2014 War on Gaza Strip:

Participatory Environmental Impact Assessment

Prepared by: Palestinian Environmental NGOs Network – FoE Palestine
Through: Maan Development Center
Funder: Heinrich-Böll-Stiftung

Ahmad Saleh Safi, PhD

October 2015

HEINRICH BÖLL STIFTUNG
PALESTINE & JORDAN

Tal az Zaatar St. 6
Ramallah, Palestine
Tel: + 972 – (0) 2 296 11 21
Fax: +972 – (0) 2 296 11 22
E-Mail: info'at'ps.boell.org
Website: http://www.ps.boell.org
For mail please use: P.O.Box 2018 Ramallah / Palestinian Territories

Friends of the Earth Palestine
PENGON
Palestinian Environmental NGOs Network

PENGON-FoE Palestine
Al-Nahda building- Second Floor
Al-Masyoun
Ramallah-West Bank
Telephone: 972 2 2966315
Fax: 972 2 2966319
Email: info@pengon.org

MA'AN Development Center

Ramallah Office
P.O. Box 51352 Jerusalem.
Fax: +972-2-2950755
Phone: +972-2-2986796 /2954451
E-mail: maan@maan-ctr.org

Gaza Office
P.O. Box 5165 Gaza city
Fax: +972-8-2823712
Phone: +972-8-2837033
E-mail: maang@maan-ctr.org

http://www.maan-ctr.org

"This document has been produced with the financial assistance of the Heinrich Böll Stiftung. The views expressed herein are those of the author(s) and therefore not necessarily reflect the opinion of the Heinrich Böll Stiftung."

ACKNOWLEDGEMENTS

This research was generously funded by Heinrich-Böll-Stiftung. The author of this research would like to thank Ms. Ronza AL Madbouh, Ms. Abeer Al Butmeh, and Mr. Ehab Abu Husein for their follow up, revision and support throughout the research implementation and finalization process. Special thanks to the anonymous reviewers whose comments were very helpful in clarifying and improving the outcomes of this assessment. The author and the researchers are deeply indebted to the experts and municipality personnel who provided crucial information, without which the assessment could not have been performed. Special thanks to the leadership of PENGON and MA'AN for their support and interest in this assessment study. The deepest gratitude is devoted to the almost 1000 people from all around the Gaza Strip who participated in the focus group discussion sessions, which are the most important component of this research.

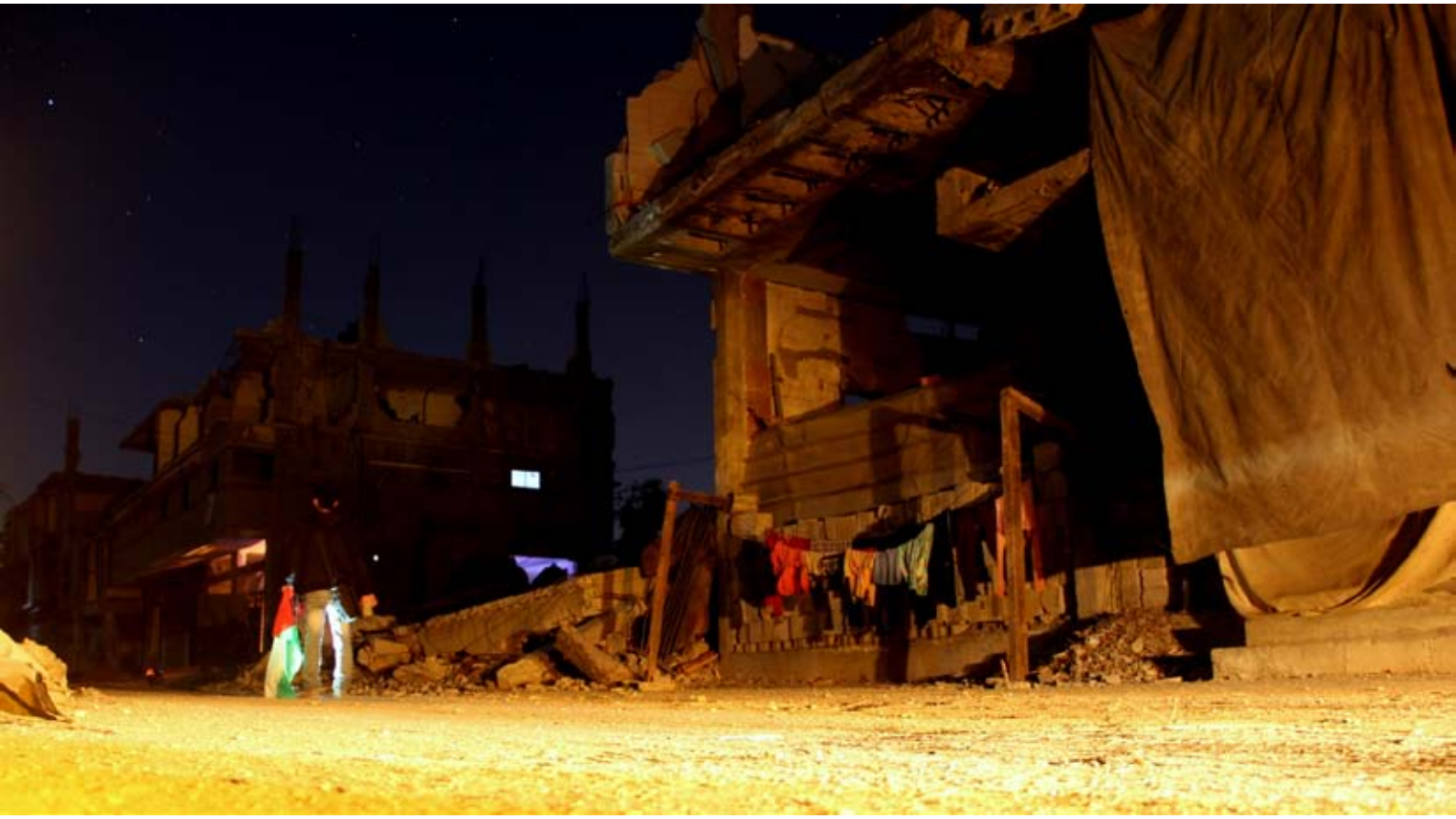
Special thanks to the Assistant Researchers who exerted huge efforts in collecting the data and information as will be seen in the methodology section. Those Assistant Researchers are:

- Mr. Mohamed Jaber;
- Mr. Majed Hamda;
- Eng. Ahmad Abu Abdo;
- Mrs. Amal Shaikhah;
- Eng. Ashraf Al Najar;
- Eng. Islam el Habil;
- Mrs. Zynab el Sersawy

Table of Contents

List of Tables

List of Figures



EXECUTIVE SUMMARY

This report discusses the findings of a participatory assessment that was performed between May and September 2015, investigating the environmental impacts of the July/August 2014 war on the Gaza Strip "Operation Protective Edge." We assess the war's impact in four steps: 1) Desktop literature review and networking; 2) In-depth interview with experts, 3) focus group discussion sessions with communities around the Gaza Strip and 4) validation of the reality of some of the impacts. This assessment is an exploratory study trying to identify all potential environmental impacts of the war almost a year after it came to an end. Through publishing this report, we aim to prompt more specialized research and assessments to further investigate the impacts of the war in terms of severity, causality, geographical distribution, and size. Within this study, 10 experts were interviewed in-depth and 982 people participated in 93 focus group discussions. The focus group discussion sessions covered all the 24 localities of the Gaza Strip. However, we split Gaza City into two localities and thus we report data from 25 localities. The focus was on those localities which sustained more damages or which are inhabited by larger populations. To validate some of the outcomes resulted from the above mentioned assessments, field visits, lab tests, and two more in-depth interviews with experts were performed.

Gaza Strip is an overly populated small belt of land located at the shore of the Mediterranean Sea. Gaza Strip is a 365m^2 land area inhabited by around 1.8 million people according to the Palestinian Central Bureau of Statistics (PCBS 2015). Decades of occupation, years of strict blockades, exploitative environmental policies, and weak governance made the Gaza Strip vulnerable to all types of natural and manmade hazards. Some of the hazards affecting the Gaza Strip are the water shortage and contamination, war destruction, environmental facilities, and flash floods (Safi et al. 2014).

Israel launched a 51 day military aggression against the Gaza strip in July/August of 2014. The aggression came at a time of heightened vulnerability and instability in the Gaza Strip, especially after the Cast Lead operation that took place in 2008/2009. Around 66% of the people in Gaza were receiving food assistance prior to this war (Operation Protective Edge) and the food insecurity level or vulnerability to food insecurity at the household level reached 72%. Poverty rates reached up to 39% in the year 2014,

and unemployment rates increased dramatically from mid-2013 to reach 43% in the fourth quarter of 2014 (The World Bank 2015).

While the war affected all aspects of life in the Gaza Strip, and exacerbated the already painful conditions of the people of the Gaza Strip, it must have caused serious damages to the environment. In this war tons of weapons, explosives and toxic gases were bombarded onto the Gaza Strip especially on the Eastern side. Tens of thousands of houses were demolished or bombarded to the ground level leaving millions of tons of rubble polluting the air with particulate matters and dust and potentially causing other types of nuisance through hosting rodents and insects. Heavy machinery, tanks, and artillery invaded almost the Eastern belt of the Gaza Strip causing damages to the top soil, both mechanical and chemical.

Trying to understand the environmental impacts of the war, PENGON and MA'AN Development Centre has successfully pursued funding from the Heinrich-Böll-Stiftung focusing solely on this assessment. The assessment also strives to define those groups of people within the society in the Gaza Strip who were more exposed to the environmental impacts of the war. Such a project fits the mission of PENGON, who will use this study as a campaign tool. PENGON is a Palestinian NGO whose role is to serve the Palestinian environment by acting as a coordinating body for Palestinian environmental organizations located in the Occupied Palestinian Territories. PENGON was founded in 1996, due to the increased demands and responsibilities of Palestinian environmental organizations to defend the Palestinian environment.

The assessment reveals that the last war on the Gaza Strip most probably has imposed differentiated impacts on almost all environmental aspects in the Strip. Those areas most hit by the war include Eastern Gaza City (Al Shijaea); Beit Hanoun, Khuza'a and Ester Khan Yunis villages, and Al Shuka which may have sustained most of the environmental impacts. Areas like Al Zahra and Western Gaza City may have sustained the least amount of environmental impacts.

However, the quality of water has not changed significantly. Participants in the focus group discussion sessions from 48% of the localities of the Gaza Strip mentioned that the water quality they receive deteriorated after the war. In five localities (20%), the changes in water quality felt by the participants was due to alterations of their wells, by the local authorities. Some municipalities' wells were destroyed during the war and so alternative ones are now in use. In the other seven localities (28%), the personnel responsible for the water reported no changes in the quality of water supplied to their

communities after the war. The vastest proportion of the water in the Gaza Strip is highly contaminated with saline (Sodium Chloride) and Nitrate. The experts though, expect water contamination with heavy metals to be observed in the future. Thus there is a need for continuous monitoring of the quality of groundwater in terms of heavy metals pollution.

The war may have resulted in extensive soil damage that may need years to be treated. The top soil was completely removed or destroyed in many places around the Gaza Strip. Such damages might have resulted from the massive rocket explosions they suffered or the stress these soils sustained due to the passing of heavy machinery on them. Even after being levelled and treated, these lands are either completely infertile or produce significantly lower crop yields than before as reported by focus group participants in 88% of the localities of the Strip. The experts interviewed in this assessment expected such impacts as a result of changes caused by the physical, chemical and biological damages sustained by the soil during the war. These expectations agree with the scientific literature on the impacts of severe fire and heavy machinery on affected soils. The size of lands which lost fertility should be assessed. Such an assessment should include comparing the physical, chemical, and biological properties of affected lands to those of neighbouring unaffected lands. The farmers being the biggest victims of soil damage should be assisted in order to properly regain the fertility of their lands as soon as possible.

The war may have resulted in air quality deterioration in many places around the Gaza Strip as a result of the existence of demotion waste. As noticed by the participants in the focus group sessions, all Gaza localities (100%) still have demolition waste in some parts. Participants from 96% of the 25 localities of the Gaza Strip asserted that the air quality in the areas that host demolition waste removal sites, storage facilities, and crushers are still widely degraded. These areas suffer from dust, particulate matter, and sometimes lead air pollution, as observed by the study participants, expected by experts and confirmed by chemical tests. Chemical tests of the air quality of sites that host demolitions waste crushers, storage facilities and removal sites proved the existence of particulate matter and lead air pollution many times above the levels identified by WHO as acceptable. Air pollution with particulate matter and lead can impose significant health impacts and may be behind increases in the incident rate of respiratory diseases, cancer, cardiovascular disease, and even premature death. The air quality in all areas that still have demolition waste should be assessed and monitored for extended periods of time, and maps should be created to show the spread of war induced air pollution around Gaza Strip. Children, the elderly, and women may be the most exposed and vulnerable to air pollution as noted by experts, reports and participants of this study.

The participants of this study perceive increasing incidence of many diseases including cancer (in 72% of the localities of the Gaza Strip), skin diseases (in 68% of the localities), premature births (in 48% of the localities), and respiratory diseases (in 44% of the localities). There are no governmental or independent statistics that prove these observations. Additionally, in Al Fukhary, Beit Hanoun and Khuza'a, the participants noticed that injuries caused by sharp demolition materials are hard and time demanding to cure. There is a need for intensive research to discuss the change in the incidence rates of the above mentioned diseases, to investigate trends, and test hypotheses regarding the causes of such diseases including wars. Women, children and the elderly may again be the groups that are more vulnerable to these diseases

The war may have also resulted in the loss of wildlife in the areas that sustained significant damages in terms of agricultural lands. The participants from 32% of Gaza's localities reported losses in wild birds, while participants from Al Shuka and Abassan el Jadida reported losses in wild animals. These losses correlated with the destruction of wide areas of agricultural lands during the war, especially lands cultivated with trees. Visiting some of the areas that witnessed this damage, it was hard to confirm the decrease in wild animals, while the people we met on those trips assured us of the decrease in birds. Losses in wildlife as a result of wars is well documented in scientific literature. Removing wide tracks of vegetated land results in depriving many animals and birds of their protective habitats and thus causing their migration or extinction. Losses in wildlife as a result of the war need to be further assessed by specialised ecologists in order to quantify and determine the reasoning behind the reduction. Additionally, plans to retain and protect the terrestrial ecosystems in the Gaza Strip, which have been stressed for a long time, need to be developed and implemented.

Similarly, participants from 56% of the localities of Gaza reported losses in relation to native herbs such mallow, thyme, and Palestine chamomile which are important part of the local diet and traditional medicine. At the same time, participants from 48% of Gaza localities reported an increase in the omnipresence of smell and rodent nuisance as a result of the existence of demolition wastes in those area.

Additionally, Participants from six communities that were physically invaded during the war emphasized that agricultural lands in their communities are suffering an explosion of previously unknown weeds that farmer cannot remove or kill. These weeds were previously isolated to very limited areas close to the Eastern Gaza/Israel border (the Green Line). The seeds of these weeds might have been transported by bulldozers and tanks during the land invasions and have caused significant damages to the farmers in the above-mentioned localities. During the field visits to some of the areas affected, the research team observed and took pictures of those weeds. The farmers in those areas need to be given the technology and resources required to exterminate these harmful weeds. The introduction of new weeds may affect farmers more than the rest of the community.

Fishermen who participated in the focus group discussion sessions observed changes in the marine environment on the coast of the Gaza Strip. These changes include an increase in the prevalence of algae blooms and changes in the fish composition, including increases and decreases in certain types of fish as well as the appearance of some new types of fish. Farmers also reported an increase in the rate of communicating skin diseases because of working in polluted seawater. The current literature on the impact of organic pollution (by wastewater dumping) agrees that organic pollution may induce algal blooms and changes in the fish community (Bonsdoreff et al. 1997; Hernandez et al. 1998). The literature also supports claims regarding potential health risks induced by organic seawater pollution. Seawater pollution can cause skin lesions, ear and eye infections, and diarrhoea (Pruss 1998; Roseneberg 1980; WHO 1999, 1998).

However, the expert (Mr. Ayash, personal communication, July 2015) consulted in this study verified the observations made by the fishermen, but could not guarantee the connection between changes in the fish community and the war. He (the expert) stated that there are many other stressors that may affect the fish community near the coast of the Gaza Strip including climate changes and weather verifiability. Accordingly, more research is needed to investigate those changes, quantify them, define their causes and find solutions to the negative changes. Fishermen of course, are the ones who are most affected by those impacts as they affect their livelihoods directly.

Farmers maybe be one of the biggest groups of victims in terms of the delayed environmental impacts of the war. Farmers may be suffering decreased crops because of the soil loss and because of the recent expansion of hard to battle weeds. This adds insult to injury for the farmers who sustained huge economic losses from crop damages, asset destruction and

bulldozed trees during the war. Other groups such as children and the elderly may be vulnerable groups to other environmental impacts including air pollution and diseases. Women as seen by experts and many focus group participants may be more exposed and vulnerable to water quantity and quality deterioration. Women also may be more exposed and more vulnerable to air pollution, and environmentally based diseases both in their own capacities and in their role as the care-takers of their families

1. INTRODUCTION

This report and its findings are based on participatory research in which more than ten experts and almost a thousand Palestinians from the Gaza Strip participated. The research aims to identify potential environmental impacts of the 2014 war on Gaza (Operation Protective Edge). The assessment was conducted by a team of eight researchers, mostly new environmental science and environmental engineering graduates led by an environmental scientist. This assessment is funded by the Heinrich-Böll-Stiftung Institute and managed by PENGON and MA'AN Development Centre.

As part of this study, 12 experts representing different governmental, educational, and non-governmental organizations interested in the issue of environment were interviewed. Additionally, 93 focus group sessions were conducted in 25 localities around the Gaza Strip in which 982 people participated. In addition, air samples were gathered from ten locations around the Gaza Strip to investigate potential air pollution with particulate matters and lead. Some municipalities' staff members were brought in to investigate increased water pollution claims, and field trips were conducted to some communities to investigate claims of changes in the terrestrial ecosystems around the Strip.

The assessment is exploratory in nature as it aims at identifying questions that need further investigation to be answered. It is also participatory and so it does not establish facts, but gives voice to the people who suffer the most from wars including the last war of 2014. This assessment strives to widen the scope of interest for researchers and scientists interested in investigating the environmental impacts of the last war "Operation Protective Edge" and it hopes to be the seed from which many studies will blossom.

In this study we were able to identify many potential environmental impacts. The soil in many areas targeted by rockets or land invasions became infertile and in need of intensive rehabilitation. The air quality in areas in which demolition waste removal activities are still taking place is largely degraded with particulate matter and even lead. In many areas, losses in the number of wild animals and birds were noticed. Previously not well-known weeds are now aggressively distressing lands that were invaded by bulldozers and heavy machines causing harm to farmers. Rodent, animal, and insect nuisances are widely noticed in areas with huge amounts of demolition waste is still present. Fishermen noticed the decrease in availability of many fish types and an increase of others. No significant changes in water quality were noticed, but experts expect heavy metal pollution to be observed in the future.

In the following sections, we will discuss both the immediate and delayed potential environmental impacts of the 2014 war "Operation Protective Edge" on the Gaza Strip. We will describe the assessment methodology in details. Then we will list and discuss the results of the outcomes of this assessment. We will later recommend further investigations and assessment work in addition to some interventions to assist those who suffered the most from the environmental impacts of the war as identified by this assessment.

2. BACKGROUND

For 51 one days starting from July 8th until the 26th of August 2014, the Gaza Strip was subjected to a brutal Israeli aggression called "Operation Protective Edge." The damages sustained due to this war are massive at all levels and for all sectors including economic, agricultural, housing, health, access to water, solid waste management, and wastewater treatment. This war has left more than 2,100 Palestinian fatalities including 1,462 civilians of which 495 were children in addition to more than 11,000 injured. Moreover, 108,000 people lost their homes and became internally displaced including the inhabitants of six-high-rise buildings. In this terrible war, 15,264 structures were damaged including 6,761 that were completely destroyed. 101 health facilities sustained damages during the war including four facilities that were completely destroyed. The destruction from the war also included 467 educational facilities including 31 which were completely destroyed. Finally, 10,326 buildings were damaged including the 6,761 that were completely destroyed (UNITAR 2014; OCHA 2914; Sarsour 2014; Health Cluster 2014).

The environment has always been a victim of wars and relatedmilitary activities as suggested by Finger (1991). Actually the environment has been manipulated purposefully in many wars in what is called "environmental warfare." According to Finger (1991), wars and the related military industry are responsible for 6-10% of global air pollution and 10-30% of universal environmental damages. At the same time, Finger further stressed environmental resources make nation states become more vulnerable and thus more exposed to increased violence and wars, which then cause even more environmental damage. In the following sections we will discuss the direct impacts of the last war on the already stressed Gaza Strip and investigate potential delayed impacts.

2.1 Immediate environmental impacts

During the war, 500,000 people were forced to leave their houses to find shelter mostly in UNRWA schools around the Gaza Strip. Many if not most of these people suffered tens of days in difficult living conditions. These bad living conditions included crowded class rooms (now shelter rooms), lack of proper medical services, lack of proper sanita-

tion facilities, and lack of proper hygiene conditions. Women were especially affected by these conditions. The conservative nature of Gaza's people made the movement of women and thus their capacity to sustain their own and their children's hygienic welfare much more complicated than their fellow men. Many women did not shower or even used the toilet for days because of the lack of private and clean facilities in the sheltering schools (MA'AN 2014; Health Cluster 2014).

During the war, the water and wastewater facilities sustained significant damages which hampered people's access to safe water and sanitation to a great extent. In some areas, especially those areas which witnessed the severest attacks such as Eastern Gaza, Eastern villages of Khan Younis, the Eastern side of the middle area and Beit Hanoun, the water supply was interrupted for weeks or tens of days because of the extensive Israeli military activities that damaged water infrastructure and prevented timely repairs. Yet, people in almost all the Gaza Strip suffered longer water cuts than usual. Additionally, the water quality also changed in some localities because of the war. In some areas like the Eastern Villages of Khan Yunis, the water which used to be supplied from Israel (Makorot) was cut off until even after the war, which forced the local authorities to use local wells of much lower water quality. Whenever municipality water wells were damaged, they were replaced by others which altered the water quality received by the people in those communities (PWA 2014). The monetary value of the damages sustained by the water and wastewater facilities and infrastructure amount to about $34,500,000 USD according to Palestinian Water Authority (PWA) estimations. These losses include water wells, water networks, water tanks, desalination units, wastewater treatment plants, wastewater pumping stations, and wastewater networks as assessed by the PWA amount (PWA 2014).

Such deterioration of the water and sanitation situation in the temporary shelters or in private homes as discussed above was not without health consequences. As monitored by UNRWA, the wartime witnessed heightened rates of communicable diseases including mumps, meningitis, diarrhea (both acute bloody and watery), and viral hepatitis. These rates went back to normal almost directly after ceasefire (UNRWA 2014).).

During the war wastewater treatment almost completely stopped, which means that the millions of cubic meters of wastewater produced by the people of Gaza were dumped completely untreated to the sea. This halt in wastewater treatment occurred for several reasons, such as restricted movement of staff due to the heightened risk status of the wastewater treatment units' locations, limited availability of electricity and fuel to operate the wastewater treatment plants, and the partial damages sus-

tained by these units. The lack of proper wastewater treatment impacted the marine environment which was already suffering from major organic pollution. All this turned 70% of Gaza seashore unfit for recreational activities, especially swimming (Sarsour 2014 and PEQA 2014)

Israel bombed thousands of tons of ammunition onto Gaza through airstrikes, naval and terrestrial artillery, and land invasions. Numerous types of bombs and missiles were used by the Israelis including arguably unlawful weapons such as Flechettes artillery or rocket rounds, white phosphorous, Dense Inert Metal Explosive (DIME), and Depleted uranium (DU). These bombs may cause chemical or even radioactive material air pollution. (Sarsour 2014)

The war also resulted in the production of more than 2.5 million tons of demolition waste in a relatively short period of time which caused the spread of dust and particulate matter pollution throughout the Gaza Strip. The heavy bombing also sparked many fires, which caused air pollution with soot, chemicals, and particulate matter. Moreover, Israel attacked the fuel stores of the Gaza power plant openly igniting two million liters of diesel in 2-3 days, which further contaminated air especially in the Middle Area and Southern Gaza City which neighbors the plant (UNDP 2014; Sarsour 2014; Stop the War Coalition 2014). The smells of dust, burning materials, and other weird smells were commonplace around the Strip as noticed by the participants and experts of the study.

During the wartime, most municipalities were not able to collect the solid waste produced by their communities as a result of obvious security reasons, especially in the areas most targeted by the Israeli forces. Such interrupted solid waste collection resulted in the accumulation of around 80,000 tons of solid waste in the streets most towns, villages and refugee camps in the Strip according to the Environmental Quality Authority-Gaza (2014). Additionally, Gaza Strip municipalities' were unable to transfer the collected solid waste to the three controlled dumpsites and landfills within the Strip. This resulted in the spread of tens of illegal and uncontrolled dumpsites around the Strip and in the over burdening of the transfer stations in some of the localities, such as Gaza City. Of course, such accumulation of large amounts of solid waste in the streets and in illegal dumpsites resulted in an omnipresent esthetic and smell nuisance. Widespread waste fires only further affected the deteriorated air quality throughout the wartime. This accumulated waste was removed directly after the war by municipalities assisted by UNDP (PEQA 2014).

The Agricultural sector sustained huge damages including damages to water and soil

infrastructure, the damage and destruction of farms, trees, crops, poultry and livestock numbers, and damages sustained by fisheries. According to the Ministry of Agriculture (MoA), the agricultural sector losses amounted to $350 million USD in direct losses as mentioned above and $200 million in indirect losses such as lost working days, opportunity cost, lost income, etc. The losses in terms of soil damage and water infrastructure amount to $69 million USD, while the direct crop production damages amounted to $137 million USD. Damages sustained by the livestock sector amounted to $52 million USD. The MoA assessed the number of dunams (one dunam equal 1,000 m^2 land area) that sustained direct damages because of the war to be 34,500 dunams including more than 250,000 trees, mostly olive, citrus, fruit, and grape trees and more than a thousand greenhouses and tens of thousands of open lands cultivated for the production of vegetables (MoA 2014).

All the above mentioned damages can be considered immediate environmental impacts of the war. The immediate impacts of war usually entail air pollution as discussed above resulting from blasts, heavy bombing, airstrikes, and burning of fuel and chemicals which consequently produced soot, carbon monoxide, carbon dioxide, and Sulphur dioxide. Contamination as a result of using radioactive explosives or chemical weapons is another clear direct impact. Another type of impacts is the effect on landscape through the devastating destruction of thousands of houses, buildings, infrastructure units, etc. War can also damage rural settings through the destruction of the agricultural lands and damages to the ecosystems such lands represents. War can remove or damage forest, mangrove, shrub lands that host in addition to the plant cover important animal cover (Mannion 2003; NCCI 2011; Sidel et al. 2009).

2.2 Delayed environmental Impacts

The potential delayed environmental impacts of the war are numerous and may last for a long time (long term impacts). Some of these delayed impacts relate directly to the above direct or immediate impacts as will be noticed shortly. One potential impact that affects agricultural communities is the degradation and sometimes the abandonment of agricultural lands because of the damages sustained by the soil as a result of the war. Another possible impact could be the limiting of biodiversity in certain communities through the loss of wildlife because of bush hunting or because of damages sustained by vital ecosystems such as forest, wetlands, shrub lands, and mangroves during the war. A third type of impact could be the destruction of the marine environment due to the destruction of oil tankers, warships, and civilian ships which could result

in the leakage of tons of oil and other chemicals into the ocean and seawaters. The environmental repercussions of the massive use of unconventional weapons such as Depleted Uranium represents another type of delayed environmental impact of the war with clear health connections including increased risks of cancer, and birth defects. Air contamination resulting from burring huge amounts of oil and chemicals such as in the case of the second Gulf War can be massive, covering a wide span of problems including climate change, ozone depletion, acid rain and local black clouds. Other impacts include deforestation, groundwater depletion as result of demographic changes and displacement (Mannion 2003; Partow 2008; Sidel et al. 2009)

2.3 2014 war environmental impact assessments done by others

More than one year after the war, none of the completely damaged houses were rebuilt, and less than 1% of the construction materials required to rebuild the Gaza Strip have entered into it because of a strict Israeli blockade (MA'AN 2005). More than one year after the war, most of the damages sustained by agricultural lands are still un-rehabilitated. The Coastal Municipalities Water Utility (CMWU) and Gaza municipalities succeeded in reconnecting almost all Gaza communities to the water and wastewater networks. The solid waste management capacities were also restored to prewar status. However, less than one quarter of the 2-2.5 million cubic meters of demolition waste were collected and reused (UNDP 2015).

A limited number of studies has been conducted to assess the delayed and indirect environmental impacts of the 2014 war. These studies were limited in scope focusing mainly on soil contamination with heavy metals. For example, the Environment Quality Authority embarked on investigating the chemical contamination of 47 sites around the Gaza Strip, the research was not completed because of the lack of the needed funds, equipment and expertise to analyze the samples collected from these sites (PEQA 2014). However, out of those 47 samples, 14 samples from Northern Gaza Strip (Beit Hanoun and Beit Lahyia) were analyzed by a group of researchers from the Islamic University for heavy metals contamination. 13 samples were taken from bombarded lands (the craters created by the bombs), and one sample was taken from an un-bombed area of land (Al Najar et al. 2015).

Many of the samples that were taken from bombed areas and analyzed by Al Najar et al. (2015) were found to contain multiple times the contamination levels of the control sample. For example, Al Najar et al. (2015) found that in nine samples, Nickel

and Chromium concentrations were higher than in the control sample, but in the other four samples, the levels were equal or less than the control sample. The concentration of the Nickel in the nine higher concentration samples ranged from 10.8 to 24.5 mg/kg in comparison to 6.3 mg/kg concentration of Nickel in the control sample. For Chromium, the concentrations in the 9 samples ranged from 22.4 to 51.07 mg/kg in comparison to the 10.2 mg/kg in the control sample. They also found that Copper and Cobalt concentrations were higher than the control sample in 11 locations. For Copper, the concentration in the 11 samples ranged from 8.4 to 43.3 mg/kg in comparison to the 7.7 mg/kg concentration of the control sample. For Cobalt, the concentration of the 11 samples ranged from 6.7 to 17.2 mg/kg in comparison with 3.34 mg/kg Cobalt concentration in the control sample (Al Najar et al. 2015).

Manganese concentrations were higher than the control sample in 12 locations, while lead concentrations were higher than the control sample in only six locations. The concentration of Manganese in the higher concentration samples ranged from 41.9 to 344.8 mg/kg in comparison with 33.0 mg/kg. The concentration of Lead ranged from 6.4 to 73.4 mg/kg in comparison with 6.31 mg/kg. The researchers also noted that the soil in these locations was compacted as a result of the heavy machinery passing over them. Such compaction reduced the macro pores of the soil by 60 to 75% (ibid). However, the research did not discuss if such concentrations of heavy metal impose serious health and/or environmental impacts. Another study investigating potential war induced heavy metal contamination of soil is currently being undergone at Al Azhar University, but the results are not yet published (Ayesh A. personal communication April 2014).

In this research, we investigate the potential environmental impacts of the war as noticed by people on the ground. We assess all possible impacts ranging from soil damage, air pollution, marine environment degradation, terrestrial ecosystem dilapidation, and water quality deterioration. This is exploratory research that highlights how people see their environment a year after the war. We understand that using this approach we cannot make definitive accusation against any side in this war. We also understand the limitations of human observation is establishing evidence connecting complicated and multifaceted issues such as war and environmental damages. However, we strive to establish questions that go beyond the limited scope of current investigations. Additionally, we investigate some of the claims using the limited resources in the Gaza Strip to discuss the results we got and give a chance for more researchers to come in and enrich such discussions.

3. APPROACH AND METHODOLOGY

3.1 Analytical Framework

Our assessment approach is a participatory one. The participatory approach is an effective way to collect qualitative data from all affected areas rather rapidly and cost efficiently. It also helps with the collection of potentially vital data and information without the need for advanced laboratories and complex technologies unavailable in the Gaza Strip. We also conducted air pollution tests to validate strong public complaints regarding deteriorated air quality in some areas around the Gaza Strip. The assessment stems from three major hypotheses which are:

- The last war resulted in serious environmental impacts on the Gaza Strip
- War induced environmental impacts vary geographically within the Gaza Strip based on the intensity and type of violence carried out in the affected localities
- War induced environmental impacts vary based on gender

These hypotheses were tested in a three phase process as can be seen in the following figure. The data and information collected in each step was analyzed descriptively and used to design the questions for the next step. In this manner, we were able to narrow the potential impacts both geographically and socially (gender). Some of the most serious impacts were further investigated using site visits, experts' opinions and lab tests that are available in the Gaza Strip.

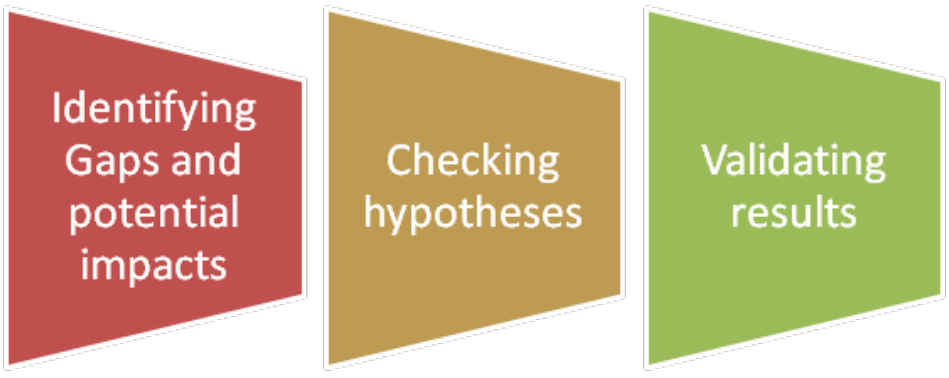


Figure 1: Assessment Approach

3.2 Data Collection Methodology:

3.2.1 Preparatory phase

Due to the analytical framework, the research methodology adopted for this study takes place in four steps: 1) preparatory phase; 2) experts' consultation phase; 3) participatory assessment phase and 4) validation phase. The preparatory phase included a desktop literature review to identify potential war impacts and prepare methodological tools. It also included coordination with key stakeholders such as the Environmental Quality Authority, Palestinian Water Authority, Coastal Municipalities Water Authority, Ministry of Health, Ministry of Agriculture, Al Azhar University, and the Islamic University. This coordination focused on war impact assessments performed by these organizations, and potential concerns identified by their experts. This phase resulted in the formulation of aspects to be discussed in the in-depth interviews. It also helped in identifying some of the key informants to be interviewed in-depth.

3.2.2 In-depth interviews

The in-depth interviews targeted ten key informants representing key organizations in the Gaza Strip related to this activity in addition to being experts in the field of water and the environment themselves. The in-depth interviews covered many aspects including the following:

1- Direct and immediate impacts of the war including any related reports and surveys by the organizations.

2- Delayed and indirect impacts on soil, water, air, marine environment and terrestrial ecosystems.

3- Geographies peculiarly impacted or which will be impacted by the war environmentally.

4- Communities peculiarly environmentally impacted or who will be impacted by the war.

5- Potential gender differentiation in terms of environmental impacts

6- Organizational war impact assessments and studies

The ten key informants who gratefully participated in this assessment are the following, noting that some potential informants could not be reached or did not want to participate. The interviews took place during the last 10 days of April 2015.

1- Dr. Tamer Al Sleby: Environmental Quality Authority-Gaza. Head of the water quality department.

2- Eng. Baha el Deen Yousef el Agha, Environmental Quality Authority-Gaza. Head of the environmental protection department.

3- Eng. Zaki Zurub: Environmental Quality Authority-Gaza. Head of the Planning and Policy Department.

4- Dr. Sameer Rady: Ministry of Agriculture-Gaza. Head of the Awareness and Guidance Department.

5- Dr. Abd el Fatah Abed Rabu: Islamic University-Gaza. Associate Professor in Marine Biology.

6- Dr. Abdel Majeed Nassar: Islamic University-Gaza. Associate Professor in Environmental Engineering.

7- Dr. Amal Sansour: Al-Quds University- Water and Environment Master's Program, Adjunct Professor in Health and Environment.

8- Dr. Adnan Ayesh, Al-Azhar University, Water and Environment Master's Program, Head and Associate Professor in Hydrology.

9- Eng. Awny Naeem, Electricity Distribution Company, General Manager. Also a researcher in the environmental impacts of war.

10- Dr. Azam Abu Habeeb, UNRWA, Project Coordinator, A researcher in water technology.

3.2.3 Participatory Impact Assessment

Based on the knowledge gained during the above two phases, a list of aspects to be discussed in the form of focus group sessions dispersed all over the Gaza Strip as will be seen momentarily. While the sessions allowed the participants to speak about the environmental impacts they suffered during the war, the aspects of interest were:

1- Environmental impacts noticed after the war on soil;

2- Environmental impacts noticed after the war on water;

3- Environmental impacts noticed after the war on air;

4- Environmental impacts noticed after the war on marine biology;

5- Environmental impacts noticed after the war on terrestrial ecosystems;

6- Environmentally related health problems and diseases noticed after the war;

7- Gender based differentiation in impact in relation to any or all the above environmental dimensions;

8- Communities or groups affected peculiarly by environmental impacts related to any or all of the above dimensions.

For the sake of this research, five newly graduated researchers with previous experience volunteering at MA'AN Development Center were trained in focus group discussion

facilitation for one day (10th of May 2015) in addition to two current MA'AN staff. Six of the seven assistant researchers were all specialized either in environmental science or environmental engineering. They were also balanced gender-wise including three women and four men.

The training focused on defining the focus group discussion approach, its objectives, and its limitations. In the training, we focused on the techniques needed for effective and sufficient facilitation including active listening tactics, ice breaking strategies and other related approaches. The researchers were also asked to facilitate rehearsal focus group sessions within the eight-hour training. In addition to group work and exercises, the training itself used techniques similar to those used while facilitating focus group sessions including brainstorming and group discussions as well as films and videos of good examples of focus group facilitation.

These five assistant researchers supported by the principal researcher and two MA'AN staff members conducted 93 focus group discussion sessions all over the Gaza Strip over around 40 days in May and June 2015. The distribution of these sessions took into consideration the differentiated population size and war impact among Gaza localities. The number of sessions per locality ranged from two in areas such as Al Zahra and Al Zawayda which sustained relatively smaller war impacts and are inhabited by a rather smaller populations to six in areas such as Khuza'a and Beit Hanoun which sustained huge damages, and the ten areas in Gaza City which host more than 50% of Gaza population as can be seen in the following table. Please note that Gaza City was split into two regions Eastern Gaza (6 sessions) and Western Gaza (4 sessions) because of the differentiated war damage sustained by these two regions even though they constitute one large city.

Three focus group sessions were designated to fishermen in order to be able to capture the war induced impacts on the marine environment. In each community (except fishermen) half of the sessions were for women and the other half for men to assure gender equity in terms of engagement and representation. In those 93 sessions, 982 people participated: 470 women and 512 men of all adult ages and socioeconomic conditions. The average participation per session was 9.4 which fit nicely the 8-12 participation range accepted in the literature for focus group sessions.

Table 1: Focus Group Sessions Conducted by Locality

Locality	# sessions	# of female participants	# of male participants	Locality	# sessions	# of female participants	# of male participants
Abasab Al Jadida	2	12	12	Bani Suhaila	2	8	8
Abasab Al Kabira	2	9	18	Beit Hanun	6	36	46
Al Bureij	4	20	18	Beit Lahyia	4	18	20
Al Fukhary	4	21	20	Dier el Balah	4	20	20
Al Maghazi	4	16	18	Gaza-East	6	36	30
Al Mughraqa	2	8	8	Gaza-West	4	26	23
Al Musaddar	2	12	8	Jabalya	4	20	19
Al Nasser	2	11	12	Khan Yunis	4	22	24
Al Nuseirat	4	32	31	Khuza'a	6	34	26
Al Qarara	4	18	17	Rafah	4	21	19
Al Shoka	2	10	8	Um Nasser	2	7	10
Al Zahra	2	8	10	Wadi Gaza	4	19	21
Al Zawayda	2	8	10	Wadi Al Salqa	4	18	22
fishermen	3		34				

3.2.4 Results' Validation

In order to validate some of the impacts mentioned by the participants in the focus groups' discussion sessions, the following activities were performed:

Water:

In order to follow up on perceived changes in the water quality, the research team followed up on these changes with the localities concern. Such follow up was performed through contacting municipality staff responsible for the water and sanitation in those localities. The perceived changes in water quality were discussed with the municipality staff members in terms of factuality and explanation.

Soil:

In order to investigate the claims made by the participants in the focus group discussion sessions regarding the deterioration of the soil quality in some of the areas, the research team performed an in-depth interview with Eng. Nizar el Wheedy, the soil expert of the MoA. Mr. Eng. Al Whaidy was asked to give his opinion regarding the factuality and explanation of the soil quality changes observed by some communities.

Air Pollution:

To investigate public perceptions of increased air pollution in many areas as a result of the continuing existence of demolition waste and the creation of waste crashers in many areas around the Strip, we assessed the air quality in some of those areas as can be seen in the following map. The air quality in ten locations was tested for particulate matter contamination of different sizes including particulate matter with 10 micrometer diameter (PM-10), 2.5 micrometer diameter (PM-2.5), and 0.3 micrometer diameter (PM-0.3), as well as lead pollution by the Environmental and Rural Studies Lab of the Islamic University in August 2015. Particulate matters of the above mentioned sizes impose huge health risks on people exposed to them because they are fine enough to be inhaled into the human body and cause serious damages to the respiratory system including lungs as will be discussed in the discussion section.

These ten locations include three areas surrounding demolition waste crushers, two areas surrounding demolition waste storage facilities, three areas surrounding active demolition waste removal sites and two control samples in areas unaffected by the

war in terms of house demolitions. The Model HAL-HPC300 handhold optical particle counter was used to determine the concentration of the above mentioned particles in the locations specified.

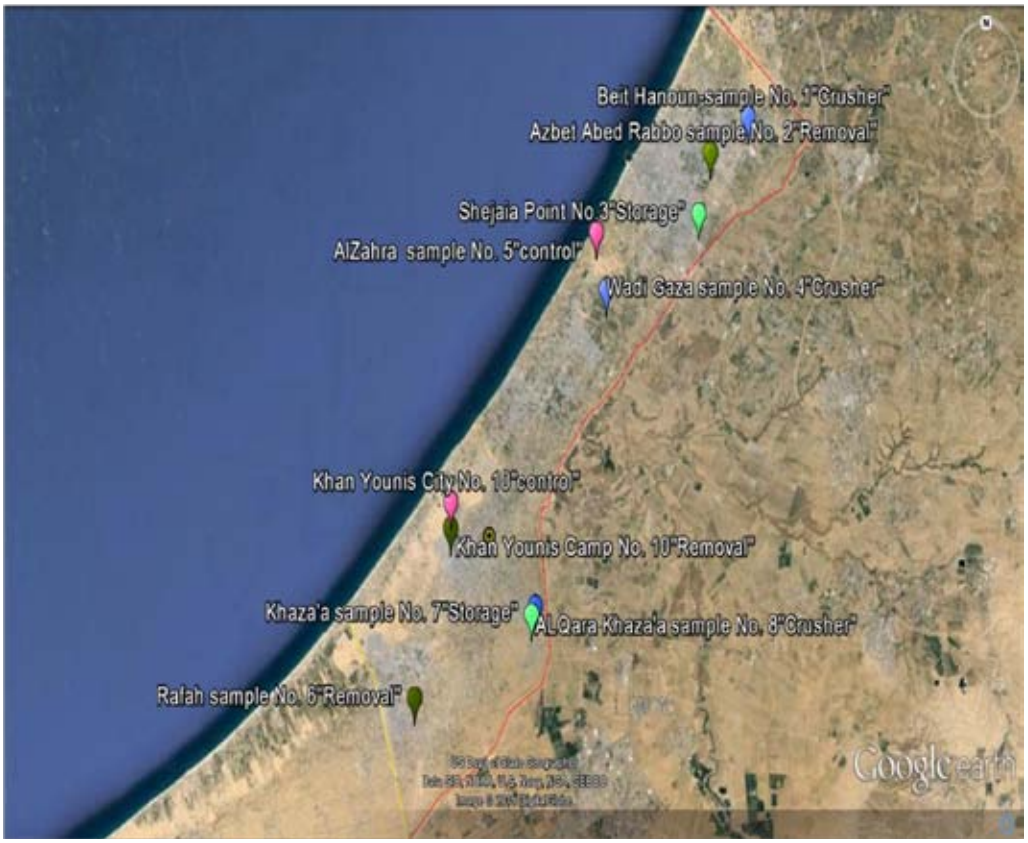


Figure 2: Air quality assessment locations

Terrestrial Ecosystems:

To investigate some of the arguments made by the participants regarding the terrestrial ecosystems, the research team organized a field trip to some of the areas in which a deterioration in the terrestrial ecosystems was noticed including Al Shouka, and Abasan al Jadeeda. In these visits, the research team met many inhabitants, and farmers to assess their views regarding observations mentioned by the people participating in the focus group sessions.

Marine Biology:

The claims made mainly by the fishermen were further discussed with the Chair Person of the Fishermen Syndicate Mr. Nizar Ayesh. Mr. Ayash was asked to attest to the changes observed by the fishermen who participated in the focus group sessions. He was also was asked to discuss such observations in terms of causality. Mr. Nizar Ayash

has many years of experience working as a fisherman himself, in addition to being deeply involved in all issues related to this activity in the Gaza Strip because he has been the representative of the fishermen for years.

3.3 Data Analysis and Reporting

Data analysis in this type of assessment is continuous and iterative. Data and information collected during the indepth interviews was compared with literature on the impacts of war, including reports on the environmental impact of wars such as the first Iraq-Kuwait war and the Sudanese internal conflict. In an effort to further understand the predictions and views of the experts, the team reviewed and analyzed literature on air pollution and its health impacts, seawater contamination, and soil pollution and destruction.

For the focus group discussion sessions, the data and information collected in the individual sessions was analyzed for each locality. The different impacts and information were then split categorically in terms of impact type (air pollution, soil contamination, etc). The impacts were then compared geographically between localities. For every impact we analyzed the number of localities in which it was mentioned by the participants in the focus group sessions as an indication of how widespread the impact was. We report the outcomes of such analysis as percentages. Views of the participants regarding the groups who were most impacted by the war's environmental impacts were discussed and analyzed in terms of repetition among localities. All this information was then compared to the interviewed experts' views and the academic literature related to the impact of concern.

Some of the claims made by the participants in the focus group sessions were investigated using different techniques. The results of those investigations were analyzed and discussed in comparison to the experts' views, focus group participants' views, and the academic literature. Finally, the most probable impacts were identified in addition to the groups who would most probably be affected.

4. RESULTS AND DISCSSION

4.1 Experts' In-depth interviews

The interviewed experts unanimously agreed that the last war on Gaza would have imposed and will impose serious and multifaceted impacts on the environment of the Gaza Strip. They all agreed that the war may have seriously harmed the quality of the soil in the Strip. They also agree that the war may deteriorate Gaza's long run water quality as the heavy metal contamination of the soil slowly moves down to the water sources. They believe that most of these impacts have been felt or will be felt by the people living in the most heavily bombarded areas in the Northern and Eastern belts of the Strip including Beit Hanoun, Eastern Gaza City (Shijaea), and Khuza'a (Ayeash; Sarsour; Agha; Saleeby; Zurub; Radi; Naeem; Abed Rabu; and Abu Habeeb. personal communication April 2015). The following sections will discuss the war's impacts on different environmental aspects as suggested by the interviewed experts and a limited number of studies that were produced by researchers before or during the course of this study.

4.1.1 Soil Destruction and Pollution

Some experts suggested that bombarding the agricultural lands with thousands of tons of explosive materials of different types may polluted the soil with heavy metals such as chromium, cobalt, cadmium, copper and lead (Zurub; Naeem; and Sarsour personal communication April, 2014). A number of these experts further suspect that some of these pollutants might be radioactive in nature such as depleted uranium (Zurub; Naeem; and Sarsour personal communication April, 2014). According to those experts such impacts may result in the pollution of crops cultivated in the impacted lands, which may cause serious diseases and epidemics in the long run including but not limited to cancer.

Heavy metals may occur naturally in some soils as a result of the weathering of rocks. Heavy metals can also be introduced into soil through the application of fertilizers,

pesticides, manure, compost and/or sludge to soil for agricultural purposes (Wuena and Okieimen 201; Khan et al. 2007). Contaminated soil may impose health risks to humans through multiple routes including bio-accumulation in the plants cultivated in those lands, direct contact with soil (skin, oral, and inhalation), or through infiltration to the groundwater aquifer (Wuena and Okieimen 201; Khan et al. 2008). Lead is one of the most toxic heavy metals. Long enough exposure to large amounts of lead can affect the nervous systems, gastrointestinal tracts, and kidneys of humans; especially children and can even cause death. Copper in high concentrations can lead to liver damage, kidney damage and anemia; while nickel is carcinogenic. However, the toxicity of heavy metal in soil is also affected by the soil texture, organic matter content and acidity (PH). The health impact of heavy metal in soil is dependent on the route of exposure, exposure intensity, and duration. Accordingly, it is not yet scientifically known which levels of soil contamination guarantee immediate health impacts (Wuena and Okieimen 2011).

A previously discussed Al Najar et al. (2015) tested 14 soil samples including one control sample and 13 samples taken from craters caused by land bombings. They discovered differentiated soil contamination in most of the samples in comparison with the control sample. For example nine locations were contaminated with nickel and chromium, 11 locations were contaminated with cobber and cobalt, 12 locations with manganese and six with lead. The maximum concentrations of these elements in the contaminated samples are 24.5 mg/kg for nickel, 51.07 mg/kg for chromium, 43.3 mg/kg for copper, 17.2 mg/kg for cobalt, 344.8 mg/kg for manganese, and 73.4 mg/kg for lead.

While the results above show significant heavy metal contamination of the lands bombed during the last war in comparison to the control sample; it is hard to predict direct health impacts as a result of such contamination because of the above discussed complexity of the toxicity of heavy metals in soil. Few standards are available for heavy metals of soil and they do not necessarily include all heavy metals. For example, the concentration of copper that the United Kingdom allows in the soil ranges between 80-200 mg/kg depending on the acidity of soil, while for nickel they allow from 50 to 110 mg/kg , and finally for lead they only allow up to 300 mg/kg (Loveland and Thompson 2000). The New York State allowable concentration for chromium is 11-22 mg/kg, while the USEPA intervention concentration is 230 mg/kg. For lead, the allowable concentration in soil in New York State is 200-400 mg/kg, and the USEPA intervention concentration is 400 mg/kg. For copper the allowable concentration is 270 mg/kg in New York State (NYSDEC 2006; USEPA 2002). As can be seen the concentrations found in the affected locations in Gaza are either within or below these allowable concentrations.

Other experts point to the fact that many agricultural lands were subjected to heavy bombing specially air bombing which in many cases resulted in huge craters in these lands sometimes many meters wide and deep, or burned the surface soil of these lands (Sarsour; Radi; Abd Rabu personal communication April, 2014). Some experts believe that invading many agricultural lands using heavy machinery including tanks and bulldozers may have destroyed the top soil of those lands and altered their physical, chemical, and biological characteristics (Sarsour; Naeem; Radi; Zurub; and Abed Rabu. personal communication April, 2014). These impacts would most probably have affected the fertility of these lands turning them into either barren or low productivity land, which in turn will impact the agricultural sector in the Strip and exacerbate its already stressed food security (Radi; Saleeby; Zurub; Abu Habbeb; and Sarsour. personal communication April, 2014).

The literature may be limited in relation to the impact of wars on soil fertility and quality, however, similar impacts as discussed above have been witnessed in other areas in the world which have suffered wars. For example, Cox (2011) reported intensive losses in soil fertility as a result of the civil wars in the Democratic Republic of Congo. Certini (2005) agreed with the expectations with our experts when he discussed the impacts of severe fires on soil. He (Certini) stated that low to moderate severity fires impose no significant or short term negative impacts on soil fertility; whereas severe fires impose significant and long terms impacts on soil fertility. He added that severe fires cause a decrease in organic content within the affected soil, changes its physical characteristics including porosity and structure, and negatively affects its (the soil's) microbial and biological content (biota) which make the affected soil less fertile and decreases its productivity.

Pantami et al. (2010) investigated the impact of severe fires on the chemical characteristics of soil and supported the hypotheses of Certini and many of the experts we interviewed. He found that severe fires decreased the affected soil's organic carbon content, total nitrogen levels, and available phosphorous and Magnesium. Whereas, Boyers and Millers (1994) found that fires decrease affected soil's available moisture holding capacity, and macrospores space, and increased the bulk density of surface soil.

Soil compaction as a result of the repetitive passing of heavy machinery is not much less destructive than that of severe fires and rocket explosions on soil fertility. The damage caused by heavy machinery is proportional to the weight of the heavy machinery in question, and the frequency of its passage. Soil compaction results in reducing the

air and water permeability of the affected top soil, decreasing its organic content and negatively affecting its biota. This results in decreased fertility (Frey et al. 2009; Koch et al. 2008). Frey et al. (2009) found that soil compaction as a result of frequent heavy machinery passage affects soil fertility and its agricultural productivity.

4.1.2 Water Pollution

While the water sector was one of the most heavily affected sectors during the war as explained before, most experts expected this sector to be affected only in the long term. Many experts predict that the water quality will further deteriorate in terms of heavy metals and even radioactive contamination as a result of the war. The experts suspect that the heavy metals that have contaminated the soil will percolate slowly to the aquifer adding pollutants such as cadmium, copper and lead. Such contaminants pose serious health risks including cancer and represent major challenges to the authorities in terms of removal and purification (Saleeby; Ayesh, Agha, Sarsour; Naeem; and Abu Habeeb, personal communication April, 2015).

The potential for groundwater pollution as a result of war induced soil contamination is well-supported by the literature. Li and Shuman (1996) stated that heavy metals can transport slowly in soil to cause eventual deterioration of groundwater quality. The transportation of heavy metals in soil is dependent on heavy metal concentrations in said soil, and soil's physical and chemical characteristics (Dube et al. 2001; Li and Shuman 1996; Mikkelsen et al. 1996).

It is worth noting that some heavy metals are already found in Gaza Strip municipality wells but at low concentrations. Shomar et al. (2010) who used the governmental data set for municipal water wells from 2008, found that the municipality wells of the Gaza Strip included traces of iron, chromium, and zink but at concentrations lower than the WHO standards of 30, 75, and 15 µg/L, respectively. Continuous monitoring is needed to detect any future rise in heavy metal concentrations in the groundwater. However, currently there are no studies that have investigated the increase of heavy metal contamination in the groundwater of the Gaza Strip as a result of this war or the previous wars.

As discussed above, few studies investigated the concentrations of heavy metals in the bombarded soil of the Gaza Strip. The one study that investigated concentrations of a few heavy metals in soil of parts of Northern Gaza, which were impacted by war found potential contamination, but the concentrations they found were within allowable

levels. There is a need for more studies that investigate soil contamination with heavy metals in more locations around the Gaza Strip, and which model the potential for heavy metals to be transported to the groundwater.

4.1.3 Air Pollution

As previously discussed, the air quality may have also deteriorated during the war as a result of the heavy bombing with different types of ammunitions, solid waste accumulation and more noticeable the heavy destruction of thousands of houses and facilities around the Strip. However, many experts expect that the air quality deterioration imposed by the war will be greatly decreased when the removal of demolition waste is completed (Agha, Naeem, Zurub, Abed Rabu, Ayesh, Radi, personal communication April, 2015). Nonetheless, Dr. Sarsour and Saleeby expect the impact of the war on air quality to go beyond the short term and even the boundaries of the Strip through its damage of the agricultural sector, especially the tree cover in the Gaza Strip and thus increasing Gaza's contribution the Climate Change problem (Saleeby and Sarsour, personal communication April, 2014).

Dust from demolitions and construction activities is a well-known source of ambient air quality pollution with particulate matter (Curtis et al. 2006; WHO 2003; Dorevitch et al. 2006; Governmental of Gibraltar 2010). Dorevitch et al. (2006) found that air pollution resulting from demolition and construction activities is short term as it disappears slowly after the activities come to an end; yet he found that implosion (explosion) of houses result in more lengthy air quality deterioration than mechanical destruction. Dorevitch et al. (2006) also found that the demolition induced air pollution with particulate matter increases when the weather conditions are windy and dusty.

Particulate matter comprises a wide range of airborne solid and/or liquid particles suspended in the air. These particles vary in sizes measured. Particles' diameter is typically measured in micron (µm). Particulate matter usually splits into coarse particles (diameter ranges from 2.5-10 µm (called PM-10), and fine particles with diameters of less than 2.5 µm (called PM-2.5) (WHO 2003; Government of Gibraltar 2010).

Extended exposure to high concentrations of particulate matter causes many health problems including premature death (Samet et al. 2000). Particulate matter also causes respiratory diseases and irritation, lung inflammation and injury, cardiovascular diseases, heart attacks, and cancer. The International Agency for Research on Cancer

designated air pollution as a carcinogen based on growing evidence that exposure to particulate matter can increase the risk of lung cancer (Hamra et al. 2014). The fine particles (PM-2.5) impose higher health risks than the coarse particles (PM-10) (WHO 2003; USEPA 2015$_{a,b}$; Landrigan et al. 2004). The WHO established concentration levels of particulate matter in air are: 25 µg/m3 for PM-2.5, and 50 µg/m3 for PM-10.

4.1.4 Terrestrial Ecosystems

While most experts do not find themselves capable of discussing the potential impacts of the war on the terrestrial ecosystems in the Gaza Strip, mostly because of their specializations on water, wastewater and solid waste management, a few experts expect that the war imposed and will impose significant implication on such eco systems. Dr. Abed Rabu expects that the destruction of natural habitats (forests mangroves or wetlands) and planted habitats (including trees orchards and vegetated lands) will result in losses of wildlife comprising of birds, animals and other forms. However, it is worth noting that there have been no specific identifications of potential losses or damages suggested by the experts of related organizations. Also there are currently no studies completed or undergoing an examination of this topic.

Losses of wildlife as a result of war is well documented. The Iraq-Iran war that extended for eight years resulted in massive destruction of natural habitats including wetlands and marshlands in addition to Palm trees orchards. The damages sustained by those habitats meant the loss of many plant (flora) and animal species (fauna) (Partow 2008). The Iraq-Kuwait conflict of 1990/1991 also imposed huge damages on wildlife in both Kuwait and Iraq and even Saudi Arabia as a result of natural and cultivated vegetation removal. Other disturbances also affected wildlife through soil and ecosystems contamination, massive crude oil discharges, leakages, fires, and war remnants such as mines and live munitions (Edeko 2011; UNEP 1991a,b,c). Similar impacts were noticed in Afghanistan, Rwanda, Mozambique, and other areas which have witnessed aggressive wars and intensive internal and external displacements of people (Mannion 2003).

.

4.1.5 Marine Environment Pollution

During the war, almost all of the wastewater of the Gaza Strip was dumped untreated to the sea. This dumping resulted in doubling the organically and bacterially contaminated portion of the seacoast from 35% to 70% as noticed by the PEQA and the many experts interviewed(PEQA 2014, Saleeby, Sarsour, Abed Rabu, Ayesh, and Radi, personal

communication April, 2015). Such pollution transformed the sea from being the most important, if the not the only, source of recreation for the Palestinian People in the Gaza Strip into being a cause of many communicable diseases which mainly affected peoples' skin and eyes (ibid).

Studies on Gaza's seawater quality prior to the war found that organic pollution by wastewater dumping caused excessive seawater pollution. The seawater and even the beach sands in some portions of the coast, specifically those close to the wastewater outlets, were sometimes heavily contaminated with bacteria, viruses, and parasites (Hilles et al. 2014; Abdallah et al. 2005). Seawater pollution can cause many health problems including eye and ear infections, skin lesions, hepatitis, diarrhea and gastroenteritis, and respiratory illness (Pruss 1998; Rosenberg 1980; WHO 1999,1998). Accordingly, increasing the portion of the seacoast polluted by wastewater will surely harm the internal tourism business as expected by Dr. Sarsour (personal communication April, 2015).

Such pollution changes both geographically and temporally as found by Abudaya and Hararah (2013). They found that most of the pollution occured near the wastewater outlets to the sea. They (Abudaya and Hararh 2013) found, that the seawater contamination increases in the months in which runoff (because of rain) or excessive dumping of wastewater, as a result of sociopolitical conditions such as heightened rates of electricity cuts, occur. This confirms the expectations of Dr. Saleeby (personal communication April 2015) from the PEQA who predicted that the organic pollution of the sea will be restored to its prewar rates soon.

Organic seawater pollution as a result of wastewater discharge results in the growth of alga (algae blooms). In polluted beaches like the one in the Gaza strip, algae blooms occur every summer. Algae blooms affect the sea bathers by causing skin rashes. Algae blooms also can cause the death of some types of fish. In addition to the above mentioned impacts, Bonsdoreff et al. (1997) and Hernandez et al. 1998, suggested that seawater pollution with wastewater may result in decreasing the biodiversity of the affected sea's fish population. Additionally, they suggested that organic pollution can lead to alterations in the structure of the species living in the affected parts of the sea through increasing some fish species (more tolerant to pollution) at the expense of other species that are less tolerant to organic pollution. Currently, no studies have been completed or are being undergone, which investigate the impact of the war on the marine environment in the Gaza Strip beyond the monitoring of the organic and bacterial pollution of the seawater. The need for such types of investigations by specialized marine biologists is imperative.

4.1.6 Most affected groups

Some experts suggest that farmers and poor communities will be affected more by the impacts of the war because of their reliance on the heavily impacted lands for a living (Naeem, Saleeby, and Abed Rabu, personal communication, April 2015). Farmers who are heavily dependent on natural resources such as soil, water, and weather conditions are usually more vulnerable to all type of hazards natural and manmade (Safi et al. 1012; Cutter et al. 2003). As discussed before, the agricultural sector was one of the most strongly affected sectors by the war both directly, through widespread land destruction, and indirectly, by soil contamination and removal. This suggests that farmers, especially the poorest among them, will sustain significant and long-term impacts on their livelihoods.

Other experts identify children and the elderly as being among the most affected groups within their communities (Sarsour, Radi, Naeem, and Abed Rabu, personal communication April, 2015). They explained that the elderly and children are more vulnerable to the health impacts that would result from the soil, water, seawater, and air pollution that would affect the Gaza Strip in the medium and long terms. Children and the elderly are usually more exposed to such risks and less resilient because of their limited physical fitness. They suggest that those groups may be more subjected to skin, chest and respiratory and diseases (Sarsour, Radi, Naeem, and Abed Rabu, personal communication April, 2015).

For example, Children are more vulnerable to soil contamination as they are more likely to play in such soil and seawater which increases the chances of them inhaling or even swallowing the contamination. The elderly and children usually spend more time than young men in their homes and thus are more exposed to air and water pollution in their communities. At the same time children and the elderly are usually weaker than young people and thus more vulnerable to the health risks imposed by such hazards (safi et la. 2012; Scheraga and Grambsch 1998; Kasperson and Kasperson 2001; Fussel and Klein 2006; O'Brien et al. 2006).

Literature on the health impacts of air pollution agree with the experts that children and the elderly are more exposed and more vulnerable to air pollution induced health risks as discussed before (USEPA 2015a,b). Other scholars such as Gauderman et al. (2004) and Gauderman (1999) found that exposure to air pollution affects the growth

of lung function among children. Paulo et al. (1995) found strong correlations between mortality and morbidity among elderly people and exposure to air pollution including particulate matter (Pope et al. 2004, 2002; Pope and Dockery 1999).

Some experts believe that women were more environmentally impacted by the war than men (Nassar Abdel Majeed; Sarsour, Abed Rabu and Radi, personal communication April 2015). During the war this impact was clear as women, specially those who were displaced, sustained more hygiene related health impacts than men largely because they were unable to keep themselves clean enough considering the local conservative culture and traditions in addition to the lack of proper toilets, bathrooms, and sanitation in the shelters (mostly UNRWA schools). Many women as noticed by those experts suffered premature births and infant death in hygienically unfit surrounding during the war like schools, private houses, etc because of the lack of access to the overloaded and in some cases damaged hospitals. Other women could not bathe for many days in the public baths of the shelters where they took refuge. In some extreme cases, some women could not use the toilets in such shelters. These claims are supported by the qualitative assessments conducted by MA'AN (2014) and the observations of the Health Cluster (2014) discussed above.

After the war came to an end, women continued being the care takers of their families and children and thus were more exposed to the different types of pollution Gaza sustained as a result of the war. Women spend more time in their houses close to the demolition waste and its dust and women are the ones that use the polluted water at the household level. Moreover, women are the ones who take care of sick children when they sustain communicable diseases or any other diseases (Nassar Abdel Majeed; Sarsour, Abed Rabu and Radi, personal communication April 2015). According to Cutter et al. 2003 and Safi et al. 2012, women usually have a slower recovery time than men because of their family care responsibilities, unjust working conditions, stricter constraints on mobility and responses to hazards.

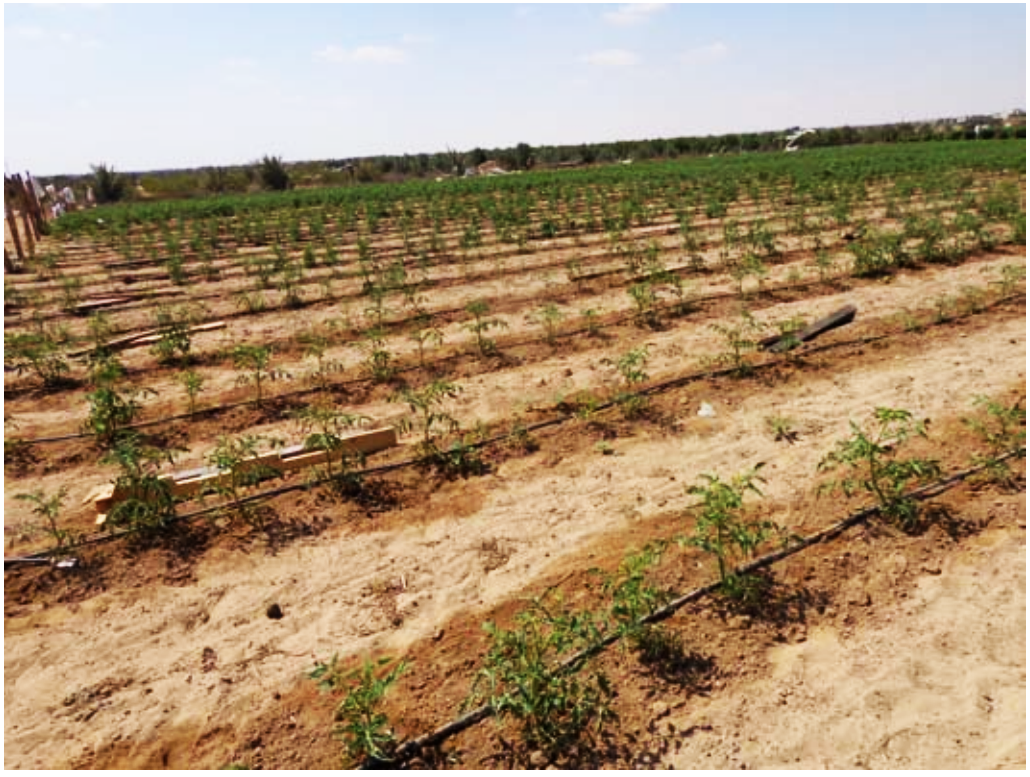
4.2 Focus Group Discussions Results

As previously discussed in the methodology section, the focus group discussion sessions focused on the environmental impacts felt by the people in Gaza almost a year after the end of the 2014 war on Gaza. The results show that the war impacted almost every environmental aspect including soil, water, air, marine environment and terrestrial ecosystems. Additionally, the people (as represented by the participants

in the focus group sessions) in the Gaza Strip felt that they suffer increased rates of diseases that can be attributed to environmental causes in addition to many other diseases resulting from the psychological stresses they underwent during the war. The environmental impacts felt by the people who participated in the focus group sessions differed according to their geographic location because the areas that were more severely bombed or invaded during the war suffer more than other areas. In the following sections we will discuss the detailed findings of each of those focus group sessions.

4.2.1 Soil destruction and pollution

In almost all the localities in the Gaza Strip, the participants in the focus group discussion sessions attested to significant impacts of the war on soil fertility and quality. Only participants from Western Gaza City witnessed limited or no apparent impacts on soil quality because Western Gaza City is almost completely urbanized. The farmers who participated in the discussion sessions reported that the soil of their agricultural lands witnessed two types of impact: first, the removal and burning of top soil as a result of heavy air bombing; and second, damage to the physical characteristics of the soil due to the compaction caused by the use of heavy machinery including tanks and bulldozers.



As can be noticed in the following table, the participants in the focus group sessions in 22 localities (88% of the localities) stated that many farmers leveled and cultivated their lands but their lands failed to produce crops or produced very small amounts. For example in Al Zahra, the participants in the focus group sessions stated that the parts of the land owned by the Abu Medeen family which were air bombed during the war became completely unproductive. Similar examples were found in almost all communities in the Gaza Strip, such as the lands of Mohammed el Ta'aban in Al Zawayda, and the lands of Ghazi el Louh in Al Msadar. Farmers from Deir el Balah, and Abassan el Jaddeda mentioned that some of their lands, which were air bombed, were still emitting strange and hideous odors. In other localities, such as Abasan el Jaddeda and Al Fukhary the participants stated that olive and fruit trees on land close to bombed land became unproductive and suffered unknown diseases. This could be the result of the fallout of dust and chemicals as a result of the heavy bombing. Similar impacts were noticed in Iraq and Kuwait as a result of the Iraq-Kuwait war (UNEP 1991a,b,c).

In Al Msadar and Deir el Balah, the participants of the focus group sessions noticed that wheat plants in lands that were heavily bulldozed by heavy machinery only grew to half of their normal length (75-80 cm). Participants from communities that were land invaded during the war stated that the lands which were heavily bulldozed, especially those lands that were used as parking lots for the Israeli tanks, bulldozer and heavy

machinery, became either completely or partially unproductive. These areas included Al Shuka, Al Qarara, Al Msadar, Al Maghazi, Al Nasser, Um el Nasser, Bani Suhaila, Beit Hanoun, Beit Lahyia, Khan Yunis, Khuza'a, Abassan el Kabeera, Eastern Gaza City, Wadi el Salqa and Wadi Gaza.

The participants in most of the focus group sessions did not believe that the war's impact on soil affected one gender more than the other. Actually, in four localities (16% of the localities) the participants believe that men were more vulnerable to such impacts because men were the ones who cultivate such lands for their livelihoods. However, in many localities the participants agreed that farmers are the ones who suffer the most as a result of these impacts. It is very well understood that farmers rely on farming and thus contamination or damage to the soil affects their livelihoods and welfare directly as well as the welfare of their families.

These results agree with the expectations of the experts as discussed above. Apparently most of the impacts on soil result from damaging the physical and chemical characteristics of the top soil (Sarsour; Naeem; Radi; Zurub; and Abed Rabu. personal communication April, 2014). These findings also agree with the scientific literature; topsoil scorching as a result of severe fires or compaction as a result of the repeated passing of heavy machinery can have detrimental impacts on the fertility of the affected soil (Cox 2011; Certini 2005; Pantam et al. 2010; Boyers and Millers 1994; Frey et al . 2009; Koch et al. 2008). The impacts of pollutants such as heavy metals are either difficult to detect by farmers or slower to appear than those of top soil removal and destruction. These results are also supported by the literature as discussed above.

Experts also agree with the participants in many of focus group sessions who pointed out that farmers are one of the groups most affected by the environmental impacts of the last war (Naeem, Saleeby, and Abed Rabu, personal communication, April 2015). Farmers are dependent on the soil of their lands for living and this makes them more vulnerable than the rest of the society. This fact is also supported by the literature on vulnerability to hazards and risk as discussed above (Safi et al. 1012; Cutter et al. 2003).

Table 2: War impact on Soil

Locality	Impacts	Gender[1]	Vulnerable Groups[2]
Al Bureij	• Even in the lands which were rehabilitated, production is limited in the lands which were air bombed or bulldozed. • Sometimes the crops from these lands are disfigured and unfit for use.	No[3]	NA[4]
Al Zahra	• In some areas such as Abu Medeen lands, the air bombed parts of the lands became unproductive.	No	NA
Al Zawayda	• Some farmers tried to level and re-cultivate their lands, but they could not get any produce such as the lands of Mohammed el Ta'aban.	No	NA
Al Shuka	• The lands which were used as stations for the invading Israeli tanks and bulldozers became completely unfit for cultivation even after being properly leveled and plowed. • Other lands which were subjected to occasional bulldozing or to heavy machinery passage produced limited amounts of crops when cultivated.	Men[5]	Farmers
Al Fukhary	• Farmers complained the soil in their lands look burned and black. • In the some of the lands, there were 6 meter deep craters. • These lands were leveled and cultivated with zucchini, tomatoes, lettuce, etc, but in most cases the lands failed to produce.	No	NA
Al Qarara	• Some farmers tried to re-cultivate the lands which were air bombed or bulldozed with zucchini and potatoes, but they got either diseased produce or no produce at all. • The wheat production in the lands that were bulldozed was limited. • Olive trees in many lands close to the bulldozed or air bombed lands suffered wide spread diseases and failed to produce, such as in the case of Abu Mihamed Fayad lands.	No	NA
Al Msadar	• In the land that was bulldozed the wheat production became very limited. Furthermore, the wheat only grew to half its normal height (40cm instead of 80 cm). • The land of Ghazi el Louh and Easter of the Al Msader, became completely unproductive after being heavily bombed during the war.	No	Farmers
Al Maghazy	• The lands which were bulldozed produced limited crops after cultivation. • The lands which were heavily air bombed became completely unproductive. • The soil in some lands became as solid as the ceramic and thus completely unproductive.	No	NA

Locality	Impacts	Gender[1]	Vulnerable Groups[2]
Al Mughraqa	• Some of the damaged lands were re-cultivated. Some lands did not produce at all and other produced very limited amounts of crops.	No	NA
Al Nasser	• The lands which were bulldozed produced limited amounts of crops after re-cultivation. • Some of the lands which were heavily bombed became completely unproductive. • The olive trees in areas close to land which was heavily bombed dried out and died. • In some of the rocketed lands, farmers tried to cultivate cactus, but got no produce.	No	Farmers
AL Nuseirat	• The lands which were air bombed or bulldozed are either unproductive or produce limited amounts of crops. • The trees neighboring the rocketed lands were burned and died.	No	NA
Um el Naser	• The lands which were air bombed or bulldozed are either unproductive or produce limited amounts of crops.	No	Farmers
Bani Suhaila	• The lands which were air bombed or bulldozed are either unproductive or produce limited amounts of crops.	No	Farmers
Beit Hanoun	• The trees neighboring the bombed lands were burned and died. • The lands which were rocketed produced limited amounts of crops after re-cultivation. • Wheat production in the bulldozed lands is very limited. Also the length of the wheat plants cultivate in those lands did not exceed 30 cm comparing to at least 70cm before.	Men	Farmers
Beit Lahyia	• The lands which were air bombed or bulldozed are either unproductive or produce limited amounts of crops.	Men	Farmers
Jabalya	• The lands which were air bombed were not re-cultivated yet	No	Farmers
Khan Yunis	• The lands which were air bombed or bulldozed are either unproductive or produce limited amounts of crops.	No	Farmers
Khuza'a	• The lands which were air bombed failed to produce or produced limited amounts of crop. • Many lands are still uncultivated and most of these lands contain craters many meters deep.	No	Farmers
Deir el Balah	• The lands which were air bombed failed to produce or produced limited amounts of crop. • Abu Saleem lands were repeatedly air bombed. The farmers tried to cultivate it with wheat, but the lands produced nothing. • Some of the lands which were air bombed still smell weird, a year later.	No	Farmers

Locality	Impacts	Gender[1]	Vulnerable Groups[2]
Rafah	• Some of the lands which were air bombed became burnt with a black color and smell like gun powder.	No	NA
Abassan Al Jadeeda	• People used to like the smell of agricultural lands, however now, land bombed gives off a very weird smell and causes people to choke. • Many trees including the resilient palm trees died in the areas that were air bombed. • Many fruit trees neighboring air bombed land became unproductive for unknown reasons.	No	Farmers
Abassan Al Kabeera	• The lands which were air bombed are either unproductive or produce very limited amounts of crops. • The lands which were invaded by heavy machinery produced very limited amounts when re-cultivated.	Men	Farmers
East Gaza City	• The lands which were air bombed are either unproductive or produce very limited amounts of crops. • The lands which were invaded by heavy machinery produced very limited amounts when re-cultivated. • The soil smells differently in many areas.	No	NA
West Gaza City	• No agricultural lands	No	NA
Wadi Salqa	• The lands which were air bombed are either unproductive or produce very limited amounts of crops. • The lands which were invaded by heavy machinery produced very limited amounts when re-cultivated.	No	Farmers
Wadi Gaza	• The lands which were air bombed are either unproductive or produce very limited amounts of crops. • The lands which were invaded by heavy machinery produced very limited amounts when re-cultivated. • Some lands lost their original colors and became white	No	NA

1- Gender: Participants' opinion regarding potential gender differentiation in terms of impact

2- Vulnerable Groups: More affected groups by the impact of concern

3- NA: The participants did not identify any group

4- No: The participants believe that there is no gender based differences in impact

5- Men: The participants identified men as being more affected by the impact of concern

4.2.2 Water pollution

While the municipalities and the CMWU successfully restored the prewar domestic water pumping rates, the participants from all localities said the water supply in their communities retained its prewar status. However, in 48% of the localities, the participants in the focus group discussion sessions complained about the quality of the water they receive. In the rest of the localities, the participants noted no change in the quality of water they receive as can be seen in the following table.

It is worth noting that, the nearly 1.8 million people living in the Gaza Strip are consuming around 160-190 million cubic meters (MCM) of fresh water a year which is almost double the sustainable extraction rate of 91 MCM (Thaher 2006, Ismail 2003). The over extraction results in a major deficit in the ground water balance, which is leading to a rapid decline of the groundwater aquifer level and will eventually lead to the collapse of this water source (PWA 2013a). The accelerating decrease of the coastal aquifer water level has resulted in deteriorating the water quality in terms of salinity due to seawater intrusion from the nearby Mediterranean Sea. Salinity adds to nitrate contamination from sewage seepage and the excessive use of fertilizers common among Gaza's farmers (PWA 2013b). Today, 90 to 95% of the Coastal Aquifer's water does not comply with the World Health Organization's (WHO) standards for drinking water (PWA 2013b).

As discussed above, most experts did not expect fast deterioration in water quality as a result of the war. They expect delayed impacts in terms of contamination with heavy metals (Saleeby, Ayesh, Agha, Naeem, and Abu Habeeb pesonnal communication April 2015). Other types of pollution such as increased salinity or nitrate pollution cannot be connected to the war because they result from other causes as mentioned above. Accordingly, experts agree more with the communities that did not notice changes in water quality. However, as can be seen later in some communities, the Israeli army destroyed the municipality wells and thus these municipalities had to change to other wells that may have had lower quality water than the ones destroyed in terms of salinity, color, or taste.

While in most communities participants in the focus group sessions found the deterioration in water quality affected the genders differently, in seven localities the participants found that women were more affected by such deterioration than men. These

localities are Al Maghazi, Al Mughraga, Al Naser, Beit Lahyia, Khuza'a, and East and West Gaza City. For them, this differentiation stems from the role of women as care takers of their families. Women are the ones who use such water everyday, multiple times to wash clothes and dishes, cook, clean children, etc. Thus women's extended exposure makes them more vulnerable to any changes in water quality. Additionally, when the water supply becomes limited, the women must work longer hours finding ways to keep their houses and children clean. Moreover, when the children become sick due to the quality of the water they drink or shower with, women are the ones who take care of them and are thus at risk for catching the same diseases. As explained above many experts agree that women are more vulnerable to deteriorations in water quality (Sarsour A, Abed Rabu A, and Radi S personal communication April 2015).

Table 3: War impacts on water quality

Locality	Impacts	Gender[1]	Vulnerable Groups[2]
Al Bureij	• No change in water quality	No[3]	NA[4]
Al Zahra	• No change in water quality.	No	NA
Al Zawayda	• No change in water quality.	No	NA
Al Shuka	• Some changes were noticed in relation to the smell and taste of municipality water	No	NA
Al Fukhary	• Some changes were noticed in relation to the smell and taste of municipality water	No	NA
Al Qarara	• No change in the water quality • Al Sureij community, in Al Al Shuka, still suffers a water supply problem	No	NA
Al Msadar	• The salinity of water increased • Complains of skin diseases that may have resulted from the water quality	No	NA
Al Maghazy	• No change in water quality.	Women[5]	NA
Al Mughraqa	• No change in water quality.	Women	NA
Al Nasser	• No change in water quality.	Women	NA
AL Nuseirat	• The salinity of the water increased	No	NA
Um el Naser	• No change in water quality.	No	NA
Bani Suhaila	• No change in water quality.	No	NA
Beit Hanoun	• The quality of water is much worse than before. People used to use water for cooking and making tea. Now they must buy treated water for such purposes	No	NA

Locality	Impacts	Gender[1]	Vulnerable Groups[2]
Beit Lahyia	• The salinity of water increased • The municipality assured no change in the water quality	Women	NA
Jabalya	• The salinity of the water increased	No	NA
Khan Yunis	• No change in the water quality.	No	NA
Khuza'a	• The water quality is now much worse.	Women	NA
Deir el Balah	• Some changes were noticed in relation to the smell and taste of municipality water.	No	NA
Rafah	• No change in water quality..	No	NA
Abassan Al Jadeeda	• No change in water quality.	No	NA
Abassan Al Kabeera	• The water quality deteriorated.	No	NA
East Gaza City	• The water quality deteriorated	Women	NA
West Gaza City	• The water quality deteriorated	Women	NA
Wadi Salqa	• No change in water quality	No	NA
Wadi Gaza	• Some people complained about the deteriorating quality of the water, while others said that there was no change.	No	NA

1- Gender: Participants' opinion regarding potential gender differentiation in terms of impact

2- Vulnerable Groups: More affected groups by the impact of concern

3- NA: The participants did not identify any group

4- No: The participants believe that there is no gender based differences in impact

5- Women: The participants identified women as being more affected by the impact of concern

4.2.3 Air Pollution

Significant amounts of demolition still exist in almost all localities in the Gaza Strip. The participants from all localities (100%) reported that demolition waste still exists in their communities. Efforts to remove demolition waste are still undergoing a year after the end of the war as can be seen in the following table. This fact makes Gaza communities subject to waves of dust especially when the weather is windy or demolition waste removal and crushing activities take place. In 24 localities (96% of the localities of the Gaza Strip), the participants complained of deteriorated air quality as a result of the demolition waste and its related activities. However, the participants from those communities agreed that situation is much better than it used to be during

the war. During the war, thousands of buildings were bombarded from the sky, the sea and the ground almost everywhere in the Gaza Strip. In some areas such as Khuza'a and Al Fukhary, demolition waste crushers were established in close proximity to the residence of the people in such communities, which caused them to suffer deteriorated air quality and thus respiratory problems.

Experts agree with the testimonies of the people who participated in the focus group sessions. Demolition waste will continue to cause air quality deterioration until the waste is completely removed (Agha, Naeem, Zurub, Abed Rabu, Ayesh, Radi, personal communication April, 2015). Literature on air pollution states that the implosion of houses and demolition waste activities cause air pollution with particulate matter of different sizes that can cause many diseases as discussed above (Curtis et al. 2006; WHO 2003; Dorevitch et al. 2006; Governmental of Gibraltar 2010).

In some areas, the participants still report smelling weird gunpowder smells in the areas which were strongly hit and damaged by air strikes of artillery shelling. These communities are Jabalya, Deir el Balah, Rafah, West Gaza City, and Wadi Salqa. In Al Zawayda and Abeit Hanoun, random solid waste dumpsites were established during the war and still exist. People close to the dumpsites suffer from odor nuisances specifically because of the continuous burning of waste at these sites. Random dumpsites also a source of rodent, street animals, and insect nuisances to nearby communities. Random dumpsite thus can have serious health impacts on asthmatic people or people with respiratory allergies, in addition children playing near them.

In ten localities participates found women more vulnerable to air pollution than men. These communities were: Al Bureij, Al Mughraqa, Al Nasser, Bani Suhaila, Khan Yunis, Khuza'a, Abassan el Kabeera, East and West Gaza City, and Wadi Gaza. They believe that women especially pregnant women are particularly vulnerable to respiratory problems as a result of such pollution. The perceptions of the participants are in agreement with the literature on air pollution. Exposure to air pollution during pregnancy is strongly correlated with low birth weights (Eun-Heeet al. 2001; Wang et al. 1997).

Focus group session participants did not find groups other than women to be particularly vulnerable to air pollution; however, experts expect children and elderly to be more vulnerable. As shown before, the literature supports the experts' opinion as air pollution can increase diseases and mortality among children and the elderly (USEPA 2015a,b; Guaderman et al 2004; Paulo et al. 1995; Pope et al. 2004, 2002; Pope and Dockery 1999).

Table 4: War impacts on air quality

Locality	Impacts	Gender[1]	Vulnerable Groups[2]
Al Bureij	• Demolition waste still exists • Dust waves happen when the wind blows	Women[3]	NA[4]
Al Zahra	• The area did not suffer major damages during the war	No[5]	NA
Al Zawayda	• Demolition waste still exists • Dust waves happen when the wind blows but it is much less than during the war • Some random dumpsites still exist and cause an odor nuisance	No	NA
Al Shuka	• Demolition waste still exists • Dust waves happen when the wind blows but it is much less than during the war	No	NA
Al Fukhary	• Demolition waste still exists • Dust waves happen when the wind blows but it is much less than during the war • A demolition waste crusher was established in the area that creates intensive waves of dust which cause respiratory problems in people around it.	No	NA
Al Qarara	• Demolition waste still exists. • Dust waves happen when the wind blows but it is much less than during the war.	No	NA
Al Msadar	• Demolition waste still exists • Dust waves happen when wind blows but it is much less than during the war	No	NA
Al Maghazy	• No change in air quality.	No	NA
Al Mughraqa	• Demolition waste still exists • Dust waves happen when the wind blows but it is much less than during the war	Women	NA
Al Nasser	• Demolition waste still exists • Dust waves happen when the wind blows but it is much less than during the war	Women	NA
AL Nuseirat	• Demolition waste still exists • Dust waves happen when the wind blows but it is much less than during the war • The air bombed areas still smell weird	No	NA

Locality	Impacts	Gender[1]	Vulnerable Groups[2]
Um el Naser	• Demolition waste still exists • Dust waves happen when the wind blows but it is much less than during the war	No	NA
Bani Suhaila	• Demolition waste still exists • Dust waves happen when the wind blows but it is much less than during the war	Women	NA
Beit Hanoun	• Demolition waste still exists • Dust waves happen when the wind blows but it is much less than during the war • Three random dumpsites still exist. The people who live close to those dumpsites suffer from odor nuisances especially because of the burning of waste at such sites.	No	NA
Beit Lahyia	• Demolition waste still exists • Dust waves happen when the wind blows but it is much less than during the war	No	NA
Jabalya	• Demolition waste still exists • Dust waves happen when the wind blows but it is much less than during the war • Sometimes weird smells still blow from the areas hit by sky rockets	No	NA
Khan Yunis	• Demolition waste still exists • Dust waves happen when the wind blows but it is much less than during the war	Women	NA
Khuza'a	• Demolition waste still exists • Dust waves happen when the wind blows but it is much less than during the war • Two demolition waste crushers were established in Khuza'a, one in the middle and the other on the Eastern side. • These crushers cause dust waves to continuously affect the nearby households. The dust causes many people to suffer respiratory problems.	Women	NA
Deir el Balah	• Demolition waste still exists • Dust waves happen when the wind blows but it is much less than during the war • Sometimes weird smells still blow from the areas hit by sky rockets	No	NA

Locality	Impacts	Gender[1]	Vulnerable Groups[2]
Rafah	• Demolition waste still exists • Dust waves happen when the wind blows but it is much less than during the war • Sometimes weird smells still blows from the areas areas hit by sky rockets	No	NA
Abassan Al Jadeeda	• Demolition waste still exists • Dust waves happen when the wind blows but it is much less than during the war	No	NA
Abassan Al Kabeera	• Demolition waste still exists • Dust waves happen when the wind blows but it is much less than during the war.	Women	NA
East Gaza City	• Demolition waste still exists • Dust waves happen when the wind blows but it is much less than during the war	Women	NA
West Gaza City	• Demolition waste still exists • Dust waves happen when the wind blows but it is much less than during the war • Sometimes weird smells still blow from the areas hit by sky rockets	Women	NA
Wadi Salqa	• Demolition waste still exists • Dust waves happen when the wind blows but it is much less than during the war • Sometimes weird smells still blow from the areas hit by sky rockets	No	NA
Wadi Gaza	• Demolition waste still exists • Dust waves happen when the wind blows but it is much less than during the war	Women	NA

1. Gender: Participants' opinion regarding potential gender differentiation in terms of impact
2. Vulnerable Groups: More affected groups by the impact of concern
3. Women: The participants identified women as being more affected by the impact of concern
4. NA: The participants did not identify any group
5. No: The participants believe that there is no gender based differences in impact

4.2.4 Environmental Related Diseases

In almost all localities (100%) people complained of increases in the spread of many diseases that may stem from environmental pollution. As can be seen in the following table, the most repeatedly mentioned diseases are skin diseases including rash, cancer (72% of the localities), skin diseases (68% of the localities), premature birth resulting in death (48% of the localities), and respiratory diseases (44% of the localities). Less repeated were congenital anomalies, ear and eye inflammations, diarrhea, hepatitis, meningitis and mumps. As discussed above, the 2014 war's possible contamination of the soil, water, and air could justify the potential increases in incidence rates of some of these diseases. Air pollution can cause cancer, premature birth, lung and respiratory disease, and increased rates of premature deaths among infants and the elderly (WHO 2003; USEPA 2015a,b,c; Landrigam et al. 2004' Hamra et al. 2014). Exposure to organically polluted seawater may impose a set of health risks such as, eye and ear infections, skin lesions, hepatitis, diarrhea and gastroenteritis, and respiratory illness (Pruss 1998; Rosenberg 1980; WHO 1999,1998).

Moreover, exposure to contamination by war remnants including the remnants of exploded shells, rockets, etc can be the cause of an unknown number of diseases. Discussing the impacts of such remnants is beyond the capacity of the researchers involved in this assessment. But it is worth noting that Israel has been accused, by the Palestinians, of using many weapons that are possibly illegal. These weapons include, Flechettes artillery or rocket rounds, white phosphorous, Dense Inert Metal Explosive (DIME), and Depleted uranium (DU). The metals and chemical used in some of these weapons such as (DIME) are carcinogenic (Sarsour 2014).

In some areas such Al Fukhary, Beith Hanoun and Khuza'a, the participants in the focus group discussions observed that children who sustain wounds playing in the areas heavily bombed during the war suffered from extended injures, beyond normal levels. In Al Shuka a few participants mentioned that some children who played in the demolition waste sustained eye inflammations for a long period of time. Such observations suggest that the demolition waste is contaminated with the remnants of unconventional weapons like the ones used in the 2008 war. According to Cook (13 January 2009), doctors in Gaza reported strange injuries they could not treat; these unusual injuries were caused by Israeli weapons (arguably DIME) during the 2008 war on Gaza. Dr. David Halpine, a retired British surgeon, was also cited in the same article (Cook, 13 January 2009) calling the weapons causing such injuries "weapons from hell."

In most communities (72% of the localities), participants believed that women were more vulnerable to such diseases than men. Women are the ones who suffer the premature births resulting in infant death, and take care of the children when they are sick or suffer congenital anomalies. In many communities (40% of the localities), participants in the focus group sessions suggested that children were particularly vulnerable to war induced diseases. This coincides with the experts who suggest that women, elderly and children are at the highest risk of communicating diseases as a result of the war (Nassar; Sarsour, Abed Rabu and Radi, Naeem personal communication April 2015). The literature on the health impacts of air pollution strongly agree that women, children and the elderly are more vulnerable than other groups in society to the risk of disease caused by air pollution, as reported before.

Table 5: War induced environmental pollution induced diseases

Locality	Impacts	Gender[1]	Vulnerable Groups[2]
Al Bureij	• Skin diseases • Cancer • Infant death	Women[3]	Children
Al Zahra	• Skin diseases • Respiratory diseases • Cancer	No[5]	NA[4]
Al Zawayda	• Cancer • Respiratory diseases • Infant death • Skin diseases	Women	NA

Locality	Impacts	Gender[1]	Vulnerable Groups[2]
Al Shuka	• Skin diseases • A child sustained eye inflammation because of playing in the war's demolition waste • Cancer • Respiratory diseases	Women	NA
Al Fukhary	• Skin diseases • Infant death • The people who got wounds dealing with war demolition waste suffered severe slow healing injuries.	No	NA
Al Qarara	• Skin diseases • Cancer • Hepatitis	No	NA
Al Msadar	• Skin diseases • Hepatitis • Cancer	Women	NA
Al Maghazy	• Cancer • Eye inflammations • Nasal inflammations	No	NA
Al Mughraqa	• Skin diseases • Cancer • Infant death • Nasal inflammations	Women	NA
Al Nasser	• Skin diseases • Respiratory diseases	Women	NA
AL Nuseirat	• Skin diseases • Cancer • Infant death • Congenital anomalies • Respiratory diseases	Women	NA
Um el Naser	• Cancer • Stomach and diarrhea	No	Children
Bani Suhaila	• Cancer • Stomach and diarrhea	Women	Children

Locality	Impacts	Gender[1]	Vulnerable Groups[2]
Beit Hanoun	• Skin diseases • The people who got wounds dealing with war demolition waste suffered severe slow healing injuries • Infant death • Congenital anomalies	No	NA
Beit Lahyia	• Respiratory diseases • Hepatitis • Infant death • Cancer • Skin diseases	No	Children
Jabalya	• Cancer • Hepatitis • Cancer	Women	NA
Khan Yunis	• Skin diseases • Cancer • Stomach and diarrhea	Women	NA
Khuza'a	• Cancer • Nasal and eye inflammations and allergies • Infant death • Congenital anomalies • Respiratory diseases • Wounds sustained touching demolition wastes lasts for months before being healed	Women	NA
Deir el Balah	• Cancer • Abortion	Women	NA
Rafah	• Skin diseases • Respiratory diseases • Cancer	No	Children
Abassan Al Jadeeda	• Cancer • Congenital anomalies • Infant death	Women	Children
Abassan Al Kabeera	• Skin diseases • .Hepatitis • Respiratory diseases • Infant Death	Women	Children

Locality	Impacts	Gender[1]	Vulnerable Groups[2]
East Gaza City	• Cancer • Nasal and eye inflammations and allergies • Congenital anomalies • Mumps	Women	Children
West Gaza City	• Cancer • Skin diseases	Women	NA
Wadi Salqa	• Respiratory diseases • Skin diseases • Stomach and diarrhea • Congenital anomalies	Women	Children
Wadi Gaza	• Infant death • Cancer • Congenital anomalies	Women	Children

1. Gender: Participants' opinion regarding potential gender differentiation in terms of impact
2. Vulnerable Groups: More affected groups by the impact of concern
3. Women: The participants identified women as being more affected by the impact of concern
4. NA: The participants did not identify any group
5. No: The participants believe that there is no gender based differences in impact

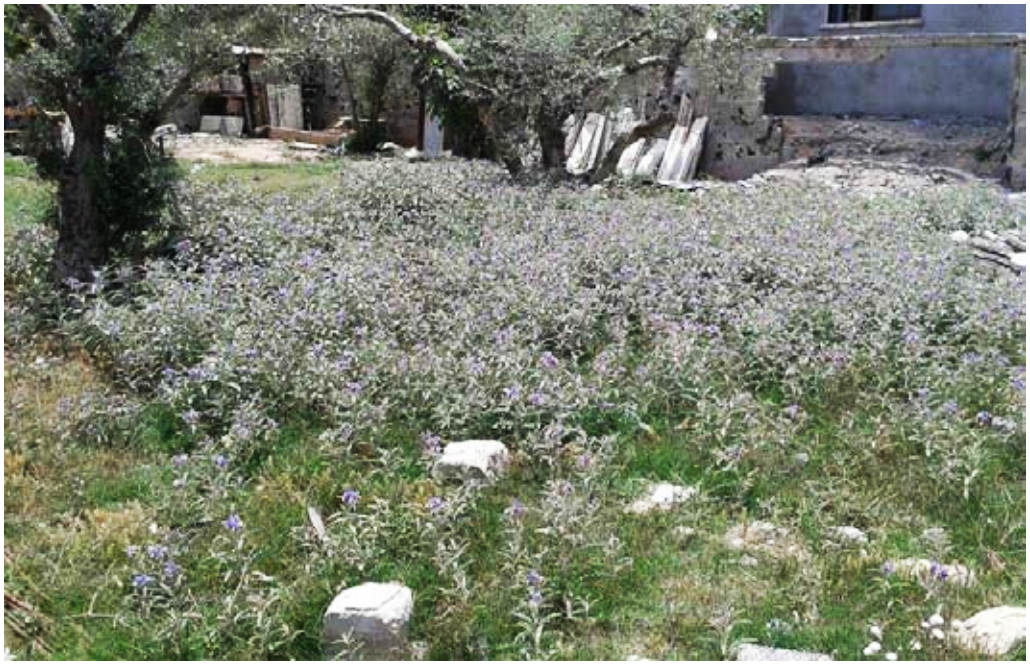
4.2.5 Terrestrial Ecosystem

As can be seen in the following table, the participants from almost every locality (96%) mentioned the destruction of wide areas of agricultural lands including tree orchards. This destruction took place either by air bombings or with bulldozers and land invasions with tanks and heavy machinery. Participants in the focus group sessions from Al Shuka, and Abassan el Jadida, reported that some wild animals such as wild rabbits, foxes, wolfs, and wild cats are less prevalent now than before the war. On the other hand, participants from many communities (32% of the localities) including Al Shuka, Al Fukhary, Al Msader, Al Mughraga, Al Nasser, Beit hanoun, Jabalya, Khuza'a, and Rafah reported a severe drop in the prevalence of wild birds such as wild pigeon, bulbuls, partridges, goldfinches and curlews.

Such losses in wildlife as reported by the participants in the focus group sessions of the above communities coincide with Dr. Abed Rabu (personal communication, April

2015). Dr. Abed Rabu expected that the massive destruction of agricultural lands, which took place during the war, will result in the loss of wild animals and birds because it destroyed their protective habitats. The literature on the impact of wars on wildlife also supports the possibility of losing wild animals and birds in the areas in which massive destruction of agricultural land occurs (Edeko 2011; UNEP 1991a,b,c). It is worth noting that almost 35,000 dunams of agricultural lands were damaged during the 2014 war, especially in the Eastern belt of the Gaza Strip. This fact suggests that the losses in wildlife levels took place as a result of this widespread destruction of the agricultural lands.

In many areas (56% of the localities), local wild herbs or plants became less widespread such as mallow, thyme, portulaca, and Palestine chamomile as witnessed by the participants in the focus group sessions. These herbs and plants have important cultural, nutritional and medicinal values to the people of the Gaza Strip. These areas are Al Fukhary, AL Qarara, Al Msadar, Al Maghazi, Al Mughraqa, Beit Lahyia, Jabalya, Khan Yunis, and Khuz'a. Also some brush lands in areas such as Al Fukhary and Jabalya were destroyed during the war. The soil that held the seeds of these plants may have been lost or damaged, which resulted in a decrease in their prevalence. This phenomenon needs further investigation.



On the other hand, participants (specially farmers) in the focus group sessions from the Northern and Eastern localities noted that some weeds which used to be contained geographically at the furthest side of the border with Israel suddenly became

very widespread on their farms. The affected communities are: Al Fukhary, Al Msader, Khuza'a, Abassan el Jadeeda, Wadi el Salqa, and Wadi Gaza (24% of the localities). Many of the farmers who participated in the focus group sessions complained that such weeds are very hard to kill or remove which weaken their production and adds insult to injury. These weeds were transferred by bulldozers and tanks from their previously isolated locations to the farms in such communities.

The participants in the focus group discussion sessions of many localities (48%) noticed that the accumulation of huge amounts of demolition waste causes an increase in the levels of insect and rodent nuisances in addition to street dogs and cats. These nuisances add to the air pollution that results from the existence of the demolition waste, removal activities and crushing. The communities that reported such types of nuisance are: Al Bureij, Al Zawayda, Al Fukhary, Al Qarara, Al Msadar, Al Nasser, Al Nuseirat, Um el Naser, Bani Suhaila, Beit Lahyia, Khan Yunis, Rafah, East Gaza City, West Gaza City, and Wadi Gaza.

Table 6: War impacts on Terrestrial Ecosystems

Locality	Impacts
Al Bureij	• Destruction of wide area of olive and citrus orchards • Rodent nuisance in the areas with a lot of demolition waste
Al Zahra	• Many citrus and fruit trees were lost during the war including many old ones
Al Zawayda	• Many citrus and fruit trees were lost during the war including many old ones • Increase in street dogs, cats and rodent nuisance
Al Shuka	• Wide areas of agricultural lands including tree cover such as olives, citrus, grapes, and fruit were bulldozed during the war • Many birds became less prominent such as wild pigeons, bulbuls, and goldfinches. Hunters used to come from other areas to hunt those birds at Al Shuka. • We also have less wild rabbits, and foxes.
Al Fukhary	• Wilds tracks of trees and agricultural lands were destroyed • Three areas of brush lands were destroyed near Al Basheer Mossque, Abu Amer area, and the Northern Neighborhood • We lost the curlews which were very common here, and wild pigeons • Rodent and insect nuisance • Decrease in the widespread of mallows • Many strange weeds are causing lots of damages for farmers

Locality	Impacts
Al Qarara	• Wide tracts of agricultural lands and trees were damaged, bulldozed, and burned during the war • Decrease in the spread of mallows and Palestinian chamomile. In some areas people noticed that the mallow plants are diseased with white spots on their leaves. • Increase in the spread of snakes, rodents and insects.
Al Msadar	• Whole orchards of citrus and olive trees were bulldozed • Decrease in the spread of birds like wild pigeon, partridge, and gold-finches. • Decrease in the spread of mallows and the portulaca plants • Increase in the spread of very harmful weeds • Increase in the street animals
Al Maghazy	• Many orchards of citrus and olive trees were bulldozed • Decrease in the spread of wild plants such as mallow, Palestinian chamomile, portulaca, and wild thyme.
Al Mughraqa	• Bulldozing wide areas of agricultural lands including olive and citrus trees • Decrease in the spread of mallows and the portulaca plants • Disappearance of partridges
Al Nasser	• Bulldozing wide areas of agricultural lands including olive and citrus trees • Insect nuisance increase • Decrease in the spread of partridges, goldfinches, and wild pigeons
AL Nuseirat	• Decrease in the spread of birds such as wild pigeons and passers • Increase int the insect nuisance • Street animals widespread
Um el Naser	• Wide agricultural areas were damaged • Rodent and street animals nuisance increased
Bani Suhaila	• Wide orchards of citrus and olive trees were bulldozed during the war. Also lots of trees were burned and killed by the bombing. • Insect nuisance increased.
Beit Hanoun	• Almost all agricultural lands were bulldozed during the war. • Many birds such as partridges, goldfinches, love birds disappeared.
Beit Lahyia	• Hundreds of dunams of agricultural lands were damaged including orchards where some trees were very old. • Increase in the spread of street dogs and cats. • Insect nuisance increased. • The mallow plants are less prevalent than before.

Locality	Impacts
Jabalya	• Wide agricultural lands were destroyed • Many brush lands such as Abu So'od lands and Northern Jabalya area were destroyed. • Decrease in the spread of mallows, and portulaca • Decrease or even disappearance of birds like wild pigeons, and partridges
Khan Yunis	• Wide areas of agricultural lands were destroyed including trees. • Increase in the spread of street animals • Increase in the insect nuisance • Decrease in the spread of plants such as mallows and Palestinian chamomile
Khuza'a	• Many agricultural lands including olive, plants and cactus orchards were destroyed • Increase in very harmful weeds • Decrease in the spread of thyme, mallow, and partulaca
Deir el Balah	• Destruction of wide tracts of trees.
Rafah	• Destruction of wide tracts of trees including grapes, olives and citrus. • Increase in insect nuisance • Increase in street animals and cats • Decrease in the spread of wild pigeons • Decrease in the spread of mallows and partulaca
Abassan Al Jadeeda	• Abassan used to be a well-known for wild birds and animals hunting. • Most of the agricultural lands were damages one way or another. • Cactus and tree cover almost disappeared. • Partridges, wild pigeons, and wild rabbits disappeared. • Even wolfs and foxes disappeared. • Spread of very resilient and harmful weeds. • Decrease in the spread of many wild plants such as mallow and partulaca.
Abassan Al Kabeera	• Wide tracts of tree covered lands were bulldozed; one farmer lost 118 olive trees • Partridges and wild rabbits disappeared • Decrease in the spread of thyme
East Gaza City	• Many orchards in Al Shejaya of different sizes were damages. • The spread of plants such as mallow, Palestinian chamomile, partulaca and thyme decreased. • Insect, rodent and street animals' nuisance increased.
West Gaza City	• Insect and street animals' nuisance increased.

Locality	Impacts
Wadi Salqa	• Wide tracts of agricultural lands were bulldozed or air bombed. Some of the trees lost were more than 20 years old. • Many wild plants were lost • The spread of many weeds • Decrease in the spread of many birds such as partridges, wild pigeons, and curlew.
Wadi Gaza	• Bulldozing many trees including old ones • Increase in insect and street animals' nuisance. • Increase in the spread of harmful weeds. • Decrease in the spread of mallows and other wild plants.

4.2.6 Marine Environment:

Participants in the focus group sessions from all localities neighboring the Mediterranean coast such as Al Zahra, Western Gaza City, Khan Yunis, Rafah, and Nuseirat confirmed that untreated wastewater from all of the treatment plants in Gaza was discharged to the sea. This fits with the reports that were issued by the CMWU and the information gathered from municipality employees. Participants from those areas reported that the color of the seawater is still strange, ranging from black to brown. They also reported the existence of widespread algal blooms over most of the Gaza beach. In areas like Al Nusierat participants reported that some types of fish such as sardine and gilt-head bream have decreased in abundance. Some participants mentioned that every year the month of May used to be a season for sardine fishing, but sardines were very rare this year. Some participants mentioned that since the war more people have suffered from skin rashes and diseases after swimming in the sea as compared to before the war.

The above impacts were confirmed by the fishermen who were engaged in three focus group sessions to discuss the impact of the war on their livelihoods as dependents on the marine environment. The fishermen stated that they sustained more skin diseases from working on the water after the war than before. These findings agree with the Dr. Sarsours' (personal communication April, 2015) expectations and the literature on sea-water pollution that emphasizes seawater pollution's potential to cause skin diseases and other diseases such as eye and ear inflammations, diarrhea, gastroenteritis and even Hepatitis (Pruss 1998; Rosenberg 1980; WHO 1999,1998).

The fishermen also confirmed the widespread presence of algal blooms as expected by experts (Sarsour; and Saleeby, personal communication, April, 2015). Organic pollution most probably results in summer algae blooms (Daoji and Daler 2004). Additionally they emphasized that certain types of fish including sardines, gilt-head breams, and striped sea breamares are now much less abundant than before. They also confirmed an increase in the spread of the poisonous Rabbitfish. According to Fatherree (2013) Rabbitfish is a tropical fish that use to be found in the Pacific and Indian oceans. Rabbitfish are venomous, they contain venom in their spine. The Rabittfish tends to be a great algae eater, which is what may have attracted them to the Gaza coast (Fatherree 2013). As discussed above, alterations in the fish community at certain coasts as a result of excessive organic pollution is possible according to the literature (Bonsdoreff et al. 1997; Hernandez et al. 1998). However, the fishermen believe that the marine biology near Gaza has been stressed for a long time because of the frequent wars on Gaza, and the other complicated sociopolitical conditions of the Gaza Strip which make it difficult to distinguish the impacts of this war from the impacts of the other wars and conditions.

Table 7: War impacts on Terrestrial Ecosystems per community

Locality	Impacts
Al Bureij	• NA
Al Zahra	• Because of the extended power cuts during the war, wastewater was disposed of untreated into the sea. • The color of the seawater changed to a more brownish color. Also the seawater now smells like rotten eggs.
Al Zawayda	• Because of the extended power cuts during the war, wastewater was disposed of untreated into the sea. • The color of the seawater changed to a more blackish color
Al Shuka	• NA
Al Fukhary	• NA
Al Qarara	• NA
Al Msadar	• NA
Al Maghazy	• NA
Al Mughraqa	• NA
Al Nasser	• NA
AL Nuseirat	• Decrease in certain fish types such as sardine and gilthead bream • Increase in algae blooms • More people are getting sick after swimming

Locality	Impacts
Um el Naser	• NA
Bani Suhaila	• NA
Beit Hanoun	• NA
Beit Lahyia	• Because of the extended power cuts during the war, wastewater was disposed of untreated into the sea. • The color of the seawater changed to a more blackish color. • Some people noticed that rodents and cockroaches sometimes live in the seawater itself now.
Jabalya	• Because of the extended power cuts during the war, wastewater was disposed of untreated into the sea. • Some fish types such as sardines are now less abundant. • The seawater now is a source of disease; in the past it was a medication.
Khan Yunis	• NA
Khuza'a	• NA
Deir el Balah	• Because of the extended power cuts during the war, wastewater was disposed of untreated into the sea.
Rafah	• Because of the extended power cuts during the war, wastewater was disposed of untreated into the sea.
Abassan Al Jadeeda	• NA.
Abassan Al Kabeera	• NA
East Gaza City	• NA
West Gaza City	• Sardines are much less abundant, after the war • Other types of fish such as Dicentrarchus, and striped red mullet also decreased in abundance • Algal blooms are now everywhere • More people are contracting skin diseases because of swimming in the sea
Wadi Salqa	• NA.
Wadi Gaza	• NA
Fishermen (Gaza City)	• Fishermen are suffering more frequent skin diseases • Algal blooms are much more pervasive than before • Many fish types decreased including sardine, gilt-head bream, and striped sea bream • Sea reptiles have disappeared

Locality	Impacts
Fishermen (Middles area	• Many fish types decreased including sardine, gilt-head bream, and striped sea bream • The widespread of the rabbitfish which is poisonous • In general fish are much less abundant than before • Algal blooms are much more pervasive than before
Fishermen South-ern area)	• Fishermen are suffering more frequent skin diseases • Algal blooms are much more pervasive than before • Many fish types decreased including sardine, gilt-head bream, and striped sea bream

4.3 Results' Validation

4.3.1 Soil destruction and pollution

Mr. Nezar el Wheedy from the MoA agrees that the lands which were hit by air bombs have sustained extensive soil damages due to the explosion of these rocket which created crater size holes in the ground, displacing all of the soil. He adds that such loss means losing all the biological, physical and biotic characteristics that made the soil suitable for agriculture. Such characteristics need years to be reestablished. This suggests that such impacts will be long term even if the craters were leveled and filled with new soils which are usually not rich with active biota and nutrients (Al Whaidy, Nizar, personal communication. July 2015).

As discussed above, severe fires cause significant changes to the physical, chemical and biological characteristics of the soil. Severe fire decreases the affected soil's biological activity, and its carbon and nutritional content. Severe fires also decrease the macrospores of the affected soil and thus its moisture holding capacity and bulk density (Pantami et al 2010; Certini 2005; Boyers and ,Millers 1994). Soil compaction as a result of heavy machinery passage decreases the ability of water and air to permeate of the affected soil, in addition to decreasing its biological activity and organic content (Frey et al. 2009; Koch et el. 2008). Accordingly, both fires and compaction, by heavy machinery, cause soil infertility as explained by Eng, EL Wheedy (personal communication, July 2015) and expected by other experts (Sarsour; Naeem; Radi; Zurub; and Abed Rabu. personal communication April, 2014). This infertility was also noticed by focus group participants from most of the localities in the Gaza Strip.

4.3.2 Water pollution

The research team communicated with the municipality personnel responsible for the water management of 13 localities. These communities are the ones whose participants' in the focus group sessions reported changes in water quality during the last year. The municipalities communicated with include: Ak Shuka, Al Fukhary, Al Qarara, Al Msadar, Beit HAanoun, Beit Lahyia, Jabalya, Der el Balah, Khuza'a, Abassan Al Kabeera, Gaza City (East and West) and Wadi Gaza.

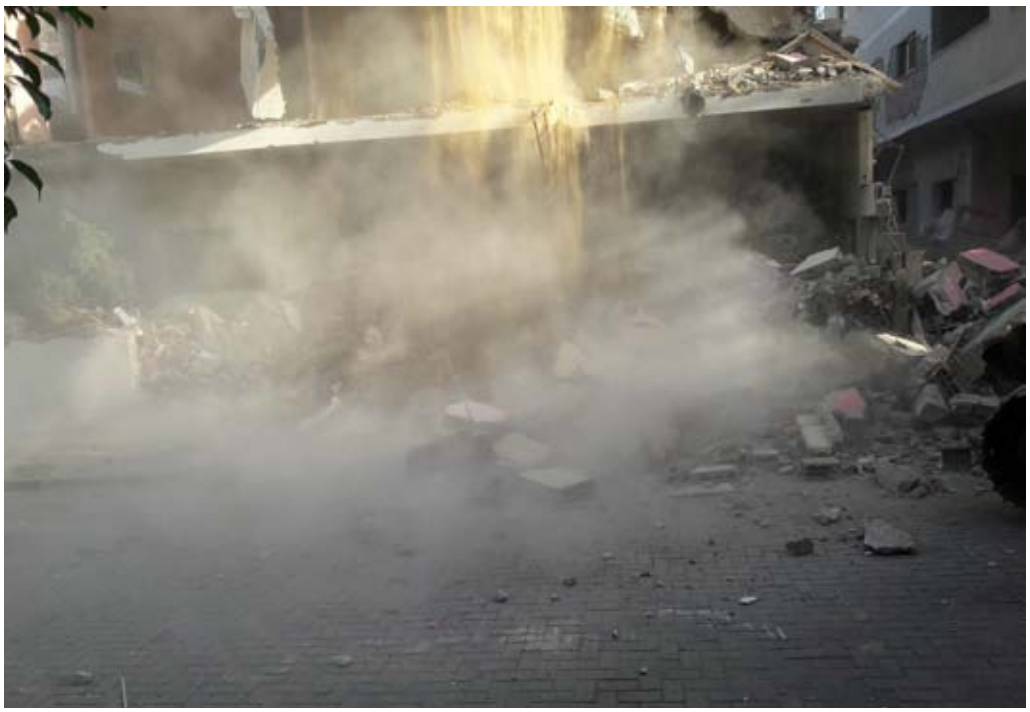
All but five of the municipalities we communicated regarding changes in the quality of water they supply to their citizens denied any such changes. The five municipalities who did not deny changes in the water quality were Khuz'a, Beit anoun, Abasaan el Kabeera, and Gaza City (East and West). In Khuza'a the changes resulted from changing the water sources, from the Israeli water company (Makorot) to local wells. The water quality from Makorort is usually better than from local wells, as water from local wells usually has a high salinity level as discussed earlier in most of the Gaza Strip. In four localities including Beit Hanoun, Gaza City (East and West) and Abassan al Kabeera, the municipality wells, which used to supply decent quality water, were damaged and now the municipality must use wells with lesser quality water for domestic purposes. Generally, these results suggest that the water quality has not sustained significant damages as a result of the war. Yet the war forced some municipalities to use lower quality water wells.

Such a conclusion generally agrees with the expectations of the experts who expect no midterm impacts, but rather long term impacts in terms of heavy metal contamination.

As mentioned before, the water quality in the Gaza Strip is greatly deteriorated. The groundwater which is the sole source of fresh water in the Gaza Strip is highly polluted with saline. Salinity is natural in some locations such as the Middle Area Governorate and South Eastern villages of Khan Yunis. In the Western sections of Gaza Strip salinity is mainly caused by seawater intrusion as a result of the groundwater level being lowered below the seawater level due to the rapid depletion of the aquifer as discussed above. The groundwater in many places is also contaminated with nitrate as a result of the use of septic tanks in some locations, and/or the extensive use of fertilizers in agriculture.

4.3.3 Air Pollution

As explained before, demolition waste (caused by the 2014 war) related activities continue to cause dust waves and air contamination with particulate matter. The samples tested for particulate matter in all the suspected areas including areas neighboring demolition waster crashers, demolition waste storage facilities and active demolition waste removal sites showed higher concentrations than the control sample. In all of those areas, as will be noted momentarily, the particulate matter concentrations were many times more than the allowable concentrations according to the WHO, USEPA, and the European Commission (EC) (WHO 2005, USEPA 2015a,b; EC 2015). The air quality in those sites was also found to be contaminated with lead.



For example the areas neighboring the demolition waste crushers have PM-10 particulate matter concentrations ranging from 1056 to 1632 µg/ m^3 (Khuza'a) which is about 10 times the PM-10 concentration of the control samples (132 and 135 µg/m^3). When it comes to areas neighboring a demolition waste active removal site, the PM-10 concentrations range from 1271 to 1503 µg/ m^3, which is again about 10 times that of the control samples. The PM-10 concentrations in the demolition waste collection sites ranges from 1331 to 2178 µg/ m^3 which is 10-16 times that of the control samples. The PM-10 in all sites discussed above is far beyond (almost 10 times) the concentrations allowed in the US which is 150µg/m^3 (USEPA 2015a) and 30 times the concentration

levels allowed according to the WHO and the EC which is 50 µg/ m^3 (EC 2015). PM-10 particles can affect breathing, respiratory systems, cause damages to the lung tissue and result in cancer and premature death especially to the elderly and children as well as people with chronic respiratory diseases (WHO 2003; Landrigan et al. 2004; USEPA 2015d).

For PM-2.5, the concentrations in the three areas surrounding the demolition waste crushers range from 154 to 250 µg/ m^3 which is 6-10 times the concentrations in the control sample (23 µg/ m^3). Whereas, the concentrations in the three sites that surround an active demolition removal site range from 222 to 298 which is 10-12 times the concentrations in the control samples. The concentrations in the two demolition waste collection sites are 232 and 378 µg/ m^3 which is 10-16 times the concentrations in the control samples. The allowable concentration of PM-2.5 in the ambient air is 25 µg/ m^3 in Europe and 35 µg/m^3 in the U.S. which means that in all the areas where demolition waste related activity is happening the PM-2.5 concentrations are much higher than those allowable by the USEAP (2015) and EC (2015). Small particles of less than 10 micrometers in diameter can have even more serious impacts than the PM-10 particles discussed above because they can go deep in the lungs and even the bloodstream of people causing damage to their lungs and hearts. Air pollution with particulate matter imposes many health risks as explained before including respiratory diseases, cancer, cardiovascular diseases, and premature death (WHO 2003; Landrigan et al. 2004; USEPA 2015c).

In sites neighboring demolition waste crushers lead concentrations range from less than 0.1 to 1.8 µg/m^3; whereas, concentrations in area surrounding an active demolition waste removal site range from 0.2 to 2.7 µg/m^3; and those in the demolition waste collection sites themselves are 4 and 8 µg/m^3. The lead concentrations in the control samples are either 0.01 µg/m^3 or less. The allowable concentrators according to the European Commission (EC) and the United States Environmental Protection Agency (EPA) are 0.5, and 0.15 µg/ m^3 respectively. This means that in many of the locations where demolition waste activities are happening, the lead concentrations are much higher than the allowable levels, sometimes 36 to 50 times more. Lead can impose adverse effects on many parts of the human body including the nervous system, kidney functions, immune system, reproductive and development systems and cardiovascular system (USEPA 2015d)

4.3.4 Terrestrial Ecosystem

During the site visit to Al Shuka, the people interviewed during the trip (mostly farmers) reported that they had noticed a decrease in the omnipresence of wild birds after the 2014 war. They stated that the population of wild animals have been decreasing over the past years as a result of the urban sprawl and the repeated Israeli military aggressions and invasions targeting the Eastern side of Al Shuka bordering Israel. The spread of relatively unknown types of wild weeds was also confirmed by the people interviewed during this trip. Farmers reported that these weeds are very resilient and hard to get rid of.

The people interviewed in Abassan Al Kabeera and Khuza'a agree with those from Al Shuka that many wild animals have disappeared or severely decreased in prevalence as a result of urban sprawl and repeated Israeli aggressions against the Gaza Strip. However, some of the people we met (male farmers) had noticed a decrease in the prevalence of different types of wild birds as a result of the last war (2014). The people from Abassan Al Kabeera and Al Shuka all agree regarding the spread of resilient relatively unknown weeds in their areas after the last war (2014). The spread of street animals, rodents and insects in the areas with large amounts of demolition waste has also been noticed all over the Strip as a result of the spread of demolition waste caused by the 2014 war.

4.3.5 Marine Environment:

Mr. Ayyash, the Chairperson of the Fishermen's Union confirms almost all the changes observed by the fishermen who participated in the focus group sessions. He agrees that the omnipresence of algae in the seawater close to the beach increased after the war. He added that some of these types of algae are particularly harmful because they have spikes that hurt both fishermen and swimmers. He also agrees that this year catch numbers dropped, especially for some types of fish including sardines, gilt-head bream and striped sea bream. He also reported that some new types of fish appeared in the sea for the first time this year; some of these types are poisonous as mentioned by the fishermen who participated in the focus group sessions.

However, Mr. Ayyash stated that he cannot confirm that these impacts were caused by the last war on Gaza or the previous ones. He added that changes in the weather and

climate might have resulted in changes in the fish composition of the Mediterranean Sea. Some of the new types of fish that appeared in Gaza originated from the Arabian Gulf and reached Gaza through the Suez Canal. Nonetheless, he believes that the organic pollution, which affected the seawater during the war, may have affected the fish composition in the area close to Gaza, by pushing the fish outside of the six nautical mile radius where fishing is allowed.

As discussed before, international studies on the impact of organic pollution agree that organic pollution can lead to changes in the fish community. Such changes include decreases in some types, and increases in others (Bonsdoreff et al. (1997) and Hernandez et al. 1998). However, a more specialized investigation is needed to assess the size of those changes and better understand their causes taking into consideration other stressors such as climate change.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Water quality has not significantly changed a year after the war. In 12 (48%) of the 25 Gaza localities investigated, participants in the focus group discussion sessions reported changes in the water quality supplied to their community. In almost half of those localities (5), this was the result of altering the water source from wells damaged during the war to other wells. In the other seven localities, the local authorities denied any change in water quality after the war.

According to the experts, potential changes are still expected as a result of the infiltration of war induced pollutants. Many experts believe that the groundwater in some areas of the Gaza Strip will be contaminated of heavy metals as a result of the war (and the previous wars). Experts and participants from 28% of the Gaza Strip localities believe that women are more vulnerable to war induced changes in water quality. While the experts also suggest that children and the elderly are more vulnerable to war induced changes in water quality, the participants in the focus group sessions do not.

One year after the open ceasefire that ended the war, the war is still affecting the air quality around the Gaza Strip. In the areas that still have demolition waste, active demolition waste removal activities or demolition waste crushers, the air quality is largely polluted with particulate matters of different sizes. In many areas, the air quality was deteriorated also with lead. Such air pollution was expected by experts, witnessed by people who participated in the focus group sessions from 96% of the localities, and confirmed by the chemical tests of air samples from some areas. Air pollution affects women more than men. Women spend more time in their houses than other groups which makes them more exposed to the health threats that are caused by air pollution. Air pollution also effects children and the elderly more than other groups within the community.

The soil in the lands damaged by air bombing or land invasions sustained serious impacts. In both cases the soil became less fertile as noticed by many people, especially farmers from 88% of the localities of the Gaza Strip, who participated in the focus group sessions and was expected by experts. The literature also supports the possibility of the war having such an impact on the soil. Farmers who rely solely on agriculture for living are the most affected victims of those impacts. They are the ones who will suffer lower levels of productivity at time of heightened poverty and unemployment.

An increase in the incidence rate of many diseases was noticed by the people who participated in the focus group sessions. For example, increases in cancer incidence rates were noticed in 72% of the 25 communities investigated. In 68% of the communities an increase in the incidence rate of skin diseases was noticed, while in 48% of the communities an increase in the incidence rate of infant deaths was noticed. Participants in 44% of communities also noticed an increase in the incidence rate of respiratory diseases. These increases in incidences of diesease are supported by the literature as a result of air pollution, seawater contamination, soil pollution, and the use of unlawful weapons during the war. However, in order to connect those changes to the war more research will need to be done. Moreover, people in many locations mentioned that wounds sustained from sharp objects in the demolition waste seemed to take an exceptionally long time to heal. The groups most affected by the increase in disease incidence rates were women, children, and the elderly.

A decrease in the prevalence of birds and to a lesser extent wild animals was noticed by participants in the focus group sessions from areas that witnessed massive destruction of their agricultural lands (32% of the localities). Moreover, the spread of resilient weeds, which were previously limited to small areas around the Strip, was noticed by people and farmers who participated in the focus group sessions from six areas where land invasions occured during the last war. These weeds are very hard to remove or kill and thus cause significant losses to farmers. The significant increase in insect, rodent, and street animal nuisances due of the widespread piles of demolition waste around the strip is also easy to notice. The most impacted group of people within Gazan society as a result of the spread of weeds is the farmers.

Fishermen who participated in three focus group sessions noted significant changes in the marine environment. Such changes include a decrease in the spread of some

types of fish and the appearance or increase of others. The algae blooms were noticed everywhere over the beach in addition to changes in the color of the seawater. While the war is most probably responsible for the increase and spread of the algae blooms as well as the change in seawater color in some areas, it is hard to point to just one reason behind the changes in the composition of the ocean fish. Also, it is hard to predict if these changes will last for a long period of time or if they are temporary. Of course if these changes are permanent then the biggest victim of such changes would be the fishermen themselves.

5.2 Recommendations

5.2.1 Research

1- The water quality around the Strip needs to be continuously monitored for heavy metal contamination over the coming years.

2- An assessment of the level of soil deterioration in all the lands affected by the last war is needed to accurately assess the size of damage caused by the war in terms of soil destruction and loss. The physical and chemical characteristics of the soil from those lands should be established against healthy soils similar in type and as geographically close as possible.

3- Finding approaches to help recover the affected lands as soon as possible is essential, especially considering the food insecurity that Gazan people are already suffering.

4- Assessing and monitoring changes in the particulate matter concentrations in all areas of the Gaza Strip in order to be able to quantify the wars impact on air pollution. Additionally, studying the impact of air pollution on the public's health in the Gaza Strip

5- Changes in the incidence rate of diseases such as cancer, skin diseases, respiratory diseases, etc need to be investigated over time in order to discover trends and test potential correlations between the wars on Gaza and such changes using statistical methods.

6- Changes in the plant, wild animals, and wild birds populations in some areas of the Gaza Strip including Abaasan al Jadida and Al Shuka are in need of further

assessment in relation to time. Such changes might reveal the impacts of wars, urban sprawl and other stressors on the biodiversity of the Strip. In general the status of biodiversity in the Gaza Strip should be assessed and updated.

7- Approaches to reviving the biodiversity of the Gaza Strip should be studied and tested.

8- The change in the fish composition of Gaza's seawater needs through investigations to understand both the causes and prospects of such changes. The impacts of such changes on the fishing economy and the fishermen need to also be assessed.

5.2.2 Interventions

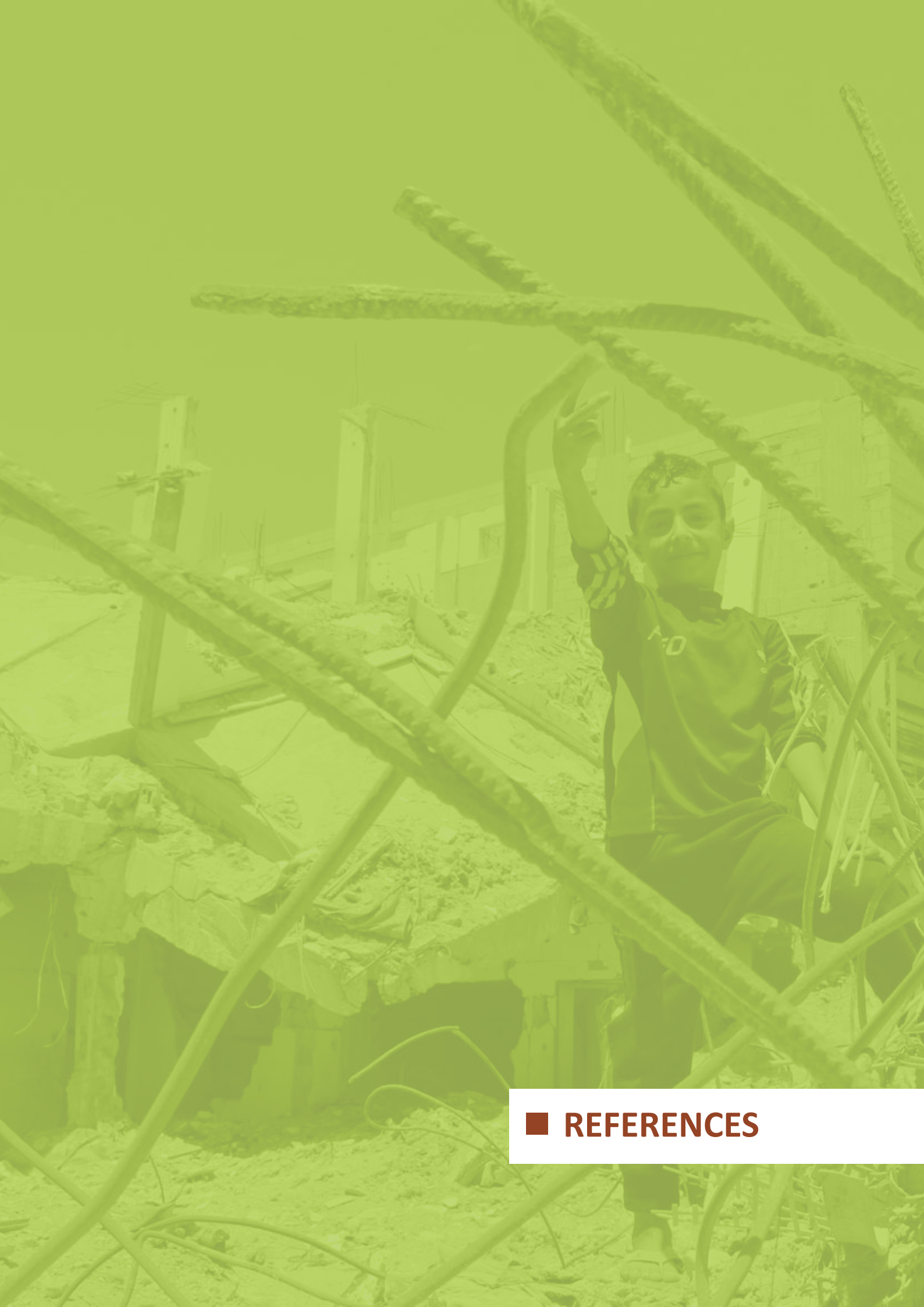
1- Finding solutions to the soil damage that help farmers regain and retain the fertility of their lands as soon as possible. The MoA and the local NGOs need to assist farmers remove the strange weeds affecting their lands and decreasing their productivity.

2- Increasing the support for farmers who were the biggest victims of the last war due to soil damage and weed infestation. These environmental impacts affect the economic wellbeing of Gaza's farmers and their families.

3- The health system including donors, local authorities and NGOs need to develop strategies to battle the rise in many environmentally based diseases through early diagnosis and efficient treatment.

4- The support for fishermen needs to be increased in order to help them survive the decrease in fish catches and the changing of the fish composition in the sea. The blockade should be lifted and so they can catch enough fish to sustain their living and enhance the food security of the Gaza Strip.

5- The local authority and the international community needs to put more effort into reviving and protecting the biodiversity of the Gaza Strip from the continuous violent and economic stresses caused by the Israeli occupation.



REFERENCES

REFERENCES

- Abdallah S.A., a.a. El Manama, M.I. Fahd, S. Afifi. 2004. Microbiological Beach Sand Quality in the Gaza Strip in Comparison to Seawater. *Polish Journal of Environmental Studies*, 14(6): 841-850.
- Abudaya M, S. Harara. 2013. Spartial and Temporal Variations in Water Quality along the Coast of Gaza Strip. *Journal of Environmental Earth Sciences*, 3(2): 53-63.
- Al Najar H., Al Rayes N., Dokhan Al., Saqer A. Silmi R., and Al Kurdi S. 2015. Assessing Heavy Metals Pollution in the Agricultural Lands of Gaza Strip That Has Undergone Three Executive Wars. *American Journal of Environmental Protection*, 3 (4): 151-158.
- Bonsdorff, E., E. Blomqvist, J. Mattila, A. Norkko. 1997. Coastal Eutrophication: Causes, Consequences and Perspectives in the Archipelago Areas of the Northern Baltic Sea. *Estuarine, Coastal and Shelf Science*, 44:63–72
- Boyer, W. D., and J. H. Miller. 1994. Effects of Burning and Brush Treatment on Nutrients and Soil Physical Properties in Young Longleaf Pine Stands. *Forest Ecology and Management*, 70: 311-318.
- Certini, G. 2005. Effects of Fire on Properties of Forest Soils: A Review. *Oecologia*, 143: 1-10.
- Chay K.Y., M. Breenstone. December 1999. The Impact of Air Pollution on Infant Mortality: Evidence from Geographic Variations in Pollution Shocks Induced by a Recession. *The Quarterly Journal of Economics*, 118 (3): 1121-1167.
- Cox, T.P. 2011. Farming the Battlefield: the Meanings of War, Cattle and Soil in South Kivu, Democratic Republic of the Congo. *Disasters*, 36 (2): 233-248.
- Cook, J. 13 Jan. 2009. Is Gaza A Testing Ground for Experimental Weapons? *The Electronic Intifada*. https://electronicintifada.net/content/gaza-testing-ground-experimental-weapons/7969
- Curtis L., W. Rea, P.Smith-Willis, E. Fenyves, Y. Pan. 2006. Adverse Health Effects of Outdoor Air Pollutants, *Environmental International*, 32: 815-830.
- Cutter, S.L. 2003. The Vulnerability of Science and the Science of Vulnerability. *Annals of the Association of American Geographers* 93(1): 2-12.
- Daoji, L, Daler D. 2004. Ocean Pollution from Land based Sources: East China Sea, China. *Royal Swedish Academy of Sciences*, 22(1-2): 107- 113.
- Dorevitch, S., H. Demirtas, V.W. Perky, S. Erdal, L. Conroy, T. Schoonover, P. A. Scheff. 2006. Demolition of High Rise Public Housing Increases Particulate Matter Air Pollution in Communities of High-Risk Asthmatics. *Journal of Air and Water Management Association*, 56: 1022-1032.
- Dube, A., R. Zbytniewski, T. Kaowalkowski, E. Cukrowska, B. Buszewski. 2001. Adsorption and Migration of Heavy Metals in Soil. *Polish Journal of Environmental Studies*, 10(1): 1-10.
- Edeko S.E. An Overview of the Environmental Implications of War. *Sacha Journal of Environmental Studies*, 1 (2): 30-54.
- Eun-Hee, H., Y. Hing, B. Lee, B. Woo, J. Schwarts, D.C Christiani. 2001. Is Air Pollution a Risk Factor for Low Birth Weight is Seoul? *Epidemiology*, 12 (6): 643-648.
- European Commission (EC). 2015. *Air Quality Standards*. EC. http://ec.europa.eu/environment/air/quality/standards.htm
- Fatherree, J. August 2013. Aquarium Fish: Fishes of the Genus Siganus: The Rab-

bitfishes. *Advanced Aquarist*, XII. http://www.advancedaquarist.com/2013/8/fish2.

- Finger M. 1991. The Military, the Nation State, and the Environment. The *Ecologists,* 21(5): 220-225.
- Frey, B., J. Kremer, A. Rudt, S. Sciacca, D. Matthies, P. Lusche. 2009. Compaction of Forest Soils with Heavy Logging Machinery Affect Soil Bacteria Community Structure. *European Journal of Soil Biology*, 45: 312-320.
- Fussel H., R. Klein. 2006. Climate Change Vulnerability Assessments: An Evolution of Conceptual Thinking. *Climatic Change 75*: 301–329.
- Government of Gibraltar. 2010. *Dust-Best Practices Guide*. Government of Gibraltar.
- Gauderman, W.J., E. Avol, F Gilliland, H. Vora, D. Thomas, K. Berhane, et al. 2004. The Effect of Air Pollution on Lung Development from 10-18 Years of Age. *The New England Journal of Medicine*, 353 (11): 1057-1067.
- Gauderman W.J., R. McConnell, F, Gilliland, S. London, D. Thomas et al. 2000. Association between Air Pollution and Lung Function Growth in Southern California Children. *American Journal of Respiratory and Critical Care Medicine*, 162: 1383-1390.
- Hamra, G.B., N. Guha, Aaron Chen, F. Laden, O. Raaschou-Nielsen et al. 2014. Outdoor Particulate Matter Exposure and Lung Cancer: A Systematic Review and Meta-Analysis. *Environmental Health Prospect,* 122: 906-911.
- Health Cluster in Occupied Palestinian Territories. September 2014. *Gaza Strip: Joint Health Sector Assessment Report*. Health Cluster in Occupied Palestinian Territories
- Hernandez, M., I. Robinson, A. Aguilar, L. Gonzalez. .M., L. Lopez-Jurado, et al. 1998. .Did Algal Toxins Cause Monk Seal Mortality. *Nature*, 393:28–29.
- Hilles A.H., A.I. Al Hindi, Y.A. Abu Safieh. 2014. Assessment of Parasitic Pollution in the Coastal Seawater of Gaza City. Journal of Environmental Health Science and Engineering, 12:26. http://www.ijehse.com/content/12/1/26
- Ismail, M. 2003. *A Prospect of Water Desalination in the Gaza Strip*. Unpublished M.Sc. thesis, Land and Water Resources Engineering, KTH, Stockholm.
- Kasperson, Roger E. and Jeanne X. Kasperson. 2001. Climate Change Vulnerability and Social Justice. Stockholm: Stockholm Environment Institute.
- Khan, S., Q. Cao, Y.M Zheng, Y.Z. Huang, and Y.G. Zhu. 2008. Health Risks of Heavy Metals in Contaminated Soils and Food Crops Irrigated with Wastewater in Beijing, China. *Environmental Pollution*, 152: 686-692.
- Koch, H., H. Huer, O. Tomanova, and B. Marlander. 2008. Cumulative Effect of Annually Repeated Passes of Heavy Agricultural Machinery on Soil Structural Properties and Sugar Beet Yield under Two Tillage Systems. *Soil and Tillage Research*, 101(1-2): 69-77.
- Li, Zhenbin, Larry M. Shuman. 1996. Heavy Metal Movement in Metal Contaminated Soil Profiles. *Soil Sciences*, 161(10): 656-666.
- Landrigan, P. J, P. J. Lioy, G.Thurston, G. Berkowitz, L.C. Chen, et al. 2004. Health and Environmental Consequences of the World Trade Center Disaster. *Human Health Perspectives*, 112 (6): 731-739.
- Loveland P.J. and T.R.Thompson. 2000. *The Draft Revised EC Sewage Sludge*

Directive (March 2000) in Relation to Concentrations of Copper, Lead, Nickel, and Zink in the Soils of England and Wales. Technical Report: R&D Project Record P5/049/01. Soil Survey and Land Research Center, Cranfield University.

- Ma'AN Development Center. 2015. *Gaza Reconstruction Mechanism: Enforcement and Legitimization of Gaza Blockade*. Ma'AN Development Center
- MA'AN Development Center. 2014. *Living Conditions of Displaced People in Shelters: Gender Focused Qualitative Study*. Ma'AN Development Center
- Mannion A.M. 2003. *The Environmental Impact of War and Terrorism*. Geographical Paper No. 169. Department of Geography, The University of Reading, Whiteknights.
- Mikkelsen P.S., m. Hafliger, M. Ochs, J.C. Tjell, P. Jacobson, M. Boller. 1996. Experimental Assessment of Soil and Grounwater Contamination from Two Old Infiltration Systems for Road Run-off in Switzerland. *Science of Total Environment,* 189-190: 341-347.
- Ministry of Agriculture. August 2014. *Assessment Report: The Impacts of the 2014 Israeli Aggression on the Agricultural Sector in Gaza Strip*. MoA, Gaza.
- NGO Coordination Committee for Iraq. June 2011. *Environmental Contaminants from War Remnants in Iraq*. NGO Coordination Committee for Iraq
- New York State Department of Environmental Conservation (NYSDEC). 2006. *New York State Brownfield Cleanup Program Development of Soil Cleanup Objectives Technical Support Document*. New York State Department of Environmental Conservation and New York State Department of Health, Albany, NY. http://www.dec.ny.gov/chemical/34189.htm.
- O'Brien K., S. Eriksen; L. Sygna and L.O Naess. 2006. Questions Complacency: Climate Change Impacts, Vulnerability, and Adaptation in Norway. *Ambio* 35(2): 50-56.
- Palestinian Central Bureau of Statistics (PCBS). 2015. *Population*. PCBS. http://www.pcbs.gov.ps/site/lang__en/881/default.aspx#Population
- Palestinian Environment Quality Authority. September 22nd, 2014. *The Environmental Impacts of the Israeli Offensive on the Gaza Strip in the period 8 July to 26th of August 2014*. PEQA. Gaza.
- Palestinian Water Authority (PWA). August 2014. *Water Sector Damage Assessment Report*. PWA, Gaza.
- Palestinian Water Authority. 2013a. *Evaluation of Groundwater Part A: Water Levels in the Gaza Coastal Aquifer*. PWA, Palestine.
- Palestinian Water Authority. 2013b. Evaluation of Groundwater Part B: Water Quality in the Gaza Strip Municipal wells. PWA, Palestine.
- Pantami, S.A., N. Voncir, G.A. Babaji, and S. Mustapha. 2010. Effects of Burning on Soil Chemical Properties in the Sub-Humid Savana Zone of Nigeria. *Researcher*, 2(7): 78-83.
- Partow, H.2008. Environmental Impact of Wars and Conflicts. In *Arab Environment Future Challenges*: *2008 Report of the Arab Forum for Environment and Development*. Ed. Mostafa K. Tolba and Najib W. Saab.
- Paulo, U., N. Saldiva, C. Arden Pope III, J. Schwartz, D.W. Dockery et al. 1995. Air Pollution and Mortality in Elderly People: a Time Series Study in Sao Paulo, Brazil. *Archives of Environmental Health: An International Journal*, 50(2): 159-163.

- Pope, C.A. III, M.l. Hansen, R.W. Long, K.R. Nielsen, N.L. Eatough, et al. 2004. Ambient Particulate Air Pollution, Heath Rate Variability, and Blood Markers of Inflammation in a Panel of Elderly Subjects. *Environmental Health Prospect*, 112(3): 339-345.
- Pope, CA III, R.T. Burnett, M.J. Thun, E.E. Calle, D. Krewski, et al. 2002. Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution. *JAMA,* 287:1132–1141.
- Pope, CA III, Dockery DW. 1999. Epidemiology of particle effects. In: *Air Pollution and Health* (Holgate ST, Samet JM, Koren HS, Maynard RL, eds) London: Academic Press,671–705.
- Pruss, A. 1998. Review of Epidemiological Studies on Health Effects from Exposure to Recreational Water. *International Journal of Epidemiology* 27, 1-9.
- Rosenberg M.L., J.P Koplan., R.A Pollard. The Risk of Acquiring hepatitis from Sewage -Contaminated Water. *Am J Epidemiol*, 112(1):17 -22, 1980.
- Safi, A., S. Claassen, N. Al Shareef, m Zayyan, and A. Wafi. *Participatory Risk Assessment in the Gaza Strip*. PARC.
- Safi, Ahmad S. William James Smith, Jr., and Zhongwei Liu. 2012. Rural Nevada and Climate Change: Vulnerability, Beliefs, and Risk Perception. *Risk Analysis* 32 (6): 1041-1059.
- Samet, J. M., F. Dominici, F. C. Curriero, I. Coursac, S. L. Zeger. 2000. Fine Particulate Air Pollution and Mortality in 20 U.S. Cities 1987–1994. *The New England Journal of Medicine*, 343 (24)" 1742-1749.
- Sarsour, Amal. 2014. *Impact of the last Israeli Military Operation on the Vital Environmental Sectors in Gaza Governorates*. http://www.tlaxcala-int.org/article.asp?reference=13881
- Scheraga, J. and A. E. Grambsch. 1998. Risks, Opportunities and Adaptation to Climate Change. *Climate Research,* 10: 85-95.
- Sidel V.W., B. S. Levy, J.E. Slutzman. 2009. Prevention of War and Its Environmental Consequences. *Handbook of Environmental Chemistry*: 21-39.
- Shomar, B., S. Abu Fakher, and A. Yahya. 2010. Assessment of Groundwater Quality in the Gaza Strip, Plaestine Using GIS Mapping. *Journal of Resources and Protection*, 2: 93-104.
- Thaher, R. 2006. *Assessment of Desalination Options in Gaza Strip*. Unpublished M.Sc. thesis, Water Resource Management, Islamic University, Gaza, Palestine.
- The World Bank. 2015. *Economic Monitoring Report to the Ad Hoc Liaison Committee*. The World Bank.
- United Nations Development Program (UNDP). 2015. Rubble Removal Infographic. UNDP.
- United Nations Development Program (UNDP). 12 Nov 014. *Under the Auspices of Prime Minister Al Hamdallah UNDP Begins Removing Rubble in Gaza, with Funding from Sweden*. http://www.ps.undp.org/content/papp/en/home/presscenter/pressreleases/2014/11/12/under-the-auspices-of-prime-minister-al-hamdallah-undp-begins-removing-rubble-in-gaza-with-funding-from-sweden-.html
- UNRWA. 6 December 2014. *Epidemiological Bulletin for Gaza Strip. Issue 7*, Volume 6.
- United Nations for Training and Research (UNITAR). 2014. *Impact of the 2014 Conflict in the Gaza Strip, UNOSAT Satellite Derived Geospatial Analysis*. http://reliefweb.int/sites/reliefweb.int/files/resources/UNOSAT_Gaza_Report_Web_Final_2014.pdf.

- The United Nations Office for the Coordination of Humanitarian Affairs (OCHA). 2014. *Occupied Palestinian Territory: Gaza Emergency Situation Report (as of 27 August 2014; 08:00 hrs*).
- United States Environmental Protection Agency (USEPA). 2015c. *Particulate matter (PM-10*). http://www.epa.gov/airtrends/aqtrnd95/pm10.html
- United States Environmental Protection Agency (USEPA). 2015c. *Particulate matter*. http://www.epa.gov/pm/health.html
- United States Environmental Protection Agency (USEPA). 2015b. *National Ambient Air Quality Standards (NAAQS)*. http://earth1.epa.gov/ttn/naaqs/criteria.html
- United States Environmental Protection Agency (USEPA). 2015d. *Lead in the Air*. http://www.epa.gov/airquality/lead/health.html\
- United States Environmental Protection Agency (USEPA). 2002. *Supplemental guidance for developing soil screening levels for superfund sites. Office of Solid Waste and Emergency Response*, Washington, D.C. http://www.epa.gov/superfund/health/conmedia/soil/index.htm
- Wang, X, H Ding, L Ryan, X Xu. Association between Air Pollution and Low Birth Weight: A community Based Study. *Environmental Health Prospect*, 105(5): 514-520.
- Wilson, D. 23 July 2014. *The Terror Weapons Israel is Using in Its War Crimes Against Civilians in Gaza*. *Stop the War Coalition*. http://stopwar.org.uk/news/the-terror-weapons-israel-is-using-in-its-war-crimes-against-civilians-in-gaza
- World Health Organization (WHO). 2003. *Health Aspects of Air Pollution with Particulate Matter, Ozone and Nitrogen Dioxide*. Report on a WHO working Group, Bonn Germany, 13-15 January 2003.
- World Health Organization (WHO). 2005. *WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide: Global Update 2005*. WHO.
- Word Health Organization (WHO). 1998. *Manual for Recreation Water and Beach Quality Monitoring and Assessment*. Regional Office for Europe, European Center for Environmental and Health Draft report. WHO.
- World Health Organization. 1999. *Health -Based Monitoring of Recreational Waters: The Feasibility of A New Approach (The Annapolis Protocol)*. Sustainable Development and Healthy Environments ,Geneva.
- Wuana, R.A., and F. F. Okieiman. 2011. Heavy Metals in Contaminated Soil: A Review of Sources, Chemistry, Risks, and Best Available Strategies of Remediation. *International Scholarly Research Network.* Article ID:402647. Doi: 10.5402/2011/402647.