City of Tempe, AZ: Plan Integration for Resilience Scorecard™ (PIRS™) For Heat

City of Tempe, AZ

Plan Integration for Resilience Scorecard™ (PIRS™) for Heat

Spatially evaluating networks of plans to mitigate heat

Research Team: Ladd Keith, Sara Meerow, Shaylynn Trego, and Erika Schmidt.

Recommended Citation: Keith, Ladd; Meerow, Sara; Trego, Shaylynn; and Schmidt, Erika. (2022). *City of Tempe, AZ: Plan Integration for Resilience Scorecard™ (PIRS™) For Heat*.

Acknowledgments: This material was supported by the Robert Wood Johnson Foundation and the U.S. NOAA Climate Program Office's Extreme Heat Risk Initiative, Cooperative Agreement NA21OAR4310148. The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the Robert Wood Johnson Foundation or the U.S. NOAA.

Table of Contents

Executive Summary

The combination of climate change and the urban heat island (UHI) effect is increasing the number of dangerously hot days and the need for all communities to plan for urban heat resilience equitably. Urban heat resilience requires an integrated planning approach that coordinates strategies across community plans and uses the best available heat risk information to prioritize heat mitigation strategies for the most vulnerable communities. The Plan Integration for Resilience Scorecard™ (PIRS™) for Heat is an approach that communities can use to analyze how heat mitigation policies are integrated into different plans and to identify opportunities to better target heat mitigation policies in high heat risk areas. The PIRS™ for Heat was developed as an extension of the original Plan Integration for Resilience Scorecard™, a methodology originally developed by Berke et al. (2015) and then further advanced and translated to planning practice by Malecha et al. (2019), for spatially evaluating networks of plans to reduce vulnerability to hazards. With support from the U.S. National Oceanic and Atmospheric Administration (NOAA) Climate Program Office's Extreme Heat Risk Initiative and in partnership with the American Planning Association, PIRS™ for Heat was initially piloted in five geographically diverse U.S. communities, including Baltimore, MD, Boston, MA, Fort Lauderdale, FL, Seattle, WA, and Houston, TX. The rationale, methodology, and findings from the first five cities are published in the guidebook *The Plan Integration for Resilience Scorecard™ (PIRS™) for Heat: Spatially evaluating networks of plans to mitigate heat*. The approach was then applied to the City of Tempe, AZ with support from the Robert Wood Johnson Foundation. This report summarizes the PIRS™ for Heat results for Tempe.

Adapting the process detailed in Malecha et al. (2019), the project team analyzed all policies in Tempe's network of plans, including their comprehensive plan, hazard mitigation plan, climate action plan, and sustainability plan. Policies were only included if they had the potential to impact urban heat, were place-specific, and contained a recognizable policy tool. Policies were then scored based on whether they would likely mitigate heat ("+1"), worsen heat ("-1"), or the impact was unclear from the description in the plan ("Unknown"). Scored policies were mapped to relevant census tracts across the city to evaluate their spatial distribution and the net effect on urban heat. The resulting PIRS™ for Heat scorecard was then compared with physical and social vulnerability data to assess policy alignment with heat risks and to identify opportunities for improved urban heat resilience planning.

PIRS™ for Heat: City of Tempe, AZ

The City of Tempe, Arizona had a population of 191,607 in 2020. Located in the Southwest region of the U.S., Tempe's average daily maximum temperature is currently 87.7°F (30.9°C), with an average of 111.4 days over 100°F (37.8°C). Under high emissions scenarios, the average daily maximum temperature would increase to 95.2 °F (35.1°C) by 2100, with 163.5 days over 100°F (37.8°C).

Methodology

This application of the PIRS™ for Heat follows the steps outlined in the guidebook (Keith et al. 2022). This includes the creation of the scorecard by assembling the network of plans, identifying, categorizing, and scoring policies in those plans, and then mapping them. These results are analyzed by comparing them with data on physical and social vulnerability, leading to recommendations for future heat mitigation planning.

Plans and Policies

Table 1 summarizes the five Tempe plans assessed using the PIRS™ for Heat approach. Across the five Tempe plans, we identified 232 heat-relevant policies that met the criteria for inclusion.

Table 1. Plan detail summary

Plan Name	Year Adopted	Scale	Plan Category	Number of policies
City of Tempe General Plan 2040	2013	City	Comprehensive	160
Maricopa County Multi-Jurisdictional Hazard Mitigation Plan	2021	County	Hazard	12
City of Tempe Climate Action Plan	2019	City	Climate	26
City of Tempe Climate Action Plan Update	2021	City	Climate	31
Annual Report 2020 Office of Sustainability	2020	City	Sustainability	3

We coded the 232 policies into six of the eight categories of land use policy tools (Table 2). The majority of the policies were categorized as capital improvements (160 policies), followed by development regulations (46), and land use analysis and permitting process policies (16). Few heat-related policies were identified that used financial incentives and penalties, land acquisition, and public facilities, and none that used density transfer provisions or post-disaster recontrstruction decisions related to heat.

Table 2. Land use policy tool categories

Policy Tool Category	Number of Policies
Land Use Analysis and Permitting Process	16
Capital Improvements	160
Development Regulations	46
Land Acquisition	1
Density Transfer Provisions	0
Financial Incentives and Penalties	3
Public Facilities	2
Post Disaster Reconstruction Decisions	0

We also coded the 232 policies into all four heat mitigation strategy categories (Table 3). The most common categories of heat mitigation strategies were related to waste heat (110 policies), followed by urban greening (49) and land use (46). Together these accounted for the majority of policies. We found 16 policies focused on mitigating heat through urban design. Note that some policies were associated with more than one heat mitigation strategy category/subcategory, so individual heat mitigation strategy category totals add up to more than the 232 policies identified.

Table 3. Heat mitigation strategy categories

Heat Mitigation Strategy Category	Number of Policies
Land use	46
Urban design	16
Urban greening	49
Waste heat	110

Scorecard

Out of the 232 policies we coded, 136 policies were found to decrease heat in the built environment (receiving a score of +1), one policy was found to increase heat in the built environment (receiving a score of –1), and two policies were found to have a neutral heat impact in the built environment (receiving a score of 0). There were 93 policies classified as having an unknown impact on heat. Only the policies that received a score of +1 or -1 were mapped; the policies with an unknown impact on heat were excluded from the scorecard map.

Figure 1 shows the PIRS™ for Heat net scores (the sum of all the applicable +1 and -1 policies) for each census tract. Net scores ranged from 95 to 120 across the city. While there is spatial variation in scores, the highest-scoring tracts tend to be in the Northern (including downtown) area of the city.

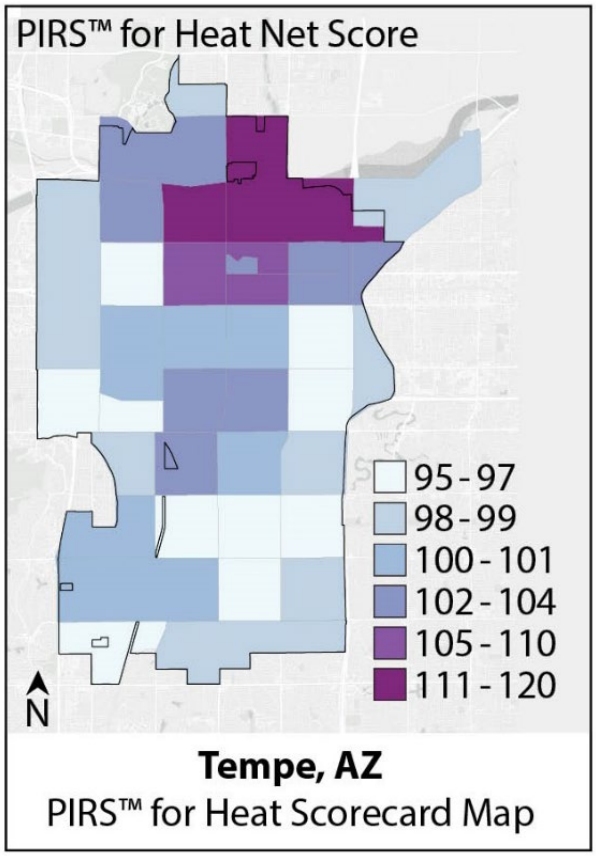

Figure 1. Tempe PIRS™ for Heat net scores by census tract.

Analysis

Figure 2 shows: 1) Tempe's PIRS™ for Heat net scores for 2020 census tracts; 2) average land surface temperature (LST) values for 2020 census tracts based on median LST from 55 images taken over six years (2015-2020) by NASA satellites and processed by NASA DEVELOP students at Arizona State University; and 3) CDC Social Vulnerability Index (SVI) ranking by 2020 census tract. We calculated Pearson correlation coefficients to determine if there was a statistically significant relationship between tract net scores and vulnerability indicators. We did not find a significant correlation between the PIRS™ for Heat net score and aggregate 2015-2020 land surface temperatures (coefficient: -0.050; p-value: 0.764). The lack of statistical significance could be, in part, the result of the small sample size, but this finding also suggests that heat mitigation policies are not systematically targeting the hottest areas of the city. We similarly found no significant relationship between the net scores and land surface temperatures just from the year 2020 (coefficient: 0.013; p-value: 0.937).

The correlation coefficient (0.305) between PIRS™ for Heat net scores and social vulnerability is positive and marginally statistically significant ($p<0.1$). This suggests that more socially vulnerable areas of the city are, to some extent, targeted with more heat mitigation policies. We also find a statistically significant correlation (coefficient: 0.574, p-value: 0.000) between social vulnerability and aggregate 2015-2020 land surface temperatures as well as 2020 land surface temperatures (coefficient: 0.585; p-value: 0.000), indicating that more socially vulnerable areas also have higher surface temperatures, compounding heat risks and providing further motivation to target these areas with heat mitigation policies in the future.

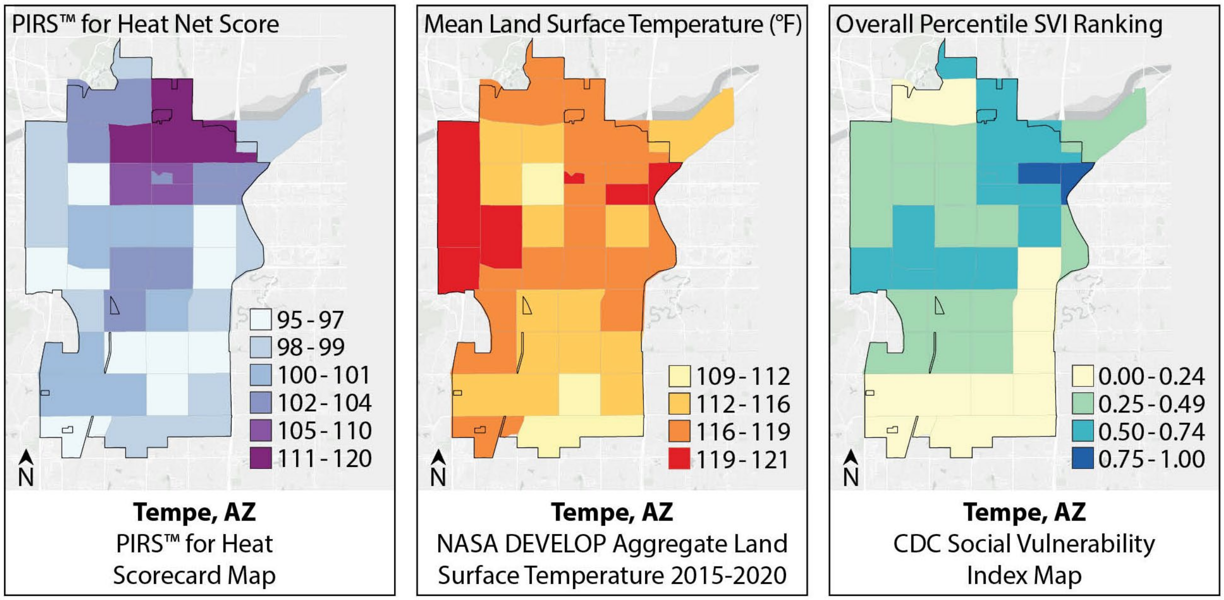

Figure 2. Tempe's PIRS™ for Heat net score by census tract (left), mean afternoon temperature by census tract (middle), and CDC SVI ranking by census tract (right).

Additionally, while only one policy was identified that would clearly increase vulnerability to heat in Tempe, 93 relevant policies were coded as having an unknown impact on heat. It would be beneficial for the city to review these policies and add additional information on potential heat impacts or heat mitigation measures. Tempe may also want to consider the impact of policies on heat in developing future plans.

Going forward, Tempe can utilize the results from the PIRS™ for Heat analysis, as well as documented heat risk and social vulnerability data to prioritize the most vulnerable areas of the city for policies that increase resilience to the impacts of heat and decrease heat in the built environment.

References

Berke, Philip R., Newman, Galen, Lee, Jaekyung, Combs, Tabitha, Kolosna, Carl, & Salvesen, David. (2015). Evaluation of Networks of Plans and Vulnerability to Hazards and Climate Change: A Resilience Scorecard. *Journal of the American Planning Association*, *81*(4), 287–302.

Keith, Ladd; Meerow, Sara; Berke, Philip; DeAngelis, Joseph; Jensen, Lauren; Trego, Shaylynn; Schmidt, Erika; and Smith, Stephanie. (2022). Plan Integration for Resilience Scorecard™ (PIRS™) for Heat: Spatially evaluating networks of plans to mitigate heat. (Version 1.0). Available from: www.planning.org/knowledgebase/urbanheat/

Malecha, Matthew, Masterson, Jaimie Hicks, Yu, Siyu, & Berke, Philip. (2019). *Plan Integration for Resilience Scorecard Guidebook: Spatially evaluating networks of plans to reduce hazard vulnerability – Version 2.0*. College Station, TX. Retrieved from http://mitigationguide.org/wp-content/uploads/2018/03/Guidebook-2020.05-v5.pdf