



Flood Equity Framework

Policy Brief

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Version One

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Introduction

Flood protection systems in Harris County currently discriminate by providing more investment and better service in whiter and wealthier areas. The Harris County Flood Control District has admitted this but has provided watershed maps to the public that show inequity in ways that 1) are not logically comparable, 2) are at an overly large scale, and 3) lack any information about flood risk. In our previous policy brief, we provided an improved method (FBI) for measuring and comparing baseline flood inequity in ways that are more logical and accurate, and without the errors mentioned above. In this policy brief, we introduce a four-step framework for addressing the flood equity problem. The four steps are:

1. Obtain accurate and comparable knowledge of flood inequity by measuring the Flood Benefits Index according to Policy Brief 1.
2. Based on the above FBI results, set measurable flood goals for the County and for census tracts with low FBIs.
3. Use Benefits Gained Analysis (BGA) to rank individual flood projects locally.
4. Measure progress toward flood goals by recalculating the FBI baseline every 5-10 years.

In the remainder of this policy brief we describe each of these steps in the proposed framework after providing background and a fully defined problem statement.

Background and Problem Statement

A recent article in the journal *Nature*¹ recommended five ways that flood risk research can help the most vulnerable: 1) collect the right data; 2) choose the right metrics; 3) examine the mechanisms that perpetuate inequity; 4) examine those who profit from the current system; and 5) broader participation in research. This policy brief addresses the second recommendation: choose the right metrics.

¹ Miyuki Hino and Earthea Nance. 2021. "Five Ways to Ensure Flood-Risk Research Helps the Most Vulnerable." *Nature* 595, 27-29 (2021) <https://doi.org/10.1038/d41586-021-01750-0>

Creating new metrics requires local agencies to break through past behaviors and tactics that have prevented progress. We have personally witnessed and/or experienced the following negative tactics that are associated with flood inequity.

Tactic 1 - Hiding Neglect. It is possible to hide years of neglect by focusing only on dollars distributed over a couple of years after a disaster. Money given to a vulnerable area while everyone is looking detracts from the normal state of inattention over decades. This allows inequity to worsen over time. Our response is to use long-term metrics..

Tactic 2 - Talk About Dollars Not Risk. Never providing information about the level of flood protection redirects the public conversation from flood protection to dollars. This makes it possible to maintain extreme inequity in flood protection while withholding the true dollars needed to achieve equity, which should be the objective. Our response is to demand data on flood risk in addition to data on dollars.

Tactic 3 - Delay the Revealing of Facts. Claiming that data is not available or that it will take years to gather is simply a delay tactic. This tactic delays the revealing of facts that, if known to the public, would allow the public to create pressure that could change decision making and priorities. Our response to this tactic is to ask the District to request the data from FEMA, HUD, and USACE. Every federal dollar that has been sent to Harris County and the City of Houston is recorded by these federal agencies. OMB will also have data on every penny sent because they have to review and approve the Benefit Cost Analysis. There should be no problem obtaining federal data. Because federal funding comprises the great majority of flood control project funding, federal agencies will have most of the data we are requesting. Having acquired the federal data, the District should then be responsible for providing local data on its own projects, which is expected to be a small fraction of the total. There is no data problem.

Tactic 4 - Scale Scheme. Only showing watershed level maps redirects the public conversation to a larger scale that hides pockets of poverty within watersheds, and which averages out the experiences of vulnerable people. This tactic directly hides the inequity. Our response is to demand smaller scales until we find the appropriate scale.

Tactic 5 - Permanent Planning. It is possible to list projects while delaying their implementation indefinitely, to have projects on the books that are never funded, and to stay in a planning phase for longer than usual while taking credit for the listed

The Property Damage Metric

Most assessments of flood risk and impact rely heavily on the metric of property damage. This practice typically treats each dollar of damage equally. Yet one dollar of damage has a much greater effect on quality of life and well-being for low-income households than for wealthier ones. For example, after floods in Mumbai, India in 2005, the lowest-income families lost more than six times their monthly household income; middle-income families lost just two to three times. Relying on estimates of property damage as a metric for evaluating the benefits of proposed mitigation methods systematically favors wealthier areas that have more to lose. Simply put, it is currently harder to protect a poor household than a rich one. One way to correct this would be to adjust for differences in income and wealth, such as measuring risk and loss as relative metrics (damage as a percentage of total value, or losses as a share of household wealth). For example, in Ho Chi Minh City, Vietnam, research shows that considering differences in income and financial protection can lead to dramatically higher assessments of the benefits of protecting low-income populations. A second way to shift the balance would be to focus more on the broad benefits to be gained by flood prevention (which everyone can experience) than on the avoided financial damage to property (which depends on existing wealth). A ‘benefits gained’ approach is theoretically more equitable than the current ‘damages avoided’ method used in the United States.

Source: Miyuki Hino and Earthea Nance. 2021. “Five Ways to Ensure Flood-Risk Research Helps the Most Vulnerable.” *Nature* 595, 27-29 (2021) <https://doi.org/10.1038/d41586-021-01750-0>

project. Our response, in solidarity with communities, is to say no to excess planning that is not directly associated with a funded project.

Tactic 6 - No List of Projects. Taking credit for maintenance, right-of-way, community meetings, and other preliminary tasks avoids discussion of construction of flood risk reduction infrastructure. Our response is to focus on construction, to engage with community on construction, and to not be distracted by other things.

The widely used and often mandated methodology for prioritizing flood infrastructure investments is benefit-cost analysis (BCA). BCA relies heavily on the property damage metric. The relationship of the property damage metric to inequitable outcome is explained in Box 1.

Just about every piece of major infrastructure that exists in the Houston region was funded with federal dollars that required use of the property damage metric within a BCA calculation. Over years of application, the result of this approach is extreme inequity in flood protection. While likely a severe underestimate, Harris County Flood Control District has made available a map estimating this inequity (see Figure 1).

Not included in Figure 1 are flood protection goals and the current amount of flood protection. If the funds needed in Figure 1 were to arrive, what outcomes would each watershed achieve, and would those outcomes be equitable? Figure 1 attempts to

communicate the need for equity without admitting what the goal is or how far away the County is from that goal. Does the District's vision of equity mean that all the watersheds will have equal flood protection? To date the District has not shared data about flood protection, and when asked the District claims they do not have it. Does the District see equity as spending equal dollars in each watershed regardless of need? To date, the District has provided Figure 1, which is based on dollars but lacks an apples to apples comparison of the outcomes created by those dollars over time, and does not represent the distribution of flood protection or the need for flood protection. Figure 1 can be viewed from another perspective. It can be viewed as the outcome of using BCA to distribute flood recovery and mitigation funds, which have privileged property owners and created a baseline of inequity in flood protection throughout Harris County. By the District's own data and from what researchers have discovered, BCA is not a metric that creates equitable outcomes. Figure 1 can also be viewed as the result of overwhelming pressure from land developers whose private profits depend on public investments in infrastructure (not to mention the local government's need for property taxes). Yet another perspective on Figure 1 is that it reflects the demand for privileged access to not only flood protection but to many other goods: exclusive homes, better schools, better parks, better air quality, grocery stores, and other amenities that are not equitably distributed.

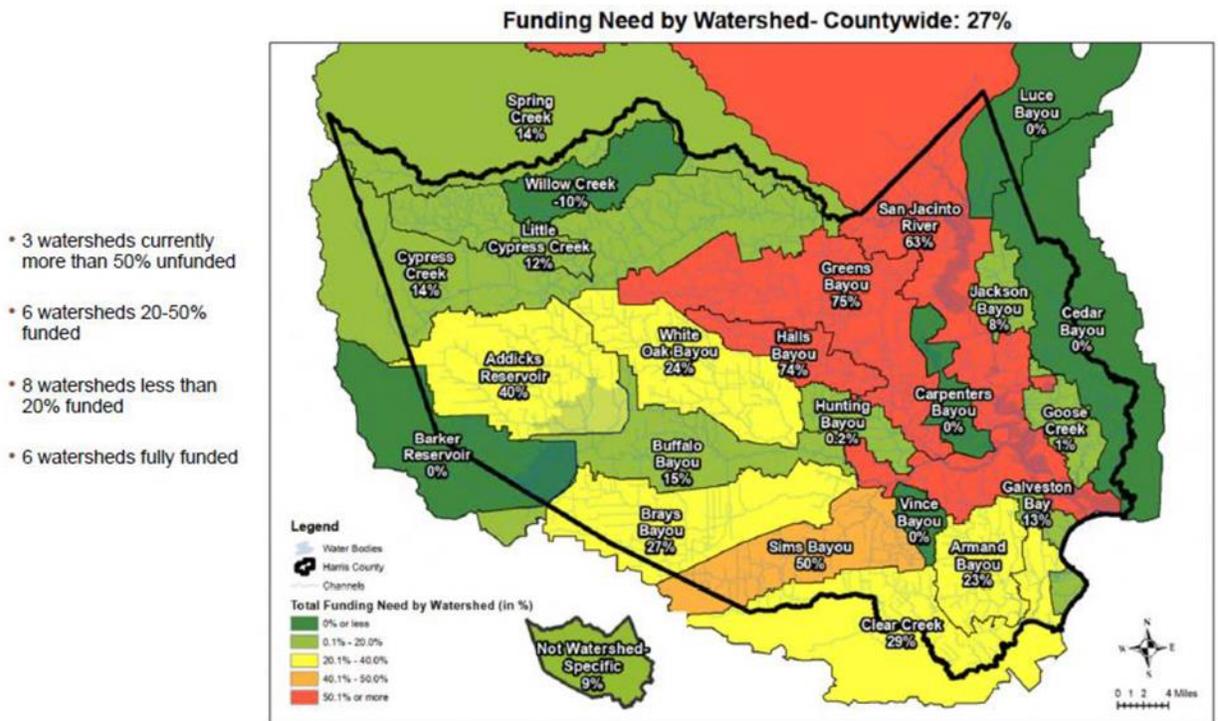


Figure 1. Funding Needed by Watershed.

There are many economically efficient allocations, and some allocations are fairer than others. In Harris County, benefit-cost analysis (BCA) has efficiently produced inequitable flood protection outcomes, with lower income groups and people of color exposed to higher environmental risks than whiter and wealthier groups. The majority of flood protection funding in Harris County has been federal, and all of it had to pass federal benefit-cost criteria (by law). The inequity that exists on the ground today is, by definition, economically efficient. Whiter and wealthier segments of the Harris County population have benefitted from the BCA approach to flood recovery and mitigation and have continued to receive downstream benefits such as community development, higher property values, and easier eligibility for disaster assistance to maintain their property values. Marginalized segments of the population have suffered physically (increased deaths and injuries), mentally (stress from lack of assistance, losing everything), and economically (lack of public and private investment).

This outcome is not the only possible economically efficient outcome. Reform would be needed to transition from the current regressive distribution of flood risk to a more progressive

distribution that is also economically efficient. One must only look at other OECD countries for plenty of examples showing it is possible to efficiently achieve universal coverage for life safety services such as drinking water, wastewater, flood protection, and firefighting. Federally sanctioned inequity in flood protection outcomes in the U.S. has created questions of fairness, racism, and human rights. Even FEMA has acknowledged these problems and recently issued a Request for Information about how its programs discriminate. CEER and its associates submitted a robust response to FEMA.

The required use of property damage as a metric in benefit-cost analysis to determine the amount of a FEMA award is discriminatory on its face and in practice. Initial damage estimates conducted after a disaster can be incorrect or manipulated, especially when the sheer number of damaged homes is enormous and there are not enough trained estimators. For low-income properties, a damage estimate can result in condemnation of the property if the estimator decides that the damage was not caused by the disaster. Property damage estimates are almost impossible to challenge, especially for low-income residents. Despite the potential inaccuracy of property damage estimates, they play a critical role in determining both eligibility and award amount. Damage estimates can be used to deny eligibility for low-income residents, and their required use in BCA privileges wealthier property owners in the awarding of funds. Wealthy property owners have more property value to lose, which makes it relatively easier to get a high BCA and a larger award. This use of property damage and property value as a metric is a fundamental bias in all federal flood programs, including FEMA, HUD, and the Army Corps.

When basic life safety infrastructure like flood protection and drinking water systems are prioritized using economic efficiency criteria, then, by definition, only those economically worthy of the investment will be served. Therefore, it is not surprising that flood protection in the Houston region is distributed inequitably. What is needed to correct this is the concept of universal service, which introduces a human rights dimension to flood protection that is achieved with public funds. A universal service is offered to the whole population. For example, the UN Millennium Development Goals declare that everyone has a right to safe drinking water and basic sanitation. The reason is that without water and sanitation,

fundamental human rights are violated. According to the UN, "the fundamental human rights that are violated in post-disaster situations include the rights to adequate housing, food, water and sanitation, health, work/livelihood, land, security of the person and home, information, participation, and education." The most vulnerable are subject to human rights violations during the event, during humanitarian assistance, and during recovery. A rights-based approach recognizes and accounts for possible rights violations in disasters.

When governments are unwilling or unable to protect people from the effects of natural disasters – or at least minimize the risks and damages of natural hazards – this is a human rights violation and governments need to be held accountable for their action.

The Brookings Institute, 2014

Step 1 - Flood Benefits Analysis

This step was first introduced and explained in Policy Brief 1, and then again in more technical detail in Memo 7 from the Community Flood Resilience Task Force to Harris County Flood Control District. Flood Protection Achieved (a metric in the denominator of the FBI) should be the fundamental unit for measuring flood protection, not dollars which are being used currently by HCFCD. Dollars alone are inadequate as a proxy for flood protection because they do not account for flood protection achieved per dollar. While perhaps it should not matter how much was spent to achieve flood protection, in fact it does because of the high degree of inequity. When dollars have been targeted to some census tracts over others, then the resulting inequity becomes relevant.

Using flood protection achieved as a single metric is also insufficient because it does not account for interactions with population density (also in the denominator of the FBI). Population density is a proxy for the number of assets exposed to flooding and the amount of impervious surface. Population density and flood protection interact with each other. In a situation such as Brays Watershed, increases in population density promoted increases in flood

risk no matter how much was spent on flood protection. The direct association between more dollars spent on flood protection, more population density, and more flood risk is rarely acknowledged. In a situation like Greens Watershed, decreasing or steady population density has resulted in increased flood risk, in this case because of a lack of infrastructure investment. The association between less dollars spent on flood protection, decreasing population density, and more flood risk is widely recognized and discussed by communities. Both extremes lead to increased flood risk. On one hand high flood risk leads to disinvestment (buyouts), while on the other hand high flood risk leads to more investment. The FBI metric handles this paradox by providing the context in which flood risk actually exists: a context of high or low investment and a context of high or low population density (see Figure 2). The FBI uses the three values that are most critical to understanding and comparing cumulative flood benefits.

Harris County Flood Control District repeatedly establishes priorities without bothering to determine the baseline. They publish their priorities without ever explaining to the public that a baseline of outcomes is missing. They also repeatedly fail to provide a target, or goal, for their program. Furthermore, the District has not informed the public of the fact that at no time in history have the flood protection systems in Harris County and Houston ever been "on spec." That is, flood protection standards have never been broadly achieved. This fact raises a serious question about what their equity goal is, and whether it is physically possible to achieve flood protection standards in every watershed. These are critical unknowns. It is not possible to set goals without knowing some kind of a baseline of where things stand now. While we have immediate access to static metrics like SVI, we have no information at all about the distribution of flood risk, how much a certain amount of flood reduction costs in different places, or the relationship of flood investments to population density. Step 1 of our framework is to establish the baseline by calculating an FBI for each census tract.

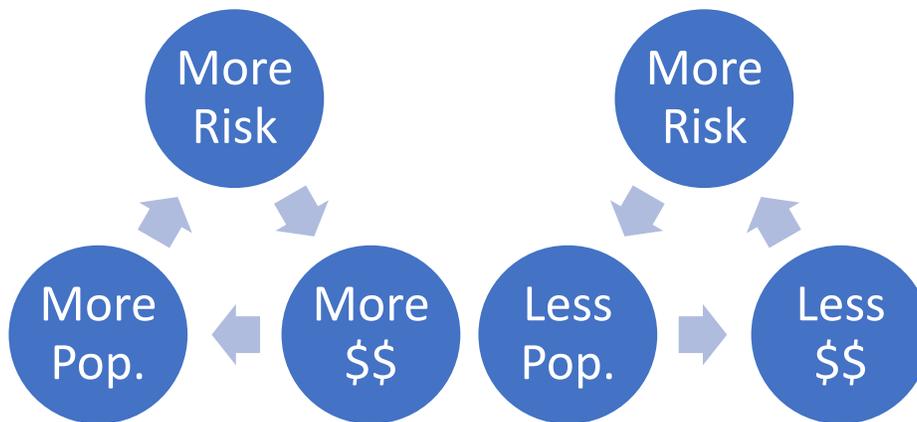


Figure 2. The paradox of flood management: both approaches can lead to more flood risk. Flood risk alone is critical but not sufficient to understanding the situations faced in different census tracts.

Step 2. Goals

Clearly stated goals for flood protection equity are critical to success. The District has prioritized projects but has no stated goals for making progress on equity in flood protection.

Our recommended goals are as follows:

1. Halve by 2026 the proportion of those without access to adequate flood benefits.
2. Increase access to improved flood benefits for everyone.

The "proportion of those without access to adequate flood benefits" in Goal #1 can be measured using the interquartile range, a simple technique that can be used to divide census tracts equally based on the median FBI. The bottom 25 percent of FBIs will be in the lower quartile, which will reveal census tract outliers that have received inadequate flood benefits. It is likely that no area in Harris County has 100-year protection, and when combined with the effects of climate change, every census tract might need additional investment. Two goals are therefore necessary. The most underserved census tracts (those in the lower quartile) will be tracked under Goal #1. The remaining census tracts will be tracked under Goal #2. Goal #1 will

be reinitiated every 5 years until all outlier census tracts are brought into the normal range of flood benefits.

Note: When the FBI results come in, hopefully we will have the information needed to understand the range and distribution of flood benefits. Once we see the data, we may decide that the bottom two quartiles apply to Goal #1 instead, or that other methods of identifying outliers are more applicable.

Step 3. Benefits Gained Analysis

Benefits Gained Analysis (BGA) comprises both a set of principles and an innovative analysis technique (see Box 1). The purpose of BGA is to counter the negative effects of BCA on the project level. Note that the previous two steps have been at the census tract level. BGA can be adopted locally to allow local flood officials to prioritize projects in underserved areas. The basic principles of BGA are as follows:

1. Formally adopt flood protection as a universal service.
2. Recognize human rights in all phases of disaster, and adopt a people-based, bottom-up perspective.
3. Formally acknowledge the negative impacts of BCA on flood equity.
4. Cease using property damage and property value as metrics.
5. Use the Flood Benefits Index to determine the flood equity baseline and to track progress toward goals.
6. Establish written, numeric Flood Equity Goals.
7. Use Benefits Gained Analysis to counter the negative effects of BCA.

As the fight against federally mandated BCA inequity continues, local prioritization is essential to making progress toward flood equity. The BGA is being offered as a tool for prioritizing projects at the local level, in spite of the fact that BCA is still necessary for obtaining federal funds. To use the BGA tool one needs three pieces of information: 1) the design flood risk established for the proposed project, 2) the baseline flood risk in the census tracts per the

FBI, and 3) a measure of vulnerability, namely the CDC's Social Vulnerability Index, which the CDC recommends for identifying areas in need and for deciding how to allocate funds. Note that FBI has already measured equity in the distribution of flood benefits by census tract. SVI measures vulnerability of the people in the tract using different indicators. Vulnerable census tracts receive additional weight to account for multiple sources of vulnerability beyond a lack of flood protection.

Figure 2 displays FBI versus SVI on a hypothetical graph to break down the interplay of these two concepts. In box 1, Flood Benefits and high and Social Vulnerability is low. This combination reflects the most advantaged populations and locations in the region, which would be exemplified by many (but not all) of the census tracts of West Houston (the Arrow). Position number 2 in Figure 2 represents high Flood Benefits and high Social Vulnerability. This is combination is rare and would be represented by a low income black and brown population that recently received flood investments, such as Sims Bayou. Box 3 represents low Flood Benefits and low Social Vulnerability. These areas with moderate to middle class income combined with flood disinvestment are likely numerous across the region, as everyone needs better flood protection. Box 4 combines low Flood Benefits with high Social Vulnerability. This represents the most neglected areas and people of the region, where inequity is expected to be widespread. Benefits gains will be highest here.



Figure 2. SVI and FBI.

It is important to point out that inequity is not the same as needing flood protection. Inequity is associated with long-term disinvestment in flood protection combined with multiple social vulnerability indicators that are not flood related. With its 15 indicators, SVI is an excellent measure of this non-flood vulnerability.

Benefits gained analysis (BGA) is a tool for prioritizing projects for Box 4 populations and census tracts. BGA is calculated as follows.

$$\text{BGA} = [\text{Baseline Flood Risk} - \text{Project Flood Risk}] * \text{Social Vulnerability Index}$$

where:

Project Flood Risk =	the project design flood risk, which is the percent annual chance flood protection to be achieved, expressed as a number (i.e., 1% = 1), from project design documents. Lower number indicates lower flood risk.
Baseline Flood Risk =	the percent annual chance of flooding in the census tract prior to the project, expressed as a number (i.e., 10% = 10), from the FBI. Higher number indicates higher flood risk.
Social Vulnerability Index =	CDC's indicator of social vulnerability, expressed as a number (i.e., 1.0 = 100% = 100). Higher number indicates higher vulnerability.

Projects with a larger risk differential (that is, a big difference between baseline risk and project risk) provide the biggest gain in flood protection. Most flood benefits will be gained by placing flood protection projects in low-FBI census tracts. The risk differential of vulnerable areas is more likely to be larger than the risk differential of wealthy areas (but not in all cases), so benefits gained will be larger when a project is installed in a low-FBI census tract. The BGA approach measures this benefit gained for projects whereas BCA does not.

Social vulnerability accounts for the cumulative effects of many sources of marginalization beyond flooding. BGA incorporates this broader marginalization by multiplying the flood risk differential (baseline minus project) by social vulnerability. If social vulnerability is small, it will reduce the benefits gained and such projects will likely rely on their ability to

meet BCA criteria. When an area has both a large risk differential and a large SVI, then the opportunity for benefits gained is at its highest. This technique can therefore be used to prioritize projects locally and to move beyond the negative effects of BCA.

The next step in the approach is to combine high-BGA projects with high-BCA projects to achieve a combined benefit-cost ratio greater than 1.0 for all federal funding applications. High BGA projects achieve high risk reduction for vulnerable census tracts and are likely not able to satisfy federal BCA criteria but would be highly desirable locally to meet flood equity goals. The BGA tool takes advantage of projects with high economic value, such as those in Box 1 that can easily meet BCA criteria with room to spare. For example, projects in the wealthiest areas will have the highest BCAs, far higher than the minimum 1.0 needed to be eligible for funding. For a Box 1 BCA of, say, 15, there is an excess of 14 units that could be utilized for projects in Box 4. The BGA tool would be used to develop a list of equity projects, and the BCA tool would be used as it has always been used, to develop a list of status quo projects. By strategically mixing projects from both lists, rather than only using the BCA list, the District would maximize equity in flood funding while following a transparent prioritization strategy. Of course, once the federal funding was received, all projects would have to be implemented without any of the delay tactics previously described, as a matter of policy.

The innovative BGA approach is part of an overall flood framework. The framework requires transparency about the baseline state of flood inequity (via the FBI), and it requires a willingness to transfer excess BCA benefits to reduce inequity. Current practice wastes these excess benefits. This practice is similar to wetland mitigation banking, whereas adversely affected habitats and watersheds are replaced with other protected habitats and watersheds. In our case, adversely affected people/areas are supported with funds earned by other people/areas.

Step 4 - Calculate New Baseline and Track Progress

After 5 years of prioritizing and implementing projects using BGA, a new baseline FBI can be measured to indicate the degree of progress toward Goals #1 and #2. This result must

be announced to the public. The Goals can be adjusted as needed, and then remeasured every 5 years and the results announced.

Conclusions

In Harris County, traditional BCA alone has led to inequitable outcomes by prioritizing higher property values as previously described. In the long run, it is hoped that BCA will be reformed at the federal level and that its role in producing inequities will end. In the meantime, we propose the use of BGA locally to counteract the negative effects of BCA on Harris County's most vulnerable populations.

HCFCFCD must transform its framework for prioritizing projects. It can do this by creating a combined list of projects that will meet federal BCA criteria and simultaneously meet local equity criteria. The proposed Flood Benefits Bank will be a groundbreaking new approach to flood equity. The new 4-step framework presented here, with specific goals and equitable metrics, should be used to prioritize projects locally. Figure 3 visually depicts our flood equity framework.

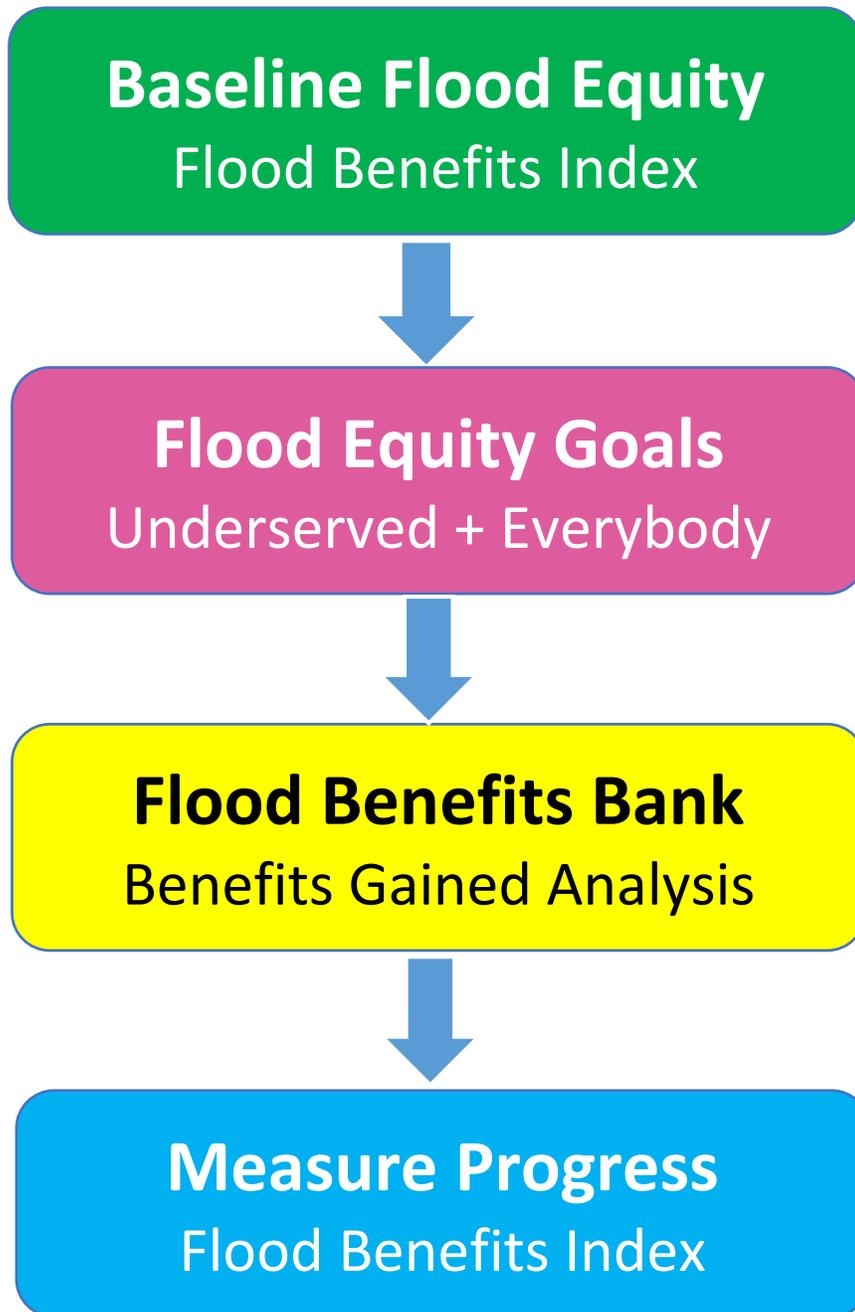


Figure 3. 4-Step Flood Equity Framework