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Preface

Julian Hunt[1,*], *Jianping Wu*[2]

1. *University College London and Trinity College, University of Cambridge, UK*
2. *School of Civil Engineering, Tsinghua University, Beijing, China*

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ABSTRACT

The Asian Network on Climate Science and Technology (www.ancst.org), in collaboration with Tsinghua University, held a conference on environmental and climate science, air pollution, urban planning and transportation in July 2015, with over 40 Asian experts participating and presentation. This was followed by a meeting with local government and community experts on the practical conclusions of the conference. Of the papers presented at the conference a selection are included in this special issue of *Journal of Environmental Science*, which also reflects the conclusions of the Paris Climate meeting in Dec 2015, when the major nations of the world agreed about the compelling need to reduce the upward trend of adverse impacts associated with global climate change. Now is the time for urban areas to work out the serious consequences for their populations, but also how they should work together to take action to reduce global warming to benefit their own communities and also the whole planet!

Introduction

The conurbations of Asia are rapidly expanding and changing faster than at any time in history, with some urban areas and populations doubling in less than 10 years. Their physical and natural states are also being transformed. Very tall buildings in business districts and new 50 story housing estates now rise to 100 m or more; urban coast-lines are moving out into the adjoining seas and lakes, with economies doubling at about the same rate, people in cities are consuming and discharging ever larger volumes of natural resources, and transforming the natural environment of their surroundings, with more people travelling across larger cities, transport facilities are having to expand, although in many cities they are still not sufficient to avoid saturation and even shut-down. In many cities, the rise in air pollution is exceeding international health standards, which particularly affect the elderly and small children. In addition to the worsening of short and long term environmental changes, an increasing numbers of people are impacted by natural hazards within these areas. Innovative cities are using a range of measures, including technologies and better planning, with cleaner transport with electric vehicles and new building systems incorporating, in tropical cities, air-conditioning to lower indoor temperatures and air-cleaners to remove fine particles from living spaces and in passenger vehicles.

It is even more important that vulnerable communities are provided with public sheltering facilities to reduce the impacts of periods of high temperature, high pollution and dangerous flooding. But many Asian cities are losing the vital contribution to public health of green spaces, despite studies showing why maintaining parks and road-side trees is a cost effective measure against high temperature and pollution, and flooding.

Atmospheric measurements and computer models confirm that, as the urban areas expand, they affect both higher layers in the atmosphere and also how they are affecting the environment over hundreds of kilometres away from the

* *Corresponding author. E-mail:* julian.hunt@ucl.ac.uk (Julian Hunt).
E-mail: jianpingwu@tsinghua.edu.cn (Jianping Wu).

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cities (Hunt et al., 2016). With urbanisation reducing the vegetation cover from 80% down to 1%, and enlarging the areas of high buildings, the albedo and the diurnal cycle of heating and cooling are changed substantially. The main consequence is that the mean surface temperature in urban areas has risen faster than by global warming, by about 1.4°C over the large conurbations. The pattern of precipitation has also changed. Just like other mesoscale disturbances in boundary layer flows, large change in surface conditions over the conurbation affect precipitation and temperature in areas more than 100 km down-wind (Cheng and Johnny, 2012).

Leaders of the major cities around the world are now well aware that the physical growth and the transformations of their regions are affecting the climate and the environment of the whole world, with serious consequences for the long term well-being of the whole of the world's population. Since the energy use by transport, housing and industry of urban areas are responsible for more than half the total consumption of carbon based fuels, large cities are responsible for the increasing global level of green-house gases and consequently for the continuing rise in global average temperature. Furthermore leaders are also showing their responsibility by explaining to their public how their urban areas are also experiencing adverse feed-back effects including rising global temperatures, changing patterns of global climate and, for coastal cities, rising sea levels and ocean acidification.

Of great concern to cities are the increased risks of more extended periods of very hot or very cold weather and high levels of dust and pollution, which can be more acute in cities than in the surrounding areas. In either of these temperature extremes there is greater incidence of illness and death among vulnerable groups such as the elderly, young children and asthmatics, which are further exacerbated when there are high levels of air pollution carried into the cities from agricultural burning, shipping in coastal cities and industries. Worsening environments on land and sea also have negative economic effects such as on tourism, fishing, agriculture and forestry.

The variability of global climate change also causes variability in natural hazards and their impacts in large urban areas, especially in Asia. Some geophysical hazard-events occur relatively slowly, such as those associated with high or low temperature, or floods from high precipitation. With very high temperatures, weak winds driven by deep turbulent convection can vary markedly across urban areas, usually with the maximum temperatures occurring towards the downwind part of the city. Also these patterns tend to vary unsteadily in time, depending on the surface conditions and density of high buildings. During extreme atmospheric events, large cities meet requirements for extra levels of energy for cooling or heating, as well as meeting the usual demands for transportation. Urban planning and design need to become more energy efficient in the future, to avoid contributing an increasing proportion of global greenhouse gas emissions. With more complete environmental data at ground level, and new data from tall meteorological masts and towers such as those in Beijing and other Asian cities, these environmental hazards could be better monitored, predicted and understood as shown recently in London where tower data have demonstrated their utility. The health of cities will also benefit from studies leading to better ventilated streets and well maintained green spaces.

Near the Equator, except when there are violent wind storms, the wind speeds are generally low, especially in the evening. The expansion of large cities, which further reduces wind speeds, also contributes to higher temperatures locally and over the whole globe. For inland urban areas over the winter months, the high concentrations of urban and rural aerosols prevent the sun's rays reaching the ground level, further reducing the temperature and even freezing small rivers, as observed in Delhi in 2014. In north Indian plain, there are increasing economic impacts as winter transport is severely disrupted for days on end not only aircraft, but even trains and road traffic reminiscent of Europe and USA before the 1960s.

The cities in South East Asia, particularly Manila, not only experience serious impacts from the worsening atmospheric environment, but they also suffer from multiple hazards resulting from severe rain, mud slides, high winds and flooding on the coasts and inland. Such events can occur simultaneously or in close succession (Hunt, 2009). The impacts of these hazards on communities are magnified in the most increasing populous areas which are often located in vulnerable locations, for example next to rivers, on hillsides or on the coasts, where typhoon flooding can devastate whole communities. Future planning has to allow for future trends that show how over the past 100 years, peak rainfall rates have doubled and their frequency has also increased, which has been partly caused as by the effects of urban growth. Since global warming is increasing and also atmospheric humidity, the severity and frequency of these flood hazards are likely to keep increasing, especially in tropical regions.

But technology can reduce the impact of these hazards through forecasting their movement a few hours ahead, for example with the aid of using weather radar systems for tracking moving clouds of intense rain. With improved modelling and communications, even to individuals, local communities can now evacuate flood prone areas and move to public refuge buildings (Lagmay et al., 2017a), which are being repositioned more appropriately using models and data of how floods build up in these critical areas. Many lives have been saved, but unless the urban infrastructure is improved, the impacts on property will keep on increasing.

A range of policies for dealing with the issues are being considered in major urban areas in Asia. In some cities in China, planning policies have focussed on reducing the continued spatial growth of some of the largest cities by creating separate new towns about 50–100 km away. In principle, this approach should produce lower air pollution in satellite cities by reducing commuting distances of car drivers, and moderate rising urban temperatures by limiting the growth of the mega city. But there is evidence that people do not necessarily behave according to plan. It is found that commuting distances can even increase because, while jobs can be moved, families may not want to be displaced. Other planning policies as in Delhi and Singapore are focusing on how to reduce air pollution whether it is produced regionally or locally within the cities. At a local level, populations are exposed to road-side traffic pollution in street canyons and densely-developed city regions. Because of low levels of