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Louisiana Resilience Roadmap

Choosing a path toward a more resilient future

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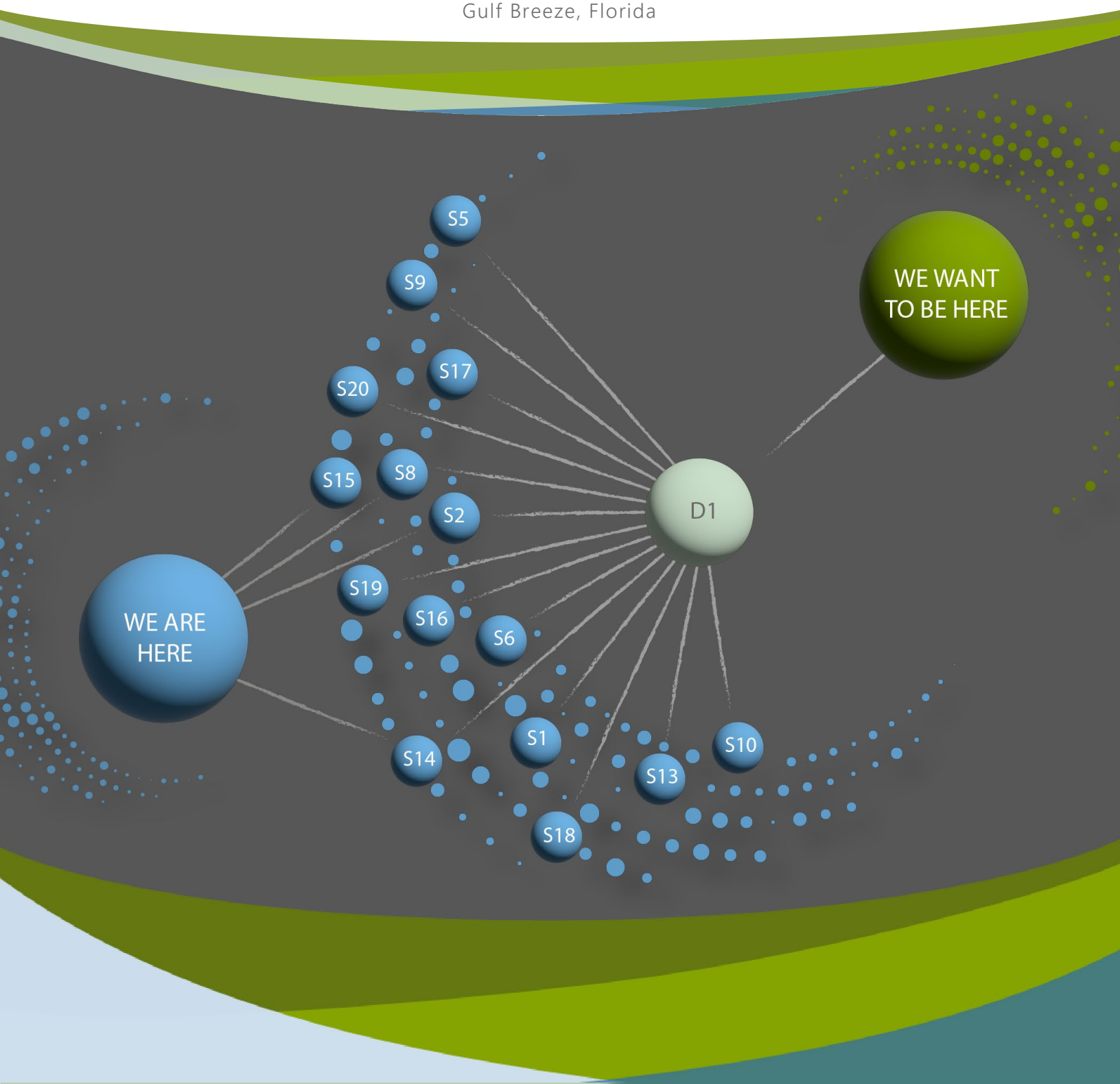

Acknowledgements

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The cover image visualizes theoretical connections between current conditions and future, changed conditions through services to stakeholders (blue circles) that comprise paths to a desired outcome (green circle); not all paths are the same, and not all paths are possible, but all need to be identified and evaluated.

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Executive Summary

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This document describes the proposed organization of a Flood Resilience Roadmap for the state of Louisiana. Its purpose is to lay groundwork for the development of a formal Roadmap in support of the Louisiana Watershed Initiative (LWI) Guiding Principles based on a Structured Decision-Making framework. This guidance document is organized around three Roadmap steps and includes links to supporting technical information through defined entry points for each Roadmap step.

Origin • The Origin is about the characteristics of the community as a starting point for change. This includes assets and vulnerabilities, as well as plans and objectives not just for flood protection but also for overall community well-being.

Pathways • A roadmap shows multiple paths to get from Origin to achievement of collaborative resilience objectives, but how does a community choose the right path? Optimally there are several to choose from and the goal of the Roadmap is not to just pick one, but to consider all of the options against community priorities and goals.

Destination • Choosing a destination is about the change a community wants to achieve based on established objectives. Improving resilience—which involves measurable change that can be compared to reference values for established performance measures—is defined during the Origins step to say we have in fact improved community resilience in meaningful ways. Defining the Destination is an answer to the question "What does community change look like?"

The Roadmap vision is to develop an interactive, visual roadmap document that allows interested users to use the Roadmap to develop a formal flood resilience planning document at the local level based on Louisiana Watershed Initiative (LWI) guiding principles, stakeholder engagement, and EPA tools to quantify ecosystem services and human well-being.

This guidance document elaborates on the roadmap framework with links to examples and sources. For additional reference, it includes results from an example exercise involving stakeholder discussions of inter-parish collaboration to improve flood resilience planning. This example is intended to demonstrate development of each step in the Roadmap and provide a starting point for development of a formal Resilience Roadmap in Louisiana.

Vision Statement

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The flood resilience roadmap is a working visual document intended to provide a set of steps for increasing community resilience through cooperative planning and consideration of ecosystem service benefits to people. The steps emphasize origin and endpoint determination based on stakeholder engagement, as well as 'entry points' for each step in the pathway so that communities can adapt the roadmap to their current efforts.

Photo credit: Joyce Stubblefield EPA Region 6

Background and Purpose

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Flood risk is an important aspect of life in Louisiana. In 2016 alone 56 of the 64 parishes in Louisiana were declared federal disaster areas as a result of flooding and the risk appears to be increasing (fema.gov/disaster/declarations). This issue is exacerbated by coastal land loss and projected sea level rise, which combine to increase risk from storm surge and contribute to a northward population migration as the cost and risk of coastal living increases. Currently, planning for a flood response is a fragmented process that occurs largely at the local level. Connections among local authorities are usually financial/operational in nature and do not reflect the reality of flood connectivity. Communities connected by waterflow—such as those in the same watershed—should unify their response to flood risk, as that risk is shared by their joint natural conditions. Such collaboration requires information on how and how much such risk is shared as well as the cause and effect of local decision making on other communities.

In response to these circumstances, the LWI was created to aid collaboration between local decision-makers, increase equity in resource availability, and change the perspective of flood resilience planning from local to considering effects throughout the watershed. The Roadmap purpose is to help make the connection between flood resilience and cooperative planning, so that the response to flooding is not simply reactionary but preparatory for future events. Flood resilience is a cooperative issue as no city or parish stands alone and the choices made by one authority have cascading effects on neighbor communities.

These issues are compounded by the equity of flood preparation and response. Options for increasing personal resilience to flood risk are tied to financial resources; those who cannot afford to invest in resilience (e.g., insurance, housing choice, flood plans) must often be content with counting on federal flood response to regain some sense of normalcy after a flood event. Equity and flood risk are inter-connected and highlight the issue that resilience is best achieved for the community as a whole rather than mainly for those who can afford to invest in it personally.

Overall, the LWI promotes a suite of guiding principles for cooperative flood resilience, which is a strong focus of this document.

Intended audience

This report is intended to provide guidance to community leaders, and those that help them, to increase community resilience to flooding, by following LWI guiding principles. **Community leaders** should include technical staff such as emergency preparedness experts, as well as planners and decision makers. The emphasis on stakeholder engagement means that community leaders should also include special interest leaders from groups such as religious organizations, small business, neighborhood organizations, and any other locally active groups that are concerned with community development. Identifying these stakeholder groups is an important step in the roadmap process. The skillset for community contribution is general but should include knowledge of what a community can do to improve and a willingness to step back from

specific projects (e.g., build levees) and discuss community needs in an open forum. Decision makers working together with community leaders is the most critical element of roadmap development.

People who help are typically community support organizations, such as LWI and the EPA, that can assist with the development of a local roadmap as in the example provided in this report. This assistance can be in the form of information, facilitation of workshops, and most importantly the organization of input and data used as input for the roadmap development. A key part of this outside support is access to previously collected data and engagement findings (See 'How to use existing data resources in Louisiana' section). Ultimately roadmap development should be in the hands of community leaders and decision makers but having support from other groups can be extremely helpful in keeping the process on track and accessing data and resources.

The process described below occurs in steps and each step should involve all the interested parties in the target community working together with support partners. Roles for specific groups are outlined in a flow diagram at the end of the Roadmap description (Figure 3) and can be used as a guide for recruiting participants. The main goal is an open and inclusive process that follows a structure needed to keep participants engaged and to assure a useful product for moving forward

LWI Guiding Principles Informing Roadmap

The LWI has five principles to guide the development of a roadmap:

- Communicate that flood risk is tied to every other part of stakeholder lives
- Improve the quality of decision-making by considering all risk
- Foster equitable resilience planning across community members
- Encourage watershed level thinking (upstream/downstream)
- Consider the impacts of migration/population shifts

Resilience is the collective capacity to recover quickly from a flood event. The easiest standard for community flood resilience is how long and how expensive it is for a community to return to their 'pre-flood' state after a flood event. The main resiliency goal is to minimize these numbers (time and cost) through planning and preparatory action. However just as important as minimizing time and cost is to promote equity across the community in these resiliency metrics so to provide higher resiliency for the community as a whole. The need for equity and inclusion ties resiliency to the well-being of community members and the Roadmap makes use of the concept of human well-being as a tool for promoting equitable resiliency.

The objective of a Flood Resilience Roadmap is to help communities reduce flood risk through the inclusion of these ideals in the planning process and promote coordination of flood resilience planning at the regional and watershed scale. Coordination, collaboration, and the inclusion of new data into the process is complicated. This can best be accomplished through a series of steps, from stakeholder engagement, to maximized access to information, to planning objectives that focus on community cohesion and well-being as a part of resilience.

This guidance document is intended to guide community leaders to do things differently by providing a framework and entry points for new thinking. This roadmap is organized around the concept of structured decision-making, or "SDM" (Gregory, 2012), which has been called "organized common sense" for issues too complicated for regular common sense (Keeney, 1982). The SDM framework has been applied in numerous contexts to identify innovative decision options for specific problems. This roadmap's SDM approach should be based on a multi-community study of transferability to a generalizable roadmap framework based on three roadmap elements: origin, pathways, and destination.

> *Throughout this document, yellow highlighted text notes an internal navigational link to a figure, table, or definition. All external links are to public-facing information on EPA or other websites. These links are a part of the interactive objectives for the Flood Resilience Roadmap.*

Roadmap Description

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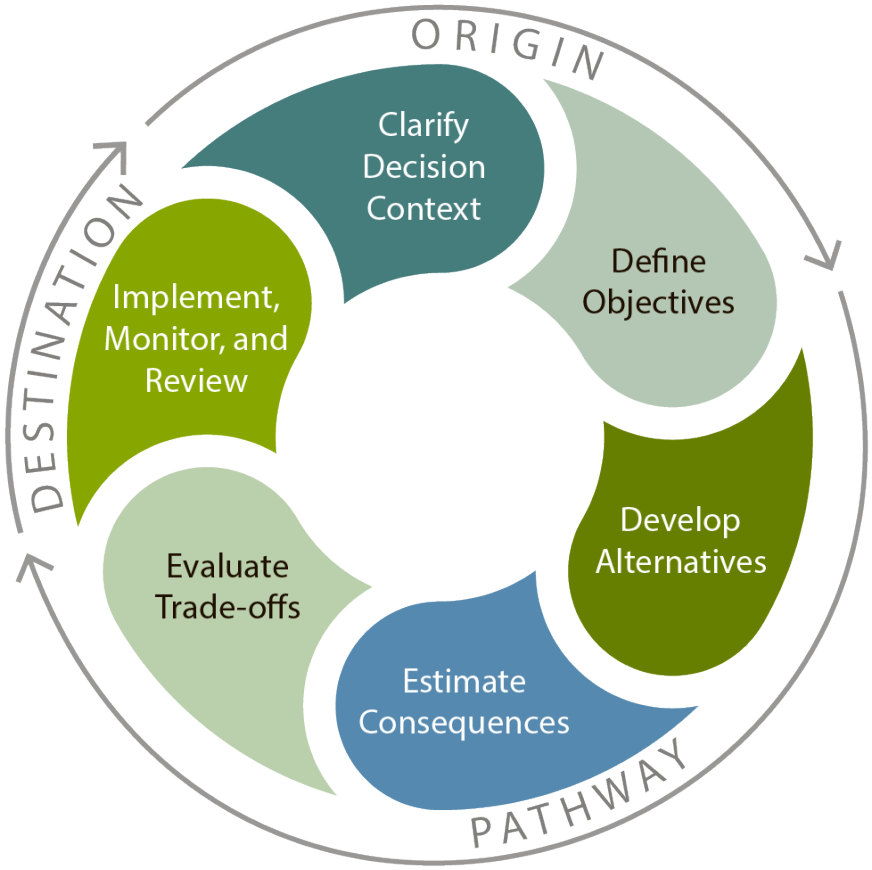
Change must begin with a clear understanding of the current state (status quo) of a community with respect to community resilience. In SDM, this is captured in the "Decision Context" step (Figure 1), specified here as the "Resilience Context" (O1) (Figure 2) as part of the Roadmap Origin" step. Origin elements include accounting for assets and vulnerabilities and listing community values framed as fundamental objectives. These objectives are organized into a hierarchy, outlining higher- and lower-level objective relationships (O2) and providing a framework for the inclusion of performance measures necessary for evaluating prospective alternative consequences (P1, P2, and P3). The latter guides users to the second step in the Roadmap, "Pathways," for improving resilience.

How does a community recognize change in community resilience? Once an alternative is selected for implementation, performance measures (P3) may be used in Implementation (D1) to verify alternative (pathway) changes to community resilience. Additional measures for tracking an alternative implementation's level of effort may also be used. The Roadmap "Destination" (D1) is desired change the paths are meant to achieve, and this change can be defined in measurable terms and tracked to determine if desired outcomes are achieved. In this document we will return to the three Roadmap elements to define and measure how to achieve resilience goals with a focus on entry points and strategies for defining each step in a meaningful way (Figure 2).

Figure 1. Structured Decision-Making Cycle (Gregory, 2012)



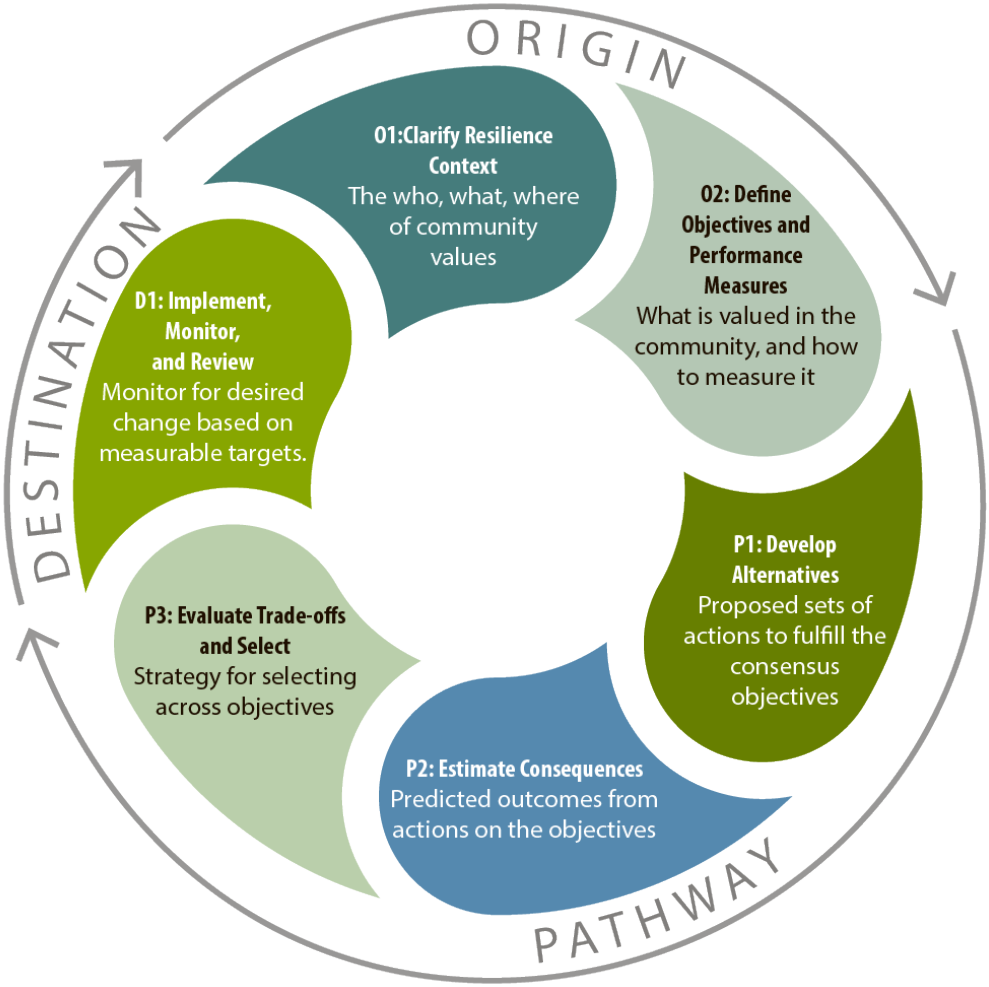
Origin

Important criteria for improving resilience include knowing current strengths and weaknesses, knowing who benefits from collaborative thinking and knowing what we need to change.

"Origin" is about the characteristics of the community. This includes assets and vulnerabilities as well as plans and objectives, not just about flood protection but about overall community well-being. Assets and vulnerabilities are about information and a formal accounting of capital, but community well-being is about community stakeholders and what they desire. First and foremost, this is about people, but from an SDM perspective, community stakeholders are described in terms of beneficiaries. **When change occurs, stakeholders gain or lose some of the benefit they enjoy as a part of their well-being. Improving community resilience should result in increased benefit to people in the form of reduced impact from flood events.**

Understanding how stakeholders benefit is a crucial step in planning for change; stakeholder engagement is therefore a critical starting place in defining a roadmap origin for a community. It is the identification of what matters to stakeholders, both in terms of community assets ("keep what we have") and community change that can contribute to an increase in resilience ("more benefit for more people").

Figure 2. Roadmap Steps Based on the SDM Cycle (Gregory, 2012)



Define resilience context by identifying community assets and vulnerabilities (O1: Clarify Resilience Context) – Frequently, a community is defined by its collective assets and vulnerabilities. For instance, a riverfront community may gather its identity from access to the river, but it may also gauge its vulnerability to flooding based on how well the river is contained, either naturally or through built protection. Natural assets (also known as ecosystem services, such as rivers and wetlands) are of particular importance, as they represent natural capital that can only be partially replaced by investment in built infrastructure. Understanding the collective natural assets and vulnerabilities of a community and setting priorities is a key input to defining a roadmap origin. It also contributes to knowing how to use new data or models in defining flood resilience, as the primary goal should always be to protect natural assets as a tool to reduce community vulnerability. These assets and vulnerabilities must be defined in measurable terms with an understanding

of how they will be affected by change. The clearest way to define natural assets and vulnerabilities is in terms of how they affect stakeholder benefits, as any resilience action should protect them.

Stakeholder benefits as objectives (O2: Define Objectives and Performance Measures) – The desires of the community stakeholders are the second key element of defining a roadmap origin. This is not just a survey of individual desire; rather, it is a collective consensus of community fundamental objectives that are consistent through time (that is to say, they don't change just after a flood event), clearly defined, and prioritized to allow for planning. Here, the terminology changes from people as **stakeholders** to people as **beneficiaries**, and we link beneficiaries to community assets by asking how their well-being changes when community assets change.

To return to the example of the riverfront community, all stakeholders are affected by the river; however, if anglers are defined as the beneficiary group, then the asset of interest is catchable fish in the river and we have shifted to an asset-stakeholder link (for example, NESCS+) that can be measured and prioritized based on how big that beneficiary group is with respect to the community as a whole. This linking of beneficiaries to community natural assets is known as "final ecosystem goods and services" or FEGS. Roadmap origins are collections of FEGS that define a community and outline how that community can improve resilience by protecting FEGS, especially common FEGS with other communities in the watershed.

> *A formal approach is a general reference to the use of formal decision analysis techniques for any or all steps in a full roadmap cycle (Figure 1), starting with formal stakeholder engagement on a focal resilience issue. This usually involves facilitated sessions, the formal quantitative analysis of data, and occasionally a guidance tool, such as DASEES, to organize the engagement and the analysis of the results. If used for all steps in the roadmap cycle, this can be a "zero to plan" approach.*

Way forward – The process of listing assets and vulnerabilities, connecting them to beneficiaries, and prioritizing the resulting pairings is how roadmap origins become the starting point for changes in community resilience. **This is best achieved through stakeholder engagement**. Since the goal is a community consensus on what change matters, the engagement should capture all community interest groups, not just those directly engaged in resilience planning or decision-making. There are a variety of tools available for this process, depending on the level of investment, and they are divided between two categories: formal and adaptive. Formal approaches to stakeholder engagement typically involve multiple facilitated engagement opportunities over a range of platforms (such as in-person, mail, or survey platforms) followed by a technical conversion of the results into an objective hierarchy. This approach is more time and resource intensive but also more inclusive; it is thereby more likely to lead to an identifiable consensus on defining a roadmap origin. Adaptive approaches, on the other hand, capitalize on former engagement information—as well as previously defined priorities—and focus more on the conversion of priorities into measures of change. Examples might include building upon an existing resilience planning document by engaging technical stakeholders on metric-to-priority conversion. The adaptive approach is faster in the short term, but missing stakeholder groups is a risk, and consensus can be hard to achieve if the existing resources are

not well understood or popular. Table 1 outlines practical strategies and entry points for defining a roadmap origin.

> *An adaptive approach is a general reference to the combined use of existing and new engagement to complete any or all the steps in the roadmap decision cycle (Figure 2). Previous engagement and consensus objectives from existing plans, as well as existing data on outcomes, can be combined and adapted to define any step in the roadmap process. Engagement is needed to assure existing information is necessary and important to resilience planning and to adapt these data into the roadmap steps. Care should be taken such that each roadmap step is considered and that existing data do not exclude new ideas or underrepresented stakeholders. This a "hybrid plan" approach.*

The formal and adaptive strategies are taken from an EPA report on practical strategies in decision-making with ecosystem services (Yee, 2017), which outlines a suite of actions for incorporating stakeholder engagement and an assessment of services into decision-making based on the SDM approach. These practical strategies are outlined in Table 1-3 as adapted from the EPA coordinated case study assessment (Fulford, 2021), which contains links to examples from community cases studies as well as tools and approaches developed for aiding community planning. The table also links to referenced tools: Decision Analysis for a Sustainable Environment, Economy, and Society (DASEES), Health Impacts Assessment (HIA), the Driver, Pressure, State, Impact, Response Framework (DPSIR), and the Human Well-Being Index (HWBI).

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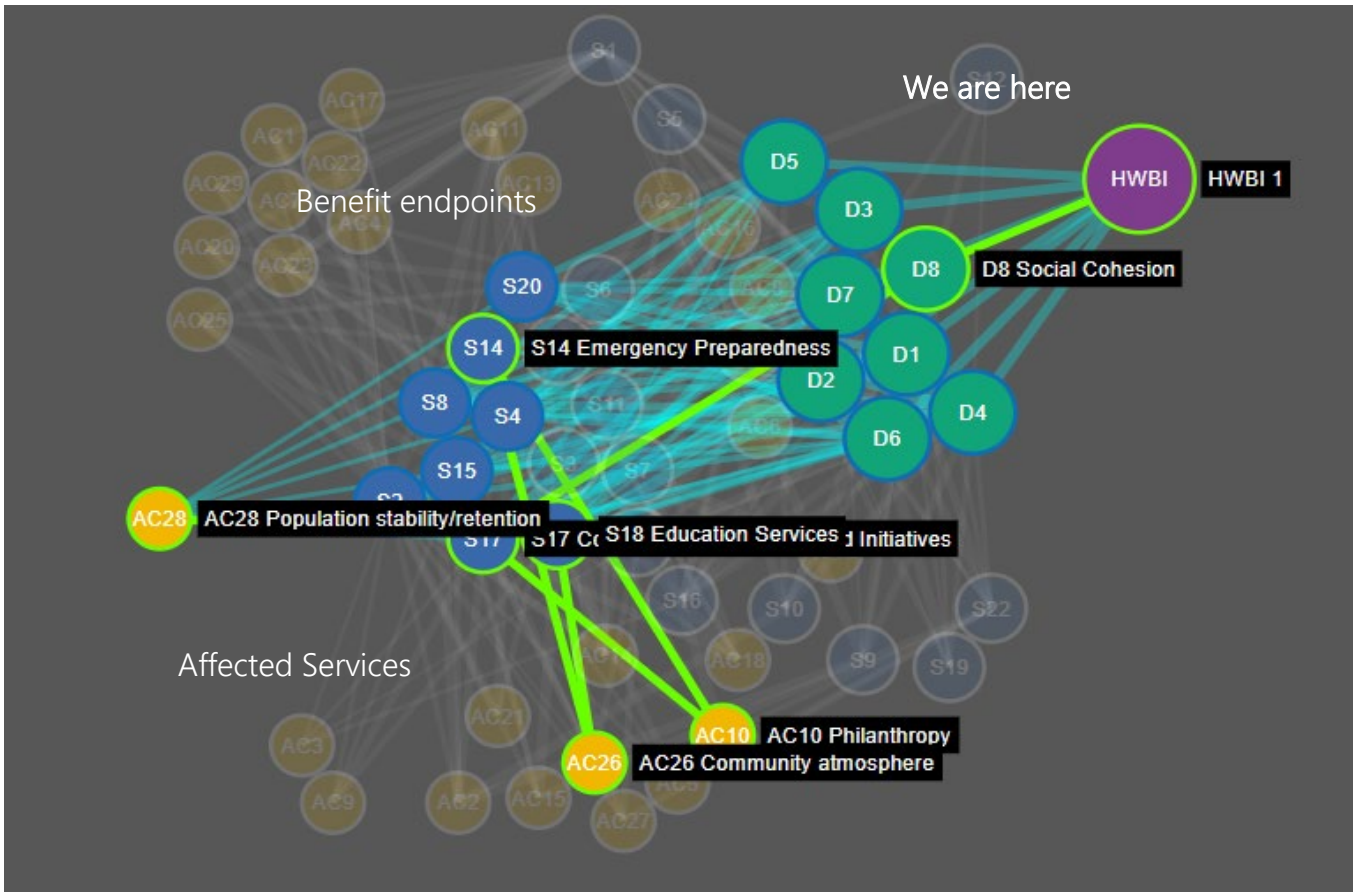
Table 1. Roadmap Origin Development – Practical Strategies and Entry Points

Practical Strategy	Case Studies	Entry Points
1. Apply FEGS concepts to explicitly connect assets and vulnerabilities to people The concept of FEGS explicitly connects ecosystem services to their benefactors, allowing for the identification of biophysical metrics that are more meaningful to a community and its values.	Formal example case study: St. Louis River, MN Adaptive example case study: Puget Sound, WA	**Formal** – Use SDM tools such as DASEES, HIA, or DPSIR to identify important FEGS through stakeholder engagement. **Adaptive** – Identify FEGS using expert opinion and existing objectives with the opportunistic inclusion of non-target FEGS that are also impacted.
2. Apply principles of SDM to emphasize flexible approaches to FEGS Principles of SDM provide a philosophy for integrating FEGS into decision-making by emphasizing flexible approaches to develop creative alternatives that are responsive to stakeholder values.	Formal example case study: Ada, OK Adaptive example case study: San Juan, PR	**Formal** – Use SDM tools such as DASEES, HIA, or DPSIR for walking through the entire SDM cycle. **Adaptive** – Identify SDM steps in the existing decision process with an effort to expand and educate stakeholders.

Practical Strategy	Case Studies	Entry Points
3. Incorporate FEGS concepts at any point in the decision process Ecosystem services concepts can be integrated at multiple points in a decision process, whether that process is in early or late stages, or whether that process includes informal or formal decision analyses. FEGS are links from people to assets and vulnerabilities.	Formal example case study: St. Louis River, MN Adaptive example case study: Mobile Bay, AL	**Formal** – Use SDM tools such as DASEES, HIA, or DPSIR to connect FEGS to objectives and performance metrics as well as to analyze trade-offs. **Adaptive** – Identify important FEGS and connect to an existing decision process based on expert opinion with an effort to educate stakeholders.
4. Use FEGS to identify beneficiaries for potential engagement FEGS is a useful construct for ensuring that potential benefits and costs of environmental impacts are under consideration and identifying beneficiaries to engage as stakeholders in the decision process.	Formal example case study: San Juan, PR Adaptive example case study: Puget Sound, WA	**Formal** – Use SDM tools such as DASEES, HIA, or DPSIR to identify all beneficiaries for inclusive stakeholder engagement. **Adaptive** – Identify beneficiaries by expert opinion and an existing stakeholder input process, such as committees. The process should be open to the identification of new beneficiaries.
5. Use conceptual models as a scaffold to visualize cause and effect and relationships Conceptual models visualize the cause and effect between decisions, stressors, FEGS, and benefits. They provide a common language, guide discussions, and elicit information, especially when built from a structured generic model as an underlying scaffold.	Formal example case study: St. Louis River, MN Adaptive example case study: Mobile Bay, AL	**Formal** – SDM tools such as DASEES, HIA, or DPSIR can be used to build conceptual models that communicate the decision context. **Adaptive** – Conceptual models can be developed as an ad hoc process to describe a decision, usually as a part of stakeholder deliberation or because of the inclusion of new data.
6. Use objectives hierarchies to define what is important for the community as a whole Objectives hierarchies define what is important about ecosystem services across stakeholder groups and the means to achieve those objectives.	Formal example case study: Ada, OK Adaptive example case study: Mobile Bay, AL	**Formal** – SDM tools such as DASEES, HIA, or DPSIR can be used to build an objective hierarchy to maximize the inclusion of all objectives and know which are the most important. **Adaptive** – The listing of all objectives associated with a decision via expert stakeholder deliberations can result in an objective hierarchy, but the objectives need to be linked and ranked by the same group.

Practical Strategy	Case Studies	Entry Points
7. Use structured classification systems as a starting point to identify measurable objectives Structured classification systems for performance measure development, such as NESCS+, Rapid Benefits Indicators, and the HWBI, can provide a starting point for clarifying objectives and measuring them in ways that reduce ambiguity.	Formal example case study: Ada, OK Adaptive example case study: Puget Sound, WA	**Formal** – SDM tools can be combined with a classification system to convert a list of stakeholder objectives into measurable performance indices. **Adaptive** – Performance indices previously developed via regulation or through expert judgement can be linked to objectives based on a classification system, which can also allow for the expansion of metrics if the classification system suggests new ones.



The above image is an example decisional network. Choosing pathways from proposed actions (yellow) through services (blue) to human well-being endpoints (green and purple) from the roadmap destination. Choices can get complicated when many actions are proposed, and endpoints are hard to define without an organized process like the SDM process. The example shows selected pathways (green lines) from all candidate pathways (blue lines).

Pathways are sets of actions that are stakeholder supported and achievable with available time and resources (Figure 2). Pathway choice starts with what is desired, then narrowed to what is possible and most likely to improve resilience based on priorities.

Pathways

Improving community resilience includes setting priorities for change. It is not doing everything; rather, it is doing what stakeholders most need and want to do.

A roadmap shows multiple paths to improve resilience based on origin priorities, but how does a community choose the right path? There are several pathways, but the goal of the roadmap is not to just pick one; rather, it is to select certain pathways after considering all options against community priorities and goals. This occurs in three steps: the identification of alternative actions, the estimation of consequences, and a trade-off analysis.

The identification of alternative actions (P1) – This scoping phase, where potential paths are defined, must be grounded in the origin's previously identified fundamental objectives, which are linked to actions through stakeholder engagement or existing planning documents. Action options should not be limited to emergency response; rather, it should consider all aspects of a community's priorities in the context on increasing flood resilience. For example, equitable housing priorities can be examined for action items that minimize flood risk in vulnerable neighborhoods alongside more general flood-safe housing initiatives like elevation standards. In general, no potential paths aligned with community values should be excluded from this scoping step. Identifying alternative actions can be viewed as a brainstorming activity with the caveat that all included paths are linked to origin objectives.

The estimation of consequences (P2) – Consequence estimation involves understanding the costs and benefits of each path under consideration. For a specific issue—such as river overbank flow in a flood—paths are well understood (in this case, building levees to protect property), and the discussion of consequences is largely technical and limited to experts; however, increasing collaboration in flood resilience planning is more comprehensive, especially while considering the origin objectives. Here, origin objectives are linked to potential actions to ensure that consequences of potential paths (that is to say, a specific set of actions) are estimated based on how and how much each one impacts the resilience objectives. More specifically, this involves the consideration of how potential paths may change defined performance measures and what these changes mean for community resilience.

Trade-off analysis (P3) – The final pathway step involves a comparison of consequences of multiple paths in terms of how each one may change performance measures. This is typically achieved through the quantitative or qualitative estimation of consequences for each individual path, followed by a standardization of the outcomes to allow for a comparison across paths (Keeney, 1982). The outcome is a consensus

prediction of effect based on measures of change selected during the "Origin" steps (O1 and O2). In a specific decision context, such as reducing overbank flooding, this is a technical process often involving quantitative data analysis; however, more generally, consequences can be quantitative or qualitative, involving a consensus opinion of effects that are revisited regularly to incorporate new information. The goal is to choose the optimal path(s) most likely to result in positive change for stated objectives and improve resilience.

Way forward – The pathway selection process is the most detailed of the three roadmap elements. It attempts to reach a consensus on the impacts of future events, but it is not necessary to completely capture impacts so much as it is to find which paths are most likely to achieve origin objectives.

Which paths are most likely to reach the desired destination? A good metaphor is a road trip where travelers are interested in a fast trip as opposed to one where they are interested in stopping at places of interest along the way. Both reach the destination (top priority), but each requires different resources and satisfies other desires at the same time (secondary priorities). Here, the formal and adaptive approaches define the paths. Formal approaches are more quantitative and technical; they better resemble predictions of a possible future. Examples include flood vulnerability models that predict change in spatial variability of flood risk relative to chosen actions, such as building levees or improving stormwater management systems. These approaches include comprehensive stakeholder engagement to achieve a consensus opinion of outcomes, so they require more time, expertise, and resources, but they can result in more acceptance/reliability of results. Adaptive methods, on the other hand, integrate existing data and resources into an estimation of consequences and selection of optimal pathways, though they still use performance measures defined during the roadmap origin step. In this case, existing data is applied to the novel comparison of potential paths. As with origin definitions, the adaptive approach to comparing different paths is faster and cheaper, but it includes a risk of excluding stakeholder groups. Care must be taken to make sure an adaptive approach is comprehensive and not just an extension of the status quo.

There is a suite of practical strategies for pathway definitions and estimations of consequences as outlined in the practical strategies report (Yee, 2017) and Table 2, which has been adapted from EPA's coordinated case study assessment (Fulford, 2021). In Table 2, each strategy has a formal and adaptive approach with links to examples from existing case studies as well as tools and approaches for aiding community planning.

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Table 2. Roadmap Pathway Development – Practical Strategies and Entry Points

Practical Strategy	Case Studies	Entry Points
8. Consider improving FEGS as paths to achieve multiple objectives at once Depending on the decision context, FEGS may be a means to achieving multiple economic, social, health, or general well-being objectives at once and may provide an opportunity for developing creative alternatives alongside more typical social or economic initiatives.	Formal example case study: St. Louis River, MN Adaptive example case study: Mobile Bay, AL	**Formal** – SDM tools such as DASEES, HIA, or DPSIR are designed to identify multiple paths to the stated objectives. **Adaptive** – Paths can be identified through the consideration of existing objectives by estimating impacts on stakeholders; however, the process should always include a consideration of multiple effects.
9. Use structured paradigms to link FEGS alternatives to broader objectives Structured paradigms, such as NESCS+ or the HWBI, can provide a clearer connection between potential alternative paths and environmental, social, and economic objectives.	Formal example case study: St. Louis River, MN Adaptive example case study: Puget Sound, WA	**Formal -** SDM tools such as DASEES and HIA are designed to identify formal decision alternatives and link them to performance measures to ease comparison. **Adaptive** – Existing decision options can be evaluated with ecosystem services metrics identified by expert opinion or through stakeholder engagement.
10. Prioritize information and analysis to what is needed to understand alternative paths Information collection and the application of tools should be prioritized to what is needed to both estimate consequences of alternative paths on measurable objectives and reflect the uncertainty that decision-makers can tolerate. Complex FEGS assessments or economic valuations may or may not be needed.	Formal example case study: St. Louis River, MN Adaptive example case study: Tillamook Bay, OR	**Formal -** SDM tools such as DASEES and HIA formally consider only those objectives identified as important through stakeholder engagement through an organized and facilitated process. **Adaptive** – An existing decision process, such as resource management, may be adequate, and consideration of new information typically requires a step-by-step process including a new data champion, a review of new data, and expert discussion.

Practical Strategy	*Case Studies*	*Entry Points*
11. Quantify paths with models and other quantitative tools that consider uncertainty and risk Mathematical modeling tools, ranging from simple lookup tables to complex biophysical models, can quantify the effects of alternative scenarios on the provisioning of ecosystem services.	Formal example case study: Puget Sound, WA Adaptive example case study: Tillamook Bay, OR	**Formal –** Developing new modeling tools will quantify ecosystem services and compare decision scenarios defined by decision-makers. **Adaptive** – Adapting an existing decision process with model-based information and projections can help improve best available information; the inclusion of new data is gradual.
12. Let objectives drive the choice of methods for FEGS benefits analyses The choice of methods to estimate ecosystem services benefits should primarily be driven by benefit endpoints under consideration and the information required for a decision.	*Formal example case study:* Puget Sound, WA Adaptive example case study: Tillamook Bay, OR	**Formal** – SDM tools such as DASEES and HIA formally link objectives to benefits analyses. **Adaptive** – The gradual inclusion of a FEGS benefit assessment into an existing decision process occurs by working backwards from known beneficiaries to FEGS to decision options. The monitoring cycle is important for development.
13. Use a decision support system (DSS) to organize and link FEGS analyses A DSS can engage stakeholders in a step-by-step process by organizing information and models linking decisions to ecological production functions (EPFs) to benefits (EBFs) and to facilitate an estimation of consequences.	Formal example case study: Ada, OK Adaptive example case study: San Juan, PR	**Formal** – SDM tools such as DASEES, HIA, or integrated modeling tools such as Envision, VELMA, InVEST, and EPA H2O can be applied from the beginning to guide a decision and engage stakeholders. **Adaptive** – A gradual inclusion of DSS might include an expansion of objectives, the addition of stakeholder engagement, and the development of conceptual models describing an issue.
14. Compare alternatives with consequence tables and trade-offs in FEGS benefits Consequence tables are a useful tool to display the effects of decision alternatives and understand trade-offs among decisions, particularly FEGS trade-offs, which are more directly relevant to beneficiaries.	Formal example case study: St. Louis River, MN Adaptive example case study: Mobile Bay, AL	**Formal** – SDM tools such as DASEES and HIA include the use of consequence tables and FEGS trade-offs. **Adaptive** – Consequence tables and FEGS trade-off assessments can be developed independently as an entry point for existing decisions.

Practical Strategy	*Case Studies*	*Entry Points*
15. Consider trade-offs in FEGS benefits relative to other objectives Trade-off analysis is valuable for considering how FEGS benefits, like human health, compare to more immediate benefits, like water quality goals.	Formal example case study: St. Louis River, MN Adaptive example case study: San Juan, PR	**Formal** – SDM tools such as DASEES and HIA use stakeholder input to organize all benefits of a decision. **Adaptive** – Benefit outcomes of a decision can be identified by experts, or data and results can be organized using ad hoc tools.

Photo credit: Ted DeWitt, EPA ORD

Destination

Improving community resilience involves changing tactics to accent a community strength or minimize a weakness and achieve stated resilience goals. How do we know we are doing something different? What does change look like?

Define the roadmap destination by setting performance measures (D1) – As the old song goes, "I don't know where I'm going but I hope I know it when I get there." Roadmaps have two goals: find the most desirable route and achieve stated objectives. For improving resilience—which involves predefining measurable change that can be compared to defined origin objectives—community resilience can be meaningfully improved.

In the "Origin" step, we defined community objectives for improving resilience and defined performance measures for these objectives. Paths are potential ways of improving resilience through action. What is needed last are targets for change. These targets can be identified conceptually based on objectives; for instance, an objective of improving equity of flood protection for all members of the community might be measured in terms of change in the social vulnerability index for the community. The "destination" would be based on a **consensus** amount of improvement in the index set based on a comparison to similar communities or perhaps on needed change to satisfy other objectives, such as lowering insurance costs. Every objective has a performance measure for which a target can be determined. These targets are then used to collectively define the community's resilience destination. If this is successfully done, the desired change will come to fruition.

One useful tool in defining a roadmap destination is the concept of human well-being. All measurable change in a community can be linked to aspects of human well-being, making an improvement in stakeholder well-being an outcome of improving community resilience. Human well-being considers environmental, social, and economic endpoints that can be classified into a measurable form, such as the Human Well-Being Index (HWBI), and used to define thresholds of change. In many cases, a measurable impact on human well-being is a clear and easily acceptable target. For instance, the objective of reducing health impacts of flooding on children might have the performance measure of reported respiratory illness up to three years following a major flood event. The threshold for this objective might be to cut the rate in half, but linking this objective target to human well-being might also be an option. A measurable well-being outcome might be reductions in reported illnesses linked to maintaining child activity levels or reducing the family cost of living so that a reduction in flood-related illness rate is more meaningful when it translates to an improvement in some or all these quality-of-life standards. The goal of linking objectives to human well-being requires effort in that these connections have to be defined, and not all communities are willing or prepared to make this additional effort to measure flood resilience impacts. Nevertheless, the value is clear and worth consideration for defining a destination as a target improvement in human well-being.

Way Forward – The final piece of the roadmap is tightly bound to the first step ("Origin") in that defined objectives have performance measures that we should use to define the destination targets for change. This last step requires defined **target levels** for each performance metric to determine if objectives have been achieved. Targets can be historical standards (such as storm impacts on health returned to historical levels), community comparison standards ("We want to be like our neighbor."), or conceptual standards ("We want to reduce impacts in half."). The key is to have a consensus on these standards for all defined objectives so that the destination is well defined at the beginning rather than an arbitrary target set after the fact based on what was done. As with the other two steps, this step considers formal and adaptive approaches to defining targets. Formal methods include more stakeholder engagement as well as a comprehensive consideration of what constitutes meaningful change in community resilience; adaptive approaches maximize the use of existing information to set targets based on existing information as opposed to a formal examination of each performance measure. One formal method for setting thresholds for objectives is to link objectives to human well-being.

Once again, the roadmap is defined by practical strategies. Thresholds of change can be defined in many ways, and each community can take full advantage of previous work. The strategies listed in Table 3 (adapted from the coordinated case study assessment (Fulford, 2021)) are linked to examples of both formal and adaptive approaches.

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Table 3. Roadmap Pathway Development – Practical Strategy and Entry Points

Practical Strategy	Case Studies	Entry Points
16. Monitor impacts to FEGS and well-being benefits helps define destination targets FEGS objectives should have their own performance metrics (PMs), and these PMs can be included in long-term monitoring and linked to human well-being metrics to improve future decisions.	**Formal example case study:** St. Louis River, MN **Adaptive example case study:** San Juan, PR	**Formal** – SDM tools such as DASEES and health impacts assessments provide the basis for targets linked to human benefit. **Adaptive** – Existing monitoring and assessment can be adapted to a roadmap approach by including chosen performance measures with group consensus on targets.

How long should a community take to complete roadmap development process? The timeline has three phases: Organization, discussion and data gathering, and Report development. The time needed to complete the process varies based on level of previous community organization, influence of the steering committee, and available resources. Ideally it will occur in a continuous process with multiple stakeholder meetings during the discussion phase and a planned report development effort at the end. This should take 6-8 months to complete. However, the process can be expediated if lots of information is already available or extended in cases where more time is needed particularly for the discussion phase. There is no fixed period to complete but the effort will provide the best results if participants remain engaged for all steps and this priority may drive the time needed to complete a Roadmap

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How to use existing data resources in Louisiana

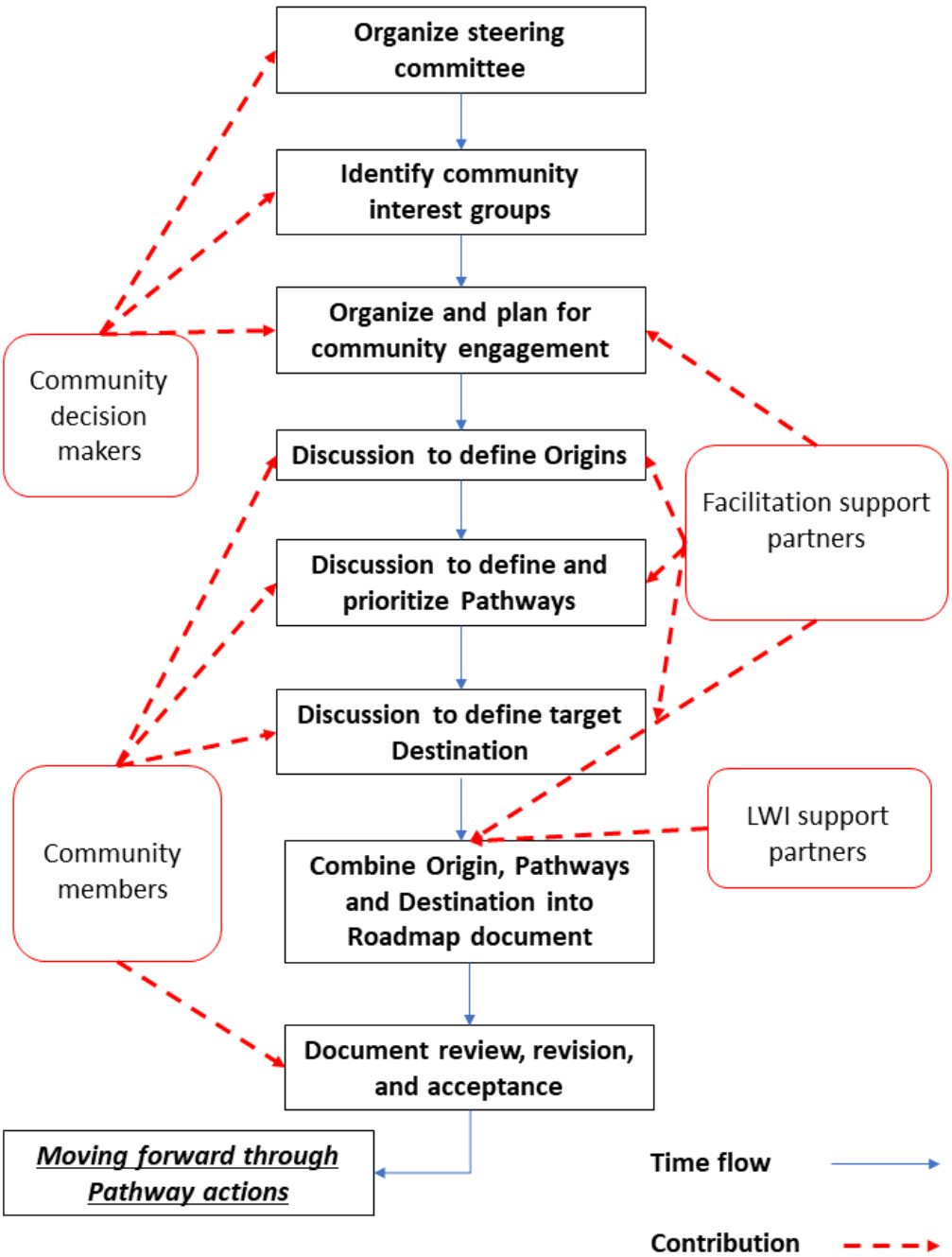
The stated purpose of the Flood Resilience Roadmap is to assist communities with flood mitigation planning following LWI guiding principles for integration of multiple interests, inter-community collaboration, and watershed level thinking about mitigation actions. Many of the actions that will be considered have been proposed through previous planning activities at the state and community level. In addition, there is a great deal of potential input data already available for Roadmap development that needs to be adapted to local use. The goal of Roadmap formation is to link this existing information to locally defined outcomes with defined measures of change to support evaluation. The Roadmap will help make these existing resources more actionable and useful in a community. Here we highlight some of the most useful resources for flood resilience planning that can be input data for development of a Flood Resilience Roadmap in Louisiana communities.

Technical data and proposed actions for increasing flood resilience can be used to create a candidate set of Pathways for roadmap development. This effort allows the community to focus on priority setting rather than developing pathway s from scratch and can greatly aid with integration across the watershed. A good resource for this is the Comprehensive Game Plan for a More Resilient Louisiana https://acrobat.adobe.com/link/review?uri=urn:aaid:scds:US:fe5f10e4-8c39-32de-87f6-4dcd6c6e5cbd– This document presents broad near-term and far-term objectives to follow that are in line with LWI guiding principles, so development of a Roadmap will align well with this gameplan. The near-term recommendations may provide community guidance for defining candidate pathways for flood resilience. For example, improving regulatory efficiency and increasing inclusion are key elements of LWI guiding principles and the Roadmap development process. A roadmap would define specific ways to achieve these objectives at the community level. Roadmap input may also include elements of the **Coastal Master Plan** (CMP; coastal.la.gov/our-plan/2017-coastal-master-plan/flood-risk-and-resilience-program/resources/city-parish-plans/) that considers statewide objectives to reduce land loss and flood damage along the coast. These resources are available to all communities but the Roadmap will help transform these recommendations into local actions acceptable to local stakeholders. The CMP calls for "better integration of hazard mitigation plans with other planning processes." And the Roadmap process is an outcome-specific and actionable approach to achieving that goal.

Roadmap input data from existing sources can greatly speed up the Roadmap development process as it does not need to begin from scratch in each community. Like the Resilience Roadmap the **LASAFE** (https://lasafe.la.gov/) initiative used a grassroots effort to identify major themes and concerns of local communities in Louisiana regarding flood vulnerability. These concerns were converted to recommendations for resilience planning at the state level. Many of the LASAFE recommendations can be applied at the local level and represent a strong starting point for the development of a community specific Roadmap Origins description. Further, the conversion of these recommendations into community Pathways and metrics of change are a part of the Roadmap development process and these LASAFE recommendations help speed up the process in

cases where they apply. The LASAFE initiative can be a powerful tool in LWI's effort to build more integrated watershed scale resilience. Another input resource for Roadmap development is the **Louisiana Speaks initiative** (https://www.cpex.org/louisiana-speaks) and the **Resilient Communities Infrastructure Program** (cdn2.assets-servd.host/utopian-bustard/production/Resilient-Communities_Final.pdf) which together provide valuable input on proposed actions and resources useful for Roadmap development.

Figure 3. Flow chart summarizing organization of example Roadmap engagement process in Louisiana parishes including formation of steering committee, community stakeholder engagement, data organization into Roadmap structure, and communication of results as actionable steps to take in the community. This report outlines the 'how' and this flow chart summarizes the 'who' as well as a flow of activities taken by the community in Roadmap development.



Roadmap Development Example

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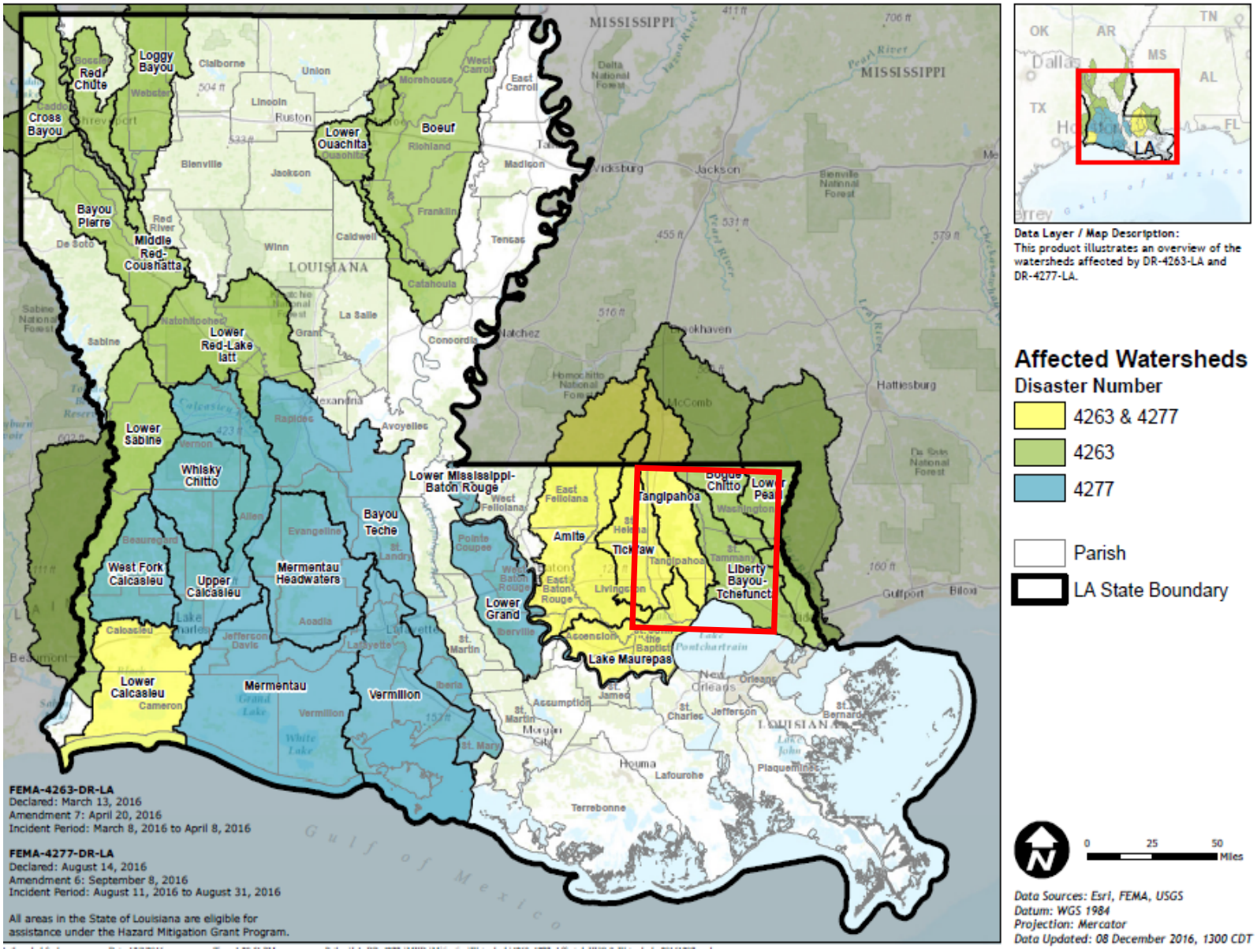
Moving forward with inter-parish collaboration in flood resilience in eastern Louisiana – achieving LWI Guiding Principles in practice

This roadmap process was initiated as a series of workshops focused on inter-parish collaboration on the overall objective of increasing flood resilience. The workshops were organized around steps for the roadmap origin element in that the parties sought to define an objective hierarchy and associated performance measures, both through stakeholder engagement. An adaptive approach was adopted for the initial steps of the roadmap by employing the roadmap steps of establishing a resilience context (O1) and an objective hierarchy (O2) through stakeholder engagement, but it also included existing information on collaboration developed by the LWI and its partners. This roadmap application example builds upon previous work by the LWI and is intended to support its guiding principles:

- Flood resilience is not a new topic, but what could be done differently?
- LWI emphasizes equity, watershed thinking, and development of a comprehensive strategy for flood resilience.
- Today's goal is to explore barriers and opportunities for collaboration that can lead to these goals for resilience planning.
- Discussion today will apply structured decision-making to achieve a consensus set of objectives and performance measures for increasing collaboration.
- Today's consensus outcome will be used to populate a guidance document that is a roadmap towards these resilience goals.

Flood Resilience • *the capacity of a system to absorb disturbance and re-organize while undergoing change to still retain essentially the same function, structure, identity, and feedbacks*. (What is community resilience?) Resilience is about the speed, effort, and resources with which a community can return to "normal" after a flood event. This requires a definition of "normal," including measures and thresholds as well as geographic boundaries of interest.

The resilience roadmap formation process will include a consensus definition of flood resilience in the context of three parishes in eastern Louisiana.



The map above shows flood-affected watersheds in Louisiana since 2016. The red box indicates the region where parishes participated in the workshop in eastern Louisiana. (Photo credit: Louisiana Watershed Initiative)

Flood Resilience Collaboration Roadmap Outcomes

The roadmap decision cycle, as based on SDM, was initiated with partners from three parishes that collaborate with LWI. Two workshops explored the specific topic of "barriers and opportunities for inter-parish collaboration on flood resilience planning," and the following summarizes the outcome of those discussions, which serves as an initial example of the roadmap process in practice. These workshops were focused on origin development, only partially considered the definition of pathways, and did not consider a destination. Hence, this roadmap process is incomplete, and we hope to continue the effort going forward.

This application of the roadmap cycle employed an adaptive approach in that discussion of origin steps (O1 and O2) were facilitated, but it also included previously developed objectives combined with novel ideas to foster collaboration. Nonetheless, the following shows one possible application of the Roadmap in practice. Details on the workshop organization is provided below in "Supplementary Material."

Origin • Knowing what to do means knowing what we should be doing differently.

The "Origin" element of the roadmap cycle focuses on the determination of community assets and vulnerabilities as a description of "who they are," followed by development of a list of objectives for protecting assets, reducing vulnerabilities, or both. The first workshop was more freeform and considered both steps, but it did not touch on performance measures as needed for completion of the origin element. Performance measures were addressed in the second workshop and through informal follow-up after the workshops. This was an adaptive approach with a minimal use of formal tools.

Three two-hour virtual workshops were held with stakeholders from parishes, state, and local agencies. Values elicitation (Step O1) followed methods (Gregory et al 2012; Dyson et al 2022) and entailed brainstorming ideas scoped to be relevant to the decision context of enhancing collaboration for regional flood resilience. The ideas were framed as objectives using brief action-verb statements such as "protect drinking water sources" and "minimize water borne pathogens." Objectives were separated into two groups: fundamental (ends) objectives and means objectives. Fundamental objectives are the results, states, and qualities desired by stakeholders; means objectives describe actions or targets that lead to the achievement of desired end results.

Often, initially stated objectives are means objectives that point to a currently undefined fundamental objective. Objectives were evaluated and clarified using iterative queries where a stakeholder is repeatedly asked why each statement of an objective is important, with each answer leading to a better formulation of a fundamental objective. Once clarified, fundamental objectives are organized into an objective hierarchy that identifies objectives having a similar intent, leading to a higher-level end objective and resulting in a hierarchy of objectives. A preliminary Objective Hierarchy was structured after the first workshop and refined as stakeholders reviewed and refined the objectives; the most current version of the hierarchy reflects stakeholder input after the three workshops.

Discussions during the workshops on inter-parish collaboration resulted in the following list of fundamental objectives. The complete "Objective Hierarchy," including fundamental and means objectives, is provided below. It highlights the fundamental objectives as the first product of Origin Element O2.

1. Define fundamental objectives – Maximize quality of life – Any change should preserve or improve the overall quality of life. This includes social, economic, and environmental elements, but not all have to be considered at once. A collective quality of life outcome is the objective.
2. Maximize community health – Flood resilience has a necessary health component in that storm recovery leads to exposure to health stressors that need to be minimized. Equity is also a factor for health as we focus on the health of the whole community.
3. Maximize environmental quality – Flood impacts key parts of the environment, such as water and air quality. Additionally, resilience can be impacted by environmental vulnerabilities already present, such as land use that facilitates toxic run-off during storms. This objective relates to minimizing impacts of flooding on environmental quality as an overall component of quality of life.
4. Minimize flooding impacts – Flood impacts are direct disruptions of daily life, such as displacement, safety risk, loss of water/power, loss of income, and loss of property. Resilience is not a response to flooding but a plan to reduce or eliminate impacts for the whole community before they happen.
5. Community continuity – Resilience of the entire community should be the target, which requires objectives related to community connections and identity. If the community is not clearly defined and supported in an equitable manner, resilience will focus on portions of the community unequally, making overall resilience harder to achieve. A key first step is to foster consensus on the optimal scale for community continuity as it applies to resilience (such as a watershed as opposed to a parish)
6. Maximize collaboration – Community-level resilience is best supported through equity among all community stakeholders in impacts as well as information and access to resources. Collaboration on resilience actions and planning will support a community-scale outcome.

Objective hierarchy – Fundamental objectives are a part of the origin but must be linked to pathways through an objective hierarchy that drills down to means objectives and associated performance measures. These performance measures are a starting place for defining pathways for action and finally to alternative actions that comprise the pathways.

Many of the practical strategies for the origin element of the roadmap cycle (Table 1) center on linking community fundamental objectives to FEGS as a method for structuring the outcome and more easily tying results to viable performance measures. This portion of the example was addressed in a workshop follow-up involving an addition of detail to the objective hierarchy table (Table S1), as the workshop discussion did not reach the performance measure step. This is a good example of the adaptive approach in that the FEGS structure greatly aids these informal discussions by providing a framework for input.

Pathways ● Define alternatives, understand trade-offs.

Choosing optimal pathways for change is the most involved step in the roadmap and was only partially considered during the workshops. The discussion of objectives during the origin step led naturally to some pathway options being mentioned that are related to increasing collaboration and new thinking on flood resilience, but the key to this step is defining and exploring trade-offs among these options, which will need

to be considered in the future to complete this step. Possible ways to complete this step are included in Table 2.

Optional actions mentioned during discussion of barriers and opportunities for collaboration on flood resilience planning are listed below:

1. Engagement with the next generation – change as a training tool for youth
2. Watershed-scale planning for impervious surface distribution
3. Planning for collective sewer discharge including new housing plans
4. Investigating land swaps – prioritizing land for flood protection
5. Stakeholder engagement for information sharing – equity
6. Access to data for all – transparency and technology
7. Housing cost equity – prioritization of flood protected/low-risk areas

Destination ● How do we know we accomplished our objectives?

Destination setting is about converting objectives defined during the "Origin" element (O2) into targets (D1) using performance measures defined for each objective. The "Objective Hierarchy" created during the workshops can be used to define and agree on performance measures which are needed to scope the Destination. One option moving forward is to use a standardized definition for performance measures such as the FEGS classification system, which helps convert local objectives, such as those listed in the origin element above and the "Objective Hierarchy," into a measurable form.

For the example, for roadmap exercise in southeastern Louisiana, we did not reach this step in the cycle during the workshops, so it was left to informal follow-up both for the identification of performance measures as well as target setting. Options going forward include using a FEGS classification approach (Table 3) combined with expert opinion to both define performance measures and set targets as a part of destination setting (D1). This is an adaptive approach used in this case study to make use of both existing data (LWI Guiding Principles) while also gathering new ideas about collaboration during the workshop. Destination setting will be initiated through a discussion of the objective hierarchy spreadsheet (Table S1), including the addition of a "Performance Measure" column to the spreadsheet, which allows for participant input via email survey.

Lessons Learned

While the roadmap cycle was not completed for the topic of barriers and opportunities for collaboration, the process allowed for new perspectives to be included in the discussion of flood resilience planning and formed a basis for continued discussion in the future. Furthermore, the combination of the LWI Guiding Principles with the roadmap cycle offered multiple potential entry points for including the LWI Guiding Principles in local decision-making.

Next Steps

For the elicited and structured information to be useful in a decision analysis of the estimated consequences of option implementation, further formulation is required:

- Further refinement of fundamental objectives
- Performance measures for fundamental objectives
- Further refinement of means objectives/actions for decision option creation

Once structured, this information will guide technical experts in the selection of methods and models to predict or estimate the consequences of actions to achieve fundamental objectives.

Supplementary Material – Workshop Example

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The following materials and outcomes were used during the SDM workshops on inter-parish collaboration to improve flood resilience planning in LWI Region 7:

S1 – This handout, used during workshop discussions, focuses discussion on barriers and opportunities for collaboration on flood resilience planning. This topic was chosen as a high priority to meeting the LWI Guiding Principles in southeastern Louisiana.

S2 – This workshop objective hierarchy table was developed as output from workshop discussions to fulfill Roadmap Steps O1 and O2. This table will also be used as a guidance tool for Steps O3 (performance measures), P1, P2, and P3 (identifying and comparing pathways), and D1 (performance measure target setting).

S3 – This summary of performance measures was developed as output from workshop discussions to fulfill Roadmap Step D1.

Supplementary Table 1 (S1) – Workshop Discussion Guide

Discussion guide for cooperation in flood resilience planning workshop

Greetings and thank you for consenting to participate in our upcoming discussion of barriers and opportunities for regional cooperation among parishes on flood resilience planning. Our goal is to identify and discuss real choices that could be game changers for the effectiveness of regional cooperation. In preparation for our discussion on April 6th, we ask that you consider the following categories and apply your expertise and experience to identifying objectives in each one. These objectives should include both how (process) and what (ends) objectives. These categories will either be used to structure break-out sessions or used to guide group discussion overall, so jotting down a few ideas beforehand can facilitate the brainstorming process.

- Land use planning
- Economic development
- Housing and quality of life

How to do Brainstorming

General guidelines:

- Brainstorming is constraint-free thinking
- No evaluation of ideas is permitted during brainstorming
- Come up with as many ideas as possible

Brainstorming Objectives

Objectives are concise statements about what matters, what is important to a decision context.

1. Brainstorm what matters: Write down **all** the concerns and issues you hope to address for the decision problem/context.
2. Issues/goals can be things you want to avoid and things you want to achieve
3. There are no wrong answers

Questions to help with idea generation for the given context/problem.

What are you trying to achieve? What would other stakeholders want to achieve?

What do you most want to avoid? What would other stakeholders want to avoid?

What would make you happy? What would make other stakeholders happy?

Think of an ideal, possibly infeasible solution. What is good about it?

Think of the worst solution. What is bad about it?

What has occurred that is good or bad? What might occur that you care about?

What constraints, goals, or guidelines are relevant?

Supplementary Table 2 (S2) – Workshop Objective Hierarchy

LWI Region 7 + EPA Resilience Roadmap Workshop		
Structured Decision Making:		
Objective Hierarchy Chart		
Note: empty cells represent needed information not yet established by the adaptive approach. This is an ongoing process.		
Strategic Objectives		
Ensure public trust in government		
Encourage environmental education		
Promote civic engagement for flood resilience		
Fundamental Objectives	**Justification**	**Means Objectives**
Maximize quality of life		
Increase access to affordable housing	Equity	MAP suitable areas for housing
Minimize commuting to work	More traffic on roads lengthens commute times, increases stress and may result in greater numbers of accidents	Partner with RPC on studies to design new traffic corridors with shorter commutes from populated areas to business centers
	Reduce emissions (NO_x, SO_x, particulates & CO_2) are precursors to O_3 and Climate Change	Education & outreach to residents & businesses regarding work-from-home options
Protect riparian corridors & Green space	Public access to waterbodies, animal habitat, tree canopy	GreenPrint shows areas the Parish might be interested in for swapping & easements to incentivize maintaining integrity & continuity of these corridoes
	Consider swapping areas of higher to lower flood risk	Development codes and GreenPrint
Minimize Loss of Trees		
Protect Flood Plain		
Maximize community health		
Minimize waterborne illness	Pathogens	Locate illicit sewage sources (inspection of individual homeowner systems)
Minimize vector-born diseases	WNV	Develop policies to regulate illicit discharges from homeowner sewer treatment systems

LWI Region 7 + EPA Resilience Roadmap Workshop		
Structured Decision Making:		
Objective Hierarchy Chart		
Fundamental Objectives	**Justification**	**Means Objectives**
Maximize community health, continued		
Protect fisheries & oyster culture (sessile creatures)	Food sources, commercial & recreational	Develop decentralized management program (for homeowner sewer treatment systems)
Promote central sewer systems & tie-in nearby ATU-dominated neighborhoods	Improve individual property values	Realtor awareness of ATUs for New homeowners
	Public buy-in for cost of centralization	Cost/benefit analysis of centralizing sewers
	Tie-in costs & user fees can be a disincentive for low-income homeowners (user fees)	Obtain subsidies for LMI homeowners for tie-in costs & user fees
		Update sewerage regulations for Lots of Record
Minimize foodborne illness from seafood		
Maintain healthy homes (mold)		
Minimize dermal exposure to people and animals		
Maximize environmental quality		
Protect drinking water sources (DW)		LDEQ Environmental Code/ EPA CWA LDWF/USFWS (fisheries, scenic rivers) LDH (oyster culture)
Protect WQ for fish & wildlife propagation (FWP)		
Protect WQ for primary & secondary contact recreation (PCR & SCR)		
Protect headwater lands	Ephemeral headwater streams are usually associated with wetlands that provide storage to prevent flooding of downstream communities	Require development to mimic nature (discharges should be the same rate pre- and post-development)
Minimize loss of perched & coastal wetlands	Wetlands provide habitat, groundwater aquifer recharge, flood storage and WQ polishing	Enforceable Plan & Ordinance for development in wetlands
		Encourage or incentivize green infrastructure/ow Impact development practices

LWI Region 7 + EPA Resilience Roadmap Workshop		
Structured Decision Making:		
Objective Hierarchy Chart		
Fundamental Objectives	**Justification**	**Means Objectives**
Maximize environmental quality, continued		
Reduce eutrophication	Entrophic algal blooms indicate excess nutrients and can be harmful to fish & humans	Outreach to homeowners regarding nitrogen in pet waste & lawn fertilizer application
		Outreach to homeowner with ATUs regarding proper O&M PER their permit with LDH
Protect recreational waterways		
Minimize flooding impacts		
Minimize sewer system upsets (I&I)	Prevent Floodwaters from inundating central sewer infrastructure	Manholes should be a minimum of 25-yr elevation and above the lip of drainage conveyances
	Because discharge pipes are below the lip of ditches, LDH requires backflow preventors on homeowner sewer treatment systems	Provide Education & outreach to homeowners to assure that these are operational over time
Protect drinking water infrastructure		
Community resilience	Stream gauges assist with flood prediction and modeling, emergency management, grants and citizen returns following a flooding event	Provide access to stream gauge network
	Support NWS to Improve flood forecasts	Prioritize and increase stream & rainfall gauging
	Preserve floodplains	Address through development code
	Minimize and enforce impervious surfaces	Address through development code incentivize Green Infrastructure and Low-Impact Development (GI & LID)
		Check H&H models for this percentage (TR-55 assumes 65% impervious for 1/4 acre lots. Smaller lots will have even greater % impervious, so runoff will be underestimated)
Community continuity		
Promote Economic Development	Incentivize actions to reduce flood insurance policy rates	Education & outreach to residents & builders
		Promote elevations, buy-outs, regional projects (detention, levees, additional culverts if downstream capacity ...)

LWI Region 7 + EPA Resilience Roadmap Workshop		
Structured Decision Making:		
Objective Hierarchy Chart		
Fundamental Objectives	Justification	Means Objectives
Community continuity, continued		
Promote Economic Development	Incentivize actions to reduce flood insurance policy rates	Revise building/zoning codes to balance flood risk, accessibility to affordable housing & affordability
Promote broadband in rural areas		
Partner equitable upstream & downstream development	Water availability can have impacts at both high flow HIGH-FLOW (flooding) and LOW-FLOW (Estuary/ecosystem health, commercial/recreational fisheries, WQ-permit dilution needs), cultural, saltwater intrusion… to downstream communities, many of whom are LMI or flood-vulnerable	MOU with Ross Barnett Reservoir and new One Lake proposed impoundment for MINIMUM flow rates
		Consider NO-Rise certificates for discharges from large developments - Mimic nature… Developments may need to hold water longer in order to not effect an increase in the downstream water surface elevation (WSEL)
Partner economic development to flood management		
Partner Federal & state agencies in Climate Change strategies		Prioritize Marsh restoration & Plantings as **non-structural coastal surge barriers** & as **carbon mitigation banks**
		Education & outreach to residents & builders regarding precursors to greenhouse gas production & mitigation
		In restoration projects add Coastal Restoration Monitoring Sites (CRMS) to measure subsidence, salinity & carbon capture
Partner Federal Assistance Programs for flood recovery	Need to recover in a timely manner	Streamline federal assistance program processes - HUD funding for 2020 and 2021 disasters as examples
Maximize collaboration		
Increase community outreach	Alleviate economic burden to local gov to manage flooding disaster impacts and increase multi-jurisdictional cooperation	Streamline federal assistance programs and increase funding for local gov including infrastructure needs
Adopt consistent approaches across parishes		
Adopt consistent regulations		

LWI Region 7 + EPA Resilience Roadmap Workshop		
Structured Decision Making:		
Objective Hierarchy Chart		
Fundamental Objectives	Justification	Means Objectives
Maximize collaboration, continued		
Standardize data management	Shorten review time and assure data are compatible with regional watershed models	Require survey & engineering models to be conducted using software that is compatible and consistent with LWI models. Software should be cost-effective and publicly available for simplicity of review and incorporation into LWI watershed-level models
Facilitate data sharing	Data-sharing at the project-level improves topographic information needed for grants and H&H modeling at local and regional level	Require surveyors and engineers to share data and model inputs with local governments
Develop a watershed-level water budget for management of upstream & downstream impacts	Impoundment in upstream communities impacts those downstream during low-flow conditions. Ross Barnett & One Lake Plan are examples of impoundments in Jackson, MS that can cause low-flow issues at the mouth of the Pearl River near Lake Pontchartrain.	Water budget will assure adequate water supply during critical summer conditions to satisfy permits, commercial & recreational fisheries and maintain habitat for estuaries.
		MOU between States of LA & MS for minimum flow at state line & Lake Pontchartrain
	Development with inadequate detention or too high an impervious surface can exacerbate downstream flooding	Improve H&H modeling of large developments, require adequate detention, regulate lot sizes in flood-prone areas, encourage/incentivize LID/GI,

Supplementary Table 3 (S3) – Performance Measures (Destination)

Maximize regional flood resilience		
Objective	*Measure*	*Notes*
Maximize quality of life		
Minimize commuting for work	Home to work distance measured in hours of quality time lost	Set standard based on index communities
Restore tree canopy	Percent tree cover by watershed	Target increases based on input
Protect riparian corridors and greenspace	Coverage of greenspace in watershed (ac)	Target increases based on input
Minimize environmental health stressors		
Minimize waterborne pathogens	Pathogen concentration (ppm)	Target decreases in post-flood spikes
Minimize vector borne illness	Illness reporting rate by watershed	Target decreases in post-flood spikes
Minimize dermal exposure to waterborne contaminants	Awareness level of stakeholders	
Prevent mold in housing	Indoor air quality measures	Target decreases in post-flood spikes
Minimize flooding stress mental health concerns	Social survey before and after flooding	Target decreases in post-flood spikes
Minimize flooding impacts		
Minimize infiltration and inflow to water infrastructure		
Minimize economic burden to homeowners	CRS increase # of participants; increase rating score	Accepted target increase
Minimize housing in flood prone areas	# 404 permits for residential development; for major subdivisions, then find # houses in wetland areas- needs clarity – former wetland areas, need new more specific sub-objectives for "flood prone"?	Increase in use of flood risk in development planning
Maximize environmental quality		
Ensure recreational water quality	Change in water quality metrics with floods	
Protect drinking water sources	Change in water quality metrics with floods	
Protect headwater lands	Use hydrology model output metrics	Minimize projected change
Minimize perched and coastal wetland loss	Use hydrology model output metrics	Minimize projected change
Protect water quality for fish and wildlife propagation	Use hydrology model output metrics	Minimize projected change

Maximize regional flood resilience		
Objective	*Measure*	*Notes*
Maximize community continuity		
Maximize homeownership	Soft second program; increase # of people enrolled	Define target increases
Maximize affordable family dwelling construction	# Median community income	Define target increases
Promote broadband in rural areas	# Of citizens with broadband access; user freq.	Report use rates per capita targets
Partner equitable upstream and downstream development		
Maximize collaboration		
Increase community outreach	# Attendees in workshops, improve our ability to listen, use different forum to reach high schools, what is appropriate engagement for students. Track social media usage, how to track civic engagement and training events? # Of classes on WQ	This was Ren. His focus was on engaging and tracking students.
Adopt consistent approaches across parishes		
Standardize data management	Agreement on data sources used and formats, agree on survey methods, agreement on data quality standards	
Facilitate data sharing	Agreements across parishes to share data, Establishing a repository for field data, database	
Adopt consistent regulations	Requirements to share data in repository, change incentives to collect, house and share data, increase participation from surveyors sharing data	These may need to go in data sharing

Supplementary Information – Case Study Links

The following case study factsheets exemplify applications of SDM framework:

Great Lakes Area of Concern *St. Louis River, MN*	https://www.epa.gov/system/files/documents/2021-08/egs-case-study-factsheet_great-lakes.pdf
Mobile Bay, Alabama *Mobile Bay, AL*	https://www.epa.gov/system/files/documents/2021-08/egs-case-study-factsheet_mobile-bay.pdf
Oklahoma Small Community, Oklahoma *Ada, OK*	https://www.epa.gov/system/files/documents/2021-08/egs-case-study-factsheet_oklahoma-small-community.pdf
Pacific Northwest *Puget Sound, WA* *Tillamook Bay, OR*	https://www.epa.gov/system/files/documents/2021-08/egs-case-study-factsheet_pnw.pdf
San Juan, Puerto Rico *San Juan, PR*	https://www.epa.gov/system/files/documents/2021-08/egs-case-study-factsheet_san-juan.pdf