social: depende del contexto social, cultural e histórico donde ocurre, así como de las condiciones biogeográficas existentes [36].

Considerando las subpoblaciones, en la zona no inundable la población encuestada consideró más importante la *educación* (77,8%) y la salud (74,4%). Sin embargo, en la zona inundable consideraron más relevante la *seguridad ciudadana* (59%) y el *empleo* (54%). El *cambio climático* fue más importante en la zona inundable (24,5%) que en la zona no inundable (20,7%)(Figura 15). Por otro lado, cabe destacar que en la zona inundable donde existe un mayor riesgo y vulnerabilidad a los impactos de los cambios climáticos, solo el 5% señaló la *atención de emergencias* y, en mayor proporción en la zona no inundable.

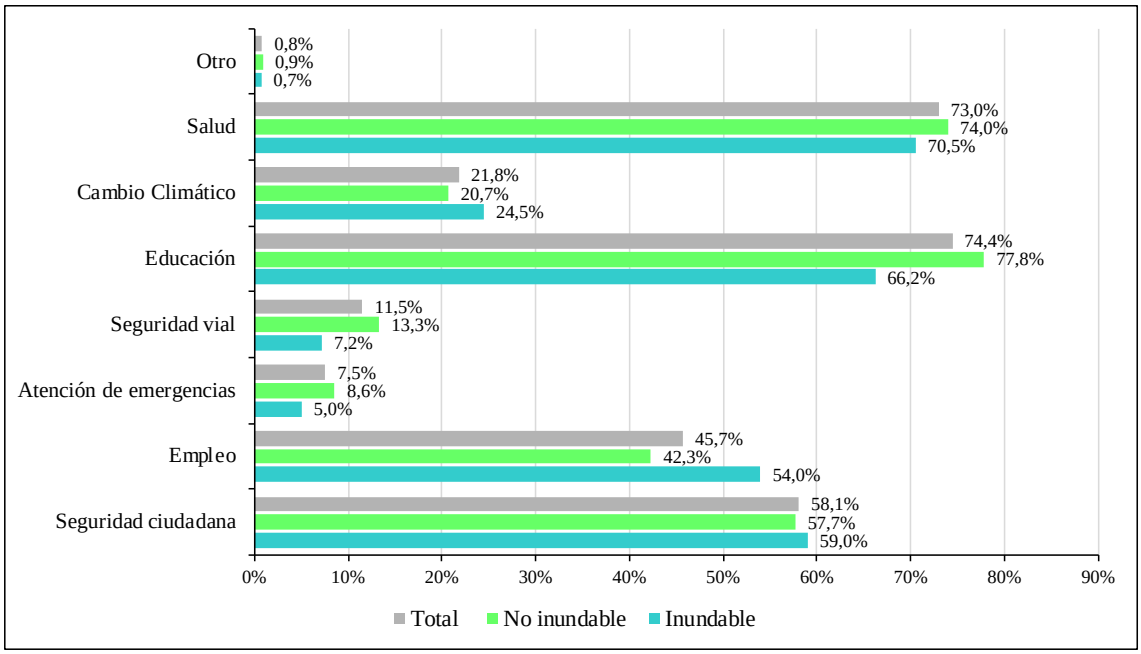


Figura 15: Principales temas por discutir en el país

f) Responsabilidad Frente al Cambio Climático

La población asuncena considera al *Gobierno* y a la *ciudadanía* como los principales actores para accionar frente al cambio climático (Figura 16). Estos resultados coinciden con los obtenidos en otras sociedades, por ejemplo, en Costa Rica [17] y en Australia [40], sin embargo, en España[30] señalaron las grandes industrias luego al gobierno.

Alrededor de ocho de cada diez encuestados (79,7%) respondieron *la ciudadanía,* ocupando la segunda posición con respecto al grado de responsabilidad que la población asuncena le atribuye en las soluciones al cambio climático. Esta posición puede denotar una actitud optimista sobre la capacidad o la posibilidad real que tienen las personas para actuar efectivamente en la articulación y aplicación de soluciones a los riesgos que implica la alteración climática.

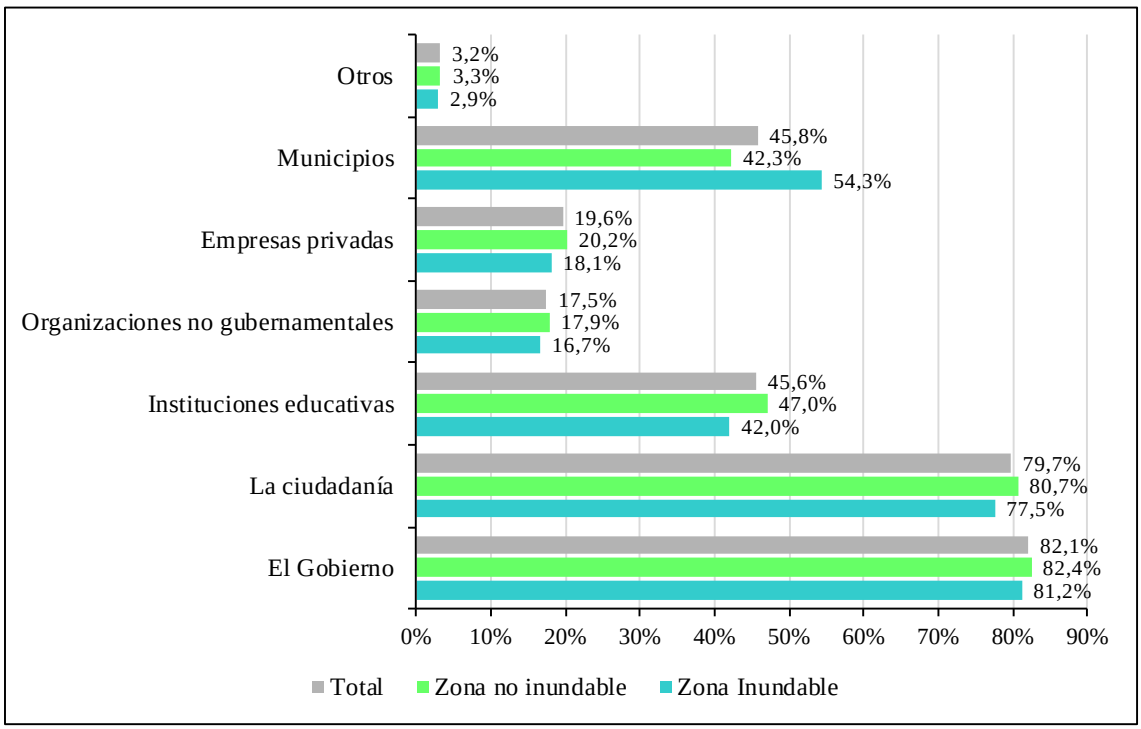


Figura 16: Sectores de la sociedad que deben aplicar estrategias en la lucha contra el cambio climático

El 91,2% de la población encuestada manifestó estar *muy dispuesta* (61,2%) y *medianamente dispuesta* (30,2%) a modificar sus comportamientos y hábitos de consumo para contrarrestar los efectos del cambio climático (Figura 17). Estos resultados fueron superiores a los obtenidos en México, donde el 77% señalaron estar dispuestos a cambiar sus comportamientos y hábitos de consumo para contrarrestar el cambio climático y sus efectos[14].

Por otro lado, considerando las subpoblaciones, el 61,2% de la zona inundable están *muy dispuestos* y en menor porcentaje la zona no inundable (55,6%). Es probable que los que experimentaron inundaciones manifestaron estar más preocupados por el cambio climático, sino que también perciben que cambiado sus comportamientos pueden ayudar a reducir los efectos del cambio climático[6].

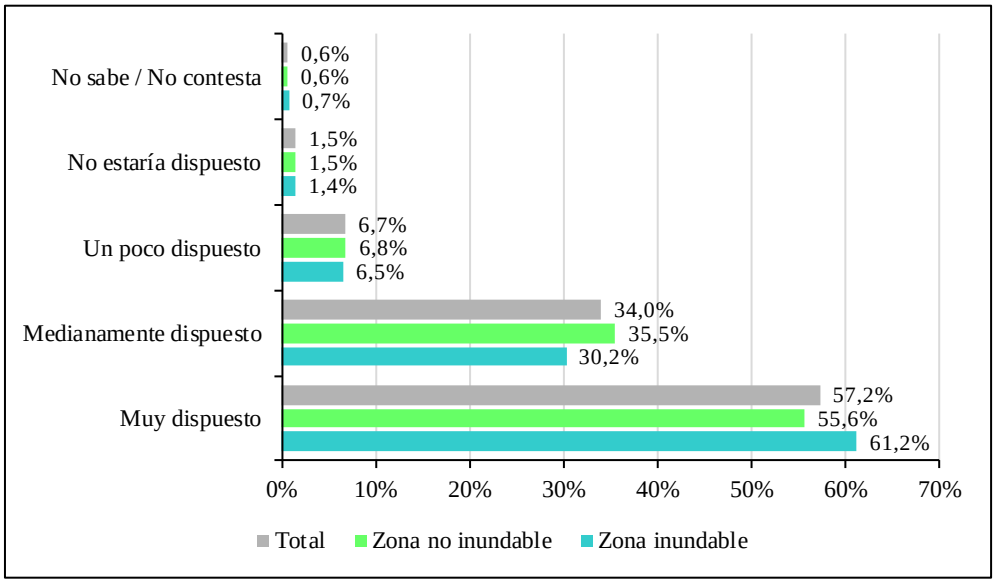


Figura 17: Disposición a modificar los comportamientos y hábitos de consumo para contrarrestar los efectos del cambio climático

Cerca del 26,8% piensa que *los seres humanos podemos reducir el cambio climático, y lo haremos con éxito* (Figura 17). El 39,2% de la población señaló que *los seres humanos podríamos reducir el cambio climático, pero no está claro si haremos lo que sea necesario*.

A pesar de la aceptación de la problemática de cambio climático, un cuarto de la población encuestada (25,4%) expresaron su pesimismo al respecto indicando que *los seres humanos no podremos reducir el cambio climático, debido a que las personas no están dispuestas a cambiar su comportamiento*. El 5,5% manifestó que *los seres humanos no pueden reducir el cambio climático, incluso si está sucediendo.*

También se encontraron comentarios negativos o de rechazo tales como “el cambio climático no está sucediendo”. Las barreras que intervienen en la opinión de las personas, a saber: escepticismo, desconfianza, fatalismo y falta de conocimiento[11].

En relación con las subpoblaciones, la zona no inundable es más optimista (29,3%) que la zona inundable (20,9%).

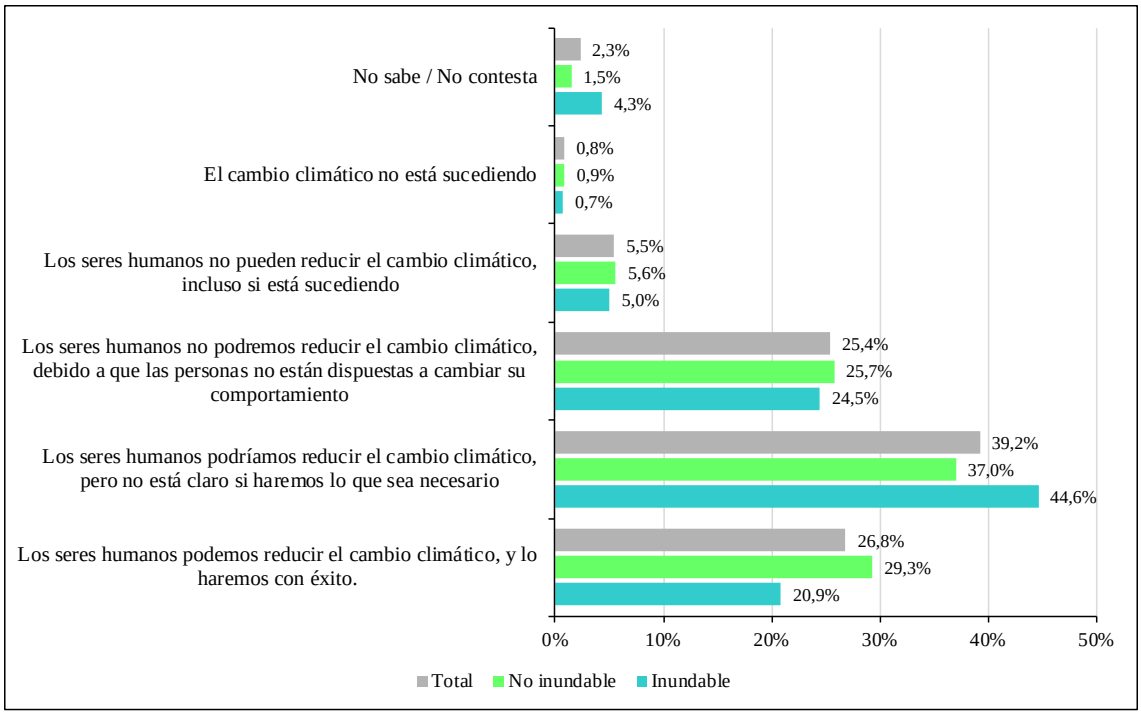


Figura 18: Optimismo acerca de la reducción del cambio climático

IV. Conclusiones

La percepción de la población asuncena sobre el aumento de la temperatura del aire y de la precipitación, están en relación con las tendencias positivas observadas en la región y se enmarcan dentro del cambio climático que se ha estado manifestando a nivel regional y global.

Los resultados obtenidos en la presente investigación señalan que tres de cada diez asuncenos no han escuchado sobre el cambio climático o que el clima está cambiando con respecto al pasado, revelando una menor proporción con respecto a otras investigaciones. Considerando las subpoblaciones, existe un mayor desconocimiento en la zona inundable. Probablemente las difusiones o comunicaciones sobre cambio climático siguen siendo de escasa cobertura a nivel nacional, principalmente en las zonas más afectadas.

Teniendo en cuenta los datos sociodemográficos, como la edad y el nivel de estudios, son indicadores que revelaron el grado de conocimiento que refiere al cambio climático. Quienes afirmaron haber escuchado sobre el cambio climático fueron en mayor medida los que tienen mayor nivel de estudios y manifestaron mayor preocupación por el cambio climático, por otro lado, la población más joven desconoce en mayor proporción sobre el tema y expresaron menor preocupación sobre el tema.

Existe una confusión de la población asuncena al momento de interpretar clima y tiempo atmosférico, la inadecuada interpretación de estos conceptos dificulta la comprensión sobre el cambio climático, sobre las causas e impactos y los riesgos que representan.

Con respecto a las causas del cambio climático, alrededor de nueve de cada diez afirmaron a las actividades humanas, siendo la causa más nombrada por la población asuncena la deforestación.

En general, la población asuncena expresó un sentido de importancia general sobre el tema (posicionándolo por encima de atención a emergencias) pero no se ha observado un sentido de urgencia, dada la tendencia de las personas a manifestar su preocupación y apoyo por la mayoría de los temas presentados en las encuestas.

La mayoría percibe que el cambio climático ya está ocurriendo en el país (alrededor de nueve de cada diez), sin embargo, si se contemplan los niveles de cercanía los resultados confirman y refuerzan los patrones de distanciamiento subjetivo espacial, temporal y social, la preocupación por el cambio climático parece estar impulsado principalmente por la percepción de peligro para las personas distantes geográfica y temporalmente. Esto dificulta la posibilidad de adoptar medidas de adaptación o mitigación por parte de la población asuncena.

Aunque el cambio climático no está bien comprendido por la población asuncena, es probable que la preocupación se traduzca en mayor disposición de cambiar sus hábitos de consumo.

A pesar de que la zona inundable señaló en mayor proporción no haber escuchado sobre el cambio climático, mayor confusión sobre los conceptos generales sobre clima, tiempo atmosférico, causas e

impactos del cambio climático, sin embargo, indicaron necesitar mayor información sobre el cambio climático, señalaron en mayor porcentaje como tema principal a discutir en el país, expresaron mayor preocupación ante el cambio climático y mayor disponibilidad de modificar sus comportamientos y hábitos de consumo para contrarrestar los efectos del cambio climático. Como señalan varias investigaciones, quienes tienen experiencia directa con eventos locales, manifiestan estar más preocupados por el cambio climático y perciben que cambiando sus comportamientos pueden ayudar a reducir los efectos del cambio climático, destacar los vínculos entre los eventos locales y el cambio climático, presentan oportunidades significativas para involucrar a las personas con el cambio climático, aumentar la preocupación y estimular la acción[6, 24].

Probablemente existe una mayor comprensión o información sobre los impactos del cambio climático y desconocimiento de las causas, así como una errada adjudicación de responsabilidad de estas o de las soluciones, llevando a la población asuncena a expresar mayor "peso emocional" a los impactos por las amenazas que implican, atenuando la imagen de "afectado" antes que responsable causal limitando su participación en la resolución de los problemas [30]. Cuatro de cada diez personas señalaron confusión ante las acciones necesarias para reducir el cambio climático, tres de cada diez personas fueron pesimistas, indicando que no podremos reducir el cambio climático debido a que no estamos dispuestos a cambiar nuestros comportamientos e incluso que no podremos reducir el cambio climático. Al juzgarse menos responsables obstaculiza la posibilidad de que se involucren en acciones de mitigación y adaptación.

A pesar de que las imágenes asociativas evocaron un efecto negativo, principalmente en los impactos del cambio climático (55,5%), sin embargo, un bajo porcentaje relacionó con los impactos en la salud (1,3%), muy pocas personas asociaron el cambio climático con sus causas (15%) y no hubo vinculaciones con las soluciones. El primer paso para afrontar el reto del cambio climático es entenderlo. Probablemente, diseñar estrategias de comunicación, que reflejen las causas del cambio climático, así como el consenso de los expertos y adopción de hábitos con información acerca de su efectividad, vinculando con el ahorro de dinero y la protección ambiental, podrían alentar a la población a participar en reducir sus emisiones de carbono para contribuir a la lucha contra el cambio climático.

La línea de investigación sobre las percepciones de la sociedad asuncena sobre los riesgos del cambio climático no es simplemente conocer lo que piensan, sienten y creen, sino que es el punto de partida para diseñar eficientes programas de comunicaciones destinadas a aumentar el compromiso con el tema [12, 14] en cumplimiento con el artículo 6 de la Convención Marco de las Naciones Unidas sobre el Cambio Climático "educación, formación y sensibilización del público". Si se vinculan las asociaciones negativas del cambio climático con los impactos locales y con soluciones personales que permitan relacionarlos con esos impactos, estos podrían ejercer una influencia positiva significativa en las acciones de las personas.

El análisis de las percepciones sobre el cambio climático expuestas en la presente investigación aspira a generar líneas de conocimiento y poder contribuir a la formulación y diseño de políticas públicas sectoriales y transversales, a diseñar estrategias de comunicación más eficaces y a colaborar en la elaboración de medidas para contrarrestar el cambio climático a nivel local.

Conflicto de Interés

El autor declara no tener conflicto de interés.

References Références Referencias

1. IPCC, Intergovernamental Panel On Climate. Resumen para responsables de políticas. Cambio Climático 2013: Bases físicas. Contribución del Grupo de trabajo I al Quinto Informe de Evaluación del Grupo Intergubernamental de Expertos sobre el Cambio Climático. Stocker, TF, D. Qin, G.-K. Plattner, M. Tignor, SK Allen, J. Boschung, A. Nauels, Y. Xia, V. Bex y PM Midgley (eds.)]. Cambridge University Press, Cambridge, Reino Unido y Nueva York, NY, Estados Unidos de América. Disponível em: http://www. ipcc. ch/pdf/assessment-report/ar5/wg1/WG1AR5_SPM_ brochure_es. pdf. Acesso em, 2013, vol. 21.
2. Barros, V. R., y Camilloni, I. A. La Argentina y el cambio climático. De la física a la política. Editorial: EUDEBA; 2016. 286p.
3. Olmos, E., González, M. E., & Contreras, M. R. Percepción de la población frente al cambio climático en áreas naturales protegidas de Baja California Sur, México. Revista Latinoamericana; 2013. 12(35): 459 – 481.
4. Soares, D., y Gutiérrez, I. Vulnerabilidad social, institucionalidad y percepciones sobre el cambio climático: un acercamiento al municipio de San Felipe, Costa de Yucatán. Ciencia Ergo Sum; 2011. 18(3): 249 – 263.
5. CLIMATICO, S. E. C. Convención Marco de las Naciones Unidas sobre el Cambio Climático; 1992.
6. Spence, A., Poortinga, W., Butler, C. & Pidgeon, N. S. Perceptions of climate change and willingness to save energy related to flood experience. Nature Climate Change; 2011. 1, 46 – 49.
7. Capstick, S. B., & Pidgeon, N. F. What is climate change scepticism? Examination of the concept

using a mixed methods study of the UK public. Global Environmental Change; 2014. 24, 389-401.
8. Bord, R. J., Fisher, A., & O'Connor, R. E. Public perceptions of global warming: United States and international perspectives. Climate Research; 1998. 11, 75–84.
9. Leiserowitz, A. A. American risk perceptions: Is climate change dangerous? Risk Analysis: An International Journal; 2005. 25(6), 1433-1442.
10. Whitmarsh, L. "Are flood victims more concerned about climate change than other people? The rol of direct risk perception and behavioral response". En Journal of Risk Research; 2008. 11 (3):351-374.
11. Leiserowitz, A. A. Climate change risk perception and policy preferences: The role of affect, imagery, and values. Climatic change; 2006. 77(1), 45-72.
12. Lorenzoni, I., Leiserowitz, A., de Franca Doria, M., Poortinga, W., & Pidgeon, N. F. Cross-national comparisons of image associations with "global warming" and "climate change" among laypeople in the United States of America and Great Britain. Journal of risk Research; 2006. 9(03), 265-281.
13. Akerlof, K., Maibach, E. W., Fitzgerald, D., Cedeno, A. Y., & Neuman, A. Do people "personally experience" global warming, and if so how, does it matter? Global Environmental Change; 2013. 23(1): 81 – 91.
14. Urbina, S. J. La percepción social del cambio climático en el ámbito urbano. En Ortiz, B. (coord.). La percepción social del cambio climático. San Andrés Cholula, Puebla: Universidad Iberoamericana; 2012. 21 – 38.
15. López, C., Chávez, R., Davydova, V. y Cornejo, J. L. Percepción de la población costera de Jalisco, México, sobre el cambio climático. Memorias; 2015. 13(23): 81 – 91.
16. Retamal, M. R., Rojas, J. y Parra, O. Percepción al cambio climático y a la gestión del agua: aportes de las estrategias metodológicas cualitativas para su comprensión. Ambiente & Sociedade; 2011. 14(1): 175 – 194.
17. Vignola, R., Otárola, M., y Moser, C. Estudio de la percepción y actitudes de la población costarricense sobre Cambio Climático. Informe para Programa de Naciones Unidas para el Desarrollo de Costa Rica. CATIE; 2010. 64 p.
18. Salas, D. Percepción del cambio climático por una comunidad ganadera en los humedales del sur del Paraguay. Estrategias integradas de mitigación y adaptación a cambios globales; 2009. 141-145.
19. Breuer, N. E., Oreggioni, F., y Báez, J. Percepción y observación de las variaciones en el régimen pluviométrico en Itapúa y Alto Paraná. Paraquaria Natural; 2017. 5(2): 37 – 44.
20. CAF, Banco de Desarrollo de América Latina. Índice de vulnerabilidad y adaptación al cambio climático en la región de América Latina y el Caribe. Caracas: CAF; 2014. Recuperado de http://scioteca.caf.com/handle/123456789/517.
21. Causarano, M. Dinámicas metropolitanas en Asunción, Ciudad del Este y Encarnación. Asunción: UNFPA/ADEPO; 2006. 321.
22. Domecq, R. G.; Baez, J.; Ávila, J.L. Las inundaciones en Paraguay. Revista de la Facultad de Ciencias y Tecnologías. Universidad Católica de Asunción. N°7 – Marzo, 2016. ISSN 2410-0021.
23. Brody, S. D., Zahran, S., Vedlitz, A. & Grover, H. Examining the relationshipbetween physical vulnerability and public perceptions of global climate changein the United States. Environ. Behav. 2008. 41, 72-95.
24. Weber, E. U. Experience-based and description-based perceptions of long-term risk: why global warming does not scare us (yet). Climatic Change; 2006. 77, 103–120.
25. DGEEC, Instituto Nacional de Estadística. Atlas demográfico del Paraguay, 2012. Fernando de la Mora, Paraguay; 2016. 133 págs.
26. Hernández-Sampieri, R., Fernández-Collado, C. y Baptista-Lucio, P. Selección de la muestra. En Metodología de la Investigación (6ª ed., pp. 170-191). México: McGraw-Hill. 2014.
27. Siegel A. "Statistics and Data Analysis". NewYork: John Wiley & Sons. 1988.
28. Cochran, W. G. Sampling Techniques. 3rd Edition, John Wiley & Sons, New York. 1977.
29. Nisbet, M. C., & Myers, T. The polls—trends: Twenty years of public opinion about global warming. Public Opinion Quarterly; 2007. 71(3), 444–470.
30. Meira, P.A.; Arto, M.; Heras, F.; Iglesias, L., Lorenzo, J.J. y Montero, P. La respuesta de la sociedad española ante el cambio climático. 2013. Madrid: Fundación Mapfre.
31. Wallace, J. M. 1., & Hobbs, P. V. Atmospheric science: an introductory survey. 2nd ed. Amsterdam; Boston, Elsevier Academic Press. 2006.
32. IPCC, Intergovernamental Panel On Climate. Resumen para responsables de políticas. Cambio climático 2014: Impactos, adaptación y vulnerabilidad. Resúmenes, preguntas frecuentes y recuadros multicapítulos. Contribución del Grupo de trabajo II al Quinto Informe de Evaluación del Grupo Intergubernamental de Expertos sobre el Cambio Climático [Field, C.B., V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea y L.L. White (eds.)]. Organización Meteorológica Mundial, Ginebra (Suiza); 2014. 200 p.

33. WMO, World Meteorological Organization. WMO Guidelines on the Calculation of Climate Normals. 2017.
34. Slovic, P.; Finucane, M. L.; Peters, E. & MacGregor, D. G. Risk as analysis and risk as feelings: Some thoughts about affect, reason, risk, and rationality. Risk Analysis; 2004. 24 (2), 311–322.
35. Meira, P. A.; Arto, M.; y Montero, P. La sociedad ante el cambio climático. Conocimiento, valoraciones y comportamientos en la población española; 2009. Madrid: Fundación Mapfre.
36. González Gaudiano, E. J. La Representación Social del Cambio Climático. Una revisión internacional. Revista Mexicana de Investigación Educativa; 2012. 17(55),1035-1062. ISSN: 1405-6666.
37. IDEAM, Instituto de Hidrología, Meteorología y Estudios Ambientales. ¿Qué piensan los colombianos sobre el cambio climático? Primera encuesta nacional de percepción pública del cambio climático en Colombia. ISBN Bogotá D.C., Colombia. 2016.
38. FAO, Food and Agriculture Organization. América Latina, la región que ha perdido la mayor superficie de bosques en el mundo. 2014. Recuperado de: https://www.fao.org/in-action/agronoticias/detail/en/c/497495/.
39. Ungar, S. Knowledge, ignorance and the popular culture: climate change versus the ozone hole. Public Understanding of Science; 2000. 9(3), 297-312.
40. Ashworth, P., Jeanneret, T., Gardner, J. & Shaw, H. Communication and climate change: What the Australian public thinks. CSIRO: EP112769. 2011.
41. Howe, P. D., Mildenberger, M., Marlon, J. R., & Leiserowitz, A. Geographic variation in opinions on climate change at state and local scales in the USA. Nature climate change; 2015. 5(6), 596-603.
42. Slovic, P. Trust, emotion, sex, politics, and science: Surveying the risk-assessment battlefield. In: M. Bazerman, D. Messick, A. Tenbrunsel, and K. Wade-Benzoni (eds.), Psychological Perspectives to Environmental and Ethical Issues in Management. San Francisco, CA: Jossey-Bass. 1997.277–313
43. Novión, C., Estrada, C. Percepción de los efectos vivenciales del cambio climático en una muestra de habitantes urbanos australes. Magallania (Punta Arenas); 2011. 39 (1), 93-102.
44. Cook, J., Oreskes, N., Doran, P. T., Anderegg, W. R. L., Verheggen, B., Maibach, E. W., & Green, S. A. Consensus on consensus: A synthesis of consensus estimates on human-caused global warming. Environmental Research Letters; 2016. 11, 048002.
45. Hinz, Franziska. Joint science academies statement: Global response to climate change. 2005.
46. Ding D, Maibach E W, Zhao X, Roser-Renouf C and Leiserowitz A. Support for climate policy and societal action are linked to perceptions about scientific agreement Nature ClimateChange; 2011.1(9), 462-466.
47. Slovic, P., Monahan, J., & MacGregor, D. M. Violence risk assessment and risk communication: The effects of using actual cases, providing instructions, and employing probability vs. frequency formats. Law and Human Behavior; 2000. 24(3), 271– 296.
48. Patz, J. A., Campbell-Lendrum, D., Holloway, T., & Foley, J. A. Impact of regional climate change on human health. Nature; 2005. 438(7066), 310-317.
49. SEAM, Secretaría del Ambiente. Segunda Comunicación Nacional a la Convención Marco de las Naciones Unidas sobre Cambio Climático, Oficina Nacional de Cambio Climático. Asunción, Paraguay: SEAM. 2011.
50. SEAM, Secretaría del Ambiente. Tercera Comunicación Nacional de Paraguay a la Convención Marco de las Naciones Unidas sobre el Cambio Climático, Oficina Nacional de Cambio Climático. Proyecto TCN e IBA. Asunción, Paraguay: SEAM; 2017. 112.
51. Sapiains, R. Percepciones del cambio climático en la población chilena: Implicancias para la política pública. 2016.
52. Maslow, A.K. Motivation and personality, Nueva York: Harper Row. 1954.
53. Inglehart, R. Culture shift in advanced industrial society, New Jersey: Princeton University Press. 1990

This page is intentionally left blank

Global Journal of Science Frontier Research: H
Environment & Earth Science
Volume 24 Issue 1 Version 1.0 Year 2024
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

ISO 14001 Environmental Standard: Process Approach and Identification of Environmental Aspects and Impacts

By Hanane El Fadel, Mohammed Merzouki & Mohamed Benlemlih

University of Sidi Mohamed Ben Abdella

Abstract- Environmental management is the management of activities that may have an impact on the environment [1]. It aims to limit polluting emissions and risks to the environment and to save natural resources [2]. Often unsuspected and therefore without us always realizing it, all economic activities can have a considerable impact on the environment [3]. Indeed, the manufacture of products requires the extraction of raw materials and the use of water and energy [4]. Similarly, activities associated with the manufacturing process, such as maintenance, transportation; all have environmental impacts [5]. The environmental management system is a progress tool that integrates the environmental dimension into an organization's strategy, leading it to set objectives, achieve and maintain performance through effective management and promotes anticipation (the forecast).

GJSFR-H Classification: *LCC Code: GE1-350*

Strictly as per the compliance and regulations of:

ISO 14001 Environmental Standard: Process Approach and Identification of Environmental Aspects and Impacts

Hanane El Fadel [α], Mohammed Merzouki [σ] & Mohamed Benlemlih [ρ]

Abstract- Environmental management is the management of activities that may have an impact on the environment [1]. It aims to limit polluting emissions and risks to the environment and to save natural resources [2]. Often unsuspected and therefore without us always realizing it, all economic activities can have a considerable impact on the environment [3]. Indeed, the manufacture of products requires the extraction of raw materials and the use of water and energy [4]. Similarly, activities associated with the manufacturing process, such as maintenance, transportation; all have environmental impacts [5]. The environmental management system is a progress tool that integrates the environmental dimension into an organization's strategy, leading it to set objectives, achieve and maintain performance through effective management and promotes anticipation (the forecast).

There is a multitude of guides allowing self-diagnosis by the organization and which make it possible to make an environmental assessment. ISO 14001 is the environmental management standard created by the international organization for standardization [6]. It defines the requirements of a global environmental management system for self-reporting or certification purposes [7]. It is organized in 17 points modeled on quality management, well known for 34 years in the industry. The standard does not establish any absolute requirement for environmental performance, other than a commitment to environmental policy, to comply with legislation and the principle of continuous improvement [8].

Pollution prevention through the identification of the various significant environmental aspects and impacts, which accounted for 70% of the requirements of ISO 14001, is the main environmental improvement point [9]. In addition, since these environmental aspects and impacts can only be identified from the activities, products and services associated with them, this article represents a working method that allows expressing good environmental practices, present in the form of environmental performance indicators that inform in a concentrated and precise manner on the different activities with environmental relevance.

I. Working Methodology

a) General Requirements

The organization must establish and maintain an environmental management system whose requirements are described as follows:

Author α σ ρ: Laboratory of Environmental Biotechnology, Faculty of Sciences Dhar el Mahraz, University of Sidi Mohamed Ben Abdellah, Fez, Morocco. e-mail: elfadelha@gmail.com

i. *Environmental Policy*

Management at the highest level must define their organization's environmental policy.

ii. *Panning*

Environmental Aspects:

The organization must maintain procedures for identifying the environmental aspects of the various activities

General Requirements and other:

The organization must maintain a procedure for identifying the legal and other requirements applied to the environmental aspects of the activities.

Objectives and Targets:

The organization must establish and maintain environmental objectives and targets.

Environnemental Management Program:

To achieve these objectives, the organization must establish and maintain one or more programs.

b) Implementation and Operation

i. *Structure and Responsibility*

The environmental management system requirements are established, implemented and maintained in accordance with this international standard.

ii. *Training, Awareness and Competency*

The staff should be made aware of:

- The importance of compliance with environmental policy and environmental management system requirements;
- With significant environmental impacts;
- Their roles and responsibilities to achieve compliance with environmental policy and requirements;
- Potential consequences of deviations from specified operating procedures.

iii. *Communication*

The organization shall establish and maintain procedures for:

- Ensure internal communication between the different levels and functions of the organization;
- Receive, document and respond to relevant requests from external stakeholders.

iv. *Environmental Management System Documentation*

The organization must establish and maintain paper or electronic information and maintain procedures to control all documents required by the standard:

Operational Proficiency

The organization must identify those of its operations and activities that are associated with significant environmental aspects

Emergency Prevention and Responsiveness

The organization must identify potential accidents and emergency situations and be able to react to reduce the associated environmental impacts.

v. *Control and Corrective Action*

Monitoring and Measurement

The organization must regularly monitor and measure activities that may have a significant environmental impact.

Non-compliance, corrective action and preventive action

The organization must define the responsibilities for the analysis of non-conformities, the taking of measures to reduce potential impacts, as well as to commit and carry out corrective and preventive and corrective actions.

Recordings

The organization must establish and maintain one or more programs and procedures for periodic audits of the environmental management system

vi. *Management Review*

The organization's management must review the environmental management system to ensure that it is still appropriate, sufficient and effective, as well as any changes to elements of the environmental management system.

II. Perform Self-Diagnosis

a) Identification of the Most Significant Environmental Aspects and Impacts of the Various Activities:

Environmental aspect: An element of an organization's activities, products or services that may interact with the environment. An aspect is therefore synonymous with impact factor, the aspect is the source of impacts [10].

Environmental impact: Any change in the environment, negative or beneficial, resulting wholly or partially from the activities, products or services of an organization [11].

From the identified activities, products and services, it is still necessary to identify environmental aspects and the impacts associated with them: It is a question of breaking down the activity to identify any operation that may generate nuisances (processes, equipment that has been part of, raw materials, outgoing products, waste or waste generated, resources, fluids and energy used, maintenance and cleaning work of equipment applied to process equipment, etc.).

The decomposition can be done on different levels, from the most general to the most detailed (workshop, manufacturing process, particular equipment) depending on the need to access or not very precise information. For to be more exhaustive, we can, for each activity, study each environment/ area or each nuisance.

The identification of environmental aspects and impacts is made taking into account the situation of the mode of operation (Table 1): Normal (N) as the situation of transitional operation (T) or the Incident operation (I)

Table 1: Situations of Operating Modes

Note	Normal Operation(N)	Transitional March(T)	Incident Operation(I)
1	The event takes place continuously	The event takes place several times a day	The event takes place several times on the site
2	The event takes place at least 50% of the time	The event takes place at least once a week	The event has already happened once on the site
3	The event takes place between 25 and 50% of the time	The event takes place at least once a month	The event has already occurred on similar sites
4	Event takes place at least 25% of the time	The event takes place at least once a month	The event has no known history

The identification of environmental aspects and impacts allows us to see environmental indicators and propose approaches for each indicator that will help us better understand environmental problems, material flows, personal perception and other environmental data.

b) Assessment of Environmental Aspects and Impacts

The process approach and the identification of Environmental Aspects and Impacts allows us to identify:

- Any operation which may generate nuisances (processes, equipment forming part of them, liquid, solid or gaseous discharges, etc.);
- Sensitive points;
- Type of action to be implemented;
- Skills and information required to master processes.

i. *Assessment of Significant Environmental Impacts*

The assessment of environmental impacts is carried out by taking into account three factors (Table 2): «Gravity», «Frequency of occurrence» and «Sensitivity of the receiving environment» and it has 4 stages:

1. *Intrinsic gravity assessment (G):* This involves determining the severity of the environmental impact. For this, it is important to define beforehand the criteria that will be taken into account in order to carry out this evaluation. Criteria such as: toxicity of products, amount of water or energy consumed… what helps to determine the order of magnitude of impacts, either critical, major, limited or minor;
2. *Frequency of occurrence assessment (F):* this involves determining the frequency of occurrence of the Environmental Impact;
3. *The evaluation of the Sensitivity (S):* the sensitivity of the receiving medium is also determined by characterizing the receiving medium (floor tightness for example);

Table 2: Environmental Impact Assessment

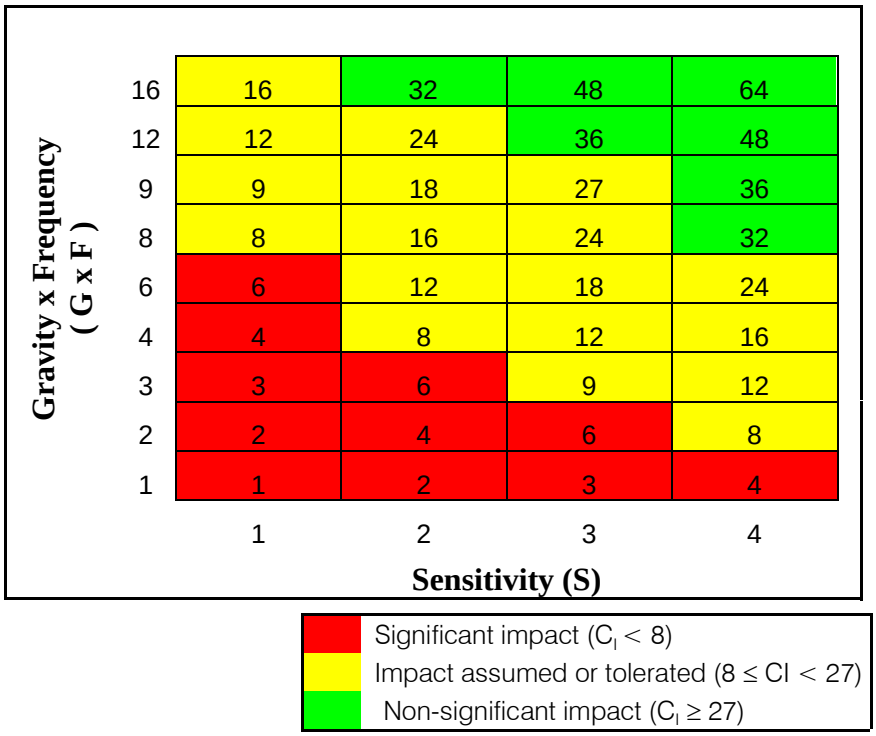
Score/Criterion	Gravity (G)	Frequency (F)	Sensitivity (S)
1	Irreversible damage to living beings (humans, fauna and flora) whether they are internal or external to the organism (critical)	Permanent	Critical
2	Irreversible damage to the environment (major)	Frequent	Important
3	Reversible harm to environment (limited)	occasional	Limited
4	Gene for staff (minor)	Rare	Low

4. Determining the criticality of the environmental impact: Taking into account the previous criteria. This score is obtained by multiplying the elementary scores for each criterion:

$$C_I = G \times F \times S$$

The Table 3 below represents the criticality matrix and determines the significance of the environmental impact:

Table 3: Matrix of Environmental Impact Criticality



ii. *Assessment of Significant Environmental Aspects:*

This part consists of 3 steps, this is to identify 2 other criteria related to the identified environmental aspects:

1. Study of regulatory compliance (C): any aspect not satisfying regulatory constraints and necessarily significant

0	Non-compliant
1	Compliant or non-regulatory

2. Environmental Control Level Assessment (M): Control level is technical, human and organizational. The evaluation must take in to account the principles of prevention

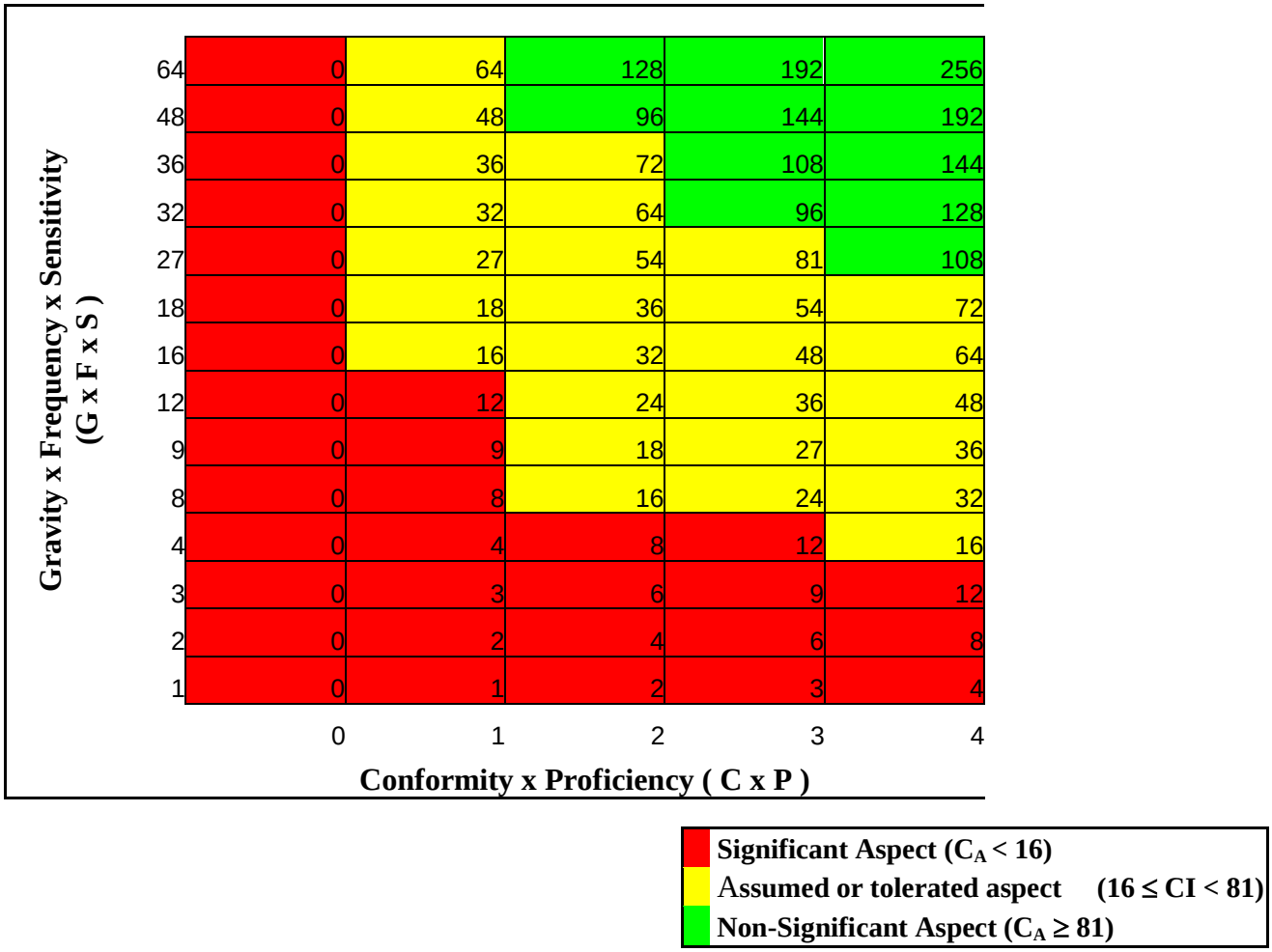
1	Non-existent
2	Low
3	Good
4	maximum

3. Determination of the criticality of the environmental aspect:

$$C_A = C_I \times C \times M$$

The Table 4 represents the criticality matrix and determines the significance of the environmental aspect:

Table 4: Matrix of Environmental Criticality



III. Conclusion

The ISO 14001 standard is the most suitable and appropriate environmental management system for its application, given its commitments and its proactive aspect that does not require an environmental declaration.

In practice, there is a wide variety of methodologies that make it possible to achieve the environmental objective, some of which are limited to a purely formal approach, while others integrate consultation or worker participation.

The methodology proposed in this work allows an improvement of environmental performance in order to achieve a clearly defined goal, the management and protection of the environment in which the activities take place.

References Références Referencias

1. Sophia Su, Kevin Baird and Thanh Phan. The association between ethical leadership and environmental activity management: The mediating role of employee environmental empowerment. Advances in Accounting. August 2023.
2. Aoxiang Zhang, Rongrong Deng and Yunfeng Wu. Does the green credit policy reduce the carbon emission intensity of heavily polluting industries? - Evidence from China's industrial sectors. Journal of Environmental Management. Volume 311, 1 June 2022.
3. Julian Clifton, Eslam O. Osman, David J. Suggett and David J. Smith. Resolving conservation and development tensions in a small island state: A governance analysis of Curieuse Marine National Park, Seychelles. Marine Policy. Volume 127, May 2021.
4. Lorenzo Rinaldi, Matteo Vincenzo Rocco, Emanuela Colombo. Assessing critical materials demand in global energy transition scenarios based on the Dynamic Extraction and Recycling Input-Output framework (DYNERIO). Resources, Conservation and Recycling. Volume 191, April 2023.
5. Uğur Karadurmuş and Levent Bilgili. Environmental impacts of synthetic fishing nets from manufacturing to disposal: A case study of Türkiye in life cycle perspective. Marine Pollution Bulletin. Volume 198, January 2024.
6. Jesus Valero-Gil a, Jordi A. Surroca b, Josep A. Tribo c, Leopoldo Gutierrez d, Ivan Montiel. Innovation vs. standardization: The conjoint effects of eco-innovation and environmental management systems on environmental performance. Research Policy. Volume 52, Issue 4, May 2023.
7. Hsin-Ju Lin and Hwong-wen Ma. Analysis of green certification standards related to recycled materials involving textiles based on life cycle thinking. Sustainable Production and Consumption Volume 41, October 2023.
8. Joel A. Tickner and Ken Geiser. The precautionary principle stimulus for solutions- and Iternatives-based environmental policy. Environmental Impact Assessment Review. Volume 24, Issues 7–8, October–November 2004.
9. Martí Casadesús, Frederic Marimon, Iñaki Heras. ISO 14001 diffusion after the success of the ISO 9001 model. Journal of Cleaner Production. Volume 16, Issue 16, November 2008.
10. Ahm Shamsuzzoha, Anna-Miia Suihkonen, Camilla Wahlberg, Bojan Jovanovski and Sujan Piya. Development of value proposition to promote green innovation for sustainable organizational development. Cleaner Engineering and Technology. Volume 15, August 2023.
11. Henri Jalo and Henri Pirkkalainen. Effect of user resistance on the organizational adoption of extended reality technologies: A mixed methods study. International Journal of Information Management. Volume 75, April 2024.

Global Journals Guidelines Handbook 2024

www.GlobalJournals.org

Memberships

Fellows/Associates of Science Frontier Research Council

FSFRC/ASFRC Memberships

Introduction

FSFRC/ASFRC is the most prestigious membership of Global Journals accredited by Open Association of Research Society, U.S.A (OARS). The credentials of Fellow and Associate designations signify that the researcher has gained the knowledge of the fundamental and high-level concepts, and is a subject matter expert, proficient in an expertise course covering the professional code of conduct, and follows recognized standards of practice. The credentials are designated only to the researchers, scientists, and professionals that have been selected by a rigorous process by our Editorial Board and Management Board.

Associates of FSFRC/ASFRC are scientists and researchers from around the world are working on projects/researches that have huge potentials. Members support Global Journals' mission to advance technology for humanity and the profession.

FSFRC

Fellow of Science Frontier Research Council

FELLOW OF SCIENCE FRONTIER RESEARCH COUNCIL is the most prestigious membership of Global Journals. It is an award and membership granted to individuals that the Open Association of Research Society judges to have made a 'substantial contribution to the improvement of computer science, technology, and electronics engineering.

The primary objective is to recognize the leaders in research and scientific fields of the current era with a global perspective and to create a channel between them and other researchers for better exposure and knowledge sharing. Members are most eminent scientists, engineers, and technologists from all across the world. Fellows are elected for life through a peer review process on the basis of excellence in the respective domain. There is no limit on the number of new nominations made in any year. Each year, the Open Association of Research Society elect up to 12 new Fellow Members.

Benefit

To the institution

Get letter of appreciation

Global Journals sends a letter of appreciation of author to the Dean or CEO of the University or Company of which author is a part, signed by editor in chief or chief author.

Exclusive Network

Get access to a closed network

A FSFRC member gets access to a closed network of Tier 1 researchers and scientists with direct communication channel through our website. Fellows can reach out to other members or researchers directly. They should also be open to reaching out by other.

Career | Credibility | Exclusive | Reputation

Certificate

Receive a print ed copy of a certificate

Fellows receive a printed copy of a certificate signed by our Chief Author that may be used for academic purposes and a personal recommendation letter to the dean of member's university.

Career | Credibility | Exclusive | Reputation

Designation

Get honored title of membership

Fellows can use the honored title of membership. The “FSFRC” is an honored title which is accorded to a person’s name viz. Dr. John E. Hall, Ph.D., FSFRC or William Walldroff, M.S., FSFRC.

Career | Credibility | Exclusive | Reputation

Recognition on the Platform

Better visibility and citation

All the Fellow members of FSFRC get a badge of "Leading Member of Global Journals" on the Research Community that distinguishes them from others. Additionally, the profile is also partially maintained by our team for better visibility and citation. All fellows get a dedicated page on the website with their biography.

Career | Credibility | Reputation

Future Work

Get discounts on the future publications

Fellows receive discounts on future publications with Global Journals up to 60%. Through our recommendation programs, members also receive discounts on publications made with OARS affiliated organizations.

Career | Financial

GJ Internal Account

Unlimited forward of Emails

Fellows get secure and fast GJ work emails with unlimited forward of emails that they may use them as their primary email. For example,
john [AT] globaljournals [DOT] org.

Career | Credibility | Reputation

Premium Tools

Access to all the premium tools

To take future researches to the zenith, fellows and associates receive access to all the premium tools that Global Journals have to offer along with the partnership with some of the best marketing leading tools out there.

Financial

Conferences & Events

Organize seminar/conference

Fellows are authorized to organize symposium/seminar/conference on behalf of Global Journal Incorporation (USA). They can also participate in the same organized by another institution as representative of Global Journal. In both the cases, it is mandatory for him to discuss with us and obtain our consent. Additionally, they get free research conferences (and others) alerts.

Career | Credibility | Financial

Early Invitations

Early invitations to all the symposiums, seminars, conferences

All fellows receive the early invitations to all the symposiums, seminars, conferences and webinars hosted by Global Journals in their subject.

Exclusive

Publishing Articles & Books

Earn 60% of sales proceeds

Fellows can publish articles (limited) without any fees. Also, they can earn up to 60% of sales proceeds from the sale of reference/review books/literature/ publishing of research paper. The FSFRC member can decide its price and we can help in making the right decision.

Exclusive | Financial

Reviewers

Get a remuneration of 15% of author fees

Fellow members are eligible to join as a paid peer reviewer at Global Journals Incorporation (USA) and can get a remuneration of 15% of author fees, taken from the author of a respective paper.

Financial

Access to Editorial Board

Become a member of the Editorial Board

Fellows may join as a member of the Editorial Board of Global Journals Incorporation (USA) after successful completion of three years as Fellow and as Peer Reviewer. Additionally, Fellows get a chance to nominate other members for Editorial Board.

Career | Credibility | Exclusive | Reputation

And Much More

Get access to scientific museums and observatories across the globe

All members get access to 5 selected scientific museums and observatories across the globe. All researches published with Global Journals will be kept under deep archival facilities across regions for future protections and disaster recovery. They get 10 GB free secure cloud access for storing research files.

ASSOCIATE OF SCIENCE FRONTIER RESEARCH COUNCIL

ASSOCIATE OF SCIENCE FRONTIER RESEARCH COUNCIL is the membership of Global Journals awarded to individuals that the Open Association of Research Society judges to have made a 'substantial contribution to the improvement of computer science, technology, and electronics engineering.

The primary objective is to recognize the leaders in research and scientific fields of the current era with a global perspective and to create a channel between them and other researchers for better exposure and knowledge sharing. Members are most eminent scientists, engineers, and technologists from all across the world. Associate membership can later be promoted to Fellow Membership. Associates are elected for life through a peer review process on the basis of excellence in the respective domain. There is no limit on the number of new nominations made in any year. Each year, the Open Association of Research Society elect up to 12 new Associate Members.

To the institution

Get letter of appreciation

Global Journals sends a letter of appreciation of author to the Dean or CEO of the University or Company of which author is a part, signed by editor in chief or chief author.

Exclusive Network

Get access to a closed network

A ASFRC member gets access to a closed network of Tier 1 researchers and scientists with direct communication channel through our website. Associates can reach out to other members or researchers directly. They should also be open to reaching out by other.

Career | Credibility | Exclusive | Reputation

Certificate

Receive a print ed copy of a certificate

Associates receive a printed copy of a certificate signed by our Chief Author that may be used for academic purposes and a personal recommendation letter to the dean of member's university.

Career | Credibility | Exclusive | Reputation

Designation

Get honored title of membership

Associates can use the honored title of membership. The “ASFRC” is an honored title which is accorded to a person’s name viz. Dr. John E. Hall, Ph.D., ASFRC or William Walldroff, M.S., ASFRC.

Career | Credibility | Exclusive | Reputation

Recognition on the Platform

Better visibility and citation

All the Associate members of ASFRC get a badge of "Leading Member of Global Journals" on the Research Community that distinguishes them from others. Additionally, the profile is also partially maintained by our team for better visibility and citation. All associates get a dedicated page on the website with their biography.

Career | Credibility | Reputation

Future Work

Get discounts on the future publications

Associates receive discounts on the future publications with Global Journals up to 60%. Through our recommendation programs, members also receive discounts on publications made with OARS affiliated organizations.

Career | Financial

GJ Internal Account

Unlimited forward of Emails

Associates get secure and fast GJ work emails with unlimited forward of emails that they may use them as their primary email. For example,
john [AT] globaljournals [DOT] org.

Career | Credibility | Reputation

Premium Tools

Access to all the premium tools

To take future researches to the zenith, fellows receive access to almost all the premium tools that Global Journals have to offer along with the partnership with some of the best marketing leading tools out there.

Financial

Conferences & Events

Organize seminar/conference

Associates are authorized to organize symposium/seminar/conference on behalf of Global Journal Incorporation (USA). They can also participate in the same organized by another institution as representative of Global Journal. In both the cases, it is mandatory for him to discuss with us and obtain our consent. Additionally, they get free research conferences (and others) alerts.

Career | Credibility | Financial

Early Invitations

Early invitations to all the symposiums, seminars, conferences

All associates receive the early invitations to all the symposiums, seminars, conferences and webinars hosted by Global Journals in their subject.

Exclusive

Publishing Articles & Books

Earn 30-40% of sales proceeds

Associates can publish articles (limited) without any fees. Also, they can earn up to 30-40% of sales proceeds from the sale of reference/review books/literature/publishing of research paper.

Exclusive | Financial

Reviewers

Get a remuneration of 15% of author fees

Associate members are eligible to join as a paid peer reviewer at Global Journals Incorporation (USA) and can get a remuneration of 15% of author fees, taken from the author of a respective paper.

Financial

And Much More

Get access to scientific museums and observatories across the globe

All members get access to 2 selected scientific museums and observatories across the globe. All researches published with Global Journals will be kept under deep archival facilities across regions for future protections and disaster recovery. They get 5 GB free secure cloud access for storing research files.

Associate	Fellow	Research Group	Basic
$4800 **lifetime designation**	$6800 **lifetime designation**	$12500.00 **organizational**	APC **per article**
Certificate, LoR and Momento **2** discounted publishing/year **Gradation** of Research **10** research contacts/day **1 GB** Cloud Storage **GJ** Community Access	**Certificate,** LoR and Momento **Unlimited** discounted publishing/year **Gradation** of Research **Unlimited** research contacts/day **5 GB** Cloud Storage **Online Presense** Assistance **GJ** Community Access	**Certificates,** LoRs and Momentos **Unlimited** free publishing/year **Gradation** of Research **Unlimited** research contacts/day **Unlimited** Cloud Storage **Online Presense** Assistance **GJ** Community Access	**GJ** Community Access

Preferred Author Guidelines

We accept the manuscript submissions in any standard (generic) format.

We typeset manuscripts using advanced typesetting tools like Adobe In Design, CorelDraw, TeXnicCenter, and TeXStudio. We usually recommend authors submit their research using any standard format they are comfortable with, and let Global Journals do the rest.

Alternatively, you can download our basic template from https://globaljournals.org/Template.zip

Authors should submit their complete paper/article, including text illustrations, graphics, conclusions, artwork, and tables. Authors who are not able to submit manuscript using the form above can email the manuscript department at submit@globaljournals.org or get in touch with chiefeditor@globaljournals.org if they wish to send the abstract before submission.

Before and during Submission

Authors must ensure the information provided during the submission of a paper is authentic. Please go through the following checklist before submitting:

1. Authors must go through the complete author guideline and understand and *agree to Global Journals' ethics and code of conduct,* along with author responsibilities.
2. Authors must accept the privacy policy, terms, and conditions of Global Journals.
3. Ensure corresponding author's email address and postal address are accurate and reachable.
4. Manuscript to be submitted must include keywords, an abstract, a paper title, co-author(s') names and details (email address, name, phone number, and institution), figures and illustrations in vector format including appropriate captions, tables, including titles and footnotes, a conclusion, results, acknowledgments and references.
5. Authors should submit paper in a ZIP archive if any supplementary files are required along with the paper.
6. Proper permissions must be acquired for the use of any copyrighted material.
7. Manuscript submitted *must not have been submitted or published elsewhere* and all authors must be aware of the submission.

Declaration of Conflicts of Interest

It is required for authors to declare all financial, institutional, and personal relationships with other individuals and organizations that could influence (bias) their research.

Policy on Plagiarism

Plagiarism is not acceptable in Global Journals submissions at all.

Plagiarized content will not be considered for publication. We reserve the right to inform authors' institutions about plagiarism detected either before or after publication. If plagiarism is identified, we will follow COPE guidelines:

Authors are solely responsible for all the plagiarism that is found. The author must not fabricate, falsify or plagiarize existing research data. The following, if copied, will be considered plagiarism:

- Words (language)
- Ideas
- Findings
- Writings
- Diagrams
- Graphs
- Illustrations
- Lectures

- Printed material
- Graphic representations
- Computer programs
- Electronic material
- Any other original work

Authorship Policies

Global Journals follows the definition of authorship set up by the Open Association of Research Society, USA. According to its guidelines, authorship criteria must be based on:

1. Substantial contributions to the conception and acquisition of data, analysis, and interpretation of findings.
2. Drafting the paper and revising it critically regarding important academic content.
3. Final approval of the version of the paper to be published.

Changes in Authorship

The corresponding author should mention the name and complete details of all co-authors during submission and in manuscript. We support addition, rearrangement, manipulation, and deletions in authors list till the early view publication of the journal. We expect that corresponding author will notify all co-authors of submission. We follow COPE guidelines for changes in authorship.

Copyright

During submission of the manuscript, the author is confirming an exclusive license agreement with Global Journals which gives Global Journals the authority to reproduce, reuse, and republish authors' research. We also believe in flexible copyright terms where copyright may remain with authors/employers/institutions as well. Contact your editor after acceptance to choose your copyright policy. You may follow this form for copyright transfers.

Appealing Decisions

Unless specified in the notification, the Editorial Board's decision on publication of the paper is final and cannot be appealed before making the major change in the manuscript.

Acknowledgments

Contributors to the research other than authors credited should be mentioned in Acknowledgments. The source of funding for the research can be included. Suppliers of resources may be mentioned along with their addresses.

Declaration of funding sources

Global Journals is in partnership with various universities, laboratories, and other institutions worldwide in the research domain. Authors are requested to disclose their source of funding during every stage of their research, such as making analysis, performing laboratory operations, computing data, and using institutional resources, from writing an article to its submission. This will also help authors to get reimbursements by requesting an open access publication letter from Global Journals and submitting to the respective funding source.

Preparing your Manuscript

Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.

Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11'", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.

Format Structure

It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

Title

The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, “What words would a source have to include to be truly valuable in a research paper?” Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

Color charges: Authors are advised to pay the full cost for the reproduction of their color artwork. Hence, please note that if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a Color Work Agreement form before your paper can be published. Also, you can email your editor to remove the color fee after acceptance of the paper.

Tips for Writing a Good Quality Science Frontier Research Paper

Techniques for writing a good quality Science Frontier Research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of science frontier then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.

6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- Single section and succinct.
- An outline of the job done is always written in past tense.
- Concentrate on shortening results—limit background information to a verdict or two.
- Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.

Segment draft and final research paper: You have to strictly follow the template of a research paper, failing which your paper may get rejected. You are expected to write each part of the paper wholly on your own. The peer reviewers need to identify your own perspective of the concepts in your own terms. Please do not extract straight from any other source, and do not rephrase someone else's analysis. Do not allow anyone else to proofread your manuscript.

Written material: You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.

Criterion for Grading a Research Paper (Compilation) by Global Journals

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals.

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

INDEX

Global Journal of Science Frontier Research

Visit us on the Web at www.GlobalJournals.org | www.JournalofScience.org
or email us at helpdesk@globaljournals.org

ISSN 9755896