

## **Systems Thinking in Communities:**

### **Understanding the Causes of Inactivity, Poor Diet/Nutrition, and Childhood Obesity in California's Central Valley—HKHC Leading Site**



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## Introduction

California's Central Valley—Healthy Kids, Healthy Communities (HKHC) Leading Site is one of 49 community partnerships participating in the national *Healthy Kids, Healthy Communities* program of the Robert Wood Johnson Foundation ([www.healthykidshealthycommunities.org](http://www.healthykidshealthycommunities.org)). The purpose of this *California's Central Valley—HKHC Leading Site* project was to introduce systems thinking at the community level by identifying the essential parts of the Central Valley, California system and how the system influences policy and environmental changes to promote healthy eating and active living as well as to prevent childhood obesity. To accomplish this goal, community partners and residents participated in a group model building session and discussions. The group model building exercises were designed by staff from Transtria LLC and the Social System Design Lab at Washington University in St. Louis, Missouri as part of the *Evaluation of Healthy Kids, Healthy Communities* funded by the Robert Wood Johnson Foundation. These exercises actively involved a wide range of participants in modeling complex systems and provided a way for different representatives (e.g., residents, government agencies, community-based organizations, foundations, academic institutions) to better understand the systems (i.e., dynamics and structures) in the community (see the *Healthy Kids, Healthy Communities Group Model Building Facilitation Handbook*, [www.transtria.com/hkhc](http://www.transtria.com/hkhc)). Overall, the evaluation was designed to assess policy, system, and environmental changes as a result of the community partnerships' efforts to increase healthy eating and active living in order to reduce childhood obesity.

## Central Valley, California: Background and Local Participation

The 240-mile long San Joaquin Valley is a major agricultural region encompassing eight counties in Central California (Kern, Kings, Tulare, Fresno, Madera, Merced, Stanislaus, and San Joaquin). However, residents, many of them migrant workers, are often unable to enjoy the abundance of food grown all around them, as Central Valley grows the bulk of the nation's fruits and vegetables. People living here have among the lowest per capita income, highest rates of poverty, and lowest educational attainment in the state (see Table 1). All are factors contributing to pronounced rates of overweight and obesity, particularly among youth.

There are over 70 ethnicities represented in Central Valley and over 100 languages spoken. Outside of the City of Los Angeles, the region has the largest concentration of Latinos in the United States. However, there are distinct differences between the North and South Central Valleys. North Valley, close to Oakland and San Francisco, adopts culture and the leadership that is almost all African American women. Whereas, the South Valley leadership is mostly Hispanic women.

The Central California Regional Obesity Prevention Program (CCROPP), a program developed by the Central California Public Health Partnership, was the lead agency for Healthy Kids, Healthy Communities (HKHC) Central Valley project. CCROPP is facilitated by California State University, Fresno and brought together eight public health departments, community-based organizations, and community councils to build the capacity of community residents as advocates for change in improving local food and physical activity environments. Through funding from THE California Endowment, Robert Wood Johnson Foundation, and James Irvine Foundation, the coalition has strengthened the capacity of county public health departments to collaborate with communities to improve local environments for healthy eating and physical activity. It also has built a regional infrastructure to leverage resources, skills, communication, and policy efforts for other health improvement activities.

## **California's Central Valley—HKHC Leading Site's Priorities and Strategies**

The partnership and capacity building strategies of *California's Central Valley—HKHC Leading Site* included:

- **Powerful People: Building Leadership for Healthy Communities:** The Project Director worked with community partners and residents to design a leadership development training program and curriculum with the goal of enabling those who have traditionally been marginalized to speak for themselves. The 12-module community leadership curriculum provided training around the basic skills needed to help residents become change agents. It is culturally, linguistically, and literacy-level appropriate for low-income communities of color, and available in English and Spanish.

The healthy eating and active living strategies of *California's Central Valley—HKHC Leading Site* included:

- **Active Transportation:** Leaders advocated for Safe Routes To School in Stockton, Ceres, and Merced, resulting in improved pedestrian and bicycling access around two schools. The partnership also implemented a Walking School Bus and secured additional funding to improve pedestrian and bicycling environments.
- **Parks and Play Spaces:** HKHC partners improved safety and park amenities (e.g., installed lighting, planted trees, repaired swings) in Bakersfield and increased secured joint use agreements in Fresno, Fairmead, and Stockton between neighborhood schools and the community, for example.
- **Healthy Eating:** Graduates of the Power People program established school farm stands in Fresno and Ceres solidified Electronic Benefit Transfer (EBT) acceptance at a flea market in Merced, increased access to fruits and vegetables at a corner store in Stockton, and started community gardens in Pixley and Bakersfield.

For more information on the partnership, please refer to the Central Valley case report ([www.transtria.com/hkhc](http://www.transtria.com/hkhc)).

## Systems Thinking in Communities: North Central Valley, California

“Systems thinking” represents a range of methods, tools, and approaches for observing the behaviors of a system (e.g., family, community, organization) and how these behaviors change over time; changes may occur in the past, present, or future. Figure 1 illustrates a system of policies, environments, local collaborations, and social determinants in North Central Valley, California that influence healthy eating, active living, and, ultimately, childhood obesity. This system and the dynamics within the system are complicated with many different elements interacting.

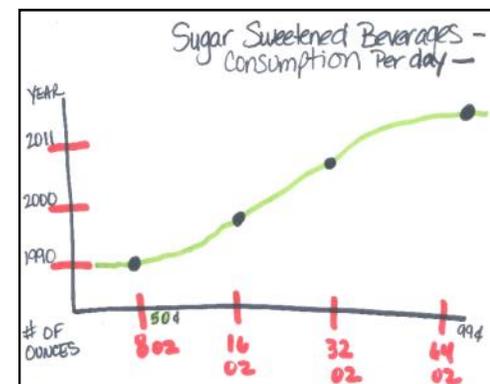
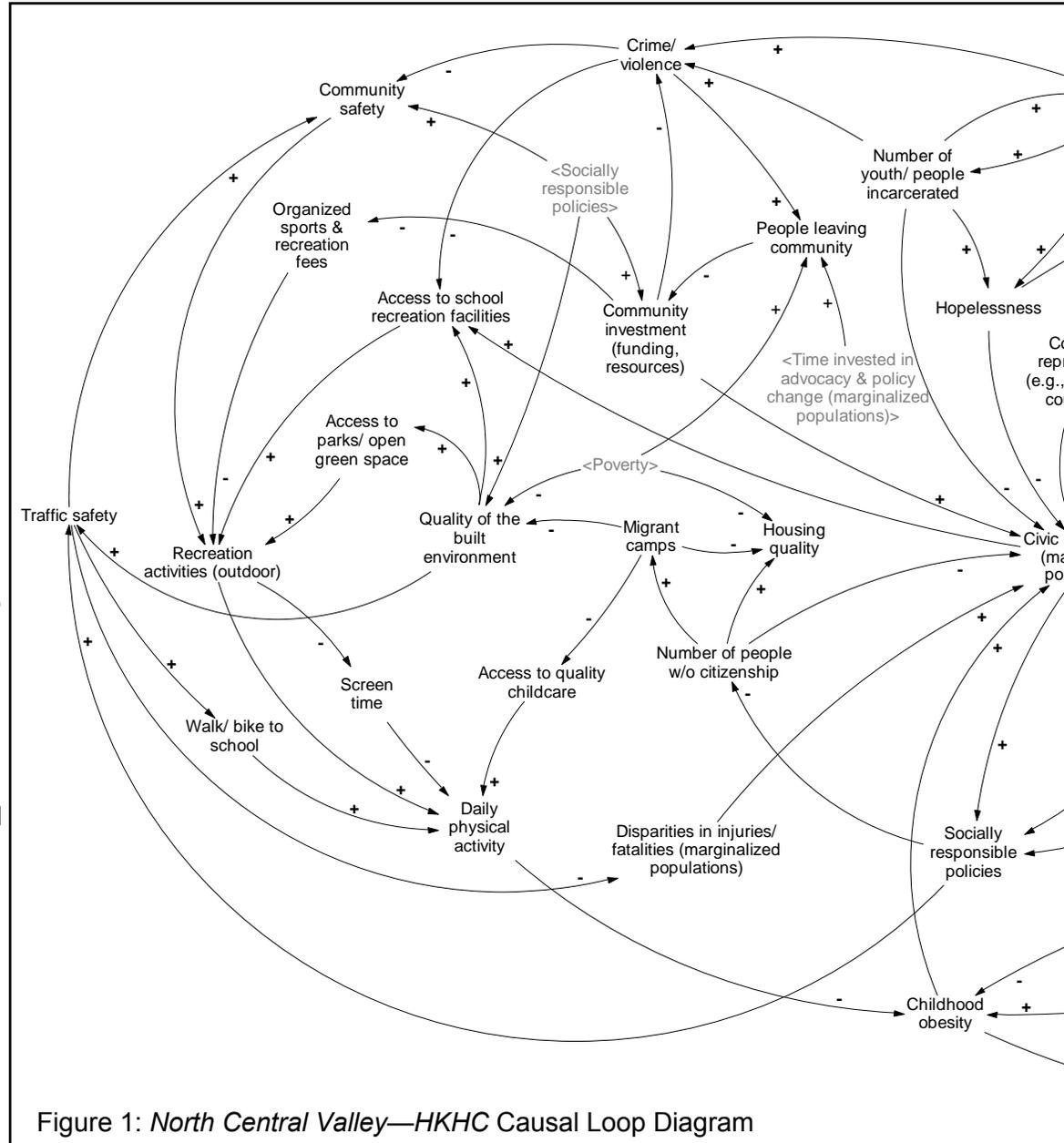
Models, such as Figure 1, provide a way to visualize all the elements of the system and their interactions, with a focus on causal relationships as opposed to associations. Through the model, specific types of causal relationships, or feedback loops, underlying the behavior of the dynamic system, can be identified to provide insights into what is working or not working in the system to support the intended outcomes (in this case, increases in healthy eating and active living, and decreases in childhood overweight and obesity). In system dynamics, the goal is to identify and understand the system feedback loops, or the cause-effect relationships that form a circuit where the effects “feed back” to influence the causes.

### Group Model Building

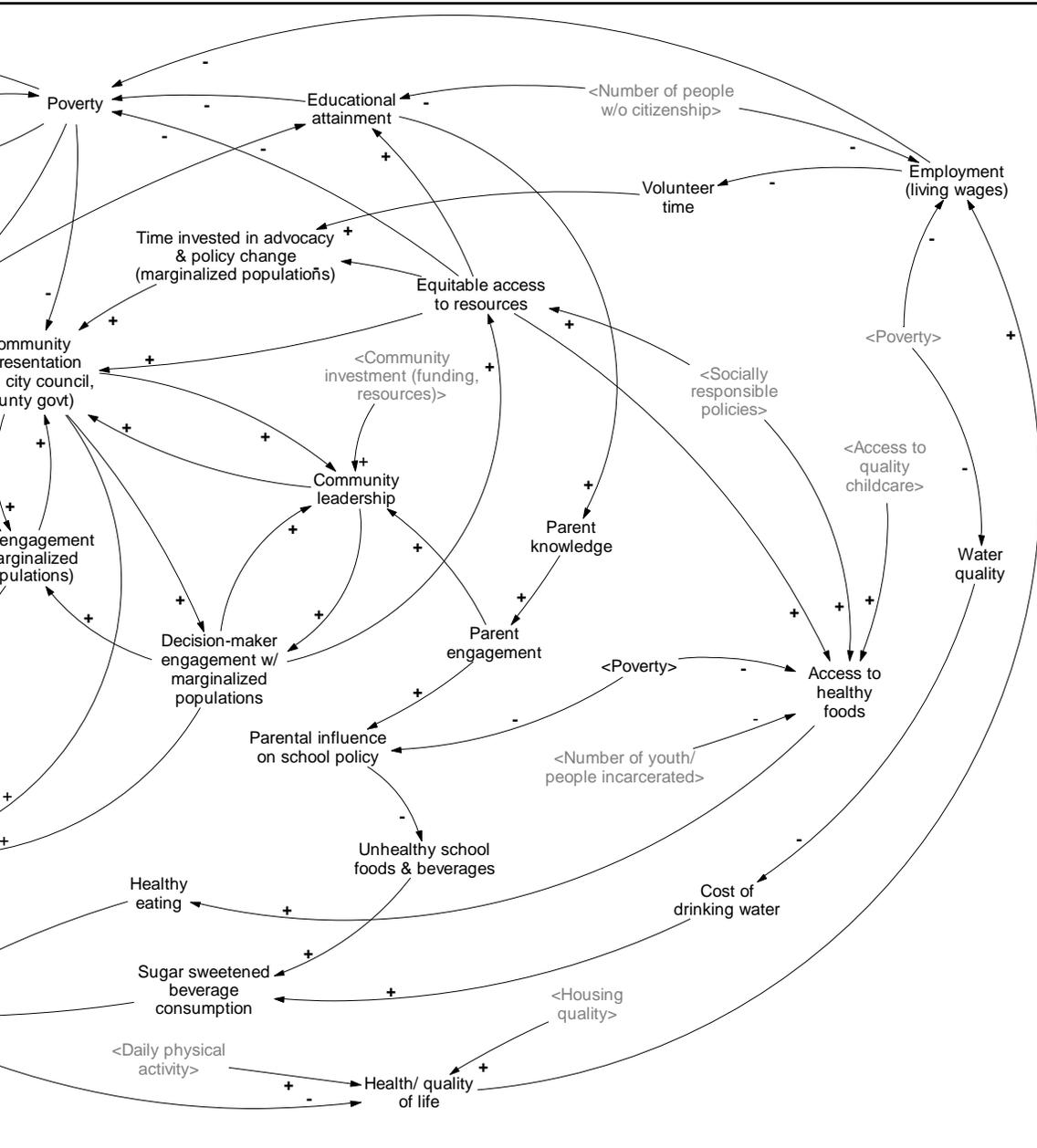
Members of *North Central Valley—HKHC* partnership participated in a group model building session in November, 2011 and generated this system. also referred to as a causal loop diagram (Figure 1). Participants in the group model building session included residents and representatives from government agencies, community-based organizations, foundations, and academic institutions. The group model building session had two primary activities: 1) a Behavior Over Time Graph exercise; and 2) a Causal Loop Diagram (or structural elicitation) exercise.

### Behavior Over Time Graphs

To identify the range of things that affect or are affected by policy, system, and environmental changes in North Central Valley related to healthy eating, active living, and childhood obesity, participants designed graphs to name the influences and to illustrate how the influences have changed over time (past,



present, and future). In this illustration for daily consumption of sugar sweetened beverages, the number of ounces for these beverages has increased from 1990 to 2012. Each graph is a tool to increase the use of common, specific language to describe *what* is changing in the community as well as *when*, *where*, and *how* it is changing. The graphs capture participants' perceptions of the influence, or variable, and through the graph, the participant tells their story. These perceptions are based on actual data or evidence, or they are part of the participants' lived experience.



### Causal Loop Diagram

To examine the relationships among the variables from the behavior over time graphs, participants worked together and with facilitators to develop a causal loop diagram. In Figure 1, the words represent variables of quantities that can increase and decrease over time (i.e., the behavior over time graphs). These variables are influenced by other variables as indicated by the lines with arrows. The lines with arrows represent causal relationships - this is what is known about the system and how it behaves.

One feedback loop is: community representation → community leadership → decision-maker engagement with marginalized populations → community representation.

What is important to notice is that there are other feedback loops interacting simultaneously to influence

or to be influenced by community representation. Some variables may increase community representation while other variables limit it. Determining the feedback loop or loops that dominate the system's behavior at any given time is a more challenging problem to figure out, and ultimately, requires the use of computer simulations.

Based on this preliminary work by the *North Central Valley—HKHC* partnership, this "storybook" ties together the behavior over time graphs, the participants' stories and dialogue, and feedback loops from the causal loop diagram to understand the behavior of the system affecting health in North Central Valley, California and to stimulate greater conversation related to North Central Valley's theory of change, including places to intervene in the system and opportunities to reinforce what is working. Each section builds on the previous sections by introducing concepts and notation from systems science.

[Note: The South Central Valley — HKHC causal loop diagram is included in Figure 3.]

## Causal Loop Diagram for the Childhood Obesity System

The causal loop diagram (CLD) represents a holistic system and several subsystems interacting in North Central Valley, California. In order to digest the depth and complexity of the diagram, it is helpful to examine the CLD in terms of the subsystems of influence. Because of this project's focus on healthy eating, active living, and childhood obesity, this system draws attention to a number of corresponding subsystems, including: healthy eating policies and environments (red), active living policies and environments (blue), health and health behaviors (orange), partnership and community capacity (purple), and social determinants (green).

From the group model building exercises, several variables and causal relationships illustrated in Figure 2 were identified within and across subsystems. This section describes the subsystems in the CLD.

### Healthy Eating Policies and Environments (Red)

The healthy eating policy and environmental subsystem includes food production, food distribution and procurement, and food retail. During the behavior over time graphs exercise, the participants generated 4 graphs related to policy or environmental strategies (e.g., unhealthy school foods and beverages) or contexts (e.g., cost of drinking water) that affected or were affected by the work of *North Central Valley—HKHC*. The variables represent participants' conversations from the behavior over time graph and causal loop diagram exercises.

### Active Living Policies and Environments (Blue)

The active living policy and environmental subsystem includes design, planning, construction, and enforcement or maintenance related to access to opportunities for active transportation and recreation. For this topic, the group model building participants developed 4 graphs related to policy or environmental strategies (e.g., access to school recreation facilities) or contexts (e.g., quality of the built environment) that affected or were affected by the partnership's work.

### Health and Health Behaviors (Orange)

The subsystem for health and health behaviors includes health outcomes (e.g., obesity), health behaviors (e.g., healthy eating, physical activity), and behavioral proxies or context-specific behaviors (e.g., walk/bike to school, sugar sweetened beverage consumption).

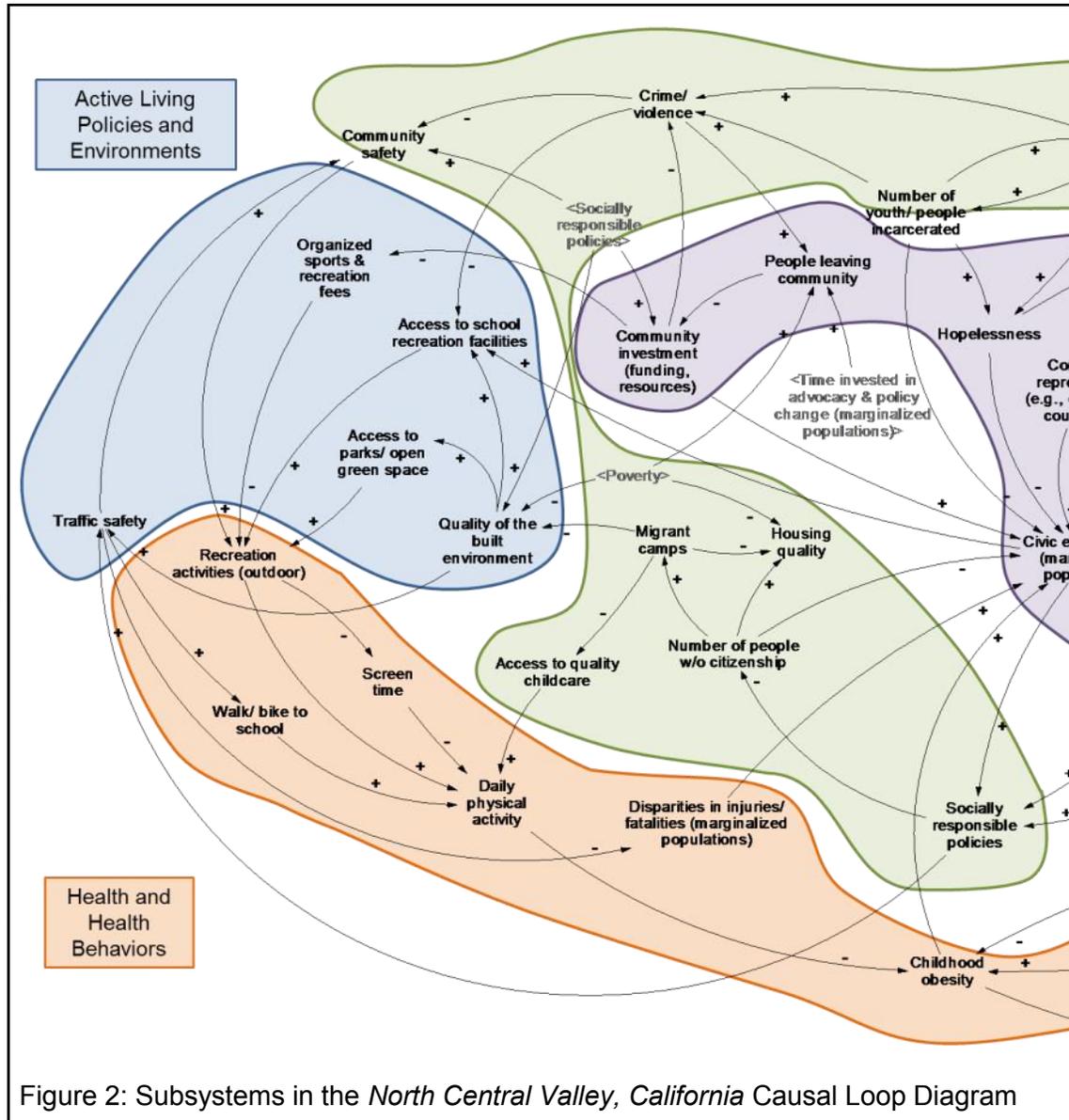


Figure 2: Subsystems in the *North Central Valley, California* Causal Loop Diagram

## Partnership and Community Capacity

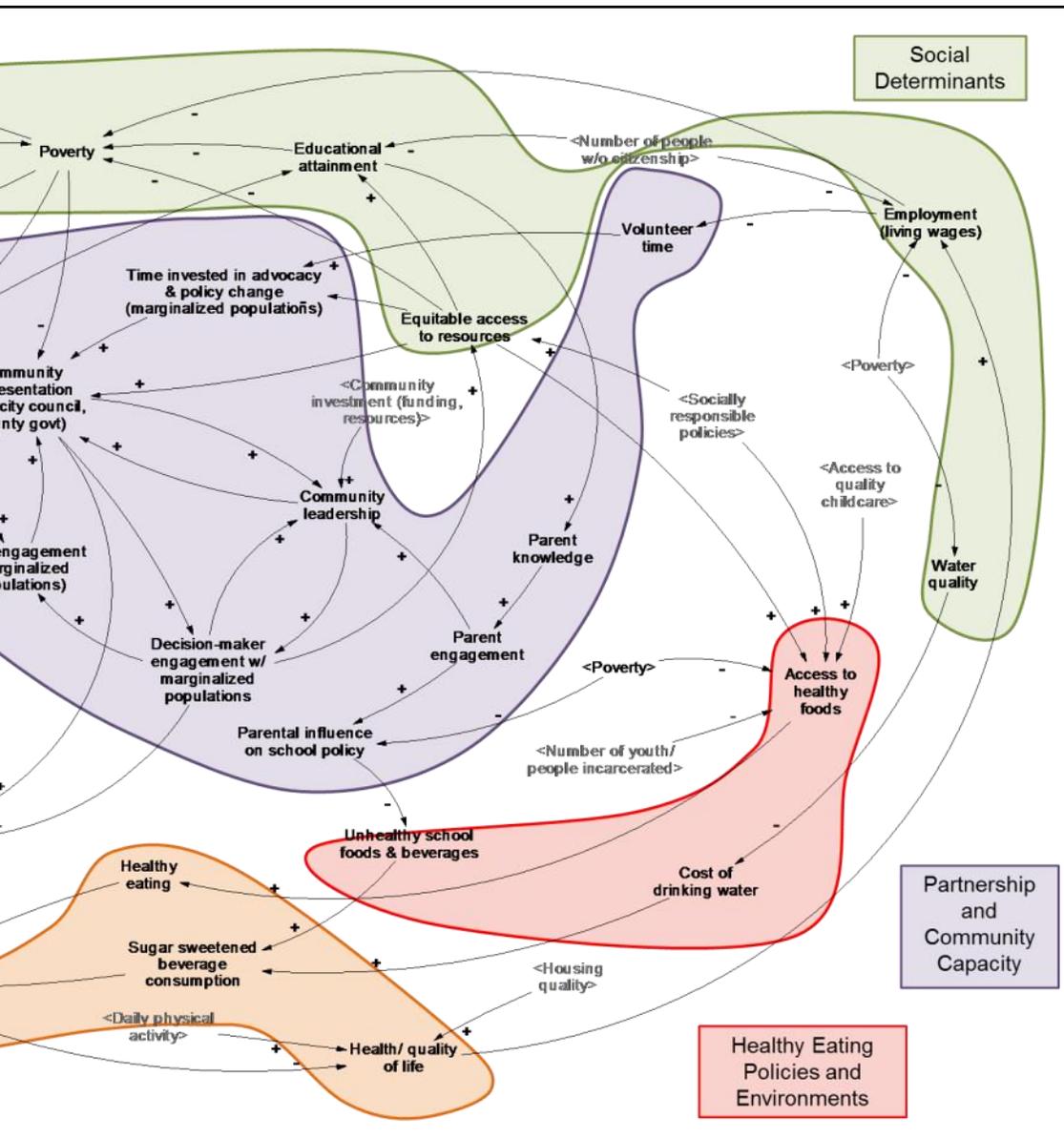
The partnership and community capacity subsystem refers to the ways communities organized and rallied for changes to the healthy eating and active living subsystems. For instance, *North Central Valley—HKHC* developed community leadership and increased civic engagement. This subsystem also includes community factors outside the partnership that may influence or be influenced by their efforts, such as parent knowledge and decision-maker engagement with marginalized populations.

## Social Determinants

Finally, the social determinants subsystem denotes societal conditions (e.g., poverty) and psychosocial influences in the community that impact health beyond the healthy eating and active living subsystems. In order to achieve health equity, populations and subgroups within the community must have equitable access to these resources and services.

Each one of these subsystems has many more variables, causal relationships (arrows), and feedback loops that can be explored in greater depth by the *North Central Valley—HKHC* partners or by other representatives in North Central Valley, California. Using this CLD as a starting place, community conversations about different theories of change within subsystems may continue to take place.

The next sections begin to examine the feedback loops central to the work of *North Central Valley—HKHC*. In



these sections, causal relationships and notations (i.e., arrows, “+” signs, “-” signs) from Figure 2 will be described to increase understanding about how systems thinking and modeling tools can work in communities to increase understanding of complex problems that are continuously changing over time, such as childhood obesity. At the end of this CLD storybook, references to other resources will be provided for those interested in more advanced systems science methods and analytic approaches.

[Note: The South Central Valley — HKHC causal loop diagram with color-coded subsystems is included in Figure 4.]





# Causal Loop Diagram for the Childhood Obesity System

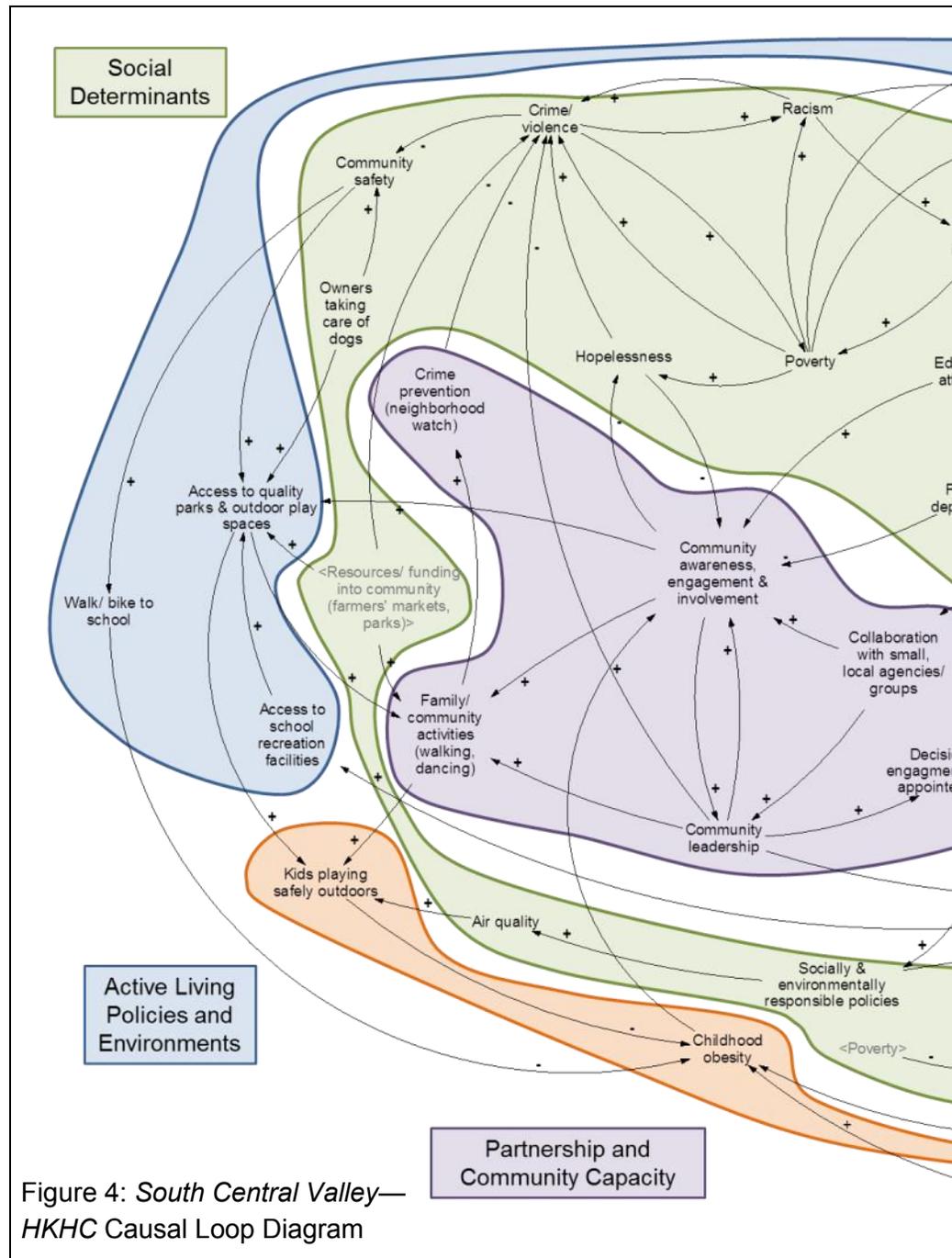
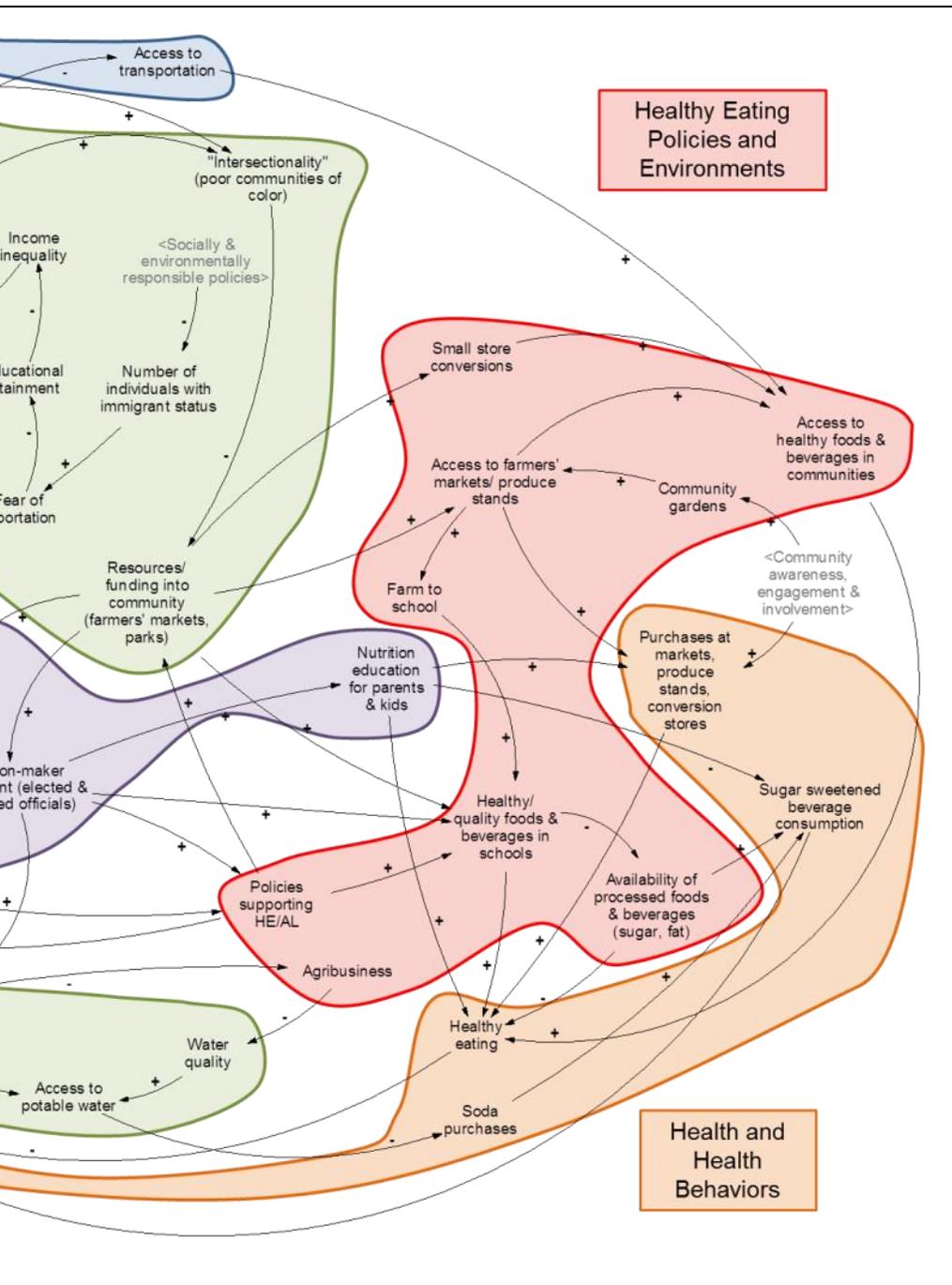


Figure 4: South Central Valley—  
HKHC Causal Loop Diagram



## Community Leadership Program Feedback Loop

To simplify the discussion about feedback loops, several loops drawn from *California's North Central Valley—HKHC CLD* (see Figures 1-2) are highlighted in Figures 5-6. While the CLD provides a theory of change for the childhood obesity prevention movement in Central Valley, California, each feedback loop tells a story about a more specific change process.

### Causal Story for Feedback Loop

**Story A:** In this case, the story is about *Powerful People*, the community leadership program (green highlighted loop in Figure 5). Participants in North Central Valley, California described how community leadership increases community representation in city council and county government. In turn, these representatives can increase opportunities for community resident engagement with decision-makers in both elected and appointed positions. This engagement feeds back to further increase community leadership.

**Story B:** While the preceding story reflected a positive scenario for North Central Valley, California, the same feedback loop also tells the opposite story. Less community leadership results in less community representation in city and county offices and agencies, leading to less engagement of community residents with decision-makers. And, this feeds back to diminish community leadership.

### Reinforcing Loop and Notation

These stories represent a reinforcing loop, and the notation in the feedback loop identifies it as a reinforcing loop (see "R1 — Community Leadership Program" and green highlighted loop in Figure 5). The words represent variables of quantities that increase and decrease as illustrated in the stories above. These variables change over time and are influenced by other variables as indicated by the arrows. Each arrow represents a causal relationship, and the plus and minus signs on the arrows indicate whether or not the influence of one variable on another variable (1) increases/adds to (plus or "+" sign), or (2) decreases/removes from the other variable (minus or "-" sign). These signs are referred to as polarities.

In a reinforcing loop, the effect of an increase or decrease in a variable continues through the cycle and returns an increase or decrease to the same variable, respectively.

***"Where does the responsibility lie? ...community residents don't know who to complain to about [issues in their community] and there's a big disconnect. We're going to have district elections for the first time in 2012 and hopefully that's going to change [the disconnect]." (Participant)***

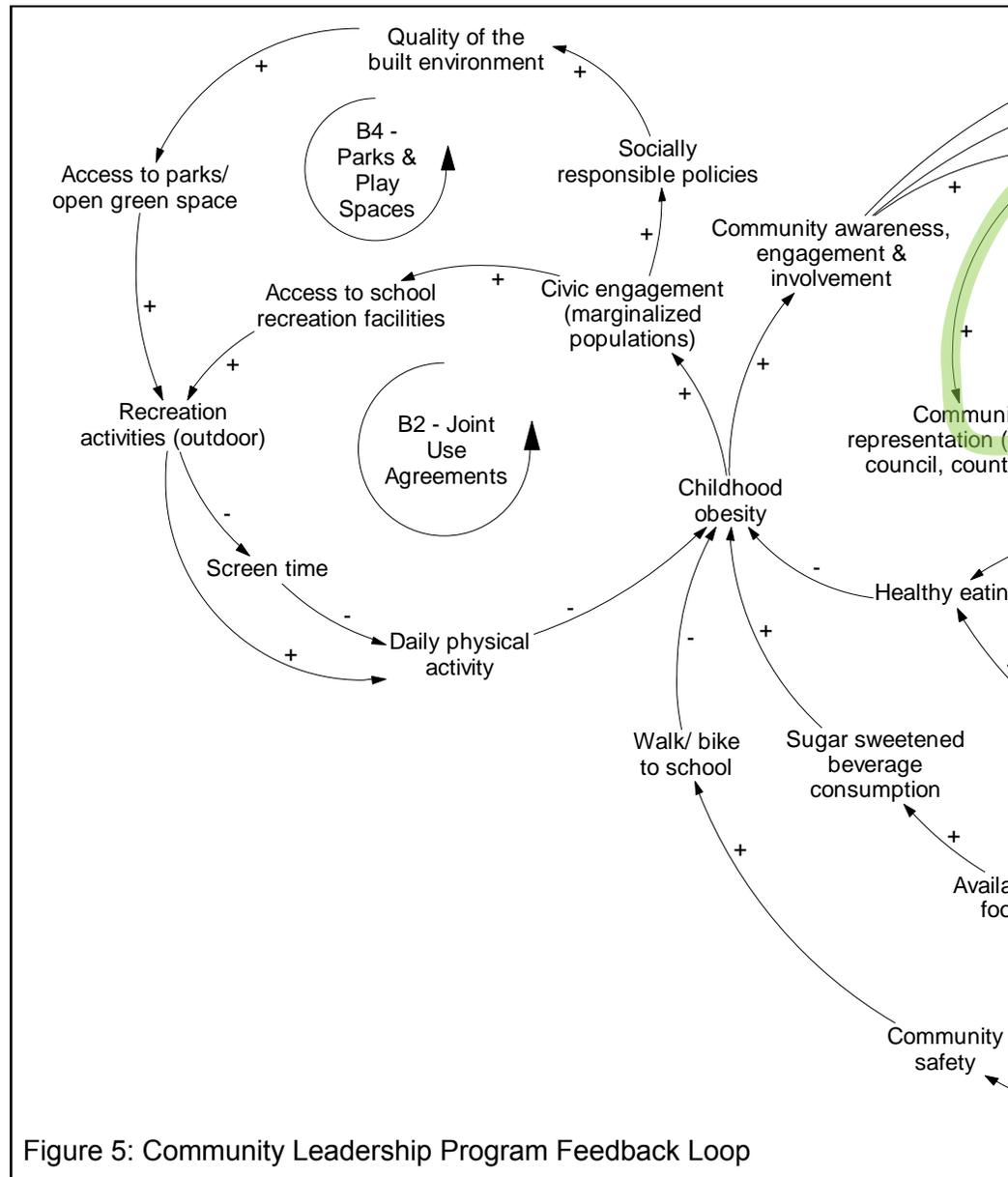
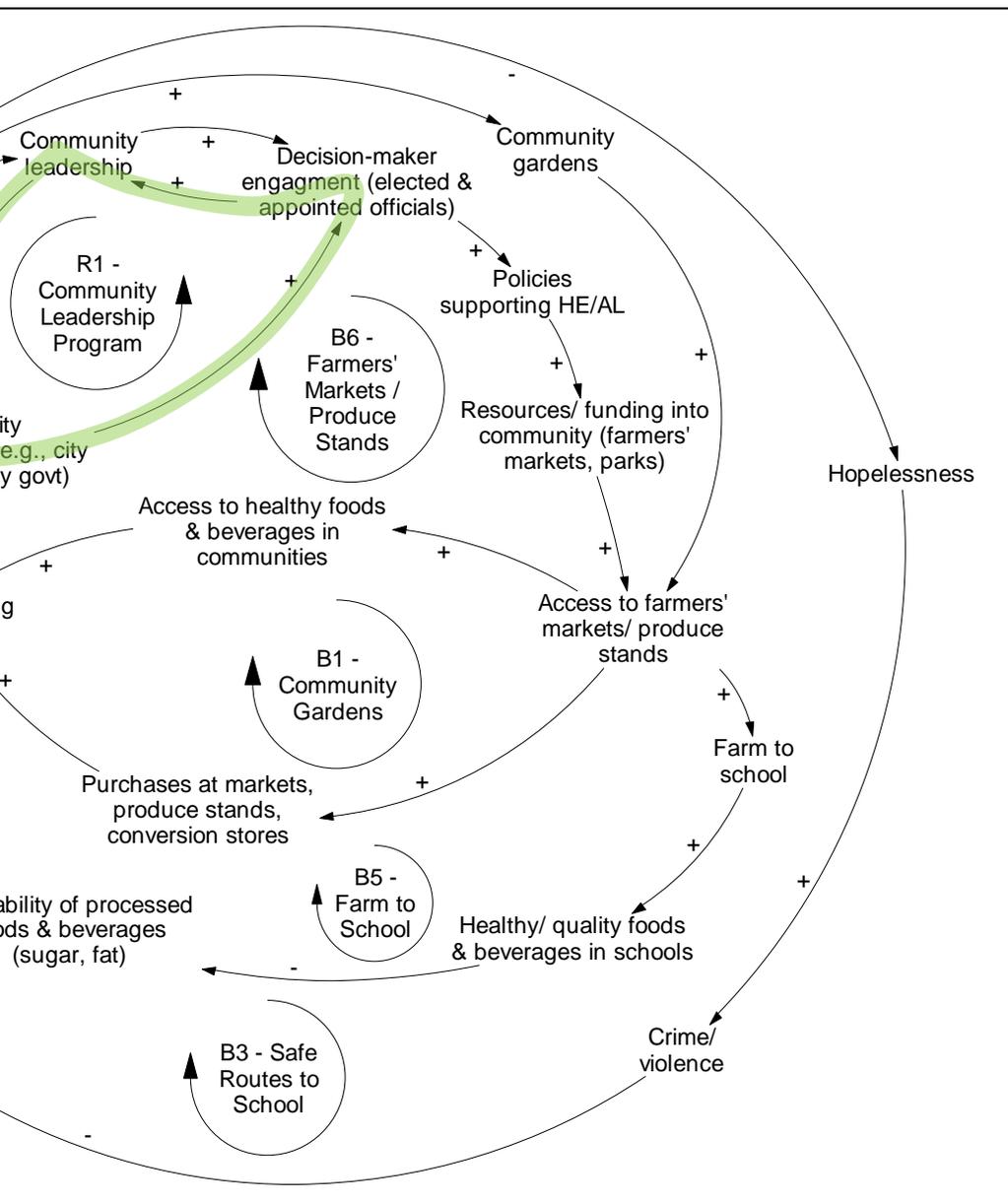


Figure 5: Community Leadership Program Feedback Loop

Looking specifically at the “+” or “-” notation, a feedback loop that has zero or an even number of “-” signs, or polarities, is considered a reinforcing loop. Balancing loops, with an odd number of “-” signs in the loop, are another type of feedback loop.

In isolation, this reinforcing loop represents a virtuous cycle in Story A as these assets positively support one another, or a vicious cycle in Story B as these challenges perpetuate a downward spiral. Yet, the increase in community leadership likely levels off at some point when the city council and county government have sufficient representation from community residents. To understand what causes community leadership to increase or decrease, it may be helpful for the partners in North Central Valley, California to consider other variables that influence or are influenced by community leadership. In addition, it is important to remember that this reinforcing loop is only one part of the larger CLD (see Figures 1 and 3), and the other loops and causal relationships can have an impact on the variables in this loop.



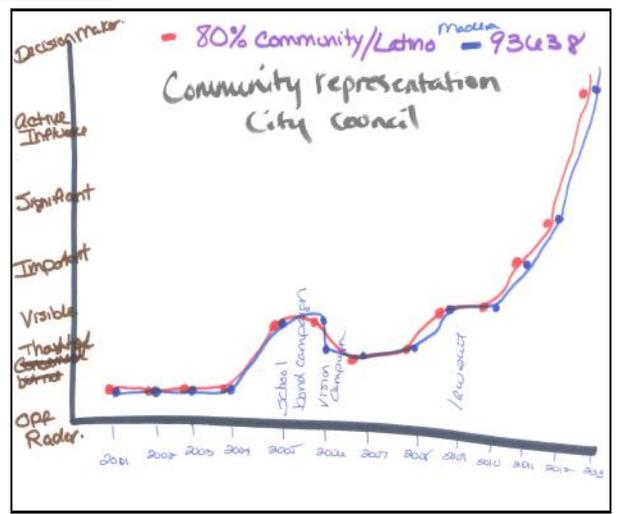
Community leadership likely levels off at some point when the city council and county government have sufficient representation from community residents. To understand what causes community leadership to increase or decrease, it may be helpful for the partners in North Central Valley, California to consider other variables that influence or are influenced by community leadership. In addition, it is important to remember that this reinforcing loop is only one part of the larger CLD (see Figures 1 and 3), and the other loops and causal relationships can have an impact on the variables in this loop.

System Insights for California's Central Valley—HKHC Sites

Participants identified insufficient representation of community residents on city council in North Central Valley, California (see behavior over time graph).

From the systems thinking exercises, several insights can inform the community leadership program, including the benefits of having community residents engaging with local decision-makers (e.g., forums, events).

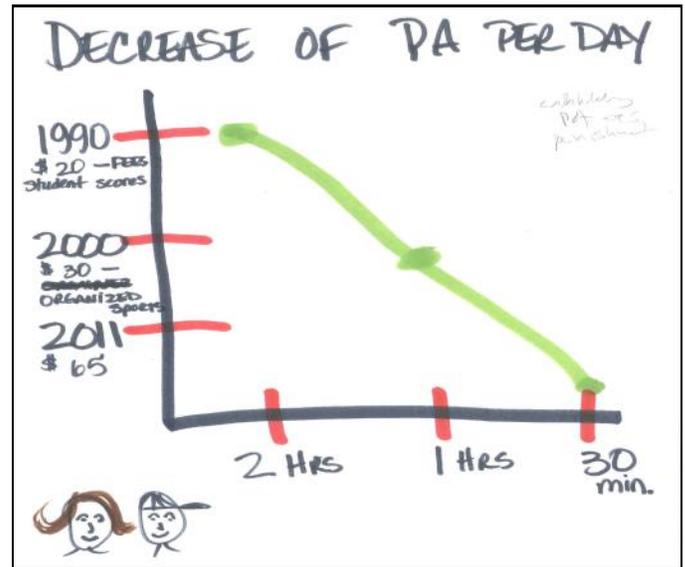
In addition to these insights, systems thinking can also help to pose key questions for assessment and evaluation, including assessment of various forms of community leadership and evaluation of leaders' respective influence on representativeness in local offices and agencies (e.g., school board, neighborhood association, city council) as well as opportunities to engage with other local elected and appointed officials.



## Parks and Play Spaces Feedback Loop

The feedback loop highlighted in yellow in Figure 6 reflects the same concepts and notation, and highlights parks and play spaces in North Central Valley, California. Unlike the previous loop (see Figure 5), this is a balancing loop (one “-” sign). This loop shows how socially responsible policies affect the quality of the built environment, including access to parks and open green space, and, in turn, how these policies and environments influence outdoor recreation, physical activity, and childhood obesity.

Some of these causal relationships may have more immediate effects (e.g., outdoor recreation increases physical activity) and other relationships may have delayed effects (e.g., civic engagement of marginalized populations increasing socially responsible policies). This delayed effect is noted using two hash marks through the middle of the arrow line (not included in Figure 6).



In the behavior over time graphs exercise, participants described a decrease in the amount of physical activity that children have per day (see illustration). Partners hope to shift this trend by increasing access to parks and play spaces in order to boost outdoor recreation activities. In the quote below, the participants also described how efforts will need to be made to make these outdoor recreation activities fun for kids, in order to get them out of the house and away from the television, video games, and other electronic devices.

The loop in Figure 6 identifies the need to engage marginalized populations in the process to create socially responsible policies in order to increase equitable access to parks and play spaces, particularly for communities where these resources are scarce or non-existent.

***“Making physical fitness fun for the kids is just not happening right now. A lot of kids at home would rather just watch TV and play computers... I’m hoping that kids will actually decide to stop the [video] games and go outside; go out there and play games, ride bikes, and hike.” (Participant)***

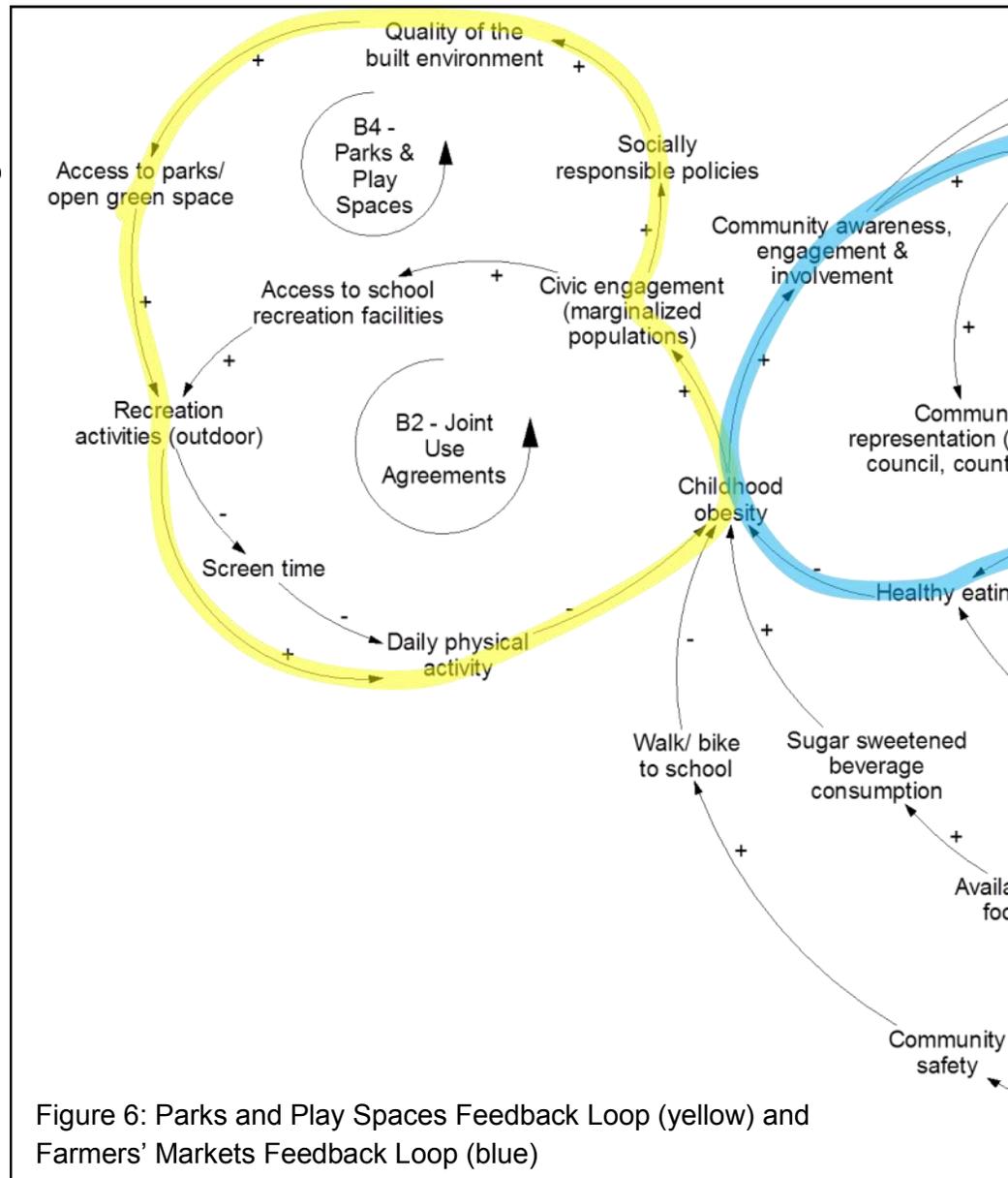


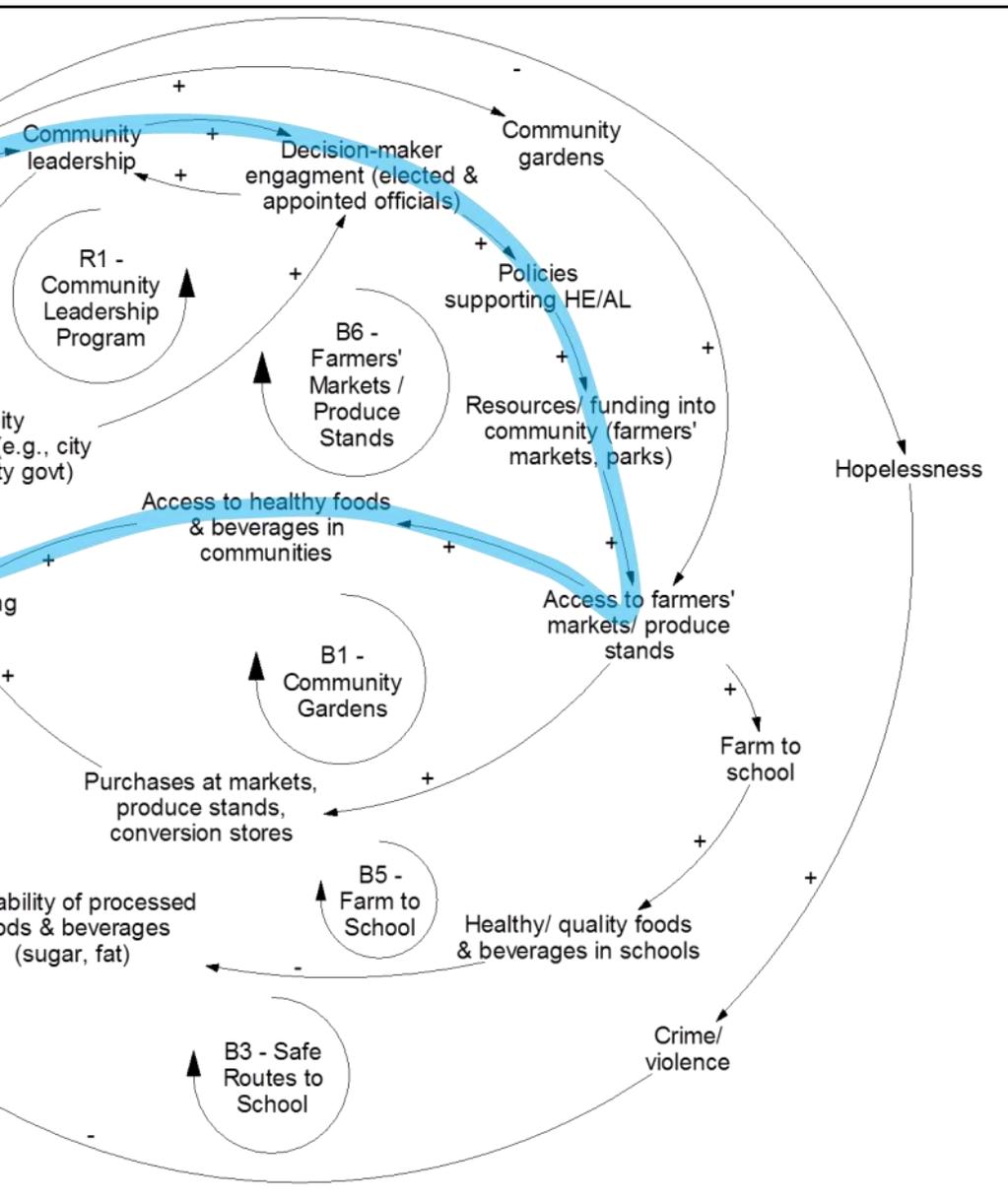
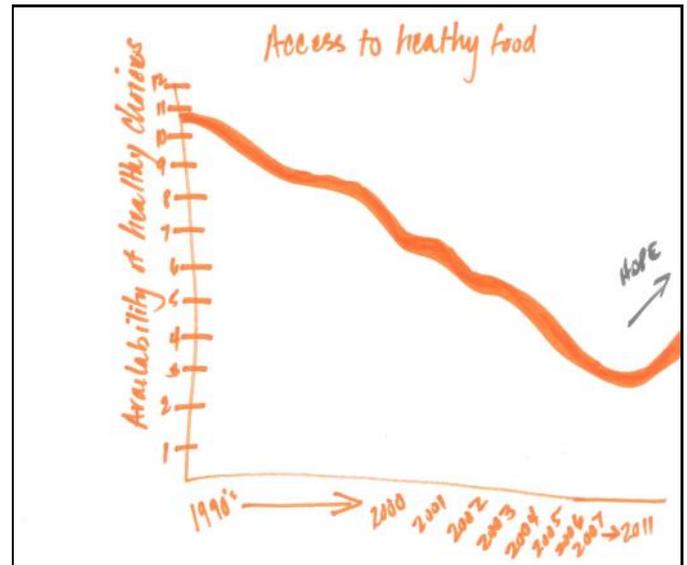
Figure 6: Parks and Play Spaces Feedback Loop (yellow) and Farmers' Markets Feedback Loop (blue)

## Farmers' Markets/Produce Stands Feedback Loop

Highlighted in blue in Figure 6, the farmers' markets and produce stands feedback loop represents one of California's North Central Valley HKHC strategies to increase healthy eating. Similar to the previous loop (see yellow loop in Figure 6), this is a balancing loop (one "-" sign).

In addition, it includes causal relationships representing more immediate effects (e.g., resources and funding for farmers' markets affecting access to farmers' markets), and, potentially, delayed effects (e.g., decision-maker engagement influencing policies supporting healthy eating).

In the behavior over time graphs exercise, participants described a decrease in access to healthy food since 1990 with the hope that this trend will reverse (see illustration). Additionally, participants described how farmers' markets and farm stands require intense and sustained engagement of consumers as well as cooperation among farmers' market managers, farm stands, and farmers to increase their viability (see quote at the bottom).



Looking at the feedback loop in Figure 6, the partners may benefit from early efforts to increase community awareness, engagement, and involvement as they work to influence local decision-makers by maintaining these relationships over time to draw on the same supporters as a consumer base for the farmers' markets and produce stands. Similarly, it may be helpful to engage local farmers from the very beginning to serve as advocates for policies supporting healthy eating policies and development and funding for farmers' markets and produce stands.

***“Farmers’ markets, school farm stands, and small store conversions actually take intense and sustained engagement for them to: 1) get the number of consumers that makes the outlet viable to be sustained; and, 2) the working relationship with the farmers’ market manager, school farm stand and local farmers. And so, if there isn’t this profit, they deplete — they’re not viable to continue.” (Participant)***

## Opportunities for Systems Thinking in Central Valley, California

This storybook provided an introduction to some basic concepts and methods for systems thinking at the community level, including: causal loop diagrams, variables, causal relationships and polarities, reinforcing feedback loops, and balancing feedback loops, among others. For *California's Central Valley HKHC* partners, this storybook also summarized the healthy eating, active living, partnership and community capacity, social determinants, and health and health behaviors subsystems in the North and South Central Valley causal loop diagrams as well as three specific feedback loops corresponding to the partnership's primary strategies.

This causal loop diagram reflects a series of conversations among partners and residents from 2011 to 2013. Some discussions probed more deeply into different variables through the behavior over time graphs exercise, or causal relationships through the causal loop diagram exercise.

This represented a first attempt to collectively examine the range of things that affect or are affected by policy, system, and environmental changes in North and South Central Valley, California to promote healthy eating and active living as well as preventing childhood overweight and obesity.

Yet, there are several limitations to this storybook, including:

- the participants represent a sample of the *California's Central Valley HKHC* partners (organizations and residents) as opposed to a representative snapshot of government agencies, community organizations, businesses, and community residents;
- the behavior over time graphs and the causal loop diagram represent perceptions of the participants in these exercises (similar to a survey or an interview representing perceptions of the respondents);
- the exercises and associated dialogue took place in brief one- to two-hour sessions, compromising the group's capacity to spend too much time on any one variable, relationship, or feedback loop; and
- the responses represent a moment in time so the underlying structure of the diagram and the types of feedback represented may reflect "hot button" issues of the time.

Much work is yet to be done to ensure that this causal loop diagram is accurate and comprehensive, for

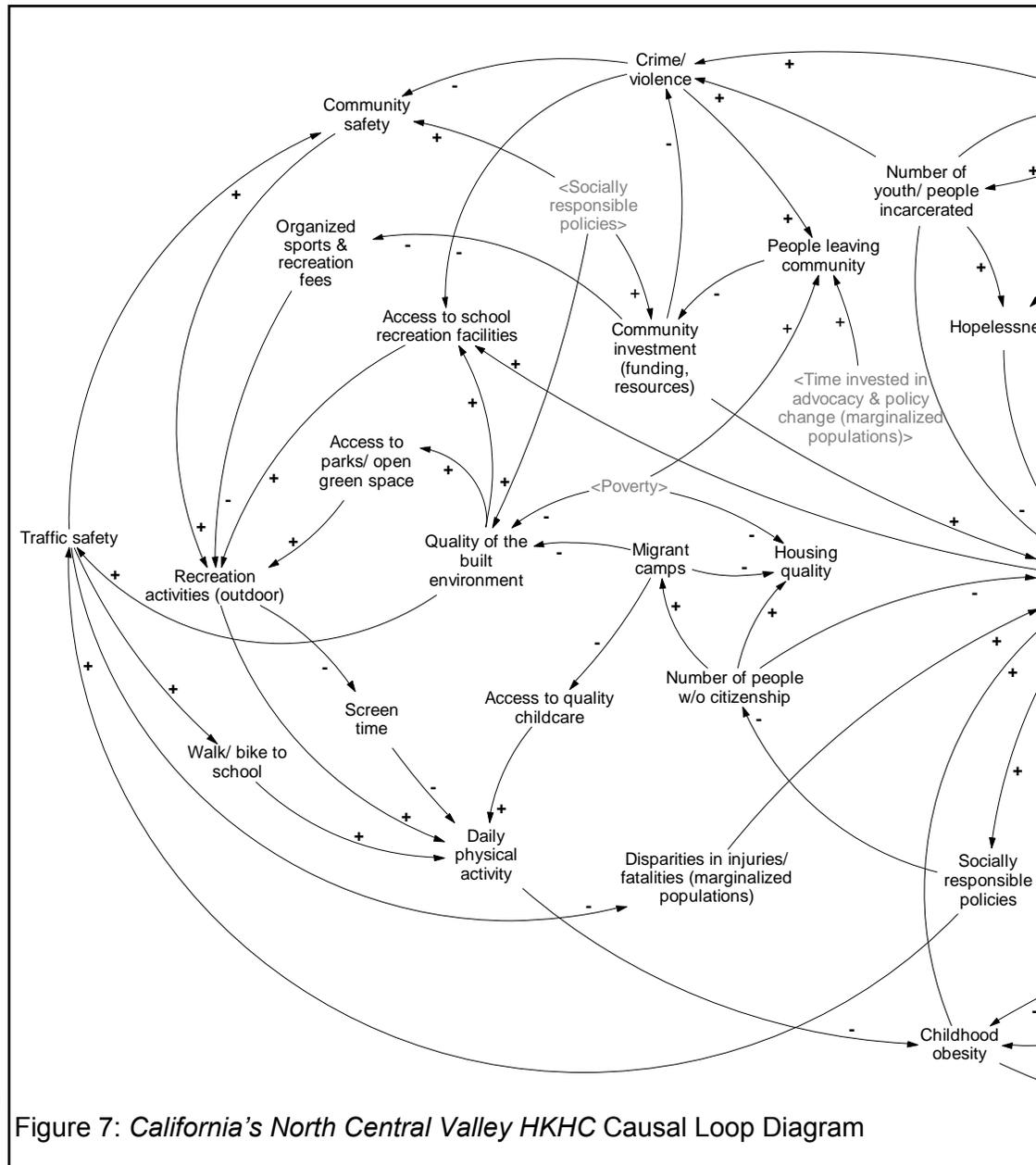


Figure 7: *California's North Central Valley HKHC* Causal Loop Diagram



## References for Systems Thinking in Communities:

### Group model building handbook:

Hovmand, P., Brennan L., & Kemner, A. (2013). Healthy Kids, Healthy Communities Group Model Building Facilitation Handbook. Retrieved from <http://www.transtria.com/hkhc>.

### Vensim PLE software for causal loop diagram creation and modification:

Ventana Systems. (2010). Vensim Personal Learning Edition (Version 5.11A) [Software]. Available from <http://vensim.com/vensim-personal-learning-edition/>

### System dynamics modeling resources and support:

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**Appendix A: Behavior Over Time Graphs Generated during Site Visit**

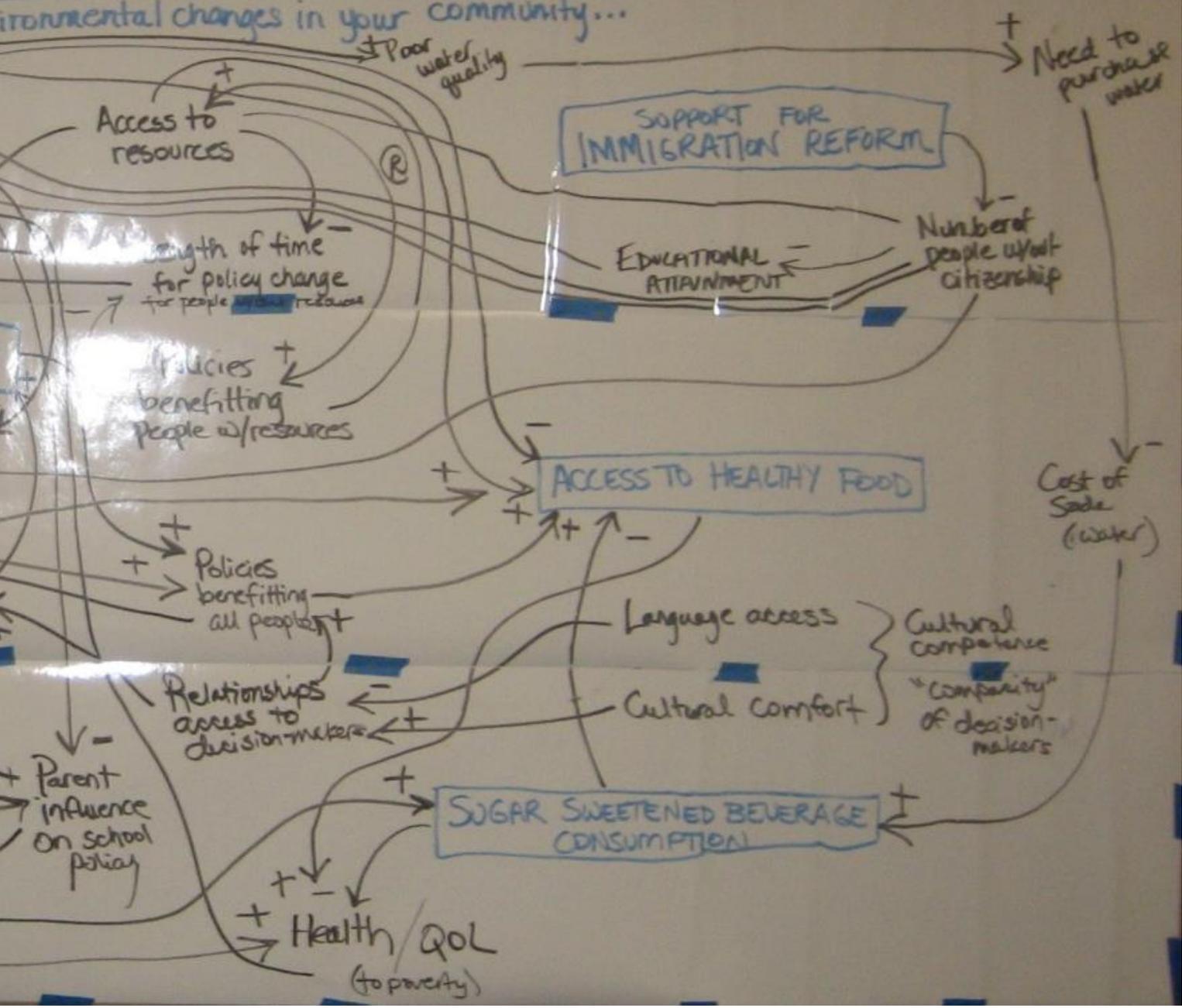
<b>Community: California's North Central Valley—HKHC Leading Site</b>	
<b>Categories</b>	<b>Number of Graphs</b>
Active Living Behavior	3
Active Living Environments	1
Funding	0
Healthy Eating Behavior	3
Healthy Eating Environments	1
Marketing and Media Coverage	0
Obesity and Long Term Outcomes	0
Partnership & Community Capacity	5
Policies	1
Programs & Promotions (Education and Awareness)	2
Social Determinants of Health	4
<b>Total Graphs</b>	<b>20</b>

<b>Community: California's South Central Valley—HKHC Leading Site</b>	
<b>Categories</b>	<b>Number of Graphs</b>
Active Living Behavior	3
Active Living Environments	1
Funding	1
Healthy Eating Behavior	4
Healthy Eating Environments	2
Marketing and Media Coverage	0
Obesity and Long Term Outcomes	1
Partnership & Community Capacity	7
Policies	0
Programs & Promotions (Education and Awareness)	2
Social Determinants of Health	5
<b>Total Graphs</b>	<b>26</b>



# HOOD OBESITY

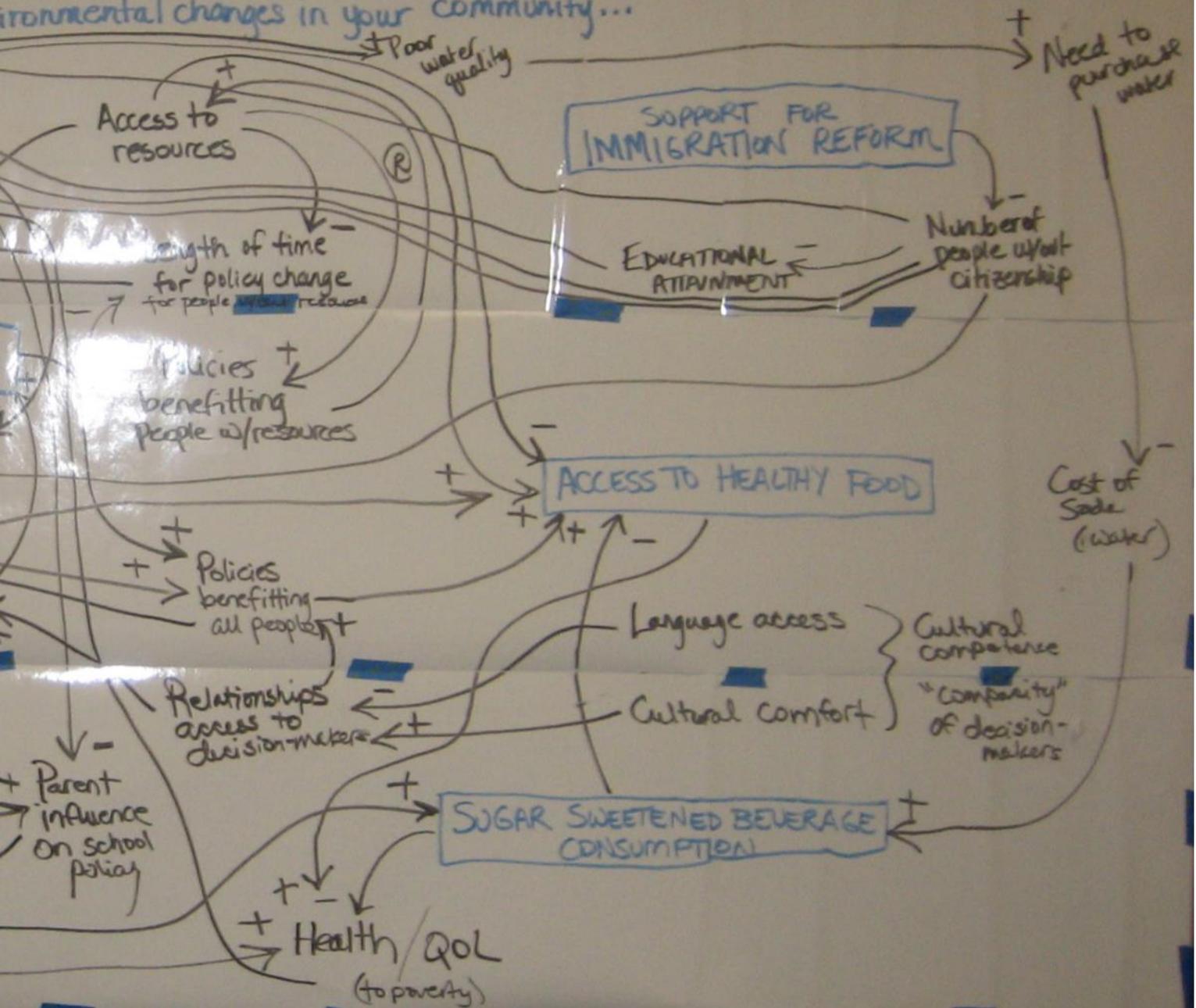
Environmental changes in your community...





# HOOD OBESITY

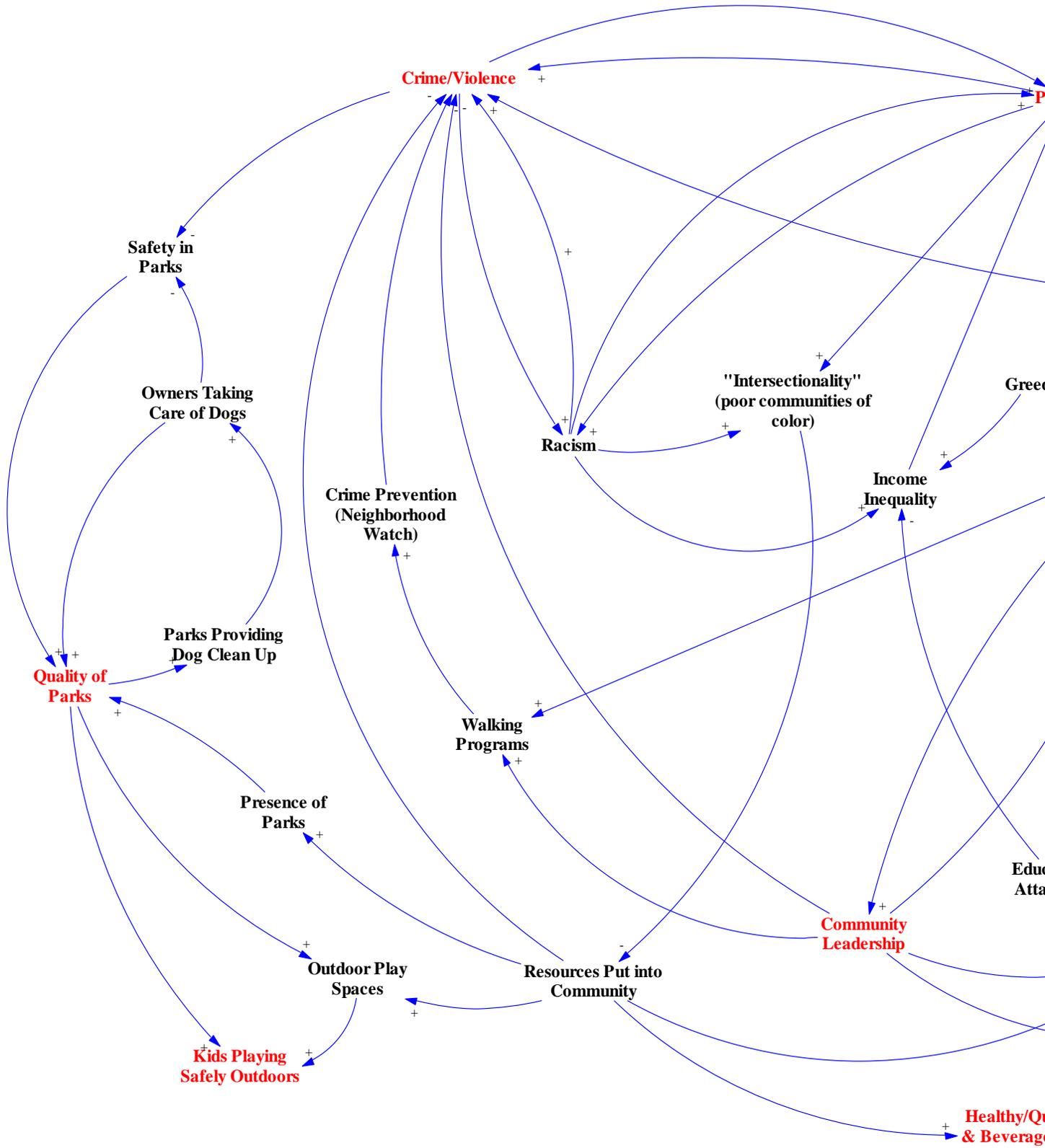
Environmental changes in your community...





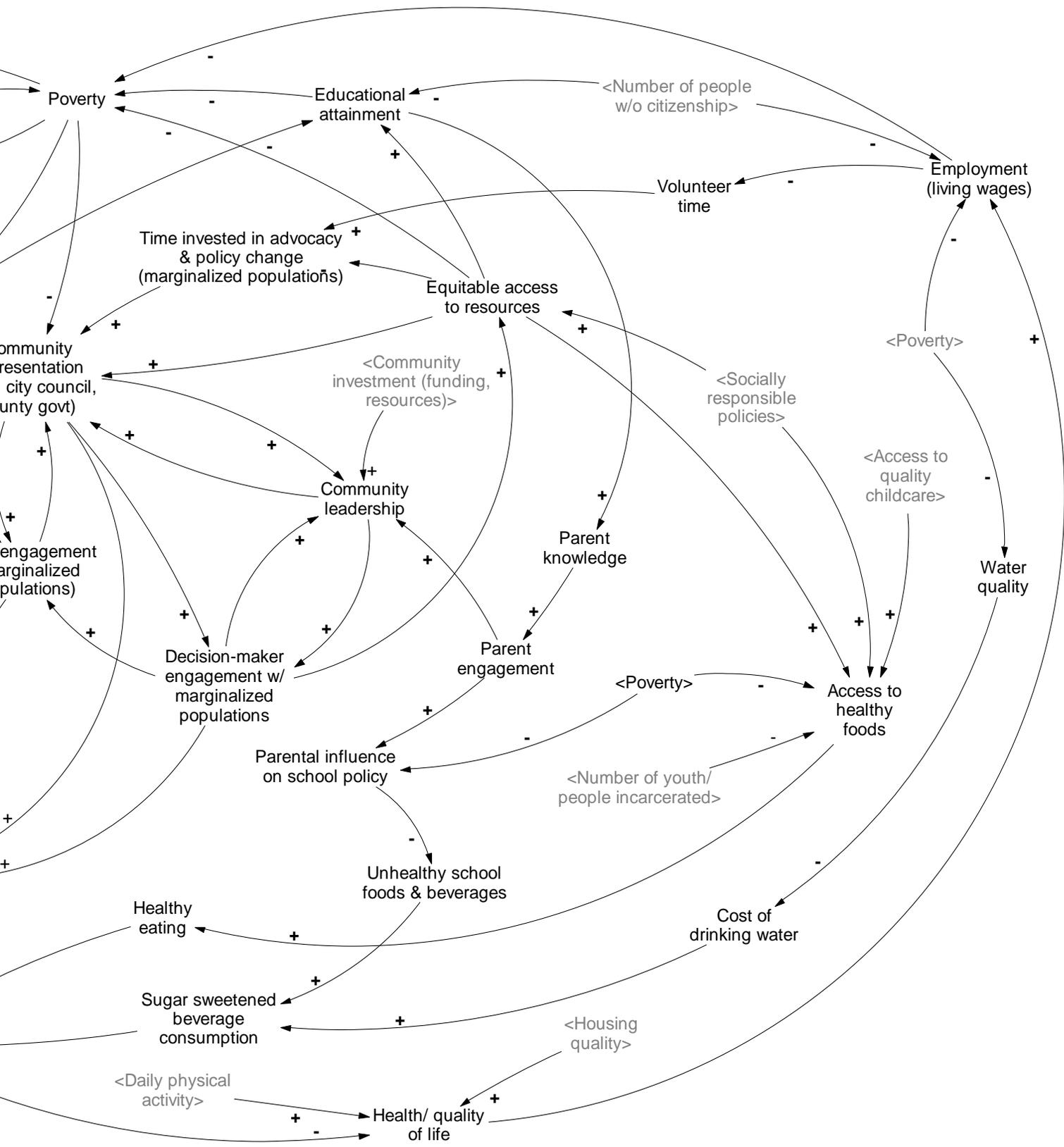


# Appendix C: Original Translation of the South Central Valley Causal Loop Diagram into Vensim PLE

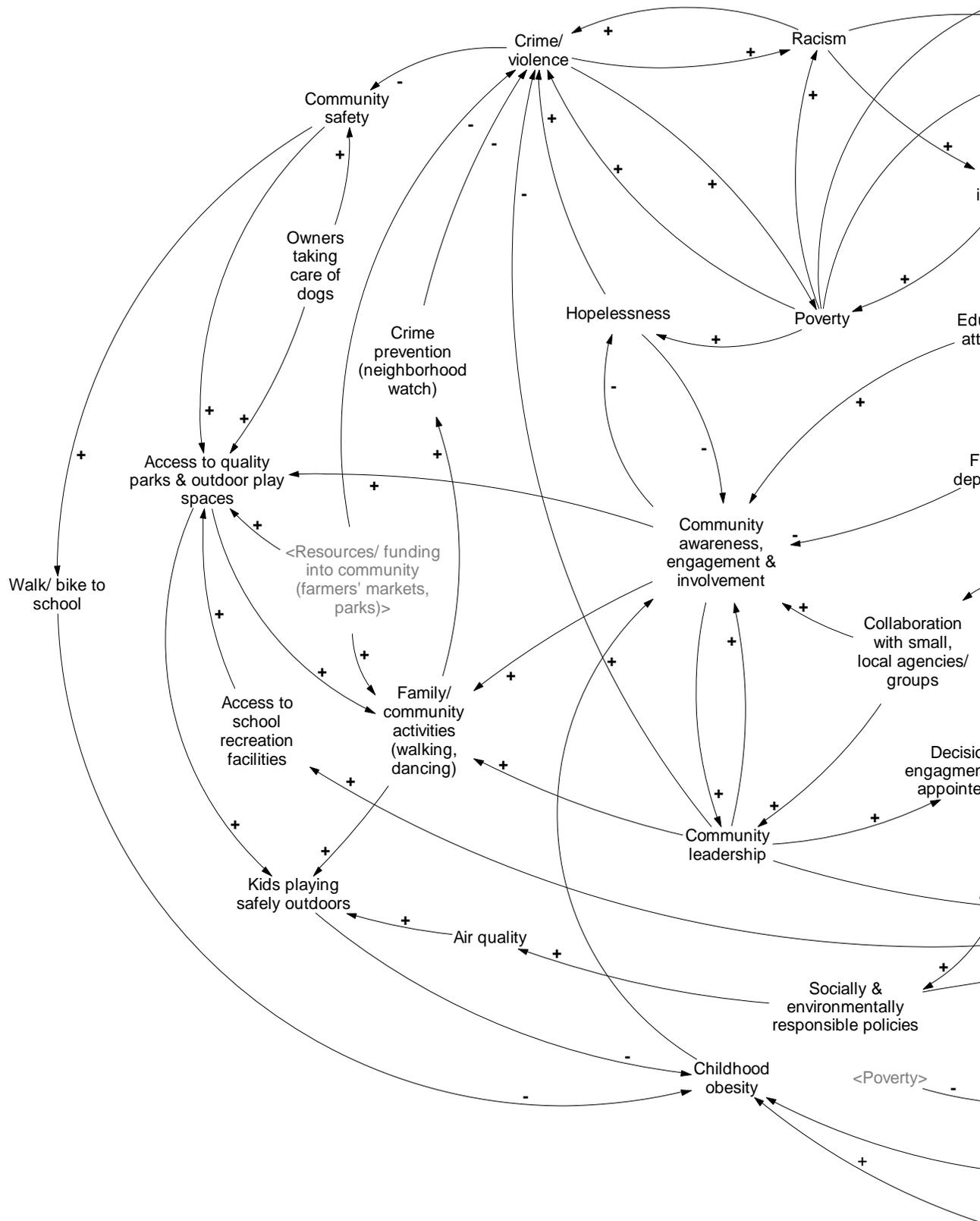


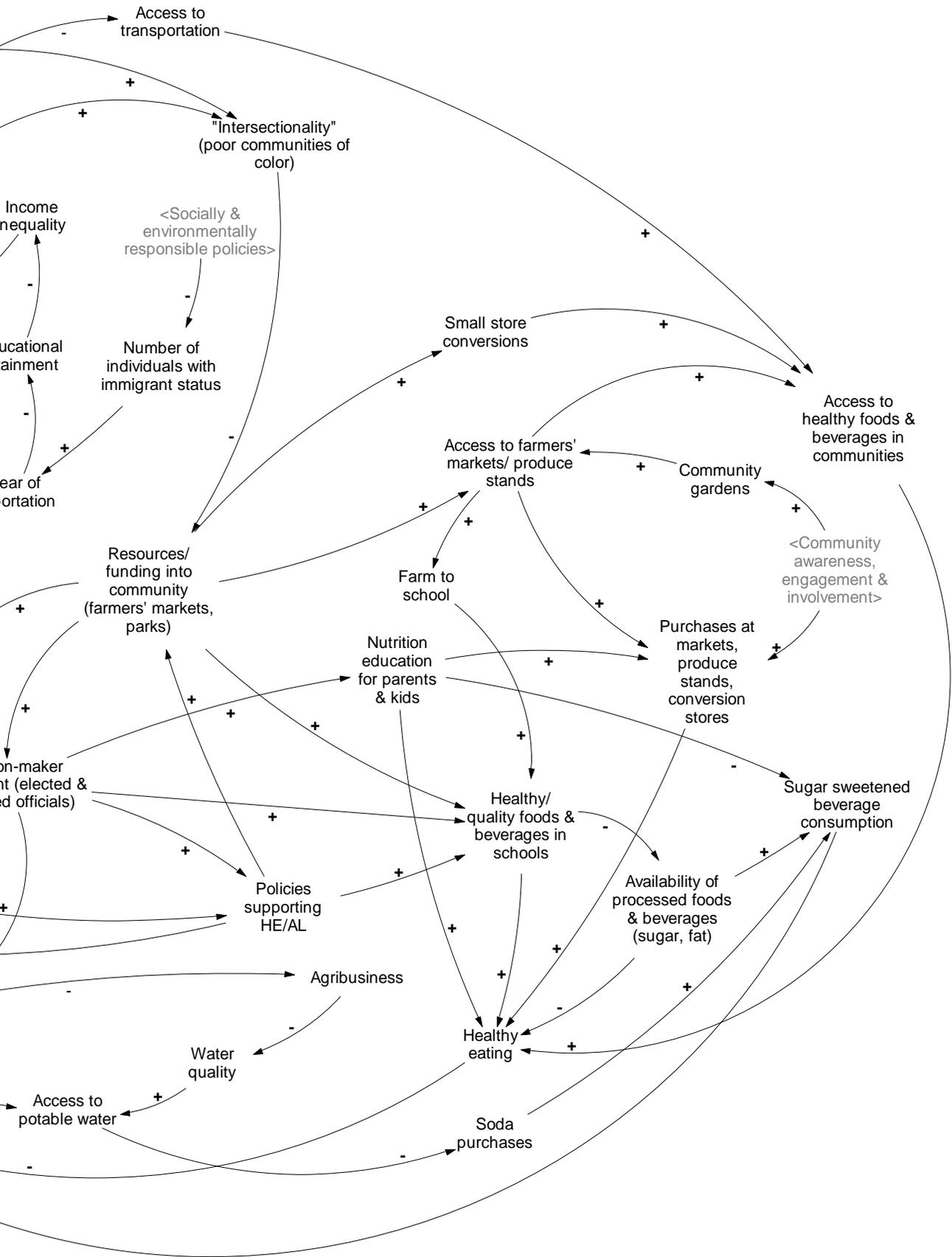




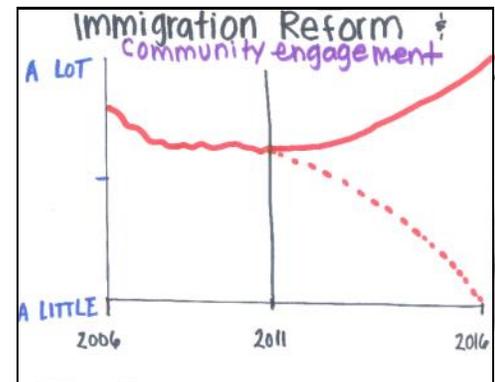
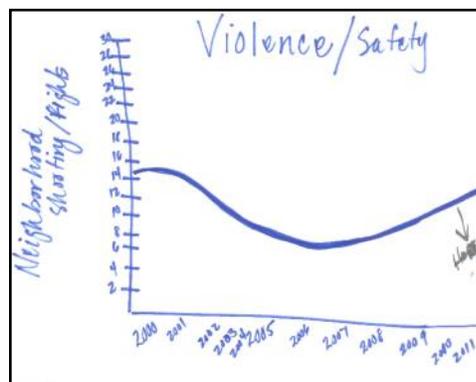
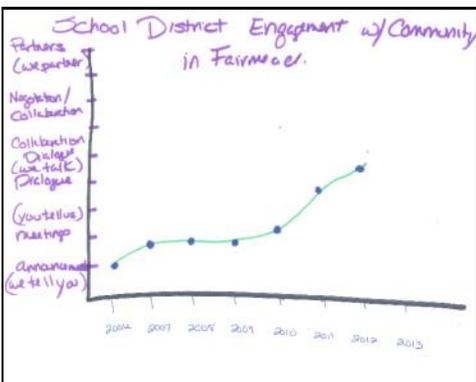
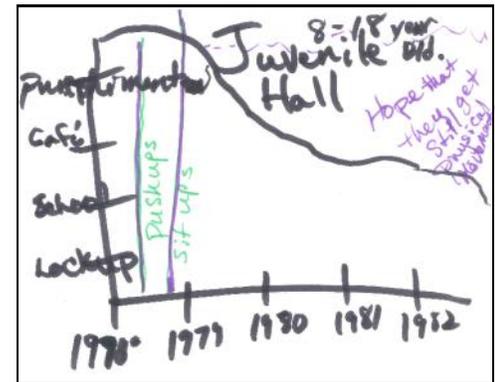
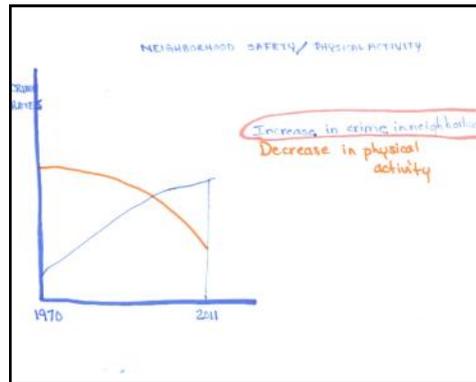
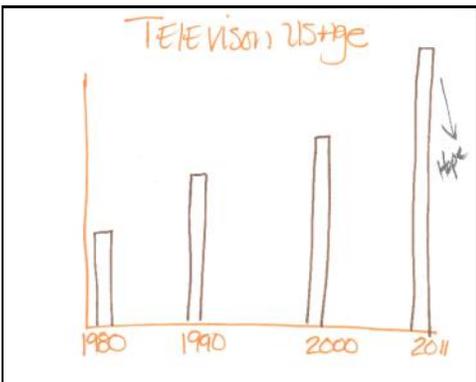
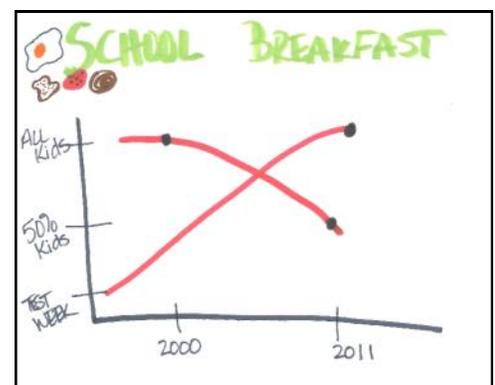
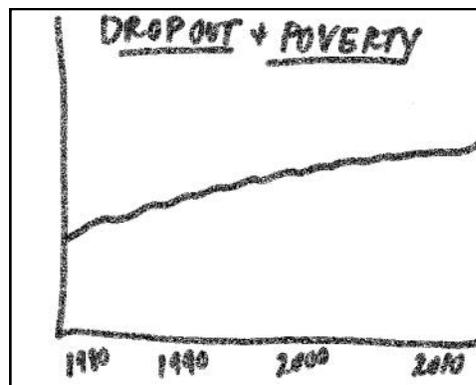
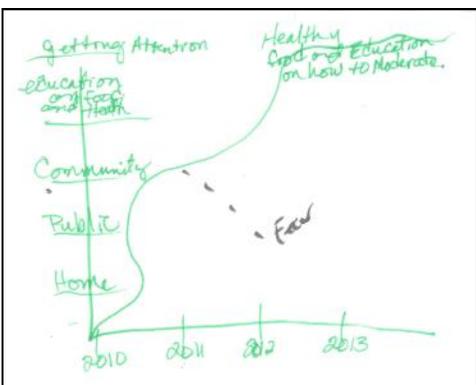
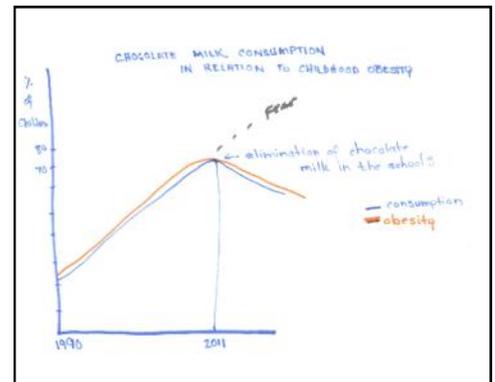
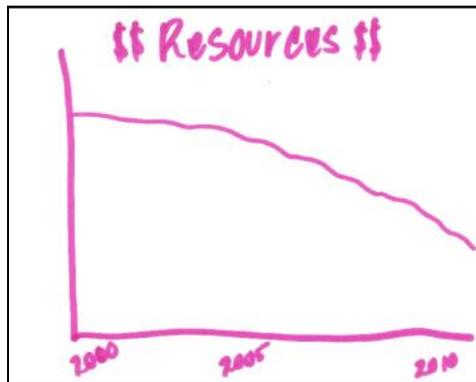
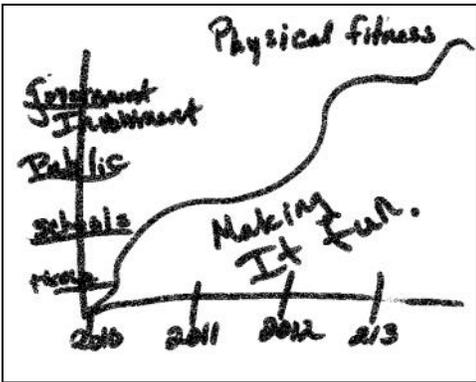


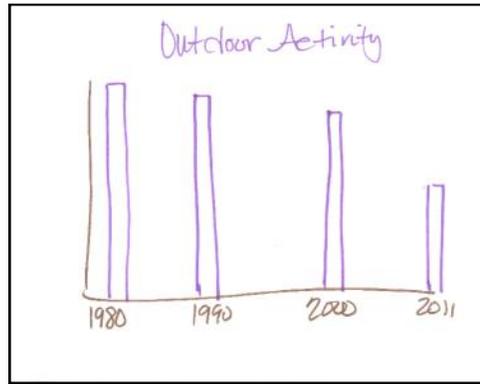
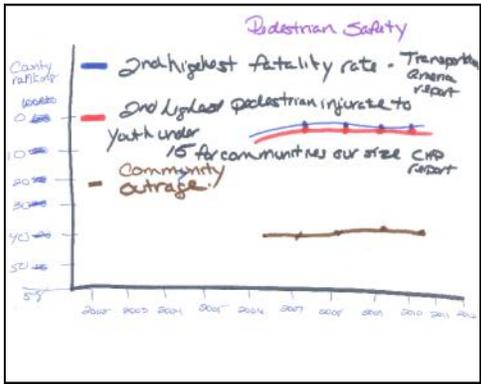
# Appendix D: Transcript Translation of the South Central Valley Causal Loop Diagram into Vensim PLE





Appendix E: North Central Valley Behavior Over Time Graphs not Represented in the Storybook





Appendix E: South Central Valley Behavior Over Time Graphs not Represented in the Storybook

