Strengthening Urban Engagement of Universities in Africa and Asia

## Thematic Paper Series TPS103/19

# Impact of University engagement on environmental resilience of urban spaces in Asia and Africa

**Felipe Ronald Argamosa; Nematollah Azizi; Neil Burnside; Muir Houston; Nickey Janse van Rensberg; Kamal Aziz Ketuly; Sizar Abid Mohammed; Heriel Moshi and Charles Nherera**

To be cited as: Argamosa. F.R., Azizi, N., Burnside, N., Houston, M., Janse van Rensberg, N., Ketuly, K. A. Mohammed, S.A., Moshi, H. and Nherera, C. (2019) Impact of University engagement on environmental resilience of urban spaces in Asia and Africa, SUEUAA Thematic Paper Series, TPS 103/19. CR&DALL, Glasgow, UK, ISSN 2517-5548 (online) ISSN 2517-553X (Print)

The SUEUAA project (Reference CI170271) is funded by the British Academy under the Cities and Infrastructure programme, which is part of the Global Challenges Research Fund, itself, part of the UK's Official Development Assistance (ODA) commitment

# An introduction to the thematic paper series and the SUEUAA project

Muir Houston[1]; Mike Osborne[1]

[1]University of Glasgow, Scotland

The collection of papers in this series of Thematic Papers published by the SUEUAA (Strengthening the Urban Engagement of Universities in Africa and Asia) team focus on topics of relevance to project partners and the city regions and institutions they represent. Papers in this series cover: Migration, Gender, Sustainable Energy, the Environment, the Economy and Policy Rhetoric. Each paper is co-authored by a member of the University of Glasgow SUEUAA team, and at least two other partner Institutions from cities in the Global South. The following cities are represented in SUEUAA: Sanandaj, Islamic Republic of Iran; Duhok, Iraq; Manilla, Philippines; Dar es Salaam, United Republic of Tanzania; Johannesburg, South Africa; and, Harare, Zimbabwe.

The SUEUAA project was funded by the British Academy under the Cities and Infrastructures Programme part of the UK Government's £1.5 billion Global Challenges Research Fund 'to support cutting-edge research that addresses the challenges faced by developing countries through:

- challenge-led disciplinary and interdisciplinary research
- strengthening capacity for research and innovation within both the UK and developing countries
- providing an agile response to emergencies where there is an urgent research need'[i]

The SUEUAA project addresses a core problem in emerging economies of strengthening the urban engagement role of universities, and ways they contribute to developing sustainable cities in the context of the major social, cultural, environmental and economic challenges facing the global south. It uses a set of well-proven benchmarking tools as its principal method, and seeks to strengthen the capacity of universities to contribute to city resilience towards natural and human-made disasters. Examples of urban engagement include supporting the development of physical infrastructure, ecological sustainability, and social inclusion (including of migrants). It calls upon contributions from science and engineering, the arts, environmental sciences, social sciences and business studies. It assesses the extent to which universities in 6 countries (Iran, Iraq, the Philippines, South Africa, Tanzania and Zimbabwe) respond to demands of society, and how through dialogue with city stakeholders this can be enhanced and impact on policy; it uses a collaborative team from the UK and emerging economies.[ii]

[i] https://www.britac.ac.uk/global-challenges-research-fund-resilient-cities-infrastructure
[ii] http://sueuaa.org/

**Disclaimer:**
This material has been funded by the British Academy. The views and opinions expressed in this paper are those of the authors and do not necessarily reflect the official policy or position of any other agency, organization, employer or company. Assumptions made in the analysis are not reflective of the position of any entity other than the author(s)

# Impact of University engagement on environmental resilience of urban spaces in Asia and Africa

Felipe Ronald Argamosa;[1] Nematollah Azizi;[2] Neil Burnside;[3] Muir Houston;[3] Nickey Janse van Rensberg;[4] Kamal Aziz Ketuly;[5] Sizar Abid Mohammed;[5] Heriel Moshi[6] and Charles Nherera.[7]

## Abstract

By 2030 most of the globes inhabitants will be living with cities. It is therefore important that cities are resilient to sustenance and energy challenge in the face of increasing demands from population expansion and increasing environmental variability and uncertainty brought about by intensifying climate change. The Strengthening Urban Engagement of Universities in Asia and Africa (SUEUAA) project aims to enhance university engagement capacity in this context and optimise engagement strategy to maximise impact in urban areas. We use the term 'environmental resilience' to encapsulate both energy and sustenance challenges. We believe these must be tackled in a holistic manner as there are intimate links between the production and usage of energy, food and water and consequent generation and disposal of waste. This paper focuses on the experiences and vision of SUEUAA partners in Johannesburg (South Africa), Dar es Salaam (Tanzania), Duhok (Iraq), Sanandaj (Iran), and Manila (Philippines), so it encapsulates views and solutions for engagement strategies on several environmental challenges facing cities in very different climatic situations.

[1] Philippines National University, Philippines; [2] University of Kurdistan, Iran; [3]University of Glasgow, UK; [4]University of Johannesburg, South Africa; [5]University of Duhok, Iraq; [6]University of Dar es Salaam, Tanzania; [7]University of Zimbabwe, Zimbabwe

**Table of contents**

1. **Introduction** …… 1
2. **Urbanism** …….. ……... 2
3. **Interventions** ……... 4
4. **Summary** …… …… 13

**References** …… 15

# 1. Introduction

Around 55% of the world's population currently live in urban environments. By 2030 this value is projected to reach 60% and one in every three people will live in cities with at least 500,000 inhabitants (UN 2018a). Environmental resilience of these domains, in the face of the considerable dual stresses of increased migration to urban centres and climate change, is a massive global challenge that universities in these settings are trying to tackle through working with a wide range of stakeholders from international governance, international and national NGOs, national and municipal government, public and private enterprises and importantly local inhabitants.

The Strengthening Urban Engagement of Universities in Asia and Africa (SUEUAA) project aims to enhance university engagement capacity in emerging economies and optimise methods of engagement so that they are strategically aligned with promoting sustainable cities. The authors of this publication are drawn from the partner intuitions within SUEUAA and the scope of the paper is to highlight strategies for environmental resilience interventions by higher education institutions. The following sections will focus on direct experience from partner universities, but will also discuss, were appropriate, the efforts of other academic institutions in the partner's respective cities.

Urban populations require abundant sustenance and energy in order to function, and often both of these requirements are gathered, or generated, using natural resources. We therefore consider 'Environmental Resilience' to broadly encompass the demands of both the individual inhabitants (i.e. water, food, energy and sanitation) and the city at large (i.e. electricity, power, transport infrastructure and water and waste management). Attempts to address these challenges are pivotal in making progress in relation to a number of the UN Sustainable Development Goals (SDGs) (UN, 2018b). According to the UN understanding and responding to the key trends in urbanization will be fundamental in the implementation of the 2030 Agenda for Sustainable Development specifically in relation to Sustainable Development Goal 11 to make cities and human settlements inclusive, safe, resilient and sustainable (UN, 2018a). More directly they suggest:

> • *Urban growth is closely related to the three dimensions of sustainable development: economic, social and environmental. Well-managed urbanization, informed by an understanding of population trends over the long run, can help to maximize the benefits of agglomeration while minimizing environmental degradation and other potential adverse impacts of a growing number of city dwellers.*
>
> • *To ensure that the benefits of urbanization are shared and that no one is left behind, policies to manage urban growth need to ensure access to infrastructure and social services for all, focusing on the needs of the urban poor and other vulnerable groups for housing, education, health care, decent work and a safe environment. (UN, 2018c: p2)*

In addition to SDG 11, several other SDGs are relevant and in some respects complementary to the environment related challenges and issues identified across the partner cities and many of the interventions are focussed on addressing SGS 6 and 7 in relation to affordable and clean energy and clean water and sanitation respectively.

It is very often the case that impacts on urban environments contain elements of both 'natural' and 'man-made' influences. It is beyond the scope of this paper to differentiate between the nuances of the causes of impacts according to these two end-member scenarios. For example, flooding could be attributed to climate change; which, despite extensive scientific endeavours, the degree of anthropogenic influence could still be the subject of debate. However, as we will see, this can be exacerbated by large informal settlements. A major environmental disaster such as a volcanic eruption, or an earthquake, could be considered, in most cases, to be completely natural. However, a geologist could potentially point to man-made influences on subsurface stresses that could trigger such events; or one could consider that it's the man-made building that the earthquake has knocked over that has caused the true impact. A specific example relevant to partners in Tanzania, Iran and Zimbabwe concerns the environmental impact and role of hydro-electricity and the creation of the dams and infrastructure required to harness the potential energy resource. While on the one hand hydro-electricity can be seen as a form of renewable technology the environmental footprint and its impact can be substantial; and, the impact of climate change in terms of increasing droughts and/or floods is likely to result in increasing power disruption to hydro power generation systems (Conway, et.al. 2017). Tanzania in particular with its reliance on hydroelectric generation is susceptible to drought impacting on supply (Baker, 2012).

We will mainly focus on academic interventions in response to long-term chronic environmental stresses, such as increasing temperature, air quality degradation from fossil fuel emissions; and, the health impact of water pollution from both human and industrial activities. In order to respond to these challenges the development and dissemination of renewable energy technologies are seen as crucial (Filho and Surrop, 2018).

## 2. Urbanism

What is a city? Well, as it turns out, this is a more philosophical question than one would initially think. Most would agree that cities are typically heavily urbanised locations that contain large numbers of inhabitants and act as hubs for a nation's or region's economy and governance.

City limits are open to interpretation as no standardized physical criteria exist for determining the boundaries of a city (UN 2018a). Several terms exist which try to explain certain core city or extended urban zones, but a lack of consensus means that these descriptions can be somewhat non-definitive (Fang and Yu, 2017). Generally speaking, urban populations tend to be defined in terms of administrative, functional or ecological boundaries (Frey and Zimmer 2015).

Definitions of 'zones' by the UN World's Cities in 2018 (UN, 2018a: p1) report provide guidance terminology that generally fits with the common methods of recording spatial urban population data and identify three main definitions. These include:

- **City Proper.** A city according to an administrative boundary
- **Urban agglomeration**. The extent of the contiguous urban area, or built-up area, to delineate the city's boundaries.
- **Metropolitan area**. Boundaries according to the degree of economic and social interconnectedness of nearby areas, identified by interlinked commerce or commuting patterns.

These definitions stop short of including the overall influence of a city both nationally, and internationally, so for the purpose of this paper we will consider these influences out of scope and focus on the tighter geographical region of the city up to the extent of the Metropolitan (or 'Metro') Area. Table 1 provides some baseline physical and population information for SUEUAA partner cities across Africa and Asia.

| City | Country | Location | Elevation (m) | City Area ($km^2$) | Urban Area ($km^2$) | Distance to coast (km) | City Population | City density ($km^2$) | Urban population | Urban density ($km^2$) |
|---|---|---|---|---|---|---|---|---|---|---|
| Johannesburg | South Africa | 26° 12′ S 28° 2′ E | 1,767 | 335 | 3,357 | 460 | 957,411 | 2,900 | 7,860,781 | 2,300 |
| Harare | Zimbabwe | 17° 49′ S 31° 3′ E | 1,494 | 660 | 872 | 475 | 1,435,784 | 2,259 | 2,123,132 | 2,249 |
| Dar es Salaam | Tanzania | 6° 48′ S 39° 17′ E | 24 | 1.393 | 596 | 0 | 4,364,541 | 3,100 | 6,048,000 | 7,487 |
| Duhok | Iraq | 36° 52′N 42° 59′ E | 567 | 24.7 | 6553 | 605 | 330,600 | 13,385 | 1,252,300 | 125 |
| Sanandaj | Iran | 35° 18′N 46° 59′ E | 1,494 | 3,033 | - | 612 | 412,767 | 136 | 501,402 | 147 |
| Manila | Philippines | 14° 36′N 121° 0′ E | 13 | 42.9 | 636 | 0 | 1,780,148 | 71,263 | 12,877,253 | 20,785 |

**Table 1: Baseline location and population statistics for SUEUAA partner organisation cities (including authors' own contributions and information from Brinkhoff 2016; Firth 2011; Philippine census 2015; Philippine Statistics agency 2016; UN 2018a). Cities are ordered from west to east (Africa through Asia).**

As can be seen from the table, statistics are limited in some locations as measurements have not followed a consistent format. For example, it appears that the City area measurement for Dar es Salaam[1] incorporates most what would be defined as the limits of the Urban area in other locations and is classified, as is Johannesburg, by the UN as Urban Agglomerations (UN, 2018a: p10-11). This highlights the difficulty of applying the above definitions as multiple different boundary definitions can be available for any given city.

[1] Dar es Salaam is one of the 10 African cities predicted to become a mega city with a population of more than 10 million by 2030.

Specifically in respect of population density, Johannesburg, Harare and Dar es Salaam all exhibit relatively high levels although these are dwarfed by Manila; reckoned to be the most densely populated city in the world. The city of Duhok also exhibits very high levels of population density exacerbated by the influx of refugees and internally displaced people from the ongoing conflicts in the region.

The partner cities also vary widely with respect to climate, and this means that in certain situations, each city must employ different environmental resilience intervention strategies. For example, Duhok has a Mediterranean climate and abundant sunshine, but this cannot be efficiently captured for electricity generation by mass deployment of photovoltaics due to the high volumes of windblown sand and dust. Sanandaj, with an arid to semi-arid climate, has significant water resource challenges which will be explored briefly below. Both Johannesburg and Harare have a subtropical highland climate, so have comparatively consistent year-round fairly-mild temperatures, but due to their elevation have real challenges with 'extreme' UV indexes (11+ on the UVI) for an average of six and eight months a year respectively[2], that can lead to serious harm from unprotected sun exposure, during the summer months (WHO 2002).[3] Located proximal to the equator and being at sea level, Dar es Salaam and Manila have tropical wet and dry climates and as such are prone to increased risk of flooding as a result of climate change and as noted later the impact can be exacerbated by the presence of informal settlements.

In addition, three of our partner cities: Dar es Salaam, Harare and Manila, are national capitals and as such generally operate as seats of government the location of major government agencies and associated support infrastructure; and, as such operate as a pull factor for national and international investment and industrial and service sector enterprises. Similar pull factors, although to a lesser extent, can also be assumed to operate in Duhok and Sanandaj the capital city of province of Kurdistan which are seen as historically important provincial cities in their respective regions while Johannesburg is South Africa's largest city and metropolitan municipality; and, a recognised financial services location which exhibited rapid social, demographic and spatial change in the post-apartheid era (Todes, 2012).

## 3. Interventions

The remainder of this paper will focus on strategic interventions employed by SUEUAA partner cities, with the main focus on those directly involving SUEUAA partner institutions. Overall the main driver has been to tackle environmental resilience in a holistic way that incorporates sustainable resources broadly in the areas of energy, water, waste and sustenance to stimulate the local green economy. In particular, many of the partner countries still rely on fossil fuels for much of their generation capacity. The impact on the environment is often exacerbated by the ageing infrastructure of much of their fossil power stations operating which often operate well below capacity in terms of energy generation and distribution. In this context the development of alternative greener technologies for both large and small scale

[2] https://www.weather-atlas.com/

[3] In addition, both are also vulnerable to drought. (UNESCO, 2018)

energy generation and distribution are seen as crucial in progress towards the SDGs.[4] While SDG7 – affordable and clean energy is most directly relevant, progress in greening energy generation and distribution has the potential to have positive benefits in relation to SDG 13 - climate action; and through improvements in air quality impact on SGD 3 – good health and well-being. In addition, by stimulating the green economy to design and manufacture renewable technologies, and the training and employment opportunities in the installation and servicing these renewable technologies should; also provide positive benefits in relation to SDG8 – decent work and economic growth and hopefully reduce poverty (SDG 1) and address inequality (SDG 10).

This approach has already been strongly developed in Johannesburg (Figure 1) and is already comprehensively incorporated into educational strategies at the University of Johannesburg's Process, Energy & Environmental Technology Station (PEETS) and their local institutional partners.[5] The primary mandate for PEETS is

> *to contribute towards improving the competitiveness of industry and SMEs through the application of specialized knowledge, technology and facilitating the interaction between industry (especially SMEs) and academia to enable innovation and technology transfer.(PEETS, 2018: p2)*


**Figure 1: University of Johannesburg Process, Energy & Environmental Technology Station (PEETS) Focus areas. Source PEETS, 2018**

[4] Readers are directed to https://energypedia.info/wiki/Main_Page which provides a detailed overview at a national level (e.g. https://energypedia.info/wiki/Zimbabwe_Energy_Situation in relation to existing and potential energy generation and distribution and the potential scale and scope for the increased development of renewable technologies.

[5] https://www.uj.ac.za/faculties/febe/peets

Concentrating on initiatives to support the green economy and developing linkages both internally and externally at the University of Johannesburg, PEETS supporting and developing a green economy services industry by partnering with neighbouring technology stations including the Sustainable Energy Technology and Research (SeTAR) Centre,[6] which has a focus on solar and renewable energy applications for poverty relief including high efficiency cooking stoves and energy efficiency applications for low cost homes; and, the UJ Energy Measurement & Verification Team[7] has developed a range of protocols and measurement tools to assess predict energy savings specifically in relation to energy conservation and the evaluation of renewable sources to accelerate the roll out of these initiatives to industrial stakeholders in the areas of air quality control and energy and waste management.

The Biofuel Research Network at UJ enhances the reach and capacity of PEETS and this relationship will be strengthened through strategic partnerships with local government, international research agencies and commercial partners. One example of this is the use of solid waste to biogas through improved sanitation and human waste management and the development of bio-digesters in low income urban communities (Figure 2)

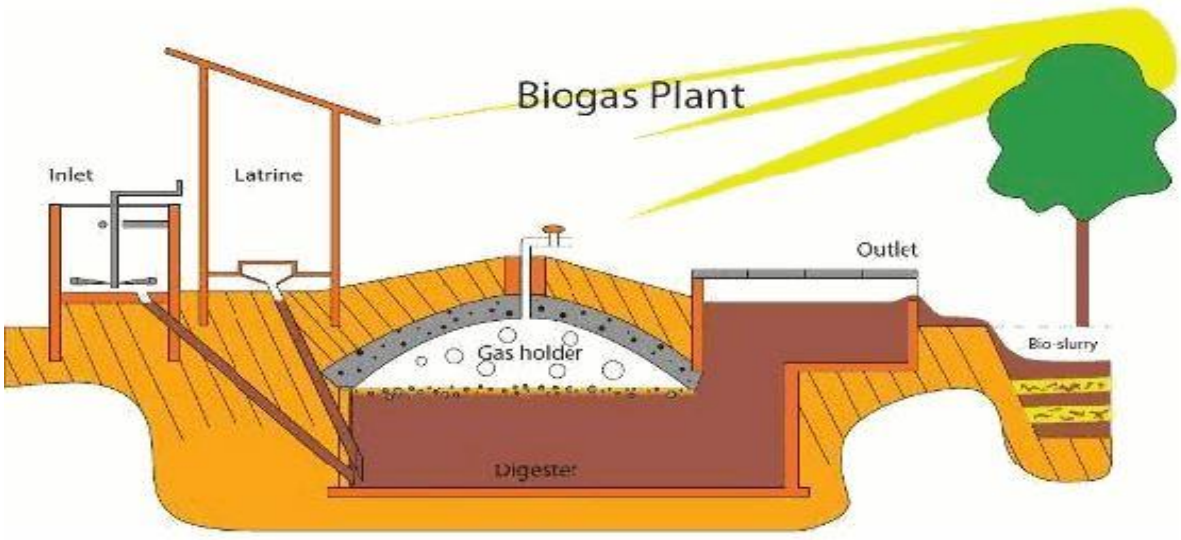


**Figure 2: small scale biogas generation (Source: PEETS, 2017)**

Food, water and energy security form the basis of a self-sufficient economy, but as a water-scarce country with little arable land (10.3%)[8] and a dependence on oil imports, South Africa's economy is testing the limits of its resource constraints (Wakeford, 2013). In its attempts to address this PEETS has developed capacity in waste to energy conversion, and its energy-water-waste-agriculture applications will support SMEs in vulnerable communities of rural and urban small-scale farmers throughout the value chain to expand renewable off-grid solutions to support production, food processing, water and waste management and logistics in this sector. The Technology Development Areas or building blocks to support the

[6] http://www.setarstoves.org/
[7] https://www.uj.ac.za/faculties/febe/ujmv/Pages/About-M---V.aspx
[8] https://www.indexmundi.com/facts/south-africa/arable-land

green economy and the potential applications in relation to the development of SMEs are illustrated in Figure 3.

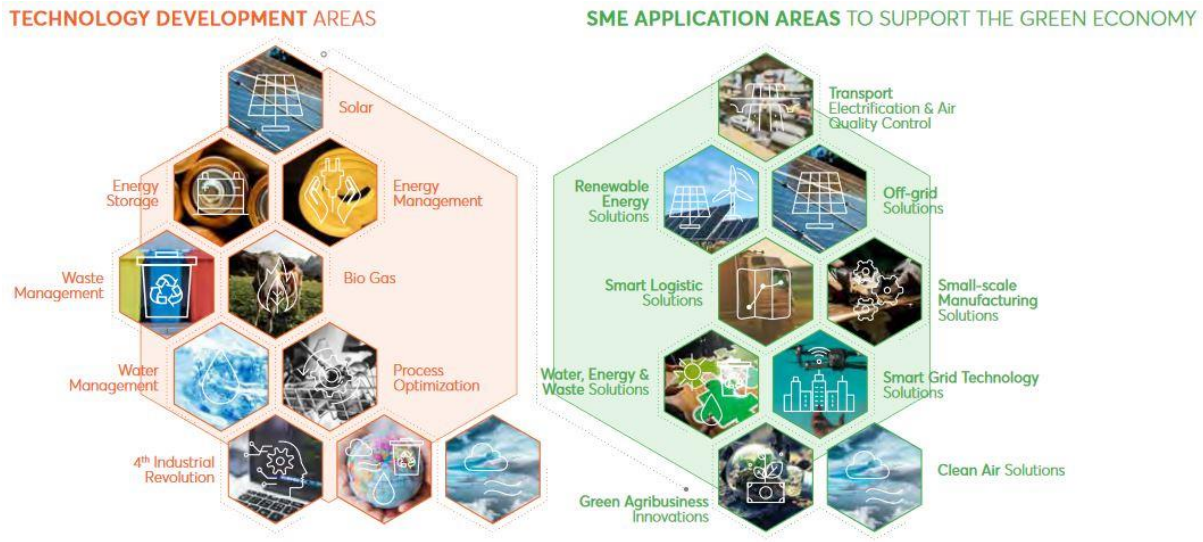


**Figure 3: Technology Development Areas and complementary SME development (Source PEETS, 2017)**

Similarly, the University of Dar es Salaam (UDeS), is diligently working on innovations in biofuel production. Over 90% of energy in Tanzania is sourced from wood fuel, which has large implications for deforestation, soil quality and surface water retention. In terms of access 85-90% of the population are not connected to the electricity grid and only 12% of urban and 2% of rural communities are electrified. However, it does have considerable potential in terms of the development of renewables in relation to solar and one of the areas underdevelopment is small scale off-grid and solar home systems that at a minimum allow lighting and mobile phone charging.[9] Investigations in cooking stove innovation are paving the way to replace charcoal or oil based systems with seed oil. This has in part been driven by Government desire to decrease the use of charcoal in cooking. Currently, plant oils are largely imported from India and Malaysia. The UDeS team are also researching appropriate plant-source variants that are non-edible and drought resistant which can be grown in Tanzania to help fuel the local economy through the production of bio-fuels. In Tanzania, agriculture represents 50% of GDP, but it is typically small-scale and is heavily reliant on the climate, so even short-term perturbations can cause massive problems for productivity. The agriculture group of UDeS is working to combat macroeconomic issues, including government corruption, and unreliable power resources. A common theme from both PEETS and UDeS, is the promotion and creation of food gardens in derelict buildings. This takes agriculture in to the inner city to increase local production, ease transport logistics, improve livelihoods and change conceptions of farming, which is commonly seen as a low-level job. Efforts are afoot to develop more interesting farming methods and technology to provide opportunities for unemployed urban youth to obtain employment.

In Zimbabwe, a similar reliance on the use of wood fuel for cooking can be identified with 80-90% dependent upon wood fuel and kerosene for cooking and lighting and similar impacts

[9] https://energypedia.info/wiki/Tanzania_Energy_Situation#Solar_Energy

on deforestation and air pollution; and, as in Tanzania local universities have been involved in research into alternative fuel sources including biogas generation and the development of bioethanol and bio diesel. Hydropower mainly from the Lake Kariba Dam[10] is a major source of electricity although having large coal reserves a considerable proportion of the capacity is delivered via inefficient and often unreliable coal powered stations with a tendency for significant under-capacity in terms of generation output. There have been moves to develop existing solar and biomass capacity particularly in rural areas. In addition to already existing bio-fuel facilities extracting bio-ethanol from bagasse; a waste product of sugar cane cultivation; there has also been a specific focus on the bio-diesel potential of the jatropha[11] plant with studies on land type and growing conditions (Jingura *et. al.* 2012), the potential socio-economic impact of large scale cultivation on local communities (Gwamuri et. al. 2012) and a study of existing and potential capacity and the challenges facing the further development of the sector (Karavina *et. al.* 2011). However despite this potential, Makonese (2016) undertook an analysis of renewable energy potential in Zimbabwe and highlighted a lack of relevant technical expertise and availability of government funding which would allow the potential to be realised in areas such as solar energy, biomass, bioethanol and biodiesel production and the development of technology including small scale biomass and thermoelectric generators.

The negative environmental and health impact of high population density with large numbers of people located in informal settlements is well documented (Sverdlik, 2011; Corburn and Sverdlik, 2018); and, these are likely to be exacerbated by the effects of climate change (Baker, 2012) In Dar es Salaam a study (START, 2011), suggested that over 70 percent of residents lived in informal, unplanned settlements that lack adequate infrastructure and services; and, that this alongside a lack of storm drainage and blocked natural drainage systems has increased the risk of flooding and is associated with a wide range of health risks including cholera, malaria, lymphatic filariasis, and diarrhoea (Ibid.). In addition many of the informal settlements were in areas vulnerable to increased risk of flooding due to climate change (Guigni and Iervolino, 2011). In Harare, a major environmental challenge is waste management in relation to both industry and informal settlements and according to a study by Tsiko and Togarepi (2012) many of issues are rooted in the colonial period with the administration regarding the segregated native suburbs as sources of cheap and easily controlled labour and made little effort to resolve issues such as access to utilities or waste management systems. A more recent study undertook a profile of 60 informal settlements was undertaken by a partnership involving the Zimbabwe Homeless Peoples' Federation (ZHPF) the NGO Dialogue on Shelter and the City of Harare looking in each settlement at the state of housing, the often complex issue of land tenure, infrastructure and social services, economic activity and, relief and developmental activities (ZHPF, 2014; 2015). Major issues particularly in relation to waste management, water and energy were identified as a result of the scoping and profiling exercises which were conducted in conjunction and with the cooperation of those living in the informal settlements to give them a voice in the planning process. The largest informal settlement at Ebworth (Msindo *et.al.* 2013) hosts 31,000

[10] The Kariba Dam is the largest man-made reservoir in the world.
[11] Jatropha curcas L

households and a total population of around 200k while the smallest might only contain 10 households illustrating the scale and scope of the settlements (ZHPF, 2015: 95-97).

**Figure 4: Amalinda settlement and an area of Mbare settlement (Source: ZHPF, 2014)**

Common environmental problems identified across the informal settlements were access to water, sanitation and waste management and these were contributory factors in the Cholera outbreak of 2009 (Chirisa, et al., 2015) in which around 100,000 people were infected and just under 4,300 died (IFRC, 2009) can perhaps be seen as a failure of environmental planning (Nyamadzawo *et.al.* 2015) while Dube and Chirisa (2012) make broader connections between informal settlements and informality more generally in terms of the economy and service provision. A further outbreak in the informal settlements in 2018 resulted in around 10,000 cases of infection and 55 deaths (Reliefweb, 2018).

For densely populated Manila, which forms an Urban Heat Island (UHI), the main environmental risks are from fires and floods. The city is built on a river delta and many areas are situated below sea level. Many people live in and on former waterways that have been colonised as the city has grown. In the 1970's flooding cleared within 1 to 2 hours, but now the city grinds to a halt during torrential downpours. In addition and noted above, densely packed settlements without adequate access to water and sanitation services have an adverse impact on both the environment and the health of the inhabitants. The Philippines National University (PNU) and local public and private partners are engaged with local communities in an attempt to bring down communication barriers and educate them about the importance of these natural and man-made drainage systems in terms of flooding risk and health implications. Due to the vast volume of people, a key challenge in Manilla is connecting and harmonising with the public and penetrating local government. Attempts at interventions are also being made with concerns to electrification of public transport, and capture and utilisation of Manila's waste heat.

The major environmental challenges for Sanandaj are development of renewables and earthquake resilience. Seismic activity is very common in the area and the city was recently impacted by a magnitude 7.3 earthquake. Though this was a terrible event, it has resulted in a

rise of community openness and positivity towards helping across all aspects of society. Investigations on building materials and structures are underway, and this is feeding directly into education programmes. The city has also experienced substantial urban growth (Mohammady and Delavar, 2014) and this has resulted on pressures on services and on the fabric and infrastructure of its important historical and cultural sites (Alizadeh and Habibi, 2008). In a study on the unsustainability of the city (Azami, *et. al.* 2015) identified issues related to social, economic, physical and environmental aspects with recognition that improvements in the first three would have positive knock-on effects for the environment. Specifically they note the impact of a lack of planning in relation to informal settlements and the lack of integrated waste, water and other basic infrastructural services and associated environmental impact. Karimia and Boussauw (2018) also identified a number of problematic issues putting pressure on the city including rapid urban expansion caused by a dramatic population increase, inward migration from rural areas resulting in increasing social segregation and inequality.

There are ca. 70,000 students in the Kurdistan area across 10 universities, but currently 40% of graduates are unemployed across all levels. It is hoped that by more explicitly linking education to real challenges, such as earthquake resistant construction, could help address this issue. There are also issues with damning of rivers in the Kurdish area. 50 to 70 damns have been built since the revolution to divert drinking water to central Iran. This has led to massive environmental damage of rivers so investigations are underway to investigate resource ownership, assess the damage and develop appropriate interventions.

Construction of dams has led to the compulsory purchase of land and displacement of large part of the rural population, including those from historic sites. This leads to an increase in displaced and marginalised populations, poverty, and unemployment in Sanandaj exacerbating the planning issues noted above.

Departments at the University of Kurdistan have been engaged toward ameliorating the negative environmental impacts on both urban and surroundings areas. There have been studies exploring the impact of the dam construction on the natural and social environments. The findings of this, which will be discussed in more depth in a later publication, have found that implementing the policy of further dam construction without true comprehensive assessment of its consequences, especially for target communities, can practically lead to destruction of surface water resources and deprivation of natural and human ecosystems from these essential resources.

The findings of this study were used to successfully petition both dam construction project managers; and, local officials to reconsider their construction plans. Academics in the Department of Urban and Natural Resources at the University of Kurdistan consulted with these officials to decrease the height of the Javeh and Daryan dams by 30 metres. Academics at the University of Kurdistan believe that the evidence base they have collated can be used to stop damages in a number of sensitive areas, and may be used to employ more effective strategies and new methods for maximising outputs of natural resources. These new methods should have an evidence base behind them, with all future construction projects requiring a critical appraisal. (Azizi, 2019).

**Figure 5: Dam construction in Sanandaj, Source: Azizi, 2019**

In Duhok the environment is threatened by several factors, namely neglect, sandstorms, drought, and legacy pollution from local hydrocarbon exploration which has proliferated since 1995. In addition, the massive influx of refugees and displaced persons has had an environmental impact and further strained already pressured waste, water and sanitation services. The University of Duhok (UoD) both centrally and at departmental or faculty level has been engaging with relevant actors including the Kurdistan Regional Government (KRG) and many of its 14 ministries.

With respect to water resources, Duhok has several internal and external issues which UoD are assessing (Figure). The main external factor is reduced flow of surface water from neighbouring countries, either through drought, or increasingly because of water projects in those countries. There are several internal factors which include; a lack of domestic water usage regulations, lack of modern Leak Detection techniques for water mains and water networks, and a lack of awareness within the public and the absence of effective educational and awareness campaigns to build the knowledge base of the public for responsible waste management, sanitation and water usage. For external factors, UoD is in dialogue with the KRG to encourage Governmental Political Initiatives and open dialogues with the neighbouring countries for a fair and equitable use of shared water resources and to get the support of the International community for equal water distribution in the basin.

This tension between neighbouring countries or between regions over access to freshwater has long been identified as a potential source of conflict and seen as an issue of national security (Gleick, 1993). When accompanied by the expected impact of global warming, population increases and climate change access to fresh water is recognised as a major challenge by the United Nations (2019) in terms of both access at an individual or community level to fresh water and is codified in SDG 6 (Ensure availability and sustainable management of water and sanitation for all.); and, also in terms of tensions related to transboundary water where river basins cross national boundaries and water flows may be restricted, cut off or otherwise impacted by for example the building of dams upstream (UN, 2014) with 2013 proclaimed as the International Year of Water Cooperation as part of the International Decade for Action ‘Water for Life’ 2005-2015 (UN, 2015). The potential for

water to increase cross border tensions and increase instability was recognised in 2018 when a 2018 Arria-formula meeting organized by the Kingdom of the Netherlands, Security Council members and UN member countries on the topic of water, peace and security was convened.[12] Urban areas suffer from unhealthy air quality and impacts to land due to practices that both the government and the public are adopting such as: unregulated use of fossil fuel power generators (due to the insufficient output of electricity generated by the government), lack of car emission regulations and modern car inspection techniques, trash (due to inadequate trash collection) and tire burning (in social and ethnic celebrations), and lack of green belts and parks in and around urban areas.

UoD environmental projects have mainly been concentrated at the College of Agriculture (Figure 6). These have included studies on the effects of heavy metals on the growth of economical plants and soil chemical treatment to reduce the effect of these metals. Further environmental research from the College of Science includes assessment of the population of algal flora in two different aquatic ecosystems inhabited by a rare species of salamander (Raoof *et al.* 2016).

**Figure 6: Environmental monitoring activities around Duhok. Top left: water quality for drinking water samples from Duhok city for analysis. Top right: wastewater monitoring and sampling for analysis. Bottom left: monitoring of air pollution. Bottom right: solid waste monitoring for management and treatment.**

In addition, the UoD, in collaboration with the Duhok Directorate of the Environment, are planning to establish two Eco-garden projects: one at Zawa Mountain and one at Zawita Forest. Duhok city is surrounded by several mountain ranges. One of the best and most accessible sites to view the city is from Zawa Mountain (Figure 7), one of the city's defining features and, despite its lack of development, a top tourist attraction. Over the last decade,

[12] https://bit.ly/2vfWEPx

Zawa hilltops and slopes have experienced consistent deforestation resulting in a grassland rocky landscape with low density of shrub cover and now largely devoid of trees. Therefore, a large-scale reforestation of trees and shrubs can both increase the potential recreational opportunities for Duhok city and at the same time ecologically conserves the mountain. It will generate income and create employment opportunities for local people and camps residents (IDPs and refugee) during the establishing phases.

**Figure7: View pf Duhok City with Zawa Mountain in the background.**

The Zawita Forest Eco-Garden is located on the northern face of the Zawita Mountain. It forms a small natural forest about 25 $km^2$ within limestone foothills ca. 16 km from the city centre. The Eco-Garden will provide a valuable means for moving towards sustainable forest areas that provide many non-woody forest products, and assure multipurpose forest functions such as recreation and conservation of habitats that host endangered species of plants and wildlife. For two decades, Zawita Forest was severely exploited- e.g., shifting agriculture, burning of trees, heavy grazing, urbanization, and mass recreational activities during spring. These activities have resulted in the erosion of large areas of the natural forest. The major driving forces behind such disturbances are the low socio-economic status of local community and low public awareness and understanding of the forests ecosystem. The establishment of an Eco-Garden in Zawita Forest could help to assess the role of such types of gardens in generating jobs and raising the local awareness towards the importance of environment preservation and forests ecosystem functions.

## 4. Summary

This brief overview has highlighted some of the environmental challenges facing the six countries and the selected cities. The impact of informal settlements on the environment and the health of the inhabitants was noted. In addition, a number of initiatives aimed at addressing or at least mitigating environmental degradation through the substitution of

cleaner and more sustainable forms of renewable energy and resource conservation were highlighted.

In relation to the Sustainable Development Goals (SDGs), while our focus on the cities is perhaps most directly relevant to Goal 6 (Clean water and sanitation); and Goal 7 (Affordable and clean energy); through them it may also impact on Goal 3 (Good health and wellbeing) and, Goal 13 (Climate Action). Additionally, some of the examples discussed also indirectly impact on other SDGs. For example the focus on renewable technologies could additionally be seen as relevant to Goal 9 (Industry, innovation and infrastructure) in the development and production of goods and services; and Goal 12 (Responsible consumption and production) in a shift to more sustainable resource use.

Serious higher education efforts are underway, in a range of contexts and urban environments, to help the environmental resilience of cities and urban settings achieve progress on the relevant SDGs Many of these efforts are still in their early stages due to the developing status of universities in some cities and the capacity of those universities to perform activities beyond teaching. Additionally, in some places linkages and interactions between universities, city or municipal governments and other stakeholders including local and international NGOs and community representatives are often informal; and there is perhaps a need for opportunities to allow greater coordination and networking to inform and implement policy initiatives to address the challenges that they face. Focused education of students to meet environmental challenges is underway, and more is being encouraged in STEM areas to help industrial and business efficiency. SME's working in these areas have been a major target of University collaboration. In terms of direct intervention via focused research, many innovative solutions are being put forward and investigated. The main mantra of developing these solutions is that they are scalable and sustainable, so they are being carefully linked to business models to ensure their long-term success. However, the scale of some of the problems to be faced may often beyond the scope of national and provincial government and may require additional inputs in the form of international aid and support.

## References


Alizadeh, H. and Habibi, K. (2008) Monitoring the Character of Place in the Historical Site of Sanandaj, Iran. *Journal of Asian Architecture and Building Engineering.* Vol.7 no.2 pp201-208.

Azami, M., Mirzaee, E. and Mohammadi, A. (2015) Recognition of urban unsustainability in Iran (case study: Sanandaj city). *Cities*, 49 pp:159–168.

Azizi, N. (2019) *Environmental impacts of dam construction in Kurdistan - the Zheveh dam in Sanandaj.* Case Study 7, www.sueuaa.org

Baker, J. (ed.) (2012) *Climate Change, Disaster Risk and the Urban Poor: Cities Building Resilience for a Changing World*, World Bank http://documents.worldbank.org/curated/en/644301468338976600/pdf/683580PUB0EPI0067869B09780821388457.pdf Accessed 17 February 2018.

Brinkhoff T., 2016. *City Population*. http://www.citypopulation.de/. Accessed 17 February 2018.

Chirisa, I., Nyamadzawo, L., Bandauko, E. and Mutsindikwa, N. (2015) The 2008/2009 cholera outbreak in Harare, Zimbabwe: case of failure in urban environmental health and planning. *Review of Environmental Health*, 30(2): 117–124.

Conway, D., Dalin, C., Landman, W.A. and Osborn, T.J. (2017) Hydropower plans in eastern and southern Africa increase risk of concurrent climate-related electricity supply disruption, *Nature Energy* VOL 2 pp.946–953 https://doi.org/10.1038/s41560-017-0037-4

Corburn J. and Sverdlik A. (2018) Informal Settlements and Human Health. In: Nieuwenhuijsen M., Khreis H. (eds) *Integrating Human Health into Urban and Transport Planning*. Springer, Cham (online https://link.springer.com/chapter/10.1007%2F978-3-319-74983-9_9 Accessed 17 February 2018

Fang, C. and Yu, D., 2017. Urban agglomeration: An evolving concept of an emerging phenomenon, *Landscape and Urban Planning*, 162, p 126-136.

Filho, W.L. and Surrop, D. (eds.) (2018) *The Nexus: Energy, Environment and Climate Change.* Springer Nature, Cham: Switzerland.

Frey W.H. and Zimmer Z. (2001) Defining the City, in *Handbook of Urban Studies*, ed. Paddison R., SAGE Publications. Chapter 2, p 14-35.

Firth A. (2011) Johannesburg: Main Place, *South Africa Census 2011.* https://census2011.adrianfrith.com/place/798015 Accessed 17 February 2018.

Giugni, M. and Iervolino, I. (2011) The CLUVA's Dar Es Salaam Case-Study http://wpage.unina.it/iuniervo/papers/Giugni-Iervolino_Dar_Es_Salaam_Case_Study.pdf

Gleick, P.H. (1993) Water and Conflict: Fresh Water Resources and International Security *International Security* Vol. 18, No. 1 (Summer), pp. 79-112

Gwamuri, J., Mvumi, B., Maguranyanga, E.F. and Nyagumbo, I. (2012) *Impact of Jatropha on Rural Livelihoods Case of Mutoko District, Zimbabwe*, Windhoek: RAEIN-Africa Secretariat

IFRC (2009) *100,000 cases The spectre of cholera remains in Zimbabwe: An Advocacy Report* http://www.ifrc.org/Global/Publications/Health/159500-Zimbabwe-Report-Final-EN.pdf Accessed 17 February 2018

Jingura, R.M., Matengaifa, R., Musademba, D. and Musiyiwa, K. (2012) Characterisation of land types and agro-ecological conditions for production of Jatropha as a feedstock for biofuels in Zimbabwe, *Biomass and Bioenergy*, 35, pp 2080-2086.

Karavina, C., Zivenge, E., Mandumbu,R. and Parwada, C. (2011) Jatropha curcas Production in Zimbabwe: Uses, Challenges and the Way Forward, *Modern Applied Science* Vol. 5, No. 2, pp: 239-243.

Karimia, N. and Boussauw, K. (2018) City profile: Sanandaj, Iran, *Cities*, 72 pp: 261–273.

Makonese, T. (2016) *Renewable energy in Zimbabwe*, International Conference on the Domestic Use of Energy, https://www.researchgate.net/publication/304021888_Renewable_energy_in_Zimbabwe Accessed 17 February 2018

Mohammady, S. and Delavar, M.R. (2014) Urban Sprawl Modelling. The Case of Sanandaj City, Iran, *Journal of Settlements and Spatial Planning*, vol. 5, no. 2 pp: 83-90.

Msindo, P.D., Gutsa, I. and Choguya, N.Z. (2013) Squatter Settlements an Urban Menace in Zimbabwe? Examining Factors behind the Continued Resurfacing of Squatter Settlements in Epworth Suburb, Harare, *Journal of Settlements and Spatial Planning*, vol. 4, no. 2: 171-182

Nyamadzawo, L., Bandauko, E. and Mutsindikwa, N. (2015) The 2008/2009 cholera outbreak in Harare, Zimbabwe: case of failure in urban environmental health and planning. *Review of Environmental Health*; 30(2): 117–124.

PEETS (2017) *Process, Energy and Environmental Technology Station*, Biogas Conference 2017. http://www.energy.gov.za/files/biogas/2017-Biogas-Conference/day3/Process-Energy-and-Environmental-Technology-Station.pdf Accessed 12 January 2019

PEETS (2018) *Overview* https://www.uj.ac.za/faculties/febe/Documents/2018%20UJ%20PEETS%20Overview.pdf Accessed 12 January 2019

PEETS (2019) *UJ PEETS Brochure* https://www.uj.ac.za/faculties/febe/peets/Documents/2019_UJ%20PEETS_Brochure_web.pdf Accessed 10 February 2019

Philippine Statistics Authority 2016. Philippine Population Density (Based on the 2015 Census of Population). https://psa.gov.ph/content/philippine-population-density-based-2015-census-population. Accessed 17 February 2018.

Raoof E.Z., Kheder N.K., Saeed A.Y., 2016. *Spatial-Temporal Variation in Algal Community in Freshwater Springs Inhabited by Aquatic Salamander Neurergus crocatus*. Department of Biology, Faculty of Science, University of Duhok, Duhok, Iraq. Volume 9, Number 1, 53 – 61.

Reliefweb (2018) Zimbabwe Cholera Outbreak – Sep 2018. https://reliefweb.int/disaster/ep-2018-000150-zwe Accessed 12 January 2019

START (2011) *Urban Poverty & Climate Change in Dar es Salaam, Tanzania: A Case Study*, https://start.org/wp-content/uploads/dar-case-study_p1-65_compressed.pdf Accessed 29 October 2018

Sverdlik, A. (2011) Ill-health and poverty: a literature review on health in informal settlements, *Environment & Urbanization*, Vol 23(1): 123–155

Tanzania National Bureau of Statistics (2012), Statistical Abstract 2011. p. 153. Ministry of Finance

Todes, A. (2012) Urban growth and strategic spatial planning in Johannesburg, South Africa, *Cities* 29 pp: 158–165.

Tsiko, R. G. and Togarepi, S. (2012) A Situational Analysis of Waste Management in Harare, Zimbabwe. *Journal of American Science* 8(4), pp: 692-706.

UNESCO (2018) Piloting the use of African Flood and Drought Monitor findings disseminated http://www.unesco.org/new/en/harare/about-this-office/single-view/news/piloting_the_use_of_african_flood_and_drought_monitor_findin/ Accessed 29 October 2018

United Nations (2014) Transboundary waters. https://www.un.org/waterforlifedecade/transboundary_waters.shtml Accessed 12 January 2019

United Nations (2015) Water for Life Decade. https://www.un.org/waterforlifedecade/ Accessed 12 January 2019

United Nations (2016) *The World's Cities in 2016*, pp 29. https://www.un.org/en/development/desa/population/publications/pdf/urbanization/the_worlds_cities_in_2016_data_booklet.pdf Accessed 29 October 2018

United Nations, (2018a). *The World's Cities in 2018—Data Booklet* Department of Economic and Social Affairs, Population Division (ST/ESA/ SER.A/417). https://www.un.org/en/events/citiesday/assets/pdf/the_worlds_cities_in_2018_data_booklet.pdf Accessed 29 October 2018

United Nations (2018b) *Sustainable Development Goals*. https://www.un.org/sustainabledevelopment/sustainable-development-goals/ Accessed 29 October 2018

United Nations (2018c) *World Urbanization Prospects: the 2018 Revision*, Department of Economic and Social Affairs, https://population.un.org/wup/Publications/Files/WUP2018-KeyFacts.pdf Accessed 29 October 2018

United Nations (2019) *Water*. https://www.un.org/en/sections/issues-depth/water/ Accessed 12 January 2019

Wakeford, J. 2013, *Oil Shock Vulnerabilities & Impacts: South Africa Case Study*, DfID, UK. https://assets.publishing.service.gov.uk/media/57a08a4c40f0b652dd00067a/61062-Case-Study-South-Africa.pdf Accessed 29 October 2018

WHO 2002. *Global Solar UV Index: A Practical Guide*. World Health Organization. pp. 18. https://www.who.int/uv/publications/en/UVIGuide.pdf Accessed 29 October 2018

Zimbabwe Homeless People's Federation (2014) *Harare Slum Profiles Report*, International Institute for Environment and Development. http://pubs.iied.org/G03861.htm Accessed 12 January 2019

Zimbabwe Homeless People's Federation/ (2015) Harare Slum Upgrading Profiles. Dialogue on Shelter and City of Harare https://knowyourcity.info/wp-content/uploads/2015/04/Harare_Slum_Upgrading_Profiles.pdf Accessed 12 January 2019

Strengthening Urban Engagement of Universities in Africa and Asia

# TPS 103/19: Impact of University engagement on environmental resilience of urban spaces in Asia and Africa

Argamosa. F.R., Azizi, N., Burnside, N., Houston, M., Janse van Rensberg, N., Ketuly, K. A. Mohammed, S.A., Moshi, H. and Nherera, C. (2019) Impact of University engagement on environmental resilience of urban spaces in Asia and Africa, SUEUAA Thematic Paper Series, TPS 103/19. CR&DALL, Glasgow, UK, ISSN 2517-5548 (online) ISSN 2517-553X (Print)

www.sueuaa.org