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The Environmental Impact of Syria's Conflict: A Preliminary Survey of Issues

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A worker at a makeshift refinery that extracts fuel from plastic waste by burning it using distillation methods to produce liquid and gas fuels in the besieged Douma

Introduction

The Syrian conflict has entered its tenth year, with a devastating humanitarian and economic toll: the death of 384,000-593,000 people as of December 2020; the forced displacement of an estimated 13.5 million people, almost half of whom are displaced internally, struggling to survive; economic loss of $428 billion from 2011 to 2018 (six times the GDP in 2010); depreciation of the Syrian lira (now 13 times less valuable than before the conflict); high unemployment; the destruction of physical property, including homes, infrastructure, hospitals, schools; and the reality of 90% of the population living below the poverty line. Yet the war has also resulted in significant environmental destruction – a form of damage that receives less attention but represents major potential harm with long-term negative consequences on public health, the economy, and peace itself, and which must be central to any post-conflict relief or reconstruction effort.

Notably, environmental damage is not just an effect but also a driver of the conflict. Poor environmental conditions in Syria before the war have been identified as a primary factor contributing to the armed conflict, namely the mismanagement of natural resources and waste, the inadequate government response to mining pollution, and the severity of the drought that occurred from 2006 to 2010, which damaged the agriculture sector (comprising 25% of GDP), increased unemployment, amplified food insecurity and triggered mass migration towards urban centres. Combined with a high population growth rate, water scarcity imposed a greater risk of political instability.

A decade of war has left a significant environmental impact as a result of the high usage of explosive weapons, the damage done to oil refineries (with soil contamination, pollution, and the subsequent reliance on highly polluting makeshift oil refineries), and the mismanagement of waste and water, especially in densely populated areas. This paper provides a preliminary survey of a set of environmental challenges that impose significant health, social and economic costs, including air pollution, emissions, deforestation, soil and vegetation degradation, water depletion, and waste mismanagement. It also suggests certain

green solutions for post-conflict relief and reconstruction. The priority right now should be towards more efforts to evaluate the environmental impact of the conflict and integrate environmental planning and considerations in reconstruction plans. Ultimately, any effort to mitigate environmental damage and set Syria on a more sustainable course would require a level of collaboration and coordination across Syria's different actors and geographies, which seems unlikely at this stage.

Environmental deterioration, health risks, and economic cost

Air pollution

Syria suffered high levels of air pollution even before the conflict erupted. In 2010, 69% of the population were exposed to high levels of particulate matter (PM2.5). This high level of air pollution was caused by industrial and vehicle emissions, waste burning, and seasonal pollution – with hazardous particles contributing to chronic disease, breathing problems, and hospitalization. Initially, the eruption of conflict lowered the percentage of the population exposed to particulate matter (by 7% in 2011), as people fled cities in large numbers and industrial activity and energy consumption decreased. Yet, starting 2012, the trend reversed and peaked to 72% in 2015.

Although causation is very difficult to ascertain – especially given the absence of fine-grained, geographically specific data on air pollution inside Syria – the drastic increase in 2015 could be the result of a combination of factors: aerial bombardments carried out by the Syrian and Russian governments against rebel groups; the US-led bombardments of Islamic State-held oil facilities; bushfires and major dust storms that resulted both from military operations as well as the decline in farming activity; and chemical attacks used by the Assad government in March, April, and May 2015. The WHO ranked Syria as the 18th worst air polluter (out of 92 countries) in 2019, with PM2.5 concentration three times above the WHO recommended exposure level.

The level of particulate matter has direct public health effects: estimates of deaths from diseases caused by outdoor air pollution increased by 17% between 2010 and 2017 to a total of 7,684 persons; disabilities related to particulate matter account for 1,625 per 100,000 persons in Syria. These high death and disability rates also affect healthcare costs: the economic burden of disease and premature death related to air pollution in Syria is estimated between 0.6–1.42% of the GDP; environmental/occupational risks driving death and disability increased by 16.5% between 2007 and 2017. High levels of PM also affect agriculture productivity and reduce crop yield, with wheat and oilseed most affected (Chuwahet et al. 2015).

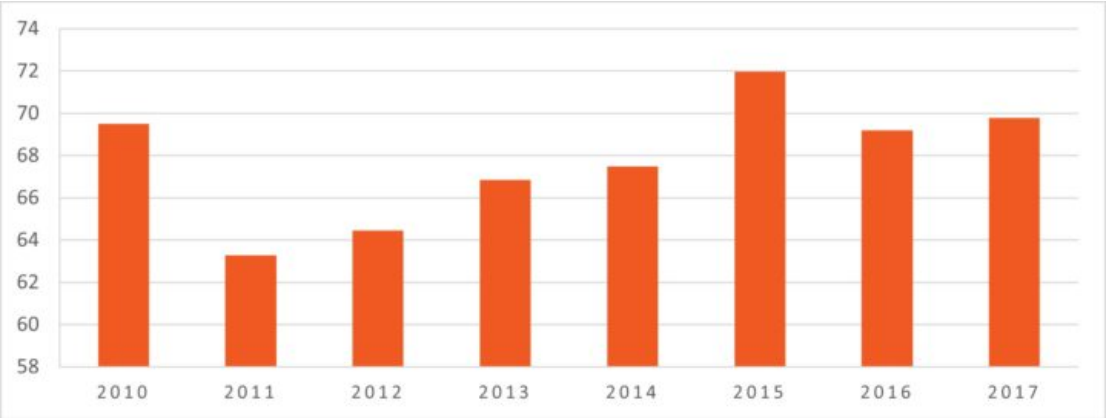

Figure 1: Syria PM2.5 Pollution Percent of Population Exposure from 2010 to 2017 (World Bank, 2017)

CO2 emissions

The eruption of war decreased CO_2 emissions as a result of the destruction in the energy sector (the dominant source of emissions), the deterioration of agricultural activities, industrialization, and disruption of oil and gas production due to damaged pipelines and other infrastructures in the state-owned main refineries in Banias and Homs. See Figure 2 for a breakdown of emissions by sector.

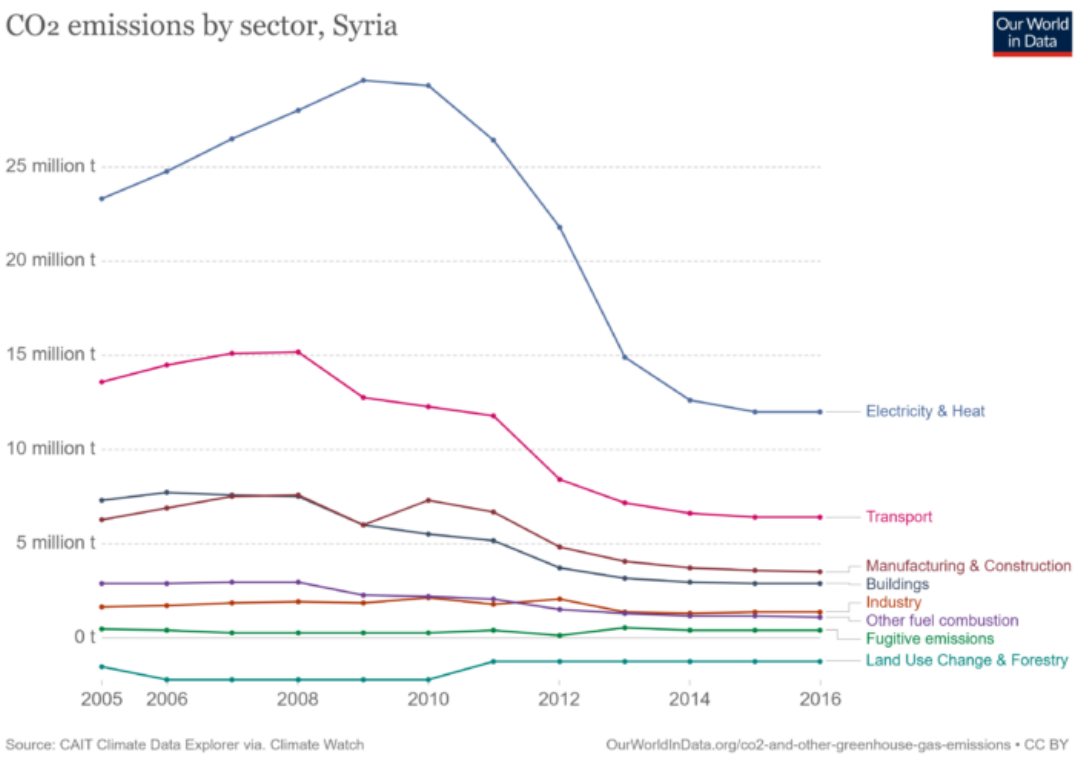

Figure 2: Syria gas emissions by sector from 2005-2016

Source: CO_2 emissions by sector, Syria (ourworldindata.org)

Oil and gas remain the major sources of CO_2 emissions (see Figure 3) although such emissions have declined drastically over the last decade, in parallel with the decrease in oil and gas-related production, which fell by 28% between 2011 and 2015 (USAID, 2017). In many cities, power plants were either fully destroyed or sustained significant damage as a result of the fighting, looting and dismantling of the facilities' metal equipment. Additionally, the shortage of natural gas, diesel, and heavy fuel oil prevented the facilities from operating, which also explains the reduction in the level of emissions (Aoun and Arshad, 2017). CO_2 emissions from cement have also declined over the years, but this trend is not expected to continue given the anticipated reconstruction phase in Syria (of at least 60% of destroyed and damaged urban areas).

Even though CO_2 emissions have decreased, they are still above recommended

levels. Syria's annual emission of CO_2 in 2019 was 26.96 million tons, imposing $1.4 trillion in social costs (the current social cost of carbon is estimated at $50 per one ton of carbon dioxide in the atmosphere), increasing the likelihood of extreme weather events such droughts, and leading to the disruptions in food supply chains – similar to pre-war dynamics.

Moreover, other environmental damage has accompanied the decline in CO_2 emissions. As a consequence of the bombing of Homs oil refineries and the development of new makeshift refineries by ISIS, hazardous substances have formed. Oil spills from the damaged refineries, wells, trucks, pipelines, and tanks from ISIS operations polluted ground and surface water, as well as soil, leading to polluted drinking water and agricultural land. The pollution and fallout from oil fires have destroyed large areas of cultivated and grazing land and killed livestock, affecting livestock breeders and farmers.

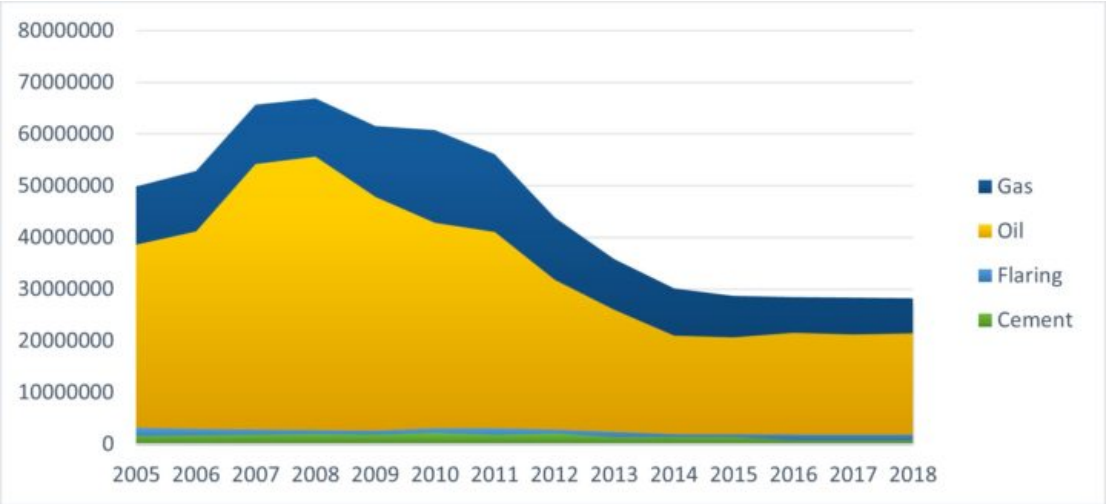

Figure 3: CO_2 emissions by source of material from 2005 to 2018

Source: CO_2 emissions by sector, Syria (ourworldindata.org)

Deforestation

From 2012 to 2019, Syria lost 20.4% of all tree cover (Pax, 2020), much of the loss

occurring in the governorates of Lattakia and Idlib, which lost 10% and 27% of tree cover area respectively between 2011 and 2014 (or 89% of the total tree cover loss in Syria). Depletion of forest cover has been linked to a variety of different socio-economic factors related to the conflict, including frequent forest fires, illegal logging, agricultural expansion, charcoal production, and the weakness of state institutions in managing natural resources and environmental development.

Forest fires are a major culprit of deforestation, and their frequency and intensity have increased dramatically during the conflict in Syria. In 2020 alone, fires wiped out over 9,000 hectares of agricultural and forested land, affecting 140,000 people through the destruction and damage to their homes and assets, the loss of power and water supply and limited access to services such as hospitals. One of the main causes of these fires has been the bombing campaigns by different parties to the conflict holed up in dense forests as protection from detection by drones and aircraft.

Another conflict-related cause of deforestation is the population's intense reliance on trees for heating and sheltering. In 2013, 40% of the country's power lines were attacked, 30 power stations were inactive, and trees became essential for heating and electricity. To give some examples of areas that have been subject to excessive logging: 7,000 trees were cut down in Tel Kelekh and Hama, including in the Al-Belas reserve where hundreds of century-old trees have been lost; 7,500 trees were cut in Hasakah, most of which are from Mount Abdul Aziz Reserve; entire forests have been logged in the Jbata reserve in Quneitra, estimated between 100 and 300 trees; and 100 stone pine trees were cut down in al-Shahar in southern Jbata. Deforestation hurts the economy and destroys natural reserves such as the reserve of Dhamna in southern Syria. The losses include rare and seasonal trees such as oak trees, Atlantic ducks, mulle trees, raspberries, wild pines, Prunus Mahaleb cherry, hundreds of species of natural plants, such as chamomile, nettle, and wild thyme, which are required for the pharmaceutical industry, and rare aromatic herbs such as lavender, coriander, and mushrooms (North Press Agency, 2020). Between October and December 2016, more than 251,000 fruit trees were destroyed in bushfires in the districts of Heffeh, Lattakia Markaz, Jableh and Kerdaha, destroying livelihoods and jeopardizing the food security of many families.

Deforestation, forest fires, damage to irrigation systems, drought, climate change, and the inability to access farms to care for the trees – all have significantly reduced the country's olive oil production. Before the conflict, Syria was a leading producer of olive oil in the region, with more than 79 million olive trees producing approximately 1.1 million tons of olives –250,000 tons for consumption and 850,000 tons set aside for oil production which produced a net of approximately 200,000 tons of olive oil. With a significant contribution to GDP, ranging from 1.5 to 3.5% before the war, the olive sector was a prominent economic sector in Syria and employed nearly 337,000 households in 2003. In Lattakia, for example, 57,000 households are sustained by 45,900 hectares of olives, and 44,700 households benefit from 42,500 hectares of citrus (MAAR , 2019). In addition, olive oil accounted for 3% of total non-fuel exports from Syria and about 10% of the population was either partially or wholly dependent upon the olive sector as a source of income, whether through olive growing, harvesting, production, or sales (Muhammad, 2017a; MAAR, 2019). At one point in the conflict, the official export of olive oil dropped to less than 20,000 tons.[1] The estimates rose to 32,000 and 30,000 tons in the 2016-2017 and 2017-2018 seasons, respectively – an increase attributed to the decrease in fighting and reclamation of olive groves by the Assad government, but still a far cry from the pre-conflict levels. The culling of at least 500,000 olive trees in Afrin, a city in northwestern Syria with 18 million olive trees, by the Turkish-backed Syrian opposition armed group in March 2018 contributed to the reduction in olive production.

Water depletion

Before the war, Syria's water resources were already under pressure, as a result of the country's limited natural reserves and its high population growth rate (Müller et al., 2016). Groundwater depletion had started in the early 1980s and worsened with the expansion of irrigation farming. Climate change played a significant role in worsening the drought and critically damaging agricultural resources. During the conflict, internal displacement and migration to urban locales placed very high pressure on potable water, especially in city suburbs (Ahmad, 2015), with drinking water becoming available for no more than four hours a day. In addition to insufficient water supply, additional problems like the contamination and

inadequate sanitation of water sources impose high costs in the form of waterborne illnesses and deaths.

Waste mismanagement

Pre-conflict Syria already suffered from a hazardous waste problem due to the lack of proper waste management systems and regulations. The long-term mismanagement of hazardous waste – primarily industrial and medical waste (80% of it infectious, 15% chemical, and 5% radioactive) – generated a high level of dioxin and other gases and increased air pollution, particularly for Aleppo and Damascus, bringing with it all the grave health risks associated with hazardous waste.

With the total shutdown of government-operated waste management services, the war created a disastrous waste disposal problem and contributed to the production of additional hazardous waste through uncontrolled burning and dumping. The destruction of industries, hospitals, and cities released high levels of toxins into the air and seeped chemicals into soil and groundwater resources. Although levels of waste disposal in Syria cannot be precisely measured at this time, it is estimated that solid waste production reaches 850 tons per day – double the amount before the war. Uncollected municipal and household waste attracts rodents and insects that carry infectious diseases, exposing children and individual trash pickers to risk. It also contaminates soil and water, imposing health risks and economic costs, particularly in agriculture and fishing.

Vegetation degradation, soil erosion and food insecurity

The long years of drought between 2006-2010 caused soil infertility and soil/vegetation degradation – problems that were compounded during the war, and that will threaten post-war land productivity, biodiversity, and agriculture. The relentless bombing stirred up the soil, making it easier to transport by wind and water and increasing the occurrences of dust storms. Soil erosion has also been accelerated by alarming vegetation changes – a result both of the high

demand for natural resources as well as the expansion of urban areas during the conflict due to population movements. More than 85% of agricultural land in Syria is exposed to soil erosion, and the use of arable land decreased by 21% between 2010 and 2014.

The high exploitation of fragile lands, particularly in the main crop cultivation area that has also been the site of intense fighting – stretching along the western coast and eastward along the northern border with Turkey – has resulted in further degradation. Coupled with the contamination of land and soil by war material, degradation exacerbates the erosion process, leading to a loss of agricultural production in these areas. Soil erosion not only caused loss of fertile land but also increased sedimentation and pollution in the rivers and streams. As a result, fish production declined by 63%.

According to the UN's Food and Agriculture Organization, the agriculture sector suffered a $16 billion loss between 2011 and 2016 – equivalent to a 41% decrease in the GDP from agricultural products — due to lost production, damage, and destroyed infrastructure and assets (damage to irrigation systems and shortage of inputs such as fertilizers, fuel, and seeds). The war decreased cultivated land by 30% on average and irrigated land by 50%. The production of wheat halved in comparison to pre-conflict estimates; four years into the conflict, Syria had turned into a net importer of wheat. While Syria's agriculture sector still provided 50% of the country's food supply in 2016, this marked a 40% decrease from pre-conflict levels. In addition, rising fuel prices (if fuel was even available), particularly in Aleppo and Idleb, high costs of once-subsidized seeds and animal feed, a shortage of specialized staff, high labour costs, labour shortages and fragmented economies with broken supply chains – all increased food prices, leaving nearly half of the population in 2016 unable to meet their daily food needs. Currently, 60% of the population is estimated to be suffering from food insecurity. The productivity of agriculture has been severely deteriorated, pushing people into poverty and forcing them to shift their cultivation to fewer resource-intensive crops. The kickstart cost of recovery for the agricultural sector is estimated by the FAO to range from $11 to $17 billion. This huge impact on the agriculture sector will also widen the rural-urban development gap.

The use of chemical and explosive weapons, containing elements of heavy metals,

fuel, solvents, and energetic materials that have contaminated groundwater and soil, are likely to cause serious environmental concerns for the future of the agriculture sector in Syria, affecting both the economy that for years relied on agriculture production and exacerbating other forms of future environmental fallouts such as droughts, sandstorms and decrease in rainfall. This impact on the agriculture sector along with soil and water contamination will have a dire consequence on the future of the food supply in Syria: intensifying the problem and increasing the reliance on importation; worsening the economic situation for future generations.

Post-conflict reconstruction plan

The war in Syria is ongoing, and the different possible scenarios and involvement of multiple parties in the conflict make it difficult to layout precise sustainability plans. But the following steps will be necessary for any sustainable reconstruction plan.

Better assessment of the conflict's environmental effects

There is much we do not know about the effects of war on the non-anthropocentric environment. The intensive use of explosive and chemical weapons will have long-term consequences on both urban and non-urban environments within Syria and beyond, increasing health risks and poverty in the region. An assessment can start with measuring more precisely the conflict's effects on the environment, detailing the location and status of environmental hotspots, establishing contingency measures for the treatment of hazardous waste, and generating knowledge of the possible environmental threats at the community level. Such an assessment must focus on socio-economic inequality as it intersects with and exacerbates environmental harm.

This information can be collected via a variety of data sources, including through citizen research performed by local actors as an innovative way to gather and exchange environmental damage information – a task that could be coordinated

by UNOSAT, Open Source Intelligence (OSINT), or branches of humanitarian organizations such as the REACH initiative and the Joint Environmental Unit of the Office for Coordination of Humanitarian Affairs (OCHA) and UNEP.

Sustainable agriculture

The challenge of production incentives and the associated problems of irrigation and climate-smart cultivation are key factors in the recovery of the agricultural sector. While irrigation is still crucial for most rural households, some new practices need to be adopted to prevent aquifer degradation. These include:

- Repairing damaged irrigation canals in areas of intense military operations and improving irrigation systems' performance.
- Rehabilitating essential infrastructure for safe storage of crops and inputs.
- Providing portable soil testing particularly for targeted areas.
- Adapting crop selection practices to sustain economic profitability, switching away from high water intensity crops to more water-efficient/drought-tolerant crops.
- Supporting the use of native legumes and wheat varieties, suited to the Syrian climate and resistant to drought and disease, would make it simpler for farmers who would otherwise fail to grow a new variety.
- Training farmers, including those with decades of experience, on innovations and technological advancements.
- Implementing conservation farming practices to minimize water and fertilizer needs, including landscape-based approaches.
- Enabling the development of private enterprises by providing access to agricultural resources such as credit extension and marketing support, which will contribute to increased agricultural production and food security.

Green re-building code

Syria's reconstruction should be used as an opportunity for practitioners to adopt sustainability values. Sustainable architecture enables planners to limit the usage

of new construction supplies, to be vigilant when using current building materials, and recycle building material from demolished buildings. One good option could be the application of green building codes such as the LGGE Energy Efficiency Code in Buildings, which is a global project funded by the Global Environmental Facility and implemented by the UN Development Program, aimed at reducing CO2 emissions by implementing thermal and energy-efficient building codes for new construction. Such a project was planned for Syria but cancelled in 2013.

Using recycled building materials instead of new materials may be another effective way to save natural resources and reduce the amount of energy available, in addition to having real economic benefits (Kernen, 2002). Reuse of rubble has also been shown to be useful as a means of reducing demolition-related contamination and waste disposal (UNESCO, 2005). Recovered building materials (stones, timber and metal) can be preserved, categorized and reused for the renovation of existing buildings and the construction of new components and buildings, including facilities for a new solar energy system, improving the viability of the reconstruction process and preserving Syria's architectural character. Scrap materials that cannot be reused can be recycled for use in new buildings. Following these practices, instead of using new materials, not only protects land resources but can also reduce the cost of recovering damaged sites by about 40-50%.

Solar energy

It is easy to be sceptical about expanding Syria's reliance on solar energy in light of the many international actors interested in Syria's reconstruction process. Yet reconstruction requires energy, and as the cases of Iraq, Yemen, and Afghanistan demonstrate, it can prove onerous to produce electricity from oil and natural gas due to the security threats and concerns associated with redeveloping centralized power generation and widespread distribution networks during the insurgency. Solar panels would help to offset some of these security concerns in Syria. Rethinking industrial priorities and switching to renewable energy is a necessary step. Supporting the expansions of clean energy such as solar power can be pursued by:

- Utilizing renewable energy sources such as wind, solar and biomass in schools and collective shelters or hospitals and public buildings.
- Placing large solar arrays in cities like Aleppo as one of the best ways to restore electricity, bringing flexibility to a war-damaged electricity network.
- Rehabilitating electrical supply for plants, grids, lines and networks, while also providing urgent rehabilitation of hydro and thermal power stations.

Recycled Scrap metal

Syria could sell its scrap metal including military material and recycle it reducing the disposal costs and raising revenues (like the case of Afghanistan,). Aluminium and steel are energy materials that contain the energy necessary for their processing, such as the refining of iron ore, the heating and shaping of goods and the transport of comparatively heavy materials. The energy needed for the process of re-using or creating new items requires a lower energy level and minimum processing to achieve it, making recycled metal a long-lasting material that does not need frequent replacement (Americas, 2016).

Debris and solid waste management

To address the difficult issue of debris and solid waste, key elements should include:

- Assessing the need for solid waste and debris management in high-risk areas.
- Identifying local partners and working with local NGO partners to create a sustainable solid waste program in each targeted neighbourhood.
- Implementing cash-for-work programs/emergency employment programs for solid waste/ debris management (removal, sorting and recycling).

Water

Syria can take steps to overcome its longstanding water challenges by responding to the urgent dynamics caused by the protracted conflict, through:

- Providing a comprehensive risk assessment and management approach to water delivery, to ensure drinking water safety by preventing or minimizing contamination. This can include implementing measures to monitor and evaluate water quality tests.
- Using water clean-up methods such as dispersants, booms and skimmer for oil spilt areas.
- Strengthening hygiene education to manage the risks of contaminated irrigation products.
- Conducting capacity development activities based on water needs and priorities through training, designing, constructing, managing, and operating sustainable water practices.
- Restoring and rehabilitating water supply networks.
- Treating sewage water and wastewater from selected industries that could fulfil the environmental requirements to be used in irrigation for agricultural production.
- Construction of artificial wetlands, which can also be designed for land reclamation after mining or as a mitigation step for water areas lost to pollution and contamination.
- Harvesting rainwater and separating it from the sewage network so that it can be used for irrigation and agricultural production.

Conclusion

Natural resources are in high demand in any post-conflict situation, especially to restore or construct new housing and infrastructure, as well as to re-establish livelihoods and the economy in general. The activities at the core reconstruction, such as removing rubble, clearing munitions, cleaning destroyed industrial sites, and restoring damaged water and sanitation systems, must all be focused on a sustainable recovery to prevent further environmental degradation.

Addressing and mitigating the environmental challenges identified in this paper will require collaboration and planning between different local and international authorities and organizations. Preparing plans to mitigate the environmental harm and promote green recovery will require a compromise agreement on economic and environmental recovery between the actors. These plans must engage with all players at the international, national, and local levels will help to avoid “blinders” in environmental policy design. Ultimately, what is needed is a well-informed, flexible, and multifaceted approach that incorporates short-term environmental emergency needs with long-term environmental efforts.

Given the current divisions in the country and the multiplicity of actors, such collaboration seems far-fetched at the moment, particularly on complex issues such as air pollution. However, key actors – be they Syrian or international – can start by cooperating to assess the environmental impact of the conflict and obtain a comprehensive understanding of the situation on the ground. With certain issues that are more local– such as the pollution caused by makeshift refineries or by the use of highly polluting sources of power generation – pilot projects could be a good start, and ultimately feed into larger efforts in the future.

Defining a long-term approach that addresses environmental concerns and assists in the evaluation of policy trade-offs – through measurement of the current damage level, as well as current resource distribution – will allow mapping of the future by developing a long-term vision for a sustainable plan that considers related threats, limitations, and trade-offs.

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Endnotes

1. Published and unpublished statistics of several years obtained by researchers in person from the Central 68 Bureau of Statistics, Damascus.

Arab Reform Initiative

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About Arab Reform Initiative

The Arab Reform Initiative is the leading independent Arab think tank working with expert partners in the Middle East and North Africa and beyond to articulate a home-grown agenda for democratic change. It conducts research and policy analysis and provides a platform for inspirational voices based on the principles of diversity, impartiality and social justice.

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