

The background is an aerial photograph of a region, possibly a coastal or mountainous area, overlaid with a grid of thin lines. The grid is composed of vertical and horizontal lines in shades of purple and blue. There are several white geometric shapes: triangles at the top-left and bottom-left corners, and circles at the top-right and bottom-right corners. A cluster of red circles is visible on the left side of the map. The text is centered and overlaid on the map.

RESCALING CLIMATE-INDUCED MIGRATION

MASTER THESIS
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EXPLORING PATHWAYS FOR AN UNCERTAIN FUTURE

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ABSTRACT

This thesis explores alternative spatial- and governance responses to deal with climate-induced migration as a result of slow-onset climate change in the southern California border region with Mexico. These responses will be specifically aimed to mitigate and adapt to a future that may see displacement as a result of changing environmental conditions. In order to do so, this project prioritizes an approach that addresses preparedness towards anticipating change as well as the scale- and temporal variability of the changing conditions and their impacts.

This project uses Dynamic Adaptive Policy Pathways (DAPP) as a methodology to explore alternative future narratives that are geared towards mitigating and adapting to changing climate conditions. It defines concentrations of social- and locational vulnerability as a proxy to anticipate potential migration flows, displacement or trapped population. It then explores potentials for adaptation across scales, which are then used to formulate spatial- and policy actions. In doing this, the project looks specifically for synergies of actions that address the before defined vulnerabilities. The formulated actions are then sequenced into alternative narratives to show their impact for two different IPCC Representative Concentration Pathways (RCP's). Finally, they are evaluated for their performance in addressing vulnerabilities related to climate-induced migration and for their applicability to the existing multi-scalar planning framework.

Keywords: climate-induced migration, vulnerability, adaptation, preparedness, Dynamic Adaptive Policy Pathways (DAPP).

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GLOSSARY

Climate migration (climate migrant)

The movement of persons or groups of persons who, predominantly for reasons of sudden or progressive change in the environment due to climate change, are *obliged* to leave their habitual place of residence, or *choose* to do so, either temporarily or permanently, within a state or across an international border (working definition of IOM, 2019).

Climate-induced migration

This term is not part of the glossary of the IOM, however is used in most academic articles that refer to the multi-causal nature of climate migration and recognize climate- or environmental adversity as one of the ‘push’-factors in deciding to migrate (Boano, 2008; Ahsan et al., 2014; Castles, 2020).

Climate / environmental refugee

This term is used to refer to a category of environmental migrants whose movement is clearly of a *forced* nature. The term has initially been used by academics, the media, and advocacy groups to draw attention to this issue and encourage international protection. This term however, has now been largely accepted as having the potential to be misleading, so the terms “environmental migrant” or “displaced person” should be used instead. The term is not part of international law and individuals forced to leave their country because of environmental processes or climatic events do not necessarily meet the definition of a refugee under the Convention Relating to the Status of Refugees (1951 [1954]) (IOM, 2019).

DAPP

Dynamic Adaptive Policy Pathways

Ecosystem services

Collective term that explains the varied benefits that ecosystems provide for human beings. They are categorized in four groups: provisional services (e.g. drinking water), regulatory services (e.g. pollination of crops), cultural services (e.g. providing opportunities for recreation) and supporting services (e.g. ecosystem nutrient cycling) (WUR, 2014).

Environmental migration (environmental migrant)

The movement of persons or groups of persons who, predominantly for reasons of sudden or progressive change in the environment that adversely affect their lives or living conditions, are *forced* to leave their places of habitual residence, or *choose* to do so, either temporarily or permanently, and who move within or outside their country of origin or habitual residence (IOM, 2019).

After the apocalyptic reintroduction of the term by Norman Myers, *environmental migration* has fairly recently been put in a more favourable light as a positive adaptation strategy learned from case studies in the global south (Barnett, J., Webber, 2010; Ionesco et al., 2017, 70).

Human mobility and migration discourse

Human mobility is a more generic term covering all the different forms of movements of persons, also tourist movement (IOM, 2019). *Migration* is only one type of movement under

this umbrella term, signifying the movement away from usual place of residence (ibid.). The term human mobility was used from 2015 onwards by the Advisory Group on Climate Change and Human Mobility for conferences for parties of the UNFCCC (ibid). A possible explanation for its use is the political discourse around the term. In the context of intra-European movement, mobility and migration have been researched to perform differently. Mobility is used to propose a course of action towards opening up the internal economic market. Migration, on the other hand, is associated with migrant ‘problems’ and ‘abuses’, and legitimizes integration and participation policy actions. Hence, both concepts also function in different storylines and legitimize different courses of action (van Ostaïjen, 2017).

IDMC

Internal Displacement Monitoring Centre

IPCC

Intergovernmental Panel on Climate Change

RCP

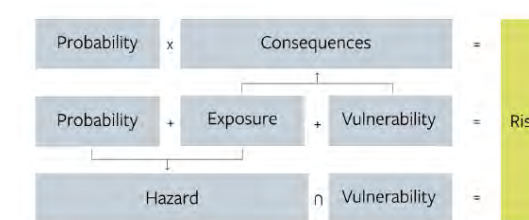
Representative Concentration Pathway. Greenhouse gas concentration trajectories adopted by the IPCC to describe different climate futures.

Risk

The three ways to conceptualize risk (literature specific to flooding, see figure).

The first one is most widely used in the natural sciences, whereas the other two are discussed

within social sciences. Here, the term vulnerability is the most contested and subject to change (Ten Voorde, 2018).



UNFCCC

United Nations Framework Convention on Climate Change

USMCA

United States-Mexico-Canada trade agreement (updated North American Free Trade Agreement)



READING NOTE

This thesis is structured into three main parts preceded by the glossary and introduction, and followed by the reflections. In general, the first part is concerned with building a research narrative, whereas the second and third part describe the application of the research.

The first part of this thesis establishes a research narrative by discussing what will be researched, and how it will be done. It starts by contextualizing climate-induced migration as a global phenomenon and situates geophysical and social aspects relevant to this phenomenon in the United States (Chapter 01). It continues by formulating the problem and knowledge gap this thesis aims to address (Chapter 02) for the state of California in the USA, and defining the theoretical concepts for addressing climate-induced migration proactively in an urban planning context (Chapter 03). The next chapter then translates these concepts into a methodological framework by proposing a process and methods that steer towards the desired outcomes (Chapter 04).

The second and third part will focus on applying the outlined methodology. The second part starts with an analysis of the

chosen region in Southern California on several scales (Chapter 05), this section concludes with a synthesis outlining vulnerable systems at risk of inability to anticipate slow-onset climate impacts, future forced migration or trapped populations. The next chapter adds to that list of focus variables by studying two reference projects (Chapter 06), after which the potentials for adaptation and development will be outlined on the regional scale and drawn up in a vision (Chapter 07). With the collected variables and focus themes, an analysis and a set of actions will be identified that work towards preparedness and adaptation for the region under slow-onset climate change uncertainty (Chapter 08).

The last part of this project focuses on constructing different narratives for the future based on the actions outlined in Chapter 07. Sequencing the actions into dynamic pathways, the different impacts and synergies of the identified actions are illustrated (Chapter 09). The last chapter of the thesis is concerned with evaluating the pathways, as well as a discussion and reflection on the performance of the pathways in answering the main research question (Chapter 10).

Figure 1. Border cantos. Source: Richard Misrach, 2016.



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I owe this thesis to the support of many people around me.

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And finally, thanks to my friends. Specifically Astrid and Rosa, for encouraging me to take a leap and start this master's programme, and Surabhi for her interest in the project, support, and the lovely Indian meals we shared.

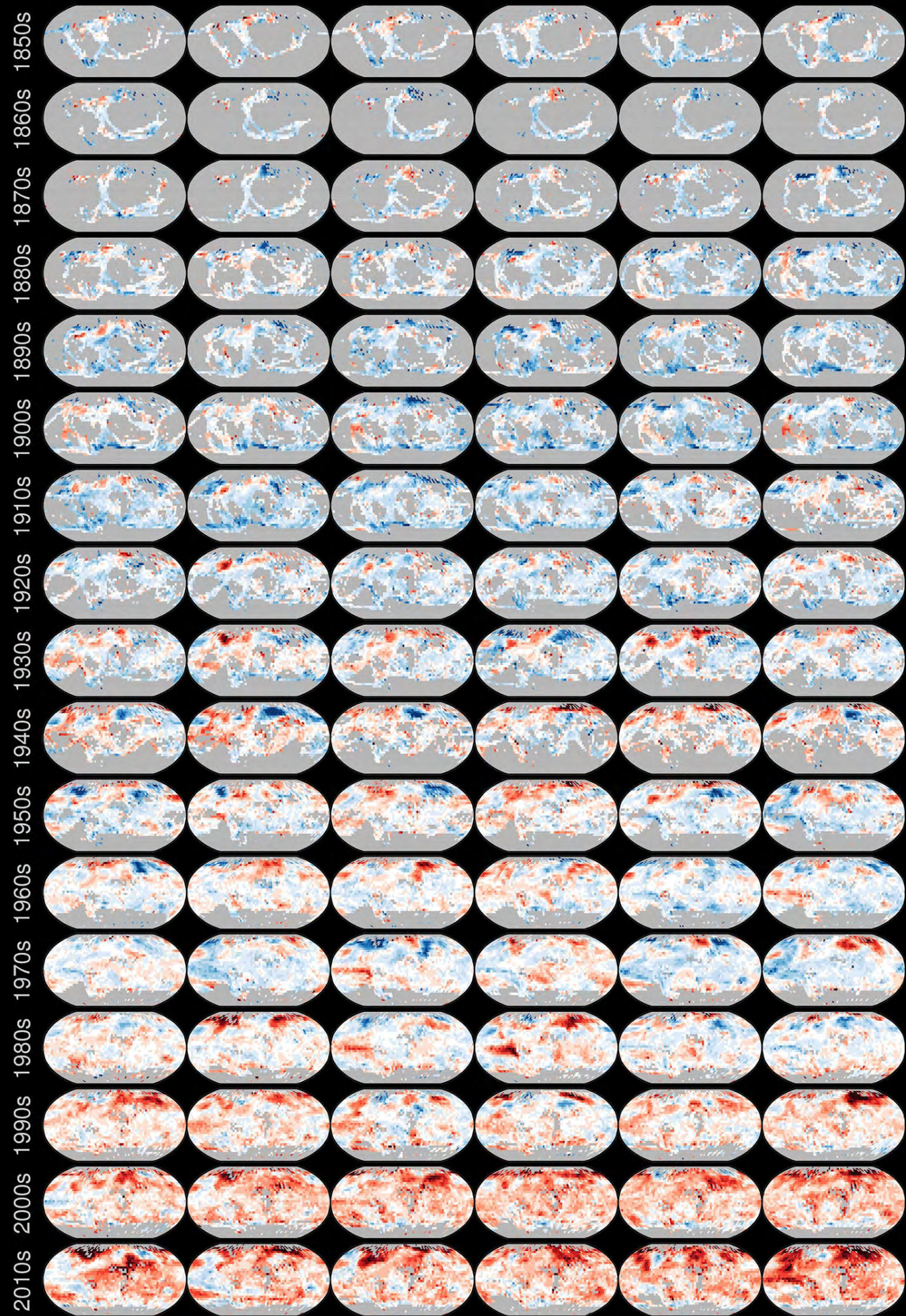
I am very grateful for the opportunities given to me by this education at the TU to hopefully make a small positive change in the world.

Figure 2. Land use across the US-Mexico border at Calexico-Mexicali. Source: NASA, 2000.



PART 1

CONTEXTUALISE



01

INTRODUCTION

This chapter offers a context to the phenomenon of climate-induced migration. The term re-emerged at the forefront of migration theory in the mid-2000s, when it became clear that the environment would be a determining factor in migration as well as a considerable threat to human populations in the face of climate change.

Although it is clear that climate change plays a part in the movement of populations, there is no direct link between the two (Adamo, 2008; Ahsan et al., 2014; Camillo Boano, Roger Zetter, 2008; Gill, 2010; Hugo, 2010; Piguet, 2010). The mechanisms linking climate change to migration are complex, resulting in an equation with migratory, environmental, climatic and political variables. Particularly when it comes to discerning the influence of these variables “on the ground”, when it involves people making decisions about (or being forced into) a new livelihood. This chapter will address the spatial layers and scales that contribute to an understanding of the complexity of climate-induced migration.

“Migration in the context of climate change is a defining phenomenon of our time, a mega-trend of this century that can only be managed with decisive and bold interventions – the time to act is now.”

William Lacy Swing, Director General of the International Organization for Migration (2015).

Figure 3. Climate scientist Ed Hawkins mapped global temperature changes from 1860 to 2016. Source: Climate Lab Book, 2019.

I. A WORLD IN MOTION

Environmental conditions have always been determinant in the distribution of the population on the planet. Around 45,000 years ago, modern humans settled in current Europe because of its suitable climate and availability of resources (see Figure 4). Most deltaic regions in the world are densely populated due to their fertile soil and in spite of regularly changing environmental conditions. And the decline of the Mayan civilization is linked to the collapse of agricultural productivity due to droughts and deforestation. Environmental factors are key in explaining settlement patterns, and it follows that a major disruption such as climate change will similarly change these patterns.

Although environmental migration is an extremely old phenomenon, the term is a

political construct that conceals different dynamics depending on who uses it and with what purpose. The International Organization for Migration defines it as “the movement of persons or groups of persons who, predominantly for reasons of sudden or progressive change in the environment that adversely affect their lives or living conditions, are forced to leave their places of habitual residence, or choose to do so, either temporarily or permanently, and who move within or outside their country of origin or habitual residence” (IOM, 2019). This definition is applicable to a displaced population of a small Pacific island, but also to northern European retirees who decide to move to sunny Portugal. Therefore, this thesis will use the term climate-induced migration to signify migration flows that are directly or indirectly

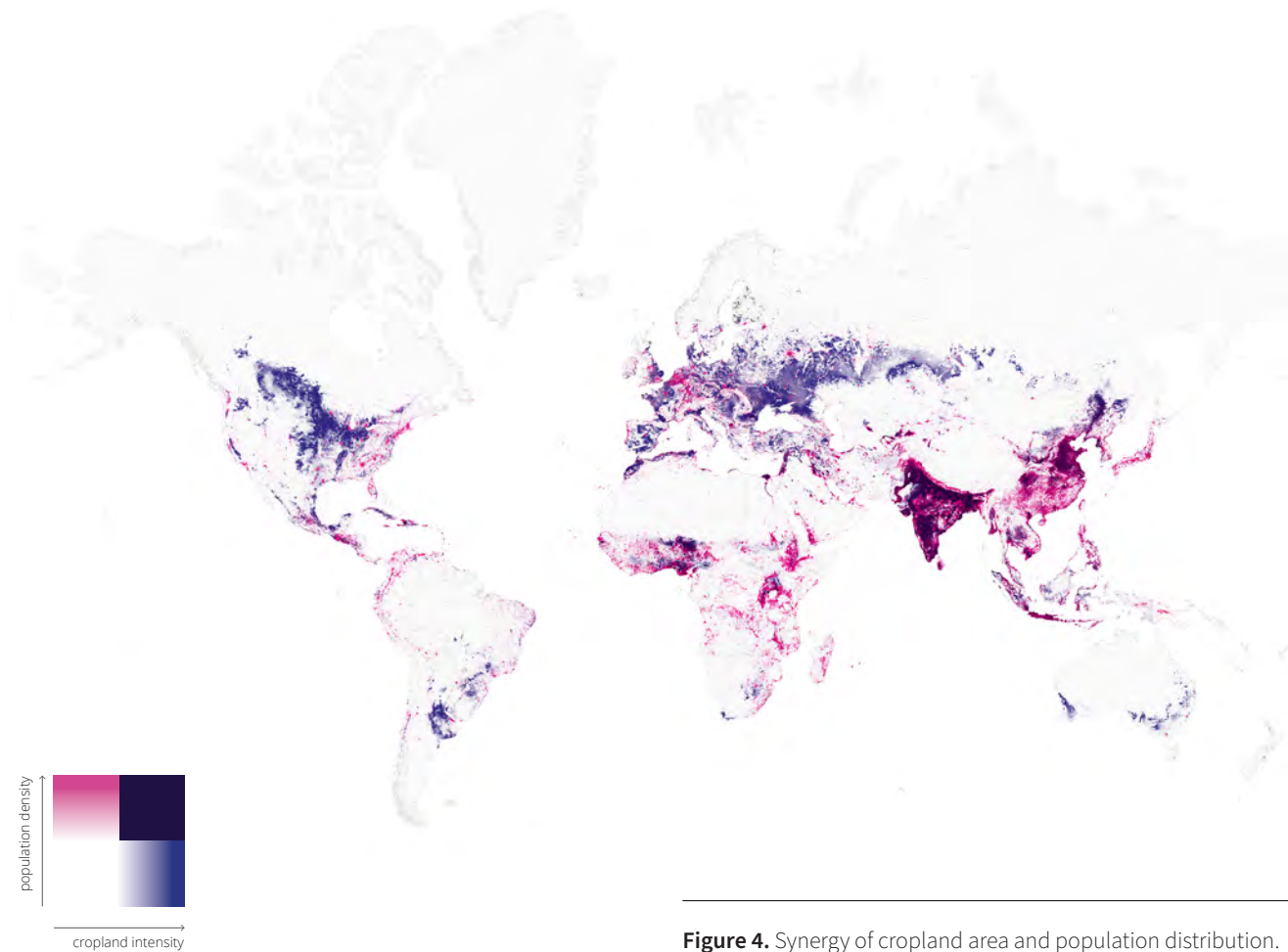


Figure 4. Synergy of cropland area and population distribution.

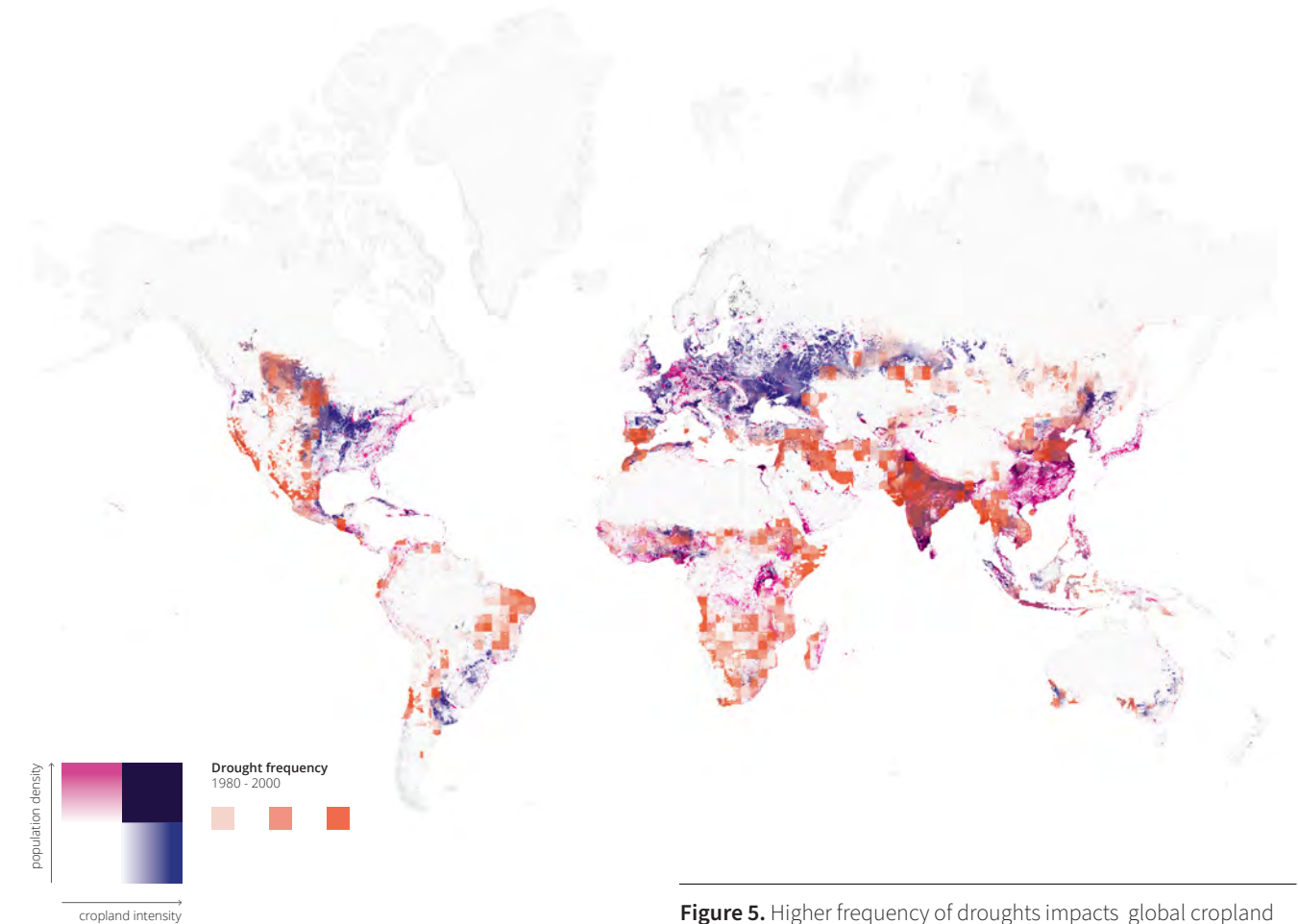


Figure 5. Higher frequency of droughts impacts global cropland areas.

related to anthropogenic climate change processes.

Effects of climate change

The effects of climate change have become increasingly noticeable over the past decade. It already disproportionately hits populations in the global South (see Figure 9). The IDMC has recorded number of displacements due to environmental disasters and conflict, although displacement due to conflict may also be caused by environmental disasters such as drought resulting in conflict over food scarcity. Disaster-related displacement especially shows up in South-East Asia. In India, for example, populations have lived with a monsoon climate for centuries, however rapid urbanization, environmental degradation and high poverty levels chip away from previous resilience to monsoon-related flooding. Even to such an extent, that a monsoon flood in June 2019 resulted in 2,5 million new

displacements.

Factors of climate-induced migration

Since the nineteenth century, the human impact on the earth and its ecosystems has significantly increased: greenhouse gas emissions, deforestation, resource extraction and intensive agriculture have all contributed to global warming at an unprecedented rate. Climate change is related with rising air- and sea temperatures, ocean acidification, melting glaciers and permafrost (IOM, 2017, 35). It is likely to result in more frequent periods of drought, wildfires and periods of extreme temperatures, impacting crop yield, food security and related livelihoods. It will also impact precipitation patterns and bring about a growing frequency and intensity of climate hazards (Figure 6). In particular floods, storms and landslides as a result of this will likely cause a vast majority of human displacements worldwide (ibid., 40). A much slower, gradual

Figure 6. Global occurrence of geophysical disasters: floods due to typhoons, cyclones and storms, and earthquake occurrences.

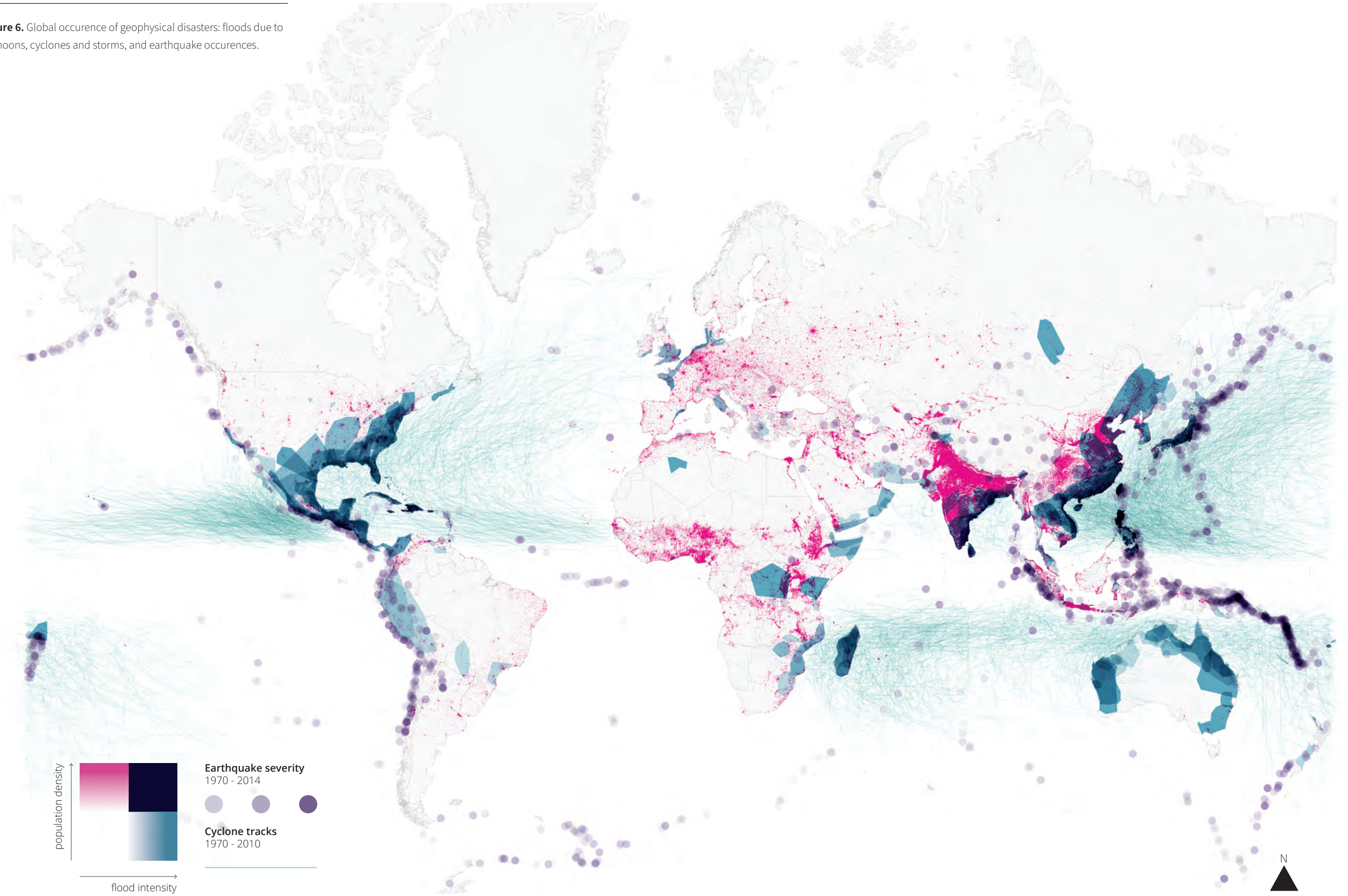




Figure 7. UNFCCC classification of slow-onset events and extreme events. Source: UNFCCC, 2018.

process is the degradation of ecosystem services. It can affect human security in a direct way, through depletion of resources for consumption for example, or indirectly through the decreased ability of an ecosystem to protect a community from hazards or conflict over scarcity of resources (ibid., 47). Sea-level rise and related coastal risks are one of the greatest threats to cause migration of coastal population in the future (ibid., 50). These changes impact social, ecological and economic systems, and although the effects will hit all continents regardless of borders, they will particularly impact disadvantaged people and communities by exacerbating existing vulnerabilities (ibid., 36).

Slow-onset climate change

There is a growing body of knowledge on how displacement and migration happens in the context of these slow-onset changes like degradation of ecosystem services. The

difficulty with this topic is that these changes only tend to become apparent when a crisis point is hit, a moment that preferably is anticipated. Research does show however, that slow-onset events can erode the capacity of ecosystems to provide critical services, such as fresh water, food, shelter and energy production. These slow-onset events may erode a community's or ecosystem's capacity to withstand the impacts of slow- and rapid onset changes, to possibly cause a cascading decrease of resilience. In that sense, slow-onset changes can be regarded as a multiplier for other drivers of crisis (IDMC, 2018).

The ways in which slow-onset changes will play out are inherently uncertain, nevertheless its impacts can be detrimental. This thesis is concerned with looking at a planning framework that can anticipate slow-onset changes and adapt to changing circumstances to be prepared for an uncertain future.

New displacements in 2019: breakdown for conflict and disasters

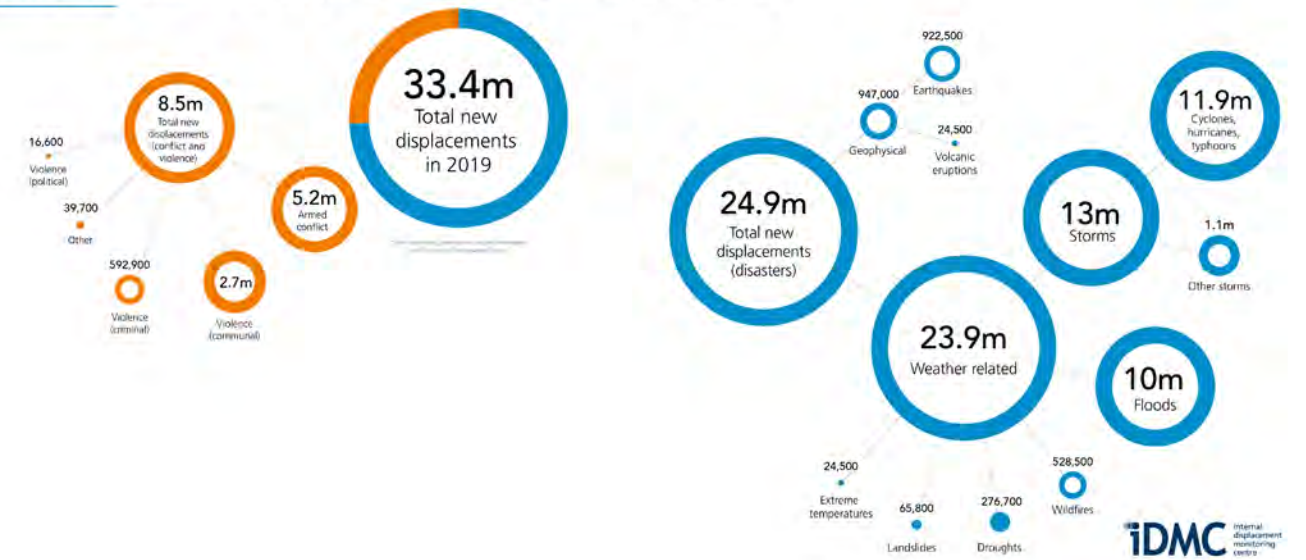


Figure 8. IDMC infographic with a breakdown of displacement numbers per cause. Source: IDMC, 2019.

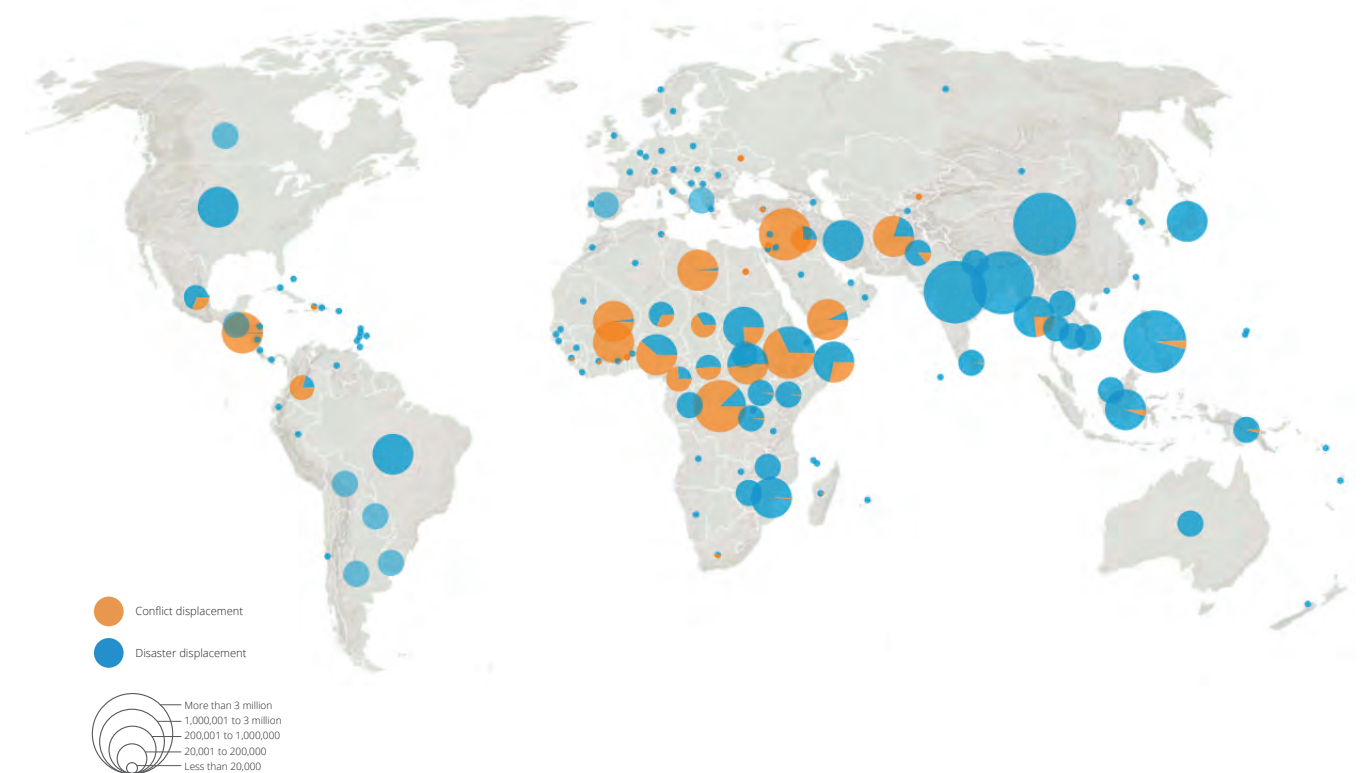


Figure 9. IDMC map with displacement numbers in 2019 per country. Source: IDMC, 2019.

II. MIGRATION AND ENVIRONMENTAL CHANGE IN THE UNITED STATES

In 2019, the United States ranked seventh in the IDMC's list of most new displacements with over 900,000 people on the move due to disaster events. This number was particularly due to hurricane Dorian, which caused heavy and prolonged periods of rain and winds, and storm surges in Florida, Georgia and South Carolina. Also in 2019, the wildfire season in California was particularly heavy due to Diablo and Santa Ana winds picking up fire. A total of 7,800 fires were recorded between October and December of that year. Although the numbers of people injured were minimal, nearly 100,000 people were evacuated by officials or left their house out of precaution (The Guardian, 2019).

Multiplier

In the case of the wildfires, many people living in hazardous areas landed in a displacement cycle. The housing affordability crisis in California left people unable to rebuild their home or move after a disaster, or left them with no time to rebuild before the next wildfire hit (IDMC, 2019). Sudden-onset climate disasters proved a multiplier to an already existing slow-onset housing crisis. This demonstrates the necessity of a risk assessment that looks at the possible dynamics between climate and social factors.

Sending and receiving regions

Where do these displaced people go? Although very few studies have been done on this topic, early research suggest that people moving away from Californian wildfires landed in neighbouring counties, most likely in urban areas (Urban, 2019). For example, 20,000 fled



Figure 10. A migrant family from Central America runs back from tear gas at the US-Mexico border in Tijuana. Source: Time, 2018.



Figure 11. Californians flee wildfires and set up camp in a Walmart parking lot. Source: VICE, 2018.

the city of Paradise in California and landed in Chico, which then saw a 20% population spike. Chico, the receiving community, reported multiple issues in the months after resettlement, most notably increased traffic, overwhelmed health services and housing shortages and decreasing affordability (The Washington Post, 2019). California's governor calls it the "new abnormal", referring to unpredictable climate events and new dynamics between sending and receiving regions after displacement.

Internal regional migration

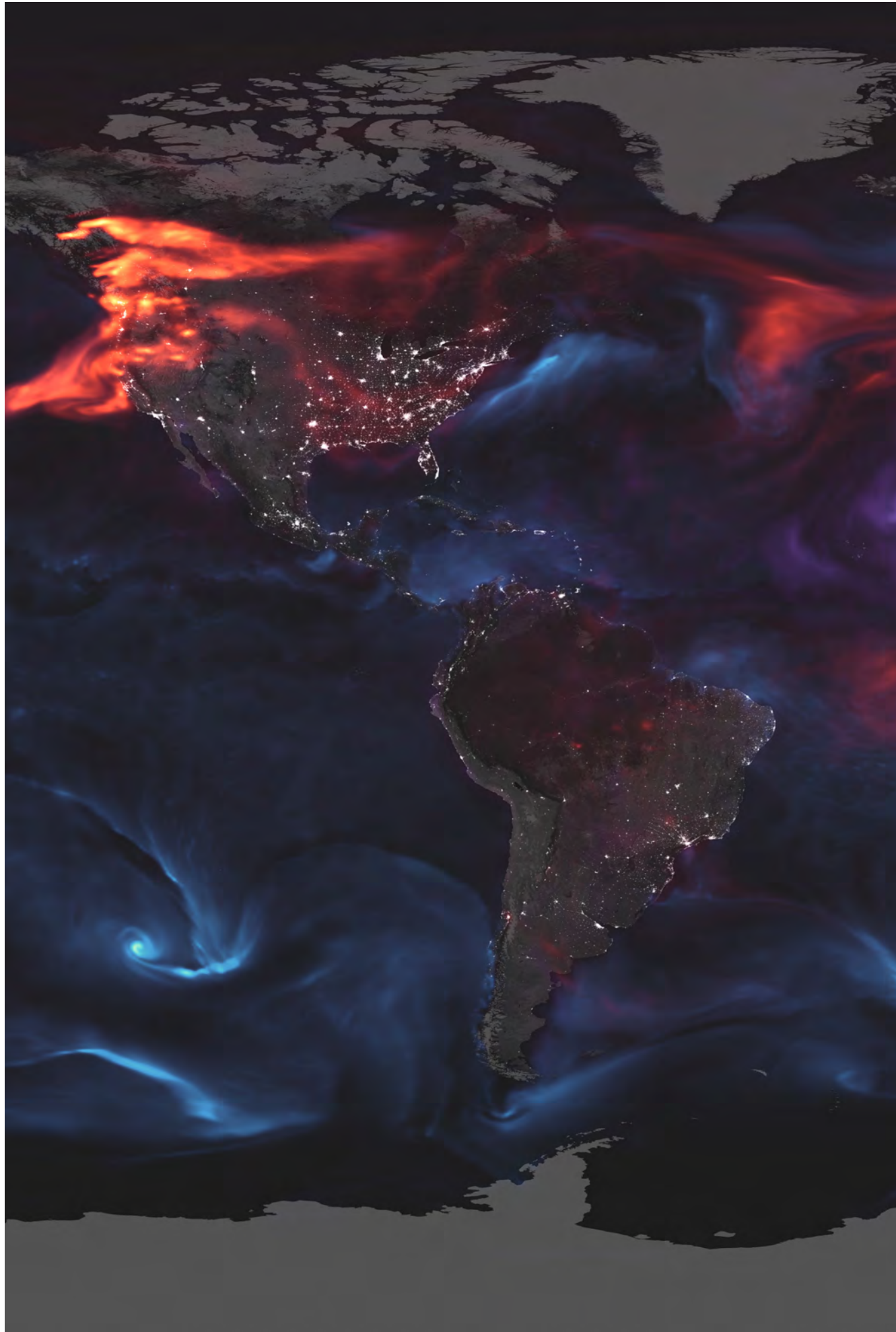
More climate-induced migration is likely to happen. The focal point in the US is currently sea-level rise (SLR), where studies predict 4,2 million people in coastal areas are at risk of becoming displaced with +0,9m SLR (Hauer et al., 2016). For slow-onset impacts, critical services like food, water and energy production should be added to the equation

in order to see how these might impact urban- and rural systems and who are most vulnerable to these early changes.

International migration

Besides internal regional migration, the United States border with Mexico is also under scrutiny. Daily, border patrols apprehend asylum seekers fleeing conflict at home, gender-based violence or loss of livelihood due to environmental degradation. In February 2021, 97,000 migrants attempted to cross the border (Rescue, 2021). These numbers are expected to increase under climate change uncertainty.

This thesis will look at climate-induced migration dynamics in California, specifically under conditions of slow-onset change and thus uncertainty. How can planning prepare for the future under these circumstances?



02

PROBLEM SYNOPSIS

This chapter aims to bring together relevant problem layers into a concise definition of the issues at stake in California. Firstly, it will address how climate change poses new conditions for existence, resulting in several socio-spatial vulnerabilities and uncertain futures. It will continue to discuss how migration could be a result of dealing with these vulnerable conditions. Lastly, it will elaborate on the role of governance in the face of uncertainty, and the knowledge gap and research aim to which this thesis will respond.

I. NEW CONDITIONS FOR EXISTENCE

Climate change

Climate change has become an inescapable future that threatens life on this planet as we know it. This crisis, which has already become very real in many of the more vulnerable parts of the earth, challenges our understanding and ways of interfering with the physical world around us. The 2015 Paris Agreement was the first legally-binding global framework to collectively tackle its dangerous effects, adopted by 190 parties who agreed to limit anthropogenic global warming to +1,5 degrees Celsius by 2050. By December 2020, the Climate Action Tracker calculated current

warming at +1,1 degrees Celsius, meaning that with current policies we are on our way to hit a grim +3 degrees Celsius by 2100 (Climate Action Tracker, 2020).

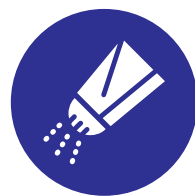
The impacts of this crisis show increased frequency and intensity of disaster events, as well as slow-onset changes that are difficult to pin down and forecast. In the state of California, the increase in greenhouse gas emissions and acidification of coastal waters are the main drivers of climate change effects that pose new conditions for existence (see Figure 13 based on California Natural Resource Agency, 2018).

Figure 12. Wildfire smoke, typhoons, hurricanes, Saharan dust and agricultural burning release particles in the atmosphere. Source: NASA Earth Observatory, 2018.

Slow-onset changes



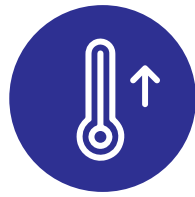
Change in water supply from mountains



Salination of fresh water sources



Sea level rise

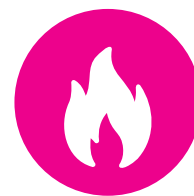


Increase in temperature

Increase in frequency of disaster events



Extreme precipitation



Wildfires and extended periods of drought



Coastal flooding and coastal erosion

Figure 13. Simplified classification of main climate change effects in California.

Increased vulnerability as a result of climate change impacts

The effects of anthropogenic climate change hits communities, ecosystems and geographies differently. Some of these systems, as well as individual situations or species, will be more vulnerable to its adversity, as they are unable to cope with the variability and extremes of its effects. Vulnerabilities could be economic in nature, such as a community's inability to invest in a more sustainable infrastructure, energy source or preparedness system. Means of existence or incomes could be threatened and sustainable living places might not be accessible to people living below or close to the poverty line. Vulnerabilities are also geographically distributed. Some places are more impacted by climate change's natural hazards, and other places by systemic vulnerabilities like increasing water scarcity, food insecurity or threatened marine dependency.

When communities are unable to cope with vulnerabilities as a result of climate change, as these impact their livelihood or the habitability of their place of residence, they may decide to (temporarily) migrate to overcome these adversities.

Climate-induced migration

Although a direct link between climate change and migration has not been established in academic literature (Adamo, 2008; Ahsan et al., 2014; Camillo Boano, Roger Zetter, 2008; Gill, 2010; Hugo, 2010; Piguet, 2010), it is however commonly understood that the impact of environment on migration flows has been underestimated (Ahsan et al., 2014; Camillo Boano, Roger Zetter, 2008; Hugo, 2010; Ionesco et al., 2017). Many authors agree that there needs to be a better understanding of the mechanisms linking climate change to migration, as these mechanisms are complex.

Norman Myers was one of the earliest scholars to (re-) address the urgency of environmental migration in 1997. Although the apocalyptic predictions in this article have been widely criticized, he established the complexity of environmental migration and its interrelation with other political- social- and economic aspects (Myers, 1997). As a direct link is lacking in research, a review of the literature on this topic reveals a number of characteristics that need to be addressed in assessing the impact of environmental degradation and climate change on migration.

First, geographer Graeme Hugo stresses the complex interrelationship between population mobility, economic development and social change, resources, and environment (Hugo, 2010, 11). An overview of these drivers of migration can be found in Figure 14.

Second, the difference between disaster events and slow onset disasters is important

to consider, especially in the case of climate change, where the former creates a lot of attention and the latter is generally neglected (Ahsan et al., 2014; Camillo Boano, Roger Zetter, 2008; Hugo, 2010; Ionesco et al., 2017). For instance, dry regions which we find in the southern USA are at risk of slow-onset processes like land degradation and desertification. It may be feasible to evacuate after a wildfire and return home to continue with your previous livelihood. However, when that livelihood is dependent on rain-fed agriculture, in-situ adaptation might be more challenging when water becomes more scarce over time. Hence, slow-onset processes take on a more permanent profile and should focus more on long-term transitions and inclusivity of different livelihoods and socio-economic backgrounds. Moreover, slow-onset processes may also decrease people's ability to move away or deal with sudden-onset hazards. In all, the chosen time frame gives a different vulnerability profile.

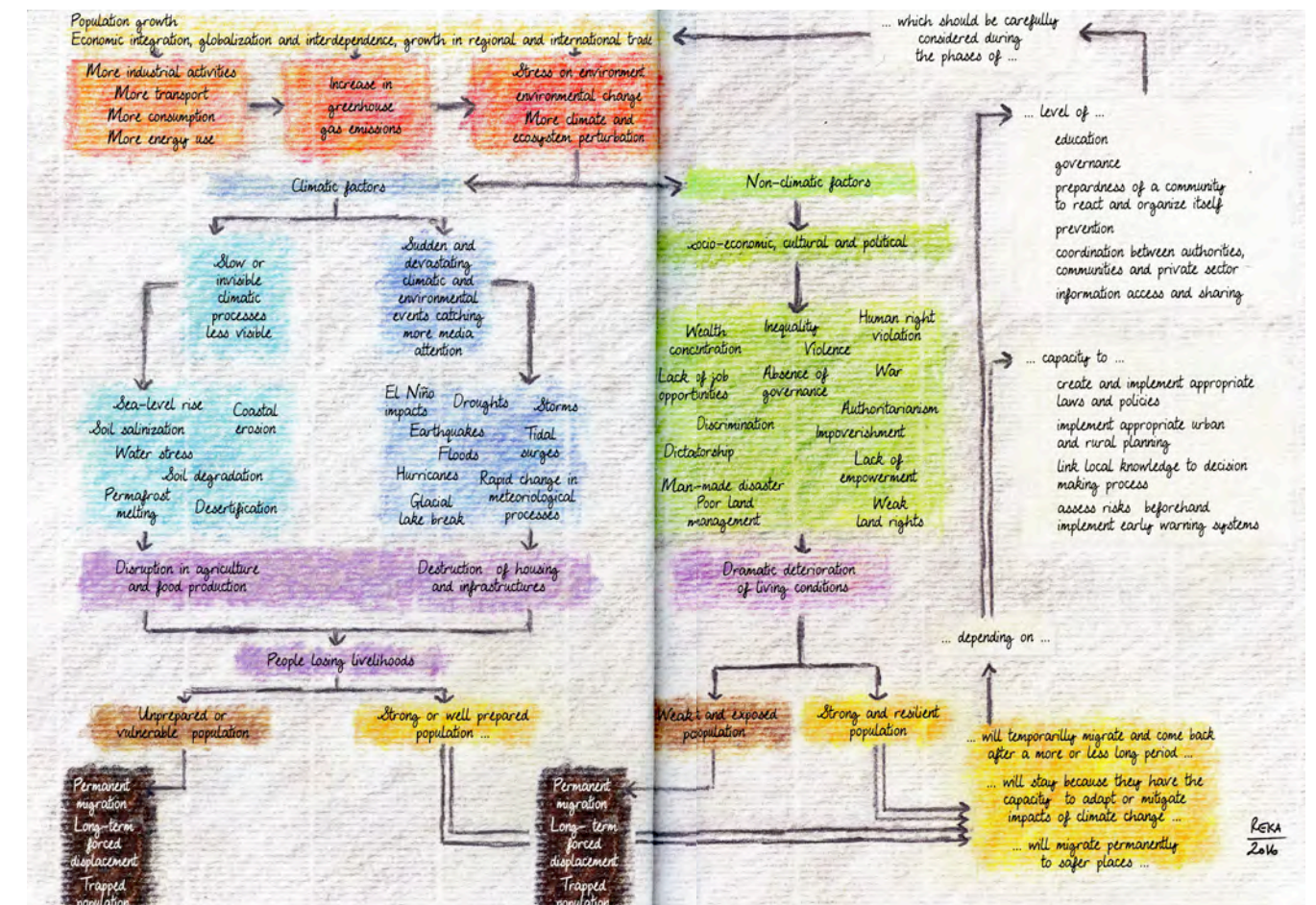


Figure 14. Drivers of migration. Source: Ionesco et al., 2017, 68.

Third, migration due to environmental degradation should be visualised along a continuum from voluntary to forced movement (Hugo, 2010; Ionesco et al., 2017).

Fourth, a key distinction to make is between mobility as a strategy for adapting to impacts of climate change versus displacement when impacts are so severe people are forced to leave (Hugo, 2010, 11). Human mobility as a response to climate change expresses itself in many ways, and often time frames are an important characteristic of that form. Temporary or circular mobility (also seen as an adaptation strategy) has in many communities been a long-established practice to adapt to seasons (Ionesco et al., 2017, 22). Displacement or relocation (also seen as a mitigation strategy) can be temporary (evacuation) or (protracted) long-term (ibid., 23). Furthermore, Hugo points out that mobility is but one response to mitigate or adapt to climate change

from a range of adaptation responses (Hugo, 2010, 13). And often, with a slow onset environmental change, the migration response is more complex (ibid., 14). Another risk which was first emphasized by the 2011 Foresight report is the challenge of trapped populations or immobility. When people feel the desire to migrate but are unable to do so, they may become 'trapped' (Ionesco et al., 2017, 28). This is most often the case in already vulnerable populations, and the environmental stress then aggravates their systemic (economic, political, demographic) vulnerability (ibid.).

Fifth, it is not just the real or experienced environmental hazard that leads to mobility, but also any changes in perception towards environmental risk (Piguet, 2010). This creates an important role for information services like governments and media.

Last, research shows that people are more

likely to resort to migration if this is an established practice around their place of residence. Termed linear migration, Hugo predicts that this will cause migration to happen overwhelmingly within countries and along existing migration corridors (Hugo, 2010, 16-17).

and recognize the variability of changing conditions.

III. KNOWLEDGE GAP AND RELEVANCE

From the reviewed literature, it is clear that the environment is just one factor of migration among others, hence the use of the term climate-induced migration in this paper. Traditional economic, demographic, political or social factors played a primary role in neoclassical migration theory, with the environment playing only a secondary role by influencing the above (Ionesco et al., 2017, 64). However, neglecting the environment is currently deemed to provide an incomplete overview of contemporary migration (Ahsan et al., 2014; Camillo Boano, Roger Zetter, 2008; Hugo, 2010; Ionesco et al., 2017). This uncertainty regarding the (measurable or assessable) impact of environmental factors on migration remains a challenge. As the individual decision to migrate or not, and based on which exact factors, remains difficult to research on a large scale, Boas et al. (2019) have argued that research should rather focus on how climate change might alter existing interconnections and migration patterns under different scenarios of global warming and mitigation and adaptation policies. That it should explore the complex connections between human mobility and climate change, rather than a minimization of it. And that it also needs to shift its focus from climate-sensitive sending areas to destination areas of migrants, as they argue that mobility only becomes a problem if there are no adequate governance interconnections between home, host, and transit areas.

II. GOVERNANCE FOR AN UNCERTAIN FUTURE

The second part of this problem synopsis is related to the way we currently plan for the future in order to accommodate uncertainty, scale and complexity related to climate change. By nature, climate change is an interdisciplinary problem that addresses our ability to deal with the long term, with different scales and administrative systems. This in itself presents decision-makers with great uncertainty. However, the interaction of environmental conditions with societal perspectives, new technologies, economic and political developments and changing preferences makes this a deeply uncertain issue. Ideally, decision-makers need to make sure that the decisions they make today continue to apply, are able to cope with changing conditions, and be inclusive of stakeholders and their changing needs and perspectives.

Here again, the difference between sudden-onset hazards and slow-onset change can inform a transition in governance. Existing emergency-centred planning approaches to climate change are reactive. They work well in case of disaster events, evacuating communities and centralizing funding for recovery action. However they fail to recognize that an increased frequency of disaster events might affect the community's (and emergency service's) ability to cope, as well as their ability to deal with slow-onset changes that might in worst-case scenarios feel like a permanent state of disaster. Governance for an uncertain future should rather create preparedness, set priorities over the long- and short-term,

Sustainable Development Goals

The current Sustainable Development Goals (SDG's) were called to life in 2015 by the United Nations to prioritize interlinked aspects of sustainable development for 2030. The



Figure 15. The SDG's this project aims to address.

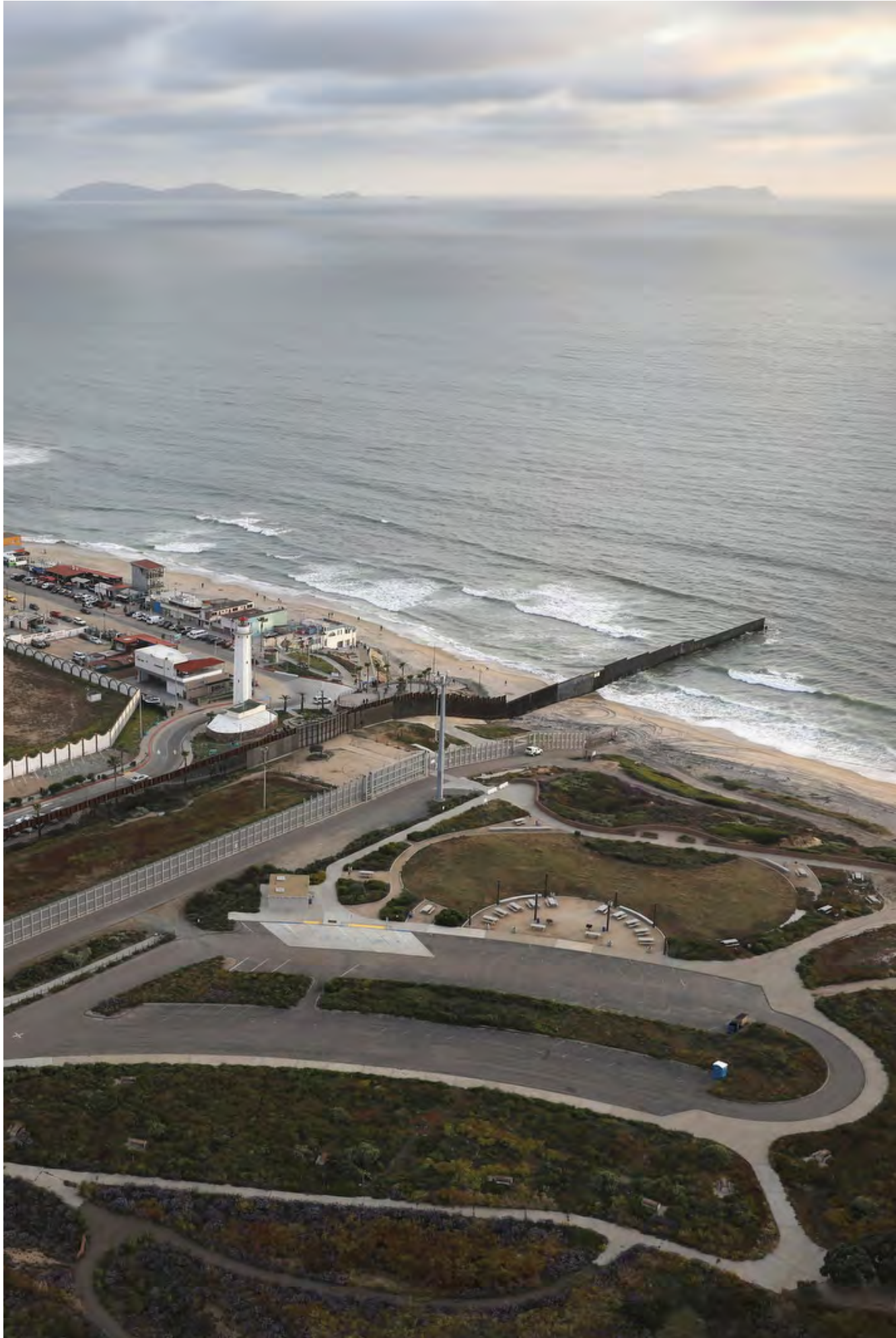
SDG's have since been localized by many governments, institutions and organizations. Although the goals and their indicators are criticized, they do manage to guide agenda setting, global cooperation and promote (to a certain extent) the links and interdependencies between the goals. This project aims to deal with eight out of seventeen of the goals (see Figure 15), be attentive to their interlinkages and contribute to the knowledge gap by exploring the complexity between migration and climate change within a specific context.

IV. PROBLEM STATEMENT

Our planet is facing acute stress due to new conditions posed by climate change. Both slow-onset and sudden-onset effects impact social-ecological systems, thereby exposing and exacerbating vulnerabilities that may render places (temporarily) uninhabitable and livelihoods unworkable. In the state of California, USA, climate change effects may in particular expose vulnerabilities related to water scarcity and systems related to it, such as agricultural production for the global market, labour, land productivity and biodiversity. California's coastal urbanized areas also face exposure to sea level rise, changing weather patterns and wildfires, which may exacerbate the conditions for already vulnerable groups of the population who are less able to prepare for and respond to (slow-onset) disasters. The accumulation of disruptions on livelihoods with climate-induced migration as a possible response strategy, needs to be accounted for on appropriate spatial- and governance scales. This response needs to take into account the temporal variability of the climate change disruptions and the vulnerabilities they expose in order to imagine just spatial futures in this context of deep uncertainty.



Figure 16. Climate change map for North America. Source: Ionesco et al., 2017.



03

RESEARCH CONCEPTS

Departing from the knowledge gap and problem statement in the previous chapter, this chapter will elaborate on the main research aims of this thesis as well as the central concepts used to understand the problem field and tackle the research questions.

I. RESEARCH AIM

The aim of this research is to explore the role of a proactive planning framework in dealing with an uncertain future that will be affected by slow-onset climate change conditions. Context-specific to southern California in the border region with Mexico, this planning framework specifically aims to mitigate and adapt to a future that may see displacement as a result of changing environmental conditions. It therefore needs to anticipate change in order to increase preparedness as the future unfolds. This thesis aims to provide a narrative for just social-ecological development of this region working with the variability of the future. It will explore strategies

that deal with climate vulnerabilities and seek opportunities to mitigate or facilitate migratory movement where necessary.

Summarising, the main research aims of this thesis are:

- to identify vulnerabilities and opportunities related to climate-induced migration as a result of slow-onset climate change;
- to explore strategies that anticipate climate-induced migration and are able to mitigate the potential injustice of forced migration and considers migratory movement as an adaptation strategy;
- to explore a proactive and flexible planning framework that is able to adapt as the uncertain future unfolds, in order to strengthen preparedness for unjust and undesirable socio-ecological outcomes.

Figure 17. The border ends in the Pacific Ocean between San Diego and Tijuana. Source: CNN, 2018.

II. THEORETICAL CONCEPTS

Several concepts need clarification in order to meaningfully address them in this thesis. Therefore, this section will discuss the most important theoretical concepts that guide an understanding of the proactive planning framework explored in this thesis.

Adaptation

Adaptation in the context of planning is a process of adjustment to changing conditions, for instance those that climate change poses. Adaptivity does not assume that a system bounces back after a disruption, but rather that it creates a permanent change in the system that needs a different response. From a decision-making point of view there are two basic adaptive responses (Adger et al., 2006):

- First, individual agents can employ adaptation actions with the alternatives they have and with the constraint of the resources available to them;
- Second, collective adaptation action can be taken by creating a set of adaptive actions and redistributing their burden.

This can be done on various scales from international to local adaptation action setting. Timing-wise, there are three ways to undertake these actions: proactive, reactive and also inaction can be chosen as a response. None of these options are likely to result in perfect adaptation, there are always negative externalities or residual impacts based on the choices made. To have fairness or justice in the adaptation process necessarily involves transparency about the approach, a clear view of the beneficiaries of the adaptation action, and an idea on how an adaptation action impacts a socio-ecological system on varying scales and over different time frames.

Disaster management

Many multi-scale governance boards address

emergency planning or disaster management. In California, these departments deal with societal emergencies such as terrorist attacks or pandemics, as well as environmental crises such as wildfires, floods and earthquakes (see for instance Emergency LA City or the California Emergency Management Agency). The departments generally devise plans according to the disaster management cycle, which is geared towards a planned response providing rescue and relief efforts, followed by recovery and reconstruction of the damage done. The final preparation phase consolidates actions prior to the next disaster event to activate the necessary resources for such an event (see Figure 18).

However, considering climate change is posing new conditions for existence, it can be argued that environmental emergency planning should to a certain extent be integrated in regular long-term planning approaches. This feedback from this new climate reality, which involves increased frequency of disasters like wildfires and floods, can be integrated into the planning loop ensuring that over time planning efforts integrate adaptation measures for increased frequency of natural disasters and changing climate conditions (see Figure 18).

Evolutionary resilience and preparedness

This concept was proposed by Davoudi (2013) to increase the value of the term resilience in the context of governance and spatial planning. To understand this addition, first follows a short reflection on resilience research.

The traditions of resilience research lie in engineering and ecology before it was adopted by urban planners, and its parameters have evolved from those research disciplines. Within engineering, resilience is used to denote the stability of a system to return to an equilibrium after disturbance (Davoudi, Brooks, & Mehmood, 2013, 308). This definition, used in engineering and ecology, seen in the context of social-ecological systems, is deterministic in its presupposition

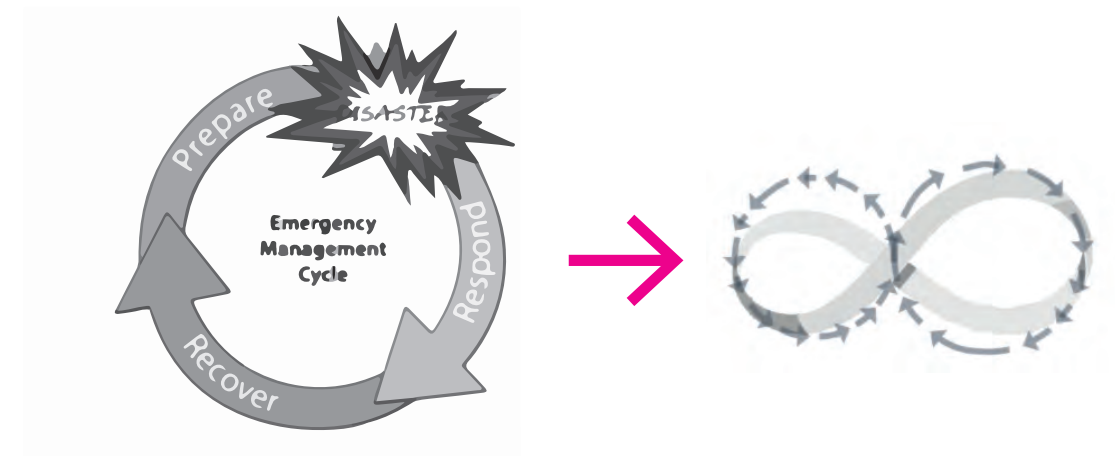


Figure 18. Integrating disaster management in long-term adaptive planning projects.

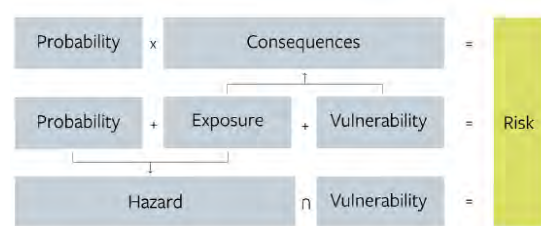
that systems have an enduring equilibrium that does not consider time, scale or the behaviour of other interrelated systems. An increase in the number of natural disasters enhanced sparked more research into resilience in social systems (Taşan-kok, Stead, & Lu, 2013, 42). Ecologists, most notably Folke, Holling and Gunderson, paired resilience with social and economic development, which generated the concept of adaptive cycles (ibid.). In the adaptive cycle, a social-ecological system moves through four distinct phases of growth, conservation, collapse and reorganization. Away from a state of equilibrium, the adaptive cycles offers an understanding of social-ecological resilience as continuously altering as the system adapts to changes, visualized as infinity curves to represent systems on different scales (Davoudi et al., 2013, 310).

Davoudi critiqued this cycle for neglecting human intervention in a social context.

She proposes the concept of evolutionary resilience adding a component of preparedness, arguing that in the face of disturbances the resilience of social-ecological systems can strengthen based on their social learning capacity (preparedness) for improving their chances of withstanding stresses (a sign of systemic robustness and persistence), absorbing disturbances without being pushed into an unwanted trajectory (a sign of flexibility or adaptability of a system) and move towards a more desirable trajectory (a sign of innovation and transformation of a system) (Davoudi et al., 2013, 311). In this way, the intentionality of human actions and their intervention in systems can be accounted for in systems-thinking. This concept of evolutionary resilience came about in response to London's Climate Change Adaptation Strategy, and is thus valuable in the context of governance and decision-making for spatial planning.

Risk

Different disciplines have different perspectives on risk. Generally, the concept indicates the possibility of suffering a harmful consequence, and it embeds that it is possible to quantify the probability of that situation happening with a degree of confidence (Measham et al., 2013). The overview below represents three ways widely used to conceptualize risk, with the first one pertaining to the natural sciences and the other two finding use social sciences.



Research in the social sciences on risk has showed that risk assessment and management need to consider:

- spatial and temporal variability;
- stakeholders' interests;
- societal values likely to be affected by a risk event;
- local knowledge and perception on the consequences of a risk;
- the distribution of risk among different socio-economic groups.

The quantified risks relating to climate change (e.g. sea-level rise) are global issues, yet present itself as local challenges. When it comes to dealing with risk, local concepts and tools need to be used to address it (ibid.).

Social-ecological justice

The term social-ecological justice recognizes that there is an ecological basis for sustaining societies and highlights that environmental resources and environmental impacts are unequally distributed amongst different groups in society. Due to this imbalance, some groups are unjustly impacted by a shortage of resources or exposed to more environmental

risks. According to Allen et al. (2003), sustainability should be considered in terms of sustainability of what, for whom, for how long, and at what cost. Their review shows that the answers to these questions are not static, but diverge depending on whose interpretation or what discourse is concerned. They argue for expanding the scope of perspective in answering these questions. This means that an answer should consider both the short- and long term as well as multiple spatial scales, in order to sidestep that too narrow a focus in (for instance) spatial scale can mask consequences on other scales.

According to Gunnarsson-Östling and Svenfelt (2017), social-ecological justice should include the following characteristics:

- Decisions are based on how the system, case or society depends upon and influences local ecosystems and social-ecological systems (see glossary) in other regions;
- Conflicts, complexity, dynamics, and uncertainty are acknowledged;
- There is a just distribution of environmental goods and services, between and within both communities and generations;
- There is a just distribution of environmental bads (environmental burdens), between and within both communities and generations;
- Principles for just distribution are discussed and defined in a deliberative process;
- Justice permeates planning, policies and production and consumption;
- There is awareness and identification of who is included, who decides, and where power is located;
- Environmental decisions are based on and shaped by affected peoples/communities.

(Deep) Uncertainty

With respect to decision-making, uncertainty designates the gap between the knowledge that decision makers have available and would need in order to make a certain choice. Hence, this concept clearly involves subjectivity as the satisfying amount of information is guided by the perspective and values of a decision maker and the actors involved (Marchau et al., 2019).

When making decisions for the future, a decision maker needs to anticipate change. And this process becomes increasingly difficult with a multitude of data of how different systems are expected to act, and deficient knowledge on how systems interrelations will cause the future to unfold. Climate change is commonly understood to be a source of deep uncertainty, meaning that experts are unsure (or cannot agree upon):

- the external context of the system;
- how the system works and its boundaries;
- the outcomes of interest from the system and their importance;
- the actions taken over time in response to unpredictable evolving situations (ibid.).

Climate change research is plagued by this imperfect understanding of its functioning, and its magnitude will depend on the speed of climate change, the implications for a specific area, and the influence of policies taken. Hence, deep uncertainty in this project is a given, and needs to be reduced in order to be manageable (but not ignored).

Vulnerability

The concept of vulnerability in the context of social-ecological systems can be traced to various research disciplines. Adger locates this research within geography and hazard and risk research (Adger, 2006, 269). Its definition is often formulated in the negative, indicating “the degree to which a system is susceptible to and unable to cope with adverse effects“ (ibid.). It has three elements that denote the degree of vulnerability: exposure, sensitivity and adaptive capacity (Adger & Brown, 2009, 110). These are similar to the parameters of resilience. The concept of resilience derived from ecological sciences and complex systems studies (ibid., 119). It is often formulated as the antonym to vulnerability focusing on the adaptive capacity of a system in preserving the capacity to deal with uncertainty or change (ibid.). Adger, from the perspective of geography, defines it as the magnitude of disturbance that can be absorbed by a system before it radically changes to a different state,

as well as the system's ability to self-organise and adapt to a changing environment (Adger, 2006, 268-9).

III. CONCEPTUAL FRAMEWORK

The aim of this thesis is to explore how a planning framework can address vulnerabilities that are affected by climate change conditions in order to mitigate forced migration or use migration as an adaptation strategy for changing conditions. Concluding from the relevant theoretical concepts discussed in the previous section, several common themes can be identified:

- the framework needs to address the contextual challenges;
- the framework needs to be sensitive to the cascading effect of vulnerabilities over several scales and timeframes;
- the framework needs to be flexible enough to adapt to changing circumstances under deep uncertainty, and yet show a desirable trajectory;

- the framework needs to address the most vulnerable populations and territories, as these are at most risk of forced displacement.

The conceptual framework shows this dynamic. Simplified, climate change effects impact already existing vulnerabilities as well as surfaces new vulnerabilities. These vulnerabilities could potentially lead to climate-induced migration if it means that spatial circumstances become thus undesirable or uninhabitable. A planning framework centred around preparedness should focus on addressing these existing and potential vulnerabilities, and be sensitive to their cascading effects of scale and time.

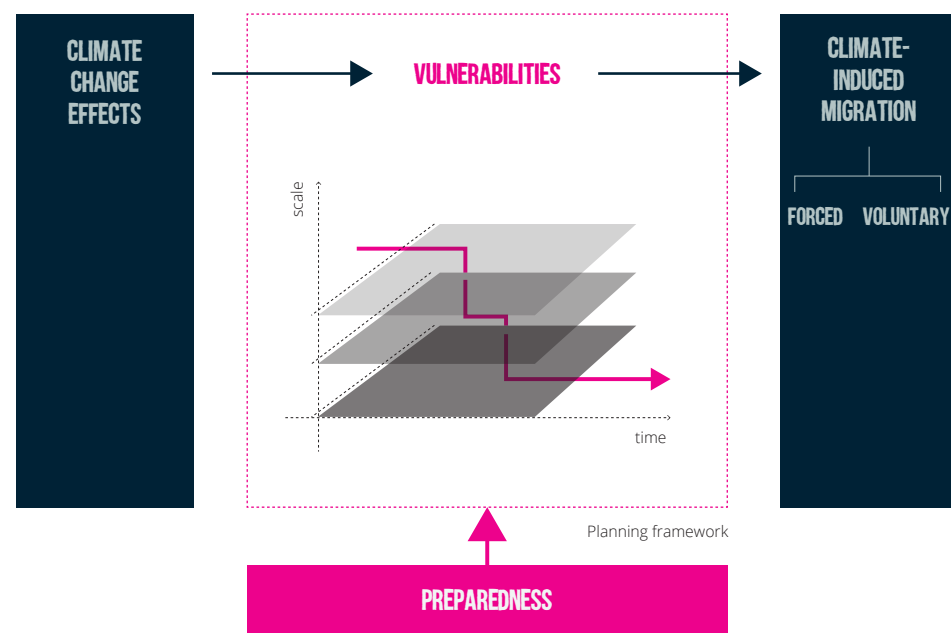


Figure 19. Conceptual framework.



Figure 20. Hospitals are being evacuated as the Kincadee wildfires come too close. Source: New York Times, 2019.

IV. RESEARCH QUESTIONS

The main research question this thesis aims to answer is:

How can a **scale- and temporal sensitive planning approach** act towards **preparedness** in order to respond to the threat of **climate-induced migration** under conditions of **climate change uncertainty** in the California-Mexico border region?

The following sub-questions were formulated to aid the understanding of the main research question.

To define the scope of climate-induced migration and its potential spatial triggers:

- 1) What are the **driving forces** of climate-induced migration? - Chapter 2 - Problem Synopsis

- 2) What are the **cascading socio-spatial interrelations** between climate change effects and migration in the California-Mexico border region? - Chapter 5 - Analysis

To propose a new narrative that acts towards preparedness:

- 3) What are the socio-spatial **potentials and synergies for development** that accommodate different types of migrants and a more flexible and adaptive lifestyle under climate change uncertainty? - Chapter 8 - Identifying actions

- 4) How can a **planning framework** acknowledge the scalar- and temporal variability of climate change effects that trigger vulnerabilities and integrate preparedness and a mobile lifestyle in the current planning discourse of the region? - Chapter 9 Exploring pathways and chapter 10 Evaluation



04

RESEARCH METHODOLOGY

This chapter describes the methodological process of this research project. It details the steps taken and methods used, as well as the advantages and limitations of the chosen methodology.

I. METHODOLOGICAL PROCESS

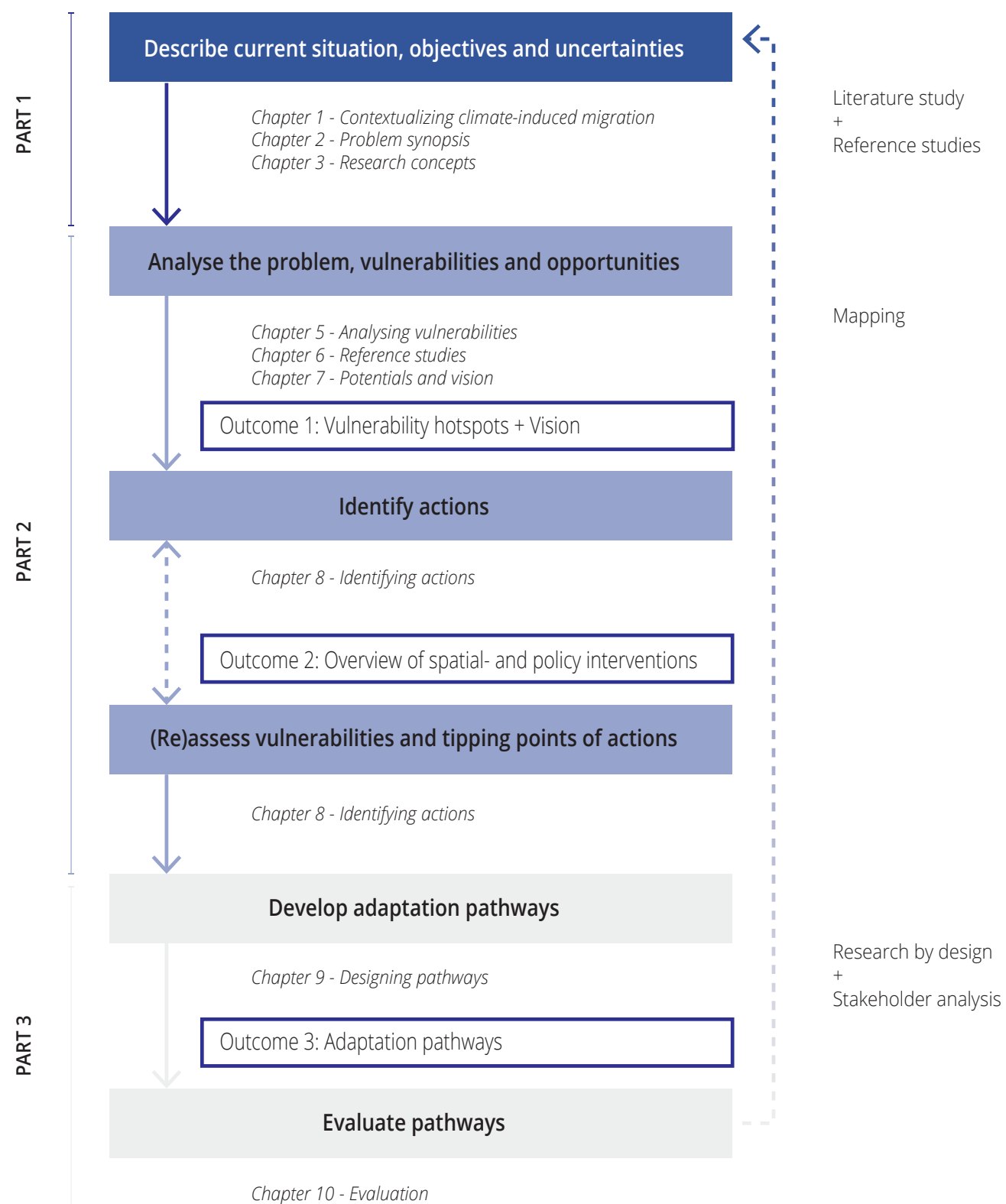
In order to explore a scale- and temporal planning framework that addresses vulnerability triggers for climate-induced migration, this project proposes a methodological process that is based on the steps taken to define Dynamic Adaptive Policy Pathways (DAPP). The different steps are geared towards three main outcomes that build on each other and function in a feedback loop in order to devise pathways and evaluate them. The methods used to reach those outcomes, as well as their limitations, will be explained in this chapter.

The first phase of this research concerned the

setting of objectives and desired outcomes, and placing the project within a body of literature. Literature study and reference studies provided the project with relevant variables to analyse and work with in later phases.

The second phase of the project focuses on analysing the relevant variables in order to determine where vulnerabilities are located, in which timeframe they surface, and on which scales they have a cascading effect. This resulted in a map with vulnerability hotspots. The analysis also presented potentials for development and adaptation. These were written into a vision for the region. With a clearer understanding of the vulnerabilities and potentials, a set of spatial- and policy actions were created to address them. For each action, an adaptation tipping

Figure 21. Border cantos. Source: Richard Misrach, 2016.



point (ATP) was determined for two IPCC Representative Concentration Pathways (RCP). The actions were then reassessed against the vulnerabilities and potentials they are meant to address.

In the final phase of the research, the actions were assembled in pathway tube maps to show synergies and exclusions between the actions and to construct multiple narratives. These narratives were then illustrated on different decision crossroads to show their different potential spatial impact. The role of stakeholder preferences is also accounted for in this phase. Finally, the pathways were evaluated against the original objectives of the research to show their use and limitations.

II. VARIABLE SELECTION AND MANAGING UNCERTAINTY

This thesis aims to explore spatial- and governance strategies for dealing with climate-induced migration in a context of slow-onset climate disruptions in southern California. Its research approach is guided by the necessity to deal with uncertainty.

Climate-induced migration as a field of study is gaining attention in the global south, where the effects of climate change are already abundantly visible. And in some of these contexts, for instance in delta regions in Bangladesh, (temporary) migration is an established adaptation practice of communities for dealing with their changing environment. Also from the literature, climate-induced migration also overwhelmingly happens via previously established migration patterns. As of yet, this is out of context for California. Its main migration narrative dates back to the Dust Bowl in the 1930s, when more than half a million people entered the state in search for work and a place to live

as a direct result of drought and economic depression in the four southern plain states of the USA. This thesis therefore assumes that (temporary) migration is a possible response to the changing climate in California. This assumption of an already multi-causal topic like climate-induced migration, and the inability to study previous migration patterns, adds uncertainty to the project. That uncertainty is deepened by the long-term approach of this project. Therefore in this research, several steps were taken to make the uncertainty manageable for a one year project. First, reference studies are used to create a clearer understanding of the interaction between environmental conditions and migration patterns, and the types of migration and timeframes involved. Second, to manage the complexity of the multitude of causes related to climate-induced migration in the literature, the concept of vulnerability is used as a proxy for migration. A definition of social and environmental vulnerability is used to reduce the number of variables and define potential key triggers for migration. Third, the analysis focuses on socio-environmental spatial layers with quantifiable prognoses (like water availability or energy demand), and dismisses contextual changes (like a change in political administration, which, based on the recent presidential change, can be of high influence to the situation but is difficult to predict).

The above creates adaptation pathways that function as scenario's, defined as "a set of plausible not probable narratives that has the ability to depict alternative pathways to the future' (Bohensky, Reyers, & Van Jaarsveld, 2006). The advantage of this being that they create identifiable possible alternative paths of future development through a reduction of uncertainty.

Figure 22. Methodological flowchart.

III. METHODS

Document and policy analysis

The objective of this method is to collect, analyze and synthesize the main policy instruments of planning at various scales that can be used to address climate-induced migration in the context of climate change disruptions. The overall analysis needs to consider the main governance structures, gaps and hurdles that influence spatial development at various scales. In addition, it needs to reveal the governance discourse underpinning these policies and structures in order to guide redefinition or reconfiguration under the concepts studied and valued through the theoretical framework. Finally, this analysis produces a guide of potentialities and limitations of governance structures to address climate-induced migration in the face of climate change disruptions.

Dynamic Adaptive Policy Pathways (DAPP)

DAPP was created as a framework to aid planners in creating a strategic vision for an uncertain future. The framework allows for committing to short-term actions and guiding future actions, in order to adapt to changing conditions over time. DAPP is an analytical approach to explore and sequence a set of actions based on alternative developments over time (Haasnoot et al., 2013). This project explores a set of actions across two Representative Concentration Pathways (RCP's) that set a different speed and progress of climate change conditions which are deemed relevant for the objectives of this project. The method follows several steps for setting objectives, analyzing vulnerabilities and potentials, setting actions and their sell-by-dates, and creating pathways; the methodological process of this project follows these steps. The continuation of the method is out of scope for this project, but includes choosing preferred pathways (based on values and beliefs of stakeholders for instance), implementing the plan and monitoring it.

Literature review

This method is used to understand the theoretical constructs of climate-induced migration, resilience and scale and to hence build the theoretical framework. They concern non-site specific theories that will help to frame the case study and reference projects to finally result in a spatial strategy and design.

Mapping

This method aims to spatialize the problem in order to map potentials and conflicts related to it. Analysis of the problem - through other methods provided in this subchapter - constructs the main units of analysis for this method: systemic disruptions related to main climate change effects (drought, freshwater scarcity and sea-level rise), socio-economic spatial structure, land-use variation and ownership, urban expansion and shrinkage, migration networks, political variation, job opportunities and spatial seasonality effects.

Data is obtained through official sources of geo information:

- + California State Geoportal
- + Cal Adapt, California's database with climate change research
- + GIS and Spatial Datasets of Humboldt University, UC Davis and University of Berkeley
- + GIS Open Data of the Department of Water Resources CA
- + Data Basin
- + NCAR Climate Data Guide AR5

Reference studies

For this project, two reference studies were chosen to create a better understanding of the interaction between environmental change and disasters and migration. These projects were studied specifically for the temporal and scalar interaction between environment and migration, and study specifically the socio-economic context of climate-induced migration through qualitative research. They therefore complement the more quantitative-

based mapping analysis. From both studies, key relevant features are highlighted, and relevant conclusions for this research are presented. The following two projects were used:

The *Hurricane Katrina Project* from Brown University was studied here because it aims to understand the long-term effects of an environmental disaster across different socio-economic groups within the population, studying the effects of hurricanes on the Gulf Coast in the USA from 1970-2005. Moreover it is USA-based, giving interesting contextual study material.

The *Migration, Environment and Climate Change: Evidence for Policy (MECLEP)* project is an EU-funded research project that ran from 2014-2017. It compares six countries (Dominican Republic, Haiti, Kenya, Republic of Mauritius, Papua New Guinea and Viet Nam) to assess the extent to which migration, including

displacement and planned relocation, can benefit or undermine adaptation to environmental and climate change. The study is specifically valuable as it is able to find common denominators and generalize results on types of human mobility, implications for these different types for adaptation and policy recommendations.

Research by design

Concepts and ideas from the spatial vision and strategy can be tested through design studies on various scales to help understand what the strategy and vision could mean spatially. These design studies can be done through mapping, drawing conceptual schemes, collaging etc. After having investigated qualities and problems in the area through other analytical and empirical methods described above, this method allows to test their spatial potentials to produce new



Figure 23. "No state is unaffected by climate migration". Source: The Guardian, 2018.

insights and knowledge.

Stakeholder analysis

This method is used to identify the main actors and power relations that intervene in spatial development. These stakeholders are understood as institutions, companies or public agents that operate at various scales within the governance framework. This method will result in an overview of the main relationships, interdependencies and areas of influence in order to identify the potentials and limitations for the spatial strategy and design. The result should also redefine critical aspects of stakeholder interrelations that could facilitate a more scale- and temporality sensitive spatial response to climate-induced migration.

IV. ADVANTAGES AND LIMITATIONS OF CHOSEN METHODOLOGY

The advantage of the chosen methodology is that it allows for navigating a project with a large time horizon and many uncertainties. It has the flexibility to adapt when new opportunities arise or conditions change. Furthermore, it also accommodates the integration of different stakeholder perspectives and provides a drawing board for a participatory planning approach as it is transparent in action formulation and sequencing of action events. The cascading impacts of an action can also be made visible in this methodology, allowing to create support for an action amongst a stakeholder group if they understand the (synergetic) effects of that action over time. Finally, the methodology accommodates the interdisciplinarity of the topic.

The methodology does not result in a blueprint or design. It rather gives a strategic sequence of actions, and different narratives to pursue. On a smaller scale, an action sequence can be captured in a quick design, but design best stays in the sketch phase to accommodate the flexible and adaptive nature of the methodology. A realistic design visualisation of the future would undermine the methodology. Finally, the narratives remain very broad due to the chosen time frame and scale. Especially on the micro scale, it becomes harder to make suggestions that uphold the flexibility of the methodology. Any suggestion therefore becomes less reliable the smaller the scale.

and policy review and educated guessing. For some tipping points, for instance water supply from the Colorado River, a proxy was used. As that data had been modelled for a Sierra Nevada study and not for the Rocky Mountains, this project used Sierra Nevada data to proxy reduction in snowpack and runoff. Data collection of tipping points is discussed further in Chapter 7 Identifying Actions.

V. REFLECTION ON DATA COLLECTION

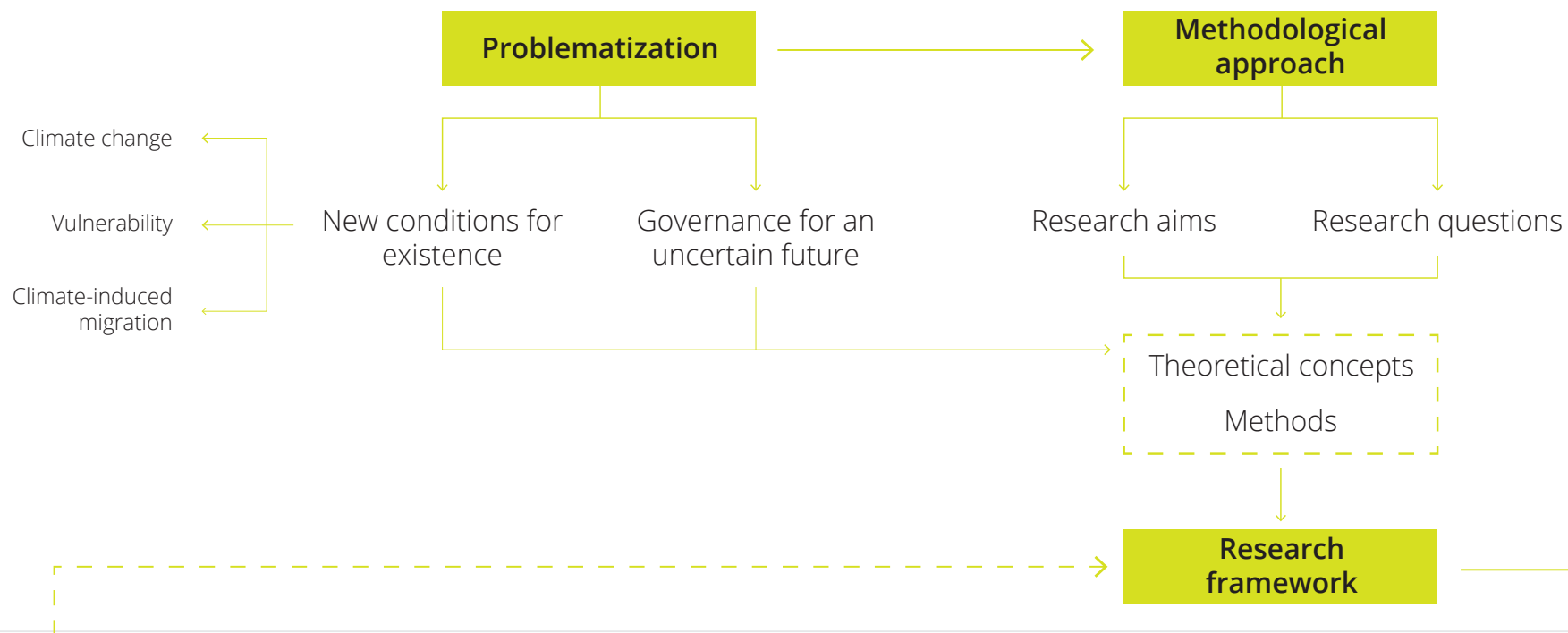
Spatial data was generally very readily available for the USA, with many available options for geospatial information. As fieldwork was undoable due to COVID-19, this project had to rely on (Google) satellite imagery to create an idea of the physical spatial context. Especially in Imperial County around the Salton Sea this proved hard, as the latest images dated from 2008 and did not match with land-use layers from geospatial datasets. To get an understanding of the conditions of working migrants, I attended online conferences on this topic which proved very useful in understanding the dilemmas between agricultural workforce demand and labour availability, rights and migrant conditions. They acted as qualitative input for this project.

In order to carry out the DAPP method, tipping points of actions need to be defined. In practice, these tipping points are often developed qualitatively according to expert judgment before more intensive model-based quantitative investigations are carried out. For this project, the tipping points were defined based on available knowledge gained from previous geospatial analysis, document

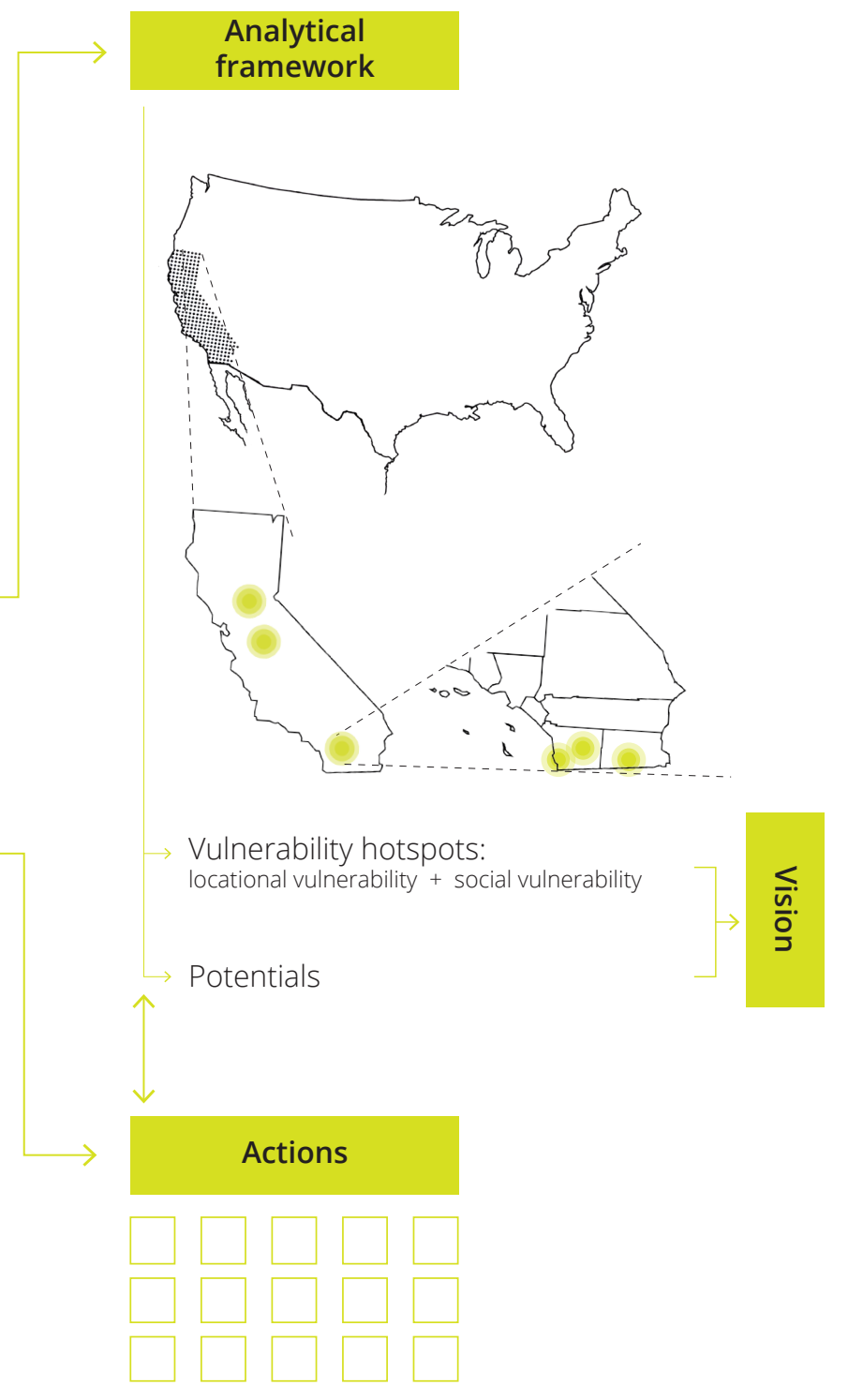


Figure 24. In this November 1936 photo from the U.S. Farm Security Administration, a mother, stands with her five children near Fresno, Calif., where she works as a cotton picker. The Dust Bowl led to a massive migration of Midwestern farmers out of the region, many of whom traveled to California in search of jobs. Source: NPR, 2018.

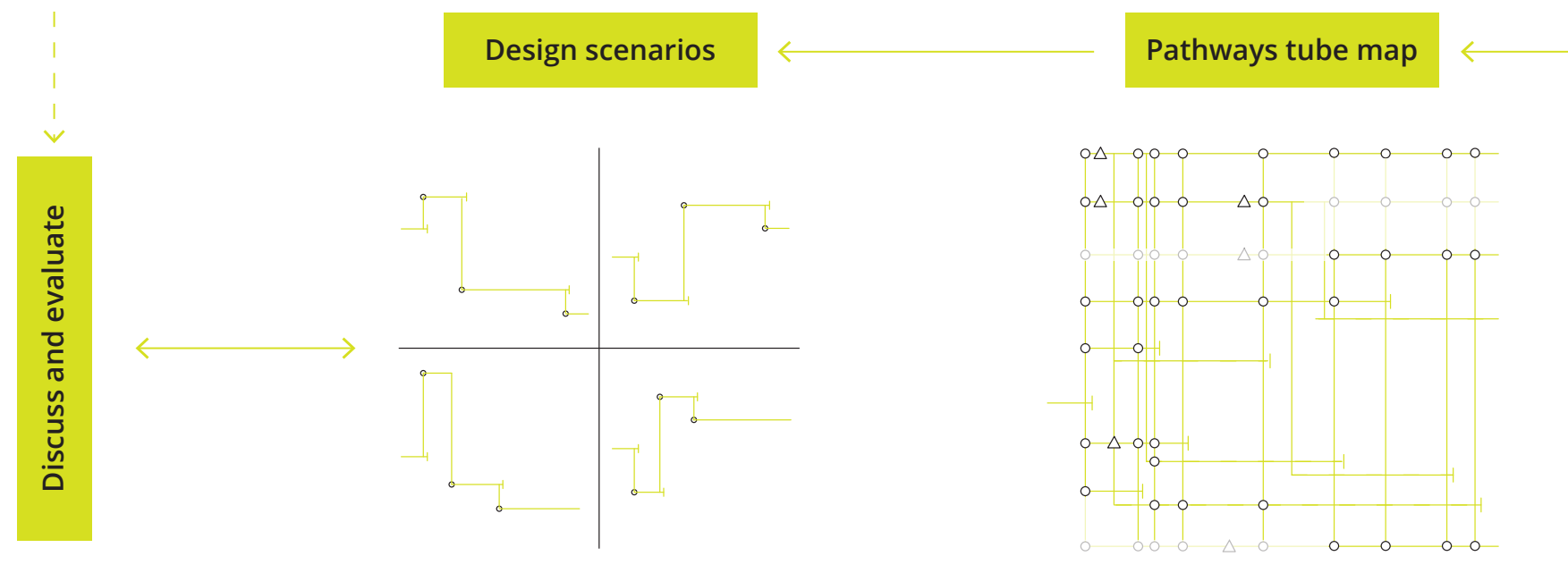
PART I / CONTEXTUALISE



PART II / ANALYSE AND IDENTIFY

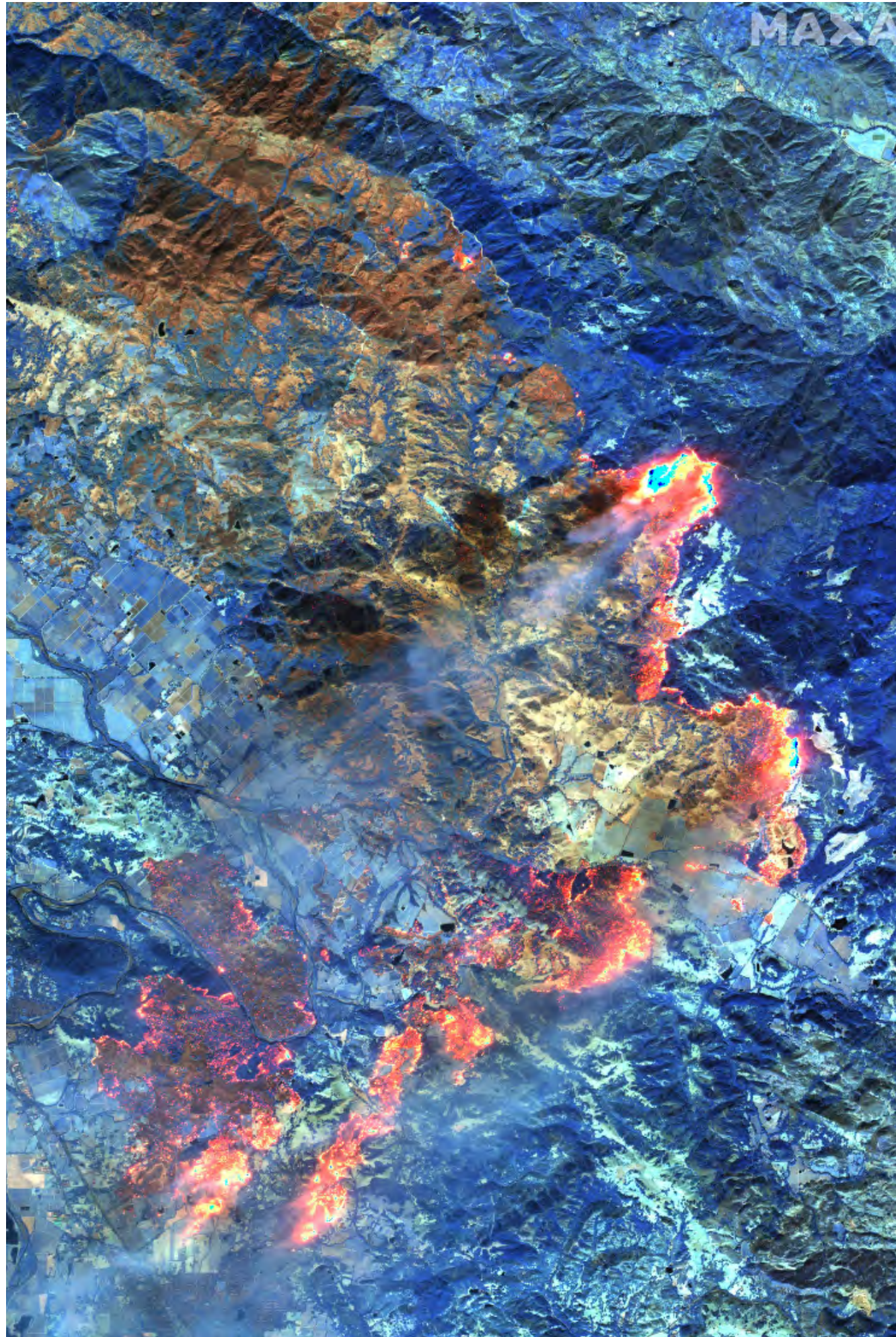


PART III / DESIGN AND EVALUATE





PART 2
ANALYSE AND IDENTIFY



05

ANALYSING VULNERABILITIES

This chapter will analyse vulnerabilities in the region to come to an overview of vulnerability “hotspots” that consider both social- and locational vulnerability.

Analytical framework

In order to analyse vulnerabilities in the chosen region, Figure 27 shows the scales that will be addressed. Instead of pertaining to government borders, this chapter will rather look at ecologically relevant areas. In the case of hydrology for instance, this will be the river basin.

Representative Concentration Pathways

The RCPs were chosen to represent a broad range of climate outcomes, based on a literature review, and are neither forecasts nor policy recommendations. While each single RCP is based on an internally consistent set of socioeconomic assumptions, the four RCPs together cannot be treated as a set

with consistent internal socioeconomic logic. For example, RCP8.5 cannot be used as a no-climate-policy socioeconomic reference scenario for the other RCPs because RCP8.5's socioeconomic, technology, and biophysical assumptions differ from those of the other RCPs. Each RCP could result from different combinations of economic, technological, demographic, policy, and institutional futures. This project focuses on 2 RCP's. Pathway 8.5, generally taken as worst-case-scenario, and combines assumptions about high population and relatively slow income growth with modest rates of technological change and energy intensity improvements, leading in the long term to high energy demand and GHG emissions in absence of climate change policies. Representative Concentration Pathway 4.5 is described by the IPCC as an intermediate scenario. Emissions in RCP 4.5

Figure 25. Image of the Kincadee fire in California in October 2019.
Source: Maxar Sattellite Imagery, 2019.

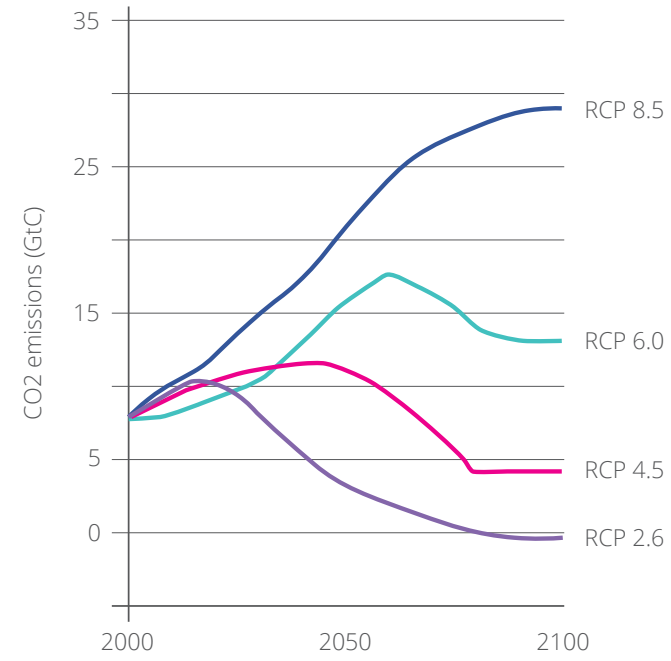


Figure 26. Progression of Representative Concentration Pathways. Source: author, based on IPCC, 2019.

peak around 2040, then decline.

Climate change forecast for temperature and precipitation

The precipitation and temperature forecast models on the next pages show their change for two different RCPs compared to a calculated baseline (average 1850-1970) for the mid-century mark (2040-2060) and the end-of-century mark (2080-2100). In these models, the end-of-century model for RCP 4.5 resembles the mid-century model for RCP 8.5. These two RCP's have been chosen to show a range in results from the effects in case of mitigation, and effects for business-as-usual.

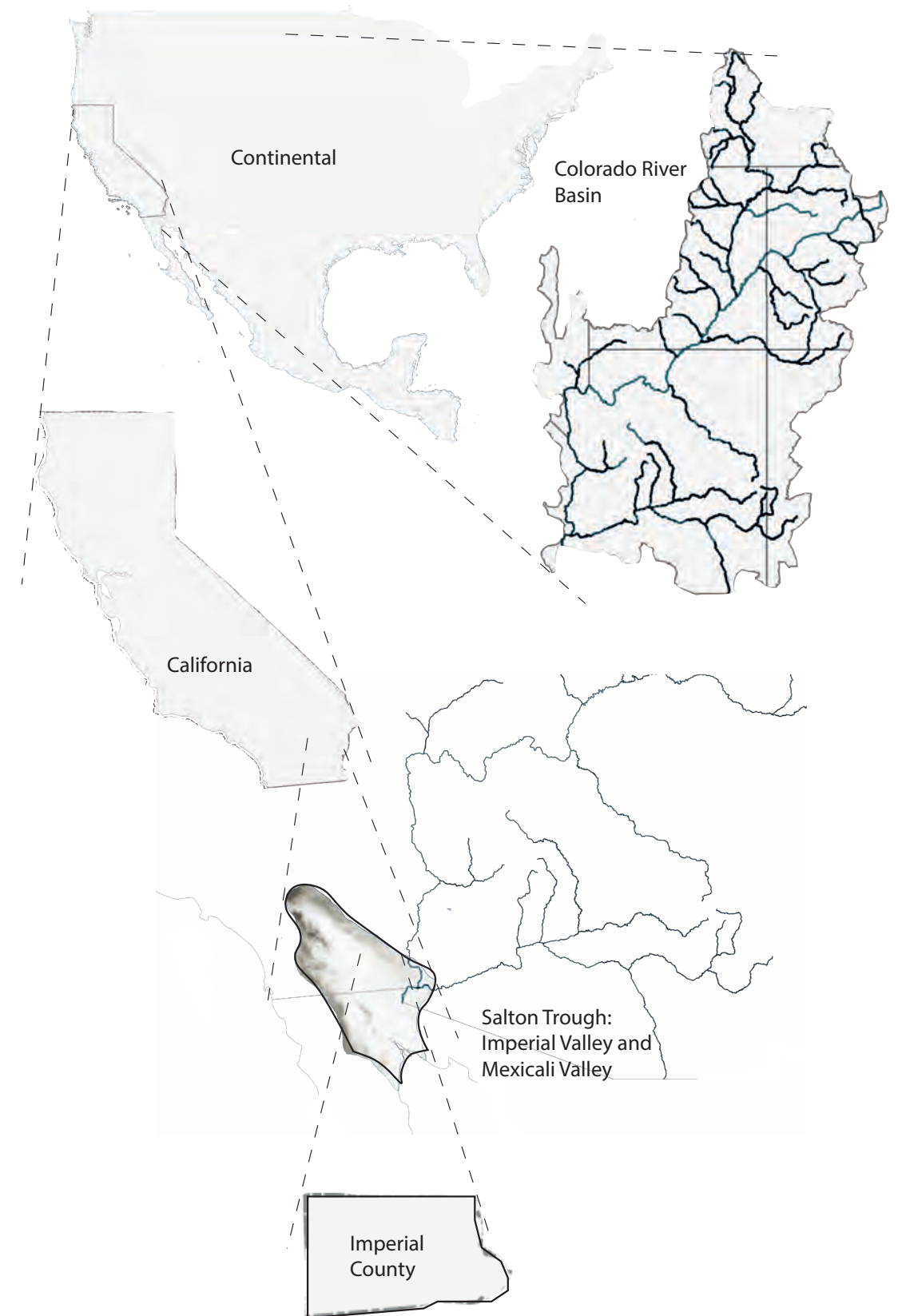


Figure 27. Overview of scales addressed in this project.

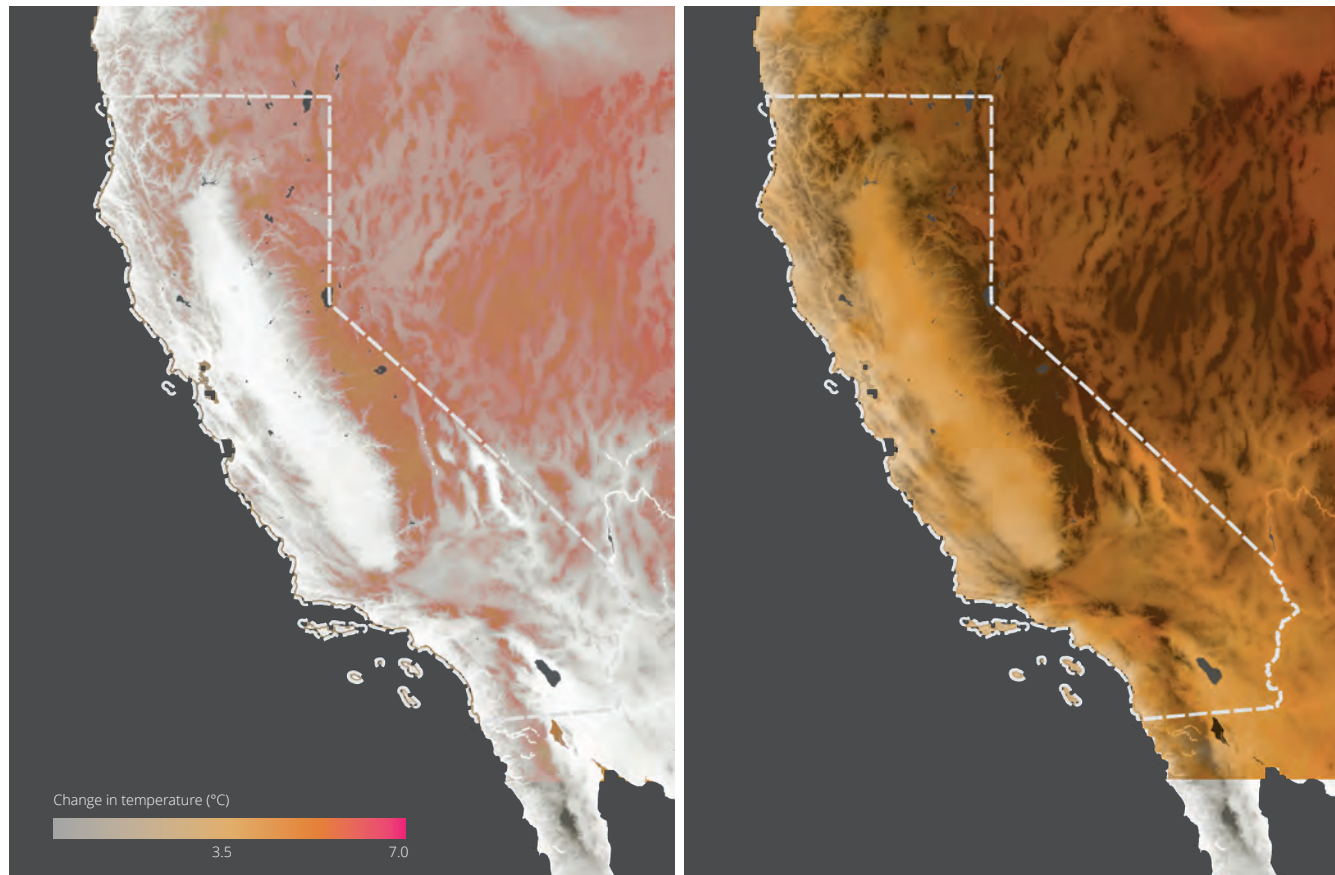


Figure 28. Temperature change for RCP 4.5, mid-century situation (left) and end-of-century situation (right). Source: author, based on Cal-Adapt, 2021.

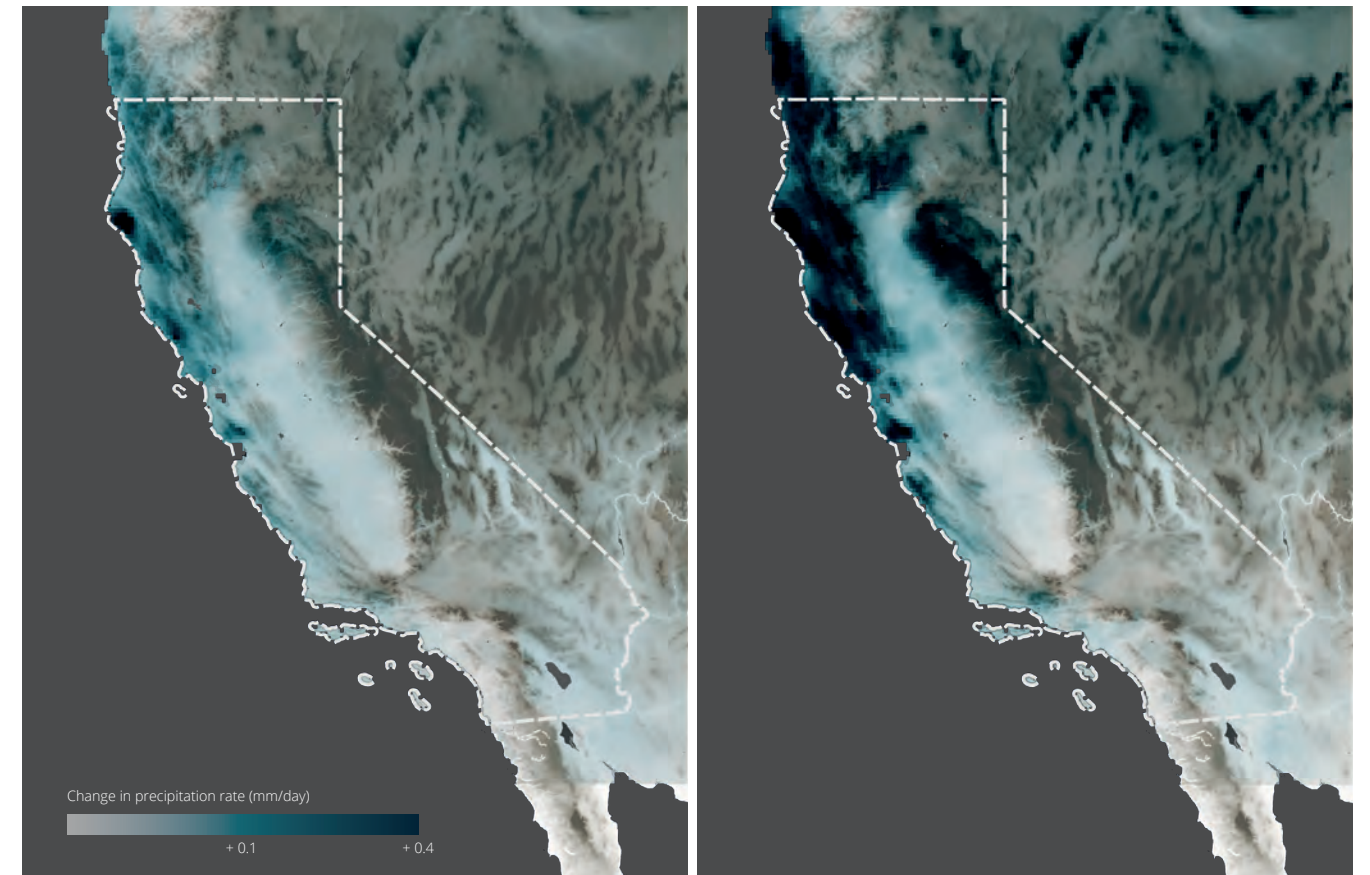


Figure 30. Precipitation change for RCP 4.5, mid-century situation (left) and end-of-century situation (right). Source: author, based on Cal-Adapt, 2021.

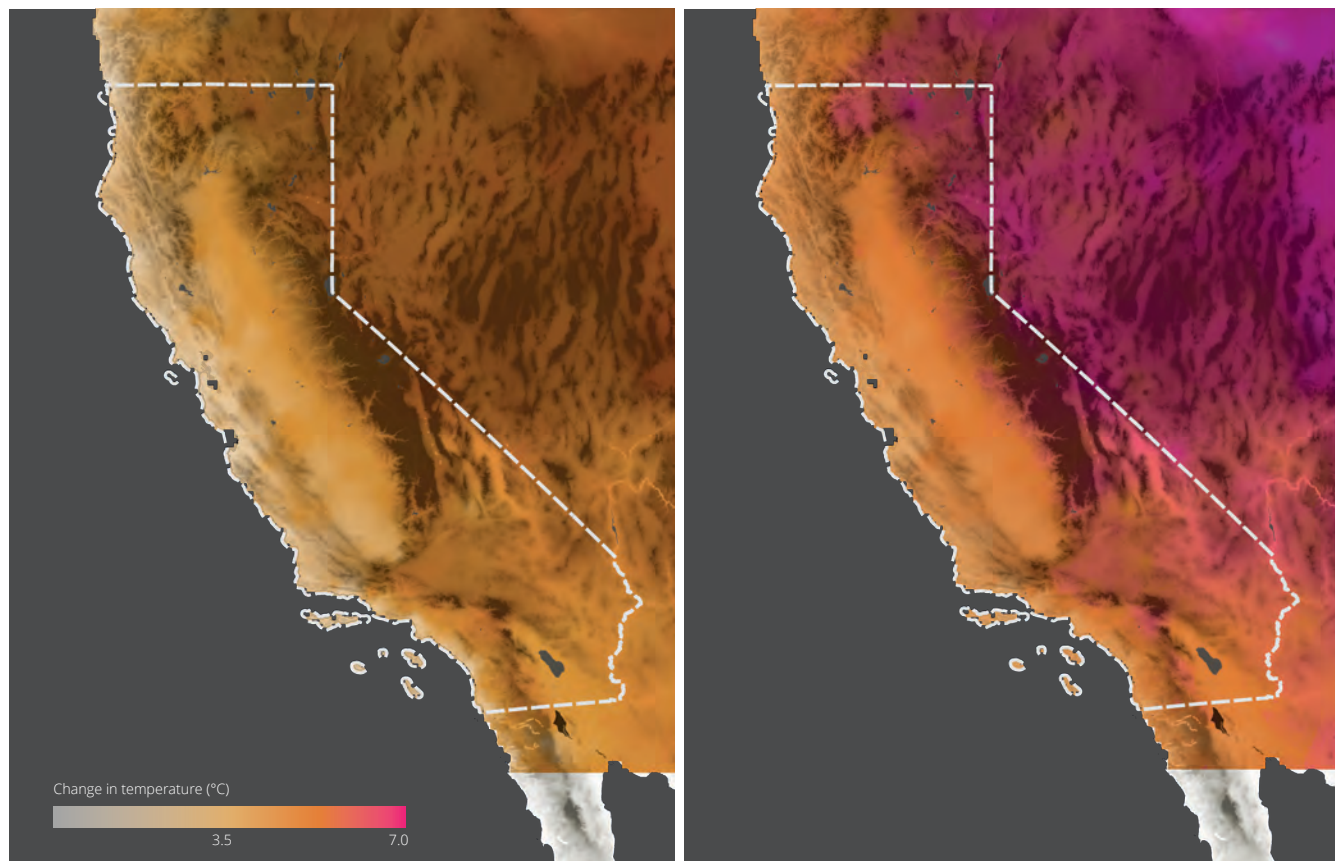


Figure 29. Temperature change for RCP 8.5, mid-century situation (left) and end-of-century situation (right). Source: author, based on Cal-Adapt, 2021.

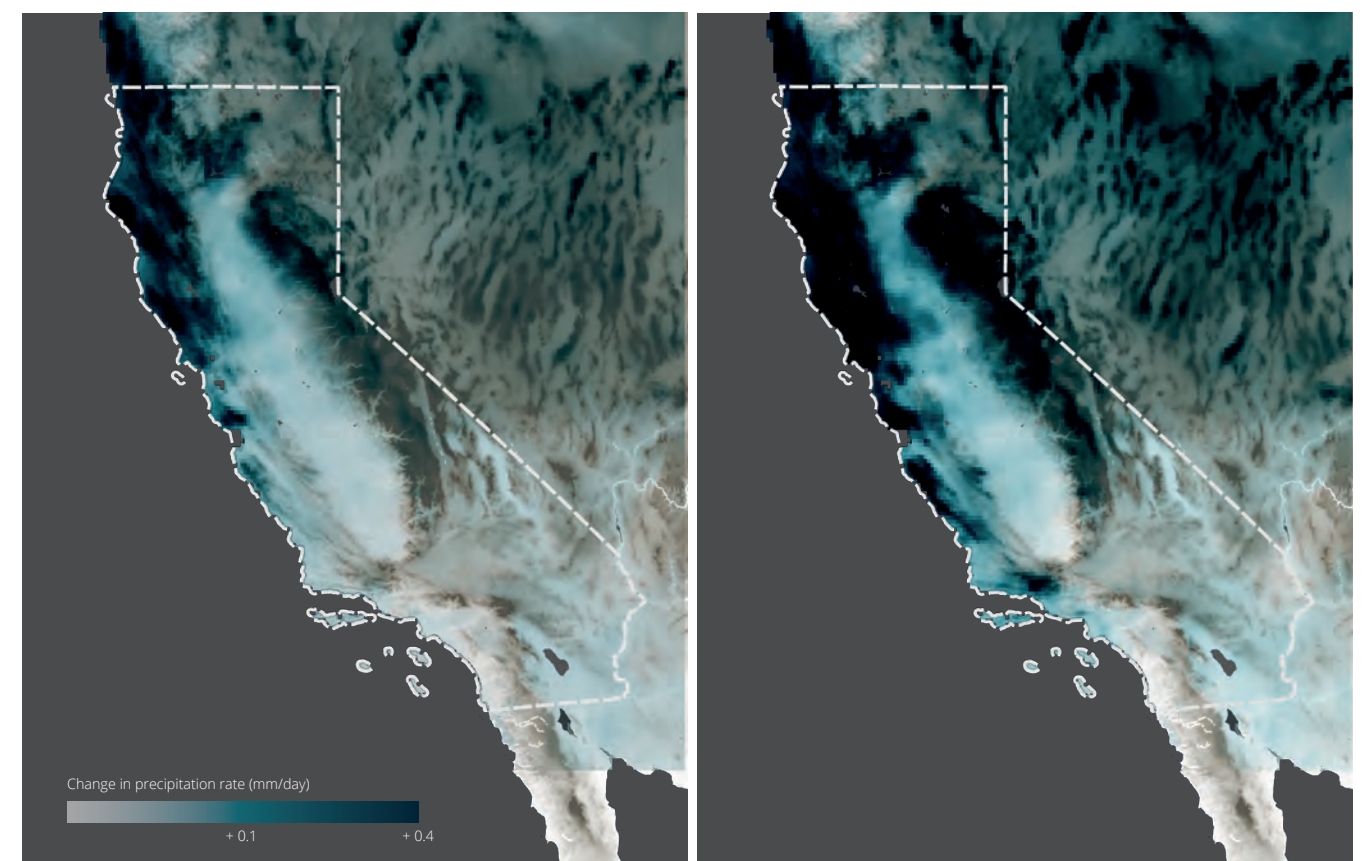


Figure 31. Precipitation change for RCP 8.5, mid-century situation (left) and end-of-century situation (right). Source: author, based on Cal-Adapt, 2021.

Social vulnerability in California

This map shows the sum of a subset of vulnerability indicators of the Social Vulnerability Index (SVI) for California per census tract. The added subset indicators were based on the literature review, showing population with highest vulnerability to climate-induced migration in the darkest coloured areas. Source: author, based on CDC, 2018.

Used indicators:

- + poverty
- + unemployment
- + population without a vehicle property (as a proxy for potential trapped population, non-migration decision, public transport dependent)
- + mobile home as housing unit
- + crowding (indicator of more people per address than available rooms, as a proxy for unregistered labour migrants)
- + group quarters (indicator for vulnerable groups such as homeless, people in need of extra services, nursing homes or hospitals)
- + less-than-average-English-speaking (indicator of minority or migrant)

Increasing vulnerability (%)

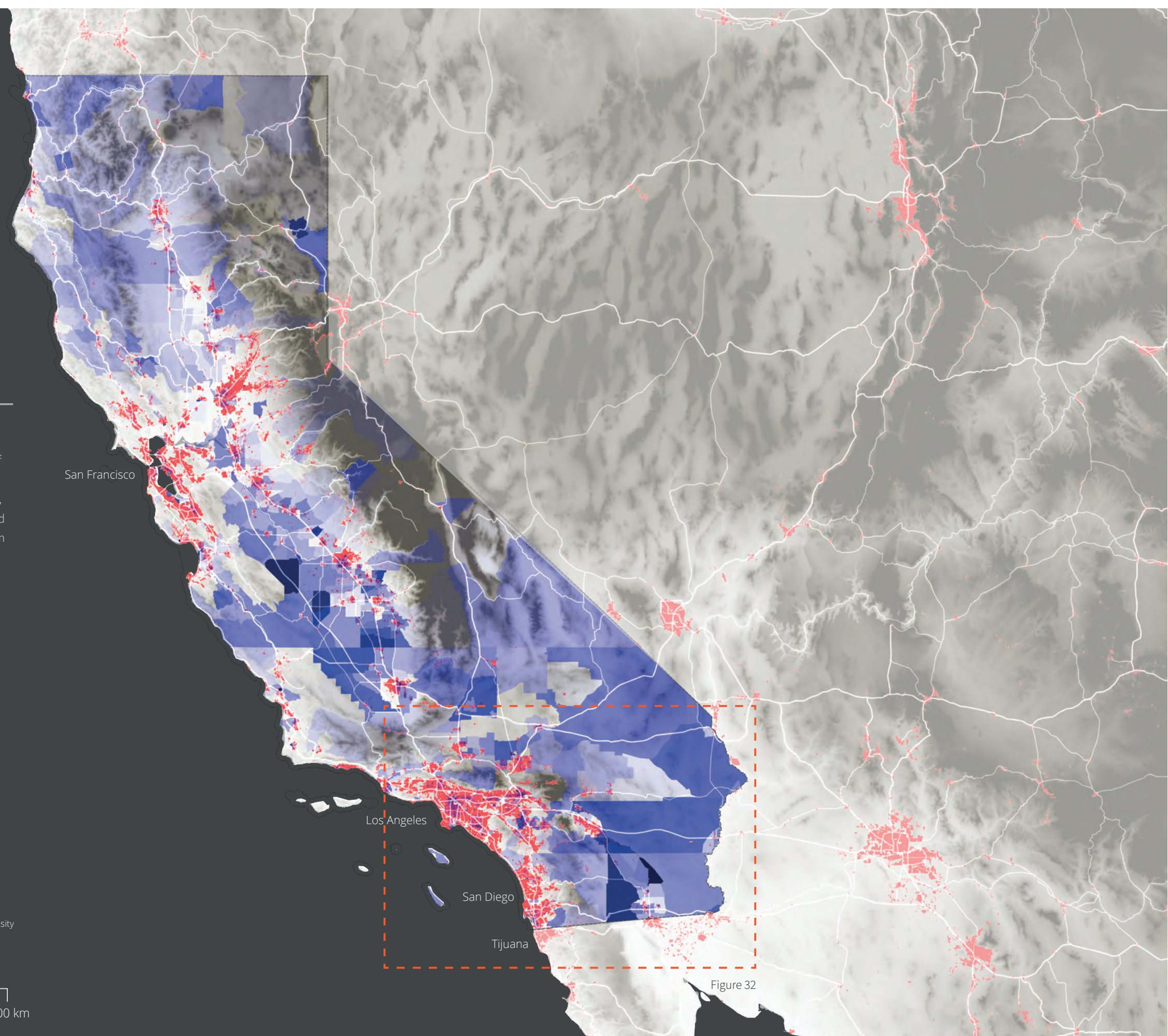
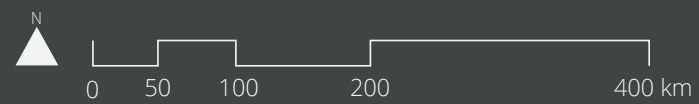


Figure 32

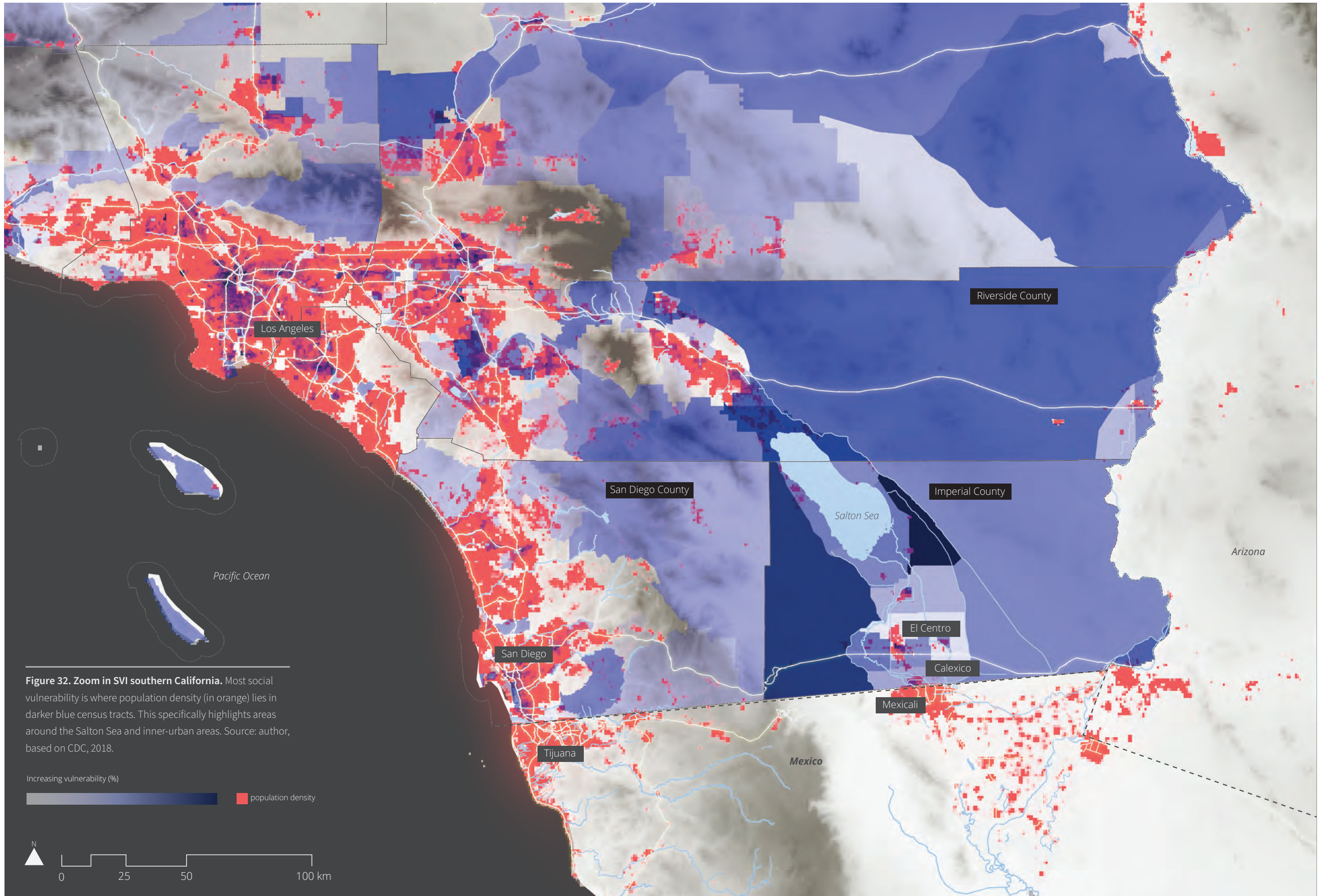


Figure 32. Zoom in SVI southern California. Most social vulnerability is where population density (in orange) lies in darker blue census tracts. This specifically highlights areas around the Salton Sea and inner-urban areas. Source: author, based on CDC, 2018.

Increasing vulnerability (%)
 [Color scale from light blue to dark blue] [Red square] population density

0 25 50 100 km

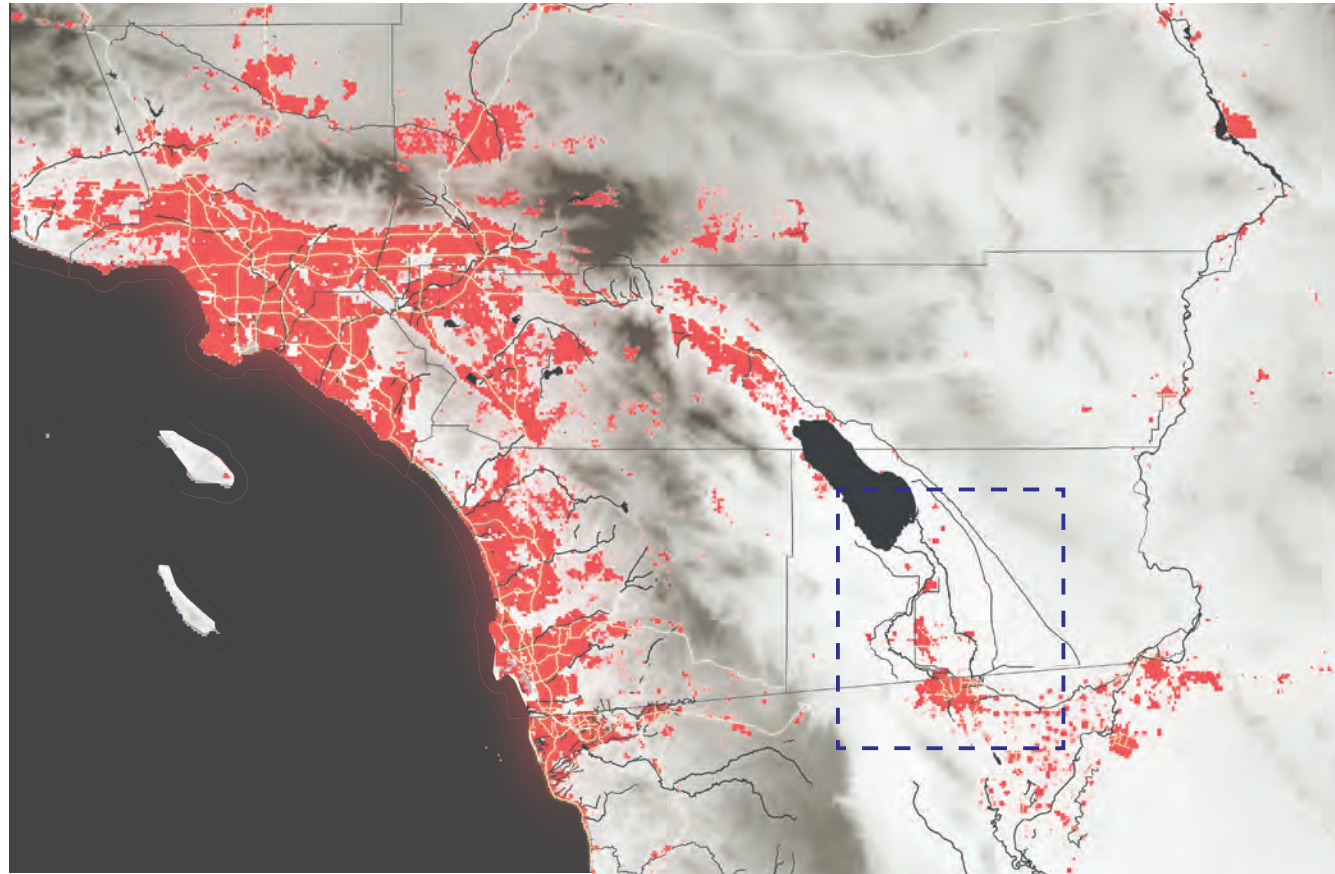


Figure 33. The selected case study covers Imperial County and the Calexico-Mexicali border region.

Based on social vulnerability results in Figure 32, a case study was chosen for this research project. The area is shown in Figure 33 and covers the Imperial Valley in Imperial County, USA, stretching over the border with Mexico into Baja California. The following maps will be specific to this case study area.

The figures on the next page add to the climate maps earlier, by showing seasonal indications for RCP 8.5, both for the winter months (DJF: December-January-February) and summer months (JJA: June-July-August). Figures 36 and 37 add indicators to the climate variability of the region.

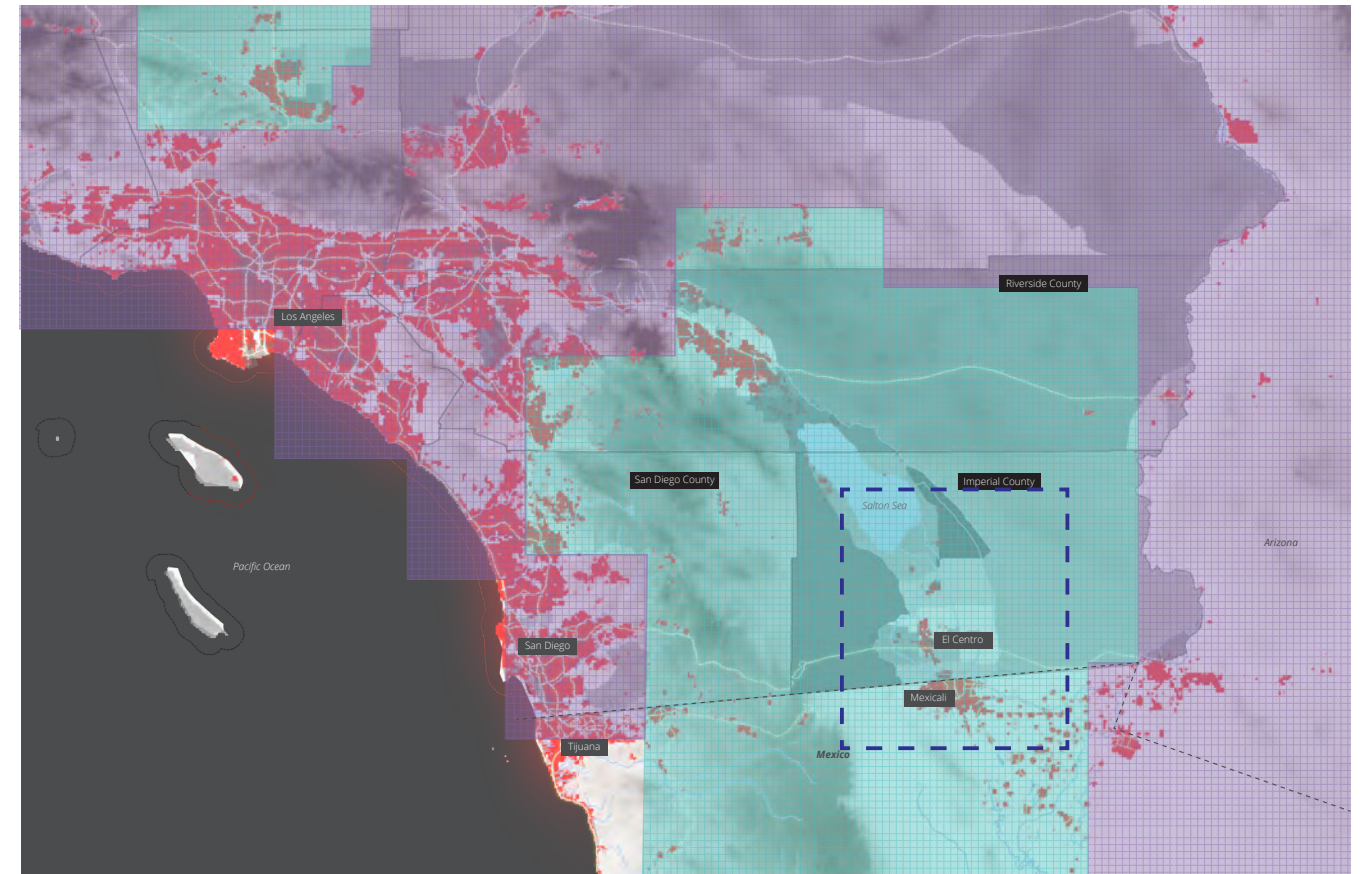
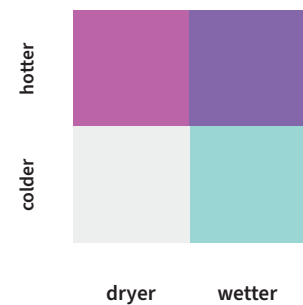


Figure 34. Climate change indication for RCP 8.5 end-of-century DJF. Source: author, based on NCAR, 2020.

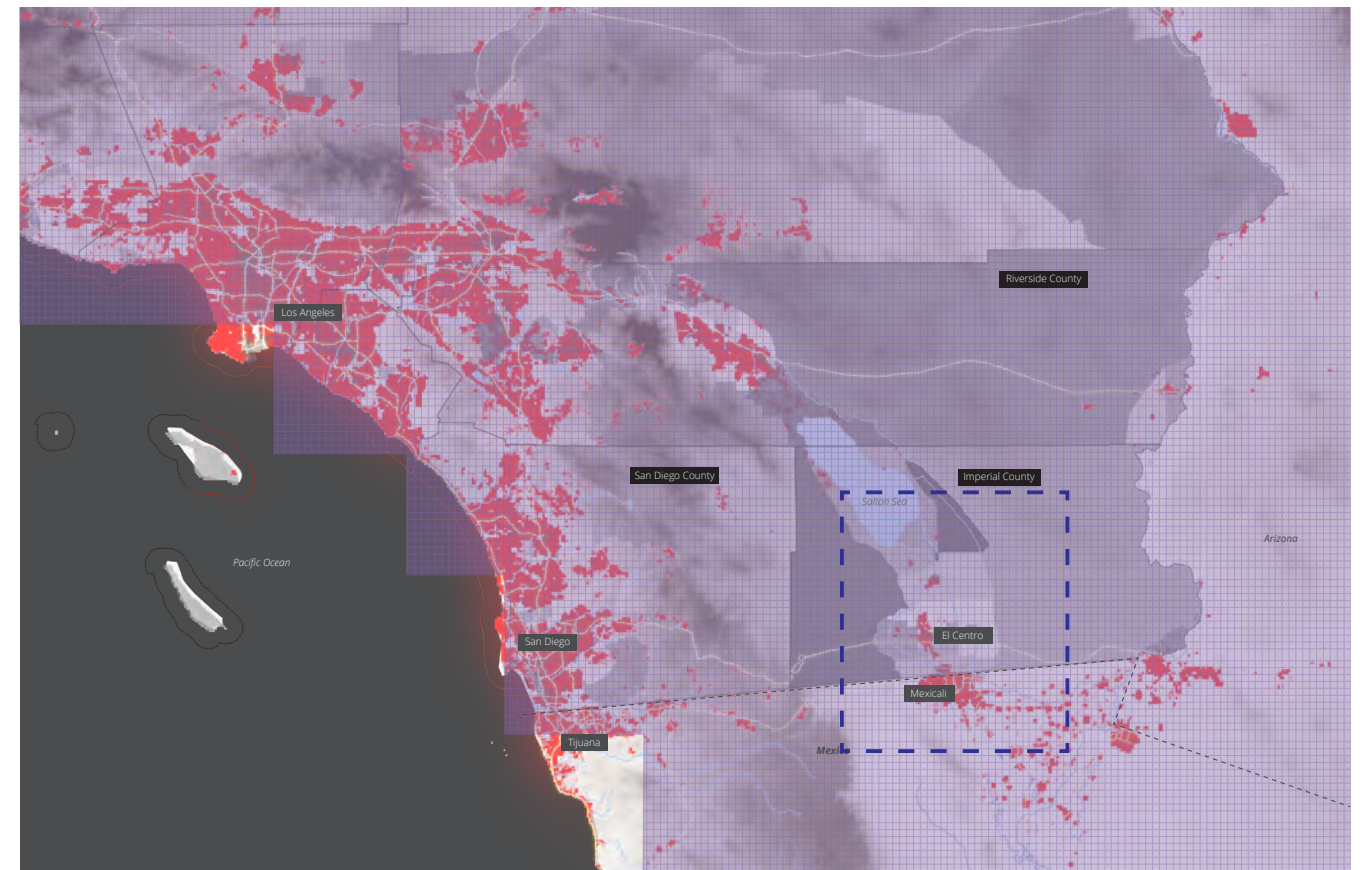


Figure 35. Climate change indication for RCP 8.5 end-of-century JJA. Source: author, based on NCAR, 2020.

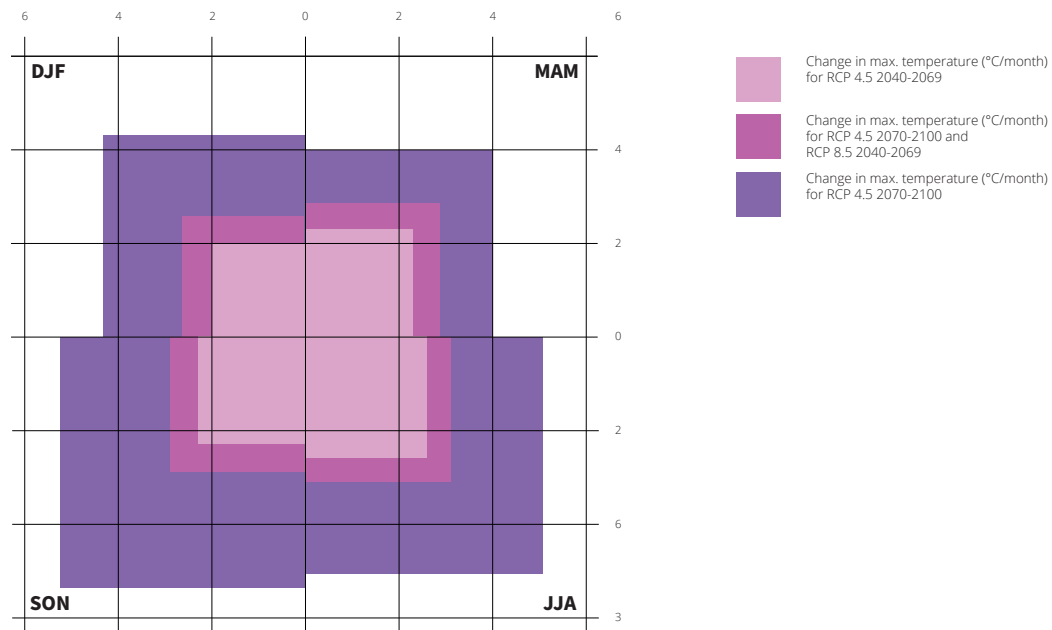


Figure 36. Seasonal temperature change in the Southern border region according to RCP 4.5 and RCP 8.5. Source: author, based on Cal-Adapt, 2020.

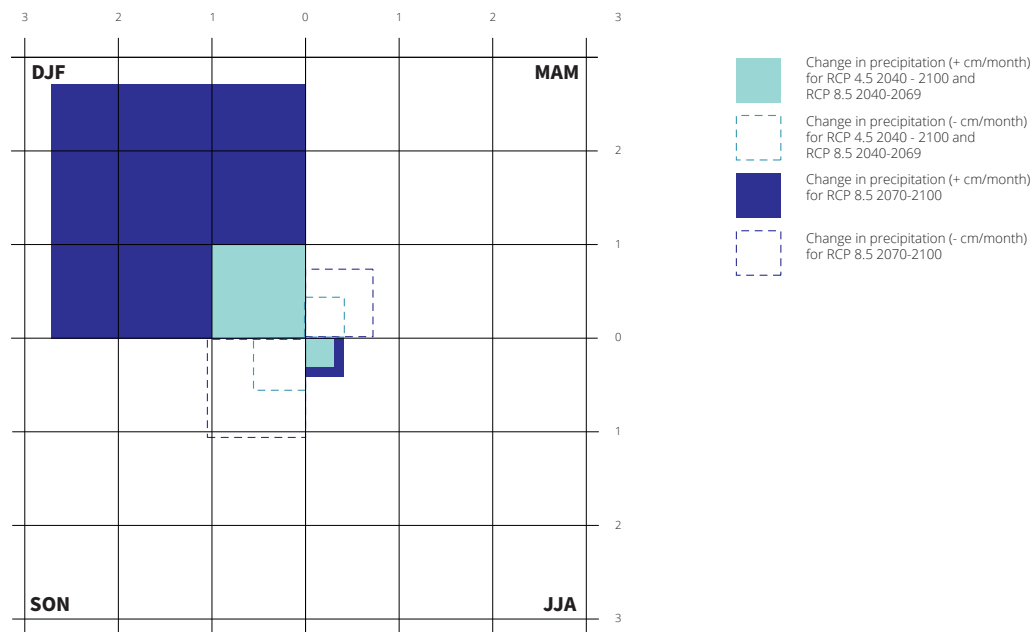


Figure 37. Seasonal precipitation change in the Southern border region according to RCP 4.5 and RCP 8.5. Source: author, based on Cal-Adapt, 2020.

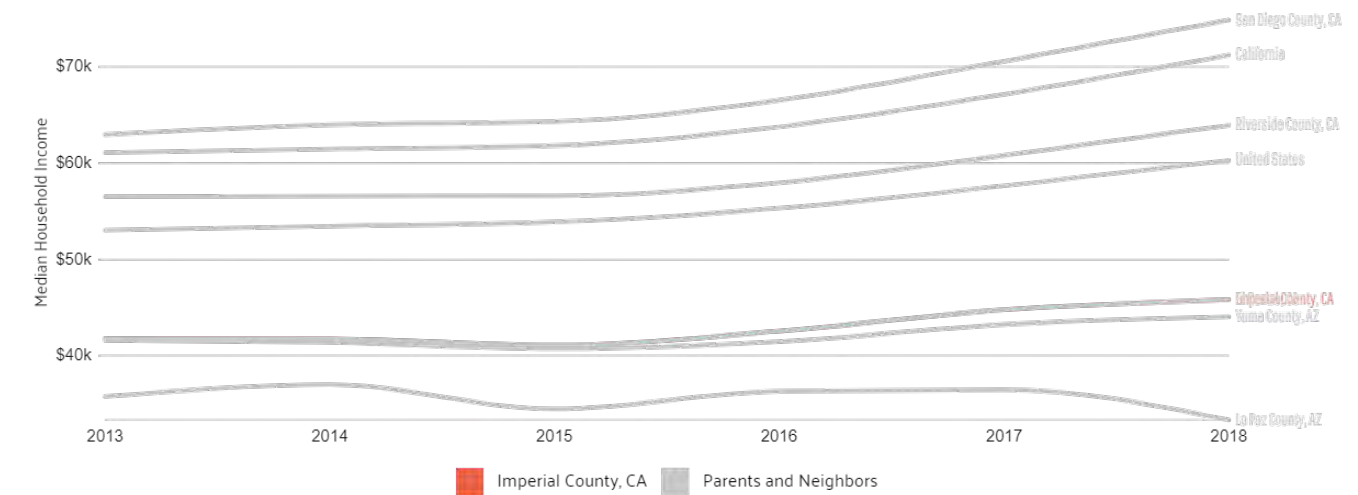
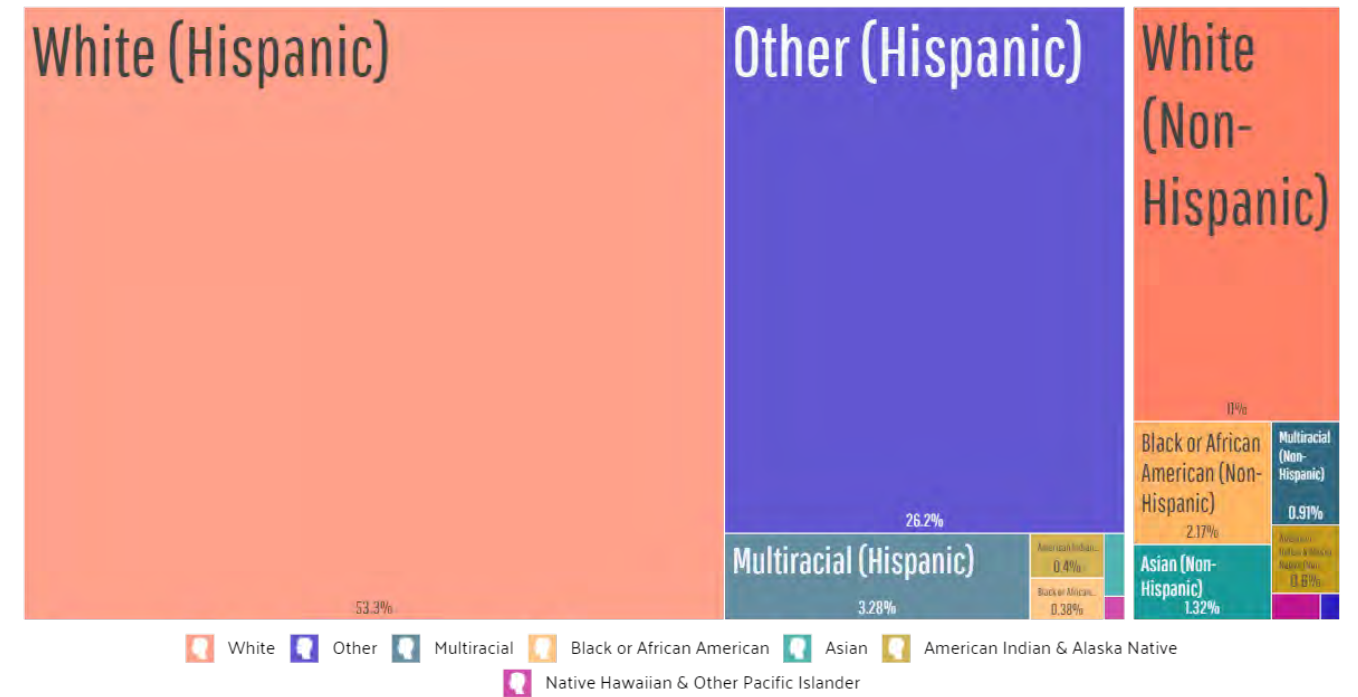


Figure 38. Demographic statistics for the 180,000 population of Imperial County. Source: Data USA, 2018.

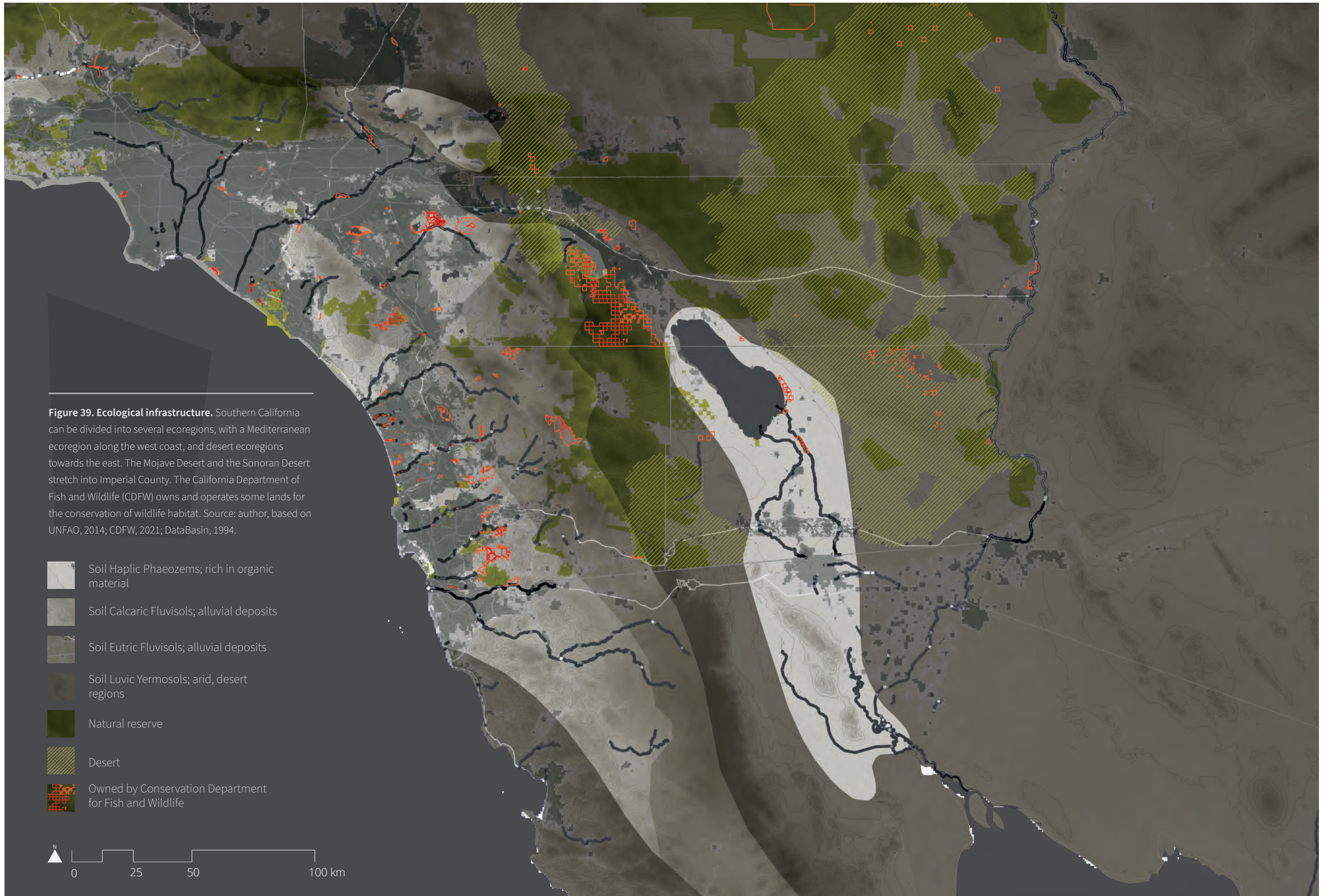
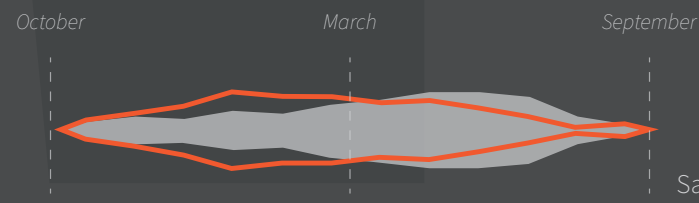


Figure 40. Hydrology Southern California. Imperial Valley receives 100% of its water from the Colorado River. Colorado River water is apportioned to closely situated counties and municipalities. The river springs in the Rocky Mountains, and its estuary lies in Baja California, Mexico. The Colorado River is under pressure from the changing climate, which alters its runoff pattern and snow pack. These determine which quantity of water is received when, for storage in reservoirs. As the current runoff matches the peak in use (summer months), a shift in this pattern means it needs to be stored longer under drought circumstances. A projected snow pack reduction of 66% under RCP 8.5 or 30% under RCP 4.5 would reduce water availability in the region significantly by the end of the century. With a current water depletion of 100% for Imperial Valley, and seasonal or dry-year water depletion for surrounding areas, the region is at risk of water scarcity. Source: author, based on Brauman, 2016; UCLA Center for Climate Science, 2016; DataBasin, 2013.

Change in runoff pattern for RCP 8.5



Water waste treatment

Water reservoir

Areas that use Colorado water:
 Mexico, 1.5 million acre feet (MAF); South California, 4.4 MAF; Arizona, 2.8 MAF

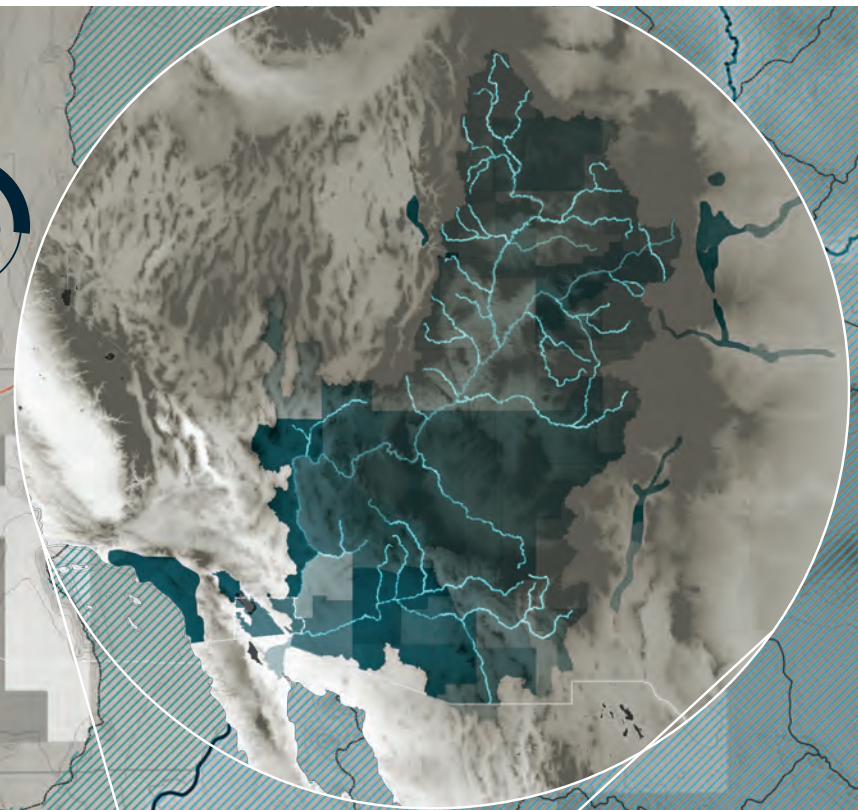
Water depletion gap:
 > 100%; Dry year; Seasonal

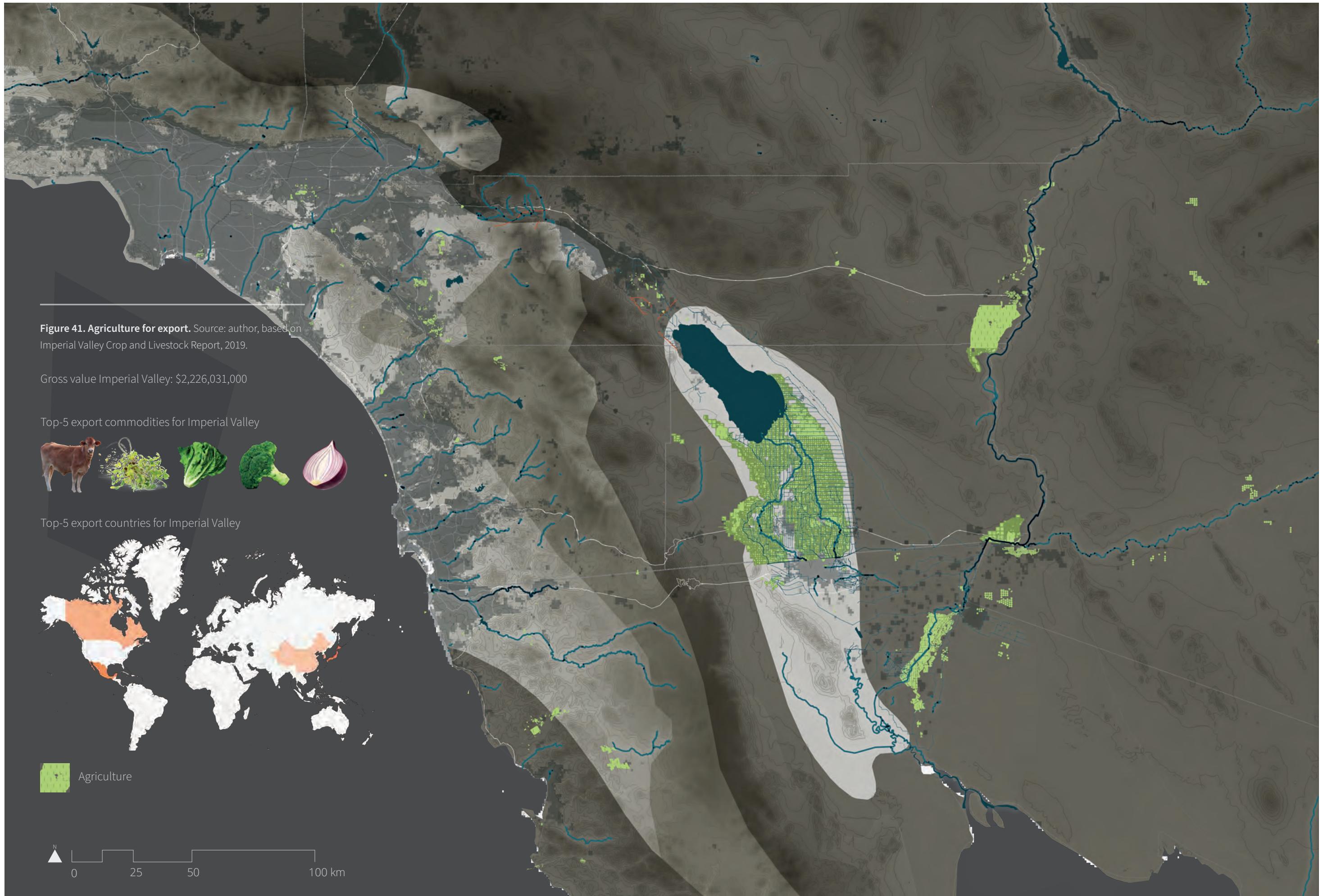
Colorado River municipality water use



Colorado River Californian apportionment 27%

Colorado River Mexican apportionment 9%





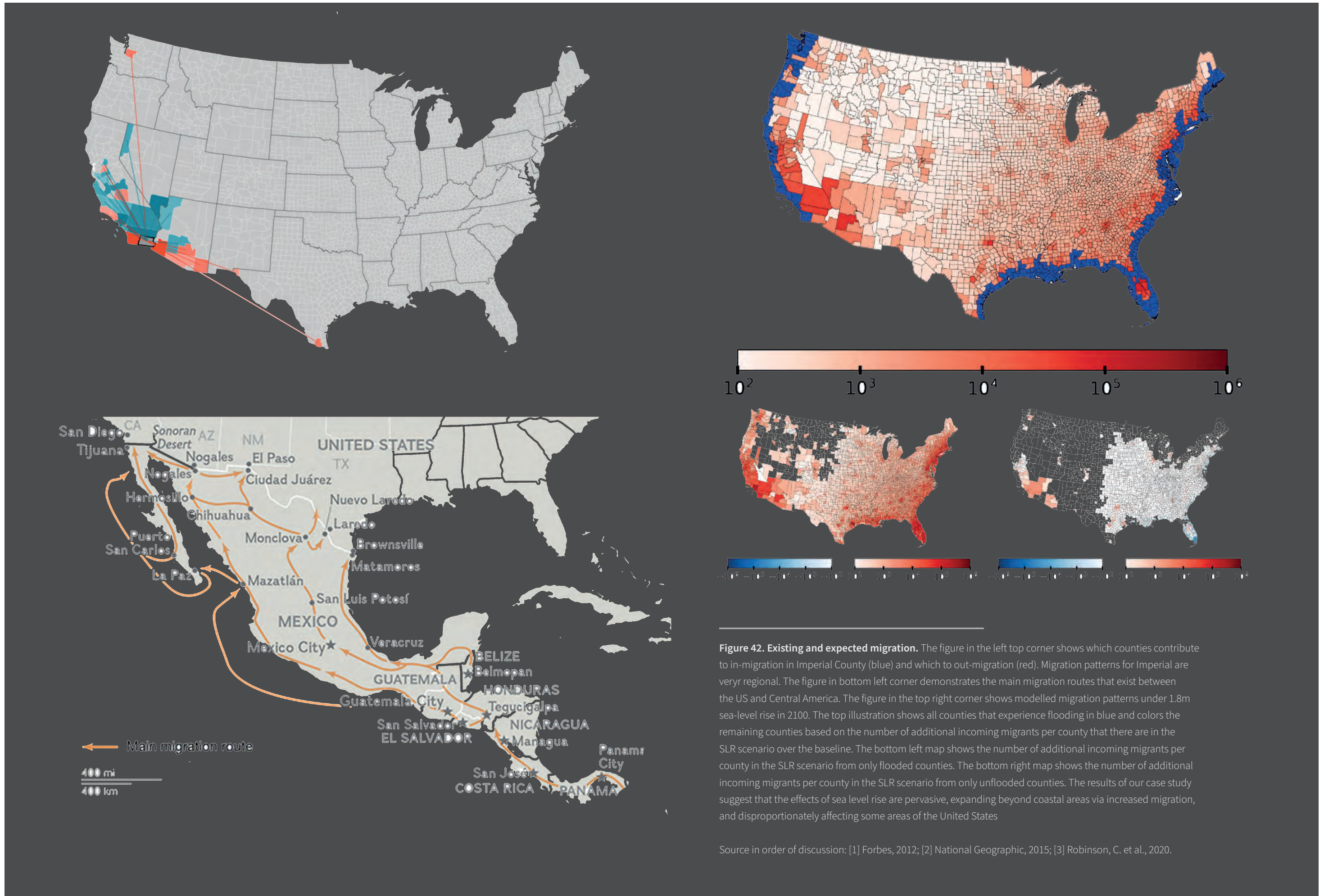


Figure 42. Existing and expected migration. The figure in the left top corner shows which counties contribute to in-migration in Imperial County (blue) and which to out-migration (red). Migration patterns for Imperial are very regional. The figure in bottom left corner demonstrates the main migration routes that exist between the US and Central America. The figure in the top right corner shows modelled migration patterns under 1.8m sea-level rise in 2100. The top illustration shows all counties that experience flooding in blue and colors the remaining counties based on the number of additional incoming migrants per county that there are in the SLR scenario over the baseline. The bottom left map shows the number of additional incoming migrants per county in the SLR scenario from only flooded counties. The bottom right map shows the number of additional incoming migrants per county in the SLR scenario from only unflooded counties. The results of our case study suggest that the effects of sea level rise are pervasive, expanding beyond coastal areas via increased migration, and disproportionately affecting some areas of the United States

Source in order of discussion: [1] Forbes, 2012; [2] National Geographic, 2015; [3] Robinson, C. et al., 2020.



06

REFERENCE STUDIES

For this project, two reference studies were chosen to create a better understanding of the interaction between environmental change and disasters and migration. From both studies, key relevant features are highlighted, and relevant conclusions for this research are presented.

I. HURRICANE KATRINA PROJECT

Introduction to the project

The Hurricane Katrina Project examines the impacts of hurricanes on the Gulf Coast. It began in response to the specific case of New Orleans' flooding in 2005 and efforts to understand who was affected and what neighbourhoods were able to rebuild. Since then it has evolved into a broader study of the Gulf Coast region in the decades since 1950. The project resulted in two recent publications, of which the first looks at hurricane risk, and the second asks how county-level population growth and decline were affected by hurricane experience. This

second research is of specific interest to this thesis and will be further elaborated on below, as it develops arguments about socio-economic vulnerability and mobility patterns.

Key learnings (from Logan et al., 2016)

Based on the results, the authors need to differentiate between locational vulnerability and social vulnerability, where the former in this context indicates that severe enough shocks in a specific place lead to migration and displacement, and the latter designates that "lower-income groups consistently bear

Figure 43. Parts of New Orleans are flooded after hurricane Katrina hits in 2005. Source: Nola, 2015.

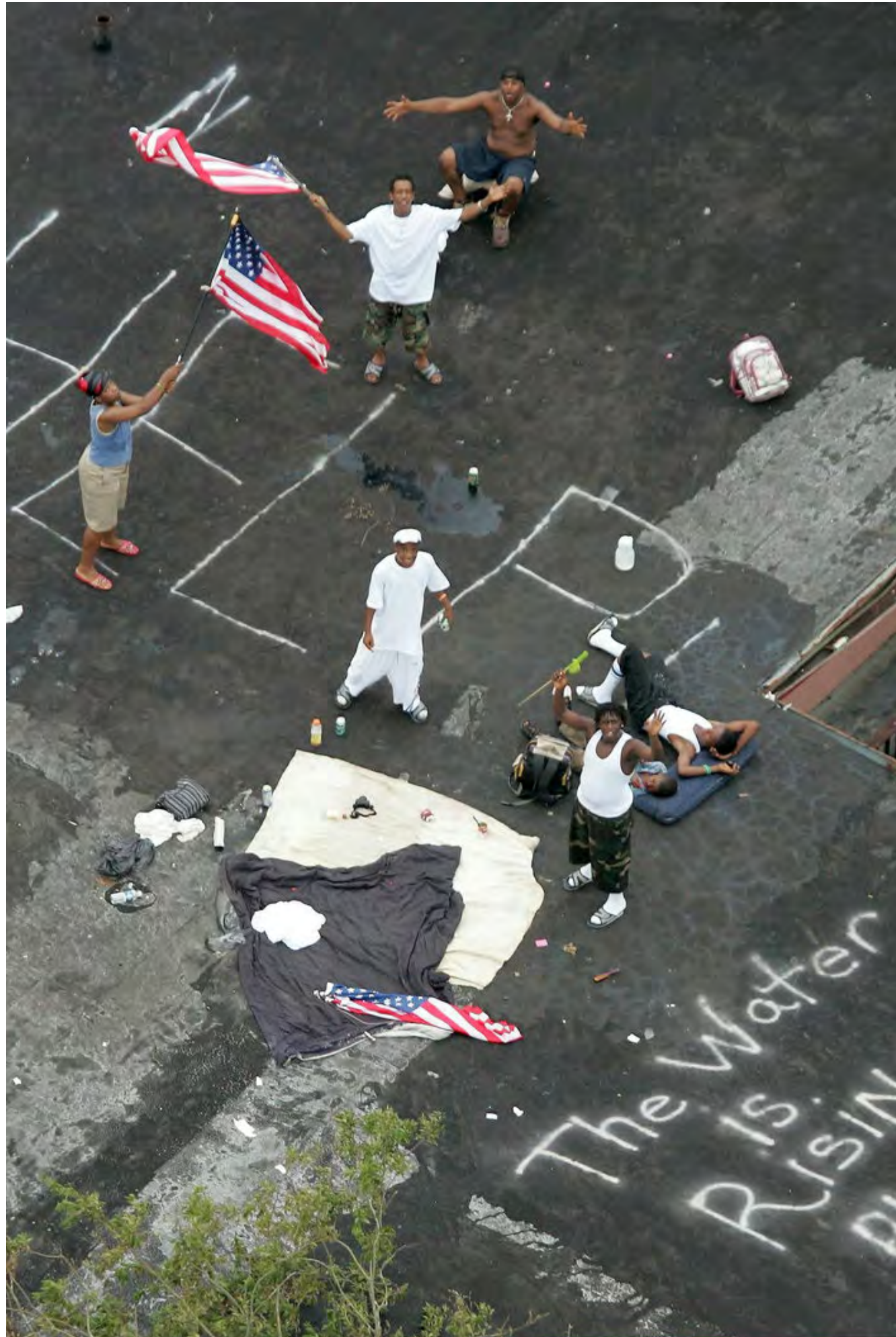


Figure 44. Residents wait on a rooftop to be rescued after the floodwaters of Katrina hit New Orleans. Source: The Guardian, 2017.

a disproportionate share of the losses, even if they are not more likely to be placed in the path of disaster” (Logan et al., 2016, 1514). The authors tested the segmented resilience hypothesis, which posits that different population groups are affected differently by disaster risk. The segmentation is in the opposite direction of what most researchers previously anticipated: “resilience” (although the authors question if this is the right term) is manifested not in a quick return to one’s original location, but in a faster exit to a safer place (segmented withdrawal). Also, the authors find the system does not bounce back to its previous equilibrium. Negative effects were recorded still three years after the hurricane event, and these effects were even experienced by counties that were not directly affected by wind damage (they are the receiving system for the hurricane-affected sending system).

The researchers found that hurricane damage impacted both black and white populations, which in this research generally represents a different socio-economic demographic. The authors indicate that the black population is overwhelmingly less affluent than the white population. Research found that flooding had a significant effect only for white population, which they attribute to locational vulnerability as this population lives in affluent coastal neighbourhoods. The significant effect they found is that New Orleans experienced a lot of white and young adults population loss, as they have more resources to move away. On the other hand, hurricane damage had less significant effects on the black population. The researchers explain this with social vulnerability: this population is more rooted in place and has more difficulty arranging a move. The same effect was shown for elderly compared to young people. Over time, the researchers remarked that young adults and white population steadily shifted their location to safer areas, and the less advantaged (older, black, poor populations) moved increasingly

into harm’s way.

Last, the research remarks that the effects of hurricanes took shape in different timeframes. Some populations evacuated immediately, only to return within a short time. Other neighbourhoods faced population loss over time as their neighbourhood failed to recover. Within five months of Hurricane Katrina, only 37% of pre-event residents were estimated to be resident in the city, while about 54% were “daytime” returnees presumably commuting to rebuild and restore (ibid., reciting Stone et al., 2007).

Conclusions

- Adaptation rather than resilience: this research does not find data to prove that a system bounces back to pre-event equilibrium. This effect might be exacerbated by increased frequency of shocks.
- It is important to distinguish between locational vulnerability and social vulnerability.
- Socially vulnerable populations (in the case of New Orleans black, elderly and poorer residents) were more likely to be trapped in place.
- Less socially vulnerable populations (white and young adults) can be equally affected, but the shock of that effect is relatively short as they have the resources to rebuild or move away.
- Negative effects after a disaster do not only impact the sending system (New Orleans) but also the receiving system.
- Return population is dependent on the recovery of neighbourhood and/or city.



II. MECLEP PROJECT

Introduction to the project

This comparative study entitled Migration, Environment and Climate Change: Evidence for Policy (MECLEP) undertaken in six countries (Dominican Republic, Haiti, Kenya, Republic of Mauritius, Papua New Guinea and Viet Nam) empirically tested how migration can benefit or undermine adaptation to environmental and climate change. Using desk research, surveys and qualitative interviews, the study represents six different contexts with varying levels of human development and environmental impacts (Melde et al., 2017, xv).

Key learnings (from (Melde et al., 2017)

This study draws conclusions for three different types of human mobility: migration, displacement and planned relocation.

Migration was generally found to be a positive adaptation strategy, as it contributes to adaptation to environmental and climate change. (Seasonal) migration allowed families to diversify their income, improve their employment, health and education opportunities. In all, it increased their preparedness for future danger caused by natural factors. The authors remark that whether people can move is context-dependent; sometimes affluent families were better able to adapt in-situ, and in other cases savings and owned land made them rooted in place (an argument for the importance of locational vulnerability rather than social vulnerability).

Displacement was found to be a major challenge for adaptation, as it hits the most vulnerable population and renders them more vulnerable.

Planned relocation was shown to reduce harm and entail benefits, but also lead to new vulnerabilities. An obvious benefit of planned relocation is it reduces the threat to life. However, a lack of sustainable livelihoods was shown to lead to increased levels of vulnerability to future hazards and undermined human development more generally.

The authors list a number of *implications* of different types of migration to adaptation. First, migration is linked to a higher likelihood of adapting preventative measures (preparedness). Second, the study highlights how mobility can represent an income diversification strategy. Third, migration allowed for learning new skills, and - to a lesser degree - apply them and teach them to others. Fourth, migration was likely to give better access to health care and education. Fifth, migration undermines adaptation in relation to housing materials, discrimination and exclusion to employment in receiving areas. If migrants were not able to access social services needed for human development, they were generally less prepared and resilient to future hazards.

The main *policy recommendations* of interest for this thesis that followed from this study were:

- to integrate internal migration as an adaptation strategy to environmental stress;
- to prioritize vulnerable groups and reduce the risk of displacement. Of importance are an early warning system, integrating gender concerns and protecting trapped populations;
- to integrate migration into urban planning to reduce challenges for migrants and the communities of destination (or receiving systems). Issues of housing standards, discrimination and access to employment and

Figure 45. View of Manam Island from Mangem Care Centre on the mainland, Papua New Guinea. Source: IOM, 2018.

social services need to be addressed.

and increases vulnerability, and reducing vulnerability contributes to a better adaptation strategy.

Conclusions

Although this study was carried out in six countries with different levels of human development, the authors were able to generalize some results into policy recommendations. Although out of context for this thesis' location, the recommendations nevertheless present a valuable focus on what aspects to prioritize in dealing with human mobility in relation to environmental stress. Generally, the importance of (seasonal) migration as part of an adaptation strategy was highlighted, where it is able to facilitate income generation and strengthen resilience to disasters. Specific importance was put on opportunities for integration and human development in the area of destination (of receiving system). Displacement should be avoided as it is a big threat to adaptation



Figure 46. Planned relocation site Nuevo Boca de Cachón, Dominican Republic. Source: Flickr, 2014.



07

POTENTIALS AND VISION

Previously, several vulnerabilities in the region were identified in chapter 05, and light was shed on the possible contextual challenges of climate-induced migration in chapter 06. In order to formulate actions for regional adaptation, this chapter will identify several regional potentials and formulate a vision that could guide future development.

I. POTENTIALS

Having explored regional vulnerabilities in the previous chapters, Figure 48 shows an overview of opportunities for the region. These can be used to further inform the formulation of actions towards regional adaptation.

Energy

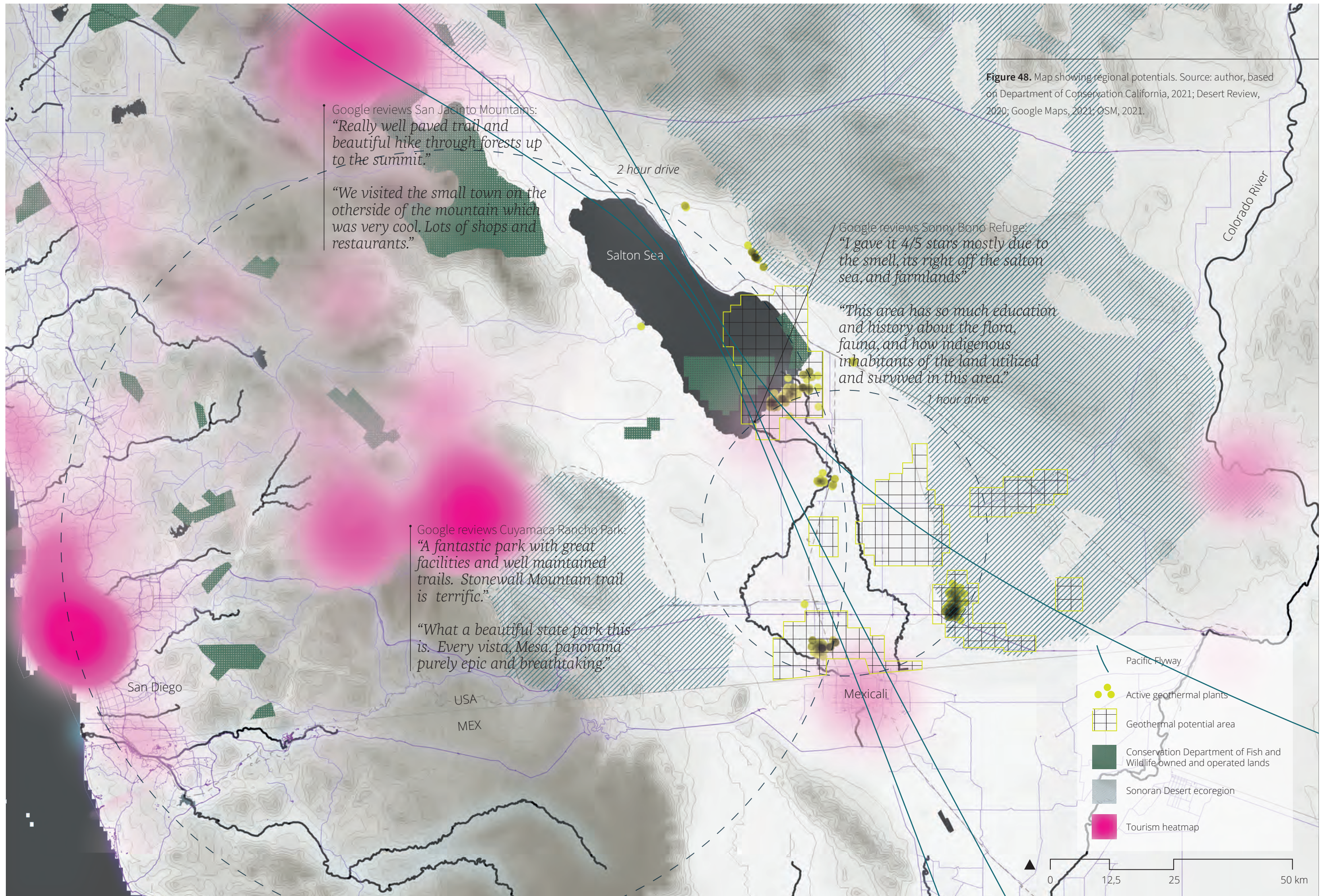
Imperial Valley has a large potential for geothermal energy, an energy source that can produce energy round the clock unlike solar panels. In Imperial Valley, drilling rigs can access high-temperature fluid relatively close to the earth's surface, making it a geothermal hotspot. The US Department of Energy estimates that if geothermal technology improves and more sources are exploited, geothermal could generate 16% of the nation's electricity in 2050 (for comparison, in 2020

40% of US electricity was generated by natural gas) (LA Times, 2020).

Tourism

The natural features in the region are popular tourist attractions. Mountains and national parks attract hikers, while the Coachella Valley to the north of the Salton Sea is a popular holiday and festival destination. In the 1930s, the Salton Sea's wetlands started to function as a resting stop on the Pacific Flyway for many bird species, sustained by the lake's fish population. In the 1950s and 1960s, the area became a resort destination for beach lovers, fishermen and bird watchers, and the population of Imperial grew with the success of the tourism industry. With growing environmental problems around the Salton Sea, tourism disappeared. A lot of abandoned infrastructure from that time remains in the area. With environmental restoration, the area might again benefit from a tourism sector.

Figure 47. A painting of an Aztec warrior adorns the Mexican side of the border. Source: CNN, 2018.



II. VISION

The Southern California border region aims to make migration a humane choice in the face of slow-onset environmental risks. It aims to proactively deal with climate risks, rather than resorting to reactive disaster management when the consequences become so unbearable or uninhabitable that they force migration. The region will accomplish this proactive stance by increasing its adaptive capacity to deal with the risk consequences in the long-term and reducing the vulnerabilities of the exposed.

By doing so, the Southern California border region creates opportunities for lifestyles and

employment that are mobile, flexible and adaptive, and that are able to work with their changing environmental surroundings. This vision requires place-specific strategies that can be categorized under 3 pillars:

- 1) Limit and control the risks where possible (Mitigation)
- 2) Transition to a durable solution (Adaptation)
- 3) Sustainable relocation







08

IDENTIFYING ACTIONS

In the previous chapters, uncertainties, vulnerabilities and opportunities have been analysed to come to a vision for the border region in chapter 07. Based on these, this chapter will identify what actions could work towards beneficial regional developments.

As the analysis in chapter 05 showed, Imperial County is defined by its agricultural industry that serves an international market. But besides its successful economic activities, the results of the Social Vulnerability Index (Figure 32) add a layer of poverty, unemployment and lack of public health. This chapter will further explore the dynamics to offer a better understanding of these SVI results. Three observations will be discussed, pertaining to border dynamics, pollution and poverty. The concluding remarks will address these observations in relation to climate-induced migration, before exploring a planning framework and actions that address vulnerabilities and opportunities in this region.

The poverty in this southernmost part of the state is linked to the border—to the fate of those who try to cross illegally, to migratory farm workers, to the realities of living in a region where more resources are devoted to security and too few dollars are available for basic social services.

Capital & Main, 2019.

Figure 49. Children look through the border fence between Mexico and the USA. Source: CNN, 2018.

I. OBSERVATION 1: BORDER DYNAMICS

Calexico-Mexicali is a transborder agglomeration connecting California in the US and Baja California in Mexico. Mexicali has 650,000 inhabitants compared to 27,000 in Calexico, however it functions as one urban area. The agglomeration dynamics are mainly due to established (international) trade practices, previously listed under the 1994 North American Free Trade Agreement (NAFTA) which was renegotiated in 2019 to the USMCA agreement. USMCA fosters economic relationships between the US, Mexico and Canada.

This section will show how economic interests have created specific economic and social border dynamics in the Calexico-Mexicali region that benefit both sides of the border. However, the border is still an (inter)national

governance tool that can be used to negate local demands to prioritize national interests to negatively impact these agglomerations.

Growth of maquiladora industry

Border dynamics have been heavily steered by these free trade agreements. Such as the establishment of a large number of maquiladoras (assemblage industries) in Mexicali, where raw materials are fabricated into products for the US and Canadian markets by low-wage Mexican labour. In Mexicali this mainly concerns fabrication of medical equipment, plastic packaging and electronics (US Tradenumbers, 2021). Mexicali currently has around 180 maquiladoras (Desert Sun, 2018).

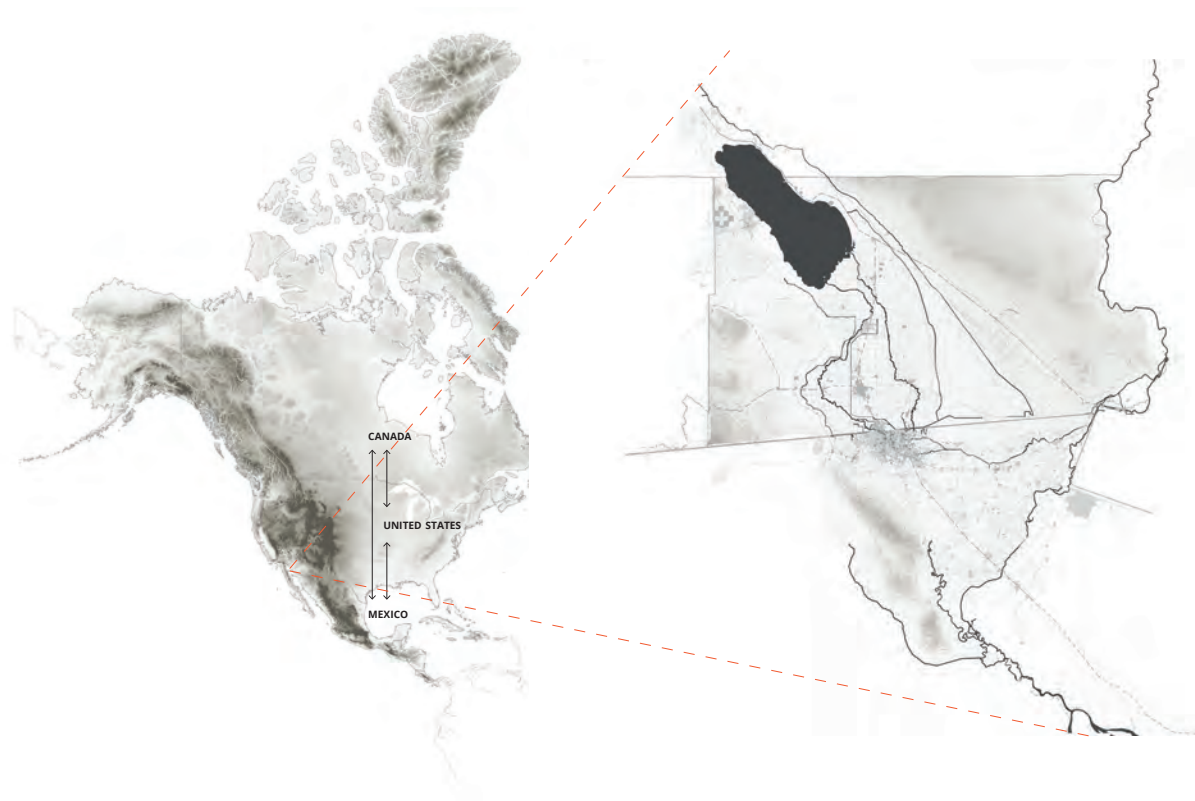


Figure 50. USMCA Agreement: international trade is prioritized over local demands.



Figure 51. Imperial farmers depend on Mexican guest labourers with H-2A visas to harvest their produce. Source: Quartz, 2019.

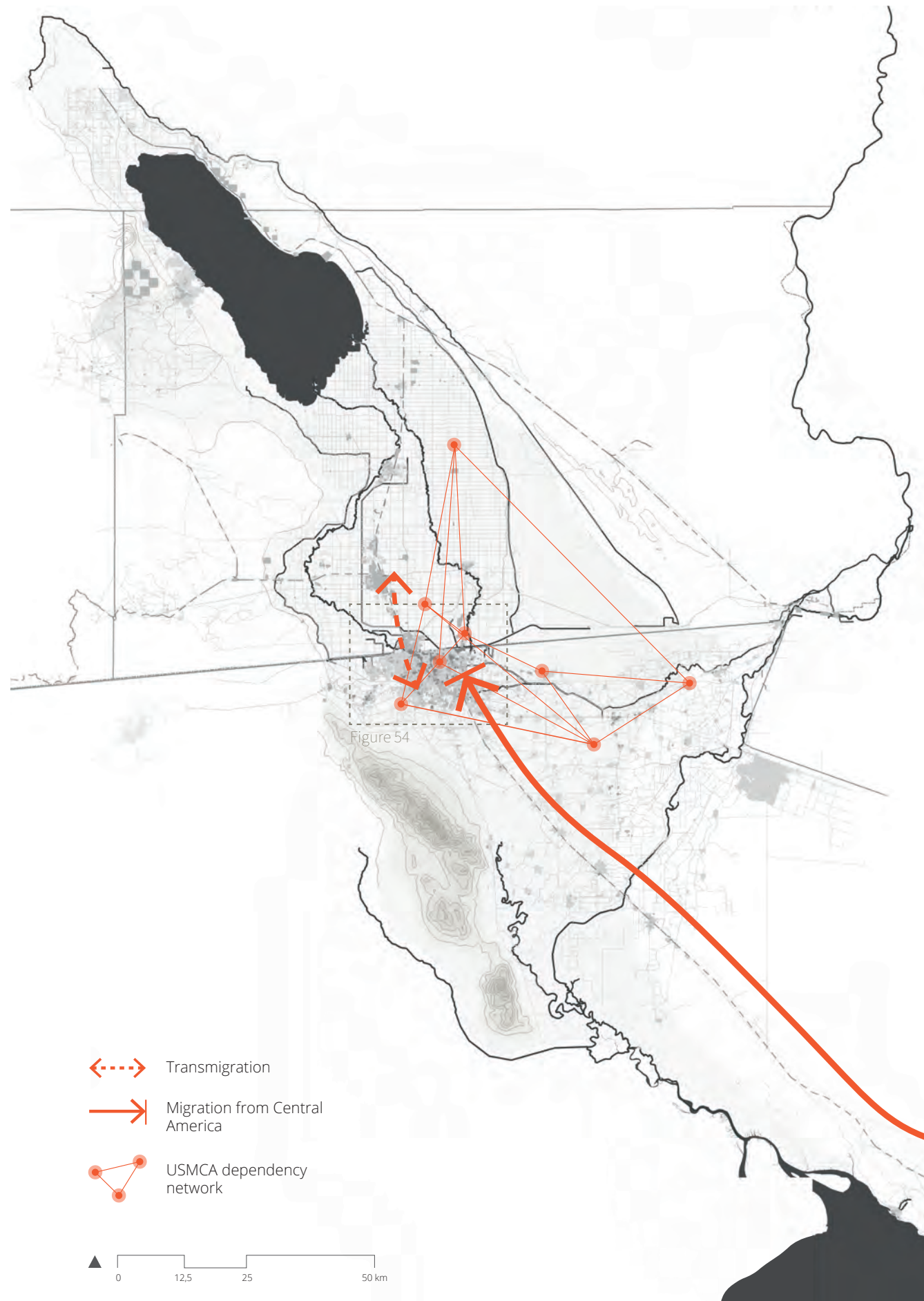


Figure 52. Economic mobility of people, goods and services is prioritized in USMCA and generates specific transborder dynamics.

The border separates functions

As medical care is cheaper in Mexico, many Americans cross the border to receive care on the Mexican side where hospitals have conveniently popped up close to the border crossing. Furthermore, Mexicali is known for its nightlife, whereas Calexico services revolve around food and convenience shopping for the 50.000 Mexican guest labourers who cross the border daily. Similarly, school children are used to crossing the border as many Mexican parents find a higher tuition a worthy investment for an American education in English (LA Times [1], 2017).

Agriculture: a two-way dependency

Farmers in Imperial are largely dependent on Mexican guest labourers (Quartz, 2019). The Department of Agriculture requires US farmers to prioritize American labourers, however supply is short in Imperial. The H-2A visa allows Mexican guest labourers to work in the fields, and receive transportation and lodging as well as higher wages compared to Mexican agricultural work, which makes it an attractive option. Angel Pompa, 28, was trained as a teacher in Mexicali but did not make enough money to get ahead. “I work four months in Yuma [Ariz.] and take home more money than I made in those six years. With all that study, you barely get into the middle class. Here, what I earn makes me upper middle class.” (LA Times [2], 2017).



Figure 53. Mexican guest labourers wait at the border crossing in Mexicali to enter the USA at 2AM. Source: Reuters, 2020.

Figure 54. The variability of mobility and separation of functions define the dynamics of border city Calexico-Mexicali. Pre-Covid-19 data was used to indicate the established pattern. Source: author, based on PEW Research, 2020; US Department of Transportation, 2019; OSM, 2021.

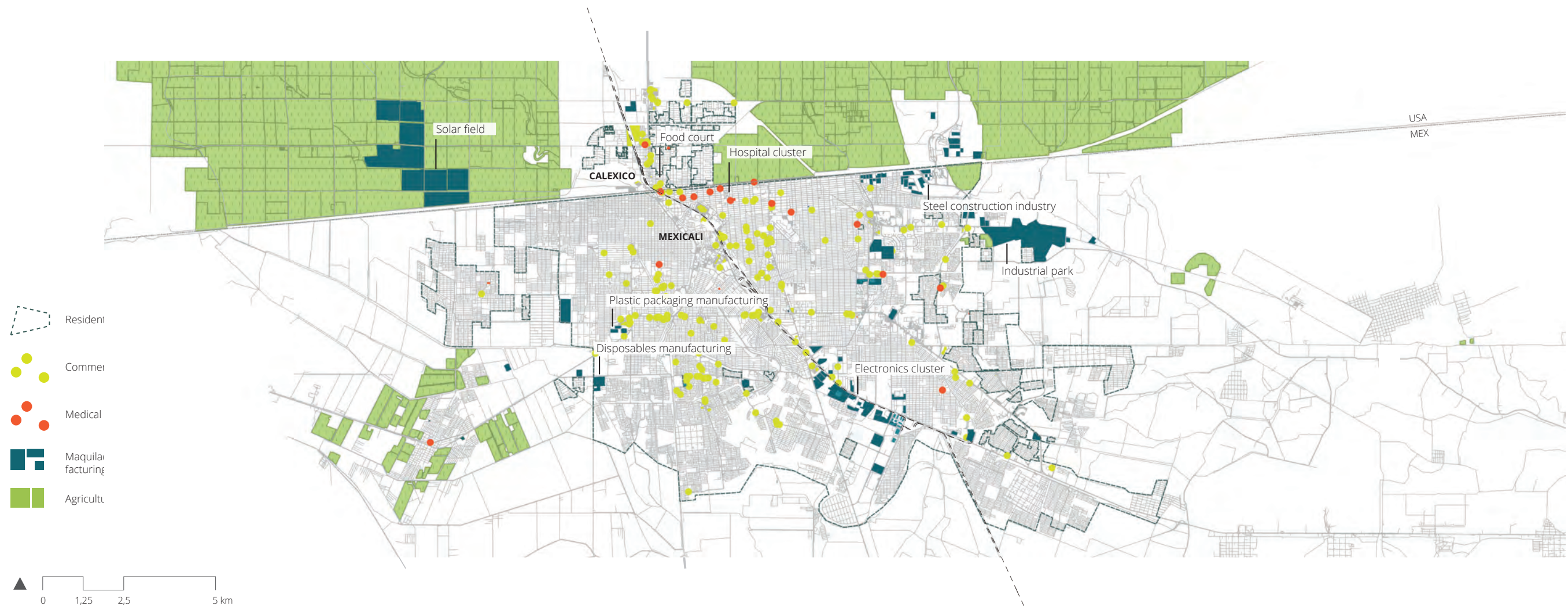
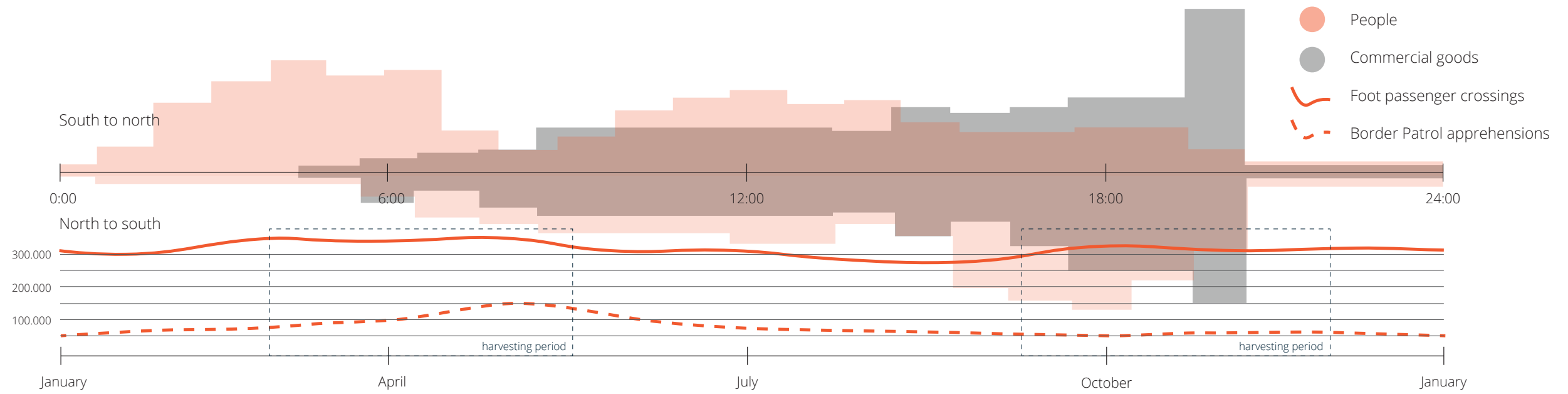




Figure 55. Migrants wait in a detention centre in Texas after having been apprehended at the border. Source: NOS, 2021.



Figure 57. Self-build shelters from essential temporary workers near the agriculture fields. Source: Daily Democrat, 2020.



Figure 56. Example of newly built dorm-style housing for farmworkers on H-2A visa in Ventura County, CA. Source: VC Star, 2020.

Degrading welfare standards for temporary workers

Not all Mexicali transmigrants who seasonally work in the fields return home every night. With notoriously long waiting lines, around 3000 workers do not make the journey back over the border but stay in one of the cities or villages until the next working day. Although H 2A-visas should provide a working migrant with transportation and lodging, a long-standing housing crisis has pushed many farmworkers into cramped and dangerous living conditions without adequate kitchens and bathrooms (CIRS, 2018). Others sleep in (car) parks, motels, garages, cars, converted school buses or self-build shelters (Mother Jones, 2018). California started building migrant housing centers in the 1960s. But the migrant housing centers only serve families, which make up a small fraction of the state's migrant workers. The majority of farmworkers — single men — aren't eligible to live there.

“You’re out in the fields four in the morning. Work eight hours, get paid. Go to the mission, take a shower. I sleep over at the park, [by] the railroads, next to the border. By myself. We find cardboard in dumpsters, go to sleep while it’s still daylight. We’re like owls. At night we’re up. Because you never know what can happen.”

Fieldworker Mark, interviewed in Calexico by Capital & Main (2019).

And as the farming industry has changed, the centers aren't doing enough to keep up with the growing demand for housing (PEW, 2016).

Negative externalities

Under the renegotiated USMCA agreement, better labour conditions and safety measures across all participating countries has been unsuccessfully debated for years (LSE Blogs, 2020). The Covid-19 pandemic unveiled the dynamics of economic prioritization with very severe consequences, as wages in maquiladoras have gone down as far as 50% at the risk of job loss, and the Mexican government prioritizing the economy in this “new normal” policy over population health (ibid.). In this case international pressure and uncertainty are prioritized over local demands and welfare.

Similarly, national entry restrictions for border areas in Covid-19 have had great impact on the border dynamics in this area. Imperial Valley farmers have had shortages of guest labourers, and many were unable to grow and harvest produce for the international market. This crisis brought up related issues of insufficient housing options as incomes decrease, barriers to appropriate healthcare for the farmers, as well as insufficient healthcare measures, housing options and rights enforcement of guest workers rights for Mexican labourers (Times of San Diego, 2021).

Conclusions

Economic interests have driven free border dynamics in Calexico-Mexicali. These dynamics have trickled down into social life, where social and family networks cross transborder due to employment availability and commercial service separation. However, the Covid-19 pandemic has shown that a border is still an (inter)national tool that negates local demands and impacts social and economic dependencies in transborder agglomerations severely. As of yet, the demands of these agglomerations are in hands of separate local and national governments on both sides of the border.

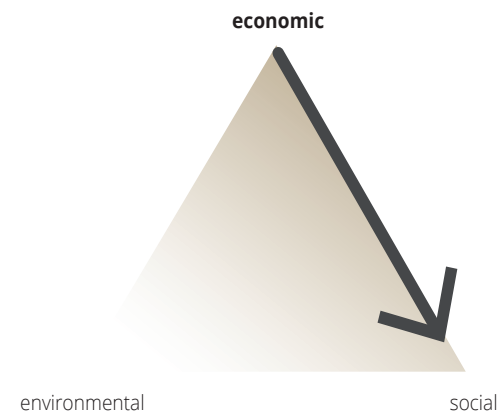


Figure 58. Farm workers have set up tent encampments outside the Calexico border wall for a lack of safe temporary housing options during the Covid-19 pandemic. Source: Border Report, 2021.



Figure 59. Women at work in a Mexican maquiladora. Source: La Voz de la Frontera, 2019.



Figure 60. Maquiladora industry just south of the border in Mexicali. Source: Desert Sun, 2018.

II. OBSERVATION 2: POLLUTION MECHANISMS

The growth of the Imperial Valley, Mexicali Valley and its urban environments went hand in hand. Its territory was formed by mistake in 1905, when a flood created the Salton Sea and two rivers that connect two cross-border valleys. Successfully managing water allotment from the Colorado River meant that both Imperial and Mexicali Valley expanded their intensive agriculture practices. This initiated several waste flows of agricultural matter and waste water. Agricultural waste was burned on site, and wastewater drained into the New River and Alamo River to be released into the Salton Sea.

Water pollution is a bi-national problem

In the century that followed, little changed in

the setup of that waste treatment. Agricultural practices innovated through better irrigation and less use of chemicals, but pollution is still released into the natural environment without treatment. With the arrival of NAFTA, Mexicali's industry boomed and so did the city's population. The two country's coupled water system suffered from that growth, with urban and industrial wastewater being released into the rivers in Mexico, only to receive added sewage and agricultural drainage in the USA. A 2018 report published by the regional water board shows that the river, where it crosses the border, contains extreme fecal coliform and E. coli concentrations that are orders of magnitude beyond established targets (New York Times, 2019). A \$30 million funding from the American Environmental Protection Agency and Development Bank installed piping on the Mexican to tunnel the New River and essentially create a sewage system, but no such piping was installed on the other side of the border (ibid.).



Figure 61. A sign warns visitors away from the polluted New River, which flows north from Mexicali, Mexico, through Calexico. Source: Reveal, 2015.

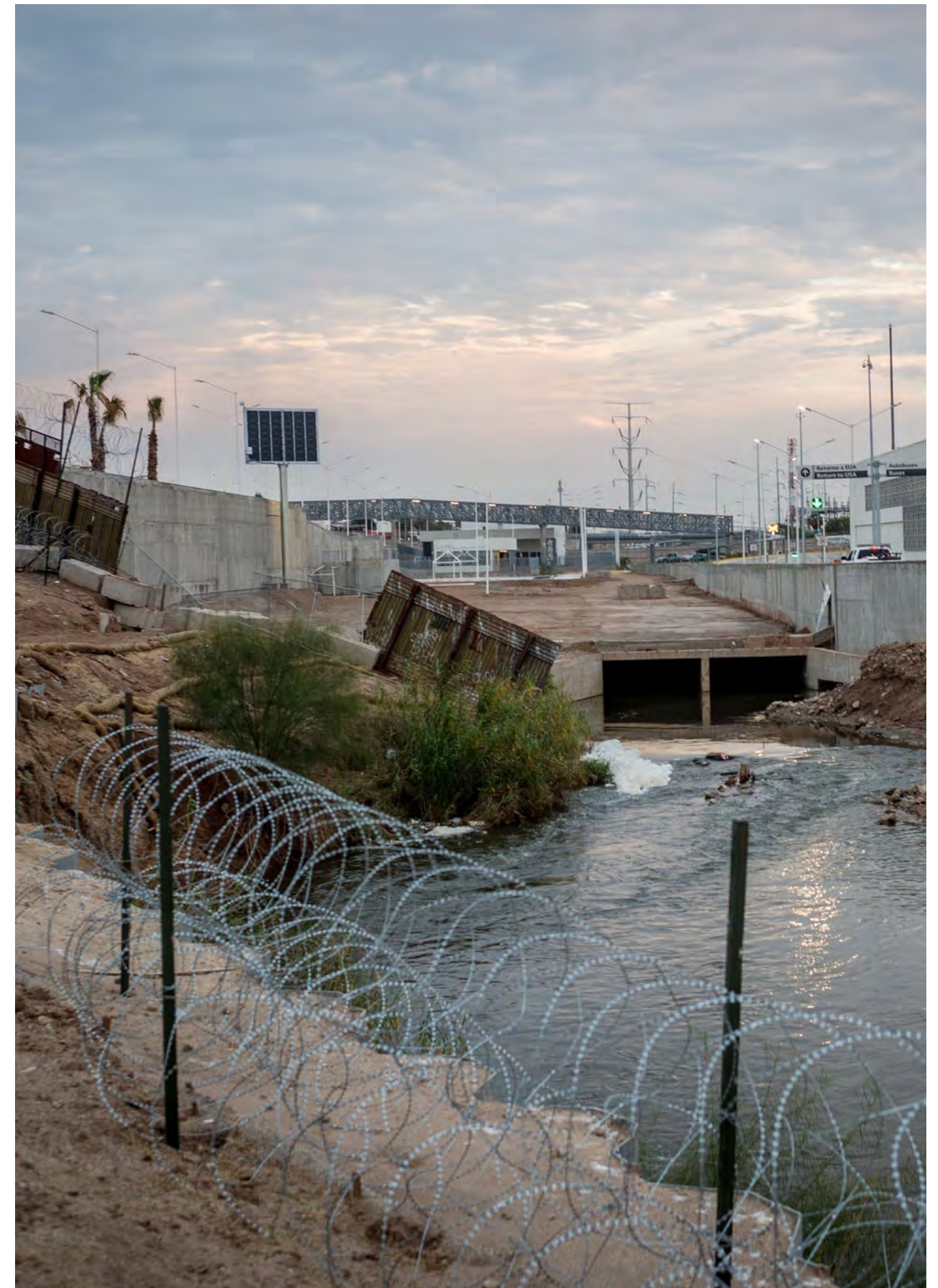


Figure 62. The border crossing cuts the binational New River, which is so contaminated that Border Patrol officials refuse to apprehend refugees seeking to enter the USA wading through the river. Source: New York Times, 2019.

Figure 63. Overview of pollution source indicators (agriculture, industry and urban environment) and source locations. Source: author, based on OSM, 2021.

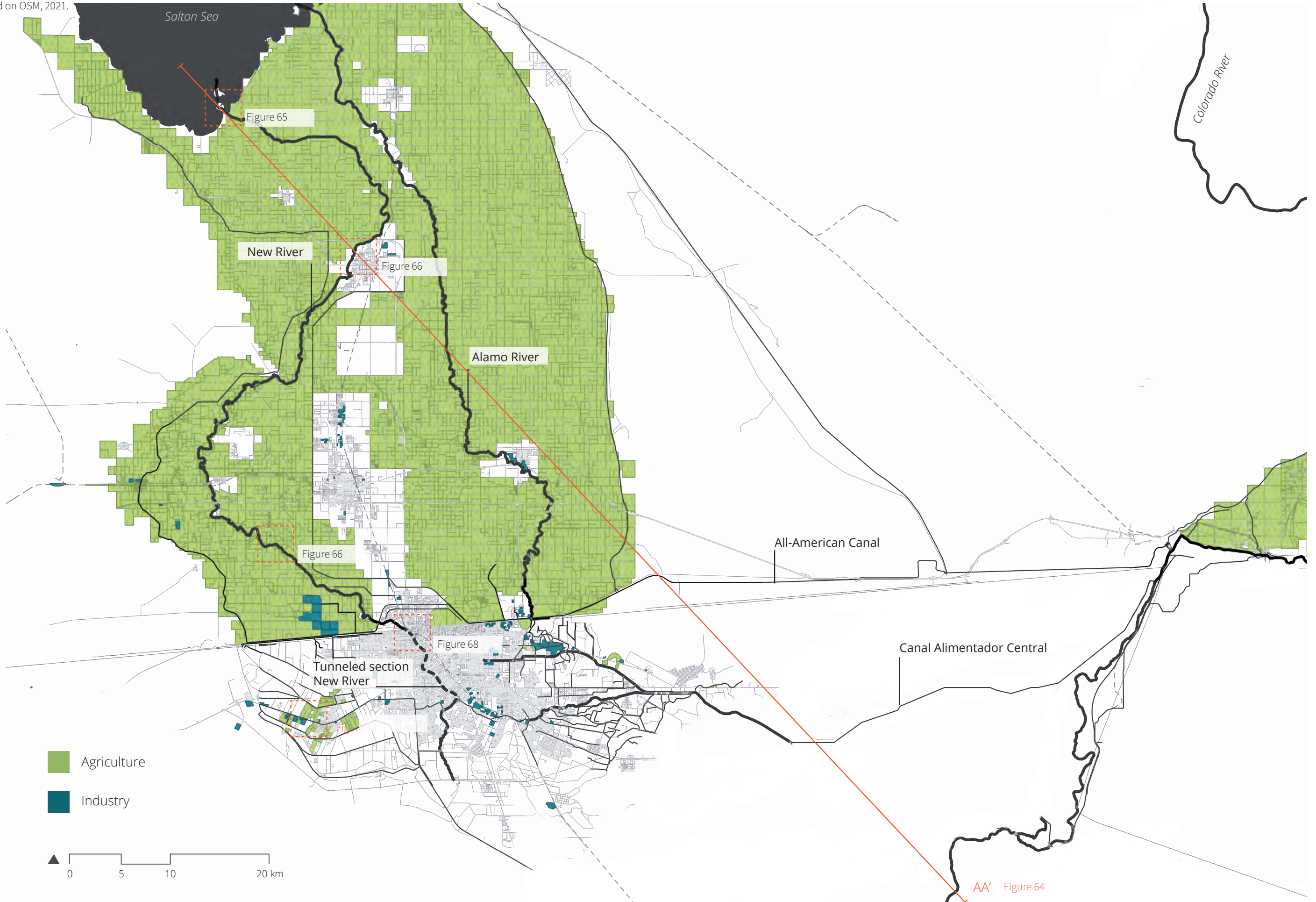
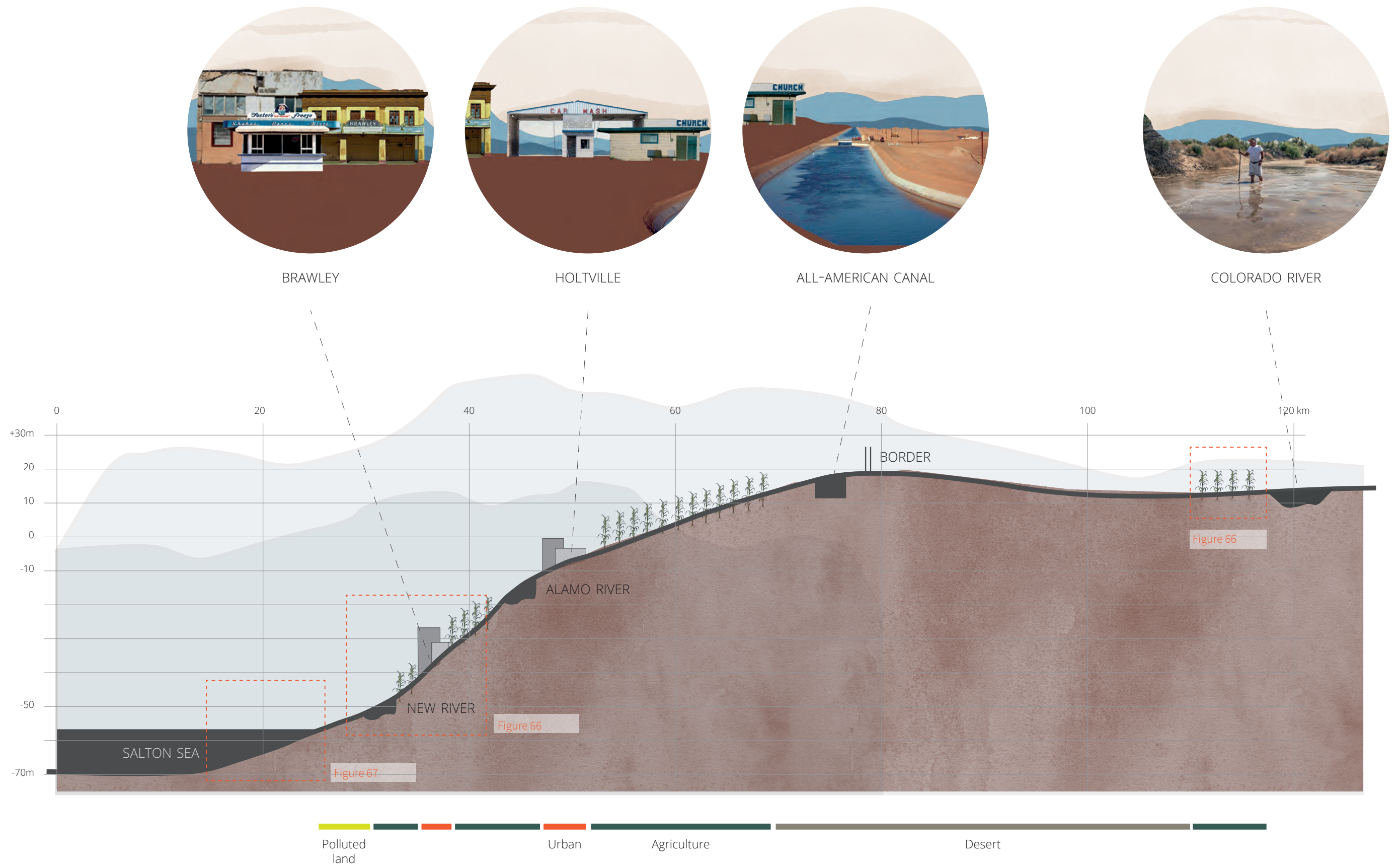


Figure 64. Section AA'. The height difference in the landscape indicates the direction of waterflow from the Mexican border area to the Salton Sea. The Salton Sea, a stagnant water body with no water outlet, receives all runoff from Alamo River and New River.



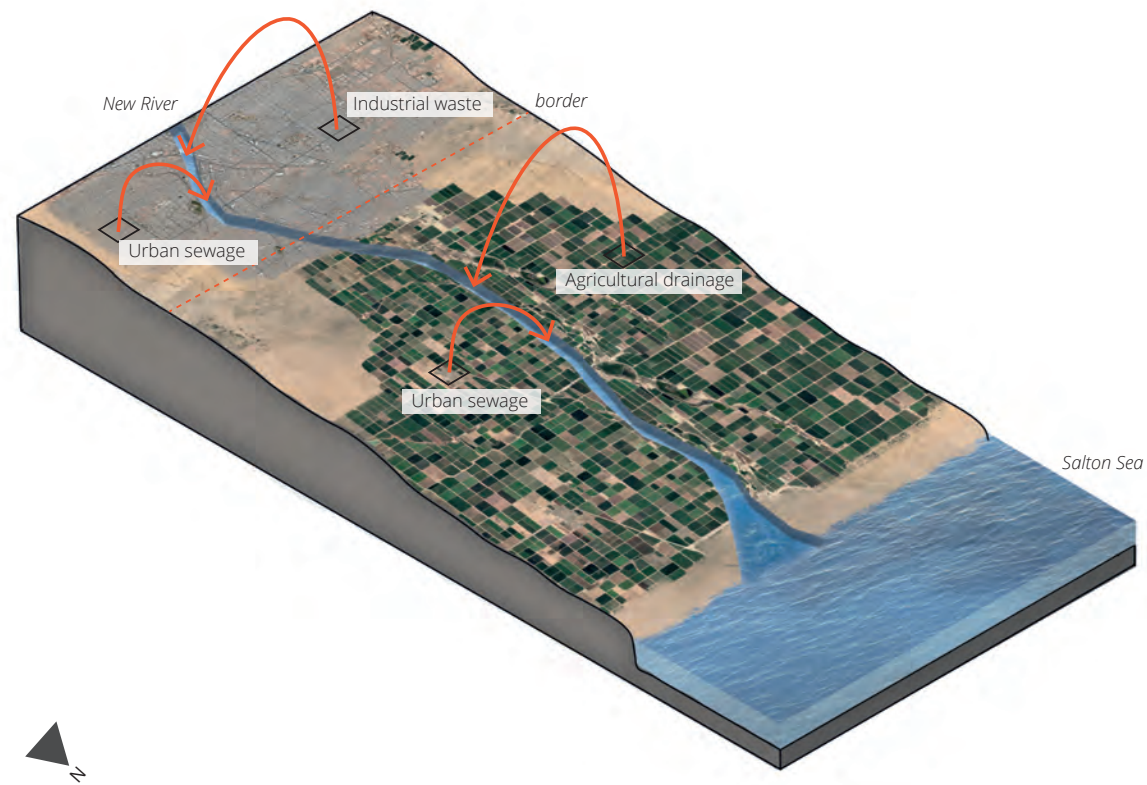


Figure 66. Pollution flow via the New River from Mexico into the USA. Source: author, based on IDD, 2021.



Figure 65. The receding shoreline of the Salton Sea leaves behind toxic pools of water. Source: Daily Mail, 2018.

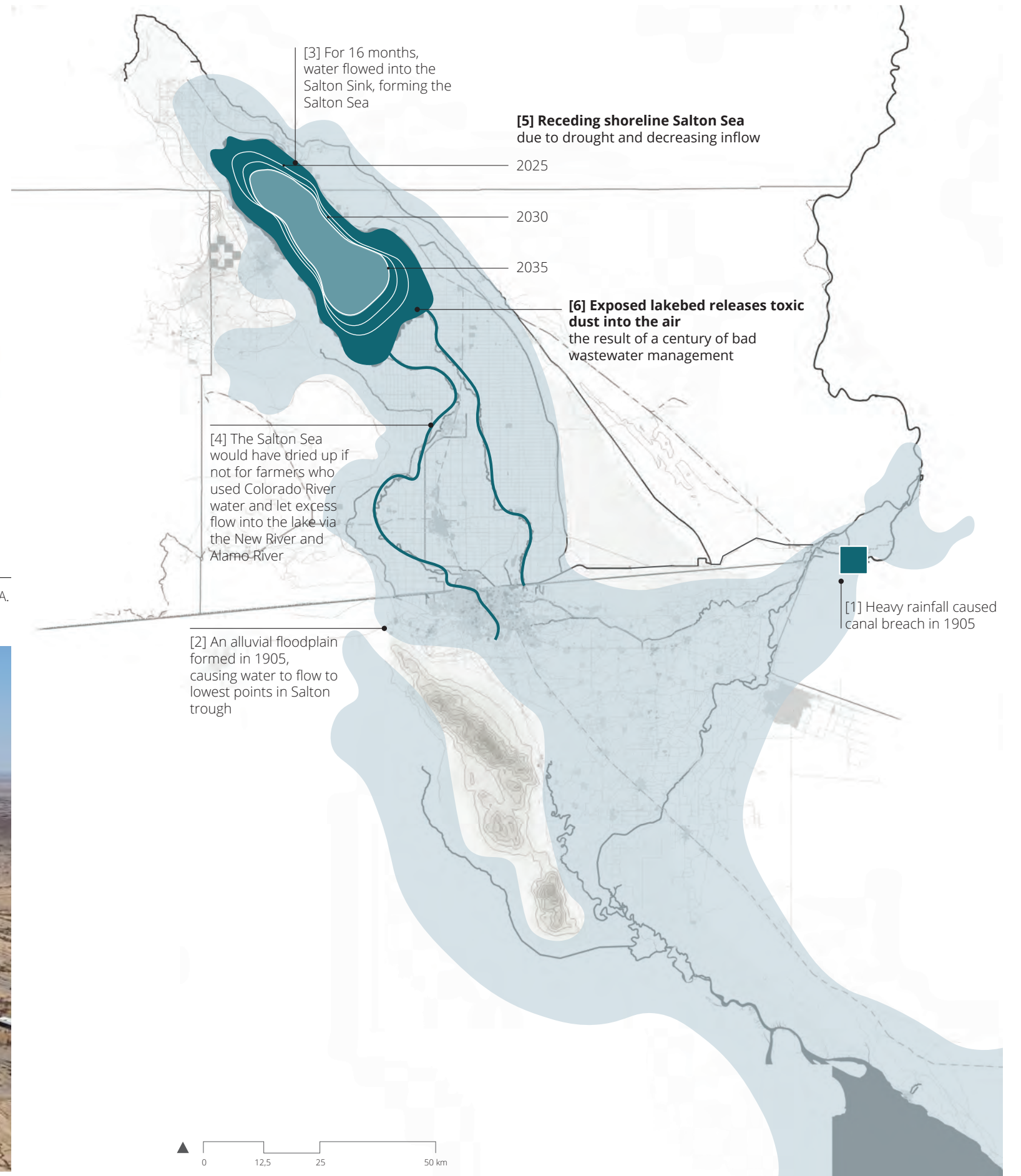


Figure 67. The Salton Sea slowly shrinks under drought and decreased inflow, exposing the polluted lakebed and releasing toxins into the air. Source: author, based on LA Times, 2014.

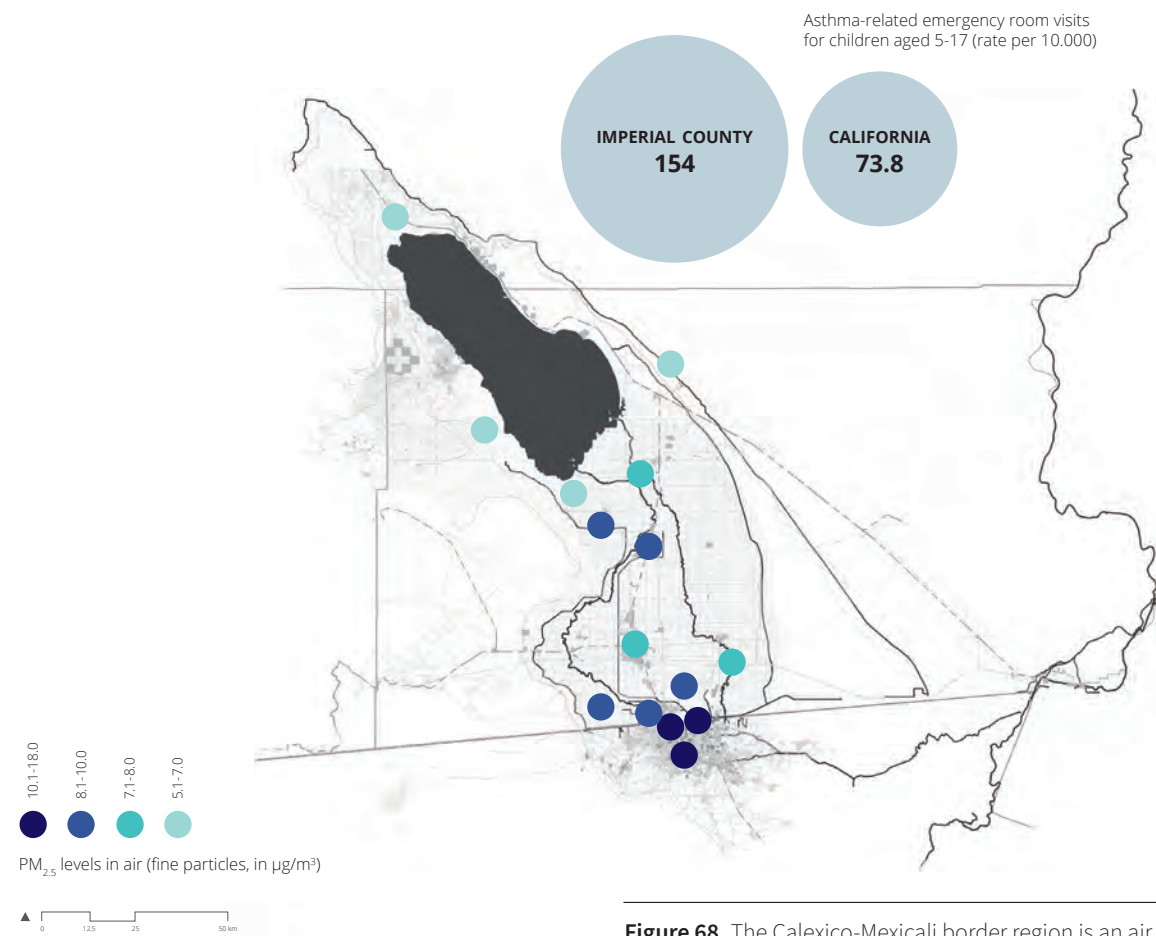


Figure 68. The Calexico-Mexicali border region is an air pollution hotspot. Source: author, based on Public Health Institute, 2017.

Air pollution is a bi-national problem

Besides severe water pollution, the border region also copes with air pollution. Officials in Baja California estimated that pollution causes 300 premature deaths annually in Mexicali, and statistics from both Mexicali and Imperial Valley show that the population with asthma steeply outgrows the state's average (Desert Sun, 2018). Its causes lie with the maquiladora industry in Mexicali, which are situated within or very close to residential neighbourhoods in Mexicali, as well as toxic dust released from the Salton Sea lakebed. Added to these are illicit burning sites of trash and medical waste on the Mexican side of the border (ibid.). These problems are expected to worsen under forecasted climate drought conditions and a steadily retreating Salton Sea shoreline.

Inadequate governance scales

As the causes for both air- and water pollution

are coupled cross-border, the lack of a relevant governance scale could partially explain why the issues are hard to address. The available governance bodies are tied to nation states which primarily have their own interest in mind. Thus, a cross-border governance body or agreement supported by federal- or state organizations could push for local and regional interests.

Proposed actions

A lack of proper monitoring and information gathering is reported as an urgent issue, since especially on the Mexicali side the state relies on environmental information supplied by the polluting industries themselves. Moreover, there is a lack of enforcement of environmental standards, and lack of budget for the local interest groups that try to push these issues to state- or federal level governance (Desert Sun, 2018; New York Times, 2019).



Figure 69. The Fevisa factory, a glass bottle manufacturing plant, burns natural gas and stands besides the neighbourhood of Ejido el Choropo in the south of Mexicali. Source: Desert Sun, 2018.



Figure 70. José García Núñez works on his family's grass farm next to the Industrias Zahori factory in Mexicali. Source: Desert Sun, 2018.

III. OBSERVATION 3: POVERTY AND UNEMPLOYMENT

The Social Vulnerability Index map in chapter 05 (Figure 32) showed that several census tracts in Imperial County scored bad. This population vulnerability is related to the high level of unemployment that the county has struggled with for years. Due to the monofunctional economy based on agriculture, and its seasonal employment opportunities and the high physical demand of that employment, many people are desperate for income diversification. Its service sector, once set up to accommodate the tourism industry, now depends largely on Mexicali shoppers and guest workers. High

“With a high unemployment rate, man, it’s difficult to get a job. The community is starving for work. Everybody wants a way out of here.”

Jesse Aguirre, manager of the Imperial Valley Food Bank, interviewed in Calexico for Capital & Main, 2019.

education drop-out rates denies people the qualifications to work in available governance jobs or likewise. Hence, incomes are generally too low to afford rent in the current housing stock, or to do housing maintenance. Delapidation statistics from 2000 show this, and it is expected these figures have risen over the past two decades with increasing unemployment (The Guardian, 2020).

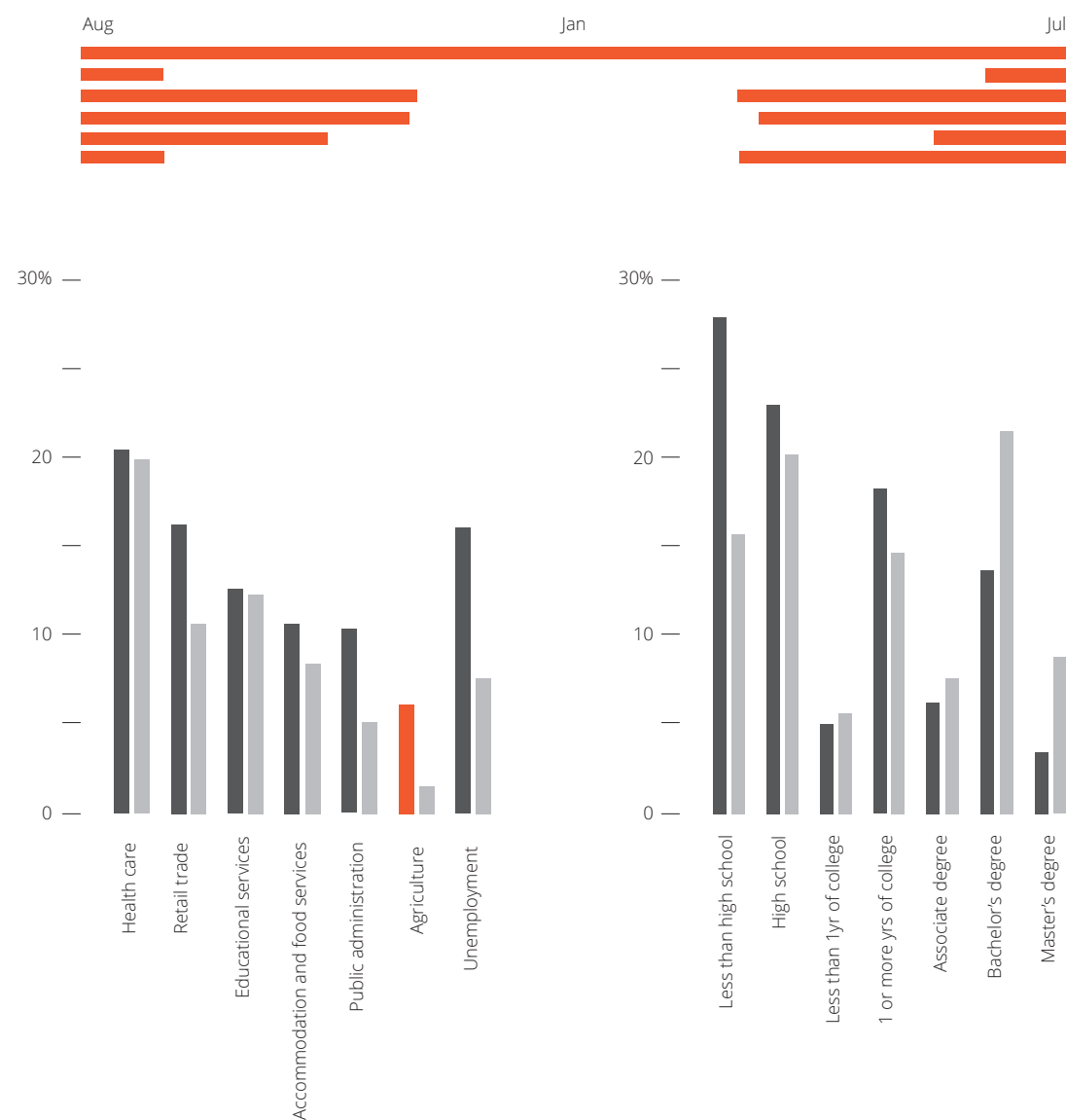


Figure 71. Most common industries, education attainment and crop cycles for the most common crops in Imperial County, offset to California average. Source: author, based on City Data, 2020.

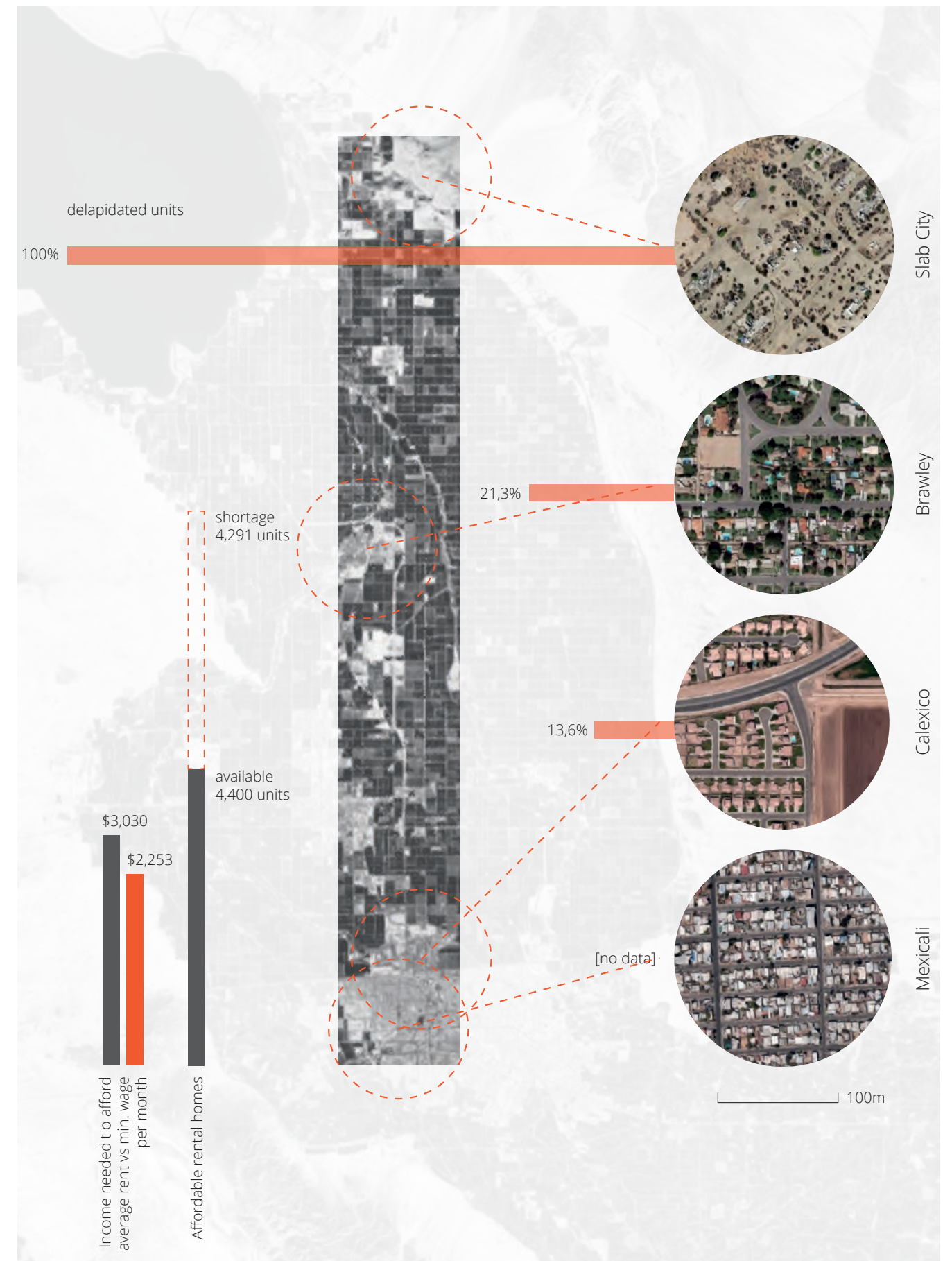


Figure 72. Housing conditions Imperial County. Source: author, based on City Data, 2020; CHP, 2020; CCBRES, 2000.

IV. CONCLUSIONS

To recapitulate, this thesis began with an introduction of the topic of climate-induced migration. Migration and climate change have not been directly linked in research, but the importance of changing environmental factors on the mobility patterns of population is evident. These changing environmental conditions can be roughly split into sudden-onset disasters and slow-onset impacts. The latter is hard to anticipate, as these impacts usually reveal themselves at a point of crisis. Nevertheless, research is showing that particularly critical ecosystem services that provide food security, water availability, shelter and energy production are focal points in anticipating slow-onset impacts. These changes are most likely to hit the most vulnerable populations first, and the longest, as they generally have less means to adapt. Importantly, sudden-onset impacts can have a multiplier effect that can slowly break down the resilience of both ecosystems and (vulnerable) populations and make it difficult to bounce back after sudden-onset disasters or slow-onset changes.

In the border region between Imperial County and Baja California, Mexico, this project analysed systemic vulnerabilities. They resulted in a picture of a future that may see water scarcity, failed crop yields due to droughts. This would spike economic losses for the region, as well as an increase in unemployment. The monothematic economic market in Imperial County currently has no wide choice of other sectors to provide income generation for its population. The resulting poverty and degradation, and the lack of (government) investment to provide better services, does not give a solid base for resilience. Nor does the state of ecosystem services, that for too long have been at the service of international market play. Pollution is another unjust process that has resulted in an urgent cross-border problem, both for ecosystem resilience and public health. Lastly, the number of migrants that try to cross the border from Mexico into the United

States has been rising over the years, as uninhabitable situations in Central America due to conflict, gender-based violence or ecosystem degradation have increased. This region may expect a rising number of migrants at the border in the coming decades as well as migratory movements from populations in nearby counties. The San Diego population is at risk of displacement due to sea-level rise. Arizona agriculture of desertification. Naturally, the way this might play out is deeply uncertain, however it is clear that the current system in the border region is unable to provide a liveable environment and preparedness towards slow-onset future changes.

V. GUIDING PRINCIPLES AND INSTRUMENTS

Based on the previous conclusions, a set of general principles (to the right) and instruments (Figure 73) for development have been established. These act as a planning framework and will guide the identification of actions that will be used to construct pathways.

[1] value-led rescaling of development

This principle recognizes that local and regional development be balanced between international and local demands. These demands cross borders (county and national) and should have appropriate representation. The approach is that unlike economic driven growth, a value-based model can withstand the political and market pressures that currently govern this region.

[2] compress and expand

This principle recognizes that this cross-border region must be able to flexibly adjust its infrastructure (mobility, housing or employment-related) in order to anticipate irregular migration flows.

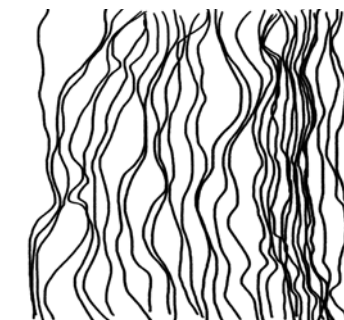
[3] restoring ecosystem services

Prioritizing ecosystem resilience is critical for anticipating slow-onset changes.

[1] value-led rescaling of development



[2] compress and expand:
flexible infrastructure for irregular
migration flows



[3] restoring ecosystem services and
prioritizing regenerative development

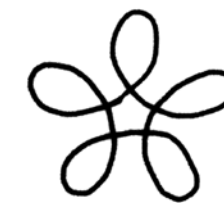


Figure 73. Instruments that can be used in planning for each guiding principle. Source: author, based on Bergevoet and Van Tuijl, 2016.



● Spatial instrument ● Legal instrument
● Organisational instrument ● Financial instrument

VI. STAKEHOLDER ORIENTATION

	USA	MEX	Cross-border
<i>International</i>			International Organization for Migration (IOM) USMCA
<i>Federal</i>	Environmental Protection Agency (EPA) US Department of Agriculture	Environmental Protection Agency	
<i>Non-Governmental Organization (NGO)</i>	North America Development Bank Imperial IVAN Air Monitoring Comite Civico del Valle (environmental justice)		
<i>State</i>	California Strategic Growth Council Environmental Protection Agency (EPA) Air Resources Board Water Quality Control Board	Baja California Environmental Protection Department Baja California State Water Commission	
<i>Regional</i>	Colorado Water Quality Control Board		Border 2020 Program International Boundary and Water Commission (IBWC) United States-México Border Health Commission (BHC)
<i>County</i>	Air Pollution Control District Public Health Department Imperial Irrigation District (IDD) Unified School District Coalition of Labor, Agriculture and Business Imperial County Transport Commission		
<i>Local</i>	Childhood Asthma Program Calexico Air Pollution Board Municipalities	Directorate for Environmental Protection Mexicali PROAIR Program Mexicali Industrial companies Municipality of Mexicali	

To the left a schematic overview of stakeholders that are most relevant to the analysed vulnerabilities in this project.

Cross-border stakeholders *Border 2020 Program*

This is an environmental program with an 8-year implementation horizon and 2-year action plan to reduce pollution in the region under the USMCA. It is a sub-organization of the EPA and works with task forces and EPA funding. Its predecessor, Border 2012, had similar environmental goals concerning the installation of water- and waste treatment plants that were not met.

IBWC

A commission headed by the US government, instated to provide binational solutions to problems that arise around application of shared treaties, such as border demarcation, water quality, sanitation and flood control in the region.

BHC

Instated to provide international leadership to improve health and quality of life along the U.S.-México border. Primarily diplomatic functions and international relations-related operations.

Stakeholder perspectives

Three perspectives are used to group similar types, assumptions and choices of stakeholders based on the Cultural Theory by Thompson et al. (1990) (see Figure 74). These perspectives can be used to anticipate value-based collaboration (RIVM, 2016).

1. The **individualistic perspective** is based on the short-term interest, impact types that are undisputed, and technological optimism with regard to human adaptation.
2. The **hierarchist perspective** is based on scientific consensus with regard to the time frame and plausibility of impact mechanisms.
3. The **egalitarian perspective** is the most precautionary perspective, taking into account the longest time frame and all impact pathways for which data is available.

VII. IDENTIFYING ACTIONS

The following actions were identified to address preparedness, vulnerabilities and opportunities in the border region:

[1] Value-led rescaling of development	[2] Compress and expand	[3] Restoring Ecosystem Services
<p>[1.1] Indoor farming Smaller local footprint with non-context dependent production</p> 	<p>[2.1] Adaptive housing policy that allows for flexibility in housing choice as well as security in tenure</p> 	<p>[3.1] Stimulate ecotourism to reduce unemployment and boost service sector</p> 
<p>[1.2] Cross-border governance equal standards for policy, monitoring, enforcement</p> 	<p>[2.2] Monitor vacancy stock that allows for quick redevelopment to educational facilities or housing facilities</p> 	<p>[3.2] Establish waste treatment and recycling infrastructure combining waste flows and reuse residual product</p> 
<p>[1.3] Local food production playgrounds to make fresh produce accessible and create flexibility if local market demands more food</p> 	<p>[2.3] Stimulate in integration services to combat unemployment children's education, education for entrepreneurship, language services, psychological services, leisure activities</p> 	<p>[3.3] Create a series of wetlands along the rivers to filter water, expand river absorptive capacity and attract wildlife</p> 
<p>[1.4] Subsidize and tax industries based on regional values and regionally defined capacity</p> 	<p>[2.4] Invest in public transport network to increase accessibility of the region for population without vehicle ownership</p> 	<p>[3.4] Industrial zoning for safe neighbourhoods capping industries with harmful emissions</p> 
<p>[1.5] Create fund for regional public health needs based on demand, such as pollution filters or heat reduction measures</p> 	<p>[2.5] Invest in renewable energy production to take advantage of solar and geothermal opportunities</p> 	<p>[3.5] Crop rotation and drought-resistant crops to prevent soil erosion and future-proof agricultural produce</p> 
<p>Action addresses:</p>  Water-conscious  Unemployment relieve  Pollution reduction  Variability-conscious		<p>[3.6] Harvesting and recycling of (rain)-water to create smaller dependency on Colorado River</p> 
		<p>[3.7] Dust suppression Salton Sea to prevent toxic air release</p> 



PART 3
DESIGN AND EVALUATE



09

EXPLORING PATHWAYS

The previous chapter identified guiding principles for planning and a set of actions that could work towards an adaptive region based on the identified vulnerabilities and opportunities. This chapter will sequence actions into pathways, to explore how they can support spatial planning and decision-making under uncertainty.

I. PATHWAYS AS STRATEGY FOR AN UNCERTAIN FUTURE

In order to explore how spatial planning can work with uncertainty, this project uses Dynamic Adaptive Policy Pathways (DAPP). This method was developed by water management engineers nearly 8 years ago, for the purpose of dealing with long-term consequences and long-term objectives while recognizing that these require near-term decisions. More than traditional prediction- or scenario-based decision methods, planning under deep uncertainty (e.g. climate change) requires more in order to evaluate alternatives. DAPP provides an adaptive plan that is able to deal with the consequences of deep uncertainty (Deltares, 2021). The working of

the method has been explained in chapter 04.iii and the methodological steps have been followed in this thesis.

This chapter will explore an Adaptation Pathways Map, in which the set of action formulated in chapter 08 are sequenced. First will be explained how to read this map in Figure 77, followed by an overview of the Pathways Map for this thesis and an explanation how it came about.

In sections II and III of this chapter, two different pathways will be explored, looking at how different actions are sequenced over time, how they synergize, what their path dependencies are, and how they could relate to changing conditions in the previously analyzed context of deep uncertainty.

Figure 76. Border landscape stretches from California into Arizona.
Source: CNN, 2018.

The right page (Figure 77) shows the schematic visualization for this method, also called *the tubemap* as it resembles the map of a metro system. Below an introduction how to read this tubemap.

Goal

Each tubemap needs to answer a specified goal. For the purpose of this method in engineering environments, this goal is monothematic and quantifiable in order to read through the uncertainty of the context. In this case, X should be smaller than Y for the next 100 years.

Timeline

Underneath the tubemap are two timelines. The upper line resembles the temporal progress under RCP 4.5, in which climate change progresses until 2040 and then stabilizes. Less actions are needed to reach the goal within the set timeframe. The bottom timeline represents RCP 8.5, where climate conditions can quickly worsen and accelerate. In order to create a long-term plan for the set timeframe, more actions are needed to meet the goal.

Actions

Several options are then formulated to meet the demand of the goal: the actions.

Robust actions

These are actions that will always meet the goal in the tubemap, in this example actions A and D. However, switching to those actions probably has many trade-offs, such as a large investment needed or big socio-cultural impacts. Therefore, these actions are not typically only considered immediately.

Short-term actions

These actions have a much shorter shelf-life. They are typically less costly and impactful, but their trade-off is that other actions are needed in the near future to keep meeting

the demands of the goal. Action C is such an example. However, in some cases the shelf-life of an action can be extended by combining it with another action, such as action B in this example. The Adaption Tipping Point can then be pushed back in time as the action can meet the demands of the goal for a longer period of time.

Adaptation Tipping Point (ATP)

ATP's signify the shelf-life of an action. It is the end-station of an action, after which point in time the action does no longer meet the demands of the goal, and decision-making should focus on switching stations to another action. In practice, determining the ATP of an action is done via bottom-up vulnerability assessments or top-down scenario analysis. This way, experts determine the range and timing of these points. As this was not feasible in this research project, all ATP's are educated guesses in order to progress at addressing the main research question of this project.

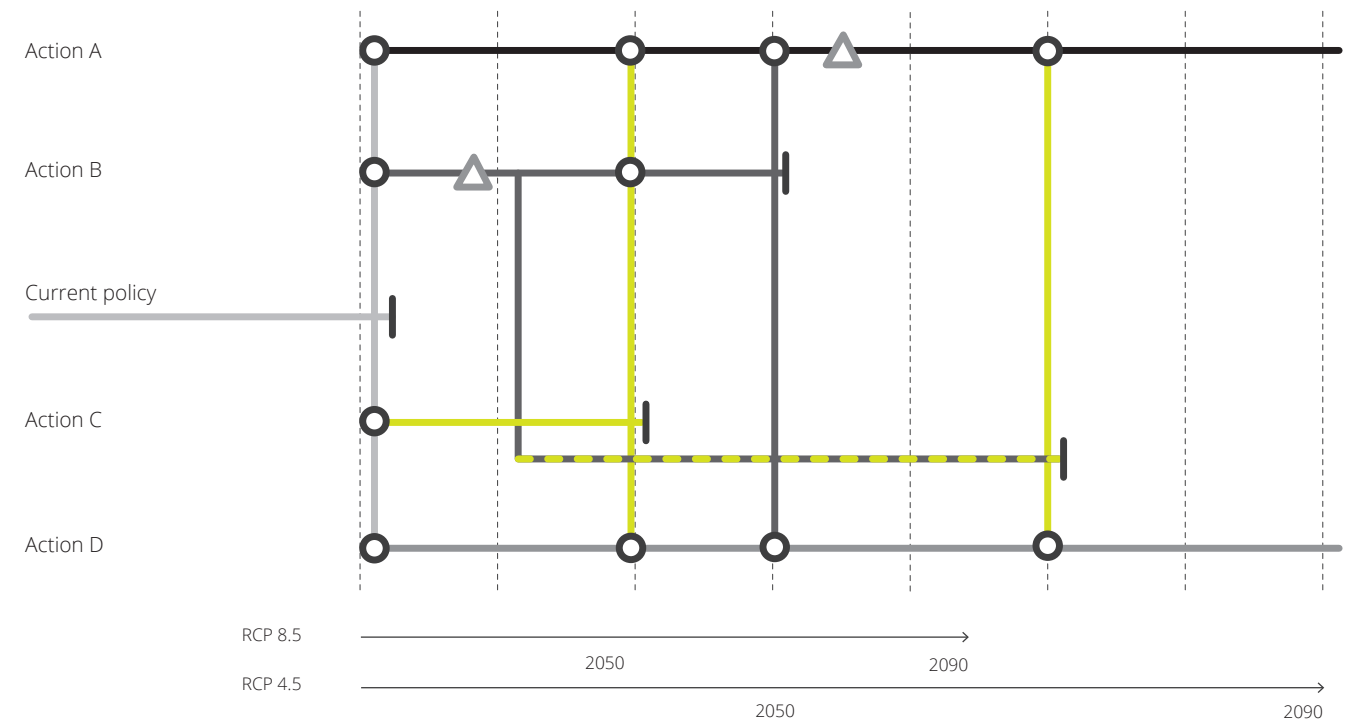
Pathways

Using the explained signage, several pathways can now be drawn through the tubemap by sequencing actions to reach the 100-year mark making sure that $X < Y$. Monitoring the performance of the actions and context determine what stations are taken, and taking a station has consequences for future development. This is called pathway-dependency, and it is therefore deemed beneficial to keep as many options open for as long a period of time as possible to avoid negative pathway-dependency.

Decision anchors

Lastly, decision anchors are added to signify moments in the tubemap that require preparation or anticipation before an action can be used, or synergy with another action can be met.

Goal: $X < Y$



DAPP signage used:






-  Station
-  Adaptation Tipping Point (ATP)
-  Action
-  Extended action due to synergy with other action
-  Decision anchor

Figure 77. Explaining how the DAPP method works.

Pathways for multi-thematic planning

The DAPP method was chosen as a starting point for working with deep uncertainty in spatial planning. Naturally, the origins of the method define its performance. As mentioned previously, coming from an engineering background in water management, the method has primarily been used sequence pathways that serve a monothematic goal. Hence, the method works best with a quantifiable goal that informs the actions and their tipping points. Regional spatial planning is far from monothematic, hence this project tries to find a useful way to adapt the method for a multi-thematic, value-driven goal. This also means that the uncertainty increases: the context remains deeply uncertain, but within the method the actions themselves and their tipping points also carry uncertainty. The project tries to work with this by addressing the embedded uncertainty in its visualisations and by presenting range and alternatives in how actions might work together towards different spatial outcomes.

Goal setting

Instead of a monothematic goal, this project uses an addition of components that each action needs to address. The exact tipping points become very difficult to pin down, but the multi-thematic goal does give an indication when an action no longer serves the goal's purpose, namely when it fails to successfully address one of the components. Naturally, "successfully" is an objective term, but this interaction between goal and action will be discussed in chapter 10.

Actions and sub-actions

A core activity of regional planning is moving between scales. Hence, an action is formulated for a particular scale, but never acts solely on that scale. This project tries to create opportunities for moving between scales in the pathways map by defining actions on the level of regional strategies, but exploring at the same time how sub-actions work together on different scales to create different spatial outcomes.

Goal: development should simultaneously address the current lack of employment, increase public health by addressing pollution, and be sensitive to the variability of climate and migration flows.

employment component [1] + waste treatment component [2] + variability component [3]

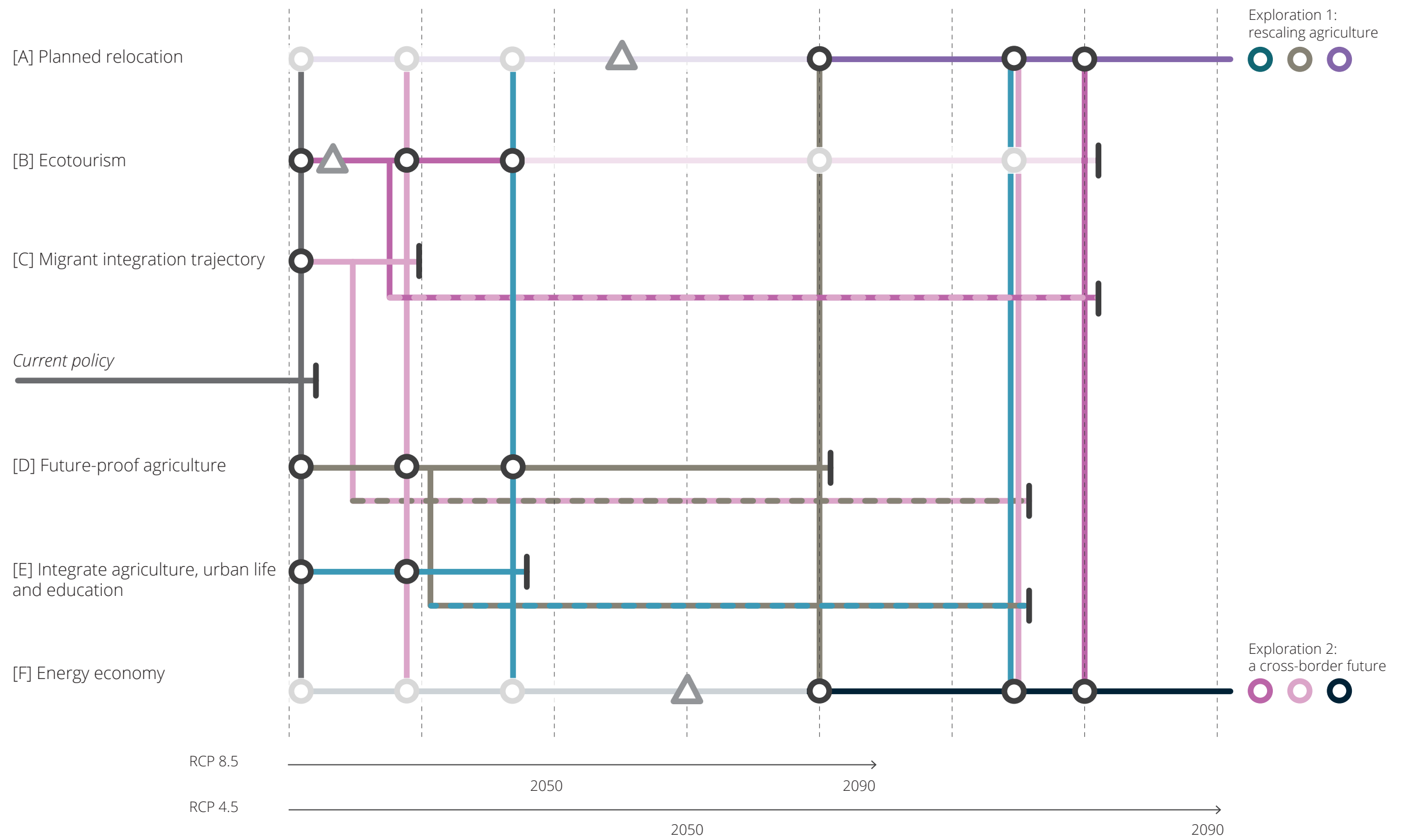
Regional strategies based on previously defined actions	Sub-actions
[A] Planned relocation <i>Robust action</i>	[1.2] Cross-border governance [1.4] Fund for regional public health demands
[B] Ecotourism	[1.2] Cross-border governance [1.4] Subsidize and tax industries [3.2] Waste treatment and recycling plants [3.3] Create a series of wetlands [3.6] Harvesting and recycling of (rain)water [3.7] Salton Sea dust suppression
[C] Migrant integration trajectory	[1.2] Cross-border governance [1.3] Local food production [2.1] Adaptive housing policy [2.2] Monitor vacancy stock [2.3] Stimulate integration services [2.4] Invest in public transport [3.2] Waste treatment and recycling plants [3.6] Harvesting and recycling of (rain)water
[D] Future-proof agriculture	[1.1] Indoor farming [3.2] Waste treatment and recycling plants [3.5] Crop rotation and drought-resistant crops [3.6] Harvesting and recycling of (rain)water [3.7] Salton Sea dust suppression
[E] Integrate agriculture, urban life and education	[1.3] Local food production [1.5] Fund for regional public health demands [2.1] Adaptive housing policy [3.2] Waste treatment and recycling plants [3.4] Industrial zoning [3.6] Harvesting and recycling of (rain)water [3.7] Salton Sea dust suppression
[F] Energy economy <i>Robust action</i>	[2.5] Invest in renewable energy production

Figure 78. Categorizing identified actions in regional strategies and sub-actions to serve a multi-thematic goal.

Figure 79. Pathway map.

Goal: development should simultaneously address the current lack of employment, increase public health by addressing pollution, and be sensitive to the variability of climate and migration flows.

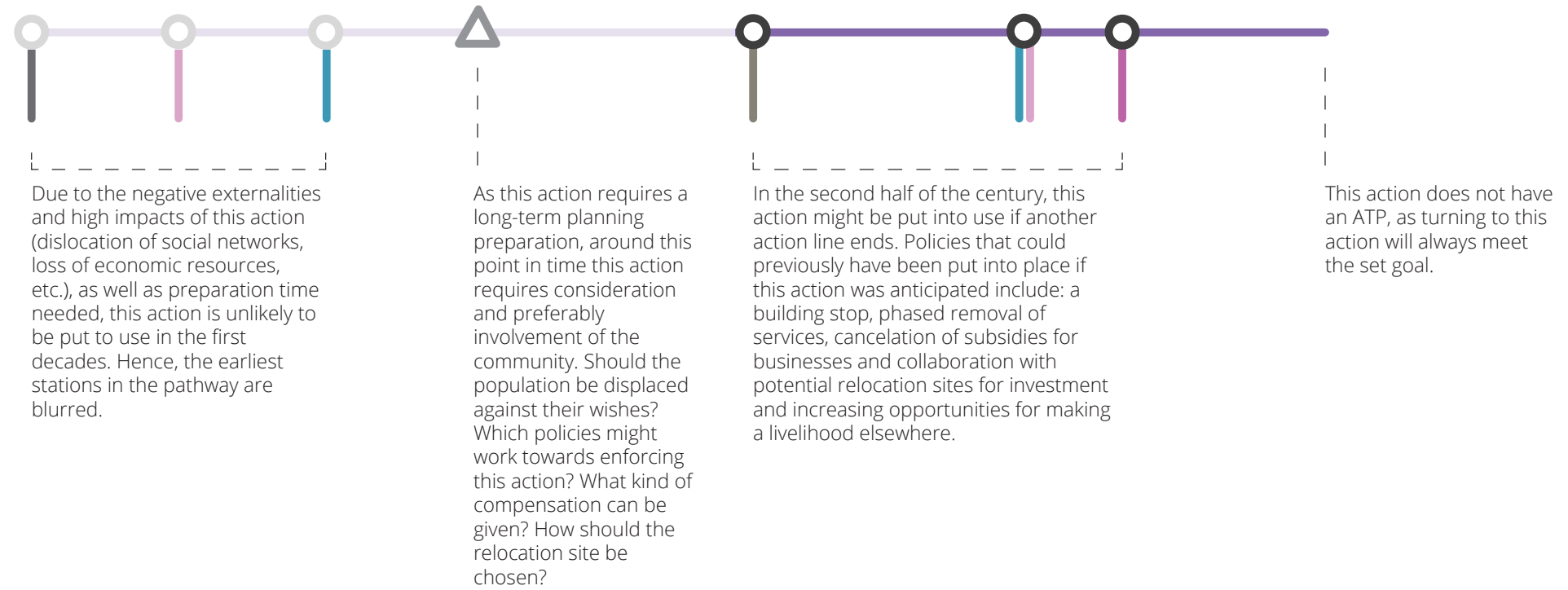
employment component [1] + waste treatment component [2] + variability component [3]



[A] Planned relocation

When the expected impacts of climate change and related disasters are unbearable and the goal cannot be met, a government may decide to pre-emptively relocate part of or the entire population in order to avoid forced migration or humanitarian disasters in the future. Although this action is often regarded as a last resort, it stands to argue that early consideration might help to better define it to ensure protection of the population and respect for human rights.

- [1.2] Cross-border governance
- [1.4] Fund for regional public health demands

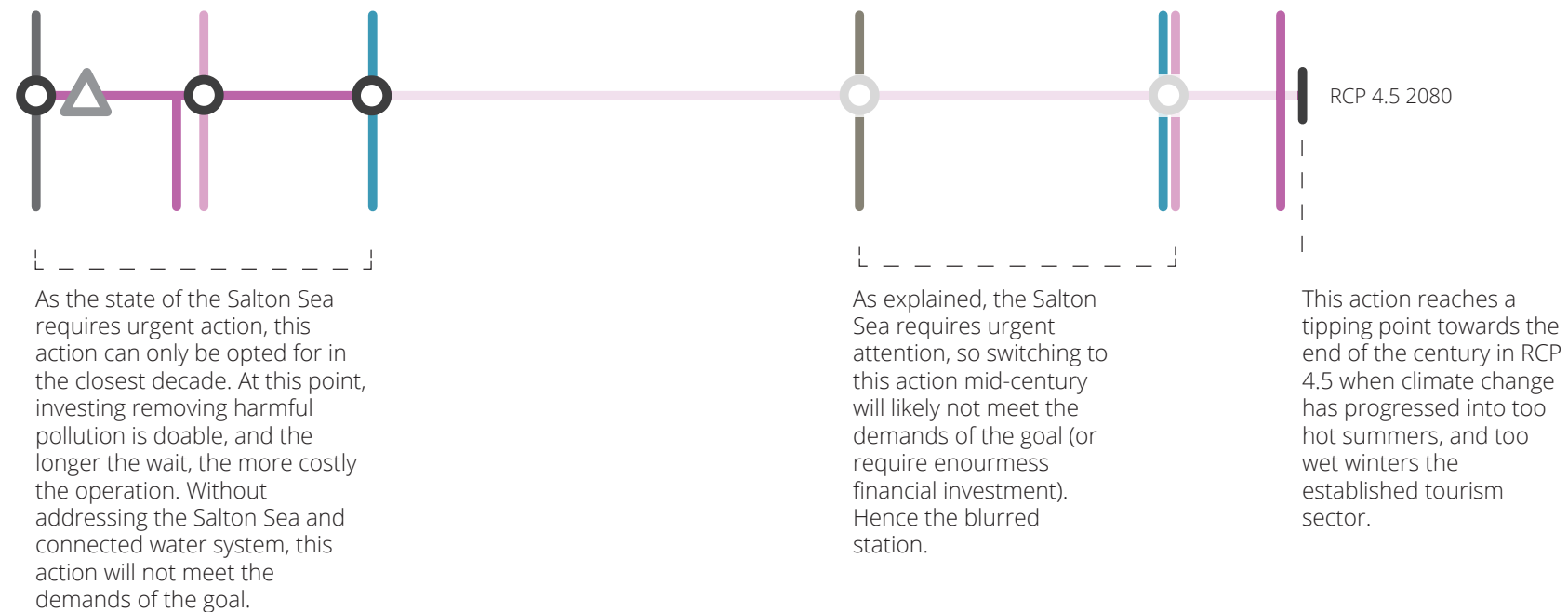


[B] Ecotourism

This action envisions a region that stimulates nature-based solutions to decrease pollution and add employment opportunities by creating a new tourism and service sector.

Required sub-actions:

- [1.2] Cross-border governance
- [1.4] Subsidize and tax industries
- [3.2] Waste treatment and recycling plants
- [3.3] Create a series of wetlands
- [3.6] Harvesting and recycling of (rain)water
- [3.7] Salton Sea dust suppression

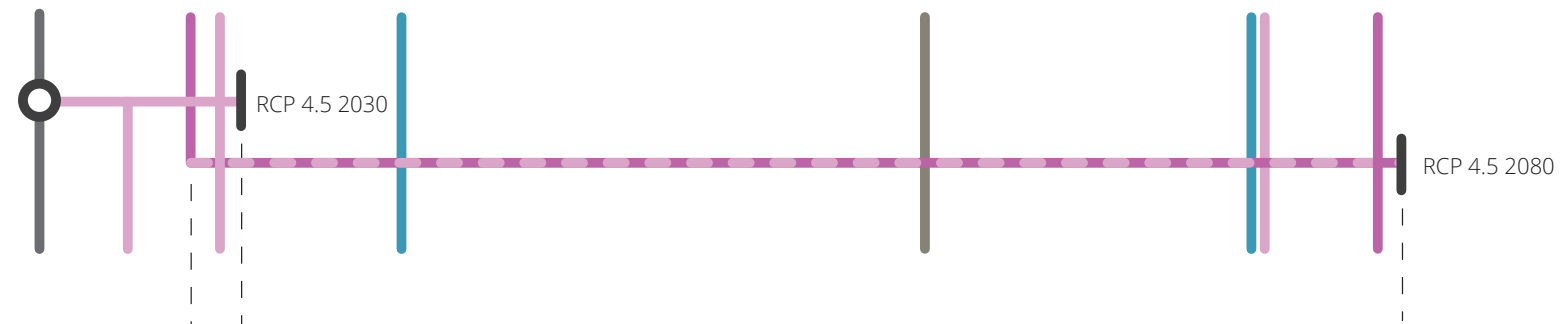


[C] Migrant integration trajectory

This action envisions a region that can expand and shrink based on the arrival of migrants. Instead of migrant apprehension and detention, this action aims to integrate them as quickly as possible and introduce them to employment, education and housing.

Required sub-actions:

- [1.2] Cross-border governance
- [1.3] Local food production
- [2.1] Adaptive housing policy
- [2.2] Monitor vacancy stock
- [2.3] Stimulate integration services
- [2.4] Invest in public transport
- [3.2] Waste treatment and recycling plants
- [3.6] Harvesting and recycling of (rain)water



This action assumes that the region can cope with an influx of migrants based on the opportunities of expanding its employment market. As the region is currently struggling with high unemployment, this action reaches a quick tipping point.

However, this action could benefit from instigating action B Ecotourism, which could provide the region with a new employment sector. Research has shown that migrants are more likely to be entrepreneurial than natives which is beneficial to the migrant and host community (Thai, 2013). Hence action B and C can show a synergy here.

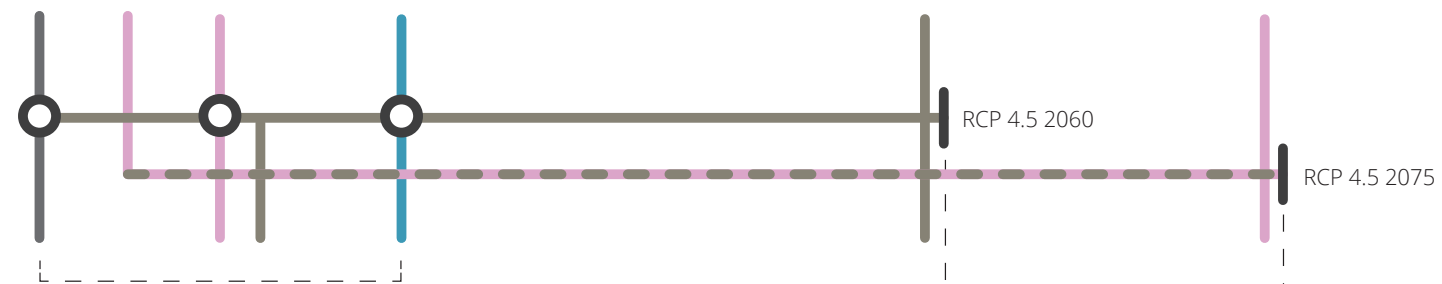
This action reaches a tipping point towards the end of the century in RCP 4.5 when action B is expected to reduce employment opportunities.

[D] Future-proof agriculture

This action aims at preparing the current agricultural system for the projected climate changes in the region.

Required sub-actions:

- [1.1] Indoor farming
- [3.2] Waste treatment and recycling plants
- [3.5] Crop rotation and drought-resistant crops
- [3.6] Harvesting and recycling of (rain)water
- [3.7] Salton Sea dust suppression



This action has some flexibility, as the coming decades give multiple opportunities to change to this action. However, the number of farms that are able (and willing) to invest in these changes will likely decrease over time the projected increased periods of drought cause crop failures and decreased income reserves for farmers.

This action reaches a tipping point just over mid-century in RCP 4.5 when it is expected that the number of farmer entrepreneurs has decreased as well as the availability of employees.

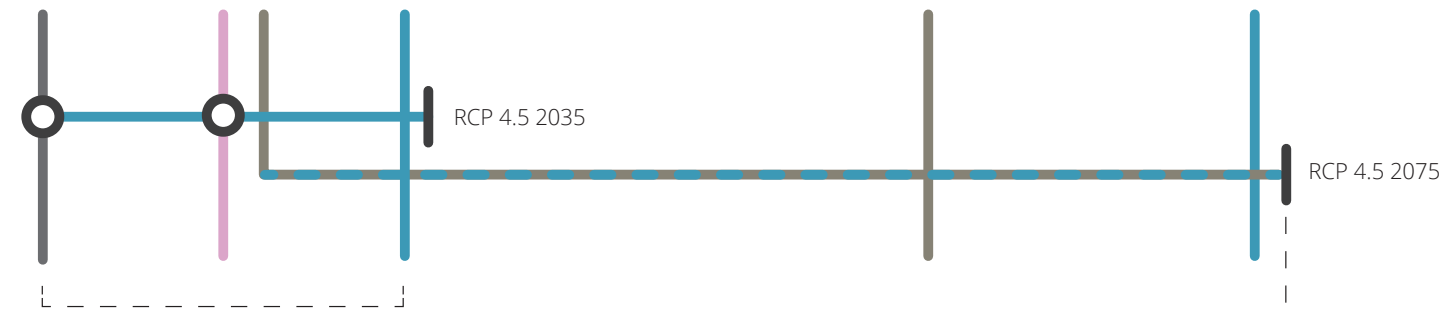
This action could possibly synergize to an extended tipping point with action C Migrant Integration Trajectory for employees and new entrepreneurs. However, the digitization of agriculture and the need for fewer employees might create a tipping point as the agricultural sector by this point is too small to relieve unemployment in the area.

[E] Integrate agriculture, urban life and education

This action aims to seek a synergy between agriculture and public health, whereby the agricultural sector starts to play a role in the life of the local community through education, participation and community service instead of solely operating for the international market.

Required sub-actions:

- [1.3] Local food production
- [1.5] Fund for regional public health demands
- [2.1] Adaptive housing policy
- [3.2] Waste treatment and recycling plants
- [3.4] Industrial zoning
- [3.6] Harvesting and recycling of (rain)water
- [3.7] Salton Sea dust suppression

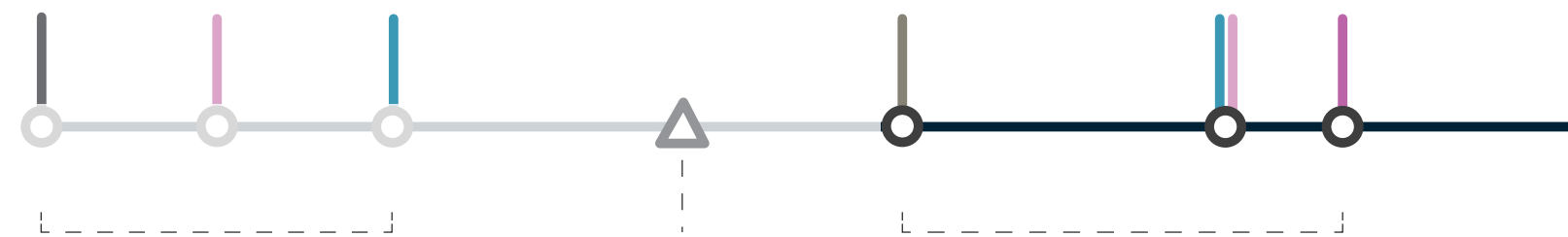


This action gives multiple opportunities to be integrated in the existing spatial layout. However, the current state of agriculture will relatively soon not meet future climate demands, and therefore has a quick tipping point.

This action could synergize to an extended tipping point when action is taken to future-proof the current agricultural system, hence with action D. However, similar to action D, by this point agriculture might be too small to relieve unemployment in the area and the added community service sector might not fill that gap.

[F] Energy economy

This action aims at transforming agricultural land-use to free space for geothermal- and solar energy plants. Energy is sold via currently existing network to Mexico and stored/used in the grid that covers the western USA.



As this action highly interferes with the existing spatial layout and stakeholder interests, a complete conversion to this action is unlikely in the first half of the century.

At this point, anticipated landuse change can be prepared or agricultural lands can partly be allowed to free space for energy production.

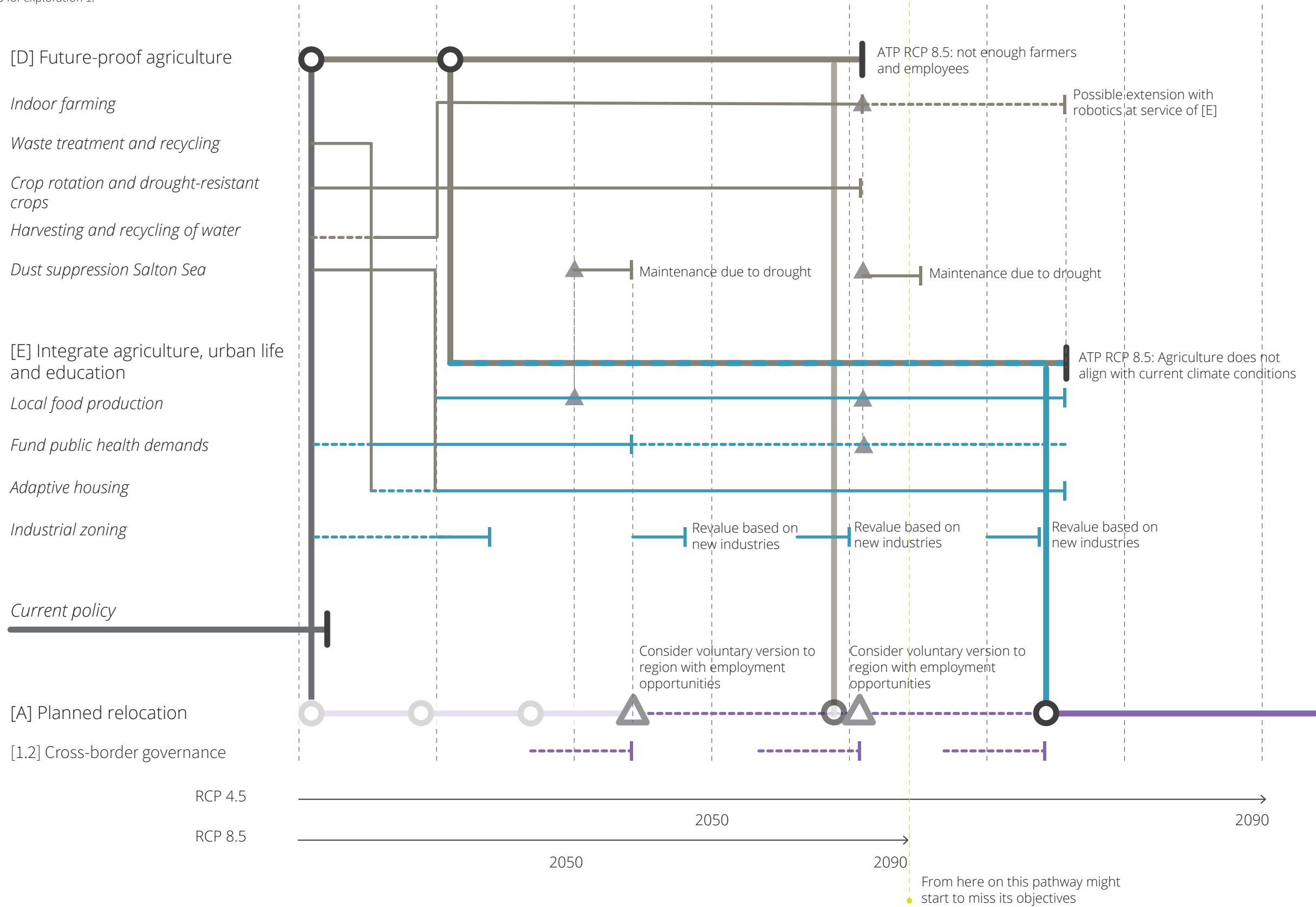
The action can be put to use, possibly creating opportunities for employment by attracting industries that benefit from a nearby energy source.

This action does not have an ATP, as turning to this action will always meet the set goal.



II. EXPLORATION 1: RESCALING AGRICULTURE

Figure 80. Pathway map for exploration 1.





This pathway sequences actions based on the premise of future-proofing the current agricultural practices. Looking for opportunities to encourage sustainable agriculture measures, this pathway first addresses pollution in order to create a healthy environment for growing food. This then forms the basis of integrating agriculture into urban life, rescaling agriculture to not only provide for the international market but also benefit the regional community, whilst simultaneously providing adaptive housing that suits an economy based on (partly seasonal) agriculture. In this pathway, climate-induced migration is not directly addressed, but increasing the possibilities of future-proofing employment and related housing

could be a stepping stone for migration policy.

First decade

The first decade is about mitigating pollution factors and establishing a cleaner system that allows for healthy agricultural produce as well as living- and working environment. The focus is on treating water pollution at the border and mitigating air pollution from the Salton Sea, looking at synergies for recycling waste products and anticipating water scarcity. Simultaneously working on industrial zoning policies that monitor and enforce environmental standards for the entire region based on the existing Border 2020 Program. With successful application of the

first pollution mitigation measures, action [E] can be initiated.

Mid-century

Towards mid-century in either RCP, the trajectory of the pathways are becoming increasingly uncertain. Especially climatological changes can trigger the performance of (sub-)actions, triggering water availability needed for agriculture, and heat influencing living conditions of workforce and more vulnerable residents. Mid-century sub-actions are concerned with maintenance of critical services (water, food production and shelter), enacting the public health fund for implementing measures that control

urban heat and educating the (younger) population on food production and water scarcity in urban-desert environments. At this point, action [A] Planned relocation might be considered for the future or in 'light' form in the present. Cross-border investigations need to take place to examine different receiving regions, their housing potentials and employment opportunities. Where can Imperial County pre-sort into planned relocation? What skills are necessary for living in the future receiving region? And how can the most vulnerable population receive compensation for moving earlier if they wish? The availability of sustainable agriculture knowledge might also spark an interest into different industries,. Whether industries fit

regional values can be revalued around mid-century in the zoning policy. Similarly, the housing stock and adaptive housing policy are up for revaluation due to end of life span, maintenance and changing climate conditions. By this time, building techniques and materials for cooling should be integrated and its increased use in the future anticipated. Changes in production levels and decreased income due to changing part of the system from international market to regional market, will also be a point of attention here. Some farmers may be offered subsidy if they can integrate their business with regional rescaling or indoor farming to create more support for action [E] to progress.

End of century

Although spatial explorations for the end of century could be made in order to anticipate what sub-actions would need to be taken, it is more important to consider the governance parameters that are most fit to deal with this deep uncertainty. In Figure 80, the yellow line indicates that at this point the pathway may start to miss its objectives in terms of actions. However, governance by this point should be able to defend critical ecosystem services (food provision, drinking water, energy production and shelter) as slow-onset impacts might turn into crises under inaction. Pre-sorting cross-border governance for planned

relocation is therefore urgent if critical services cannot be defended in this region. If climate change progresses along RCP 8.5, possibly actions in this pathway map do not suffice. Under this RCP, more measures need to be taken to deal with heat, water scarcity and employment, and phased relocation needs to be considered earlier on in the pathway.

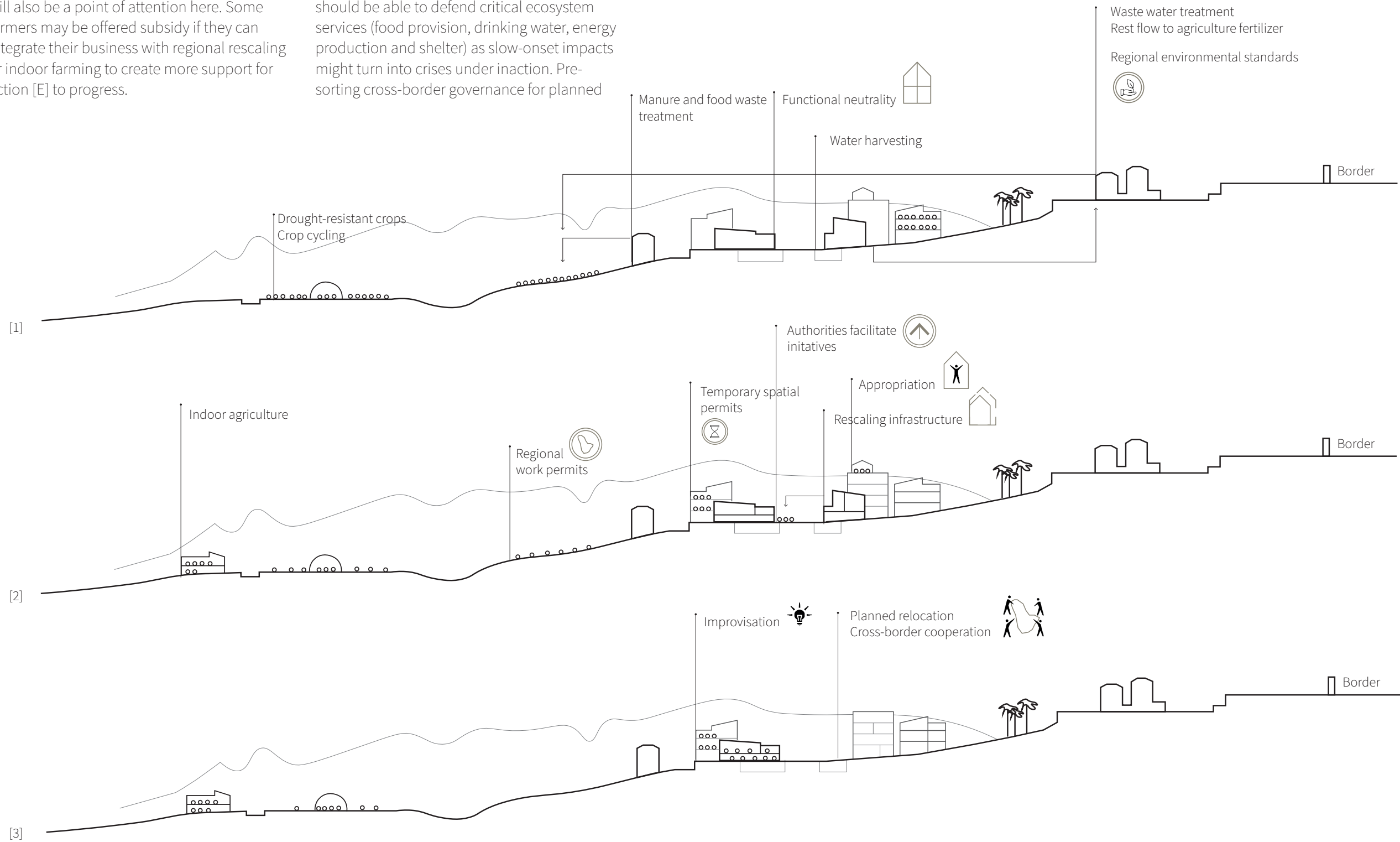
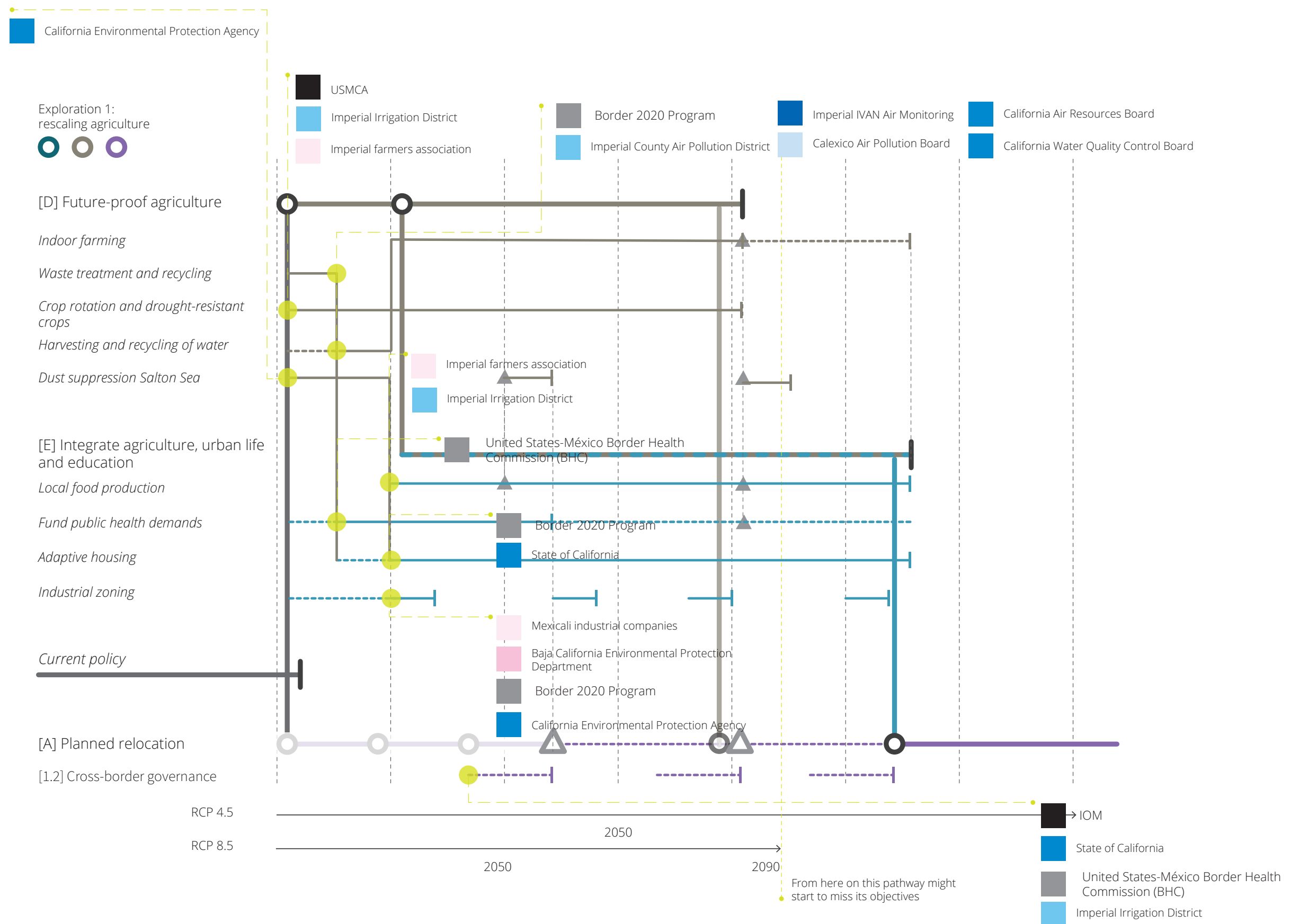


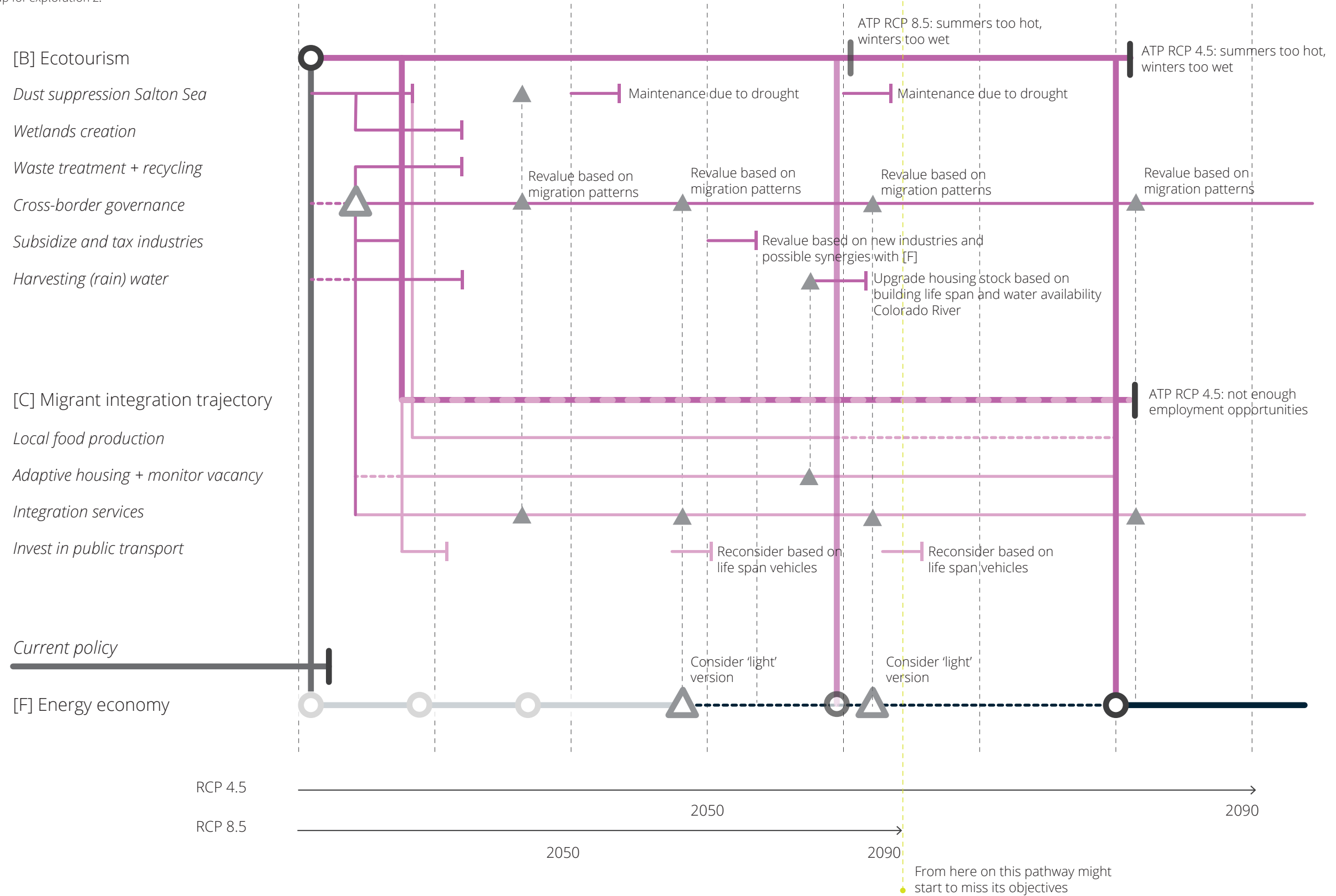
Figure 81. Stakeholder engagement.





III. EXPLORATION 2: A CROSS-BORDER FUTURE

Figure 82. Pathway map for exploration 2.



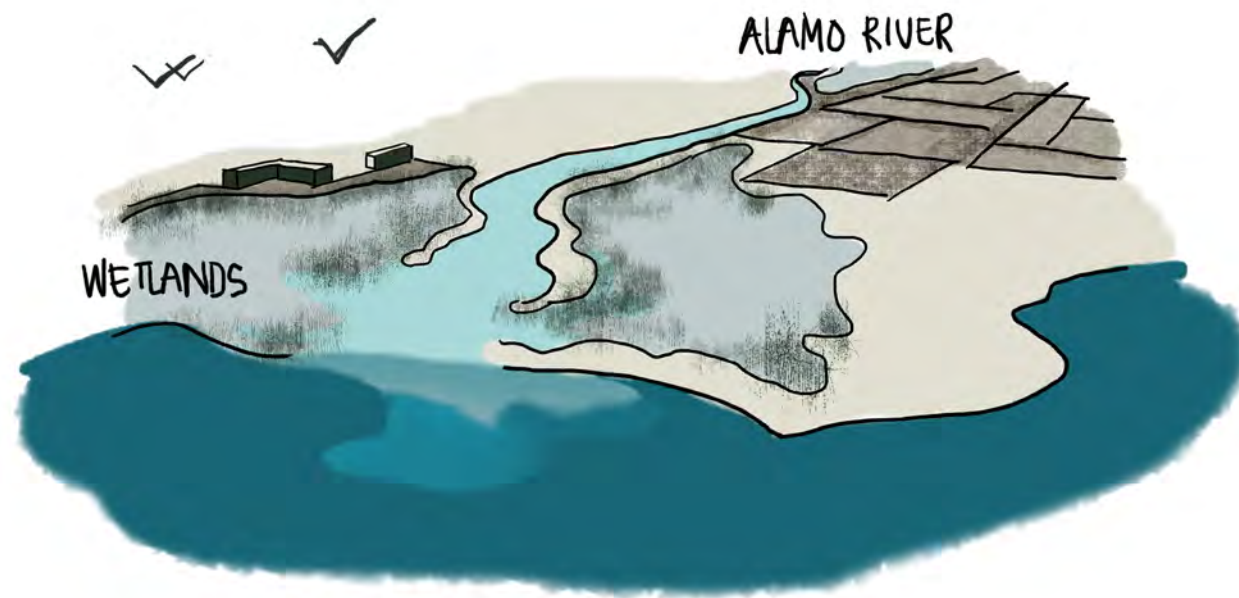


Figure 83. A series of wetlands provide space for growth of ecotourism economy, mitigation of water pollution and increased wildlife habitat.

This pathway sequences actions based on the premise of successful cross-border governance. Based on bi-national agreements, this pathway first addresses minimal pollution measures in order to stimulate an ecotourism sector in the border region. These then form the basis of establishing a migrant integration trajectory, that taps into the theory of the entrepreneurial migrant to contribute to the regional economy, whilst simultaneously providing adaptive housing and humanitarian support. In this pathway, international agriculture is not necessarily stimulated, but a cross-over between agricultural knowledge and current spatial use of land is found in dedicating a portion of this to food production for local and regional use.

First decade

The first decade is about mitigating pollution factors and establishing a cleaner system that allows for ecotourism to thrive and a healthy

living- and working environment. The focus is on air and water, looking at synergies for recycling waste products and anticipating water scarcity. Simultaneously working on a cross-border agreement that includes waste treatment, monitoring and enforcement of environmental standards, and migrant integration and housing. This cross-border agreement is a lasting sub-action that needs constant monitoring of the circumstances and requires a lot of investment from local-, state- and national governments. With successful application of the first pollution mitigation measures and early cross-border agreements, action C Migrant Integration Trajectory can be initiated.

Mid-century

Towards mid-century in either RCP, the trajectory of the pathways are becoming increasingly uncertain. Especially (international) political directional changes

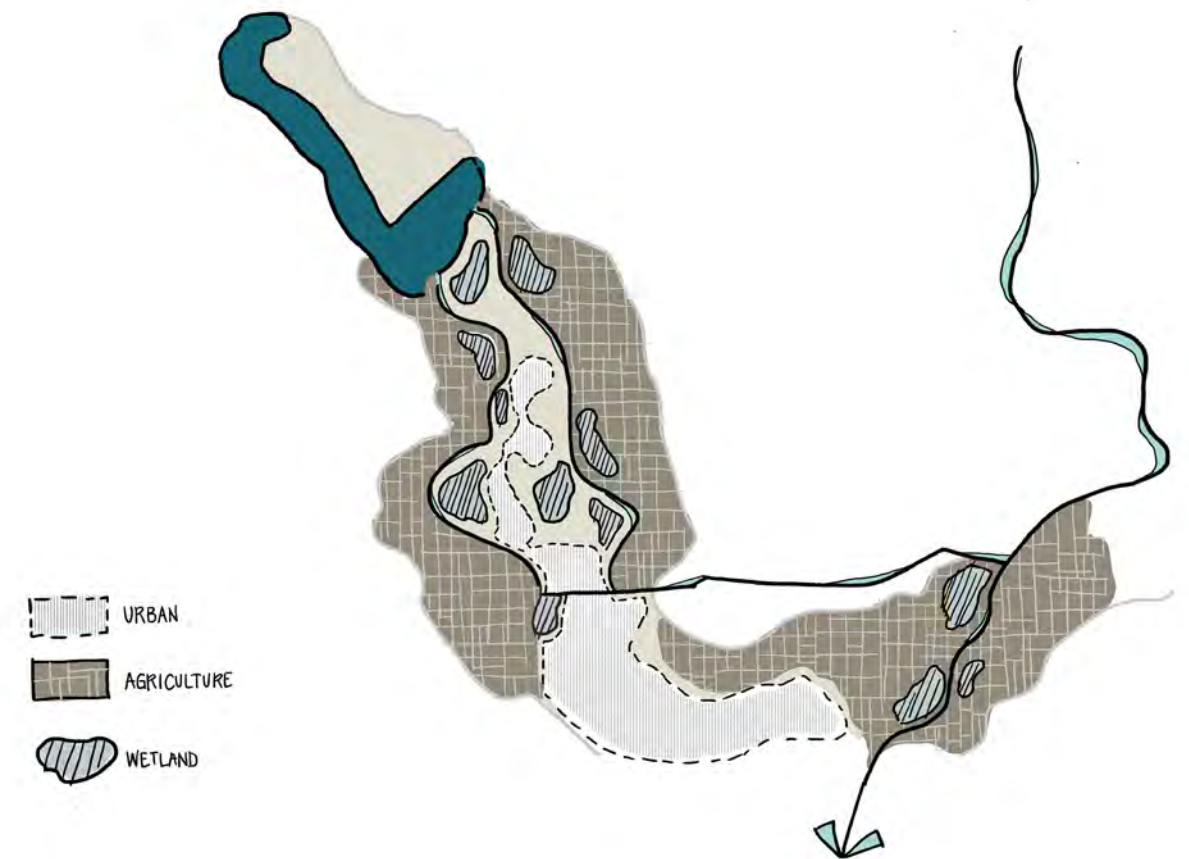


Figure 84. Dust suppression measures in the Salton Sea (that dam wildlife habitat) are followed by wetland construction and further pollution measures that enable ecotourism and a safe living environment.

can trigger the performance of (sub-)actions. Also, ecotourism depends on workable climate conditions and water availability for water-related activities. Mid-century sub-actions are concerned with working with changing migration flows, integration into the local economy and supporting sustainable livelihoods and public health. To this end, flexibility in governance is needed to quickly adapt to changing situations. Previously discussed instruments for 'Compress and Expand' in Figure 73 should have been integrated into local- and regional governance at this point. Depending on how climate conditions progress, this could also be the moment to pre-sort into action [F] Energy economy. Possibly a light version, where some agricultural land is offered for transformation into solar fields for example. The availability of sustainable energy might also spark an interest into different industries, like chemical industries, machinery production or data centers. Whether industries fit regional values

can be revalued around mid-century. Similarly, the housing stock and adaptive housing policy are up for revaluation due to end of life span, maintenance and changing climate conditions. By this time, building techniques and materials for cooling should be integrated and its increased use in the future anticipated.

End of century

Although spatial explorations for the end of century could be made in order to anticipate what sub-actions would need to be taken, it is more important to consider the governance parameters that are most fit to deal with this deep uncertainty. In Figure 82, the yellow line indicates that at this point the pathway may start to miss its objectives in terms of actions. However, governance by this point should be able to defend critical ecosystem services (food provision, drinking water, energy production and shelter) as slow-onset impacts might turn into crises under inaction.

Cooperation in governance is therefore critical to address the right scales, as well as maintenance and monitoring of ecologically restorative work done. If climate change progresses along RCP 8.5, possibly actions in this pathway map do not suffice. Under this RCP, more measures need to be taken to deal with heat in the ecotourism sector. If [F] Energy economy is to be a robust action, it needs to consider providing employment in industries that benefit from being close to sustainable energy sources. Surplus energy is put into the grid that connects the Western USA and Mexico (in case of energy production emergencies in other states). These industries need to be considered on their water use, in order for the apportioned water to meet demands with the forecasts of growing population in San Diego and nearby cities in Mexico.

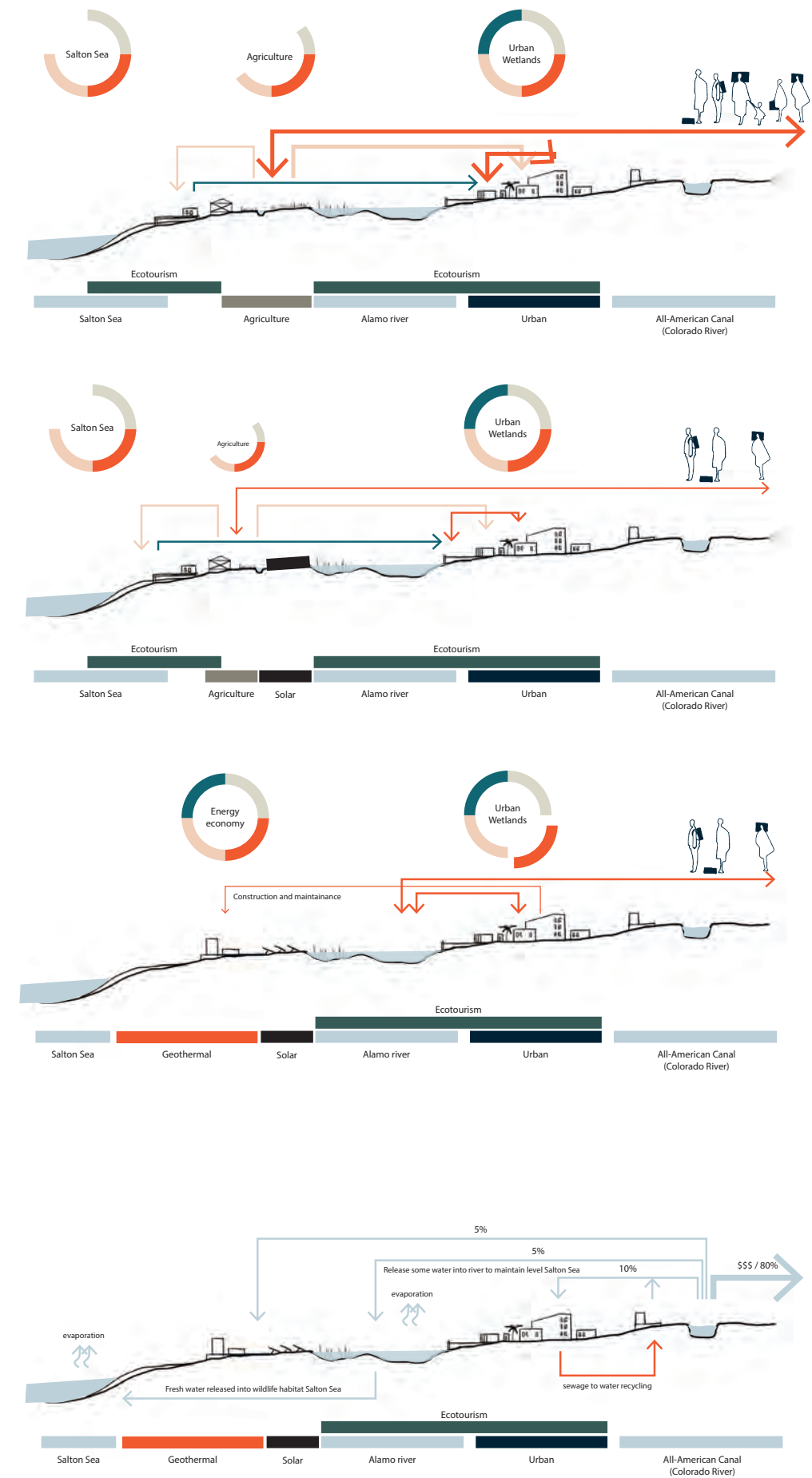
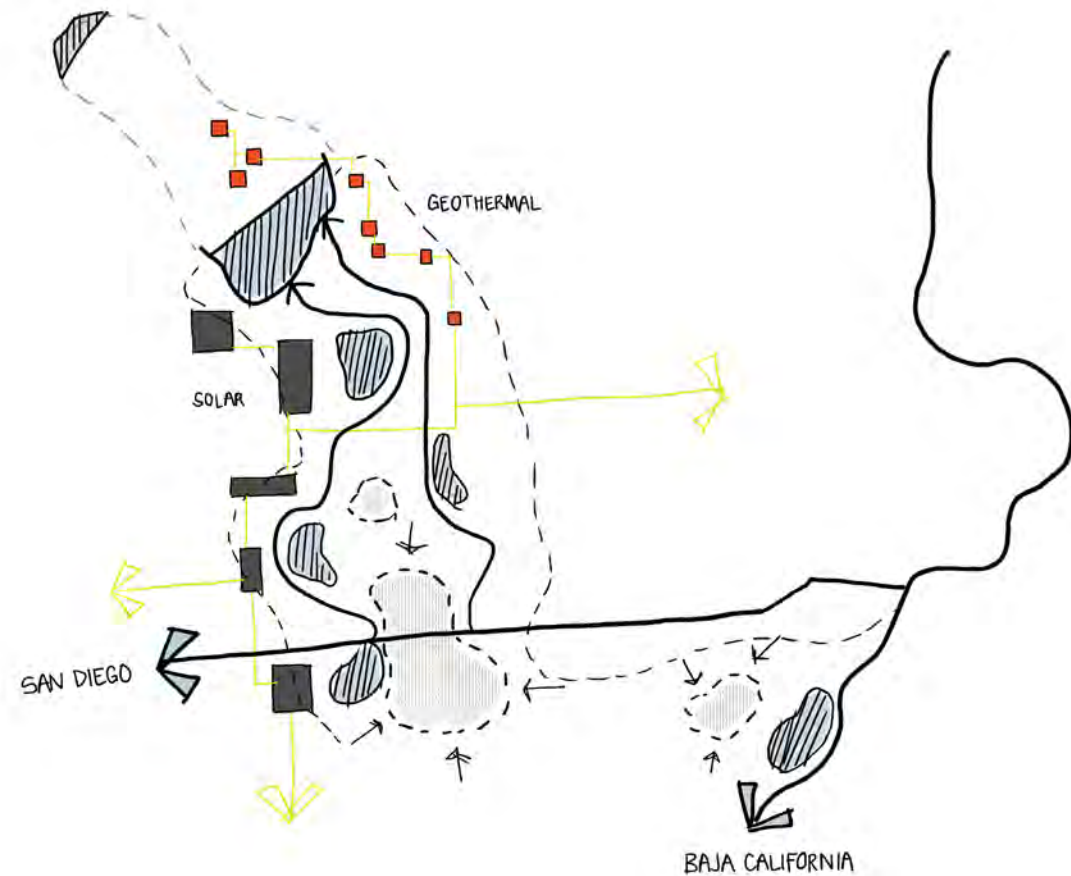
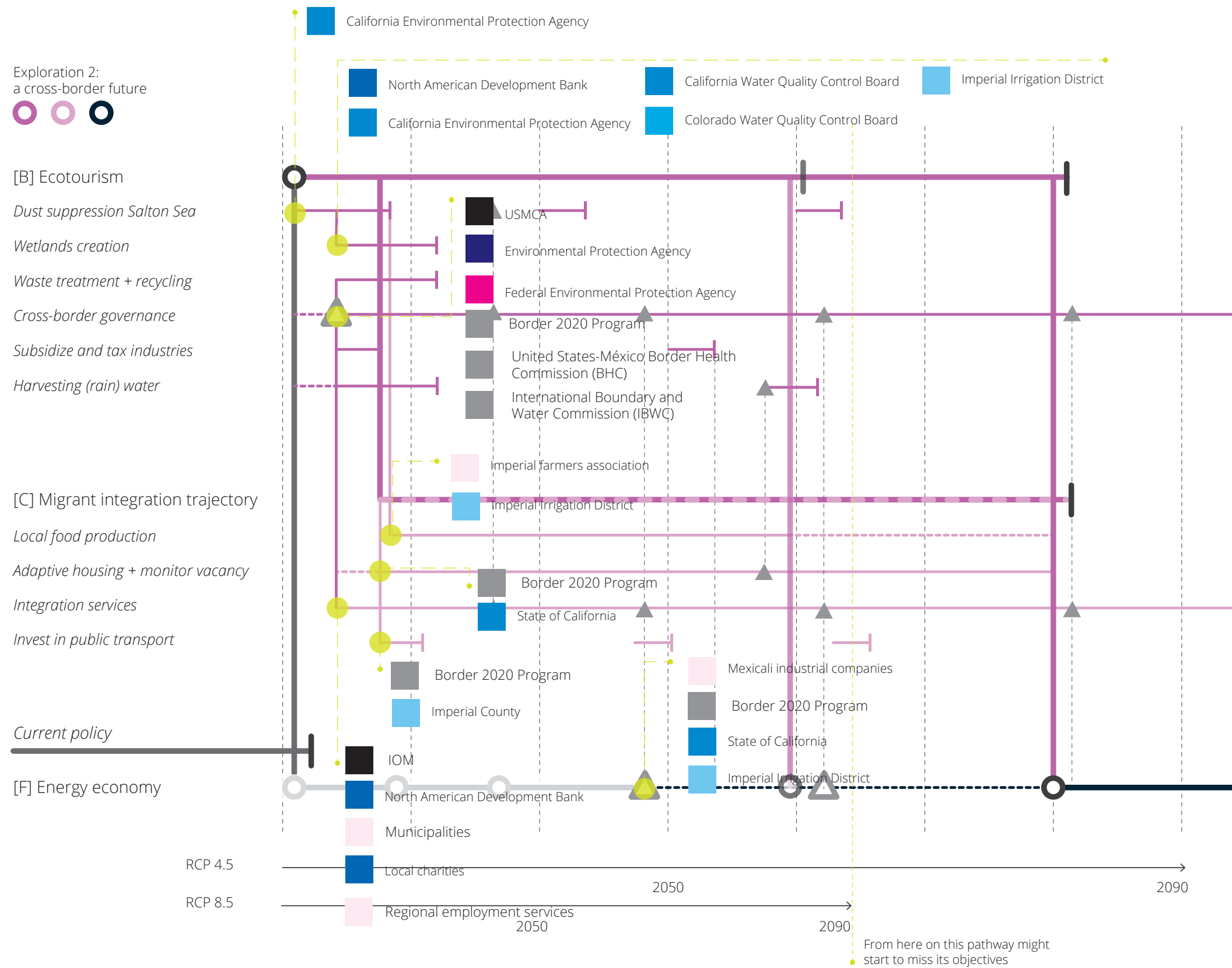


Figure 85. Exploring pportunities for a sustainable energy economy.

Figure 86. Stakeholder engagement.





10

EVALUATION

This final chapter will present a discussion of the results, as well as conclusions to and reflections on the project.

I. DISCUSSION OF THE RESULTS

Reflecting on the chosen approach for addressing climate-induced migration

Climate-induced migration is essentially a subject of dual political interest, both migratory and environmental. But, as this thesis has shown, it also touches upon a number of other fields, making action towards mitigating or adapting to climate-induced migration very comprehensive and complex.

In order to recognize and plan for climate-induced migration, two issues have proven to require recognition throughout this narrative. First, for addressing migration international

governance is extremely important. However, nation states wish to advance their national interests, making international negotiation frameworks very difficult. States favour non-binding practices, such as the IOM's International Dialogue on Migration, the Berne Initiative (a consultative process with the goal of obtaining better management of migration at the national, regional and global level through enhanced cooperation between states), or the Nansen initiative (consultative process intended to build consensus on the development of a protection agenda addressing the needs of people displaced across international borders in the context of disasters and the effects of climate change) whose non-binding agenda was adopted by 109 states in 2015. Second, the variety in types of migration causes migrants not to fit under one single legal framework but rather fall

Figure 87. The border separating San Diego from Tijuana. Although many undocumented immigrants can actually cross over the border, the terrain often funnels people through certain areas. Source: CNN, 2018.

within different jurisdictions. Climate-induced migrants are protected by human rights law, but when these rights are not applied or respected, this creates new vulnerabilities.

Then in order to address climate-induced migration under slow-onset climate change, flexible approaches can be used as this thesis attempted to demonstrate. Spatial and governmental instruments that support changing conditions and flexibility were used in this thesis, but we can likewise think about soft laws that are created under (in this case) cross-border agreements. Regional processes can be brought to the forefront, and by looking for cooperation that is mutually beneficial they could contribute to the establishment of a global migration architecture.

Applicability of DAPP method in multi-thematic spatial planning

As mentioned, Dynamic Adaptive Policy Pathways (DAPP) is a method designed by water engineers, initially for application in the Dutch Delta Program. The method incorporates the ideas of (1) anticipating ways in which a plan might fail and design actions to guard against such failures, (2) preparing for actions that might be triggered later, and (3) implementing a monitoring system to identify when actions should be triggered (Haasnoot et al, 2019).

In the case of this project, the method was used to explore how to integrate preparedness for slow-onset impacts under conditions of uncertainty. Using the method's steps of identifying vulnerabilities and potentials were useful to get a grasp of what the actions would need to address. This however, created a multi-thematic framework that then needed to be captured into a pathway.

Goals, actions and values

As setting a mono-thematic quantifiable goal was challenging in this context, the project attempted to adhere to the method by formulating the goal of the pathway in such

a way that it would be clear when an action would not meet the demands of the goal. It attempted to create an interdisciplinary goal by adding objectives. The disadvantage of this is that it does not provide any guidance with respect to content. "Waste treatment component" does not say anything about the nature of that treatment, when it would be successful or what waste flows need to be addressed. Similarly, a value-oriented goal like "pollution-free system" or "clean system" would be freely interpretable by stakeholders. As an urban planner, much regarding vision-setting or action-setting is based on values of what the world can look like, what should be prioritized and how benefits and negative externalities weigh out. Using this method as a professional with embedded values that cannot be captured by quantifiable goals proved difficult. A water engineer might think about the objective of security from rising water, but an urbanist might also consider who receives that security and who doesn't in that plan, what negative externalities water security might transpose on wildlife habitat and interfering in ecosystems, and what the cascading effects on our spatial environment could be and if these are beneficial for its users. DAPP proved too simplistic to capture these considerations in a scheme.

Therefore, the project decided to work with embedded/implicit values in the goal it set and the actions it laid out. Instead, it merged the idea of (1) anticipation (or preparedness in this thesis) and (2) triggering actions (or cascading actions across scale in this thesis) by creating one major pathway on regional strategy level, and creating exploration pathways to show the interaction between sub actions on different scales. The sub actions reflected different lines of thought and different disciplines and sectors, but are by no means exhaustive. They were drawn from literature and journalistic documents, and not tested to explore their progress. This is what gave the exploration pathways their name. A series of explorations as scenario testing might be used to better understand the interaction between sub actions. Another aspect of DAPP that was lost in this process is 'keeping options open for as long as possible.'

In order to have maximum flexibility to choose between the available actions, DAPP attempts to choose short-term and mid-term actions that postpone shutting off other options for as long as possible so as to not immediately become path-dependent. In this project, path-dependency is more present due to the 'regional strategy' approach. Ecotourism excludes focus on agriculture, and although lighter versions of sustainable agriculture might be incorporated, this is not clear from the way the pathway is drawn up. Similarly, the explorative pathways are drawn up to show dependencies between actions, not all possible variants in which actions can be related in time as the adaptation tipping points were too uncertain to draw up.

Uncertainty

The DAPP method was designed to work in a context of deep uncertainty by being flexible in action-taking and switching. Although the application of flexible action-taking is somewhat present in this project, the interdisciplinary nature the pathway map tries to address defies any uncertainty-reduction rules that were embedded in the original DAPP application. Instead of formulating actions that reduce uncertainty and clearly answer to the demands of the goal, the goal in this project was too complex to formulate actions that reduce uncertainty. At best, this project's pathway map openly acknowledges uncertainty as do the visualizations, and stresses the instruments and spatial actions needed at certain points in the pathway map to cope with uncertainty.

Engaging stakeholders

According to Haasnoot et al. (2019), the visualization of the pathways is seen as attractive by policymakers. This way of visualizing works best if the objectives can be summarized in a single main objective, such as 'fresh water supply for different sectors' or 'safety against flooding', according to the authors. In this project, the objective is not compartmentalized and the cooperation and

contribution of stakeholders is necessary over a long period of time. Categorizing stakeholders by perspective showed that very few organizations potentially incorporate this long-term interest. Also, making indications of stakeholder engagement for the exploration pathways shows that for environmental planning alone one deals with many different stakeholders over a long time. These conditions are challenging: attempting to align the values and interests of stakeholders along pathway actions is a disadvantage of this planning method. A possible advantage is that visually showing interdependencies between actions might create goodwill and perspective for stakeholders that would not immediately benefit from an action taken.

Possibilities for further research

This project adapted the DAPP method to suit an interdisciplinary and multi-thematic planning goal under conditions of uncertainty. Although the author was not knowledgeable enough to research actions and their Adaptation Tipping Points, the project did show that the complexity and uncertainty of the context (slow-onset impacts, possibly resulting in climate-induced migration) could benefit from an approach that shows interdependencies of actions taken, cascading effects and opportunities to change course of action under monitoring after implementation. Possibilities for further research could include using scenario planning and pilot study to further develop and investigate the range and interdependencies of actions and sub actions, using opportunity tipping points as signposts in the pathway map rather than ATPs in order to create pathways based on synergies, and researching how value-led planning might influence long-term planning approaches like DAPP under deep uncertainty.

II. CONCLUSION

This project set out to answer the following research question:

How can a scale- and temporal sensitive planning approach act towards preparedness in order to respond to the threat of climate-induced migration under conditions of climate change uncertainty in the California-Mexico border region?

Migration and climate change have not been directly linked in research, but the importance of changing environmental factors on the mobility patterns of population is evident. These changing environmental conditions can be roughly split into sudden-onset disasters and slow-onset impacts. The latter is hard to anticipate, as these impacts usually reveal themselves at a point of crisis. Nevertheless, research is showing that particularly critical ecosystem services that provide food security, water availability, shelter and energy production are focal points in anticipating slow-onset impacts. These changes are most likely to hit the most vulnerable populations first, and the longest, as they generally have less means to adapt. Importantly, sudden-onset impacts can have a multiplier effect that can slowly break down the resilience of both ecosystems and (vulnerable) populations and make it difficult to bounce back after sudden-onset disasters or slow-onset changes.

In the border region between Imperial County and Baja California, Mexico, this project analysed systemic vulnerabilities. They resulted in a picture of a future that may see water scarcity, failed crop yields due to droughts. This would spike economic losses for the region, as well as an increase in unemployment. The monothematic economic market in Imperial County currently has no wide choice of other sectors to provide income generation for its population. The resulting poverty and degradation, and the lack of (government) investment to provide better services, does not give a solid base for resilience. Nor does the state of ecosystem

services, that for too long have been at the service of international market play. Pollution is another unjust process that has resulted in an urgent cross-border problem, both for ecosystem resilience and public health. Lastly, the number of migrants that try to cross the border from Mexico into the United States has been rising over the years, as uninhabitable situations in Central America due to conflict, gender-based violence or ecosystem degradation have increased. This region may expect a rising number of migrants at the border in the coming decades as well as migratory movements from populations in nearby counties. The San Diego population is at risk of displacement due to sea-level rise. Arizona agriculture of desertification. Naturally, the way this might play out is deeply uncertain, however it is clear that the current system in the border region is unable to provide a liveable environment and preparedness towards slow-onset future changes.

The project then adopted the Dynamic Adaptive Policy Pathways approach to work with the variability and uncertainty of the context. Using the defined vulnerabilities and spatial opportunities, a planning framework was established that recognizes value-led development, variability and restoring ecosystem services. Under these pillars, several short-term to long-term actions were formulated that could respond to the analyzed vulnerabilities as well as a set of instruments that could work towards preparedness in an uncertain future. These actions were then sequenced into pathways that work on a regional level to provide adaptive strategies. To show their impact on a smaller scale, sub actions were formulated under each strategy and played on a second pathway map, the explorative pathway, for two strategies. Although the DAPP planning approach needed adaptations to be explored for a multi-thematic context, and could not be tested sufficiently due to the complexity of determining Adaptation Tipping Points and application for a non-objective profession where values are important in exploring and decision-making, conclusions can be made pertaining to the main research question.

In order for a scale- and temporal sensitive planning approach to act towards preparedness in a context of uncertainty, it needs to:

- understand the interdependencies and cascading effects between different actions and their context on different scales;
- it needs to anticipate future change by incorporating instruments that allow for flexibility, both in spatial planning, governance, and legal and financial sectors, in order to be able to change course of action when needed;
- it needs to have an understanding and focus on how to maintain the provision of critical services: food provision, water availability, energy production and shelter, including a monitoring practice for related systems;
- it needs to be able to rescale depending on what is addressed, meaning that cross-border, temporary or flexible forms of governance are needed to address the challenges of the future beyond currently defined borders or nation-states. As an hypothesis, value-led approaches might be beneficial in these hybrid forms of governance, to transcend national or state interests. To this extent, the role of public information, representation and framing of migration and migrants, as well as the role of gender in migration are important to address.

III. REFLECTIONS

Societal relevance

This research project set out with an explorative intention, namely to imagine a future in which climate change (temporarily) poses such unbearable or disruptive conditions that migration (permanent or temporary) is necessary. This future is already reality in parts of the world. Small islands in the Pacific, like Kiribati, are dealing with planned resettlement in the face of a 'drowning' future. Or Haiti or Bangladesh, where rural-urban or urban-urban migration patterns are common in dealing with environmental challenges. This thesis chose to focus on an area where climate migration

practices are not (yet) established patterns, and explores the opportunities for mitigating potentially forced migration, as well as adapting to a lifestyle where migration can be a humane choice and voluntary lifestyle.

Analysing the slow-onset climate change conditions and their potential effects on migration, the question arose who the beneficiaries are. This thesis draws on migration literature which discusses that climate migration is overwhelmingly regional, and that the most vulnerable populations are in danger of being trapped in place by the nature of their situation and their limited financial means (see Chapter 2). Therefore, this project firstly tailored the case studies to (a discussed definition of) vulnerable populations in the chosen spatial context (see Chapter 5), and then looked at regional synergies for development that incorporate climate-induced migration. In looking for synergies, migrants with multiple socio-economic backgrounds were considered, as climate change will not only hit the most vulnerable even if they are hit the hardest. In choosing to partly divert away from a focus on vulnerable populations, the spatial proposals in this thesis gear towards how a place (and a system of places) can accommodate for whoever lives and works there, with a special focus on the temporal nature of their residency (temporary, seasonal or permanent).

Furthermore, this thesis set out to explore how planning for slow-onset climate change could be proactive rather than reactive disaster planning. The Californian State is already the most ambitious of the United States in planning for climate change and the energy transition. However, the climate change agenda is mainly part of Environmental Departments of different administrative boundaries. The focus on vulnerability as a proxy for climate-induced migration gives a different spatial focus, wherein environmental engineering solutions are still of high importance, but could be made more effective given the right synergies with systems that influence the most vulnerable populations.

Lastly, the idea of climate change rendering

parts of the USA uninhabitable, possibly displacing populations, is perhaps an unsettling and uneasy thought that is currently not considered in long-term planning. This thesis aimed to address that narrative, recognizing the severity of the situation, designating displacement as a possibility and suggesting transitioning strategies that mitigate and adapt to the displacement-scenario in order to mitigate its potentially painful side.

Ethical dilemmas

During the research, several agents have come to stand out: the sending area and receiving area, the (potential) migrant, and the planner. With regard to these agents, I will present some ethical dilemmas encountered in this research.

The literature review stressed the importance of the interaction between sending and receiving areas. It was mentioned that most research focuses on addressing vulnerabilities and exposure to environmental stress in the sending area, however, the receiving area is crucial to the success of an adaptation strategy that involves migration. However, an adaptation strategy is not an end station. If a strategy manages to successfully incorporate migration that is beneficial to human development, then those staying behind in the sending area might be negatively impacted in the form of rising property costs, a decrease in availability and quality of commercial and social services. It is necessary to consider the functions and exposure of the sending area and include residents in risks, future scenarios for their neighbourhood and adequate planning and policy responses.

With regards to the receiving areas, this thesis has focussed on the (temporary) migrant as an asset to their new environment. Although this stance might increase the readiness to integrate migrants into local life, it also reduces the migrant to a functional unit whereby “functional” is assessed by the receiving area. This potentially leads to integration problems, a one-sided view of the

migrant and a reduction of their development potential. Migrants have families, trauma’s and aspirations of their own. Can this be accommodated by the receiving region without assessing them simply on their functionality within a planning framework?

This project creates potential for labour migrants with different socio-economic backgrounds, following the idea that migrants can strengthen their resilience to environmental stress by diversifying their income generation. However, the current state of labour migrants in the USA is very problematic, and dependent on political climate and local perception. Although labour migrants from Mexico are deemed valuable to Californian agriculture, a legal status is hard to obtain. Labour migrants therefore choose to function under the radar in fear of eviction, but this also means they do not receive basic social services such as health care, and their rights are not properly looked after in absence of legal status. The rights-based framework to migration and the perception of migrants is not included in this thesis, although it is incredibly important to its functioning. The same counts for gender issues in migration. Gender shapes the causes and consequences of migration and its experience, but addressing how gender influences migration was outside the scope of this thesis.

Finally, with regards to the planner, it must be noted that an adaptation strategy is not the end station. This strategy, as with any adaptation strategy, creates winners and losers of its own depending on the choices made, the solutions considered and the collective and individual governance responses. Although this project aimed to be sensitive to impacts across scale and time, each narrative creates negative impacts of which a few have been described above. In the end, the fact that California has assets to invest in proactive, pre-emptive strategies already creates winners and losers compared to neighbouring regions.

Possibilities to generalize the results

From studying relevant literature, the

emphasis on a context- and place-based specific approach could not be escaped. Both climate-induced migration as a topic and Dynamic Adaptive Policy Pathways (DAPP) as an approach rely on their context specificity. Their use is dependent on interaction with the relevant scales. However, there are a few scenarios in which the results of this thesis may be generalizable.

First, a set of vulnerabilities was identified in this location that involved water scarcity in relation to increasing drought and changing water supply from a major river system (Colorado River) that originates in a chain of mountains with a specific altitude range (Rocky Mountains). It might be possible to define other territories that fit under a similar umbrella archetype, in which case some actions may be transferable. Similarly in this way, it might be possible to look at different levels of severity for sea-level rise in an urban-coastal archetype or wildfire risk in an urban-forest archetype.

Second, the way in which identified actions are sequenced might be optimized with further research. It could be feasible that for some archetypes, there is a most appropriate sequence of actions that helps to limit risks.

Last, the results may be transferable on a regional scale within the Californian context, to the Central Valley that will see similar climate impacts and deals with high agriculture production. The planning- and governance context is very similar, although a new stakeholder analysis and an understanding of potential sending- and receiving areas would be important.



Figure 88. After 14 years of drought, Lake Powell, source of electricity and water for agriculture along the Colorado River, was at 42% of its capacity. Source: NASA Earth Observatory, 2014.



REFERENCES

Abramsky, S. (2019, June 13). Hard Times in the Imperial Valley. *Capital and Main*. <https://capitalandmain.com/hard-times-in-the-imperial-valley-0613>

Adams, H. (2012). Migration decision-making under environmental change: Place utility, mobility and ecosystem services in highland Peru. Thesis submitted for the degree of Doctor of Philosophy to the School of Environmental Sciences, University of East Anglia.

Adamo, S. B. (2008). Addressing environmentally induced population displacements: a delicate task (background paper). In *Population-Research Network Cyberseminar on Environmentally Induced Population Displacements*, 18–29 August 2008 (pp. 1–20).

Adger, N. Jouni Paavola, Saleemul Huq and M. J. Mace (eds) (2006). *Fairness in Adaptation to Climate Change*. MIT Press.

Adger, W. N. (2006). Vulnerability. *Global Environmental Change*, 16(3), 268–281. <https://doi.org/10.1016/j.gloenvcha.2006.02.006>

Adger, W. N., & Brown, K. (2009). Vulnerability and Resilience to Environmental Change: Ecological and Social Perspectives. In *A Companion to Environmental Geography* (pp. 109–122). <https://doi.org/10.1002/9781444305722.ch8>

Ahsan, R., Kellett, J., & Karuppanan, S. (2014). Climate Induced Migration. *The International Journal of Climate Change: Impacts and Responses*, 5(2), 1–15. <https://doi.org/10.18848/1835-7156/cgp/v05i02/37204>

Figure 89. Border cantos. Source: Richard Misrach, 2016.

- Barnett, J., Webber, M. (2010). Migration as Adaptation: Opportunities and Limits. In J. McAdam (Ed.), *Climate Change and Displacement: Multidisciplinary Perspectives* (pp. 37–55). Bloomsbury Publishing Plc. <https://doi.org/10.5040/9781472565211.ch-003>
- Blessing, L., & Chakrabarti, A. (2009). *DRM, a Design Research Methodology*. Springer.
- Bergevoet, T., Van Tuijl, M. (2016). *The Flexible City. Sustainable solutions for a Europe in transition*. Nai010.
- Brenner, N. (2011). The urban question and the scale question: Some conceptual clarifications. In N. Glick Schiller & A. Caglar (Eds.), *Locating Migration: Rescaling Cities and Migrants* (pp. 23–41). Ithaca: Cornell University Press. <https://doi.org/10.7591/9780801460340-003>
- Brenner, N. and Katsikis, N. (2020). *Operational Landscapes: Hinterlands of the Capitalocene*. In *Architectural Design*, volume 90 (1). <https://doi-org.tudelft.idm.oclc.org/10.1002/ad.2521>
- Burke, M., Emerick, K. (2016). Adaptation to climate change: Evidence from US agriculture. *American Economic Journal: Economic Policy* 2016, 8(3): 106–140. <http://dx.doi.org/10.1257/pol.20130025>
- California Natural Resource Agency, 2018. *Indicators of Climate Change in California. Report Summary*. Accessed January 2021 via: <https://oehha.ca.gov/media/downloads/climate-change/report/2018indicatorssummary.pdf>
- Camillo Boano, Roger Zetter, T. M. (2008). *Environmentally displaced people Understanding the linkages between environmental change, livelihoods and forced migration*. Refugee Studies Centre, (November), 44.
- Castles, S., De Haas, H., Miller, M. (2020). *The Age of Migration. International population movements in the modern world*. (Sixth edit). New York: Guildford Press.
- CCDS. (n.d.). *The Hands That Feed Us*. Catholic Charities Diocese of San Diego. Retrieved 5 April 2021, from <https://ccdsd.org/the-hands-that-feed-us/>
- CIRS. (n.d.). *Executive Summary and Recommendations—DocumentCloud*. Retrieved 5 April 2021, from <https://www.documentcloud.org/documents/4443696-Executive-Summary-and-Recommendations.html>
- City Data. (2021). *Imperial County, California detailed profile—Houses, real estate, cost of living, wages, work, agriculture, ancestries, and more*. https://www.city-data.com/county/Imperial_County-CA.html#
- Climate Action Tracker, 2020. *Warming Projections Global Update December 2020*. Accessed January 2021 via: https://climateactiontracker.org/documents/829/CAT_2020-12-01_Briefing_GlobalUpdate_Paris5Years_Dec2020.pdf
- Cohen, M. and Hyun, K. (2006). *Hazard: The Future of the Salton Sea*. Pacific Insitute. Accessed via <https://pacinst.org/wp-content/uploads/2014/04/hazard.pdf>
- Coren, M. J. (2019, April 4). *The Trump administration is streamlining visas for Mexican farm workers*. Quartz. <https://qz.com/1586797/trump-administration-streamlining-visas-for-mexican-farm-workers/>
- Coronado, G. (2017, May 25). *To keep crops from rotting in the field, farmers say they need Trump to let in more temporary workers*. *Www.Latimes.Com*. <http://www.latimes.com/projects/la-fi-farm-labor-guestworkers/>
- Davoudi, S., Brooks, E., & Mehmood, A. (2013). *Evolutionary Resilience and Strategies for Climate Adaptation. Planning Practice and Research*, 28(3), 307–322. <https://doi.org/10.1080/02697459.2013.787695>
- Deltares. (n.d.). *Dynamic Adaptive Policy Pathways: Supporting decision making under uncertainty using Adaptation Tipping Points and Adaptation Pathways in policy analysis*. Deltares. Retrieved 5 April 2021, from <https://deltares.productie.hoppinger.com/en/adaptive-pathways/>
- Desert Sun. (2018a, December 5). *Air pollution is taking a deadly toll on the U.S.-Mexico border*. <https://eu.desertsun.com/in-depth/news/environment/border-pollution/poisoned-cities/2018/12/05/air-pollution-taking-deadly-toll-u-s-mexico-border/1381585002/>
- Desert Sun. (2018b, December 5). *Mexicali, a city transformed by maquiladoras, faces pollution crisis*. <https://eu.desertsun.com/in-depth/news/environment/border-pollution/poisoned-cities/2018/12/05/mexicali-industrial-city-factories-maquiladoras-border-pollution/1295896002/>
- Desert Sun. (2018c, December 5). *This river is too toxic to touch, and people live right next to it*. <https://eu.desertsun.com/in-depth/news/environment/border-pollution/poisoned-cities/2018/12/05/toxic-new-river-long-neglect-mexico-border-calexico-mexicali/1381599002/>
- Desert Sun (2018d). *The polluted New River poses a hazard on U.S.-Mexico border*. (n.d.). Retrieved 5 April 2021, from <https://eu.desertsun.com/in-depth/news/environment/border-pollution/poisoned-cities/2018/12/05/toxic-new-river-long-neglect-mexico-border-calexico-mexicali/1381599002/>
- Esri (2019). *Population Migration from Each State in the US*. Accessed June 2020 via: <https://www.arcgis.com/home/item>.
- Fainstein, S. (2015). *Resilience and justice*. *International Journal of Urban and Regional Research*, 39(1), 157–167. <https://doi.org/10.1111/1468-2427.12186>
- Falco, C., Galeotti, M., Olper, A. (2019). *Climate change and migration: Is agriculture the main channel?* *Global Environmental Change* 59. <https://doi.org/10.1016/j.gloenvcha.2019.101995>
- Feng, S., Krueger, A., Oppenheimer, M. (2010). *Linkages among climate change, crop yields and Mexico-US border migration*. *PNAS*, 107 (32). www.pnas.org/lookup/suppl/doi:10.1073/pnas.1007978107/-/DCSupplemental
- Feng, S., Oppenheimer, M., Schenkler, W. (2015, Working paper). *Weather anomalies, crop yields and migration in the US Corn Belt*. Accessed May 2020 via: https://www.researchgate.net/publication/228268805_Climate_Change_Crop_Yields_and_Internal_Migration_in_the_United_States
- Forbes (2012). *American Migration [Interactive Map]*. Accessed May 2020 via: <https://www.forbes.com/special-report/2011/migration.html>
- Fung, V. (2019, July). *Displacement and housing affordability in the United States*. IDMC. <https://www.internal-displacement.org/expert-opinion/displacement-and-housing-affordability-in-the-united-states>
- Gill, N. (2010). *“Environmental refugees”: Key debates and the contributions of geographers*. *Geography Compass*, 4(7), 861–871. <https://doi.org/10.1111/j.1749-8198.2010.00336.x>
- Google Maps (2020).
- Haasnoot, M., Warren, A., & Kwakkel, J. H. (2019). *Dynamic Adaptive Policy Pathways (DAPP)*. In V. A. W. J. Marchau, W. E. Walker, P. J. T. M. Bloemen, & S. W. Popper (Eds.), *Decision Making under Deep Uncertainty: From Theory to Practice* (pp. 71–92). Springer International Publishing. https://doi.org/10.1007/978-3-030-05252-2_4
- Haeffner, M., Baggio, J., Galvin, K. (2018). *Investigating environmental migration and other rural drought adaptation strategies in Baja California Sur, Mexico*. *Regional Environmental Change* (2018) 18:1495–1507. <https://doi.org/10.1007/s10113-018-1281-2>
- Heathcote, R. L. (2013). *Drought in World Literature, Art, Philosophy and Community*. In *Drought and the Human Story: Braving the Bull of Heaven* (p. 318). Routledge.
- Hugo, G. (2010). *Climate Change-Induced*

Mobility and the Existing Migration Regime in Asia and the Pacific. In J. McAdam (Ed.), *Climate Change and Displacement: Multidisciplinary Perspectives* (pp. 9–36). Bloomsbury Publishing Plc. <https://doi.org/10.5040/9781472565211.ch-002>

IDMC (2018). No matter of choice: Displacement in a changing climate. (n.d.). Retrieved 5 April 2021, from <https://www.internal-displacement.org/sites/default/files/publications/documents/20181213-slow-onset-intro.pdf>

IDMC. (n.d.). United States. IDMC. Retrieved 5 April 2021, from <https://www.internal-displacement.org/countries/united-states>

IID. (n.d.). Water Transportation System | Imperial Irrigation District. Retrieved 5 April 2021, from <https://www.iid.com/water/water-transportation-system>

Imperial_County_Crop_and_Livestock_Report.pdf. (n.d.). Retrieved 5 April 2021, from https://agcom.imperialcounty.org/wp-content/uploads/2020/02/2018_Imperial_County_Crop_and_Livestock_Report.pdf

IOM. (2019). International Migration Law N° 34: Glossary on Migration. Retrieved from https://publications.iom.int/system/files/pdf/iml_34_glossary.pdf

Ionesco, D., Mokhnacheva, D., & Gemenne, F. (2017). *Atlas of Environmental Migration* (1st editio). Routledge, Earthscan, IOM.

Jessoe, K., Manning, D.T., Taylor, E.J. (2016). Climate change and labour allocation in rural Mexico: evidence from annual fluctuations in weather. *The Economic Journal*, 128 (February), 230–261. Doi: 10.1111/eoj.12448

Kocher, S.D.; Butsic, V. (2017). Governance of Land Use Planning to Reduce Fire Risk to Homes Mediterranean France and California. *Land* 6, 24.

LA Times. (2017a, April 24). Wake up, cross the border, go to school: For some Mexican students, it's a daily routine. Los Angeles

Times. <https://www.latimes.com/local/california/la-me-ln-calexico-border-school-20170321-htmlstory.html>

LA Times. (2017b, July 2). Desired for their labor, rejected as neighbors. Farmworkers in California face hostile communities—Los Angeles Times. <https://www.latimes.com/projects/la-fi-farmworker-housing/>

LA Times. (2020, January 22). California to build first geothermal power plants in a decade—Los Angeles Times. <https://www.latimes.com/environment/story/2020-01-22/california-needs-clean-energy-after-sundown-geothermal-could-be-the-answer>

Lele S, Springate-Baginski O, Lakerveld R, Deb D, Dash P. (2013). Ecosystem Services: Origins, Contributions, Pitfalls, and Alternatives. *Conservat Soc* 2013;11: 343-358.

Maesham, T. and Lockie, S. (eds) (2012). *Risk and Social Theory in Environmental Management*. CSIRO Publishing.

Mann, Michael, Peter Berck, Max A. Moritz, Enric Batllori, James G. Baldwin, Conor K. Gately, D. Richard Cameron (2014). Modeling residential development in California from 2000 to 2050: Integrating wildfire risk, wildland and agricultural encroachment. *Land Use Policy* (41), pages 438-452. <https://doi.org/10.1016/j.landusepol.2014.06.020>.

Manzo, K. (2010). Imaging vulnerability: the iconography of climate change. *The Royal Geographical Society*, 42(1), 49–64. <https://doi.org/10.1111/j.l>

Marchau V.A.W.J., Walker W.E., Bloemen P.J.T.M., Popper S.W. (2019) Introduction. In: Marchau V., Walker W., Bloemen P., Popper S. (eds) *Decision Making under Deep Uncertainty*. Springer, Cham. https://doi-org.tudelft.idm.oclc.org/10.1007/978-3-030-05252-2_1

Martín, C. (2019, October 22). Who Are America's "Climate Migrants," and Where Will They Go? *Urban Institute*. <https://www.urban.org/urban-wire/who-are-americas-climate-migrants-and-where-will-they-go>

Melde, S., Laczko, F. and Gemenne, F. (eds) (2017). Making mobility work for adaptation to environmental changes. Results from the MECLEP global research. IOM. Accessed via: https://publications.iom.int/system/files/pdf/meclep_comparative_report.pdf#page=17 Merrifield, A. (2013). "The Urban Question under Planetary Urbanization" *International Journal of Urban and Regional Research*; Volume 37.3 May 2013 909–22.

Michaels, S. (2018, April 21). Farmworkers are living 20 to a house in California's 'salad bowl'. *Mother Jones*. <https://www.motherjones.com/food/2018/04/farmworkers-are-living-20-to-a-house-in-californias-bountiful-salinas-valley/>

Millennium Ecosystem Assessment (2005). *Ecosystems and Human Well-being: Synthesis*. Washington D.C.: Island Press.

Myers, N. (1997). Environmental refugees. *Population and Environment*, 19(2), 167–182. <https://doi.org/10.4337/9781785360497.00019>

NASA (2016). Drought Continues to Grip Southern California. Accessed May 2020 via: <https://landsat.visibleearth.nasa.gov/view.php?id=89110>

PEW (2017). States Struggle to Provide Housing for Migrant Farmworkers. (2017, May 2). <http://pew.org/1SPAF6R>

Piguet, E. (2010). Climate Change and Migration: A Synthesis. In T. Afifi & J. Jäger (Eds.), *Environment, Forced Migration and Social Vulnerability* (pp. 73–85). Springer.

Public Health Institute. (2017, June 10). Toxic dust and asthma plague Salton Sea communities. Public Health Institute. <https://www.phi.org/press/toxic-dust-and-asthma-plague-salton-sea-communities/>

Rescue. (2021, March 24). What is happening at the U.S. southern border? | International Rescue Committee (IRC). International Rescue Committee (IRC). <https://www.rescue.org/article/what-happening-us-southern-border>

RIVM (2016). ReCiPe. 2016-0104.pdf. Retrieved 5 April 2021, from <https://www.rivm.nl/bibliotheek/rapporten/2016-0104.pdf>

Sayre, N. F. (2009). Scale. In N. Castree, D. Demeritt, & D. Liverman (Eds.), *A Companion to Environmental Geography* (pp. 95–108). John Wiley & Sons, Incorporated.

Scheffran, J., Marmer, E., & Sow, P. (2012). Migration as a contribution to resilience and innovation in climate adaptation: Social networks and co-development in Northwest Africa. *Applied Geography*, 33(1), 119–127. <https://doi.org/10.1016/j.apgeog.2011.10.002>

Schiller, N. G., & Çağlar, A. (2011). Locality and globality: Building a comparative analytical framework in migration and urban studies. In N. Glick Schiller & A. Çağlar (Eds.), *Locating Migration: Rescaling Cities and Migrants* (pp. 60–84). Ithaca: Cornell University Press. <https://doi.org/10.7591/9780801460340-005>

State of California Government. Merced County, Imperial County California. Accessed May 2020 via: <https://www.labormarketinfo.edd.ca.gov/geography/merced-county.html>

Taşan-kok, T., Stead, D., & Lu, P. (2013). Conceptual Overview of Resilience: History and Context. In A. Eraydin & T. Taşan-kok (Eds.), *Resilience Thinking in Urban Planning* (pp. 39–51). Springer Science+Business Media. <https://doi.org/10.1007/978-94-007-5476-8>

Ten Voorde, J. (2018). Relocating Rotterdam. The task of spatial planning and urban design throughout scales in the context of extreme flood risk scenarios in the Netherlands (Master thesis). Delft University of Technology.

Thai, M., & Turkina, E. (2013). Entrepreneurial Migration: Characteristics, Causes and Effects. *Journal of Enterprising Communities: People and Places in the Global Economy*, 7, 188–195. <https://doi.org/10.1108/JEC-11-2012-0055>

The 2100 Project: An Atlas for the Green New Deal. The McHarg Center. Accessed June 2020 via: <https://mcharg.upenn.edu/2100-project-atlas-green-new-deal>

The Guardian. (2019, October 28). 'You can't fight this': California wildfires force evacuation in Sonoma county | California | The Guardian. The Guardian. <https://www.theguardian.com/us-news/2019/oct/27/california-wildfires-latest-thousands-evacuations-pge>

The Guardian. (2019, June 19). How a small Turkish city successfully absorbed half a million migrants. The Guardian. <http://www.theguardian.com/cities/2019/jun/19/gaziantep-turkish-city-successfully-absorbed-half-a-million-migrants-from-syria>

The Guardian. (2020, July 13). 'This is a war': The coronavirus disaster in California's hardest-hit – and poorest – county. The Guardian. <http://www.theguardian.com/us-news/2020/jul/13/coronavirus-imperial-county-california-latino>

The New York Times. (2019, February 9). 'Pit of Infection': A Border Town's Crisis Has Nothing to Do With Migrants—The New York Times. <https://www.nytimes.com/2019/02/09/us/calexico-new-river.html>

Times of San Diego. (2021, March 8). Imperial County farmworkers face housing issues during COVID-19. Times of San Diego. <https://timesofsandiego.com/politics/2021/03/08/feeding-the-nation-fighting-for-housing-imperial-county-farmworkers-issues-persist-amid-pandemic/>

UC Davis (2010). California: Drought & Jobs, Housing. Accessed May 2020 via: <https://migration.ucdavis.edu/rmn/more.php?id=1562>

UC Davis (2016). California Agriculture: Water, Labor and Immigration. Accessed May 2020 via: <https://gifford.ucdavis.edu/events/2016-04-15-california-agriculture-water-labor-and-immigration/conference-report/>

United States Census Bureau (2019). 2014-2018 Poverty Rate in the United States by County. Accessed June 2020 via: <https://www.census.gov/library/visualizations/interactive/2014-2018-poverty-rate-by-county.html>

US Geological Survey (2015). Map of Croplands in the United States. Accessed June 2020 via: <https://www.usgs.gov/media/images/map-croplands-united-states>

US Tradenumbers. (n.d.). Calexico/Mexicali (East) Border Crossing, Calif.'s trade decreases 0.61 percent through January. Retrieved 5 April 2021, from <https://www.ustradenumbers.com/port/calexico-mexicali-east-border-crossing-calif/>

Vale, L. J. (2014). The politics of resilient cities: Whose resilience and whose city? *Building Research and Information*, 42(2), 191–201. <https://doi.org/10.1080/09613218.2014.850602>

van Ostaijen, M. (2017). Between migration and mobility discourses: the performative potential within 'intra-European movement.' *Critical Policy Studies*, 11(2), 166–190. <https://doi.org/10.1080/19460171.2015.1102751>

Wilson, S. (2019, October 3). Secondary burns: Chico, Calif., is in tumult after a fire emptied out neighboring Paradise. *Washington Post*. https://www.washingtonpost.com/national/secondary-burns-chico-calif-is-in-tumult-after-a-fire-emptied-out-neighboring-paradise/2019/08/02/26263e38-b2e5-11e9-951e-de024209545d_story.html

WUR. (2014, August 19). Ecosystem services. WUR. <https://www.wur.nl/en/Dossiers/file/Ecosystem-services.htm>

FIGURE REFERENCES

Border Report. (2019). Access Restricted. <https://www.borderreport.com/hot-topics/the-border-wall/california-campsite-at-foot-of-border-wall-takes-in-homeless-farmworkers/>

Brauman, K. (2016). Water depletion: An improved metric for incorporating seasonal and dry-year water scarcity into water risk assessments. *Water depletion: Improved metric for seasonal and dry-year water scarcity | Elementa: Science of the Anthropocene | University of California Press*. <https://online.ucpress.edu/tudelft.idm.oclc.org/elementa/article/doi/10.12952/journal.elementa.000083/112909/Water-depletion-An-improved-metric-for>

CCBRES. (n.d.). Retrieved 5 April 2021, from <http://www.sci.sdsu.edu/ccbres/Housing2.PDF>
CDC Social Vulnerability Index. (2018). CDC SVI Data and Documentation Download | Place and Health | ATSDR. https://www.atsdr.cdc.gov/placeandhealth/svi/data_

[documentation_download.html](#)

City Data. (2021). Imperial County, California detailed profile—Houses, real estate, cost of living, wages, work, agriculture, ancestries, and more. https://www.city-data.com/county/Imperial_County-CA.html#

Climate Lab Book. (2019). Mapping global temperature change | Climate Lab Book. <https://www.climate-lab-book.ac.uk/2016/mapping-global-temperature-change/>

CNN. (2018). This is what the US-Mexico border looks like—CNN.com. <https://edition.cnn.com/interactive/2018/12/politics/border-wall-cnnphotos/>

Daily Democrat. (2020). Homeless essential workers face greater risk of COVID-19 – Daily Democrat. <https://www.dailydemocrat.com/2020/08/28/homeless-essential-workers-face-greater-risk-of-covid-19-2/>

Daily Mail. (2018). A ghost town in the making: How the Salton Sea went from busy resorts to a 'public health disaster' | Daily Mail Online. <https://www.dailymail.co.uk/news/article-5839677/A-ghost-town-making-Salton-Sea-went-busy-resorts-public-health-disaster.html>

Desert Review. (2020). State senate energy committee approves lithium commission helping Valley move closer to lithium opportunities. The Desert Review. https://www.thedesertreview.com/news/state-senate-energy-committee-approves-lithium-commission-helping-valley-move-closer-to-lithium-opportunities/article_3b440a8e-dcbf-11ea-be54-a7fe5f2326d9.html

Desert Sun. (2018a). Air pollution is taking a deadly toll on the U.S.-Mexico border. <https://eu.desertsun.com/in-depth/news/environment/border-pollution/poisoned-cities/2018/12/05/air-pollution-taking-deadly-toll-u-s-mexico-border/1381585002/>

Desert Sun. (2018b). Air pollution is taking a deadly toll on the U.S.-Mexico border. <https://eu.desertsun.com/in-depth/news/environment/border-pollution/poisoned-cities/2018/12/05/air-pollution-taking-deadly-toll-u-s-mexico-border/1381585002/>

Desert Sun. (2018c). Mexicali, a city transformed by maquiladoras, faces pollution crisis. <https://eu.desertsun.com/in-depth/news/environment/border-pollution/poisoned-cities/2018/12/05/mexicali-industrial-city-factories-maquiladoras-border-pollution/1295896002/>

Field-Crops-Calendar-Final.pdf. (n.d.). Retrieved 5 April 2021, from <http://www.eltoroexport.com/CMS/Media/Field-Crops-Calendar-Final.pdf>

Flickr. (2014). Welcome to Flickr! <https://www.flickr.com/photos/presidenciard/13858557893/player/63f7bc9158>
Forbes. (2012). American Migration [Interactive Map]. Forbes. <http://www.forbes.com/special-report/2011/migration.html>

IDMC. (2019). IDMC | Global Report on Internal Displacement 2019. <https://www.internal-displacement.org/global-report/grid2019/>

Imperial_County_Crop_and_Livestock_Report.pdf. (n.d.). Retrieved 5 April 2021, from https://agcom.imperialcounty.org/wp-content/uploads/2020/02/2018_Imperial_County_Crop_and_Livestock_Report.pdf

Imperial_Housing_Needs_Report_2020-HNR.pdf. (n.d.). Retrieved 5 April 2021, from https://1p08d91kd0c03rlxhmhtydpr-wpengine.netdna-ssl.com/wp-content/uploads/2020/06/Imperial_Housing_Needs_Report_2020-HNR.pdf

IOM. (2017). Maps | Environmental Migration Portal. <https://environmentalmigration.iom.int/maps>

IOM. (2018, June 4). Migration as a Climate Change Adaptation Strategy | by IOM - UN Migration | Medium. <https://medium.com/@UNmigration/migration-as-a-climate-change-adaptation-strategy-2ba22c0978fe>

IPCC. (2021). Socio-Economic Data and Scenarios. https://sedac.ciesin.columbia.edu/ddc/ar5_scenario_process/RCPs.html

LA Times. (2014). Drought, drawdowns and death of the Salton Sea—Los Angeles Times. <https://www.latimes.com/local/california/la-me-g-drought-drawdowns-and-death-of-the-salton-sea-20141021-htlstory.html>

LA Times. (2019). This corner of California is suffering economic misery despite boom all around it—Los Angeles Times. <https://www.latimes.com/local/california/la-me-imperial-county-unemployment-20190205-htlstory.html>

La Voz de la Frontera. (2019). Tiene BC primer lugar en empresas maquiladoras—La Voz de la Frontera | Noticias Locales, Policiacas, sobre México, Mexicali, Baja California y el Mundo. <https://www.lavozdelafrontera.com.mx/local/tiene-bc-primer-lugar-en-empresas-maquiladoras-2968941.html>

Maxar Satellite Imagery. (2019). Maxar Shares Satellite Imagery of California Wildfires—GISuser.com. <https://gisuser.com/2019/10/maxar-shares-satellite-imagery-of-california-wildfires/>

Misrach, R. (2016). Border cantos. Magazine. <https://www.nationalgeographic.com/magazine/article/proof-border-wall-united-states-mexico>

NASA. (2000). Land Use Across the U.S.-Mexico Border. <https://visibleearth.nasa.gov/images/792/land-use-across-the-us-mexico-border>

NASA Earth Observatory. (2014). Lake Powell half empty. <https://earthobservatory.nasa.gov/images/83716/lake-powell-half-empty>

NASA Earth Observatory. (2018, August 28). This NASA image shows how California's wildfires are affecting the atmosphere. CNBC. <https://www.cnbc.com/2018/08/28/nasa-visualization-shows-california-wildfires.html>

National Geographic. (2015, June 12). An Anthropologist Unravels the Mysteries of Mexican Migration. Culture. <https://www.nationalgeographic.com/culture/article/151206-immigration-border-migrant-mexico-desert-ngbooktalk>

New York Times. (2019). 'Pit of Infection': A Border Town's Crisis Has Nothing to Do With Migrants—The New York Times. <https://www.nytimes.com/2019/02/09/us/calexico-new-river.html>

Nola. (2015). Anatomy of a flood: How New Orleans flooded during Hurricane Katrina | Environment | nola.com. https://www.nola.com/news/environment/article_238e35b0-e52a-5ed8-aed1-ec5da3ef16da.html

NOS. (2021). Meer kinderen via Mexico naar VS, grenskwestie ligt weer onder vergrootglas. <https://nos.nl/l/2374481>

NPR. (2018). What Migrants Displaced By The Dust Bowl And Climate Events Can

Teach Us. NPR.Org. <https://www.npr.org/2018/10/20/659074873/what-migrants-displaced-by-the-dust-bowl-and-climate-events-can-teach-us>

Parodi, S. (2019, November 1). Opinion | When 'Do No Harm' Means Evacuating Hospitals in California. The New York Times. <https://www.nytimes.com/2019/11/01/opinion/california-kincade-hospital-wildfire.html>

Pew Research Center. (2019). Southwest border apprehensions have often peaked in March, but pattern has changed in recent years. Pew Research Center. https://www.pewresearch.org/wp-content/uploads/2020/11/ft_2020.11.04_borderapprehensions_05.png

PHI. (2021). Working With Imperial County Communities to Monitor Air Quality. Public Health Institute. <https://www.phi.org/about/impacts/working-with-imperial-county-communities-to-monitor-air-quality/>

Quartz. (2019). Trump Administration streamlining visas for Mexican farm workers—Quartz. <https://qz.com/1586797/trump-administration-streamlining-visas-for-mexican-farm-workers/>

Reuters. (2020, May 28). Mexican farmworkers crammed into border tunnel despite contagion risk. Reuters. <https://www.reuters.com/article/us-health-coronavirus-mexico-border-idUSKBN23435D>

Reveal. (2015). The air is dark and asthma is deadly along the Mexico border. Reveal. <https://revealnews.org/article/the-air-is-dark-and-asthma-is-deadly-along-the-mexico-border/>

Robinson, C., Dilkina, B., & Moreno-Cruz, J. (2020). Modeling migration patterns in the USA under sea level rise. PLOS ONE, 15(1), e0227436. <https://doi.org/10.1371/journal.pone.0227436>

Synthesizing the state of knowledge to better understand displacement related to slow onset events. (n.d.). Retrieved 5 April 2021,

from <https://unfccc.int/sites/default/files/resource/WIM%20TFD%20I.2%20Output.pdf>

The 2100 Project: An Atlas for the Green New Deal. (2019, December 7). The McHarg Center. <https://mcharg.upenn.edu/2100-project-atlas-green-new-deal>

The Bureau of Transportation Statistics. (2021). Border Crossing Entry Data | Open Data. Socrata. <https://data.bts.gov/Research-and-Statistics/Border-Crossing-Entry-Data/keg4-3bc2/data>

The Guardian. (2017, July 6). Naomi Klein: How power profits from disaster. The Guardian. <http://www.theguardian.com/us-news/2017/jul/06/naomi-klein-how-power-profits-from-disaster>

The Guardian. (2018, September 24). 'We're moving to higher ground': America's era of climate mass migration is here. The Guardian. <http://www.theguardian.com/environment/2018/sep/24/americas-era-of-climate-mass-migration-is-here>

The Guardian. (2019, June 19). How a small Turkish city successfully absorbed half a million migrants. The Guardian. <http://www.theguardian.com/cities/2019/jun/19/gaziantep-turkish-city-successfully-absorbed-half-a-million-migrants-from-syria>

Time. (2018). The Story Behind Photo of Family Running From Tear Gas at Border | Time. <https://time.com/5464560/caravan-mexico-border-iconic-photo/>

UCLA Institute of the Environment & Sustainability. (2016). Climate Change in the Sierra Nevada. <https://www.ioes.ucla.edu/project/climate-change-sierra-nevada/>

US Customs and Border Protection. (2021). Border Wait Times. <https://bwt.cbp.gov/details/09250302/PED>

VC Star. (2020). COVID 19: Oxnard farmworker housing outbreak in California. <https://eu.vcstar.com/story/news/local/2020/07/03/oxnard-california-farmworker-housing-covid->

19-coronavirus-outbreak/5368774002/ VICE. (2018). California Wildfires Have Created Climate Refugees in a Walmart Parking Lot. <https://www.vice.com/en/article/ev3x5e/california-wildfires-have-created-climate-refugees-in-a-walmart-parking-lot>

APPENDICES

Rescaling climate-induced migration

A critical framework towards a just response in spatial planning

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Abstract: As the body of knowledge on climate change grows and its impact on the environment and livelihoods of people exacerbates, so increases the understanding of its interdependence and interconnectedness with other social-, political- and economic systems. The reintroduction of environmental migration in migration studies is one research field that gains much attention in literature, advocacy, politics and media. Although a direct causal link between climate change and migration lacks, it is commonly understood the impact of environment on migration flows may not be overlooked. This paper will discuss the phenomenon of climate-induced migration in the context of systemic disruptions due to climate change. It will discuss its multi-causal nature and its diverse terminology in different discourses. Then, it will discuss the conceptual framework of evolutionary resilience after Davoudi as a possible framework to respond to challenges of climate-induced migration in the context of spatial planning for climate change. This paper will argue that, in order to pursue a just response towards the challenges of climate-induced migration, a critical inquiry of the concept of evolutionary resilience is needed, as well as a reading of scalar- and temporal processes to reveal the underlying discourse of power. Appropriated in a context of spatial planning, this framework can uncover where opportunities can be created for migrants to actively shape their environment and livelihood as social agents.

Keywords: climate-induced migration, evolutionary resilience, scalar processes, spatial planning, justice

Introduction

Over the past decades, the body of science around climate change has exploded, and its impacts seem to be omnipresent. From melting glaciers to rising sea levels, longer periods of drought to heavy rainfall and hurricanes. They increasingly influence animal habitat and human livelihoods. As research continues, the understanding of the interdependence between stresses in biophysical systems and repercussions on social-, political- and economic systems grows. One field of research in which the interconnectedness of systems is very clear is environmental migration. The term has been gaining attention since it was coined in a 1985 UNEP report by El-Hinnawi, and was followed by forecasts about the magnitude of mobility flows that climate change would induce. Ranging from apocalyptic numbers to minimalist perspectives, a direct link between climate change and migration has not been established. It is however commonly understood that the impact of environment on migration flows has been underestimated (Hugo, 2010, 30).

This paper will discuss the phenomenon of climate-induced migration in the context of climate change. It aims to discuss a relevant theoretical framework that can understand and address the challenges of the social processes of migration within the conceptual language of climate change research, in order to meaningfully address the phenomenon in spatial planning and governance which depend on timeframes and scale. To this end, this paper will ask the following question:

What theoretical framework can best address the challenges of climate-induced migration in a context of systemic disruptions, in order to meaningfully address its scale- and temporal nature?

In order to address the question, this paper will discuss and critically assess relevant concepts and their interrelation. As such, the first section will address the phenomenon of climate-induced migration to gain a basic understanding of this research field. It will explore terminology, the different discourses around the concept, its relation to migration studies, as well as a current understanding of its multi-causal nature. Hereafter, the second section will focus on the concepts involved in describing and assessing systemic disruptions in the context of climate change: adaptation, vulnerability and resilience. The section continues by discussing their applicability for understanding and intervention in climate-induced migration, which not only requires an understanding of disruptions in the biophysical system, but especially its interlinkages with an inseparable socio-political system. It will argue that these concepts need critical inquiry and transparency in decision-making from spatial planners to give a just response to climate-induced migration. Last, the third section will argue that adaptive spatial planning responses based on a critical framework of evolutionary resilience can benefit from an inquiry into scale, time and scalar processes. Looking at scalar processes reveals power relations and barriers to social appropriation and shows where the opportunities lie to create agency for climate-induced migrants.

1. Defining climate-induced migration: a contested concept

This era is experiencing an unprecedented level of human mobility. This mobility is a result of multiple interrelated factors, but there is growing awareness and research for the impact of environmental factors (particularly natural disasters and climate change) (Ionesco, Mokhnacheva, & Gemenne, 2017, VI). This paragraph will discuss the re-introduction of environment within migration theory. This revival cannot be separated from media, advocacy and political struggle that surround the phenomenon. Within the research field of migration studies, a direct link between climate change and migration patterns cannot be established. Here, focus lies rather on untangling its complex, multi-causal nature in devising responses to the challenges ahead.

1.1 Environmental migration in migration theory

Climate-induced migration cannot be understood in isolation from other forms of movement. The first theories of migration appeared at the end of the nineteenth century and included an understanding of environmental conditions in human mobility as they are numerous throughout history (Ionesco, Mokhnacheva, & Gemenne, 2017, 2). However, the post-war years marked a change in migration theory towards one rooted in a binary understanding: *involuntary* migration due to political conflict, or *voluntary* migration for economic reasons (ibid.). This theory, known as neoclassical migration theory, depends heavily on so-called push-pull models to explain that demographic, economic or political factors push people away from a place, and economic opportunities pull people towards a destination (Ahsan, Kellett, & Karuppanan, 2014; Castles, S., De Haas, H., Miller, 2020). These push-pull models draw a direct causal relationship between two variables and emphasize choice (Ahsan et al., 2014, 4). They are now recognized to be profoundly deterministic and to misinterpret the reality of migratory dynamics (Castles, S., De Haas, H., Miller, 2020; Ionesco et al., 2017). This realization was brought about by the re-emergence of environmental migration in the early 2000s with growing research on the impacts of climate change (although the dichotomy resurfaced with the influx of, notably Syrian, refugees to Europe in 2015) (Ionesco et al., 2017, 2).

1.2 Terminology: advocacy, media portrayal, politics and research

The International Organisation for Migration (IOM) periodically publishes a glossary containing definitions of migration-related terminology. It specifically reflects international migration practices and jargon for a variety of people who deal with migration. For the purpose of this paper, the definitions give an overview of the current global thinking around the phenomenon and highlight the political constructs behind the terminology.

As environment is the determining factor of interest, the generic concept *environmental migration* still encompasses a myriad of dynamics. It is defined as “the movement of persons or groups of persons who, predominantly for reasons of sudden or progressive change in the environment that adversely affect their lives or living conditions, are *forced* to leave their places of habitual residence, or *choose* to do so, either temporarily or permanently, and who move within or outside their country of origin or habitual residence” (IOM, 2019, emphasis added). This definition is applicable to a displaced population of a small Pacific island, but also to northern European retirees who decide to move to sunny Portugal. The term *climate migration* on the other hand, tailors to people who are obliged to leave or choose to do so due to sudden or progressive climate change events (IOM, 2019, *working definition*). This term is a subcategory of *environmental migration* and has no legal status but is rather designed for advocacy purposes. Similarly, the terms *climate-* or *environmental refugee* are not part of international law and hence individuals forced to leave their country due to environmental processes or climatic events do not necessarily meet the definition of a refugee under the Convention Relating to the Status of Refugees of 1951 (IOM, 2019). The terms *climate migration* and *climate refugee*, initially used by environmental scholars, media and advocacy groups to draw attention to international

protection and to accompany staggering statistics on climate-induced displacement, are unpopular in the research field of migration. Scholars argue that the term *climate refugee* reduces the issues of migration and does not account for key factors that define human mobility in the context of climate change (Camillo Boano, Roger Zetter, 2008; Hugo, 2010; Ionesco et al., 2017). In literature of geographers and social scientists, the term *climate-induced* (or *climate change-induced*) migration is used more often to refer to the multi-causal connection linking migration to climate change and environmental deterioration. This term does not appear in the 2019 IOM Glossary.

1.3 Climate-induced migration: a contested multi-causal concept

Many authors agree that there needs to be a better understanding of the mechanisms linking climate change to migration, as these mechanisms are complex and a direct link between environmental hazards and migration has not been established (Adamo, 2008; Ahsan et al., 2014; Camillo Boano, Roger Zetter, 2008; Gill, 2010; Hugo, 2010; Piguet, 2010). Norman Myers was one of the earliest scholars to (re-) address the urgency of environmental migration in 1997. Although the apocalyptic predictions in this article have been widely criticized, he established the complexity and of environmental migration and its interrelation with other political- social- and economic aspects. (Myers, 1997).

As a direct link is lacking in research, a review of the literature on this topic reveals a number of characteristics that need to be addressed in assessing the impact of environmental degradation and climate change on migration. First, geographer Graeme Hugo stresses the complex interrelationship between population mobility, economic development and social change, resources, and environment (Hugo, 2010, 11). The Foresight report of 2011 presented a conceptual framework for the drivers of migration that further specifies his categories and the applicable scales (see figure 1).

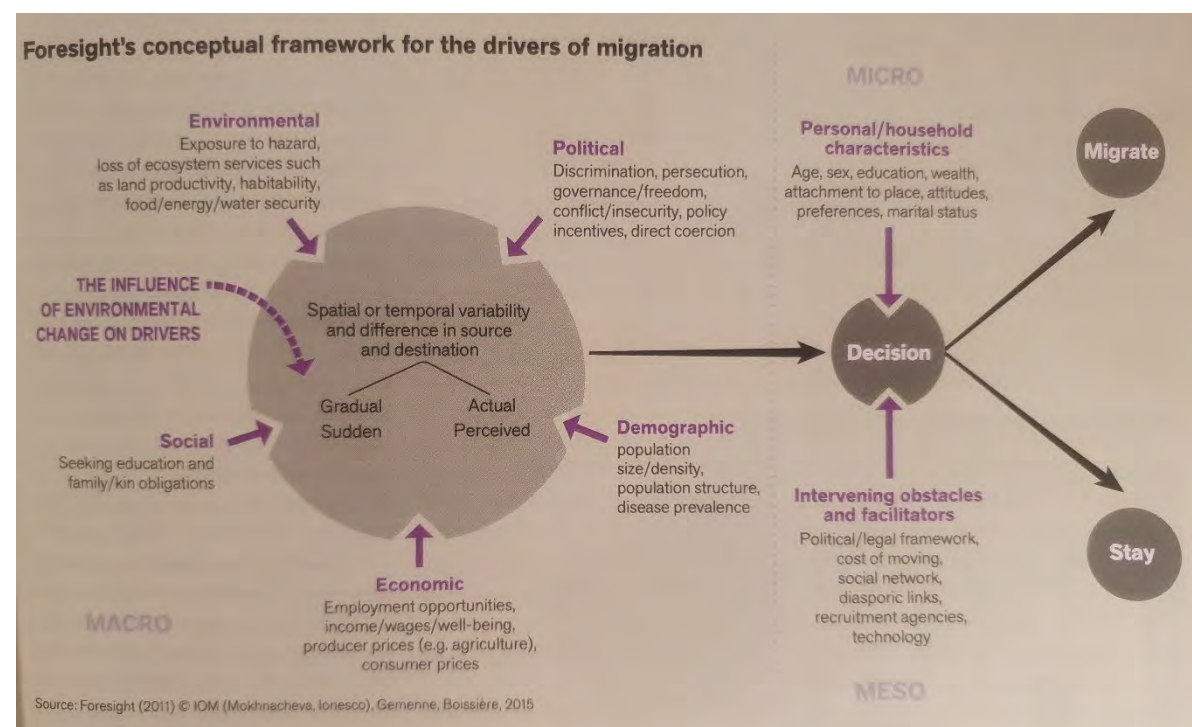


Figure 1. Foresight's conceptual framework for the drivers of migration. Based on Foresight (2011) in (Ionesco et al., 2017, 37).

Second, the difference between disaster events and slow onset disasters is important to consider, especially in the case of climate change, where the former creates a lot of attention and the latter is

generally neglected (Ahsan et al., 2014; Camillo Boano, Roger Zetter, 2008; Hugo, 2010; Ionesco et al., 2017). Third, migration due to environmental degradation should be visualised along a continuum from voluntary to forced movement (Hugo, 2010; Ionesco et al., 2017). Fourth, a key distinction to make is between mobility as a strategy for *adapting* to impacts of climate change versus *displacement* when impacts are so severe people are forced to leave (Hugo, 2010, 11). Human mobility¹ as a response to climate change expresses itself in many ways, and often time frames are an important characteristic of that form. Temporary or circular mobility (also seen as an adaptation strategy) has in many communities been a long-established practice to adapt to seasons (Ionesco et al., 2017, 22). Displacement or relocation (also seen as a mitigation strategy) can be temporary (evacuation) or (protracted) long-term (ibid., 23). Furthermore, Hugo points out that mobility is but one response to mitigate or adapt to climate change from a range of adaptation responses (Hugo, 2010, 13). And often, with a slow onset environmental change, the migration response is more complex (ibid., 14). Another risk which was first emphasized by the 2011 Foresight report is the challenge of trapped populations or immobility. When people feel the desire to migrate but are unable to do so, they may become 'trapped' (Ionesco et al., 2017, 28). This is most often the case in already vulnerable populations, and the environmental stress then aggravates their systemic (economic, political, demographic) vulnerability (ibid.). Fifth, it is not just the real or experienced environmental hazard that leads to mobility, but also any changes in perception towards environmental risk (Piguet, 2010). This creates an important role for information services like governments and media. Last, research shows that people are more likely to resort to migration if this is an established practice around their place of residence. Termed linear migration, Hugo predicts that this will cause migration to happen overwhelmingly within countries and along existing migration corridors (Hugo, 2010, 16-17).

De Haas is altogether more critical towards the current discussion on climate-induced migration (Castles, S., De Haas, H., Miller, 2020). He argues that too often research draws a simplistic, causal link between climate change and migration. He is especially critical towards governments employing the narrative of climate migration to depoliticize the migrants. He evokes an example from the Maldives where the government used a migration narrative to move inhabitants because they thought it too costly to provide services for dispersed population. In case of drought and desertification, De Haas questions specifically anthropogenic impact on the environmental outcome, such as over-extraction of water or irrigation for urban industry. His main argument is therefore that a focus on climate not only ignores that actually political and social issues are the main cause of environmental crises, but that this also diverts the government's attention away from responsibility towards these core issues (ibid., 213). This suggests that inquiry in environmental factors is as important as inquiry in the political discourse around interventions for climate-induced migration.

1.4 What are the main challenges?

From the reviewed literature, it is clear that the environment is just one factor of migration among others, hence the use of the term *climate-induced migration* in this paper. Traditional economic,

¹ *Human mobility* is a more generic term covering all the different forms of movements of persons, also tourist movement (IOM, 2019). *Migration* is only one type of movement under this umbrella term, signifying the movement away from usual place of residence (ibid.). The term *human mobility* was used from 2015 onwards by the Advisory Group on Climate Change and Human Mobility for conferences for parties of the UNFCCC (ibid.). A possible explanation for its use is the political discourse around the term. In the context of intra-European movement, *mobility* and *migration* have been researched to perform differently. *Mobility* is used to propose a course of action towards opening up the internal economic market. *Migration*, on the other hand, is associated with migrant 'problems' and 'abuses', and legitimizes integration and participation policy actions. Hence, both concepts also function in different storylines and legitimize different courses of action (van Ostaijen, 2017). Also in international context after its apocalyptic reintroduction by Norman Myers, the term *environmental migration* has fairly recently been put in a more favourable light as a positive adaptation strategy learned from case studies in the global south (Barnett, J., Webber, 2010; Ionesco et al., 2017, 70).

demographic, political or social factors played a primary role in neoclassical migration theory, with the environment playing only a secondary role by influencing the above (Ionesco et al., 2017, 64). However, neglecting the environment is currently deemed to provide an incomplete overview of contemporary migration (Ahsan et al., 2014; Camillo Boano, Roger Zetter, 2008; Hugo, 2010; Ionesco et al., 2017). This uncertainty regarding the (measurable or assessable) impact of environmental factors motivates multiple challenges. Since the first UNEP report on environmental migration in 1985, a growing body of literature discusses its legal and human security parameters and an extension of the Convention Relating to the Status of Refugees to include displacement caused by natural disasters and climate change. Moreover, some studies address the iconography and literary portrayal of climate change and migration to understand better the power struggle and agency of the voices heard and unheard in media, politics and advocacy (Heathcote, 2013; Manzo, 2010). Of particular interest for this thesis are the challenges relating to governance and spatial planning in the context of climate change. The next section will introduce a conceptual framework that is often used to address challenges and create strategies in the face of climate change.

2. Reading climate-induced migration in the context of climate change: vulnerability and resilience

Talking about the impacts of climate change evokes images of natural disasters like rising sea-levels, hurricanes, drought and excessive rainfall. These disasters, be they slow-onset or short events, result from stresses in biophysical systems, simultaneously revealing vulnerabilities in other systems. As discussed in the previous section, there is increasing concern about the implications of these systemic disruptions for migration in the face of slow onset progression of climate change effects. Adaptation has established itself over the past decade as a major means of action to address climate change (Ionesco et al., 2017, 71). The term specifies the processes and strategies that aim to reduce the vulnerability of social and biophysical systems faced with the impacts of climate change (ibid.).

This section will explore these concepts that are used most commonly to understand and strategize biophysical stresses due to climate change. In aiming to create a more integral understanding of the phenomenon of climate-induced migration, it needs to be emphasized that biophysical stresses do not stand in isolation of disruptions in other systems. A potential solution in one system can create new problems in another. Hence, this section will look at the applicability of vulnerability and resilience in the context of social-ecological systems. The concept of social-ecological systems reflects the inseparability of systems and suggests that any distinction between natural and social systems is arbitrary (Adger, 2006). This inseparability is also reflected in a growing body of literature around migration as an adaptation strategy towards resilient migrant communities in the face of climate change. However, this section will argue that the concept of resilience needs critical inquiry from spatial planners to pursue justice facing the vulnerabilities of climate-induced migrants.

2.1 Defining vulnerability and resilience

The concept of vulnerability in the context of social-ecological systems can be traced to various research disciplines. Adger locates this research within geography and hazard and risk research (Adger, 2006, 269). Its definition is often formulated in the negative, indicating “the degree to which a system is susceptible to and unable to cope with adverse effects” (ibid.). It has three elements that denote the degree of vulnerability: exposure, sensitivity and adaptive capacity (Adger & Brown, 2009, 110). These are similar to the parameters of resilience. The concept of resilience derived from ecological sciences and complex systems studies (ibid., 119). It is often formulated as the antonym to vulnerability focusing on the adaptive capacity of a system in preserving the capacity to deal with uncertainty or change (ibid.). Adger, from the perspective of geography, defines it as the magnitude of disturbance that can be absorbed by a system before it radically changes to a different state, as well as the system’s ability to self-organise and adapt to a changing environment (Adger, 2006, 268-9). The traditions of resilience research lie in engineering and ecology before it was adopted by urban planners, and its parameters have evolved from those research disciplines. Within engineering, resilience is used to denote the stability of a system to return to an equilibrium after disturbance (Davoudi, Brooks, & Mehmood, 2013, 308). This definition, used in engineering and ecology, seen in the context of social-ecological systems, is deterministic in its presupposition that systems have an enduring equilibrium that does not consider time, scale or the behaviour of other interrelated systems. An increase in the number of natural disasters enhanced sparked more research into resilience in social systems (Taşan-kok, Stead, & Lu, 2013, 42). Ecologists, most notably Folke,

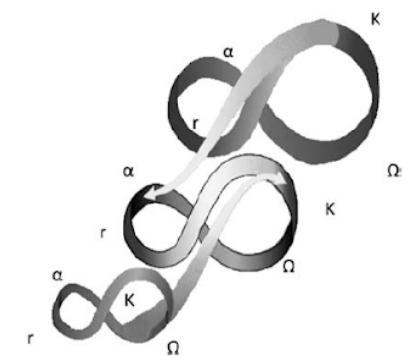


Figure 2. The adaptive cycles. Image adapted from Holling and Gunderson (2002) by Davoudi (2013).

Holling and Gunderson, paired resilience with social and economic development, which generated the concept of adaptive cycles (ibid.). In the adaptive cycle, a social-ecological system moves through four distinct phases of growth, conservation, collapse and reorganization. Away from a state of equilibrium, the adaptive cycles offers an understanding of social-ecological resilience as continuously altering as the system adapts to changes, visualized as infinity curves to represent systems on different scales (see figure 2) (Davoudi et al., 2013, 310).

Davoudi critiqued this cycle for neglecting human intervention in a social context. She proposes the concept of evolutionary resilience adding a component of preparedness (see figure 3), arguing that in the face of disturbances the resilience of social-ecological systems can strengthen based on their social learning capacity (preparedness) for improving their chances of withstanding stresses (a sign of systemic robustness and persistence), absorbing disturbances without being pushed into an unwanted trajectory (a sign of flexibility or adaptability of a system) and move towards a more desirable trajectory (a sign of innovation and transformation of a system) (Davoudi et al., 2013, 311). In this way, the intentionality of human actions and their intervention in systems can be accounted for in

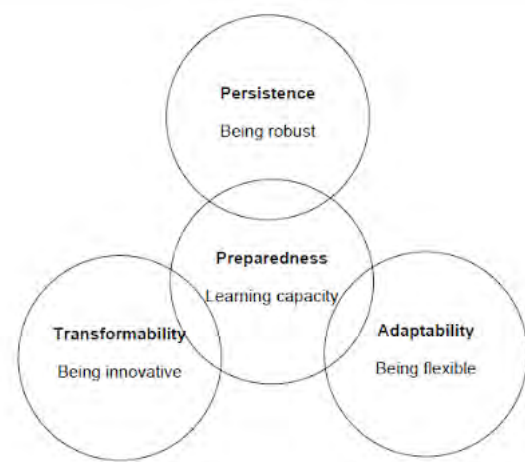


Figure 3. Evolutionary resilience: four-dimensional framework for resilience-building. Davoudi (2013).

systems-thinking. This concept of evolutionary resilience came about in response to London's Climate Change Adaptation Strategy, and is thus valuable in the context of governance and decision-making for spatial planning. Adger and Brown agree that the concepts of vulnerability and resilience are very useful in spatial planning and geography as they are important characteristics of places, people and social-ecological systems (Adger & Brown, 2009, 120). Although they originate from different research traditions, they moved over time towards a common agenda that recognizes its place-specific nature and the range of scales in which they can be assessed (ibid.).

2.2 Resilient migrant communities: migration as adaptation

With regard to planning for resilient migrant communities in the face of natural disasters, there is a growing body of literature that explores migration as an adaptation strategy for climate change. A general consensus is that the discussion should go beyond a threat-victim discourse, and should rather describe the migrant as an active social agent able to shape their livelihood under changing environmental conditions (Barnett, J., Webber, 2010; Scheffran, Marmer, & Sow, 2012). Migration could offer opportunities to acquire new knowledge, financial means and social networks (ibid.). The most researched link between migration and adaptation to climate change is the way in which adaptation can prevent forced migration (in global south case studies, looking at traditional circular migration practices for instance) (Scheffran et al., 2012). However, following the definition of evolutionary resilience by Davoudi, the authors argue that migration-for-adaptation can improve resilience and strengthen links between home and host communities (ibid., 126). This perception on (voluntary) migration assumes that transfers of resources like knowledge, remittances and return migration can benefit well-being and institutional innovation in the home community for climate adaptation as well as strengthen livelihoods and capacities in the host community if there is

willingness and ability of governments and organisations to maximise benefits and lower barriers to migration and the formation of migrant networks (Barnett, J., Webber, 2010, 45; Scheffran et al., 2012, 120). This approach would step away from reactive adaptation towards an anticipatory learning relationship between host- and home communities.

2.3 What resilience? And for whom?

The brief discussion of research on planning for resilient migrant communities shows that a particular discourse (threat-victim vs. shaping agent) influences the type of adaptation and resilience that is put to effect. This paragraph will expand that argument further, as several authors have critiqued the concept of resilience (in its most used definition in relation to climate change by the IPCC). Their discussion specifically pertains to spatial planning in pursuit of resilient cities. Although the city is not the relevant object of inquiry for this paper, the questions and comments they place are equally relevant for the issue of migration. Susan Fainstein, through a Marxist reading of the concept of resilience that allows her to focus on agency and struggle, concludes that the term obscures disagreement and distribution of costs and benefits resulting from policy choices (Fainstein, 2015, 157). Governance choices made, also in pursuit of a 'feel-good term' like resilience, always involve trade-offs or negative externalities that might be covered to justify controversial actions under a resilient strategy (ibid.). She critiques the current formulation of resilience to be too idealistic, causing planners to design responses that are divorced from reality. This is, for instance, visible in the way data are represented and categorized: interrelated risk charts often omit agents and targets for effective action (ibid., 160). A similar note of caution is placed for terminology by Lawrence Vale. Using, for instance, the term *drought* could evade responsibility under the label of 'natural' disaster, whereas the term *flood* indicates an encroachment of human-made infrastructure that shows that risk allocation is a (societal) choice about infrastructure location or disaster recovery priorities (Vale, 2014, 197).² These choices and priorities inform of what level of risk is tolerable and where, as well as for whom. This means that resilience (or evolutionary resilience for that matter) must do more than judge the social-ecological stresses and responding design structures; it must also assess the power dynamic and ask *whose* resilience, and *against what*?

² This word of caution on terminology is also applicable to definitions given by international authorities with regard to science on climate change. The unusual feature of this interdisciplinary field of research is its focus on consensus, stemming from the interaction between science and the guiding legal framework posed by the UN Framework Convention on Climate Change (UNFCCC) (Adger, 2006, 273). The UNFCCC was a result of the second World Climate Conference that discussed the findings of a scientific report published by the 1988 instituted Intergovernmental Panel on Climate Change (IPCC). The IPCC have become an authoritative voice in defining concepts like vulnerability and resilience in the context of climate change (many of the quoted journal articles refer to IPCC definitions), but their definitions do not represent the full scope of research findings on causes and consequences of vulnerability. With a focus on natural hazards as a result of climate change, they omit aspects of for instance violent conflict, loss of ecosystem services (ibid., 274) and anthropogenic-induced environmental impacts. In short, they do not respond to the discussion of agents and power struggle.

3. Rescaling climate-induced migration

The previous section discussed the framework of evolutionary resilience by Davoudi (2013) as a useful conceptual interrelation of persistence, adaptability, transformability and preparedness as capacities of socio-ecological systems that can address both climate change-related disruptions as well as decision-making for spatial planning and governance. However, a critical reading using Fainstein (2015) and Vale (2014) showed that this framework does not address questions of agency and power that necessarily have to be asked to give the concept of resilience value in pursuit of justice. By asking *what* resilience and *for whom*, the vulnerabilities that are addressed by a resilience strategy are revealed as well as how risk is assessed and distributed.

However, in relation to climate-induced migration, proactive and reflective spatial planning (Davoudi's *preparedness*) needs to address a temporal and geographical scale. Although reactive resilience is often seen as more urgent, preparedness is a necessary form of planning. However, it has a radically different timetable (Vale, 2014, 199-200). Scale and time are central to evolutionary resilience and also to migration. Climate-induced migration is process-based in that it is in a state of continuous change and restructuring and has thus simultaneously a spatio-temporal dimension (Sayre, 2009, 106). Time and scale are often tied to together (as the scale increases, so does usually the timeframe in spatial planning) and both time and scale shape resilience and reveal power and agency.

Scale, indicated by terms like local, regional or global, is different from other geographical denominations like place, space and territory. The former are constituted, historical concepts that are abstractions of specific social relations (Brenner, 2011). These scales, in turn, structure perceptions, understandings and representations. It is social processes that precede and inform the unit of scale. Hence, looking at climate-induced migration through a fixed territorial scale removes the agency of social processes as none of the scales are static frames of social life (ibid., 37). Instead, these spaces are produced through social relations. Therefore, Brenner proposes to analyse not scales but scalar processes (the process of production of scale), because these can reveal fields of (transformative) power.

When returning to Davoudi's evolutionary resilience in pursuit of justice, and the proposal of migration-for-adaptation that steps away from the threat-victim discourse towards a perception of the migrant as an active social agent, then it should be argued that this discourse can benefit from an inquiry of scale and scalar processes in a project. In this discourse towards resilient communities, the migrant is not rendered a passive being who finds him- or herself in a coincidental situation. Discussing migration through a spatial unit (the regional scale for instance, or worldwide diasporic flows of migration) bypasses that this spatial unit is in itself produced and transformed through social relations which the migrant then inherits. Instead, the migrant as agent suggests that they interact with scale because they produce it. They contribute to and contest the changing status of their environment (Schiller & Çağlar, 2011). The migrant is then an active contributor to the rescaling process, opening up transformation and emergence of institutions and spaces that they can actively involve in. *Rescaling* here draws attention to the continuous production of scale. It is through rescaling processes that migrants have the ability to circumvent or overturn conventional hierarchies of power (Sayre, 2009, 105).

Conclusion

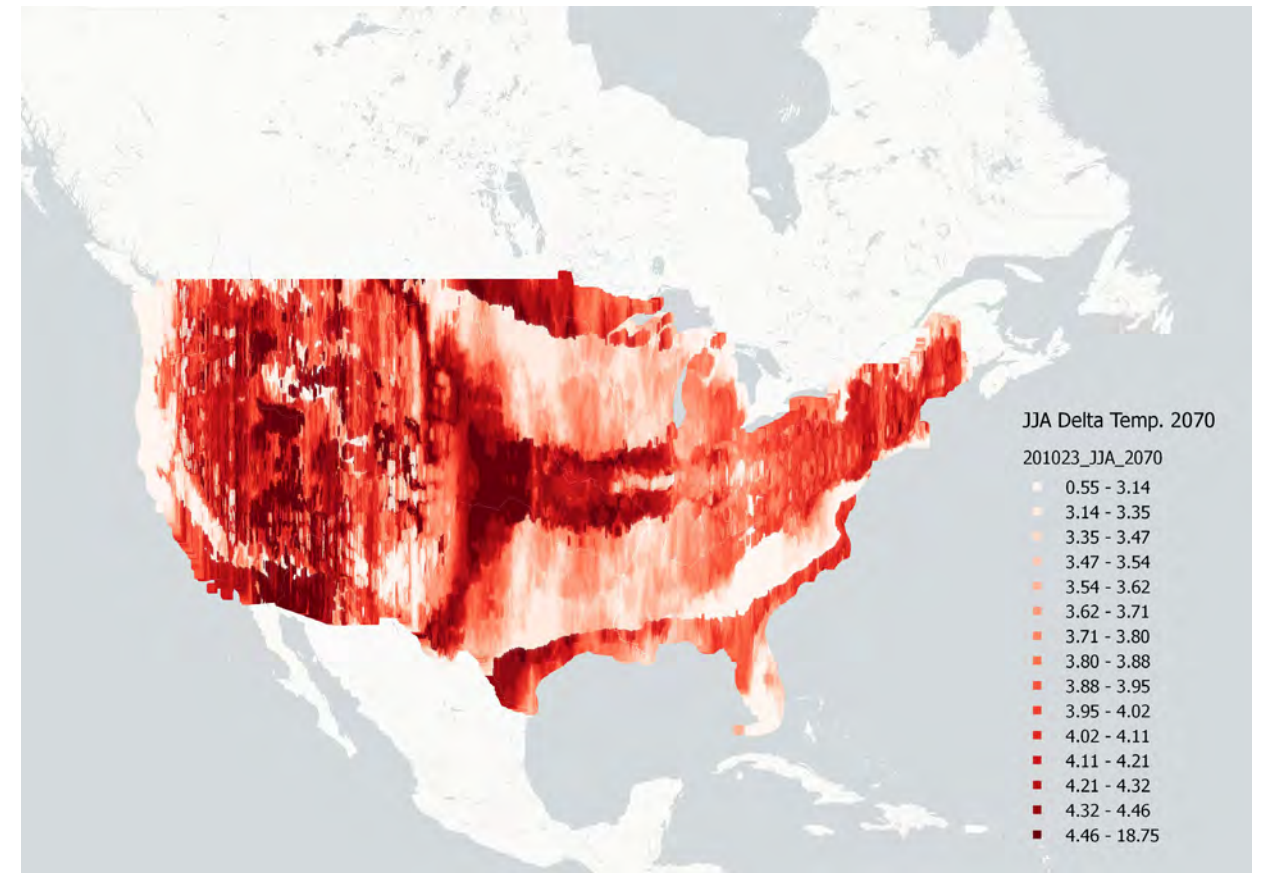
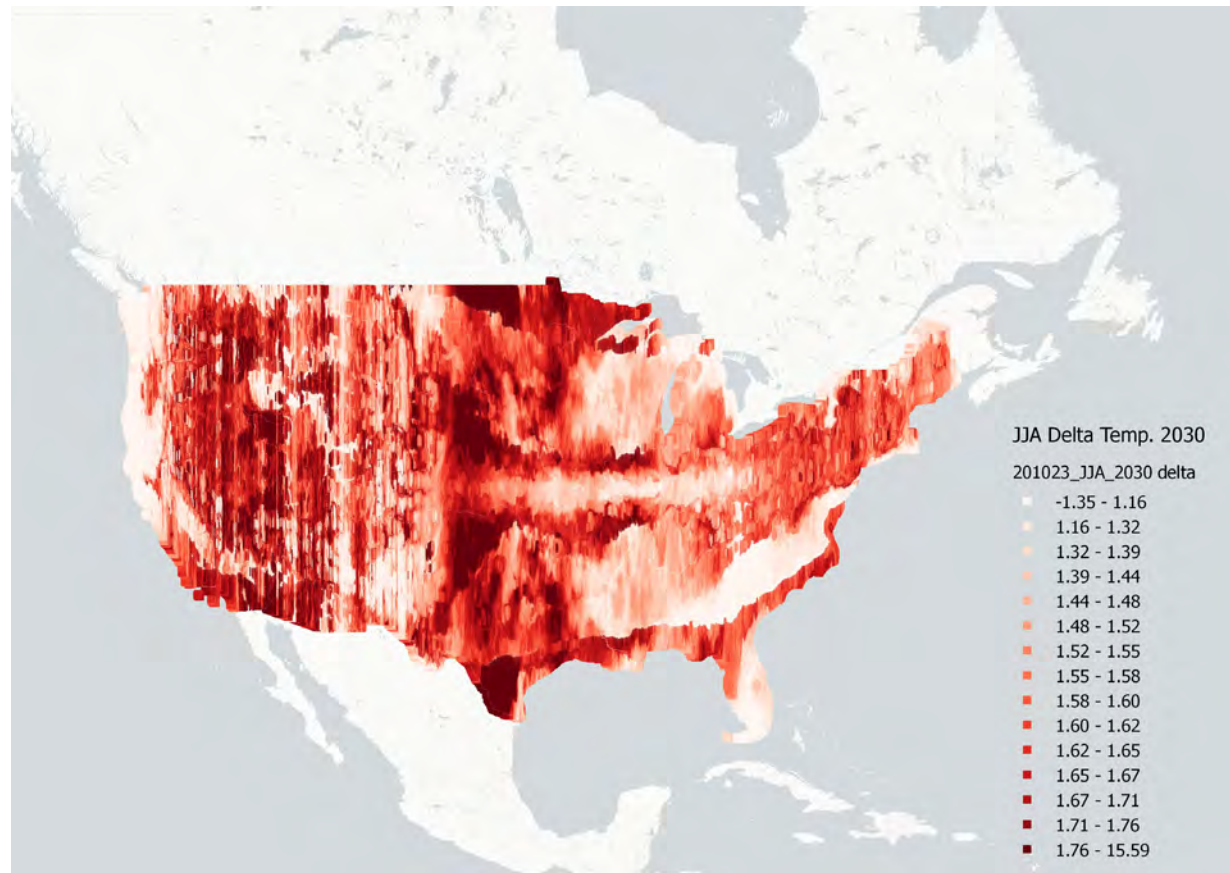
This paper set out to answer the following question:

What theoretical framework can best address the challenges of climate-induced migration in a context of systemic disruptions, in order to meaningfully address its scale- and temporal nature?

To this end, this paper first addressed the phenomenon of climate-induced migration, placing it in the context of migration theory and emphasizing its re-introduction through the attention to climate change and subsequent awareness raised by media and advocacy groups. Then it briefly reflected on the current focus of the research field on the multi-causal nature of climate-induced migration, as a direct link between climate change impacts and migration has not been established. The paper then moved on to discuss adaptation as a major means to address climate change impacts, which aims to reduce vulnerability and increase resilience. It argued that resilience in its ecological definition is too deterministic for the complex social-ecological systems at stake when discussing climate-induced migration. However, the concept of evolutionary resilience by Davoudi, which adds the notion of preparedness and accounts for intentionality of human intervention, was argued to be useful in the context of social-ecological systems and decision-making in spatial planning. A critical reading through Fainstein and Vale proposed that, in pursuit of justice in climate-induced migration, the agency and power in decision-making for adaptation strategies need to be revealed: *what* resilience and *for whom*? Last, the paper set out to argue that this framework of critical evolutionary resilience can benefit from an inquiry into scale, time and scalar processes to reveal where opportunities can be created for migrants to appropriate and actively shape their environment and livelihood. This proposed framework builds on the concepts resilience and vulnerability from the context of systemic climate change disruptions, to show that through addressing the scale- and temporal nature of climate-induced migration spatial planners can appropriate critical inquiry and transparency to work towards a just response to its challenges.

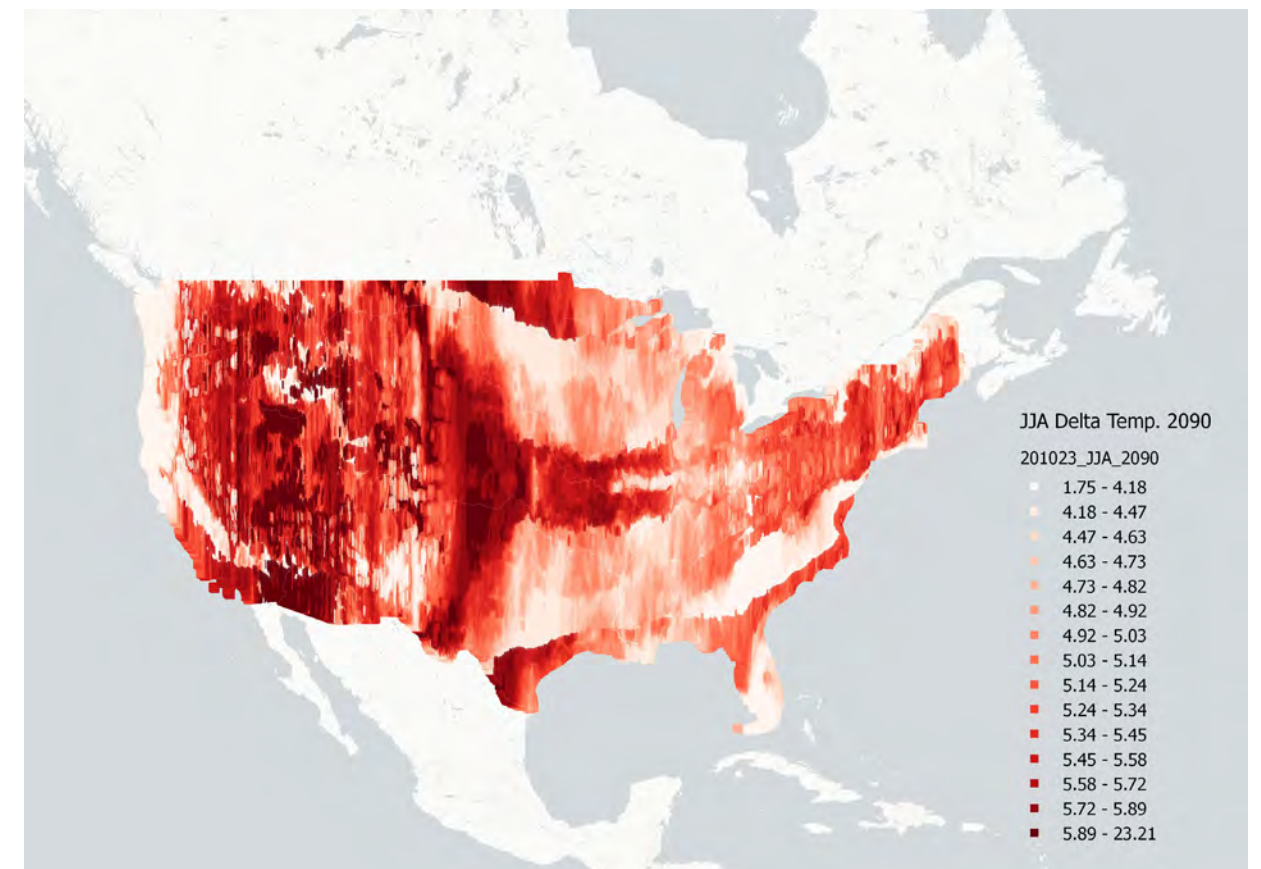
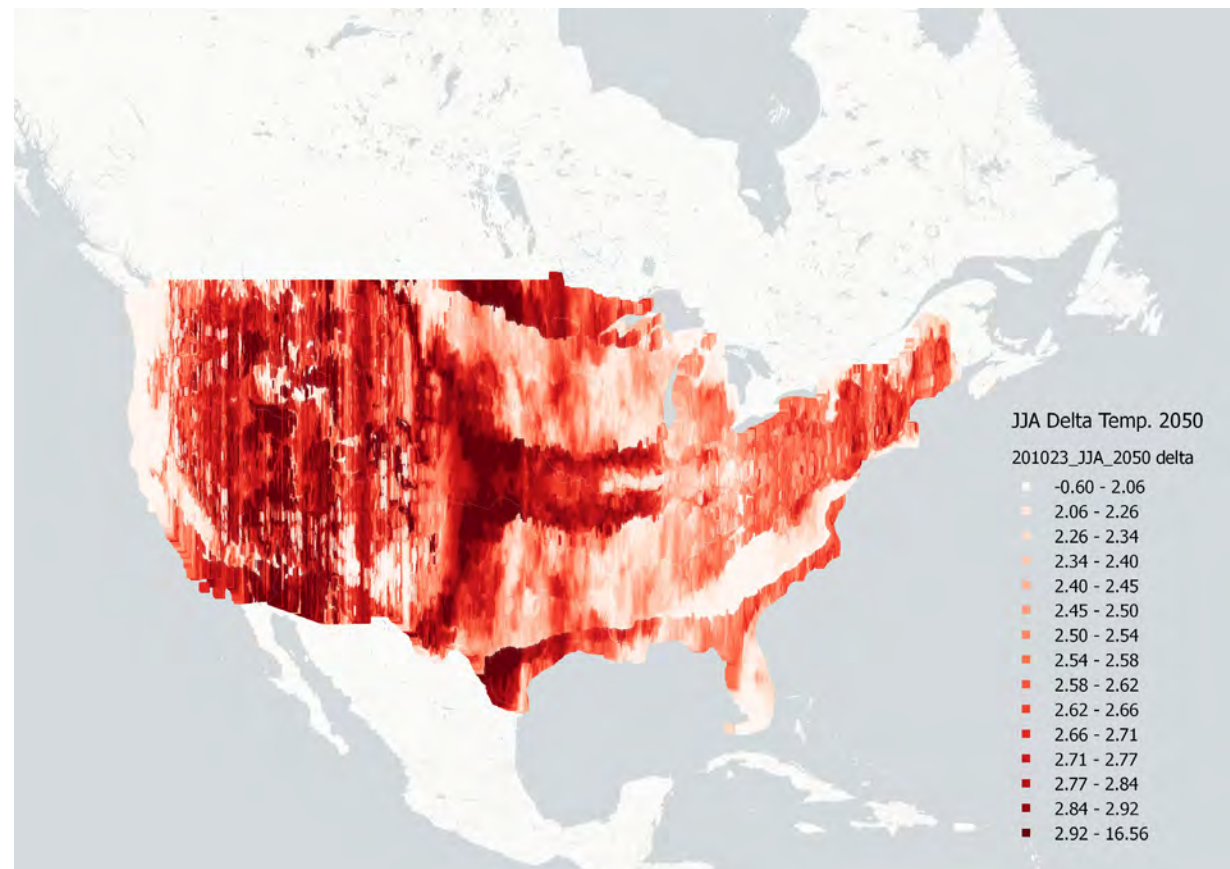
References

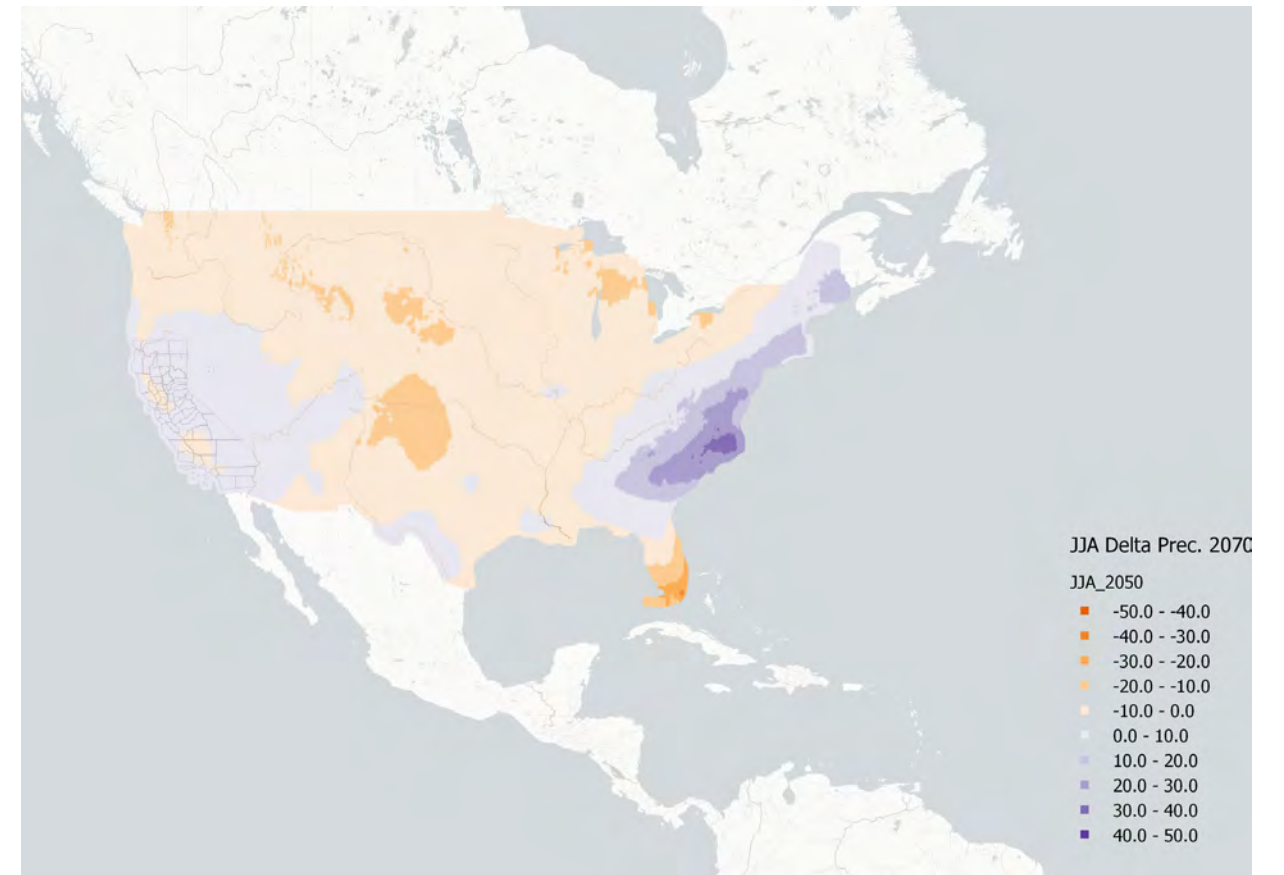
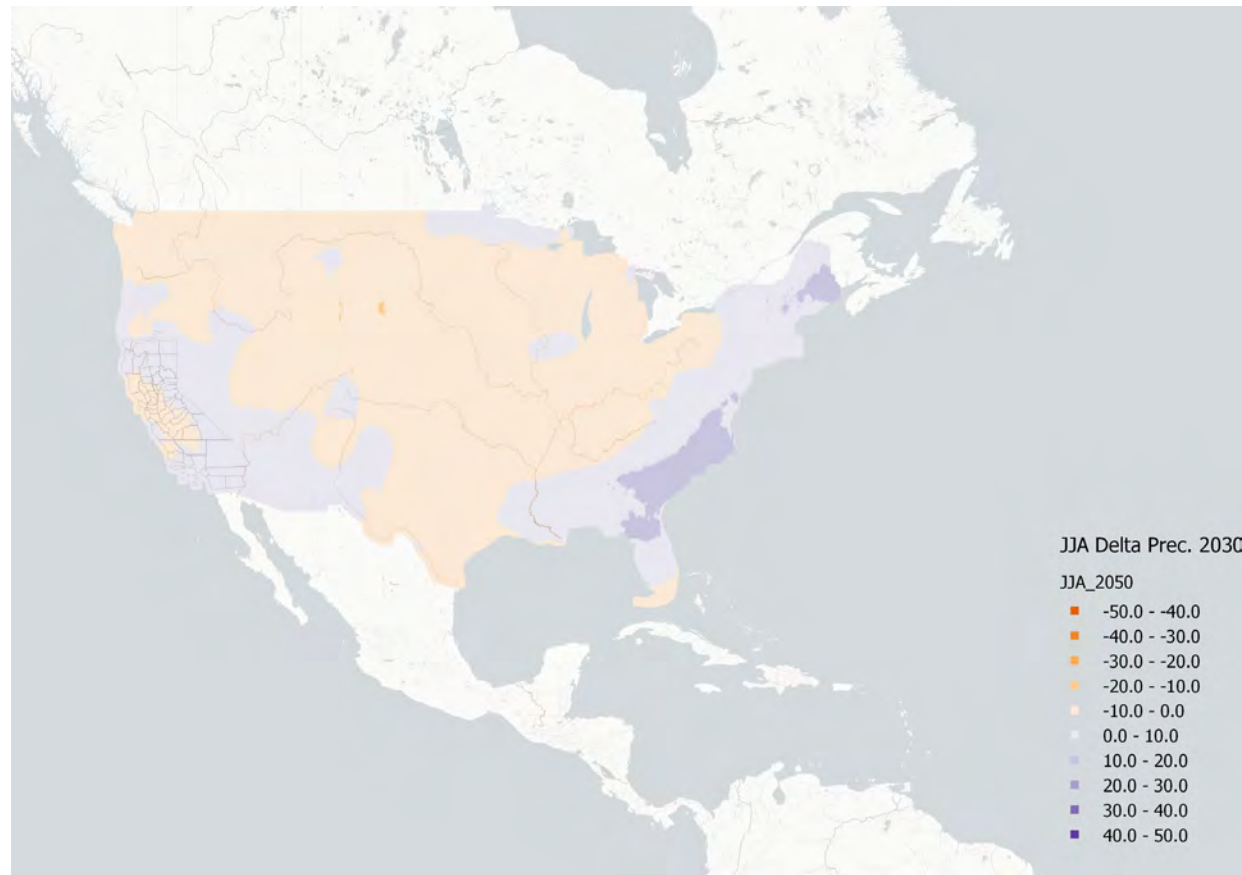
- Adamo, S. B. (2008). Addressing environmentally induced population displacements: a delicate task (background paper). In *Population-Research Network Cyberseminar on Environmentally Induced Population Displacements, 18–29 August 2008* (pp. 1–20).
- Adger, W. N. (2006). Vulnerability. *Global Environmental Change, 16*(3), 268–281. <https://doi.org/10.1016/j.gloenvcha.2006.02.006>
- Adger, W. N., & Brown, K. (2009). Vulnerability and Resilience to Environmental Change: Ecological and Social Perspectives. In *A Companion to Environmental Geography* (pp. 109–122). <https://doi.org/10.1002/9781444305722.ch8>
- Ahsan, R., Kellett, J., & Karuppanan, S. (2014). Climate Induced Migration. *The International Journal of Climate Change: Impacts and Responses, 5*(2), 1–15. <https://doi.org/10.18848/1835-7156/cgp/v05i02/37204>
- Barnett, J., Webber, M. (2010). Migration as Adaptation: Opportunities and Limits. In J. McAdam (Ed.), *Climate Change and Displacement : Multidisciplinary Perspectives* (pp. 37–55). Bloomsbury Publishing Plc. <https://doi.org/10.5040/9781472565211.ch-003>
- Brenner, N. (2011). The urban question and the scale question: Some conceptual clarifications. In N. Glick Schiller & A. Caglar (Eds.), *Locating Migration: Rescaling Cities and Migrants* (pp. 23–41). Ithaca: Cornell University Press. <https://doi.org/10.7591/9780801460340-003>
- Camillo Boano, Roger Zetter, T. M. (2008). Environmentally displaced people Understanding the linkages between environmental change, livelihoods and forced migration. *Refugee Studies Centre*, (November), 44.
- Castles, S., De Haas, H., Miller, M. (2020). *The Age of Migration. International population movements in the modern world*. (Sixth edit). New York: Guildford Press.
- Davoudi, S., Brooks, E., & Mehmood, A. (2013). Evolutionary Resilience and Strategies for Climate Adaptation. *Planning Practice and Research, 28*(3), 307–322. <https://doi.org/10.1080/02697459.2013.787695>
- Fainstein, S. (2015). Resilience and justice. *International Journal of Urban and Regional Research, 39*(1), 157–167. <https://doi.org/10.1111/1468-2427.12186>
- Gill, N. (2010). “Environmental refugees”: Key debates and the contributions of geographers. *Geography Compass, 4*(7), 861–871. <https://doi.org/10.1111/j.1749-8198.2010.00336.x>
- Heathcote, R. L. (2013). Drought in World Literature, Art, Philosophy and Community. In *Drought and the Human Story: Braving the Bull of Heaven* (p. 318). Routledge.
- Hugo, G. (2010). Climate Change-Induced Mobility and the Existing Migration Regime in Asia and the Pacific. In J. McAdam (Ed.), *Climate Change and Displacement : Multidisciplinary Perspectives* (pp. 9–36). Bloomsbury Publishing Plc. <https://doi.org/10.5040/9781472565211.ch-002>
- IOM. (2019). *International Migration Law N° 34: Glossary on Migration*. Retrieved from https://publications.iom.int/system/files/pdf/iml_34_glossary.pdf
- Ionesco, D., Mokhnacheva, D., & Gemenne, F. (2017). *Atlas of Environmental Migration* (1st editio). Routledge, Earthscan, IOM.
- Manzo, K. (2010). Imaging vulnerability: the iconography of climate change. *The Royal Geographical Society, 42*(1), 49–64. <https://doi.org/10.1111/j.l>
- Myers, N. (1997). Environmental refugees. *Population and Environment, 19*(2), 167–182. <https://doi.org/10.4337/9781785360497.00019>
- Piguet, E. (2010). Climate Change and Migration: A Synthesis. In T. Afifi & J. Jäger (Eds.), *Environment, Forced Migration and Social Vulnerability* (pp. 73–85). Springer.
- Sayre, N. F. (2009). Scale. In N. Castree, D. Demeritt, & D. Liverman (Eds.), *A Companion to Environmental Geography* (pp. 95–108). John Wiley & Sons, Incorporated.
- Scheffran, J., Marmer, E., & Sow, P. (2012). Migration as a contribution to resilience and innovation in climate adaptation: Social networks and co-development in Northwest Africa. *Applied Geography, 33*(1), 119–127. <https://doi.org/10.1016/j.apgeog.2011.10.002>
- Schiller, N. G., & Çağlar, A. (2011). Locality and globality: Building a comparative analytical framework in migration and urban studies. In N. Glick Schiller & A. Caglar (Eds.), *Locating Migration: Rescaling Cities and Migrants* (pp. 60–84). Ithaca: Cornell University Press. <https://doi.org/10.7591/9780801460340-005>
- Taşan-kok, T., Stead, D., & Lu, P. (2013). Conceptual Overview of Resilience: History and Context. In A. Eraydin & T. Taşan-kok (Eds.), *Resilience Thinking in Urban Planning* (pp. 39–51). Springer Science+Business Media. <https://doi.org/10.1007/978-94-007-5476-8>
- Vale, L. J. (2014). The politics of resilient cities: Whose resilience and whose city? *Building Research and Information, 42*(2), 191–201. <https://doi.org/10.1080/09613218.2014.850602>
- van Ostaijen, M. (2017). Between migration and mobility discourses: the performative potential within ‘intra-European movement.’ *Critical Policy Studies, 11*(2), 166–190. <https://doi.org/10.1080/19460171.2015.1102751>



RCP 8.5; temperature JJA. These maps show the seasonal temperature change for the USA for June/July/August 20-year means compared to baseline temperature (20-year monthly means for period 1986-2006). The data is distributed in quantiles. The darkest colour represents a small amount of data points for a wide range of temperatures. This temperature excesses are partly explained by the uncertainty of the

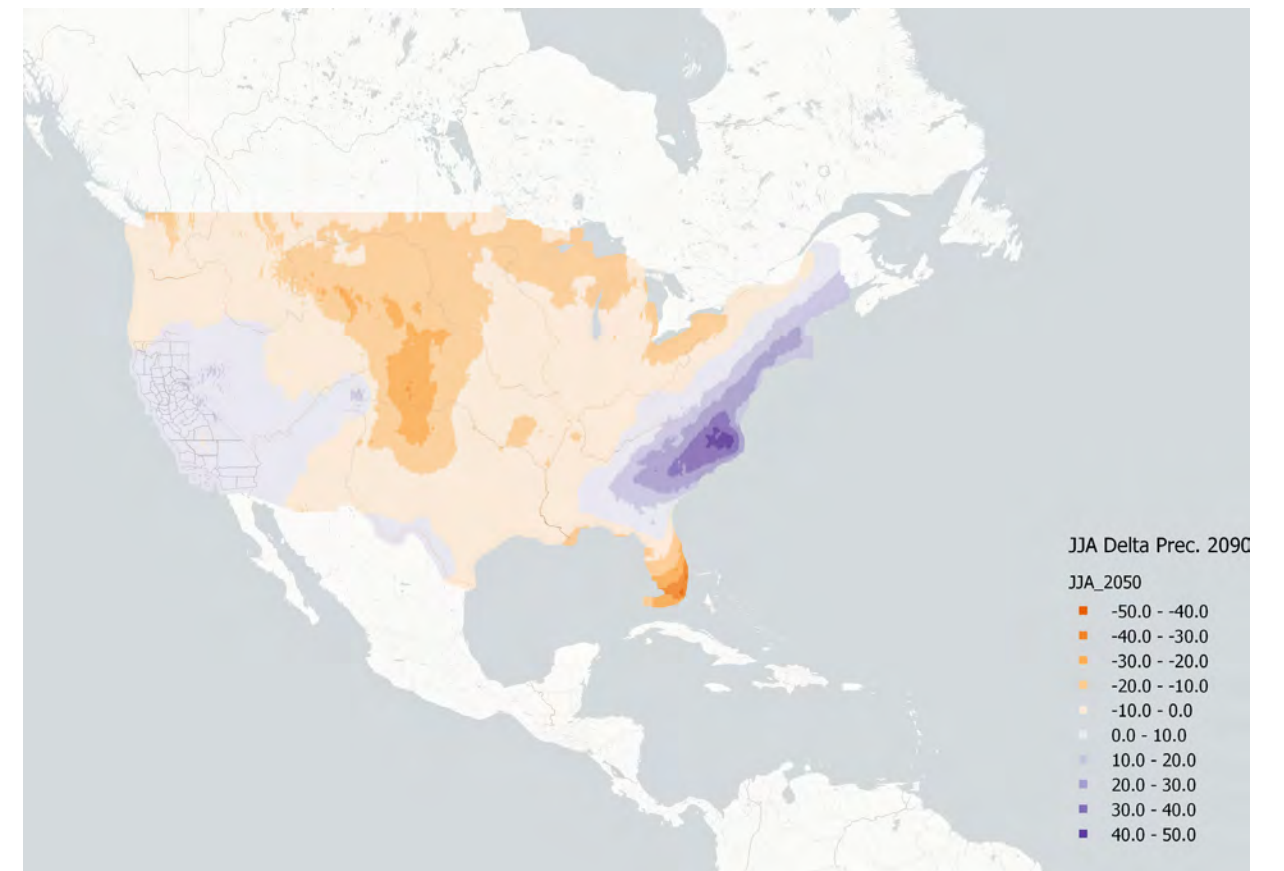
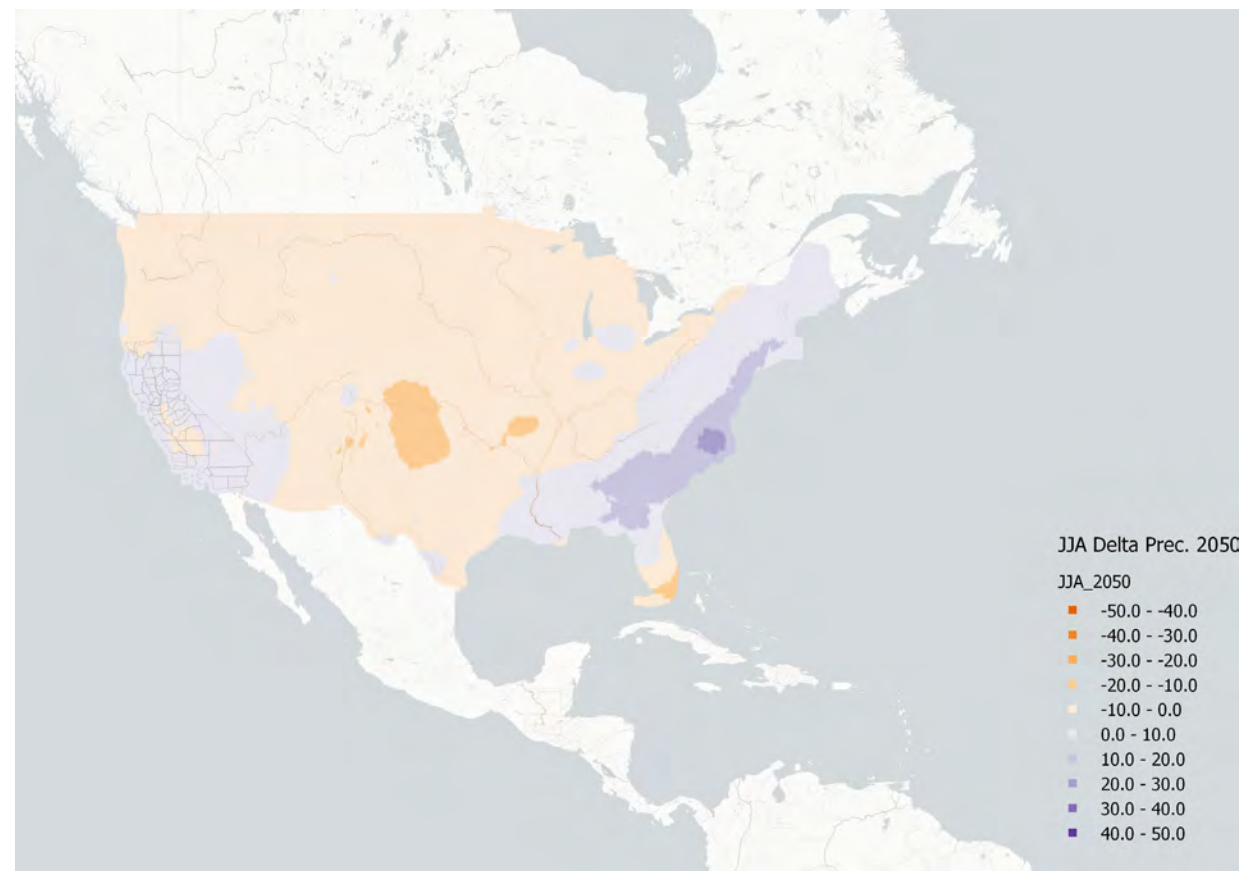
models, hence the reason for choosing this data distribution. The darkest colours are in every map present in the Southern counties of California. The seasonal temperature change fluctuates from +1.6 degrees Celsius in San Diego in 2030, to +5.5 degrees Celsius in 2090. These data are based on RCP 8.5, the 'business-as-usual' model of the IPCC (continuation of exponential CO2 deposition in atmosphere).

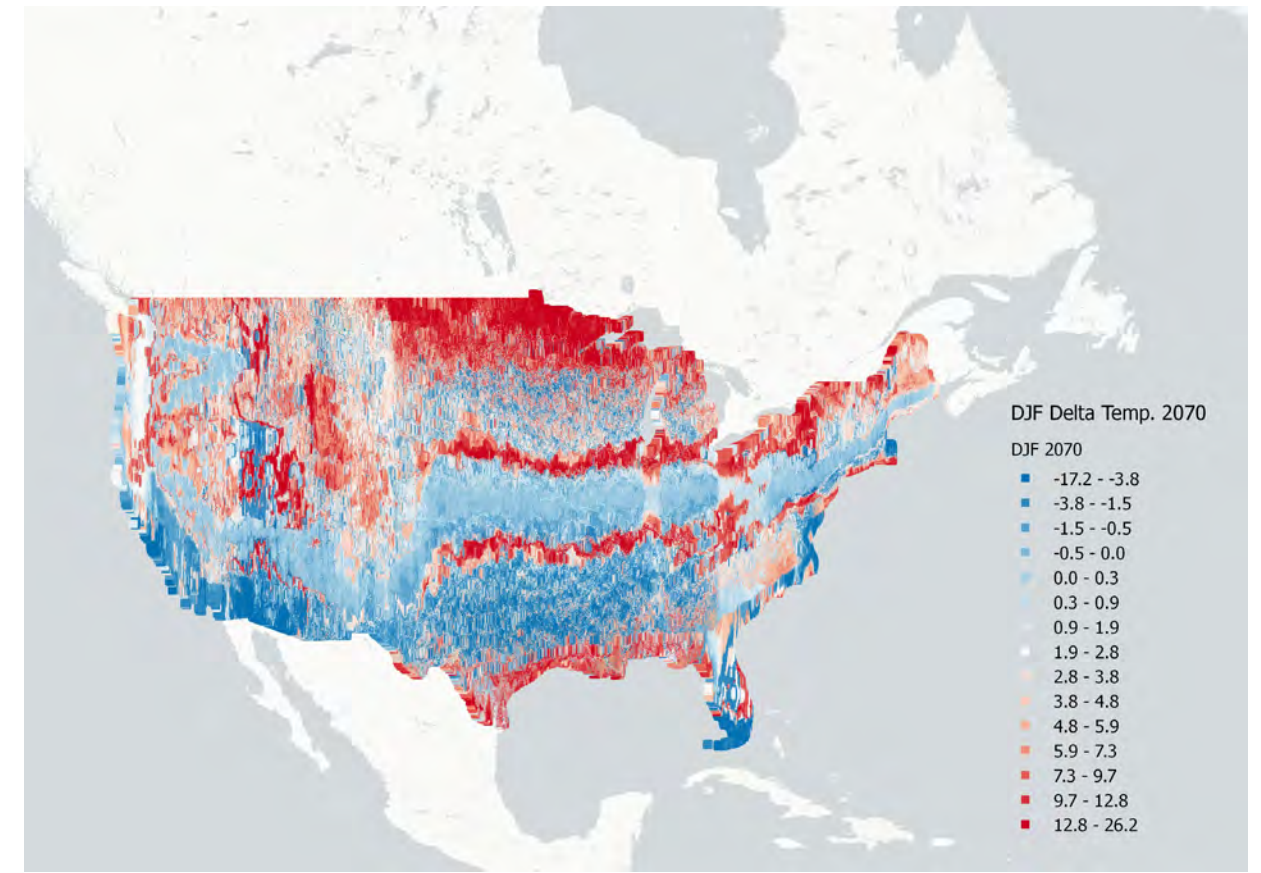
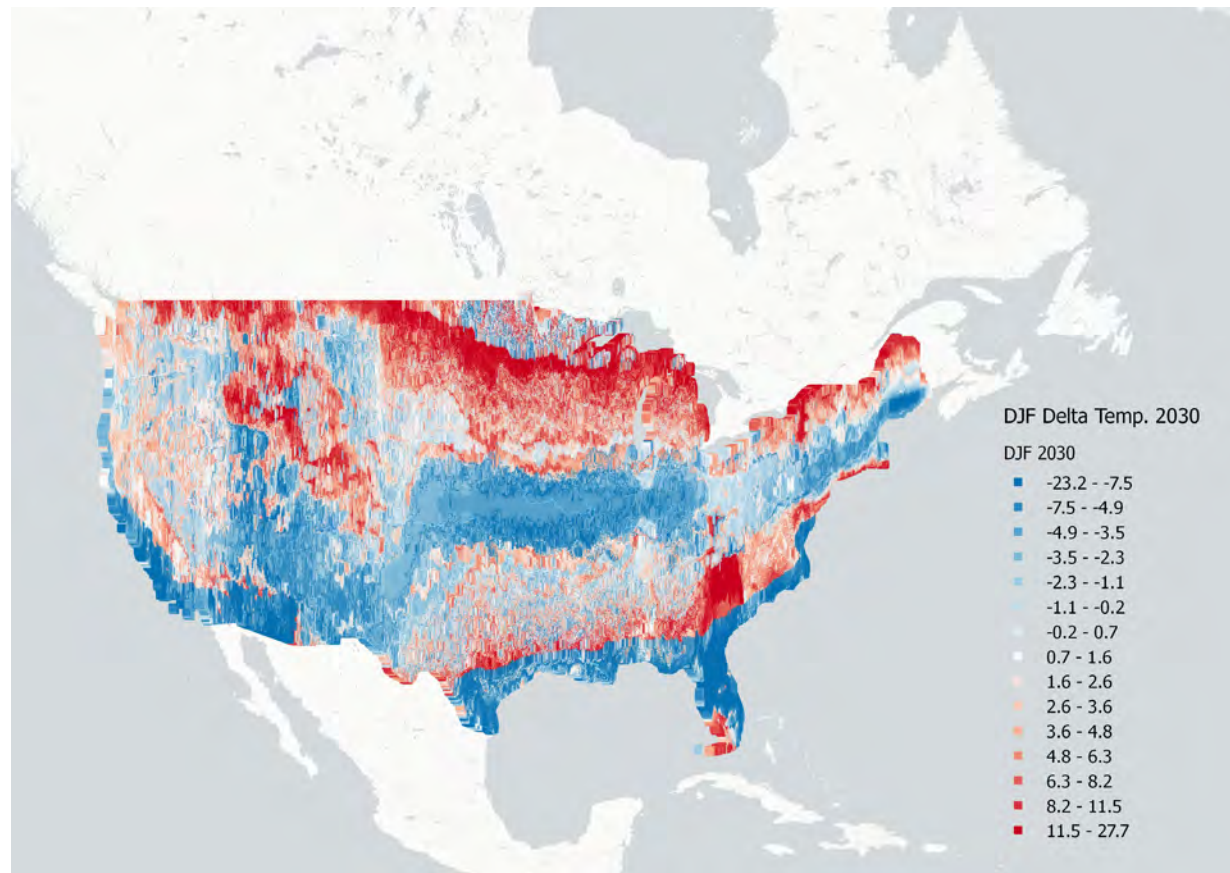




RCP 8.5; precipitation JJA. these maps show the seasonal precipitation change for the USA for June/July/August 20-year means compared to baseline precipitation (20-year monthly means for period 1986-2006). The data is distributed in the same equal parts over all timeperiods. For the southern counties in California, the precipitation changes very little from +1mm in 2030, to +3mm in 2090. The Central Valley

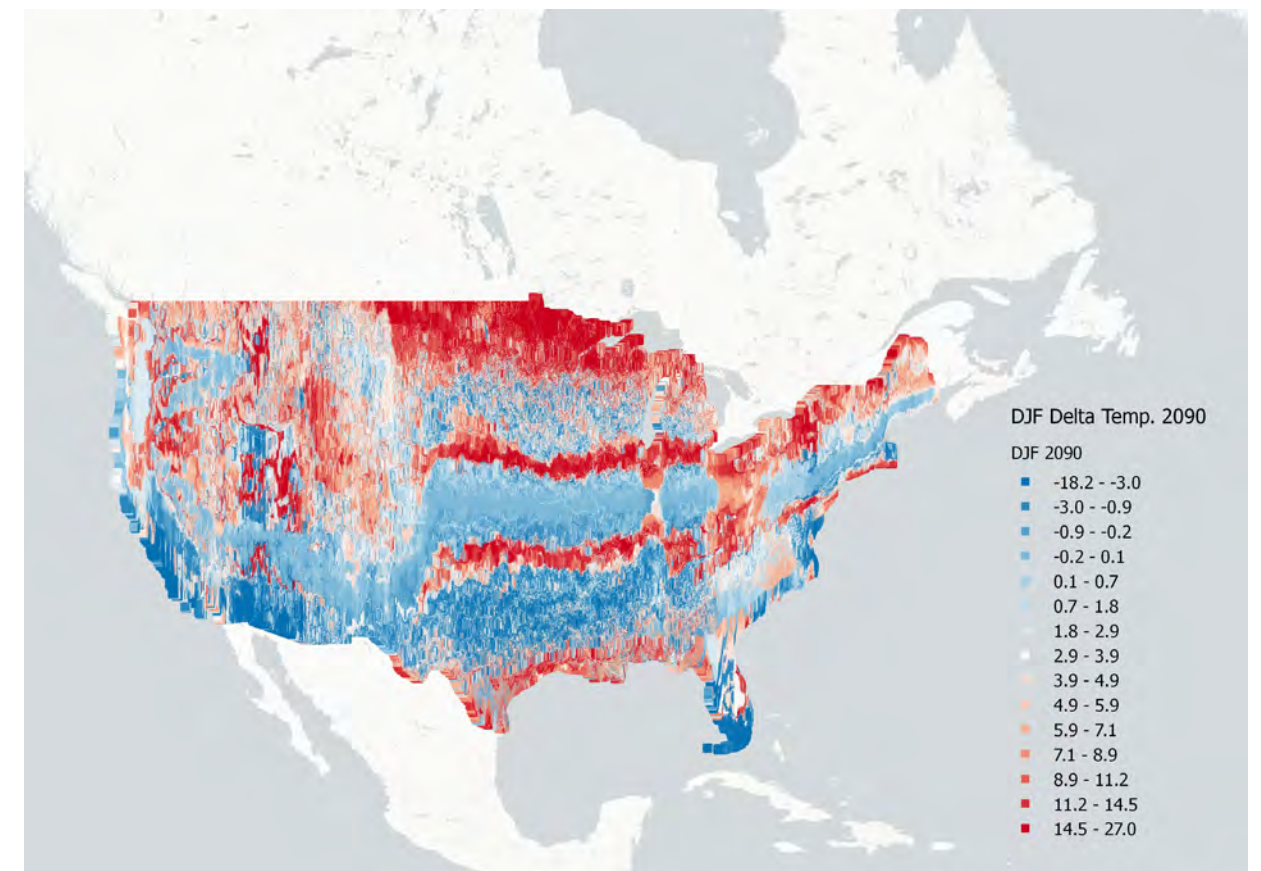
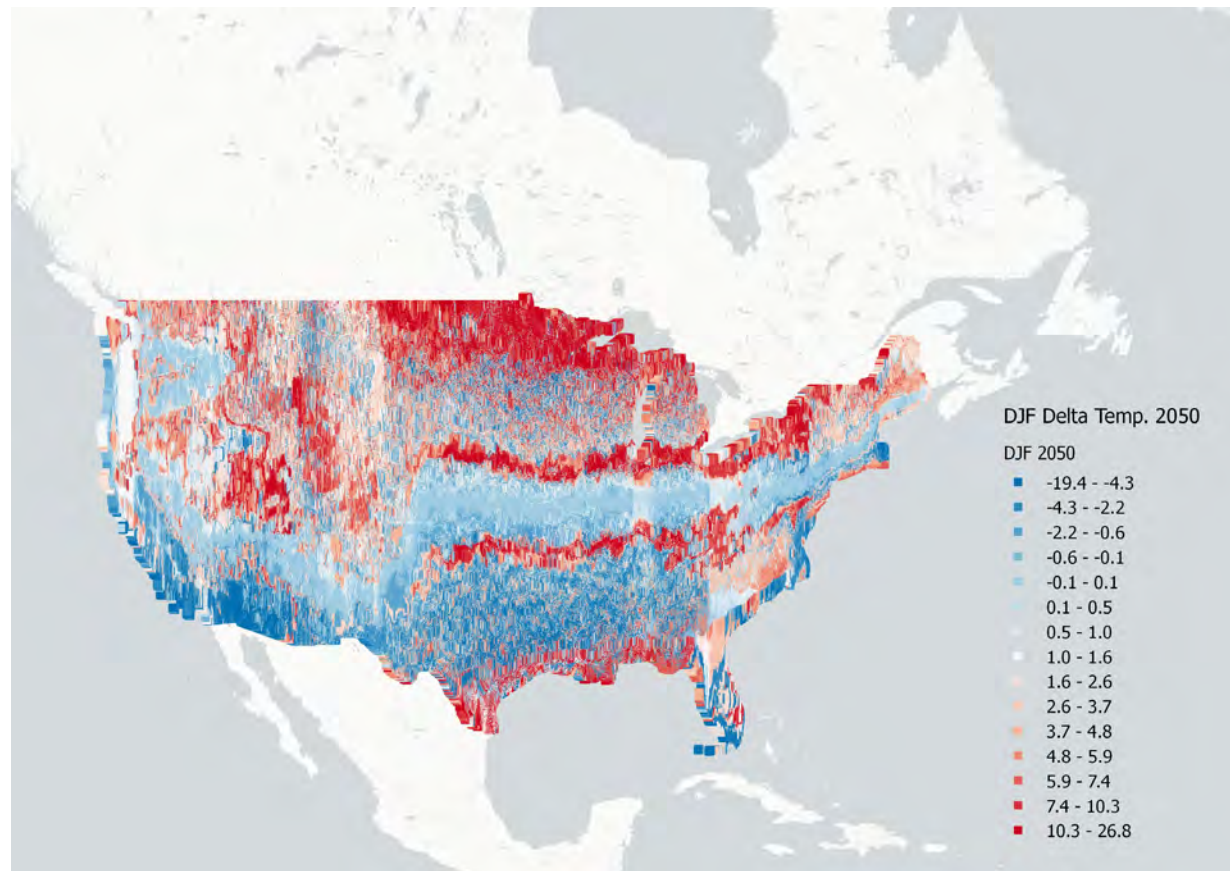
agriculture area initially becomes dryer compared to the baseline values. The mountainranges in the northern USA that provide fresh water for southern states become increasingly dryer in the summer period.

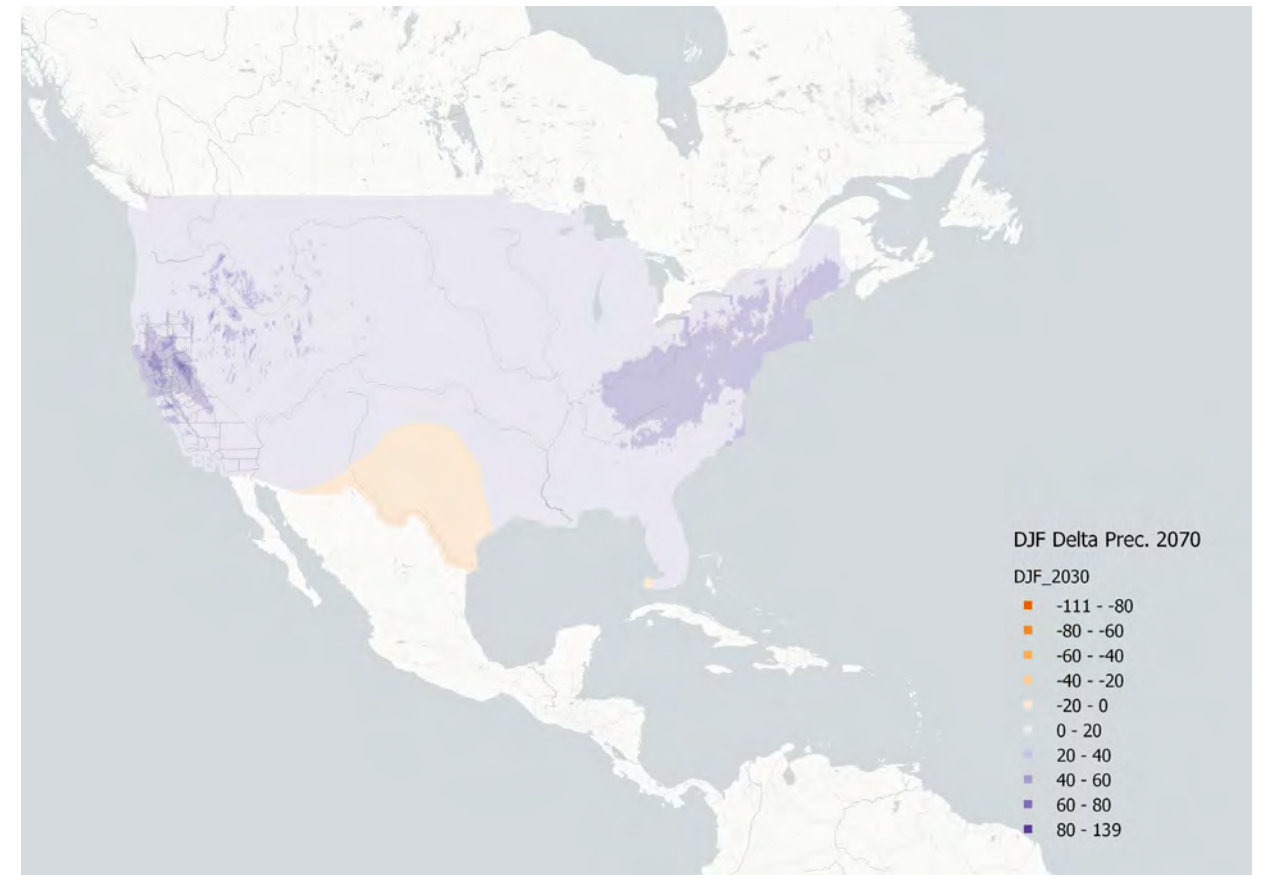
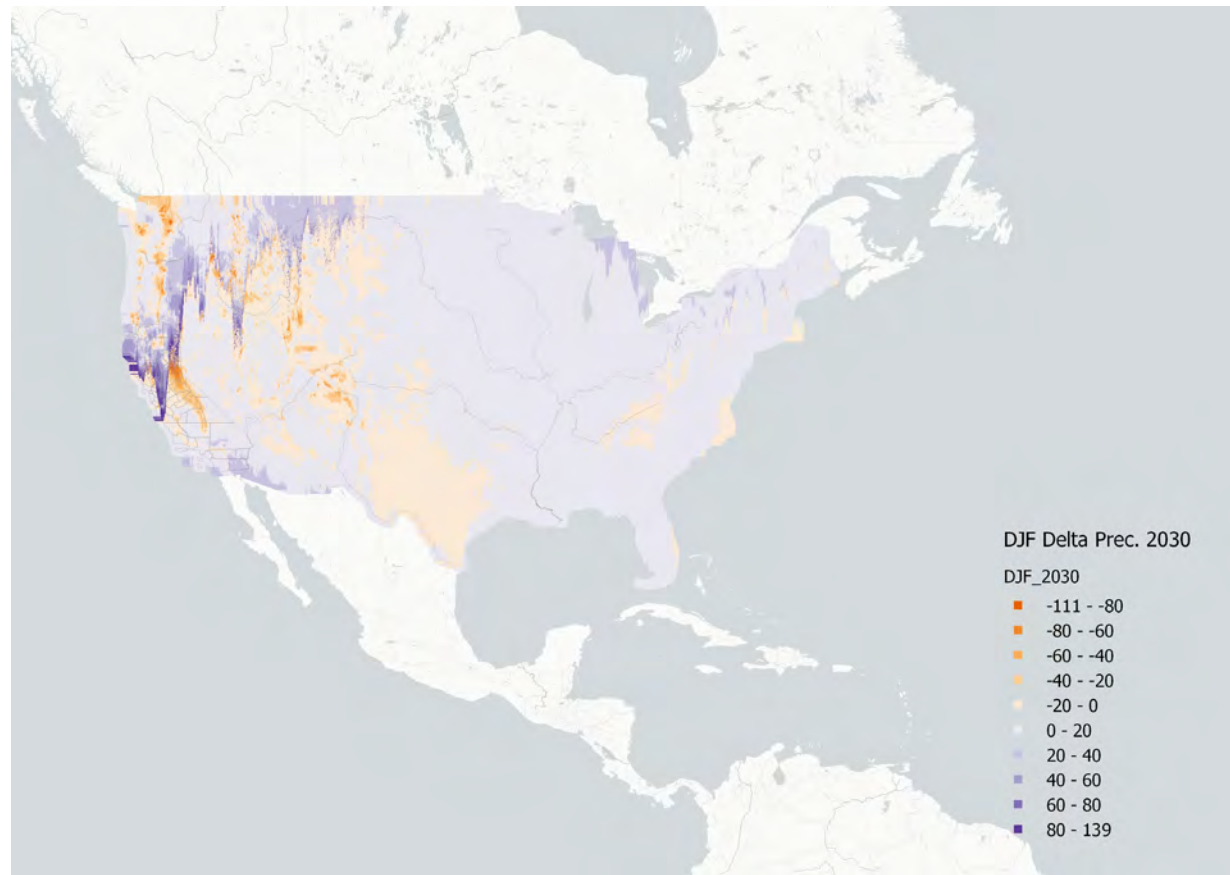




RCP 8.5; temperature DJF. These maps show the seasonal temperature change for the USA for December/January/February 20-year means compared to baseline temperature (20-year monthly means for period 1986-2006). Similarly to the JJA maps, the data is distributed in quantiles. For the souther counties in California, the general trend is that the temperature decreases from -1 degree Celsius in 2030 to -7 degrees Celsius in 2090 according to this RCP. This holds for the Mediterranean (coastal) climate, and the desert climate. Generally, the

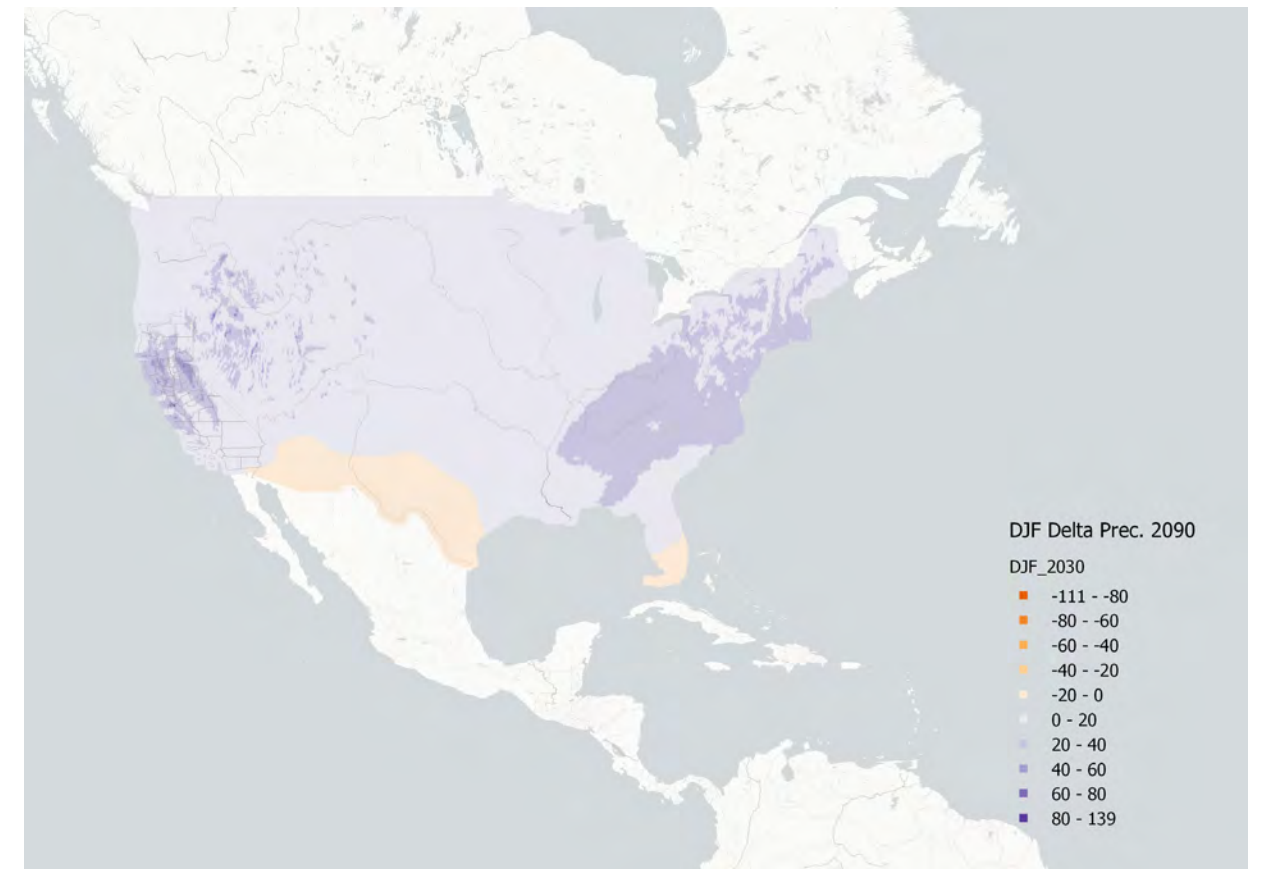
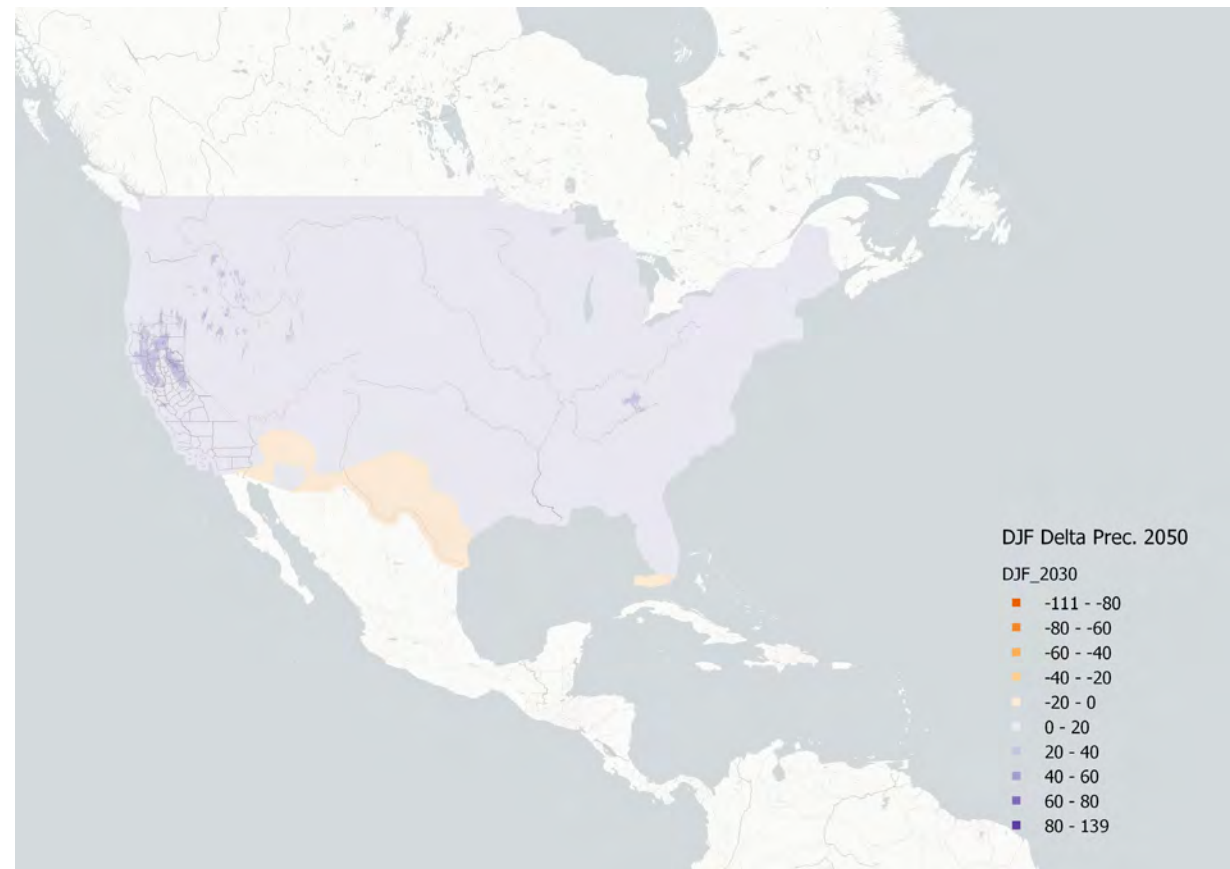
mountain ranges rather see a temperature increase of +5 degrees Celsius in the winter season.



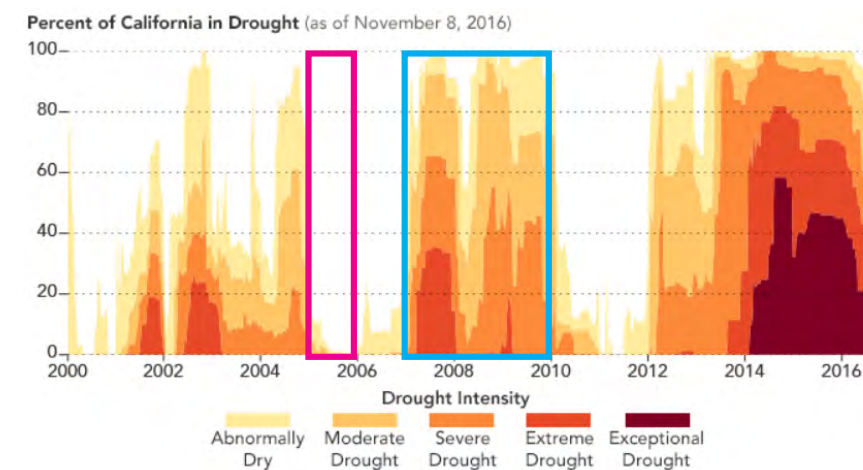
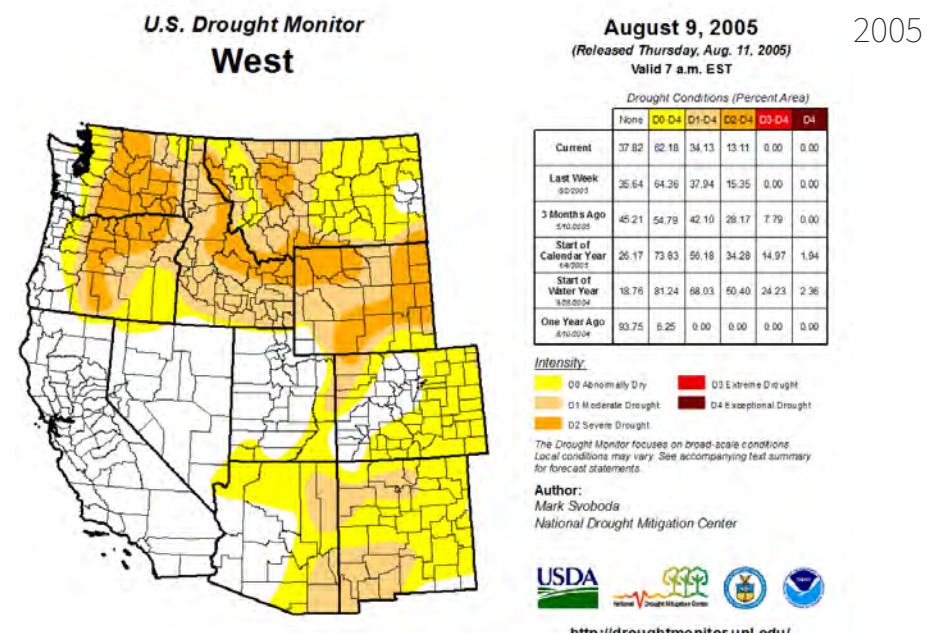


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Hypothesis: more (internal) migration between agricultural areas in years of drought



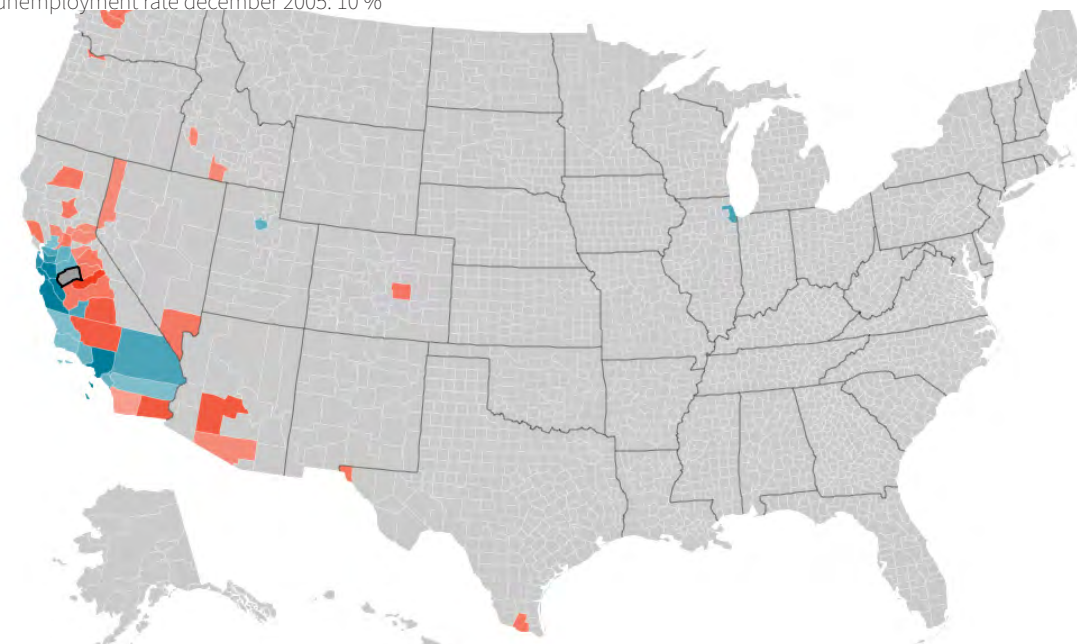
Source: <https://landsat.visibleearth.nasa.gov/view.php?id=89110>

2007-2009 is the 12th worst drought period in the history of state California, and the first drought for which a state-wide proclamation of emergency was issued.

unemployment rate december 2005: 13,8 %

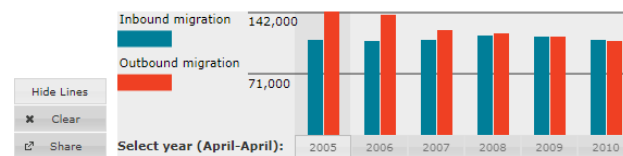


unemployment rate december 2005: 10 %



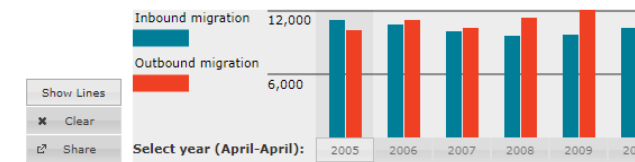
Imperial County (El Centro), Calif.

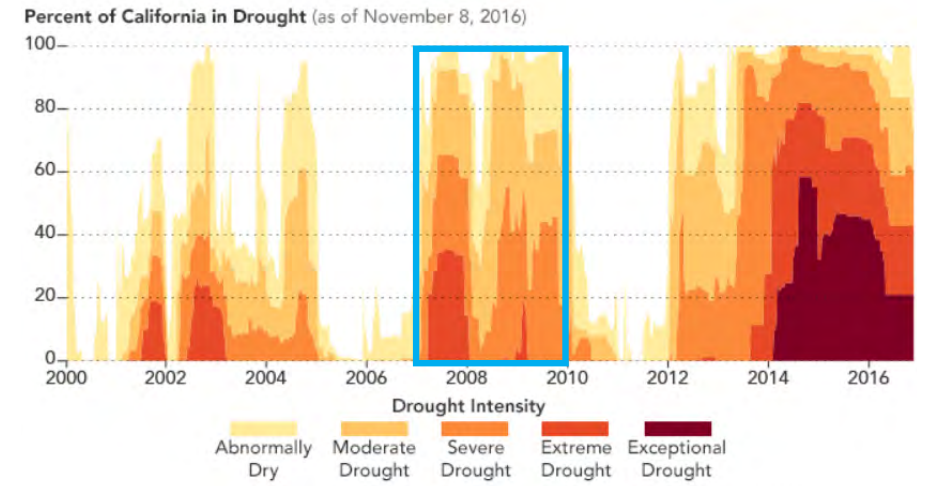
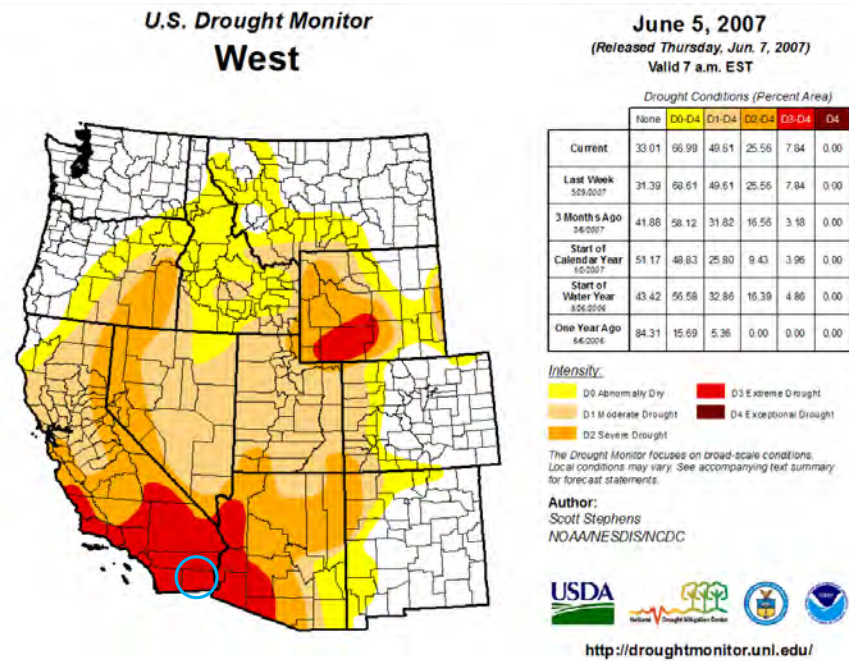
Population (2010): 174,528
 Population (2005): 156,113
 Inbound income per cap. (2005): \$11,500
 Outbound income per cap. (2005): \$13,400
 Non-migrant income per cap. (2005): \$12,000



Merced County (Merced), Calif.

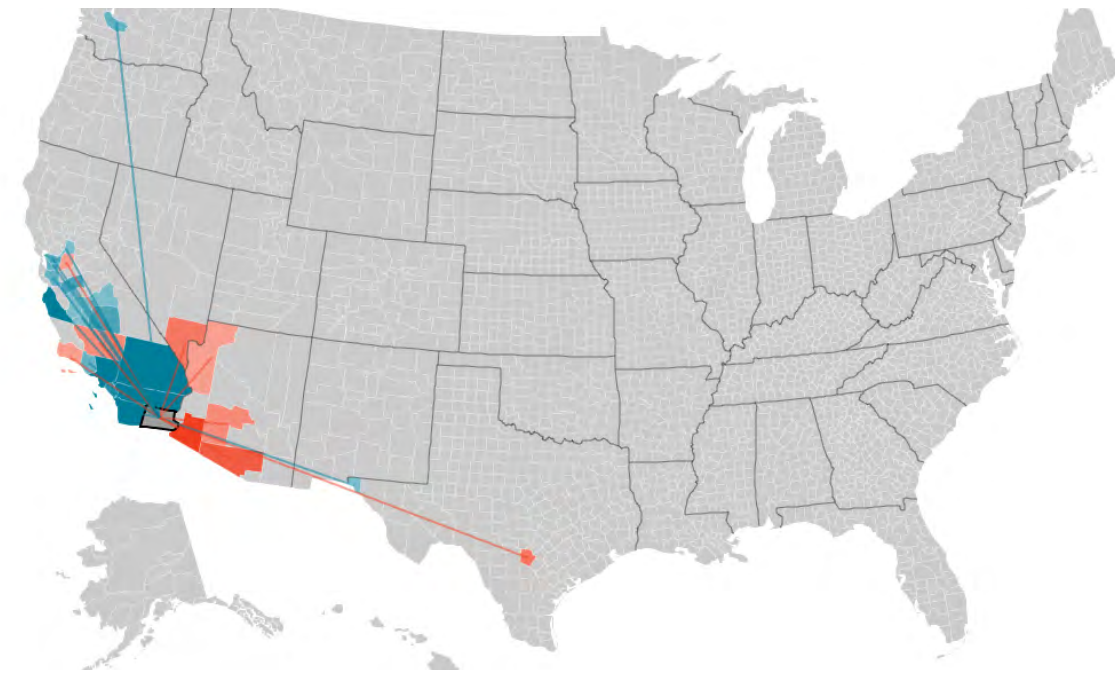
Population (2010): 255,793
 Population (2005): 242,554
 Inbound income per cap. (2005): \$14,400
 Outbound income per cap. (2005): \$15,500
 Non-migrant income per cap. (2005): \$15,000





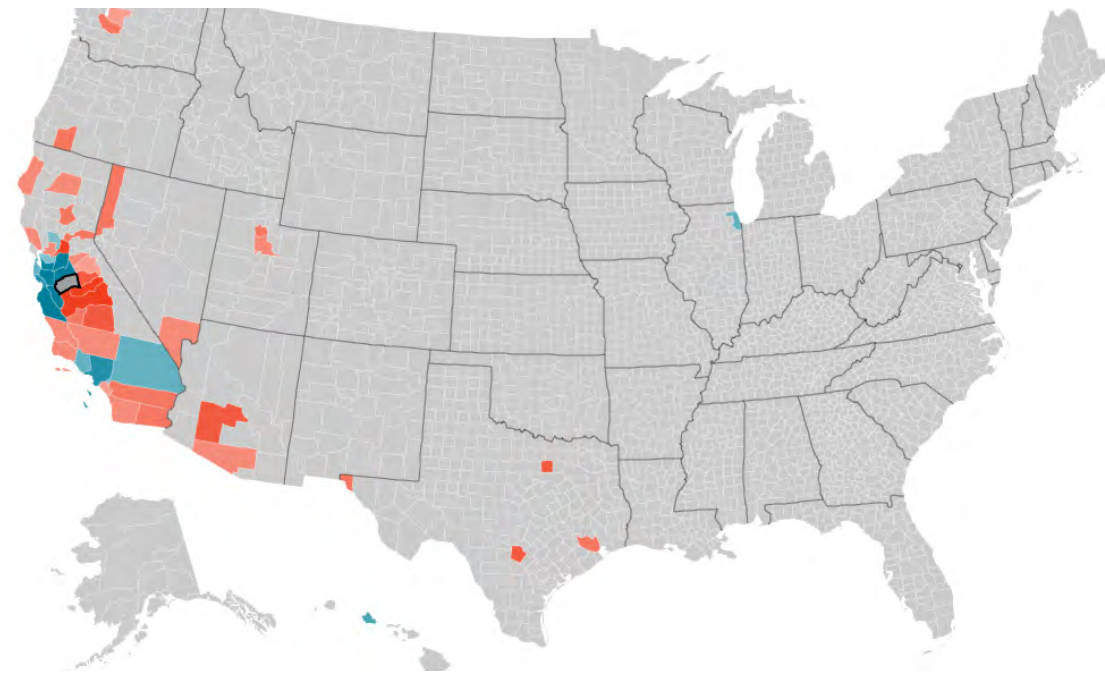
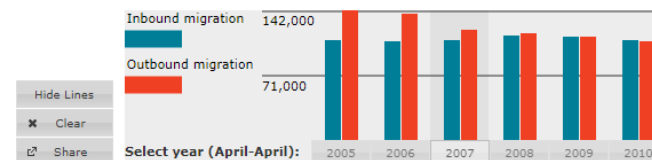
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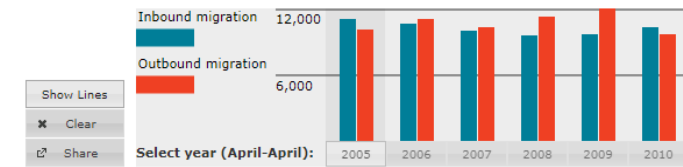
Imperial County (El Centro), Calif.

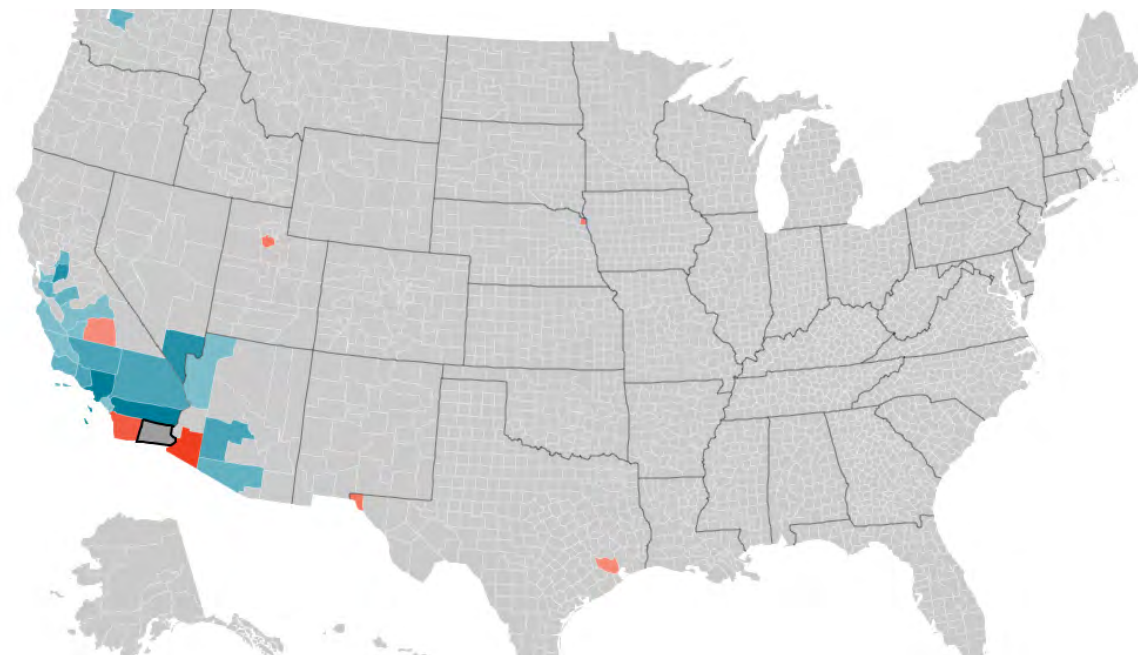
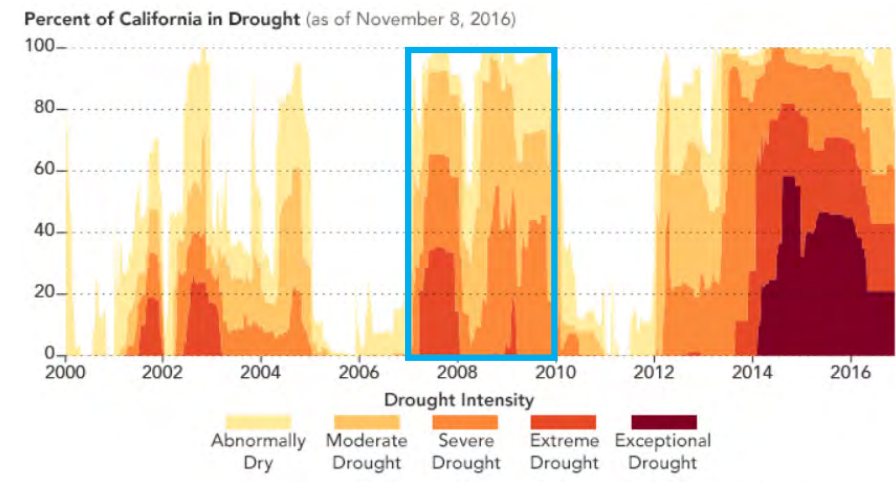
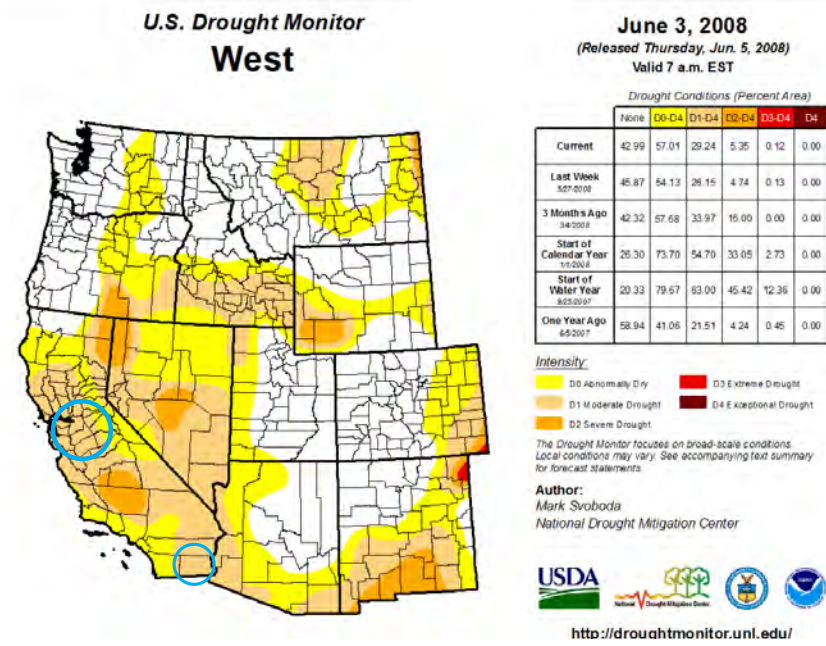
Population (2010): 174,528
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 Outbound income per cap. (2007): \$15,100
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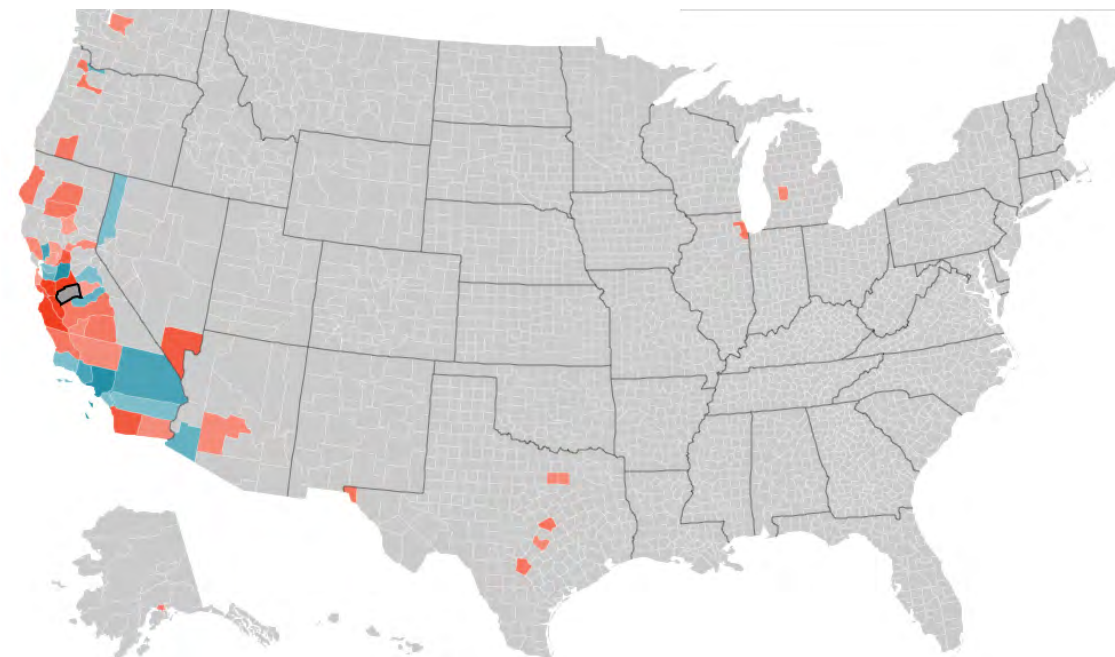
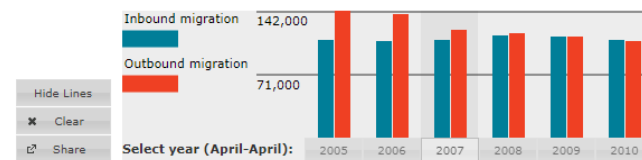
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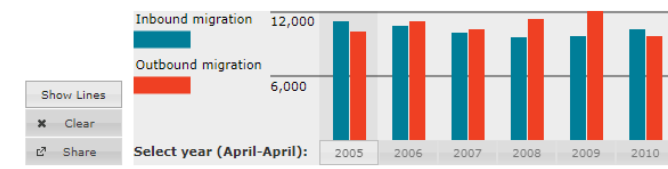
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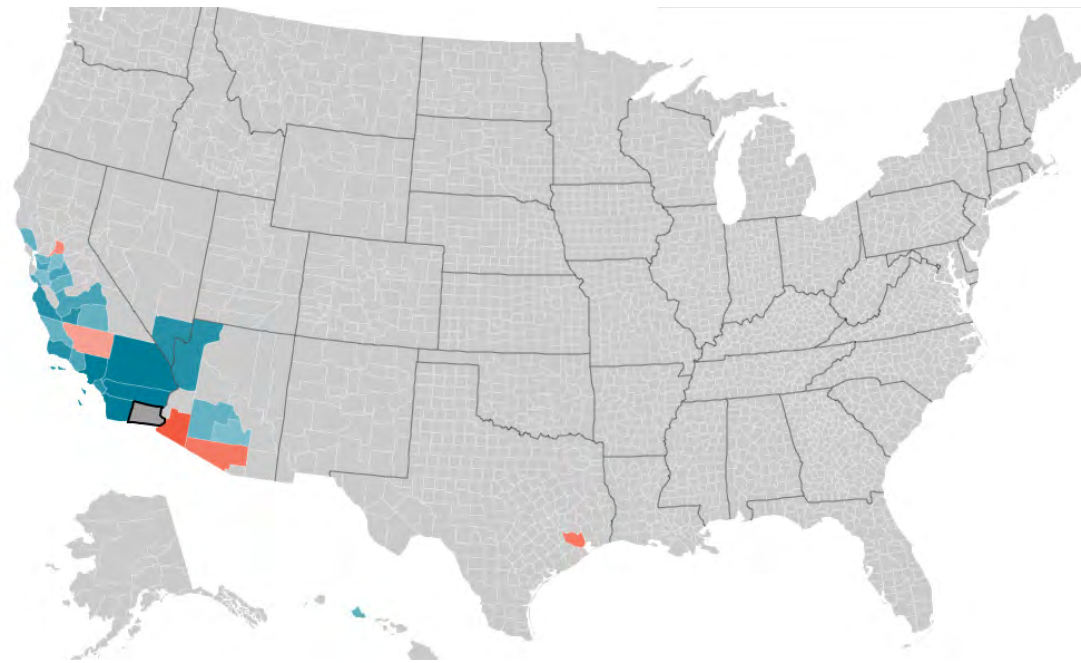
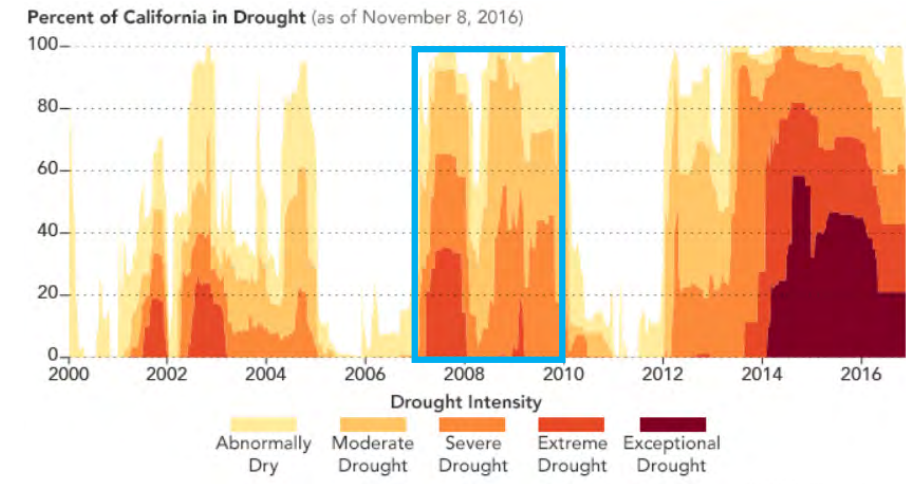
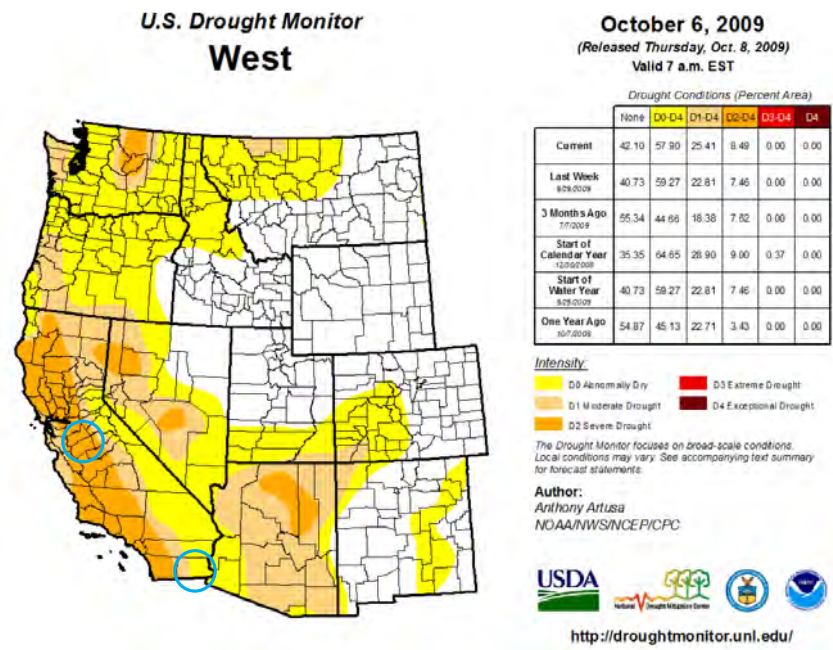
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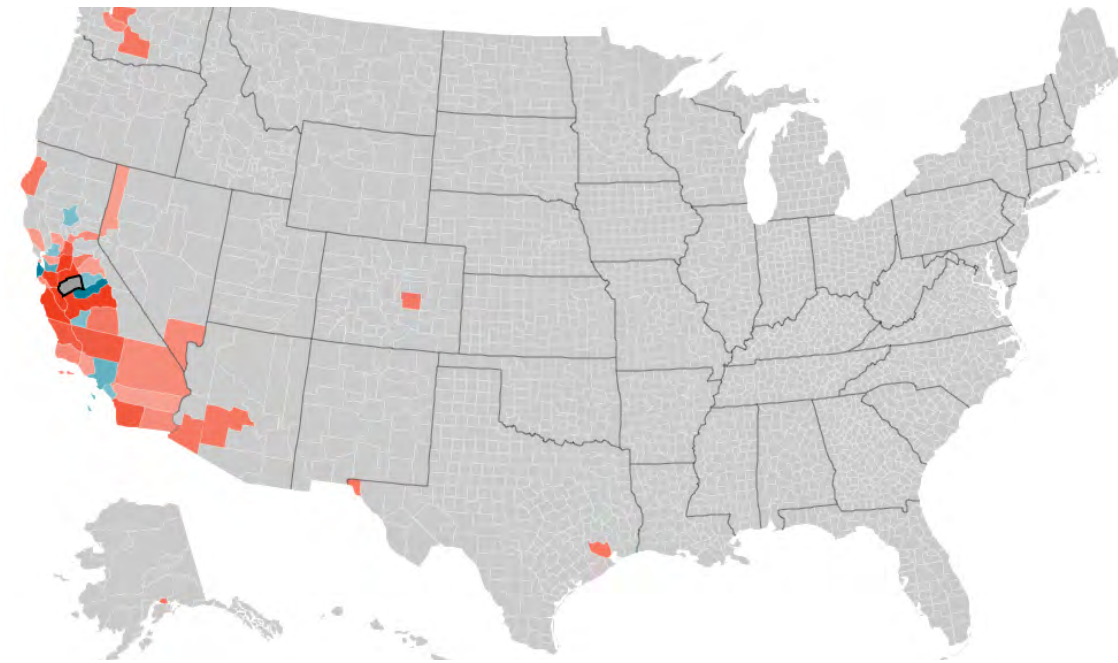
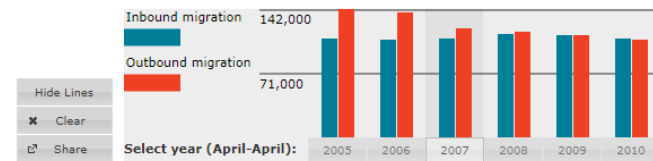
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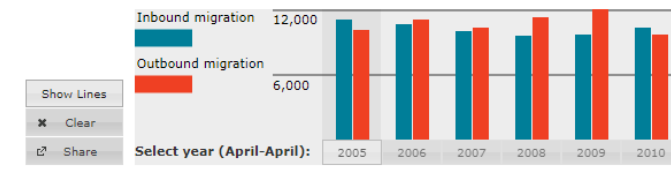





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This thesis explores alternative spatial- and governance responses to deal with climate-induced migration as a result of slow-onset climate change in the southern California border region with Mexico. These responses will be specifically aimed to mitigate and adapt to a future that may see displacement as a result of changing environmental conditions. In order to do so, this project prioritizes an approach that addresses preparedness towards anticipating change as well as the scale- and temporal variability of the changing conditions and their impacts.

This project uses Dynamic Adaptive Policy Pathways (DAPP) as a methodology to explore alternative future narratives that are geared towards mitigating and adapting to changing climate conditions. It defines concentrations of social- and locational vulnerability as a proxy to anticipate potential migration flows, displacement or trapped population. It then explores potentials for adaptation across scales, which are then used to formulate spatial- and policy actions. In doing this, the project looks specifically for synergies of actions that address the before defined vulnerabilities. The formulated actions are then sequenced into alternative narratives to show their impact for two different IPCC Representative Concentration Pathways (RCP's). Finally, they are evaluated for their performance in addressing vulnerabilities related to climate-induced migration and for their applicability to the existing multi-scalar planning framework.