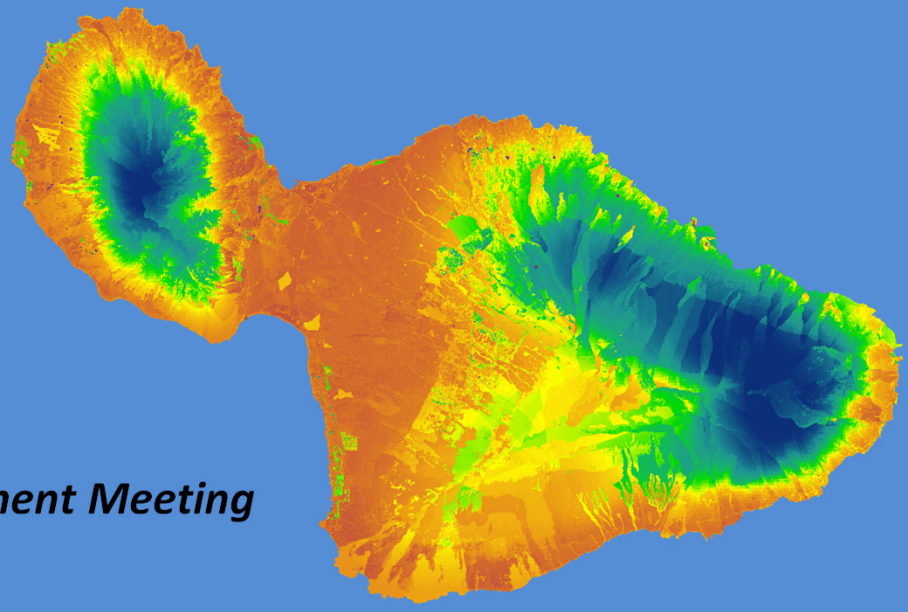
Groundwater Recharge for Projected Future Climate and Stakeholder-Defined Land-Cover Scenarios for the Island of Maui, Hawai‘i



Alan Mair

Pacific Islands Water Science Center

State of Hawai‘i

Commission on Water Resource Management Meeting

November 20, 2019

U.S. Department of the Interior
U.S. Geological Survey

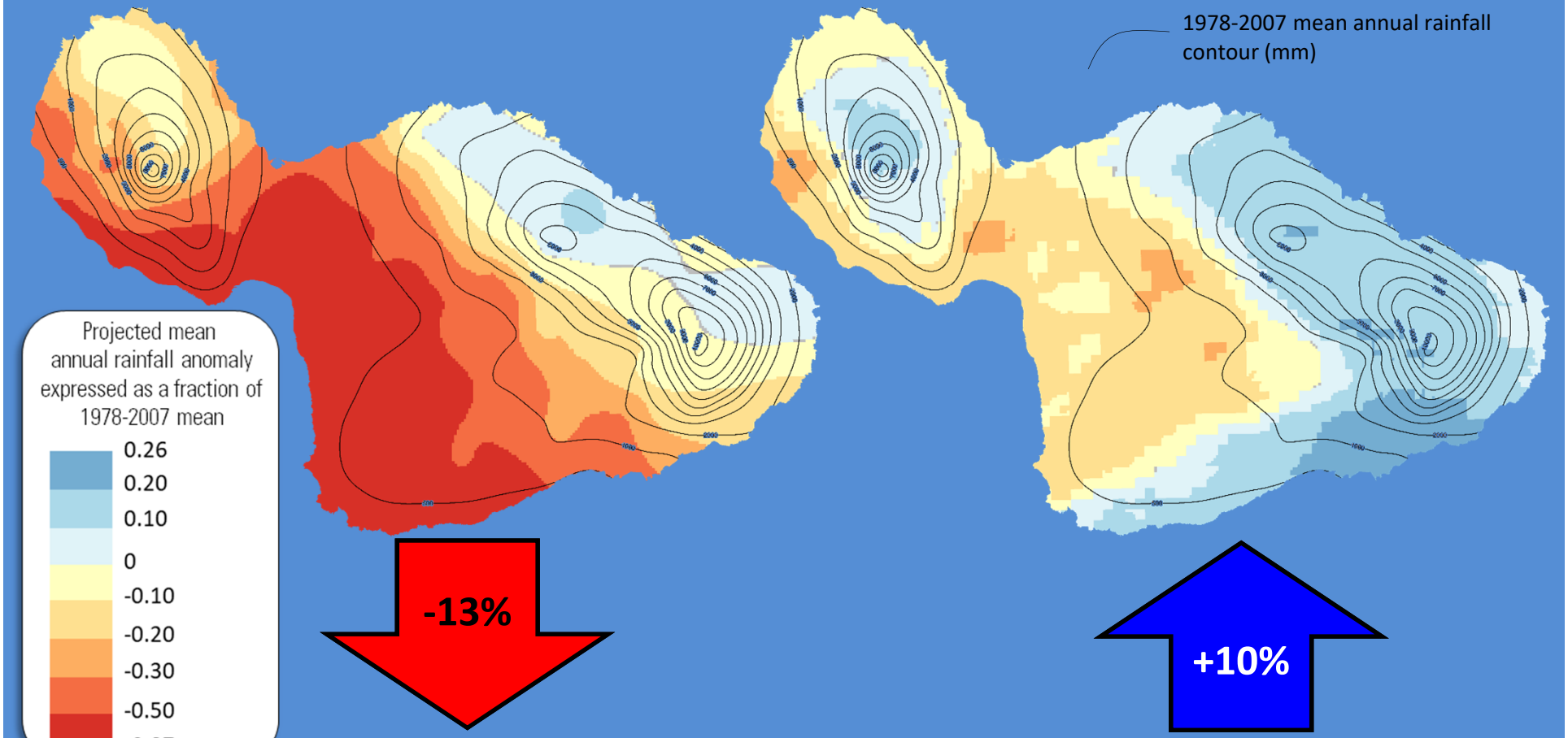
Summary of Water-Budget Model Scenarios

Land-Cover Scenario	Climate Scenario		
	1978-2007	*"Dry Climate" Projection*	*"Wet Climate" Projection*
2017	*1978-2007 Baseline*		
Future 1: Conservation	-	✓	✓
Future 2: Business as Usual	-	✓	✓
Future 3: Development	-	✓	✓
Future 4: Balanced	-	✓	✓

Selected End-of-Century Rainfall Projections by International Pacific Research Center

"Dry Climate" Projection (Statistical Approach)

"Wet Climate" Projection (Dynamical Approach)



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Preliminary Information—Subject to Revision.
Not for Citation or Distribution.

Elison Timm and others (2015),
Giambelluca and others (2013),
Mair and others (2019),
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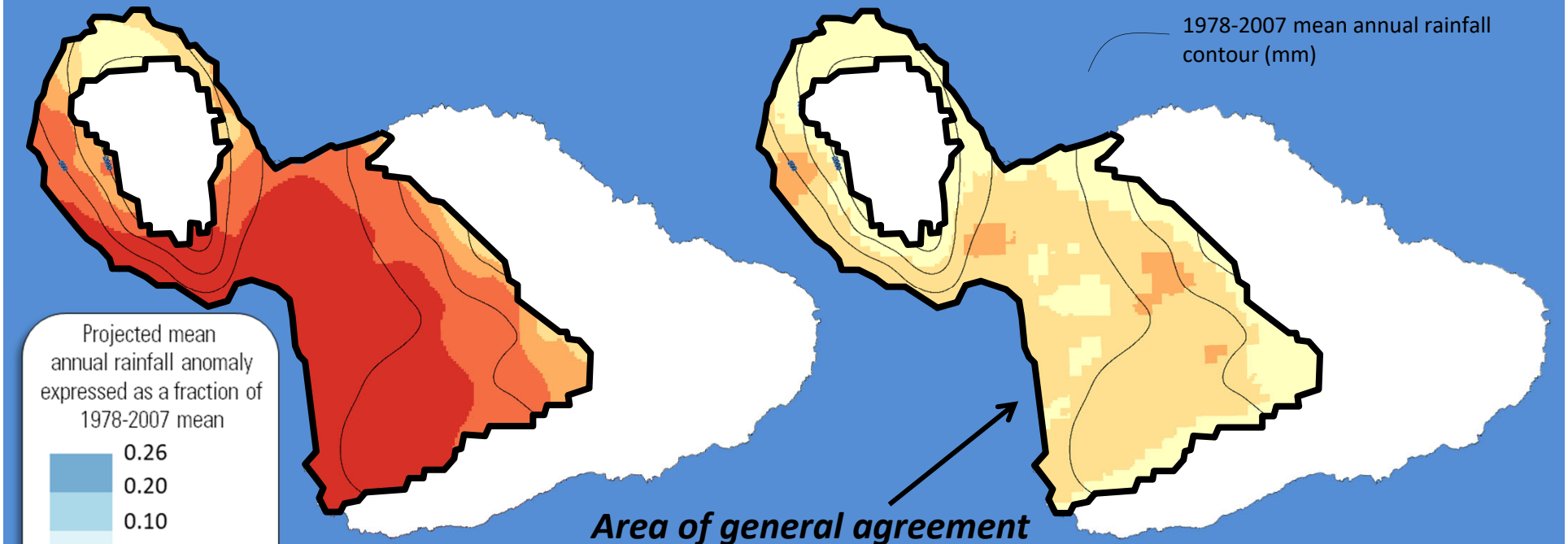

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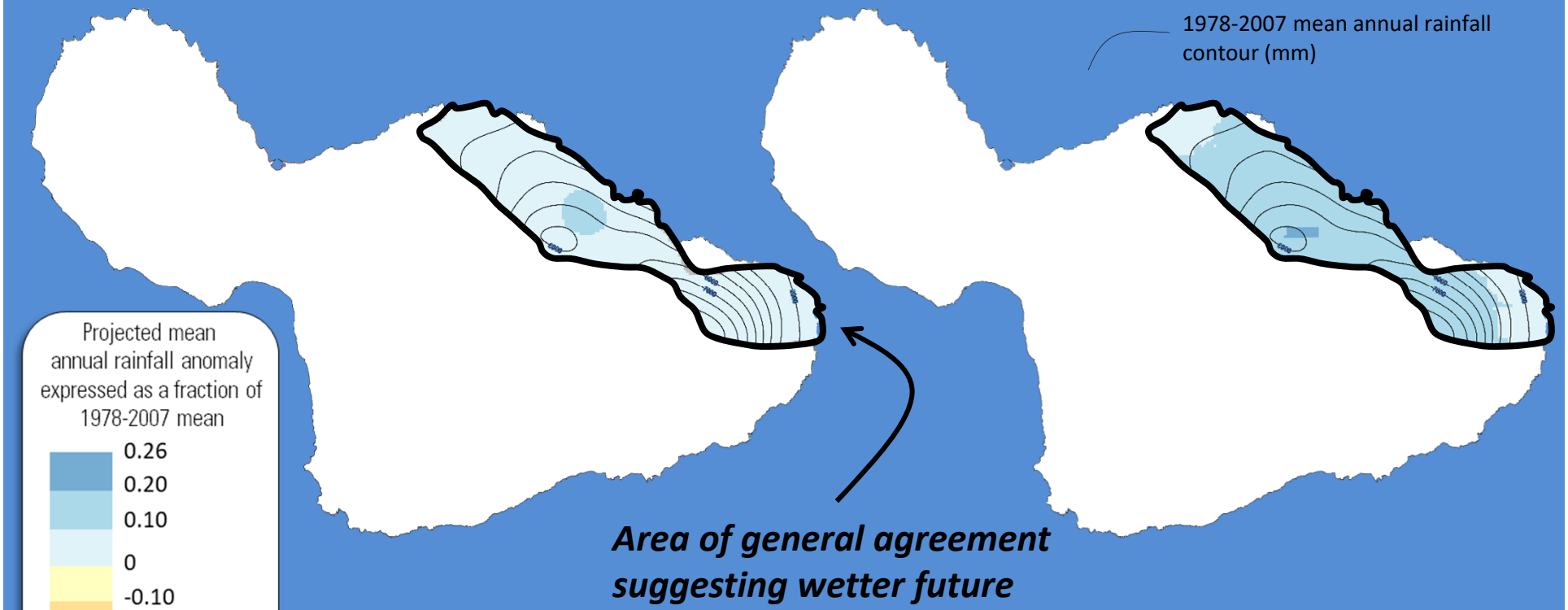

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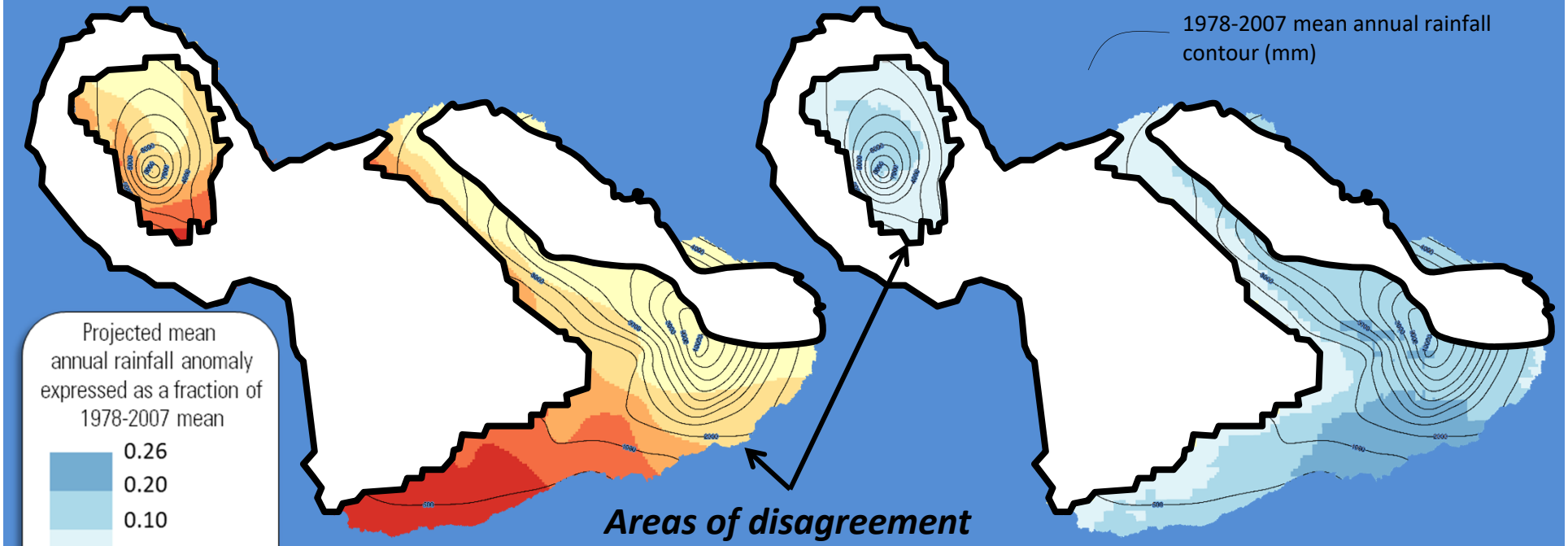

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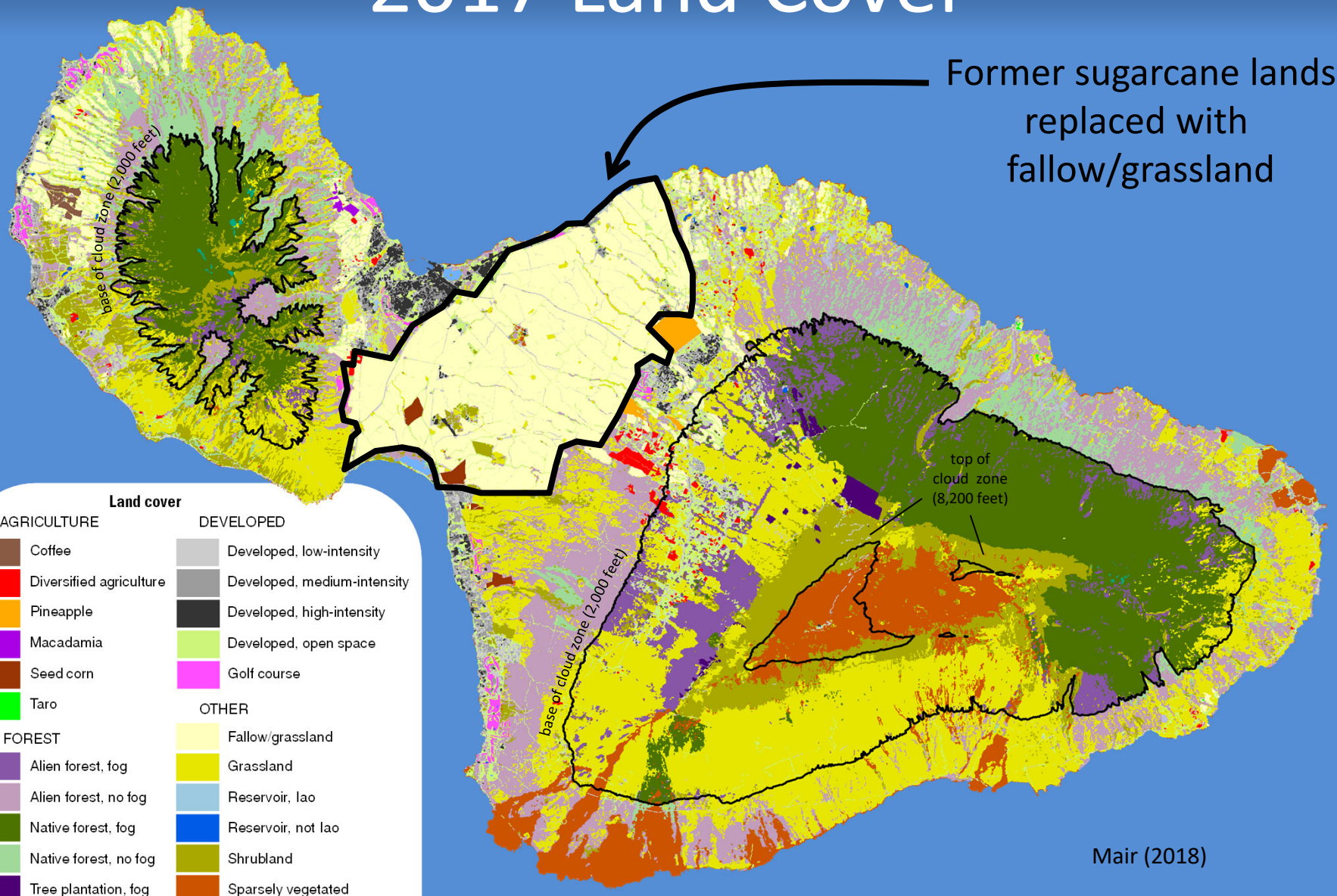
2017 Land Cover



Mair (2018)

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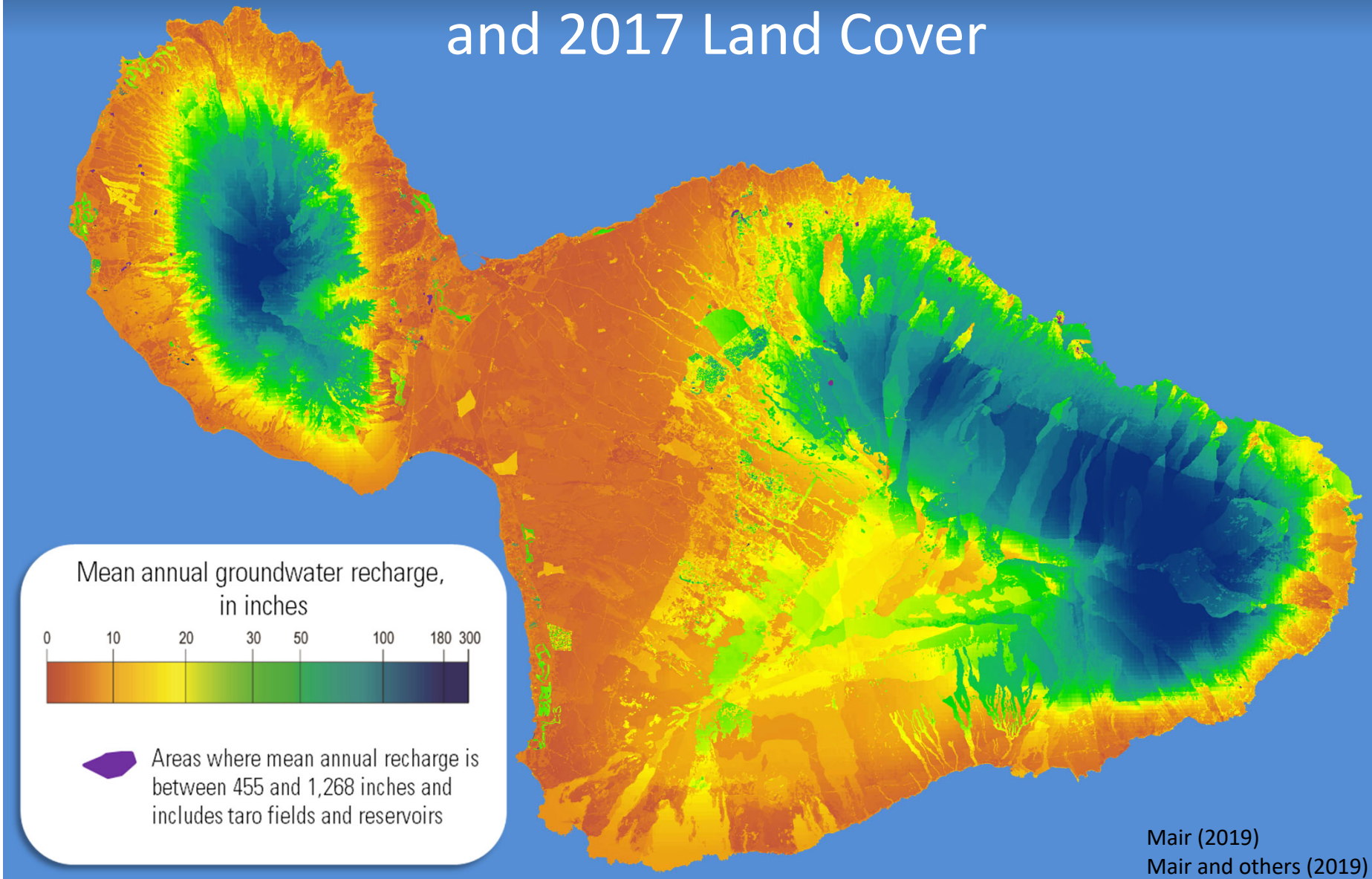
Groundwater Recharge for 1978-2007 Climate and 2017 Land Cover



Mair (2019)
Mair and others (2019)

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Preliminary Information—Subject to Revision.
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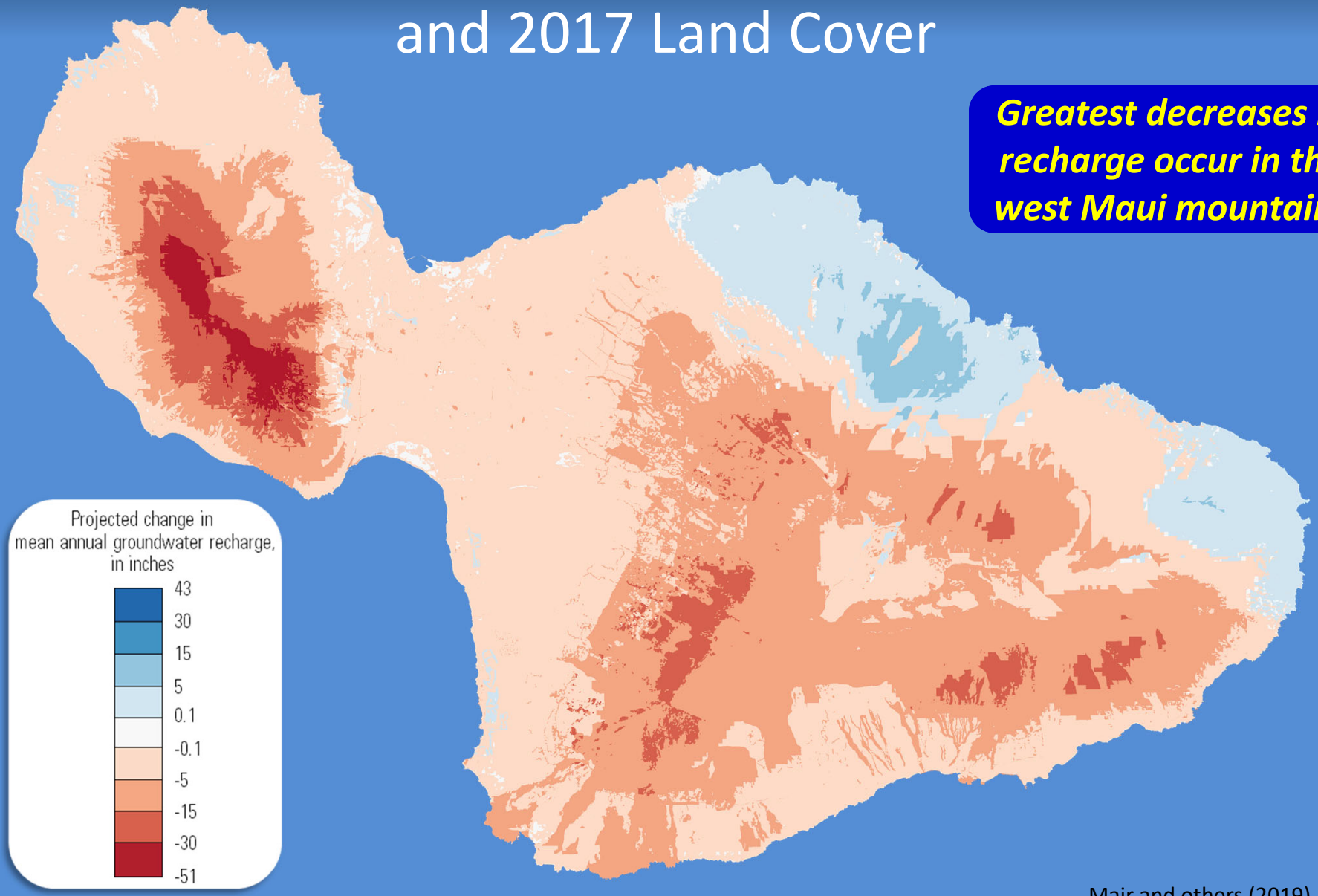
Change in Recharge for "Dry Climate" Projection and 2017 Land Cover

Greatest decreases in recharge occur in the west Maui mountains



Mair and others (2019)

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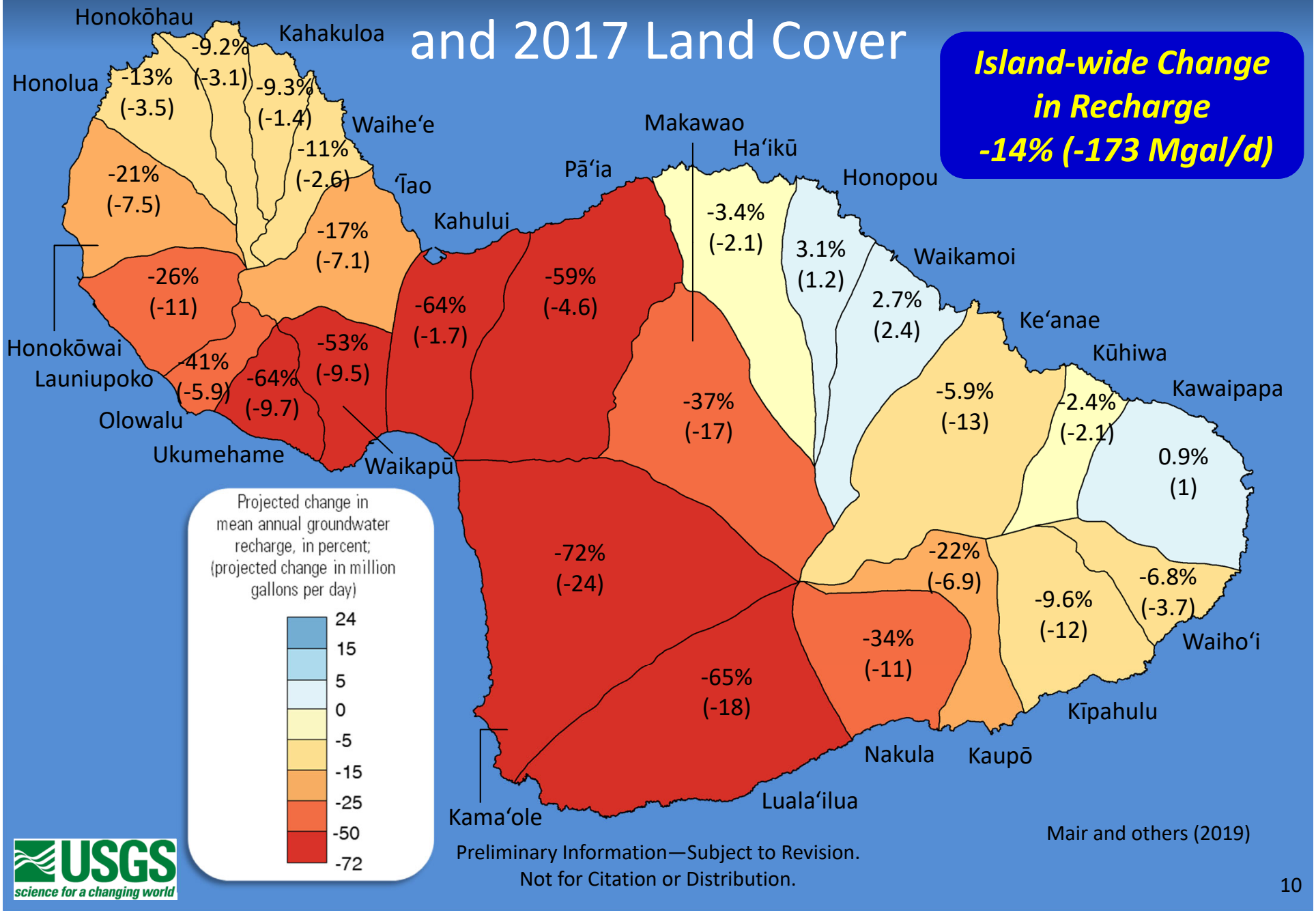
Change in Recharge for "Dry Climate" Projection and 2017 Land Cover



Island-wide Change in Recharge -14% (-173 Mgal/d)

Mair and others (2019)

Preliminary Information—Subject to Revision.
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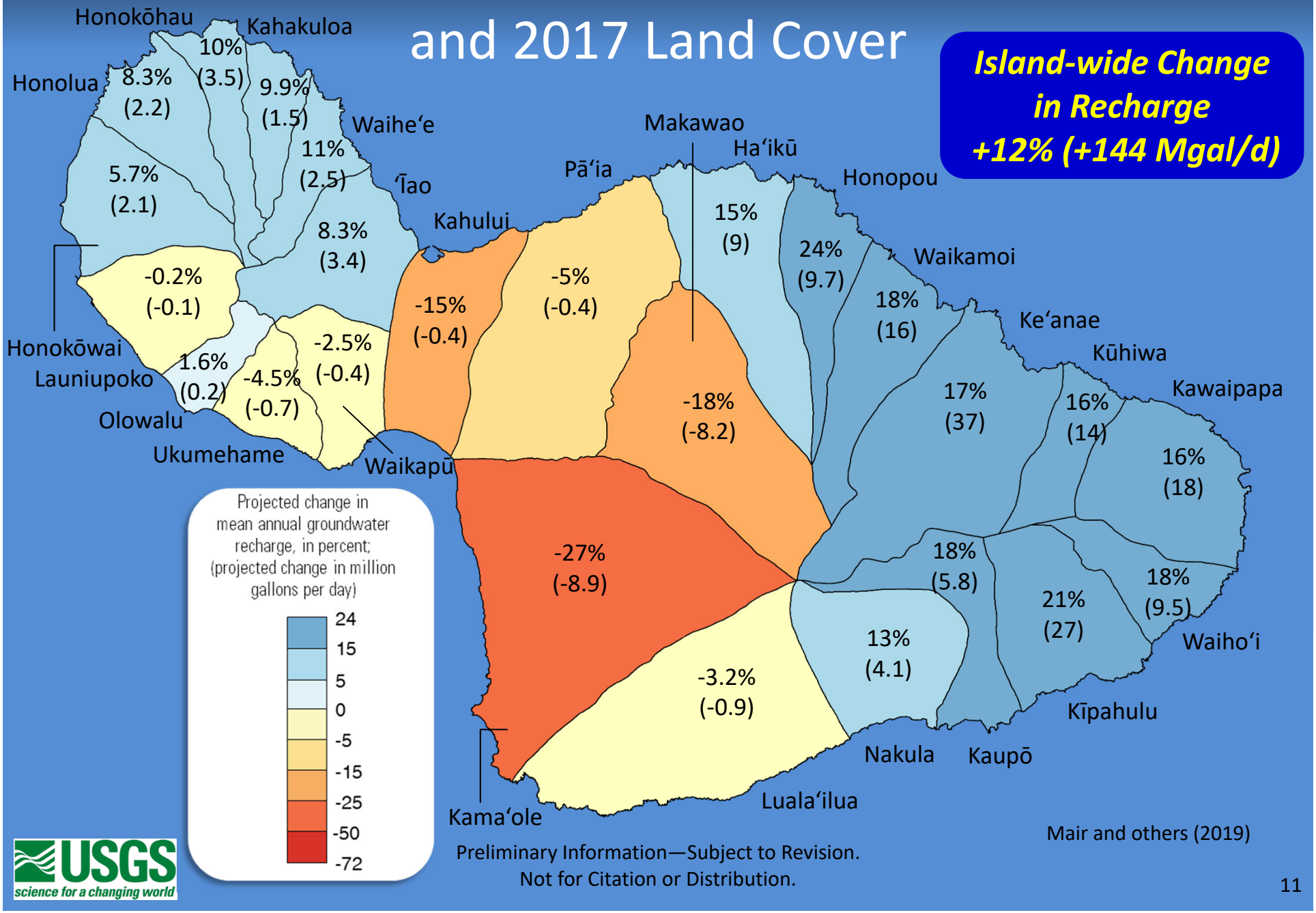
Change in Recharge for "Wet Climate" Projection and 2017 Land Cover



Island-wide Change in Recharge +12% (+144 Mgal/d)

Mair and others (2019)

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Effects of Projected "Dry Climate" and Future Land-Cover Scenarios

Land-Cover Scenario	Climate Scenario		
	1978-2007	*"Dry Climate" Projection*	*"Wet Climate" Projection*
2017	✓	*2017 Baseline*	✓
Future 1: Conservation	-		✓
Future 2: Business as Usual	-		✓
Future 3: Development	-		✓
Future 4: Balanced	-		✓

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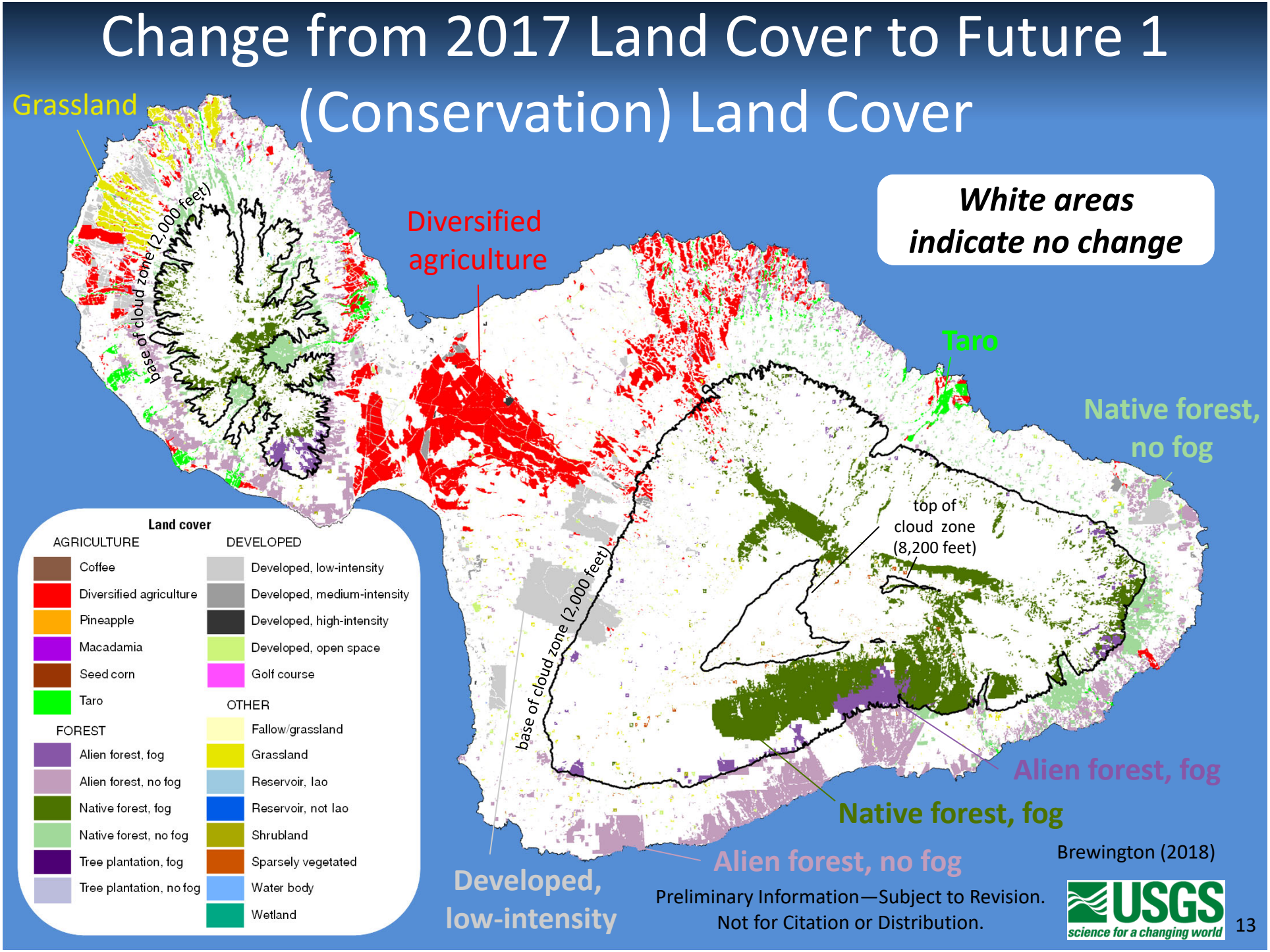
Change from 2017 Land Cover to Future 1 (Conservation) Land Cover



Brewington (2018)

Preliminary Information—Subject to Revision.
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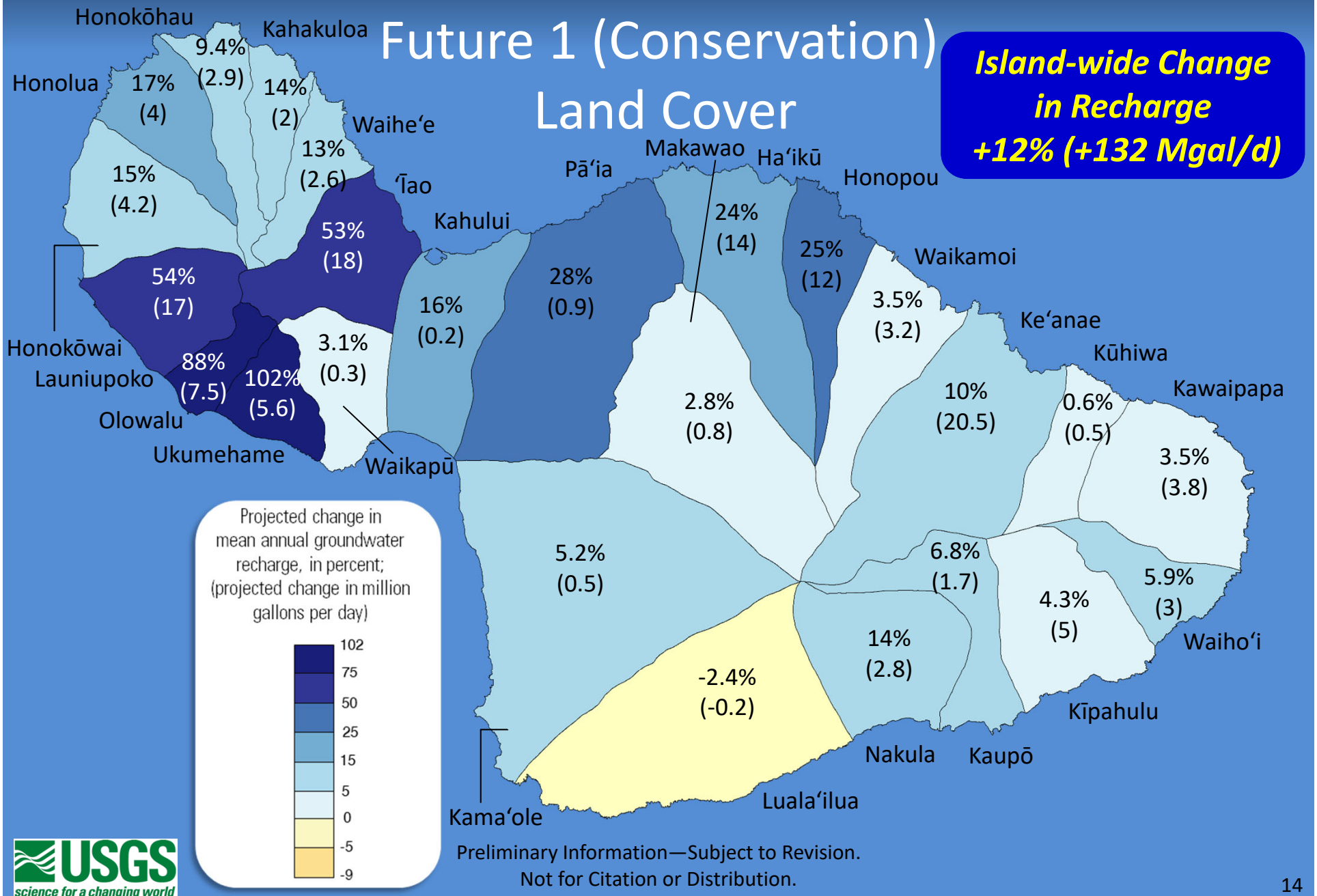
Change in Recharge for "Dry Climate" Projection and Future 1 (Conservation) Land Cover



Island-wide Change in Recharge +12% (+132 Mgal/d)

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Preliminary Information—Subject to Revision.
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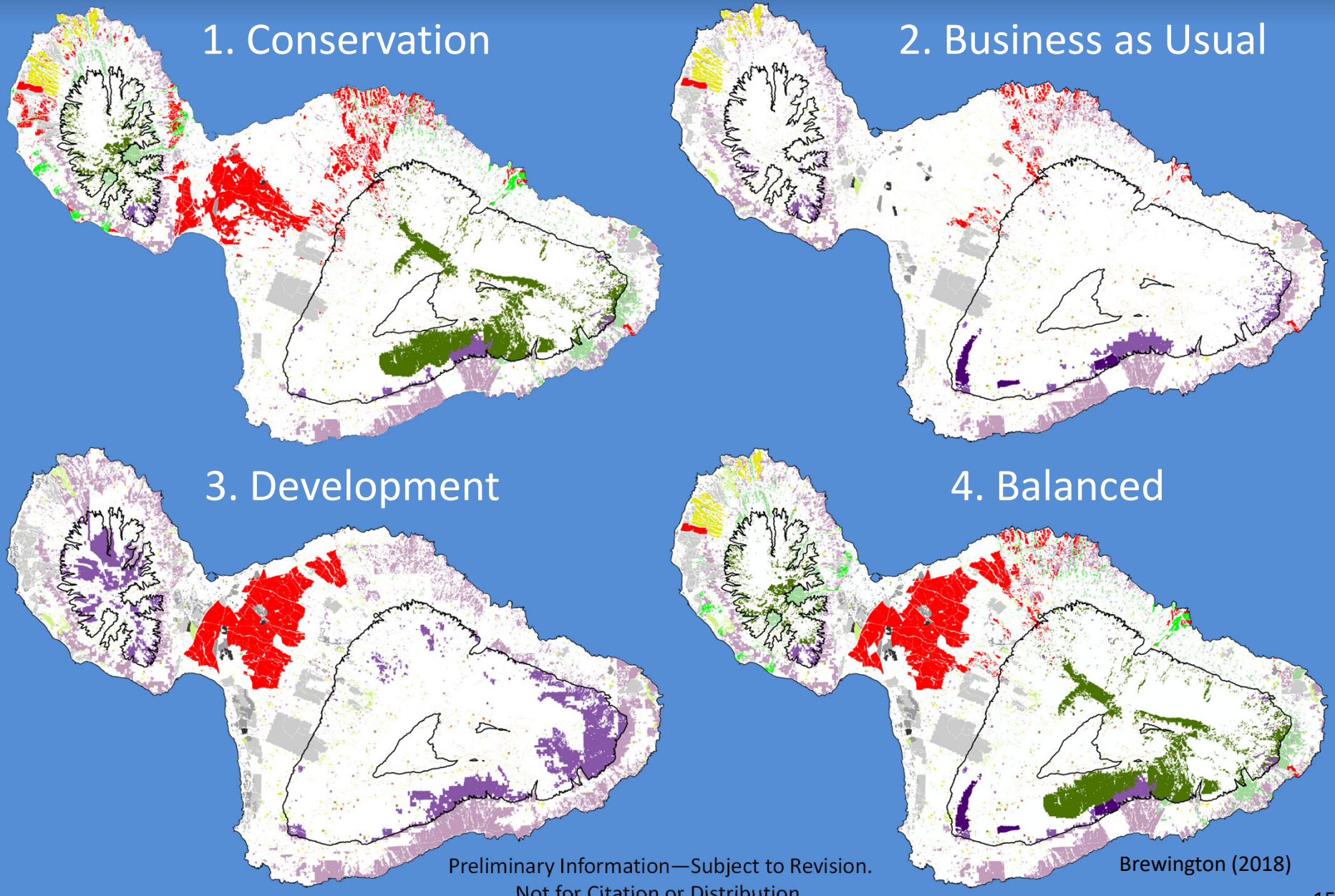
Change from 2017 Land Cover



Preliminary Information—Subject to Revision.
Not for Citation or Distribution.

Brewington (2018)

Water-Budget Components
"Dry Climate" Projection
Difference from 2017 Land-Cover Scenario

Land-Cover Scenario	Fog interception	Irrigation	Evapo-transpiration	Recharge
2017	*153*	*36*	*821*	*1,059*
Future 1: Conservation	*+20*	*+169*	*+65*	*+132*
Future 2: Business as Usual	*+7.5*	*+5.8*	*+5.1*	*+7.7*
Future 3: Development	*+9.2*	*+61*	*+69*	*+0.1*
Future 4: Balanced	*+20*	*+170*	*+79*	*+112*

Mean annual value in million gallons per day

Values for Future 1 to 4 Land-Cover Scenarios reported as difference from 2017 Land-Cover Scenario

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Implications for Water-Resource Management: Effects of Climate

- Both climate projections show drying in central and leeward areas of Maui but the magnitudes of the drying differ
- Large uncertainty in range of impacts will require adaptive management strategies
  - For ʻĪao aquifer system, estimated changes to recharge vary from a **decrease** of 17% to an **increase** of 8%
  - For Waiheʻe aquifer system, estimated changes to recharge vary from a **decrease** of 11% to an **increase** of 11%

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Implications for Water-Resource Management: Effects of Land Cover

- Land-management strategies may partially offset the effects of a drying climate
- Expansion of forested areas in cloud zone can increase fog interception and recharge rates
- Significant increases in irrigation may be needed to support agriculture

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Limitations

- Differences in the evapotranspiration rates of native and non-native forests are not well known
- Difference in direct-runoff characteristics among land covers is not well known and not considered in the water budget
- Recharge rates from taro and reservoir land covers are not well known and assigned constant values based on limited data
- Water-budget model does not consider source and availability of irrigation water (surface water or groundwater)

Proposed Next Steps

- Species distribution mapping
- Data collection
  - Leaf-level evaluation
  - Continuous monitoring at “anchor” stations
  - Statistical analyses to estimate transpiration
- Water-budget modeling
  - Identification of critical areas for reducing uncertainties related to hydrologic effects of non-native forests
- Groundwater modeling
  - Analysis of land-cover and climate change on groundwater availability using a numerical groundwater model

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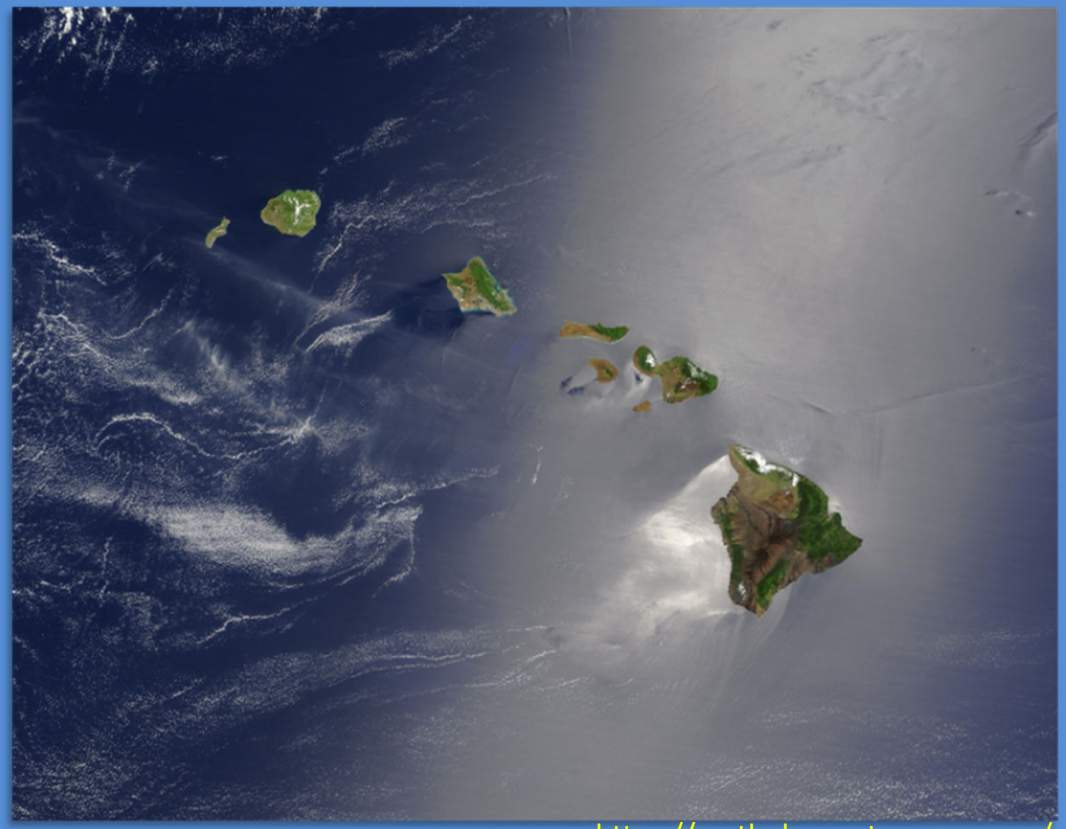
QUESTIONS?



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