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What might 'just green enough' urban development mean in the context of climate change adaptation? The case of Taipei Metropolis, Taiwan.

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What might ‘just green enough’ urban development mean in the context of climate change adaptation? The case of Taipei Metropolis, Taiwan.

HIGHLIGHTS

- Climate adaptation needs reconsideration of equity in urban greening, as ecosystem function comes from range of greenspaces
- Risk of reinforcing inequality via structural issues in planning processes must be balanced with risk of harm from inaction
- In Taipei, site-specific controversies about greenspace in urban development challenge evidence-based adaptation planning
- Taipei illustrates how excessive pragmatism towards how greening is achieved may sideline or obscure justice concerns
- Taipei suggests scientific and political competences required for strategic greening make equity planning more complex

FULL FINAL MANUSCRIPT

What might 'just green enough' urban development mean in the context of climate change adaptation? The case of urban greenspace planning in Taipei Metropolis, Taiwan.

ABSTRACT

This paper argues that climate change adaptation through strategic greenspace planning requires scholars and planners to think differently about what equity means in an urban greenspace context. We use the heat mitigation potential of greenspace and the case of Taipei Metropolis in Taiwan to assess challenges arising from thinking about fairness in terms of distribution of benefits from greenspace functions, as opposed to fairness in greenspace accessibility and availability. Urban greening to foster 'resilient' communities arguably deflects from – or even exacerbates - structural causes of vulnerability, with benefits accruing disproportionately to more affluent or empowered groups. Yet the need for practical action on climate threats in cities is urgent, and for heat, strategic greenspace use considered systematically across a city may mitigate effects through the cooling effect of vegetation. The challenge is thus to balance the justice concerns associated with urban greening with this tangible risk reduction potential.

We undertake content analysis of articles from two Taiwanese newspapers – the *Taipei Times* and the *China Post* - to assess how heat and greenspace issues have been discussed in urban governance debates within Taipei. We suggest change adaptation through urban greening raises three challenges for equity thinking: (a) guiding planning and governance processes with scientific understanding of how greenspace functions are delivered, even in the face of

urban development pressures and site-specific controversies; (b) tempering the social cohesion and practical deployment benefits of neighbourhood-level greening with the need for specific understanding at the city-wide level to most effectively realise ecosystem services; and (c) linking targeted adaptation actions with broader rationales for urban greening, whilst not diluting justice concerns. We caution that pragmatism towards all urban climate adaptation via greening as intrinsically 'good' must not serve as a blinder to the need for accompanying social policy measures to reduce unequal vulnerability to climate risks.

Keywords: climate change adaptation; ecosystem services; equity planning; Taipei; urban greenspace; urban heat island effect.

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1. Introduction

This paper elaborates questions raised by climate change adaptation for addressing equity issues in urban greenspace planning. We take the heat mitigation potential of greenspace as a point of departure to consider the challenges and complexities that may arise when considering equity in terms of distribution of benefits arising from greenspace functions, as opposed to purely issues of access and availability.

Greenspace planning of course considers many factors, of which cooling service is only one. However, the urban heat island (UHI) effect - higher temperatures in urban areas than their rural surroundings – is one of the crucial issues for urban climate change adaptation (Gill, Handley, Ennos, & Pauleit, 2007; Roszenweig, Solecki, Hammer, & Mehrotra, 2011). Development patterns lead to uneven distribution of physical exposure and societal vulnerability to heat across cities, with recognition that more vulnerable people - elderly, low-income or marginalised groups such as migrants or ethnic minorities – may be disproportionately exposed to heat risk (Harlan, Brazel, Prashad, Stefanov, & Larsen, 2006; Byrne et al., 2016). Greenspaces can have a cooling effect through the lower radiance, increased evapotranspiration and greater shading provided by vegetated surfaces (Bowler, Buyung-Ali, Knight, & Pullin, 2010). This may be realised through preservation and development of urban greenspace, thinking about cooling as one of the functions greenspace provides (e.g. heat mitigation, water storage, air purification) beyond its recreational potential (Hebbert, 2008; van Leeuwen, Nijkamp, & de Noronha Vaz, 2010) (see Table 1 for definitions). Nonetheless, urban development processes may also influence how greenery is distributed within a city, potentially accruing towards more affluent areas (Apparicio, Pham, Séguin, & Dubé, 2016) and/or displacing more vulnerable groups through processes such as

environmental gentrification (Dooling, 2009). Due to its cooling function – and the fact greenspace is an important measure in urban planning – heat mitigation through greenspace is therefore a useful starting point for a conversation on how climate change adaptation might require scholars to think differently about greenspace equity in urban development.

Our case study is Taipei City in Taiwan. Global warming and rapid urbanisation are significantly increasing temperatures in Taipei (Bai, Juang & Kondoh, 2011; Hsu et al., 2011). The thermal comfort-increasing potential of green infrastructure has been evaluated in the national-level Adaptation Strategy to Climate Change in Taiwan (Council for Economic Planning and Development [CEPD], 2012). However, development and deployment of green infrastructure for UHI mitigation in Taipei has thus far not been as fully developed as it could have (Huang et al., 2013). The inadequacy of guidelines for addressing heat mitigation via strategic green infrastructure planning at the local-level could arise due to lack of awareness on how the heterogeneity of heat exposure is influenced by urban development; inadequate evidence to develop land use strategies for mitigating heat exposure; low policy priority compared to other climate impacts; and limited integration of climate change adaptation into existing urban planning systems (e.g. Chang, Seto & Huang, 2013; Mabon and Shih, in press).

Chu, Anguelovski, and Roberts (2017) suggest that in such situations of demonstrable potential but a challenging socio-political context, urban environmental planning targeted strategically at climate adaptation gains may transcend traditional sectoral barriers to climate action. We therefore use one particular goal, heat mitigation, as a point of departure to evaluate the extent to which 'strategic action' may balance up with the risk of overlooking or reinforcing existing inequalities in the rush for short-term adaptation gains. Specifically, we assess the potential of existing ‘just green enough’ (Curran & Hamilton, 2012; Wolch, Byrne,

& Newell, 2014) and 'equity planning' (Metzger, 1996; Zapata & Bates, 2015) frameworks to safeguard equity within strategic climate adaptation responses. Thus far, these concepts have largely been applied in relation to accessible usable greenspaces such as playgrounds (Talen & Anselin, 1998) and nature walks (Curran & Hamilton, 2012) as opposed to areas such as agricultural lands, rivers and wetlands which are not planned for the use of people yet are crucial to delivering ecosystem function. Like Talen and Anselin (1998), we understand spatial *equity* to mean 'equality' in the context of how questions of need, fairness or justice are addressed across space. We look at how potential equity issues have arisen over time in Taipei in relation to (a) which locations in the city are getting attention in greenspace discussions; (b) whose voices are most prominent in discussions around heat and greening; and (c) what current rationales and pathways to greening are and how well suited they may be to equitable climate adaptation. We argue that maintaining equity thinking within strategic action for climate adaptation may require: recognising that controversy over greenspace access and allocation may not sit with the manner in which greenspace functions like cooling are delivered and distributed; acknowledging the value of neighbourhood-scale actions but also their potential limitations in delivering ecosystem services; and ensuring more broad-based rationales for greening actions do not dilute or sideline justice concerns.

[INSERT TABLE 1 NEAR HERE: TERMINOLOGY AND DEFINITIONS]

2. Theoretical and conceptual background

Recent critical social science scholarship indicates that urban planning responses to climate change - including greening - are not value-neutral and may if adopted uncritically perpetuate or exacerbate existing inequalities (e.g. Anguelovski et al., 2016; Castan Broto, 2017). This

paper speaks to this literature by considering the additional complexities that arise from considering equity within the full suite of greenspaces across a city (e.g. agricultural lands, rivers, wetlands) which deliver ecosystem functions.

2.1. Green inequality, resilience and consensus

Different approaches have sought to consider how greening is distributed within a city. Concepts such as 'luxury effect' (Hope et al., 2003; Liu & Hite, 2013) and 'green inequality' (Apparicio et al., 2016) argue greening may disproportionately accrue to affluent areas. This applies to benefits such as climate risk reduction (Gill et al., 2007) and more specifically cooling (Harlan et al., 2006; Byrne et al., 2016) which come from the existence value of greenspace; and also to health (Ward Thompson et al., 2012), psychological (Fuller, Irvine, Devine-Wright, Warren, & Gaston, 2007) and social cohesion (Jim and Chan, 2016) benefits that can build adaptive capacity and relate to the use value of greenspace. More vulnerable populations are less likely to live in areas which have well-planned greenspaces, and/or have less ability to fund, maintain and develop such spaces in cities. This further increases the heat risk they face (Reckien et al., 2017). Moreover, environmental (Dooling, 2009) and green gentrification (Wolch et al., 2014) (hereafter ‘green gentrification’) suggests that urban greening initiatives may, by improving environmental quality, lead to increases in land and housing prices, thereby forcing out of the area the vulnerable people that the initiatives were intended to benefit. In Taipei, it has been argued in Jou, Clark, & Chen (2016) that participation in municipal-led greening initiatives has served as cover to allow developers access to land and planning privileges.

Urban greening is increasingly justified through its contribution to ecosystem services and building resilience (e.g. Hunter & Brown, 2012; Steiner, 2014; Meerow & Newell, 2017). Thinking of urban greening in this way is argued to go beyond the health and aesthetic arguments outlined above and emphasise the value urban greening brings to society in responding to environmental issues through, for example, UHI mitigation or rainfall retention (Gill et al., 2007). These ecosystem services can in turn be linked to quality of life and comfort issues for people via, for instance, pollution reduction or climate regulation (Schekte, Haase, & Breuste, 2010). However, use of ecosystem services framings to build cross-sector consensus on the value of urban environments (e.g. Roberts et al., 2012; Baro et al., 2016) has been argued to lack clarity on definitions and practical courses of action (Matthews, Lo, & Byrne, 2015); over-simplify the complex socio-political landscape behind environmental problems (Norgaard, 2010); or even perpetuate inequality through replication of capitalist processes of economic valuation (Kosoy & Corbera, 2010). The time component involved must also be borne in mind, Jim (2004) noting benefits and effects of greening actions are realised across generations.

'Resilient' cities too have faced criticism. Parnell (2016) charts the emerging centrality of cities to sustainable development thought, which is reflected in high-profile initiatives aimed at urban resilience (e.g the Rockefeller Foundation's *100 Resilient Cities* Programme; the *New Urban Agenda*; the *UN Global Compact Cities Programme*; and the aim of Sustainable Development Goal 11 to "make cities inclusive, safe, resilient and sustainable" (United Nations, 2015, para. 1)). Yet there is a critical social science backlash against resilience thinking (Meerow, Newell, & Stults, 2016). This centres on concerns that governance based on 'resilience' shifts attention away from underlying justice concerns (Lockie, 2016) and acts - especially when linked with sustainability - as a depoliticising concept where a focus on

consensus reinforces existing power relations and maintains the status quo (e.g. Clark, 2013). A focus on making cities and the communities within them resilient to 'inevitable' shocks is argued to be a diversion from reflection on the need for deeper structural change (Kaika, 2017). Chu et al. (2017) concede that whilst strategic planning for climate change adaptation may be able to transcend sectoral interests and make gains in practical action, it may not be able to facilitate this kind of deeper political economic restructuring in cities.

These concerns over ecosystem services and resilience occupy separate fields. Yet there is a common concern that current trends in urban environmental governance and planning processes towards building consensus on the need for 'resilient' cities may not be up to the job of ensuring justice for the most vulnerable members of society. In theory, there would therefore be good reasons to be suspicious of the ability of large-scale, municipal-led greening initiatives, undertaken within current urban governance frameworks under the aim of building 'resilience', to be able to deliver greening benefits equitably (e.g. Haase et al., 2017). However, a UHI mitigation and climate change adaptation context adds additional complexity. Setting aside debates on what 'resilience' means in urban governance and why (Meerow et al., 2016), in an engineering and risk management context, ‘success’ in building resilience can be viewed as the ability of organisations, groups and individuals to anticipate the complexity of the real world before failures and harm occur (Hollnagel, Woods, & Leveson, 2006). deVerteuil and Golubchikov (2016) similarly argue that ‘resilience’ may in situations help to sustain survival, thus acting as a necessary precursor for the kind of deeper reflection outlined above. In this way, greening might be important in making cities 'resilient' to impending climatic changes by acting to anticipate and prevent future harm – as we now discuss.

198 2.2. Taipei, climate change and spatial planning

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200 Policy, planning and socio-cultural context are very dynamic spheres, hence our intention is
201 not to evaluate how equitable Taipei's greenspace planning processes are in relation to
202 climate adaptation or even heat mitigation *per se*, but rather to use recent greenspace debates
203 in the city to make more general observations about the challenges that thinking in terms of
204 functional greenspace raises for equity planning. Under the IPCC RCP 8.5 scenario (business
205 as usual), Taipei will see average summer temperatures increase by 1.125 to 1.25 ° C over the
206 2021-2040 period (Taiwan Climate Change Protection and Information Platform [TCCIP],
207 2017). Even under the RCP 2.6 scenario (i.e. radical emissions reductions), Taipei average
208 summer temperatures are still set to increase by 0.625 to 0.75 ° C over the same period
209 (TCCIP, 2017). Liu et al. (2010) note that the decadal mean number of hot days increased
210 from 5-22 days/year to 37 days/year in the 2000s. Taipei also has an ageing population -
211 nearly 15% of the population in 2016 were over 65 (Taipei City Government, 2016). This
212 ageing trend is set to continue in Taipei, with the elderly being among the most vulnerable
213 groups to extreme heat (Chen et al., 2016).

214

215 In short, even under ambitious climate mitigation pathways, Taipei is arguably already
216 'locked in' to potentially harmful levels of warming and to an increase in vulnerable
217 population in the near future. Furthermore, the need to renew national electricity
218 infrastructure may well increase electricity prices (Tung, Tseng, Huang, Liu, & Hu 2013),
219 limiting potential for air conditioning use. As such, the *Adaptation Strategy to Climate*
220 *Change in Taiwan* (CEPD, 2012) considers land use and green infrastructure. Nevertheless,
221 to realise cooling benefits, this must be deployed in a systematic manner (Gill et al., 2007)
222 through actions such as preserving green hills, expanding parks, planting urban trees and

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forests, and proliferation of ground and roof vegetation (Bowler et al., 2010; City of Stuttgart, 2017). In Taipei, for instance, the findings of Shih (2017b) indicate that preservation of existing large greenspaces, the extension of greenery at greenspace edges, and the connection of 'cool islands' may be effective to extend cooling. From this evidence, it can therefore be summarised that cooling via green intervention is not an 'anything goes' approach, requiring coordinated strategic action with scientific knowledge and organisational capability.

Nonetheless, in cities like Taipei, current land ownership, property and planning processes are very complex, involving negotiation between municipal governments, private developers, planning consultants and civil society. Bristow (2010) holds that political differences impact upon public policy-making (including planning) in Taiwan, with opposition grounded in political difference acting as a barrier to agreement on planning progress. This influence of political motivation on land use management has been observed in Taipei specifically (Chou & Chang, 2008; Shih, 2010), where Liu (2013) also observes the emergence of NGOs and community groups lobbying government institutions for improvement of living conditions in the city. In New Taipei City, Shih and Chang (2016) note how lobbying by investors and private developers can inform processes of land allocation and land use. Shih and Chang (2016, pp. 1245-6) go on to argue in the case of development right transfer that "the profit-driven urban growth coalition often trumps public-oriented planning actions". In Taipei, decisions over land use and configuration of the built environment are hence informed by wider political processes and societal discourses. This in turn has tangible effects on where in the metropolis development actions are undertaken, and where attention may be focused. Chang et al. (2013) explain in the context of flooding how this may present problems for climate adaptation in the city. Chang et al. argue that Taipei City Government's overall focus on urban economic development has led to development in at-risk locations, with limited

coordination between sectors making it difficult to undertake actions that are appropriate across space.

In sum, there is evidence to suggest that political processes and societal discourses in Taipei inform the nature of spatial planning, adding additional complexity to the processes within which adaptation responses are planned. Whilst contributing to cooling through greening requires coordinated implementation and rapid action, the existing urban governance processes through which this coordination will likely have to be achieved in Taipei may hence be susceptible to the equity and justice concerns raised in Section 2.1.

2.3. Synthesis: potential challenges to equity thinking when considering greenspace functions for climate adaptation

We do not intend to set up a ‘false choice’ in response to a complex urban issue, as Slater (2014) warns. However, if we understand that:

(a) climate change is happening, and that even with dramatic reductions in carbon dioxide emissions, cities like Taipei are already 'locked in' to potentially harmful warming;
(b) greenery has scientifically demonstrated potential to play a part in cooling urban areas, and thus contribute to reducing harm in the face of warming trends;

But also that:

(c) relatively swift action is required to understand how greening may mitigate increasing UHI effects and realise this harm reduction;

(d) UHI mitigation through greening needs specific technical actions, both in targeted areas and across the city as a whole, to extend cooling beyond greenspaces and out to citizens;

(e) planning processes in cities like Taipei at present involve managing complex relations between municipal government departments, planning consultants, private developers, civil society groups, communities and others, with structural change a slow process;

Issues such as cooling raise challenges for how we think about justice in urban greening. Namely, to imagine technically suitable pathways to UHI mitigation via greenery that acknowledge the realities of climate change and can come to fruition reasonably quickly within the nature of current planning processes, whilst all the time keeping the emphasis on delivering cooling benefits to the most vulnerable people and keeping a critical check on more fundamental criticisms of resilience and green gentrification. Using the case study of Taipei Metropolis, in this paper we sketch out some of the challenges to reappropriating equity thinking within this complex situation.

To do so, we evaluate two related ways of conceptualising fairness in urban governance: equity planning, and 'just green enough' thinking. In equity planning, urban planners work towards programmes and policies that explicitly redistribute benefits to more marginalised members of society (Metzger, 1996). Equity planning has a strong interest in understanding and redressing spatial inequality, and has been applied in public facility and open space contexts such as public playgrounds (Talen & Anselin, 1998), tree canopy cover (Danford et al., 2014) and urban agriculture (Horst, McClintock, & Hoey, 2017). One tool which helps to

297 understand how processes such as planning create or reinforce inequalities is an equity lens,
298 essentially a series of questions to help decision-makers understand possible impacts of their
299 actions on disadvantaged communities (Williams-Rajee & Evans, 2016; Horst et al., 2017).
300 In Section 4 we loosely use an 'equity lens' approach to structure our evaluation of urban
301 greening in Taipei. 'Just green enough' thinking (Curran & Hamilton, 2012) is more specific
302 to the gentrification and capitalisation concerns of urban greening, but shares a common
303 interest with equity planning in ensuring marginalised groups are not further disenfranchised
304 by planning processes. 'Just green enough' strategies may include: shaping green space
305 projects by community requirements; small-scale and scattered green interventions; and
306 accompanying policies such as rent stabilisation (Wolch et al., 2014). Using insights from
307 Taipei, we hence assess what thinking about greenspace comprehensively in terms of
308 function (Jim, 2004) might mean for equity planning and 'just green enough' thinking in a
309 climate adaptation context of this nature.
310
311 ## 3. Method
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313 ### 3.1. Rationale and sources
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315 This paper uses content analysis (Hsieh and Shannon, 2005) of newspaper articles to
316 understand how issues relating to benefits from urban greening, with a particular focus on
317 cooling, are discussed in Taipei. Urban environmental planning encompasses a range of
318 sectors and spans formal and informal processes (e.g Huang & Pai, 2015; Miner, Taylor,
319 Jones, & Phelan, 2016). As we elaborate in Section 4.1., these wider societal debates and
320 issues have been demonstrated in Taipei too to inform spatial and environmental planning
321 outcomes (e.g. Chang et al., 2013; Shih & Huang, 2016). Fuller understanding of the societal

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dimensions of urban greening in Taipei hence necessitates looking beyond government policy documents to understand the range of actors involved in the issue, and how their interests are balanced through processes of urban environmental governance (Castan Broto, 2017). Newspaper coverage has been argued to be one way of mapping out this broader context which constitutes climate- and environmental governance (McComas & Shanahan, 1999; Woods, Fernandez & Coen, 2012; Pulver & Sainz-Santamaria, 2017). It is however important to clarify that, like Pulver & Sainz-Santamaria (2017), for the purposes of this study we focus only on the interpretative function of newspaper coverage. That is, we are interested in how newspaper coverage mirrors – and gives us insight into – local, national and international events and debates over time. The question of whether the newspaper articles reviewed for Taipei have driven policy attention is separate, and outside the scope of our study. To elaborate the relationship between broader societal issues and specific planning actions, when required we support our analysis of newspaper content with reference to specialist academic literature (i.e. peer-reviewed articles and books/book chapters) on the society-planning interface in Taipei written by scholars with significant familiarity with the local context.

The sources sampled were two English-language Taiwanese newspapers – *Taipei Times* and The *China Post*. These are regarded in journalism scholarship as being among the largest English-language daily newspapers in Taiwan (Neilan, 2001; McDaniel, 2009) and at the time the research was undertaken were the last two English-language newspapers in print in Taiwan. The *Taipei Times* is considered to have a stronger pro-Taiwan editorial line, whereas the *China Post* leans more to softer policy towards and greater linkage with China. Both newspapers report on local issues in Taipei, featuring a mix of factual reporting and also clearly-marked editorials from different sectors of society (e.g. academia, business, NGOs). Sampling the *Taipei Times* and the *China Post* hence fits with the overall aims of the study

by giving a broad-based survey of the urban governance landscape in Taipei within which greening and heat issues are considered, from two newspapers of comparable size and standing but, for balance, with different political perspectives representing a key political divide in Taiwan. To more precisely understand the linkage between overarching socio-political issues and specific planning practices, as above academic literature relating to planning policies and practices in Taipei was also surveyed. This drew on the authors' knowledge of key planning academics in Taiwan, and was augmented with a literature search for peer-reviewed articles on the socio-political aspects of planning in the city. This scholarly literature was used to evaluate the significance of the themes identified in the newspaper articles.

English-language newspapers were sampled due to resourcing and capabilities of the research team. This is clearly a limitation of the research, and a comparable study of Chinese-language media would be valuable follow-on research. Nonetheless, given the standing of the newspapers and our interpretative use of their articles (i.e. to track issues raised, lines of argument reported and actors involved over time), when combined with academic planning scholarship they can be considered an insight into the greening and heat landscape in Taipei.

3.2. Data and analysis

This paper is a development of a mixed-method qualitative and quantitative study into newspaper reporting of greenspace issues in Taipei (Mabon and Shih, in press). In this paper, we focus on in-depth qualitative analysis of the article content and on understanding the relationship to the theories of equity in urban greening outlined in Section 2.1. We undertake directed content analysis, reading to identify themes which have arisen in previous theoretical

or empirical work but also being prepared to develop new or refined themes if required. Hsieh and Shannon (2005) argue the value of a directed approach is that it allows the researcher to read the text in light of work that has gone before, refining or challenging this scholarship through analysis and discussion. Our aim is to assess how issues of equity in urban greening and planning, which have been discussed at length in the literature, have played out over time in relation to an emerging issue and context (urban heat mitigation via greening in Taipei). This directed qualitative analytical framework, allowing us to go beyond the content of the articles and draw links to extant environmental- and social science research undertaken in Taipei and elsewhere, enables us to both acknowledge and nuance extant scholarship. Content analysis of this nature, which provides room to acknowledge wider context, has been deemed appropriate in analogous research into newspaper reporting of climate issues (e.g. Asayama & Ishii, 2014; Pulver & Sainz-Santamaria, 2017).

Articles from 1 December 1999 to 31 March 2016 were selected from each publication. This study period was selected to give as large a data sample as possible, spanning the period from the first day of winter in the earliest year that news articles from the sampled publications were available online (1 December 1999), through to the last day of the month in which the data collection phase for the project was scheduled to conclude (March 2016). To identify relevant articles, each publication's website (http://www.taipeitimes.com and http://www.chinapost.com.tw) was searched for articles containing the words/phrases 'heat', 'heat island', 'greenery', 'greenspace', 'green space', ‘green infrastructure’, ‘climate change’, ‘global change’, ‘green roof’, ‘renewable energy’, ‘mitigation’, ‘green house gases’, ‘greenhouse gases’, ‘heat wave’, ‘heatwave’ and ‘urban trees’. This encompassed the wider context in which greenery and greenspace is discussed in Taipei beyond heat mitigation, as well as the interface between excess heat and greenery. Returned articles unrelated to the

specific study aims or not relevant to Taiwan (such as syndicated news association reports relating to excess 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 provide analogous cases or contextual background which may reflect and/or feed into discussions around greenspace in Taipei. This process returned a sample of 96 articles, 34 from the *China Post* and 62 from the *Taipei Times* (see Supplementary Material), of which 59 - 15 from the *China Post* and 44 from the *Taipei Times* - were deemed to have sufficient relevance to warrant further analysis.

Each article was read fully, and statements referring to heat and/or greenery were identified. For each statement, the sector of the speaker, the category/topic of the statement, and tone of the statement were recorded. This process returned 224 statements. The categories and topics for coding were developed iteratively within the research team following the directed content analysis approach (Hsieh & Shannon, 2005), identifying themes through reading the articles but with an eye on refining/challenging themes in extant greenspace governance scholarship summarised in Section 2.1. The categories used for this coding are presented in Table 2. The individual statements were then grouped into argument clusters under these themes via an 'argument mapping' exercise (van Egmond & Hekkert, 2012; Mabon & Shih, in press). This argument map acted as a heuristic tool to visualise the identified themes and help the researchers spot lines of argumentation, and was used in tandem with a second more holistic reading of the articles. Given the aim of evaluating equity issues around greenspace function in Taipei, this second reading focused on identifying and refining the themes laid out in the argument map, looking for extracts which supported or challenged issues around urban greening and resilience.

Intercoder reliability was assessed by getting an additional researcher independent from the project to independently code a 20% sample of articles. This process returned a Krippendorff's Alpha (Hayes & Krippendorff, 2007) of 0.82 for topic identification of overall articles; 0.78 for statement categorisation within articles and 0.81 for tone of statements within articles. Krippendorff's Alpha assesses the agreement between two or more observers describing the units of analysis separately from each other. Perfect agreement among the observers on the codes assigned to observations would record 100% or a Krippendorff's Alpha of 1.00, whereas the complete absence of agreement would record a Krippendorff's Alpha of 0.00 (Hayes and Krippendorff, 2007). The scores reported above for our hence study suggest around 80% agreement across all categories, consistent with what is considered good intercoder reliability for qualitative research (McComas & Shanahan, 1999).

Such iterative analysis, whereby the validity of the findings comes through the evidence presented and its relation to underpinning theory, is argued to be appropriate for qualitative research of this nature (Henwood & Pidgeon, 2012). Moreover, over the course of the paper we follow the Mays and Pope (1995) principles for rigour in qualitative research by: (a) setting out the theoretical framework and context (see Section 2); (b) describing the sampling strategy and fieldwork (see earlier in this Section); (c) describing procedures for data analysis and involving more than one researcher in the process; (d) using evidence that can be inspected independently (see Supplementary Data for full list of news sources used); and (e) providing quotes to demonstrate the relationship between our interpretations and the evidence.

[INSERT TABLE 2 NEAR HERE: CATEGORIES USED FOR CODING ARTICLES]

4. Findings

We preface the findings by summarising the reviewed newspaper articles. The relatively small number of articles (and statements) across the time frame means the proportions reported ought to be treated with caution. Figure 1 shows that the number of words written about heat and greenery is increasing over time in both frequency and volume, and that there may be more attention in the summer and autumn months when temperatures in Taipei are higher (Huang et al., 2013). For both the *China Post* and the *Taipei Times*, the number of articles addressing heat and/or greenery has increased over time, and the topics these articles address has become more diverse (Table 3). The dominant sectors whose statements are reported within the articles are academia/research and government, however NGOs and politicians are also emerging more in recent years (Table 4). Statements relating to climate change and UHI mitigation have also been increasingly reported within the articles, with a corresponding increase in statements relating to environmental issues more generally (Table 5). Lastly, the nature of greenery mentioned in the articles changes over time, with less focus on generic greenery and large-scale greenspaces and increasing prominence of community/neighbourhood-scale greenspaces as well as trees and plants (Table 6).

In sum, societal discussion around heat and greenery reported in the sampled media has surfaced more frequently over time, and has engaged with a broader range of topics (Figure 2 visualises the breadth of arguments, with a full argument map included in the Supplementary Data). A wider range of voices appear to be being reported within these discussions, with increasing prominence of smaller-scale urban greenery within Taipei and increasing visibility of climate and UHI mitigation issues. To consider how equity planning thinking may have to be developed within this climate change adaptation landscape, we divide our analysis into broad areas of place; people; and process and power. This structure is commonly considered

within equity lenses, including by City of Portland and Multnomah County when integrating equity into their Climate Action Plan (Williams-Rajee & Evans, 2016).

[INSERT FIGURE 1 NEAR HERE: NUMBER OF WORDS WRITTEN ABOUT HEAT AND GREENERY OVER TIME. (NOTE: Q1=DECEMBER OF PREVIOUS YEAR, JANUARY, FEBRUARY; Q2=MARCH, APRIL, MAY; Q3=JUNE, JULY, AUGUST; Q4=SEPTEMBER, OCTOBER, NOVEMBER)]

[INSERT FIGURE 2 NEAR HERE: ARGUMENT MAP FOR HEAT AND GREENERY IN TAIPEI (SOURCE: MABON AND SHIH, IN PRESS)]

[INSERT TABLE 3 NEAR HERE: ARTICLE TOPICS OVER TIME]

[INSERT TABLE 4 NEAR HERE: SECTOR OF STATEMENT-MAKERS OVER TIME]

[INSERT TABLE 5 NEAR HERE: DISTRIBUTION OF ARGUMENT CATEGORIES OVER TIME]

[INSERT TABLE 6 NEAR HERE: TYPES OF GREENERY MENTIONED OVER TIME]

4.1. Place: where are greening debates happening?

We first look at where in Taipei debates around greenspace and UHI mitigation have flared up. Tan, Feng, and Hwang (2016) in the case of Singapore indicate that discussions over how to manage urban greenspace are informed by – and reflect – bigger issues of power and trust between different sections of society, and that these socially-informed decisions affect management actions and hence ecological conditions. Section 2.2. indicates this may be the case in Taipei too. Sampled newspaper articles relating to heat and greenery give us an insight into the wider context within which greenspace planning actions are debated. UHI mitigation has been drawn in to controversies over the role of greenspace in large-scale, high-

profile developments within the city. For instance, an article describing a plan to turn Songshan Airport into a large park cites a city politician:

Yao suggested that the 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*, November 18, 2012)

The Taipei Dome controversy - a long-running debate over the development of a former tobacco factory site into an indoor arena as opposed to preservation as greenspace – also drew out UHI mitigation arguments to support positions. Organisation of Urban Re-S (OURs), an NGO focused on urban development issues, made claims about cooling effects of greenspace in an article about opposition to the Taipei Dome:

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. 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 (NGO, reported in *Taipei Times*, August 31, 2011)

Heat mitigation is used here to support OURs' broader aim of preserving greenspace, even if the underlying statement about higher temperatures than the global average arguably does not convey scientifically surprising or significant information. Less controversially, heat mitigation potential was also raised in reporting on a new farm park project in Neihu District

on site of former Taipei Flower Market, through a Parks and Street Lights Office explanation of the project value:

The farm base will allow residents to grow greens and experience the fun of farming [...] A study is being conducted on the feasibility of collecting rainwater and surface water for the wetland, the officials said, suggesting that the project could maintain biodiversity and reduce the urban heat island effect (Parks and Street Lights Office, reported in *Taipei Times*, April 15, 2015)

In all of the above, cooling is not the main or only rationale for greenspace creation or preservation. Heat mitigation is instead used by actors to support other reasons to create or preserve greenspace, and to justify or oppose potentially controversial developments. This breadth of rationales is to be expected given the range of reasons for which greenspace may be managed (e.g. flood management, biodiversity conservation, societal benefit), of which cooling is but one. What may make this problematic for considering equity in availability of greenspace cooling function, however, is that discussion centered on accessibility and development at several sites of high controversy may not encompass the full range of greenspaces delivering functions, or indeed the distribution of exposure and vulnerability to heat within a city in a spatially comprehensive way. Indeed, reporting on differences in heat risk within Taipei Metropolis reflects the still-emerging nature of knowledge on heterogeneity of heat exposure within the city, such as an op-ed in which an academic argues for the need for a heat wave warning system:

The heat island effect caused by high rise buildings and high density clusters of buildings will make summer temperatures in Taipei soar above those felt in, say, Kaohsiung, and heat

waves are going to hit Taipei residents much harder (academic, writing in *Taipei Times*, July 14, 2010)

Another academic in an op-ed on lack of green space in Taipei states:

Climate change has become an issue in urban development all over the world, and the heat-island effect in the Taipei basin is becoming increasingly obvious. In summer, beneath clear blue skies, heat is trapped in the basin, pushing the temperature up to record levels. With the additional factor of radiant heat emanating from the concrete jungle, temperatures in Taipei sometimes measure close to 39 ° C (academic, writing in *Taipei Times*, September 2, 2010)

The only mention of a specific location within Taipei where heat-related effects were observed - Wanhua District - comes in a factual article on temperatures and heat-related events during period of extreme heat:

Taipei's temperature reached 38.3 ° C on Wednesday. The record-breaking high was 38.6 ° C, which occurred in 2010. Three seniors were found dead in Wan Huah District, with officials blaming the deaths on the high temperatures (staff reporter, *China Post*, July 13, 2012)

Newspaper articles are not expected to go into the same level of technical depth as academic papers or planning materials. It is of course also true that scholarly knowledge to support adaptation decisions in Taipei is emerging, such as that contained within the *Taipei Climate Change Adaptation Plan* (Huang et al., 2013). However, considering Section 2.2. and the ways in which broader societal discourses and political processes can inform land use decisions and provision of public facilities, it is worth noting some of the complexities in

distribution of exposure and vulnerability in comparison to the aforementioned locations which have historically gathered socio-political interest due to controversy. For instance, Shih (2017b) identifies differences of over ten ° C in land surface temperatures across Taipei City. Vulnerability too varies according to demographic and socio-economic factors, and in relation to the hazard being discussed (e.g. large elderly and low-income populations identified as making Wanhua and Datong Districts vulnerable to flood risk (Lin et al., 2012); low availability of shelters arguably limiting preparedness for flood and typhoon hazards in Zhongshan, Beitou and Shilin Districts (Chou & Lee, 2014). Clearly drivers and locations of heat vulnerability will differ, but the point is that spatial distribution of heat risk – and the locations in which greening may provide benefit in mitigation – is thus rather more complex than the way in which it has traditionally been discussed by the politicians, NGOs and even government officials who feed into planning processes.

Taipei Metropolis hence illustrates additional complexity for greenspace equity planning in a climate change adaptation context. As well as the spatial differences in social vulnerability to which equity planning thinking is already well aware (e.g. Danford et al., 2014), there are also significant differences in physical exposure across the city which need to be reckoned with, but which might not necessarily sit with the spaces and locations that the more influential voices in the urban governance area have focused on. Clearly we are not claiming that planners in Taipei are unware of or ignoring the scientific basis for where greening actions to mitigate heat are required. However, this indicates that applying 'just green enough' thinking to discussions on greenspace function entails finding ways to ensure that scientific understanding of how and where greenspace can deliver cooling remains able to guide governors and planners in the face of urban development pressures and site-specific controversies. These controversies may take a less informed view of the way in which heat

and other climate risks are distributed across the city, and how the cooling function of greenspace may mitigate their effects. We return to the challenges of bringing such evidence into planning processes in Section 5.

4.2. People: who is doing the greening?

We now assess the different actors involved in undertaking greening within Taipei. Challenges in recent years are illustrated by the Regulations of Bulk Reward for Urban Renewal and the associated 'Taipei Beautiful' programme. The Regulations of Bulk Reward for Urban Renewal allowed developers an increase in the permitted floor-to-area of new developments, on the condition that they implement environmental or community improvements (Construction and Planning Agency of the Ministry of the Interior [CPAMI], 2014). The 'Taipei Beautiful' programme likewise granted developers increased floor-to-area ratios (up to 10%), on the condition that derelict sites were temporarily 'greened' for 18 months in the run-up to the 2010 Taipei International Flora Expo.

Superficially at least, 'Taipei Beautiful' was promoted by Taipei City Government as a means of removing poor-quality buildings and increasing greenspace in the city by incentivising developers to undertaken pro-environmental actions, as quoted in an article reporting a range of viewpoints on 'Taipei Beautiful':

Taipei City's latest urban renewal program will create a 6.3 hectare green space and improve the city's landscape, the Taipei City Government said yesterday, denying the plans will greatly benefit private land investors (Taipei City Government, reported in *Taipei Times*, August 26, 2010)

The Urban Renewal Act (CPAMI, 2011, para. 1) similarly set out "to promote a well-planned urban land redevelopment, revitalize urban functions, improve urban living environments, and to increase public interest." Although such policies could have been argued to be a pragmatic means of encouraging developers to engage in pro-environmental actions and thus facilitate rapid deployment of greenery across the city, the result was scepticism towards both developers and the municipal government. For example, an article reporting concerns on the short-term nature of the programmes conveyed responses from NGOs and opposition politicians:

Democratic Progressive Party (DPP) Taipei City Councilor Kao Chia-yu (高嘉瑜) yesterday accused the city government of profiting conglomerates and contributing to skyrocketing housing prices [...] Huang Jui-mao (黃瑞茂), board chairman of OURs, a non-profit organization that combats speculation and urban renewal projects that benefit private investors, described the program as a fraud that profited private investors and urged the city government not to sacrifice green space for the sake of gains for a few investors (opposition politician and NGO chair, reported in *Taipei Times*, April 28, 2011)

This perception of prioritisation of economic development over integrated long-term greening in turn was translated into wider suspicion of the municipal government's competences and motives, as illustrated in a biographical piece on an NGO founder:

Most governments, argued Winkler, are doing as much as possible to keep people from understanding how extreme the situation actually is — whether it is climate change, the heat

island effect or the environmental impact of removing thousands of trees for the International Flora Exposition on bio-life. (NGO leader, reported in *China Post*, May 30, 2011)

The above extracts reflect concerns seen in Taipei (e.g. Jou et al., 2016) and other contexts about green gentrification and private sector profiteering, in that participation in greening has been perceived as a means for developers to boost profit with limited attempt from the city government to provide safeguards to ensure environmental benefits accrue to citizens. Significant from a climate change adaptation perspective is that in Taipei, municipal attempts to make tangible gains on greening by engaging the private sector have back-fired. Over-extending pragmatism around the means and motivation through which greening is achieved to encompass developers appears to have lost the support - or at least hardened the opposition - of opposition political parties and NGOs. This has the effect of actually reducing the possibility for the desired consensus on greening actions to emerge. The fact that these academics and NGOs have potential to shape public opinion through processes such as writing op-eds, and hence turn wider public sentiment against municipal policy, illustrates the risk that over-stretching greening policy based on pragmatism may have if the objective is making practical gains on greening.

By contrast, the role of neighbourhood-scale interventions in response to environmental issues have drawn more positive sentiment. For example, a piece on generally high environmental quality and abundant greenery in the Fujin Street area quotes a district chief:

Cheng said the community had been active in creating a green environment for many years. Aside from planting banyan, bodhi and some other trees on the sides of the street as well as

in the park, the community has also been diligent in trimming those trees, she said (district chief, reported in *Taipei Times*, June 4, 2011)

And an academic, in an op-ed on the value of greenery to Taipei, writes:

[T]here is much Taipei can achieve if every public garden, green space, tree-lined street and ancient tree — even community farms and rooftop gardens — can, under the jurisdiction of a citywide ecological system, use safe layouts and be responsive to the nation' aging society. If Ko's administration could do this, and also implement policy guidance and provide technical advice to assist non-governmental organizations and increase the responsibility of neighborhood and district leaders for the management of the ecological environment and social welfare, then Taipei can truly become a leader in green-city policy (academic, *Taipei Times*, January 30, 2015)

The implication is that actions undertaken at the neighbourhood scale by community groups may be a force for good in facilitating city-wide greening. Such community-level actions in spatial planning have been evaluated positively in Taiwan (Peng, Kuo, & Lin, 2010), and also other tropical/subtropical Asian cities where greenspace is at a premium (e.g. Tan, Wang, and Sia (2013) on Singapore; Jim and Chan (2016) on Hong Kong). There may hence be value in considering the role of neighbourhood-level greening in aiding climate adaptation actions like UHI mitigation, particularly as extension of greenery beyond formal greenspaces and into communities is consistent with the actions environmental science research (e.g. Bowler et al., 2010) indicates may maximise cooling. Initiatives such as *Open Green*, whereby communities in Taipei City work in partnership on greenspace planning on issues such as

elderly wellbeing, environmental quality and social innovation, could be a base for this (Taipei Open Green, 2017).

However, there may be limits to how well these community-scale actions can maximise ecosystem services. The need for specific ecological knowledge to maintain diversity and build ecosystem services (Jim, 2004) makes the necessity of cooperation between communities and municipal governments – and the need to build competence in realising strategic land use – even stronger. Examples of challenges faced in Taipei in managing greenspace at small scales (e.g. community spaces, rooftop gardens, green walls) for strategic purposes are illustrated in the newspaper articles:

"Rooftop gardens require a detailed knowledge of plant biology, hydraulic engineering and architecture. It's not only about what looks good." [...] it is best for landscapers or architects to be involved in the design and construction of rooftop gardens. At present interior designers design most gardens on old buildings in Taipei because landscapers and architects tend to focus on large projects, such as new buildings or park designs (civil engineer, reported in *Taipei Times*, June 12, 2005)

It has recently become trendy to hang greenery on buildings in an effort to stop radiant heat from penetrating indoors. However, parks and green spaces do much more to conserve water and provide shade, acting as a basic defense against the heat-island effect for the whole city (academic, writing in *Taipei Times*, September 2, 2010)

[National Taiwan University] students tried to plant seasonal vegetables by reading farming manuals and books, but the heat that radiated from the concrete surfaces seemed to shrink

whatever sprouts dared to show signs of thriving. After much puzzling over the garden, the students began perfecting the farming methods through experience and experimenting (university students, reported in *China Post*, March 10, 2014)

Whilst greening at household and neighbourhood levels offers potential in delivering localised social benefits, it is thus important that not only communities, but also municipal government staff involved in developing and realising partnerships, have access to the skills, knowledge, funding and policy support to realise ecosystem functions like cooling. Scholarly literature has emphasised such maintenance and quality management requirements for street greenery not only in Taipei, where hot summers place stress on greenery (Lin & Huang, 2013), but also Hong Kong, where a lack of skilled practitioners to manage street trees has likewise been argued to limit potential for strategic neighbourhood greening (Jim & Chan, 2016; Jim, 2017). Moreover, given our concern with equity issues, particular attention ought to be paid to ensuring partnerships are developed in areas of high exposure or vulnerability and not only in existing 'charismatic' sites like the Fujin Street example mentioned earlier in this section. This may entail – as per the quote above - planners and architects being willing to work at community level rather than on flagship projects. Despite the technical requirements of strategic greening, caution must also be exercised to avoid the criticisms of community-led planning in Taipei made by Raco, Imrie, and Lin (2011), whereby interventions from external 'experts' were seen as patronising or unwelcome.

These insights from Taipei illustrate a key challenge to addressing equity concerns related to availability of the ecological functions of greenspace. On one hand, whilst consensus-building on urban greening may seem appealing given the urgency of action required for climate change adaptation, care must be taken not to over-extend pragmatism to developers

and lose support from civil society actors who are also crucial in greenspace development and preservation. On the other, although partnerships between communities, planners and municipalities are understood positively in both 'just green enough' and equity planning contexts and can help meet communities' specific greenspace requirements, the ability of small-scale actions to contribute to coordinated city-wide ecosystem services may be limited. The challenge is thus to balance the equity concerns of larger-scale actions, with the techno-scientific limits of 'bottom-up' actions.

4.3. Process and power: why is greening being undertaken?

We last evaluate processes and rationales for greening in Taipei over time, assessing their fit with strategic understanding of greenspace for ecosystem functions like heat mitigation. Following Section 4.2. and community-scale greening, two articles report on Taipei City Government activity with communities to enhance greening:

Although part of the motivation of the greening campaign is to promote the horticulture exposition, its more far-reaching mission is to increase citizen involvement in environmental landscaping and eventually transform Taipei into a permanent "garden city," Chen said [...] *through the campaign, the city government is trying to instill an appreciation for plants among residents, further encouraging them to grow and cherish flowers.* (Department of Economic Development, reported in *China Post*, August 20, 2009)

For those who wish to enjoy cherry blossoms in Taipei, the Yangmingshan National Park (陽明山國家公園) is no longer the only destination, following a project led by the Taipei City

Government which has overseen the renovation of 251 community parks, including the planting of cherry trees and flowers, transforming the parks into scenic gardens for residents [...] In Songshan District (松山), six community parks have become popular recreational areas for residents, with cherry blossoms and maple trees attracting people who come to enjoy the flowers and greenery on a daily basis (*Taipei Times*, March 2, 2013)

Greenspace development has historically been framed in terms of recreational and aesthetic benefits provided to citizens, especially visual qualities provided by flowers and attractive trees. Even argumentation for greening positioned more closely to strategic land use has emphasised general environmental quality within the city, as per an op-ed on biodiversity and the future of Taipei Circle:

A future Taipei Circle full of ecological significance would be sure to attract a variety of flowers, plants, insects and birds that would enrich the diversity of the area's natural environment. It could even act as a big air filter, reducing pollution and muffling noise. Having a green traffic circle at this urban intersection would also enhance the slower, more easygoing aspect of the city. An old district such as Datong does not need to be, and indeed cannot be, made into another commercial zone (nature writer, writing in *Taipei Times*, November 25, 2014)

These broad-based arguments come from a range of perspectives - nature writers, staff journalists, those tasked with economic development - whereas arguments in favour of UHI mitigation as a strategic greenspace planning action reported in Sections 4.1. and 4.2. tend to be confined to academics, environmental NGOs and engineers. To evidence this, over half of statements in the analysed articles relating to UHI mitigation and climate change are made by

academics or government departments. For heat mitigation, for example, 25% of statements (n=6) are made by academics, with a further 25% (n=6) made by government departments. For climate change, 23.8% (n=5) of statements come from academia, and 33.3% (n=7) from government departments. By contrast, arguments grounded in general environmental quality or health and wellbeing are distributed more evenly across sectors. The sector with most statements relating to environmental quality is civil society at 22.2% (n=8); and the sector making most statements about health and societal benefit is press reporters (28.6%, n=12) (see Supplementary Data for full crosstabulation). Rationales for urban greening grounded narrowly in climate change adaptation may hence struggle to gain traction beyond a narrow range of actors with technical expertise. The final extract indicates that connecting strategic land use (in this case biodiversity) with more generic arguments about general environmental quality, health and wellbeing may make it a shorter step for non-technical stakeholders (e.g. other municipal government sections, communities) to engage with greening actions and move forwards in the practical direction of greening to realise strategic benefits.

Nonetheless, justice issues have been largely absent from the reviewed articles on greening and heat. When raised, justice concerns have tended to come from academics or NGOs, and even then usually as an issue that has been forgotten or marginalised. Examples include an academic, writing on the need to develop methods to include less quantifiable issues in environmental impact assessments:

What is the value of wetlands, environmental protection and protecting agricultural resources, and who stands to benefit from this value? [...] Today, those who will be affected by such projects are overlooked, whether on purpose or by accident, and their values are not expressed in the assessment (academic, writing in *Taipei Times*, September 3, 2010)

And an academic quoted in an article reporting on protests against Taipei Dome and calling for creation of green space instead:

Liao Pen-chuan (廖本全), an associate professor in National Taipei University's Department of Real Estate and Built Environment, said Taipei residents have the right to stand up and ask for fresh air, sunlight and greenery, which could be provided by a park (academic, reported in *Taipei Times*, October 31, 2011)

This relates to Section 4.1. and the question of who - and where – may benefit the most from greening. Both the above extracts express concern at a *lack* of justice considerations in Taipei's environmental planning debates thus far. Moreover, both come from academics who, whilst having potential to shape public opinion and inform climate adaptation-specific policy (e.g. Huang et al., 2013), may not hold as much sway in lobbying governors and influencing planning directions as, say, private sector developers motivated by urban development (e.g. Jou et al., 2016; Shih & Chang, 2016). More broad-based rationales for greenspace preservation and creation grounded in environmental quality, health and recreation as opposed to risk reduction for a specific hazard like heat may indeed help to enhance buy-in. Yet, as per the resilience and ecosystem services criticisms reviewed in Section 2.1., this emphasis on environmental quality for the city as a whole may mask - if not actively suppress - the fact that risks and benefits are distributed unequally across society.

Thinking of greenspace in terms of its functions such as cooling thus presents a challenge for 'just green enough' action and for equity in climate adaptation. Our evaluation for Taipei indicates that issues such as heat mitigation have remained a niche area within planning

debates, and that wider-ranging messaging around greenspace framed in terms of environmental quality and societal wellbeing may stand more chance of sustaining political traction and hence moving towards practical gains on greening. Yet emphasising more 'accessible' framings for greenspace such as general environmental quality could risk sidelining the justice and social sustainability concerns which ought to be central to 'just green enough' actions and equity planning, regardless of whether they are considered in terms of greenspace accessibility or greenspace function. The strong spatial differentiation of heat risk within a city, both in terms of physical exposure and social vulnerability, means that a technically appropriate planning response will inevitably have to involve some consideration of where within the city strategic greening is required. Nonetheless, when shifting towards thinking about and planning according to greenspace functions, a balance has to be struck between connecting to more mainstream rationales for greening to build support for rapid and sustained action, versus not losing sight of the sorts of people – and locations – who these green interventions ought at base to benefit.

5. Discussion

The challenges identified for equitable strategic greening in Taipei reflect those seen in practical applications of both 'just green enough' thinking and also equity planning (e.g. Wolch et al., 2014; Horst et al., 2017) in terms of ensuring actions justified in terms of sustainability or general environmental quality do not sideline justice concerns. However, when it comes to UHI mitigation (or, indeed, other forms of climate change adaptation), *not* taking appropriate action could expose already marginalized groups to even greater harms. As equity planning and green inequality have already been discussed at length in the

867 literature, we reflect on three particular challenges raised by the Taipei case for addressing
868 equity issues in climate adaptation via strategic land use.
869
870 The first relates to the role of evidence – here understanding of environmental characteristics,
871 established through scientifically-informed assessments (e.g. Svancara, Brannon, Scott,
872 Groves, Noss & Pressey, 2005) - in governance of a green network for climate change
873 adaptation and other benefits such as biodiversity conservation, air purification, and societal
874 wellbeing. Observations from Taipei illustrate that the way 'evidence' about the spatial
875 effects of greenery and heat works its way into, and is used within, reported societal
876 discussion around greening and greenspace topics is itself a social process. For instance, heat
877 mitigation arguments have been deployed strategically by NGOs and civil society to oppose
878 developments like the Taipei Dome. Social and environmental benefits of greenery have been
879 (arguably) adopted strategically by developers in Taipei to gain more favourable building
880 conditions. Equitable green adaptation may hence require careful reflection on how
881 'evidence-based planning' (Svancara et al., 2005) may be guided to deliver benefit to those
882 who need it most. Examples globally suggest this can be done. Factors aiding successful
883 urban environmental planning based on robust ecosystem knowledge include knowledge and
884 political nous of key municipal government departments (e.g. Freund (2001) on departmental
885 leaders' knowledge and vision in Durban); overall municipal vision (Baro et al. (2016) and
886 Depietri, Kallis, Baro, and Cattaneo (2016) on Barcelona's vision to become a leader in green
887 infrastructure); or political timeliness and connection with socio-economic challenges (e.g.
888 Newell et al. (2013) on Los Angeles Green Alley Program). Attaining equitable outcomes for
889 climate adaptation via greening hence requires both the provision of robust scientifically-
890 informed evidence, and also competence - especially from environmental planners or
891 academics – in navigating the broader political terrain within which urban greenspace

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planning happens (e.g. Leck & Roberts, 2015; Shih & Mabon, 2017). This involves understanding the key people, framings and forums that can help knowledge of spatial inequality in climate risk gain political traction and inform decision-making.

The second relates to a common concern in equity planning - the need to remember that inequality in urban greenspace availability can arise from procedural or structural factors. 'Solutions' to increase the likelihood of interventions taking root in marginalised neighbourhoods may thus be social or political as well as technical. These could include, for instance, improved citizen engagement in planning processes to understand social context (Jim & Chan, 2016); rent controls and anti-poverty measures (Horst et al., 2017); safeguards to ensure economic benefits accrue primarily to citizens and not to developers (Jou et al, 2016; Horst et al., 2017); and removing administrative or practical barriers to participation in programmes (Danford et al., 2014). Yet when it comes to thinking in terms of functional greenspace serving climate adaptation purposes, the perceived urgency of climate change may mean *any* green intervention in the built environment is viewed as a force for good. The extracts presented in this paper, for instance, talk about UHI mitigation, flood reduction and air quality benefits of greening in Taipei in almost exclusively positive terms regardless of location. However, such pragmatism towards the ecosystem functions of greenspace must not serve as a blinder to ongoing underlying structural causes of unequal exposure to heat risk (e.g Klinenberg, 2002; Harlan et al., 2006). Haase et al. (2017) too express concern that issues of social and spatial inequality remain sidelined in urban greening discussion. When thinking in terms of greenspace delivering specific benefits, then, there is an even greater need to guard against 'all greening is good' thinking and to keep a critical check on equity dimensions.

Third, to realise climate adaptation benefits, the smaller-scale and locally-appropriate projects advocated within both 'just green enough' thinking (e.g. Curran & Hamilton (2012) on avoiding gentrification) and equity planning (e.g. Horst et al. (2017) on urban agriculture) also need to be considered in terms of their contribution to a city-wide network (Jim, 2004; Schekte et al., 2010). While these kinds of actions are good for building social capital and enhancing wellbeing, even the best greenspace system planned or created from a 'bottom-up' approach may not necessarily deliver the most effective ecosystem services due to this need to think in terms of an entire urban ecosystem when it comes to responding to environmental and climatic changes (Tan and Abdul Hamid, 2014). As well as the aims of broadening participation and building partnerships discussed elsewhere in equity planning literature, our findings and the extant literature therefore suggest that working towards equity in availability of greenspace functions for climate change adaptation may also require significant competence at the municipal government level to deliver in concert city-wide physical exposure reduction and social policy measures targeted specifically at vulnerable communities. There is of course also need for reflection on who it is that defines what 'equity' means, and who is involved in setting the criterion through which 'equity' in planning is assessed.

Lastly, in this paper we have focused only on the cooling function of greenspace. Greenspace may serve many functions (Jim & Chan, 2016), notably in Taipei flood mitigation and disaster preparedness. Trade-offs between UHI mitigation and these other functions due to the change of spatial configuration of green infrastructure may be required in planning discussions (Norton et al., 2015; Meerow & Newell, 2017). Assessing where these trade-offs might occur and how these functions may be balanced is beyond the scope of our paper. However, in the spirit of the preceding discussion it is imperative that there are fair, open and

inclusive decision-making *processes* through which these trade-offs are deliberated, and that careful consideration is afforded as to who may be most negatively affected by any trade-offs made in land use change. Moreover, greening is not a catch-all solution for cooling, and ought to be considered as one of only a number of options such as changing roof/pavement colours and building materials, creating wind corridors and changing building layouts (Emmanuel, 2005).

6. Conclusions

Our review indicates that, due to concerns over the role of developers in existing greening initiatives and the limited presence of justice concerns, greater reflection on 'just green enough' planning and on equity concerns may be of significant value for UHI mitigation and similar climate adaptation via greening in cities like Taipei. Nonetheless, insights from Taipei suggest three developments to this equity planning thinking for relevance to climate adaptation. First, the heterogeneity of exposure to heat *within* cities means there is a key role for scientific knowledge (both environmental- and social science) in tempering debates about equity in access to greenspace with understanding of how ecosystem functions from greenspace are distributed across a city, and of where vulnerable communities are located in relation to ecosystem services. Second, whilst careful cooperation with developers may be able to realise increases in greenery, there is a risk that such pragmatism may backfire and alienate civil society groups necessary to implement greening. As such, municipal governments may be able to make some gains by developing competence in working collaboratively with communities to develop neighbourhood-scale greening targeted at climate adaptation action. However, whilst these neighbourhood-level actions can help to build community cohesion, their contribution to ecosystem services at a city-wide level may

be limited. Third, whilst a narrow focus on heat mitigation may be a 'hard sell' and the general environmental, health and aesthetic benefits of greenery to society as a whole may give an easier pathway to buy-in for greening decisions, this may risk diluting the emphasis on justice. It is thus imperative to develop planning policies (perhaps through engagement of social scientists with planners) that take seriously the question of what delivering ‘equitable’ benefit means in the context of ecosystem functions from greenspace.

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Figure and Table Legend

Figure 1: Number of words written about heat and greenery over time. (Note: Q1=December of previous year, January, February; Q2=March, April, May; Q3=June, July, August; Q4=September, October, November).

Figure 2: Argument map for heat and greenery in Taipei (source: Mabon and Shih, in press).

Table 1: Terminology and definitions.

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Table 4: Sector of statement-makers over time.

Table 5: Distribution of argument categories over time.

Table 6: Types of greenery mentioned over time.

Figure(s)

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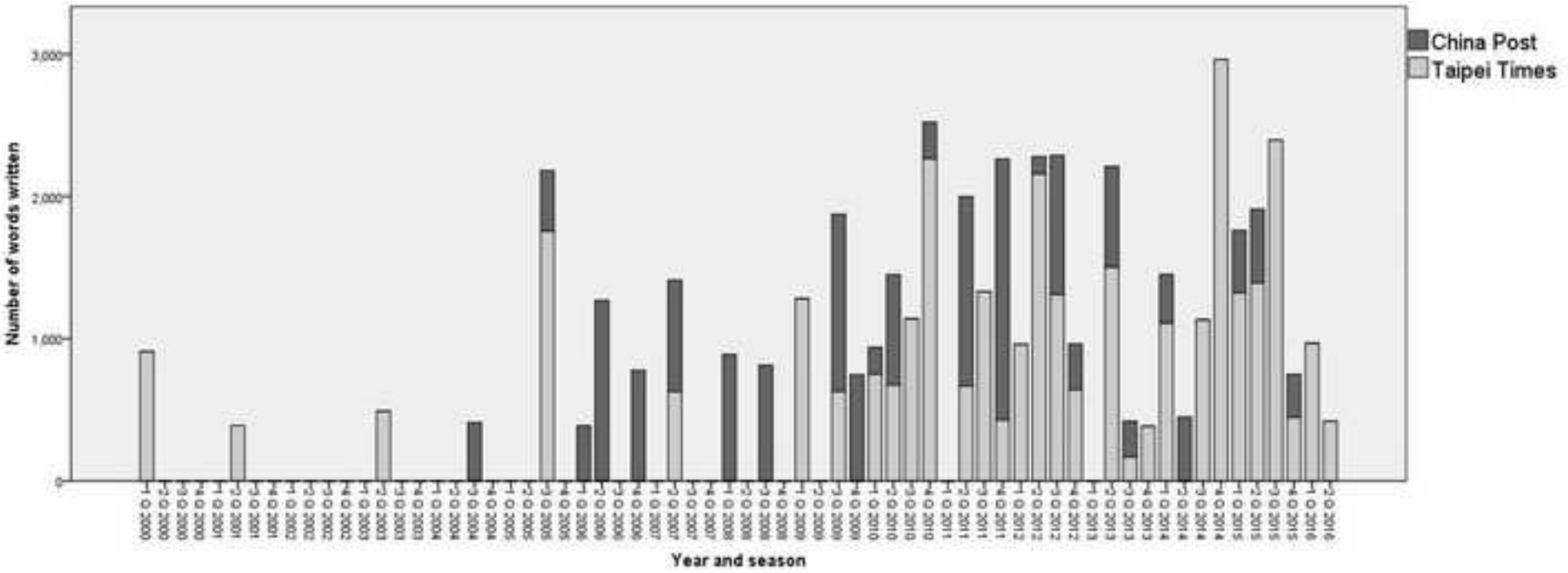

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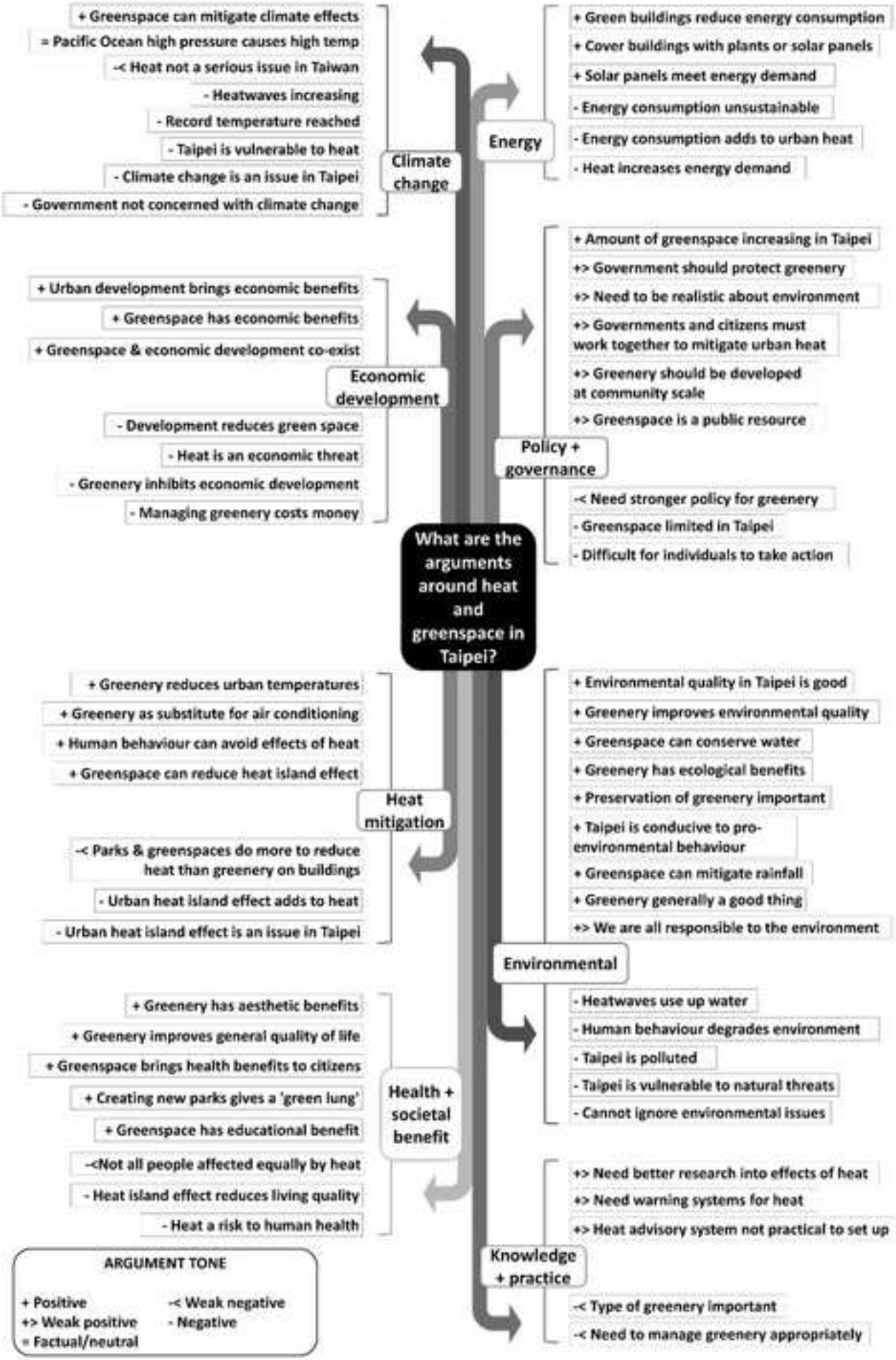

What might 'just green enough' urban development mean in the context of climate change adaptation? The case of Taipei Metropolis, Taiwan.

Table 1: terminology and definitions

Term	**Definition**	**How and when used in this paper**
Greenspace	"(N)atural greenspaces in an urban context […] many types of land in an urban setting from formally designated areas such as parks, areas set aside under legislation such as allotments, to more natural areas such as nature reserves and corridors along river banks" (Comber et al, 2008: 103). Given the dense city context, we also include very small-scale spaces e.g. rooftop gardens, neighbourhood parks, street trees within this (Tan and Jim, 2017).	We use *greenspace* when discussing sites or locations for vegetation within the city. Given our interest in greenspace function we consider both 'planned' and 'unplanned' greenspaces.
Green infrastructure	"(A)n interconnected network of natural areas and other open spaces that conserves natural ecosystem values and functions, sustains clean air and water, and provides a wide array of benefits to people and wildlife" (Benedict and McMahon, 2002: 1)	Our focus within this paper is on greenspace and greenspace function, however we refer to 'green infrastructure' when citing the work of others using this term, in situations when vegetation is created or managed with a stated strategic purpose.
Urban greening	Any process which increases the abundance or cover of vegetation in a given area within a city (after Bowler et al, 2010)	We use *greening* or *urban greening* to refer to any actions which may increase vegetation within the city.
Urban greenery	"[E]ssentially either a human creation or a human modified form of natural vegetation." (Tan and Jim, 2017: vii)	We use *greenery* to broadly refer to any piece of vegetation created, modified or managed by humans at any scale.

What might 'just green enough' urban development mean in the context of climate change adaptation? The case of Taipei Metropolis, Taiwan.

Table 2: categories used for coding articles

Variable	**Categories**
Article topic	Economic development; energy; environmental issue; environmental benefit; excess heat; greenery and greenspace; planning and built environment.
Argument type	Climate change; economic development; energy; environmental; health and societal benefit; heat mitigation; knowledge and practice; policy and governance.
Sector of speaker	Academia and research; civil society; community groups; government; NGOs; politics; press; private sector.
Tone	Positive (including solutions such as green roofs; and also 'weak positive' i.e. generally positive / solution-focused but pointing out difficulties or limitations); negative (including problems, such as greenspace getting in the way of economic development; and also 'weak negative', i.e. generally negative / problem-focused but pointing out potential solutions); balanced / factual / neutral.
Type of greenery	Agricultural land; biodiversity; community space; garden; general environment; green building; greenery; greenspace; park; plants; renewable energy-related; river; rooftop garden; trees.

What might ‘just green enough’ urban development mean in the context of climate change adaptation? The case of Taipei Metropolis, Taiwan.

Table 3: article topics over time

Time Period	**Article Topic**	***China Post***	***Taipei Times***
1 December 1999 – 31 December 2004	Economic development	1 (100%)	0 (0%)
	Energy	0 (0%)	0 (0%)
	Environmental issue	0 (0%)	0 (0%)
	Environmental benefit	0 (0%)	0 (0%)
	Excess heat	0 (0%)	0 (0%)
	Greenery and greenspace	0 (0%)	2 (67%)
	Planning and built environment	0 (0%)	1 (33%)
1 January 2005 – 31 December 2010	Economic development	2 (13%)	1 (8%)
	Energy	0 (0%)	0 (0%)
	Environmental issue	1 (7%)	2 (15.3%)
	Environmental benefit	4 (27%)	2 (15.3%)
	Excess heat	0 (0%)	1 (8%)
	Greenery and greenspace	4 (27%)	5 (38%)
	Planning and built environment	4 (27%)	2 (15.3%)
1 January 2011 – 31 March 2016	Economic development	3 (16.5%)	2 (4%)
	Energy	0 (0%)	2 (4%)
	Environmental issue	3 (16.5%)	4 (9%)
	Environmental benefit	2 (11%)	6 (13%)
	Excess heat	4 (22%)	4 (9%)
	Greenery and greenspace	1 (6%)	12 (26%)
	Planning and built environment	5 (28%)	16 (35%)

What might 'just green enough' urban development mean in the context of climate change adaptation? The case of Taipei Metropolis, Taiwan.

Table 4: sector of statement-makers over time

Time Period	**Sector of Statement-Maker**	***China Post***	***Taipei Times***
1 December 1999 – 31 December 2004	Academia	0 (0%)	0 (0%)
	Civil society	0 (0%)	0 (0%)
	Community group	0 (0%)	0 (0%)
	Government	0 (0%)	4 (66%)
	NGO	0 (0%)	1 (17%)
	Politics	0 (0%)	0 (0%)
	Press	0 (0%)	1 (17%)
	Private sector	0 (0%)	0 (0%)
1 January 2005 – 31 December 2010	Academia	0 (0%)	23 (44%)
	Civil society	1 (5%)	2 (4%)
	Community group	3 (15%)	0 (0%)
	Government	3 (15%)	5 (10%)
	NGO	0 (0%)	0 (0%)
	Politics	0 (0%)	9 (17%)
	Press	13 (65%)	6 (12%)
	Private sector	0 (0%)	7 (13%)
1 January 2011 – 31 March 2016	Academia	4 (16.5%)	18 (15%)
	Civil society	0 (0%)	21 (17%)
	Community group	0 (0%)	3 (2.5%)
	Government	6 (25%)	27 (22%)
	NGO	4 (16.5%)	11 (9%)
	Politics	0 (0%)	18 (15%)
	Press	7 (29%)	21 (17%)
	Private sector	3 (13%)	3 (2.5%)

What might 'just green enough' urban development mean in the context of climate change adaptation? The case of Taipei Metropolis, Taiwan.

Table 5: distribution of argument categories over time

Time Period	**Argument Category**	***China Post***	***Taipei Times***
1 December 1999 – 31 December 2004	Climate change	0 (0%)	0 (0%)
	Economic development	0 (0%)	0 (0%)
	Energy	0 (0%)	0 (0%)
	Environmental	0 (0%)	2 (33%)
	Health and societal benefit	0 (0%)	1 (17%)
	Heat mitigation	0 (0%)	0 (0%)
	Knowledge and practice	0 (0%)	0 (0%)
	Policy and governance	0 (0%)	3 (50%)
1 January 2005 – 31 December 2010	Climate change	1 (5%)	6 (11.5%)
	Economic development	4 (20%)	7 (13%)
	Energy	1 (5%)	4 (8%)
	Environmental	3 (15%)	5 (10%)
	Health and societal benefit	4 (20%)	11 (21%)
	Heat mitigation	2 (10%)	5 (10%)
	Knowledge and practice	1 (5%)	6 (11.5%)
	Policy and governance	4 (20%)	8 (15%)
1 January 2011 – 31 March 2016	Climate change	3 (12.5%)	11 (9%)
	Economic development	2 (8.5%)	15 (12%)
	Energy	1 (4%)	8 (7%)
	Environmental	5 (21%)	21 (17%)
	Health and societal benefit	6 (25%)	20 (16.5%)
	Heat mitigation	3 (12.5%)	14 (11.5%)
	Knowledge and practice	3 (12.5%)	8 (7%)
	Policy and governance	1 (4%)	25 (20%)

What might 'just green enough' urban development mean in the context of climate change adaptation? The case of Taipei Metropolis, Taiwan.

Table 6: types of greenery mentioned over time

Time Period	**Type of green infrastructure mentioned**		***China Post***		***Taipei Times***	
1 December 1999 – 31 December 2004	Community / individual-scale	Community space	0 (0%)	0 (0%)	1 (11%)	1 (11%)
		Garden		0 (0%)		0 (0%)
		Green building		0 (0%)		0 (0%)
		Renewable energy-related		0 (0%)		0 (0%)
		Rooftop garden		0 (0%)		0 (0%)
	Generic greenery	General environment	0 (0%)	0 (0%)	1 (11%)	1 (11%)
		Greenery		0 (0%)		0 (0%)
	Large-scale	Agricultural land	2 (20%)	0 (0%)	5 (56%)	1 (14%)
		Biodiversity		0 (0%)		0 (0%)
		Embankment		0 (0%)		0 (0%)
		Greenspace		0 (0%)		2 (28%)
		Park		1 (10%)		1 (14%)
		Reclaimed land		0 (0%)		0 (0%)
		River		1 (10%)		0 (0%)
	Trees and plants	Plants	8 (80%)	4 (40%)	2 (22%)	1 (11%)
		Trees		4 (40%)		1 (11%)
1 January 2005 – 31 December 2010	Community / individual-scale	Community space	3 (14.3%)	1 (4.7%)	4 (21%)	0 (0%)
		Garden		1 (4.7%)		0 (0%)
		Green building		1 (4.7%)		1 (5.25%)
		Renewable energy-related		0 (0%)		1 (5.25%)
		Rooftop garden		0 (0%)		2 (10.5%)
	Generic greenery	General environment	11 (52.3%)	2 (9.5%)	5 (26%)	2 (10.4%)
		Greenery		9 (42.8%)		3 (15.6%)
	Large-scale	Agricultural land	7 (33.3%)	0 (0%)	8 (42%)	0 (0%)
		Biodiversity		0 (0%)		0 (0%)
		Embankment		0 (0%)		1 (5.25%)
		Greenspace		3 (14.3%)		2 (10.5%)
		Park		4 (19%)		4 (21%)
		Reclaimed land		0 (0%)		1 (5.25%)
		River		0 (0%)		0 (0%)
	Trees and plants	Plants	0 (0%)	0 (0%)	2 (11%)	0 (0%)
		Trees		0 (0%)		2 (11%)

1 January 2011 – 31 March 2016	Community /individual-scale	Community space	8 (50%)	0 (0%)	12 (17%)	6 (8.5%)
		Garden		0 (0%)		0 (0%)
		Green building		0 (0%)		2 (3%)
		Renewable energy-related		0 (0%)		3 (4%)
		Rooftop garden		1 (6.25%)		1 (1.5%)
	Generic greenery	General environment	0 (0%)	3 (18.75%)	14 (20%)	6 (9%)
		Greenery		4 (25%)		8 (11%)
	Large-scale	Agricultural land	6 (37.5%)	0 (0%)	29 (41.5%)	1 (1.5%)
		Biodiversity		0 (0%)		2 (3%)
		Embankment		0 (0%)		0 (0%)
		Greenspace		4 (25%)		12 (17%)
		Park		2 (12.5%)		12 (17%)
		Reclaimed land		0 (0%)		0 (0%)
		River		0 (0%)		2 (3%)
	Trees and plants	Plants	2 (12.5%)	0 (0%)	15 (21.5%)	1 (1.5%)
		Trees		2 (12.5%)		14 (20%)

e-components

Click here to download e-components: taipei_green_eq_supp_data.docx

What might ‘just green enough’ urban development mean in the context of climate change adaptation? The case of urban greenspace planning in Taipei Metropolis, Taiwan.

Statement of no conflict of interest

We hereby confirm that this manuscript is not currently under consideration for publication elsewhere and has not previously been published elsewhere; that neither author has any financial interest or benefit arising from the direct application of their research; and that no funder has had any influence over the research design, execution or analysis.