**WHO EMRO | Water usage in the Gaza Strip: recommendations from a literature review and consultation**

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# استخدام المياه في قطاع غزة : توصيات تستند إلى مراجعة للأدبيات واستشارات للخبراء

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لقد كانت جودة المياه في قطاع غزة منقوصة بشدة نتيجة لتزايد الملوحة والتلوثالخلاصة :
ببعض الملوثات وعدم وجود خيارات كافية لمعالجتها . ولتقديم النصيحة لسكان قطاع غزة
بشأن كيفية التخفيف من المخاطر الصحية الناجمة عن المياه قمنا بوضع توصيات حول
استخدام المياه ذات المصادر المختلفة لأغراض مختلفة ( مثل : الاستهلاك، والنظافة،
والاستخدام في أسباب الراحة، والاستخدام في الأغراض الإنتاجية، والري ) ، وذلك
استناداً إلى مراجعة الأدبيات واستشارة الخبراء . وقد وضعت نصائح محددة للعديد من
الفئات الضعيفة؛ بما في ذلك الرضع والأطفال والنساء الحوامل أو المرضعات وكبار السن .
إن التوصيات التي سبق وضعها قاصرة أصلاً، إذ أنه من غير المقبول أن يوصى باستهلاك مياه
دون المستوى المعياري . ومع ذلك فإنه ريثما يتم إيجاد حلول طويلة الأجل يمكن أن تستهدف
الفئات الضعيفة لضمان تجنب تعرضها للملوثات الأكثر ضرراً . إن تنفيذ هذه التوصيات قد
يتطلب تنظيم حملات إعلامية لمساعدة السكان على تمييز استعمال المياه ذات المصادر
المختلفة في الاستخدامات المختلفة .

**ABSTRACT** Water quality in the Gaza Strip has been severely compromised due to increasing salinity, contamination with pollutants, and lack of adequate treatment options. To provide the population of the Gaza Strip with advice on how to mitigate health risks from water we developed recommendations on using water from different sources for different purposes (such as for consumption, hygiene, amenities, and irrigation) based on a literature review and

1 / 9

consultation with experts. Specific advice was developed for several vulnerable groups, including infants, children, pregnant or lactating women, and elderly people. The recommendations are inherently limited, as it is unacceptable to recommend consuming water that is of substandard quality. However, pending long-term solutions, information can be targeted to vulnerable groups to ensure that exposure to the most harmful contaminants is avoided. The implementation of these recommendations may require information campaigns to assist the population in differentiating water from different sources for different uses.

## Utilisation de l’eau dans la Bande de Gaza : recommandations reposant sur une analyse documentaire et des consultations d’experts

**RÉSUMÉ** La qualité de l’eau dans la Bande de Gaza a été grandement compromise du fait de l’augmentation de la salinité, de la contamination par les polluants, et du manque d’options de traitement appropriées. Afin de conseiller la population de la Bande de Gaza sur la façon de réduire les risques sanitaires liés à l’eau, nous avons mis au point des recommandations pour l’utilisation de l’eau provenant de différentes sources en vue d’usages variés (consommation; hygiène; utilisation des infrastructures y compris le lavage des voitures et l'arrosage de la pelouse, production et irrigation), sur la base d’une analyse documentaire et de consultations d’experts. Des conseils spécifiques ont été mis au point pour différents groupes vulnérables tels que les nourrissons, les enfants, les femmes enceintes ou allaitantes, et les personnes âgées. Les recommandations mises au point sont nécessairement limitées ; il est en effet inacceptable de recommander la consommation d’une eau ne répondant pas aux normes. Cependant, en attente de solutions sur le long terme, les groupes vulnérables peuvent être ciblés afin de garantir que l’exposition aux contaminants les plus dangereux soit évitée. La mise en place de ces recommandations pourrait nécessiter des campagnes d’information pour aider les populations à reconnaître l’eau de différentes sources en vue d’usages variés.

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Received: 10/06/16; accepted: 22/09/16

## Introduction

The Gaza Strip is approximately 365 km2 and home to more than 1.85 million people who live in 5 governorates (1). The population is projected to grow to 3.7 million inhabitants by 2035 (2).

One of the main challenges facing the growing population is access to potable water. Water in the Gaza Strip is sourced primarily from the coastal aquifer, which has been infiltrated by the Mediterranean sea, leading to increased salinity in the groundwater. Extraction from the coastal aquifer in 2010 was estimated to be 170 million m3/year, but the annual sustainable yield of the aquifer within the Gaza Strip is estimated to be 55 million m3/year (3). Contamination of water resources with fertilizers, pesticides and solid waste, as well as a lack of adequate water and sewage treatment options, including desalination facilities, has further compromised the quality of the water (4, 5). It is estimated that the water extracted from the coastal aquifer will be unusable by as early as 2016, with the damage becoming irreversible by 2020 (6). In addition, damage to and destruction of the infrastructure due to the ongoing conflict with Israel and blockade of the Gaza Strip has gone unrepaired, which further complicates the situation (7).

It is essential that the public health and water authorities in the Gaza Strip pursue long-term solutions for the worsening water crisis. However, the population relies on the existing water resources, despite the insufficient quantity and questionable quality. Therefore, as part of an initiative to support the establishment of the Palestinian National Institute of Public Health (PNIPH), the Norwegian Institute of Public Health (NIPH) was commissioned by the World Health Organization (WHO) to collaborate with the PNIPH, WHO and the Palestinian Ministry of Health to provide the population in the Gaza Strip with clear advice on how to mitigate health risks from water.

## Water sources in the Gaza Strip

Piped water in the Gaza Strip generally originates from the coastal aquifer, which extends from Haifa to the Sinai desert to Hebron Mountain. Water from the aquifer is drawn from deep wells and is used for domestic, agricultural and industrial purposes. However, the quality of the water sourced from the coastal aquifer has been severely compromised due to the infiltration of seawater and contamination from chemicals, such as pesticides and fertilizers (8,9).

Desalination has been pursued as a means of increasing the amount of potable water in the Gaza Strip. Currently, there are 7 public desalination facilities run by the Coastal Municipalities Water Utility, at least 40 small-scale private desalination plants, and more than 20 000 households using reverse osmosis units. Drinking water from desalination plants is sold from water tankers. As much as 83% of the population uses water from tankers as their primary source of household water (10). According to a water-quality monitoring campaign conducted in 2009, the water from desalination plants is of good microbiological and chemical quality (11). However, bacteriological contamination has been detected in samples taken from distribution points and in samples taken from household storage tanks, owing to contamination from non-hygienic handling and storage (12).

Bottled water in the Gaza Strip is both produced locally (using the aquifer as a source) and imported from Egypt, Israel, Jordan, Turkey and the West Bank. It has been estimated that 80% of the total amount of bottled water consumed in the Gaza Strip is imported, according to information provided by managers of large stores in Gaza (S. Lubbad, Public Health Laboratory, Palestinian Ministry of Health, personal communication, 2012). Due to a lack of systematic monitoring of the production and import of bottled water, there is limited information about the overall microbiological quality.

The harvesting of rainwater, commonly practiced in the West Bank (13), is not generally conducted by private households in the Gaza Strip. A 2008 study found that residents of the Gaza Strip would be willing to adopt on-site rooftop rainwater filtration systems in urban areas where land is available, but financial incentives from local authorities would be necessary to make this alternative more attractive (14). Given that the long-term annual average rainfall in Gaza is 327 mm, with uneven geographical distribution and large fluctuations in quantity from year to year (9), and there is hardly any precipitation from May through September, the viability of rainwater collection as major source of water in the Gaza Strip is limited.

## Methods

### Review of literature and water-quality guidelines

To develop evidence-based recommendations for water use, a literature review was conducted to identify all studies related to water in the Gaza Strip. The search for peer-reviewed literature was conducted during July 2013 in the Ovid MEDLINE and Scopus databases, using general and specific terms related to “water” and “Gaza”. Titles and abstracts were screened for relevance by two reviewers. Relevant articles were classified into thematic areas. Any recommendations proposed in the literature for addressing water quality in the Gaza Strip were extracted in order to potentially support the recommendations developed by the NIPH.

A total of 304 article titles were obtained using the search terms. Of these, 87 relevant original articles were identified and classified under 11 thematic areas. Only nine studies (15–23) examined the association between water quality and health effects ( Table 1 ). In the literature describing contaminants in the water supply in the Gaza Strip, salt was the most notable cause of decreased water quality, followed by nitrates and infectious organisms. There is negligible information about the health effects of specific contaminants in the Gaza Strip, such as heavy metals and pesticides. The recommendations proposed in the literature predominantly emphasized the overall need to improve water resources. The full methods and results of the literature review and review of water guidelines are presented in a report by the NIPH and PNIPH (24).

A review of the Palestinian Water Authority's (PWA's) and international water-quality guidelines was conducted to propose practical recommendations based on the data about using the water available in the Gaza Strip and how the population could mitigate the health risks associated using it. For some parameters, the PWA's guidelines (11) are less restrictive than WHO's guidelines (25). Those PWA parameters that differ from WHO's guidelines are generally related to natural chemical constituents in the water. When compared with the results from regular testing for chemical contaminants in wells in the Gaza Strip from 2010 (169 wells), 2011 (173 wells) and 2012 (193 wells), levels for several parameters exceeded the limits recommended by WHO and the PWA (Palestinian Water Authority, personal communication, 2013). For example, from 2010 to 2012 the average chlorine levels observed in wells varied from 50 mg/L to 1 1476 mg/L, which exceeds the recommended maximum in both WHO's and and the PWA's guidelines (WHO's guidelines specify a maximum of 250 mg/L and the PWA specifies 600 mg/L). Nitrate levels up to 528 mg/L also exceeded the recommended limits in both guidelines (WHO's guidelines: maximum 50 mg/L; PWA guidelines: 70 mg/L). Although the routine testing of wells does not include microbiological parameters, high levels of total and faecal coliform bacteria have also been found in water samples collected from groundwater wells, particularly those near wastewater treatment ponds, resulting from contamination with sewage (10,26).

## Results

### Development of recommendations for water usage

The evidence collected through the literature review was presented to experts and key stakeholders in the Gaza Strip and Norway by the Palestinian Ministry of Health, the NIPH, the PWA, the Coastal Municipalities Water Utility and WHO. Through a consultative process, recommendations were developed about using water from different sources for different purposes (consumption; hygiene; amenities, such as car washing or lawn watering; production; and irrigation) ( Table 2 ). Water used for consumption and hygiene has direct consequences for human health, both in relation to physiological needs and for controlling diverse infectious and non-infectious waterborne diseases. Water used for amenities (such as for watering lawns) may not directly affect human health, but water used for production (such as for raising animals, or for small-scale horticulture or construction) may be critical to sustaining livelihoods and, therefore, may have considerable indirect influence on human health. Water used for irrigation, such as for growing vegetables, demands significant amounts of water and was considered to be a separate category. In addition, the following vulnerable groups were defined

Infants up to 6 months of age were considered to be at risk for methaemoglobinemia (or "blue baby syndrome"), for which the most common environmental cause is high levels of nitrates in drinking water. Other groups potentially susceptible to this condition include pregnant women and people deficient in glucose-6-phosphate dehydrogenase or methaemoglobin reductase (27).

Children between 6 months and 5 years of age have an increased risk of morbidity and mortality from diarrhoeal diseases, generally resulting from the consumption of contaminated food and water.

Pregnant women or lactating women may have an increased risk of, and severity of, illnesses, such as hepatitis E, from specific waterborne pathogens due to immune alterations that occur with advancing pregnancy (28,29). In addition, contaminants such as pesticides can cross the placenta from the mother to the fetus, harming fetal development.

Elderly people are predisposed to a greater frequency and severity of infections than the general population due to factors such as the presence of multiple underlying medical conditions, a weakened immune system, malnutrition, age-related changes in the gastrointestinal tract, the concurrent use of different medicines, delays in diagnosis, or a delayed or diminished response to therapy, or some combination of these (30).

Specific advice was developed for vulnerable groups, including not to drink piped water even after boiling ( Table 3 ). We also recommended that infants should be exclusively breastfed. If infants are fed formula, bottled water may be used for the formula. However, due to a lack of evidence that bottled water is microbiologically safe, the water needs to be boiled before use.

## Discussion

The water-use recommendations that we developed are inherently limited, as it is unacceptable to recommend that people consume water that is of substandard quality according to WHO's guidelines on drinking water (25). It is essential that long-term solutions are identified to ease the worsening water crisis. However, in the interim, groups at high risk from drinking contaminated water can be targeted to ensure that their exposure to the most harmful contaminants is avoided. The implementation of these recommendations may require information campaigns that assist the population in differentiating water from different sources for different uses.

Several measures can be implemented to improve water quality in the short term. Currently, chlorine is not added during transport to the desalinated water distributed by water tankers, so its use should be encouraged to ensure that safe water is delivered to customers. If desalinated water cannot be treated and safely stored, it should be boiled before consumption. Making improvements to water-quality monitoring in the Gaza Strip is also encouraged, including screening for heavy metals, radioactivity and pesticides every 5 years; screening for chemical

parameters 4 times each year; and screening for microbial parameters every month. Targeted studies are needed to investigate the burden of disease associated with water consumed from different sources and districts in the Gaza Strip, including estimating the long-term effects of consuming substandard water.

## Acknowledgments

The authors thank the Palestinian Ministry of Health, the Palestinian Water Authority, and the Coastal Municipalities Water Utility for their contributions.

**Funding:** This work was supported by project funding from the Norwegian Ministry of Foreign. Affairs, Norway.

**Competing** interests: None declared.

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