Mapping the socio-political landscape of heat mitigation through urban greenspaces: the case of Taipei Metropolis.

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Title: Mapping the socio-political landscape of heat mitigation through urban greenspaces: the case of Taipei Metropolis

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ABSTRACT

We assess socio-political challenges for urban heat island (UHI) mitigation in greenspace planning, focusing on Taipei Metropolis, Taiwan. Through analysis of articles from two newspapers, we suggest that attention to greenery and heat tends to reflect immediate weather or planning considerations, and that a perception of greenspace as a barrier to economic development remains. Broad-based, durable rationales extending beyond climate adaptation benefits may be required to sustain support for greenspace planning in Taipei. There is also a need to raise decision-maker awareness of the specific actions required to realise cooling benefits via greening. We argue the Taipei case demonstrates the potential for policy messaging based on greenspace functions to attain cross-sectoral buy-in for greenspace development or preservation, but that planners and policymakers must ensure consensus-based governance actually delivers cooling benefits to citizens. Our results also indicate greenspace planning policy could more explicitly address community-level greening specifically targeted at cooling or other climate adaptation challenges.

KEYWORDS: climate change adaptation; greenspace; green infrastructure; media analysis; Taipei; urban heat island.

I. INTRODUCTION

This paper assesses social and policy challenges and opportunities for urban heat island mitigation

within strategic greenspace planning, focusing on Taipei Metropolis, Taiwan. Whilst cooling is of course only one of a number of services greenspace may deliver, the UHI effect – higher temperatures in urban areas than their rural surroundings – is a key issue for urban climate change adaptation, especially in tropical and subtropical cities and low-to-middle income countries[1]. Greening within cities is increasingly considered an effective response[2], but an understanding of the climate adaptation potential of greening is still emerging in many low-to-middle-income city contexts[3]. In this paper we use the UHI mitigation potential of greenspace as a focal point for elaborating pathways and barriers to climate adaptation actions via urban greening. Indeed, although urban heat has been researched in Taipei[4], within the city's urban plan and its climate adaptation measures an understanding of heat is still emerging. This is particularly concerning given the significant warming trend within Taipei. Moreover, whilst greenspaces are recognised for their cooling potential in Taipei, they rarely appear in the development debate. Taipei is therefore a city where greenspace provision has the potential to address climate change issues, but where the social and policy milieu may frustrate planning initiatives. Evaluation of the socio-political context around greenspace deployment in Taipei can thus identify barriers that planners working in similar cities elsewhere may face, as well as policy frameworks and messages to surmount these challenges. Our aims are therefore (a) to assess the socio-political landscape around UHI mitigation within greenspace governance in Taipei; and (b) to use the Taipei case to describe challenges for addressing UHI issues and broader climate adaptation responses in greenspace planning.

Our evaluation draws on analysis of two major English-language newspapers in Taiwan – the Taipei Times and the China Post. Press reporting is a channel for observing governance priorities and reflecting societal discourse, and can thus help identify reasons why heat mitigation related to greenspace provision may or may not succeed in Taipei. Our findings indicate that heat mitigation could act as one of several arguments emphasising the *value* of greenspace to Taipei, which may work together to build political traction for strategic greenspace planning. More broadly, we argue that the Taipei case demonstrates the potential for messaging about greenspace function to galvanise diverse actors in the common direction of greenspace preservation or deployment, and also the need to further explore municipal collaboration with communities targeted at specific strategic actions such as heat mitigation.

II. BACKGROUND AND CONTEXT

a. Conceptual framework

Whilst cities are recognized as significant sites for climate change actions, and as an appropriate scale for this action[5], there remains the question of how different actors (e.g. developers, policymakers, scientists) interpret and engage with climate change. Not everyone involved in environmental governance debates will engage with 'scientific' rationales for action[6]. A decline in trust has been observed in 'expert' scientists and policymakers previously entrusted to make decisions on behalf of society.[7] Coupled with this, top-down governance processes based on technical or scientific arguments alone may struggle to encompass the range of concerns at play for issues like climate change[8].

In an urban context, these issues become even more pronounced. Cities are complex systems[9] where systematic urban greening requires the support of governmental, private sector and civil society actors – each with their own motivations and value positions[10]. The complexity of environments and ecosystems themselves means a range of specialisations and knowledge needs to be brought together to develop and initiate truly 'sustainable' planning[11]. Moreover, there are the social implications of sustainability, which involves a concern with equity. Yet there are challenges around enacting interventions that primarily benefit vulnerable sectors of society[12] and it can be difficult to retain a focus on the underlying structural causes of inequality and vulnerability[13].

In short, when responding to climate change, the range of strategies open to urban planners is influenced not only by what is technically and scientifically appropriate, but also by what is socially and politically perceived as acceptable. Policymaking for planning climate adaptation actions hence necessitates processes of environmental governance, defined by Adger et al in 2003 as the resolution of conflicts through institutional arrangements that may facilitate or limit the use of natural resources[14]. This definition was later elaborated in the urban environmental context as the coordination of multiple actors involved in steering society towards low-carbon, resilient or sustainable objectives[15]. There has been increasing interest in messaging that can bring a diverse and potentially conflicting range of interests together early in the planning process, to work in the common direction of developing planning outcomes that address both technical and societal concerns[16]. Strategic actions in urban governance that link climate adaptation with socio-economic imperatives have been argued to have a better chance of taking root and transcending sectoral interests than actions justified in terms of climate change adaptation alone[17]. In this paper, we assess the range of value positions around greenspace planning in Taipei, and what opportunities this might give for strategic messaging around greenspace policy in Taipei and other localities, in order to work towards such planning-based adaptation actions as UHI mitigation.

b. UHI and role of greenspace in cooling

Multifunctional greenspace may serve many purposes – recreation, biodiversity, water management, air quality among others – of which cooling is only one. However, to assess the socio-political dimensions in sufficient depth within the confines of a paper, we focus on UHI mitigation as one specific greenspace planning objective relevant to Taipei. Increasing the abundance and cover of vegetation can counter the UHI effect through the lower radiance, increased evapotranspiration and greater shading provided by vegetated surfaces[18]. Increasing thermal comfort is also a benefit of 'green infrastructure', defined as an interconnected network of greenspace conserving natural ecosystem values and delivering benefits to humans[19]. Greenspace may cover a range of scales, from urban street trees to private gardens to city parks[20]. Whilst more research is arguably needed to understand how effective different greening actions are in delivering cooling[21], recent research in Taipei suggests that creating connections between greenspaces and/or enhancing greenery at greenspace edges may maximise cooling benefits[22].

Heat and greenspace access are socio-political as well as techno-scientific issues. Heat

vulnerability and access to greenspace varies within cities usually in accordance with socio-economic and demographic factors[23]. Due to its cost-effective nature, greening may be one way of providing cooling to communities with lower adaptive capacity, thus reducing such 'thermal inequity'[24]. Greenspace preservation or deployment is also increasingly framed in terms of economic development and municipal or regional policy[25]. As such, the provision of greenspace – and its role in mitigating UHI effects – is likely to reflect a complex range of interests, as discussed in Section 2a.

c. Taipei, climate change adaptation and heat

Taipei Metropolis, situated in north Taiwan, encompasses Taipei City and New Taipei City. The urbanised area covers approximately 2,726 km^2 with a population estimated at 6.67 million in 2014. The climate is humid subtropical and influenced by monsoon. Due to global warming and rapid urbanisation[26], temperatures in Taipei are rising at 0.27°C/year compared to the global average of 0.16°C/year. The number of extreme hot days (defined as above 35.5°C) has increased by 4 days per decade over the last 30 years[27]. The Representative Concentration Pathway 8.5 scenario is one of four future greenhouse gas concentration scenarios developed by the Intergovernmental Panel on Climate Change (IPCC) for modelling and research purposes, and is the one representing a 'business as usual' emission rise throughout the 21st Century[28]. Under this scenario, average annual temperatures in Taiwan are predicted to rise between 1.66°C and 5.01°C by the 2080s, with mean summer temperatures expected to increase 2.7°C by 2050[29].

Extreme heat is therefore a serious issue for Taipei, with concerns over deterioration of air and water quality, spread of disease, change of precipitation, and such public health impacts as increased mortality among the elderly[30]. Taiwan is among the fastest aging countries globally, and nearly 15 percent of the Taipei population is over 65 years old – an age group highly vulnerable to heat[31]. Extreme urban heat could thus increase the burden on Taiwan's national health care system. Warming enhances the demand on air conditioning and cooling systems, increasing the risk of electricity shortages. This may intensify in coming decades as Taiwan replaces its current coal and nuclear electricity base with renewable sources. This transition could (in the short term at least) be costly and affect capacity, with knock-on effects for consumers in terms of electricity pricing (and hence affordability of air conditioning) and availability at times of high demand[32].

To improve urban thermal comfort, urban greening has been considered in the Adaptation Strategy to Climate Change in Taiwan[33]. However, due to lack of evidence-based guidelines, low policy priority, and limited integration into existing urban planning systems, this strategy has to date been addressed to only a limited extent. Recreational greenspaces, officially defined as parks, sports venues, greeneries, squares and playgrounds, are controlled by land zoning regulations and designed to reach 10% of the city[34]. Yet by 2015, green coverage in Taipei City only reached 5.08%. Taipei City Government aims to provide every citizen with up to 7.48 m^2 of greenspace [35]. By the end of 2015, greenspace per capita in Taipei had reached 5.04 m^2 [36]. More than 80% of official greenspaces (excluding riverside parks) in Taipei are less than one hectare. Large greenspaces (greater than 4 hectares) are primarily located in the less accessible city outskirts.

The area-distance standard is not explicitly included in planning documents, but most areas in Taipei have greenspaces accessible to residents within 400m. The limited greenspace size in the urban core and the challenge of balancing greening with development pressure is not dissimilar to that in other densely-populated Asian cities such as Hong Kong[37] and Singapore[38]. Exploring ways to develop multifunctional greenspace in Taipei may contribute to a more general understanding of common problems and solutions, and facilitate mutual learning for urbanising tropical and subtropical cities.

III. METHOD

We draw on and analyse news articles to identify stakeholders and arguments around UHI mitigation within greenspace debates in Taipei. Similar to Pulver and Sainz-Santamaria[39], we use newspaper content interpretatively to assess the societal events and issues that are described, rather than the substance of the reporting *per se*. News sources have been used to map out an issue in this way across a number of climate change-related contexts[40].

a. Data

We sampled the online versions of two of Taiwan's largest English-language newspapers (and the last two producing print versions at the time of data collection): The Taipei Times and The China Post. These newspapers provide balanced and in-depth reporting on social issues in Taipei and Taiwan as well as editorials, regular columns and opinion pieces that provide different perspectives on current issues. They can hence be considered an appropriate resource for surveying the governance landscape.

Articles were selected from 1 December 1999 (the earliest year that online articles were available) to 31 March 2016. Each publication's website (http://www.taipeitimes.com and http://www.chinapost.com.tw) was searched for the words/phrases 'heat', 'heat island', 'greenery', 'greenspace' or 'green space.' This choice of terms encompassed the wider context in which greenery and greenspace is discussed in Taipei beyond heat mitigation, as well as the interface between heat and greenery. Articles unrelated to the research focus or not relevant to Taiwan (such as syndicated news association reports relating to heat in locations other than Taiwan) were excluded. However, articles discussing heat and greenery in other cities such as Kaohsiung or in Taiwan generally were included, as they provided analogous cases or contextual background which might reflect and/or feed into greenspace discussions in Taipei.

First, information on the date, authorship, topic and tone, as well as the type of greenery involved, was recorded for each identified article (n=90; 33 China Post, 57 Taipei Times). Second, for articles within this sample engaging specifically with heat or greenspace (n=57, 14 China Post, 43 Taipei Times), information on the speaker, type and tone of each statement reported within the article was recorded. 215 statements were identified through this process, giving a broader representation of the argumentation used in these articles than would have been available from their authors' perspectives alone.

Table 1 shows the coding scheme for article topics, argument types, article/argument tones, sector of speaker; and type of greenery. The categories were developed iteratively through discussion within the research team during initial reading, based on the language used in the articles themselves and guided by the researchers' pre-existing knowledge of urban greening. Due to the larger number of statements and their particular value in assessing perceptions of the role of greenery in heat mitigation, argument types were further assessed through argument mapping[41]. This involved the identification of individual arguments within articles, and their grouping into similar clusters under eight main themes, providing as noted a more nuanced picture of the different kinds of arguments deployed in the governance landscape. The map is a heuristic tool to represent the data in visual form and aid in the interpretation of the quantitative and qualitative results, not a precise or exhaustive overview. A version of the map showing the two highest levels of argument is presented in Section 4c (see Figure 3), and a full map down to the level of individual statements is available online in the Supplementary Data.

INSERT TABLE 1: Variables and categories used for analysis

Intercoder reliability was calculated for both the first stage (identifying themes in articles overall) and second stage (identifying themes in individual arguments) on a 20% data sample (20 articles and 58 arguments, considered appropriate for a small dataset[42]). Krippendorff's Alpha assessed reliability for the subjective or interpretative categories drawn from the articles[43]. For the first stage analysis (general perspective of articles), an alpha of 0.82 was recorded for theme identification and 0.70 for tone (however, this lower number is attributable to difference in coding 'strong' versus 'weak' arguments, and when 'strong' and 'weak' categories were collapsed, alpha improved to 0.90). For the second stage (arguments within stories), an alpha of 0.78 was recorded for argument categorisation and 0.81 for tone when collapsed into 'positive', 'negative' and 'neutral' categories (an alpha of 0.61 was recorded initially for the different types of tone, again indicating the difficulty in differentiating between 'strong' and 'weak' arguments). The categories used for the analysis on which this paper is based – theme/argumentation and tone collapsed into positive/negative/balanced – thus return scores consistent with good inter-coder reliability[44].

b. Analysis

Quantitative analysis was undertaken via SPSS. To assess trends in reporting on heat and greenery over time, the number of words per season written about heat and greenery was calculated (winter/Q1 was taken as December of the preceding year, January and February; spring/Q2 as March-May; summer/Q3 as June-August; and autumn/Q4 as September-November). To understand the context in which heat and greenery were discussed, by whom, and in what way, frequencies were calculated: for the distribution of article themes, topic and tone; for the distribution of argument by type, tone and sector of speaker; and for the type of greenspace/greenery mentioned and the tone in which it was discussed at both the article and argument level.

Relationships between tone of article, sector of speaker and type of argument were assessed through chi-square tests (tone vs type of argument; tone vs sector of speaker; sector of speaker vs

type of argument). The objectives was to give deeper insight into the governance landscape for heat and greenery in Taipei, by evaluating whether certain types of argument tended to be viewed more positively or negatively than others; whether certain groups viewed greening and heat mitigation more positively than others; and whether some types of argument were more engaging to some groups than others. The relationship between tone and type of greenery was also assessed through chi-square testing at both the article and individual argument level, to evaluate whether different types of green infrastructure were viewed equally favourably. The purpose of these analyses was (a) to understand which groups of people were likely to act as a barrier for greening in Taipei and for what reasons; and (b) to identify greening solutions and rationales likely to be supported across the different sectors in the governance process. Chi-square is an appropriate measure for assessing the relationship between nominal data of this nature[45]. To meet validity criteria or enhance intercoder reliability, some variables were collapsed for analysis, as indicated in Table 1. Neutral or factual statements were excluded from statistical analysis, but in any case only made up a small proportion of the dataset (n=2 for arguments; n=32 for greenery by article tone; n=1 for greenery by argument tone). Full statistical tables and analyses – plus an inventory of sampled news articles – are included in the Supplementary Data.

The trends identified in quantitative analysis were used as a basis for further qualitative assessment of the sampled news articles through thematic coding. This involved re-reading the articles to identify places where the themes and arguments identified during data collection were raised, with the aim of thinking holistically about the articles and assessing the wider context behind the trends identified in statistical analysis. Indicative quotes which refine, add nuance or explain the statistical findings are reported in Section 4 alongside the quantitative results.

IV. FINDINGS

Our findings inevitably focus on governance challenges for urban greenspace in Taipei, which are reflective of the local complexities and context. In Section 5 we discuss the implications for UHI mitigation of strategic urban planning more broadly.

a. Seasonality and attention cycles in greenspace planning debates

INSERT FIGURE 1: word count per season for articles about heat and/or greenery in Taipei.

We first assess when heat and greenery is discussed in Taipei. Figure 1 shows the number of words written about heat and about greenery in Taipei per season between winter 2000 and spring 2016. Two points are noticeable: that the number of words written over time on the topics of greenery and heat in Taipei has increased, and that peaks in the number of words written tend to come in spring (Q2), summer (Q3) and autumn (Q4). For years where complete data is available (2000-2015), the highest number of words is written in Q1 on only two occasions, compared to five for Q2, five for Q3 and three for Q4 (plus one year where no words were written). Of the ten highest peaks, four fall in Q2, three in Q3 and three in Q4, with none in Q1. The increase in words over time points to the increasing prominence of both extreme heat and greenery in debates in Taipei; however, the comparatively limited discussion in winter suggests attention to the issue

may not be consistent throughout the year. This is reflected in the article content:

> *Over the last few days the temperature in Taiwan has shot up and the media has been awash with articles of how people can avoid the worst of the heat wave. The papers have also been full of stories about the number of heat-related deaths. Questions have been raised as to the potential health risks posed by the scorching heat* (academic, writing in Taipei Times, 14 July 2010)

> *The Taipei City Government announced yesterday that it will send out water sprinkling vehicles whenever the temperature reaches above 37.5 degrees Celsius to reduce the persistent heat. Taipei's temperature reached 38.3 C on Wednesday […] According to local media reports, the continuous heat is believed to have killed four people in Taipei so far* (staff reporter, China Post, 13 July 2012)

The lower prominence of discussion about heat and about greenery in winter is not surprising. The negative effects of extreme heat on humans become 'newsworthy' when the temperatures are highest and the risk to people is greatest, which likely happens in and around summer. Time markers such as "over the last few days" and "Taipei City Government announced yesterday" indicate that discussions on extreme heat take place in response to events which have either just happened, or are about to happen. However, UHI mitigation interest also rises around bigger debates on greenspace provision in Taipei, for instance the Taipei Dome development and Songshan Airport renewal:

> *The group called for the creation of a green space at the dome site to prevent an increase in the urban heat island effect, modulate sudden rainfall and maintain biodiversity* (environmental NGO, reported in Taipei Times, 31 August 2011)

> *The ambitious plan would make the airport a park connected with a number of other parks along the Keelung River […] The proposed park, which would be larger than the 260 hectare Hyde Park in London and the 340 hectare Central Park in New York City, could change the microclimate and the urban heat island phenomenon in Taipei, he said* (politician, reported in Taipei Times, 24 February 2014)

Heat mitigation gains attention here as one dimension of larger Taipei planning controversies, namely, the removal of trees and loss of greenspace related to construction of the new Taipei Dome, and proposals to close Songshan Airport and replace part of it with a park. Although not statistically confirmable with the data available, the word count peaks in late 2010 and mid/late-2012 (see Figure 1) respectively correspond to the run-up to approval of Taipei Dome's urban design review; and the Ministry of Transportation and Communications launch of an expansion and development plan for Songshan Airport (which reignited political debate on the future of the airport area). More attention may hence be drawn towards heat mitigation potential when controversy over the future and value of greenspaces in Taipei flares up for other reasons.

The possible relation of heat mitigation and greenery reporting, in Taipei at least, to immediate

weather considerations and larger planning controversies reflects the attention cycle concept[46]. Both the realist (physical reality of the situation) and narrative (wider social context and stories around an event) components of attention cycles elaborated for climate change by McComas and Shanahan[47] can be seen in Taipei. The realist dimension comes through the fact that extreme summer heat is a growing concern in Taipei[48], making it logical to expect discussion and coverage will increase during summer. The narrative dimension comes through the connection of UHI to a bigger social narrative about the role and value of greenspace in the city, reflected in site-specific controversies like Songshan Airport or the Songshan Tobacco Factory/Taipei Dome site. However, the development of greening and spatial planning decisions at the municipal level, and also greenery planting/maintenance at the local level - require sustained and long-term action[49]. For urban greening actions to deliver benefits like UHI mitigation in Taipei, sustained social momentum is required. There may thus be a need for those with specialist knowledge about greenery and climate, for instance urban planners or academics, to develop framings which can stimulate politicians' and citizens' attention to the role of greenery in UHI mitigation (or, indeed, other functions) beyond peak points in attention cycles. What these arguments might be - and which might be the strongest - is the focus of the rest of this section.

b. The breadth and vagueness of greenspace planning discussion

INSERT FIGURES 2A AND 2B: Figure 2a (left): main theme of articles referring to heat or greenery; Figure 2b (right): distribution of arguments within articles by category.

Figures 2a and 2b summarise the themes of articles mentioning heat and/or greenery, and the distribution of arguments within the articles themselves. Figure 3 further represents this diversity in argument map form. It is perhaps not surprising to note that over half of the articles focus on planning (n=26, 29%) or greenery and greenspace (n=21, 23%) issues, and that no single kind of argument dominates within the articles. Moreover, the two most frequent argument categories in the articles are the more generic categories of health and societal benefit (20%, n=40) and environmental issues (18%, n=35). These appear rather more frequently than articles with a narrower focus on climate change (11%, n=21) or techno-scientific knowledge (7%, n=13). In our qualitative analysis too, statements or reports about heat and greenery in Taipei are limited in specificity:

> *OURs added in a press release that the average nighttime temperature in metropolitan Taipei was about 3°C higher than the global average, and that the number of days in downtown Taipei where temperatures rose above 35°C was also increasing* (environmental NGO, reported in Taipei Times, 31 August 2011)
>
> *Temperatures above 36 degrees are expected in the Greater Taipei area due to the urban heat island effect* (Central Weather Bureau, reported in China Post, 7 July 2013)

Temperatures are reported as an average for Taipei as a whole, referring to "Greater," "metropolitan" or "downtown" rather than specific districts or areas where temperatures may be higher. There is likewise only limited discussion of the cooling effects to be gained from different

types of 'greenery':

> *The popularity of the greening projects is partly due to the use of landscape technology that does not damage the structure of buildings. The vegetation's cooling effect, which helps reduce energy consumption, is another factor* (borough chief, reported in China Post, 20 August 2009)

> *Yao suggested that* [Songshan] *airport be relocated so that a riverside park can be developed on the land along the Keelung River (基隆河). More green space in the urban area would not only reduce the "heat island effect" in the city, but also expand the space city residents have to engage in leisure activities, he said* (politician, reported in Taipei Times, 18 November 2012)

INSERT FIGURE 3 NEAR HERE: argument map for heat and greenery in Taipei, showing two highest levels of argument (following principles of van Egmond & Hekkert, 2012).

Whilst some sampled articles touch on the comparative cooling effects of green roofs, trees, plants and parks[50], the majority utilise the kinds of descriptions seen above - "green space", "greening" and "vegetation". Table 2 records the frequencies and percentages of all instances of greenery or greenspace mentioned across all the news articles in the sample. The most frequent are either the most generic ('greenery' (18%, n=24), 'greenspace' (17%, n=23)) or those used in common parlance ('park' (17%, n=23), 'trees' (16%, n=22)). Newspaper reports intended for the public are of course not expected to go into the same kind of depth as technical documents for heat vulnerability or the cooling effects of greenery. But the statements above report the speech of actors who shape the social and political context within which planners work - governors, NGOs and government institutions. By contrast, the heterogeneity in heat effects that have been demonstrated to exist within cities like Taipei[51] and possible differences in cooling provided by different kinds of greenery[52] mean that specific and detailed knowledge is required to understand which planning decisions and which actions can deliver the most effective cooling via greenery in urban areas. The generic language used by decision-makers and opinion shapers when discussing heat and greenery in Taipei indicates more needs to be done through policy inputs from planners or academics to raise awareness of the complexity of heat and greenery across Taipei - and of the kinds of greenspace planning actions that can deliver cooling - if effective heat mitigation is to be attained.

INSERT TABLE 2: Types of greenery/greenspace mentioned in articles and frequency/percentage

Heat mitigation is but one of many benefits that may be derived from greenspace. Finding ways to connect with broader rationales for urban greenery may help to bring discussion of strategic actions like heat mitigation into mainstream planning debates. These rationales may be coalitions of arguments working in the same practical direction of greening in Taipei. Potential messages identified in our analysis which planners could link with heat mitigation arguments may include flood mitigation (especially important for Taipei); preserving historically or culturally meaningful spaces such as Songshan Tobacco Factory Park and wetlands at 202 Munitions Works in Nangang

District; or economic benefits provided either directly or indirectly by open spaces and greenery (see Section 4c). Yet there may be a simultaneous need to build understanding across all sections of society as to how the UHI effect differs *within* the city, and to ensure that greening is undertaken strategically in ways and in locations that will deliver heat mitigation. We now look in more depth at which of these wider arguments for greening may get the most support, and how an understanding of 'functional greenspace' may be developed.

c. Towards greenspace function as common ground?

To further elaborate what pathways to building heat mitigation understanding in greenspace governance might look like for Taipei, relationships between different sectors, types of arguments made and the tone of these arguments are assessed. The aim is to understand which kinds of arguments - and which kinds of greenery - are perceived positively and by whom, in order to identify messaging for greenspace planning policy that could be engaging to a range of constituencies. Relationships between the nature of arguments made and who makes them are assessed through chi square tests. These focus on the sector of the speaker and theme/tone of their argument, as well as the kinds of greenery referred to.

There is a weak connection between sector and theme. Private sector statements are distributed more towards economic arguments, whereas academic, decision-maker and civil society arguments are distributed more towards the environment and climate change. However, this distinction is not statistically significant ($df = 12$, $\chi^2 = 14.37$, $p = 0.28$). Likewise, there is a weak connection between sector and tone. Private sector statements are more negative or problem-focused, and civil society statements are more positive or solution-oriented. Again, this connection is not statistically significant ($df = 4$, $\chi^2 = 6.95$, $p = 0.14$).

However, there is variation in how different arguments - and types of greening - are perceived. A significant relationship exists between argument type and tone ($df = 3$, $\chi^2 = 8.73$, $p = 0.03$). This becomes even stronger when type of argument is disaggregated from the four collapsed categories into the eight initial categories identified ($df = 7$, $\chi^2 = 28.91$, $p = < 0.001$). Economic arguments are mainly negative and problem-oriented, whereas arguments based on health and society and environmental grounds are more positive and solution-focused. Moreover, a moderately significant relationship exists between type of greenery and the general tone of the articles ($df = 3$, $\chi^2 = 8.34$, $p = 0.04$). Articles focusing on community-scale greenery (rooftop gardens, community spaces) carry a more positive tone than those focusing on large-scale parks, greenspaces or ecosystem-level features like rivers and wetlands. A more positive view towards smaller-scale 'greenery' is observable in the individual arguments, although this is not statistically significant ($df = 3$, $\chi^2 = 3.71$, $p = 0.30$). The fact that the tone of the individual arguments gives a more mixed picture than the tone of the articles overall demonstrates that even within 'balanced' or 'factual' articles, a range of different arguments can be reported.

The first point to take is that greenery - especially large-scale greenspace - tends to be seen negatively in Taipei with regard to economic development. The qualitative article content reflects this:

> *Development and environmental protection must go hand-in-hand. Taiwan's economy cannot afford to get bogged down by people who aren't seeing the big picture* (editorial staff, China Post, 26 May 2010)

> *Farglory Land Development Co chairman Chao Teng-Hsiung (趙藤雄), who is eager to get on with the project, then held a press conference at which he asked for a meeting with Ko and said that "frankly speaking, these trees are ugly ... more beautiful trees could be planted there later," adding that it seemed "human life is worth less than the life of a tree."* (Taipei Dome developer, reported in Taipei Times, 16 January 2015)

Protection of the "environment" or "trees" is positioned as a potential barrier to "development" (short for economic development), something that gets in the way of enhancing the economy. By contrast, the second point to take from the chi-square analysis - again backed up by the qualitative content analysis - is that there is some emerging awareness in Taipei that greening can deliver 'value' in ways beyond recreation and intrinsic value. This is especially so when working at smaller scales:

> *In sweltering concrete jungles like Taipei, rooftop gardens are often touted as an effective means of bringing nature back into the city and addressing ecological issues [...] A green roof costs more to build and maintain than other roofs, but the potential energy savings may be able to offset those costs* (staff reporter, Taipei Times, 12 June 2005)

> *Taipei City is trying to build its image as a garden city with an emphasis on a balanced ecosystem, but* [a municipal government official] *also indicated it could have a strong stimulative effect on a number of sectors [...] help Taiwan's horticulture sector boost its production value by 23 percent [...] the tourism sector is also expected to benefit* (municipal government official, reported in China Post, 30 August 2009)

> *The "big tree" brand air conditioner does not add a single New Taiwan dollar to your electricity bill and in addition, it produces oxygen. This is well worth the money spent on trees and one can only hope that local academics would be able to produce a study to make the calculations on how valuable they are* (environmental political party, writing in Taipei Times, 13 August 2015)

'Value' here extends beyond the mere aesthetic benefit described in the second quote to also encompass energy savings and health benefits from cooling effects. Discussion of loss of worker productivity due to heat in other articles[53] shows another way in which cooling effects of greenery may indirectly return economic benefit.

Developing stronger messaging in Taipei around the services and functions (such as cooling) that urban greenspace at all scales provides[54] may be one way to balance competing developer, municipal government and civil society interests within the city. Lessons in this regard may be learned from urban climate research in Singapore, where the involvement of policymakers from

the outset in assessment of greenspaces for UHI mitigation aided the subsequent translation of urban ecology-related findings into policies and guidelines[55]. Our findings indicate that greenery - when understood as providing functions across a range of scales – can be perceived as an asset to Taipei, but that large-scale greenspaces may still be viewed as a barrier to economic development. It is also important to note, however, that cooling is only one service among several, and that trade-offs[56] may be required when thinking in terms of function – within which cooling benefits may not always win out.

V. DISCUSSION

The obstacles faced in considering UHI mitigation within greenspace planning in Taipei, and the opportunities identified around consensus and greenspace function, may be discussion points for urban planners working in other locations. First among these obstacles and opportunities is the role of evidence in greenspace planning. A recurring theme in our Taipei findings is the important role for environmental planners and practice-focused academics in ensuring planning for climate adaptation is supported with technical knowledge about greenspace functions and the nature of climate effects, rather than being at the mercy of attention cycles or sites of high-profile controversy. Challenges to enacting such 'evidence-based planning' are of course not new[57], and decision-support frameworks for integrating scientific findings in planning – including for heat mitigation specifically - do exist[58]. However, pathways to incorporating such knowledge into planning policy may not be clear in practice. Bristow (2010) believes that environmentally-focused policymakers and planners in Taiwan already possess the required competences to respond to climate issues but face political and institutional barriers[59]. Indeed, the breadth of sectors engaging with greenspace debates in Taipei indicates decisions over which benefits may win out in decision-making processes will likely depend on social relations as well as techno-scientific evidence. In comparable content analysis-based research in Singapore, debates over management of secondary forests are likewise informed not only by ecological knowledge, but by social relations between interest groups[60]. Governance of greenspace, including the appropriation of knowledge about ecosystem function, is thus a social process. The complex socio-political landscape around greenspace planning in Taipei reminds us the social sciences have a crucial role in climate change adaptation research - not only in assessing vulnerability and keeping a check on justice concerns, but also in identifying figures, points and framings in decision-making processes where the scientific evidence base for effective UHI mitigation via greening might be able to get traction.

The second issue is the importance – but also the potential limitations - of governance based on pragmatism and consensus. For urban greening there are at least two routes – urban planners focusing on people, and biologists or landscape ecologists focusing on environmental issues. Building on extant literature on collaborative governance and strategic action[61], throughout the paper we have argued for the need to develop broad-based durable rationales for urban greening with the potential to appeal to a range of constituencies, if specific actions such as UHI mitigation are to be realised. Given (a) the importance of private sector developers in shaping the built environment (including greenspace) in Taipei and cities like it[62], and (b) the need to initiate action relatively quickly given the urgency of climate issues, using framings such as greenspace function

to galvanise different actors could offer the best chance of realising tangible cooling benefits within a short time frame. This may be especially appealing if the alternative is polarised debate and paralysis on practical action. Previous experience in Taipei suggests, however, that cross-sector engagement may backfire if not undertaken sensitively. The Regulations of Bulk Reward for Urban Renewal (deployed by the Construction and Planning Agency of the Ministry of the Interior) and the 'Taipei Beautiful' programme (run by Taipei City) both gave additional building capacity or floor area to developers whose projects made ecological contributions to the city. However, these initiatives arguably lost the municipality support from civil society, after being perceived as shifting the focus of greening too far from delivering environmental benefit and towards developer profits[63].

Given that interest is growing in finding ways to transcend sectoral interests and gather broad support for urban climate adaptation actions[64], our Taipei findings raise a challenge for planners and municipal governments. If they are to make tangible progress on climate adaptation and reduce harm to citizens, they need to be able to balance the potential for consensus-based decisions grounded in greenspace function with the more fundamental risks of reinforcing inequality or losing focus on environmental outcomes that may come from inviting a wide range of actors into the planning process.

This leads to our third point - the need for planning policy to support community- or household-scale greening actions intended at realising specific strategic benefits. Partnerships between communities and municipalities with a focus on social sustainability have already been advocated in scholarship on equitable urban greening[65], and could be evaluated further for application to heat mitigation and similar climate adaptation contexts. In city contexts where greenspace is at a premium, attaining the necessary mass for functionality from limited available greenery – including community spaces and 'above-ground' greenspace such as rooftop gardens – becomes even more important[66]. Our Taipei data indicates these smaller-scale greenspaces are perceived more positively than their larger counterparts. Technically too, extending greenery at greenspace edges and connecting 'cool islands' - both of which may be achieved with small-scale greenery undertaken at the community or household level - has been suggested to extend greenspace cooling effects in Taipei[67]. A policy focus on community-level greening might thus make quicker practical gains on issues such as UHI mitigation in cities like Taipei where greenspace close to the population is limited, sidestepping some of the contestations and challenges associated with provision of larger greenspaces.

Elsewhere in subtropical and tropical Asia, it has also been argued that such neighbourhood-scale greening helps social cohesion and responds to communities' geographically- and socially-specific needs[68]. However, related research suggests skill and knowledge gaps may be a barrier to fully realising neighbourhood-scale greening – whether the lack of skilled practitioners to maintain trees as in Jim and Chan's (2016) evaluation of Hong Kong[69], or limited citizen understanding of appropriate strategies in Canadian and US cases[70]. The vague language around urban greening reported in our Taipei findings reflects this too. Some greening actions at the local scale are also more effective than others.[71] Ensuring that small-scale greening translates into cooling benefits requires context-specific technical knowledge from municipalities or associated

experts, with systematic planning across space, good technical understanding of greening strategies, and awareness of how heat exposure varies across a city.[72] As a means of maximising benefit, municipal urban greenspace planning policies intended for strategic planning on issues like heat might therefore include provision for education, funding and technical support for communities and individuals, alongside efforts to understand functions at the city scale. This provision could be particularly effective if targeted at communities with high exposure and vulnerability, or proximate to greenspaces where further greening may be able to extend cooling.

VI. FUTURE DIRECTIONS AND LIMITATIONS

Based on our analysis and subsequent discussion, we suggest the following actions may help to realise greenspace benefits in Taipei and could form the basis for further enquiry in future:

1) Raise understanding of greenspace functions by facilitating decision-maker engagement with academics and scientifically-aware environmental planners;
2) Expand municipal government definition of greenspace beyond the current narrow focus on 'parks and recreation'. Many types of greenspace (such as rooftop gardens or community spaces) which have the potential to deliver cooling benefits are currently not included in urban plans in Taipei;
3) Reconceptualise municipal greenspace planning in Taipei along the lines of green infrastructure. This may bring these smaller or informal greenspaces - which draw more positive sentiment in our dataset - into planning processes;
4) List multiple pathways to delivery of UHI mitigation via greening in Taipei – e.g. energy saving from above-ground greenspaces, aesthetic benefit from street tree preservation, building social relations via collaboration on functional greening of neighbourhood parks - to attain buy-in across sectors.

We have focused on articles from two English-language newspapers as a means of mapping out different positions and their implications for greenspace governance in Taipei. One extension of this research, perhaps branching out into social media where societal interaction with news stories can be more easily traced, would be to evaluate how news sources report heat and greenery/greenspace development and assess how this reporting might itself shape societal awareness and opinion. A second development would be extending beyond English-language coverage – which is nevertheless useful in identifying key actors and arguments – to include Chinese-language sources. Third, comparative studies in other cities where formal green infrastructure planning and/or UHI considerations are further developed could identify how differences in the social and policy landscape influence the success or otherwise of greening initiatives. Lastly, further enquiry into places where cooling benefits may have to be traded off against other benefits in Taipei would give a richer sense of the complexity around greenspace for climate adaptation in the city. Nevertheless, this paper has illustrated that using newspaper sources can give an accessible and high-level overview of the range of viewpoints around urban planning debates, and may – at limited cost – help planners to identify possible framings or messages to gain traction for greenspace decisions.

VII. CONCLUSIONS

The cooling potential of greenspace has to date received only limited attention from decision-makers and developers in Taipei. Nonetheless, the potential for greenspace to reduce the need for air conditioning, coupled with the potential for municipal greening actions to be extended or complemented at the household or community scale, means it has significant potential as a cost-effective and attainable climate adaptation strategy for tropical and subtropical cities like Taipei. However, our findings indicate that to realise these benefits, at least in in Taipei, policy messaging on UHI mitigation via strategic land use needs to be packaged with broader-based rationales that include the social, cultural and economic values delivered by greenspace, and its potential to engage a range of constituencies including developers, communities and non-specialist policymakers. Moreover, the experience in Taipei reminds us that although building cross-sectoral consensus could well help to make tangible gains on greening, it is important this does not lead to uncritically viewing all greening through any means as intrinsically 'good'. It remains imperative to retain a critical check on whether pragmatic greening processes do deliver benefit to the people – and locations – that are most vulnerable to climate risks.

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Table 1

Variable	**Categories**	**Collapsed categories for statistical testing (if applicable)**
Article topic	Economic development; energy; environmental issue; environmental benefit; excess heat; greenery and greenspace; planning and built environment.	N/A
Argument type	Climate change; economic development; energy; environmental; health and societal benefit; heat mitigation; knowledge and practice; policy and governance.	Economic (economic development; energy consumption); environment and climate (climate change; environmental quality; heat mitigation); health and social benefit (health and societal benefit); and policy and practice (knowledge and practice; policy and governance)
Sector of speaker	Academia and research; civil society; decision-maker; press; private sector.	N/A
Tone	Positive (including solutions such as green roofs); weak positive (generally positive / solution-focused but pointing out difficulties or limitations); weak negative (generally negative / problem-focused but pointing out potential solutions); negative (including problems, such as greenspace getting in the way of economic development); balanced / factual / neutral.	Positive (positive and weak positive); negative (negative and weak negative); balanced / factual / neutral.
Type of greenery	Agricultural land; biodiversity; community space; garden; general environment; green building; greenery; greenspace; park; plants; renewable energy-related; river;	Community or individual scale (community space; garden; green building; renewable energy-related; rooftop garden); generic greenery (general environment; greenery); large-

rooftop garden; trees.	scale (agricultural land; biodiversity; greenspace; park; river); trees and plants (plants; trees).

Table 2

Type of greenery/greenspace	**Frequency/percentage**
Agricultural land	1 (>1%)
Biodiversity	2 (1%)
Community space	8 (6%)
Garden	1 (>1%)
General environment	14 (10%)
Green building	4 (3%)
Greenery	24 (18%)
Greenspace	23 (17%)
Park	23 (17%)
Plants	6 (4%)
Renewable energy-related	4 (3%)
River	3 (2%)
Rooftop garden	3 (2%)
Trees	22 (16%)

Figure 1

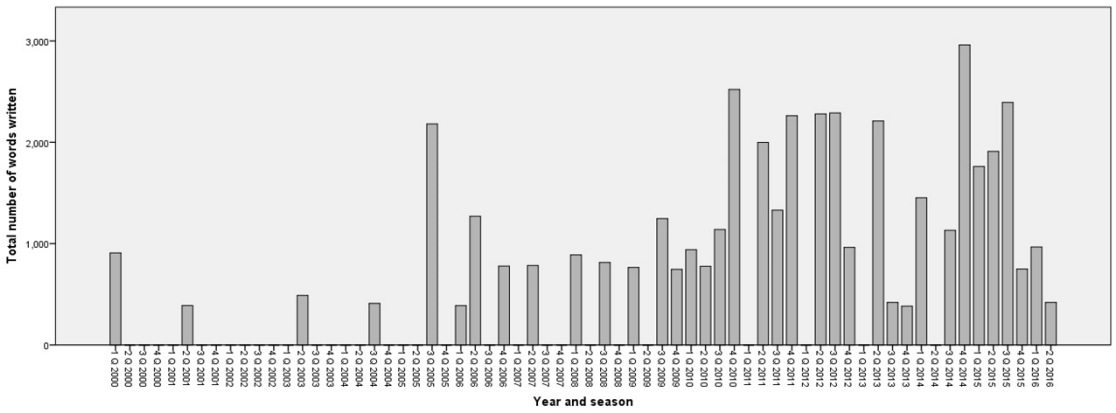


Figure 2a and 2b

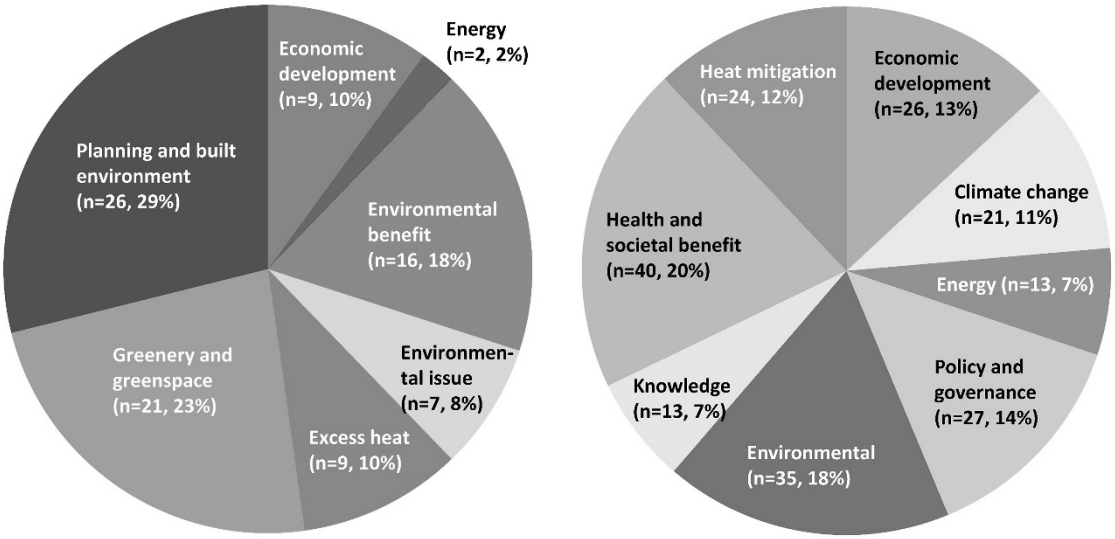
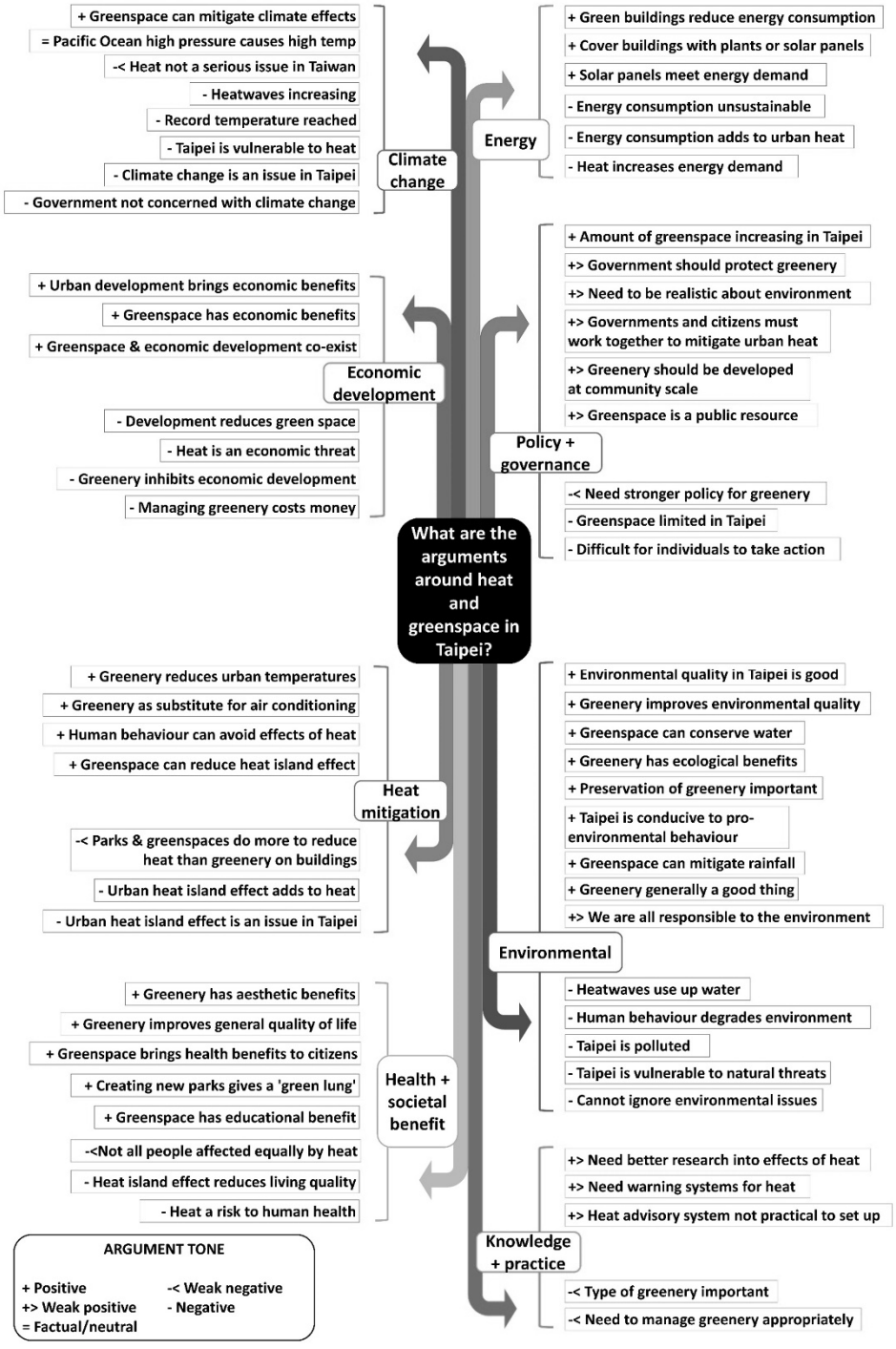
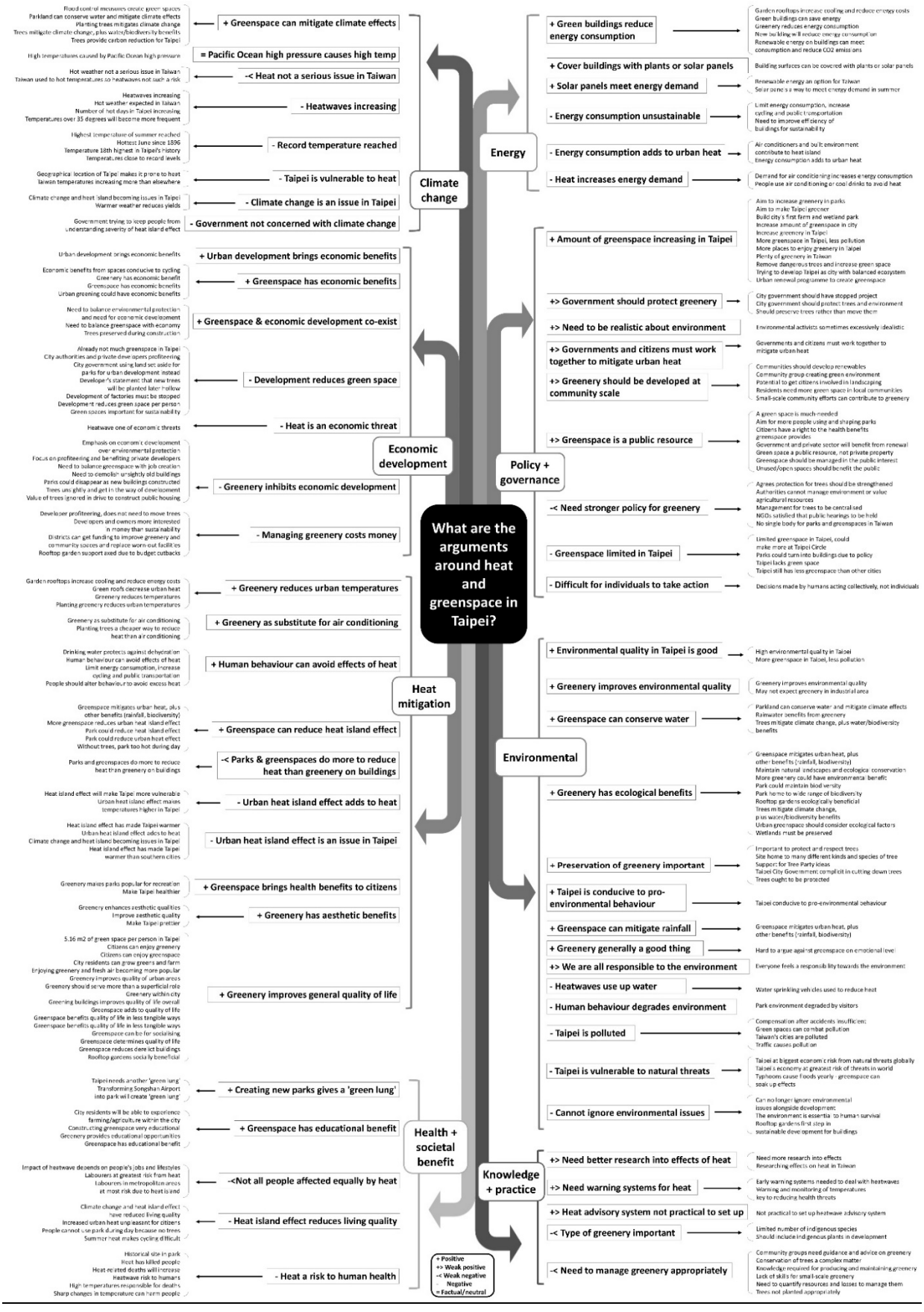


Figure 3


What are the arguments around heat and greenspace in Taipei?
Climate change
+ Greenspace can mitigate climate effects
= Pacific Ocean high pressure causes high temp
-< Heat not a serious issue in Taiwan
- Heatwaves increasing
- Record temperature reached
- Taipei is vulnerable to heat
- Climate change is an issue in Taipei
- Government not concerned with climate change
Economic development
+ Urban development brings economic benefits
+ Greenspace has economic benefits
+ Greenspace & economic development co-exist
- Development reduces green space
- Heat is an economic threat
- Greenery inhibits economic development
- Managing greenery costs money
Heat mitigation
+ Greenery reduces urban temperatures
+ Greenery as substitute for air conditioning
+ Human behaviour can avoid effects of heat
+ Greenspace can reduce heat island effect
-< Parks & greenspaces do more to reduce heat than greenery on buildings
- Urban heat island effect adds to heat
- Urban heat island effect is an issue in Taipei
Health + societal benefit
+ Greenery has aesthetic benefits
+ Greenery improves general quality of life
+ Greenspace brings health benefits to citizens
+ Creating new parks gives a 'green lung'
+ Greenspace has educational benefit
-<Not all people affected equally by heat
- Heat island effect reduces living quality
- Heat a risk to human health
ARGUMENT TONE
+ Positive
+> Weak positive
= Factual/neutral
-< Weak negative
- Negative
Energy
+ Green buildings reduce energy consumption
+ Cover buildings with plants or solar panels
+ Solar panels meet energy demand
- Energy consumption unsustainable
- Energy consumption adds to urban heat
- Heat increases energy demand
Policy + governance
+ Amount of greenspace increasing in Taipei
+> Government should protect greenery
+> Need to be realistic about environment
+> Governments and citizens must work together to mitigate urban heat
+> Greenery should be developed at community scale
+> Greenspace is a public resource
-< Need stronger policy for greenery
- Greenspace limited in Taipei
- Difficult for individuals to take action
Environmental
+ Environmental quality in Taipei is good
+ Greenery improves environmental quality
+ Greenspace can conserve water
+ Greenery has ecological benefits
+ Preservation of greenery important
+ Taipei is conducive to pro-environmental behaviour
+ Greenspace can mitigate rainfall
+ Greenery generally a good thing
+> We are all responsible to the environment
- Heatwaves use up water
- Human behaviour degrades environment
- Taipei is polluted
- Taipei is vulnerable to natural threats
- Cannot ignore environmental issues
Knowledge + practice
+> Need better research into effects of heat
+> Need warning systems for heat
+> Heat advisory system not practical to set up
-< Type of greenery important
-< Need to manage greenery appropriately

Mapping the socio-political landscape of heat mitigation through urban greenspaces: the case of Taipei Metropolis – Supplementary data

Supplementary data 1: full argument map



Supplementary data 2: full crosstabulations

(a) Sector vs argument type

			Argument				Total
			Economic	Environ-ment and climate	Health and social benefit	Policy and practice	
Sector	Academia	Count	8	16	7	11	42
		% within Sector	19.0%	38.1%	16.7%	26.2%	100.0%
		% within Argument	19.5%	20.3%	17.1%	21.2%	19.7%
		% of Total	3.8%	7.5%	3.3%	5.2%	19.7%
	Civil society	Count	7	18	9	12	46
		% within Sector	15.2%	39.1%	19.6%	26.1%	100.0%
		% within Argument	17.1%	22.8%	22.0%	23.1%	21.6%
		% of Total	3.3%	8.5%	4.2%	5.6%	21.6%
	Decision-maker	Count	9	27	12	18	66
		% within Sector	13.6%	40.9%	18.2%	27.3%	100.0%
		% within Argument	22.0%	34.2%	29.3%	34.6%	31.0%
		% of Total	4.2%	12.7%	5.6%	8.5%	31.0%
	Press	Count	10	15	12	9	46
		% within Sector	21.7%	32.6%	26.1%	19.6%	100.0%
		% within Argument	24.4%	19.0%	29.3%	17.3%	21.6%
		% of Total	4.7%	7.0%	5.6%	4.2%	21.6%
	Private sector	Count	7	3	1	2	13
		% within Sector	53.8%	23.1%	7.7%	15.4%	100.0%
		% within Argument	17.1%	3.8%	2.4%	3.8%	6.1%
		% of Total	3.3%	1.4%	0.5%	0.9%	6.1%
Total		Count	41	79	41	52	213
		% within Sector	19.2%	37.1%	19.2%	24.4%	100.0%
		% within Argument	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	19.2%	37.1%	19.2%	24.4%	100.0%

df = 12, $\chi 2 = 14.37$, p = 0.28. Factual/neutral statements (n=2) excluded.

(b) Tone vs sector

			Sector					Total
			Academia	Civil society	Decision	Press	Private	
Tone	Negative	Count	22	16	22	20	8	88
		% within Tone	25.0%	18.2%	25.0%	22.7%	9.1%	100.0%
		% within Sector	52.4%	34.8%	33.3%	43.5%	61.5%	41.3%
		% of Total	10.3%	7.5%	10.3%	9.4%	3.8%	41.3%
	Positive	Count	20	30	44	26	5	125
		% within Tone	16.0%	24.0%	35.2%	20.8%	4.0%	100.0%
		% within Sector	47.6%	65.2%	66.7%	56.5%	38.5%	58.7%
		% of Total	9.4%	14.1%	20.7%	12.2%	2.3%	58.7%
Total		Count	42	46	66	46	13	213
		% within Tone	19.7%	21.6%	31.0%	21.6%	6.1%	100.0%
		% within Sector	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	19.7%	21.6%	31.0%	21.6%	6.1%	100.0%

df = 4, $\chi 2 = 6.95$, p = 0.14. Factual/neutral statements (n=2) excluded.

(c) Tone vs argument type

			Argument				Total
			Economic	Environ-ment and climate	Health and social benefit	Policy and practice	
Tone	Negative	Count	25	31	13	19	88
		% within Tone	28.4%	35.2%	14.8%	21.6%	100.0%
		% within Argument	61.0%	39.2%	31.7%	36.5%	41.3%
		% of Total	11.7%	14.6%	6.1%	8.9%	41.3%
	Positive	Count	16	48	28	33	125
		% within Tone	12.8%	38.4%	22.4%	26.4%	100.0%
		% within Argument	39.0%	60.8%	68.3%	63.5%	58.7%
		% of Total	7.5%	22.5%	13.1%	15.5%	58.7%
Total		Count	41	79	41	52	213
		% within Tone	19.2%	37.1%	19.2%	24.4%	100.0%
		% within Argument	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	19.2%	37.1%	19.2%	24.4%	100.0%

df = 3, $\chi 2 = 8.73$, p = 0.03. Factual/neutral statements (n=2) excluded.

(d) Argument type (un-collapsed) vs tone

			Tone		Total
			Negative	Positive	
ArgType	Climate change	Count	15	5	20
		% within ArgType	75.0%	25.0%	100.0%
		% within Tone	17.0%	4.0%	9.4%
		% of Total	7.0%	2.3%	9.4%
	Economic development	Count	19	8	27
		% within ArgType	70.4%	29.6%	100.0%
		% within Tone	21.6%	6.4%	12.7%
		% of Total	8.9%	3.8%	12.7%
	Energy	Count	6	8	14
		% within ArgType	42.9%	57.1%	100.0%
		% within Tone	6.8%	6.4%	6.6%
		% of Total	2.8%	3.8%	6.6%
	Environmental	Count	10	26	36
		% within ArgType	27.8%	72.2%	100.0%
		% within Tone	11.4%	20.8%	16.9%
		% of Total	4.7%	12.2%	16.9%
	Health and societal benefit	Count	13	28	41
		% within ArgType	31.7%	68.3%	100.0%
		% within Tone	14.8%	22.4%	19.2%
		% of Total	6.1%	13.1%	19.2%
	Heat mitigation	Count	6	17	23
		% within ArgType	26.1%	73.9%	100.0%
		% within Tone	6.8%	13.6%	10.8%
		% of Total	2.8%	8.0%	10.8%
	Knowledge and practice	Count	9	5	14
		% within ArgType	64.3%	35.7%	100.0%
		% within Tone	10.2%	4.0%	6.6%
		% of Total	4.2%	2.3%	6.6%
	Policy and governance	Count	10	28	38
		% within ArgType	26.3%	73.7%	100.0%
		% within Tone	11.4%	22.4%	17.8%
		% of Total	4.7%	13.1%	17.8%
Total		Count	88	125	213

	% within ArgType	41.3%	58.7%	100.0%
	% within Tone	100.0%	100.0%	100.0%
	% of Total	41.3%	58.7%	100.0%

df = 3, $\chi 2$ = 31.83, p = <0.001. Factual/neutral statements (n=2) excluded.

(e) Greenery versus tone (for overall articles)

			Tone		Total
			Negative	Positive	
G Type	Community/individual scale	Count	3	13	16
		% greenery	18.8%	81.3%	100.0%
		% tone	8.3%	18.8%	15.2%
		% Total	2.9%	12.4%	15.2%
	Generic	Count	6	22	28
		% greenery	21.4%	78.6%	100.0%
		% tone	16.7%	31.9%	26.7%
		% Total	5.7%	21.0%	26.7%
	Large-scale	Count	18	17	35
		% greenery	51.4%	48.6%	100.0%
		% tone	50.0%	24.6%	33.3%
		% Total	17.1%	16.2%	33.3%
	Trees and plants	Count	9	17	26
		% greenery	34.6%	65.4%	100.0%
		% tone	25.0%	24.6%	24.8%
		% Total	8.6%	16.2%	24.8%
Total		Count	36	69	105
		% greenery	34.3%	65.7%	100.0%
		% tone	100.0%	100.0%	100.0%
		% Total	34.3%	65.7%	100.0%

df = 3, $\chi 2$ = 8.34, p = 0.04. Factual/neutral articles (n=32) excluded.

(f) Greenery versus tone (for arguments within articles)

			Tone		Total
			Negative	Positive	
G Type	Community/individual scale	Count	7	27	34
		% greenery	20.6%	79.4%	100.0%
		% tone	15.6%	25.2%	22.4%
		% of Total	4.6%	17.8%	22.4%
	Generic	Count	10	13	23
		% greenery	43.5%	56.5%	100.0%
		% tone	22.2%	12.1%	15.1%
		% of Total	6.6%	8.6%	15.1%
	Large-scale	Count	16	42	58
		% greenery	27.6%	72.4%	100.0%
		% tone	35.6%	39.3%	38.2%
		% of Total	10.5%	27.6%	38.2%
	Trees and plants	Count	12	25	37
		% greenery	32.4%	67.6%	100.0%
		% tone	26.7%	23.4%	24.3%
		% of Total	7.9%	16.4%	24.3%
Total		Count	45	107	152
		% greenery	29.6%	70.4%	100.0%
		% tone	100.0%	100.0%	100.0%
		% of Total	29.6%	70.4%	100.0%

df = 3, $\chi 2$ = 3.71, p = 0.30. Factual/neutral statements (n=1) excluded.

Supplementary data 3: full list of news articles analysed

Date	Title	Sampled for further analysis?	URL
27/12/1999	A closer look at governing Taipei		http://www.taipeitimes.com/News/editorials/archives/1999/12/27/0000017333/2
12/03/2001	Taipei launches campaign to protect its ancient trees	*	http://www.taipeitimes.com/News/local/archives/2001/03/12/0000077197
09/04/2003	Environmentalists pan EPA's recreation project	*	http://www.taipeitimes.com/News/taiwan/archives/2003/04/09/0000201392
30/07/2004	Hsinchu's science-based industrial park — Taiwan's Silicon		http://www.chinapost.com.tw/news/2004/07/30/51107/Hsinchu%E2%80%99s-science-based.htm
09/06/2005	Over the handlebars: Xindian Stream and Danshui River Bikeway		http://www.chinapost.com.tw/travel/taiwan-north/taipei/2005/06/09/63588/Over-the.htm
12/06/2005	Rooftop Gardens	*	http://www.taipeitimes.com/News/feat/archives/2005/06/12/2003259053/3
08/12/2005	The Taipei Story House: Narrating the story of Taipei		http://www.chinapost.com.tw/travel/taiwan-north/taipei/2005/12/08/73291/The-Taipei.htm
04/05/2006	Taking a walk on the greener side of Hsinchu City		http://www.chinapost.com.tw/travel/81632.htm
18/05/2006	Get out of town - without leaving Taipei's urban area	*	http://www.chinapost.com.tw/travel/82472.htm
21/09/2006	An urban home for Taiwan's indigenous plants	*	http://www.chinapost.com.tw/travel/taiwan-south/kaohsiung/2006/09/21/90956/An-urban.htm
10/05/2007	ECCT celebrates 50th Europe Day in Taipei		http://www.chinapost.com.tw/supplement/2007/05/10/109314/ECCT-celebrates.htm
10/01/	Discover culture,	*	http://www.chinapost.com.tw/travel/taiwan-north/taipei/2008/01/10/138520/Discover-culture.htm

2008	history and ecology at Zhishanyen		
03/07/2008	Scenic vistas await you on Hsiping Highway		http://www.chinapost.com.tw/travel/taiwan-north/taipei/2008/07/03/163861/p2/Scenic-vistas.htm
26/01/2009	Chen Chu touts Kaohsiung's green expanse	*	http://www.taipeitimes.com/News/taiwan/archives/2009/01/26/2003434665
28/01/2009	FEATURE: Fruit picking a fun holiday treat	*	http://www.taipeitimes.com/News/taiwan/archives/2009/01/28/2003434757
20/08/2009	Taipei is on its way to becoming a 'garden city'	*	http://www.chinapost.com.tw/taiwan/local/taipei/2009/08/20/221212/p1/Taipei-is.htm
30/08/2009	Taipei hopes to impress with 2010 international flora expo		http://www.chinapost.com.tw/taiwan/local/taipei/2009/08/30/222606/Taipei-hopes.htm
09/10/2009	Xinsheng expressway to re-open on Saturday		http://www.chinapost.com.tw/taiwan/local/taipei/2009/10/09/227855/Xinsheng-expressway.htm
02/11/2009	Kaohsiung to get exposure on National Geographic channel		http://www.chinapost.com.tw/taiwan/local/kaohsiung/2009/11/02/231157/Kaohsiung-to.htm
13/12/2009	Nature has answers to problems	*	http://www.taipeitimes.com/News/editorials/archives/2009/12/13/2003460825/1
25/12/2009	Government mulls regulating overhanging objects		http://www.chinapost.com.tw/taiwan/local/taipei/2009/12/25/237938/Govt-mulls.htm
26/05/2010	Economy, nature both served by Biopark plan	*	http://www.chinapost.com.tw/editorial/taiwan-issues/2010/05/26/258071/p1/Economy-nature.htm
14/07/2010	Heat wave warning system crucial	*	http://www.taipeitimes.com/News/editorials/archives/2010/07/14/2003477873/1
26/08/2010	DPP pans new urban renewal plan	*	http://www.taipeitimes.com/News/taiwan/archives/2010/08/26/2003481343
02/09/2010	Taipei's disappearing green space	*	http://www.taipeitimes.com/News/editorials/archives/2010/09/02/2003481895
03/09/	Quantifying the non-	*	http://www.taipeitimes.com/News/editorials/archives/2010/09/03/2003481966/1

2010	quantifiable		
10/09/2010	Ground broken on convention complex		http://www.taipeitimes.com/News/biz/archives/2010/09/10/2003482530
17/09/2010	Su releases green policy plan for Taipei	*	http://www.taipeitimes.com/News/taiwan/archives/2010/09/17/2003483108
20/09/2010	Taipei Flora Expo flowers withstand typhoon winds		http://www.chinapost.com.tw/taiwan/local/taipei/2010/09/20/273211/Taipei-Flora.htm
12/03/2011	Taipei on Yahoo! list of most under-rated cities	*	http://www.chinapost.com.tw/taiwan/local/taipei/2011/03/12/294384/Taipei-on.htm
12/03/2011	Taipei one of world's most underrated cities: Yahoo	*	http://www.taipeitimes.com/News/taiwan/archives/2011/03/12/2003498004
28/04/2011	Parks may disappear with 'Taipei Beautiful' program	*	http://www.taipeitimes.com/News/taiwan/archives/2011/04/28/2003501887
02/05/2011	Flora Expo Yuanshan site to open to public		http://www.chinapost.com.tw/taiwan/local/taipei/2011/05/02/300744/Flora-Expo.htm
30/05/2011	Legal experience transforms Robin Winkler into eco-activist	*	http://www.chinapost.com.tw/dream//2011/05/30/309837/p1/Legal-experience.htm
04/07/2011	Street popular for wedding photos	*	http://www.taipeitimes.com/News/taiwan/archives/2011/07/04/2003507387
30/08/2011	Letters: Kudos to Taiwan	*	http://www.taipeitimes.com/News/editorials/archives/2011/08/30/2003511999
31/08/2011	Drop Taipei Dome plan: activists	*	http://www.taipeitimes.com/News/taiwan/print/2011/08/31/2003512111
19/09/2011	Taipei tops the 2011 CommonWealth Happiness Survey	*	http://www.chinapost.com.tw/commentary/china-post/special-/2011/09/19/317147/p1/Taipei-tops.htm
31/10/	Make tobacco factory into a	*	http://www.taipeitimes.com/News/taiwan/archives/2011/10/31/2003517124

2011	park: protesters		
19/04/2012	Local high-end porcelain maker opens Taipei cafe		http://www.chinapost.com.tw/taiwan/arts-&-leisure/2012/04/19/338361/Local-high-end.htm
20/04/2012	Letters: Future bright for solar power	*	http://www.taipeitimes.com/News/editorials/print/2012/04/20/2003530771
22/04/2012	Gone, but not forgotten		http://www.taipeitimes.com/News/feat/archives/2012/04/22/2003530949
10/07/2012	Mercury rises as Taipei hits record summer highs	*	http://www.taipeitimes.com/News/taiwan/archives/2012/07/10/2003537397
12/07/2012	'Heat wave leave' unrealistic for Taiwan: weather experts	*	http://www.chinapost.com.tw/taiwan/national/national-news/2012/07/12/347304/Heat-wave.htm
12/07/2012	Experts pan ‘heat wave leave’ idea	*	http://www.taipeitimes.com/News/taiwan/archives/2012/07/12/2003537556
13/07/2012	Taipei finds ways to beat the heat	*	http://www.chinapost.com.tw/taiwan/local/taipei/2012/07/13/347419/Taipei-finds.htm
18/07/2012	‘Green’ living can help lower heat	*	http://www.taipeitimes.com/News/editorials/archives/2012/07/18/2003538010/2
26/07/2012	Taiwan High Speed Rail to open three new stops by 2015		http://www.chinapost.com.tw/taiwan/2012/07/26/348866/Taiwan-High.htm
26/09/2012	DGH building to feature eco-friendly design	*	http://www.taipeitimes.com/News/taiwan/archives/2012/09/26/2003543698
31/10/2012	Taipei Twin Towers to be 'city within city'		http://www.chinapost.com.tw/taiwan/national/national-news/2012/10/31/359375/Taipei-Twin.htm
18/11/2012	Relocate Taipei airport, DPP legislator urges	*	http://www.taipeitimes.com/News/taiwan/archives/2012/11/18/2003547990
02/03/2013	Capital’s residents enjoy benefits of parks project	*	http://www.taipeitimes.com/News/taiwan/archives/2013/03/02/2003556081

12/04/2013	Prime Kaohsiung plot goes for record NT$3 mil./ping		http://www.chinapost.com.tw/taiwan/local/kaohsiung/2013/04/12/375852/Prime-Kaohsiung.htm
28/05/2013	Returning Taipei to its early vision	*	http://www.taipeitimes.com/News/editorials/archives/2013/05/28/2003563348
30/05/2013	Premier orders halt to urban development plan	*	http://www.chinapost.com.tw/taiwan/national/national-news/2013/05/30/379896/Premier-orders.htm
01/07/2013	WEATHER: Taipei sees hottest June ever	*	http://www.taipeitimes.com/News/taiwan/archives/2013/07/01/2003566080
01/07/2013	Capital endures historymelting June	*	http://www.chinapost.com.tw/print/382594.htm
07/07/2013	Hot weather likely to last well into next week: CWB	*	http://www.chinapost.com.tw/print/383104.htm
11/11/2013	Preserve Nangang Bottle Cap Factory, activists urge	*	http://www.taipeitimes.com/News/taiwan/archives/2013/11/11/2003576630
12/12/2013	Uni-President's planned park ordered to undergo 2nd environmental study		http://www.chinapost.com.tw/taiwan/national/national-news/2013/12/12/395767/Uni-Presidents-planned.htm
13/12/2013	Drama in the house		http://www.taipeitimes.com/News/feat/archives/2013/12/13/2003578901
24/02/2014	DPP aspirant mayor touts closing Songshan airport	*	http://www.taipeitimes.com/News/taiwan/archives/2014/02/24/2003584232
22/06/2014	For the love of leather		http://www.taipeitimes.com/News/feat/archives/2014/06/22/2003593362/1
27/07/2014	Nature art	*	http://www.taipeitimes.com/News/feat/archives/2014/07/27/2003596016
08/09/2014	Tree Party aims to speak for trees, wildlife, youth	*	http://www.taipeitimes.com/News/taiwan/archives/2014/09/08/2003599270

19/09/2014	Fight for your right ... to picnic	*	http://www.taipeitimes.com/News/feat/print/2014/09/19/2003600036
26/09/2014	Groups oppose plan for Railway Workshop		http://www.taipeitimes.com/News/taiwan/archives/2014/09/26/2003600620
28/09/2014	Access to riverside parks in Taipei to be improved	*	http://www.taipeitimes.com/News/taiwan/archives/2014/09/28/2003600769
04/11/2014	Green campus rooftop opened at junior high school	*	http://www.taipeitimes.com/News/lang/archives/2014/11/04/2003603603
25/11/2014	Taipei Circle needs some fresh air	*	http://www.taipeitimes.com/News/editorials/print/2014/11/25/2003605231
03/12/2014	CTBC Holdings inaugurate new financial park in Nangang		http://www.chinapost.com.tw/taiwan/business/2014/12/03/423208/CTBC-Holdings.htm
16/01/2015	EDITORIAL: The Taipei Dome controversy	*	http://www.taipeitimes.com/News/editorials/archives/2015/01/16/2003609339/1
30/01/2015	Green Taipei is worth supporting	*	http://www.taipeitimes.com/News/editorials/print/2015/01/30/2003610394
11/03/2015	Ko dismisses Taipei Dome deconstruction rumors		http://www.chinapost.com.tw/taiwan/local/taipei/2015/03/11/430793/Ko-dismisses.htm
20/03/2015	Ko outlines city plans for ‘smart, green’ development		http://www.taipeitimes.com/News/taiwan/archives/2015/03/20/2003613992
15/04/2015	Farm park planned for Neihu site	*	http://www.taipeitimes.com/News/taiwan/archives/2015/04/15/2003615987
12/05/2015	Supporters pleased with meetings on protecting city trees	*	http://www.taipeitimes.com/News/taiwan/archives/2015/05/12/2003618095
27/05/2015	Taichung councilor chides plan for 1m trees; city resolute		http://www.taipeitimes.com/News/taiwan/archives/2015/05/27/2003619278
02/06/2015	Letters: drive your own wind turbine	*	http://www.taipeitimes.com/News/editorials/archives/2015/06/02/2003619713

12/06/2015	Society: Daan Park station awarded		http://www.taipeitimes.com/News/taiwan/archives/2015/06/12/2003620532
04/07/2015	Taipei calls for bids on six major city projects		http://www.taipeitimes.com/News/taiwan/print/2015/07/04/2003622241
14/07/2015	Urban renewal plans for Datong District revealed		http://www.taipeitimes.com/News/taiwan/archives/2015/07/14/2003623009
13/08/2015	The root of the problem for Taipei's fallen trees	*	http://www.taipeitimes.com/News/editorials/archives/2015/08/13/2003625217
26/08/2015	Treeless Taichung park causes complaints	*	http://www.taipeitimes.com/News/lang/archives/2015/08/26/2003626171
19/09/2015	Taipei has world's 'highest exposure to threats'	*	http://www.chinapost.com.tw/taiwan/business/2015/09/19/446248/Taipei-has.htm
24/11/2015	Protesters decry factory proposal in Kaohsiung		http://www.taipeitimes.com/News/taiwan/archives/2015/11/24/2003633218
06/01/2016	Residents, Trees Party slam proposed renovation project	*	http://www.taipeitimes.com/News/taiwan/archives/2016/01/06/2003636556
26/01/2016	Ko laments Taipei's lack of Tokyo's urban aesthetics		http://www.taipeitimes.com/News/taiwan/archives/2016/01/26/2003638105
27/02/2016	Bureau to give away 150,000 tree saplings	*	http://www.taipeitimes.com/News/taiwan/archives/2016/02/27/2003640346