# Scenario Narratives Case Study: KBNERR

Each of the following 4 scenario narratives was developed through one-on-one informational interviews with local leaders and researchers through the KBNERR Coastal Training Program; and facilitated discussions at the Kachemak Bay and Kenai Peninsula Climate Resilience Workshop: Scenario Planning & Pathways to Successful Adaptation in October 2016. The scenarios were used in the "Game of Futures" activity in the KBNERR April 2017 Workshop.

In this case study for the Kenai Peninsula, the participants targeted the relationship between hydrologic drivers of change (shallow groundwater and surface water) based on the framework developed by identifying local impacts, best available science, and local expertise. Each individual scenario narrative is an alternative description of how the future may unfold, outlining a different plausible future state of a system. Scenarios are not predictions but are grounded in the best available science and community experts' expertise and experiences. Each scenario contains the following components:

**Future Description:** Each scenario begins with a brief description of the future with respect to environmental and management impacts and changes. These drivers of change are chosen because of their strong role in physical and biological processes operating on landscape and their centrality to effective management of many resources and assets.

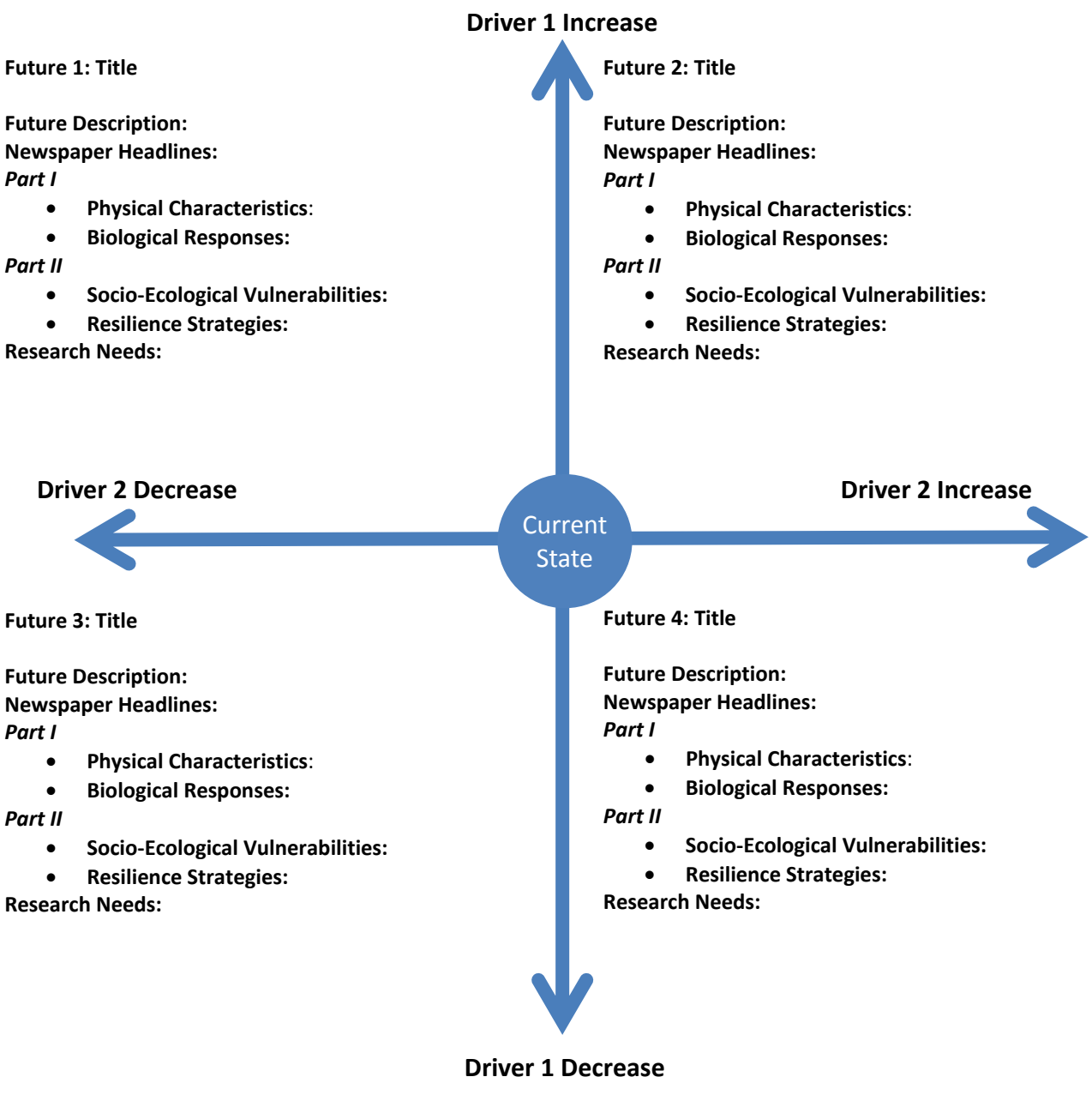
**Newspaper Headlines:** Three newspaper headlines that capture specific changes to the environment or community based on what is likely to be experienced in each scenario (potential future).

***Part I***

- **Physical Characteristics**: How the area's physical landscape may change due to the changes in local hydrology experienced in a scenario.
- **Biological Responses:** How habitats and wildlife may change due to the changes in local hydrology and physical characteristics (outlined in first section) experienced in a scenario.

***Part II***

- **Socio-Ecological Vulnerabilities:** How the community may change due to changes in local hydrology, physical characteristics, and biological responses (outlined in previous sections)
- **Resilience Strategies:** Identification of potential strategies that could be used to decrease vulnerabilities identified in previous sections, and increase resilience.
- **Research Needs:** Questions that arose throughout the scenario development process.



Future1 Scenario Narrative: Kachemak Bay and Kenai Peninsula Climate Resilience Workshop

# *Southeast Alaska (Sitka)*

**High groundwater recharge and steady surface flow** results from relatively consistent rain and warm temperatures, or water storage and melt in snowpack. Conservation of wetlands and development of new rain gardens contribute to steady recharge and flow.

**Newspaper Headlines**

- *Mud slide buries Two Sisters Bakery*
- *Slash and burn vs. fillet and release conflict between agriculture and fisheries*
- *Xtra Tuff business booms*

## *Part I: Physical Characteristics and Biological Response*

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|---|---|
| **Physical Characteristics** | Erosion<br>• Little erosion, scour or turbidity<br>• Increased coastal erosion along southern Kenai Peninsula bluffs due to saturated soils<br>• Unstable slopes experience mass wasting driven by soil creep or slip along impermeable surfaces<br>Fire<br>• Drier uplands from infiltration and muddy conditions in low lands causes changing fire regime with vegetation cover and water availability<br>Flooding<br>• Groundwater discharge occurs in downslope areas of Homer<br>Sediment<br>• Reduced riverine sediment inputs cause sedimentation issues with the harbor<br>• Sediment depletion from spit and other beaches<br>Rivers & Streams<br>• Water availability is high, with increased residence time on surface<br>• Increased water movement causes depletion of nutrients in soils<br>• Stream flow and temperature are more consistent and buffered by groundwater<br>Wetlands & Estuaries<br>• Experience infrequent flushes of water and pollutants<br>• Sediment starved except for fines |
| **Biological Response** | Algal Blooms & Nutrients<br>• Higher stream productivity in upper watershed if nutrient pathways stay intact<br>• Greater importance of marine derived nutrients and alder nitrification<br>Salmon & Fish<br>• Climate refugia for salmon at groundwater discharge areas due to water flow, moderation of temperature, and nutrient delivery<br>• Watershed habitat supports multiple life stages of salmon, leading to increased returns<br>• Non-anadromous fish (trout, char) thrive, without marine related climate pressures<br>Vegetation<br>• More heavily wooded stream buffers because of nutrient system<br>• Creates more shading and low productivity as tree cover ties up nutrients in living biomass<br>Wetlands & Estuaries<br>• Slope drainage (alder swamps) are only wetlands with more nutrients |

## *Part II: Socio-Ecological Vulnerabilities, Resilience Strategies, and Research Needs*

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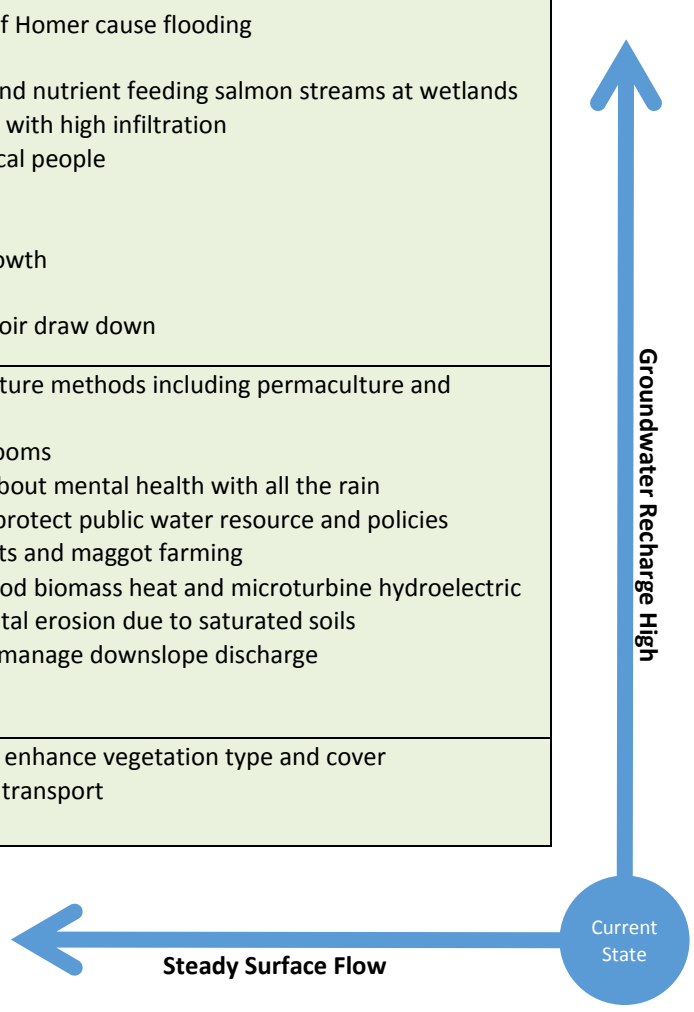
| **Socio-Ecological Vulnerabilities** | Economic Vitality<br>• More forest leads to more industry for wood production<br>• Sediment depletion from spit could impact the harbor<br>Flooding<br>• Groundwater discharge in downslope areas of Homer cause flooding<br>Food Security<br>• Conflict between fertile soils for agriculture and nutrient feeding salmon streams at wetlands<br>• Conventional agriculture may not be possible with high infiltration<br>• More salmon leads to increased access for local people<br>• Seaweed for food production increased<br>Population<br>• More rainy days equals slower population growth<br>Water Supply<br>• Freshwater storage or availability with reservoir draw down |
| **Resilience Strategies** | • Nutrient poor soils require alternative agriculture methods including permaculture and plasticulture, slash and burn<br>• Local foods rely on fish seaweeds and mushrooms<br>• More indoor recreation to address concern about mental health with all the rain<br>• Enhance water export business but co-op to protect public water resource and policies<br>• Fishy peat demand shift to fish waste nutrients and maggot farming<br>• More local energy development including wood biomass heat and microturbine hydroelectric<br>• Use living shoreline practices to stabilize coastal erosion due to saturated soils<br>• Use green infrastructure and rain gardens to manage downslope discharge<br>• Importing sand to nourish the beaches |
| **Research Needs / Questions** | • Sediment transport and how it may inhibit or enhance vegetation type and cover<br>• Wave, tides and currents as part of sediment transport |



Future 2 Scenario Narrative: Kachemak Bay and Kenai Peninsula Climate Resilience Workshop

# *Wet and Wetter*

**High groundwater recharge and extreme surface flow** is caused by heavy precipitation events and warmer temperatures where water could both infiltrate and move over land. Onsite storm water management decisions could contribute to this scenario.

**Newspaper Headlines**

- *Future for salmon uncertain*
- *Highway blows out again*
- *Downstream neighbor plugs culvert*

## *Part I: Physical Characteristics and Biological Response*

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|---|---|
| **Physical Characteristics** | Erosion<br>• Erosion, scour and turbidity during extreme events<br>• Increased coastal erosion along southern Kenai Peninsula bluffs due to saturated soils<br>• Decreased slope stability with mass wasting driven by soil creep or slip along impermeable surfaces (bluff collapse) as well as sheet or debris flow<br>Flooding<br>• Flooding during extreme events<br>• Water availability is variable, with decreased residence time on surface, likely to quickly runoff or infiltrate<br>• Potential to develop into a badlands<br>Groundwater<br>• High infiltration<br>• Groundwater discharge in downslope areas of Homer<br>Rivers & Streams<br>• Stream flow and temperature are buffered by groundwater inputs<br>• Storm water runoff issues in downslope areas of Homer<br>Wetlands & Estuaries<br>• Experience flushes of water and pollutants<br>• Deliver potentially high sediment loads to marine environments<br>• Wetlands aggrade as they need to accommodate more sediment, water and pollutants |
| **Biological Response** | Algal Blooms & Nutrients<br>• Algal blooms in reservoirs with unsteady recharge<br>Salmon & Fish<br>• Scour in streams impacts salmon returns<br>• Climate refugia for salmon at groundwater discharge areas due to water flow, moderation of temperature, and nutrient delivery |

## *Part II: Socio-Ecological Vulnerabilities, Resilience Strategies, and Research Needs*

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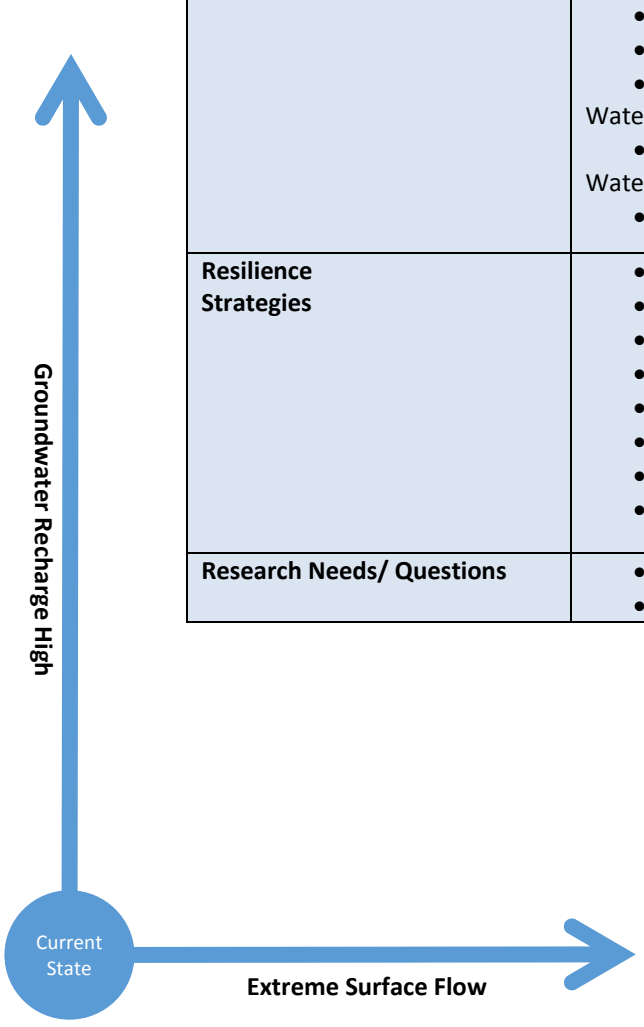
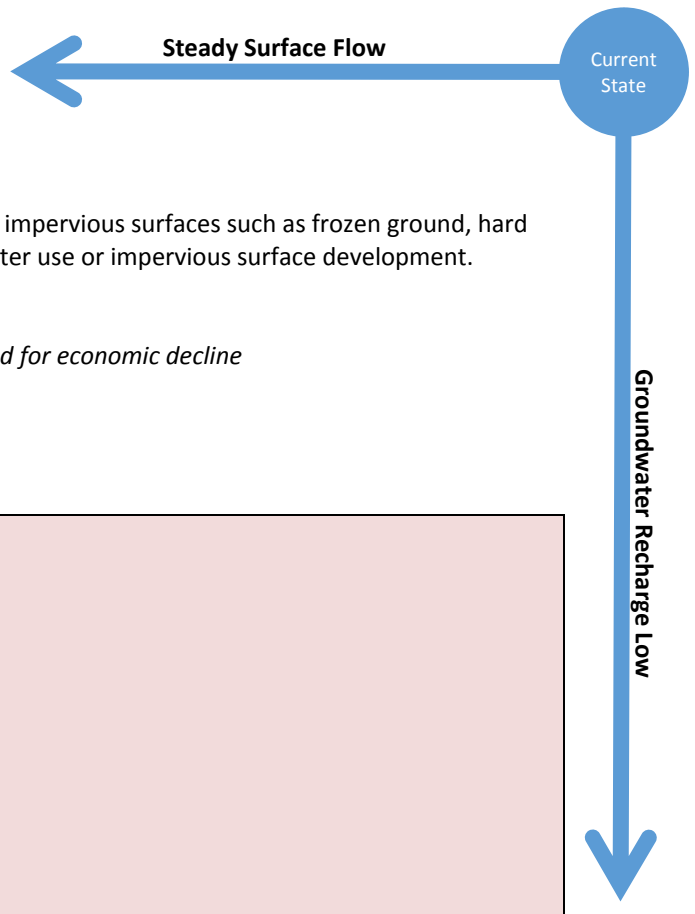
| **Socio-Ecological Vulnerabilities** | Economic Vitality<br>• Lots of job opportunity building and maintaining infrastructure<br>• Increased demand for water related services<br>• Dangers to oil and gas infrastructure<br>Food security<br>• Increased groundwater good for salmon, good for Bradley Lake and other small hydro projects<br>Infrastructure<br>• Roads and culverts impacted by debris flows and bluff collapse<br>• Extreme flooding events of streams washing out roads, bridges, culverts, and water sewer systems<br>• Groundwater discharge in downslope areas of Homer cause flooding<br>• Managing risk and damage- destruction becomes normal<br>• Fear and uncertainty reducing structural stability at neighborhood or larger scales<br>• Storm water system capacity challenged<br>Water Supply<br>• Freshwater stability - storage or availability<br>Water Quality<br>• Increased water contamination from groundwater connectivity |
| **Resilience Strategies** | • Stabilize spit with increased dredging<br>• Higher drive to use emergency mitigation methods for scour and erosion - like riprap<br>• Educate people on the consequences of their actions, what they can and can't control<br>• Increase shared knowledge between scientists, contractors, homeowners, and managers<br>• Educate people about functions and values of wetlands for preservation<br>• Educate people about where clean water comes from<br>• Emphasize property rights and cumulative impacts of upstream neighbors<br>• Increase industry that is water intensive look into selling/exporting water |
| **Research Needs/ Questions** | • Current precipitation study for Homer<br>• Under what conditions would we cross landscape tipping points? |






Future 3 Scenario Narrative: Kachemak Bay and Kenai Peninsula Climate Resilience Workshop

# *Steady Flow and Dry Below*

**Low groundwater recharge and steady surface flow** is caused by steady or reduced precipitation and impervious surfaces such as frozen ground, hard panning, riparian vegetation removal, some agricultural practices, heavy groundwater and surface water use or impervious surface development.

**Newspaper Headlines**

- *Sucking Us Dry: lacking groundwater recharge blamed for low salmon return, for dry wells and for economic decline*

## *Part I: Physical Characteristics and Biological Response*

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| **Physical Characteristics** | Erosion<br>• Less erosion and scour<br>Groundwater<br>• Reduced infiltration<br>• Increased evaporation and freezing<br>• Increased depth to water<br>Rivers & Streams<br>• Interrupted streamflow<br>• Decreased turbidity<br>• Higher stream temps in summer<br>Wetlands & Estuaries<br>• Drying wetlands |
| **Biological Response** | Algal Blooms & Nutrients<br>• Algal blooms in reservoir in warm dry periods<br>Rivers & Streams<br>• Heat stress on riverine ecosystems<br>Salmon<br>• Reduced salmonid overwintering sites<br>• Warmer streams leads to less productive salmon<br>Water Quality<br>• Increased surface pollution with more hardened surfaces and less wetland absorption<br>• Possible dead zone at marine entry from land pollutants<br>Wetlands & Estuaries<br>• Less sediment<br>• Less water<br>• Less pollutants<br>• Heat stress estuarine ecosystems |

## *Part II: Socio-Ecological Vulnerabilities, Resilience Strategies, and Research Needs*

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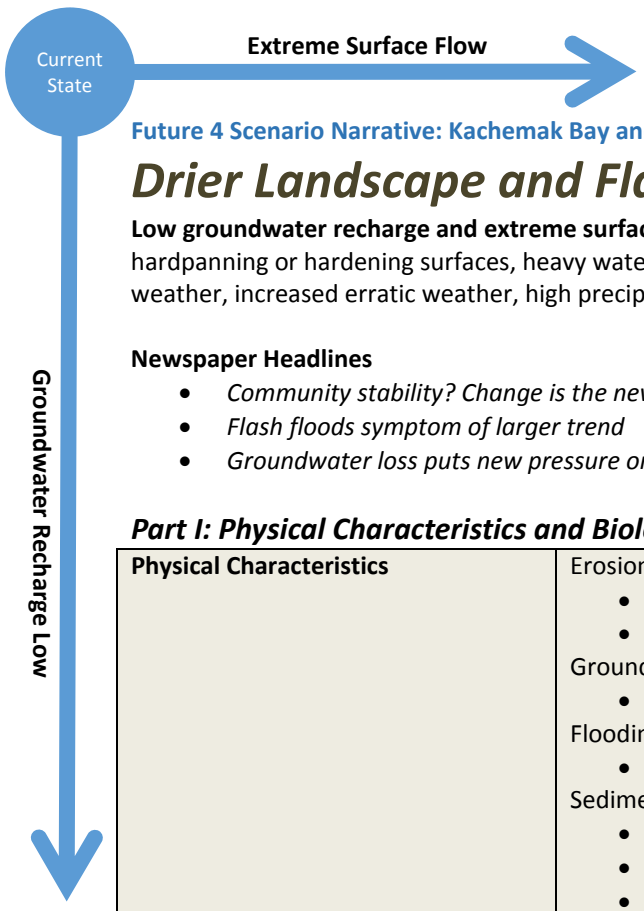
| **Socio-Ecological Vulnerabilities** | Food Security<br>• Increase in pressure for farmed salmon as wild runs decline<br>• Increased plasticulture (greenhouses)<br>Water Supply<br>• Lack of water supply for both people and salmon<br>• Increased population using too much groundwater<br>Economic Vitality<br>• Shifting of groundwater resources (industry, fracking)<br>• Water costs make it prohibitive to move and conduct business here |
| **Resilience Strategies** | • Set aside agricultural lands<br>• Shift from natural food sources to managed food sources<br>• Hatcheries seem more feasible politically and in terms of salmon feed<br>• Rain gardens<br>• Groundwater intervention would help us make decisions - increase importance to protect those areas where there is recharge happening<br>• Desalination plants<br>• Reclaiming riparian zones and buffer zones<br>• Water conservation<br>• Retention ponds instead of wells and cisterns<br>• Pastoral economy takes advantage of grasslands with barley goats, dairy bison and honey |
| **Research Needs/ Questions** | • Understand groundwater recharge locally<br>• Uncertainty of what is being lost at a watershed scale<br>• Costs and impact of desalinization<br>• How will higher temperatures and evaporation impact stream flow and groundwater recharge?<br>• Economic incentive to protect or preserve wetlands |




Future 4 Scenario Narrative: Kachemak Bay and Kenai Peninsula Climate Resilience Workshop

# *Drier Landscape and Flashier Floods*

**Low groundwater recharge and extreme surface flow** results from heavy precipitation events and impervious surfaces. Fall rain on frozen ground, hardpanning or hardening surfaces, heavy water use, agricultural practices or storm water bypass- could create this situation. Longer summers and warm weather, increased erratic weather, high precipitation generally occurs during cooler wetter months.

**Newspaper Headlines**

- *Community stability? Change is the new norm*
- *Flash floods symptom of larger trend*
- *Groundwater loss puts new pressure on reservoir*

## *Part I: Physical Characteristics and Biological Response*

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|---|---|
| **Physical Characteristics** | Erosion<br>• Changing hydraulics causes increased erosion and scour<br>• Change in water quality with increased erosion<br>Groundwater<br>• Reduced/episodic infiltration<br>Flooding<br>• Flooding increased during big events<br>Sediment<br>• Sediment gravity flows<br>• Change in sediment availability<br>• Subsidence and sinkholes in some areas<br>Rivers & Streams<br>• Increased turbidity in streams<br>• Higher stream temps in summer<br>• Lower stream productivity<br>• Rivers more flashy discharge and less consistent flow<br>• Stream beds drying up<br>Snowpack<br>• Snowpack melting too early leading to insufficient storage<br>Wetlands & Estuaries<br>• Variable water and sediment input rates to wetlands |
| **Biological Response** | Algal Blooms & Nutrients<br>• Algal blooms in reservoir in dry periods<br>• Loss of marine derived nutrients<br>Salmon & Fish<br>• Reduced salmonid overwintering sites<br>• Erosion scrubs out salmon reds and fry<br>Rivers & Streams<br>• Heat stress on riverine ecosystems<br>Vegetation<br>• Drying causes cover changes (hydraulic changes, nutrient-water dynamics, increased erosion and scouring)<br>Wetlands & Estuaries<br>• Need to accommodate more sediment, water and pollutants<br>• Heat stress on estuarine ecosystem |

## *Part II: Socio-Ecological Vulnerabilities, Resilience Strategies, and Research Needs*

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|---|---|
| **Socio-Ecological Vulnerabilities** | Community<br>• Community identity changes<br>• Public health risks<br>Economic Vitality<br>• Economic costs with loss of tourism, recreation and fisheries<br>• Cost of emergency response<br>Food Security<br>• Changes to traditional subsistence cultures<br>Habitat Conservation<br>• Fish habitat impacted<br>• Fire potential increase without reliable source of water<br>Infrastructure<br>• Storm water system capacity challenged by extreme floods<br>• Roads and culverts impacted by debris flows<br>• Impacts transportation including streets, buildings, bridges and public facilities<br>• Dams and reservoirs are impacted by flooding<br>• More drive for emergency solutions like riprap<br>• Flooded septic sewage<br>• Increased erosion with property loss<br>Water Supply<br>• Not enough water to support community<br>• Freshwater storage or availability less reliable<br>• Wells dry up |
| **Resilience Strategies** | • Shift from fisheries to agrarian<br>• More dams and reservoirs<br>• Drier landscape - water thirsty industry could do well here<br>• Recharge groundwater with smaller rain gardens<br>• Changing landscape from individualistic to more communal shared resources<br>• Communities protect assets from flash floods (roads, structures, streams, and agricultural lands) |
| **Research Needs / Questions** | • What is the opportunity for alternative energy?<br>• Learn from similar communities and adaptation strategies (pacific northwest)<br>• What do climate models predict about extreme weather events for our area?<br>• Feasibility of pumping water below ground during flood events<br>• Is it possible to recharge using flood events? (instead of filling reservoirs go directly into groundwater storage) |