THE WATER INSTITUTE

Technical Memorandum

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RESILIENT JACKSONVILLE

Analysis of Spatial Planning Alternate Future Scenarios

INTRODUCTION

The City of Jacksonville has developed a resilience strategy for safeguarding the city's future in the face of shocks and stressors including hurricanes, winter storms, coastal erosion, and extreme heat. One significant threat to the city is flooding, which is likely to become more frequent and widespread in the coming years as sea levels rise and storms intensify (IPCC, 2022). Jacksonville is considering a variety of actions to reduce or mitigate risk, including implementation of policies or incentives for directing future development toward lower flood risk areas. The Water Institute (the Institute) undertook an analysis of hypothetical alternate future scenarios of citywide spatial development patterns to support decisions made by the City to increase resilience to flooding as a shock and stressor. These scenarios are not predictions of the future of Jacksonville, but instead characterize current conditions in the city; provide realistic projections of outcomes under a "Future without Action" approach; benchmark how outcomes might positively or negatively change with implementation of spatial planning actions; and inform the degree of impact spatial planning might have in the context of comprehensive resilience planning.

METHODS

The overarching process for this analysis was based on structured decision making (SDM), an organized method for supporting systematic, objectives-orientated decision making for complex problems (Dalyander et al., 2016; DeJong et al., 2022; Hammond et al., 1999). The steps undertaken within SDM include identifying the Problem (i.e., the decision context, which frames the specific scope of a decision); articulating Objectives; formulating Alternatives; analyzing Consequences; and considering Tradeoffs (PrOACT). Objectives for Jacksonville were identified and refined as part of developing Resilient Jacksonville (City of Jacksonville, 2023) and are presented therein. Here, we present the consequence analysis of spatial planning strategies to reduce flood risk.

DECISION CONTEXT AND SCENARIO DEVELOPMENT

In 2022–2023, through facilitated discussions with the Jacksonville Chief Resilience Officer (CRO), Anne Coglianese, we identified and refined two decision context questions related to spatial planning and flood risk reduction:

- Where should Jacksonville allow or even direct/incentivize new development to minimize long-term flood risk and lower long-term costs?
- Where should Jacksonville restrict new or infill development to limit flood risk and reduce long-term cost of recovery, repair, etc.?

We then identified four hypothetical scenarios to analyze to inform these questions:

- **Future without Action (FWOA):** no targeted actions taken to influence the spatial pattern of development
- **Urban Core Infill:** maximize growth in existing downtown and walkable neighborhoods in lower flood risk areas and minimize encroachment of new development in rural areas
- **Suburban Infill:** maximize growth in existing suburbs in lower flood risk areas and minimize encroachment of new development into rural areas
- **Targeted Greenfield Development:** extend new development into currently undeveloped lower flood risk areas

These scenarios are framed around Development Types that were defined for Resilient Jacksonville (City of Jacksonville, 2023): Contemporary Suburbs, Downtown, Historic Walkable Neighborhoods, Post-War Suburbs, Rural Mosaic, Coastal Communities, Protected Lands, and the Industrial Waterfront. The focus of this analysis is on the residential and rural Development Types away from the coast and does not include projections or analysis of Coastal Communities, Protected Lands, or the Industrial Waterfront. More information on Development Types and their characteristics can be found in Resilient Jacksonville (City of Jacksonville, 2023).

The FWOA scenario provides a benchmark for assessing the consequences of the other scenarios. The other three alternatives provide information on potential outcomes of actions that direct or incentivize development in different typological areas of the city, such as focusing growth in the urban core areas of Downtown and the Historic Walkable Neighborhoods, to guide implementation. A fifth, "balanced solution" hypothetical scenario was developed based on the results of the initial simulations to inform how a combination of spatial planning approaches could affect Jacksonville.

CONSEQUENCE ANALYSIS TOOL DEVELOPMENT

The consequence analysis tool was developed as a set of Python (Sanner, 1999) Jupyter notebooks that process input data, project future conditions for scenarios, and generate a set of decision-relevant outcome metrics. The spatial unit of the underlying model (i.e., the smallest unit that the city is divided into for input data and model application) is the census block group (CBG). Because insufficient information is available to realistically project growth patterns for CBGs, all results are aggregated at the development type or citywide scale. The outcome metrics used in the analysis include:

- People: total number of residents
- People at risk: number of individuals located within the 100-year flood plain (FEMA, 2021)

- Assets: number of assets of all types, including residential, commercial, and municipal buildings (more information on asset classification may be found in the Resilient Jacksonville Vulnerability Assessment Report, (Fernleaf & The Water Institute, 2023))
- Vulnerable assets: number of assets vulnerable to flooding, i.e., projected to be located within the 100-year flood plain
- Undeveloped land: area of land associated with non-urbanized land cover classes following the U.S. Geological Survey National Land Cover Database (Dewitz, 2021) classifications
- Developed land: area of land associated with urbanized land cover classes
- Population density: population divided by the acreage of developed land[1]
- Heat vulnerability: population at high, moderate, and low vulnerability to heat

Current Conditions and Future without Action

The first step in applying the consequence analysis tool was initializing it with the current conditions in Jacksonville (i.e., putting in data for the first-time step). The population for CBGs was taken from the Resilient Jacksonville Vulnerability Assessment (Fernleaf & The Water Institute, 2023), which incorporated 5-Year American Community Survey 2020 U.S. Census data (U.S. Census Bureau, 2023) (U.S. Census Bureau, 2020). The number of assets and vulnerable assets for each CBG was also taken from the vulnerability assessment. Developed and undeveloped land area were taken from the National Land Cover Database (Dewitz, 2021); all Urban Land Cover classifications were aggregated and assigned as "developed" land area and the remainder of the total area was assigned as "undeveloped" regardless of land cover or habitat type. CBGs were assigned to development types by overlaying their distribution on the Development Type Map (City of Jacksonville, 2023) and assigning the Development Type with the greatest spatial area to each CBG.

Population trends for the City of Jacksonville between 2000–2020 included approximately 1.13% population growth each year (U.S. Census Bureau, 2020). For the FWOA scenario, this annual population growth was assumed to continue over the 50-year planning horizon from the baseline year of 2020 through 2070. To spatially distribute the citywide population growth, we used urban land use conversion data from 2001–2019 as a proxy for historical population growth distribution (Homer & Fry, 2012). We overlaid urban land use conversion on the Development Type Map to determine the percentage of urban conversion associated with each Development Type, combining the Rural Mosaic and Contemporary Suburb Development Types under the assumption that urban conversion in rural areas was associated with suburban expansion (Table 1). **It should be noted that the population growth used here is a single projection of a possible future and not a precise prediction of population changes**. There is considerable uncertainty in local, regional, and national population growth drivers that was beyond the scope of this study to consider.

[1] For areas in the urban core (Downtown and Historic Walkable Neighborhood), the total land area is used rather than the developed land area under the assumption that the undeveloped area in these Development Types is predominantly smaller parks, green spaces, and vacant lots that would normally be considered in calculating population density.

Table 1. Percentage of urban conversion from 2001–2019 by Development Type. Conversion within the Rural Mosaic has been added to the Contemporary Suburbs assuming conversion in those CBGs is associated with suburban expansion.

Development Type	Adjusted %
Downtown	0.2%
Historic Walkable Neighborhoods	0.8%
Post-War Suburbs	8.0%
Contemporary Suburbs (includes Rural Mosaic)	89.1%
Coastal Communities	1.9%

To evaluate the robustness of this novel approach for distributing population growth, we used an independent estimate of the total population growth for Jacksonville from 2000 (735.6K) to 2019 (936.9K[2]) (World Population Review, 2023). We distributed that population growth across Development Types following the method described above, then converted that population to area of land converted from undeveloped by dividing by the mean population density for each of the typologies. The population density value for Contemporary Suburbs was used for Rural Mosaic under the continued assumption that urbanization of this development type is associated with suburban expansion. We then hindcasted the total urban land conversion for the city (41.9 mi^2) and compared it to the actual total urban conversion acreage for the city over the same time period (45.0 mi^2). The hindcast error was 3.1 mi^2 or 7%.

Within each Development Type, the projected population growth was distributed across CBGs based on the amount of undeveloped land as a percentage of the total area of undeveloped land within that Development Type. Under the FWOA scenario, the Rural Mosaic is also available for development into Contemporary Suburbs. The area of new development for each CBG was calculated as the projected population growth divided by the average population density for the Development Type associated with that CBG; this area of undeveloped land was converted to developed land. If all the undeveloped land within a CBG was converted to developed, the population density of that CBG was then recalculated (i.e., once all undeveloped land in a CBG is converted, the population density increases with population). This method is consistent with an assumption that developers would first build in undeveloped areas to meet population growth demands before infilling with higher density housing.

The total number of new assets within each CBG was calculated by multiplying the population increase for that CBG by the average (arithmetic mean) number of assets per person for the associated Development Type. This number was added to the number of assets in 2020 to get the total number of assets in 2070. The percentage of these new assets identified as vulnerable was taken by calculating the percentage of the CBG that is within the future (2070) flood plain but outside of the current (2020) flood plain. The underlying assumption is that this represents the fraction of assets built outside of the current flood plain and not required to be built to flood plain standards but that will be within the future flood

[2] This estimate is different from the estimates used for the Resilient Jacksonville Strategy, which is based on estimates from the U.S. Census Bureau and includes Jacksonville Beach, Neptune Beach, and Atlantic Beach

plain (i.e., the flood plain "comes to them"). This value is added to the number of existing assets that are vulnerable in 2070 as identified through the Resilient Jacksonville Vulnerability Assessment (Fernleaf & The Water Institute, 2023). Because the Vulnerability Assessment used a combined flood scenario for the 2070 analysis and the FEMA NFHL for the 2020 analysis, there are some CBGs for which the number of vulnerable existing assets decreases from 2020 to 2070. For the consequence analysis, the number of vulnerable existing assets is taken as the 2020 value for CBGs where it is higher than the 2070 value calculated with the method described above.

To reflect the possibility that city expansion will include more Contemporary Suburbs being built within what is currently the Rural Mosaic, we added the possibility of Development Type conversion to the consequence analysis model. This conversion was based on the fraction of developed land area in Rural Mosaic CBGs exceeding 30%, which is equivalent to the 1st percentile of fraction of developed land for Contemporary Suburbs. This value was chosen given the wide disparity of population density between Contemporary Suburbs and the Rural Mosaic, where the median population density of the latter is only 27%. These results should be interpreted as giving insight into the changing character of the Rural Mosaic but cannot realistically account for spatial development patterns that are likely to be concentrated in spatial areas based on factors not included in the model (e.g., cost of land, willingness of current owners to sell, proximity to current or planned infrastructure, etc.).

Heat vulnerability was assessed using data from the Resilient Jacksonville Vulnerability Assessment (Fernleaf & The Water Institute, 2023), which identifies each CBG as being high, moderate, or low vulnerability. The population at these heat vulnerability levels was extracted for current conditions, then the percentage of people at high, moderate, and low heat vulnerability was calculated for each Development Type (Figure 1). In future scenarios, these percentages were used to calculate future heat vulnerability. These projections provide a benchmark of future heat vulnerability to consider in implementing resilient growth actions and do not account for targeted adaptation actions taken to reduce heat vulnerability or the potential for heat exposure to increase with climate change.Figure 1

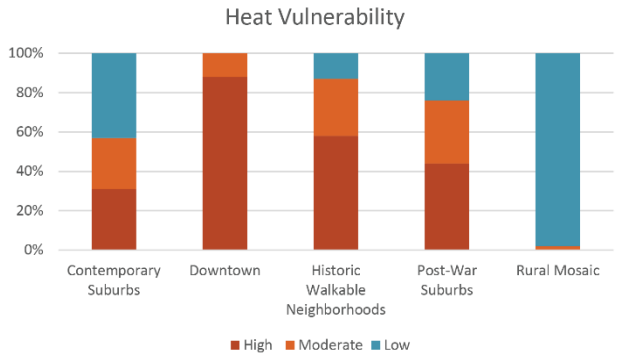

Figure 1. Percentage of the 2020 population at high, moderate, and low heat vulnerability for each Development Type.

Spatial Planning Hypothetical Scenarios

The first set of hypothetical scenarios considered was an urban core infill case in which population growth was focused in Downtown and Historic Walkable Neighborhoods. For this scenario, we varied the percentage of the population growth that would occur in these Development Types between 5–100%,

compared to the FWOA where less than 1% of growth occurs in these Development Types (Table 1). In addition, growth was focused within "lower risk" areas defined here as CBGs where less than 50% of the area is in the future flood plain and less than 25% of the area is in the current flood plain. The total population growth of the city under this scenario is the same as for the FWOA case, therefore increased growth within the targeted urban areas reduces growth in other Development Types and in higher risk CBGs. All other rules for evolving the outcome metrics remained the same, noting that assets and undeveloped land within the model are dependent on population growth and that these metrics will change depending on the population growth associated with each CBG.

A similar set of modified model rules was used for the suburban infill case. In this scenario, between 90–100% of the population growth was focused within Contemporary and Post-War suburbs associated with "lower risk" as defined above. Because the focus of this scenario set was on infill, all Contemporary Suburb growth was restricted to those CBGs already associated with that Development Type, as opposed to the FWOA scenario where growth can also occur within the Rural Mosaic.

The last set of hypothetical scenarios targeted greenfield development, focused population growth by modulating the percentage of population growth that occurred in the Contemporary Suburbs as expansion into the Rural Mosaic. In this case, the population growth in Contemporary Suburbs and the Rural Mosaic varied from 0–100%, which in most cases represents less expansion than the FWOA case where 90% of population growth is associated with these areas. The total population growth was kept constant, resulting in more population growth in other areas of the city for these scenarios than for FWOA.

RESULTS

CURRENT CONDITIONS AND FUTURE WITHOUT ACTION

Under a projected population growth of 1.13% per year, the population of Jacksonville would increase by more than 685,000 from 949,611[3] to nearly 1.6 million people over 50 years, an increase of 75%.[4] Most of this growth would occur as expansion of the Contemporary Suburbs if recent land development patterns continue, including excursion into land area that is currently part of the Rural Mosaic, leading to an increase in the number of people and structures within suburban areas (Figure 2).

[3] Population projections based on data from U.S Census Bureau, "U.S. Census 2020 American Community 5-Year Survey Data," and total population numbers for 2020 are from the 2020; U.S. Census Bureau, "United States Census Quick Facts: Jacksonville." Note: Due to differences in survey methodology projections from 5-year ACS datasets will vary from the 1-year dataset information.

[4] Citywide population estimates and projections include estimates for Coastal Communities, Protected Lands, and the Industrial Waterfront. Because these Development Types are not a focus of the consequence analysis presented here, they are not included in statistics or plots broken down by Development Type (e.g., Figure 2, Table 2).

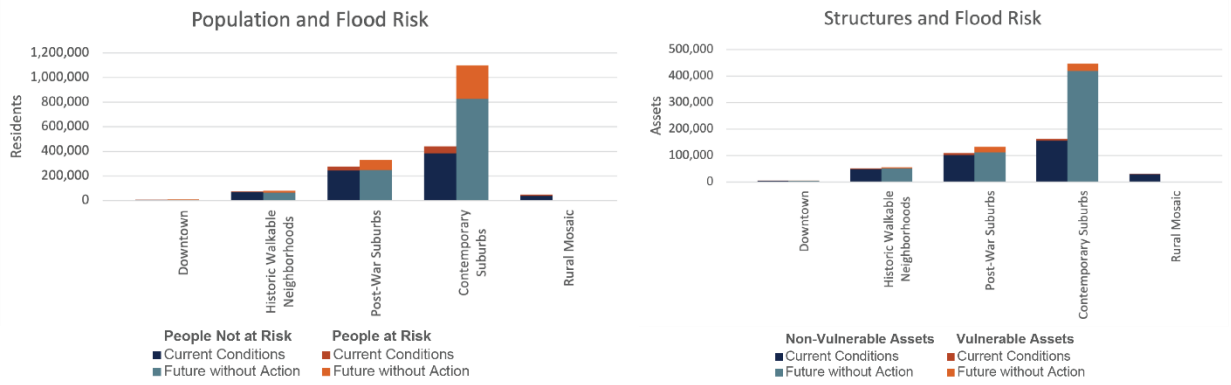

Figure 2. Jacksonville population (left) and assets (right) by residential and rural Development Types. Shown are current conditions and projections for a Future without Action.

More than 150 mi^2 of additional land would need to be developed to accommodate this growth while maintaining a similar population density as current conditions (Figure 3, Table 2). Much of that development would therefore occur as expansion of the Contemporary Suburbs into what is now the Rural Mosaic, leading to the disappearance of that Development Type from the landscape.

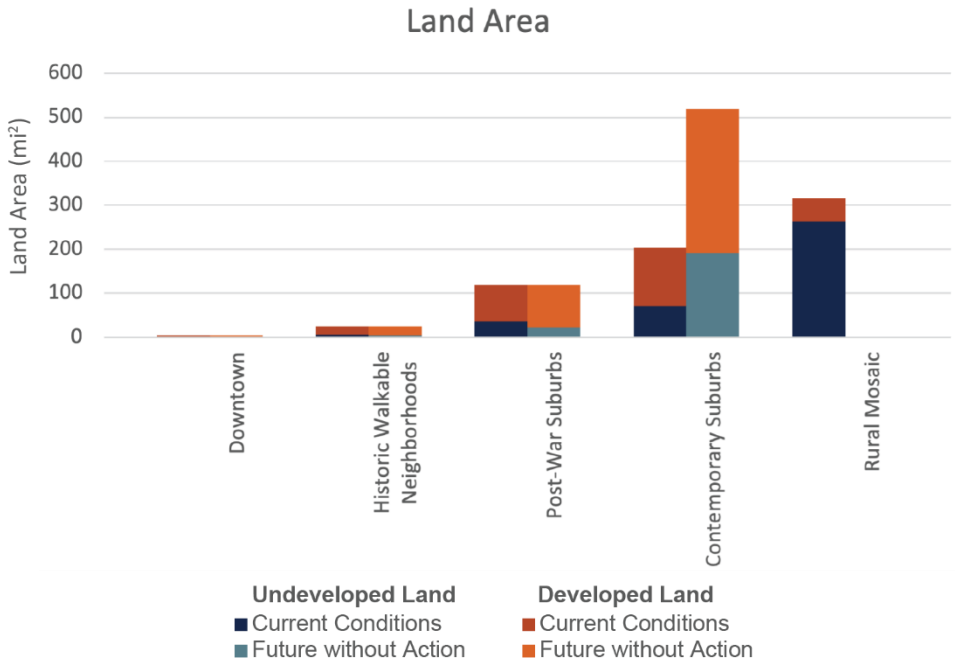

Figure 3. Developed and undeveloped land area in Jacksonville by residential Development Type for current conditions and projections for a Future without Action. Land area is given in square miles (mi^2). Note: there is no land area remaining in the Rural Mosaic in the Future without Action scenario.

Table 2. Population density of Development Types for current conditions and a projected Future without Action in people per square mile.

People per Square Mile	Current Conditions	Future without Action
Downtown	2,169	2,425
Historic Walkable Neighborhoods	3,120	3,365
Post-War Suburbs	3,305	3,417
Contemporary Suburbs	3,333	3,365
Rural Mosaic	954	n/a

The risk flooding poses to the residents and infrastructure of Jacksonville also increases substantially in a FWOA scenario. The number of people within the 100-year flood plain more than triples from approximately 137,000 to 430,000 because of expansion of the flood plain with sea level rise and new development in higher risk areas (Figure 2). The number of assets vulnerable to flooding also increases under a FWOA, rising from 23,000 to 58,000 over 50 years. Lastly, the number of residents at high or moderate vulnerability to heat would also increase dramatically if recent population trends continue and mitigating actions are not taken, increasing from 536,000 to more than 959,000 in the next 50 years even without accounting for a potential increase in the number of heat waves with climate change (Figure 4).

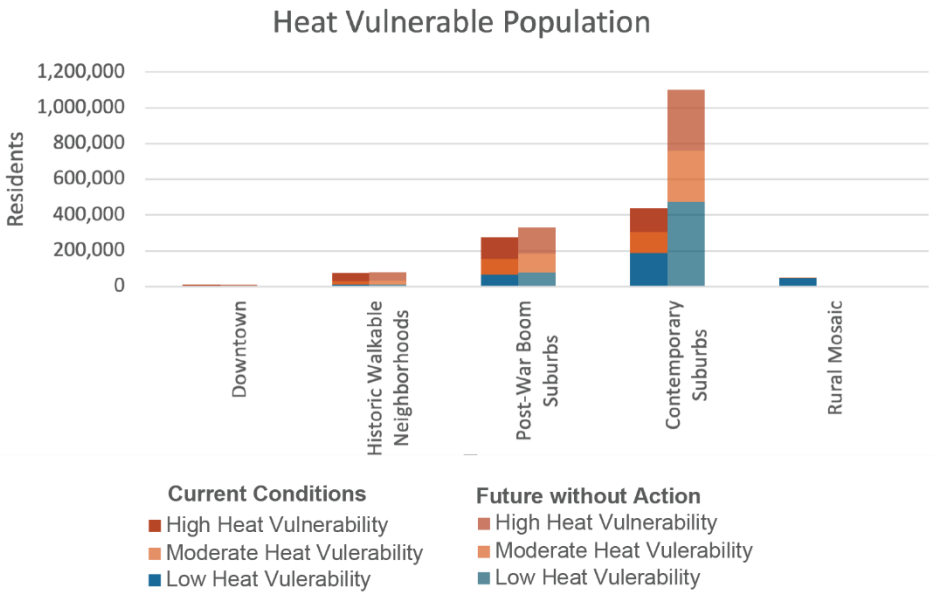

Figure 4. Total number of residents by Development Type at high, moderate, and low vulnerability to heat under current conditions and a projected Future Without Action.

SPATIAL PLANNING SCENARIOS

Focused Growth in the Urban Core

Four hypothetical scenarios were run that varied the percentage of population growth occurring in the urban core Development Types of Downtown and Historic Walkable Neighborhoods (5%, 25%, 50%, and 100%). Growth was focused in all cases on lower-risk CBGs and distributed as one person moving

Downtown for every four people moving to the Historic Walkable Neighborhoods, which cover a larger spatial area (24 mi^2 compared to 5 mi^2). Increasing the percentage of new residents that move to the urban core can reduce population growth in suburban areas. However, the low population density and associated space required for development of new Contemporary Suburbs—assuming action is not also taken to infill or densify these areas—still results in loss of the Rural Mosaic Development Type under all scenarios except 100% of new residents moving to the urban core (Figure 5).

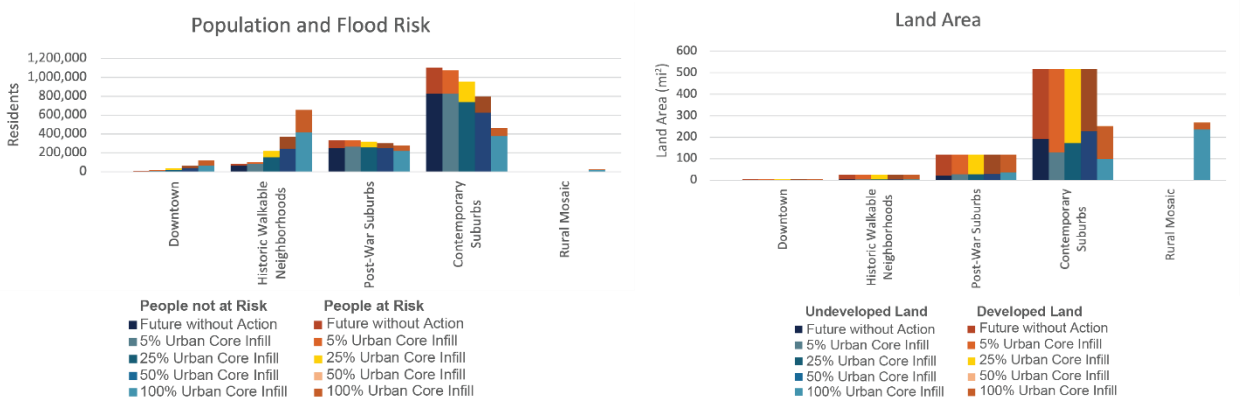

Figure 5. Population (left) and land area (right) by Development Type for four hypothetical scenarios of focusing growth in low-risk areas of the urban core: 5%, 25%, 50%, and 100% of population growth occurring as infill in the Downtown and Historic Walkable Neighborhoods, benchmarked against a Future without Action (FWOA). Land area is given in square miles (mi^2). Note that the Rural Mosaic is absent in all these hypothetical scenarios except 100% growth in the urban core.

Adaptation actions to reduce the heat island effect and the vulnerability of residents to extreme heat would need to be considered if growth is focused in the urban core. If 100% of new residents move to the urban core without mitigating action to reduce heat vulnerability, for example, the number of residents at moderate to high vulnerability to heat could increase to more than 1.1 million people.

Focusing population growth Downtown and in Historic Walkable Neighborhoods would require increasing the population density above current levels. If 1% of new residents move Downtown and 4% move to Historic Walkable Neighborhoods, for example, the population density of these Development Types would increase from around 2,000 and 3,000 people per square mile, respectively, to 3,000 to 4,500 people per square mile. Increasing urban core infill to 16% and 84% of new residents moving Downtown and to Historic Walkable Neighborhoods (i.e., 100% of new growth as infill of the urban core) would increase the population density of those areas to more than 27,000 people per square mile (Table 3). Focusing significant growth in the urban core—were it to be desirable to the City of Jacksonville—could be achieved with relatively reasonable increases in population density by expanding the footprint of higher density Downtown and Historic Walkable Neighborhoods, and density increases would also be more modest if population growth is lower than projected in the hypothetical scenario used here.

Table 3. Population density of Development Types for hypothetical scenarios focusing growth as infill in the urban core (Downtown and Historic Walkable Neighborhoods). Values are given in people per square mile. The slight decrease in population density of the Contemporary Suburbs compared to the FWOA is a result of the Rural Mosaic still reaching the criteria for conversion to suburbs, even as fewer people are occupying the same area.

People per Square Mile	5% Urban Core Infill	25% Urban Core Infill	50% Urban Core Infill	100% Urban Core Infill
Downtown	3,420	8,423	14,676	27,182
Historic Walkable Neighborhoods	4,318	9,106	15,091	27,062
Post-War Suburbs	3,588	3,483	3,378	3,305
Contemporary Suburbs	2,764	2,752	2,732	3,059
Rural Mosaic	n/a	n/a	n/a	757

Focused Infill in Suburban Neighborhoods

Three hypothetical scenarios were run that varied the amount of population growth that occurred as infill of suburban neighborhoods: 90%, 95%, and 100%, with growth focused in lower risk CBGs. In these hypothetical scenarios, 11 people move to the Contemporary Suburbs for every 1 that moves to the Post-War Suburbs, reflecting the current area of undeveloped land available for infill. The 90% case represents approximately the same suburban population growth as the FWOA but with a focus on suburban infill in low-risk areas. Because the Contemporary Suburbs were not allowed to expand into the Rural Mosaic and no other Development Type conversion occurs, the land area of each of the Development Types remains constant (Figure 6).

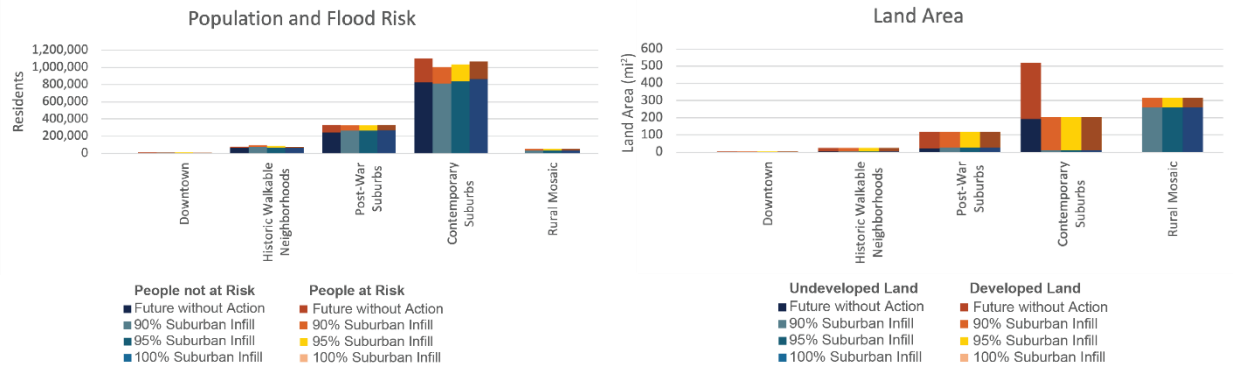

Figure 6. Population (left) and land area (right) by Development Type for four hypothetical scenarios of focusing growth as infill in suburban areas (90%, 95%, and 100% of population growth as infill of the Contemporary and Post-War suburbs, benchmarked against a Future without Action (FWOA)). Land area is given in square miles (mi^2).

The overall population growth in each of the Development Types for this set of hypothetical scenarios is similar as in the FWOA case because this set of scenarios does not vary the distribution of future growth by Development Type. Instead, focusing on infill in the suburban primarily changes the population density of the suburban Development Types necessary to support this growth (Table 4); the distribution of land between Contemporary Suburbs and the Rural Mosaic (Figure 6); and the amount of undeveloped land within each Development Type (Figure 6). The Rural Mosaic is preserved, while virtually all undeveloped land in CBGs that are currently part of the Contemporary and Post-War suburbs is developed. Population density in suburban areas would need to increase under these scenarios from present-day conditions of around 3,000 people per square mile to around 5,500 people per square mile for

Contemporary Suburbs and 3,600 people per square mile for Post-War Suburbs if 100% of new growth occurs as suburban infilling.

Table 4. Population density of Development Types for hypothetical scenarios varying the level of population growth that occurs as infill of suburban areas (Contemporary Suburbs and Post-War suburbs). Values are given in people per square mile.

People per Square Mile	90% Suburban Infill	95% Suburban Infill	100% Suburban Infill
Downtown	3,049	2,609	2,169
Historic Walkable Neighborhoods	3,962	3,542	3,120
Post-War Suburbs	3,570	3,598	3,626
Contemporary Suburbs	5,216	5,377	5,540
Rural Mosaic	954	954	954

Targeted Greenfield Expansion

The last set of hypothetical scenarios varied the percentage of population growth associated with expansion of the Contemporary Suburbs, allowing for expansion into the Rural Mosaic. Cases considered included 5%, 25%, 50%, and 75% of growth occurring as suburban expansion, all of which are lower than the FWOA case where 90% of growth occurs in this Development Type. The remaining population growth is distributed across the other Development Types according to the FWOA distribution.

Reducing greenfield expansion to 25% or less of new population growth can preserve portions of the Rural Mosaic (Figure 7). Changes in the amount of greenfield development also has potential implications for the population of the Post-War Suburbs: if a greater percentage of new residents move to newly developed Contemporary Suburbs, there is a decrease in infill and population growth in those established suburban areas.

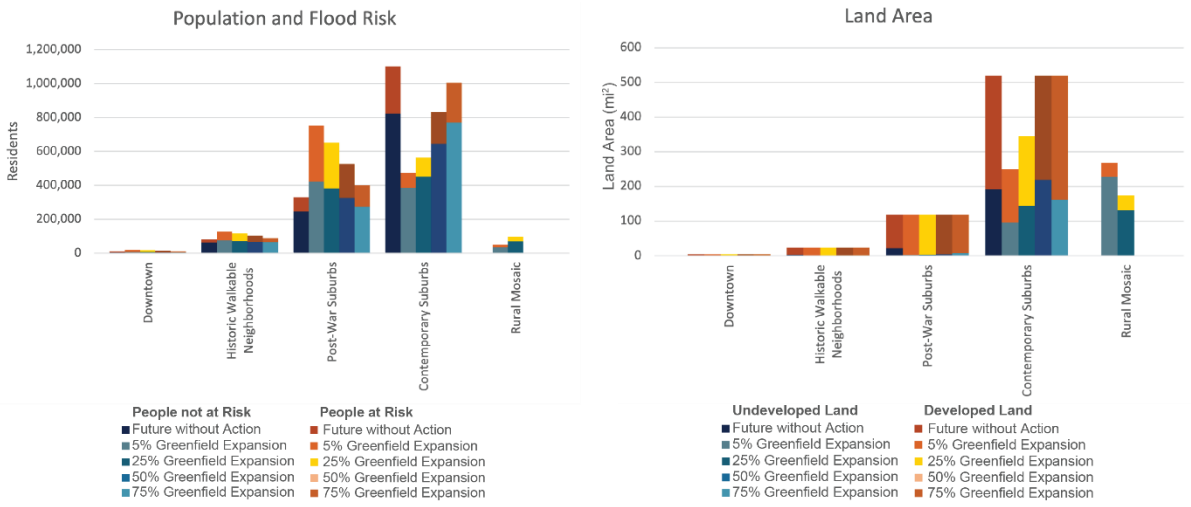

Figure 7. Population (left) and land area (right) by Development Type for four hypothetical scenarios of population growth in the Contemporary Suburbs (5%, 25%, 50%, and 75% of population growth, benchmarked against a Future without Action (FWOA)). Land area is given in square miles (mi^2).

The population density of the Contemporary Suburbs initially decreases with greenfield expansion as more area is converted from Rural Mosaic, then increases again after all the available land in the Rural Mosaic has been converted. When 25% or less of the population growth occurs in Contemporary Suburbs, portions of the Rural Mosaic are also preserved, albeit with increasing population density until the threshold is reached when all of the Rural Mosaic is converted to suburbs (Table 5).

Table 5. Population density of development types for four hypothetical scenarios of population growth in the Contemporary Suburbs (5%, 25%, 50%, and 75% of population growth, benchmarked against a Future without Action (FWOA)). Values are given in people per square mile.

People per Square Mile	5% Greenfield Expansion	25% Greenfield Expansion	50% Greenfield Expansion	75% Greenfield Expansion
Downtown	4,390	3,923	3,338	2,754
Historic Walkable Neighborhoods	5,246	4,799	4,239	3,680
Post-War Suburbs	6,490	5,650	4,608	3,602
Contemporary Suburbs	3,052	2,814	2,777	2,809
Rural Mosaic	1,223	2,336	n/a	n/a

BALANCED GROWTH FUTURE SCENARIO

The hypothetical growth scenarios described above highlight tradeoffs for consideration in determining where and how strategies for promoting resilient growth are implemented, such how much population densification would be needed to accommodate different levels of targeted infill and what the resultant impacts would be on preservation of undeveloped land and the Rural Mosaic. The results can also be used to inform development of one possible 'balanced' future scenario, in which multiple strategies for growing resiliently are deployed across different Development Types as part of deliberately shaping the future character of the City of Jacksonville.

To investigate this possibility, a final hypothetical scenario was created informed by the results of the previous scenarios. In this hypothetical scenario, 10% of new residents move Downtown and 13% to Historic Walkable Neighborhoods, or about a quarter of new residents moving to the urban core. In the suburban areas, 1 in 10 new residents would move to the Post-War Suburbs and about 2 in 3 residents would move to the Contemporary Suburbs, split approximately equally between infilling existing areas and moving to new areas developed within the Rural Mosaic.

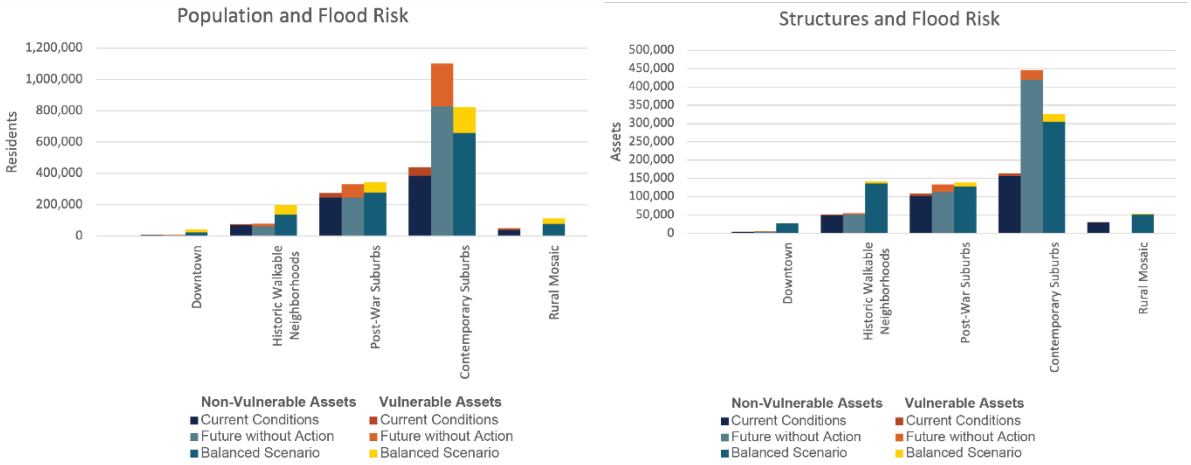

Figure 8. Jacksonville population (left) and assets (right) by residential Development Type for current conditions, projections for a Future without Action, and a hypothetical scenario balancing urban core and suburban infill with targeted greenfield expansion.

Under this scenario, most population growth and development would still occur in Contemporary Suburbs (Figure 8). Infilling of suburban areas, greater population growth in the urban core, and targeted population growth in areas that are still predominantly rural would, however, allow for over 100 square miles of Rural Mosaic to be preserved (Figure 9). Development would lead to an increase in population density for some Development Types compared to present day, particularly in the urban core (Figure 9). Increasing the population density could be aligned with a revitalization of the urban core. Regardless of the approach taken to mitigate flood risk, however, deliberate action should also be taken to mitigate the vulnerability of residents to other hazards such as heat (Figure 10).

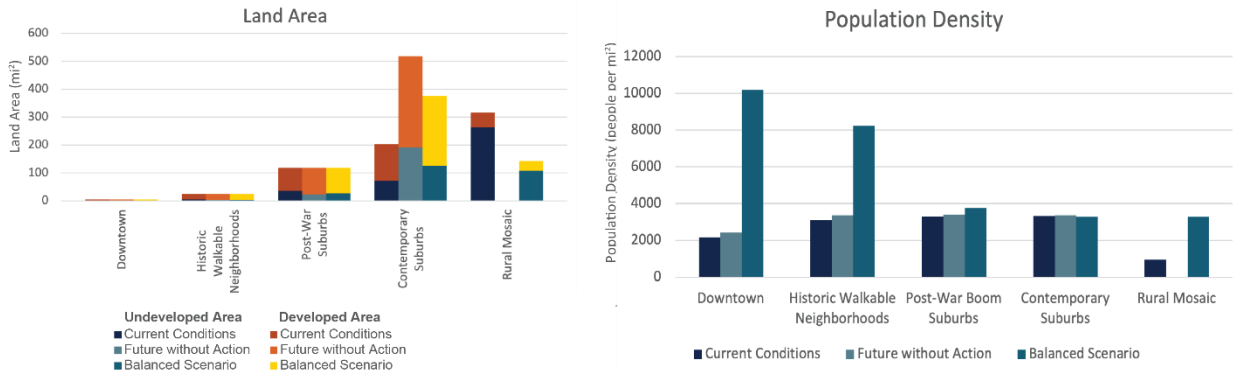

Figure 9. Land area (left) and population density (right) by residential Development Type for current conditions, projections for a Future without Action, and a hypothetical scenario balancing urban core and suburban infill with targeted greenfield expansion. Land area is given in square miles (mi^2).

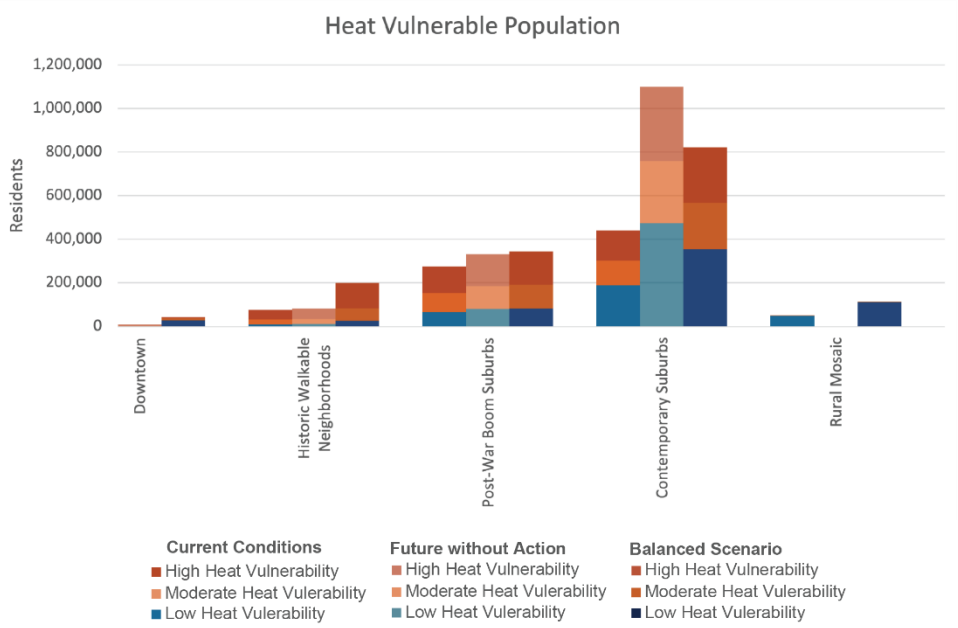

Figure 10. Total number of residents by Development Type at high, moderate, and low vulnerability to heat under current conditions, a projected Future without Action, and a hypothetical scenario balancing urban core and suburban infill with targeted greenfield expansion.

SUMMARY

An analysis framework was developed to project outcomes for Jacksonville under a Future without Action and hypothetical scenarios of spatial planning to reduce flood risk. These projections assumed that recent population growth in Jacksonville will continue and projected impacts to population and assets at risk of flooding, area of developed land, population density, and heat vulnerability. This analysis illustrates that spatial planning actions can reduce the flood risk posed to Jacksonville, and that implementation—as well as taking no action—could have implications for the character of Development Types within the city mosaic. Due to the tendency for more densely populated areas to be more vulnerable to heat, future scenarios that incorporate increasing population density in lower risk could also result in increased heat vulnerability if mitigating actions are not taken. This analysis can inform implementation of Resilient Jacksonville and illustrate that deliberate action can preserve rural, natural, and open spaces as well as the character of Development Types in the city while reducing flood risk.

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