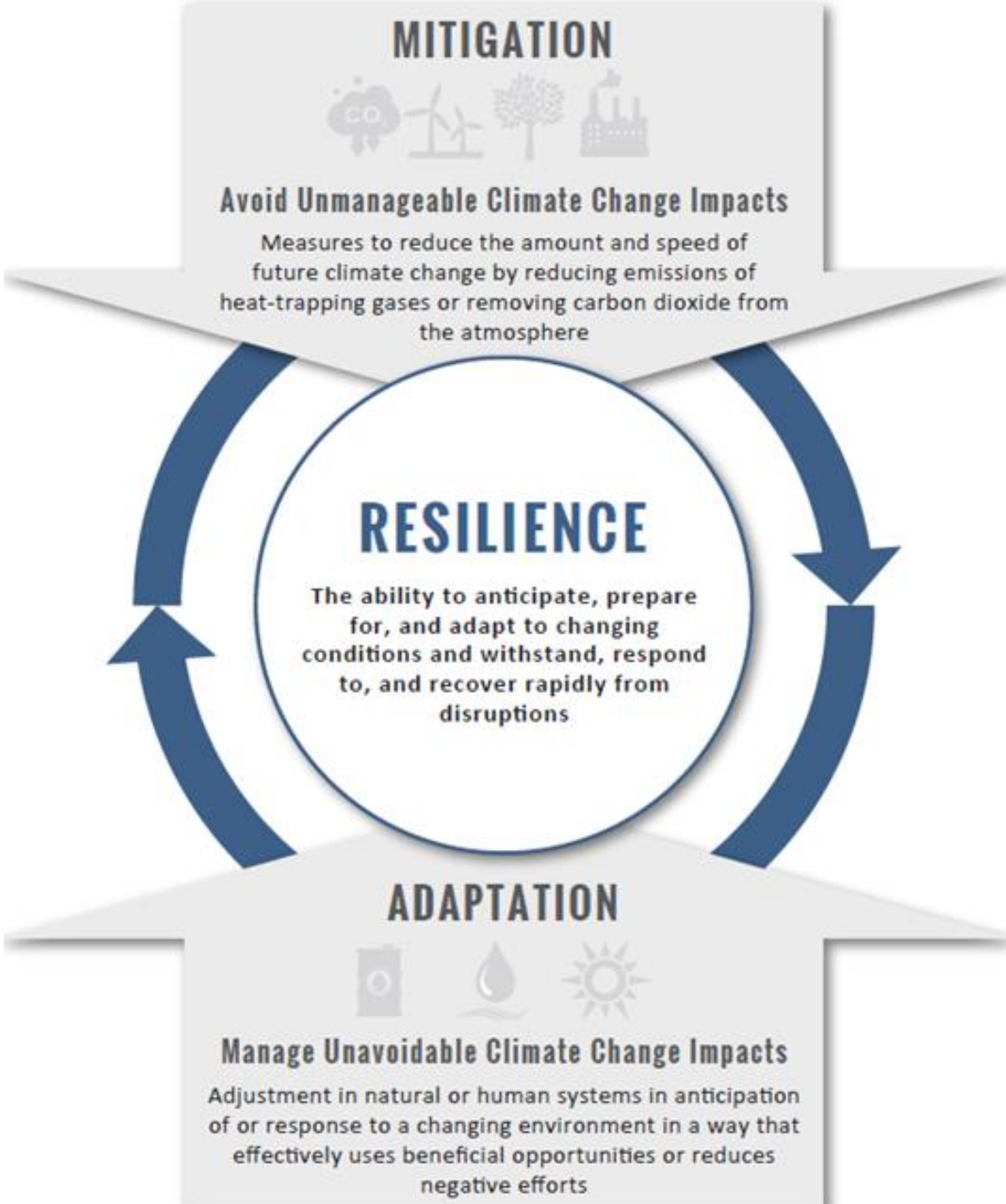
Conference on Innovations in Climate Resilience

DoD Climate Adaptation

Kate White, PhD, PE, Director for Climate Programs
Office of the Deputy Assistant Secretary of Defense of Environment and Energy Resilience
29 March 2022


No entity can opt out of the effects of climate change.
-Department of Defense Climate Adaptation Plan
The Department must take bold steps to accelerate adaptation to reduce the adverse impacts of climate change.
-Department of Defense Climate Adaptation Plan


MITIGATION
Avoid Unmanageable Climate Change Impacts
Measures to reduce the amount and speed of future climate change by reducing emissions of heat-trapping gases or removing carbon dioxide from the atmosphere
RESILIENCE
The ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions
ADAPTATION
Manage Unavoidable Climate Change Impacts
Adjustment in natural or human systems in anticipation of or response to a changing environment in a way that effectively uses beneficial opportunities or reduces negative efforts

manage


WATER LEVEL IN RED
CROSSING PROHIBITED
WATER LEVEL IN GREEN
PROCEED WITH CAUTION


YOUR SAFETY COMES FIRST
SHERIFF

unavoidable

Manage Unavoidable Climate Change Effects

Operations:

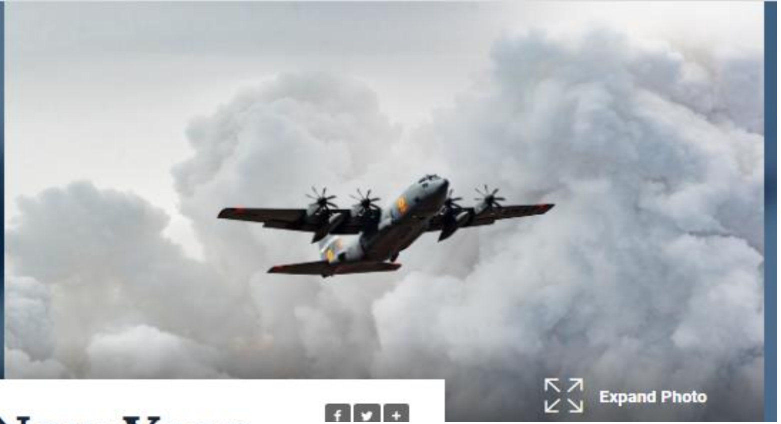
- Increased global insecurity – "Failed States"
- International Humanitarian Response
- Defense Support to Civil Authorities

Installations and Infrastructure

- Sea level rise
- Loss of access to training areas
- Flash floods and erosion
- Severe weather

People and Equipment

- Heat stress
- Performance Degradation



An Air National Guard MAFFs-equipped C-130 out of Reno, Nev., flies over plumes of smoke after dropping retardant on the Beckwourth Complex Fire, July 9, 2021, near Frenchman Lake in northern California. Air National Guard photo.

AIR FORCE MAGAZINE

Fire Season Now Year Round for the Guard, Hokanson Says

July 30, 2021 | By Abraham Mahshie

Firefighting technology hasn't changed much from the days when Chief of the National Guard Bureau Gen. Daniel R. Hokanson dropped buckets of water from a UH-60 Black Hawk, and his brother, a smokejumper, parachuted in to fight wildfires on foot.

What has changed is the number of fires—and their intensity.

"We used to talk about 'fire season,'" Hokanson told a gaggle of journalists at the Pentagon on July 29 as fires raged in Oregon and California. "It's really a 'fire year' now. Fires really almost go year round."

National Guard Surging to Louisiana for Hurricane Relief, California to Combat Fires

Military.com

Trees burn within eyesight of a California National Guard hand crew with Joint Task Force 578 during the Dixie Fire, Aug. 16, 2021, in Northern California. (U.S. Army National Guard photo by 1st Sgt. Harley Ramirez)

MSMR
MEDICAL SURVEILLANCE MONTHLY REPORT

Update: Heat Illness, Active Component, U.S. Armed Forces, 2020

In 2020, there were 475 incident cases of heat stroke and 1,667 incident cases of heat exhaustion among active component service members. The overall crude incidence rates of heat stroke and heat exhaustion were 0.36 cases and 1.26 cases per 1,000 person-years; both were the lowest annual rates in the 2016-2020 surveillance period. In 2020, subgroup-specific rates of both incident heat stroke and heat exhaustion were highest among males, those less than 20 years old, Asian/Pacific Islanders, Marine Corps and Army members, recruit trainees, and those in combat-specific occupations. During 2016–2020, a total of 341 heat illnesses were documented among service members in Iraq and Afghanistan; 7.0% (n=24) were diagnosed as heat stroke. Commanders, small unit leaders, training cadre, and supporting medical personnel must ensure that the military members whom they supervise and support are informed about the risks, preventive countermeasures, early signs and symptoms, and first-responder actions related to heat illnesses.

WHAT ARE THE NEW FINDINGS?

During 2016–2020, annual rates of both heat stroke and heat exhaustion among active component service members peaked in 2018 but were the lowest in 2020. The annual numbers of heat illnesses diagnosed in Iraq and Afghanistan have trended downward since 2016.

WHAT IS THE IMPACT ON READINESS AND FORCE HEALTH PROTECTION?

This analysis demonstrates again the magnitude of risks of heat illnesses among active component service members and the enhanced risks associated with sex age, location of assignment, and occupational categories. Recognition of these risk factors should inform the preventive measures that military leaders, trainers, and service members routinely employ.

What happens if the unavoidable becomes the unmanageable?

Will We Recognize That Point?

npr

ENVIRONMENT

Both of the planet's poles experience extreme heat, and Antarctica breaks records

March 19, 2022 • Parts of Antarctica were more than 70 degrees warmer than average, and areas of the Arctic saw temperatures that were more than 50 degrees warmer than average.

David Goldman/AP

ScienceNews
INDEPENDENT JOURNALISM SINCE 1921

NEWS CLIMATE

Smoke from Australia's intense fires in 2019 and 2020 damaged the ozone layer

Increasingly large blazes threaten to undo decades of work to help Earth's protective layer

A towering cloud of smoke rises over the Green Wattle Creek bushfire on December 21, 2019, near the township of Yanderra in New South Wales, Australia.
HELITAK430/WIKIMEDIA COMMONS (CC BY-SA 4.0)

The Guardian

US west 'megadrought' is worst in at least 1,200 years, new study says

Human-caused climate change significant driver of destructive conditions as even drier decades lie ahead, researchers say

Houseboats are moored on Lake Oroville reservoir during the California drought emergency in Oroville, California, on 25 May 2021. Photograph: Patrick T Fallon/AFP/Getty Images

The Problem of Overshoot

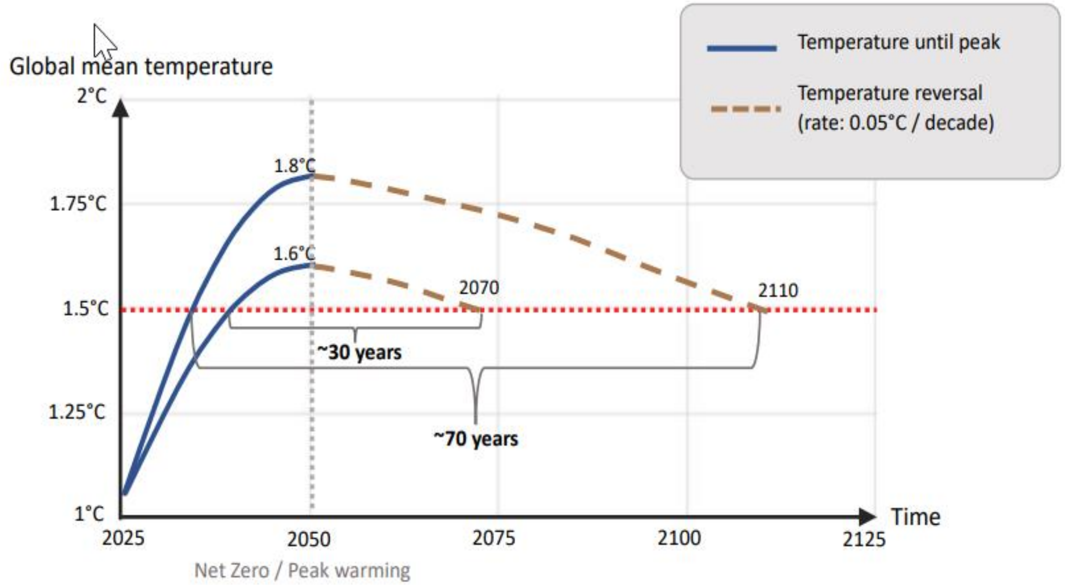


Figure 3: Illustration of the interdependency of overshoot magnitude and overshoot length. Best estimate pace for temperature reductions with high CDR deployment is from Rogelj et al., 2019.

Climate Analytics (2021). The science of temperature overshoots

Climate Report Rebukes Overshoot Plans with "Irreversible Consequences"

Many pathways to stopping climate change involve overshooting 1.5°C temporarily. The latest synthesis of 34,000 references says that's a bad idea.

By Jenessa Duncombe 28 February 2022

Eos Science News by AGU

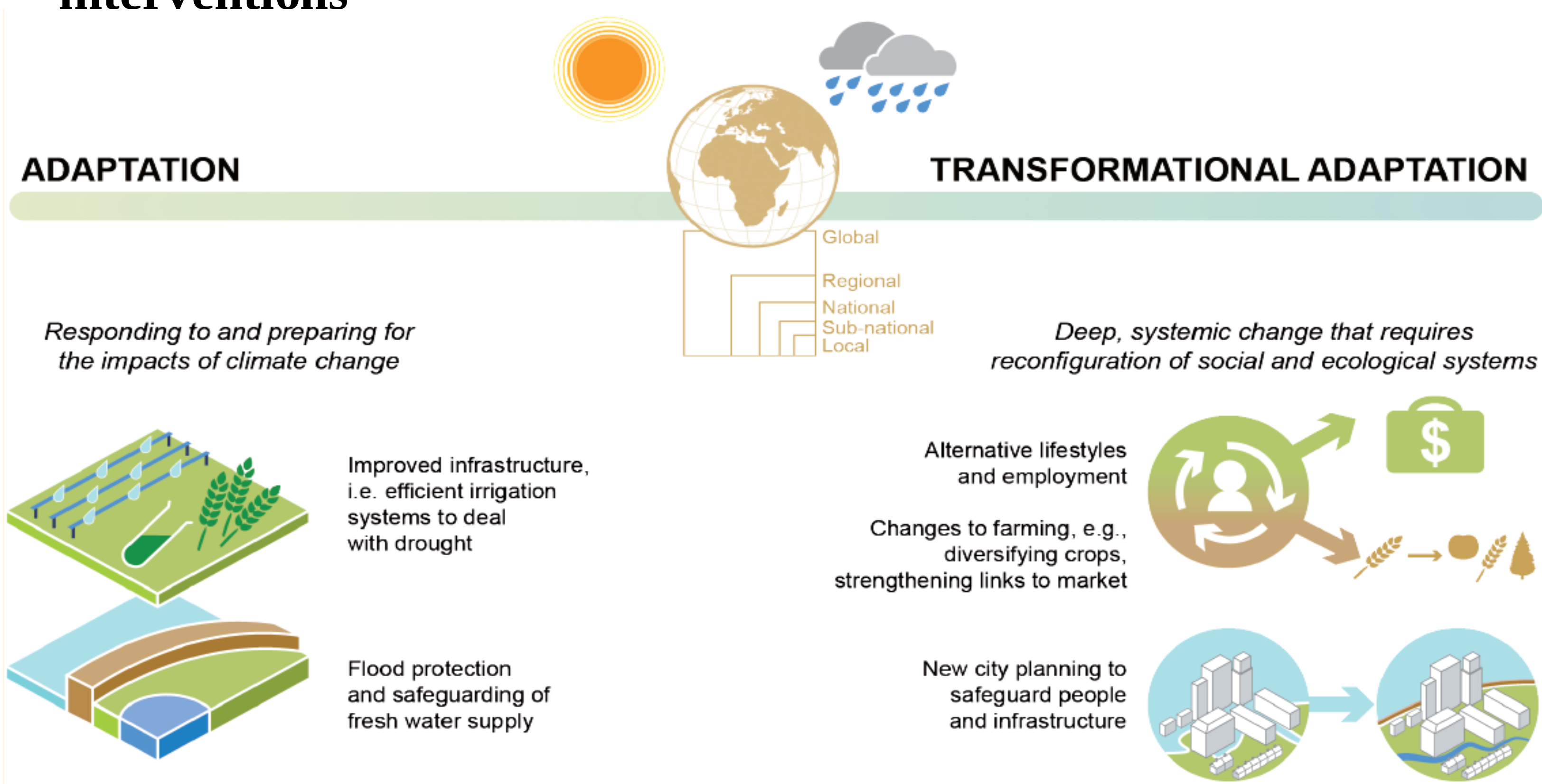
"Pursing the **stringent mitigation** as outlined in "as likely as not" (33-66% likelihood) 1.5°C pathways would lead to a small or even no overshoot. "

"Whether it is feasible or desirable to reduce temperatures after peak warming is reached – at what pace and with what tools – will be a decision that will depend on the magnitude of peak warming and available CDR options."

"The **potential reversibility of global mean temperature does not mean that the impacts of climate change can be reversed**."

Implications of Overshoot on Adaptation

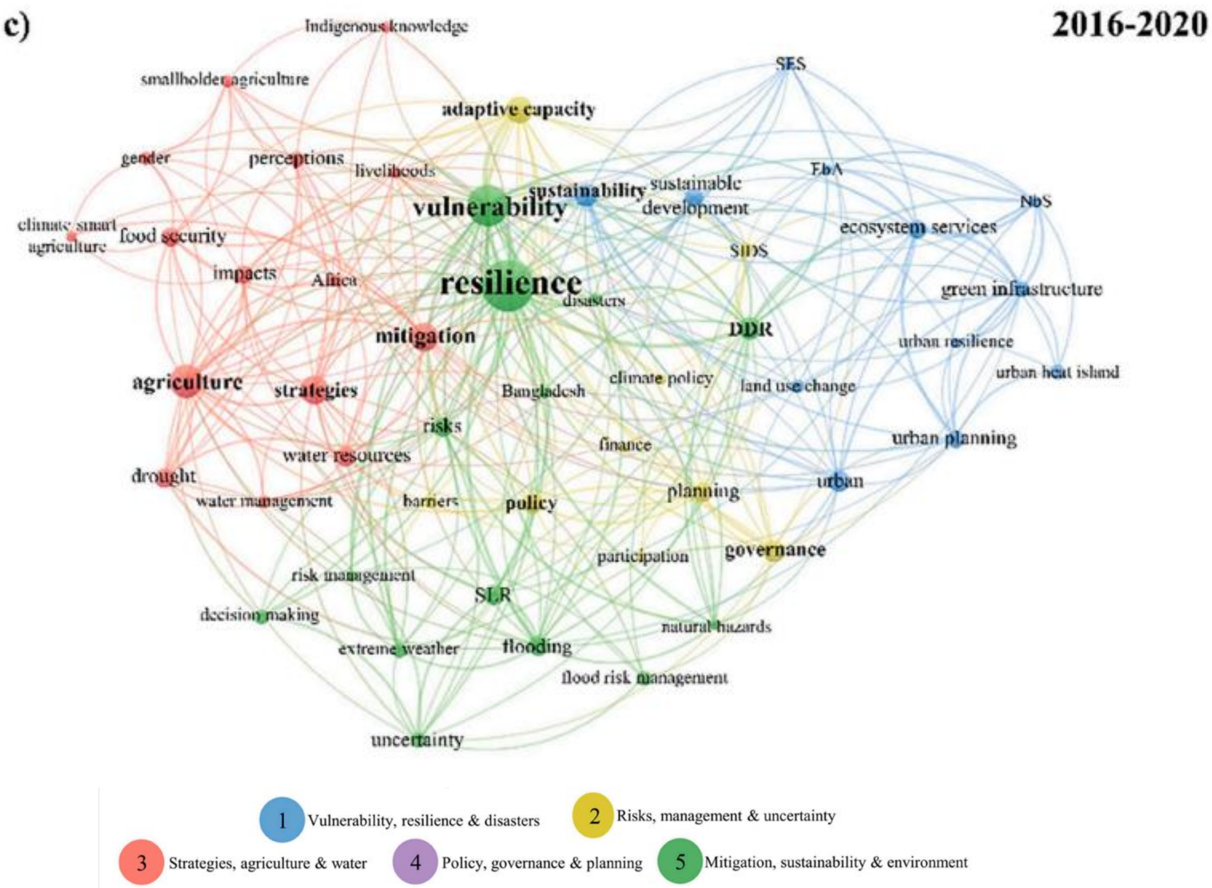
- **Adds pressure to already difficult adaptation decisions**
- **Pushes adaptation more toward transformational adaptation than incremental adaptation**
- **Requires continuum of small to large, short-term to long-term interventions**



IPCC 2018

Opportunities for Novel Approaches

"…literature is still heavily dominated by developed countries… pressing need to increase especially developing country contributions to this vast literature so that it adequately reflects the diversity of climate adaptation insights and experiences."



Climate Risk Management 32 (2021) 100290

Contents lists available at ScienceDirect

Climate Risk Management

journal homepage: www.elsevier.com/locate/crm

Mapping the evolution and current trends in climate change adaptation science

Johanna Nalau [a,*,1], Brodie Verrall [b,1]

[a] Adaptation Science Research Group, Cities Research Institute and School of Environment and Science, Griffith University, Queensland, Australia
[b] Environment Futures Research Institute and School of Environment and Science, Griffith University, Queensland, Australia

ARTICLE INFO

Keywords:
Climate change adaptation
Adaptation theory
Climate adaptation science
Multicomponent bibliometric analysis
VOSviewer

ABSTRACT

Research on climate change adaptation has increased in number and significance since the 1970s. Yet, the volume of information on adaptation is now difficult to manage given its vast scope and spread across journals, institutions, disciplines and themes. While an increasing number of researchers have used systematic literature reviews to analyse particular themes within this rapidly growing field of research, there is still missing an overall analysis of the current state of climate change adaptation science literature and its evolution. This paper fills this gap by providing a multifaceted bibliometric review of climate change adaptation science literature that is focused on the human dimensions and how it has been constructed across time, disciplines, social relationships and geographies. Our novel review, spanning from 1978 to mid-2020, identifies the underpinning foundations of climate change adaptation literature, leading authors, countries and organisations as well as dominant research themes and priorities and explores how these have changed over time. Our results show an annual average increase of 28.5% in climate change adaptation publications, with over 26,000 authors publishing on this topic, and increasing diversity in publishing sources. Priority research topics and themes have been dynamic over time, while some core concepts (vulnerability, resilience, adaptive capacity) and sectors (water, agriculture) have remained relatively stable. The key challenge going forward is how to consolidate this vast research endeavour into a more coherent adaptation theory that in turn can better guide science of adaptation and support adaptation policy and practice (science for adaptation).

1. Introduction

Over the last two decades climate change adaptation has emerged as a central and now acknowledged component of the international climate change policy and research agenda (Klein et al., 2014; Owen, 2020; Swart et al., 2014). The Paris Agreement and its Article 7 have secured a prominent platform for climate adaptation as a key issue for global governance (Persson, 2019). Adaptation received its own ISO standard [ISO 14090] in 2019, cementing it further as a distinct area of research, policy and practice. Specific climate change adaptation conferences, such as the *Adaptation Futures* series, have been running since 2010 and new scientific degrees and professional certifications are being developed specifically for climate adaptation. That climate change adaptation literature is flourishing is evidenced also by the rapid expansion of the number of publications with a focus on climate adaptation (Di Matteo et al.,

* Corresponding author.
E-mail address: j.nalau@griffith.edu.au (J. Nalau).

[1] These authors contributed equally to this work.

https://doi.org/10.1016/j.crm.2021.100290
Received 21 August 2020; Received in revised form 19 February 2021; Accepted 19 February 2021
Available online 25 February 2021

Carefully Evaluate Heuristics

- Heuristics: from Nalau et al 2021:
  - Heuristics "**steer and inform** research priorities, policy debates, and funding agency guidelines and may cause increased burdens on certain actors or misdirect resources."
  - In the event of "untested decision-making heuristics **may be both costly and risky**… **Not challenging embedded assumptions** can steer us towards particular policy pathways even when they are not optimal.
  - "when they get embedded into decision-making and **become unchallenged 'expert knowledge**' within an organisation or institution."


Climate Risk Management 32 (2021) 100292

Contents lists available at ScienceDirect

Climate Risk Management

journal homepage: www.elsevier.com/locate/crm

A critical exploration of adaptation heuristics

Johanna Nalau [a,*], Elnaz Torabi [a], Naomi Edwards [b], Michael Howes [a], Ed Morgan [a]

[a] Adaptation Science Research Group, Cities Research Institute and School of Environment and Science, Griffith University, Queensland, Australia
[b] Griffith Centre for Social and Cultural Research, School of Humanities, Languages and Social Science, Australia

ARTICLE INFO

Keywords:
Climate change adaptation
Adaptation theory
Adaptation heuristics
Decision-making
Australia

ABSTRACT

A large body of knowledge has been evolving to guide efforts in how we adapt to climate change. This knowledge is underpinned by a set of standardised rules of thumb (heuristics) that define what climate adaptation is and what it means. For example, it is widely accepted that adaptation is a local issue that is best achieved by urgent anticipatory action by using participatory processes. Yet, the validity and relevance of these heuristics have rarely been tested or questioned. If these heuristics are not based on sound empirical evidence, their inclusion and use in scientific studies, policy development, planning and implementation processes can generate inappropriate solutions for highly complex problems. This research critically examines and tests a set of common climate adaptation heuristics and investigates the extent to which they correspond to with the lived experiences of practitioners who are engaged in climate adaptation planning in Queensland, Australia. The findings provide new insights into the applicability of adaptation heuristics, and point to several new rules of thumb that underpin climate adaptation in practice. For example, adaptation was mainly seen as a regional/transboundary issue with broader stakeholder involvement that is best pursued through an incremental 'learn-as-we-go' approach. Retaining flexibility in the policy- and decision-making systems was preferred as were no-regret, value- and risk-based approaches. Future research is needed to explore further the different types of heuristics and how these best support adaptation science, policy, planning and decision-making processes.

1. Introduction

Each science and policy domain has its own rules that guide the choices and decisions that scientists and/or practitioners make in a particular field (Hey, 2016; Preston et al., 2015a; Ravetz, 1972). These rules of thumb (herein heuristics) are mental shortcuts that enable more rapid decisions on policy/project design, development and implementation, and directly impact on which methods or implementation strategies are seen as legitimate. As Crandall et al. (2006, p. 41) note: "what practitioners know and believe about their domain – rightly or wrongly – is critical to their decision-making". Yet, we know surprisingly little about how such heuristics develop and evolve in different domains and the extent that these correspond with the practical realities of decision-making and planning.

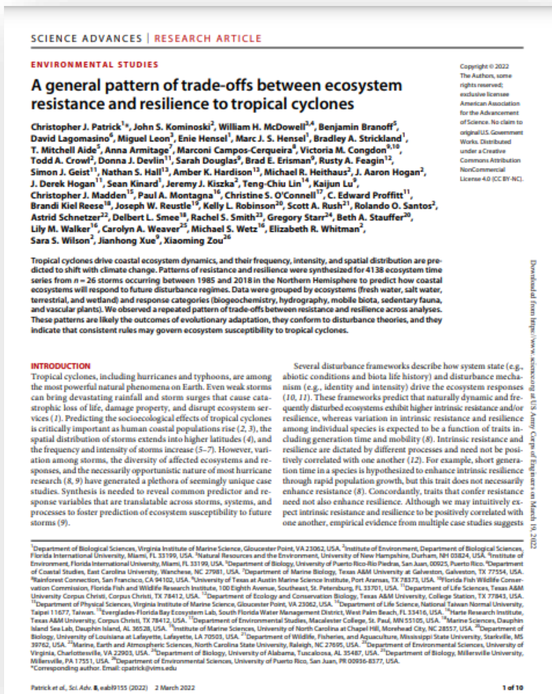
Heuristics consist of the collective experiences and knowledge within a particular domain, complemented by lived experiences and insights (Crandall et al., 2006; Klein, 2004). Such rules of thumb, if sound, are often useful in assisting decision-making processes for highly complex problems (Artinger et al., 2015). They become problematic when they are not supported by evidence but are still widely used to justify particular policy positions or funding decisions (King and Pucker, 2020; Leach et al., 1997). Furthermore, once

* Corresponding author.
E-mail address: j.nalau@griffith.edu.au (J. Nalau).

https://doi.org/10.1016/j.crm.2021.100292
Received 16 September 2020; Received in revised form 28 February 2021; Accepted 1 March 2021
Available online 17 March 2021

Explore Resistance-Resilience Tradeoff

- **How best to identify adaptation measures suited to different climate hazards**


SCIENCE ADVANCES | RESEARCH ARTICLE

ENVIRONMENTAL STUDIES

A general pattern of trade-offs between ecosystem resistance and resilience to tropical cyclones

Christopher J. Patrick[1]*, John S. Kominoski[2], William H. McDowell[3,4], Benjamin Branoff[5], David Lagomasino[6], Miguel Leon[3], Enie Hensel[1], Marc J. S. Hensel[1], Bradley A. Strickland[1], T. Mitchell Aide[5], Anna Armitage[7], Marconi Campos-Cerqueira[8], Victoria M. Congdon[9,10], Todd A. Crowl[2], Donna J. Devlin[11], Sarah Douglas[9], Brad E. Erisman[9], Rusty A. Feagin[12], Simon J. Geist[11], Nathan S. Hall[13], Amber K. Hardison[13], Michael R. Heithaus[2], J. Aaron Hogan[2], J. Derek Hogan[11], Sean Kinard[1], Jeremy J. Kiszka[2], Teng-Chiu Lin[14], Kaijun Lu[9], Christopher J. Madden[15], Paul A. Montagna[16], Christine S. O'Connell[17], C. Edward Proffitt[11], Brandi Kiel Reese[18], Joseph W. Reustle[19], Kelly L. Robinson[20], Scott A. Rush[21], Rolando O. Santos[2], Astrid Schnetzer[22], Delbert L. Smee[18], Rachel S. Smith[23], Gregory Starr[24], Beth A. Stauffer[20], Lily M. Walker[16], Carolyn A. Weaver[25], Michael S. Wetz[16], Elizabeth R. Whitman[2], Sara S. Wilson[2], Jianhong Xue[9], Xiaoming Zou[26]

Tropical cyclones drive coastal ecosystem dynamics, and their frequency, intensity, and spatial distribution are predicted to shift with climate change. Patterns of resistance and resilience were synthesized for 4138 ecosystem time series from $n = 26$ storms occurring between 1985 and 2018 in the Northern Hemisphere to predict how coastal ecosystems will respond to future disturbance regimes. Data were grouped by ecosystems (fresh water, salt water, terrestrial, and wetland) and response categories (biogeochemistry, hydrography, mobile biota, sedentary fauna, and vascular plants). We observed a repeated pattern of trade-offs between resistance and resilience across analyses. These patterns are likely the outcomes of evolutionary adaptation, they conform to disturbance theories, and they indicate that consistent rules may govern ecosystem susceptibility to tropical cyclones.

INTRODUCTION

Tropical cyclones, including hurricanes and typhoons, are among the most powerful natural phenomena on Earth. Even weak storms can bring devastating rainfall and storm surges that cause catastrophic loss of life, damage property, and disrupt ecosystem services (*1*). Predicting the socioecological effects of tropical cyclones is critically important as human coastal populations rise (*2*, *3*), the spatial distribution of storms extends into higher latitudes (*4*), and the frequency and intensity of storms increase (*5*–*7*). However, variation among storms, the diversity of affected ecosystems and responses, and the necessarily opportunistic nature of most hurricane research (*8*, *9*) have generated a plethora of seemingly unique case studies. Synthesis is needed to reveal common predictor and response variables that are translatable across storms, systems, and processes to foster prediction of ecosystem susceptibility to future storms (*9*).

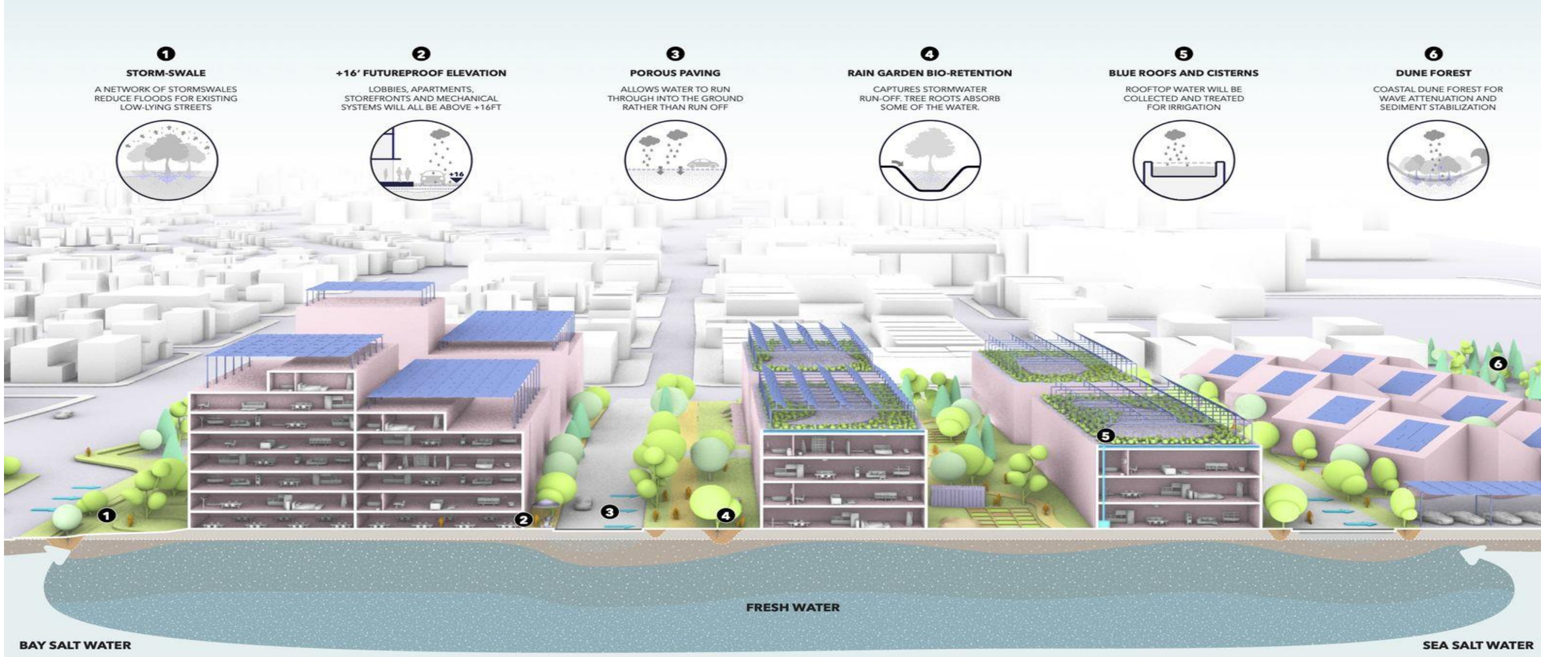
Several disturbance frameworks describe how system state (e.g., abiotic conditions and biota life history) and disturbance mechanism (e.g., identity and intensity) drive the ecosystem responses (*10*, *11*). These frameworks predict that naturally dynamic and frequently disturbed ecosystems exhibit higher intrinsic resistance and/or resilience, whereas variation in intrinsic resistance and resilience among individual species is expected to be a function of traits including generation time and mobility (*8*). Intrinsic resistance and resilience are dictated by different processes and need not be positively correlated with one another (*12*). For example, short generation time in a species is hypothesized to enhance intrinsic resilience through rapid population growth, but this trait does not necessarily enhance resistance (*8*). Concordantly, traits that confer resistance need not also enhance resilience. Although we may intuitively expect intrinsic resistance and resilience to be positively correlated with one another, empirical evidence from multiple case studies suggests

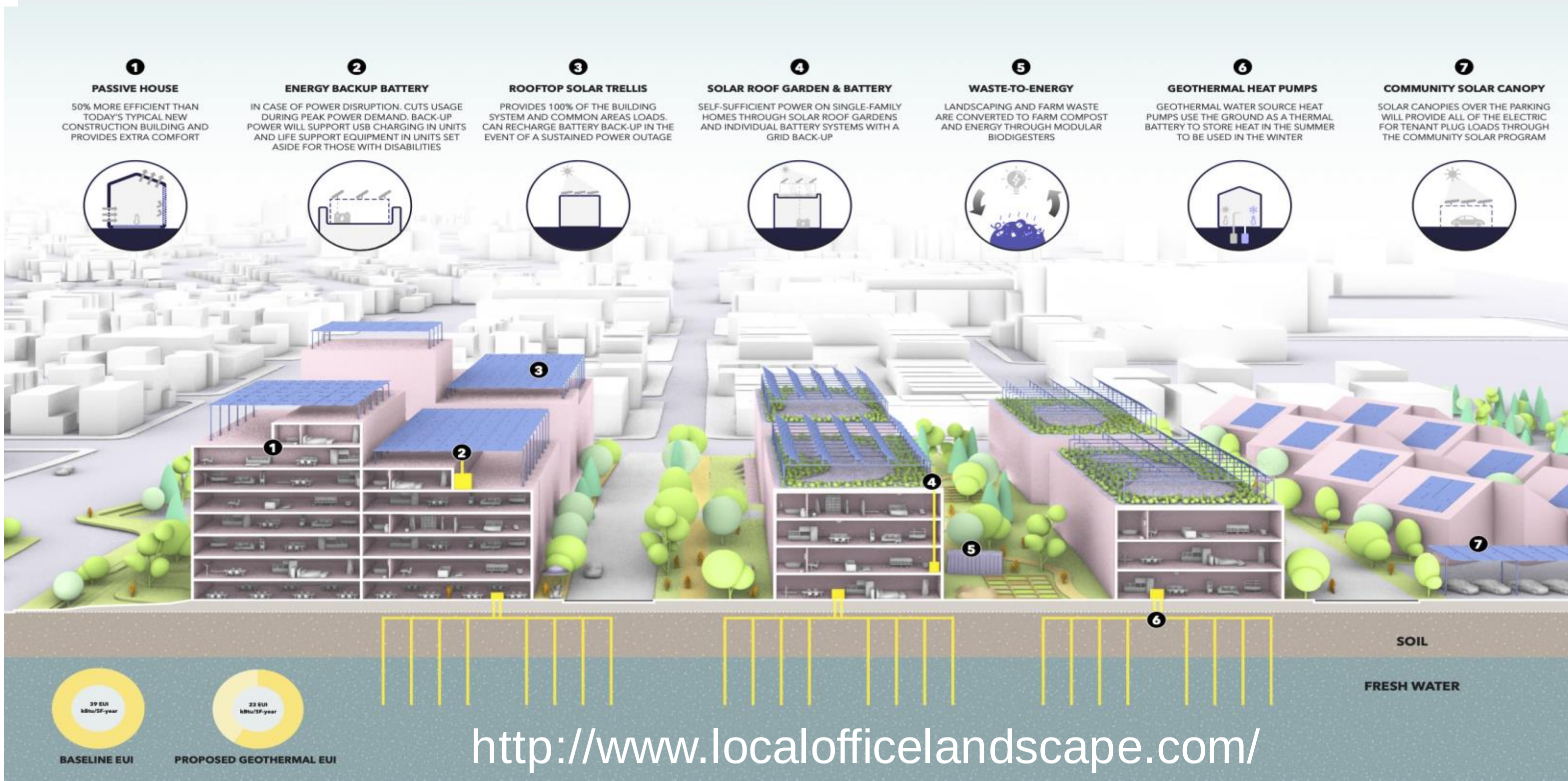
"For example, in a predictable climate with very little disturbance, **focusing on resistance** to tropical storms — such as encouraging the growth of stronger, larger plants— is generally the better option for restoration.

But with tropical mid-latitude storms becoming stronger and more frequent, coastal land managers might need to consider **an approach based more on resilience** by focusing on plants that grow back quickly following major storms to prevent coastal erosion and preserve water quality."

UNH today 2 March 2022

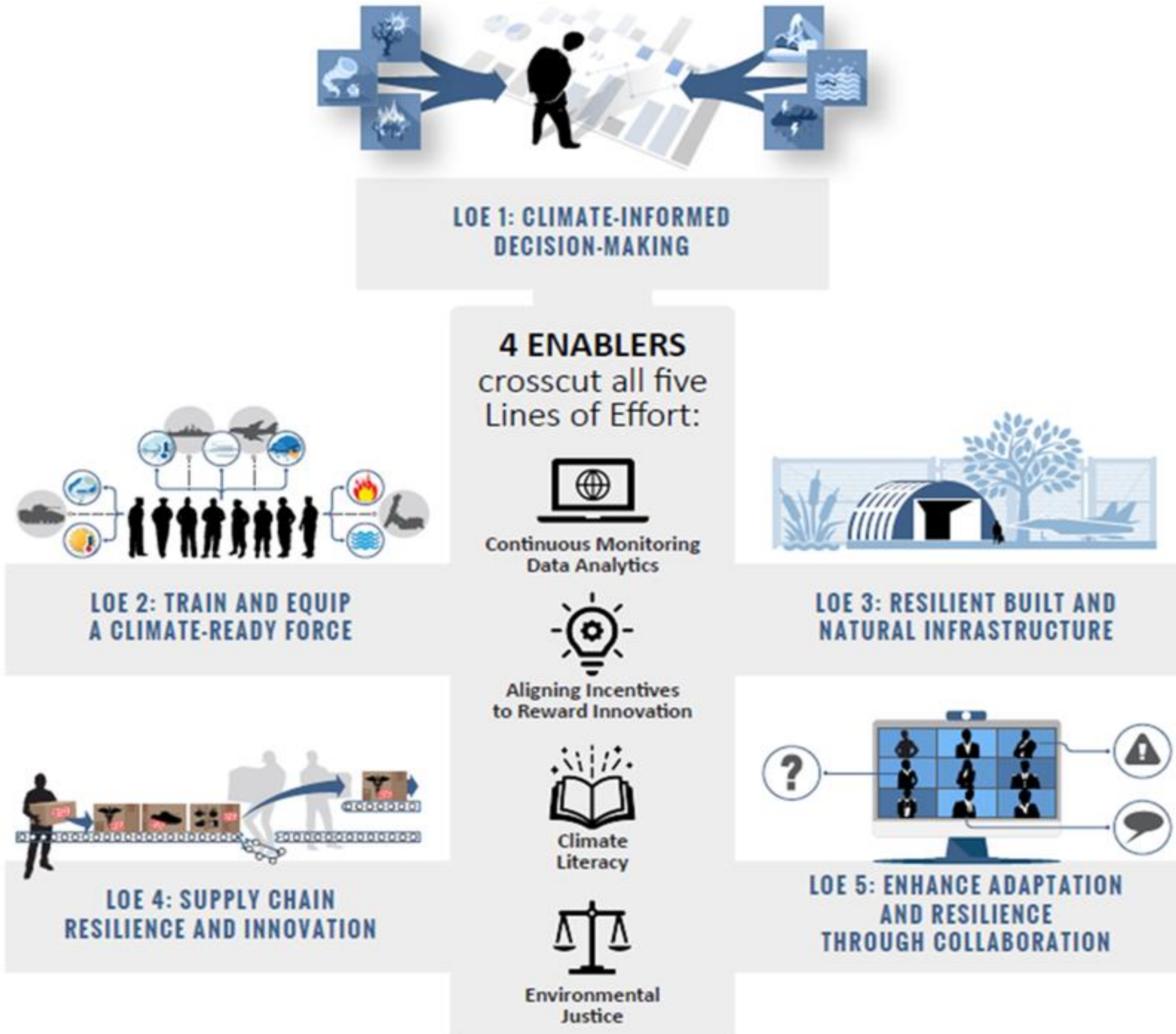
Mitigate While Adapting





http://www.localofficelandscape.com/

5 LINES OF EFFORT (LOEs) reflect the scope and scale of DOD's adaptation and resilience efforts:



END STATE: The above five Lines of Effort and four enablers are to ensure that DOD can operate under changing climate conditions, preserving operational capability and enhancing the natural and man-made systems essential to the Department's success.

Kate White, PhD, PE, Director for Climate Programs
Kathleen.D.White.civ@mail.mil
Office of the Deputy Assistant Secretary of Defense of Environment and Energy Resilience
29 March 2022