An Exploration of "Weaving Threads" as a Model for Resilience in Bay Area Marginal Suburban Communities

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Abstract

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From a broad and comprehensive perspective, the thesis discusses social-ecological resilience and guides application of resilience in Bay Area marginal suburban communities. First of all, the thesis describes the challenges and opportunities in the San Francisco Bay Area and specifically in the marginal suburban communities. The thesis then continues exploring resilience by demonstrating its definition, how it works as well as difference between specific resilience and general resilience. General resilience is the main focus of this thesis. The conclusion of the research on resilience concerns the two important qualities of resilience – dynamic adaptivity as well as complex and clear systems. To showcase the adaptivity, complexity, and clarity of the resilient systems, the thesis cites examples of the undergoing transforming systems in the Bay Area in a wide spectrum. After an in-depth research of resilience in theory and practice, the

thesis explores its own theory of *"weaving threads" as a model for resilience in Bay Area marginal suburban communities.* The materials for weaving a resilient suburban fabric are the six resilient threads including ecology thread, identity thread, infrastructure thread, transportation thread, land use thread, and technology thread. A community named Alviso in San Jose is chosen as a good representation of Bay Area marginal suburban community for applying the theory. Using the example of Alviso, the thesis gives a guidance of weaving processes – characterizing the "warp" (the strong threads) and "weft" (the flexible threads) of the marginal suburban fabric, carding the relationship between different threads, and weaving the resilient fabric with proper firmness and looseness.

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Chapter 1. INTRODUCTION

Resilience of social-ecological systems is a topic under hot debate and active exploration by governments, developers, planners and designers, and related professions. Resilience is a dynamic process that helps adapt social-ecological systems to both short-term and long-term disturbances. The resilience discussed in this thesis is general resilience (see Chapter 2), which needs a broader perspective to accomplish. The two important qualities of resilience discussed in this thesis are dynamic adaptivity and complex systems. These two qualities emphasize flexibility and connectedness of complex social-ecological systems. The anticipated outcome of the dynamic processes discussed in this thesis will be a resilient future for Bay Area marginal suburban communities.

The thesis explores the resilience of social-ecological systems in the Bay Area, where great challenges and opportunities exist together at this pivotal time. There is no one-time solution for each and every problem. It is necessary to reconsider existing problems and future challenges from a broader and more integrated perspective. There has been a lot of concern from government staff, developers, and professions focused on the development of Bay Area urban centers. However, urban centers are not the communities that are most vulnerable to great ecological and social challenges. What's needed is greater concern for marginal suburban communities in the Bay Area and application of resilience to them.

The focus of this thesis is on Bay Area marginal suburban communities that are facing neglect and abandonment by governments and developers through the ways in which urban

development is planned and implemented. Marginal suburban communities lying on the edge of the Bay, exist between shrinking space caused by rising sea level and rapidly expanding urban development. Degrading ecology, inefficient infrastructure and transportation systems, monotonous land use, and fading community identity make marginal suburban communities vulnerable to both ecological and social challenges. The Bay Area's suburban fabric is not strong enough to protect residents from sudden challenges such as earthquakes and flooding let along long-term challenges such as sea level rise and fading identity.

Nevertheless, Bay Area marginal suburban communities have their own strengths and positive potentials, the most remarkable of which are ecological resources and culture heritage. Convenient access to tidal marshes, salt ponds, and open water resource of the Bay and creeks are valuable resources for these marginal suburban communities. What's more, their location close to the Bay has endowed them with rich histories. Many of these marginal communities served as important transit and trade centers in the past. Development around their special and convenient locations nurtured the diverse and rich cultures of the Bay Area's marginal suburban communities.

Although ecological systems are degrading and community identity is fading, they play important roles in how we as a society approach resilience. Using the dynamic processes of resilience, we can preserve and extend the ecological and cultural strengths of Bay Area marginal suburban communities and we can help build what they lack, such as efficient transportation and infrastructure systems. At the same time, planning and design should not neglect the importance of protecting their unique community identities.

The theory developed in this thesis demonstrates how to "weave" social-ecological systems together in order to build a strong and adaptive suburban fabric. It is a metaphoric way to make the abstract process of resilience clear and thus easier to implement. The materials for weaving a resilient fabric are six threads of important social-ecological systems, which all greatly impact marginal suburban communities. The six resilient threads are the ecology thread, the identity thread, the infrastructure thread, the transportation thread, the land use thread, and the technology thread. The ecology thread is composed of natural ecological system and built ecological system. The identity thread is composed of culture system and education system. The infrastructure thread is composed of built infrastructure system and flexible infrastructure system. The transportation thread is composed of private vehicle-dominant transportation system and public transportation system. The land use thread is composed of residential land use, commercial land use, and industrial land use. From this thesis's perspective, the technology thread is an important but not a dominant thread. It can assist in building a resilient suburban fabric.

The thesis provides a general guide that fits the characteristics and conditions of marginal suburban communities to make the six major threads resilient. In the ecology thread, natural ecological systems should be preserved. Adaptive natural boundaries should be strengthened to adapt to sea level rise. Increasing the use of built ecological systems such as rain gardens and green corridors in marginal suburban communities is also beneficial. In the identity thread, the diverse cultures of suburban communities should be preserved and enhanced. The educational systems should be improved and strengthened for both adults and children. In the infrastructure thread, built infrastructure systems should be updated and improved. Flexible infrastructure

systems should be established to respond to different types of disturbances. In the transportation thread, the current private car-dominant transportation system should be made more efficient and environmentally-friendly. Additionally, public transportation with better connection and convenience for pedestrians and bicyclists is crucial for weaving a resilient suburban fabric. In the land use thread, diversity should be fostered in marginal suburban communities. A mixed-use of industry, commerce, and residence can improve efficiency in land use and in residents' circulation patterns and activities. The technology thread can assist in building resilient suburban fabric in many ways. However, it is important to keep technology in an assistant position prevent unexpected negative changes in society and ecology that might result from technological changes.

These suggestions for making systems more resilient can be applied to many suburban communities because they are essential for building a resilient suburban fabric. However, each marginal suburban community has its own unique characteristics so the relative importance of specific systems will change for each unique community. The connectedness between systems and the looseness or firmness of systems should be adjusted to the needs of different marginal suburban communities.

To explain the theory vividly, the thesis provides process guidelines for how weave a resilient suburban fabric. The theory is applied to the planning of Alviso, San Jose, as a demonstration. Alviso is a community locates in the South Bay, between flood-prone land because of rising sea level and rapid urban development of other parts of San Jose. It represents the conditions of many Bay Area marginal suburban communities face similar ecological and social problems. Alviso is threatened by rising sea level. The tidal marshes around it are

vanishing due to floods and sea level rise. Although consolidated into San Jose in 1968, it has been segregated from richer parts of San Jose by Highway 237 and has lost its characteristic small-town identity. The car-dominant transportation system and lack of diversity in land use make the community less attractive to residents and visitors. Nevertheless, Alviso retains a resourceful natural heritage along with caring and loving community members. It is possible and necessary to weave a resilient fabric for the community that will provide for a better future.

The first step in weaving a resilient fabric for Alviso is to characterize the "warp" (the strong threads) and "weft" (the flexible threads) of the suburban fabric. As a start, it is important to identify which threads are most important for the community (warp threads). For Alviso, the ecology thread and the identity thread are the most important. Ecology is very important to Alviso residents for the significance of its protecting and adapting functions. Additionally, people in Alviso care about ecology because of the birds that have shared this space with human being for a long time. Restoring salt ponds and tidal marshes are crucial for preventing sea level rise and habitats degradation. Alviso is also losing its small-town character and community identity. It is crucial to keep people caring and loving their community in order to keep them actively involved in building a resilient community.

The next step of weaving a resilient fabric is to card the relationship between these threads. For the two "warp threads", the ecology thread and the identity thread, there is overlap that makes sharing resilience possible. People in Alviso care about local ecology so preserving ecology can contribute to preserving Alviso's community identity. The "weft threads" should serve to support "warp threads". For example, better public transportation can provide a better

connection to restored marshlands and diverse programming. It can also provide better circulation to make the community active and safe by inviting more active use of streets. Take infrastructure as another example, improving and strengthening existing built infrastructure elements such as levees, dikes, drainage systems, and electricity systems are very important in terms of preventing sudden disasters. Flexible infrastructure such as rain garden and green roof can also improve local ecology.

Planning of Alviso tests the possibility of large-scale implementation of a resilient ecological system. The planning reclaims marshlands as the natural process for habitats restoration and flood prevention. It not only protects people from rising sea level but also connects people with nature. The proposed diverse programming adjacent to the marshlands and the pedestrian and bicycle-friendly transportation system will make preserved nature more accessible and attractive to people. Active circulation will keep the community vigorous. Intriguing programming and diverse activities will keep people caring for and loving of the place they live, which is a key point to strengthen community identity. Collectively, these proposals will help Alviso build a more resilient fabric.

"Weaving resilient threads" in Alviso explores methods to make a more resilient marginal suburban fabric that is adapted to current and future challenges. With the rapid development of city centers in the Bay Area, it is crucial to preserve and enhance the unique characteristics and strengths of Bay Area marginal suburban communities instead of abandoning or gentrifying them. At this pivotal time when Bay Area marginal suburban communities are facing unprecedented

social-ecological challenges, we should let them live with nature and tell future generations brilliant, unique local stories.

Chapter 2. KNOWING RESILIENCE

Resilience is a hot topic being discussed by government agencies, developers, scientists, planners, and designers. It is a strong and flexible approach that can be used in many disciplines such as economic, computer science, psychology, and ecology, etc. The main focus of this chapter is on resilience's earlier use in ecology and society, as well as its broader application in planning and design. The two qualities of resilience, dynamic adaptivity along with complex and clear systems will be discussed to generate deeper knowledge of resilience. Resilience can help us tackle difficult problems that have broad and long-term effects. When facing interrelated and complex social-ecological problems, resilience is a good approach to adopt not only to current simple disturbances but also to long-term and complex disturbances.

2.1 DEFINITION OF RESILIENCE

Innis (1975) defined resilience as the ability of a system to timely return to the original equilibrium after a disturbance.[1] This definition is termed "engineering resilience", and it focuses more on efficiency, constancy, and predictability. Holling (1996) later defined "ecological resilience" as the ability of a system to absorb disturbance without losing its basic structure and function, a definition which stresses persistence, change, and unpredictability.[2] This definition highlights the dynamic natures of living ecosystems.

Over time social aspects were gradually taken into consideration - “social resilience” is defined by Adger as the ability of a human community to bear and to recover from exterior environmental, economic, and political disturbances.[3]

With more research and work on resilience, its definition is becoming more and more comprehensive and refined. The system’s self-organization and adaptative abilities are emphasized. Resilience is now defined by resilience scientists Walker and Salt (2006) as the capacity of a system to adapt to disturbances and re-organize so as to maintain substantially the same function, structure, and feedbacks.[4] That is to keep the essential identity of the system. To keep the essential identity of social-ecological systems is to restore its surrounding ecology, protect its local economy, improve the existing built environments, and conserve community identity.

2.2 Definition of Disturbances

What kind of disturbances do resilient systems need to be able adapt to? A disturbance is a consequence of many shifting forces, including cultural, political, technological, and environmental changes. These changes can occur suddenly in a short period of time or can develop over a long time. Thus, disturbances can be classified into two types:[5]

Sudden shocks: These types of disturbances include natural disasters such as floods and earthquakes, industrial accidents, power failures, drainage breakdown, and economic collapses,

etc. Although these kinds of disturbance occur suddenly, they can be stimulated by the accumulation of long-term latent crises.

Gradual stresses: These types of disturbances include global climate change, urbanization, population growth, and the rising income gap between the poor and the wealthy, etc. Many gradual stresses are not remarkable and are not scientifically tested by professionals when they begin. However, after a long accumulation of hidden problems, this type of disturbance may be experienced as a sudden burst of severe consequences.

Many sudden shocks and gradual stresses are interrelated. This situation adds a great deal of complexity to social-ecological systems. Hence, resilience becomes more and more important as the shifting social-ecological systems become more and more complex and their actions unpredictable.

2.3 Stable States, Thresholds, and Regime Shifts

Multiple stable states and regimes exist in social-ecological systems. Graphically, thresholds may be shown as tipping points between stable states. Crossing a threshold leads to a system transferring from one to another stable state. (Figure 2.1.) Transitions between different stable states are known as "regime shifts" in social-ecological systems.[6] Regime shifts can be gentle and slow or rough and sudden. Some regime shifts are reversible, however, if a system turns into an irreversible state, only resilient intervention can return it to its previous self-sustainable state and the success of this is not assured.[7]

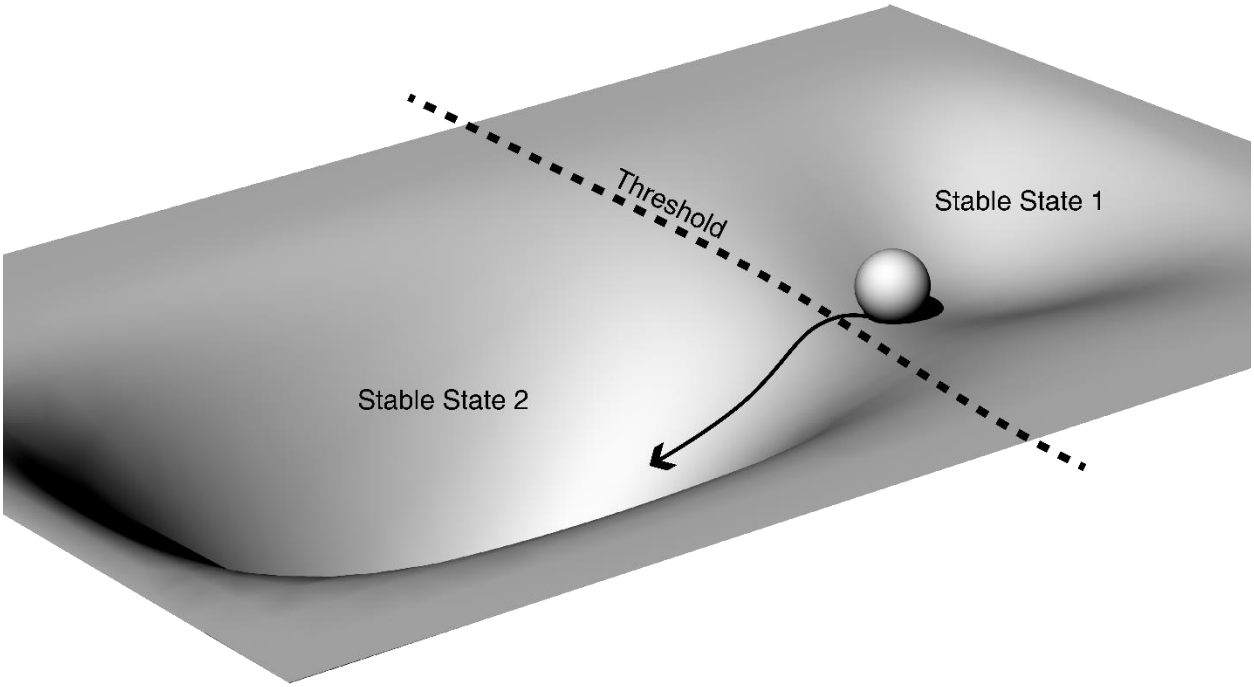


Figure 2.1. Conceptual diagram of a regime shift.[8]

Regime shifts demonstrate the unpredictability of systems. Sometimes, these shifts are not easy for people to perceive. For example, we may not recognize it when a society and its surrounding environment are experiencing regime shifts. This makes keeping systems working and self-sustaining difficult.

The social-ecological systems in Bay Area marginal suburban communities may be at thresholds or have already started to cross these thresholds. One thing that is certain is that we've already noticed many sudden shocks and gradual stresses in these communities. Floods, hurricanes, rising sea levels, losing identity, and gentrification, etc. are pushing Bay Area marginal suburban communities to the edge. Resilient planning and design of social-ecological systems is needed.

2.4 Specific Resilience and General Resilience

The resilience of social-ecological systems can be discussed in terms of "specific resilience" and "general resilience".[9] The specific resilience of systems aims to adapt the system to predictable disturbances. For example, building wider and adaptive shorelines would be a specific resilience response to sea level rise. General resilience is the overall resilience of systems to adapt to both predictable and unpredictable disturbances. General resilience could help the Bay area get through its rapidly growing social and ecological challenges. Specific resilience is essential to solve problems in isolation. But optimizing for specific resilience may restrain consideration of the general resilience of social-ecological systems. This is because overconcern on dealing with specific resilience can reduce the whole area's diversity, flexibility, and responsiveness in terms of intersectional actions.[10]

Failing to design for general resilience may lead to the tragic collapse of social-ecological systems. For example, when superstorm Sandy hit the northeast coastlines of the United States in 2013, New York City and surrounding cities were under severe threats of sea level flooding, power loss, and fresh water shortage for weeks. This catastrophic disaster caused a loss to the economy of around $70 billion. In this example, specific resilience broke down when there was no broad consideration of the general resilience of the whole region. Specific resilience alone is not enough for understanding or predicting the interlocked effects of complex disturbances on society and ecology.[11]

To resist uncertain challenges, a substantially successful strategy is considered to be retaining the capacities for adaptation and self-organization to preserve the same identity of

systems.[12] Comprehensive thinking of specific and general resilience is crucial. Specific resilience can resist specific problems efficiently. General resilience is developed to enable adaptation to a broader range of known and unknown disturbances and is not only beneficial for the whole region but also has positive long-term impacts on specific issues.

2.5 Qualities of Resilience

Two important qualities of resilience are dynamic adaptivity and complex and clear systems. Inspired by natural systems, which are generally self-sustaining, resilient social-ecological systems should be designed to adapt to disturbances by recovering and regenerating themselves. Social-ecological systems are becoming more and more complex as they take human activities and social aspects into consideration. However, influential disturbances are also becoming more connected and complicated. We may take this as an opportunity to plan and design social-ecological systems that are more efficient by keeping the efficient complexity and maintaining clarity in order to approach resilience.

2.5.1 *Dynamic Adaptivity*

Living organisms are inherently resilient because they are able to adapt to disturbances by themselves. Networks of living things are even more resilient than individual organisms because they are usually stronger and more resistant to disturbances. Natural systems are resilient at every level, from the functioning of individual cells to the evolution of species and the balance of broad food webs.[13]

Systems are constantly changing. It is inspiring to learn about the *adaptive cycle* of natural ecological systems in order to understand the qualities of resilience and their influences on broad and complex social-ecological systems. Ecologists have developed the theory of *adaptive cycle* to demonstrate how an integral ecosystem may be self-sustain or change naturally over time. There are four phases in adaptive cycle. They are *rapid growth, conservation, release,* and *reorganization,* which showcase the dynamic nature of the adapting process of ecosystems.[14] (Figure 2.2.)

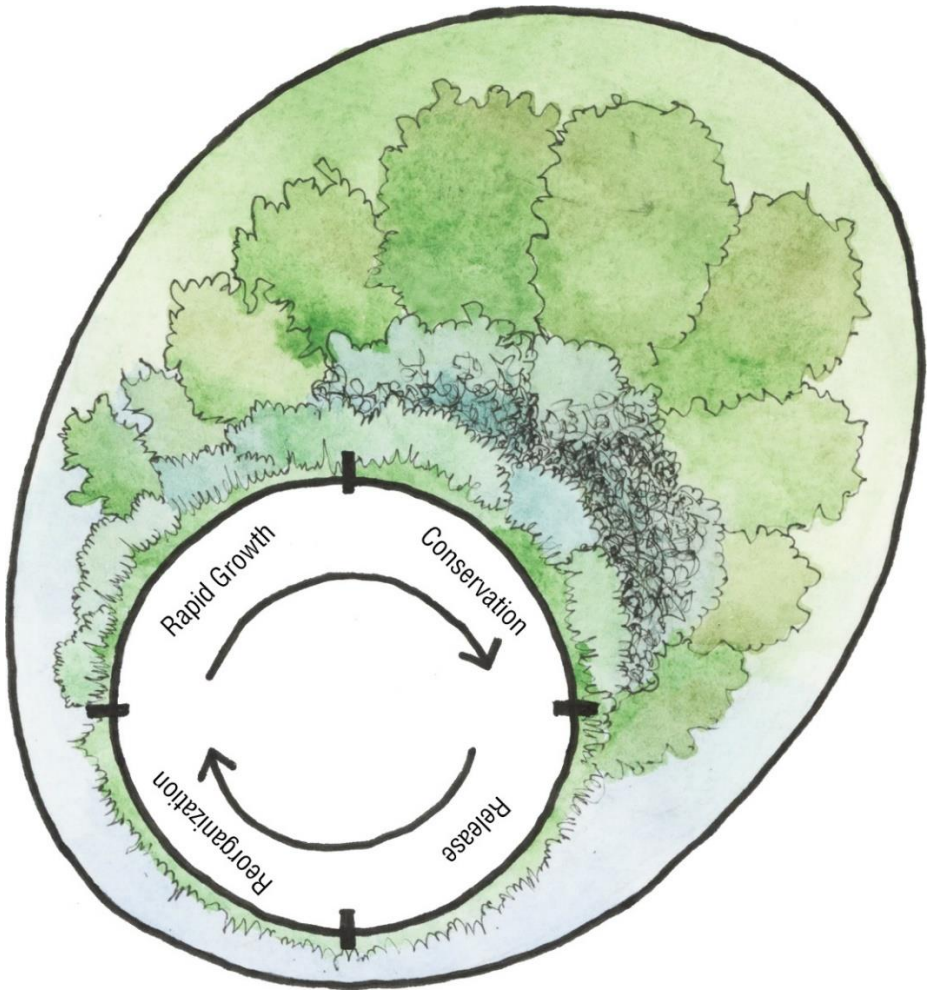


Figure 2.2. The adaptive cycle.

Pioneer forest species are replaced by dominant species after rapid growth. The forest, composed gradually stabilized ecosystem, goes into a conservation phase until a disturbance, such as wildfires, earthquakes, or tornados, breaks the existing balance of the ecosystem. The forest then enters to the phase of release when the ecosystem is no longer connected due to the disturbance. The release phase is harsh to some extent but it provides opportunities for the forest to reorganize with renewed ecosystems of essentially identical functions and structures as before. This is how ecosystems adjust themselves to be resilient when there's little human-induced disturbance. Especially in the last two phases of the adaptive cycle, "release" and "reorganization" are characterized by unpredictability and demonstrate the strong resilience capacity of the natural ecosystem.

Correspondingly, we may describe changes in social systems using the adaptive cycle as a metaphor. After the fast growth of a business, a manager may replace entrepreneurs to enhance productivity. As the scale of operation grows and efficiency levels out at higher level, the mature business system drives into the conservation phase. The business continues to grow gradually bigger and more complex and it gets harder for the system to adjust to new technologies or disturbances from the market. The falling phase of business (the "release" of a business system) is highly uncertain.[15] Under intense uncertainty, resilience prevents the business system from experiencing total destruction and losing substantial identity. When resilience plays this essential role of adapting to the social system, it can lead to positive innovation during "reorganization".

Resilience is important in all four phases of the adaptive cycle because it is important for all dynamic changes. But resilience is especially crucial when the social-ecological systems reach

pivotal points during the “release” and “reorganization” phases, which are more unpredictable and experimental under external disturbance and challenges.

2.5.2 *Complex and Clear Systems*

Resilient thinkers Brian Walker and David Salt describe the complexity of systems in this way:

> “The mechanism that drives an old-style clock is a set of tiny, intricate cogs and springs, often consisting of many pieces. This is a complicated machine… However, the individual pieces are not independent of on another; rather, the movement of one depends one another in an unvarying way… A farm might produce just one item, the farm is far from simple. The farmer, the farming practices, the crop, the soil it grows on, and the market are all interacting and changing over time. This is a complex adaptive system.”[16] (Figure 2.3.)

Figure 2.3. A simple farm system.

In the other word, appropriate complexity is necessary for an adaptive system to work efficiently. Systems get more and more complex with the development of society. To further

elaborate the example of the farm, the development of suburbs for residential and industrial uses as well as many other factors have greatly changed agricultural patterns. New seeding and harvesting machinery enlarge the scale of agriculture. Mature logistical activities enable crops to be transported further to markets. However, with new suburban development, rising housing prices lead to reductions in agriculture land. Pollution and changing weather due to the growth of population and industry also negatively impact food security. All these factors combine directly or indirectly to influence farming practices. The farm is no longer an isolated system when other social-ecological systems are introduced. (Figure 2.4.)

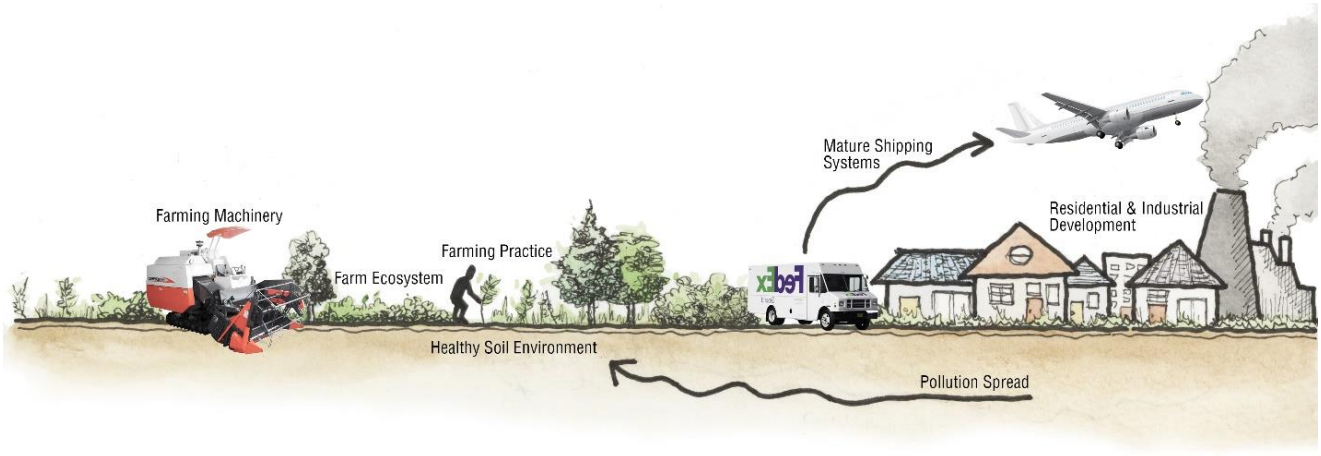


Figure 2.4. A complex farm system that is connected with other systems.

However, excessive complexity in social-ecological systems may inhibit resilience when it hits a tipping point where adaptability descends and resistance ascends. (Figure 2.5.) When systems reach a certain degree of complexity, little disruptions can induce large-scale disconnections and even collapse of systems. For example, a 2002 labor dispute in California shut down West Coast ports for several weeks, costing US companies roughly $1 billion per day.

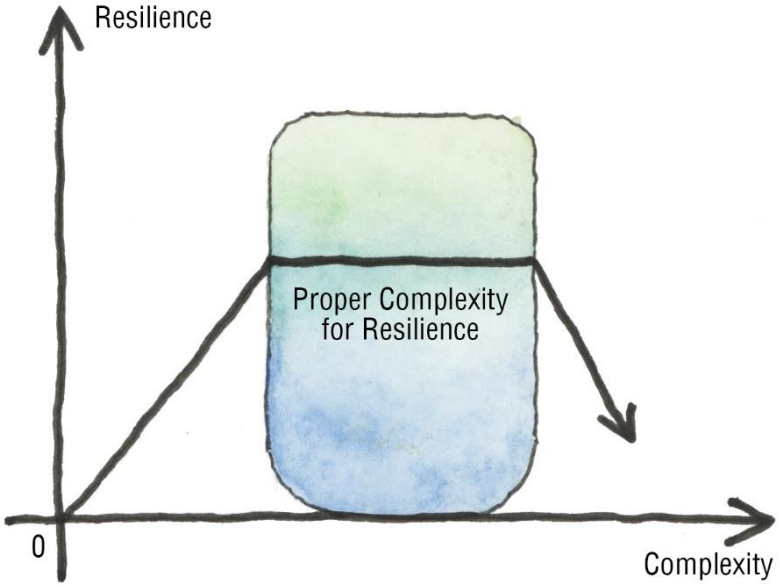


Figure 2.5. The relationship between complexity and resilience.

Social-ecological systems are getting more and more complex with rising populations and rapidly developing technologies. “Complex systems are characterized by highly nonlinear behavior, emergent properties (properties arising in a system because of the interactions between its components), time lags, and unpredictable surprises; they function at multiple, interconnected scales of space, time, and organization.”[17] This nonlinear behavior leads to unpredictability in complex systems. “We can’t impose our will upon a system. We can listen to what the system tells us and discover how its properties and our values can work together to bring forth something much better than could ever be produced by our will alone.”[18]

Thinking in systems, “simultaneously seeing the parts, the whole, and the relationships within a system”, helps us find the complex and clear logic of systems.[19] Knowing clearly how

systems work both individually and cooperatively is important for understanding what is missing and what parts are redundant in the social-ecological systems. A balance of looseness and firmness of connected systems is critical (see Chapter 5).

2.6 Resilience and Sustainability

Resilience is about reducing undesirable variations in systems and maintaining them in stable states instead of shifting regimes. “Sustainability is not about maintaining systems at their equilibrium or optimizing systems’ performance, but rather sustainability focuses on the systems’ ability to create and test opportunities and maintain adaptive capabilities.”[20] Hence, resilience is a key process to reach ultimate sustainability in social-ecological systems.[21]

Chapter 3. THE CHALLENGES AND THE OPPORTUNITIES

The Bay Area is at a pivotal time, facing ecological problems including climate change, sea level rise, floods, droughts, fires, and earthquakes as well as social problems such as energy crisis, uneven distribution of resources and wealth, lack of affordable housing, and loss of community identity. These problems are not separated from each other: human activities have driven ecological degradation to an unprecedented extent. Ecological degradation has driven environmental and energy crises that negatively impact the society. The problems are complicated and interlocked. Systemic thinking by collective intelligence is needed to solve the concurrent problems and prevent future challenges.

Resilience is the capacity of a system to adapt to disturbances without losing its fundamental function and structure.[22] In this thesis, resilience is discussed as a dynamic systemic process to recover from problems as well as resisting and adapting to challenges. Resilience not only resists current crises but also has benefits on ecological and social systems in long-run. Dynamic adaptability along with complex and clear systems are two key qualities of resilience (see Chapter 4), which highly meet the requirement to adjust the interrelated and unpredictable challenges Bay Area marginal suburban communities currently face. Resilience is an important process that contributes to the region's healthy and sustainable development. An innovative and systemic design must be implemented to approach resilience in the Bay Area.

Although the Bay Area is under numerous challenges, it is nevertheless one of the most vibrant and inspiring places in the world. It is still blessed with abundant resources, brilliant

diversity, and robust democracy. Bay Area residents have the potential to recover from the problems and resist challenges by loving, working, and weaving collaborative intelligence together.

To contribute, this thesis will explore a theory of *"weaving threads" as a model for resilience* that can be used to guide resilience in Bay Area marginal suburban communities. First of all, four relevant questions need to be addressed. The first is why I chose the Bay Area for my research; the second is why I focus more on marginal suburban communities; the third is what is the inducement of the ecological and social challenges; the last is why I propose to use "weaving threads" as an approach.

3.1 WHY THE BAY AREA

In a statement from the Office of the Mayor of San Francisco in April 2016, Mayor Ed Lee said,

> "San Francisco has a history of solving our challenges through bold action. On the anniversary of the 1906 Great Earthquake and Fire, we remember our City's past and look to the future. This new office will oversee the implementation of the resilience strategy and continue to work alongside City departments and work with our communities to ensure we are taking the steps necessary to make sure San Francisco rapidly recovers from an emergency."[23]

The Bay Area consists of a dense population - more than 7 million people - that needs thoughtful consideration to approach regional resilience. Although the Bay Area currently faces many challenging problems, it has potential to resist and adapt since adjusting to challenging situations is an important character of development in the Bay Area. The mild weather and diverse resources have nurtured a culture of creation, innovation, democracy, and strong identity to share and protect the land. Collaborative intelligence based on the strong identity will help people successfully respond to the challenges.

The Bay Area is about earthquakes, fires, droughts, floods, and landslides as well as bustling street life and memorable shops.[24] No matter how much uncertainty the Bay Area faces today, it remains one of the world's preeminent centers for nature, culture, industry, economy, education, and technology. The natural resources, vibrant social life, and efficient productivity are still valuable contributions to the nation and even the whole world.

3.2 WHY THE MARGINAL SUBURBAN COMMUNITIES

Rem Koolhaas talked about the countryside in a speech at Melbourne School of Design in Australia in October 2017. In Koolhaas's definition, the countryside is all the space other than the city, including farmlands, woods, oceans, etc. He mentioned that only 2% of the earth's surface is covered by the city centers.[25] The dense city centers accommodate 50% of the whole world's population and contribute 75% of energy consumption and 80% CO_2 emission. (Figure 3.1.) Overconcern about urban issues and neglecting countryside needs have made the world an unbalanced development. Inspired by Koolhaas's speech, the "countryside" that I shall examine

in this thesis are marginal suburban communities located in the Bay Area, pushing by the rising sea level and rapidly developing city centers. Compared to dense city centers and inner communities, the Bay Area's marginal suburban communities receive less attention from city research, planning, and design professions.

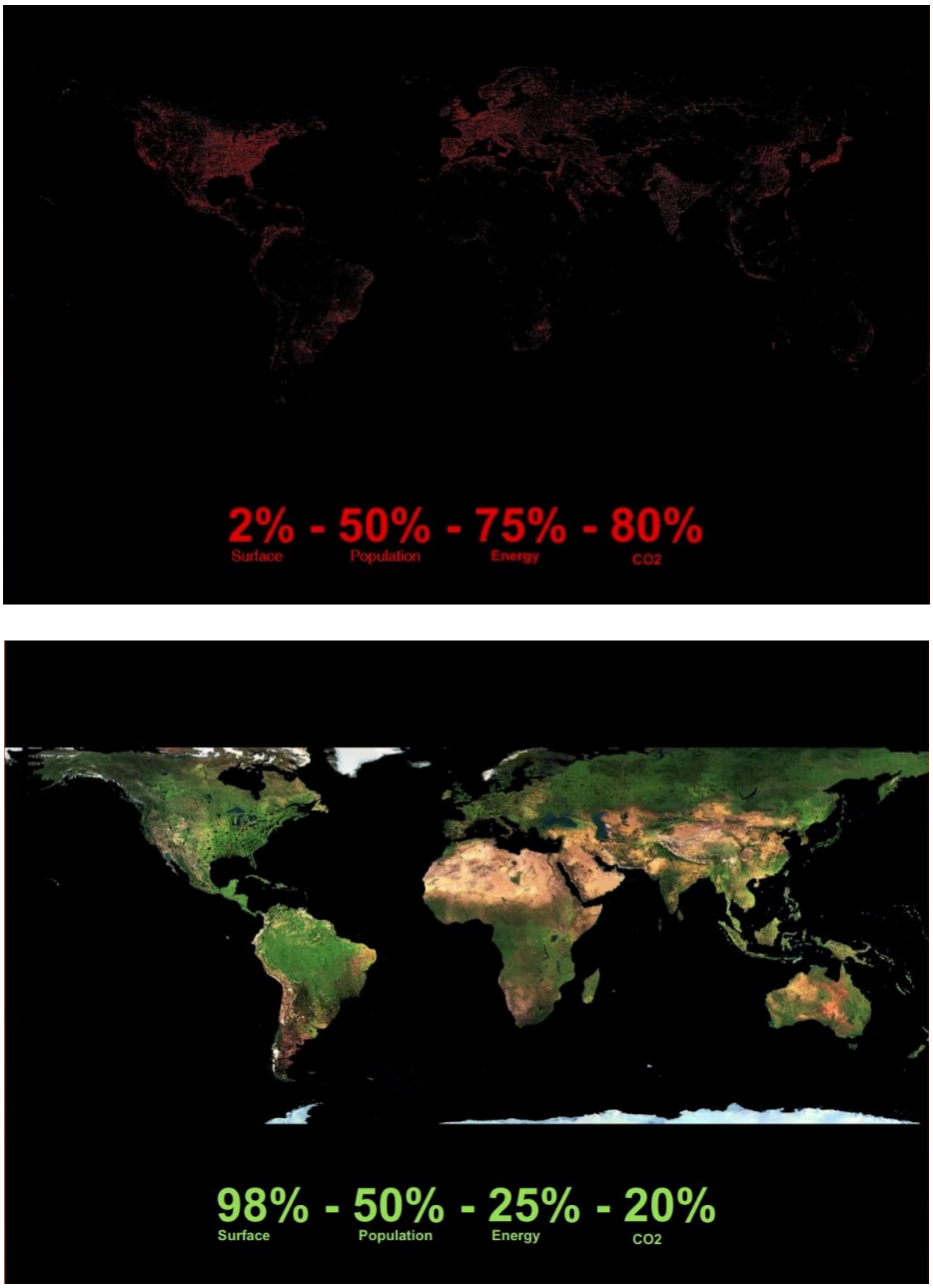


Figure 3.1. Worldwide comparison between city centers and countryside.[26]

City centers typically have easier access to abundant government and business investment than suburbs. The density of Bay Area city centers has attracted much more investment in public transportation, housing, infrastructure, commercial development, and tourism. (Figure 3.2.) High investment in city centers has increased the uneven distribution of wealth, left suburban communities in danger of being ignored by governments and developers.

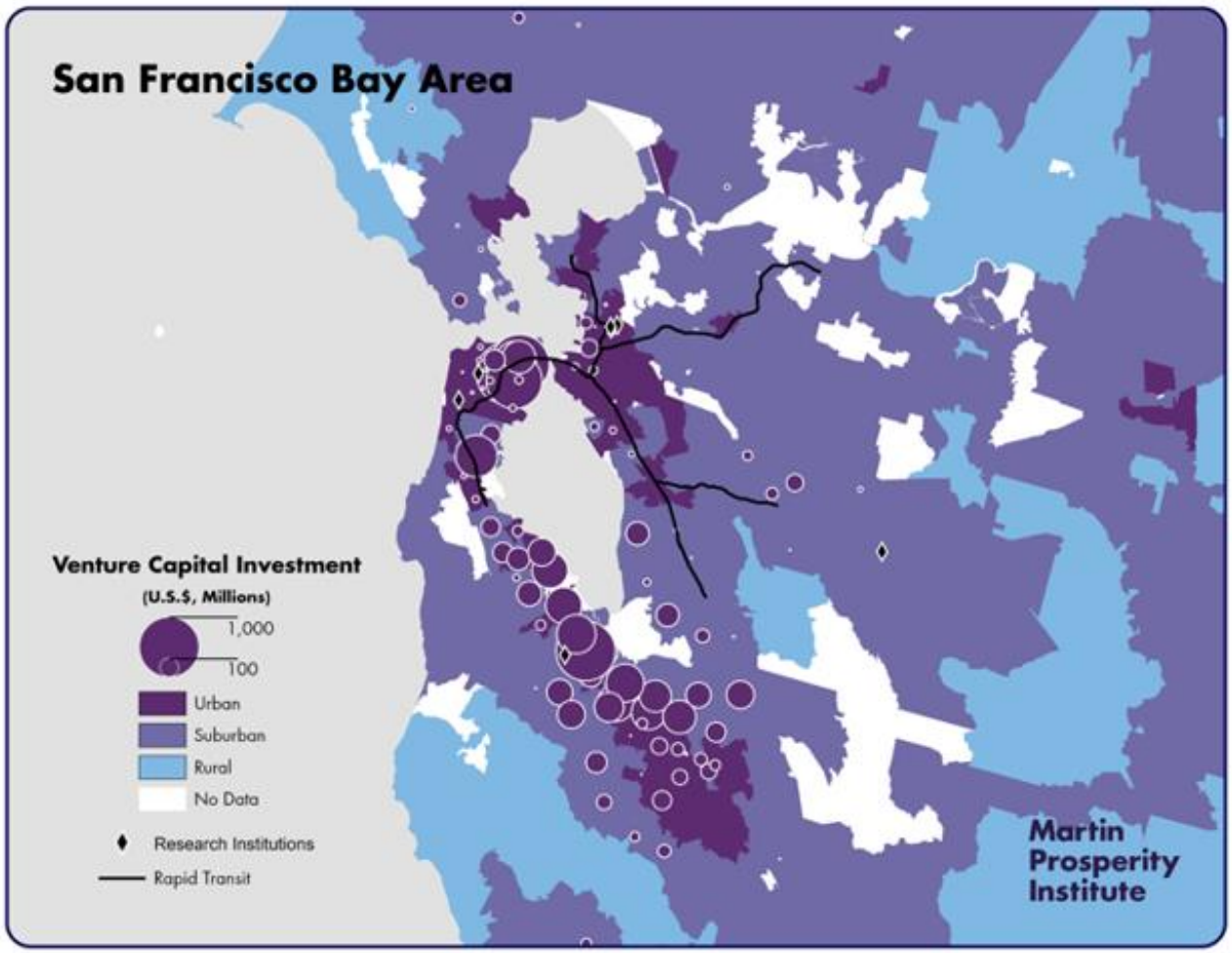


Figure 3.2. Data visualization of venture capital investment in San Francisco Bay Area.[27]

In terms of resilient design, Bay Area city centers are ideal locations for pilot experiments because they tend to receive more private, public, and government support. First of all, the Bay

Area's deep-rooted history of democracy is one foundation that promotes positive social and ecological changes. Secondly, with abundant investment in development and research, city centers receive a lot of attention from planning and design firms as well as professionals in allied fields. What's more, residents living in the city centers mostly have strong self-identity as responsible citizens and awareness of environment and health are vehicles for resilient design. In contrast, suburban residents seem to have more concerns about livelihood. The fact that they possess less strong identity as citizens and are more concerned about basic needs weakens their social, political, and economic voices.

When we turn our sight to the Bay Area's marginal suburbs, we may find vulnerable communities subsisting on limited resources and lacking mobility. Usually segregated from city centers, residents in such areas suffer more from sea level rise threats, lack of systemic infrastructure, as well as lack of convenient access to grocery stores, diverse activities, and recreation opportunities. Passive lifestyle results in marginal suburban community residents gradually losing their identity and faith to make changes for places they reside. The government might abandon a community at some point when it becomes easier to totally change the substantial identity and characteristics of the community than to address and fix the complicated existing problems. For example, Alviso in the City of San Jose is an abandoned community located in South Bay. Despite rich history as a trade and transportation port, it has been gradually neglected by government and developers when urban development in adjacent Silicon Valley became more important. (See Chapter 5) Without enough investment and thoughtful planning, Bay Area marginal suburban communities are incapable of adapting to challenges of sea level

rise, ecological degradation, inconvenient infrastructure and transportation systems, inefficient land use, along with losing community identity.

Many Bay Area marginal suburbs are very important locations for facilities and infrastructure that supply and store materials that support the cities. For example, they may preserve the cities' food, water, and energy supplies as well as accommodate the valuable infrastructure of big companies. If they experience disasters, this will cause tremendous loss and damage throughout the Bay Area. It will even cost more to recover from the damage than to implement new resilient systems. Moreover, if the suburban communities struggle with adversity, this will efface people's faith in and love towards their beloved Bay Area.

Although many Bay Area marginal suburbs suffer from poverty and many other disadvantages, they possess a huge potential for resilient development. Resourceful ecological heritage provides huge potential for reclaiming natural processes to adapt to natural disasters. Abundant vacant space provides opportunities for rebuilding at the proper density. The less complex nature of marginal suburban development also provides an ideal environment for applying new planning and design.

The Bay Area is at a pivotal time to respond to both ecological and social challenges. It is obviously wrong for the region to ignore or abandon its suburbs. Bay Area marginal suburban communities have great potential to develop their local economies, to strengthen their community identities, and to adapt to challenges collaboratively. It is important for design professions to assist the Bay Area marginal suburbs in building resilience.

3.3 WHY "WEAVING THREADS"

"Weaving threads" is a metaphoric approach to make the abstract processes of resilient planning and design more practical and easier for implementation. It is a method to make Bay Area marginal suburban community fabric stronger and more resilient.

Looking down on the Bay Area regional fabric from above, we will observe remarkable comparison between very dense patterns of city centers and loose patterns in many marginal suburbs. (Figure 3.3.) The abandoned marginal suburban communities, wasted infrastructures, flattened topography, and contaminated land are broken holes that people have made to the fabric. These holes have loosened the interweaving threads of the Bay Area fabric as compromise its integrity. The fabric will eventually lose its resilience and break apart if the holes in the marginal suburban communities are not fixed.

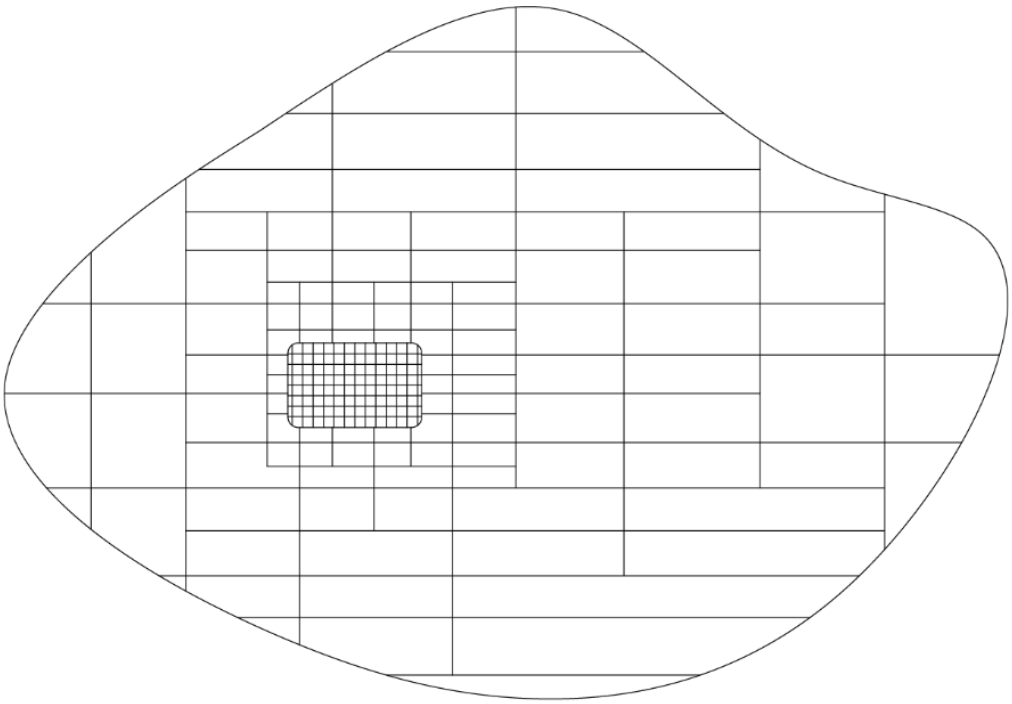


Figure 3.3. Conceptual Bay Area regional plan.

Looking at a section through the Bay Area regional fabric, we see city patterns that are rich, thick, consisting of dense buildings, parks, transportation and infrastructure systems, as well as new technology coverage. By contrast, marginal suburban patterns are much thinner and less diverse. (Figure 3.4.) To some extent, the marginal suburban fabric is more fragile but meanwhile, it clearly possesses big opportunities for future growth and changes. It is crucial to retain its unique strengths while fixing its problems.

Figure 3.4. Conceptual Bay Area regional section.

3.3.1 *The Gradually Fragile Marginal Suburban Community Fabric – A Thinning, Loosening, and Breaking Process*

Research has proven negative human impacts on ecology health and growth. The International Geosphere-Biosphere Program indicates that: 1. There has been a marked acceleration of conditions that are causing environmental adversities around the world; 2. Human activities are unequivocally at the helm of this acceleration; 3. The world is, in fact, facing a global environmental crisis.[28] The unlimited deprivation of resources and unsustainable development have directly or indirectly caused many environmental problems such as global climate change, pollution, sea level rise, floods, droughts, fires, and earthquakes.

Human activities in the Bay Area have led to the unneglectable weakening of the marginal suburban ecology fabric, including flattened and barren land, massive shrinkage of marshlands and vegetation, as well as fragmented eco-systems. These changes have led to unfunctional natural curing and producing process.

- *The Flattened and Barren Land*

Covered by resourceful mountains and waterbodies, Bay Area marginal suburbs have been blessed with geographic advantages, mild weather, and sufficient natural resources. The green

areas and open spaces surrounding the Bay Area have created natural boundaries to grow, nurture wildlife, and provide numerous recreational opportunities.[29] However, Bay Area marginal suburbs are losing their natural advantages due to endless expanding and deprivation by developers. The process of flattening suburban patterns is remarkable throughout the 20th Century in order to save money for rapid development.[30]

Vertically, the geological layers of the earth get weaker because of unhealthy soil condition and depleted underground resources.[31] Horizontally, the flattening barren process has led to massive reduction in marshlands and vegetation in Bay Area marginal suburbs.

- *The Massive Shrinkage of Marshlands and Vegetation*

One of the most evident changes in the ecological patterns of Bay Area marginal suburbs is the shrinkage of marshlands and vegetation. The comparison of the historical and current Bay Area creeks and marshlands distribution shows the massive deduction in lands covered by marshlands and vegetation. (Figure 3.5. and 3.6.) The expanding urban development along with massive shrinking marshlands and vegetation have led to breaking ecosystems in Bay Area marginal suburbs.

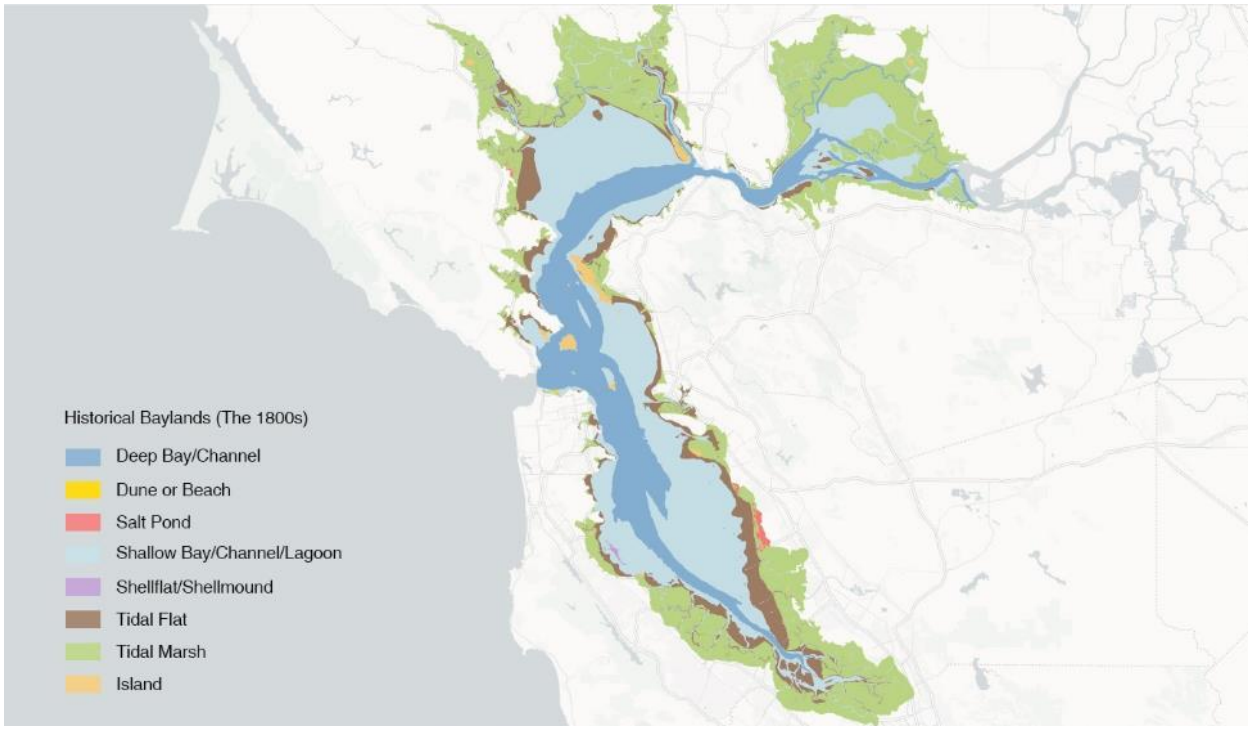


Figure 3.5. The Bay Area historical baylands distribution.[32]

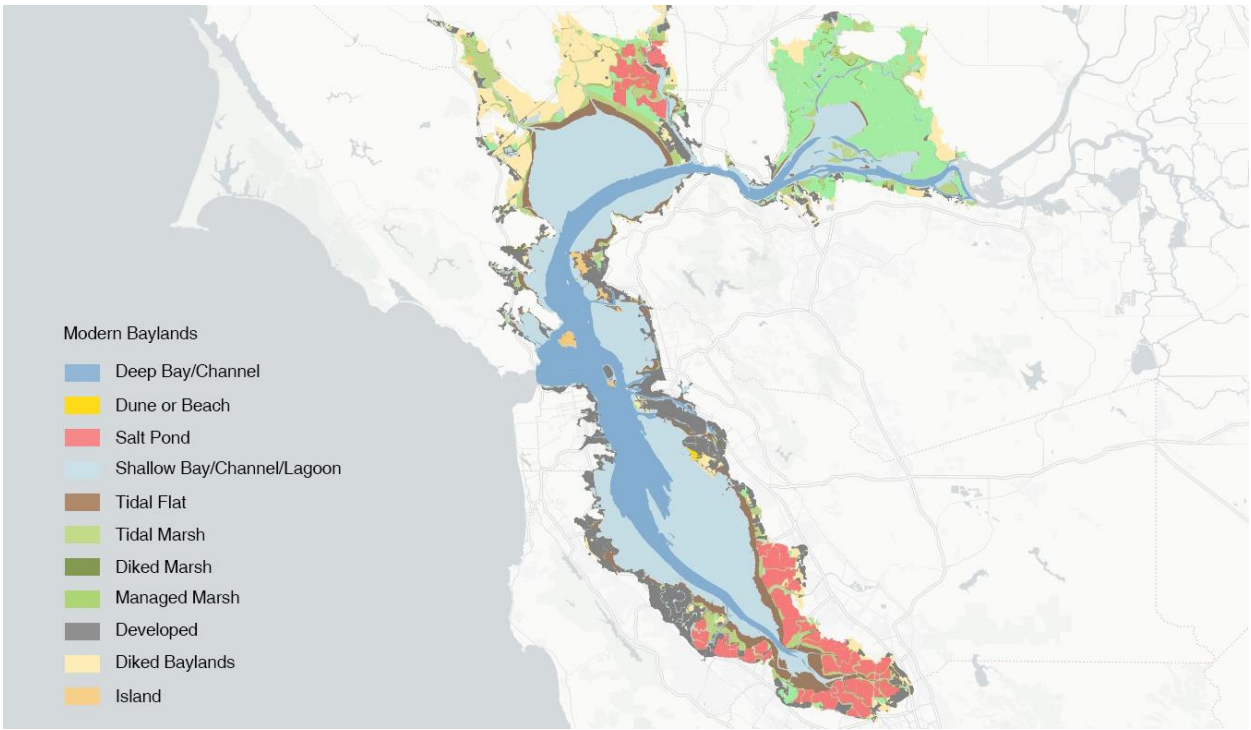


Figure 3.6. The Bay Area modern baylands distribution.[33]

- *The Fragmented Ecosystems*

The connections between ecosystems in Bay Area marginal suburbs are breaking apart mainly due to human-induced reduction in marshlands and vegetation. Buildings, freeways, railroads, canals, and reservoirs, etc. have taken place of woods, marshlands, and natural waterways. The consequence of the unsustainable urban sprawl in Bay Area marginal suburbs is the fragmented, fragile, and endangered ecosystems.[34]

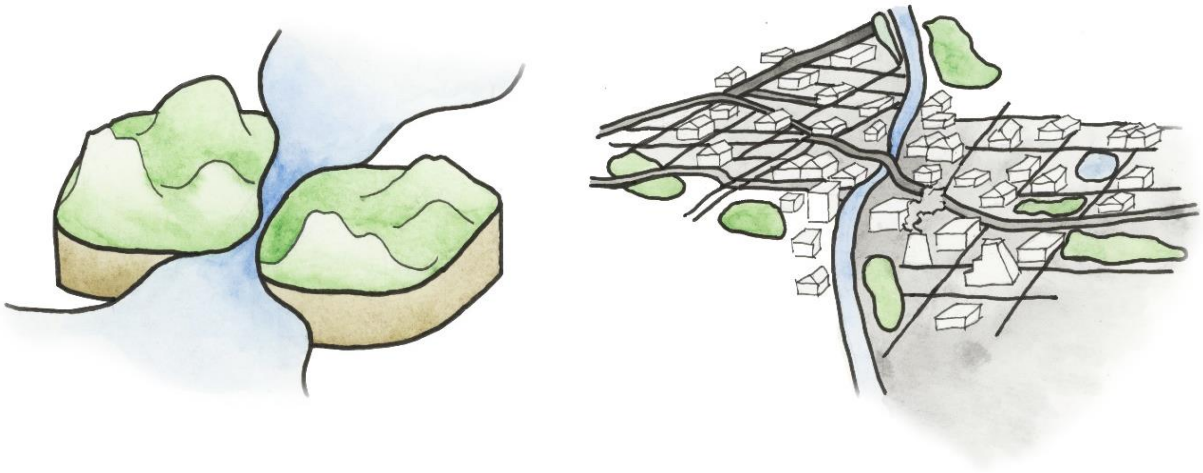


Figure 3.7. The integral ecosystems on the left and the fragmented ecosystems due to urban sprawl on the right.

The degraded ecosystems are left scattering in pieces, gradually losing their strength, diversity, and balance. Nature is losing its ability to heal and regenerate efficiently. It is extremely threatening to lots of native species as well as the environmental health of the whole region.

- *The Failing Natural Healing and Regenerating Process*

The way human exploiting the nature is much faster than the metabolism rate of nature. Nature is resilient itself with the self-healing and regenerating ability of plants, water, and soils. The ability is critical for the Bay Area to adjust unbalanced environment, treat pollution, resist natural disasters, and deal with the energy crisis. However, nature may gradually lose its curing and regenerating ability if the unsustainable development doesn't slow down its pace. The failing natural healing and producing process will expose vulnerable Bay Area marginal suburbs to unprecedented ecological challenges such as global climate change, pollution, sea level rise, etc. The changing ecological patterns such as erratic temperature and precipitation can directly or indirectly increase the frequency of droughts, floods, landslides, etc.[35]

Besides ecological challenges, Bay Area marginal suburban communities are facing social challenges such as energy crisis, uneven distribution of resources and wealth, lack of affordability, and loss of community identity, etc. These problems are extremely challenging because of the dense population, high diversity, and complex systems of the Bay Area.

The rapid but unsustainable development in the Bay Area stretched the suburban fabric thin and fragile. Lack of density, resources, and wealth has further weakened the suburban community fabric. The unsustainable transportation based on private vehicles and freeways highly limits the connection between communities. The weakened suburban fabric is not beneficial to the resilience of the fabric of the whole area.

Retroactively, the vulnerability of the marginal suburban communities has reflected in many aspects at the regional scale.

- *The Unsustainably Stretched City Boundaries*

The communities surrounding Bay Area city centers were built in the late 1800s and early 1900s around public transportation systems, which made it possible for people to work in the city centers while living farther for quietness and peacefulness. People took trolleys, trains, and ferries to work in city centers every day. In the communities, the healthy density was economically efficient to support schools, libraries, local stores, and many other community services within walking or cycling distance. However, the attractive human-scaled planning and design in these communities were ignored by developers when more space for commercial and residential was needed. Instead of re-investing tax money in the reinvention of the established communities by building public transportation, new infrastructure, services, and schools, public money has been using for new suburban development distant from the city centers.[36]

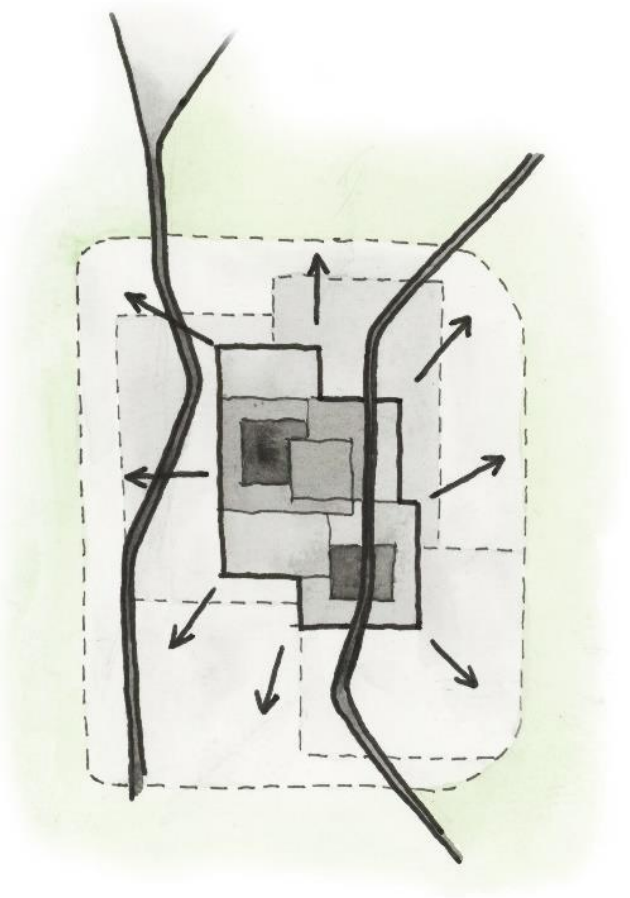


Figure 3.8. The expanding city boundaries.

In search of inexpensive and vacant land for convenient development, the developers and governments turned to the suburbs in the Bay Area. Starting from the 1920s, the private vehicle has become the dominant transportation for residents in the Bay Area. Private cars have largely freed people in terms of living, working, and traveling.

However, in the long term, the ultimate cost of this unsustainable development is huge. Stretching city boundaries and building suburban communities in low-density cost more in time, space, natural resource, and energy. Single families in Bay Area suburbs have used up massive

prime agricultural land and hillside open space… New development in the marginal suburban area that has moved farther and farther from the Bay Area's city centers has stretched the outskirt of regional fabric too thin to be economically, socially, and ecologically sustainable.[37] The marginal suburban economy cannot efficiently support diverse local services, activities, facilities, and infrastructures in a long-run.

- *The Unequal Distribution of Density, Resources, and Wealth*

The rich have a tendency to get richer.[38] Accrediting to constant accumulation of density, resource, and wealth, Bay Area city centers that aggregate more people and resources tend to gain more wealth than marginal suburbs. (Table 3.1.) The situation won't be mitigated unless currently weak density and diversity would be improved. Lack of protection and strengthening of the local economy, the uneven distribution of density, resources, and wealth will further weaken the marginal suburban fabric in the Bay Area.

Neighborhood	Venture Capital Investment (millions)	Density (households per sq. mile)	Walk, Bike, or Use Transit
South of Market/Mission District	$1,063	9,659	61.2%
Rincon Hill	$1,004	9,718	59.6%
Palo Alto	$998	3,194	21.3%
Potrero Hill/Dogpatch/South Beach	$885	7,665	46.8%
South San Francisco	$501	2,049	14.8%
Financial District	$481	2,654	92.1%
Menlo Park	$430	1,309	12.7%
Mountain View	$416	1,158	9.5%
Old Mountain View	$392	3,899	15.9%
Redwood City	$378	1,281	14.6%
Redwood Shores	$369	1,946	5.9%
Sunnyvale	$351	2,199	7.2%
Santa Clara (north)	$313	1,348	5.6%
Financial District/Embarcadero	$306	6,875	60.3%
Sunnyvale	$292	1,213	5.8%
Chinatown	$261	28,252	71.4%
Cuesta Park/Blossom Valley	$250	3,735	14.6%
Hayes Valley/Civic Center	$228	25,103	68.9%
Los Altos Hills	$222	405	7.1%

Table 3.1. Data shows richer communities have a tendency to accumulate more investments and density to improve efficiency in public facility use.[39]

- *The Unsustainable Connection*

Lots of residents in Bay Area marginal suburban communities spend less time at home but more time on freeways to work. Even within the communities, people's daily life is highly dependent on cars. Planning of suburbs in the Bay Area is not friendly to pedestrians and bicycles. The cul-de-sac street patterns are inconvenient for people to walk and cycle freely.[40]

Singularly dominant transportation system - private vehicles - is unsustainable for the healthy development of a community. The unsustainable connection has restrained mobility and circulation in marginal suburban communities. Superficially, massive freeways provide a fast and convenient connection between city centers and marginal suburbs. However, they not only separate the ecosystems but also enlarge the gaps between people in city centers and marginal suburbs in terms of space and identity.

3.3.2 *The Complex and Disconnected Social-Ecological Systems*

The ecological and social problems have great overlap. Complex human activities and human-induced ecology degradation have significant impacts on each other. The challenges in the Bay Area are complicated because we cannot thoroughly fix one problem at a time. The intertwined influence of the social and ecological challenges on each other pushes us to think in systems instead of analyzing the problems in isolation. We need to consider a problem in its system as well as consider the system's relationship to other systems. Social and ecological systems should be considered cohesively, as social-ecological systems.

> "When existing systems have been destabilized, one might well feel a heightened sense of vulnerability. In such times, community support is essential. When existing systems have been destabilized is also when opportunities for systemic changes arise. Another world is possible. Systems that are more equitable and more resilient to environmental change are ours to design and develop."[41]

At the pivotal time when social-ecological systems in Bay Area marginal suburban fabric are turning fragile and vulnerable to disturbances, fundamental change may be needed.

3.3.3 *"Weaving Threads" to Make Resilient Bay Area Marginal Suburban Fabric*

"Weaving threads" is a metaphor for the process of building resilient Bay Area marginal suburban fabric by fixing "holes" on the fabric, adding density and diversity, improving connectedness of systems, and creating a rhythm of firmness and looseness. It guides planning and design toward resilience with qualities of adaptability and systems. The materials and process of "weaving threads" will be discussed in Chapter 5 by using Alviso, San Jose as an example of Bay Area Marginal suburban community. If we weave the suburban systems strong and flexible enough, we can generate an integral resilient regional fabric of the Bay Area instead of a fabric that is strong in city centers but much more fragile in marginal suburbs.

The thesis will also discuss firmness and looseness of the resilient fabric in Chapter 5. Weaving process toward resilience is about strengthening and enriching the suburban fabric, but it is also about leaving some space within the weaved systems as well as allowing the natural growth and spontaneous changes in society and ecosystems.

Chapter 4. RESILIENCE IN PROCESS – THE TRANSFORMING SYSTEMS IN THE BAY AREA

Holling (2001) defined transformability as the capacity to overcome the obstacles of an undesirable regime to create a fundamentally new system.[42] Bay Area social-ecological systems are transforming correspondingly to the current social-ecological challenges. In this chapter, many resilient social-ecological systems that are beneficial to the whole region are analyzed. These systems tested in the Bay Area are a valuable demonstration for the resilient systemic development in marginal suburban communities. The system shifts are streamlined by the sequence of conserving ecosystem, increasing affordable housing, building efficient transportation system as well as improving infrastructure system such as water systems, energy systems, food systems, and waste systems. These exemplary resilient systems are possible to be implemented in Bay Area marginal suburban communities at broader scales.

4.1 CONSERVING ECOSYSTEM

One of the main ecologically resilient strategies is a combination of conserving ecology and building resilient ecosystems that imitate natural patterns and reclaim natural processes. There are two good examples of transforming urban ecosystems to adapt to the current ecological challenges. They are Flood Control 2.0[43] and Re-Oaking Silicon Valley[44].

4.1.1 *Flood Control 2.0*

Rivers, lakes, and oceans in the Bay Area are tremendously modified and changed by people for different land use purpose and flood management. The original flood infrastructure, such as flood control channels and built dikes, are not resilient since they ponderously changed the natural patterns and cannot exert important ecological functions such as sustaining the natural processes of forming and maintaining tidal marshlands.

To prevent the unsustainability of original flood control methods, engineers and managers have turned their sights on transferring sediment from accumulating flood control channels to downstream habitats through rebuilding natural deposition process. This is a resilient process to prevent the Bay Area from sea level rise under threat of global climate change. EPA and other entities funded the project, Flood Control 2.0, that was created to achieve multi-benefits for both communities and ecosystems by redesigning resilient landscape for flood control.

4.1.2 *Re-Oaking Silicon Valley*

Re-Oaking Silicon Valley is a project of San Francisco Estuary Institute. It approaches to integrate oaks and other associated native trees, bushes, meadows, and grass within developed California landscapes to provide valuable functions for both wildlife and people. Oaks are beneficial to mitigate climate change: the canopies of oaks create cool microclimate while the root systems effectively retain and absorb the urban runoff. What's more, oaks are important habitats for wildlife in the Bay Area. They have also sustained indigenous residents by providing

plenty of food resources such as acorns. Additionally, oaks also provide abundant good quality wood material for construction.

However, native oak trees coverage in Silicon Valley has dramatically dropped throughout time. From forming around 80% of all trees on the valley floor in the 1850s to currently composing solely 4% of the street canopies. The Re-Oaking project emphasizes re-establishing landscapes that allow native oak growth in order to support ecosystems' health and growth under tremendous ecological crises. The main strategy of the project is promoting native oak woodlands conservation in order to help the whole area increase bio-diversity and achieve ecological resilience in an urban environment.

4.2 Increasing Affordable Housing

The housing problem is always a big issue in the Bay Area due to consistently rising population. Housing affordability has a great impact on social security, community identity, and regional resilience. Preserving existing housing, increasing affordable housing, building energy-efficient and environmental-friendly housing, and vitalizing local business are several undergoing processes that contribute to Bay Area regional resilience.

The new affordable housing at Balboa Park Upper Yard is developed by Related California and Mission Housing Development Corporation (MHDC).[45] The two-acre site is currently a parking lot jointly owned by the San Francisco Mayor's Office of Housing and Community Development (MOHCD), San Francisco Municipal Transportation Agency (SFMTA), and Bay

Area Rapid Transit (BART). The project will create 80 to 120 units that are affordable to low-income and very-low-income families. Part of the housing will also be designed as a permanent support for formerly homeless households. Adjacency to BART station allows convenient mobility for the future residents. Moreover, the developing process is community-driven: MHDC led a year-long series of community meetings for local voices of suggestions and comments. This affordable housing development demonstrates a good communication and collaboration between different organizations, partners, and community members.

4.3 Building Efficient Transportation System

> "Transportation is the largest source of air pollution and greenhouse gases in the Bay Area. To protect public health and protect the climate, we need to make better use of our transit systems, and we need to build and create livable communities that reduce our dependence on the automobile."[46]

Endowing Bay Area transportation systems with diverse affordable options and equal accessibility is a strategic guide for the region towards a resilient future. Improving existing public transportation, transferring from fossil fuel-reliant to bike and pedestrian friendly transportation systems, and establishing new transportation options are all very important contributions.

4.3.1 *Improving Public Transportation*

Bay Area Rapid Transit (BART) is a regional scale public transportation with more than 400,000 riders per day. Investment on BART was not always efficient: much money was invested on expensive expansions instead of maintaining the core system in better condition. System-scale delay, congested trains, and old interior facilities are the results of the inefficient investment.[47] Now, BART Board of Directors has put more investment on improving existing BART core system. In addition, BART is acting to support affordable housing and walkable streets that are developed around the transportation system.

The other project, Bus Rapid Transit, is undergoing throughout the Bay Area. This project prioritizes bus transportation by increasing bus frequency and calibrating bus line schedule. Methods including adding bus-only lanes, timed green-wave traffic lights (a series of coordinated traffic lights allowing consistent traffic flow), and building rail-like stations, etc. will together make bus transportation faster, more convenient, and more accurate.[48]

4.3.2 *Establishing Bicycle and Pedestrian-Friendly Transportation System*

Research indicates that half of the children walked or biked to school regularly in 1969. In contrast, only one in ten children walk or bike to school.[49] Additionally, a part of rush hour congestion is due to parents driving children to school. The Safe Routes to Schools Program in the Bay Area reclaims safer streets for next generations by building new sidewalks, adding lights at intersections close to schools, and designing bike path in communities, etc. This program

mitigates the traffic congestion, improves the local environmental condition, and educates the next generations by encouraging physical exercise and reducing their reliance on vehicles.

Another similar project is Safe Routes to Transit Program. It strengthens mobility of people in different communities and makes the public transportation more convenient to access. Same to the Safe Routes to Schools Program, this program helps make the streets connected to public transportation safer and easier.

4.3.3 *Shared Mobility*

Oakland Mobility 101 is a sharing bike program jointly initiated by TransForm and the City of Oakland starting from summer 2017.[50] The low-income communities in Oakland have poor access to public transit systems. The bike-sharing system allows short-term rental of public bikes, which is ideal for short trips. Bike sharing makes the trip to public transit faster and more convenient. This investment may tremendously change people's mobility patterns, which can help the community transportation systems complete shift from fossil-based to environmental-friendly.

4.4 Improving Sustainable Water System

The Bay Area faces increasing water crises due to human-induced global climate change's impact on snowpack, potential earthquake's threat on water delivery, regional droughts, unsustainable distribution of fresh water, and population growth.[51]

4.4.1 *Regional Groundwater Storage and Recovery*

The Regional Groundwater Storage & Recovery project includes construction of new infrastructure that consists of chemical treatment equipment, tanks, pumping systems, and associated pipelines. The major method of this project is more groundwater storage and better water recovery, which is also known as “conjunctive water management”. That is to store water in wet seasons and years and recover the stored water for use during drought seasons and years.

During a dry time, the qualified stored water will be pumped up for daily use at a rate of up to 7.2 million gallons per day, which can serve up to 24,000 homes. This project amplifies and diversifies the water supply that can also improve the resilience during not only drought seasons but also natural disasters.[52]

4.4.2 *Water System Improvement Program*

Hetch Hetchy Water System has supported four Bay Area counties’ water supply for around 100 years. Starting from 2002, the Water System Improvement Program initiated by San Francisco Public Utilities Commission (SFPUC) is invested to upgrade and improve the Hetch Hetchy regional and local water systems. This program involves a wide range of 87 projects diverse in size and complexity: from dams, reservoirs, pipelines, and tunnels to water treatment infrastructure, pump stations, and water storage tanks.[53] The program helps protect and strengthen the existing water system to resist natural disasters such as potential earthquakes. The upgraded water systems ensure the reliable water delivery to residents within one day after

earthquake.[54] Although for average residents, the monthly cost of water will rise for better water systems, this program will definitely increase regional resilience in a long run.

As a pioneer city of establishing sustainable water systems, San Francisco is implementing the Local Water Program to conserve local water, use recycled water, and develop local groundwater. As a part of the Local Water Program, the Westside Enhanced Water Recycling Project aims to diversify the water resource by establishing a new recycled water system to support water usage for non-drinking purposes. Within the west side of San Francisco, 8 miles of new recycled water pipelines will convey recycled water to multiple areas for irrigation use. The 840,000-gallon underground reservoir and the aboveground recycled water pump station at Golden Gate Park will also combinedly supply recycled water for park irrigation.[55] This project will largely relieve the competition between drinking water and non-portable water use. The recycled water supply will make the area less vulnerable and more resilient during earthquakes and droughts.

4.5 Decentralizing Renewable Energy System

Reliance on fossil fuel-generated energy has irreversibly undermined the ecosystems. Reducing energy demand, establishing energy-efficient buildings and infrastructure, and improving education and behavior of consuming energy can effectively contribute to reducing dependency on fossil fuel. Moreover, in concern of a resilient future, the transition towards renewable energy such as solar energy, wind energy, hydropower, and biofuel, is in urgent need. To reduce reliance

on fossil fuel and to further transit towards renewable energy, revolutionary and resilient energy systems should be applied.

4.5.1 *Community Power*

Community Power is a report by Al Weinrub from the Sierra Club California Energy-Climate Committee. The project focuses on analyzing benefits of decentralized generation of energy at community-scale. A few benefits of the decentralized generation are increasing cost-effectiveness by saving environmental and transportation cost compared to remote energy generation location; meeting California's Renewable Energy Targets; providing local, equitable economic benefits and jobs; minimizing the environmental impact of renewable energy; and increasing energy security by avoiding the failure of centralized energy generation.[56]

4.5.2 *Sunnyvale Community Solar Array Development*

The report of Sunnyvale Community Solar Array Development discusses the feasibility of sharing solar array by multiple users. The report compares the major characteristics and considerations under different regulatory scenario including city-owned community solar plant, shareholder-owned community solar plant, and third-party owned solar plant. (Table 4.1.)

Option	Key Characteristics and Considerations
Option A: (Model Scenario) City-Owned Community Solar Plant	• Potential service to all city members • City carries significant financial risk, can't utilize tax benefits • May be difficult to find enough city subscribers to offset city investment • Requires Government approval and implementation
Option B: Shareholder-Owned Community Solar Plant	• Potential service only to plant shareholders • City has reduced financial risk, and can also be an investor in the solar plant without loss of tax benefits • Some precedent for model in other states, but at relatively small scale • Government approval required, and additional agreements likely necessary to implement
Option C: Third-Party Owned Community Solar Plant	• Potential service to all city members • City has minimal financial risk • Scalable, utility-based model • Requires government approval and implementation

Table 4.1. Primary options and key characteristics of community solar array development under different regulatory scenario.[57]

Another good example in Sunnyvale is the application of solar array system on Applied Materials' parking lot. The large-scale solar energy usage broadens potential locations for applying the decentralized renewable energy system. The solar panels are not only restrictedly applied in limited rooftop space, they can also be applied on the ground level and be applied at much larger scale.

4.6 EXPLORING HEALTHY FOOD SYSTEM

According to research, 10% of adults in the Bay Area are struggling to find three meals per day consistently and more than half of all adults in the Bay Area are suffering overweight or obese.[58] Food-related health problems are a big issue in the Bay Area. The widespread of fast food restaurants and lack of local grocery stores at community scale negatively influence people's health by cutting off the access to healthy food sources.

4.6.1 *Healthy Food Within Reach*

The report, Healthy Food within Reach, documented by SPUR digs deep in strategies for improving agriculture and food systems in the Bay Area in order to make healthy food more accessible. SPUR claims that the main barriers for people to have healthy food in the Bay Area including a physical barrier, which hinders people from finding healthy food in their own communities; economic barrier, which makes good ingredients unaffordable to poor people; and lack of education on food and health.[59] Local grocery stores in the communities, long-term investment on healthy food encouraging programs, collaborative support from interdisciplinary institutions and organizations become more and more important.

4.6.2 *Veggielution Community Farm*

Along with investment in local grocery stores, the establishment of community farm is also a good way to improve food systems. "They are thus places of magic and inspiration – and hope for a more sustainable food production system in suburban ecosystems."[60] The Veggielution

Community Farm located in the Mayfair neighborhood in east San Jose. The 6-acre community farm relies basically on voluntary work and imported irrigation water. The most educational takeaway from this project is the focus on “community”. The voluntary work vitalized community activities and local residents’ conscience and responsibility towards local food production. The community farm not only provides safe and healthy food for local residents but also enhances community identity by connecting people through the meaningful food production process. There is a big potential to enlarge the scale of this program by educational popularization and improvement in management.

4.7 Closing the Loop of Waste Management System

The waste treatment and transferring system have always been a big problem due to the rising population and massive consumption. Closing the loop of waste system is crucial for building a resilient future in the Bay Area in terms of sustainable use of resource and preventing pollution.

Waste Management (WM) EarthCare is an organization that recycles local organic waste generated by Bay Area residents to produce compost and mulch to farms, gardens, and landscapes. Closing the loop of organic waste helps reduce the carbon footprint associated with raw farm and landscape materials. The compost and mulch are made from food and yard waste collected in Alameda County and Marin County. Compost machinery at Redwood Landfill Composting, which receives 450 tons of compost per day, that are placed into windrows can turn the huge amount of organic waste into compost in about 17 weeks. WM EarthCare also donates compost and mulch to communities that share the same ecological value and mission. The donated materials are usually applied in schools, community gardens, and urban beautification

programs.[61] These funded programs also educate people about the importance of reusing and recycling.

4.8 TAKEAWAYS FROM THE TRANSFORMING SYSTEMS

The transforming resilient systems in the Bay Area are exemplary demonstration and guide for marginal suburban development. With the successful investment on the transforming systems listed above, new investment on improving and changing existing social-ecological systems in Bay Area marginal suburban communities is promising.

The resilient transforming systems highlight the importance of community engagement throughout the process. The transforming resilient systems are mostly community-centered and part of them are community-driven. What's more, there's a balance of modularity and connectedness in the resilient systems. The systems are independently strong but also properly connected to each other to be more efficient.

4.8.1 *Highlighting Community Engagement in System-Transforming*

Many undergoing transforming systems in the Bay Area stress the importance of community engagement. It is important because the designated service systems are ultimately serving local community members. Governments, developers, scientists, and designers' idea and advice are important. However, only the community members know most about the places they live. It is so important to see problems and opportunities from a local aspect. Thus, mutual education between community members and professionals from multi-disciplines is necessary. The communicating

and learning process is important for finding out the main problems and inducement as well as brainstorming foundational solutions.

4.8.2 *Modularity and Connectedness of the Transforming Systems*

Resilient systems should be individually strong as well as be connecting to a wide range of social-ecological systems without hindering their development. The unnecessary connectedness of social-ecological systems may raise the complexity too much and reduce the resilience of a system. For example, Hurricane Katrina in 2005 caused power outages in New Orleans, which led to pollution of the city water supply and loss of many other services. The power outages also interrupted the offer of transportation fuels because most pumps and compressors rely on electric power.[62] In this case, we can tell the importance of modularity of a system. The decentralizing process can enhance a system's modularity. The Community Power program is a good demonstration of decentralizing the energy system to prevent large-scale energy outrages during unexpected disasters. Maintaining modularity can help hedge against dangers of low resilience caused by over-connectedness in system structure and function.[63]

However, the connectedness between social-ecological systems cannot be neglected. From a broader view, the complex social-ecological systems are more or less interrelated. Changes in one system may interfere with others. We need to prevent their negative impacts on each other but also to find the potential of sharing functions. For example, the community food system (Veggielution Community Farm, community-scaled) and the waste management system (WM EarthCare, regional) can collaborate in order to close the loop of food and waste recovery system more efficiently. Separately, these two systems work independently-well. Collaboratively, the

two systems can support each other by providing necessary materials (compost and fertilizer). This combination may greatly promote the efficiency of closing the waste to food cycle.

Chapter 5. AN EXPLORATION OF "WEAVING THREADS" AS A MODEL FOR RESILIENCE IN BAY AREA MARGINAL SUBURBAN COMMUNITIES

In this chapter, the theory of *"Weaving Threads" as a model for Resilience in Bay Area Marginal Suburban Communities* will be applied to Alviso, San Jose, which is a marginal suburban community located in the South Bay. It is vulnerable due to many social-ecological challenges such as rising sea level, losing community identity, and gentrification pressure from adjacent rich area in San Jose. With both great challenges and opportunities, Alviso can be a pilot community for demonstrating theoretical planning guidelines that can lead Bay Area marginal suburban communities towards a resilient future.

The theory discusses the materials that are needed for weaving a resilient suburban fabric. It uses Alviso as an example to showcase the processes of weaving a resilient fabric. It discovers the firmness and looseness of a resilient fabric and guides readers to think critically about the application of the theory.

5.1 WEAVING MATERIALS: THE SIX RESILIENT THREADS

The material selections for weaving a resilient fabric for marginal suburban communities are important. The materials should be strong and flexible in order to resist both sudden shocks and gradual stresses. In this thesis, I have picked six resilient threads that may be applied to weave a

resilient suburban fabric. They are: 1. ecology thread composed of natural ecological system and built ecological system, 2. identity thread composed of culture system and education system, 3. infrastructure thread composed of built infrastructure system and flexible infrastructure system, 4. transportation thread composed of private vehicle-dominated transportation system and public transportation system, 5. land use thread composed of residential land use, commercial land use, and industrial land use, and 6. the assisting technology thread. (Figure 5.1.)

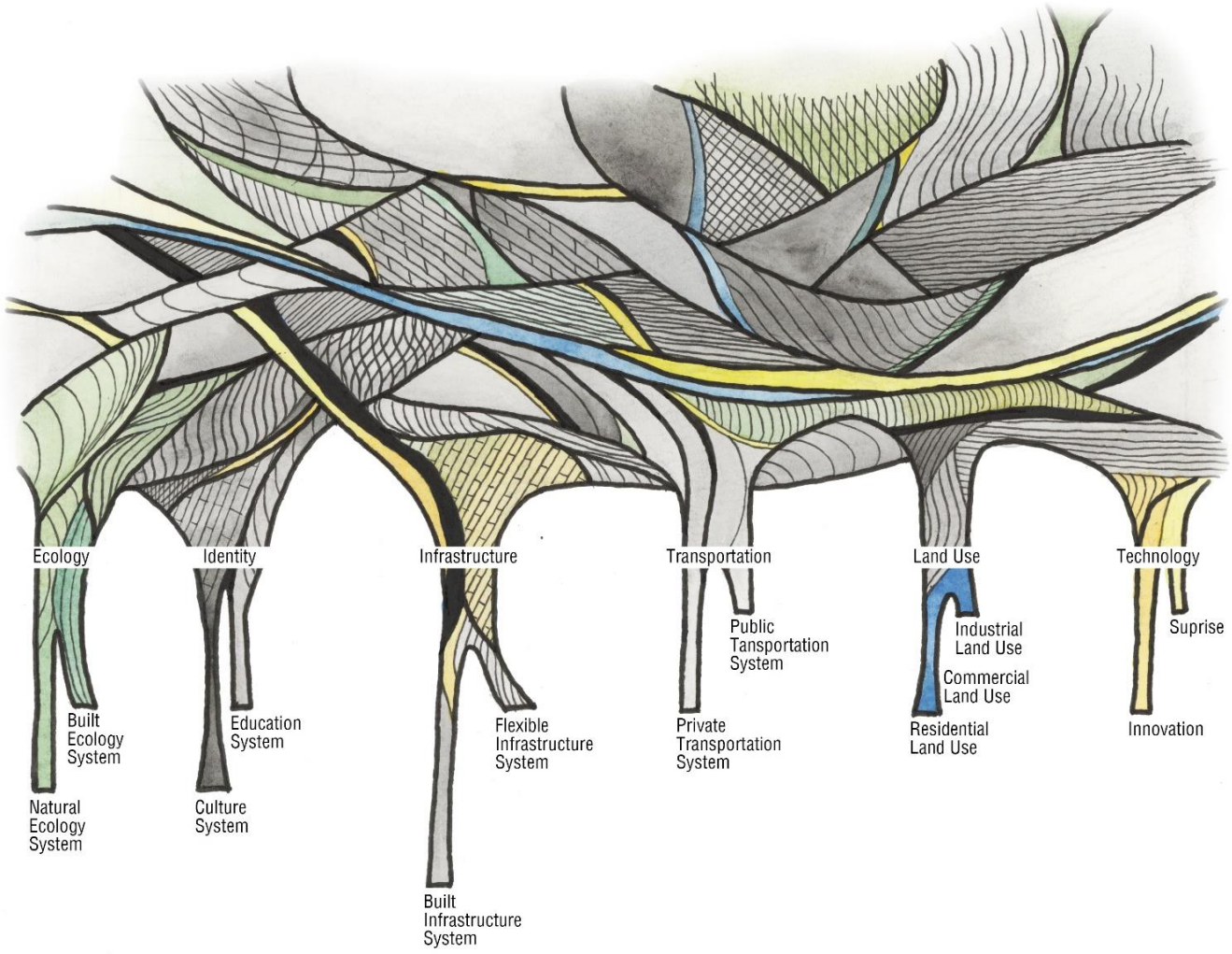


Figure 5.1. The conceptual diagram of weaving resilient suburban fabric by using the six resilient threads.

5.1.1 *Ecology Thread*

The ecology thread consists of two systems. One is natural ecological system, the other is built ecological system. The natural ecological system stresses the resourceful ecological heritage of the Bay Area. The built ecological system is also an important part of the ecology thread. Rain gardens, green roofs, street trees, parks, and farmlands, etc. are all important components of the complex ecological system under a complex city context.

- *Natural Ecological System*

The Bay Area had abundant natural resources. It is blessed with mountains, rivers, oceans, and resource-rich lands. The natural boundaries are crucial for protecting the communities from harsh weather conditions and natural disasters as well as providing fruitful resource and energy. Before large-scale human intervention, the natural ecological systems were adaptive itself. The tidal marshes played an important role as animal habitats and for flood control. The natural water system was integrally connected and adjusted by meandering rivers and creeks through natural processes. Huge areas of trees and other vegetation protected soil from erosion and kept the planet cool.

Protecting the natural ecological system and its self-organization and adaptive ability is important for building a resilient suburban fabric especially for suburban communities that lie on the edge of the ocean. Restoring the degrading ecosystems, strengthening natural boundaries, and improving natural adaptive processes are foundational methods for making the ecology thread resilient.

- *Built Ecological System*

The built ecological system is very important in an urban context, where almost everything is built or altered by humans. The marginal suburban communities discussed in this thesis are not only influenced by rapidly expanding city development but also pushed by rising sea level. The built ecological system in Bay Area marginal suburban communities is usually composed of waterways, marshlands, and farmlands, etc. There is much less investment in designed landscapes in marginal suburban communities.

Nevertheless, rain gardens, street trees, and green roofs are all worth-while investments in terms of a resilient development of the area. The built ecological system fits well with the surrounding built environment. Improving built ecological systems and connecting them with other social-ecological systems is an efficient way to enhance the overall resilience of the area. For example, adding street trees in communities has ecological benefits of stabilizing soil and improving micro-climate. It can also provide shade for pedestrians and cyclists in order to make bicycle and pedestrian-friendly streets more attractive to people. What's more, restoring marshlands, enlarging estuaries as well as widening and curving rivers are all human-intervention methods to restore natural processes. These processes not only conserve animal habitats but also mimic naturally adjusting processes to resolve ecological problems.

5.1.2 *Identity Thread*

Community identity is gaining more and more public attention. Planners and designers have realized the importance of community-driven design because no one knows how to address local problems better than local community members. It is crucial to encourage marginal suburban

community members to stand up and speak for themselves. Meanwhile, planners and designers should listen carefully to community members and think thoughtfully for them. A good mutual educational process may encourage local people to care more and participate more. Through active participation, not only will a good community be built, but community identity will be greatly strengthened as well.

- *Culture System*

Keeping the culture system diverse is important. In the Bay Area, people in marginal suburban communities usually have diverse backgrounds. These communities are a good place to share and celebrate different cultures. It is important to make people of different cultural backgrounds feel cared for and concerned about.

Diversified programs for different cultural backgrounds can keep diverse communities vibrant. If all community members can find food from their hometown, go to religious places for spiritual uplift, and celebrate holidays that matter to them, they will feel being cared for. Correspondingly, they will care more about the communities.

- *Education System*

Education is a conveying and inheriting process from generation to generation. The education system is important because it can actually change people's lifestyles and influence future generations in many ways. For instance, trash diversion is common knowledge and its management is well-organized in Germany and Japan. By comparison, in many countries,

without enough public education, a high trash diversion rate is still very hard to reach. Education plays a major role in this huge difference.

People in the United States have relied strongly on private cars for decades. Governments and developers are partially responsible for planning cities based on a private car-dominated world. Lack of education about ecology, the changing environment, the energy crisis, and the benefits of walking and cycling are other factors that have led to unsustainable development. The power of education cannot be unneglected. Providing good and affordable educational opportunities in marginal suburban communities is a good way to approach a resilient future by fundamentally improving sustainable lifestyles.

5.1.3 *Infrastructure Thread*

Bay Area city centers are developed with complex infrastructure systems. Many of these systems are transforming into a more resilient version by improving their functions, considering the surrounding ecology and environment more, and enhancing their efficiency. A shift in the infrastructures of marginal suburban communities is necessary for a resilient future. Besides necessary infrastructures such as stormwater systems, drainage systems, waste management systems, and energy services, there are many important infrastructures and facilities that are located in Bay Area marginal suburban communities. For instance, some wastewater treatment plants, resource recovery facilities, and electricity generation facilities are located in marginal suburbs. Improving these infrastructure threads in these areas and protecting them from being submerged are urgent needs.

- *Built Infrastructure System*

The existing built infrastructure system needs to be improved and strengthened. Infrastructure systems that are in the planning phase or under construction need to be more strongly built than in the past to resist sudden shocks and sustain long-term service. Smart investment is important in this case. The investment in the Hetch Hetchy Water System Improvement Program and BART transit system improvement are smart and resilient decisions. In the beginning, the investment cost of fixing old infrastructure may seem large. Good-quality infrastructure may cost a lot more to build. However, in the long run, smart investment on improving old infrastructure and enhancing the quality of new infrastructure will show benefits because it can last longer and reduce unnecessary economic and environmental construction and maintenance costs.

- *Flexible Infrastructure System*

Flexible infrastructure systems are usually multi-functional, adaptable, and transformable. For example, stormwater and drainage systems can be assisted by rain gardens, green corridors, buffer lands, green roofs, and other forms of flexible infrastructure. Flexible infrastructures can adjust to different environments and functional needs. Most importantly, as a whole system, they mimic natural processes to filter and absorb flood and polluted water, create milder micro-climates, etc. in order to mitigate ecological challenges.

5.1.4 *Transportation Thread*

Transportation is an important thread that directly impacts people's daily lives. Almost everyone needs to use a transportation system every day, either public or private, to commute to

workplaces, schools and commercial and recreational places. Most importantly, transportation connects people and provides opportunities for people to bump into each other and get to know each other. Good transportation system should focus on human-centered planning and design. Making sure the transportation system is pleasing, efficient, and affordable is key to encouraging people to use it more often. A resilient transportation system should make marginal suburban communities friendly to walkers and bikers. Hence keeping the communities safe, connected, and active.

- *Private Vehicle-Dominant Transportation System*

Private vehicle-dominated transportation systems need to be optimized for better efficiency and reduced environmental costs. Private vehicle-dominated systems also need to transform to a non-dominant position. Planning, design, and regulation should encourage people to use more sustainable public transportation systems.

Transportation systems in the Bay Area are already undergoing positive transitions. In general, the developing transportation system gives people more choices, saves people's time, and also reduces environmental costs. For example, technology assisted road-monitoring systems provide people with real-time information about traffic conditions. With more information, people have the opportunity to choose the most efficient way to commute.

Improvements in efficiency and changes in regulations also encourage people to use public transportation more often. A transition in people's behavior is necessary. There are many new privileges for public transportation such as bus and bicycle lanes and regulatory benefits for

people taking public transportation and riding bicycles. By reducing the dominant privileges of roads, private vehicle use may be reduced in the long run. This is a resilient transition of the transportation system.

- *Public Transportation System*

It is important to thoughtfully consider public transportation systems in marginal suburban communities since they typically have weaker transportation connections and less developed public transportation systems. Affordability, better connection to public transportation, access to more destinations, and increased frequency of buses and trains can make people in the marginal suburban communities more willing to use public transportation.

Instead of considering public transportation in isolation, it is necessary to think about bicycle and pedestrian-friendly connections to public transportation in details. Without pleasing and convenient access, public transportation will lose its advantage. Increased user rates for public transportation will be enhanced by better access, which makes sure public transportation has more advantages than convenient private vehicles.

5.1.5 *Land Use Thread*

Land use in Bay Area marginal suburban communities is more monotonous and spacious than in city centers. Residential, commercial, and industrial land uses are segregated by wide roads. People have to drive a long way to the places where they work and shop. There are many vacant grey fields between the different land use being wasted, covered by barren and dusty soil.

Densifying and diversifying land use patterns in marginal suburban communities are resilient approaches that will reduce waste of space and improve the community's environment.

- *Residential Land Use*

Residential housing with appropriate density can make full use of precious and limited space in the Bay Area. The constantly rising population and limited affordable land are problems for sustainable development.

In high-density city centers, there are more dense condos and apartments. High density is a prerequisite for high frequency transportation and infrastructure use and efficiency. By comparison, in marginal suburban communities, single-family housing dominates. This land use pattern stretches the suburban fabric and low density also reduces the efficiency of many systems.

There is potential for mixed-density housing in marginal suburban communities, retention of residential neighborhoods located within villages and opportunities for new medium density residential development.

- *Commercial Land Use*

Large commercial areas are usually distant from the residential areas in marginal suburban communities. People drive to commercial centers for one-time shopping for a week or longer. The segregation of residential and commercial land uses restricts movement of people and encourages large-scale shopping center to take the place of local businesses. Encouraging development of local business is good for a community's health.

- *Industrial Land Use*

Industrial land uses are common in marginal suburban communities. Currently, industrial areas are mostly separated from the residential and commercial area. The division can lead to the large area of inactive space and irresponsible environmental management around the industries. Adding a variety of mixed land uses to industrial area can encourage diverse activities in these areas, stimulate community circulation, improve safety, and restore ecological systems in the open industrial area.

5.1.6 *Technology Thread*

Rapidly developing technology is in part responsible for the changes and challenges that the Bay Area is facing today. The invention of private cars freed people to go wherever they want, which was a major reason for unsustainable development and stretching of the urban fabric. Technology also brought convenience to manufacturing and construction industries. The convenience has also driven massive use of energy and resources, with consequential ecological problems. History has taught us lessons about the pros and cons of rapidly developing technology. It has made people's lives much more convenient and efficient but on the other hand, current high efficiency may negatively interfere with future generations' development. It is crucial to take technological development into consideration when planning and designing future communities.

A resilient technology thread should be in a subservient position instead of a dominant position when weaving resilient suburban fabrics because it is changing so rapidly. Due to its

rapid changes, technology can be dangerous when people apply technology at large range since the influence of the application of this technology can be unpredictable and hidden.

For example, electric cars are positively transformative in some respects but not others. The popularization of electric cars may be problematic because they may encourage private vehicle usage instead of fundamentally changing people's lifestyles to make them more resilient. The actual cost of energy to produce adequate electricity for electric cars is huge.[64] A worst-case scenario is that people may rely more on private electric vehicles because they think they consume clean energy. It makes an "out of sight out of mind" situation worse by developing without having people worry about leading a convenient but unsustainable lifestyle.

New technology is not the main focus of this thesis. However, the significant benefits of technology should not be neglected. Technology is the foundation for human development and it truly makes our lives better and more convenient. What's more, it can assist in building a resilient future. Technology such as the Internet of Things (IoT) and computer assisted smart city projects are sustainable concepts for building resilient cities. Technology makes using big data to detect and observe potential social-ecological crises easier. With the help of new technology, many resilient city projects such as improving public transportation, sharing bicycles, recovering waste, recycling water, etc. can be implemented.

5.2 WEAVING A RESILIENT FABRIC FOR ALVISO, SAN JOSE

The purpose of the plan and guide is to protect and enhance the small-town quality of Alviso by guiding appropriate new development, community facilities, infrastructure, transportation system, and reclaiming natural process to conserving the local ecology and prevent the damages from rising sea level. By weaving a resilient fabric that can resist sudden shocks and adapt to gradual stresses, the community identity will be enhanced.

5.2.1 *An Overview of Alviso*

Located at the northern end of San Jose (Figure 5.2.), Alviso is a suburban community known for its small-town character, rich history, and special bayside location. In addition, it has wide open spaces, agricultural lands, and a mixed land use of residences, commerce and industry.

Figure 5.2. Alviso regional context.[65]

Alviso has a rich history. Its original name was Embarcadero de Santa Clara. There was a waterfront area established surrounding Alviso Slough at the estuary of the Guadalupe River to the San Francisco Bay. The Embarcadero was a trading center for 18th-century Spanish settlements. The community changed its name to Alviso. Ignacio Alviso was the person who received a Mexican land grant for the community. In 1840, the Alviso port was built. The open water provided the connections to world markets for trading agricultural products and other materials and productions. A regular steamship transportation service to Alviso started in 1850. In the 1850s, during the Golden Rush, hotels, stores, and residential areas were established throughout the area.

Alviso's fast decline as a port and trade hub started with the opening of the railroad from San Francisco to San Jose in 1864. Fewer people traveled and products sent through the waterway after the establishment of several railroads.

The Bayside Canning Company is a local historic landmark. It was built shortly after the earthquake in 1906. As one of the biggest canneries in California, the Bayside Canning Company hired hundreds of Chinese workers who lived in Alviso. The company closed down in 1931. The Bayside Canning Company and its adjacent area have significant historic value. The western area of Alviso is listed as a Historic District on the National Register of Historic Places. The 60-acre Historic District is surrounded by ecologically significant Marina County Park and Guadalupe River. (Figure 5.3.)

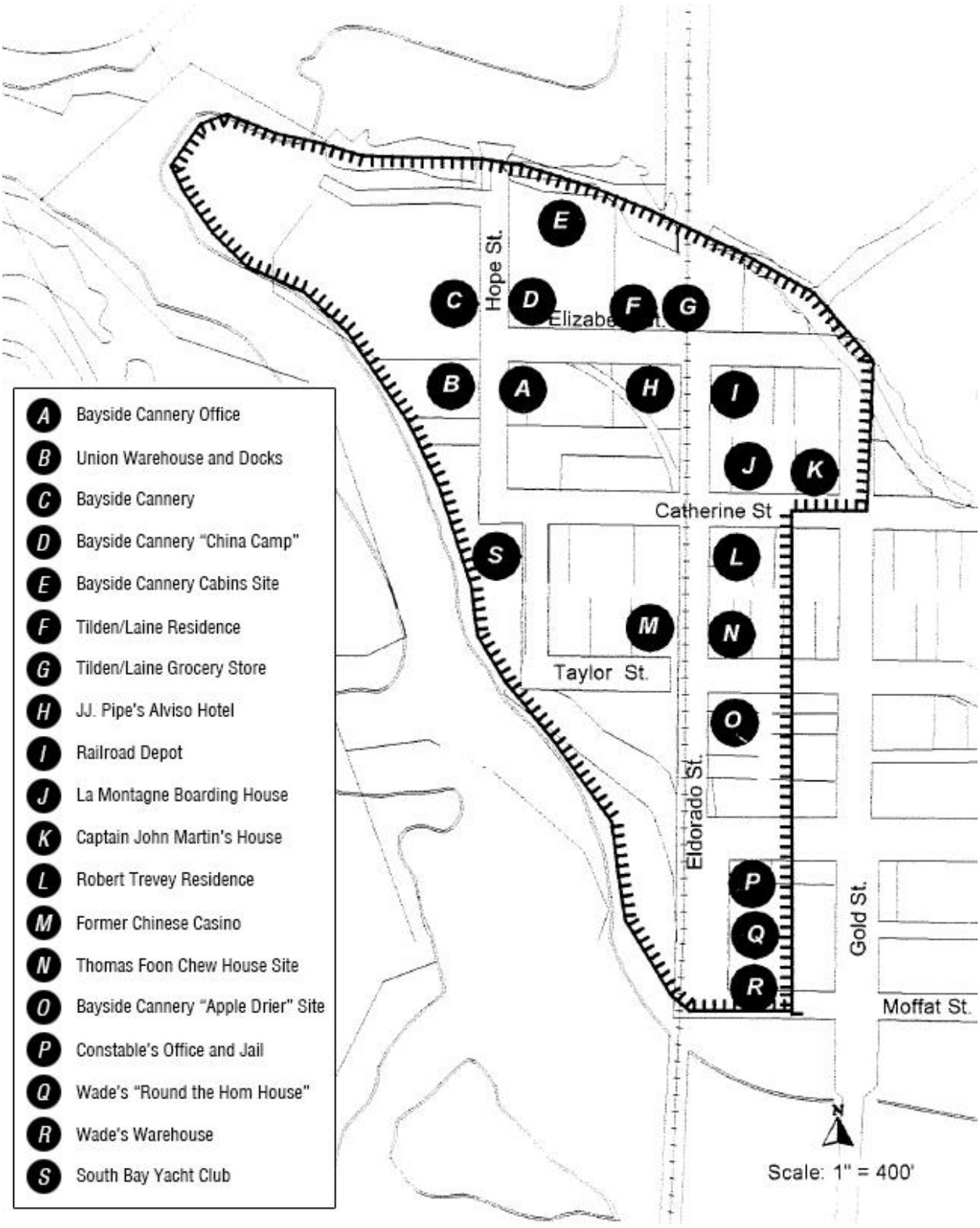


Figure 5.3. The Alviso Historical District.[66]

Alviso was consolidated into the City of San Jose in 1968. It now lies between an area prone to rising sea level and the expanding city development of San Jose. Here's a brief historical timeline of Alviso indicating important events that mark its development. (Figure 5.4.)

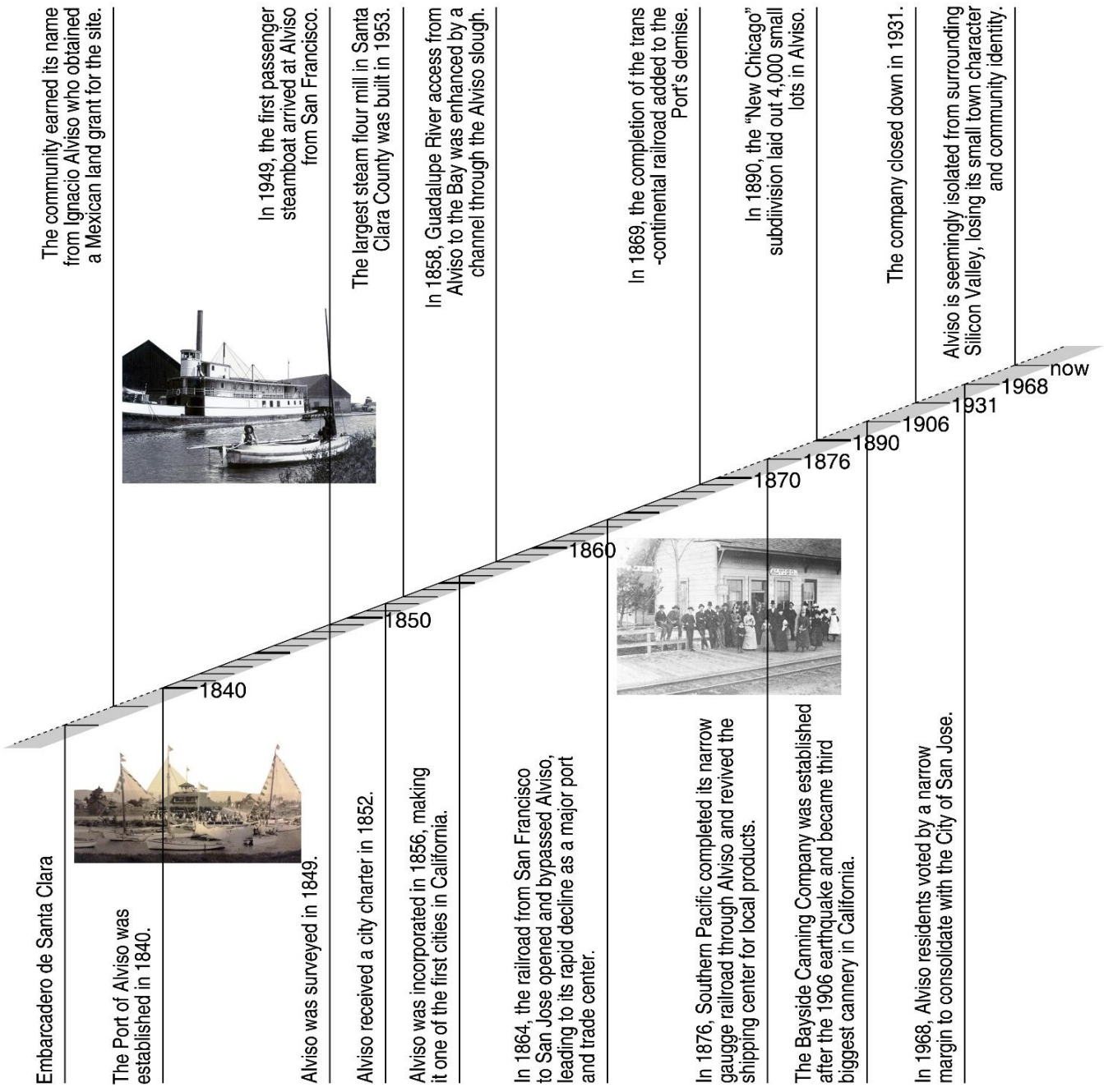


Figure 5.4. The Alviso historical timeline.

Land use in the community includes single-family residences, a few duplexes, triplexes, and small apartment buildings, small local grocery stores, restaurants, warehouses, and light industry. Alviso also has the only yacht club and associated harbor in San Jose. Local ecology is important to residents of Alviso. The Alviso Marina County Park, Don Edwards San Francisco Bay National Wildlife Refuge, and Cargill salt ponds occupy a large area on the outskirts of Alviso beyond the civic service area. There is a wastewater treatment facility in the eastern part of Alviso and a landfill facility located to the northeast. (Figure 5.5.)

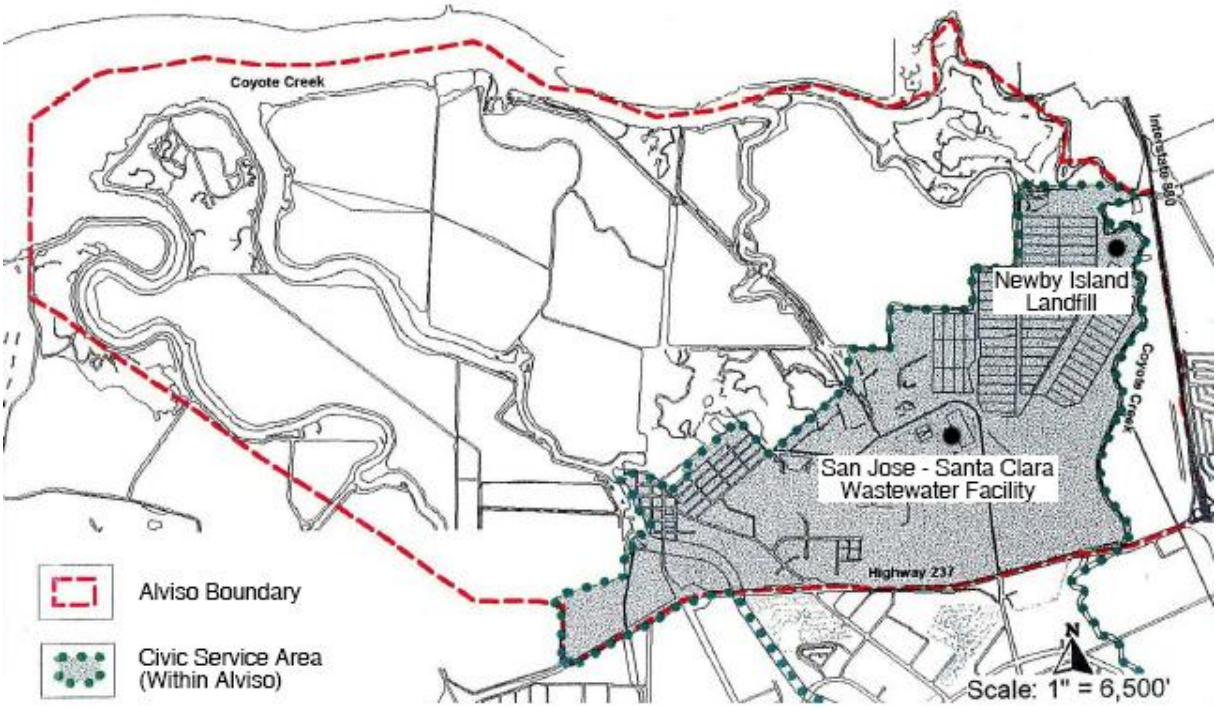


Figure 5.5. The civic service coverage in Alviso.[67]

5.2.2 *In-between the Rising Sea Level and Rapid Urbans Development*

Alviso is separated by Route 237 from the southern area of San Jose and is adjacent to San Francisco Bay. It looks like a self-contained small town. Alviso is a marginal suburban community between areas prone to rising sea level and the rapid urban development of San Jose.

Under a scenario of 5-foot sea level rise in a century, almost all of the community is under threat of a hundred-year storm surge if no better planning for the community occurs. (Figure 5.6.)

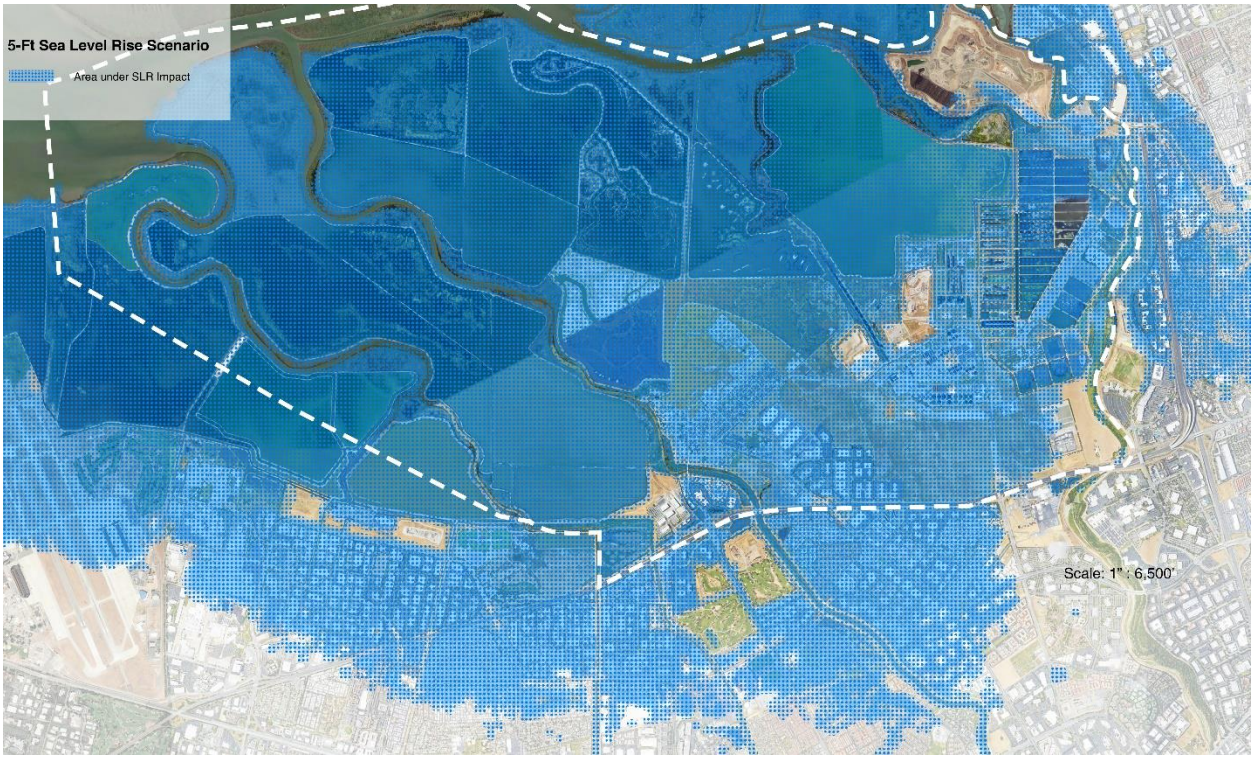


Figure 5.6. Surging area under a 5-foot sea level rise/century scenario.

Alviso is developed on resource-rich land surrounded by tidal marshes, salt ponds, and freshwater watercourses. The current landscape can be classified into six types by elevation,

mostly protected by dikes and levees. Only upland (1 foot and up) and high marsh (0.1 foot to 1 foot) are higher than sea level. The middle marsh (-1 foot to 0.1 foot), low marsh (-2 feet to -1 foot), mudflat (-6 feet to -2 feet), and subtidal (-8 feet to -6 feet) are under sea level. (Figure 5.7.) The residential area is mostly built on mudflat topography. In general, Alviso has a comparatively flat and muddy topography with abundant ecological resources. Alviso has unstable soil conditions that include high groundwater level, expansive soils, undocumented fill, and alluvial deposits of low-density sands. These poor soil conditions are hazardous for any future development such as establishing facilities and infrastructures as well as resisting earthquakes and sea level rise.

Figure 5.7. Current land types in Alviso.

Under a scenario of 5-foot sea level rise in a century, the land of Alviso will be mostly underwater. Landforms will be more and more uniform which may further reduce biodiversity. (Figure 5.8.)

Figure 5.8. Future land types in Alviso under a 5-foot sea level rise/century scenario.

Alviso's adjacency to naturally-formed tidal marshes makes it a very important natural habitat for native birds and many other animals. (Figure 5.9.) The United States Fish and Wildlife Don Edwards San Francisco Bay National Wildlife Refuge, which is located in Alviso includes 3,000 acres for migratory birds and endangered species.

Figure 5.9. Current marsh wren habitat in Alviso.

Native bird habitat will be influenced by changes in landform. Take the common marshland breeding, marsh wren, as an example. The current distribution of marsh wrens is majorly scattered throughout the tidal marshes surrounding the salt ponds, and in some urban parks in southern Alviso. The impact of highly potential sea level rise promises to expand the area of marsh wren habitat. However, it would be driven closer to the center of San Jose under a scenario in which Alviso is flooded. (Figure 5.10.) There is a possibility to enlarge bird habitats in the northern tidal marsh and salt pond area, allowing birds to live with people in Alviso.

Figure 5.10. Future marsh wren habitat in Alviso under a 5-foot sea level rise/century scenario.

For decades, its location close to the edge of South Bay and predominantly mudflat topography has protected Alviso from being overtaken by the urban development of San Jose. However, due to the rapidly rising population and fast development of Silicon Valley and surrounding area, Alviso is facing inevitable housing pressures from Silicon Valley while current residents worry about their livelihood and the environmental impacts of sea level rise and floodings. As the land use diagram in the San Jose 2040 General Plan indicates, commerce will be the main type of development in Alviso. Alviso is included within San Jose's urban development boundary. (Figure 5.11.)

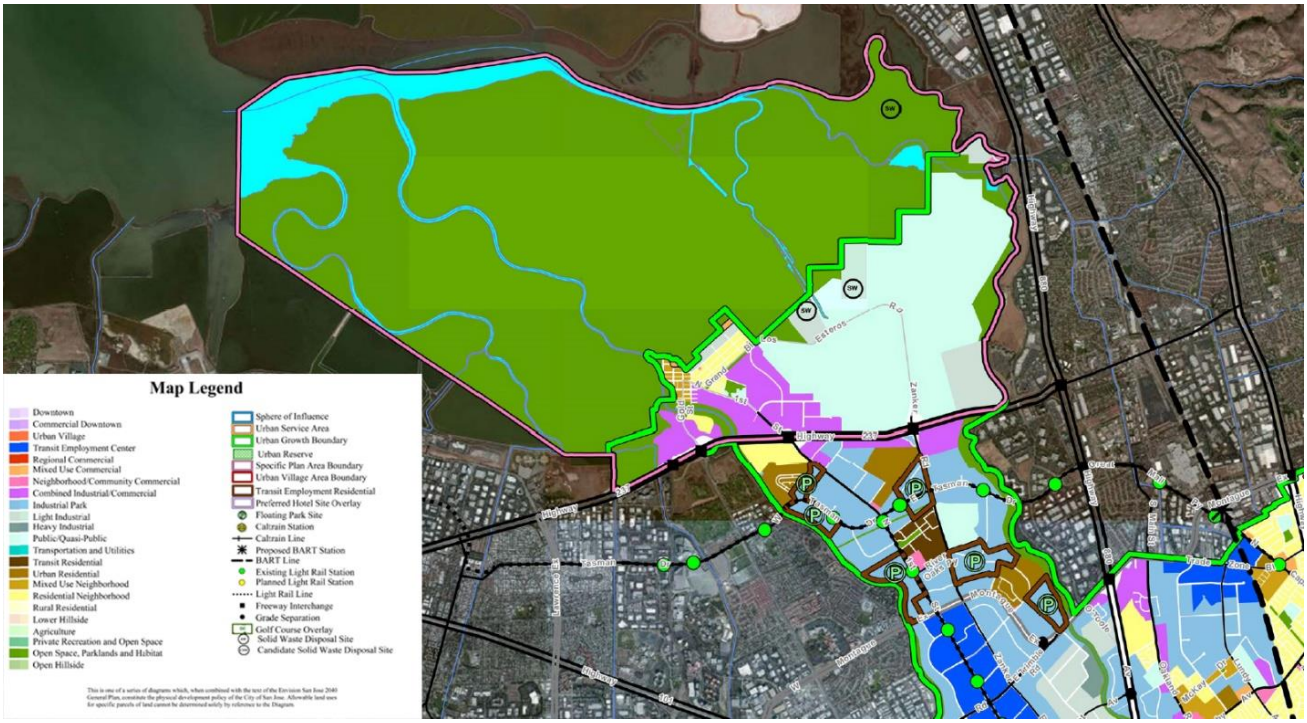


Figure 5.11. Land use map of San Jose General Plan 2040.[68]

Nowadays, its closeness to Silicon Valley and its separation from it by Route 237 are causing an identity problem in Alviso. In a survey, a resident named Mike Hauser who lives in Alviso and works in San Jose described his feeling about Alviso: “You’re this close to the forefront of technology. It’s like you’ve got the future right next to the past.”[69] Although there are no immediate sudden shocks from rising sea level or urban development, Alviso is certainly under long-term threats from both of these. Building a resilient fabric for Alviso is urgently needed.

5.2.3 *Strength in Ecological Heritage and Community Identity*

Despite its big ecological and social challenges, Alviso has characteristics and strengths that make it unique. The two of the main strengths of Alviso are its ecological heritage and community identity.

- *Strength in Ecology Heritage*

Historically, Alviso had resource-rich and scenic marshlands along with convenient access to open ocean water and freshwater creeks. (Figure 5.12.)

Figure 5.12. Historical marshlands (shaded area) in Alviso, 1867.[70]

The Alviso Marina County Park and the United States Fish and Wildlife Don Edwards San Francisco Bay National Wildlife Refuge located in Alviso retain its significant ecology. (Figure 5.13.) The large area of marshlands and salt ponds provides great opportunities for ecological preservation and huge potential for the large-scale reclaiming of natural processes for flood control.

Figure 5.13. The scenic Alviso Marina County Park.

- *Strength in Community Identity*

The small but diverse population of Alviso have a strong sense of the community's rich history and natural heritage. Alviso consists of over 2,000 residents, 500 buildings and structures,

as well as more than 3,000 commuters who work and travel through the area every day, Alviso has unique small-town characteristic despite its proximity to high technology industrial parks in Silicon Valley.[71] The intimate scale of Alviso provides close proximity to anywhere in the community and great opportunities to meet and build trust with neighbors. Improvements in education, activating community activities, and improving the community environment could make big differences for this charming community.

5.3 WEAVING PROCESS

Using the six resilient threads as materials, the weaving process for building a resilient marginal suburban fabric is complex and clear. The process encourages people to think about the relationships of different threads. It will make the interrelated threads both strongly independent and collectively efficient. Thus, when major disturbances happen, people will have better vision and knowledge of the complex and clear fabric and will respond efficiently instead of panicking through the unexpected disturbances.

5.3.1 *Characterizing the "Warp" and "Weft" Threads of the Marginal Suburban Fabric*

"Warp" and "weft" threads are the two basic components of weaving that turn threads into fabric. In a fabric, the warp are the strong threads which support the fabric. The weft are the flexible threads which go through the set of warp threads. *"Weaving threads" as a model for resilience in Bay Area marginal suburban communities* uses the word "warp" as a metaphor for the more important resilient threads and "weft" as a metaphor for assisting resilient threads to build a resilient marginal suburban fabric. For Alviso, the warp threads are the ecology thread and the

identity thread which express the community's remarkable strength; which need thoughtful improvement and transformation to create a resilient future. The weft threads are the transportation thread, the infrastructure thread, the land use thread, and the technology thread. The weft threads can support the warp threads and assist in enhancing their performance. (Figure 5.14.)

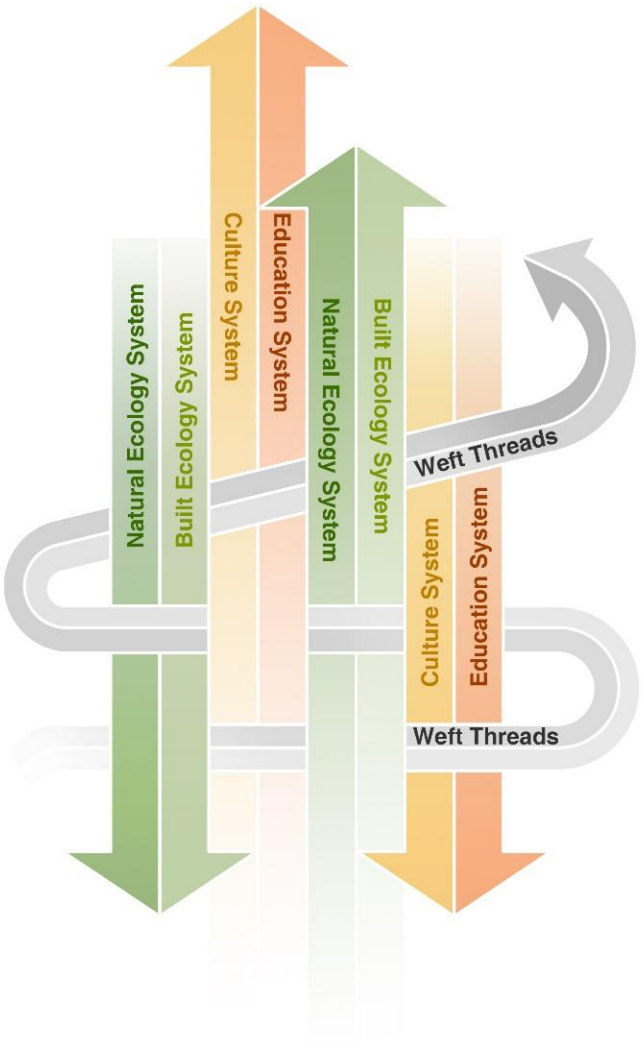


Figure 5.14. Conceptual diagram of the warp and weft threads of Alviso.

- *Ecology Thread*

As mentioned before, the ecology thread is very important for Alviso not only because of its significance in moderating and preventing harsh natural disasters but also for strengthening community identity by protecting what local people care about.

The natural ecological system in Alviso has been degraded through unsustainable development. As shown in the historic bay land landscape diagram, tidal channel systems can reduce flooding problems naturally by absorbing the tides. Natural creeks and rivers connected to the ocean also slowed down and absorbed ocean water. Naturally accumulating sediments nurtured flourishing vegetation that was ideal habitats for wildlife. (Figure 5.15.)

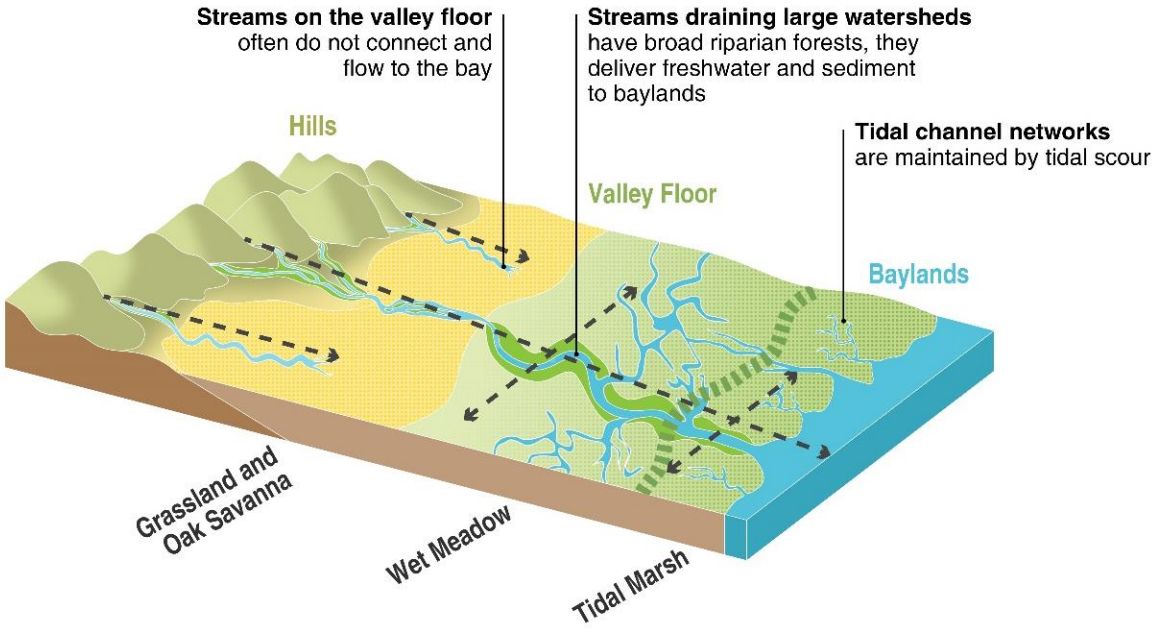


Figure 5.15. Historical bay land landscape.[72]

However, with the rapid expansion of urban development, natural patterns and processes were tremendously changed to accommodate human needs. The tidal channel system was diked. With the building of levees, streams no longer naturally drain to the floodplains. There are huge break and disconnections of the natural ecological systems. (Figure 5.16.) Unsustainable human interventions lead to nonfunctional natural processes and dangerous environmental conditions for marginal suburban communities on the outskirt of the Bay Area.

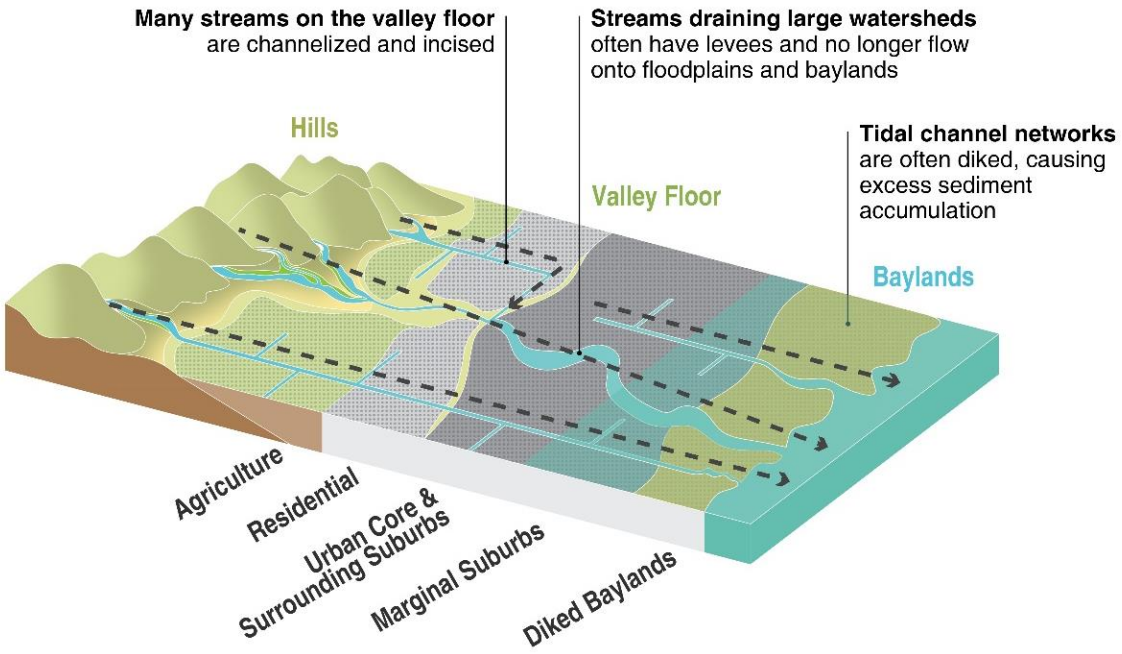


Figure 5.16. Current Bay Land landscape.

To make the essential ecology thread resilient in Alviso, the proposed ecological preservation aims to restore the resilient natural processes. (Figure 5.17.)

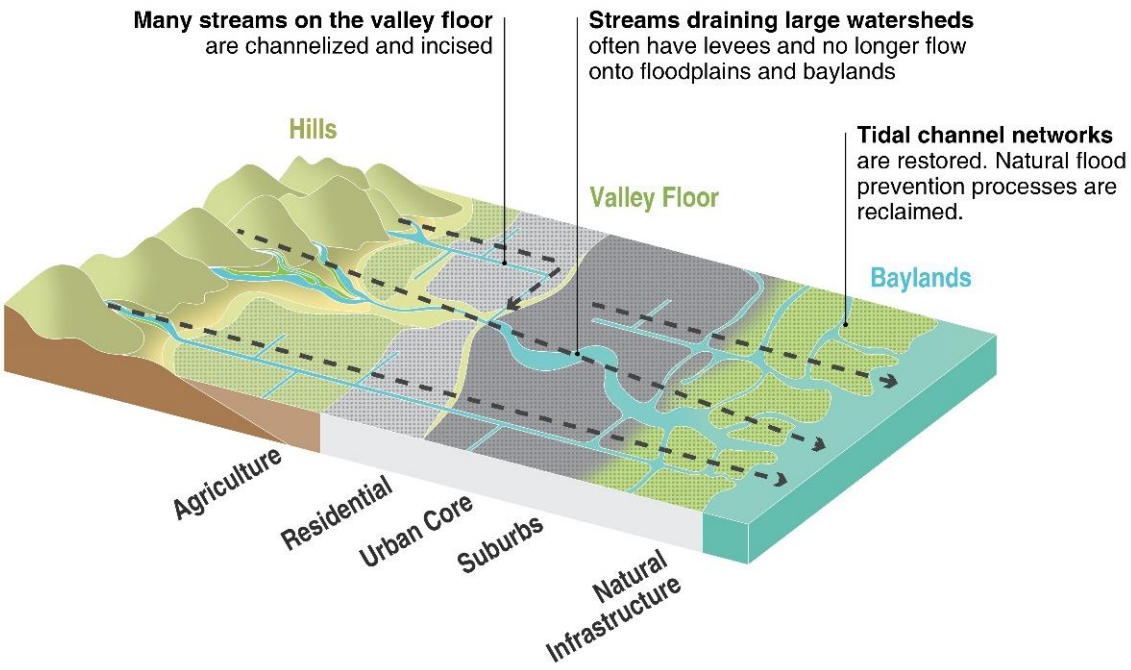


Figure 5.17. Proposed bay land landscape.

Currently, most of Alviso is diked and soil has accumulated over time as a result of deposition from rivers that flow through the area to the Bay. (Figure 5.18.) However, the current flood control system doesn't work well and certainly won't prevent damage from long-term sea level rise. Besides improving existing flood control infrastructure; a more resilient system needs to be built that mimics the natural processes of adjustment.

Figure 5.18 Current infrastructure system in Alviso.

Restoring natural processes can be achieved by Flood Control 2.0 (see Chapter 4) to transfer soil depositions in diked salt ponds to strengthen existing shorelines and increase marshlands. (Figure 5.19. and Figure 5.20.) Thus, deeper salt ponds can accommodate more flood water. Transferred soil is a good foundation for strengthening existing shorelines. Softening hard shoreline edges and restoring adjacent marshlands can make built ecological systems more resilient by adapting to long-term environmental changes and providing wildlife habitats.

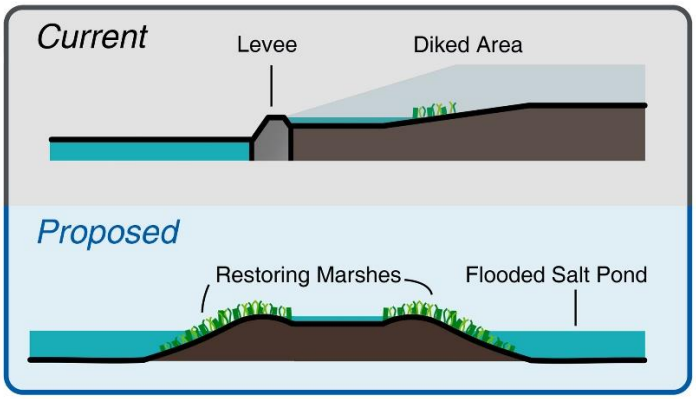


Figure 5.19. Diagram of restoring marshlands by transferring soil.

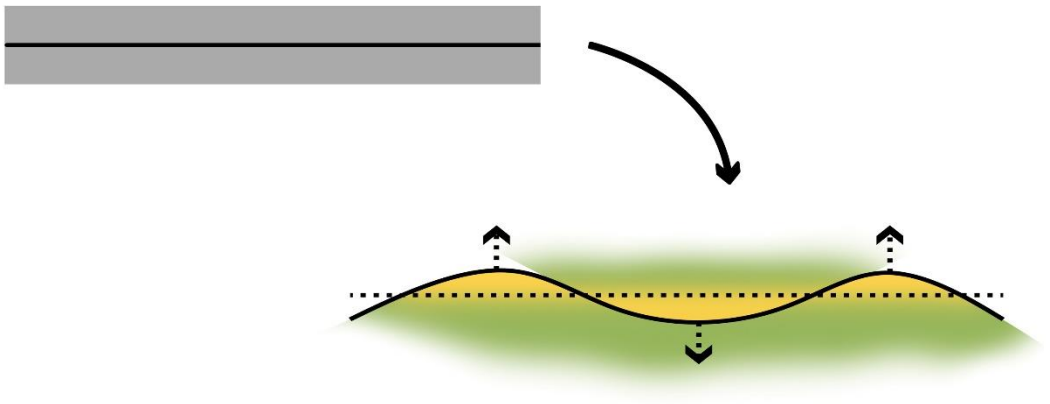


Figure 5.20. Conceptual diagram of softening and widening edges.

The following sections demonstrate existing and proposed changes to the elevations of salt ponds and adjacent marshlands. (Figure 5.22. – 5.26.) These subtle changes will make big differences in increasing flood water storage capacity and adapting the marshes as natural boundaries of Alviso.

Figure 5.21. Ecological intervention.

Figure 5.22. Section 1, current condition.

Figure 5.23. Section 1, proposed change.

Figure 5.24. Section 2, proposed change.

Figure 5.25. Section 3, proposed change.

Figure 5.26. Section 4, proposed change.

In the phase of restoring the marshlands, native salt-tolerant and upland plants will be used. A list of plants (from water edge to upland) include eel grass, sea lettuce, cordgrass, pickle weed, salt grass, salt bushes, mule fat, willows, tules, cattail, coastal sage scrub, and grass cover. (Figure 5.27.) The root systems and above ground structures of plants can effectively slow down flood water. What's more, these native plants provide habitat for birds and other wildlife.

Figure 5.27. Plants suitable for harvesting the adaptive shorelines.

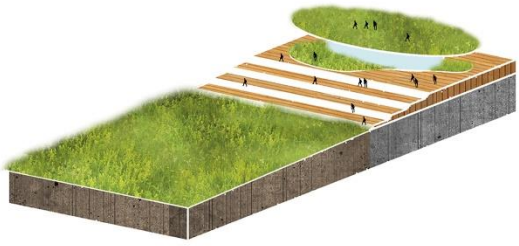
- *Identity Thread*

The identity thread is the other warp thread for building a resilient Alviso. With the establishment of resilient shorelines, programs can be added to these shorelines to attract more people to enjoy the scenic natural views while engaging in colorful community activities.

A variety of programming is proposed along the strengthened edges in both natural and built ecology areas as well as in vacant space within Alviso. These include local business, tourist attractions, floating islands for different purposes, industrial heritage, habitat protection and education center, p-patches and local farms, energy infrastructure, community meeting and activity center, as well as sports and recreation facilities. (Figure 5.28.) The activities and facilities are not only attractive for people to engage in but also educational for future generations. Some of them teach people about the history of Alviso; some teach people about local birds they care about; some help change people's lifestyles into more responsible and sustainable ones. These low-cost and flexible projects will help strengthen community identity by adding valuable functions, a spirit of playfulness, and community activities.

Pop-up Restaurant

Floating Islands



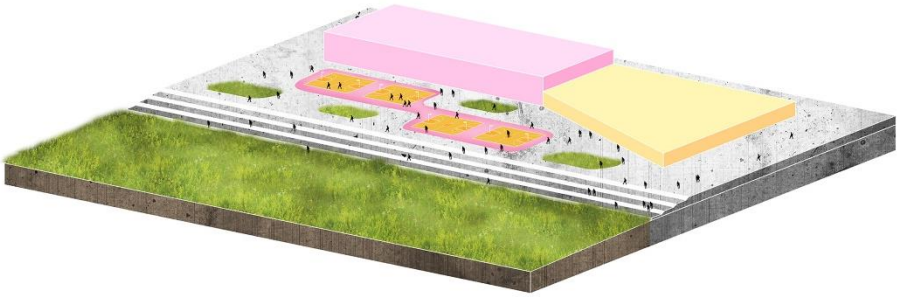
Habitat Prevention & Education Center

Airbnb

Industrial Heritage

Community Garden, P-Patch, & Market

Energy Infrastructure



Community Meeting & Educational Center

Sports & Recreation

Figure 5.28. Proposed programming for diverse community activities.

5.3.2 *Carding the Relationships between Threads*

There is an obvious overlap between the ecology thread and identity thread. Natural ecosystems and built ecosystems are important to the people in Alviso to protect their homes from environmental disruptions and provide places for community activities. Alviso residents care about the local ecology and will be able to keep living with nature and preserving ecology.

Not only are the two warp threads interrelated in the resilient suburban fabric, but the weft threads are also connected to each other as well as to the warp threads. It is the complex and clear relationship between each thread that makes the marginal suburban fabric resilient.

Take the transportation thread as an example of weft thread, a good transportation thread strengthens connections to and accessibility of the other threads. Good connections will ensure that the designed ecological system and diverse community activities are conveniently accessible for local people.

The current transportation system in Alviso mainly accommodates private vehicles. All streets in Alviso are two-lanes with street parking on each side. Pedestrian paths are comparatively narrow. Wide vehicle lanes make the streets inactive and unappealing to pedestrians. A transition to a pedestrian and bicycle-friendly community is needed to make Alviso active, easy to move around in and safe for more experiences and activities.

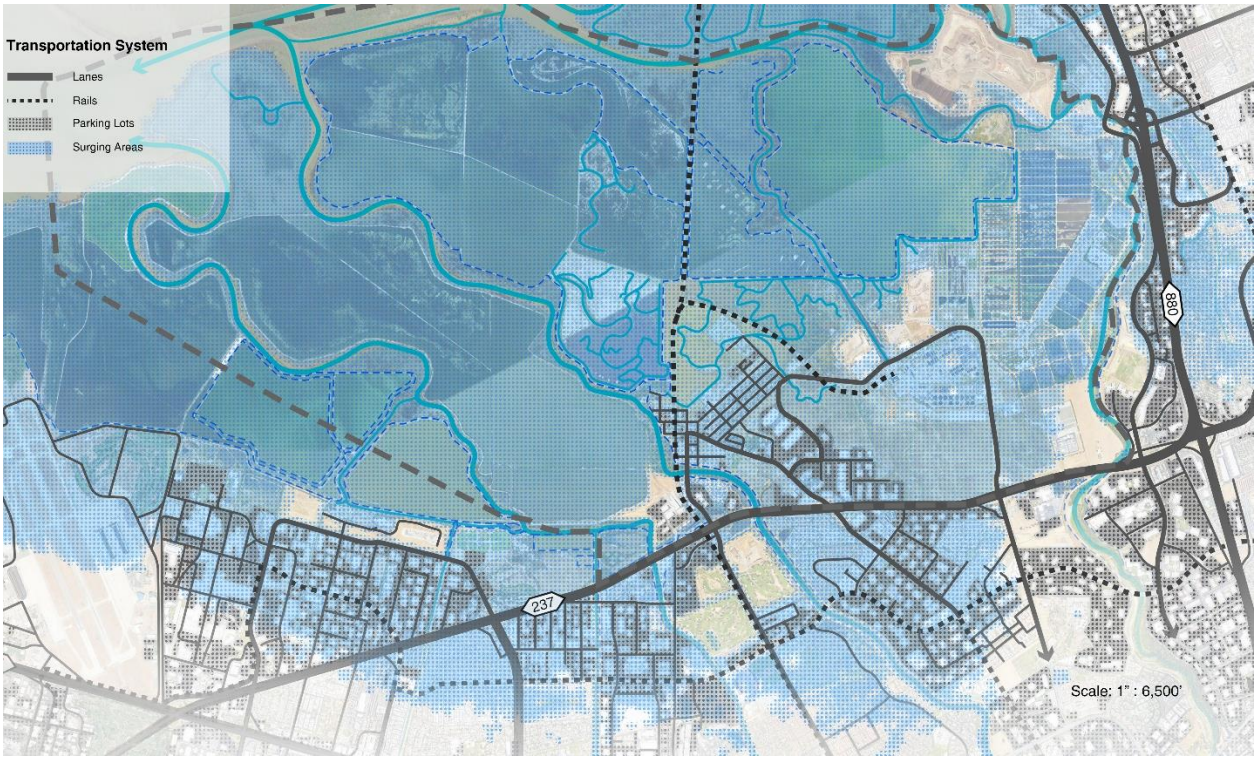


Figure 5.29. A private vehicle-dominant community.

Figure 5.30. The wide and empty private vehicle-dominant streets in Alviso.

The following sites were chosen to show the potential and benefits of turning private vehicle-dominated transportation system into a pedestrian and bicycle-friendly transportation system. By widening pedestrian and bicycle paths, transferring the transportation priority from private cars to people, improving unsafe pedestrian and bicycle paths adjacent to the freeways. These changes will also enhance connections to regional public transit system such as BART and will gradually change people's perspectives on transportation options and encourage greener lifestyles. A resilient transportation system will also benefit the community by encouraging residents to go outside more and enjoy a good community environment as well as diverse community activities. Walkable and cyclable streets provide good opportunities for people to bump into each other and build trust through the daily walks and cycling. Human-scaled streets will also help retain the small-town character, neighborliness, and strong community identity.

Figure 5.31. Examples of street improvements locations.

Figure 5.32. Location 1: current wide vehicle lanes and narrow pedestrian walks.

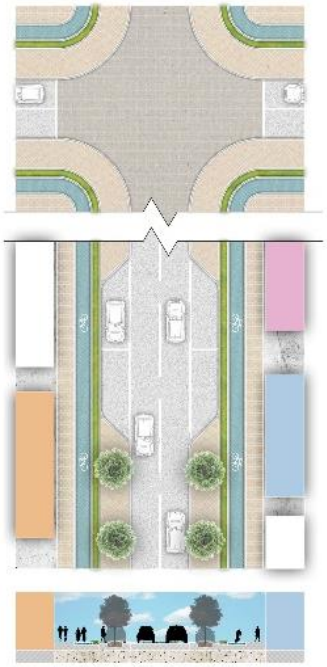


Figure 5.33. Location 1: proposal for more pedestrian and bicycle-friendly streets.

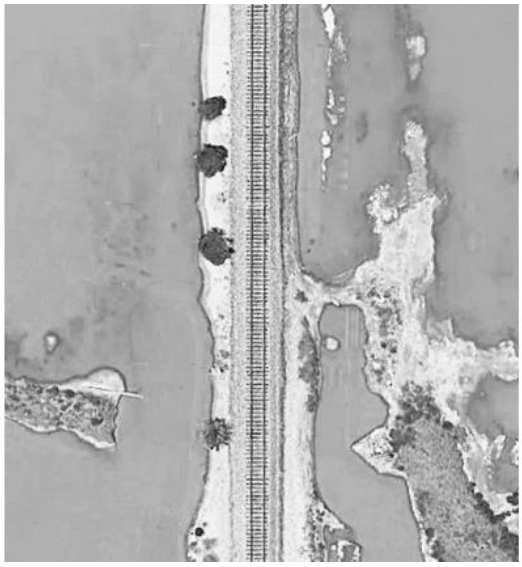


Figure 5.34. Location 2: unpleasant environment along the railroad.

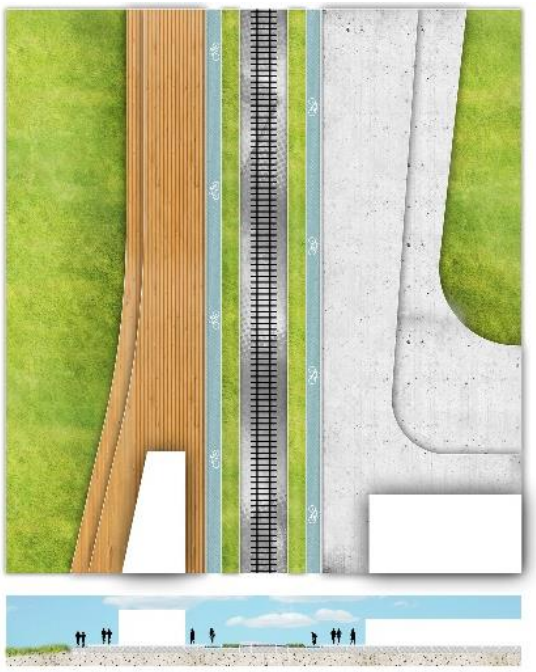


Figure 5.35. Location 2: attractive and fun walk along the railroad.

Figure 5.36. Location 3: unsafe and unappealing marginal space underneath the freeway.

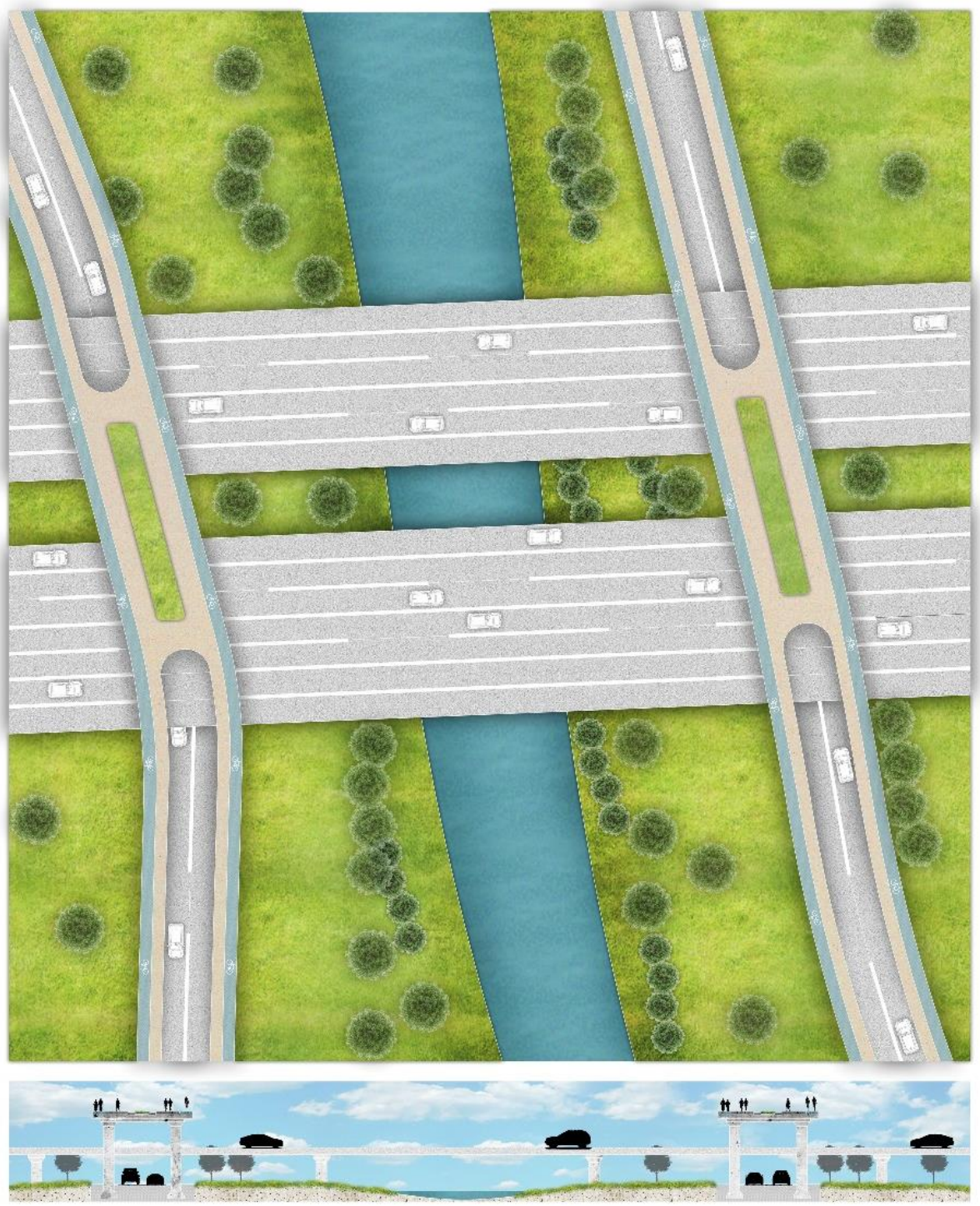


Figure 5.37. Location 3: elevated pedestrian and bicycle paths over the freeway.

The warp threads of ecology and identity are also supported by the weft threads of infrastructure, land use, and technology. Here are some proposals to improve those threads' performance and card each thread together into a complex and clear fabric.

For the infrastructure thread, strengthening the existing built infrastructure is needed. The dikes, levees, stormwater system and drainage system, energy services, waste management system, etc. should all be enhanced. There should also be opportunities for new facilities and infrastructure at the community-scale to keep the community functional and efficient. The Water Pollution Control Plant in the San Jose-Santa Clara Regional Wastewater Facility and the facilities in Newby Island Resource Recovery Park should be improved. Their associated activities and buffer lands should also be improved as well in order to strengthen community identity and local ecology.

For the land use thread to increase resilience, a mix of residential, commercial, and public uses should be developed within the historical core of the community. Adding diversity to the community land use can encourage people to interact more. The refined transportation system can make the small community into walkers' paradise with diverse views and activities along beautiful and walkable streets. Residential neighborhoods' existing patterns should be maintained. Although the housing will be largely protected by the surrounding ecology and infrastructure, improvements in housing structure is necessary to prevent natural disasters. Some new medium density housing should be added to the neighborhoods to make them more dense, efficient, and safe. The light industry in northern Alviso can be continued with adding other land uses and programming to keep the industrial area active, safe, and environmental-friendly.

As for the technology thread, it is everywhere in people's lives and can assist community development in so many ways. Keeping it in an assisting rather than a dominant position can prevent unsustainable development caused by human arrogance and ignorance of natural development. (see Chapter 5)

Sharing resilience is possible and it is important that it be successfully implemented in Bay Area marginal suburban communities. To do so will make the threads connected and efficient. We should keep in mind that all threads can positively share functions together as well as negatively impact each other. It is important for planners and designers to keep in mind that each thread and each system should be independently resilient. Ensuring connectedness and interrelatedness can elevate the efficiency of the resilient marginal suburban fabric.

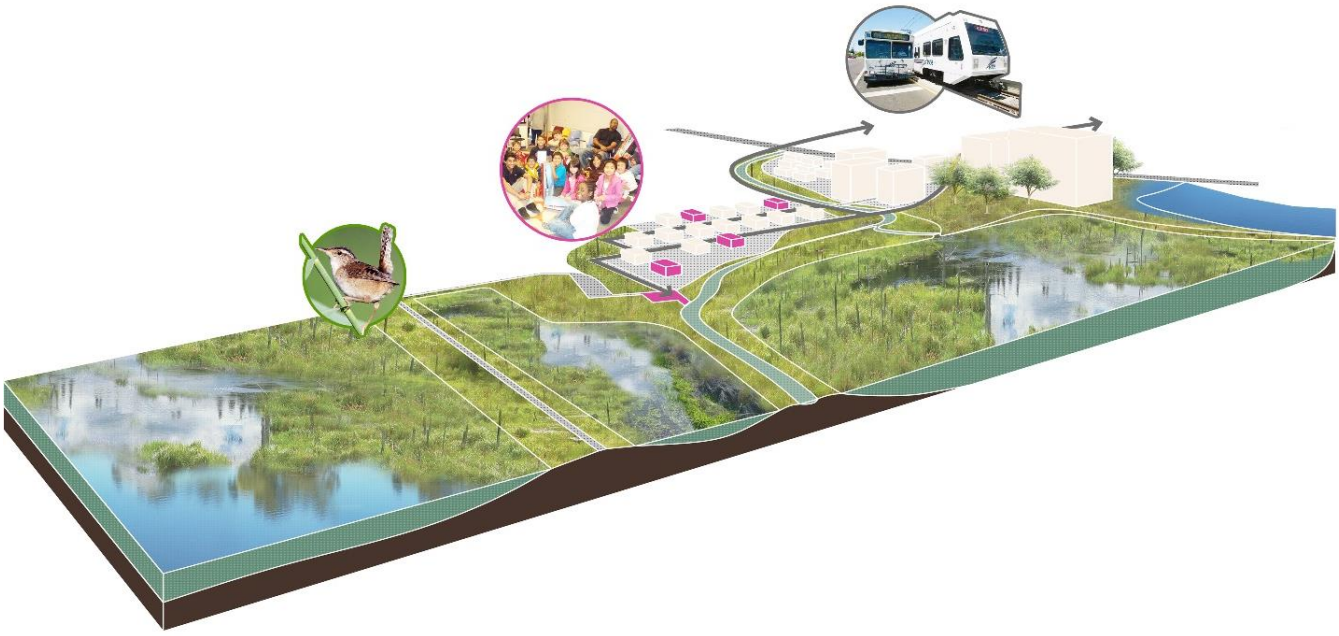


Figure 5.38. Sharing resilience in Alviso.

In this conceptual plan for Alviso, the marshlands and salt ponds are adjusted by using the methods mentioned above to prevent floods and create habitats for local wildlife. The curving and organic forms proposed for the marshlands can slow down and absorb flood water. The constructed marshlands can be occupied by the diverse programs mentioned above to enhance community identity. The highlighted roads and streets will be improved for better walking and cycling experiences as well as to improve connection and circulation within the community.

Figure 5.39. Conceptual plan for a resilient Alviso.

5.4 The Firm and Loose Rhythm of a Resilient Fabric

Although the connections between each thread are important, this does not mean that the threads must be firm and as closely connected as possible. Leaving space between the threads for

adjustment and future development is necessary. Unnecessary complexity and tight connection between threads will reduce the general resilience of a suburban fabric. (see Chapter 2)

A balance of firmness and looseness is an important aspect to consider when weaving a resilient fabric. In general, the marginal suburban fabric should be made denser and firmer than current conditions to increase its ability to resist all kinds of disturbances. Actions such as adding more vegetation, strengthening infrastructure systems, improving public transportation, and diversifying land use will make the suburban fabric firmer. However, it is also important to leave some blanked spaces as buffers to slow down and absorb disturbances. Take, for example, the method used for flood control, which is to dig deeper into the salt ponds to increase floodwater storage. The excavated soil will be transferred to existing shorelines to add marshlands as adaptive buffers to slow down and absorb floodwater. There is much space spared for salt ponds and marshlands in the planning for Alviso, not only working for ecology preservation but also working for flood control. Keeping the community diverse with appropriate density is important. Leaving some open space for self-adjustment is also important to make its fabric resilient.

Chapter 6. CONCLUSION: TOWARDS RESILIENT FUTURES

The thesis not only gives guidelines on how to build resilience in Bay Area marginal suburban communities but also provides valuable advice to other cities and communities for building a resilient future.

6.1 BROAD VISION FOR A CONNECTED AND COMPLEX WORLD

Open information, sharing technologies, connectedness among different systems, and better communication between people of diverse backgrounds are making the world more and more connected. This connected and complex world brings us both tough challenges and great opportunities and as a result a broader view for planning resilient futures is needed.

From a broad perspective, this thesis analyzes the challenges in the Bay Area in terms of time and space. Additionally, it gives suggestions for the planning and design of social-ecological systems from a broad view to make these connected systems clear, stable, and easily re-organized when faced with challenges.

This broad vision stresses the importance of comprehensive knowledge of different systems at the regional scale. For example, the establishment of the railroads that bypass Alviso, Highway 237 that segregates the community, and the adjacent rapid development of Silicon Valley have collectively caused Alviso's degradation as a characteristic suburban community. A

broad vision for resilient development can help prevent similar situations of unequal and partial development from occurring.

6.2 Community-Centered Planning and Design

Having clear and broad knowledge about regional systems is important. It is also crucial to zoom in to the community scale to create specific and efficient designs based on each community's own unique and distinct problems and strengths. A shift from exclusively profit-driven design to broader community-centered and community-driven planning and design is key to the development of resilient futures.

The thesis analyzes and summarizes a wide range of pioneering community-centered social-ecological systems that can contribute to regional resilience. Additionally, it provides theoretical guidelines for governments, developers, planners, and designers to build suburban communities with resilient fabrics. Application of the theory of "weaving threads" in Alviso highlights its great potential for resilient development especially in vulnerable marginal suburban communities. Every community has its own valuable history, culture, and strengths. To design better and more resilient communities for people, it is necessary to know that history, convey and conserve its culture, and enhance the strengths and potentials of different communities.

The process of community engagement is an educational process between community members and designers/planners to strengthen mutual understanding and build trust between local people and professionals from diverse fields. A deep knowledge of the process of building

a resilient fabric and enhancing the precious trust between people is a foundation to collectively preparing for unexpected challenges.

6.3 Towards Resilient Futures

The planning and design process for developing resilient communities is not simple and linear. Broad knowledge of the region and deep knowledge of each community is not enough to building a resilient fabric. We need the flexibility to jump back and forth between the regional scale and the community scale to prevent over-emphasizing some issues and neglecting others. This is similar to the importance of comprehensive thinking of specific resilience and general resilience discussed in Chapter 2. With a broad vision for the whole region, deep knowledge and humane concerns for diverse communities, and persistent trust and faith, people can collaboratively build resilient futures.

BIBLIOGRAPHY

[1] Levin, S. A. *Ecosystem Analysis and Prediction: Proceedings of a SIAM-SIMS Conference Held at Alta, Utah, July 1-5, 1974*. Philadelphia: Society for Industrial and Applied Mathematics, 1976. 131-140.

[2] Gunderson, L. H., Allen, C. R., and Holling, C. S. *Foundations of Ecological Resilience*. Washington, DC: Island Press, 2010. 51-66.

[3] Adger, W. "Social and ecological resilience: Are they related?" *Progress in Human Geography*, Vol. 24(3) (2000): 347-364.

[4] Lerch, D. *The Community Resilience Reader: Essential Resources for an Era of Upheaval*. Washington, DC: Island Press, 2017. 163-178.

[5] Fiksel, J. R. *Resilient by Design: Creating businesses that adapt and flourish in a changing world*. Washington, DC: Island Press, 2015. 3-18.

[6] Folke, C. "Resilience: the emergence of a perspective for social-ecological systems analyses" *Globe Environ Change*, Vol. 16(3) (2006): 253-267.

[7] Pickett, S. T. A., Cadenasso, M. L., and McGrath, Brian. *Resilience in ecology and urban design: Linking theory and practice for sustainable cities.* New York: Springer, 2013.

[8] Walker, B. H. and Salt, D. A. *Resilience thinking: sustaining ecosystems and people in a changing world*. Washington, DC: Island Press, 2006.

[9] Walker, B. H. and Salt, D. A. *Resilience thinking: sustaining ecosystems and people in a changing world*. Washington, DC: Island Press, 2006. 120-122.

[10] Walker, B. H. and Salt, D. A. *Resilience thinking: sustaining ecosystems and people in a changing world*. Washington, DC: Island Press, 2006. 7-8.

[11] Fiksel, J. R. *Resilient by Design: Creating businesses that adapt and flourish in a changing world*. Washington, DC: Island Press, 2015. 3-18.

[12] Walker, B. H. and Salt, D. A. *Resilience thinking: sustaining ecosystems and people in a changing world*. Washington, DC: Island Press, 2006. 120-122.

[13] Fiksel, J. R. *Resilient by Design: Creating businesses that adapt and flourish in a changing world*. Washington, DC: Island Press, 2015. 51-68.

[14] Gunderson, L. and Holling, C. S., eds. *Panarchy: Understanding Transformations in Human and Natural Systems*. Washington, DC: Island Press, 2002.

[15] Lerch, D. *The Community Resilience Reader: Essential Resources for an Era of Upheaval*. Washington, DC: Island Press, 2017. 171-174.

[16] Walker, B. H. and Salt, D. A. *Resilience Practice: Building Capacity to Absorb Disturbance and Maintain Function.* Washington, DC: Island Press, 2012. 5.

[17] Meadows, D. H. and Wright, D. *Thinking in Systems: A Primer*. Vermont: Chelsea Green Publishing, 2008.

[18] Meadows, D. H. and Wright, D. *Thinking in Systems: A Primer*. Vermont: Chelsea Green Publishing, 2008. 169.

[19] Meadows, D. H. and Wright, D. *Thinking in Systems: A Primer*. Vermont: Chelsea Green Publishing, 2008.

[20] Pickett, S. T. A., Cadenasso, M. L., and McGrath, Brian. (2013). *Resilience in ecology and urban design: Linking theory and practice for sustainable cities.* New York: Springer, 2013.

[21] Walker, B. H. and Salt, D. A. *Resilience thinking: sustaining ecosystems and people in a changing world*. Washington, DC: Island Press, 2006.

[22] Walker, B. H. and Salt, D. A. *Resilience thinking: sustaining ecosystems and people in a changing world*. Washington, DC: Island Press, 2006. xiii.

[23] City and County of San Francisco, Office of the Mayor. *Strategy Creates New Office of Resilience and Recovery to Protect Lives and Safeguard City Against Next Earthquake or Disaster*: http://sfmayor.org/article/mayor-lee-unveils-city-resilience-strategy-110th-anniversary-1906-great-earthquake-fire

[24] Urban Ecology, Inc. *Blueprint for a Sustainable Bay Area*. California: Urban Ecology, 1996. 10.

[25] The University of Melbourne, Melbourne School of Design. *MTALKS Rem Koolhaas and David Gianotten on Countryside*: https://msd.unimelb.edu.au/events/mtalks-rem-koolhaas-and-david-gianotten-on-countryside

[26] The University of Melbourne, Melbourne School of Design. *MTALKS Rem Koolhaas and David Gianotten on Countryside*: https://msd.unimelb.edu.au/events/mtalks-rem-koolhaas-and-david-gianotten-on-countryside

[27] Citylab. *Startups and Venture Capital are Going Urban*: https://www.citylab.com/life/2016/06/startups-and-venture-capital-are-going-urban/485978/

[28] Geosphere-Biosphere Program: http://www.igbp.net/

[29] Urban Ecology, Inc. *Blueprint for a Sustainable Bay Area*. California: Urban Ecology, 1996. 10.

[30] Urban Ecology, Inc. *Blueprint for a Sustainable Bay Area*. California: Urban Ecology, 1996. 12-13.

[31] University of Washington, College of the Environment, School of Environmental and Forest Sciences: http://depts.washington.edu/envaplab/

[32] SFEI, Resilience Atlas: https://resilienceatlas.sfei.org/

[33] SFEI, Resilience Atlas: https://resilienceatlas.sfei.org/

[34] Urban Ecology, Inc. *Blueprint for a Sustainable Bay Area*. California: Urban Ecology, 1996.

[35] Xu, J. "The Melting Himalayas: Cascading Effects of Climate Change on Water, Biodiversity, and livelihoods" *Conservation Biology*, Vol. 23 (3) (2009): 520-530.

[36] Urban Ecology, Inc. *Blueprint for a Sustainable Bay Area*. California: Urban Ecology, 1996. 40.

[37] Urban Ecology, Inc. *Blueprint for a Sustainable Bay Area*. California: Urban Ecology, 1996. 44.

[38] Lerch, D. *The Community Resilience Reader: Essential Resources for an Era of Upheaval*. Washington, DC: Island Press, 2017. 136-138.

[39] Citylab. *Startups and Venture Capital are Going Urban*: https://www.citylab.com/life/2016/06/startups-and-venture-capital-are-going-urban/485978/

[40] Urban Ecology, Inc. *Blueprint for a Sustainable Bay Area*. California: Urban Ecology, 1996. 44.

[41] Lerch, D. *The Community Resilience Reader: Essential Resources for an Era of Upheaval*. Washington, DC: Island Press, 2017. 140-141.

[42] Walker, B., Holling, C. S., Carpenter, S. R., and Kinzig, A. “Resilience, Adaptability and Transformability in Social-ecological Systems” *Ecology and Society*, Vol. 9 (2) (2004): Art. 5.

[43] Dusterhoff, S., Pearce, S., McKee, L., Beagle, J., Doehring, C., McKnight, K., and Grossinger, R. *Changing Channels: Regional Information for Developing Multi-benefit Flood Control Channels at the Bay Interface*. California: SFEI, 2017.

[44] Spotswood, E., Grossinger, R., Hagerty, S., Beller, E., Robinson, A., Grenier, L., and Askevold, R. *Re-Oaking Silicon Valley: Building Vibrant Cities with Nature*. California: SFEI, 2017.

[45] Mission Housing Development Corporation: https://missionhousing.org/mhdc_project_type/balboa-park-upper-yard/

[46] Metropolitan Transportation Commission and Association of Bay Area Governments. *Plan Bay Area 2040: Regional Transportation Plan and Sustainable Communities Strategy for the San Francisco Bay Area 2017-2040*. California: MTC, 2017.

[47] TransForm. *Keeping BART on Track: The Bay Area depends on BART Being Safe, Reliable, and Affordable for the Long Term*: http://www.transformca.org/landing-page/keeping-BART-on-track

[48] TransForm. *Bus Rapid Transit (BRT) Projects in the East Bay and South Bay Can Start a Public Transportation Revolution*: http://www.transformca.org/landing-page/bus-rapid-transit

[49] Lowe, B., Cohen, S., and Paine, C. *Bringing Safe Routes to Scale: How Safe Routes to Schools Can Get Bay Area Kids and Commuters Moving*. California: TransForm, 2007.

[50] Brown, B., Cabansagan, C., Irons, E., and Hernandez, C. *OakMob 101: A Case Study in Expanding Access to Shared Mobility*. California: TransForm, 2017.

[51] Lassiter, A. *Sustainable Water: Challenges and Solutions from California*. California: University of California Press, 2015.

[52] Services of the San Francisco Public Utilities Commission, San Francisco Water Power Sewer. *Regional Groundwater Storage and Recovery*: http://sfwater.org/index.aspx?page=982

[53] Services of the San Francisco Public Utilities Commission, San Francisco Water Power Sewer. *Water System Improvement Program (WSIP)*: https://sfwater.org/index.aspx?page=114

[54] Services of the San Francisco Public Utilities Commission, San Francisco Water Power Sewer. *WSIP Overview: Seismic Reliability, Delivery Reliability, Water Quality Reliability, Water Supply Reliability*: http://sfwater.org/index.aspx?page=115

[55] Services of the San Francisco Public Utilities Commission, San Francisco Water Power Sewer. *Westside Enhanced Water Recycling Project: Strengthening San Francisco's Water Supply*: http://sfwater.org/index.aspx?page=144

[56] Weinrub, A. *Community Power: Decentralized Renewable Energy in California*. California: Local Clean Energy Alliance, 2011.

[57] Bray, D. *Sunnyvale Community Solar Array Development: Feasibility Study*. California: Silicon Valley Institute for Regional Studies, 2013. 25-28.

[58] Zigas, E. and Becker, S. *Healthy Food within Reach: Helping Bay Area Residents Find, Afford and Choose Healthy Food*. California: SPUR Report, 2015. 4-5.

[59] Zigas, E. and Becker, S. *Healthy Food within Reach: Helping Bay Area Residents Find, Afford and Choose Healthy Food*. California: SPUR Report, 2015. 6-7.

[60] Bryson, M., Roosevelt University. *Urban Farms in Silicon Valley*: https://blogs.roosevelt.edu/mbryson/2012/06/26/urban-farms-in-silicon-valley/

[61] Waste Management: https://www.wm.com/us

[62] Fiksel, J. R. *Resilient by Design: Creating businesses that adapt and flourish in a changing world*. Washington, DC: Island Press, 2015. 199-200.

[63] Pickett, S. T. A., Cadenasso, M. L., and McGrath, Brian. *Resilience in ecology and urban design: Linking theory and practice for sustainable cities.* New York: Springer, 2013.

[64] U.S. Department of Energy. *Benefits and Considerations of Electricity as a Vehicle Fuel*: https://www.afdc.energy.gov/fuels/electricity_benefits.html

[65] City of San Jose, Department of Planning, Building and Code Enforcement. *Alviso Master Plan: A Specific Plan for the Alviso Community*. California: San Jose, Capital of Silicon Valley, 1998. iv.

[66] City of San Jose, Department of Planning, Building and Code Enforcement. *Alviso Master Plan: A Specific Plan for the Alviso Community*. California: San Jose, Capital of Silicon Valley, 1998. 9.

[67] City of San Jose, Department of Planning, Building and Code Enforcement. *Alviso Master Plan: A Specific Plan for the Alviso Community*. California: San Jose, Capital of Silicon Valley, 1998. 3.

[68] City of San Jose. *Envision San Jose 2040: General Plan*. California: City of San Jose, Capital of Silicon Valley, 2011.

[69] Cassidy, M., Mercury News. *Cassidy: Alviso isn't Silicon Valley's Ghost Town, but it is Something Else*: https://www.mercurynews.com/2013/06/25/cassidy-alviso-isnt-silicon-valleys-ghost-town-but-it-is-something-else/

[70] David Rumsey Map Collection, Cartography Associates: https://www.davidrumsey.com/home

[71] City of San Jose. *Envision San Jose 2040: General Plan*. California: City of San Jose, Capital of Silicon Valley, 2011.

[72] Dusterhoff, S., Pearce, S., McKee, L., Beagle, J., Doehring, C., McKnight, K., and Grossinger, R. *Changing Channels: Regional Information for Developing Multi-benefit Flood Control Channels at the Bay Interface*. California: SFEI, 2017. 9.