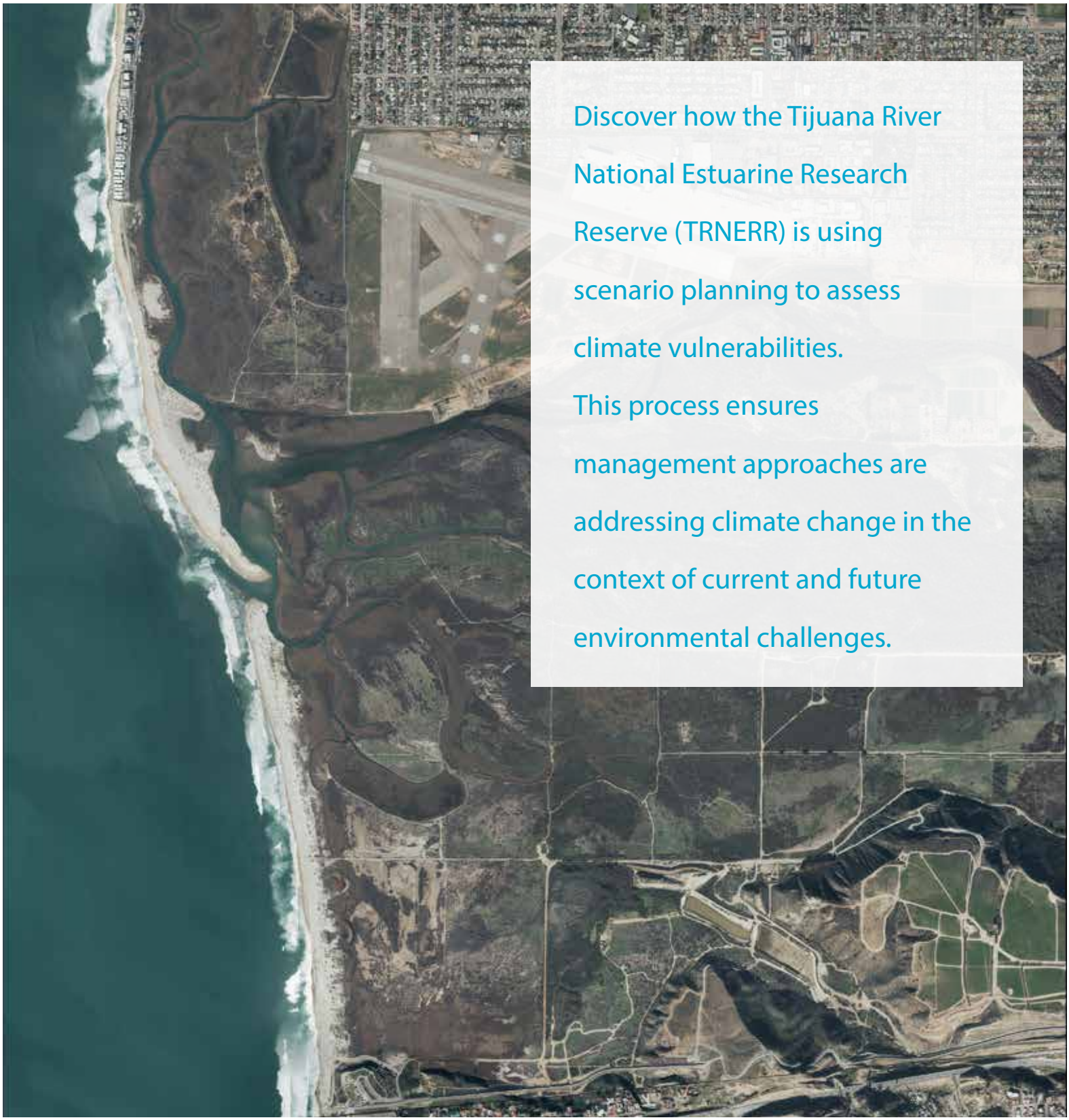
Preparing for Climate Change in the Tijuana River Valley



Discover how the Tijuana River National Estuarine Research Reserve (TRNERR) is using scenario planning to assess climate vulnerabilities. This process ensures management approaches are addressing climate change in the context of current and future environmental challenges.

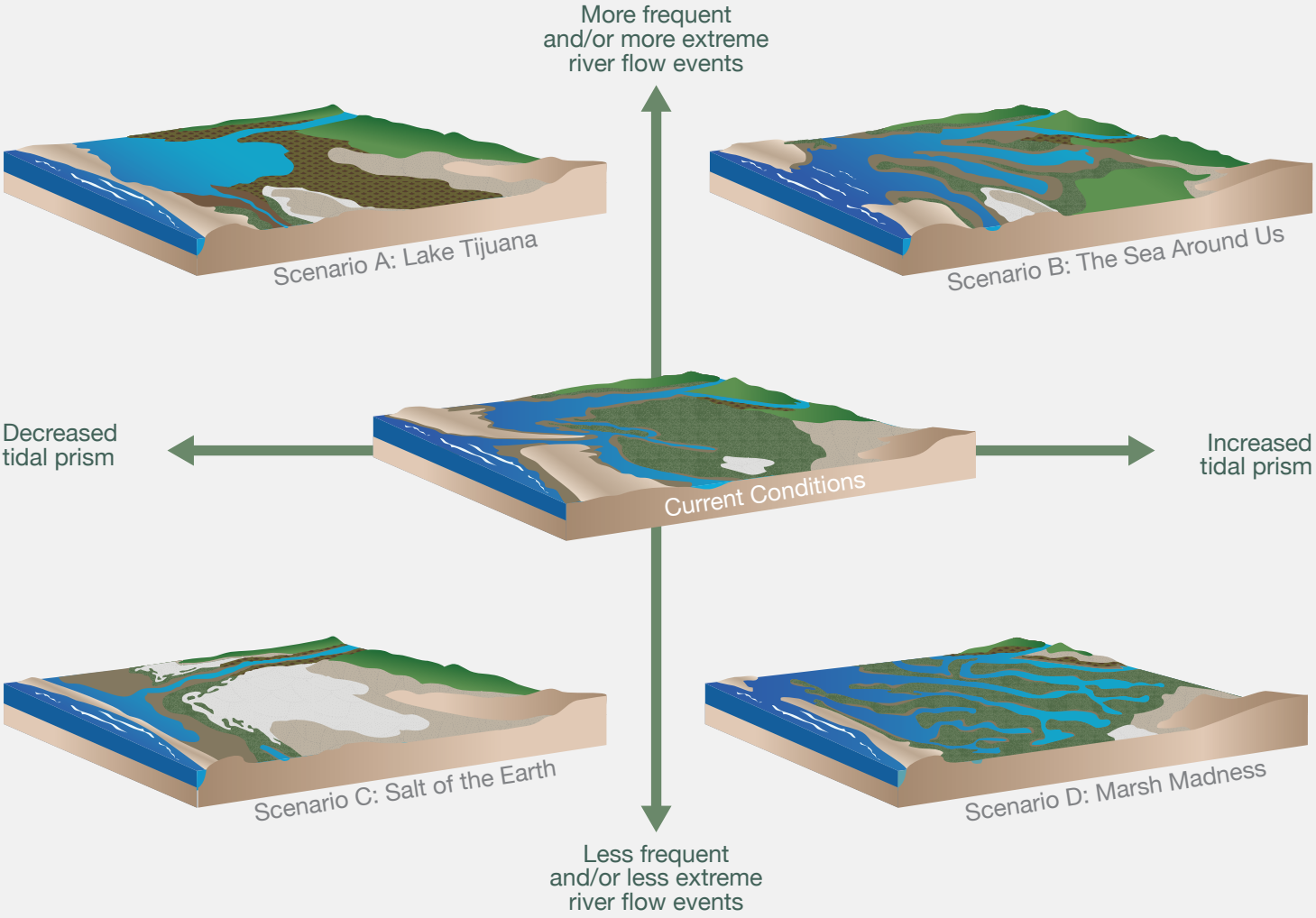
The Future: Challenges, Changes, and Scenarios

Climate change poses new management challenges for resource managers working to conserve and enhance resilient coastal habitats. Typical vulnerability assessment frameworks are challenging to consistently implement in the complex and uncertain socio-ecological context that resource managers make decisions in.

An alternative approach, scenario planning, is emerging as a framework that allows current and future vulnerabilities to be assessed. Scenario planning addresses the challenges associated with having to make informed decisions in the short-term while planning for long-term resilience.

Developing Scenarios

Changes in two primary variables — extreme river flow events and tidal prism — were used to frame the development of four alternative, plausible futures for the Tijuana Estuary and River Valley. The resulting scenarios serve as a tool to integrate climate change science into the development and implementation of current and future management strategies.



Scenario Planning: Integrating Science and Management

What are Scenarios?

Each individual scenario is an alternative description of how the future may unfold, outlining a different plausible future state. Scenarios are not predictions but provide a framework through which managers can assess vulnerabilities and make decisions under highly uncertain conditions.

Scenarios were created by considering trajectories of change through time, guided by the following questions:

- **Past:** What was the River Valley like historically?
- **Present:** What characterizes the River Valley today?
- **Future:** How might changes in our climate shape the River Valley in the future?

Key Variables

TRNERR used the relationship between two primary variables to frame the development of four separate scenarios:

- **Tidal prism**, and
- **Extreme river flow events**

Key Changes

Each scenario was developed in three stages. Through discussions at workshops and one-on-one interviews with local researchers, managers, and planners, vulnerabilities were identified in three categories:

- **Physical Environment**
  Experts outlined how changes in tidal prism and extreme river flow events may alter how important physical characteristics shape the landscape.
- **Natural Habitats**
  Considering the physical scenario characteristics identified in the previous step, changes in extent of natural habitats were identified.
- **Built Environment**
  The results from the previous two steps were used as a foundation to discuss how changes in the physical landscape and natural habitats may impact critical infrastructure and alter management approaches.

Key Variables: Tidal Prism and Extreme River Flow Events

Tidal prism and extreme river flow events were chosen to frame the discussion because they:

- Serve a primary role in shaping the River Valley's landscape;
- Will likely be altered as a result of climate change;
- Have high uncertainty associated not only with each individual variable but the interaction between the two; and
- Are central to effective management of the shoreline, watershed, and River Valley.

Tidal prism is the volume of water tides bring in and out of the estuary. It influences and is influenced by the dynamic connection between the estuary and ocean - the river mouth. Increases or decreases in tidal prism also depend in large part on the relationship between local elevations and sea level. In addition to being directly affected by a changing climate and sea level rise, tidal prism can be impacted by land management practices, including: restoration activities, interventions to keep the river mouth open, or land uses that affect water or sediment supply.

Extreme river flow events can increase or decrease based on changes in: precipitation patterns (e.g., changes in frequency and intensity resulting from climate change); water management practices (e.g., dams, channelization of river channels); and / or land use patterns (e.g., increased impervious or denuded surfaces). Each of these changes alters the amount and velocity of freshwater and sediment entering the system. This in turn also affects the status of the river mouth.

Key Changes: Physical, Natural, & Built Envrionments

Each scenario considers important potential changes to the River Valley, outlining: (1) how changes in key characteristics will shape the physical environment; (2) the key vulnerabilities of primary habitat-types; and (3) the key vulnerabilities of the built environment.

Physical Environment

- River-Ocean Connection (open vs. closed river mouth)
- Water Residence Time
- Flooding
- Inundation
- Sedimentation
- Surface Water Salinity
- Groundwater Salinity

Natural Habitats

- Beaches & Sand Dunes
- Tidal Channels & Mudflats
- Salt Marsh
- Salt Flats
- Wetland-Upland Transition Zone
- Fresh-Brackish Marsh
- Riparian
- Upland

Built Environment

- Agriculture
- Border Security & Infrastructure
- Cultural & Historical Resources
- Naval infrastructure
- Parks, recreation, & public access
- Stormwater management
- Transportation
- Wastewater management

Linking scenarios to management

These scenarios were developed as part of the Climate Understanding & Resilience in the River Valley (CURRV) project. Through CURRV, the Tijuana River National Estuarine Research Reserve (TRNERR) is leading a collaborative process to directly inform restoration of coastal habitats and integrate climate adaptation strategies into Reserve management and programs.

To learn more about the process visit: http://www.trnerr.com/currv/

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Scenario A: Lake Tijuana

Increased extreme river flow events
Decreased tidal prism

Decreased tidal prism contributes to sand and sediment building up between the river and the ocean leading to a river mouth that is usually closed, with occasional extreme river flows breaching the built-up sand bar. River water trapped behind the sand bar forms a large freshwater or brackish lake, which displaces many of the more saline habitats in the estuary. This lake also increases flood risk by decreasing the ability of the system to retain additional water produced during a storm. The effect of sea level rise on habitats is limited as increased sedimentation allows the land to rise faster than ocean water levels.

Changes to the Physical Environment

River-Ocean Connection & Water Residence Time
The river mouth is usually closed, which traps water in the system for long periods of time. This increases the accumulation of nutrients and contaminants in aquatic habitats.

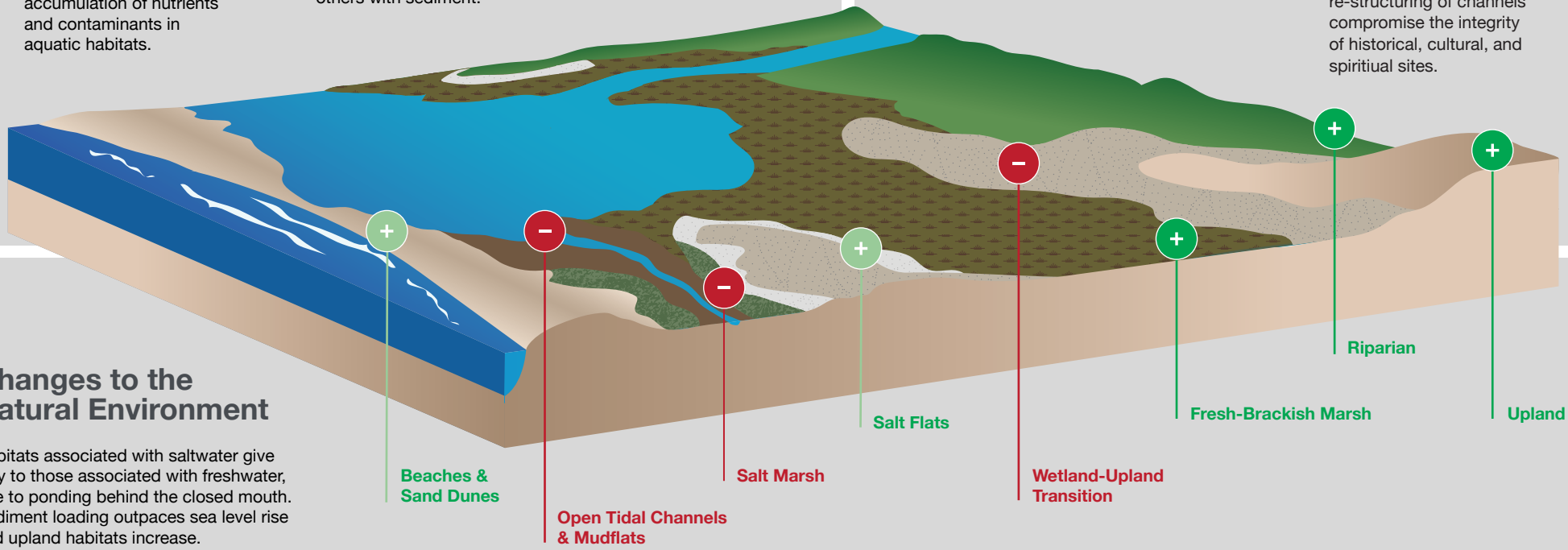
Flooding, Inundation, & Sedimentation
Riverine flooding impacts the Valley as water ponds behind the closed river mouth. There is the potential for restructuring of the Valley as storm waters carve new channels and fill others with sediment.

Surface Water & Groundwater Salinity
Increased freshwater influence is experienced during mouth closure, which may recharge groundwater supplies.

Potential Management Challenges

Transportation
Access in the Valley is frequently impaired by sedimentation, standing water, and flooding. This obstructs roads, bridges, trails, and evacuation routes; and leads to a need for increased flood preparedness, especially among emergency responders.

Cultural & Historical Resources
High rates of erosion and re-structuring of channels compromise the integrity of historical, cultural, and spiritiual sites.



Changes to the Natural Environment

Habitats associated with saltwater give way to those associated with freshwater, due to ponding behind the closed mouth. Sediment loading outpaces sea level rise and upland habitats increase.

Scenarios are not predictions but are alternative representations of how the future may unfold in response to potential climate and environmental changes.
For more details visit: http://www.trnerr.com/currv/.
October 2017

Change in Habitat Area

- Large Decrease
- Slight Decrease
- Large Increase
- Slight Increase
- No Change

Habitat Types

- Beaches & Sand Dunes
- Open Tidal Channels & Mudflats
- Salt Marsh
- Salt Flats
- Fresh-Brackish Marsh
- Wetland-Upland Transition
- Riparian
- Upland

Scenario B: The Sea Around Us

Increased extreme river flow events
Increased tidal prism

Increased tidal prism, in conjunction with increased extreme river flow events leads to an enhanced connection between the river and the ocean through a consistently open and deep river mouth. This creates a system that is heavily shaped by the ocean both biologically and physically. Ultimately, sea level rise will greatly influence the habitats in the lower valley, and coastal flooding will increase when high sea levels interact with more frequent river flows.

Changes to the Physical Environment

River-Ocean Connection & Water Residence Time
Water is in the system for short periods of time due to an open river mouth and tidal flushing.

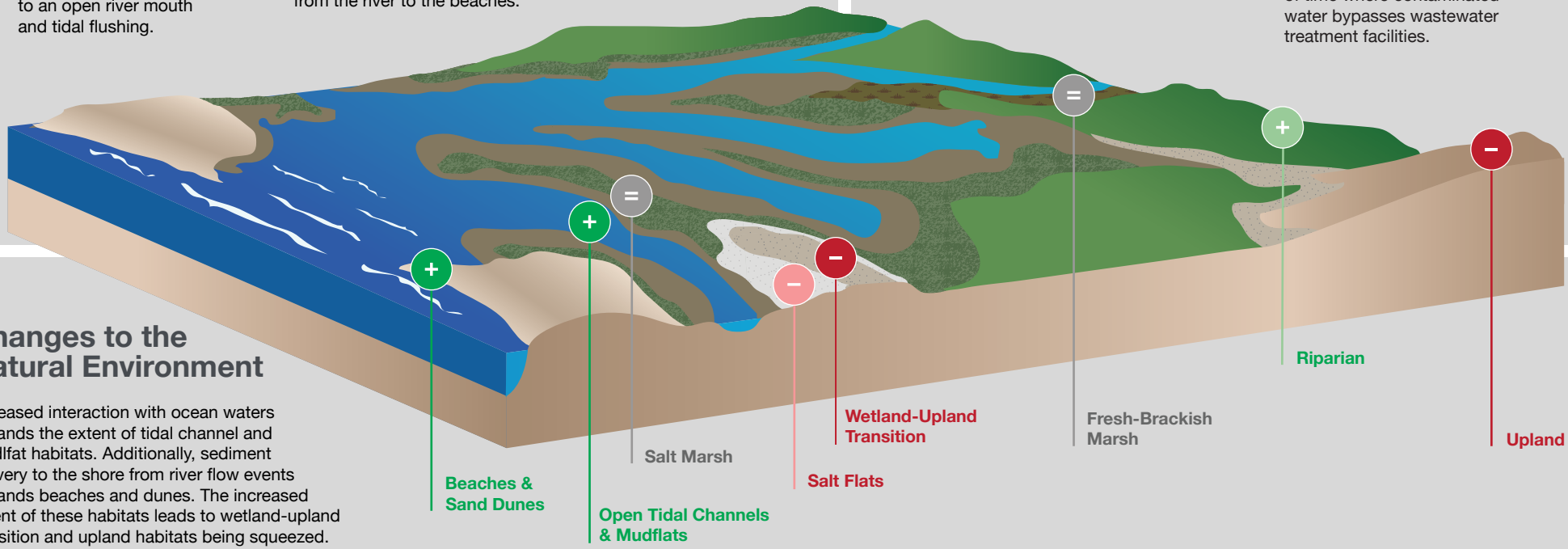
Flooding, Inundation, & Sedimentation
The combination of storms and sea level rise cause extensive flooding throughout the valley. During extreme river flow events, there is increased sediment export from the river to the beaches.

Surface Water & Groundwater Salinity
Saltwater influence in surface water and groundwater reaches further inland.

Potential Management Challenges

Stormwater Management & Flood Control
Critical infrastructure may become ineffective due to rising seas, increased river flows, and the interaction between the two.

Wastewater Management
More frequent extreme river flows increases the amount of time where contaminated water bypasses wastewater treatment facilities.



Changes to the Natural Environment

Increased interaction with ocean waters expands the extent of tidal channel and mudfat habitats. Additionally, sediment delivery to the shore from river flow events expands beaches and dunes. The increased extent of these habitats leads to wetland-upland transition and upland habitats being squeezed.

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Change in Habitat Area

− Large Decrease
− Slight Decrease
+ Large Increase
+ Slight Increase
= No Change

Habitat Types

Beaches & Sand Dunes
Open Tidal Channels & Mudflats
Salt Marsh
Salt Flats
Fresh-Brackish Marsh
Wetland-Upland Transition
Riparian
Upland

Scenario C: Salt of the Earth

Decreased extreme river flow events
Decreased tidal prism

Decreased tidal prism, coupled with decreased extreme river flow events, results in the river being cut-off from the ocean as the river mouth closes. Over time, this lack of consistent tidal influence creates a system that is highly variable and is characterized by salt flats that develop as ponded water evaporates. The variability of this system challenges effective management, as long periods of dry conditions are punctuated by extensive flooding associated with the closed mouth.

Changes to the Physical Environment

River-Ocean Connection & Water Residence Time
Water will collect behind the closed river mouth, remaining in the system for long periods of time, likely until it evaporates.

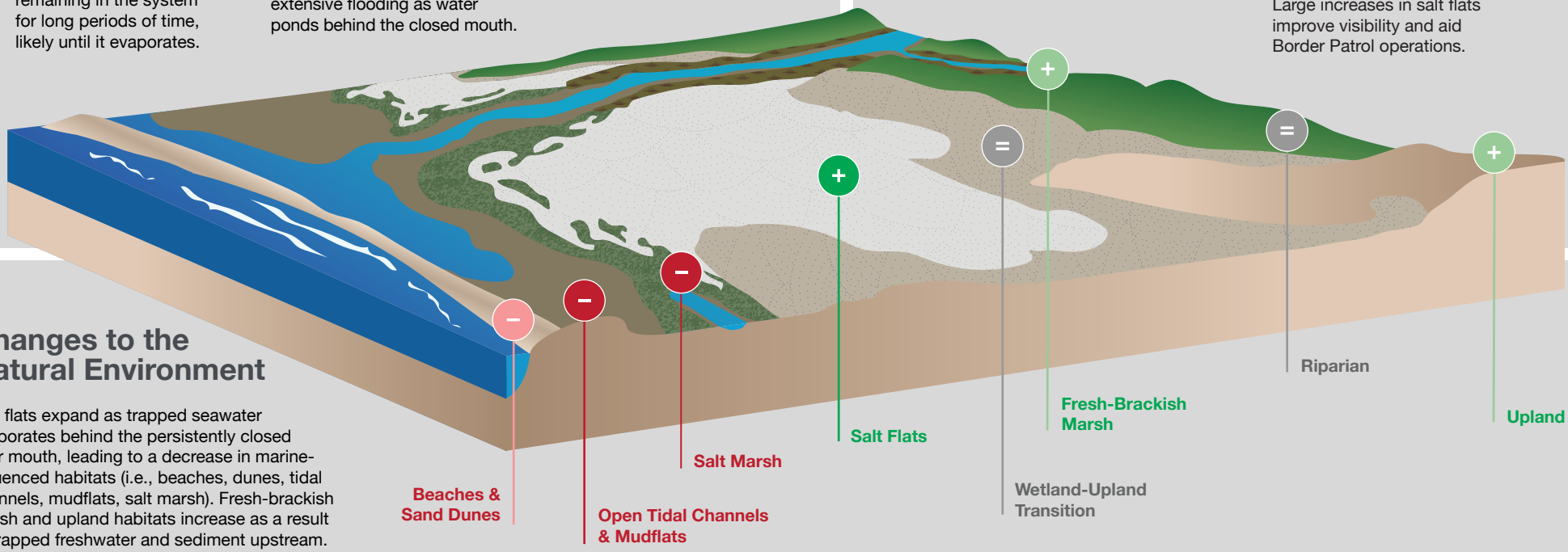
Flooding, Inundation, & Sedimentation
The closed river mouth traps sediment, elevating land and filling in channels. Even though large river flows are rare, those that do occur will lead to extensive flooding as water ponds behind the closed mouth.

Surface Water & Groundwater Salinity
Conditions are variable, ranging from hypersalnity resulting from the evaporation of trapped seawater to freshwater conditions resulting from ponding of riverine water.

Potential Management Challenges

Public Health
Public health concerns arise as contaminants such as pollutants and trash are trapped within the poorly-flushed system.

Border Security
Large increases in salt flats improve visibility and aid Border Patrol operations.



Changes to the Natural Environment

Salt flats expand as trapped seawater evaporates behind the persistently closed river mouth, leading to a decrease in marine-influenced habitats (i.e., beaches, dunes, tidal channels, mudflats, salt marsh). Fresh-brackish marsh and upland habitats increase as a result of trapped freshwater and sediment upstream.

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Change in Habitat Area

- Large Decrease
- Slight Decrease
- Large Increase
- Slight Increase
- No Change

Habitat Types

- Beaches & Sand Dunes
- Open Tidal Channels & Mudflats
- Salt Marsh
- Salt Flats
- Fresh-Brackish Marsh
- Wetland-Upland Transition
- Riparian
- Upland

Scenario D: Marsh Madness

Decreased extreme river flow events
Increased tidal prism

Increased tidal prism, coupled with decreased extreme flow events results in mouth conditions that are similar to those that occur today – with the inlet typically open to the ocean. Sea level rise, coupled with mouth conditions that allow for some trapping of sediment, expands the area influenced by salt marsh further inland.

Changes to the Physical Environment

River-Ocean Connection & Water Residence Time
The river mouth is mostly open and tidal action limits the amount of time water resides in the system.

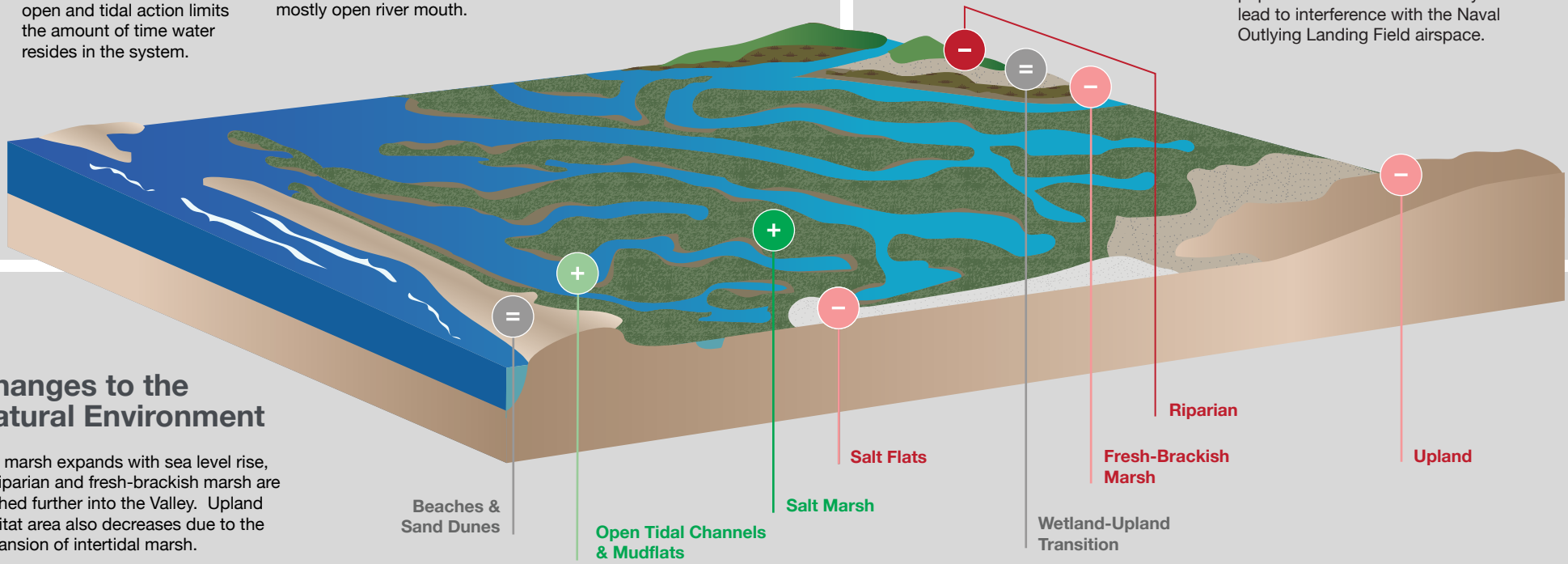
Flooding, Inundation, & Sedimentation
The system experiences increased inundation and flooding, especially near the coast, which is left vulnerable to sea level rise effects through the mostly open river mouth.

Surface Water & Groundwater Salinity
Saltwater influence increases due to higher tidal prism and sea level rise, coupled with decreased riverine inputs.

Potential Management Challenges

Agriculture
Freshwater becomes less available for crops and other water dependent operations.

Naval Operations
Potential shifts in local bird populations and behaviors may lead to interference with the Naval Outlying Landing Field airspace.



Changes to the Natural Environment

Salt marsh expands with sea level rise, as riparian and fresh-brackish marsh are pushed further into the Valley. Upland habitat area also decreases due to the expansion of intertidal marsh.

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Change in Habitat Area

- Large Decrease
- Slight Decrease
- Large Increase
- Slight Increase
- No Change

Habitat Types

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