

The Efficiency Gap

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A Systems Diagnosis of Declining Recovery Capacity Across Health, Land, and Public Institutions

Working Draft

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Abstract

Public systems in the United States face sustained strain across health, wildfire, infrastructure, and workforce domains. These challenges are frequently treated as separate sectoral crises managed through distinct agencies and funding streams. This paper proposes an integrated systems interpretation. It defines the efficiency gap as the widening disconnect between system inputs and durable functional stability when recovery mechanisms are suppressed or fragmented. Drawing on systems science, resilience engineering, planetary health scholarship, and public governance literature, the analysis synthesizes evidence showing that rising throughput and emergency response can coexist with declining long-term performance. The paper argues that efficiency should be understood as conversion capacity, meaning the ability of systems to translate investment into stable, adaptive outcomes over time. Human metabolic dysfunction and ecological degradation are presented as parallel signals of disrupted regulation, diminished recovery capacity, and poor coordination across subsystems. The Wildfire Resilient Landscapes framework is used as a conceptual lens to interpret these patterns across interconnected human and ecological landscapes. The paper concludes with policy recommendations emphasizing recovery-centered metrics, regenerative land management, metabolic health as infrastructure, cross-sector coordination, and upstream design that reduces repeat crises. The goal is diagnostic and integrative rather than empirical, offering design principles for stabilizing system performance and reducing long-term public costs.

Keywords systems resilience; recovery capacity; efficiency gap; resilience engineering; public governance; planetary health; wildfire resilience; metabolic dysfunction

Institutions

Section 1: Introduction

The underlying causes of America's health, climate, and infrastructure challenges are interconnected. Public systems across the United States are under sustained strain. Wildfire impacts are becoming more destructive, and suppression expenditures are projected to rise (Carlson et al., 2025). Health care spending continues to increase, with chronic conditions accounting for a large share of overall costs (Hartman et al., 2026). Workforce capacity is pressured by disability, long-term health conditions, and burnout that undermines sustained participation and performance (Dennett et al., 2025).

These challenges are typically treated as separate crises managed by different agencies and funding streams. Growing evidence suggests they share a common underlying cause rooted in chronic system stress, fragmented governance, and diminished recovery capacity rather than isolated sector-specific failures (Bennett et al., 2015; Grossi & Argento, 2022; Yu & Chaturvedi, 2025). This paper describes the common cause as an efficiency gap.

This is not primarily a problem of resource scarcity. Energy, land, labor, and public investment remain available. The problem lies in conversion, meaning the ability of public systems to translate inputs into stable, adaptive, long-term function. Community resilience research emphasizes that resilience failures frequently arise not from insufficient resources, but from weak coordination, institutional fragmentation, and an overreliance on short-term response rather than sustained recovery pathways (Federal Emergency Management Agency, 2025; Grossi & Argento, 2022).

This paper synthesizes existing evidence across public health, land management, and governance literature rather than presenting new empirical findings.

Section 2: Purpose and Argument

This paper argues that human metabolic dysfunction and ecological degradation can be understood through the same systems lens. In both cases, chronic stress overwhelms recovery capacity, forcing systems into continuous compensation rather than regeneration (Bennett et al., 2015). When systems cannot restore function after stress, they require increasing input and repeated emergency interventions while delivering diminishing long-term stability.

Wildfire Resilient Landscapes advances an integrated resilience framework that treats people, landscapes, and communities as interconnected systems governed by shared principles: signal clarity, recovery capacity, and coordinated function. Addressing efficiency failures requires coordinated system design rather than isolated interventions, consistent with systems-based resilience research, planetary health scholarship, and federal recovery doctrine (Bennett et al., 2015; Federal Emergency Management Agency, 2025; Yu & Chaturvedi, 2025).

By reframing resilience as an efficiency and recovery challenge, this paper presents five policy recommendations that emphasize regeneration, preventive investment, cross-sector coordination, and upstream system design. Together, these strategies aim to reduce long-term public costs, stabilize system performance, and restore the human and ecological capacity necessary for sustained economic and democratic participation (Bennett et al., 2015; Federal Emergency Management Agency, 2025; Organisation for Economic Co-operation and Development, 2021).

Section 3: Defining Efficiency in Systems

Efficiency is often misunderstood as austerity, cost cutting, or reduced consumption. In systems science and public governance, efficiency refers to how effectively inputs such as energy, resources, and effort are converted into stable, useful outcomes over time. Efficient systems are not those that maximize short-term output, but those that sustain function without excessive waste, strain, or degradation (Bennett et al., 2015; Federal Emergency Management Agency, 2025; Grossi & Argento, 2022).

Across disciplines, efficient systems share three core characteristics that enable sustained stability over time. First, they maintain clear signals that allow early detection of stress and imbalance, making it possible to respond before disruption escalates into crisis. Second, they possess built-in recovery capacity through processes of rest, regeneration, and repair that restore function after disturbance rather than relying solely on continuous output. Third, they exhibit coordinated function across subsystems so that actions in one domain do not undermine stability in another. Together, these features support adaptive performance by enabling systems to detect strain, recover from disruption, and maintain alignment across interconnected components (Bennett et al., 2015; Yu & Chaturvedi, 2025).

When these characteristics are weak, systems tend to substitute throughput for stability. They increase activity to manage symptoms while underlying drivers remain unchanged. Over time, this pattern increases long-term costs and vulnerability across sectors (Bennett et al., 2015; Federal Emergency Management Agency, 2025).

Section 4: What Efficiency Characteristics Look Like in Practice

4.1 Clear Signals

Clear signals allow systems to detect rising stress early and reduce escalation into crisis. In health care, integrated pathways and information sharing across primary care, specialty care, and preventive services support early risk identification and reduce delays in diagnosis and fragmented treatment. Fragmented care pathways correlate with increased emergency service utilization and poorer long-term outcomes (Dennett et al., 2025; Hartman et al., 2026).

In infrastructure, monitoring technologies and preventive maintenance programs enable early detection of wear, overload, or imbalance and reduce catastrophic failure and emergency repair costs (Huang et al., 2025). In ecosystems, intact feedback loops, including changes in vegetation structure, soil condition, and species composition, signal stress and enable recovery before collapse. Disrupted signals are associated with increased wildfire severity and ecological instability (U.S. Forest Service, 2022).

4.2 Recovery Capacity

Recovery capacity is the ability to restore function after stress. In health systems, this includes prevention, rehabilitation, and effective chronic disease management. Poor control of metabolic and chronic conditions increases acute care use, disability, and long-term costs (Hartman et al., 2026; Hu et al., 2025).

In workforce systems, insufficient recovery support contributes to prolonged work absence, reduced labor force participation, and persistent productivity losses following illness or injury (Dennett et al., 2025). In land management, suppression of recovery processes such as low-intensity fire and ecological regeneration has contributed to fuel accumulation and more

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severe wildfires, increasing suppression and disaster response costs (California Department of Forestry and Fire Protection, 2023; U.S. Forest Service, 2022).

4.3 Coordination Across Subsystems

Coordination ensures actions in one system do not increase strain in another. Fragmented systems increase duplication, conflicting interventions, and downstream burden, while coordinated design improves long-term performance across sectors.

Public governance research shows that lack of coordination across institutional, social, and ecological subsystems often shifts risk rather than reducing it. Integrated approaches that align policy, infrastructure, health, and environmental management improve system efficiency by reducing counterproductive interactions and reinforcing shared recovery goals (Grossi & Argento, 2022; Yu & Chaturvedi, 2025).

Section 5: Human Metabolic Inefficiency as a Systems Signal

One of the clearest indicators of systemic efficiency breakdown in the United States is the prevalence of metabolic dysfunction, particularly insulin resistance. Longitudinal analyses show rising rates of metabolic disease over the past two decades, reflecting a growing share of the population experiencing impaired metabolic regulation, including individuals not yet formally diagnosed with diabetes (Hu et al., 2025).

In metabolic dysfunction, fuel is present but not effectively converted into usable energy. Glucose circulates in the bloodstream, yet cellular uptake and utilization are impaired. Systems-based research characterizes this condition as a failure of metabolic signaling and regulation, leaving the body in a functional state of scarcity despite abundant inputs (Bennett et al., 2015).

The body compensates through stress-mediated and regulatory pathways. When these compensatory responses persist, they increase inflammatory load and regulatory strain rather than resolving the underlying dysfunction (Bennett et al., 2015). Population-level analyses link metabolic dysfunction to fatigue, chronic pain, mood disturbance, delayed recovery, and reduced physical and cognitive capacity. These impairments increase reliance on medical care and reduce sustained workforce participation, generating long-term strain across health and labor systems (Dennett et al., 2025; Hartman et al., 2026; Hu et al., 2025).

Recognizing metabolic dysfunction as a systems signal rather than an individual behavioral failure reframes policy responses. It shifts attention from individual compliance to upstream design, recovery capacity, and coordination across health, labor, and environmental systems. In this context, supporting metabolic health functions as an infrastructure investment that stabilizes human capacity and reduces long-term public costs.

Section 6: Ecological Parallels in Land Management

The same efficiency breakdown observed in human metabolic systems is visible across land and climate systems. Across many regions of the United States, landscapes are subjected to chronic stress while being deprived of mechanisms that allow recovery. Rather than functioning as adaptive systems, these environments operate in a near-constant state of compensation, relying on suppression and emergency response rather than regeneration and long-term stabilization (U.S. Forest Service, 2022).

Common expressions of this pattern include prolonged fire suppression without sustained fuel management, urban heat islands without adequate green infrastructure, degraded soils without recovery periods, and fragmented habitats without ecological connectivity. Research in land and fire management demonstrates that these conditions disrupt ecological feedback loops, suppress regeneration, and reduce resilience to disturbance over time (California Department of Forestry and Fire Protection, 2023; Yu & Chaturvedi, 2025).

6.1 Urban Heat and Public Health Connections

Urban heat islands provide a clear example of ecological inefficiency translating into human health risk. Neighborhoods with limited tree canopy, high impervious surface coverage, and minimal green infrastructure experience elevated temperatures, reflecting the loss of ecological buffering capacity described in resilience and planetary health research (Yu & Chaturvedi, 2025).

Heat exposure interacts with metabolic and cardiovascular strain, reducing the body's ability to regulate temperature and recover from exertion. Large-scale analyses associate extreme heat events with increased emergency department utilization, lost workdays, and preventable mortality, with disproportionate impacts on communities already experiencing structural

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vulnerability (Dennett et al., 2025; Hartman et al., 2026). Rather than moderating stress through shade, evapotranspiration, and soil moisture, these environments amplify physiological strain and shift costs into health care, emergency response, and labor systems.

6.2 California-Specific Context

California illustrates how ecological inefficiency compounds across systems. Decades of fire suppression, land fragmentation, and development in the wildland-urban interface have increased fuel loads and wildfire severity, while urban expansion has intensified heat exposure in many communities. Areas with degraded vegetation structure and limited recovery mechanisms experience higher fire intensity and escalating suppression costs over time (California Department of Forestry and Fire Protection, 2023).

At the same time, urban regions across California, including parts of Los Angeles, the Central Valley, and the Inland Empire, exhibit overlapping patterns of low tree canopy, elevated heat exposure, and increased health and economic vulnerability. Analyses link chronic health burden and environmental stress to higher medical utilization, reduced workforce participation, and sustained pressure on public health, housing, and labor systems, particularly in communities already facing structural disadvantage (Dennett et al., 2025; Hartman et al., 2026; Yu & Chaturvedi, 2025).

From a systems perspective, wildfire and extreme heat are not failures of nature but signals of prolonged efficiency breakdown. Landscapes that cannot regenerate accumulate stress until failure becomes inevitable. Research in forest and fire science demonstrates that systems with intact recovery mechanisms, including prescribed fire, diverse native vegetation, healthy soils, and connected habitat corridors, experience lower disturbance intensity and recover more rapidly following shock. In contrast, systems optimized for short-term control rather than long-

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term function accumulate risk that is ultimately released catastrophically (Bennett et al., 2015; California Department of Forestry and Fire Protection, 2023).

Section 7: Throughput Without Recovery

Many public systems in the United States are designed and evaluated around throughput. Success is measured by activity levels, services delivered, acres treated, patients seen, or cases processed. These metrics capture short-term output, but they rarely measure whether systems are regaining stability or reducing future demand.

Across resilience, disaster management, and systems engineering research, sustained performance depends on the ability of systems to absorb stress, adapt, and restore function after disturbance. When recovery is excluded from system design, efficiency declines even as activity increases (Bennett et al., 2015).

In the absence of recovery capacity, systems compensate. They respond to rising strain by increasing throughput rather than reducing underlying causes. Emergency responses expand, service utilization rises, and workloads intensify while conditions generating demand remain unchanged. Resilience engineering shows compensatory responses can temporarily maintain performance but increase fragility by masking accumulating stress and delaying restoration (Huang et al., 2025).

Quantitative resilience research confirms that recovery time is often a dominant determinant of long-term system performance. Systems that delay repair or operate continuously without recovery experience compounding performance loss and higher failure risk over time (Huang et al., 2025). In this context, constant activity is not a sign of strength but a signal of unresolved strain.

This pattern is visible across public systems. In wildfire management, suppression-focused strategies that prioritize immediate control without sustained fuel reduction allow ecological stress to accumulate, leading to larger and more severe fires and escalating

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suppression costs (U.S. Forest Service, 2022). In health systems, repeated acute encounters without upstream stabilization are associated with rising emergency utilization and long-term cost growth (Bennett et al., 2015; Hartman et al., 2026). In governance and social service systems, crisis-oriented delivery without stability and recovery goals increases churn while long-term vulnerability deepens (Grossi & Argento, 2022).

This is not a failure of effort or commitment. It is a design problem. Systems optimized for constant throughput without recovery will consume more resources to produce diminishing returns. Over time, emergency responses become the dominant mode of governance rather than an exception.

Section 8: WRL Integrated Resilience Framework

Wildfire Resilient Landscapes approaches resilience as an integrated system spanning land, people, and communities. At this stage, WRL functions as a conceptual and analytical framework rather than an implemented program. Its purpose is to synthesize existing research across environmental management, public health, housing, and workforce systems into a coherent way of understanding systemic efficiency and recovery.

The framework is grounded in the observation that challenges often treated as separate, such as wildfire risk, chronic illness, housing instability, and workforce attrition, share structural features. WRL proposes that these challenges reflect breakdowns in recovery capacity rather than isolated failures within individual sectors. This framing is consistent with resilience and planetary health scholarship that emphasizes interconnected ecological and human systems and the cascading effects of suppressed recovery across domains (Bennett et al., 2015; Yu & Chaturvedi, 2025).

8.1 Core Theoretical Principles

Regenerative land management as recovery infrastructure

WRL draws on land and fire science to argue that landscapes function more efficiently when managed for regeneration rather than continuous suppression or extraction. Practices such as prescribed fire, native vegetation restoration, soil recovery, and habitat connectivity restore ecological feedback loops, improve adaptive capacity, and reduce long-term risk. Research shows landscapes with intact recovery mechanisms experience lower fire severity, greater post-disturbance regeneration, and reduced long-term suppression costs compared to systems optimized for short-term control (California Department of Forestry and Fire Protection, 2023; U.S. Forest Service, 2022).

Community-scale stress reduction as a resilience strategy

WRL extends resilience thinking beyond ecological systems to include chronic stress exposure in human environments. Systems-based research in disease prevention and public health indicates sustained exposure to heat, pollution, housing instability, and environmental degradation increases physiological stress, disrupts metabolic regulation, and reduces recovery capacity over time. These conditions contribute to chronic illness and diminished workforce participation, particularly in communities facing cumulative environmental and socioeconomic burdens (Bennett et al., 2015; Dennett et al., 2025; Hu et al., 2025). Community-scale interventions, including green infrastructure, urban canopy expansion, and place-based resilience design, function as upstream strategies that reduce cumulative stress rather than relying solely on downstream emergency response (Huang et al., 2025; Hartman et al., 2026).

Interdependence of ecological and human health

A central assumption of WRL is that ecological health and human health are interdependent components of the same system. Degraded landscapes amplify heat, pollution, and disaster risk, which can worsen chronic disease burden, increase disability, reduce labor participation, and elevate public costs. Conversely, healthier ecosystems support environmental conditions that improve physical, mental, and social well-being. When recovery mechanisms are disrupted in either ecological or human systems, compensatory processes dominate and long-term vulnerability increases across domains (Bennett et al., 2015; Yu & Chaturvedi, 2025).

8.2 Why an Integrated Framework Matters

WRL proposes siloed approaches that limit public effectiveness because they address symptoms within individual systems while leaving underlying stressors intact. Wildfire suppression without land recovery, health care delivery without environmental stability, or

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housing services without attention to environmental exposure may meet immediate needs while perpetuating long-term inefficiency and rising demand.

The integrated resilience framework offers a way to align analysis and policy thinking across sectors without requiring institutional consolidation. It provides a lens for evaluating whether systems regain stability, reduce repeat crises, and restore functional capacity over time. Synthesized research across resilience engineering, planetary health, and public systems analysis indicates integrated, recovery-oriented approaches have greater potential to reduce cumulative risk and long-term cost than isolated interventions (Huang et al., 2025; Yu & Chaturvedi, 2025).

Section 9: Policy Recommendations

The following recommendations do not propose new programs or institutions. They translate existing evidence into design principles that prioritize recovery, efficiency, and long-term system stability.

Policy Recommendation 1: Measure Recovery Capacity, Not Only Output and Throughput, in Public Systems

Action: Expand performance metrics to include recovery and regeneration indicators that reflect long-term system stability, rather than relying solely on short-term output measures. This recommendation focuses on performance measurement reform, not program expansion, and can be implemented within existing agency structures.

Policy Recommendation 2: Invest in Regenerative Land Management That Reduces Chronic Ecological Stress

Action: Prioritize funding toward land management practices shown in the literature to restore ecological recovery capacity and reduce long-term wildfire risk, including prescribed fire, native vegetation restoration, soil recovery, and habitat connectivity.

Policy Recommendation 3: Support Metabolic Health Initiatives as Infrastructure Investments, Not Lifestyle Programs

Action: Treat metabolic health as a systems-efficiency issue that directly affects workforce participation, disability rates, and long-term public spending, rather than framing it primarily as an individual lifestyle concern.

Policy Recommendation 4: Fund Cross-Sector Resilience Programs That Integrate Land, Health, and Community Systems

Action: Create funding structures that enable coordination across environmental, health, housing,

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and labor sectors through shared funding criteria and performance goals. Participating agencies retain distinct roles and authorities while coordinating around long-term recovery and resilience outcomes.

Policy Recommendation 5: Shift From Reactive Spending to Upstream Efficiency Design to Reduce Long-Term Public Costs

Action: Rebalance public budgets toward upstream efficiency design that reduces the frequency and severity of repeat crises. This recommendation focuses on preventing recurring emergencies and stabilizing systems over time, not on cutting services or reducing access to care.

Section 10: Conclusion

The efficiency problem described in this paper is systemic, not sector specific. Health, environment, housing, homelessness, education, and labor are interacting systems. When they underperform together, people do not simply fall through cracks. They are worn down over decades. This framing is consistent with emerging planetary health scholarship, which identifies wildfire, chronic disease, and governance fragmentation as interconnected efficiency failures rather than separate sectoral problems (Yu & Chaturvedi, 2025).

Political and administrative theory has long emphasized democratic governance depends on meaningful access to public institutions. In principle, democracy assumes individuals can seek assistance, exercise choice, and navigate public systems when needs arise. Services exist. On paper, the system functions.

However, this assumption breaks down when access is structurally impaired. Choice without functional access is not real choice. Democratic systems implicitly assume stable bodies, stable housing, cognitive and physical bandwidth, and institutions that can be navigated. When those conditions are absent, the language of personal responsibility becomes inaccurate as a policy frame.

This is not a failure of democracy as an ideal. It is a failure of implementation and system design. Systems that cannot convert energy, care, and investment into stable, regenerative outcomes burn through people, landscapes, and public budgets (Huang et al., 2025). The Wildfire Resilient Landscapes framework advances a resilience lens grounded in efficiency, recovery capacity, and coordination across systems. Recovery is not an ancillary benefit. It is a structural requirement for sustained capacity and meaningful participation.

Systems that can recover do not burn as easily.

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