Urban environmental challenges in developing countries—A stakeholder perspective

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Abstract

Developing countries face significant urban environmental challenges due to rapid urbanization, population growth, inability to effectively tackle climate and environmental risks, inefficient governance and environmental management, the prevalence of corruption and a chronic shortage of investment. Environmental degradation is often acute in politically unstable countries such as Iraq. Several post-war urban development and regeneration projects are currently underway in Iraq, but without evident participation from the wider public in decision-making. This study investigated stakeholders' perception of urban environmental challenges—their level of importance and priority in the Iraqi context. A nationwide survey (n=643) was conducted using a 25-item structured questionnaire where respondents' views were gathered on a 5-point Likert-type scale, in addition to demographic information. Principal component analysis (PCA) and statistical tests were applied to investigate the relationship between the perceptions of urban environmental challenges and demographic factors. Five principal components were identified, namely: water, waste, and materials; environmental impact; natural hazard; personal mobility; and transport. The results showed that about 70% of the respondents considered 'water conservation' as the most important urban environmental challenge, followed by 'increase choice of transport modes'. 67.2% of the respondents rated 'efficient infrastructure and utilities' as a very important factor, and was ranked the third. All demographic characteristics except location showed statistically significant differences in perception. The relatively high importance placed by the respondents on infrastructure related items such as water, transport and utilities demonstrate a possible link between the perceptions and: (a) the citizens' day to day experience and hardship, and (b) the lack of adequate infrastructure and service provisions in Iraq, due to political instability in the recent decades.

Keywords: Urban sustainability, Urban environmental challenges, Public participation in development, Stakeholder perception

1 Introduction

Cities are engines of economic prosperity and social development (Mourshed et al. 2016). However, urban environmental challenges have become a pressing global issue due to the undesirable impacts on the environment caused by rapid urbanization (Komeily & Srinivasan, 2015), the use of non-renewable resources, and pollution (Ameen et al., 2015). Cities are growing, both in terms of both population and geographical spread, and have become the key determinant of environmental quality at local, regional and global scales. According to the United Nations Department of Economic and Social Affairs, in 2010, the global urban population had reached 3.5 billion, which is predicted to double by 2050 (UNDESA, 2010). Urban development factors such as land use changes, energy consumption and associated greenhouse gas emissions, water consumption and availability, waste generation and recycling, pollution, sanitation, and infrastructure are likely to become more challenging (Clarke & Ramalingam, 2012). In addition, local and global factors such as natural disasters, wars, corruption, and economic downturn can exacerbate the situation (Smith, 2013).

Cities in developing countries have been affected by unprecedented population growth and rapid urbanization (Wei & Ye, 2014), and most have transformed into a source of negative environmental impacts and a driver for the rapid depletion of natural resources. The scale of the challenge is such that some authors have gone as far as to label these factors uncontrollable and unpredictable, now and in the future (Rana, 2010). Furthermore, past research on urban development focused mostly on meeting the demands of policy-makers and planners without adequately addressing stakeholders' perceptions and their aspirations. Identifying urban environmental challenges is, therefore, important, especially from a stakeholder perspective, so that effective and widely-acceptable solutions and policies can be developed based on local priorities, which are often different from the global ones (Ameen et al., 2016).

The aspiration to create a globally applicable understanding of urban challenges can be seen in the development of urban sustainability assessment methods such as CASBEE-UD[1], LEED-ND[2], and BREEAM[3] Communities. Despite their adoption in many countries, global sustainability assessment tools have been found to be limited in the developing context (Ameen et al., 2015), which is characterised by different socio-economic trajectories than those found in the developed countries. Moreover, the existing sustainability assessment tools primarily focus on minimising resource consumption (e.g. energy, water, and materials) and often disregard the overarching sustainability goals such as healthy environment, and social cohesion and capital. The understanding of the country-specific contexts is, therefore, essential for achieving sustainable urban development (Kadhim et al. 2016) and should begin with the identification of the local urban challenges and their

[1] CASBEE (Comprehensive Assessment System for Built Environment Efficiency). http://ibec.or.jp
[2] LEED-ND (Leadership in Energy and Environment Design—Neighborhood Development). http://gbci.org
[3] BREEAM (Building Research Establishment Environmental Assessment Method). http://breeam.com

deviations from the global, especially in the high-density cities in developing countries that face significant environmental challenges of varying magnitude.

Realising the gap in the literature, this research investigated stakeholders' views on urban environmental challenges in Iraqi cities with a view to identify their importance and priorities for implementation.

The rest of the paper is organised as follows. Urban environmental challenges in Iraq and other similar developing countries are reviewed next; the outcome is a list of key environmental indicators on which the respondents' views are gathered. The development of the questionnaire is illustrated along with the discussion on analysis methods, followed by the interpretation of the results. The paper ends with concluding remarks on the environmental priorities for urban sustainable development in Iraq.

2 Review of urban environmental challenges

Iraq represents a unique context where cities have suffered from the destruction and degradation due to political instability for more than four decades—resulting in severe damages to infrastructure (MOE, 2013). Rebuilding and rehabilitation while establishing new urban regions and cities are the topmost priority for development stakeholders. There is also a societal aspiration for an improved standard of living because of the new oil boom and economic prosperity. The Iraq National Development Plan (2013-2017) has identified key urban environmental challenges that need to be addressed as a priority: air, water, and soil pollution; shortage of water resources; desertification; lack of waste recycling and reuse; untreated contaminated areas; and inefficient infrastructure (CSO, 2013). The significant environmental impacts in Iraq in the past four decades are summarised in Table 1, and the key challenges are discussed, as follows.

<Insert Table 1 about here>

2.1 Environment

Vegetation cover has a significant effect on weather and climate variability. Increasing vegetation cover is considered an effective solution to stabilise dune areas and mitigate the impact of frequent sandstorms (Brovkin, 2002). There has been a decrease in vegetation cover in the central and southern of Iraq during 2000-2012 (Abbas et al., 2014). The successive wars in Iraq led to significant chemical pollution, exposing civilians to hazardous materials. **Tackling environmental pollution** is, therefore, the key to ensuring a sustainable future for Iraq. Despite being responsible for only 0.5% of global GHG emissions, Iraq plans to reduce its emissions to tackle global climate change (IG, 2015). Cities being the engine of economic prosperity and growth are the primary geographies that can help **reduce GHG emissions** and mitigate the impact of climate change.

2.2 Energy, utilities and infrastructure

Efficient infrastructure and utilities are essential to enable support and enhance a community's living conditions (Fulmer, 2009). Infrastructures in Iraqi cities have suffered severe damages because of the wars and the international sanctions, leading to the postponement of new and the upgrading of ageing infrastructure such as water distribution systems, sewage, roads, electricity generation plants and energy distribution systems (Foote et al., 2004). Secure, flexible, and economic production and distribution of energy while increasing the share of renewables and reducing the demand are essential for an environmentally resilient society (SWECO, 2015). **Smarter power systems** and the grid require significant investments and effective policies (Widergren et al., 2011). Increasing the share of renewable energy results in a cleaner and healthier environment, with improved local air quality and reduced GHG emissions (Siegel et al., 2010). Iraq has significant potential for renewable energy resources such as solar and wind. **Diversification of energy mix** is, therefore, an essential component for the future development of Iraqi energy infrastructure to meet the growing demand for energy. **Minimising energy consumption** is the cornerstone of policies for energy security and climate impact mitigation (Omer, 2008). Energy conservation reduces the need for costly investments in energy infrastructure and delays investments needed for network upgrades.

2.3 Natural hazards

Iraq suffers from many natural hazards common to arid climates. **Desertification**—the transformation of fertile land into desert, is caused by the loss of green cover; drought and hardening of soil; increased salinity rates; and the extension of sand dunes (Geist, 2005). Desertification threatens food security and affects social and economic development (Reynolds et al., 2007). 39% of the Iraq's surface has been affected by desertification, and 54% is under threat (CSO, 2010). **Sandstorms** affect large areas and cause environmental pollution, economic losses and health problems (Liu & Diamond, 2005). Iraq is one of the countries most affected by sandstorms due to regional climatic changes such as decreasing annual rainfall, and environmental changes such as drying marshlands, and degrading land (Sissakian et al., 2013). **Drought**, also, causes direct environmental damage to plants and forests; animal species; air and water quality (Ole-MoiYoi, 2013). Many of agricultural areas in southern Iraq are vulnerable to frequent drought. (Shean, 2008).

2.4 Mobility and transportation

Modal choice of transport is essential for sustainability. The utilization of alternative transportation modes can help address traffic congestion, and minimise undesirable impacts on the environment, especially in areas of high population density. Iraq lags other countries in the provision of public and alternative transportation modes such as trains, subways, and buses (Al-Akkam, 2012). As a sustainable transport mode, **Cycling** can reduce the use of fossil fuel and associated GHG emissions,

as well as help tackle the risks of sedentary lifestyle and obesity (Ege & Krag, 2010). Increasing bicycle trips can reduce congestion on roads and improve the urban environment. Another sustainable mode of travel, **walking**, is healthier, the promotion of which enhances liveability in cities (Evans & Jones, 2011). The **increased use of public transportation**, especially mass transit systems such as rail, subway, and bus rapid transport (BRT) reduces overall energy consumption and associated emissions (Hodges, 2009). Private cars are the primary means of passenger transport in Iraq due to the underdeveloped public transport infrastructure (UNEP, 2015). **Reducing the number of vehicles** on roads is critical to alleviate traffic congestion, and associated urban environmental impacts. Car use reduction requires effective planning for urban transport, against the fivefold increase in the number of cars in Iraq between 2001 and 2012 (CSO, 2014).

2.5 Water

Water is one of the most important natural resources in the Middle East, and is vital for sustaining life, industry, and economy (Waylen et al., 2011). Tigris and Euphrates represent 98% of Iraq's surface water, and are the primary source of drinking, irrigation, and industrial water use (CSO, 2013). The availability of water in the two rivers is likely to decrease by between 50 and 80% by 2025 (CSO, 2013), which necessitates the search for **alternative water sources** such as artesian wells, groundwater, springs, lakes, and marshes. **Urban rainwater harvesting** has received renewed interests as an alternative to conventional water supply, despite the scarcity of precipitation across the Middle East (Lange et al., 2012). **Greywater** can be used on-site for landscape irrigation, toilet flushing and constructed wetlands (OECD, 2009), thereby reducing the demand for treated water from utilities.

Moreover, by mid-century, as populations grow, demand rises, and climate changes, per capita water availability is projected to decrease by half (Michel et al., 2012). Therefore, along with the diversification of water sources, strategies for **water conservation** need to be prioritised. On the other hand, water recycling is regarded as a sustainable option to tackle the increasing mismatch between available water resources and the rising demand for water (OECD, 2009). Finally, **water consumption needs to be minimised** as only 91% of the population has access to drinking water in 2012, with significant differences in consumption between rural and urban areas (Allan 2001).

2.6 Waste and materials

As one of the most underdeveloped sectors, "waste and materials" need to mainstream recycling and move away from harmful waste processing techniques such as landfill and incineration (Knowles, 2009). **Waste recycling** and **reuse of materials** saves energy and reduces the need for raw materials and natural resources—thereby mitigating the impact of climate change (Thormark, 2006). Moreover, the **separation of waste** at source leads to increased recycling (FoEEUROPE. 2013). On

the other hand, **wastewater treatment** and poor effluent quality from municipal wastewater treatment plants are a fundamental problem in developing countries, and the cause of pollution of water in lakes and rivers (ECO, 2003). 6.2% of the Iraqi population does not have access to basic sanitation facilities, resulting in an increased risk of disease outbreaks, particularly among the vulnerable groups such as children and women (UN, 2013).

3 Methodology

A nationwide 25-item questionnaire was conducted for investigating stakeholders' perception of urban environmental challenges in Iraq. The questionnaire was selected as the main method as it enables the capture of a large number of people's opinions in an efficient and coherent way. It has been successfully used in several previous studies on public perception in diverse topics. Balram & Dragićević (2005) used self-administered mail-back questionnaire to investigate attitudes to urban green spaces in Montreal, Canada. Hamilton-Maclaren et al. (2013) and Aldossary et al. (2015) used online questionnaire to explore public opinions on alternative lower carbon wall construction techniques in the UK and cultural barriers to the delivery of low energy homes in Saudi Arabia respectively.

3.1 Questionnaire development

The questionnaire was developed in five stages:

First, an initial list of urban environmental indicators was identified based on an extensive review of the literature on urban environmental and sustainable development challenges, as discussed in Section 2. Attention was paid to the relevance of the identified indicators to the cities and regions of Iraq and the Middle East.

Second, one of the authors visited four Iraqi governorates from the central and southern regions, Baghdad, Babel, Karbala, and Al-Najaf, between November and December 2014. Stakeholders from the public, professional, and governmental groups were contacted by telephone, through social media, and via internal communications within relevant government departments, and municipalities. Interviews were held with willing stakeholders to explore their opinions on the identified indicators, as well as other relevant local urban environmental challenges. In the light of these face-to-face interactions, the list of indicators was updated and their definitions were refined to enhance clarity—resulting in a final list comprising 25 items.

Third, a draft online questionnaire was developed based on the two preceding stages. The survey was first produced in English and then translated into Arabic to enable wider participation from the public, who may not be well-versed in English. Two professional translators reviewed the draft to check for accuracy and clarity of the content. The questionnaire draft was assessed in a pilot survey to analyse the comprehensibility and clarity of the items linked to the psychometric features of the

instrument. The pilot study participants (n=16) included city planners, urban designers, academics, architects, civil engineers, and the members of the public. They were asked to comment on content deficiencies (if any), the length of the questionnaire, the level of understanding of the components, other potential perceptions, and the importance of the items. The pilot study results were used to amend the final questionnaire, improving content validity.

Fourth, the final questionnaire was distributed via online, which is faster than a manual survey, as well as being less costly (Huang, 2006; Weible & Wallace, 1998). The survey was conducted between December 2014 and April 2015 via Survey Monkey (SurveyMonkey, 2016) that facilitates the widespread distribution of questionnaires and enables the authors to control and monitor the responses and to gain a preliminary analysis of the results in a short time (Baker et al., 2010).

Fifth, face-to-face interviews were conducted with the two age groups, i.e. 55-60 years and 61 years and above, that have the lowest internet usage rate. One of the researchers went through the questions from the questionnaire during the interviews and recorded the responses on the SurveyMonkey web tool via an internet- enabled Tablet.

In both the fourth and fifth stages, participants were asked to rate their perceptions of the questionnaire items on a 5-point Likert-type scale, ranging from 1 to 5, where 1= unimportant; 2= of little importance; 3= moderately important; 4= important; and 5= very important. The questionnaire also contained open-ended questions to enable respondents to provide comments on included items, or other significant factors they thought were important. Demographic information such as age, gender, occupation, academic qualification, governorate (i.e. region) and the location (i.e. urban, suburban or rural) was included.

3.2 Survey respondents

The study was conducted for both genders with different social backgrounds, occupations, and qualifications. All three Iraqi regions were included in this research—the northern, central, and southern, comprising all 18 governorates. The only participation requirement was that the respondents should be over the age of 18. Respondents were informed in writing that taking part in the survey was voluntary and that the data would be kept confidential.

3.3 Sampling and data collection

A snowball sampling technique (Dragan & Maniu, 2013) was used in this study to cover large-scale distribution of the survey across all cities/regions of Iraq. Snowball sampling widens the reach of a questionnaire to include many hitherto unknown participants, as reported in the previous work by Hamilton-Maclaren et al. (2013). After issuing the survey, the link was sent to a group of potential respondents across Iraq by email, text messages, and messaging on social networks. The same

process was repeated several times during the survey period until the required number of stratified samples was collected.

3.4 Data analysis

IBM SPSS Statistics for Windows, version 20.0 (Leech et al., 2015) was used for statistical data analysis. Descriptive statistics on the indicators and scale frequencies, response percentages, means, modes and standard deviations (SD) were computed. The demographic data were also analysed descriptively by computing frequencies and percentages. Internal consistency reliability was assessed via Cronbach's alpha (α) coefficient (Cronbach, 1951) that provided a single estimate of internal consistency or average correlation of questionnaire items to measure the reliability (Webb et al., 2006). Several social studies suggested $\alpha = 0.70$ as the threshold of acceptable reliability (Tavakol & Dennick, 2011).

Principal Component Analysis (PCA) was carried out on all 25 indicators to determine the underlying structure, by characterizing a group of correlated variables. The importance of a component was evaluated by testing scree plots and the contribution of each component to total variance (>5%). Variance Maximization (varimax) as an orthogonal rotational strategy was applied using the results of the PCA. Rotation reduces the number of factors on which the variables under investigation have high loadings and makes the interpretation of the analysis easier (Mourshed & Zhao, 2012). Factor loading greater than 0.40 was the criterion for including an item. Bartlett's test of sphericity was used to identify significant correlations between items. Sampling adequacy was assessed with Kaiser-Meyer-Olkin (KMO) measure, which was 0.918 for this study. KMO greater than 0.8 can be considered good and indicates that PCA is useful for these variables (Cerny & Kaiser, 1977).

4 Results and findings

4.1 The respondents' characteristics

A total of 643 responses were received, of which 411 answered all survey questions. The remaining analysis is on 411 valid responses. Table 2 summarises demographic characteristics of the respondents, which are described below.

- **Gender**: About two-thirds (68.4%) of the respondents were male, and the rest were female.
- **Age**: 19.2% were aged between 25 and 30 years, representing the highest rate of participation, followed by 15.8% for 41–45 years. The >61 age group had the lowest participation, at 4.4%.

- **Occupation**: 53% of the respondents were government employees, primarily because they represent 20% of the workforce (Alwardi, 2015). The unemployed, students and homemakers, represented the second largest group of respondents (16.5%).
- **Qualification**: 49.1% of the respondents had an undergraduate degree as their highest qualification, followed by 32.8% with a post-graduate degree. 18% had either studied up to secondary school or had no formal qualification.
- **Geographical coverage**: the highest participation was from the southern region (65.9%), followed by the central (32.4%) and northern (1.7%) regions.
- **Location**: most of the respondents lived in urban (83%) areas, followed by suburban (13.9%) and rural (3.2%) areas.

<Insert Table 2 about here>

A descriptive analysis of the environmental factors is given in Table 3, representing the percentage of responses for each option on the 5-point scale. Mean, mode and standard deviation (SD) of responses are computed for each item.

<Insert Table 3 about here>

4.2 Principal component analysis (PCA)

PCA results, the factor loadings after rotation, eigenvalues, and percentages are presented in Table 4. All questionnaire items had a substantial factor loading in the range 0.4–0.8. Five summated indices were extracted from the 25 items: environmental impacts; water, waste and materials; natural hazard; personal mobility; and transport. Initial analysis was run for each component to obtain eigenvalue over Kaiser's criterion, which is greater than 1.0. The eigenvalues of the five factors ranged from 1.044 to 9.549. Bartlett's test of sphericity as a factor solution showed a significant correlation among questionnaire items (p<0.000), suggesting that all selected variables were related to each other and were suitable for further analysis. The KMO (0.918) measure verified the sampling adequacy, indicating that the questionnaire variables were appropriate for factor analysis and can be considered high (Zhao & Mourshed, 2012). The total variance extracted was 63.72%. The first component, 'environmental impact', was clustered by ten items, and represented the largest percentage of explained variance (38.19%). While the fourth and fifth components had only two items, accounting for 5.4% and 4.17% of the variance respectively.

<Insert Table 4 about here>

None of the 25 items had dual loading, which is an indicator for questionnaire clarity. Given the large sample size, the convergence of the scree plot and Kaiser's criterion results, five components have been retained for final analysis. Reliability estimates (Cronbach's alpha) for all generated

components were greater than 0.60 (Table 4), indicating a robust internal reliability between the questionnaire items with similar attributes (Cerny & Kaiser, 1977). Overall Cronbach's alpha was 0.925 indicating a very high level of reliability (Ahmad & Ahlan, 2015).

4.3 Relationship between personal information and the perception of environmental challenge indicators

Participants were regrouped, and the variables were re-categorised to summarise data analysis and interpretation. Data distribution was not normal. Non-parametric tests, were, therefore, carried out on all survey items by following a non-normal distribution. Mann-Whitney *U*-test was carried out on 'gender' while Kruskal-Wallis test was carried out on 'occupation', 'qualification', 'region' and 'location'. All demographic characteristics except location showed statistically significant differences in perception, as shown in Table 5.

Gender has a significant effect on perception about *minimise energy consumption*, while age group has a significant effect on perception about *increasing vegetation cover*, *minimise GHG emissions* and *increase choice of transport modes*. Occupation has a significant effect on perception about *water, waste and materials* and the *use of recycled/greywater*, *water recycling waste separation and recycling* items. Region has a significant effect on perception about the items: *water*, *waste, and materials* and *promote the use of alternative sources of water*, *use of recycled/grey water* and the need for *sewage treatment*. Finally, qualification has a significant effect on perception about the component, *increase waste recycling*.

<Insert Table 5 about here>

5 Discussion

Stakeholders are key in achieving urban sustainability. Their perceptions are a result of their experiences of daily living and places of work and study, as well as their observation of existing urban challenges. The 25 investigated items were ranked based on the mean scores ranging between 3.40 and 4.56, from the lowest to the highest, on a Likert-type scale of 1–5, as shown in Table 4.

Overall, about 70% of the respondents considered *water conservation* the most significant urban environmental challenge for Iraqi cities. The item has been granted a highest mean score ($\bar{x}$=4.56) and the lowest SD (σ=0.759), followed by *increase choice of transport modes*. The indicator *efficient infrastructure and utilities* was ranked third, followed by *increase vegetation cover* and *promote the use of public transport* respectively. While, the respondents considered *promote the use of the bicycle* the least important item of the investigated aspects, with the lowest mean score ($\bar{x}$=3.40) and the highest SD (σ=1.267), preceded by *rainwater harvesting*.

The results suggest that the Iraqi stakeholders are more concerned about wider environmental aspects such as water, transport modes, infrastructure, vegetation cover, and energy management.

The respondents' views broadly coincide with prior findings of environmental challenges that were initially identified through the comprehensive literature review. Twenty of the investigated 25 indicators had mean scores greater than 4 (=important), while only five had mean scores greater than 3 (=moderately important).

The results of the principal component analysis highlighted five structured components, with high internal consistency, even though some factors contained only two items. The discussion of environmental challenges in the following sub-sections will, therefore, be grouped around PCA components, and according to their importance and priority, as shown in Table 5.

5.1 Environmental impact

Environmental impact is the largest PCA component, comprising ten items with a mean score greater than 4.00—indicating high importance for all constituent items. *Efficient infrastructure and utilities* is the most important item in the group. Infrastructures in Iraqi cities have suffered severe damages due to the political instability (Foote et al., 2004). Despite significant investments most reconstruction efforts in Iraq have largely been unsuccessful because of the lack of security, corruption, and coordination between local Iraqi officials and the specialised global actors (GAO, 2005).

Increase vegetation cover is the second most important item. The global trend of decreasing vegetation cover significantly affects weather and climate variability, and influences the amount of water vapour and CO_2 in the air (Bonan et al, 1992). Vegetation also helps in stabilising dune areas and mitigating the impact of sandstorms (Brovkin, 2002). There has been a decrease in vegetation cover in central and southern Iraq, where the number of palm trees decreased from 30 million to about 10 million between 2000 and 2012 (WHO, 2015). Hence, vegetation cover has a crucial role in urban physical and socio-ecological sustainability in Iraq (Abbas et al., 2014).

Effective and smart management of energy resources is the third most important item. Smart energy management is aimed at flexible and economic production and distribution of energy while increasing the share of renewables. Smart electricity grid can enable Iraq to leapfrog in implementing innovative, and flexible services at the local level. The challenge is to adapt the existing institutions and infrastructure for market transformations, while enhancing energy efficiency in a cost-optimal way (SWECO, 2015). Smart management of electricity generation and distribution can meet environmental sustainability and energy-efficiency policy goals, but at the same time, it requires a significant investment and effective policies (Widergren et al., 2011).

Reduce environmental pollution came fourth. Pollution increases with population and economic growth, and increased resource consumption, transportation, and industrial production (Yang et al., 2005). Pollution has large and detrimental effects in developing countries, which is yet to be

sufficiently addressed. Evidence demonstrates that environmental risk factors regularly play a role in more than 80% of diseases (YCELP, 2008). Four decades of war in Iraq led to significant chemical pollution, exposing civilians to hazardous materials. Furthermore, the dependence on fossil fuels for economic activities increased by more than 92% in Iraq (UNEP, 2015). Some Iraqi regions suffer from depleted uranium pollution because of the Gulf War and military operations of 1991 and 2003—impacting on public health and increasing the incidence of cancers and birth defects (Fathi *et al.*, 2013). Reducing environmental pollution, therefore, will lead to improving environmental health, and it should be the top policy priority.

The item *maximise the use of renewable energy* is the fifth most important item in the environmental impact group. Nowadays, energy is considered as the lifeblood of a country, requiring effective and efficient management of energy resources (Kharaka & Dorsey, 2005). In addition to reducing dependency on fossil fuel, increasing the share of renewable energy results in a cleaner and healthier environment, with improved local air quality and reduced GHG emissions (Siegel et al., 2010). Despite being a major hydrocarbon producer and exporter in the world, Iraq has significant potential for renewable energy resources such as solar and wind. Diversification of energy mix is essential for energy sector resilience in Iraq.

The remaining items in the environmental impact component have also been identified in previous studies as global urban challenges: *minimise water consumption*, *reduce vehicles on road*, *minimise GHG emissions*, *reduce energy consumption*, *minimise water consumption*, *minimise energy consumption*, and *increase waste recycling* (Omer, 2008; Siegel et al., 2010). These global challenges need to be addressed through collective actions. Moreover, global responses are critical for enhancing local capacity, increasing public awareness, and providing solutions for nations with regional commonalities. Responses at national and international levels interact to tackle the urban challenges and can generate a gradual, structural, and transformational modifications in the management of environmental issues in the future (Ameen et al., 2014).

5.2 Water, waste and materials

The second PCA component has eight items related to resource efficiency. Mean scores ranged between 3.72 and 4.56—highlighting the variations in the importance of various indicators in the component. *Water conservation* came in first. It was also considered the most important indicator of the questionnaire items. The Arab world is considered the most water-scarce region in the world. By mid-century, as populations grow, demand rises, and climate changes, per capita water availability is projected to decrease by half (Michel et al., 2012). The water in the main Iraqi rivers, Tigris and Euphrates, is projected to decrease by between 50 and 80% by 2025, which are controlled by neighbouring countries that contain the main headwaters (CSO, 2013). A government report showed that Iraq's per capita share of water decreased by 35.2% in 2014 compared with 2012 (CSO

2015). Drinking water supplied to Iraqi cities is likely to be insufficient, and can cause humanitarian crises (UNESCO, 2010).

Sewage treatment came in second. It is regarded as a fundamental problem for developing countries, including Iraq, where poor effluent quality from municipal wastewater treatment plants cause pollution in lakes and rivers (ECO, 2003). Political instabilities in Iraq have resulted in the destruction of vital infrastructures, including sewage plants. 6.2% of the Iraqi population do not have access to basic sanitation facilities. They live with an increased risk of disease outbreaks, particularly affecting the vulnerable groups such as children and women (UN, 2013). Effective solutions to wastewater treatment in the existing and future urban development projects are, therefore, essential for Iraq.

Waste separation and recycling came in third. Recycling waste assists in reducing air and water pollution by decreasing the need for waste disposal and bringing about lower GHG emissions. Many studies have found that separating and recycling waste is a preferable solution for the environment rather than incineration or landfilling (FoEEUROPE. 2013). Ezeah et al. (2013) suggested that only 30% of the waste generated in cities in developing countries is collected and separated. Waste and resource management services in Iraqi cities have seen years of deterioration. Traditional solid waste treatments are still prevalent, despite the negative impacts on the environment (Knowles, 2009).

Water reuse and recycling is regarded as a sustainable option to tackle the increasing mismatch between availability and the rising demand for water (OECD, 2009). With the gradual decrease in water availability in the Arab region in general, and especially in Iraq, water recycling will play a fundamental role in the coming decades.

The rest of the component's factors have been ranked with mean scores less than 4.00. They ranged from 3.9 to 3.72 for *reuse of materials*, *use of greywater*, *promote the use of alternative sources of water*, and *rainwater harvesting*—indicating moderate importance to respondents. For instance, *rainwater harvesting* is 'moderately important' to the public, probably due to the perception that water is scarce in Iraq but the amount of annual rainfall is too little[4] for them to consider it to be more important.

5.3 Natural hazards

The third group relates to natural hazards. With the highest mean score of 4.29 in the group, the top ranked item is *desertification* of land that threatens food security and affects socio-economic development. 75% of Iraq's total arable (Saidi & Al-Jumaiali, 2013) and 61% of agricultural land are affected by desertification (Abbas et al., 2014). The second item in the group is *sandstorms*, which is considered an extremely violent and unpredictable phenomenon. Increased occurrences of

[4] The average annual rainfall in Iraq is less than 100 mm over 60% of the country especially in the central and southern regions with a high rate of evaporation (Al-Ansari, 2013).

sandstorms result in regional climatic changes such as decreasing annual rainfall, and environmental changes such as drier marshlands, land degradation and desertification (Sissakian et al., 2013). *Droughts* is the third most important item in the group. Much of the agricultural areas in southern Iraq are vulnerable to frequent droughts. One of the worst droughts occurred in 2007, due to a lack of water supply to farmlands through the Tigris and Euphrates rivers, affecting agricultural crop production (Shean, 2008). It should be noted that natural hazards such as earthquakes and volcanic eruptions are rare or non-existent in Iraq.

5.4 Personal mobility

The fourth component has two items: *walking as a means of mobility* and *promote and provide the use of the bicycle*. They have been ranked as moderately important by the respondents. Walking is considered the most efficient means of mobility in many Iraqi regions, especially in the capital. Driving cars in Baghdad is difficult because of the negative impacts of extensive security measures involving numerous security checkpoints, the sudden shutdown of arterial roads, and the lack of adequate car parking. These factors affected traffic movement, and resulted in the reduced use of private cars, and indirectly promoted walking, cycling, and the use of motorcycles—especially for short trips (Sarsam, 2013). However, excessive heat in summer, dusty air and the lack of shaded walkways discourage people to walk or use the bicycle. Moreover, respondents aged forty and over mentioned during face-to-face interviews that they rarely used bicycles because of the prevalent class-oriented social stigma associated with adult men riding bicycles.

5.5 Transport

The final component, transportation, comprises two items. *Increased choice of transport modes* was ranked as the first and second most important item among the transport group and all indicators respectively. Diversity in transportation modes is a challenge for Iraqi cities as they lack adequate alternative means of public transport such as trains, buses, and subways, as well as a clear lack of marine transport systems (Al-Akkam, 2012). The indicator has not received enough attention in previous literature as one of the urgent public needs for Iraqi cities. *Promoting the use of public transport* comes second of this component, and it was regarded as the fifth most important environmental indicator with a mean score of 4.36. In Iraq, public transportation systems are not yet fully developed. Thus, private cars are the dominant type of road transport (UNEP, 2015). The respondents in our study collectively emphasized on increasing diversity in transportation modes and the use of public transport—both in the questionnaire and during face-to-face interviews.

It is important to mention that face-to-face interviews revealed some rather extreme perceptions, e.g. the unwillingness to reduce energy consumption to compensate for the electricity shortage. In addition, some considered that water recycling and the use of grey water is inconsistent with the social and religious norms relating to recycled water being unclean and thus these measures cannot

be implemented. Hence, there is a need for educational campaigns to increase public awareness of the environmental challenges that may have an association with social and religious beliefs and practices.

6 Limitations of the study

The questionnaire was conducted in all Iraqi governorates. Therefore, the responses are inherently a national snapshot of stakeholder perception of urban environmental challenges and their relative importance in Iraq. Hence, the differences in perception between respondents were due to the disparities in age, educational attainment, occupation, and the extent of the participants' appreciation of the indicators. The main challenge that the survey faced was its dependence on participants using a computer to access the internet to answer the questions, as, among its regional counterparts, Iraq has the lowest rate of internet usage (Heshmati *et al.*, 2014) and, in general, the internet services provided to Iraqi citizens can be considered inefficient. Internet usage among the educated people in Iraq is 86.4%. Therefore, the questionnaire concentrated on them, with the provision of a mobile team to solicit the opinions of non-educated people, particularly in rural areas, or people who do not have access to internet facilities. Another limitation was the difficulty in obtaining views from the older population; i.e. those aged 55 years and above. Together with the category of respondents without any qualifications, they are unlikely to have access to the internet on a regular basis, compared to the younger population, who access the internet at their places of work and study. Chronic electricity outages across Iraq and the lack of access to electricity in rural areas further exacerbated the challenges in reaching the rather marginalised sections of society. However, the face-to-face interviews ameliorated some of these problems and helped in reaching a wider distribution in urban, suburban and rural Iraq.

7 Conclusion

There is now a widespread agreement that environmental issues are very important to all communities, at the present and in the future. It is an essential and ongoing task to involve stakeholders in identifying urban environmental challenges for informed decision making and effective implementation of adopted policies. This study, first, identified the relevant environmental challenges and, then, provided a comprehensive snapshot of public opinion on their importance and priorities in the Iraqi context. Respondents' perception of the identified urban environmental challenges resulted from their day-to-day interactions with the immediate environments, as well as their aspirations for the future. Most of these Iraqi challenges have resulted from the political instability in the country for more than four decades. This study concludes with the following key recommendations for the decision-makers, practitioners and researchers in urban development.

- Water scarcity has been identified as the most pressing challenge in Iraq. The situation is exacerbated further by less than acceptable water quality and the prevalence of high levels of contaminations. Water recycling and promoting the use of available alternative sources of water are, therefore, viewed as priorities in both the existing and new urban development projects.
- Attention must be paid to reduce undesirable environment impacts by increasing vegetation cover, promoting infrastructure projects, and adopting sustainable and diverse transportation—all have been found in this research to be very important to stakeholders.
- Increasing the share of renewable energy and smart management of energy infrastructure can meet future environmental sustainability and energy-efficiency policy goals while mitigating the present-day acute electricity shortage.
- Urban waste recycling must be prioritised to convert different types of waste into useful products while preventing their accumulation. Waste recycling reduces the consumption of raw materials and energy.
- Walking and cycling as a means of mobility need to be encouraged through the design and implementation of walkable neighbourhoods and cycle routes. Social stigmas associated with cycling need to be addressed through awareness campaigns.

A good response rate and the nationwide representation suggest that the findings of this study are appropriate for consideration in the development of future policies and guidelines at the urban scale.

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Tables and figures

Table 1: Significant environmental impacts in Iraq in the past four decades. Adapted from Matar (2010) and WHO (2015)

Environmental impact	Major effects
Air pollution	• Toxic smoke produced by oil fires. • Toxic gases are resulting from the use of weapons and explosives. • The concentration of environmental pollutants increased eleven times since 1990.
Degradation of agricultural land	• 70% of agricultural land exposed to pollution and destruction. • The decrease of 26,000 acres of arable land due to increased salinity.
Vegetation damage	• Decreasing number of palm trees from 30 million to about 10 million. • The decrease of forest area from 1.8 to 1.5% due to desertification.
Lack of safe drinking water	• Reduction in production capacity of the water purification plants from 7 to 1.5 Mm^3/day. • 91% of households must buy bottled drinking water privately, due to concerns about the quality of water from public utilities • Drinking water shortages caused the death of one in eight Iraqi children under 5.
Destruction of infrastructure, and transportation networks	• Destruction of infrastructures such as power plants, roads, and bridges. • Destruction of 96% of power plants. • 57% of problems with infrastructure are related to the water supply networks. • 70% of school buildings suffer from war damage or neglect.
Contamination of lands with radioactive depleted uranium	• More than 380 sites were contaminated with radioactive depleted uranium.
Contamination of water sources	• 50% of sewage is discharged directly into main water resources. • Leaking sewage pipes and septic tanks contaminate the public drinking water network with wastewater.
Accumulation of waste	• Lack of separation and recycling of waste. • Waste is treated by landfilling or burning. • Frequent accumulation of waste in residential areas or at the rivers.
Contaminated areas by mines and bombs	• ~25 million landmines planted in Iraq. • ~1200 km of the Iraqi-Iranian border is contaminated by mines and bombs. • ~84,000 tons of bombs were dropped on more than 6500 km^2 southern Iraq.

Table 2: Respondent's demographic factors

Variable	Scale	Frequency	Total (%)
Gender	Male	281	68.4
	Female	130	31.6
Age group (yr)	18- 24	57	13.9
	25- 30	79	19.2
	31- 35	58	14.1
	36- 40	57	13.9
	41- 45	65	15.8
	46- 50	34	8.3
	51- 55	19	4.6
	56- 60	24	5.8
	>61	18	4.4
Occupation	Government employee	218	53.0
	Non-government employee	62	15.1
	Self-employed	63	15.3
	Other	68	16.5
Qualification	Post-graduate degree	135	32.8
	Undergraduate degree	202	49.1
	Up to secondary school	74	18.0
Region*	Central	133	32.4
	Southern	271	65.9
	Northern	7	1.7
Location	Urban	341	83.0
	Suburban	57	13.9
	Rural areas	13	3.2

Notes:
* Regions are defined as comprising the following governorates; i.e. administrative units:
• Central: Baghdad, Dayala, Al- Anbar, and Salah Al-deen.
• Southern: Babylon, Karbala, Al-najaf, Wasit, Al-quadisiya, Maysan, Al-muthanna, Thi-qur, and Basrah.
• Northern: Erbil, Sulaymaniya, Douhok, Kirkuk, and Nainawa.

Table 3: Descriptive analysis of the environmental factors

Environmental Items	Response* (%)					Mean	Mode	SD
	1	2	3	4	5			
Water conservation	1.0	1.7	5.6	22.9	68.9	4.56	5	.759
Increase choice of transport modes	2.4	1.7	5.8	26.8	63.4	4.46	5	.872
Efficient infrastructure and utilities	1.2	1.6	14.5	15.4	67.2	4.45	5	.886
Increase vegetation cover	1.6	2.0	16.2	11.7	68.4	4.43	5	.943
Promote the use of public transport	1.0	1.5	10.2	34.3	53.0	4.36	5	.802
Effective and smart management of energy resources	2.4	3.4	10.0	26.5	57.7	4.33	5	.959
Reduce environmental pollution	2.0	3.3	16.2	19.1	59.4	4.30	5	.990
Desertification of lands	1.9	3.9	12.9	24.8	56.7	4.29	5	.968
Sewage treatment	3.4	4.9	9.2	24.1	58.4	4.29	5	1.046
Waste separation and recycling	2.9	3.9	11.4	29.0	52.8	4.24	5	1.000
Sandstorms	1.5	3.9	15.3	29.0	50.4	4.22	5	.945
Maximise the use of renewable energy	3.4	6.8	14.6	21.7	53.5	4.15	5	1.113
Minimise water consumption	2.0	5.5	19.5	21.3	51.6	4.14	5	1.047
Reduce vehicles on road	2.0	4.7	19.5	25.8	48.0	4.12	5	1.016
Minimise GHG emissions	3.9	5.5	17.8	20.3	52.5	4.11	5	1.123
Drought	2.4	6.8	15.6	27.0	48.2	4.11	5	1.057
Minimise energy consumption	1.6	4.9	23.8	23.6	46.1	4.07	5	1.019
Water recycling	3.9	5.1	14.4	33.3	43.3	4.07	5	1.032
Increase waste recycling	3.9	4.3	19.5	27.0	45.3	4.05	5	1.062
Walking as a means mobility	3.9	7.8	20.0	25.8	42.6	3.95	5	1.134
Reuse of materials	3.2	6.6	21.2	35.3	33.8	3.90	4	1.035
Use of greywater	4.6	4.4	23.8	32.1	35.0	3.88	5	1.044
Promote the use of alternative sources of water	3.4	7.5	23.6	29.7	35.8	3.86	5	1.089
Rainwater harvesting	6.6	10.7	19.2	30.4	33.1	3.72	4	1.213
Promote the use of the bicycle	8.5	17.3	24.6	24.3	25.3	3.40	4	1.267

Notes:
*Response scales are as follows:
1. Unimportant; 2. Of little importance; 3. Moderately important; 4. Important; 5. Very important

Table 4: Rotated Component Matrix of the survey items

Items	Component				
	Environmental impact	**Water, waste & materials**	**Natural hazards**	**Personal mobility**	**Transport**
Reduce environmental pollution	.837	-	-	-	-
Increase vegetation cover	.826	-	-	-	-
Efficient infrastructure and utilities	.816	-	-	-	-
Minimise GHG emissions	.806	-	-	-	-
Minimise water consumption	.763	-	-	-	-
Reduce vehicles on road	.755	-	-	-	-
Minimise energy consumption	.744	-	-	-	-
Increase waste recycling	.719	-	-	-	-
Effective and smart management of energy resources	.506	-	-	-	-
Maximise the use of renewable energy	.458	-	-	-	-
Promote the use of alternative sources of water	-	.711	-	-	-
Use of recycled/ grey water	-	.705	-	-	-
Water recycling	-	.688	-	-	-
Reuse of materials	-	.669	-	-	-
Sewage treatment	-	.667	-	-	-
Waste separation and recycling	-	.633	-	-	-
Rainwater harvesting	-	.632	-	-	-
Water conservation	-	.497	-	-	-
Desertification of lands	-	-	.817	-	-
Drought	-	-	.762	-	-
Sandstorms	-	-	.678	--	-
Promote the use of the bicycle	-	-	-	.815	-
Walking as a mean of mobility	-	-	-	.803	-
Increase choice of transport modes	-	-	-	-	.659
Promote and provide for the use of public transport	-	-	-	-	.641
Cronbach's alpha coefficient (0.925)	.918	.866	.751	.706	.657
Eigenvalues	9.549	2.477	1.509	1.351	1.044
Percentage of explained variance (63.721)	38.194	9.910	6.036	5.404	4.177

Table 5: Results of non-parametric test

PCA	Questionnaire items	Mean	Non-parametric test (p- value*)					
			Gender†	Age group‡	Occupation‡	Qualification‡	Region‡	Location ‡
Minimise environmental impact	Efficient infrastructure and utilities	4.45	.427	.067	.877	.223	.581	.324
	Increase vegetation cover	4.43	.946	**.046***	.798	.117	.424	.430
	Effective and smart management of energy resources	4.33	.427	.067	.877	.223	.581	.324
	Reduce environmental pollution	4.30	.281	.153	.273	.085	.589	.882
	Maximise the use of renewable energy	4.15	.835	.295	.181	.249	.696	.477
	Minimise water consumption	4.14	.057	.095	.864	.160	.784	.346
	Reduce vehicles on road	4.12	.121	.110	.935	.055	.556	.898
	Minimise GHG emissions	4.11	.405	**.018***	.261	.650	.263	.799
	Minimise energy consumption	4.07	**.001***	.575	.821	.061	.845	.689
	Increase waste recycling	4.05	.052	.062	.245	**.033***	.696	.534
Water, waste and materials	Water conservation	4.56	.529	.058	.431	.353	.943	.697
	Sewage treatment	4.29	.901	.903	.135	.212	**.047***	.139
	Waste separation and recycling	4.24	.099	.089	**.010***	.108	.172	.995
	Water recycling	4.07	.810	.188	**.018***	.314	.263	.650
	Reuse of materials	3.90	.892	.866	.087	.163	.660	.592
	Use of greywater	3.88	.436	.186	**.031***	.249	**.002***	.422
	Promote the use of alternative sources of water	3.86	.972	.059	.510	.931	**.022***	.548
	Rainwater harvesting	3.72	.240	.361	.132	.293	.832	.301
Natural hazard	Desertification of lands	4.29	.480	.128	.592	.838	.306	.843
	Sandstorms	4.22	.180	.311	.271	.341	.147	.235
	Drought	4.11	.861	.144	.211	.824	.057	.719
Personal mobility	Walking as a mean of mobility	3.95	.053	.168	.356	.836	.174	.701
	Promote the use of the bicycle	3.40	**.013***	.723	.796	.241	.922	.985
Transport	Increase choice of transport modes	4.46	.463	**.004***	.947	.716	.793	.094
	Promote the use of public transport	4.36	**.**756	.663	.416	.631	.448	.982

Notes:
* $p < 0.05$, † Mann-Whitney *U-test*, ‡ Kruskal-Wallis test