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Special Issue on LiFE

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Development that is Sustainable, Inclusive and Responsive

The G20 is the world's economic powerhouse. The G20, comprising 19 nations and the European Union, accounts for close to 65 per cent of the world's population, controls 84 per cent of the global economy and deals with 79 per cent of trade. However, this strength has come at a cost.

Unsustainable lifestyles, production and consumption patterns in G20 nations, coupled with huge disparities in prosperity, are driving the three environmental planetary crises of climate change, nature and biodiversity loss, and pollution and waste. For example, G20 nations emit around 80 per cent of the world's greenhouse gases, making them the biggest drivers of climate change. These crises are harming people, economies and the planet, undermining hard-won gains. We cannot allow them to keep intensifying. The articles in this issue of G20 Digest offer options on how to implement reforms that will dampen the crises and ensure a better, more sustainable future.

These articles focus on evidence-based actions: on, for example, sustainable infrastructure, nature-based solutions, green and resilient cities and energy challenges. A common thread is how to adjust lifestyles so that we can all remain within planetary boundaries. Such a focus aligns with the G20 Indian Presidency's theme of Lifestyles for Sustainable Development, which puts lifestyles and demand-side changes at the top of the agenda while recognising the important structural shifts in high impact sectors of the economy that will ultimately influence and shape choice sets and choice architecture.

Nobody is asking people and nations to sacrifice their own prosperity. On the contrary, people and nations – particularly the G20 – can only secure their own long-term prosperity, and give others the chance to enjoy similar opportunities, by acting to protect and restore nature and the climate.

The theme of the September G20 meeting in New Delhi – *One Earth. One Family. One Future* – speaks to the need for the G20 to deliver on development that is sustainable, inclusive and responsive. By agreeing on actions that back the Paris Agreement, the Global Biodiversity Framework and many other Multilateral Environmental Agreements, the G20 can lead the world towards this smarter development model – and the articles in this issue can guide the G20 towards providing leadership, which the world so desperately needs.

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Research Article

Exploring "Aspirational Consumption" to Drive Systemic LiFE Changes

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Abstract: In this article, we explore the potential of "aspirational consumption" to drive systemic changes, supporting G20 efforts to decarbonize, detoxify and decouple production on the supply side for countries at different income and development levels. We also explore how the concept of a "fair consumption space" could shape G20 decisions around infrastructure options and provisioning systems used to meet and fulfil basic human needs – and how these options and decisions can fundamentally reshape our development pathways and relationship to the environment. We argue that the rise of aspirational consumption, coupled with a stronger value orientation aligned with moral objectives and responsibility, can be a driver of systemic change.
Keywords: aspirational consumption, sustainable lifestyles, fair consumption space, choice sets, systemic change

Introduction

The scale of the multiple crises that the would faces now – human and planetary - is unprecedented in history and will require the efforts of all. Most policy efforts have focused on supply side conditions and sustainable production and, while these are essential, less attention has been given to the important role that consumers along the value chain could play in supporting systemic change. Some change in this regard has been observed in recent years. The recently adopted UN resolution (28 July 2022) establishing a human right to a clean, sustainable, and healthy environment[1] calls into question not only the license to operate of highly polluting firms but also the role that individuals and consumers can play in enabling and demanding a cleaner and healthier future.

* An earlier version of the paper adapted from a longer research paper titled "Exploring Aspirational Consumption to Drive Systemic Lifestyle Changes" was presented at G20 side event held in Mumbai on 13 December 2023 at the G20 side event on "Infusing new LiFE into Green Development." Mumbai, India. 13 December 2022. This paper is adapted from a longer research paper entitled, "Exploring Aspirational Consumption to Drive Systemic Lifestyle Changes."

**Authors are staff at the UN Environment Programme. Views are of the authors alone and should not be construed as representing official UNEP policy. The authors would like to thank Janez Potočnik and Izabella Teixeira (IRP Co-Chairs); and Merlyn van Voore and Hala Razian (UNEP, IRP Secretariat) for their contributions.

At the Climate Conference in Glasgow in 2021, Prime Minister of India announced a new campaign which could deliver solutions to address the climate crisis i.e. Lifestyles for Environment (LiFE). As India assumed the G20 Presidency in 2023, LiFE is coming front and centre as a key issue – putting lifestyles at the top of the agenda for key economic and development ministries. Perhaps this is the first time any G20 Presidency gives importance to this dimension. While previous presidencies have flagged the critical importance of circularity and sustainability in their flagships and communiques, this is the first presidency to bring full attention onto the significant role of individuals and consumers. And it is highly significant that this proposal comes from the most populous and fast-growing economies of the world.

This paper explores the potential of "aspirational consumption" to drive systemic changes, supporting G20 efforts to decarbonize, detoxify and decouple production on the supply side for countries at different income and development levels. It also explores how the concept of a "fair consumption space" could shape G20 decisions around infrastructure options and provisioning systems used to meet and fulfil basic human needs – and how these options and decisions can fundamentally reshape our development pathways and relationship to the environment.

LiFE: Builds on Past G20 Efforts on Sustainability

Before embarking on literature and reasons why aspirational consumption may offer a strong foundation for supporting sustainable lifestyles, stock review of how this approach builds on and complements earlier G20 efforts is in order.

While sustainable development is a recurring theme for most G20 presidencies since the inception of the G20 in 2008, more recent efforts that connect to sustainable living and demand side choices include:

- *G20 Resource Efficiency Dialogue* (2017): The G20 Resource Efficiency Dialogue was launched in 2017 as part of the German presidency's focus on sustainable development and climate change. The initiative aims to promote resource efficiency and *sustainable consumption and production* patterns, by bringing together policymakers, experts, and stakeholders to share best practices and collaborate on solutions.
- *Osaka Blue Ocean Vision* (2019): The Osaka Blue Ocean Vision was announced at the G20 Osaka Summit in 2019, as part of the Japanese presidency's focus on the *circular economy*. The initiative aims to reduce plastic marine litter by 2025, through a range of actions such as reducing the use of single-use plastics and promoting recycling and waste management.
- *Circular Carbon Economy Platform* (2020): The Circular Carbon Economy Platform was launched by the Saudi Arabian presidency in 2020, as part of its focus on *circular economies and sustainable production and consumption systems*. The initiative aims to promote the use of renewable energy and circular economy principles to reduce carbon emissions and achieve climate goals.
- *G20 Global Smart Cities Alliance* (2021): The G20 Global Smart Cities Alliance was launched in 2021 as part of the Italian presidency's focus on sustainable development and climate change. The initiative aims to promote the development of smart

cities that use innovative technologies to improve sustainability, including through sustainable transportation, energy-efficient buildings, and green infrastructure. Sustainable finance was also a notable push for the Italian G20 presidency.

The 2022 communique from Bali, Indonesia during the last G20 presidency is also instructive, as it pulls many of these threads together. Paragraph 15 of the communique states:

> *We will further promote sustainable development and lifestyles, resource efficiency and circular economy to increase sustainability and work together on scientific knowledge-sharing, raising awareness, and capacity building, particularly to advance on the ocean-based climate action.*

Thus, in many ways, the current G20 Indian presidency focus on sustainable lifestyles is a logical evolution of previous efforts to introduce and expand individual choice set and demand side elements into the policy agenda of the world's largest and most populous economies. The fact that the G20 has now adopted high level principles to guide Lifestyles for Sustainable Development[2] speaks to the importance and timeliness of the issue: the environment is central to LiFE, and hence to all efforts to develop sustainably.

Consumption and Sustainability: Understanding the Connections

Lifestyles are inherently connected with patterns of consumption. By exploring these connections, pathways can be identified to increase the pace of the system-wide changes required in global and national economic systems to address climate change realities. These changes and transformations are essential not only for environmental sustainability and social equity, but for human well-being and the right of all countries to develop and build capacities.[3]

The importance of responsible and sustainable consumption is no longer in question. Instead, the issue is how and what kinds of pathways exist to steer consumption patterns and behaviours to reshape demand and supply, and accelerate the pace of market transformations. Many companies, bankers, insurers, and investors are increasingly adopting sustainability as a strategic objective for reasons of resource security, reputational purposes but also concerns for the planet. In the recent Climate conference - COP 27 (Egypt, 2022), 19 developed country governments signed up to meet net zero emissions by 2050. This recognizes that governments are consumers and have the purchasing power[4] and technologies to transform markets and influence the available products and services. Now all consumers need to be part of this change, and become active players to accelerate the transformation at the pace and scale required to meet climate, biodiversity, and pollution-free planetary goals.

Unpacking Consumption

Over the years, falling prices of manufactured goods have led to affordable prices for the middle class in developed and developing countries; for the poor in general. This was possible in part because prices do not internalise the "bads" – the social (child labour, sweat labour), the environmental (emissions, effluents, destruction of forests) and health impacts (dangerous chemicals in products). It has raised many questions

about what sustainable consumption is, such as:

- How much consumption do we need? How much is enough?
- How much and what kind of consumption is possible given the 1.5 degrees climate goal, the need to live in harmony with nature and in a pollution free world?[5]
- What kind of per capita norms do we need to ensure equity, fairness, and value to the consumer?[6]

Consumption has a spatial, temporal and agency aspect to it. These together influence sustainability both local and global, both today and in the future, and can be examined better through three types of consumption: **1) Underconsumption 2) Overconsumption and 3) Aspirational consumption**. Each of these types of consumptions have implications for all countries, and particularly for large emerging economies. In this paper, the focus is on aspirational consumption as it is a road less travelled and has interesting aspects that can help re-shape demand to support responsible consumption and production choices.

1. Underconsumption: The issue of underconsumption, one that does not meet basic human needs, is not addressed in SDG 12, the core goal that focuses on consumption and production. Underconsumption – of basic services, food and nutrition, education, housing and shelter, energy, leisure, justice - has implications for sustainability in terms of social equity and economic opportunity and issues of basic human dignity, health, and resilience, in the short term and in the longer term. Underconsumption reduces the capability and functioning of individuals, quality of life and opportunity, and the achievement of the SDGs, namely SDGs 1 to 8, SDGs 10 to 13 and SDG 16. In that context, policies should strive to ensure a minimum level of well-being for all.

2. Overconsumption: Both overconsumption and wasteful consumption have impact on the planet which is increasingly becoming evident. It creates huge externalities in terms of emissions, waste, and effluents that are detrimental to well-being. Waste and overuse impact the achievement of the SDGs adversely in terms of public health, safety and security with implications that are spatial and temporal in their externalities. Overconsumption patterns also have a deep inequality embedded in it as some consume too much while others do not have enough for sustenance and development whether in terms of ecological space or resource availability. To illustrate, the carbon profile of the top 10 per cent of income earners globally accounts for almost 50 per cent of total emissions; while per capita emissions of the top one per cent accounts for 15 per cent of the total and exceed 70 MT/yr.[7]

The International Resource Panel's Global Resources Outlook 2019 explains the disparities amongst country (income) groups when it comes to natural resource consumption and environmental impacts. An average person living in a high-income country consumes 60 per cent more materials than the average person in an upper-middle income country and over 13 times the level of an average person in a low-income country. Furthermore, the per capita environmental impacts of high-income countries are up to six times those of low-income countries.[8] Reducing this overconsumption is critical to live within the planetary boundaries.

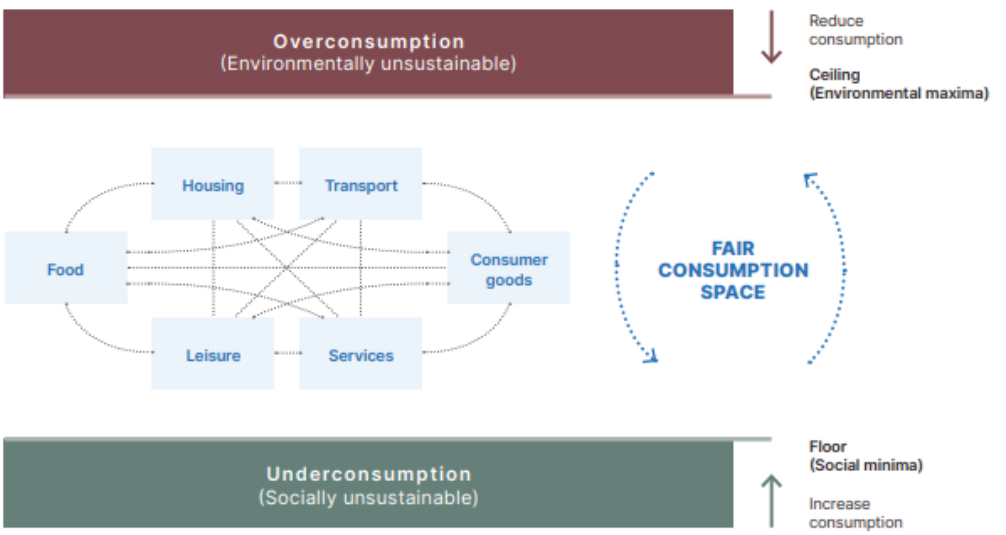
Essentially, the skewed distribution of over - and underconsumption leads us to the inescapable conclusion that

there is a dire need for a "fair and responsible" consumption space. Within the fair consumption space, there are many choice sets that are structurally determined. This has been explored in a report on 1.5-degree lifestyles[9] as well as in the Emissions Gap Report of 2020, which examined the carbon footprints of different income groups across the globe.[10]

3. Aspirational consumption. As its name suggests, aspirational consumption is linked with aspirations and differs in orientation across socio-economic contexts. The literature, both business and social science research, suggests that the understanding, the motivation and the sustainability outcomes of this type of consumption differ depending on where this consumption is located: bottom of the pyramid, young middle classes or the upper classes in emerging or developed economies. To understand how this kind of consumption can be leveraged to align lifestyles with environmental and social imperatives, there is need of some unpacking.

Aspirational consumption at the bottom of the pyramid (BOP): The evidence suggests that contrary to popular belief, price alone does not drive consumer choice, particularly at the bottom of the pyramid. Granados and Prabhu (2022) suggest that because those at the BOP have lower social status, "consumers at the BOP seek to consume aspirational items as a way to increase their self-esteem or achieve a higher social standing within their communities."[11] Srivastava et al. (2020)[12] provide many definitions of this consumption but in sum refer to a consumption undertaken to match with those better off in the economic hierarchy, aspiring to a lifestyle of the more affluent, even if not commensurate with affordability. As with the classic work of Thorstein Veblen[13] from over 100 years ago, aspirational goods for those in BOP can include private schools, TVs, beauty care, jewelry, footwear, cell

Figure A. A Fair Consumption Space for Sustainable Lifestyles



Source: Akenji et al. 2021.

phones, motorcycles, etc. It can also include "cyber-leisure" goods – anything that pulls the imagined "good life" closer into reach.

***Aspirational consumption of the millennials and the young middle classes, especially in emerging markets*:** Aspirational consumers are materialistically-oriented while, at the same time, aspiring to be sustainable in their purchases and beliefs,"[14] adopting lifestyles that privilege "becoming" over "owning."[15] Aspirational consumers, according to market research firm GWI, are the largest consumer segment (39 per cent on average), with clear dominance in the developing markets of Latin America (56 per cent) and Middle East and Africa (47 per cent).[16] According to BWI research, 86 per cent consumers surveyed value contributing to their communities, 48 per cent want their favourite brands to be socially responsible, and 51 per cent want their brands to be eco-friendly; and 80 per cent would pay a premium for a sustainable or eco-friendly product.[17] In addition, the UNESCO "World in 2030" Survey Report canvassed more than 15,000 people worldwide in 2020 and observed that climate change and biodiversity loss are topmost concerns for the youth.[18]

***Aspirational consumption in high income groups*:** Currid-Halkett (2017) refers to the "dominant elite" and their consumer habits, which consist of conspicuous production, conspicuous leisure and inconspicuous consumption. "Ultimately those who are members of this new cultural and social formation aspire to be their version of better humans in all aspects of lives, with economic position taking a back seat."[19] A 2021 Pew Research Center Survey done in 17 advanced economies also suggest that citizens are willing to change how they live and work as the impacts of climate change are becoming more evident with younger adults tending to be more concerned.[20] The aspirational consumer of the high income world today may actually be seeking a more socially acceptable and conspicuous "enlightened consumption." The trend towards more discrete consumption patterns could be further reinforced with the backlash against private yachts, jets and other high emission sources of conspicuous and unequal over-consumption.[21]

Aspirational consumption in the higher income classes signals perhaps a philosophy of life and a value system in their consumption choices as in the case of the young and emerging middle classes above. Those less well-off who choose to be part of the aspirational class do so even when they must use their insubstantial means to be part of the club, as is the case for those in the Bottom of the Pyramid. Each have their different reasons.

The argument here for the purposes of the G20 discussions this year is that aspirational consumption - linked to aspirations for a good life that is "meaningful, productive and fulfilling" - has the potential to be an instrument of positive change for reinforcing and advancing sustainability transitions. This insight lies in the following five aspects:

- Aspiration to a "good life" exists in most individuals and especially those who are at the bottom of the pyramid and young, in both developed and developing countries, who form well over half of the world's population.
- Youth are increasingly becoming concerned with environmental issues and are weaving that factor into their understanding of what a good life or lifestyle is or should be. Youth are also concerned with their

future. This may revolve around scarcity of resources and greater climate instability. This means that the notion of what is a "good life" is open to influence and narratives around responsible consumption and how this translates around what to wear, what goods to buy and what to avoid.

- The globalised world of today is also an increasingly digital world. The consumption question gets more complex in such a world with regard to work and leisure, as argued by Arora (2012).[22] The main difference, Arora (2012) argues, between the industrial and the digital age is in its from the perspective of leisure. In the former, leisure was seen to supplement labor; while the digital age recognizes that leisure can also be labor. This suggests the need to re-examine how labor and leisure are viewed across opposing ends of the development spectrum.
- The energy sector shows us that given advances in digital technology, the consumer is transforming from a passive to an active agent. With increased decentralization and digitalization of the sector, choices of how to consume and when to consume energy to enable savings is becoming a key aspect not only to save money for the consumer but also to "save the planet." More needs to be made of this clear example of informed consumers and choice making, extending to other goods and services, particularly with increasing traceability and concerns around provenance.
- "Aspirational consumption" lends itself to social media, non-material and non-consumptive goods and services. When social influencers create norms that put a premium on the experiential and quality of life aspects of consumption, this opens doors for wider entry to the aspirational consumer class, to the benefit of all.

Steering aspirational consumption in G20 countries towards a global shift to more sustainable consumption is critical.

How to re-orient aspirational consumption to be more responsive to environmental and social concerns? How can we catalyse shifts to more sustainable consumption, that have the "potential to transform lives, ensuring better and more permanent access to basic goods and services; a consumption that can generate new opportunities for economic development and well-being, create decent and green jobs, and help mitigate socio-economic risks in emerging economies, serving as a connecting thread between the industrial, agricultural, mining, digital and energy transitions being promoted in G20 emerging economies and yet factor in climate realities?[23]

The following are three possible pathways that could enable a collective movement, building on the work of researchers in business, consumption, and public policy. These could also support the G20 efforts under consideration as part of LiFE.

Converting "Affordable" and "Sustainable" Aspirational

Frugal innovations are about doing more with less.[24] It is a well-developed field of study in business schools, and along with sharing and the circular economy, it has begun to create a place for itself in economies which seek to address dwindling natural resources, new technologies and knowledgeable consumers. Granados and Prabhu (2022)

refer to aspirational consumption as a good route to enhancing the adoption of frugal innovations as the use of ubiquitous technologies to innovate faster, better, and cheaper "by creating a positive aspirational narrative" around such innovations.

To achieve this potential, four factors merit the attention of the G20:

First, the frugal good needs to make the consumer feel she/he has achieved and is not being serviced because she is poor. If these 'frugal' innovations are also imbued with environmentally friendly and circular design, then it could nudge consumers in the Base of the Pyramid to use and acquire more "affordable aspirational goods".[25] Frugal innovations offer companies and entrepreneurs opportunities to meet needs of those at the Base of the Pyramid that are affordable and are mainstream alternatives in typical market segments through radical business models and innovations. Creating positive aspiration narratives around frugal innovations while making them circular in design and environmentally friendly can help steer this group to access goods and services they aspire to while being sustainable. This could be, for example, around cooling, food, electronics, housing, mobility, and fashion to name some of the high-impact sectors. Fashion in particular has shown the ability to disrupt and shape social norms. *G20 can reinforce this trend by acknowledging and underlining the importance of reaching the bottom of the pyramid with frugal innovations that improve human welfare, human capacities and the environment.*

Second, a "responsible aspirational marketing approach" one that delivers value to the consumer to improve well-being, creates aspirational connections but in a socially conscious way is required. This requires marketing and advertising narratives around aspirational consumption targeted to different socio-economic contexts. Influencers, along with responsible marketing approaches can be instrumental in supporting behavioral change. They can be key to ensure that negative outcomes are avoided. If the non-material values that characterise and drive aspirational consumption of the millennials and the well-off are used to launch a social movement on responsible consumption, it could take away from the social stratification that Currid-Halkeit warns us of results from the aspirational consumption of the rich. *The G20 can highlight and underline the role of the private sector – and marketing in particular to ensure that promoting responsible consumption is part of the license to operate.*

Third, "cyber leisure"[26] needs to be explored as an opportunity to build social capital with its potential social effect of binding people and sustaining relationships. Arora (2012) suggests the need for greater attention to the "… ingenious strategies that the poor employ to cope and escape from their current plight."[27] Entertainment is a key tool here with class taking a backseat. The literature indicates that cyber-leisure has the potential of creating social bonds and contributing to personal health, well-being, and fulfilment through sustenance of relationships and overall life satisfaction.[28] Can these positive social effects be harnessed to trigger deliberative processes and organized movements towards a more sustainable consumption?

Fourth, Engage influencers and institutions (e.g Bollywood in India) to promote sustainable consumption, not just the "official ambassadors" of different causes, but the larger community of influencers needs to become more environmentally conscious and responsible. Social media can be a great

amplifier in this regard. *G20 can promote social movements towards aspirational and sustainable consumption by working with influencers, educational and media leaders and outlets to bring an aspirational lens to content and programming.*

Enable "Responsible" Consumer Choices through Investment in Consumer Capabilities

Responsible consumption requires investment in time and effort and learning about available choices.[29] Consumption capabilities are a matter of learning about, choosing among, and creating routines.[30] What can help expand and make the sustainable choice set more accessible?

Three factors deserve consideration by the G20:

First, remove products and choices that are harmful. This can be accomplished by, *inter alia*, maintaining and introducing regulations that keep those harmful products and services out of the market. For example, the single use plastic ban in India and Kenya was very effective. In Kenya, they immediately gave rise to alternative products and innovations, e.g., recycling old jeans for shopping bags. Lead in paint is another known toxic products that impairs human health and childhood development. *G20 can promote the right to a clean and health environment that improves human well-being by carefully examining and removing products from the market that are known to damage human health and the environment.*

Second, increase the ease and transparency of product information for consumers. More transparent and standardized information about the product can be implemented, just as is done for tobacco and other health related products. More fundamentally, governments and companies build trust through increased accountability and reporting on supply chain processes, tracking provenance of goods through supply chains. They can harness the power of digital information and social networks to increase transparency and accountability in products and services for more informed choices. *The G20 can empower informed consumers and more sustainable lifestyles by implementing enhanced frameworks for consumer information.*

Third, pay attention to infrastructure decisions that reinforce and determine choice boundaries. In the case of cities, sustainable urban planning, infrastructure and policies are fundamental in shaping choice that will determine circularity of use, reuse, repair, refurbish, and safety. For example, in the New Delhi metro, investments in a separate compartment for women and the support of security guards to raise awareness helped women feel safe and adopt a new routine. The more sustainable mobility choice was enabled because of this capability to learn and accept a new routine for travel. *G20 can exchange information on successful efforts at the local/national/regional level to promote sustainable infrastructure, policies and planning that create and enable a "sustainable" default for improved choice architecture. This is an area where further research is needed.*

Enhance "Public Value" by Expanding Choice Sets

Enhancing public value in strategies to support more responsible value chains will need better alignment of the world views of consumers and producers on sustainability. Some possible pathways that the G20 could include:

- Introduce governance mechanisms that enforce circular and resource efficient mechanisms across jurisdictions for business to be accountable and responsible. The

plastics treaty under negotiation is a notable example and opportunity; and would reinforce and bring together the climate/circular economy and development working group tracks.

- Correct pricing of natural resources and environmental costs is needed. Full cost pricing is an important aspect of embedding public value and interest especially in the long run. The long-term social impact of many subsidies attests to this fact. Current pricing does not make sustainability the default option ; in fact it is the contrary. Full cost pricing also promotes innovation. The G20 Pittsburg agreement to remove fossil fuel subsidies is an important step in this direction.
- Focus should be on investment in extended producer responsibility; regulate planned obsolescence; extend product lifetimes. The advances in many countries, including Europe in this regard, are notable and can be extended to further align pricing signals with life cycle costing.
- Link resource efficiency and sustainability factors to incentives for credit customers. For example, credit card reward schemes can offer sustainable lifestyle choices. Green mortgages can drive energy efficient choices through preferred interest rates. For instance, the Norwegian bank Romerike Sparebank, a signatory of UN Principles of Responsible Banking, developed green mortgages coupled with a tool helping customers to identify possible energy efficiency improvement measures.
- Build innovative and sustainable solutions around social and green jobs in value chains; the UNEP, ILO, UNICEF "Green Jobs and Youth Pact" to address inter-generational equity is a case in point.
- Embed the voice of the aspirational consumer better in product planning and have stronger interfaces in the value chains. Explore how joined up and more transparent value chains can benefit not only consumers but also producers, particularly in lower income producer countries.

These are just a few of the policy instruments that can be brought to complement and expand the sustainable choice sets that are at the disposal of G20 countries.

Way Forward

Market and academic research suggests that there is a class of consumer – the 'aspirational consumer" – in various socio-economic brackets. They have increasingly become the force of numbers and hence the power to cause markets to transform through changes in preferences and demand away from the goods and services that are harmful to the environment. This can trigger a ripple effect across the value chain.

While governments change laws and rules, pricing and influence markets in the choices they make as consumers of goods and services; while investors pressure firms for more responsible production practices, while the producers themselves begin to invest in more environmentally friendly technologies and practices in value chains as they see the value of nature for business, aspirational consumers can become a force for transformative change and contribute to "tipping points" through a

desire for a "good life" that aligns with environmental and social imperatives.

This paper has attempted to make the case for utilizing "aspirational consumption" as a pathway to accelerate the pace of change. It recognises that a focus on the producer, the company or even the individual consumer alone will not result in the economic transformations in the scale and pace desired. The rise of aspirational consumption with a stronger value orientation aligned with moral objectives and responsibility can be an opportunity to build a narrative that scales change across countries and income brackets.

This paper argued that finding ways by which the aspirational consumers can come together to share common, collaborative spaces into an environmental movement can help reshape demand, influence markets and supply chains towards more responsible choices and lifestyles. They represent a unique opportunity to mobilize lifestyles around a greater responsibility in consumption keeping equity and the longer term in view, with youth playing an important role in shaping this collective action. The pace of sustainability transitions can be accelerated if all actors in the market are aligned with strategic and moral objectives. Aspirational consumption, aligned with moral objectives, can support a wider political vision for a new society that recognizes and aligns the socio-economic realities of the emerging and developing world with climate and environmental realities.

Finally, with leadership coming from the Indian G20 presidency, and with a hand-off to Brazil who will host the presidency in 2024 and South Africa in 2025, the G20 could mobilize movements around the world to understand how aspirational consumption could support increased equality and sense of fairness between countries. A renewed focus on sustainable living is timely, and can help address the urgent need for improving human well-being and capacities within an increasingly constrained planet, while reducing consumption inequalities. And that can bring more meaning to LiFE.

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Research Article

G20 Leadership Required to Keep the Paris Agreement Temperature Goals Alive

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System for Developing
Countries (RIS).

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Abstract: The G20 leadership should accelerate the implementation of emissions reduction given that these countries account for 75 per cent of global emissions. There has been some significant progress noted in the energy sector. However, the transport sector and food systems remain high emitters. Further, deforestation and forest degradation lead to 11 per cent of global emissions while housing, mobility and food account for 70 per cent of an individual's emissions. This paper highlights the need of the G20 countries to focus on reducing emissions by resorting to the "Avoid, Shift and Improve" principle to meet the 1.5 C target by 2050.

Introduction

The world is losing the 1.5-degree temperature target of the Paris Agreement. Global greenhouse gas emissions have risen 1.1 per cent annually in the last decade, reaching a record 59.1 gigatons of carbon dioxide equivalent (GtCO2e) in 2019 (see Figure 1). According to IPCC Sixth Assessment Report, average annual greenhouse gas emissions are at highest levels in human history.

Despite reduction in emissions during the Covid-19 pandemic, as per the 2022 Emissions Gap Report, it seems annual emissions in 2021 were like or even higher than the record 2019 levels. Nevertheless, concentrations of GHG in the atmosphere continue to break records and will continue to rise until the world reaches net-zero emissions. The average global temperature is now 1.2°C warmer than pre-industrial times and even if countries meet, to 100 per cent, their current commitments, temperatures are forecast to rise at least 1.8°C by 2100.[1] If countries only deliver their un-conditional and conditional Nationally Determined Contributions (NDCs), temperatures are forecasted to rise by 2.6°C and 2.4°C respectively. The impacts of climate change can already be felt across the globe with the heat waves, wildfires and flooding in Pakistan and elsewhere providing an insight of

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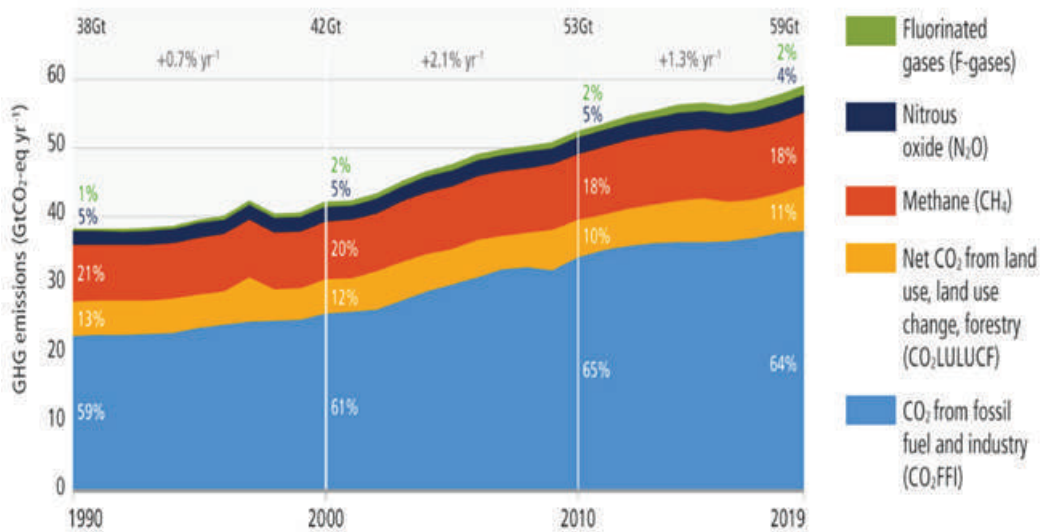
the magnitude of threat the world is facing. Further, to maintain the 1.5- and 2-degree temperature goals of the Paris Agreement, the report observes that emissions must peak by 2025 and reduce by 43 per cent and 27 per cent respectively by 2030.

An emerging silver lining but the window to meet the temperature goals of the Paris Agreement is closing. Compared to pre-Paris Agreement, the world was forecasted to reach an average 3.5-4°C heating by 2100, but since the Paris Agreement the collective commitment has taken a step change forward. Globally, 88 parties covering approximately 79 per cent of total emissions have adopted net-zero goals, including all G20 members, except Mexico. In addition, zero emissions targets have been adopted by at least 826 cities and 103 regions.

Of the 139 new or updated Nationally Determined Contributions (NDCs), more than half will result in lower 2030 emissions relative to the initial NDCs.[2] The quality and coverage of sectors and greenhouse gases in NDCs has also improved. Figure 2 depicts the implied emission trajectories of the G20 members based on their NDCs and net-zero targets. This illustration does not consider fairness or the principle of common but differentiated responsibilities, but it does point to the importantce of alignment between short and long-term climate goals. It further indicates that pathways to net-zero will require early action and backing of effective policies.

As of 2019, most countries had increasing emissions over the past decade (74 countries accounting for 65 per cent of emissions), or remained stable (39 countries, 25 per cent of emissions). A group of 35 countries, accounting for about 10 per cent of global emissions, had peaked and reduced their net GHG emissions, including Land Use and Land use Change emissions, for at least the last 10 years. These countries include Argentina, Brazil, European Union countries, the Republic of Korea, South Africa and North American countries.[3]

Figure 1: GHG Emissions

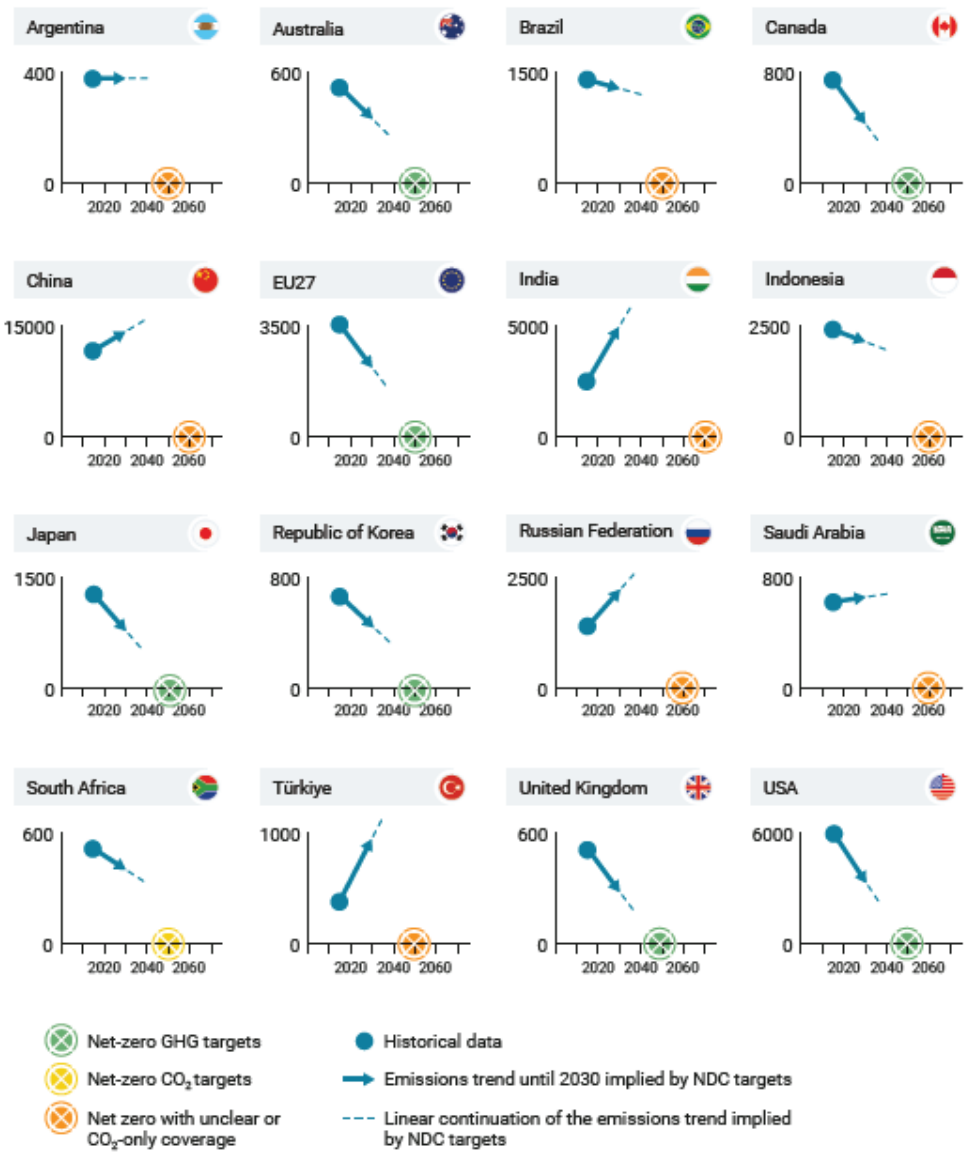


Source: Emissions Gap Report, 2022.

Currently, G20 members account for about 75 per cent of global GHG emissions.

By end of CoP27, the collective ambition of the NDCs of G20 members brings their 2030 emissions to the range of 31-39Gt, accounting for 68-77 per cent of global emissions. In other words, the share of emissions, based on the current ambition, is expected to stay like the share it was at the time of sealing the Paris Agreement. To close the emissions gap, annual emissions must be cut to 33 GtCO2e by 2030 to limit warming to

Figure 2: Emissions Trajectories by NDC and Net-zero targets of G20 Members.



Source: National emissions in MtCO2e/year over time (EGR 2022).

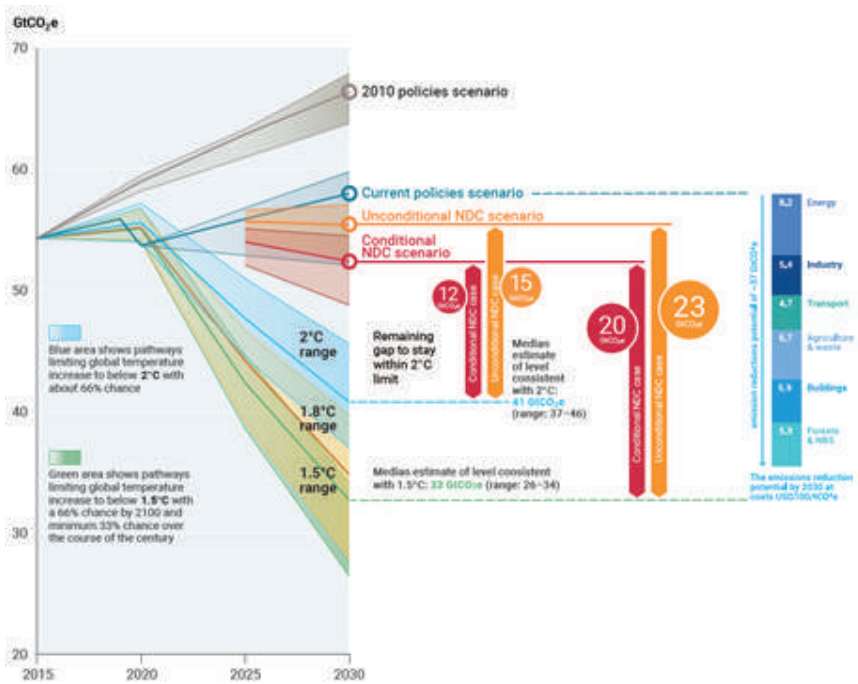
1.5°C and 41 GtCO2e for a 2°C trajectory. Needless to say, the strengthened leadership of G20 members and their accelerated success in implementing emission reduction will carry a deciding impact on the collective ability of the world to limit global heating to well below 2°C.

Sectoral Solutions can Close the Emissions Gap

Globally, net anthropogenic GHG emissions have increased since 2010 across all major sectors, but technically and economically, the emissions gap can be closed. Across various energy types and industrial sectors including agriculture, forestry, transport, and buildings there are feasible, scalable, and economic solutions that are ready for large-scale investments. These solutions are estimated to be able to deliver emission reductions of around 37 Gigaton, at less than $100/tCo2e.

This is more than sufficient to reduce emissions from 59Gt to 33 Gt by 2030. The transformation to net-zero GHG emissions will require accelerated action and increased investments in energy, industry, agriculture, forestry, transport and buildings. Of these sectors, energy, especially electricity supply, is the most advanced and a tipping point has been reached, with renewable energy being the cheapest form of new electricity generation in 90 per cent of the market. For building operations and road transport, the most efficient technologies available still need policy and fiscal support, while

Figure 3: Solutions across Six Sectors to Close Emission Gap



Source:

for industry, shipping, and aviation, low-carbon technologies need to be further developed and supported. Noting that public procurement alone accounts for 15 per cent of global emissions, G20 governments can strongly influence the decarbonization of all these sectors. Furthermore, 40 per cent of public procurement related emission reductions can be delivered at a cost of less than $15/ tons of CO2e.[4]

Climate, and the various sectors that must undertake climate action are well featured in G20 Summit Declarations and the various groups on Climate & Sustainability and Finance. G20 have committed multiple times to climate action on nature-based solutions, buildings and cities, energy, methane, fossil fuel subsidies, etc. Indian Presidency must now focus on finance and implementation of a science –based effort to put the Paris Agreement back on track. The sectoral sections below provide guidance and examples of how this can be done.

Renewable Energy

In August 2022, the United States of America approved the Inflation Reduction Act. The act covers key sectors, such as transport, energy, buildings and it is projected to reduce emissions by one Gigaton. USA also published a supplemental proposal on reducing harmful emissions and energy waste that will achieve 87 per cent reductions in methane emissions from covered sources by 2030 from 2005 levels. Canada has published its proposed regulatory framework to achieve at least a 75 per cent reduction in methane emissions from the oil and gas sector by 2030 relative to 2012. Likewise, Mexico is set to develop and release a plan for methane and flaring reduction activities by the first half of 2023.

According to the Renewables 2022 Global Status Report, renewable power generation continued to attract far more investment in 2021 than did fossil fuel or nuclear plants. G20 has been at the forefront of the growth in low-carbon technologies. In 2021, the world invested a record $366 billion in renewable energy, with G20 accounting for more than 4/5th of the investments. China accounted for 37 per cent of the total investment in renewable power, with an overall investment of $137 billion. Among others, European Countries invested $79.7 billion followed by USA ($46.7 billion), Brazil ($11.6 billion) and India ($11.3 billion). Since 2011, more than two-thirds of global investments in renewable power and fuels has been concentrated in China, Europe and the United States. In China, since 1996 the annual installed solar and wind capacity has, accounted for about 55 per cent of new power installations (Statista 2022).

From 2010–2019, there have been sustained decreases in the unit costs of solar energy (85 per cent), wind energy (55 per cent), and lithium-ion batteries (85 per cent), and large increases in their deployment, e.g., >10x for solar and >100x for electric vehicles (EVs), varying widely across regions. The mix of policy instruments which reduced costs and stimulated adoption included public R&D, funding for demonstration and pilot projects, and demand-pull instruments such as deployment subsidies to attain scale.

The energy transition is yet at the scale needed and the share of fossil fuels in the overall energy mix has only dropped marginally since 2010. The notable growth in renewable energy installations has largely gone to meet the overall growth in energy demand.

Fossil fuel CO2 emissions grew, in the global energy system, by 4.6 per cent

between 2015 and 2019 (1.1 per cent/year), reaching 38 GtCO2/year and accounting for approximately two-thirds of annual anthropogenic GHG emissions. Globally, the power system is at 42 per cent, the single largest source of energy-related emissions and investment in the sector is a must to keep the temperature goals of the Paris Agreement alive.

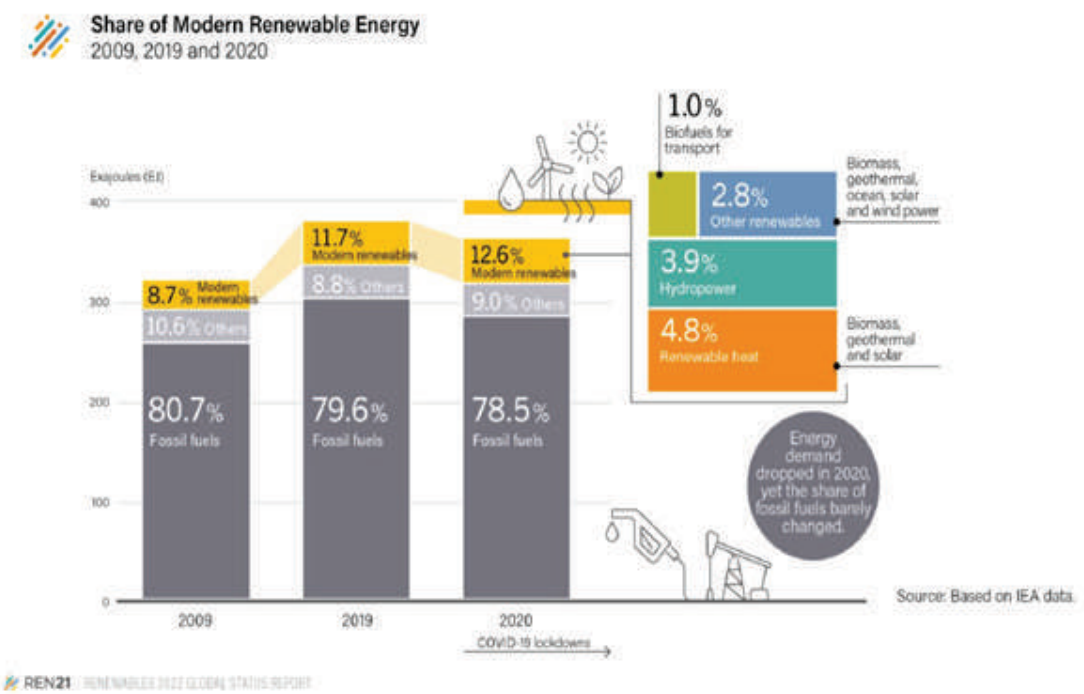
The sector is estimated to hold more than 8 Gigaton of emission reductions potential at a cost of less than $100/ton. In addition to investments in renewable energy, investments are also needed in the efficient use of energy and in industrial and domestic heating & cooling. For example, IEA estimates that investment in energy efficiency must grow 2 to 7 fold to deliver on the sector's contribution to decarbonization. Other recommendations for G20 action towards the energy sector transformation include:

- Avoiding lock-in of new fossil fuel intensive infrastructure and cooperate on a just coal phase-out;
- Removing fossil fuel subsidies in a socially acceptable manner and plan for just fossil fuel phase-out;
- Removing barriers to expansion of renewables and invest in system flexibility, interconnections, and energy-efficiency to enable the energy transformation.

Industry

Achieving net-zero emissions in the industry sector is considered challenging but possible. The industry sector is currently the largest contributor to total emissions when direct and indirect emissions are included. If emissions from electricity and heat production are attributed to industry, the sector accounts for 24 per cent of relative GHG emissions

Figure 4 : Share of Renewables in Energy Mix, 2022



(direct emissions 6 per cent). The annual GHG emissions, between 2010 and 2019, continued to grow but slowed compared to the previous decade in industry from 3.4 per cent to 1.4 per cent.

Industry efforts to reduce emissions will require coordinated action throughout value chains, including demand management, energy and materials efficiency, circular material flows, as well as abatement technologies, and new solutions in production processes. The sectoral transformation, including carbon capture and storage, is expected to create new jobs and opportunities in processes using zero GHG electricity, hydrogen, fuels, and carbon management. In industry, electrification and circular material flows contribute to reduced environmental pressure and increased economic activity & employment.

The sector is estimated to have feasible solutions which can deliver at least 5.4 Gigaton of emission reductions by 2030. G20 members should, at the soonest:

- Promote efficiency, circularity and electrification;
- Support research and innovation, and reduce demand for carbon intensive cement and steel production;
- Support and cooperate on carbon pricing mechanisms; and
- Cooperate on hydrogen, basic minerals and materials, and plan for a just transformation.

Transport

The transport sector was the fastest growing fossil fuel combustion sector worldwide from 2010 to 2019, with sectoral emissions rising more than 17 per cent during this period. Transportation is the second-highest emitting sector and the global vehicle fleet is set to double in size by 2050. Decarbonising the transport sector is essential to meet the Paris climate targets and the sector holds at least 4.7 Gigaton worth of emission reduction potential per year at a cost of less than $100/ton. To keep the rise in global temperature below 2 degrees Celsius, annual transport emissions must be reduced to 6.5 gigatons of CO2 or less by 2050; and to keep the rise below 1.5 °C, emissions must be reduced to roughly 3 gigatons of CO2 or less.

While most G20 countries have started decarbonizing their transport sectors, a global approach should aim at introducing zero emissions fleets worldwide and must also include measures to promote walking, cycling and public transport. To meet the targets of the Paris Agreement, all vehicles being added to the global fleet should be zero emissions by 2035 (IPCC 2018).

The Emissions Gap Report (2022) estimates that annual investment in decarbonizing the transport sector needs to increase seven fold, compared to 2017-2020 levels, to deliver the emission reductions needed from the sector by 2030. G20 members can take the following action to speed up the transition to sustainable transportation through:

- Three groups of interventions; AVOID transport (for example through better city planning); SHIFT to more efficient modes (such as walking, cycling and public transport); and IMPROVE transport modes (by introducing zero emissions electric motor vehicles).
- Elimination of fossil fuel subsidies and phasing out internal combustion engines and a shift of finance to low carbon and resilient transport options.
- Accelerated electrification of buses, cars, vans, and two and three wheelers accompanied by low carbon

electricity supply and advanced grid integration.
- Inclusion of maritime and aviation sectors in global transport decarbonization efforts.

Food Systems

Food systems are major contributors to land-use change, biodiversity, depletion of freshwater resources, pollution and climate change. The food system is currently responsible for about one-third of total emissions (~18 Gigaton Co2e/year), more than 40 per cent of anthropogenic methane emissions, and two-third of overall global anthropogenic N2O emissions. Projections show that food system emissions could reach ~30 GtCo2e/year by 2050 and rapid transformation across the sector is needed to align with the Paris Agreement. According to IPCC Sixth Assessment Report, carbon sequestration in agriculture can contribute 1.8-4.1 GtCO2-eq /year reduction. Demand-side and material substitution measures, such as shifting to balanced, sustainable healthy diets, reducing food loss and waste, and using bio-materials, can contribute 2.1 GtCO2-eq/year reduction. In addition, demand-side measures together with the sustainable intensification of agriculture can reduce ecosystem conversion and CH4 and N2O emissions. Adding up all GHG reduction potential (including energy, land-use change) for food systems, the reduction potential is about 6.7 Gigaton/year between now and 2030, and the Emissions Gap Report (2022) estimates that by 2050, the reduction potential could be 24.7 GtCo2e/year, with major health and food security benefits. GHG reduction contribution by food systems will require a 10-31 times higher investment flows compared to 2017-2020. G20 members can support this transition through:

- Alignment of food system governance with climate and health objectives, e.g., reforming dietary guidelines and labelling;
- Update fiscal policies, including taxation and subsidies to contribute to the needed food system transformation;
- Support on-farm, food industry and retailers investments in emission reductions through regulations and targeted investments in manure management and renewable energy; and
- Strengthen international cooperation to ensure a just transition and enhanced resilience of the food system to climate change

Ecosystems

The world still loses 10 million hectares of forests annually, and deforestation and forest degradation account for approximately 11 per cent of emissions. Forests and nature-based solutions provide an intervention with high adaptation and mitigation & livelihood benefits to around 400 million people who live within one kilometer of a forest in G20 member states alone. Eight G20 members are among the top 10 countries with the largest forest area. In fact, the G20 declared a commitment to halt and reverse deforestation and biodiversity loss by 2030.

Nature is not a substitute for other decarbonization pathways but ecosystem conservation and restoration can make a substantial, high-return contribution to building resilience to climate change. Large-scale investments in dryland agriculture, mangrove protection and water management can generate benefits worth around four times the original investment. Nature-based solutions are cost-effective, easily available and proven to deliver high livelihood returns.

Reducing Emissions from Deforestation and Forest Degradation (REDD+) is one of the cheapest opportunity for large-scale climate change mitigation and adaptation.

The G20 Indian Presidency provides the opportunity to translate the growing political ambition for nature into real commitments and a decade of action to enhance mitigation benefits by around six Gigaton/year between now and 2030. This can be done through the three Rio Conventions and action platforms, such as the UN Decade of Action for the SDGs and the UN Decade on Ecosystem Restoration 2021-2030. Both provide large-scale contributions to achieve the Sustainable Development Goals (SDGs), ensure food security and address climate change.

A number of new programmes on oceans, forests and food systems could further accelerate climate action and mobilize private investments. For example, the Green Gigaton Challenge with the UN-REDD Programme can boost the market for forest-based carbon, lifting REDD+ from a niche solution to a major pillar of the Paris Agreement.

Lifestyles

Lifestyle is not directly a sectoral solution but lifestyle does connect to sectoral solutions, e.g. housing, mobility, and food, account on average for 70 per cent of an individual's emissions. Lifestyles are also at the heart of building the political support and consumer demand for low carbon policies and solutions as ensured by the initiative on Lifestyles for Environment (LiFE) proposed by the G20 Indian Presidency.

At a combined GDP of 85 per cent of the global GDP, G20 countries have a distinct role in shaping global lifestyles and consumer behavior. The wealthiest one per cent of households, are responsible for around 15 per cent of global emissions, more than the combined share of the least wealthy 50 per cent of the global population.

The top 10 per cent wealthiest people (some 782 million people) can be found across all continents, and they account for about half of all emissions. Around 85 per cent live in advanced economies – including Australia, Canada, China, the European Union, Japan, Korea, the United States, and United Kingdom. The rest are from Russia, Saudi Arabia and South Africa, countries with fossil fuel-intensive energy mixes and relatively high income inequality.

It is well known that the average level of consumption emissions varies substantially between countries. For example, per capita consumption emissions in the USA are approximately 17.5 tons CO2e per capita, which is around 10 times that of India at 1.7 tons per capita. By contrast, the nations of Europe have an average footprint of 6.9 tons per capita. Per capita emissions are an often-highlighted measure when discussing "common but differentiated responsibilities". While it provides a useful insight, these per capita averages mask significant variation among households within countries and globally.

Addressing unsustainable lifestyle emissions holistically requires therefore a deeper understanding of how consumption emissions are distributed among populations and by activities so that mitigation measures can be targeted in a way that is equitable encouraging reductions from households with the highest consumption emissions and avoiding negative social impacts. For example, Oswald *et al.* (2020) estimate that the top 10 per cent wealthiest households use around 45 per cent of all the energy used for land transport and around 75

per cent of all energy linked to aviation, compared to just 10 per cent and 5 per cent respectively for the poorest 50 per cent households.

Addressing lifestyle emissions of the wealthiest segments of the population does not only deliver the highest emission reductions but it also focuses on people who are able to pay for any additional cost that the transition requires. The potential to rapidly reduce demand for energy and resources via lifestyles remains largely untapped. To some extent this is unsurprising given the politically controversial nature of lifestyle change, which often seeks a shift in focus away from a continuous growth agenda towards equity and wellbeing within ecological limits. Arguments for promoting sustainable lifestyles may challenge powerful vested interests and raise concerns about economic stability. Bridging structural barriers to lifestyle change requires understanding the power dynamics that come into play, and agency, or lack thereof, in rethinking public policy and governance, and navigating corporate interests (Akenji, 2019).

G20 members can address lifestyle emissions through focus on the wealthiest segments of the populations and use of "Avoid, Shift and Improve" principles and country appropriate solutions. The participation of actors and groups across civil society, as well as government, is needed to ensure this happens in ways that meet basic needs and preserve people's wellbeing while achieving substantial and rapid cuts in GHG emissions.

Way Forward

The task facing the world is enormous. Setting ambitious targets is not sufficient and large-scale, rapid sector-wise decarbonization and system transformation is required and must happen now to peak emissions by 2025.

The IPCC sixth Assessment Report has called for an emission reduction of 45 per cent under current policy projections, whereas current commitments are estimated to reduce emissions by 5 to 10 per cent depending on the conditionality of the NDCs. To close the emissions gap, G20 members must strengthen their national and collective ambition, and more importantly accelerate implementation of their existing targets.

Collectively, the G20 members are not on track to achieve their current NDCs. There is an implementation gap, which the Emissions Gap Reports (2022) estimates to 1.8-2.6 GtCO2e annually depending on assumptions. Beyond G20, the global implementation gap for 2030 is estimated at 3-6 GtCO2e depending on the conditionality of the NDC targets.

Setting the ambition is the first step in designing development pathways to match the temperature pathways of the Paris Agreement. However, most G20 countries also have a policy discrepancy where fossil fuel production plans present a misalignment with their Nationally Determined Contribution. Since the beginning of the COVID-19 pandemic, G20 countries had directed $300 billion in new funds to fossil fuel activities by 2021. Fossil fuel producing governments had plans and projections for fossil fuel production that would lead to around 240 per cent more coal, 71 per cent more gas, and 57 per cent more oil which would be consistent with limiting global warming to 1.5°C.

To close the ambition gap, further ambition is needed to align G20 member NDCs and their sectoral targets with the Paris Agreement temperature goal. Mexico needs to join other G20 members with a commitment to net-zero, and Argentina, Australia, Brazil, China, India,

Indonesia, Saudi Arabia, South Africa and the USA should upgrade their net-zero commitment to law. Each G20 country must review its pathway to net-zero and provide its economy with credible economy-wide and sectoral pathways (policies and budget allocations) which align with the magnitude of the task ahead.

Endnotes

[1] Achieving net-zero targets in addition to unconditional NDCs results in keeping projected global warming to 1.8°C (range: 1.8–2.1°C) with a 66 per cent chance. United Nations Environment Programme (2022). Emissions Gap Report 2022.

[2] 74 NDCs from parties representing 77 per cent of global emissions.

[3] European and North American countries have started from a high base of per capita and/or cumulative emissions.

[4] WEF 2022 White paper on Green Public Procurement www.weforum.org/whitepapers/green-public-procurement-catalysing-the-net-zero-economy

Research Article

Fast Action on Methane Emissions as a Climate and Energy Security Imperative

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System for Developing
Countries (RIS).

Roland Kupers[*], Manfredi Caltagirone[*] and Mark Radka[**]

Abstract: Ambitious methane emission reductions are an integral part of any realistic climate agenda. Indeed, the Paris targets are out of reach without such reductions. Fortunately, many are cost effective and/or technically feasible. The IEA estimates that G20 countries account for 63 per cent of anthropogenic methane emissions. The G20 has already taken a leadership role; acknowledging in 2021 that methane emissions represent a significant contribution to climate change, promoting several initiatives. Furthermore, the climate consequences of methane emissions might be exacerbated as G20 countries through hydrogen emissions inhibit the breakdown of methane in the atmosphere.

Introduction

One challenge with reducing CO_2 emissions is that they are the result of the primary process of generating useful energy. In contrast, industrial emissions of methane and hydrogen are side effects in most sectors. They are waste streams that can potentially be eliminated or greatly reduced, with relative ease. Both gases have a very strong warming effect, many times stronger that CO_2 but with shorter duration, and the emissions have a great impact on warming. But targeted reduction requires more precise data on source of the emissions. Most scientific work has historically been focused on assessing the global or regional volume of emissions of various greenhouse gases. Local emissions have overwhelmingly been estimated using emission factors, not empirical measurements. This has hindered progress on mitigation, as actual localised data is imperative to efficiently allocate efforts and investments towards reductions by those individuals with the potential agency to tackle them.

Investments in empirical science studies over the past decade are starting to pay off in several sectors, most notably the energy sector where the largest reduction potential lies (UNEP/CCAC Global Methane Assessment, 2021). It has now become possible for site managers to effectively measure methane emissions, to direct their mitigation efforts rapidly and effectively. Enabling local empirical emission measurements that advance mitigation is nothing less than a data revolution for climate action on methane: from global empirical data with local estimates, to local empirical data that is reconciled with the global picture This ensures that the whole of the emissions are the proverbial sum of the parts.

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The Figure 1 shows the current best estimate of methane emissions in various sectors of G20 countries. However, this does not include emissions embedded in imported products, which would substantially increase especially the EU in the energy sector.

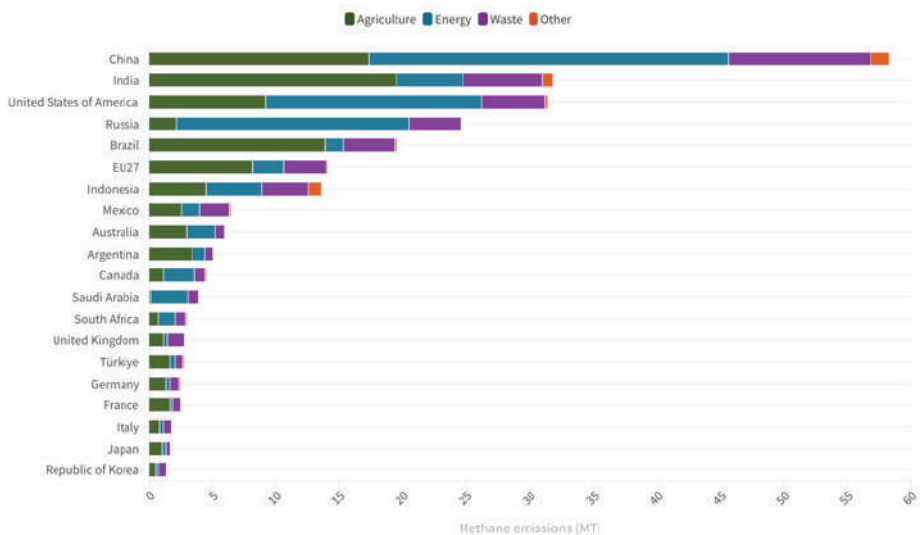
While the greatest reduction potential undoubtedly lies in the energy sector in the coming years rapid progress is expected in the availability of local data on emissions from the other sectors such as livestock, rice, solid waste and water. As described below, the mitigation potential, methods and agency varies greatly between sectors, and each should be considered separately. In contrast, for hydrogen, the scientific work is just starting.

Methane: Over 80 Times More Potent than CO_2

To stay on track to reach the Paris Agreement goal of limiting climate change to 1.5°C, the world needs to almost halve greenhouse gas emissions by 2030. The Intergovernmental Panel on Climate Change notes that if the world is to achieve the 1.5°C temperature target, deep methane emissions reductions must be achieved over this time:

"As highlighted by IPCC, if the world is serious about avoiding the worst effects of climate change, we need to cut methane emissions from the fossil fuel industry. But this is not a get-out-of-jail free card: methane reductions must go hand in hand with actions to decarbonize the energy

Figure 1: Estimates of Methane Emissions from Anthropogenic Souces Among G20 Members



Source: IEA's Global Methane Tracker 2022 https://www.iea.org/reports/global-methane-tracker-2022
UNFCCC GHG inventory (2020 data for the EU27 and Türkiye only) https://di.unfccc.int/

system to limit warming to 1.5°C, as called for in the Paris Agreement".

Methane released directly into the atmosphere is more than 80 times as potent as CO_2 over a 20-year time horizon. However, as methane's atmospheric lifespan is relatively short at 10 to 12 years, actions to cut methane emissions can yield the most immediate reduction in the rate of warming, while also delivering air quality benefits.

Mitigating methane emissions is entirely compatible with the push for net zero and the Paris climate targets.

Box 1: Green Hydrogen, Climate Change, and the Energy Transition

Governments and the private sector are showing great interest in "green hydrogen", particularly for the so-called hard to abate sectors. The IPCC (2022) notes that for "almost all basic materials – primary metals, building materials and chemicals – many low- to zero-GHG intensity production processes are at the pilot to near-commercial and in some cases commercial stage, but they are not yet established industrial practice. Low-emissions hydrogen could also reduce CO_2 emissions from shipping, aviation, and heavy-duty land transport if production process improve and costs decline. (IEA, 2019, 2021; IRENA, 2021; The Economist, 2020). Hydrogen, however, slows the destruction of methane in the atmosphere and therefore has an indirect global warming effect. Any push toward hydrogen must therefore take into consideration the negative environmental consequences of this shift to a new energy carrier.

Green hydrogen is produced through electrolysis, the process where electricity from renewable energy sources is used to separate water into hydrogen and oxygen molecules. If the energy comes from net additional renewable sources, the process itself does not release any carbon into the atmosphere.

Almost all 90 million tons of hydrogen production today involves fossil fuels. The main uses are in oil refining, the production of ammonia and methanol, and direct reduction of iron in steel production (IEA, 2021). The IEA estimates that at present fossil gas accounts for around three-quarters of the annual global dedicated hydrogen production, using around 6 per cent of global fossil gas use. Coal comes next, due to its dominant role in China: it accounts for an estimated 23 per cent of global dedicated hydrogen production and uses 2 per cent of global coal use (IEA, 2021; IEA, 2019; IRENA, 2021).

The cost of hydrogen produced using fossil fuels and CO_2-free alternatives is at present significant, but is projected to fall to fossil fuel parity by 2050. Given these cost trajectories, the Hydrogen Council and McKinsey estimate that $500 billion will be invested in hydrogen production infrastructure by 2030.

A massive build out of renewable energy infrastructure is required to achieve net zero emissions, so until there is a net surplus of renewable electricity, producing green hydrogen will prolong the operating life of fossil power plants. Another consideration is that in many developing countries new renewable energy production might arguably be better used to meet basic energy needs, particularly in sub-Saharan Africa where the global goal of universal access to electricity is far from being attained.

An important environmental consideration regarding hydrogen's role in our energy future is its role as a greenhouse gas. Hydrogen leaks easily and reacts with tropospheric hydroxyl radicals so that emissions of hydrogen to the atmosphere act to prolong atmospheric concentrations of methane and ozone. Hydrogen is therefore an indirect greenhouse gas with a global warming potential that is estimated to be 33 over a 20-year time horizon (Warwick *et al.*, 2022; Colombia University, 2022; Ocko and Hamburg, 2022, Frazer-Nash, 2022; Falko *et al.*, 2021). Arguably the 20-year GWP is appropriate because of the relatively short atmospheric lifetime of hydrogen compared with CO_2.

Estimates of hydrogen's GWP and great uncertainties regarding fugitive emissions rates point to the need for exercising caution. Most measurement and detection protocols are designed with safety as an objective, not environmental consequences. In this regard hydrogen is similar to methane and only now is the industry monitoring emissions, reducing them, and reporting. The same needs to be done for hydrogen, in addition to undertaking more research and modelling. Considering realistic estimates of both methane and hydrogen emissions, green hydrogen has the potential to be less climate intensive than the fossil fuel it replaces, but it will not have zero climate impact (Ocko and Hamburg, 2022).

Under any decarbonization scenario, substantially reducing methane emissions has a great climate benefit. In fact, without it, the target are all but unattainable. Consequently, ambitious methane reductions are an integral part of any realistic climate agenda. There are also no real trade-offs between mitigation of methane and carbon dioxide, and they should be pursued concurrently. China had drafted its own methane strategy to control emissions in the energy, agriculture and waste treatment sector (Reuters, 2022).

Upside Opportunities for G20 Action on Methane

Recalling that cutting human-caused methane by 45 per cent this decade would keep warming beneath a threshold agreed by world leaders, G20 Italy summit in 2021 acknowledged that methane emissions represent a significant contribution to climate change, and welcome the contribution of various institutions, including the establishment of the UNEP International Methane Emissions Observatory (IMEO).

UNEP's IMEO catalyzes the collection, reconciliation, and integration of empirically based near real time methane emissions data, to provide unprecedented climate transparency and the information required for action. Closely involving and partnering with many other players in methane mitigation such as energy companies, the Global Methane Hub (GMH), satellite providers, and NGOs, it is one of the implementation partners for the Global Methane Pledge (GMP).

The GMP engages over 150 participating countries across sectors and needs a sectoral delineation of commitments. Also, as noted above the private sector has a critical role to play in reducing emissions from the energy sector in the short-term. As part of its implementation role under the GMP, UNEP's IMEO developed a robust framework for engaging the oil and industry that has established itself as the gold standard of transparency for the sector. The Oil and Gas Methane Partnership 2.0 (OGMP 2.0) commits energy companies to measuring, reporting and mitigating their emissions; but progress is uneven. There is great potential upside for methane mitigation by the G20 members. Two years after its launch, fewer than half (9/20) of G20 members have national companies as members of OGMP 2.0, although a higher share (14/20) of domestic assets is reported to UNEP through their foreign holdings. Only three G20 members have engaged in IMEO, notwithstanding the majority (15/20) being members of the Global Methane Pledge. There is an opportunity for climate action on methane with G20 countries aligning their commitments on methane emission abatement.

G20 countries account for approximatively 63 per cent of global oil and gas production, but OGMP 2.0 currently has merely 29 per cent coverage of G20 countries' oil and gas production. For countries outside G20, it has 50 per cent coverage. Overall, 37 per cent of global oil and gas production is covered by OGMP 2.0. This underrepresentation of industry in the G20 countries represents a clear opportunity for progress.

Collective Action is Needed for Solving Complex Problems

As in many environmental issues, the concept of LiFE (Lifestyle For Environment) is applicable to the behavioural aspects of tackling methane emissions. To mitigate methane emissions, it is action by individuals that

are required to enact change and the idea of LiFE is to develop ways to change behaviour at scale (Government of India, Ministry of Environment, Forest and Climate Change, 2022). For methane, the world is rightly focused on regulatory and policy measures, but these government frameworks shape the context that guides individual behaviour. India has demonstrated this in several sectors such as the Ujjwala Scheme to increase LPG use in the home or the Swachh Bharat Mission to construct toilets in rural areas. Collective action is not an alternative to regulatory measures, but the mechanism through which action is delivered.

For methane, the collective action required is often not by consumers, but it still concerns individuals, such as asset managers of oil and gas installations, government shareholders who approve capital allocation for mitigation, steel company procurement managers who specify the methane content of coking coal, investors who are not satisfied with estimates and require empirical emissions data, individuals who make dietary choices, rice farmers who change their flooding practice, citizens who separate organic matter from waste, among others. All these actors need to evolve their behaviour for a collective outcome.

In the instance of methane emissions, three aspects require attention to drive this collective action:

First, there is awareness of the seriousness of the issue and opportunity for climate action. It is still relatively recent that attention has focussed beyond CO_2. Since 2012, the Climate and Clean Air Coalition (CCAC) has highlighted the importance of short-term pollutants as part of an effective climate policy.

Second, there is empirical data for measurement data. Without quantification of emissions, it is not possible to prioritise actions and investments towards the largest sources. Critically, the data must be direct measurement data, not generic emission factors and tailored to the scale of the individuals who are able to take action at the facility or site level.

Third, it is to ensure that individuals who are in a position to act have the agency to do so. In the energy industry, most often these will be asset or site managers. As in all LiFE campaigns, this means that they must change behaviour from what they were in the past. Social norms must change in the sector to make methane mitigation a priority, such as safety. This requires a combination of motivation, empowerment or sometimes even compulsion. Involving the individuals at the site level in the direct measurements and providing information on the impact of emissions can help motivate them. A supportive environment that gives these individuals access to the means to act and recognises them for doing so is imperative. This will be strengthened by rules and regulations that make mitigation more compulsory.

Elaborating Experiences and Approaches

Partnerships in the Energy Sector

Lifestyle for Environment, introduced by Prime Minister Modi at COP26, encourages a focus on mindful and deliberate utilisation of resources and encourages individuals to adopt simple changes in their daily life that can contribute to climate change. Consistently with the LiFE approach, UNEP has developed partnerships with the individuals who have the agency to mitigate emissions in methane assets. These partnerships also function to develop and agree a global Measurement, Reporting and Verification (MRV)

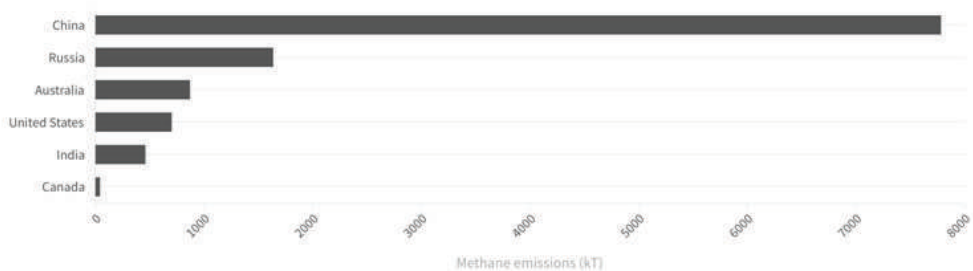
standard for the different sectors.The Oil and Gas Methane Partnership 2.0 (OGMP 2.0) currently brings together over one hundred companies from five continents, representing over a third of oil and gas production. Member companies strive for a defined Gold Standard level of measurement, reporting and mitigation. UNEP assesses the reports for consistency and quality and reports the results to the public. A similar initiative focus on methane emissions from mining metallurgical coal used in producing steel, a "hard to abate" industrial sector, having the potential to reduce the carbon footprint of steel production by up to one third. This could make material difference on G20 emissions considering its members represent the vast majority of steel demand and metallurgical coal production.

For the oil and gas sector, methane emissions are a consequence of extraction, processing, and delivery, either intentional (venting and flaring) or unintentional (equipment leaks). Methane is emitted because of a combination of design choices in equipment, operational practices and equipment failures or leaks. As such, many mitigation measures can be readily engineered, without impacting the main processes of producing oil and gas. An additional benefit is that often by reducing methane emissions, the captured product can be sold, offsetting some of the cost.

Consequently, oil and gas operations that target near-zero methane emissions (for example, a methane intensity target of 0.2 per cent) are entirely plausible without greatly affecting operational activities, although potentially adding some cost and obviously not addressing the impact of consuming the product. The primary agents of change are the asset managers, who must plan, implement, and monitor the changes in equipment or process. To prioritize mitigation actions cost-effectively, asset managers need to have a comprehensive understanding of the scope and scale of emissions across infrastructure. They need access to the required resources from the company capital allocation process. They also need to be encouraged by company priorities, the regulatory context, as well as the social norms of their industrial community.

Metallurgical coal is used to produce steel. During mining operations methane is released from the coal seams and primarily managed for safety concerns. Emissions can fluctuate widely as they result from processes such as the displacement of natural soil layers or microbiological activities. Mitigation actions must not affect safety in any way, which means that the methane is diluted as quickly as

Figure 2: Estimates of Methane Emissions Coking Coal Mining in G20 Countries



Source: IEA's Global Methane Tracker 2022 https://www.iea.org/reports/global-methane-tracker-2022 and IMEO's own calculations
G20 countries account for >90% of worldwide coal mine methane emissions from coking coal.

possible during underground operations. The main mitigation option is drainage of the methane from the mine before production, which both increases safety and delivers higher-concentration streams of gas that can be destroyed or monetized. The other important mitigation option is destruction of Ventilated Air Methane (VAM), a technology that is already operational in several mines around the world and needs to be substantially scaled up.

While a substantial reduction in the emissions of the steel sector by lowering the methane emissions in its supply chain appears technically realistic, the incentive structure is more complicated than it it for oil and gas sectors. As with the oil and gas sector, participants in the metallurgical coal sector have ready access to capital and knowledge, and the asset managers generally have a high degree of agency over their emissions.

Better Actionable Data

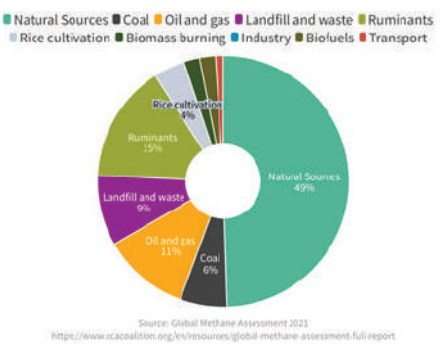
To deliver the Global Methane Pledge and remain within the envelope of global temperature rise, requires reliable actionable data for the individuals who act to reduce 150 Mt of methane emissions across all sectors by 2030. UNEP launched IMEO at the G20 for this purpose. Working with research institutions and companies, UNEP's IMEO assembles and integrates emissions data from multiple sources at the site and regional levels, into a public data set – diligently noting their uncertainty range.

A prominent example of this effort is IMEO's Methane Alert and Response System (MARS) launched at COP27. This integrates detections from multiple satellites into a comprehensive and consistent view, and generates alerts to the emitters, while registering subsequent mitigation results. The success of the system is predicated on clear focal points for each major asset, at each oil and gas company and for each government concerned. Having a dedicated MARS focal point in each G20 country is a small and necessary implementation step.

Beyond Energy

Beyond the energy sector, livestock, rice and waste are estimated to represent almost two-third of anthropogenic methane emissions. It is recognized that the greatest short-term mitigation potential is in the energy sector, but reductions will be required to meet GMP aims. While there are many organisations and individuals that are already involved in mitigation action for these sectors, assembling a global dataset of measured emissions is a necessary step to focus and direct the collective action required in these sectors.

Figure 3: Share of Different Methane Emission Sources (Estimates)



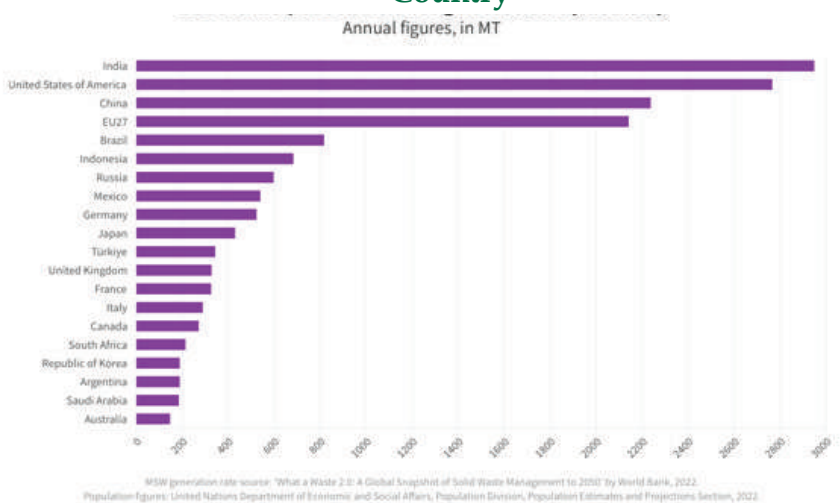
In the solid waste sector, methane emissions stem exclusively from the organic component of the waste, which comprises 30-50 per cent of waste streams. Organic waste in anaerobic conditions is decomposed by bacteria, which produces methane that escapes into the atmosphere if not captured. Globally, around 37 per

cent of municipal solid waste is disposed of in some type of landfill, 33 per cent is openly dumped, 19 per cent undergoes materials recovery through recycling and composting, and 11 per cent is treated through modern incineration (World Bank, 2018). These systems are highly diverse, ranging from highly managed facilities to unmanaged dumps.

Upstream mitigation, such as the separation of organic and non-organic waste at the household or commercial level, can reduce methane emissions if the organic waste is properly managed (through anaerobic digestion, composting, combustion, etc.). In principle, targets for near-zero methane emissions are technically possible, but they are harder to achieve.

The solutions to mitigate methane emissions from rice production are relatively well established. The source of emissions is anaerobic decomposition of organic matter in flooded rice paddies. Mitigation can be accomplished through management practices such as alternate wetting and drying, direct seeding, using short-duration varieties and shifting to different crops. However, it is important to ensure that the interplay between methane and nitrous oxide is also considered, given that in reducing one of these greenhouse gases, it is easy to inadvertently increase the other. How

Figure 4: G20 Municipal Solid Waste Generation by Country



these emissions vary over space and time is not well understood.

This is a sector where the LiFE approach holds promise, as the key is behavioral change by a large number of individual farmers. Livestock produce methane both through the digestion of feed in ruminant animals (i.e., enteric fermentation in cattle, buffalo, sheep) and the operations through the handling and storage of liquid manure. Unsurprisingly, emissions vary greatly by animal type, feed quantity and quality, and environmental context. These emissions are part of meat and dairy supply chains. As such, the methane footprint of livestock is deeply interconnected with food security,

cultural and behavioural patterns of food consumption, and, in many parts of the world, rural livelihoods.

The livestock sector is further complicated because concentrating and intensifying livestock production can reduce enteric methane emissions per unit of output but increase absolute emissions of methane. Concentrated livestock facilities also have animal welfare and health implications, such as contributing to increased antibiotic resistance (UNEP, 2023). There is a need for better quantification of methane emissions in intensive and extensive livestock systems, especially in low- and middle-income countries.

In all five sectors, it is essential to establish a public record of empirical data, collected through state-of-the-art scientific methods. This allows for a characterization of uncertainty and provides the various actors of the methane ecosystem with a sound basis for action.

Conclusion

Mitigating methane from the main emitting sectors of fossil fuels, waste, livestock and rice should be a priority under any climate strategy. The most cost-effective and highest degree of agency exists in the oil and gas, as well as metallurgical coal sectors. A trusted set of empirically verified emissions data is essential for any collective action, and UNEP's IMEO has been designed for this purpose. Individual behavioral change programs, such as LiFE should be part of the solution, as action ineluctably is taken by individuals in any instance. We also draw attention to take early action in the growing hydrogen industry, to learn from the lessons of methane mitigation and make the climate consequences of hydrogen emissions an integrated component of the sector.

The G20 has demonstrated a strong focus and concern with limiting methane emissions in its declarations in Article 26 of the 2021 Rome summit communiqué, notably enabling the launch of UNEP's IMEO. In the last two years much progress has been made, and there is an opportunity to do more to accelerate climate mitigation.

The following is a list of five suggested short-term actions by the G20.

- As stated in the EU Joint Declaration from Energy Importers and Exporters on reducing Greenhouse Gas Emission from Fossil Fuels, fossil fuel energy producers can implement projects and support measures to significantly reduce emission across fossil fuel energy operations.
- A G20 statement underscoring the essential role of empirical data at the granularity of the entity that has the agency to mitigate the emissions, is both essential and highly innovative in climate policy. Most data efforts have been global or regional, and achieving higher precision and granularity coherent with agency is an important statement. Two years after its launch fewer than half (8/20) of G20 members have national companies as members of OGMP 2.0. If G20 countries would encourage their national oil and gas companies to join OGMP 2.0, this would increase global coverage from 35 per cent to 80 per cent of production.
- At the Rome summit, the G20 facilitated the IMEO launch and encouraged members to support the initiative. To date, only three G20 members have contributed funding to IMEO, notwithstanding the majority (15/20) being members of the Global Methane Pledge.

Since the Pledge was created after the Rome G20 summit, there is an opportunity for climate action on methane with G20 countries aligning their commitments on methane emission abatement by supporting IMEO directly.

- Steel production accounts for seven percent of global CO_2 emissions. Under any realistic decarbonisation pathways, mitigating methane emissions from the metallurgical coal production can reduce the climate footprint of steel by up to one third. Reducing emissions in the steel industry and its supply chain should be a priority. Steel companies are called on to include methane emissions from metallurgical coal in their environmental considerations.
- To avoid offsetting gains in reducing methane emissions, avoiding hydrogen emissions from the very start is imperative to the contribution of the gas in the energy transition. Hydrogen emissions are potentially large and have a strong warming effect.

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Research Article

G20 Actions for Deepening the Sustainability of Infrastructure Systems

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Abstract: The forthcoming wave of infrastructure investment is critical for responding to contemporary global crises. A deeper focus on sustainability is required to address the complex web of infrastructure service needs, underlying vulnerabilities and multiple policy objectives. Infrastructure and sustainability considerations have gradually gathered momentum in the G20 while, in 2023, the impact of infrastructure on lifestyles has garnered increased attention. This paper examines the International Good Practice Principles for Sustainable Infrastructure as a complement to the G20 Principles for Quality Infrastructure Investment. It sets out a rationale for integrating the natural environment as an intrinsic component of infrastructure systems that support sustainable lifestyles.

Introduction

Infrastructure underpins the world's economies and societies, providing essential services for day-to-day living like water and sanitation, food, energy, mobility, healthcare and education, *inter alia*. Indeed, infrastructure influences all of the United Nations Sustainable Development Goals (UN SDGs), including 92 per cent of the individual SDG targets (Thacker *et al.*, 2018). Infrastructure is also vital since it shapes and influences the way societies organise everyday life and their systems of accessing services, production and consumption.

In the organisation of G20 meetings and present global context, infrastructure represents a cross-cutting theme in the context of development and a dedicated G20 Working Group on infrastructure deals with those issues. As G20 members face overlapping planetary, political, economic and health crises,

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responsive and resilient infrastructure systems are needed as the backbone of socio-economic functionality. Enabling infrastructure assets and the services they provide are required to unlock sustainable lifestyles, as highlighted in Lifestyle for Environment (LiFE) movement, now reflected in the G20 Lifestyles for Sustainable Development Approach (G20, 2023a). Yet, the world's stock of infrastructure is currently responsible for an estimated 79 per cent of global greenhouse gas emissions (UN Office for Project Services [UNOPS], UN Environment Programme [UNEP] and University of Oxford, 2021), while contributing to pollution and nature loss (Seiler, 2003). To build more resilient communities and support environment-friendly lifestyles, the G20's actions on infrastructure require a deeper focus on sustainability.

Sustainable infrastructure systems can be considered those that are "planned, designed, constructed, operated and decommissioned in a manner that ensures economic and financial, social, environmental (including climate resilience), and institutional sustainability over the entire infrastructure life cycle" (UNEP, 2022a). As such, this understanding of sustainable infrastructure is not restricted to certain types of infrastructure or specific sectors, but rather focuses on outcomes, based on a holistic understanding of sustainability. Amid the recent context of overlapping crises including climate change, biodiversity loss, conflict, pandemics and the cost of living, there is a need for an integrated approach that recognise infrastructure systems comprise interlinked components of the built, natural and enabling environments. Public budgets are increasingly constrained following the COVID-19 pandemic, meaning infrastructure policies and investment must be carefully targeted to deliver critical services and promote resilience and sustainable lifestyles. By conceptualising a deeper environmental perspective for sustainable infrastructure systems through integrating nature and circularity - as explained later, the G20, under India's presidency in 2023, can drive Lifestyles for Sustainable Development and simultaneously address the priorities and risks stemming from the current global circumstances.

At the Fifth Session of the UN Environment Assembly (UNEA) in 2022, UN member states adopted a resolution on sustainable and resilient infrastructure (UNEP/EA.5/Res.9). This encourages all UN member states to promote investment in natural infrastructure and nature-based solutions as key components of systems-level strategic approaches to infrastructure planning and development. The UNEA resolution also recognises the 10 *International Good Practice Principles for Sustainable Infrastructure* ("SI Principles") that were endorsed across the UN system (UNEP, 2022a). Building on the *G20 Principles for Quality Infrastructure Investment* ("QII Principles"), the holistic environmental considerations reflected in the SI Principles provide a complement to the QII Principles and a rationale for more effective environmental action among G20 members.

Infrastructure and the G20

Infrastructure appeared as a topic in the initial G20 Washington Declaration in 2008, and later grew in prominence in 2014 at the Brisbane Summit. This heralded the "G20 Global Infrastructure Initiative", as a multi-year programme to support public and private investment in quality infrastructure. The Global Infrastructure Hub was then created to provide dedicated resources to help implement

the programme. Thematically, the early focus was on improving domestic investment and financing environments, with the Global Infrastructure Hub charged with working collaboratively with governments, the private sector, national, regional and multilateral development banks, international organisations and other stakeholders.

Efforts continued to focus on scaling up investment, and the *Roadmap to Infrastructure as an Asset Class* sought to help mobilise more capital for infrastructure (Global Infrastructure Hub, 2018). In 2019, the Japanese G20 Presidency recognised infrastructure as a driver of economic growth and prosperity and endorsed the QII Principles to emphasise quality. The six QII Principles provide a high-level strategic direction, covering: 1) Maximising the positive impact of infrastructure to achieve sustainable growth and development; 2) Raising economic efficiency in view of life-cycle cost; 3) Integrating environmental considerations in infrastructure investments; 4) Building resilience against natural disasters and other risks; 5) Integrating social considerations in infrastructure investment and 6) Strengthening infrastructure governance (G20, 2019). Importantly, these principles started to articulate a more holistic view of infrastructure and its impacts and benefits, focusing on the project-level.

In 2021, the Italian Presidency reiterated the role of the QII Principles and emphasised the importance of a more systematic analysis of macroeconomic risks including those stemming from climate change. This brought consideration of the costs and benefits of different transitions, as well as macroeconomic and distributional impacts of risk prevention strategies and climate mitigation and adaptation policies. A growing recognition of climate and environmental dimensions was therefore observable moving into the Indonesian Presidency in 2022. Sustainability considerations were incorporated into additional finance-focused work completed, while a *Compendium of Quality Infrastructure Investment Indicators* was produced in line with the QII Principles (G20, 2022b). In November 2022, the G20 Bali Leaders' Declaration included a commitment to promote investment in sustainable infrastructure and industry, and highlighted key environmental issues that are closely related to infrastructure (G20, 2022a). These included nature-based solutions, resource efficiency and circular economy, implementation actions to support Nationally Determined Contributions and net-zero commitments, as well as sustainable finance.

Through the Indian G20 Presidency of 2023, and the 18th G20 Leaders' Summit, there is a critical opportunity to further connect environmental considerations with infrastructure and deepen G20 members' conception of sustainable infrastructure. The Indian Presidency is expected to produce a new report on infrastructure taxonomies, while the Disaster Risk Reduction Working Group is covering priority areas, such as increased commitment towards making infrastructure systems disaster and climate resilient (G20, 2023b). The Indian Presidency is also expected to highlight the Sustainable Infrastructure Principles, while Lifestyles for Sustainable Development represents an approach to promote sustainability at the individual and community level including through appropriate supporting infrastructure. Indeed, Principle 5.6 of the G20 High Level Principles on Lifestyles for Sustainable Development states, "Encourage markets to leverage the potential created by sustainable consumer choices and create

the necessary sustainable, resilient, inclusive and quality infrastructure and policies to support sustainable lifestyles" (G20, 2023a).

Parameters of Deepening Sustainable Infrastructure Systems

Stronger action on sustainable infrastructure should begin with recognition of the role of the natural environment as a key component of infrastructure systems. A holistic infrastructure system comprises not only the built environment, but also the enabling environment and natural environment (UNOPS, UNEP and University of Oxford, 2021).

Viewing infrastructure provision in terms of service delivery, the natural environment provides many ecosystem services that can complement or replace the delivery of services by built infrastructure (Pearlmutter *et al*., 2021). Here, the term "natural infrastructure" refers to a "strategically planned and managed networks of natural lands, water and soil, such as forests and wetlands, working landscapes and other open spaces that conserve or enhance ecosystem values and functions and provide associated benefits to human populations" (UNEA of UNEP, 2022). Infrastructure services provided through natural infrastructure include carbon sequestration, hazard protection and water management, among many others. Natural infrastructure and nature-based infrastructure solutions (a subset of nature-based solutions that includes natural infrastructure, as well as hybrid infrastructure that combines elements of natural and built assets) can be cost-effective and is also associated with numerous co-benefits, from job creation to improved wellbeing (Lieuw-Kie-Song and Pérez-Cirera, 2020; Sturm and Cohen, 2014). In any case, the enabling environment of policy, regulatory and governance frameworks, technical capacity and resources are key to incentivising and delivering both built and natural infrastructure services in line with national and global priorities, and for better integrating the built and natural environments for effective infrastructure service provision.

Following this logic, the Sustainable Infrastructure Principles set out 10 guiding principles for building an enabling environment for sustainable infrastructure through integrated, systems-level approaches (UNEP, 2022a). Complementing the QII Principles, the Sustainable Infrastructure Principles focus "upstream" of the individual project level, and cover a deeper examination of environmental dimensions alongside important economic and social dimensions. In this sense, they do not seek to replace the QII Principles, but delve further into the topic of *sustainable* infrastructure explicitly, based on priorities and experiences in countries worldwide, and in alignment with the SDGs and the Paris Agreement. For instance, "Avoiding Environmental Impacts and Investing in Nature" (Principle 4) is addressed as an individual principle, as is "Resource Efficiency and Circularity" (Principle 5). Each contain considerations across the built, natural and enabling environments. Integrating circularity into infrastructure systems is key, since the construction, maintenance and demolition of buildings, for example, is responsible for 40 per cent of the solid waste produced in developed countries (Bringezu *et al*., 2017). This calls for actions to minimise resource use and close material loops. There is a clear economic

Case Study: Gurugram's Nature-based Infrastructure Solutions, India

Owing to its geographical location and increasing economic activities, the city of Gurugram is highly vulnerable to earthquakes, severe air pollution, floods and droughts. Compounded by gaps in critical infrastructure, its drainage system became overstressed, and the natural drainage system was threatened by large-scale development of real estate.

Recently, the Gurugram Metropolitan Development Authority (GMDA) started working on the Geospatial Mapping of the Natural Ecosystem (GeoSM-Nate) framework with the support of professional organisations. Neighborhood and city-level resilience mapping are proposed. As part of the initiative, the city plans to work on a "nature-based blue-green infrastructure network" (Mukherjee *et al*. 2022).

One example already implemented is the restoration and rejuvenation of the Wazirabad Lake in Gurugram, carried out by the organisation "SEEDS" (SEEDS India, 2023). The lake had become very polluted due to the inflow of raw sewage from its inlets and greywater from the nearby housing areas. The outflow of this water was blocked due to the construction of buildings and new roads on the eastern and northern sides of the lake. The waterbody restoration activities helped to revive the biodiversity and recover the green spaces within the area. Thus, the lake was able to contain the excess water flowing from the Aravalli hills abutting it. The area around the lake was also developed into recreational and learning spaces for children. Not only did the interventions increase the green areas of the city, but they also improved the natural absorption of rainwater and the water quality of the water channels around the area (SEEDS India, 2023).

Sources: Mukherjee *et al*., 2022 and SEEDS India, 2023

rationale to do so, as the potential savings are significant: the cost of raw materials can account for 40 – 60 per cent of the overall cost of construction of a given infrastructure asset (UNEP, 2022a).

Relatedly, the availability and design of infrastructure systems directly and indirectly shapes day-to-day lifestyles worldwide (UNEP, 2022b). Due to the long lifespan of infrastructure assets, their influence on behaviour patterns and broader impacts are long-term. Depending on the form, siting and materials or resources used (as per Principle 5 of the Sustainable Infrastructure Principles), infrastructure can support or prevent sustainable lifestyles. For example, green designs of buildings like university or health facilities can encourage citizens to recycle, minimise waste and energy use and reduce overall environmental footprints. Conversely, a lack of bike lines, for instance, can prevent low-carbon mobility. As illustrated in the LiFE movement and subsequent Lifestyles for Sustainable Development Approach, there is considerable potential to "nudge" individuals and communities to practise more environmentally sustainable lifestyles, with appropriate infrastructure needed to support this (India, Ministry of Environment, Forest and Climate Change and NITI Aayog, 2022; G20, 2023a). These initiatives therefore present a vehicle to further enhance the long-term environmental impacts of infrastructure, given that decisions on infrastructure will have cascading impacts on daily social and economic activity for many decades. Overall, as guided by the Sustainable

Case Studies: Infrastructure Enabling Sustainable Lifestyles in Latin America

Infrastructure for a Bike-friendly City, Mexico

In 2007, the Mexico City government launched an open streets programme called "Muévete en Bici", banning car traffic every Sunday on several streets to promote sustainable mobility and improve air quality. A bike network was later introduced in 2019, integrated with the city's existing transit infrastructure, and the city continued to construct safe cycle lanes in different areas.

As a result, the "EcoBici" system - a bike-sharing concept launched in 2010 - has become popular among the residents. The provision of high-quality infrastructure, with smart integration of different systems, enables people in Mexico City to use multi-modal mobility systems.

Green roofs to improve well-being in local communities, Brazil

In Rio de Janeiro, Brazil, 19 per cent of the population lives in informal settlements, or *favelas*. These areas are densely populated, often built without adequate thermal insulation and lacking green spaces for thermal control. To make efficient use of limited space and mitigate the heat island effect in the Arará *favela*, green roofs have been established and planted with succulents, herbs and small shrubs.

The incorporation of green roofs has successfully improved the health and well-being in the local communities. The green roofs reduce the temperature by around 20˚C, potentially lowering the mortality risks from extreme heat. They increase social interaction in the communities, engaging the local population to plant together. Establishing green roofs also helps to improve the general urban environment in informal settlements.

Sources: Herbert (2023) and Institute for Transportation and Development Policy (2021)

Infrastructure Principles, deepening the sustainability of infrastructure systems requires a vision that goes beyond only minimising harm to the environment, to one that actively harnesses ecosystem services and promotes sustainable lifestyles in communities long-term.

Way Forward

The G20 has a critical role to play in deepening the environmental sustainability of infrastructure, and better integrating it with economic and social considerations. Based on current trends, the Global Infrastructure Hub (2023) has estimated $ 79 trillion of investment up to 2040, meaning there is a window of opportunity to lock-in positive impacts in the years ahead.

Domestically, the Sustainable Infrastructure Principles can be mainstreamed with the QII Principles as a means of implementing the UNEA resolution on sustainable and resilient infrastructure in national policy frameworks. For example, the Sustainable Infrastructure Principles offer a guiding framework to advance Principle 3 of the QII Principles (Integrating Environmental Considerations in Infrastructure Investments). As G20 members elaborate national infrastructure plans, different ministries will require specific tools to enhance environmental sustainability

as well as quality. This includes methodologies to assess and incorporate natural infrastructure and resource-efficient, low-carbon solutions across systems. To facilitate local action and sustainable lifestyles in long term, demand and supply dynamics can also be influenced by broader government policies (India, Ministry of Environment, Forest and Climate Change and NITI Aayog, 2022). Infrastructure ministries can embed comprehensive sustainability criteria in procurement processes, from needs assessments to awarding and execution of contracts (UNEP, 2021). In addition, finance ministries can demonstrate commitment by aligning public budgets for infrastructure with sustainability and performance objectives.

Internationally, there is scope to further promote collective action on sustainable infrastructure among G20 members, and also support non-G20 members where required. The UNEA resolution encourages all UN member states and other stakeholders, as appropriate, to "cooperate internationally to strengthen frameworks, including for financing, for sustainable and inclusive infrastructure that maintains and enhances ecological connectivity, avoids further fragmentation, and minimises other potential impacts on ecosystems and livelihoods" (UNEA of UNEP, 2022). Consideration should be given to ensuring that sustainability is integrated in both bilateral and multilateral financing for infrastructure.

In the current G20 cycle, there have been several relevant events leading up to the G20 Leaders' Summit in September 2023. Beyond the Infrastructure Working Group Meetings, the discussion questions of the Disaster Risk Reduction Working Group included, "*How can we further build upon the Principles of Quality Infrastructure Investment Indicators that G20 members have adopted?*" (G20, 2023b). Further responding to this, the recommendations developed in this paper offer potential pathways for deepening the sustainability of infrastructure systems.

In order to deepen the sustainability of infrastructure systems, G20 members can:

- Assess and measure the role of the natural environment as a key component of infrastructure systems, including for Disaster Risk Reduction and wider service provision.
- Prioritise infrastructure forms, siting, materials and resource use options that support sustainable lifestyles.
- Mainstream the *International Good Principles for Sustainable Infrastructure* with the *G20 Principles for Quality Infrastructure Investment,* integrating them into national infrastructure plans, procurement processes, fiscal policies and financing.

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Appendix

Table 1: Overview of QII Principles

QII Principle:	Summary:
Principle 1: *Maximizing the positive impact of infrastructure to achieve sustainable growth and development*	The **first** principle recognizes the role of quality infrastructure in setting off a virtuous circle of economic activities, and the importance of having sustainable development and connectivity at the core of developing infrastructure. This contributes to ensuring that infrastructure is broadly available, accessible, inclusive, and beneficial to all. Quality infrastructure investment also needs to be tailored to individual country conditions and consistent with local laws and regulations.
Principle 2: *Raising Economic efficiency in view of life-cycle cost*	The **second** principle highlights the significance of considering the life-cycle cost of infrastructure investments in ensuring efficiency. Quality infrastructure investment should attain value for money and remain affordable with respect to life-cycle costs.
Principle 3: *Integrating environmental considerations in infrastructure investments*	The **third** principle highlights the importance of environmental considerations for quality infrastructure. Both positive and negative impacts of infrastructure projects on ecosystems, biodiversity, climate, weather, and the use of resources should be internalized. Infrastructure projects should align with national strategies and nationally determined contributions for those countries determined to implement them, and with transitioning to long-term low emissions strategies, while being mindful of country circumstances. These environmental considerations should be entrenched in the entire life cycle of infrastructure projects. Ecosystem-based adaptation should be considered. The environmental impact of infrastructure investment should be made transparent to all stakeholders.
Principle 4: *Building resilience against natural disasters and other risks*	The **fourth** principle recognizes the growing importance of designing infrastructure that is resilient to natural and human-made risks. The increasing number and heightened magnitude of natural disasters, and slow onset of environmental changes, imply an urgent need to ensure long-term adaptability and build resilience of infrastructure against these risks.
Principle 5: *Integrating social considerations in infrastructure investment*	The **fifth** principles capture importance of social inclusiveness considerations in infrastructure investments. Infrastructure should be inclusive, enabling the economic participation and social inclusion of all. Economic and social impacts should be considered as an important component when assessing the quality of infrastructure investment and should be managed systematically throughout the project life cycle.
Principle 6: *Strengthening infrastructure governance*	The **sixth** principle focuses on governance, recognizing the need to have clear rules, robust institutions, and good governance in the public and the private sector, reflecting countries' relevant international commitments. This will mitigate various risks related to investment decision-making, thus encouraging private-sector participation. Capacity building is also key in ensuring informed decision-making and effectiveness of anti-corruption efforts. In addition, improved governance can be supported by good private sector practices, including responsible business conduct practices.

Source: G20, 2022b

Table 2: Overview of SI Principles

	**1. STRATEGIC PLANNING** to ensure the alignment of infrastructure policies and decisions with global sustainable development agendas and to strengthen the enabling environment.
	**2. RESPONSIVE, RESILIENT, AND FLEXIBLE SERVICE PROVISION** to meet actual infrastructure needs, allow for changes and uncertainties over time, and promote synergies between infrastructure projects and systems.
	**3. COMPREHENSIVE LIFE CYCLE ASSESSMENT OF SUSTAINABILITY,** including the cumulative impacts of multiple infrastructure systems on ecosystems and communities over their entire lifespans, to avoid "locking in" infrastructure projects and systems with various adverse effects.
	**4. AVOIDING ENVIRONMENTAL IMPACTS** of infrastructure systems and investing in natural infrastructure to make use of nature's ability to provide essential, cost-effective infrastructure services and provide multiple co-benefits for people and the planet.
	**5. RESOURCE EFFICIENCY AND CIRCULARITY** to minimize infrastructure's natural resource footprint, reduce emissions, waste and other pollutants, and increase the efficiency and affordability of services.
	**6. EQUITY, INCLUSIVENESS, AND EMPOWERMENT** through a balance between social and economic infrastructure investment to respect, protect and fulfil human rights and promote well-being, particularly of more vulnerable or marginalized groups.
	**7. ENHANCING ECONOMIC BENEFITS** through employment generation and support for the local economy.
	**8. FISCAL SUSTAINABILITY AND INNOVATIVE FINANCING** to close the infrastructure investment gap within the context of increasingly constrained public budgets.
	**9. TRANSPARENT, INCLUSIVE, AND PARTICIPATORY DECISION-MAKING** that includes stakeholder analysis, ongoing public participation, and grievance mechanisms for all stakeholders.
	**10. EVIDENCE-BASED DECISION-MAKING** that includes regular monitoring of infrastructure performance and impacts based on key performance indicators and the promotion of data sharing with all stakeholders.

Source: UNEP, 2022a

Research Article

Accelerating Action towards Net Positive Agriculture and Food Systems

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Research and Information System for Developing Countries (RIS).

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Abstract: Sustainable food systems are essential to providing healthy and nutritious food while enhancing livelihoods and climate resilience for people and the planet. While there are many forms of agriculture that support food security, healthy diets, economic prosperity and the environment; unsustainable agricultural practices are also a key contributor to the triple planetary crisis of biodiversity loss, climate change, and pollution and waste. Responding to these challenges requires taking a systems-based approach that addresses these complexities in a holistic and sustainable manner. Building on the outcomes of the 2021 UN Food Systems Summit, which launched bold new actions for progress on all 17 SDGs through the development of national food systems pathways; in this paper we consider agricultural systems as an integral part of food systems and evaluate their contribution to sustainable development outcomes - specifically those that are biodiversity-friendly, climate-resilient, pollution-free and human-centered.

Introduction

Despite the long-lasting G20 experience in recognizing and providing the tools to tackle complex crises, the world continues to face a severe food security crisis. This has been exacerbated by the COVID-19 pandemic and the war in Ukraine, putting the world further off track in achieving the 2030 Agenda for Sustainable Development, including its goals of ending hunger, fighting against climate change and sustainably managing life on land and below water. Meanwhile, agriculture representing over 31 per cent of total anthropogenic GHG emissions (FAO, 2021) and over one-third per cent of the global land area (SCBD, 2020), accounts for 70 per cent of freshwater withdrawals (FAO, 2020), and drives 50 per cent of deforestation through conversion of forest into cropland (FAO, 2020). Ongoing global crises have increased the need for a more resilient and sustainable global food

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system, and the G20 plays a key role in achieving these objectives through a multilateral, systemic and inclusive approach. Since its inception, improving agriculture productivity and increasing access to technology and food have been key strategies to reduce global poverty and guarantee long-term food security (G20, 2009). Since then, G20 has widened its scope to recognize the role of, and take action on several global crises endangering and destabilizing the global economy including, food security and nutrition. As such, G20 has consistently reiterated its commitment and engagement to tackle *inter alia* climate change (first mentioned in UK, 2009), corruption (USA, 2009), ocean degradation (South Korea, 2010), threats to animal and human health (i.e. antimicrobial resistance and infectious diseases) (Turkey, 2015), food loss and waste (Turkey, 2015), migration (Turkey, 2015), environmental and land degradation (Saudi Arabia, 2020), childhood overweight and obesity (Argentina, 2018), biodiversity loss (Japan, 2019), pollution (i.e. land, fresh water, and marine) (Japan, 2019) and, water insecurity (Italy, 2021) through action. A food systems lens can help show how these disparate commitments are connected in a way that optimises outcomes for environment, livelihoods and health.

Unsustainable Agriculture: As Catalyst of Multiple Global Crises

As recently recognised by the UN Global Crisis Response Group, a complex set of factors, including disruptions in critical value chains, have increased food prices and decreased food availability (GCRG, 2022). The resilience of global food systems are under pressure, notably due to unsustainable agriculture production and its role in catalyzing and amplifying various other crises(Steffen *et al*., 2015; Lade et al., 202; Campbell *et al*., 2017). Despite unprecedented volumes of food being available for consumption globally, impacts on the environment, human health and farmer livelihoods are only getting worse. Food systems are facing climate instability and extreme weather events, stagnant yields, poor soils, polluted water, increased GHG emissions, massively reduced agricultural and wild biodiversity (important for pollination, pest control, soil fertility, and resilience), and widespread food and nutritional insecurity. The reality of our current food systems is that the most vulnerable and poor in developed and developing countries are disproportionately impacted. For example, current widespread food inflation is impacting poor communities and populations worldwide, notably by restricting their access to food, particularly fresh and nutritious foods. As such, a significant part of world population is facing serious health issues now (malnourishment, micronutrient deficiencies, obesity, diabetes) (FAO *et al*., 2022).

For these reasons, the UN Food Systems Summit in 2021 was a critical step in recognizing the urgent need for a food and agriculture system transformation. A transformation that has at its core a systems approach to foresee and actively pursue solutions that result in multiple co-benefits (synergies) and tackle the multiple crises while actively mitigating unavoidable tradeoffs. Interestingly, 14 of the G20 countries have developed National Pathways for sustainable food systems transformation through multi-stakeholders' dialogues. In the run up to the official Summit follow-up in 2023 (Stocktaking Moment), the challenge will be to accelerate action to further the resilience of food systems, enhance their capacity to adapt to climate change and improve management of biodiversity,

Table 1: G20 Summits and Related Commitments to Food Systems, Agriculture and the Environment

G20 Summit & Year	Commitments
G20 London Summit (UK, April 2009)	Committed to engageme to tackle *inter alia* climate change_
G20 Seoul Summit (South Korea, November 2010)	Addressed ocean degradation, food security, and strategies to improve agriculture productivity and ensure access to technology for food production.
G20 Cannes Summit (France, November 2011)	Emphasised the importance of addressing food price volatility and promoting sustainable agriculture to enhance food security.
G20 Los Cabos Summit (Mexico, June 2012)	Focused on fostering sustainable development, including issues related to food security, agriculture, and energy.
G20 St. Petersburg Summit (Russia, September 2013)	Continued discussions on addressing food security and promoting agricultural productivity.
G20 Brisbane Summit (Australia, November 2014)	Addressed food security, agricultural productivity, and the role of technology in boosting agricultural efficiency.
G20 Antalya Summit (Turkey, November 2015)	Renewed commitments to tackle food security issues and promote sustainable agriculture; Discussed threats to animal and human health (i.e. antimicrobial resistance and infectious diseases) food loss and waste, migration; Discussed diversification to mitigate risk
G20 Hangzhou Summit (China, September 2016)	Highlighted the importance of sustainable agriculture and food security; Discussed diversification to mitigate risk
G20 Hamburg Summit (Germany, July 2017)	Reiterated commitments to promote food security, sustainable agriculture, and environmentally-friendly practices.
G20 Buenos Aires Summit (Argentina, November 2018):	Discussed the importance of sustainable food systems; to increase productivity, production, incomes and employment ;and agricultural practices; as well as childhood overweight and obesity
G20 Osaka Summit (Japan, June 2019)	Discussed biodiversity loss, pollution (i.e. land, fresh water, and marine)
G20 Riyadh Summit (Saudi Arabia, November 2020)	Discussed environmental and land degradation
G20 Rome Summit (Italy, October 2021)	Highlighted the need for water insecurity through action; Discussed diversification to mitigate climate risk
G20 Bali Summit (Indonesia, November 2022)	Highlighted the importance of enhancing market predictability, minimizing distortions, increasing business confidence, and allowing agriculture and food trade to flow smoothly; highlighted the need for digital innovation in agriculture and food systems to enhance productivity and sustainability in harmony with nature, to diversify business opportunities and promote farmers and fishers' livelihoods and increase income, in particular smallholders by increasing efficiency, and equal access to food supply chains

Source: Authors' compilation.

while ensuring their contribution to communities' resilience to future shocks and crises.

How has the G20 Treated So Far

Diversification from mitigating risk and managing investment portfolios to increase health and resilience

Diversification is a strategy commonly mentioned in previous G20 ministerial declarations and summits to guarantee security (energy in USA, 2009, Turkey, 2015, China, 2016), to deliver co-benefits and multiple outcomes (agriculture in Indonesia, 2022), to increase resilience (water: Indonesia, 2022), to adapt to the changing climate (industry: Indonesia, 2022, Italy, 2021), to guarantee stability, security and affordability (value chains, markets and energy sources, in Indonesia, 2022), to diversify business opportunities (Micro, Small and Medium-sized Enterprises and financial instruments, Indonesia 2022, China, 2016), and to increase productivity, production, incomes and employment (agri-food, in Argentina 2018). Local level diversification is a strategy commonly deployed by small farmers for mitigating risk whereas scientific evidence demonstrates that countries with diversified production systems have more stable national food production systems(Renard & Tilman, 2019).

Despite the recognition of diversification as key strategy in the G20, current agriculture and food systems remain increasingly dependent on few crops. Previous G20 efforts to tackle some of the global challenges led to the creation of very important monitoring tools, initiatives, or programs, however these often lack a system-lens. For example, the GEO Global Agricultural Monitoring (GEOGLAM) Initiative monitors only four crops (all cereals), and the Agricultural Market Information System (AMIS) focuses on prices of three cereal crops and one legume. Likewise, half of the global harvested area in 2021 was allocated to only four crops (wheat, maize, rice, and soybeans) (FAOSTAT), in contrast with over >7,000 edible plants that exist (Ulian et al., 2020). This over-dependence on few crops reduces the resilience of our food production by increasing susceptibility to disease and extreme weather events as well as significantly weakening the gene pool. It is also a missed opportunity for developing new and diverse markets, strengthening ecosystems while increasing both agriculture and food systems' resilience and adaptability (Jones *et al*., 2021) .

Clarity and Consensus needs in International Frameworks

Multiple methodologies, movements and initiatives (several endorsed and mentioned already across G20 declarations) have been proposed to achieve better food systems outcomes. While embedded in agreed international frameworks and initiatives, clarity and consensus from development and research partners is needed to accelerate progress towards these comittments. Furthermore, government capacity to monitor and evaluate such progress needs to be strengthened. Despite widespread agreement worldwide regarding the necessity of transitioning agricultural systems into more sustainable forms, the specific methods and components of this transformation continue to be a source of disagreement and discussion among various interested parties and policymakers. Current methodologies and approaches to improve agricultural practices include

sustainable intensification (Pretty *et al*., 2011; Tilman *et al*., 2011), conservation agriculture (Hobbs *et al*., 2008), climate-smart agriculture (Harvey *et al*., 2014), agroecology (Wezel *et al*., 2014) , ecological intensification (Bommarco *et al*., 2013), diversified farming systems (Kremen & Miles, 2012) , circular economy (Barros *et al*., 2020), nature-based solutions (Nesshöver *et al*., 2017) , natural farming (Nesshöver *et al*., 2017) , nature positive agriculture, organic agriculture (Seufert *et al*., 2012), permaculture (Ferguson & Lovell, 2015) and regenerative agriculture (Lacanne & Lundgren, 2018). The politics behind these methodologies and approaches (Tittonell *et al*., 2022) (Loconto *et al*., 2020) , the contested scientific evidence supporting some of them (Perfecto & Vandermeer, 2010; van Etten, 2022) and their limited capacity to contribute to multiple priorities due to their sectoral focus (e.g. yields) (Loconto, 2020) reinforce entrenched positions and divergent efforts undermining urgently needed collective action.

Attaining the global goal of a healthy, sustainable, and inclusive economy requires therefore going beyond specific methodologies and evaluating agriculture and food systems with a systems lens where the overall aim is to have a net positive balance. For example, multiple agricultural practices promoted across methodologies contribute to multiple ecosystem services (Kremen & Miles, 2012) (weed control, nutrient cycling, soil fertility, soil health, water regulation, carbon sequestration) without compromising yields (Rosa-Schleich *et al*., 2019; Tamburini et al., 2020; German *et al*., 2017). Also, certain agricultural practices result in more nutritious foods, lower environmental impacts and higher profitability in tandem with more social and ecosystem benefits (Reganold and Wachter, 2016). The lower environmental impacts of alternative production systems mobilizing multiple agricultural practices, also results, on average, in larger gross income, and profits, even in the cases when these demand higher labour (often compensated by larger gross incomes) (Sanchez Bogado et al, 2022).

Yet, evidence remains scattered for multiple practices while the performance of certain practices is determined by contextual factors (e.g. climate, soil types, production system) (Dawson *et al*, 2019). Hence, the importance of condensing scientific evidence around the diversified agricultural practices and technologies promoted across methodologies that contribute to biodiversity friendly, climate resilient, pollution free, and human-centered agriculture and food systems (See Table 1).

In this context, multilateralism represents an effective tool for global coordination and for streamlining environmental governance. The recent adoption of the Kunming-Montreal Global Biodiversity Framework (GBF) is a powerful reminder of the importance of Multilateral Environmental Agreements (MEAs) to tackle multiple challenges that go beyond national borders. The parties in meeting in Montreal in December 2022 agreed among others to reduce the risk of pesticides and nutrients lost to the environment by at least 50 per cent by 2030, increase the sustainable management of biodiversity in agricultural areas, reduce global consumption footprint and cut food waste by half, and repurpose harmful agricultural subsidies. National implementation and enforcement will be key to ensure that these targets further promote healthy and resilient agriculture and food systems. Use of innovative climate financing, including blended finance, offers a promising avenue to expedite the adoption of climate-

Table 1: A net positive agriculture contributes to multiple outcomes often ignored in current economic models, policies, and investments. A systems-lens to agriculture and food systems will enable reducing the pervasive role of the current dominant agriculture production models while positively contributing to solve many of the intertwined global crises.

Net positive agriculture and food systems							
		Biodiversity friendly	**Climate resilient**	**Pollution free**	**Human centered**		
					Material	**Quality of life**	**Relational values**
Conceptual Framework	**Agricultural management, practices and technologies at the field and landscape levels can…**	• Increase wild and cultivated species diversity (i.e. richness, abundance and evenness) above and below ground. Improve biodiversity-mediated ecosystem services provision (i.e. pollination[37–39] pest or pathogen control[40–42], nutrient cycling[43,44], production value[45], yield stability[46], connectivity[47,48])	Reduce GHG emissions (i.e. CH4, CH2, N2O) Sequestrate GHG emissions (i.e. carbon) Improve soil physical and chemical conditions (i.e. structure, carbon, aggregation, density, pH, temperature, water content) Increase recovery after shocks (e.g. hurricanes, drought spells)[49]	Reduce nutrient runoff, leaching or infiltration in surface and ground water Reduce input dependency (i.e. increase N fixing) Reduce soil erosion[50] and sediment load in streams[51] Improve water infiltration and sediment retention Reduce microplastics in the system[52]	Provide income and production stability in the short and long term[35] Offer farmers safety nets for climatic or economic shocks	Provide year-round nutritious, safe, fresh and diverse food [53] Guarantee farmers enjoy mental, emotional, and physical health Reduce disease agents and infectious diseases[54]	Recognize and value farmers' knowledge and contributions as the stewards of terrestrial and aquatic systems Reinforces place-based connections and attachments [55,56]
	Why it matters	Agriculture production is often portrayed as separated from nature, however, agriculture **fully depends** on cultivated and wild biodiversity for ecosystems functioning and service provisioning. Both, wild and cultivated biodiversity are disappearing an alarming rate.	The agriculture from the 60s is **very different** from the agriculture in the Anthropocene. In present days, agriculture is a main contributor to GHGs[57], while facing water scarcity, poor and degraded soils, and more frequent and extreme events.	Soil, oceans, and freshwater systems are not only under **unprecedented pressure and exploitation levels**, these also experience **unprecedented pollution levels** threatening future human use and all the biodiversity using and living in those ecosystems.	Farmers are confronted with **volatile and globalized pric**ing Hence, regardless of the level of yield, other metrics will be more informative by capturing better farmers financial , stability and production systems viability. Yield, as a performance metric, has been heavily criticized due to its myopic and limited capacity to account for food systems performance [58].	**Farmers are leading suicide rates** worldwide and compared to other sectors, notably in countries where farmers have access to and use most up-to-date and advanced technologies and conventional agriculture dominates[59–63]	Vulnerable, degraded, and polluted agricultural landscapes **deprived humans** from vital cultural, environmental, and social dimensions of human wellbeing.

Enabling Frameworks	**Contributions to Kunming-Montreal Global Biodiversity Framework**[64]	Bringing wild and cultivated biodiversity in fields and agricultural landscapes to increase connectivity, viable and adaptable populations contribute to target 1, 2, 4, 10 and 12	Using traditional (also called neglected or underutilized) species adapted to harsh conditions contributes to target 4 Designing fields and agricultural landscapes to host wild and cultivated biodiversity to maintain viable populations and the ecosystem services these provide contributes to target 2 and 12 Mobilizing cultivated and wild biodiversity in tandem with sustainable practices contributes to target 8 and 10	Designing fields and agricultural landscapes to host wild and cultivated biodiversity for maintaining viable populations and the ecosystem services these provide contributes to target 2 Mobilizing cultivated and wild biodiversity in tandem with sustainable practices contributes to target 7 and 10	Measuring agriculture performance and contributions beyond yields (e.g. land use equivalent ratio, nutritional functional diversity) while accounting for massive food waste reductions will contribute to target 1	Ensuring farmers and local communities reach good quality of life and overall wellbeing is in line with the consideration for the implementation of the framework – different value systems.	Mobilizing local and traditional knowledge to diversify plates, markets, fields and agricultural landscapes contributes to target 21 and 22
	Enabling Kunming-Montreal Global Biodiversity Framework targets for a net positive agriculture and food systems[64]	Integrating cultivated and wild biodiversity in fields and agricultural landscapes for their contribution to farmers, production, food systems and other multiple values will be enabled by a close aligment of national and global policies, agreements, and financial flows (Target 14). This will also require repurpusing policies and phase out harmful subsidies and incentives for biodviersity, the environment and people (Target 18)[65] National policies and global programs fostering, supporting and enabling sustainable, healthy and diversified consumption choices is central to dinamize diversified local, national and international markets offering fresh, locally adapted and diversified foods (Target 16)						
	Contributions to SDGs						

Source: Authors' compilation.

friendly and pollution-free agricultural practices in G20 countries. By combining public and private sector resources, it can provide the necessary financial support and incentives to accelerate the widespread implementation of sustainable agricultural technologies and methods, driving positive environmental outcomes.

Box 1: From Global Crisis to Local Solutions: Andhra Pradesh Community Managed Natural Farming in India

Since 2016 the Government of Andhra Pradesh has undertaken the task of transitioning to a climate change resilient system of farming, called Natural farming (NF). It is a system that mimics nature, and utilises certain universal principles which include covering the ground with diverse crops all year round, minimizing disturbance of soil, using biostimulants for catalyzing soil biology, pest management through better practices and botanical pesticides and zero use of synthetic fertilizers, pesticides, weedicides. Natural Farming aims to restore degraded soils, support biodiversity, and in turn build resilience to weather and climate related shocks including drought and flood resistance. For farming communities, the practices can reduce costs, improve health and create better livelihoods. The land equivalent ratios are better in natural farming, enabling enhanced crop diversity and better food nutrition.

While NF is a paradigm shift, transfer of NF technology is challenging and calls for saturated transformation of a village rather than converting into a single farmer or single farm. The Implementation strategy is as follows-

The programme spends 7-10 years (3-5 years/farmer) in a Gram Panchayat (village). The programme plans to cover at least 85 per cent farm families in the GP.

The programme works through the vast network of the women Self-Help Groups (SHGs) and their federations, Village Organizations (VOs) and community cadres responsible to them ensuring continuous local handholding and thematic support.

Local natural farming champions farmers, who are identified, nurtured and counselled. These cutting-edge internal community resource persons (L3 CRPs) spearhead NF transformation on ground in each village/GP. They are accountable to Village Organization locally and take responsibility for converting around 100 farmers into NF over a period of 3-5 years by means of demonstration, training, nurturing, trouble shooting, handholding, etc. They also help SHGs and Village Organization in tracking progress of the farmers towards transformation on the entire land and in all practices.

These L3 CRPs supported by CRPs at L2 CRPs, responsible to a cluster of 3-5 GPs. Some of the L2 CRPs provide exclusive digital support. L2 CRPs, with better performance and leadership, are emerging from the L3 CRPs to take higher order/ thematic responsibility.

The CRPs at higher levels (L1) support and work with multiple clusters.

Capacity building and knowledge enhancement are crucial for the field functionaries; dedicated pool of **Master Trainers** have been created identified from

Box continued...

Box continued...

existing Community Resource Persons. They support Natural Farming, Institution Building, Health & Nutrition, Digital, and Marketing and Educated Young Practitioners engagements. They are responsible for covering all the units in their districts and deliver trainings to cadres (CRPs), lead farmers, SHG leaders etc.

Based on this, the programme has currently enrolled 630,000 farmers in 3730 villages across Andhra Pradesh and it aims to reach all the 6 million farmer households in the state, over an area of 6 million hectares by 2031.

Apart from working with women collectives and champion farmers for transformation, the programme engages with critical players of the food systems through convergence with the various Government departments of Agriculture, Rural Development, Education, Women and Child Development, along with involvement of civil society and national and international partnerships on aspects of science and research, communications, exchange of technologies etc., APCNF is working on long term system change. The success of APCNF is inspiring other States in India to replicate this transformative model at scale.

Notes: G20 Agriculture Ministers' Declaration, 2017.

Source: Authors' compilation.

Way Forward

G20 economies depend on 60 percent of all agricultural land and about 80 percent of world trade in agricultural products. Hence, G20 is uniquely positioned to accelerate and create the propelling conditions to transition to net-positive agriculture and food systems (i.e. biodiversity friendly, climate resilient, pollution free and people centered). This must also include elements around sustainable consumption, sustainable diets and include accelerating factors, such as enhanced public and private financial flows and better governance of food systems. In response to the interlinked multiple crises, the Triple Planetary Crisis, increases in global food insecurity, and as a follow up to the Food Systems Summit, the G20 can accelerate progress towards achieving net-positive food systems by taking the following key actions:

Support the application of net-positive food systems approaches integrate the 2030 Agenda, the Paris Agreement and the Kunming-Montreal Global Biodiversity Frameworks by strengthening enabling governance and financing mechanisms at the national level and through disbursements of overseas development aid.

Promote a systems approach for net-positive food systems through enabling food loss and waste prevention, for example, investments in human capital and technologies that promote a robust regulatory environment for sustainable food production; and provision of incentives to facilitate access to sufficient, nutritious and diversified diets.

Embed relevant indicators and metrics into current G20 monitoring and knowledge platforms, the National Pathways for sustainable food systems transformation developed as a process of the UN Food Systems Summit, and other international commitments(including under the Paris Agreement, and the Kunming-Montreal Global Biodiversity Framework). Metrics to encompass context-relevant innovations (e.g. diversification with local crop and agroforestry species, and identification of corelating agroecological zones)

and formalized pathways to integrate indigenous practices and land rights, as these net-positive contributions are commonly overlooked by governments and the private sector.

In the face of geopolitical and climate related shocks, G20 can explore policy and fiscal measures including blended finance mechanisms to incentivize agriculture towards greater resiliency and positive outcomes on nature, climate and pollution and human health/food security.

Through closer collaboration with the UN system - including the UN Food Systems Coordination Hub – the G20 can support the operationalisation and implementation of the transformational Food Systems Pathways, developed by countries in the run up to the 2021 UN Food Systems Summit. This will help to overcome multifaceted challenges blocking desirable collective transformation at the required pace. National food systems pathways can become learning sites for jointly tackling the multiple crises in an orchestrated fashion and outlining key pragmatic steps at the individual, public, and private sector levels to bring the desired and envisioned "integrated, inclusive, and equitable development" (G20 declaration Argentina, 2018).

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Research Article

Nature-based solutions and the G20

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Abstract: Nature-based solutions (NBS) and ecosystem-based approaches have assumed importance in the past three G20 presidencies. The G7 has emphasised the role of NBS too. The approach aims to 'conserve, manage, and restore natural and modified ecosystems in ways that address social, economic, and environmental challenges'. The Indian presidency also proposes the concept of LiFE (Lifestyles for Environment) which involves lifestyle transformation at the individual and community levels. This paper focuses on the need to evolve a common understanding of the NBS despite a variety of nomenclatures used, and scale it up for further implementation.

Introduction

Nature underpins the functioning of all societies, providing a wide range of benefits which are often termed 'ecosystem services'. However, where ecosystems are degraded and biodiversity is lost, the capacity of nature to deliver these benefits is reduced. The term 'nature-based solutions' refers to actions that conserve, manage and restore natural and modified ecosystems in ways that address a range of social, economic and environmental challenges (UNEP, 2022). So while this term is relatively new and alternative terms are preferred by some, the concept of nature-based solutions builds on a long-standing recognition of our dependence on nature. Moreover, it emphasises the positive role that working with nature can play in addressing diverse challenges.

In recent years, the importance of nature-based solutions has been increasingly emphasised by the G20. The previous three Presidencies have all highlighted this. Under the Presidency of Saudi Arabia in 2020 the Leaders Declaration acknowledged "the importance of fostering synergies between adaptation and mitigation, including through nature-based solutions and ecosystem-based approaches"(G20, 2020). In 2021, the G20 Rome Leaders' Declaration, under the Italian Presidency, committed to "scale up and encourage the implementation of Nature-based Solutions or Ecosystem-based Approaches as valuable tools providing economic, social, climate and environmental benefits including in and around cities, in an inclusive manner and through the participation of local communities and indigenous peoples" (G20, 2021). The Indonesian Presidency in 2022 renewed the commitment to "step up efforts to halt and reverse biodiversity

loss, including through nature-based solutions and ecosystem-based approaches, support climate mitigation and adaptation, enhance environmental conservation and protection, sustainable use and restoration, responding to natural disasters, reduce ecosystem degradation, enhance ecosystem services and to address issues affecting the marine and coastal environment" (G20, 2022).

Under Indian Presidency of the G20, there are already strong signals of building the earlier commitments. The Environment and Climate Sustainability Working Group has identified one of its three priority areas as arresting land degradation, accelerating ecosystem restoration and enriching biodiversity (G20, 2023a). The LiFE (Lifestyles for Environment) programme, with its focus on changing individual and community action to promote an environmentally conscious lifestyle, provides a broader, supportive context for this priority. Additionally, there are also links to the G20 High Level Principles on Lifestyles for Sustainable Development, including through Principle 1 (promote linkages between development, environment and climate agendas and their associated goals), Principle 5 (mainstream sustainability of all components/ aspects of the economy) and Principle 7 (recognise and amplify the role of local communities, local and regional governments and traditional knowledge in supporting sustainable lifestyles) (G20 2023c).

The G20's increased attention to nature-based solutions is reflected in the wider landscape of global decision-making. There are references to nature-based solutions included in both the Sharm el-Sheikh Implementation Plan (United Nations Framework Convention on Climate Change, 2023) agreed at UNFCCC COP 27 and the Kunming-Montreal Global Biodiversity Framework (Convention on Biological Diversity, 2023) CBD COP 15.

The recent Presidencies of the G7 have also emphasised the importance of nature-based solutions. This is shown in the Communiqués issued by the Climate and Environment Ministers of both the UK and Germany Presidencies in 2021 and 2022 respectively. The UK document recognises ''the crucial role of nature-based solutions in delivering significant multiple benefits for climate mitigation and adaptation, biodiversity and people'' and the Ministers committed to ''strengthen their deployment and implementation'' (G7, 2021). In the German Communiqué, the ministers committed to ''substantially increase our national and international funding for nature by 2025 including increased funding for nature-based solutions" (G7 2022). To the extent that there is support for building closer alignment between the G7 and G20, nature-based solutions may be one policy issue where such alignment may be possible.

It should also be noted that in 2022 the United Nations Environment Assembly (UNEA) agreed resolution 5/5 entitled "nature-based solutions for supporting sustainable development" (UNEP, 2022). A number of G20 countries, including Argentina, Australia, Brazil, Canada, France (on behalf of the European Union), Russia, South Africa, UK and USA played a leading role in the negotiation of the resolution. It includes a definition of nature-based solutions which states: *nature-based solutions are actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems which address social, economic and environmental challenges effectively and adaptively, while*

simultaneously providing human well-being, ecosystem services, resilience and biodiversity benefits (UNEP, 2022). This is the first multilaterally agreed definition of nature-based solutions. The resolution also calls for inter-governmental consultations on nature-based solutions.

These consultations are taking place in 2023 and one of the issues that is being addressed is the diversity of terms that are used in this context. As already mentioned, sometimes the term 'nature-based solutions' is coupled with the expression 'ecosystem-based approaches'. There are also a wide range of other terms that are used to refer to what some would regard as specific types of nature-based solution. These include ecosystem-based adaptation; ecological infrastructure; conservation agriculture; regenerative agriculture; and eco-disaster risk reduction. This paper does not address the various definitions of terminology further, on the grounds that many of these other terms do embody similar ideas and perspectives.

In addition to the recent political commitments to scaling up the use of nature-based solutions, expressed by leaders of the G20, the extensive use of nature-based solutions in many G20 countries should also be noted. Illustrations of these, covered in subsequent solutions, provide an explication of the concept of nature-based solutions and offers some recommendations for consideration of the G20.

Concept of Nature-based Solutions

To understand the concept of nature-based solutions, it helps to distinguish three different elements in the concept. First, nature-based solutions involve working with different types of ecosystems, natural or modified. These systems may be terrestrial (e.g. forest, farmland, mountain and urban), freshwater (e.g. river, lake, peatland and wetland) and coastal and marine (e.g. mangrove and salt marsh).

Second, nature-based solutions use and work with nature in different ways, which can be broadly categorised as involving the conservation, sustainable management, or restoration of ecosystems. In practice, nature-based solutions often involve combinations of these types of action. For example, regenerating degraded areas may include components of both conservation and active restoration. Importantly, nature-based solutions often involve hybrid solutions where "green/blue infrastructure", such as woodland strips, green roofs, and wetlands, among others, are combined with "grey infrastructure" such as dams, pumps, retaining walls and storm drains to provide various benefits from flood control, to cooling effects, biodiversity benefits, and human wellbeing (European Environment Agency, 2015; European Commission, 2015; Kabisch, Korn, Stadler & Bonn, 2017).

Third, nature-based solutions are, as the name makes clear, solution-oriented (Albert, *et al*., 2019), reflecting the fact that they can be used to address a range of social, economic, and environmental challenges (International Union for Conservation of Nature, 2020; UNEP, 2022) such as climate change and disaster risk reduction, land degradation, biodiversity loss, and unemployment. In addition, nature-based solutions are often explicitly targeted at more than one challenge, and able to deliver benefits across a range of goals. For example, nature-based solution for adaptation to

climate change such as conservation and restoration of mangroves can help reduce coastal flood risk. If well designed and implemented, it may also increase carbon uptake and storage, conserve biodiversity and provide opportunities for sustainable livelihoods (UNEP, 2021). Investment in nature-based solutions for disaster risk reduction, along with integrating gender-responsive policies, can enhance the community-based adaptative capacities, and contribute to gender equality and empowerment (United Nations Office for Disaster Risk Reduction, UNEP & Partnership for Environment and Disaster Risk Reduction, 2021).

The three dimensions of nature-based solutions – the type of ecosystem where the intervention is made, the different ways in which these interventions work with ecosystems, and the different kinds of social, economic and environmental challenge which they address – entail that there is a wide diversity of nature-based solutions, varying along these three dimensions (see Table 1).

In addition to the types of nature-based solutions that are summarised in Table 1, there is a growing body of research that focuses on the opportunities for and benefits from the implementation of nature-based solutions in G20 countries.

- Food security among the rural poor in India is closely linked to poverty and agricultural productivity. A study of smallholder farmers in Odisha compared the conventional tillage of maize with an approach utilising conservation agriculture techniques, including reduced tillage

Table 1: The Three Elements of Nature-based Solutions

Type of Nature-based Solution	Three elements		
	Working with Different Ecosystems	Working with Ecosystems in Different Ways	Addressing Challenges
Combination of natural biocontrol products for coffee crops, improving habitats for natural enemies of insect pests, and promoting agroforestry practices to provide shade for the coffee plants (CABI, 2021a; 2021b).	Farmland; plantations	Sustainable Management	• Pest regulation • Economic development • Climate adaptation
Restoration of natural forests under community management and promotion of agroforestry for carbon storage and diversified local livelihoods (United Nations Development Programme, 2022)	Forests; farmland	Sustainable management Restoration	• Climate change mitigation • Land degradation • Food security • Biodiversity loss
Introducing wildlife management in protected areas to support wildlife-based tourism to diversify pastoralist livelihoods (Chausson, Turner, Seddon, Chabaneix, Girardin, Kapos, V. et al., 2020; Osano, Said, Leeuw, Moiko, Kaelo, Schomers et al., 2013).	Grasslands; pastoral lands	Conservation Sustainable Management	• Biodiversity loss • Poverty alleviation

Table 1 continued...

Blocking drains and rewetting peatlands to re-establish their hydrology, and where needed apply paludiculture to support livelihoods (Strack, Davidson, Hirano & Dunn, 2022; Tanneberge, Appulo, Ewert, Lakner, Brolchain, Peters, *et al*.,2021).	Peatlands	Conservation Sustainable management Restoration	• Climate change mitigation • Water security • Biodiversity loss • Land degradation
Riparian buffer and floodplain management and restoration to manage flooding and reduce infrastructure assets at risk (Kapos, Wicander, Salvaterra, Dawkins & Hicks, 2019).	Rivers; floodplain	Conservation Sustainable Management Restoration	• Climate change adaptation • Disaster risk reduction
Constructed or restored wetlands for water filtration and pollution abatement, flood control and restoration of biodiversity (Nagabhatla, 2018).	Freshwater (wetlands)	Sustainable Management Restoration	• Disaster risk reduction • Water security • Biodiversity loss
Network of effectively managed marine protected areas to maximise conservation of biodiversity while protecting the assemblage of fished species harvested outside the protected areas, benefiting local fisheries (Grorud-Colvert, Claudet, Tissot, Caselle, Carr, Day, *et a*l., 2014; Eggermont, Balian, Azevedo, Buemer, Brodin, Claudet, J *et al*., 2015).	Marine / Coastal	Conservation	• Biodiversity loss • Poverty alleviation • Food security
Restoration and conservation of seagrasses aiming to stabilise sediments while providing habitat for invertebrates and fish (Nature-based Solutions Initiative 2022; Kapos, Wicander, Salvaterra, Dawkins & Hicks, 2019).	Marine / Coastal	Conservation Restoration	• Biodiversity loss • Disaster risk reduction • Pollution
New assemblages of organisms for green roofs and walls to mitigate city warming and clean polluted air (Eggermont, Balian, Azevedo, Buemer, Brodin, Claudet, J *et al*. 2015; European Commission, 2015).	Urban	Sustainable Management	• Climate change adaptation • Pollution • Health and wellbeing
Renaturalisation of abandoned urban areas via community-based green space to promote cultural identity and recreational spaces (URBiNAT, 2022).	Urban	Sustainable Management Restoration	• Health and wellbeing • Sustainable cities & communities
Protection of key micro-headwaters by local community agreements, while restoring mountain wetlands (Peru Ministry of Environment, 2019).	Mountains/ highlands; wetlands	Conservation Restoration	• Water security • Poverty alleviation

Sources: Compiled from Various Sources.

and intercropping with cowpeas. This led to an improved maize yield of 60-70 per cent (Chan *et al.*, 2017)

- Brazil's Atlantic forest is one of the most degraded biomes in the country. While it remains a biodiversity hotspot and plays an important role in water provision, it needs restoration. One study has urged the value of agroforestry, as practiced by smallholder farmers, as an important means of restoring the forest. The studies note that the smallholders have reported higher soil moisture on their plots and higher proportions of household food produced on their farms. They also emphasise the importance of full inclusion of smallholder farmers in the planning and implementation of restoration, with appropriate policy support and access to finance (Shennan-Farpón, Mills, Souza, & Homewood, 2022).
- A South African study of the potential contribution of ecological infrastructure argues that while the development agenda may increase the potential risk of degradation of the natural environment it also creates opportunities to demonstrate how the rehabilitation and maintenance of ecological infrastructure can provide a complementary mechanism for contributing to development objectives. The study cites research showing that the livelihood benefits from urban wetlands in Cape Town is worth $1,570/ha/year. Further, investment in ecological infrastructure can contribute to job creation as well. The study cites the well-known Working for Water programme which removes invasive species to improve ecosystem services, including water supply. The programme employs around 9,000 people per year, of whom about 50 per cent are women. The programme has increased from supporting 10 projects in 1995 to over 300 projects in 2015 (Cumming *et al.*, 2017).
- In a different context, a study from India makes some similar points to the South African research. It also emphasises the importance of combining ecosystem-based approach with engineered water resource governance and management. The study focused on the semi-arid landscapes of the Banas Catchment in Rajasthan and note that engineered solutions enable the technically efficient extraction and distribution of water toward areas of demand, whether urban or agricultural. But they also argue that this is not combined with resource regeneration which can lead to many adverse ecological and human consequences. In this case, the restoration or establishment of groundwater recharge practices, particularly in the upper catchment is recommended. These re-charge practices are largely ecosystem-based (Everard *et al.*, 2018).

The diversity of these examples, across different ecosystem, with different forms of intervention and serving to address different challenges, gives an indication of the broad range of nature-based solutions. It also illustrates the diversity of terminology that is used in this context, including terms such as ecosystem-based approaches, conservation agriculture, agroforestry and ecological infrastructure.

Way Forward

The severity and urgency of the various challenges that societies face implies that if nature-based solutions are to deliver for people and biodiversity in a changing world, they need to be substantially and rapidly scaled up (Dick *et al.*, 2017).

The solutions broadly split into two categories. The first category comprises different types of nature-based solutions and second category covers actions that contribute to building a common understanding of nature-based solutions.

Types of Nature-based Solution

Different nature-based solutions can be classified along three different dimensions (the type of ecosystem they focus on; the type of intervention they involve; and the social, economic or environmental challenge that they address).

Some of those include the followings:

Action to address land degradation and accelerate ecosystem restoration

This would build on the work of the Saudi Arabia Presidency on addressing land degradation and reflect India's priorities, including on the restoration of abandoned mine sites and of forest fire impacted areas. It would represent a significant contribution to the UN Decade on Ecosystem Restoration (UNEP and FAO of the United Nations) in addition to the Ganges River Rejuvenation (UNEP and FAO of the United Nations, 2022), which is one of the Decade's ten Flagship programmes.

Highlight the contribution of nature-based solutions to the creation of employment

The contribution of nature-based solutions to creating sustainable jobs, including for youth, is being increasingly recognized (ILO, UNEP and IUCN, 2022). This focus would be consistent with the Chair's summary from the G20 Foreign Ministers' meeting in March 2023, which noted that the "digital economy and green transitions are fundamentally changing the nature of work and leading to new jobs and tasks. Skilling, re-skilling and upskilling of the workforce, particularly under-represented workers, including women, youth and persons with disabilities, is essential" (G20, 2023b). Such an initiative would also build on the Mahatma Gandhi National Rural Guarantee Scheme, which is the world's largest Public Employment Programme and currently by far the largest source of nature-based solutions related employment.

Scale up the use of nature-based solutions for climate change

The use of nature-based solutions for climate mitigation can make significant contribution to address environmental and economic challenges in the short term (UNEP & IUCN, 2021). It will be vital to acknowledge that the use of nature-based solutions does not replace the need for rapid, deep and sustained reductions in greenhouse gas emissions from fossil fuel usage. G20 political leadership on this issue could play a significant role.

Build a Common Understanding of Nature-based Solutions

Several terminologies are used in the context of nature-based solutions. In the commitments to support nature-based solutions, including those made under the previous presidencies of the G20, the term has always been coupled with 'ecosystem-based approaches'. The same linkage is also found in the Sharm el-Sheikh Implementation Plan and the Global Biodiversity Framework.

The diversity in the terminology that is used to describe nature-based solutions reflects both the different institutional contexts in which the term and its synonyms have emerged, and the wide range of challenges that these solutions can address. Nevertheless, this diversity

is one barrier to building a common understanding.

The G20 is well-placed to promote development of a common understanding of nature-based solutions including through the dissemination of examples of best practices and the development of guidelines for the implementation of such solutions. This play a complementary role to the broader inter-governmental consultations on nature-based solutions that are currently being supported by the United Nations Environment Programme.

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About G20 Digest

G20 has emerged as an important global forum over the years, and G20 Leaders' Summits are watched worldwide with interest and suspicion. Successive presidencies of G20 have encapsulated a vast array of issues beyond the financial sector; each having potential impact on trade & investment, global governance and social sector. Each presidency has contributed to the summit process by adding new issues along with the routine ones resulting in a wider and diverse G20 Agenda. In view of the diversity of issues and complex challenges the world is grappling with, the expectations from G20 has multiplied. It is imperative to comprehend and assess the rise of G20, and its role and function in shaping the future global order. In order to motivate and stimulate fresh ideas on G20 and its implications for global economy, RIS brings out the quarterly journal, G20 Digest, as a platform to compare, contrast and create new knowledge that matter for the people in the G20 countries and in the world, including the developing and less developed countries.

Guidelines for Submissions

- *G20 Digest* is a peer-reviewed journal dedicated to the issues and subject matters relating to G20 and its broader linkages to global governance, functioning of multilateral institutions, role of emerging markets, and larger development interests of the people.
- Scholarly articles on various topics of interest to G20 are invited from academics, policy makers, diplomats, practitioners and students. The articles may cover the whole range of issues including role and effectiveness of G20, functioning of G20, coverage of sectors, G20 and global governance, G20 and global financial stability, and similar topics.
- Original manuscripts not exceeding 5000 words prepared in MS Word using double space with a 100 word abstract and three key words may be sent to pdash@ris.org.in.
- The submitted articles must follow APA referencing style.
- All numbers below 10 should be spelt out in words such as 'five' 'eight', etc.
- Percentage should be marked as 'per cent', not '%'.
- For numeric expressions, use international units such as 'thousands', 'millions', 'billions', not 'lakh' and 'crore'.
- For time periods, use the format '2000-2008', not '2000-08'.
- Mere submission of an article does not guarantee its publication in the journal.

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