Systems Thinking in Communities:

Understanding the Causes of Inactivity, Poor Diet/Nutrition, and Childhood Obesity in Kingston, New York

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Introduction

Healthy Kingston for Kids (HKK) is one of 49 community partnerships participating in the national *Healthy Kids, Healthy Communities* program of the Robert Wood Johnson Foundation (www.healthykidshealthycommunities.org). The purpose of this *Healthy Kingston for Kids (HKK)* project was to introduce systems thinking at the community level by identifying the essential parts of the Kingston, New York 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 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., academic institutions; local government agencies; civic, youth, and community based organizations) 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). 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.

Kingston, New York: Background and Local Participation

The HKK partnership is situated in Kingston, New York, the county seat of Ulster County located 90 miles north of New York City. Kingston is located on the historic Hudson River and a tributary, the Rondout Creek. It was founded in 1652, served as New York State's first capital, and is the gateway city for outdoor tourism in the Catskill Mountains.

The target population for the HKK partnership was the Kingston City School District (KCSD), including the population of Kingston and four surrounding towns encompassing urban, rural, and suburban communities. The district currently has 13 schools (10 elementary, 2 middle, and 1 high school) and over 500 teachers serving a student population of 6,639 students in 2011-2012.3 Private schools located in the city serve approximately 1,300 students.

The lead agency for the HKK partnership was the Cornell Cooperative Extension of Ulster County (CCEUC), a non-profit educational organization. Started in 1913, the Extension Association is part of the Cornell Cooperative Extension land-grant system, a partnership between County, State, and Federal governments. The mission of Cornell Cooperative Extension is to enable people to improve their lives and communities through partnerships that put experience and research knowledge to work. CCEUC staff and trained volunteers deliver educational programs, conduct applied research, and foster community collaborations. It houses four departments that impact various sectors of communities: 1) Family and Consumer Science, 2) 4-H Youth Development, 3) Ashokan Watershed Stream Management, and 4) Consumer and Commercial Agriculture. Staff members work across departments on integrated projects and draw upon each other to accomplish multidisciplinary goals. A leadership team was formed at the onset of the HKK project. This team consisted of the chairs of the committees (described below) and other members of the community. When unpaid stakeholders showed signs of losing interest, an HKK Advisory Network was formed. This group served as a forum for networking among professionals interested in a healthier Kingston.

HKK's Priorities and Strategies

The partnership and capacity building strategies of *HKK* included:

- **Complete Streets Advisory Council:** This city-sanctioned 11-member council was established in 2010 by a resolution passed by the Common Council to work towards enhancing the walking and bicycling environment in Kingston. Their focus has been on developing and implementing a strategic plan for the City of Kingston, as well as establishing a sidewalk taskforce, which is examining possible policy solutions and incentives to enforce, encourage, or support homeowners to repair broken sidewalks. One significant success included regular meetings with the Department of Public Works to create sharrows on Broadway and address sidewalk repairs.
- **Bike-Friendly Kingston:** With a new champion leader on board, this group has become active in advocating for more bikeable streets in Kingston. They have been meeting with the Department of Public Works and held a fund-raiser dinner for the sharrows planned on Broadway.

- **Crime Prevention through Environmental Design:** In September 2013, a training was held on Crime Prevention through Environmental Design with seventeen participants. A group of graduates of the training identified a leader and developed an action plan to prevent crime in Kingston, including one focused on Van Buren Park, as well as one addressing crime in the city as a whole. The group presented the training and action plan to the Mayor in November 2013.
- **LiveWell Kingston:** This coalition emerged in 2013 out of the Healthy Kingston for Kids partnership's desire to expand the movement and have a more coordinated approach to addressing the barriers that prevent active living and healthy eating in Kingston. This city-endorsed coalition includes organizations, businesses and individuals that are collaborating to improve the environment, culture, and opportunities in Kingston for residents to lead healthier lives. LiveWell Kingston is supported by the City of Kingston through the Mayor's Wellness Initiative.

The healthy eating and active living strategies of *HKK* included:

- **Safe Routes to Schools and Parks:** While the focus of HKK's SRTS efforts have been on infrastructure improvements, their work has been complemented by extensive assessments and several programs such as a Walking School Bus program and Walk-Bike-Roll Days. A significant achievement of HKK's SRTS efforts was the City's receipt of a Safe Routes to School grant in 2013, amounting to $489,000 to cover infrastructure improvements around several city schools. Construction will begin in 2015.
- **Complete Streets:** HKK partners have been instrumental in supporting the passage of a resolution by the Common Council in support of an infrastructure improvement project for a major Kingston intersection. These improvements will be funded by the New York State Department of Transportation as part of the Transportation Improvement Plan to start in 2015. Another achievement includes the addition of sharrows on a major thoroughfare in midtown Kingston in spring of 2014.
- **Gardens:** The HKK garden committee worked on assessments, school gardens, community gardens, communication outreach, policy, and supported HKK partnership goals related to improving access to healthy foods. Following extensive assessment reports and maps which were broadly disseminated, the HKK garden committee supported the installment of 11 school gardens and worked with the Kingston City School District to adopt school garden language in their health and wellness policy. They also supported installment of a community garden in front of a low-income housing complex and gardens at four Kingston -area non-profit organizations. The garden committee also successfully advocated for the Kingston Common Council to adopt a resolution supporting the promotion of community gardens throughout Kingston.
- **Healthy Afterschool Snacks:** A healthy afterschool snack (HAS) policy was drafted and subsequently endorsed by the Ulster County Health Department. The health department has actively promoted the policy throughout the county. At least one afterschool program has adopted the policy, while language from the policy is being incorporated into the Kingston City School District's Wellness Policy. The work of the HAS committee influential in the passage of the "Eat Well Kingston" resolution by the City of Kingston Common Council in 2013. This resolution calls for (1) the inclusion of healthy snack foods in vending machines on property operated and owned by the City of Kingston and (2) Healthy Meeting Policies to be followed by city employees in city-owned buildings.
- **Farmer's Market:** In 2012, the HKK partnership along with the Kingston Farmers' Market launched a Midtown Farmers' Market serving the whole Kingston community but targeting a nearby low-income neighborhood. It has been running for two seasons.
- **Corner Stores:** HKK partners from the "Creating Healthy Places" initiative implemented a six-week corner store pilot project in 2012 in partnership with the Kingston Farmer's Market. Two stores increased access to fresh fruits and vegetables. Many lessons were learned about community outreach, building demand, and working with farmers and store owners that will be incorporated into the continuation of this project.
- **School Wellness:** HKK partners recommended policy language to support healthy eating and physical activity in the Kingston City School District, which is being written into administrative regulations. Relevant administrators are beginning to work on implementation.

For more information on the partnership, please refer to the Kingston case report (http://www.transtria.com/hkhc_case_reports.php).

Systems Thinking in Communities: Kingston, New York

"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 Kingston, New York 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.

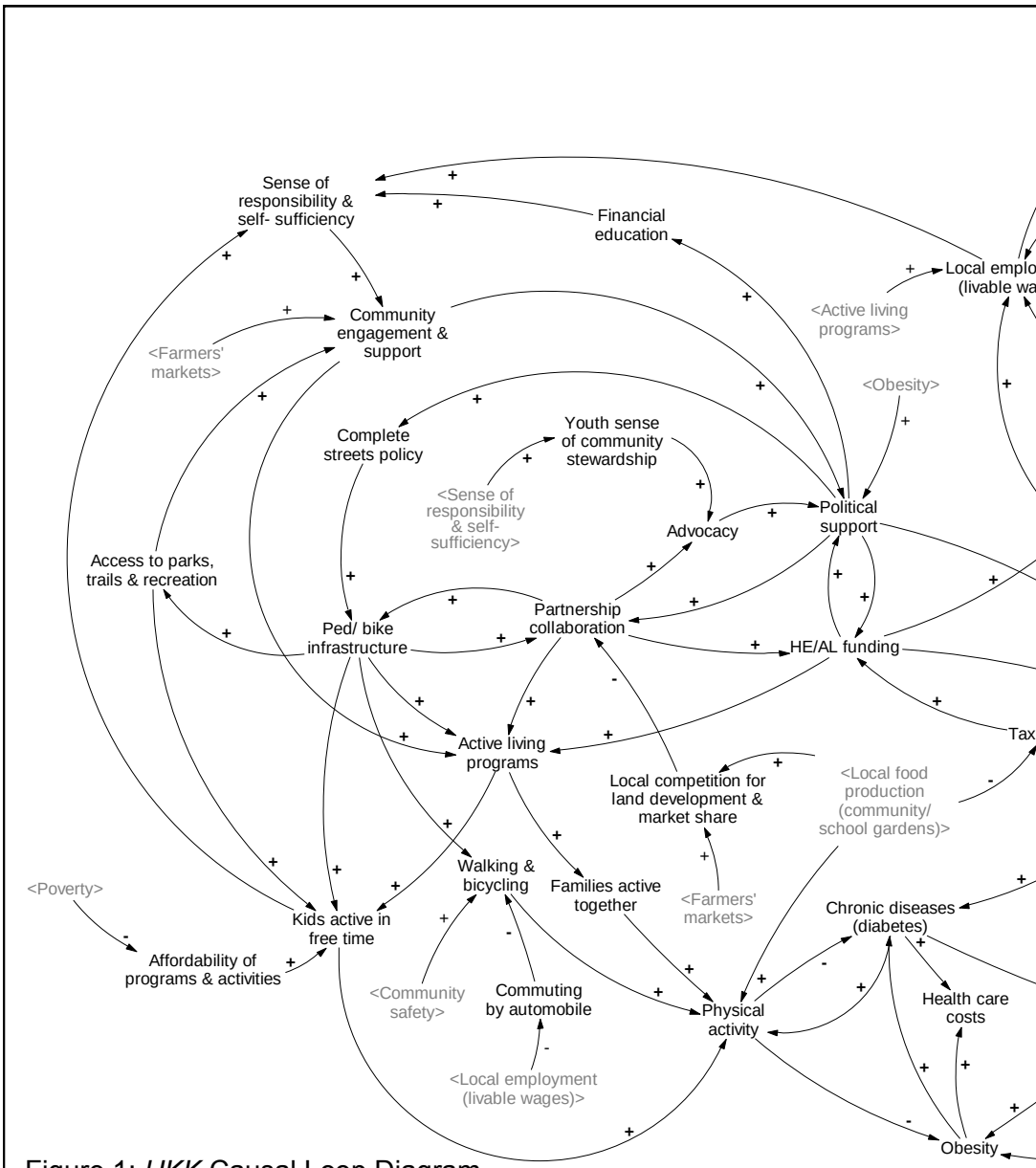


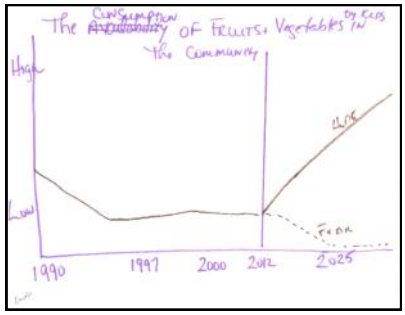
Figure 1: *HKK* Causal Loop Diagram

Group Model Building

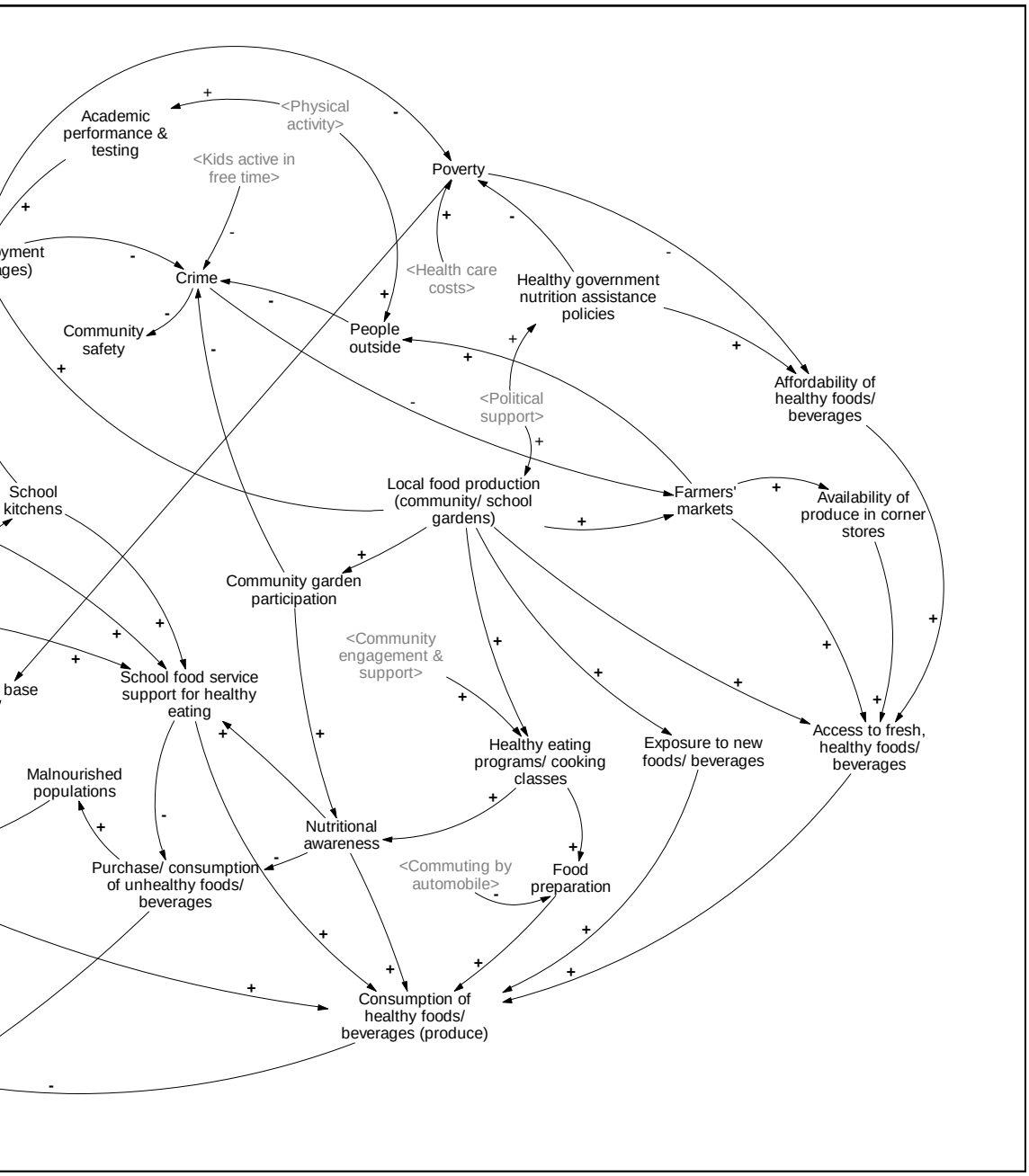
Members of the *HKK* partnership participated in a group model building session in October, 2012 and generated this system. also referred to as a causal loop diagram (Figure 1). Participants in the group model building session included representatives from academic institutions; local government agencies; civic, youth, and community based organizations; and advocates. 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.

<u>Behavior Over Time Graphs</u>

To identify the range of things that affect or are affected by policy, system, and environmental changes in Kingston 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 the consumption of fruits and vegetables in the community has decreased since 1990 to 2012 with the hope that consumption



of fruits and vegetables will change and increase into the future (see behavior over time graph bottom left). 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.

For instance, there are many feedback loops influencing or influenced by partnership collaboration in this causal loop diagram. One feedback loop is: partnership collaboration → advocacy → political support → partnership collaboration. A second feedback loop is: partnership collaboration → pedestrian and bike infrastructure → access to parks, trails, and recreation → community engagement and support → political support → partnership collaboration.

What is important to notice in these examples is that there are two different feedback loops interacting simultaneously to influence or to be influenced by partnership collaboration. Some variables may increase partnership collaboration while other variables limit partnership collaboration. 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.

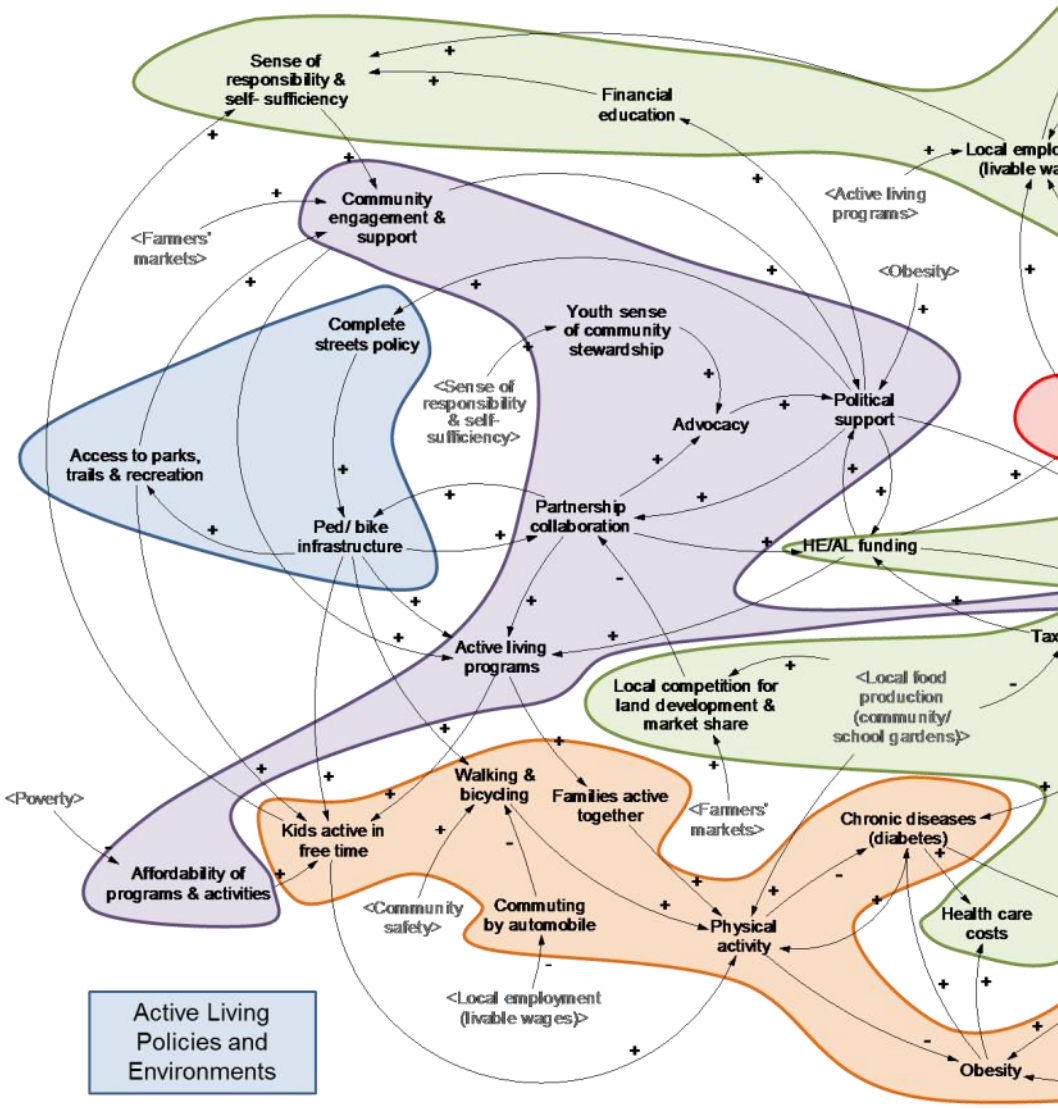
Based on this preliminary work by the *HKK* partnership, this "storybook" ties together the behavior over time graphs, the participants' stories and dialogue, and feedback loops from the causal loop diagram to understand the behavior of the system affecting health in Kingston, New York and to stimulate greater conversation related to Kingston'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.

Causal Loop Diagram for the Childhood Obesity System

The causal loop diagram (CLD) represents a holistic system and several subsystems interacting in Kingston, New York. 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.

Figure 2: Subsystems in the *HKK* Causal Loop Diagram



Healthy Eating Policies and Environments (Red)

The healthy eating policy and environmental subsystem includes food production (e.g., local food production community and school gardens), food distribution and procurement (e.g., healthy government nutrition assistance policies), and food retail (e.g., farmers' markets). During the behavior over time graphs exercise, the participants generated eleven graphs related to policy or environmental strategies (e.g., farmers' markets, availability of produce in corner stores) or contexts (e.g., exposure to new foods and beverages) that affected or were affected by the work of *HKK*. The variables represent participants' conversations from the behavior over time graph and causal loop diagram exercises.

Active Living Policies and Environments (Blue)

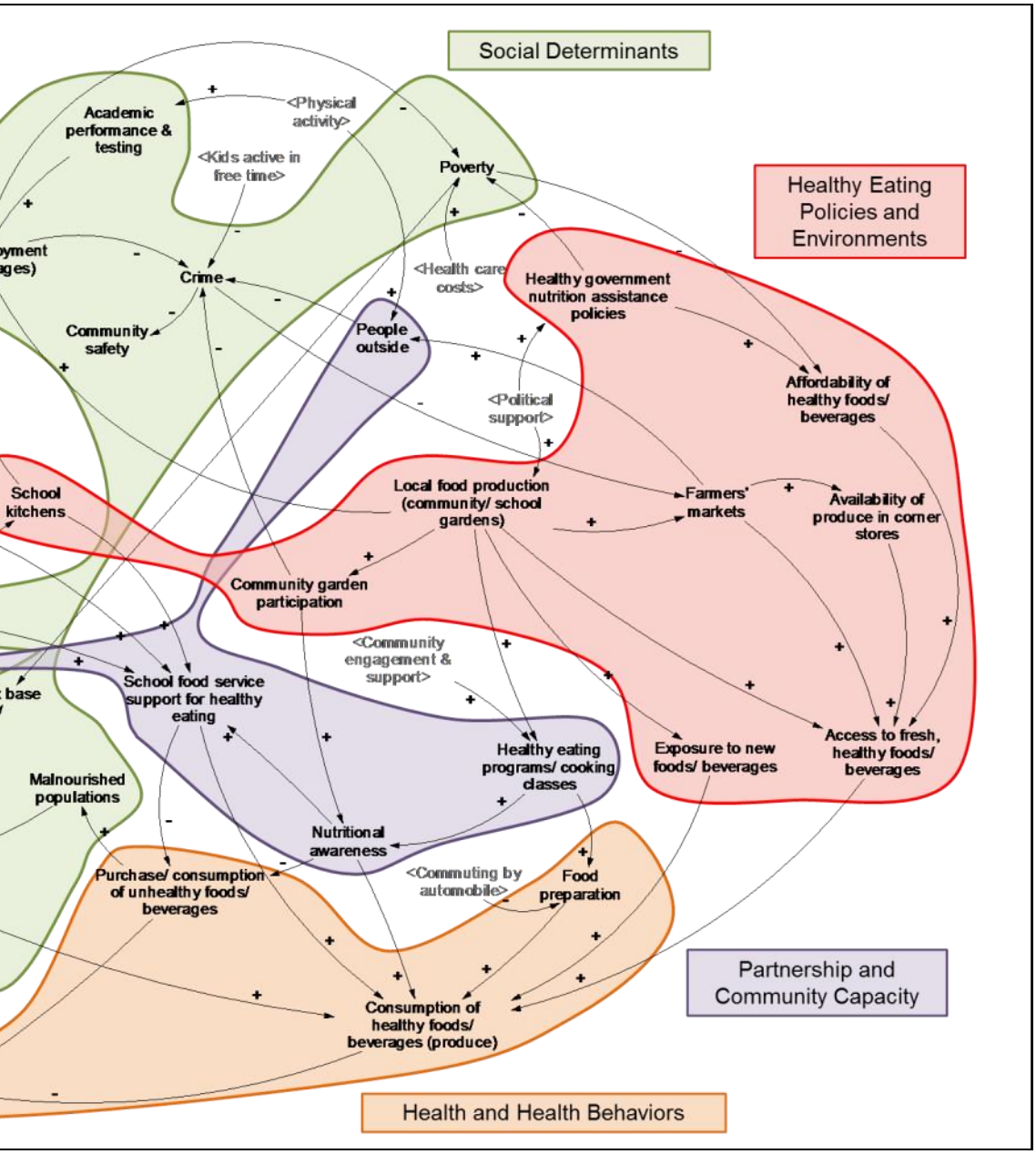
The active living policy and environmental subsystem includes design, planning, construction, and enforcement or maintenance related to access to opportunities for active transportation and recreation. For this topic, the group model building participants developed six graphs related to policy or environmental strategies (e.g., complete streets policy, pedestrian and bike infrastructure) or contexts (e.g., access to parks, trails, and recreation) 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., food preparation, purchase and consumption of unhealthy foods and beverages, families active together).

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, *HKK* has several coalitions and advisory councils (e.g., the Complete Streets Advisory Council) comprised of partners and local residents working towards healthy eating and active living changes in the community. This subsystem also includes community factors outside the partnership that may influence or be influenced by their efforts, such as political support or youth sense of community stewardship.



Social Determinants

Finally, the social determinants subsystem denotes societal conditions (e.g., local employment, poverty, crime) and psychosocial influences (e.g., sense of responsibility and self-sufficiency) 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 *HKK* partners or by other representatives in Kingston, New York. Using this CLD as a starting place, community conversations about different theories of change within subsystems may continue to take place. For instance, these participants identified interest in understanding more about the relationships among political support, community engagement and support, and complete streets policy.

The next sections begin to examine the feedback loops central to the work of *HKK*. 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.

Coalition Feedback Loop

To simplify the discussion about feedback loops, several loops drawn from the *HKK* CLD (see Figures 1 and 2) are highlighted in Figures 3-8. While the CLD provides a theory of change for the childhood obesity prevention movement in Kingston, New York, 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 the Coalitions in Kingston (green highlighted loop in Figure 3). Participants described how more partnership collaboration with the coalitions, there is an increase in advocacy toward healthy eating and active living initiatives. In turn, as there is more advocacy, the political support increases for healthy eating and active living initiatives, which increases partnership collaboration.

Story B: While the preceding story reflected a positive scenario for Kingston, New York, the same feedback loop also tells the opposite story. As there is less partnership collaboration with the coalitions, there is a decrease in advocacy toward healthy eating and active living initiatives. In turn, as there is less advocacy, the political support decreases for healthy eating and active living initiatives, which decreases partnership collaboration.

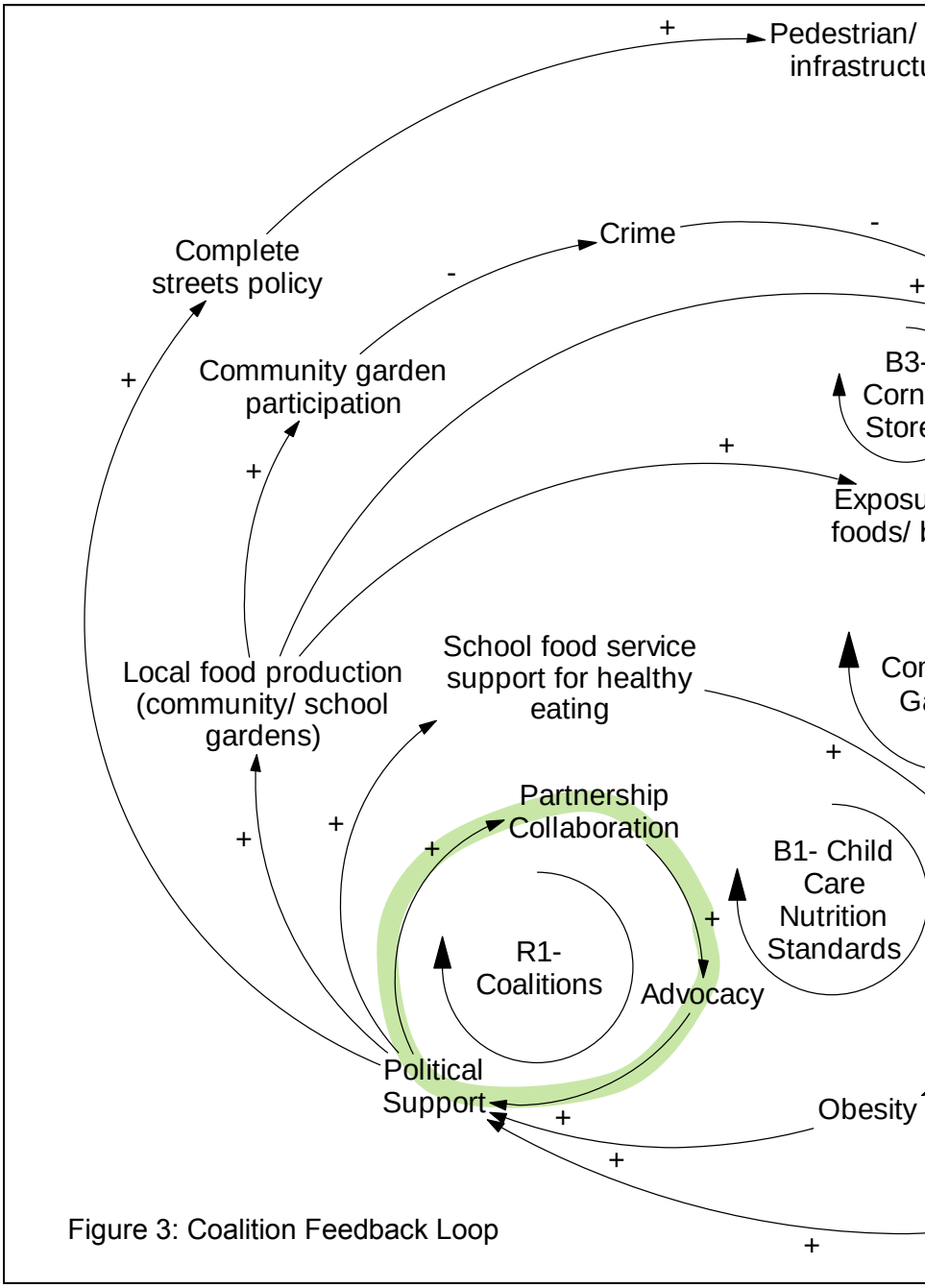


Figure 3: Coalition Feedback Loop

Reinforcing Loop and Notation

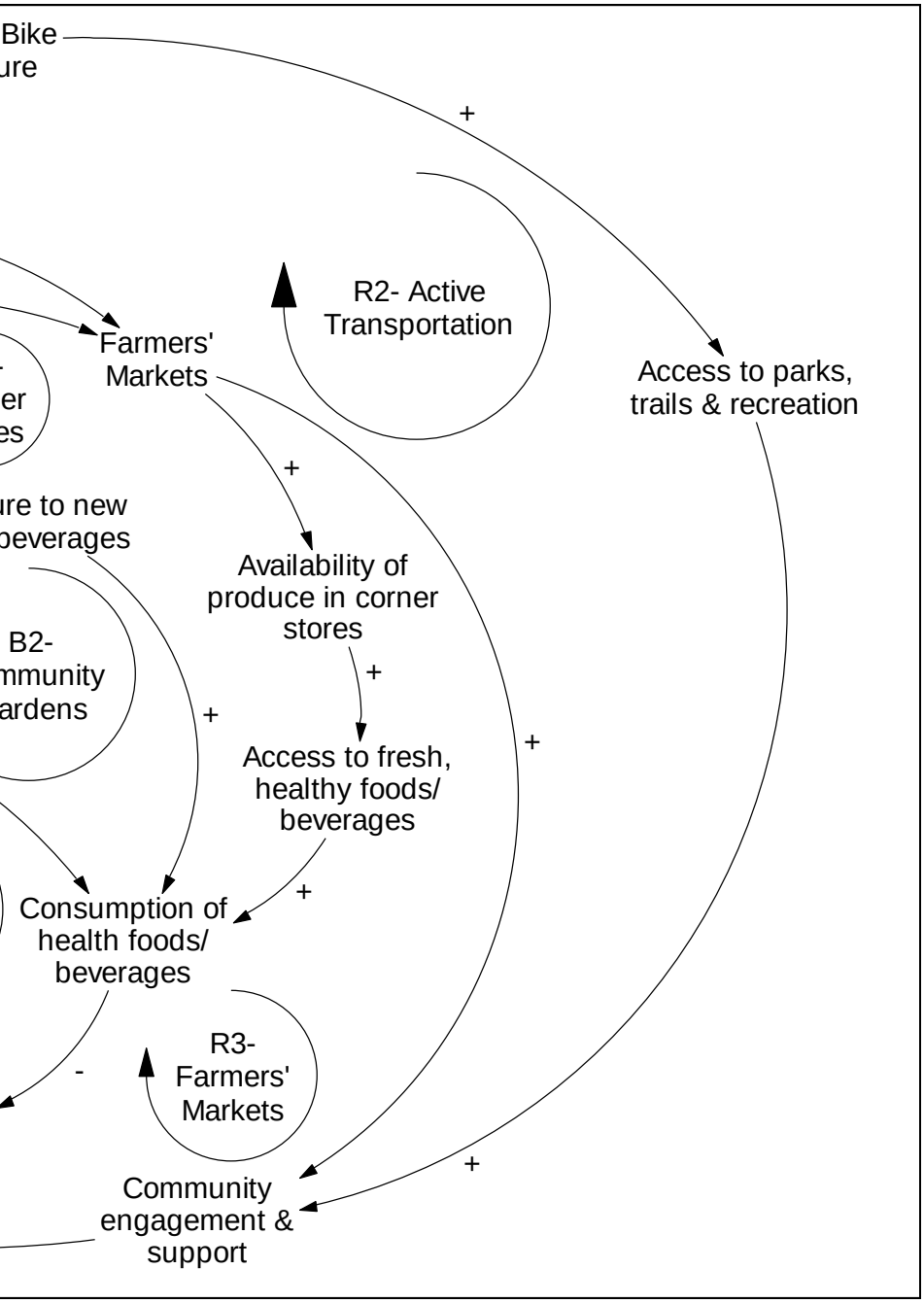
These stories represent a reinforcing loop, and the notation in the feedback loop identifies it as a reinforcing/balancing loop (see "R1 — Coalitions" and green highlighted loop in Figure 3). The words represent variables of quantities that increase and decrease as illustrated in the stories above. These 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. Looking

"The community helps to support families in the community; I look at the communities as agencies, as the schools, as the hospitals, profits and nonprofits, all coming together to focus on a common cause of health in our community." (Participant)

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 and are referenced in the next sections.

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 influence of partnership collaboration likely levels off at some point. To understand what specifically leads to the leveling off of partnership collaboration, it may be helpful for the partners in Kingston, New York to consider other variables that influence or are influenced by partnership collaboration. In addition, it is important to remember that this reinforcing loop is only one part of the larger CLD (see Figures 1 and 2), and the other loops and causal relationships can have an impact on the variables in this loop.



<u>System Insights for *HKK*</u>

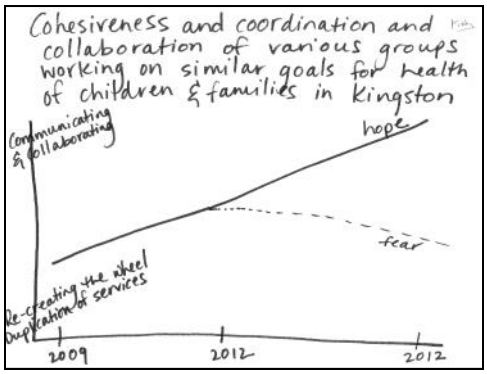
Participants identified an increase in cohesiveness and coordination and collaboration of various groups working on similar goals for health of children and families in Kingston since 2009 to 2012 with the hope that the cohesiveness, coordination, and collaboration will continue to increase into the future (see behavior over time graph bottom right).

From the systems thinking exercises, several insights can inform future coordination and collaboration of the coalitions working on healthy eating and active living initiatives in Kingston, including:

- Strategic partnerships to engage residents in advocacy initiatives stimulate support and funding from city government agencies.
- New and coordinated collaborations forged with city agency representatives or community organization leaders generates more political will in various sectors of the community for those whose voices are not well represented.

In addition to these insights, systems thinking can also help to pose key questions for assessment and evaluation, including:

- What types of partnerships increase resident engagement and participation in advocacy?
- What are successful funding structures to incentivize partnership and collaboration?



Child Care Nutrition Standards (Afterschool Snacks) Feedback Loop

Given the introduction to feedback loops and CLD notation in the previous section, this discussion of the feedback loop highlighted in orange in Figure 4 expands on the concepts and notation, and highlights child care nutrition standards.

Causal Story for Feedback Loop

Story A: In this case, the story is about improvements to child care nutrition standards in afterschool and child care settings. With more school food service support for healthy eating, there is an increase in consumption of healthy foods and beverages, which decreases obesity. With less obesity, there is less political support for healthy eating and active living initiatives, which decreases school food service support for healthy eating.

Story B: Alternatively, with less school food service support for healthy eating, there is a decrease in consumption of healthy foods and beverages, which increases obesity. With more obesity, there is more political support for healthy eating and active living initiatives, which increases school food service support for healthy eating.

Balancing Loop and Notation

Unlike the coalition loop in Figure 3, this loop has one "-" sign or polarity; identify this as a balancing loop (see B1 —Child Care Nutrition Standards in Figure 4).

In a balancing loop, the effect of the variables tend to create more of a stable trend over time, as opposed to one that is continually increasing or decreasing. This effect continues through the cycle and returns a stabilizing influence to the original variable, respectively.

Some of these causal relationships may have more immediate effects (e.g., school food service support for healthy eating influence on consumption of healthy foods and beverages) and other relationships may have delayed effects (e.g., consumption of healthy foods and beverages influence on obesity). This delayed effect is noted using two hash marks through the middle of the arrow line (not included in Figure 4).

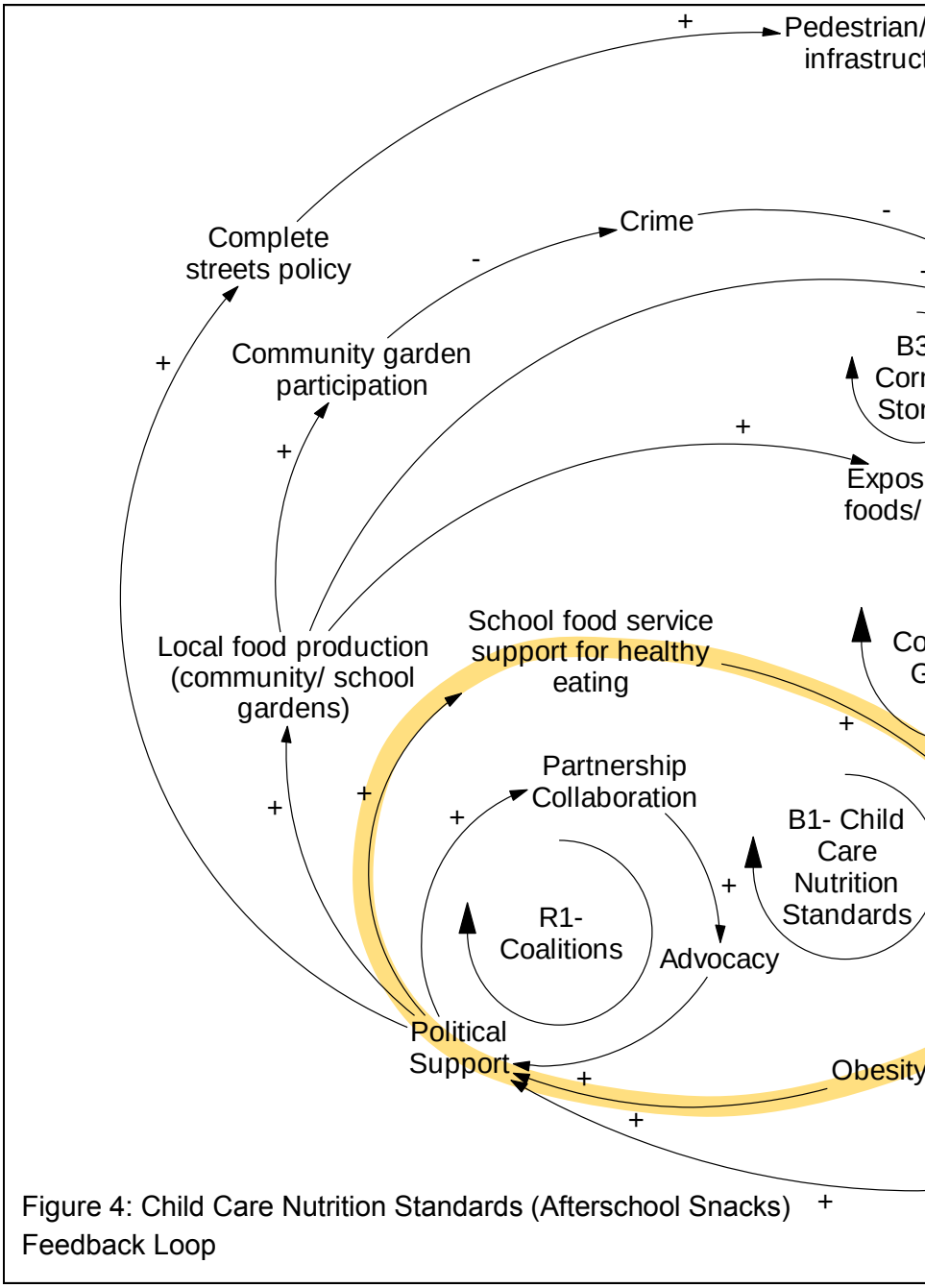
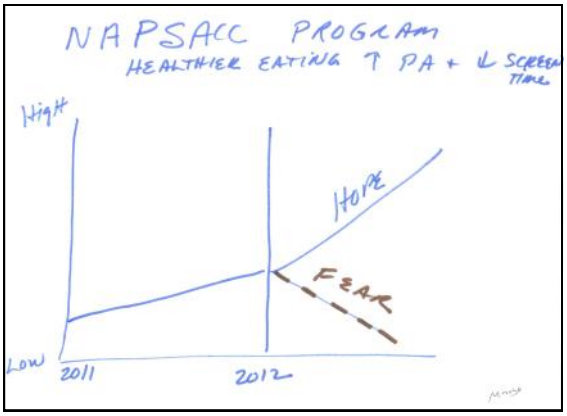


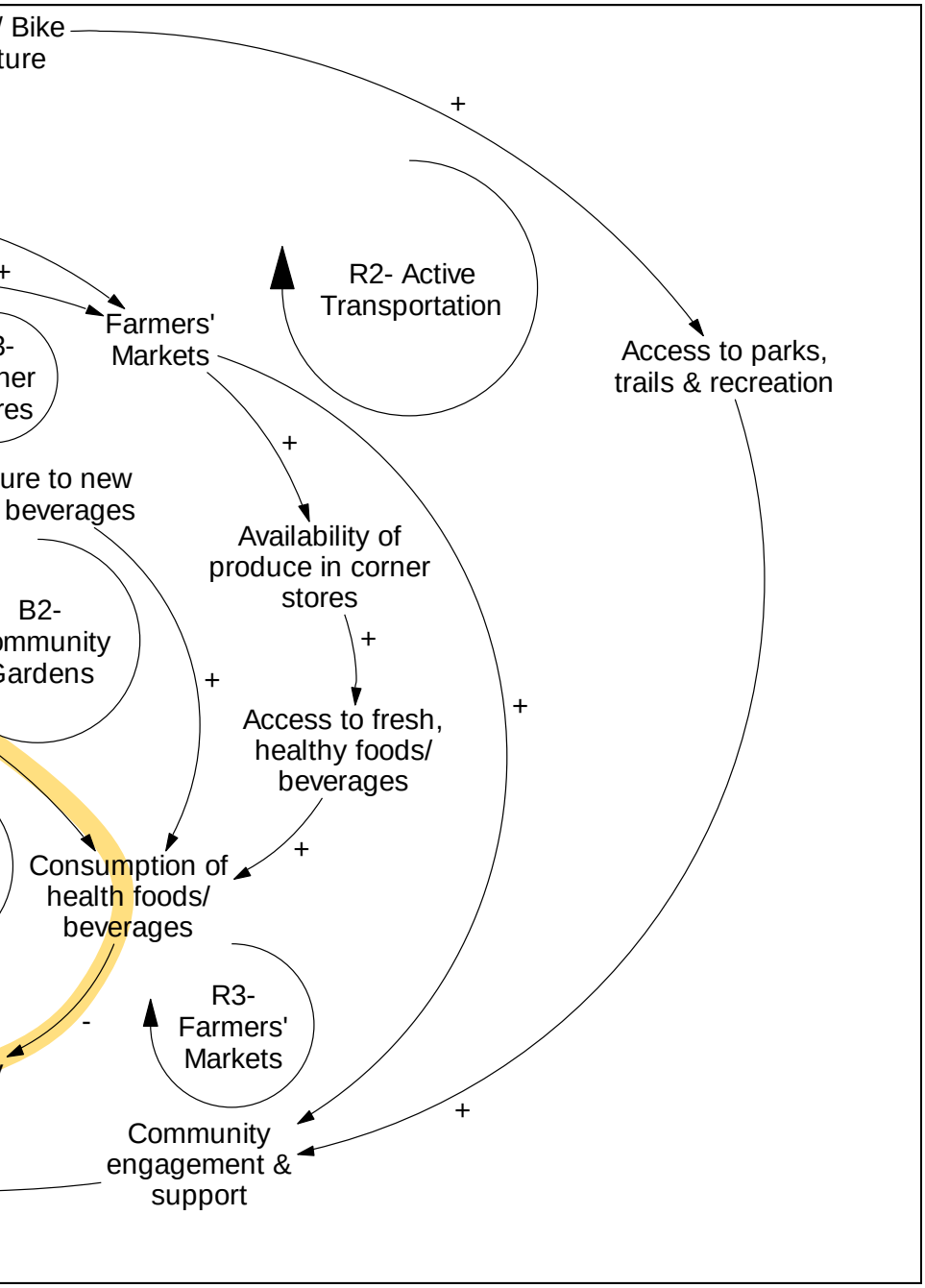
Figure 4: Child Care Nutrition Standards (Afterschool Snacks) Feedback Loop

"We've started a NAP-SAAC program at the day care centers here in our community and the anecdotal pun from one of the places where we opened the program was not only were these 2- and 3 -year-olds now eating their fruits and vegetables but it was a parental comment that also came back from the day care center, "my kids eat fruits and vegetables at home now." (Participant)

System Insights for *HKK*

In the behavior over time graphs, participants identified an increase in healthier eating and physical activity through the NAPSACC program that was implemented in the child care facilities since 2011 to 2012 with the hope that the NAPSACC program will continue to increase healthier eating and physical activity in the child care facilities (see behavior over time graph top right).





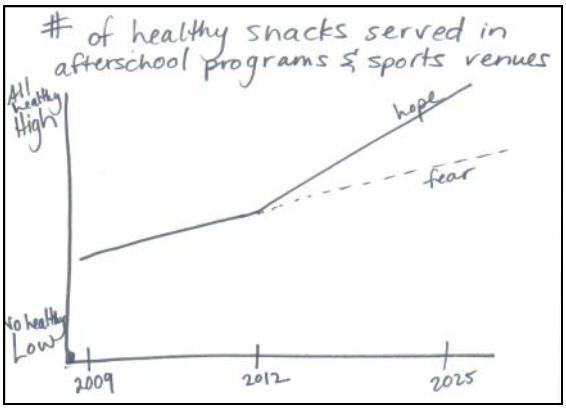
Similarly, participants identified an increase in the number of healthy snacks served in after school programs and sports venues since 2009 to 2012 with the hope that the number of healthy snacks will continue to increase into the future (see behavior over time graph bottom right).

System insights can inform the partnership's next steps with child care nutrition standards, including:

- Developing community organizing strategies to increase advocacy and support from partners (school food service staff), leaders, and residents for improved healthy eating standards community-wide.
- Working with school food service staff and youth to inform and educate others about the benefits of healthy eating in order to generate greater collaboration in the community.

In addition to these insights, systems thinking can also help to pose key questions for assessment and evaluation, including:

- How accessible are junk and fast foods and beverages compared to fresh fruits and vegetables in the afterschool programs and child care centers and among vendors within a one-mile radius of the centers?
- What factors influence partners, leaders, and residents to collaborate to improve healthy food and beverage standards?



Community Gardens Feedback Loop

Highlighted in blue in Figure 5, the community gardens feedback loop represents one of the *HKK* strategies to increase healthy eating in Kingston, New York.

Causal Story for Feedback Loop

Story A: With more local food production through community and school gardens, there is an increase in exposure to new foods and beverages. As more residents are exposed to new foods and beverages, there is an increase in the consumption of healthy foods and beverages, which decreases obesity. In turn, with less obesity, there is less political support, and less local food production.

Story B: Alternatively, with less local food production through community and school gardens, there is a decrease in exposure to new foods and beverages. As less residents are exposed to new foods and beverages, there is a decrease in the consumption of healthy foods and beverages, which increases obesity. In turn, with more obesity, there is more political support, and more local food production.

Balancing Loop and Notation

Similar to the previous loop (see Figure 4), this one also represents a balancing loop (one "-" sign). In addition, it includes causal relationships representing more immediate effects (e.g., local food production influence on exposure to new foods and beverages), and, potentially, delayed effects (e.g., consumption of healthy foods and beverages influence on obesity).

Story A provides a good illustration of the reason why it is not advantageous to separate the feedback loops from the causal loop diagram (see Figures 1-2). For instance, while the political support may have an influence on local food production, many other factors influence local food production. In this case, examining this loop without the context of the other variables and loops may lead to inappropriate conclusions.

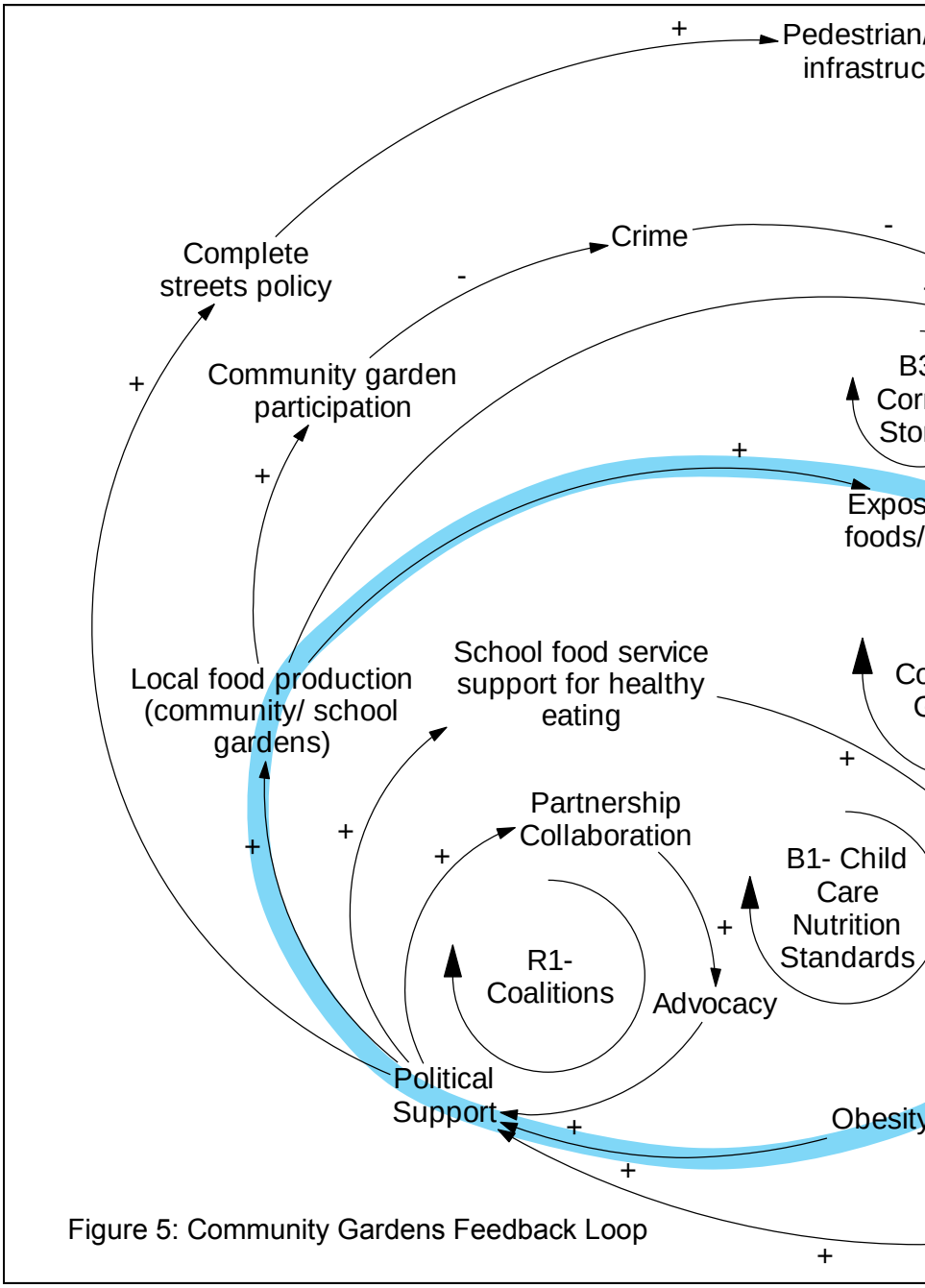


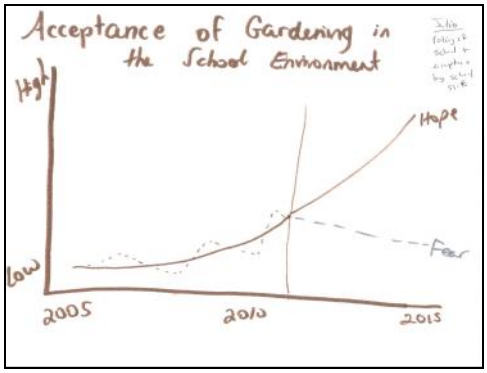
Figure 5: Community Gardens Feedback Loop

System Insights for *HKK*

In the behavior over time graphs exercise, participants described an increase in the acceptance of gardening in the school environment since 2005 to 2012 with the hope that acceptance of gardening in schools will continue to

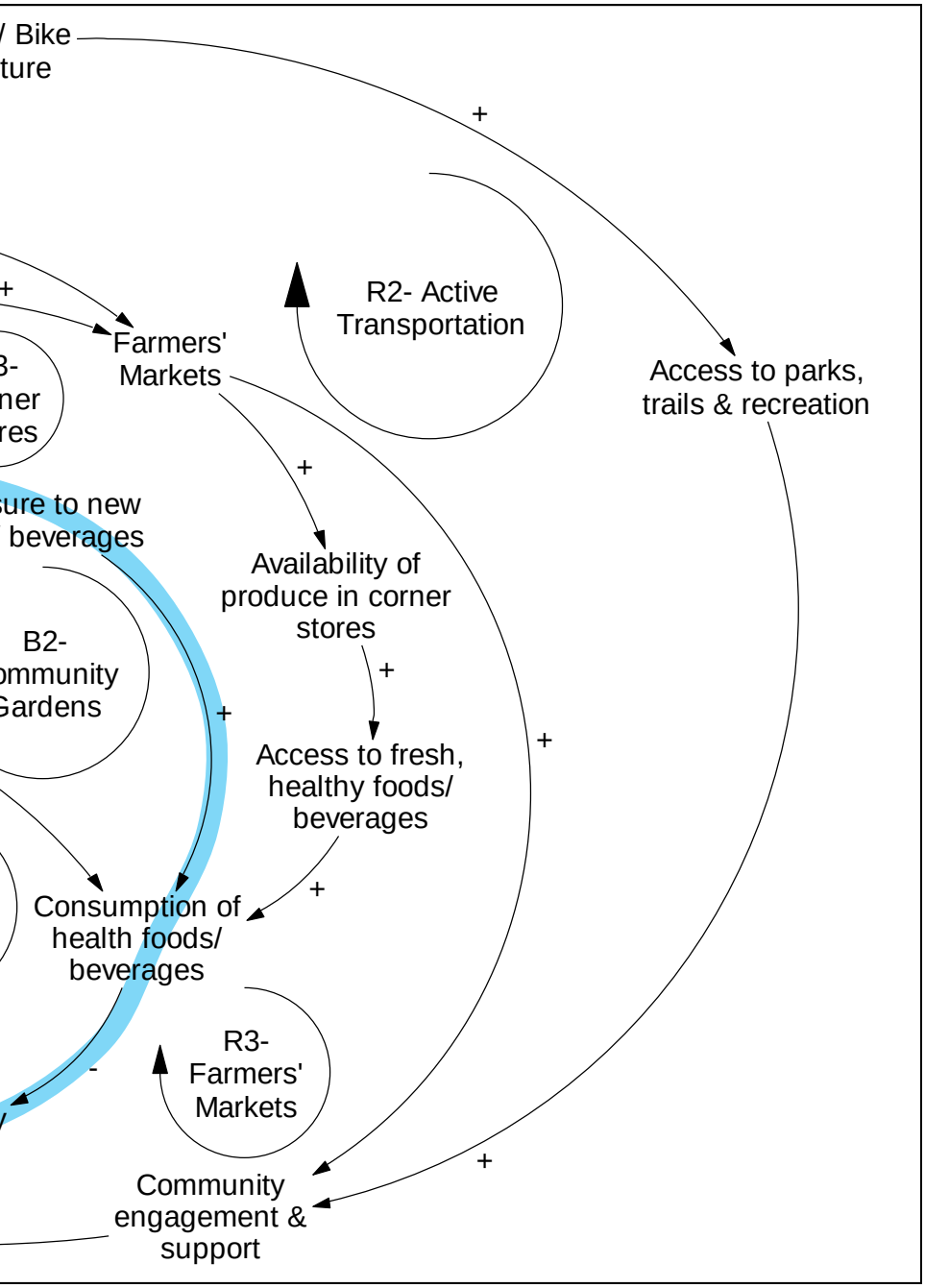
"People's demand for farmers' markets, local and organic produce in the stores, chickens and bees in their back yards, home school gardens and local food production has increased in Kingston, and I hope it continues to go up." (Participant)

increase into the future (see behavior over time graph top right).). Participants also identified an increase in the availability of fresh produce in food deserts since 1980 to 2012 with the hope that the availability of fresh produce in food deserts will continue to increase into the future (see behavior over time graph bottom right).



System insights for the partnership's community gardens efforts include:

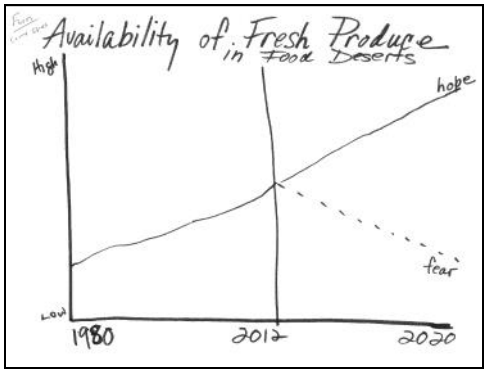
- Community gardens and urban agriculture designed to enhance youth and community engagement can focus on learning about native fruits and vegetables as well as agricultural practices of ancestors; this engagement also connects youth and community residents to other programs and services available in the community.



- Parent knowledge and awareness through exposure to new foods and beverages is key to their engagement in efforts to increase healthy eating (and active living) and reduce childhood obesity; this knowledge and awareness increases their skills to interact with their children through cooking meals at home or engaging in physical activity.

In addition to these insights, systems thinking can also help to pose key questions for assessment and evaluation, including:

- What is the optimal number of school or community gardens or farms for a neighborhood or urban area?
- What factors lead to an increase in demand for healthy foods and beverages in communities?



Active Transportation (Complete Streets, Safe Routes to Schools & Parks) Feedback Loop

Highlighted in red in Figure 6, the active transportation feedback loop represents one of the *HKK* strategies to increase active living in Kingston, New York.

Causal Story for Feedback Loop

Story A: With more complete streets policy emphasizing transportation options for all modes of transportation, there is an increase in pedestrian and bike infrastructure. With more pedestrian and bike infrastructure, there is an increase in access to parks, trails, and recreation facilities through active transportation methods. With greater access to parks, trails, and recreation facilities, there is an increase in community engagement and support, which increases political support. In turn, with greater political support, there is more complete streets policies.

Story B: Alternatively, with less complete streets policy emphasizing transportation options for all modes of transportation, there is a decrease in pedestrian and bike infrastructure. With less pedestrian and bike infrastructure, there is a decrease in access to parks, trails, and recreation facilities through active transportation methods. With less access to parks, trails, and recreation facilities, there is a decrease in community engagement and support, which decreases political support. In turn, with less political support, there is less complete streets policies.

Reinforcing Loop and Notation

Similar to the first loop (see Figure 3), this is a reinforcing loop (all "+" signs). In addition, it includes causal relationships representing more immediate effects (e.g., community engagement and support influence on political support), and, potentially, delayed effects (e.g., complete streets policy influence on pedestrian and bike infrastructure).

System Insights for *HKK*

In the behavior over time graphs exercise, participants described a slight increase in the number of children and people biking in Kingston since 2009 to 2012 with the

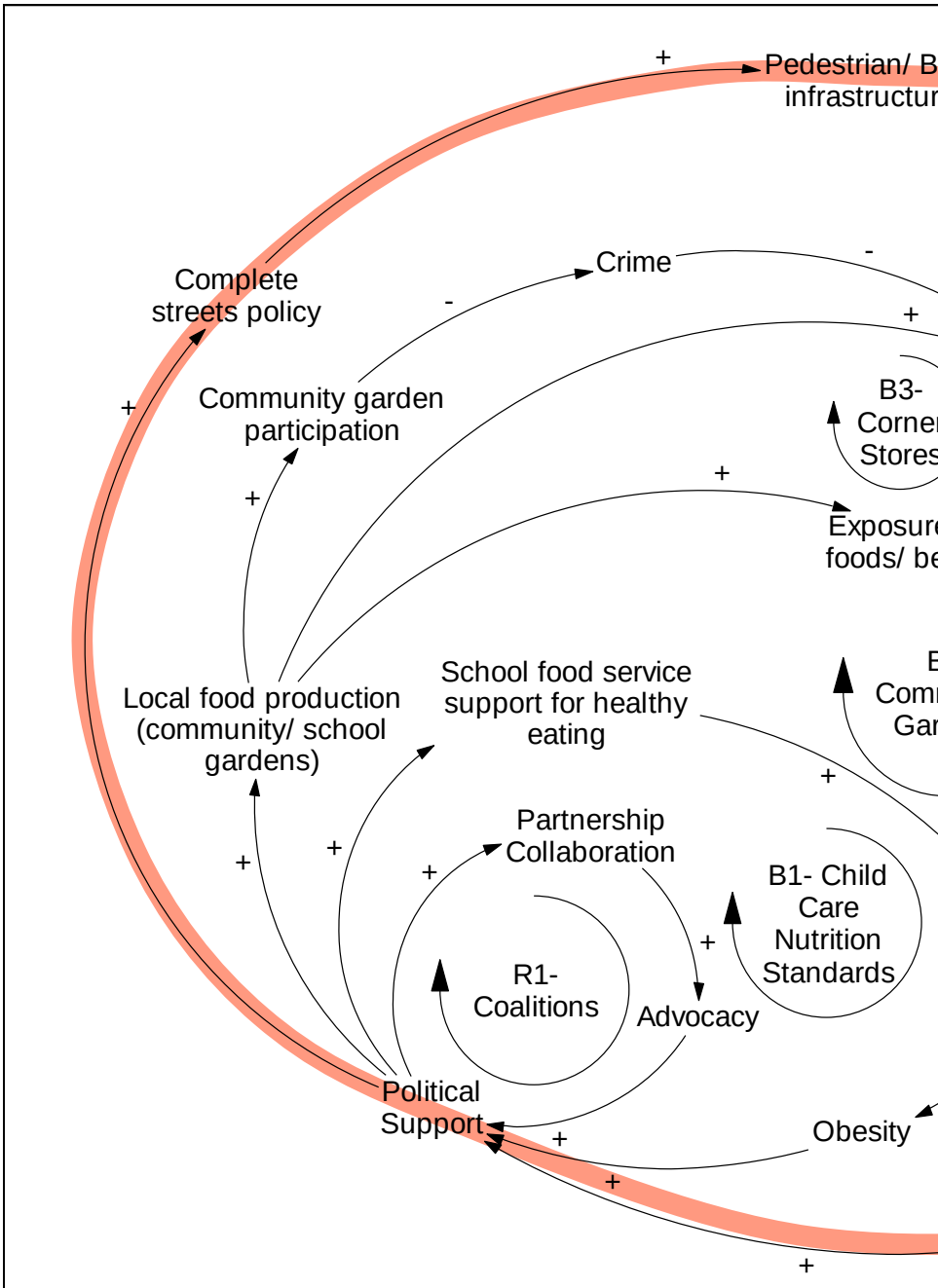
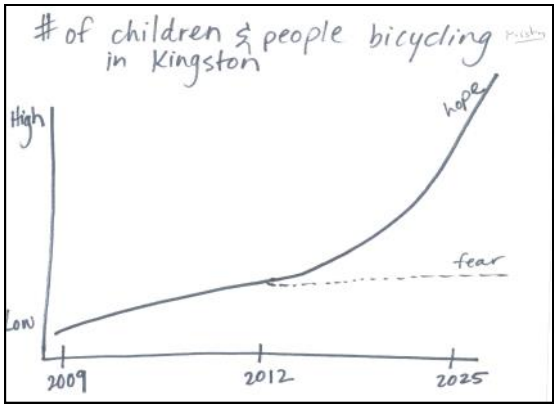
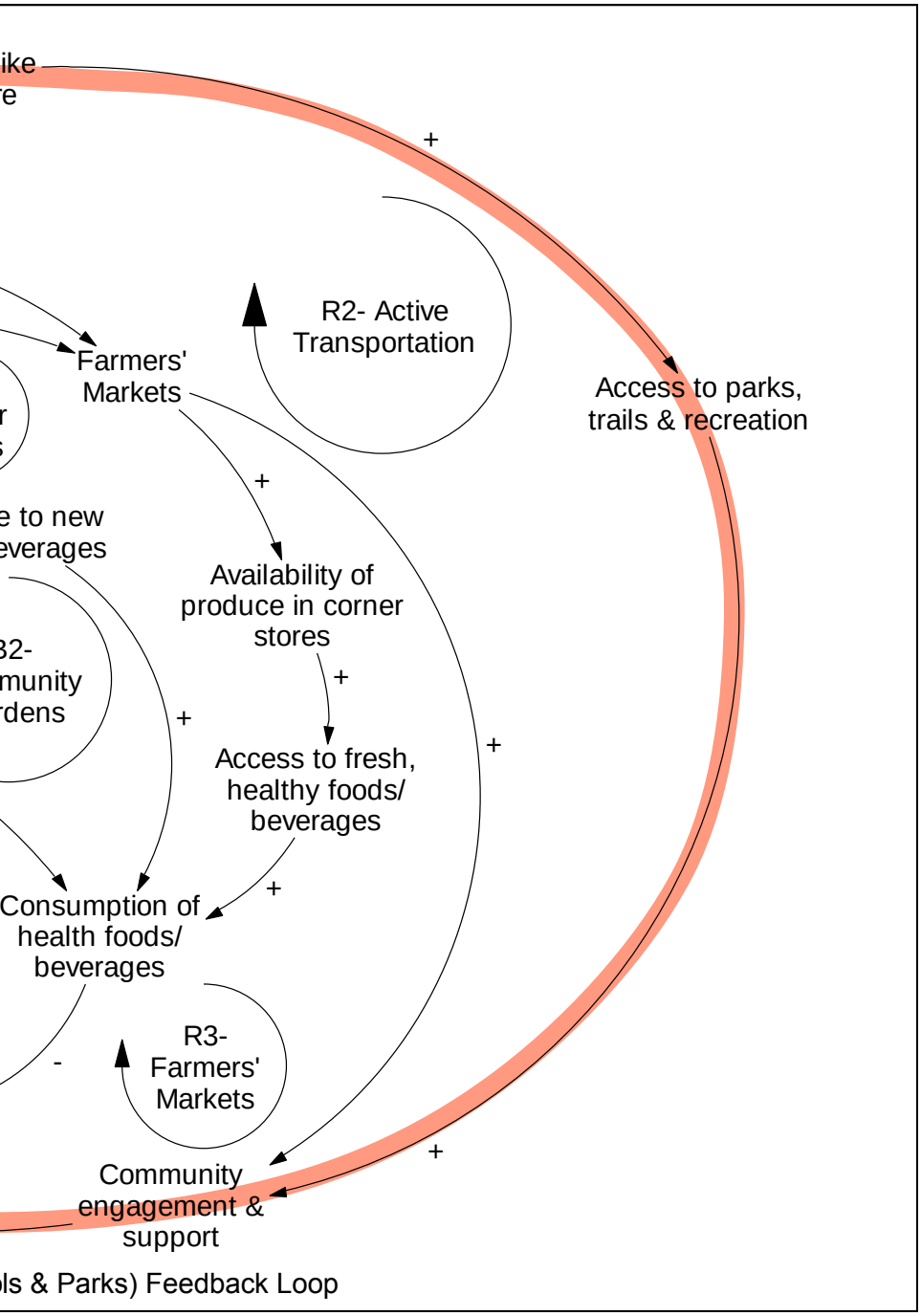


Figure 6: Active Transportation (Complete Streets, Safe Routes to Schoo

"Something I've used in my life in training people is knowing that we have to capture children at a young age. And because we're adults, we're bombarded with just so many things that create excuses. We look for an excuse not to focus, not only on nutrition but the exercise part, the movement of getting out into the parks, the riding the bikes. If we can use the community collaborations and teach the parents and teach the kids." (Participant)

hope that the number of children and people biking will continue to increase rapidly into the future (see behavior over time graph top right). Additionally, participants also described an increase in the awareness of complete streets policies since 2008 to 2012 with the hope that awareness of complete streets policies will continue to increase into the future (see behavior over time graph bottom right).



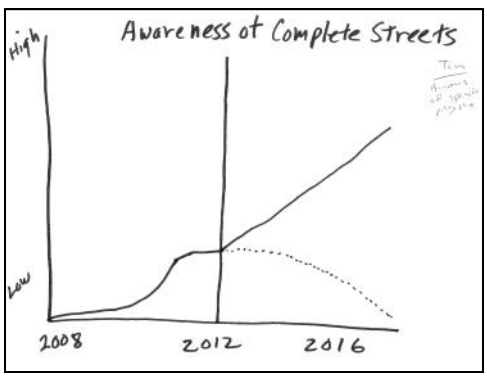


System insights for the partnership's active transportation efforts include:

- Infrastructure for pedestrians and bicyclists increases the number of families being active together; sidewalks and bike lanes — along with traffic calming and other safety measures — create opportunities for families to choose active rather than sedentary transportation modes.
- Incorporation of efforts to increase community knowledge and empowerment generates more community engagement to bolster advocacy efforts (e.g., programmatic and promotional efforts to complement policy, system, and environmental changes can enhance overall advocacy).

In addition to these insights, systems thinking can also help to pose key questions for assessment and evaluation, including:

- What streets have accommodations for pedestrians, bicyclists, and drivers? Are they safe for all users? What is still needed (e.g., traffic calming measures, more sidewalks and bike lanes)?
- What types of partnerships increase resident engagement and participation in advocacy?
- What types of trips are made by car, bike, and foot in communities? Who is using the current active transportation infrastructure and who is not (e.g., adults, children)?



Farmers' Markets Feedback Loop

Highlighted in yellow in Figure 7, the farmers' markets feedback loop represents one of the *HKK* strategies to increase healthy eating in Kingston, New York.

Causal Story for Feedback Loop

Story A: With more farmers' markets, there is an increase in community engagement and support, which increases political support. With greater political support, there is an increase in local food production in community and school gardens. With greater local food production, there are more residents participating in community gardens, which decreases crime. In turn, with less crime, there is more need or demand for farmers' markets.

Story B: Alternatively, with less farmers' markets, there is a decrease in community engagement and support, which decreases political support. With less political support, there is a decrease in local food production in community and school gardens. With less local food production, there are less residents participating in community gardens, which increases crime. In turn, with more crime, there is less need or demand for farmers' markets.

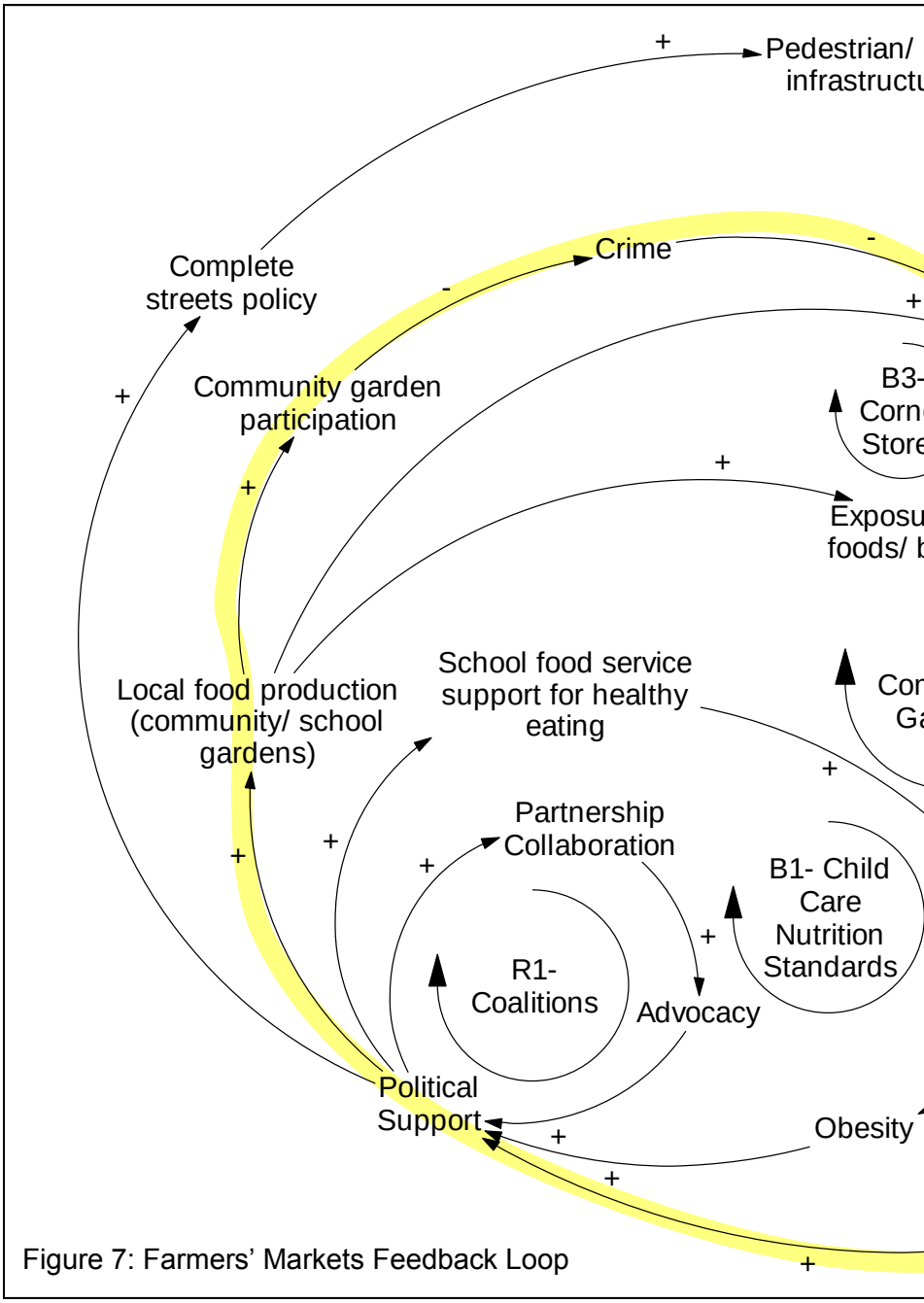


Figure 7: Farmers' Markets Feedback Loop

Reinforcing Loop and Notation

Similar to the previous loops (see Figure 3 & 6), this is a reinforcing loop (two "-" signs). In addition, it includes causal relationships representing more immediate effects (e.g., local food production influence on community garden participation), and, potentially, delayed effects (e.g., crime influence on farmers' markets).

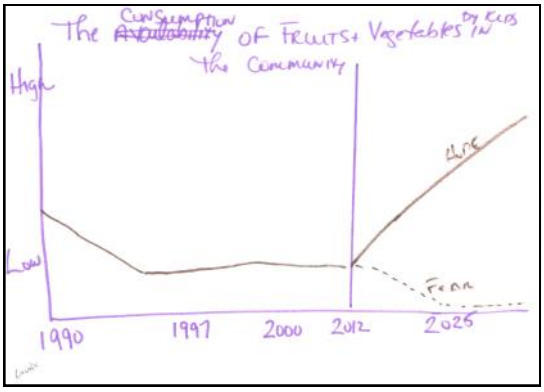
System Insights for *HKK*

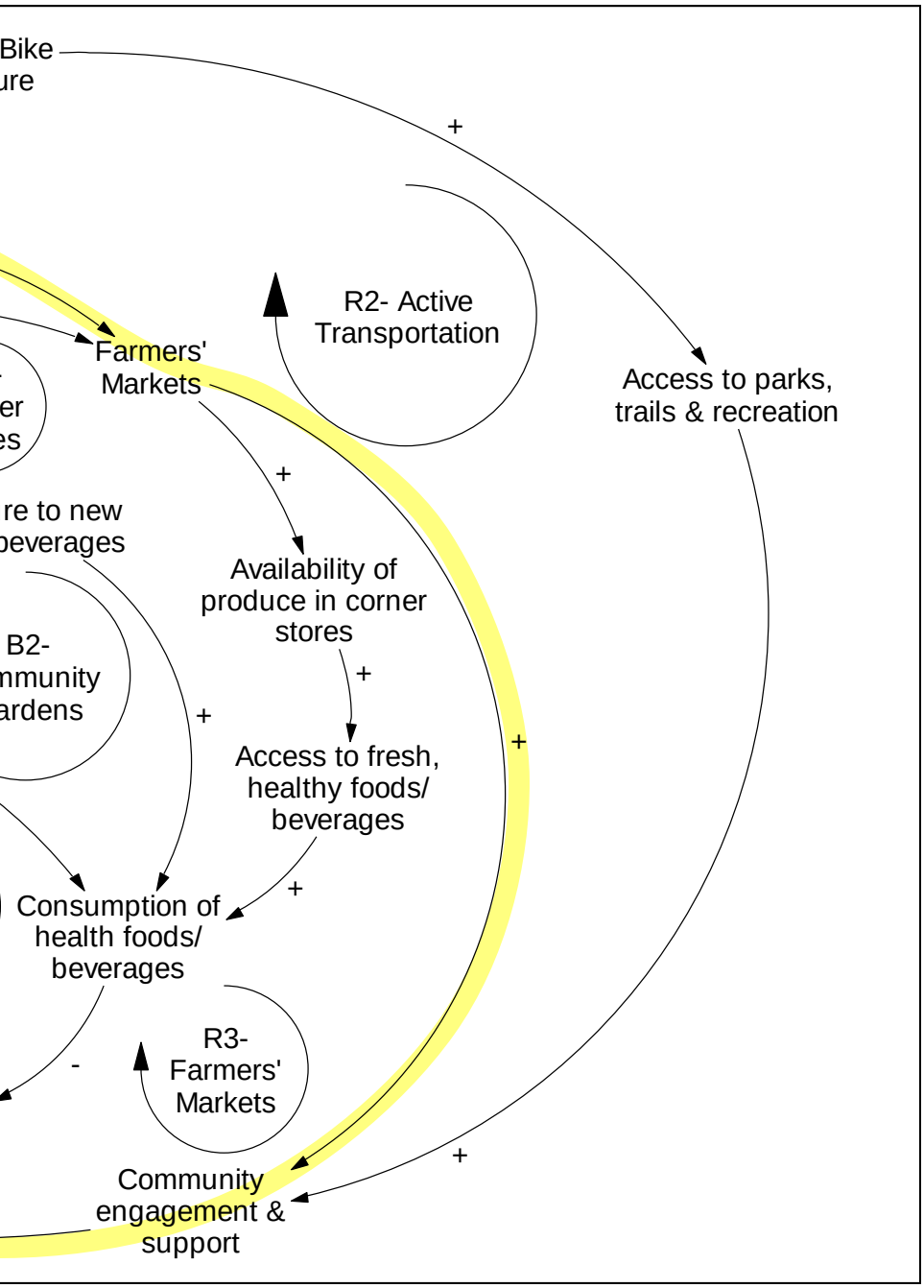
In the behavior over time graphs exercise, participants described a decrease in the consumption of fruits and vegetables by kids in the community since 1990 to 20120 with the hope that the consumption of fruits and vegetables by kids will increase into the future (see behavior over time graph next page top right). Participants also described an increase in the amount of community concern for access to local produce since 2005 to 2012 with the hope that the amount of community concern for access to local produce will continue to increase into the future (see behavior over time graph next page bottom right).

"Fresh food and local food and organic food shouldn't be for just those who can afford it; it should be for everyone. And how do you get to that point and how do you do it with food stamps? And so how do you do it if you have a limited budget and you [need to] stretch your food budget? It's not easy." (Participant)

System insights for the partnership's farmers' markets efforts include:

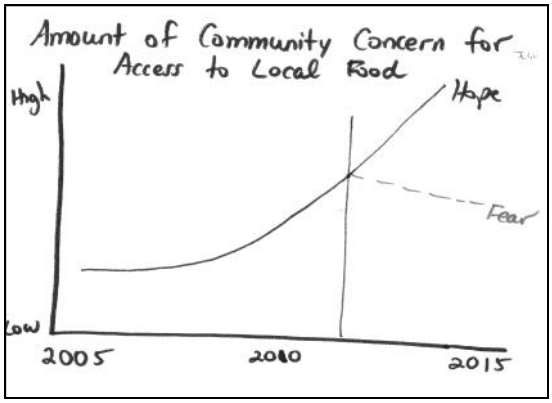
- Farmers' markets have the benefit of increasing a sense of community and community engagement.
- Community gardens and farmers' markets increase neighborhood revitalization and limit or reverse suburban sprawl as residents feel less vulnerable to crime or violence in urban areas; by drawing residents back into more dense, urban neighborhoods, the gardens and farms minimize geographic isolation in suburban dwellings.





In addition to these insights, systems thinking can also help to pose key questions for assessment and evaluation, including:

- What is the proportion of unhealthy food and beverage products to healthy food and beverage products sold by local food vendors (e.g., farmers' markets, corner stores, grocery stores)? How do these products differ by cost, product placement within the stores, and marketing or signage in and around the stores?
- What factors influence neighborhood safety (e.g., rates of crime, violent actions)? Are these the same factors that influence perceptions of neighborhood safety? What are the actual rates of crime and violence as compared to perceptions?
- How does social engagement increase sense of community, and, in turn, sense of identify? What are the key ingredients to a successful approach?



Corner Stores Feedback Loop

Highlighted in purple in Figure 8, the corner stores feedback loop represents one of the *HKK* strategies to increase healthy eating in Kingston, New York.

Causal Story for Feedback Loop

Story A: With more availability of produce in corner stores, there is an increase in access to fresh and healthy foods and beverages, which increases consumption of healthy foods and beverages. When more residents are consuming healthy foods and beverages, there is less obesity, which decreases political support. With less political support, there is less support for local food production through community and school gardens. With less local food production, there is less farmers' markets, which also decreases the availability of produce in corner stores.

Story B: Alternatively, with less availability of produce in corner stores, there is a decrease in access to fresh and healthy foods and beverages, which decreases consumption of healthy foods and beverages. When less residents are consuming healthy foods and beverages, there is more obesity, which increases political support. With more political support, there is more support for local food production through community and school gardens. With greater local food production, there is more farmers' markets, which also increases the availability of produce in corner stores.

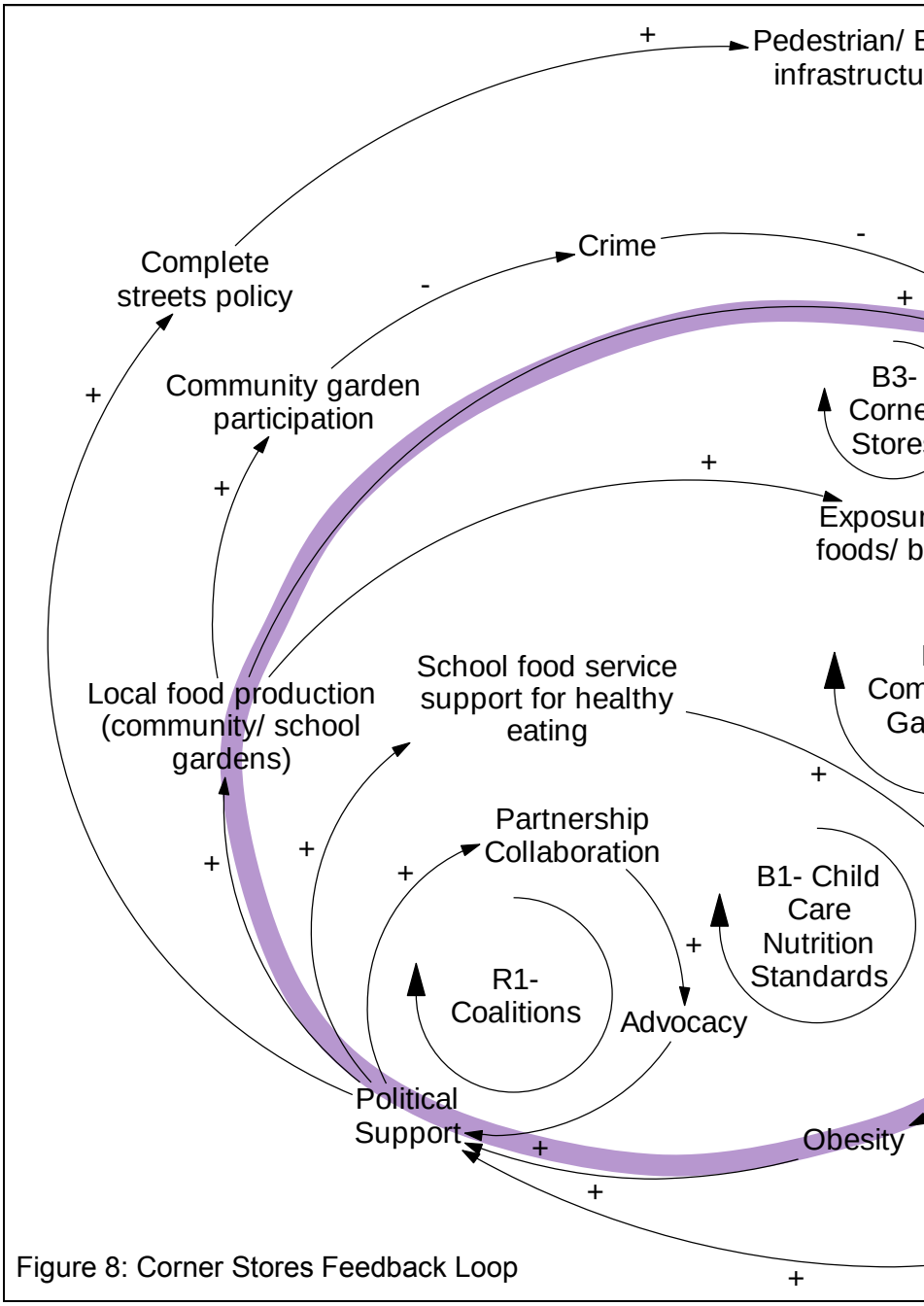


Figure 8: Corner Stores Feedback Loop

Reinforcing Loop and Notation

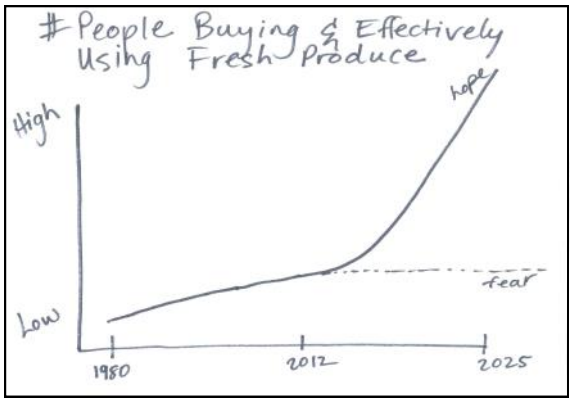
Similar to the previous loops (see Figure 4 & 5), this is a balancing loop (one "-" sign). In addition, it includes causal relationships representing more immediate effects (e.g., availability of produce in corner stores influence on access to healthy foods and beverages), and, potentially, delayed effects (e.g., consumption of healthy foods and beverages influence on obesity).

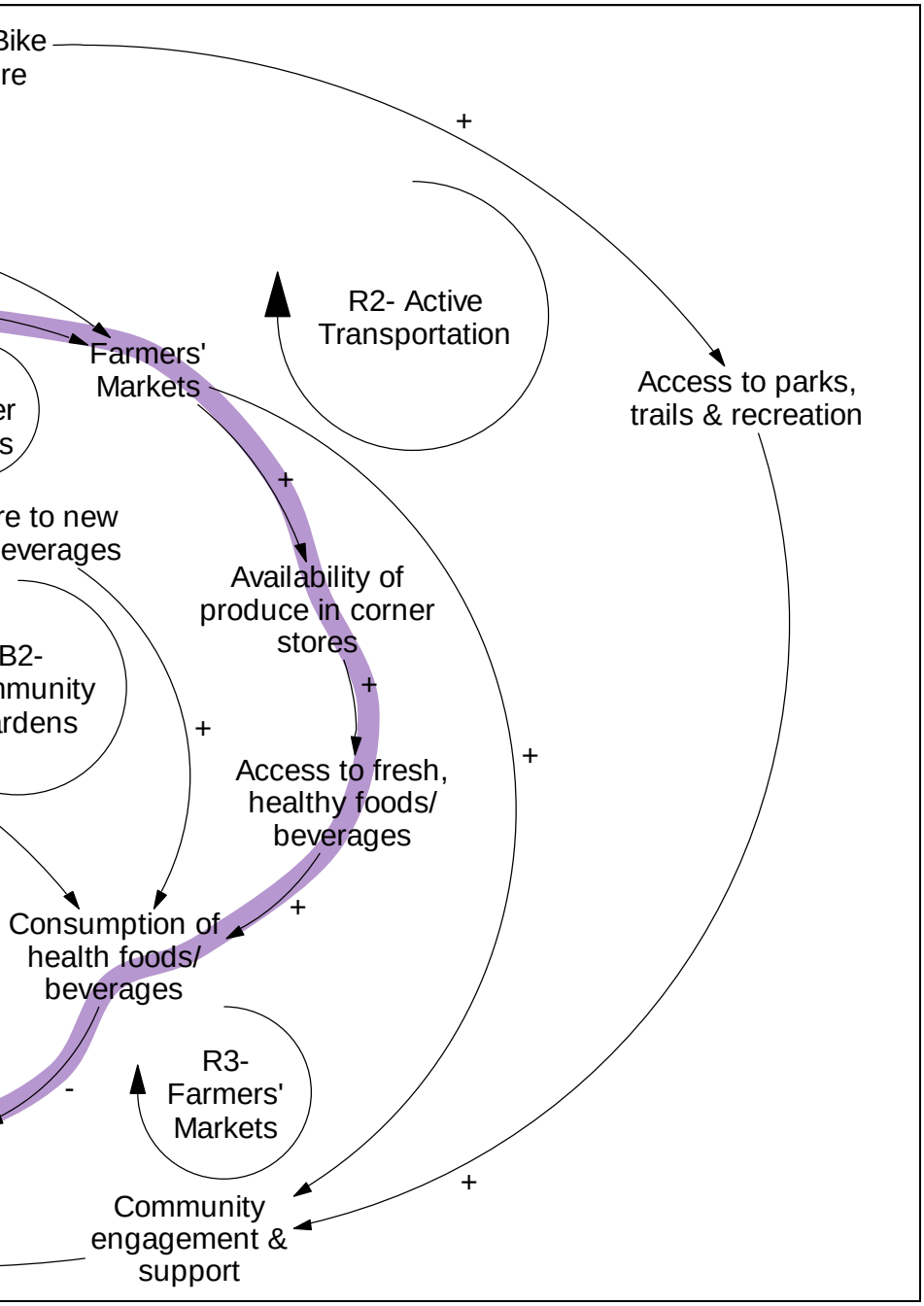
System Insights for *HKK*

In the behavior over time graphs exercise, participants described a slight increase in the number of people buying and effectively using fresh produce since 1980 to 2012 with the hope that the number of people buying and effectively using

"If you look at healthier snacks, even in grocery stores, it costs more. I'm just so glad whole grain costs have finally come down to the regular cost, because that's been some years, just even for it to do that, but when you're talking kids that barely got any money as it is to even talk about getting a healthy snack or whatever." (Participant)

fresh produce will drastically increase into the future (see behavior over time graph at the top right). However/Additionally, participants also described an increase in the availability of fresh produce in Kingston's food deserts through farmers markets and corner stores since 2009 to 2012 with the hope that the availability of fresh produce in corner stores and farmers' markets will continue to increase into the future (see behavior over time graph bottom right).



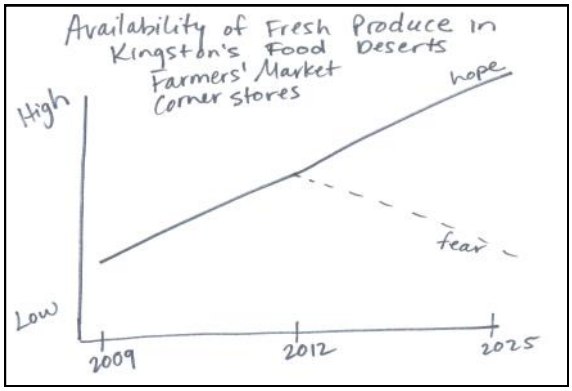


System insights for the partnership's corner stores efforts include:

- Greater numbers of healthy corner stores — as well as other healthy food vendors — can lead to a more competitive local market for healthy foods and beverages that may help to drive down costs and increase access.
- Corner stores — similar to fast food restaurants — are perceived to increase access to unhealthy foods and beverages by people in the community; this presents an opportunity to increase the number of healthy corner stores to change residents' perceptions of these food vendors as providers of healthy food and beverage alternatives.

In addition to these insights, systems thinking can also help to pose key questions for assessment and evaluation, including:

- Does an increase in the number of healthy food vendors increase competition in the local market that drives down the cost of healthy foods and beverages? If so, how?
- What is the proportion of unhealthy food and beverage products to healthy food and beverage products sold by local food vendors (e.g., farmers' markets, corner stores, grocery stores)? How do these products differ by cost, product placement within the stores, and marketing or signage in and around the stores?



Opportunities for Systems Thinking in Kingston, New York

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

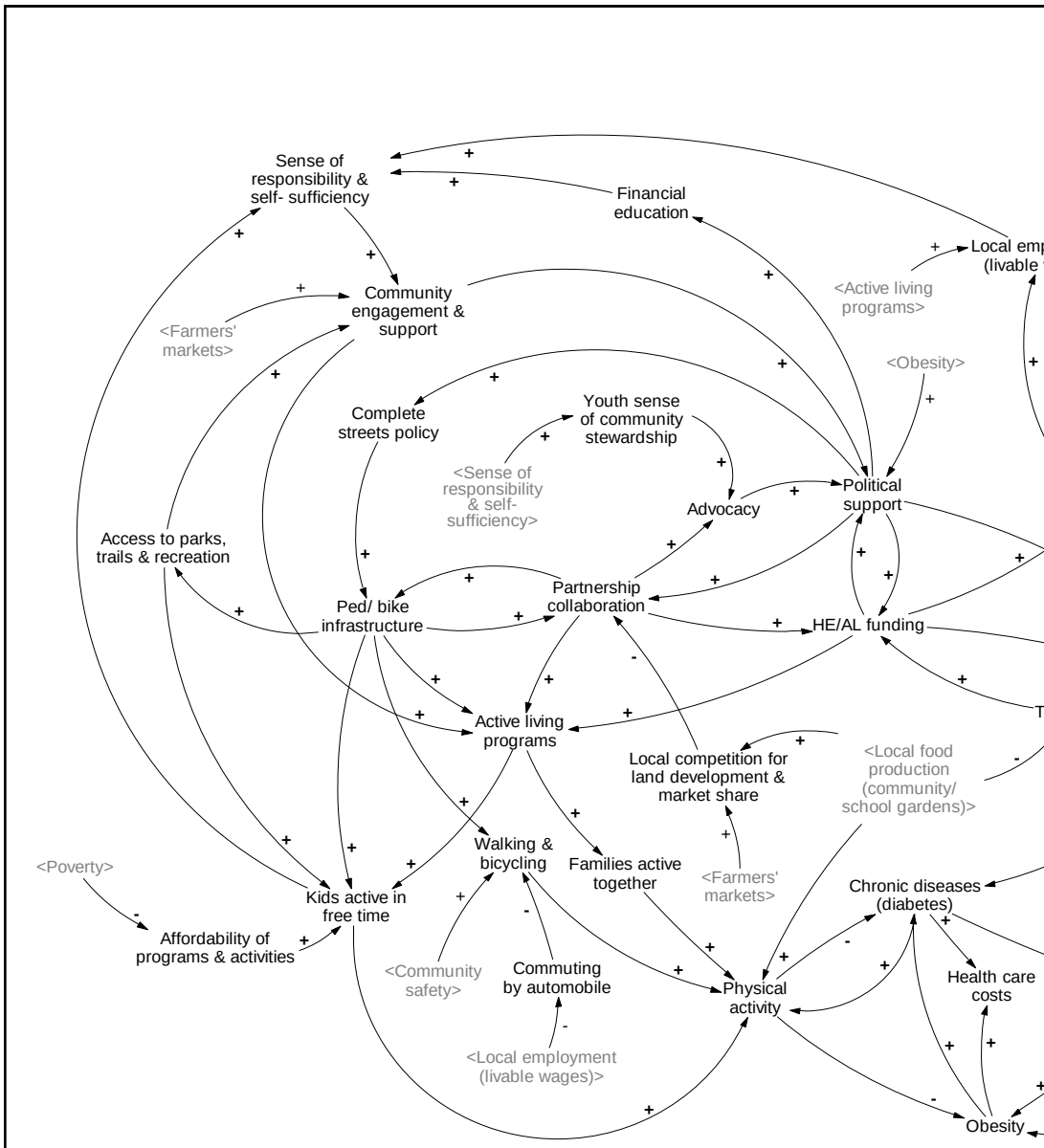


Figure 8: *HKK* Causal Loop Diagram

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 Kingston, New York to promote healthy eating and active living as well as preventing childhood overweight and obesity.

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

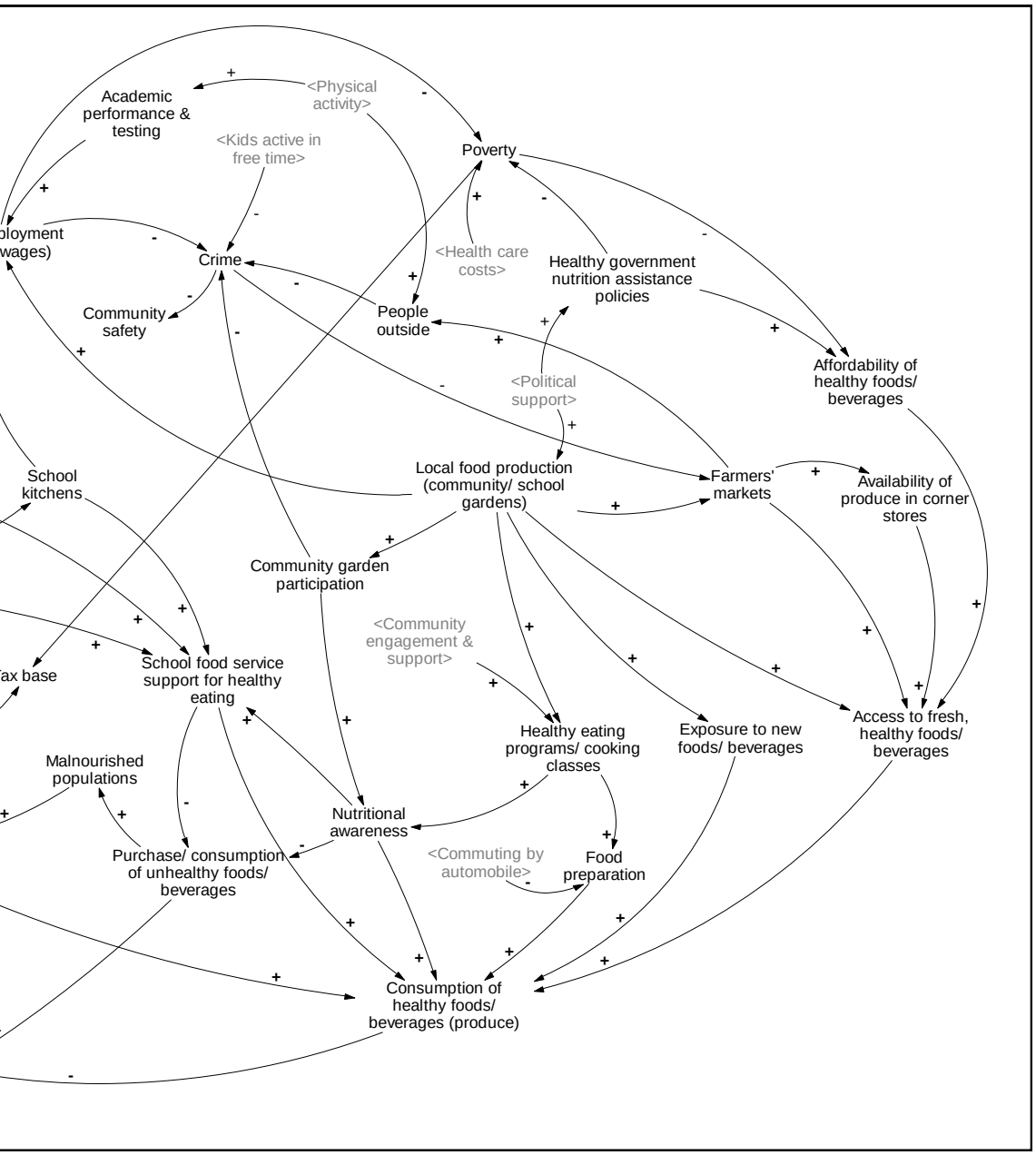
- the participants represent a sample of the *HKK* partners (organizations and residents) as opposed to a representative snapshot of government agencies, community organizations, businesses, and community residents;
- the behavior over time graphs and the causal loop diagram represent perceptions of 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 example:

- having conversations to discuss existing feedback loops to ensure that the appropriate variables and

relationships are represented accurately;

- reviewing the behavior over time graphs (see also Appendix E) to confirm that the trends reflect common perceptions among residents and compare these trends to actual data;
- revisiting variables removed because they were not part of feedback loops, including air quality, non-English speaking populations, food distribution distance, mental/emotional health and wellbeing, remove exogenous variables , gas prices, liability concerns, screen time, demand for local, organic produce & livestock, fast food & sugar sweetened beverages marketing, menu labeling, culturally competent nutritional education, perceptions of cost of health foods/beverages, fat, sugar & salt taste preferences, healthy foods/beverages in child care, fast food establishments, and quick-food marts; and



- starting new conversations about other variables (behavior over time graphs exercise) or relationships (causal loop diagram exercise) to add to this diagram.

In addition, different subgroups in Kingston may use this causal loop diagram to delve in deeper into some of the subsectors (e.g., healthy eating, active living) or feedback loops, creating new, more focused causal loop diagrams with more specific variables and causal relationships.

Use of more advanced systems science methods and analytic approaches to create computer simulation models is another way to take this early work to the next level. The references section includes citations for resources on these methods and analytic approaches, and it is necessary to engage professional systems scientists in these activities.

Please refer to the Appendices for more information, including:

- Appendix A: Behavior over time graphs generated during site visit
- Appendix B: Photograph of the original version of the *HKK* Causal Loop Diagram
- Appendix C: Original translation of the causal loop diagram into Vensim PLE
- Appendix D: Transcript translation of the causal loop diagram into Vensim PLE
- Appendix E: Behavior over time graphs not represented in the storybook

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:
Andersen, D. F. and G. P. Richardson (1997). "Scripts for group model building." System Dynamics Review 13(2): 107-129.

Hovmand, P. (2013). Community Based System Dynamics. New York, NY: Springer.

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Richardson, G. P. (2011). "Reflections on the foundations of system dynamics." System Dynamics Review 27 (3): 219-243.

Rouwette, E., et al. (2006). "Group model building effectiveness: A review of assessment studies." System Dynamics Review 18(1): 5-45.

Sterman, J. D. (2000). Business dynamics: Systems thinking and modeling for a complex world. New York, NY: Irwin McGraw-Hill.

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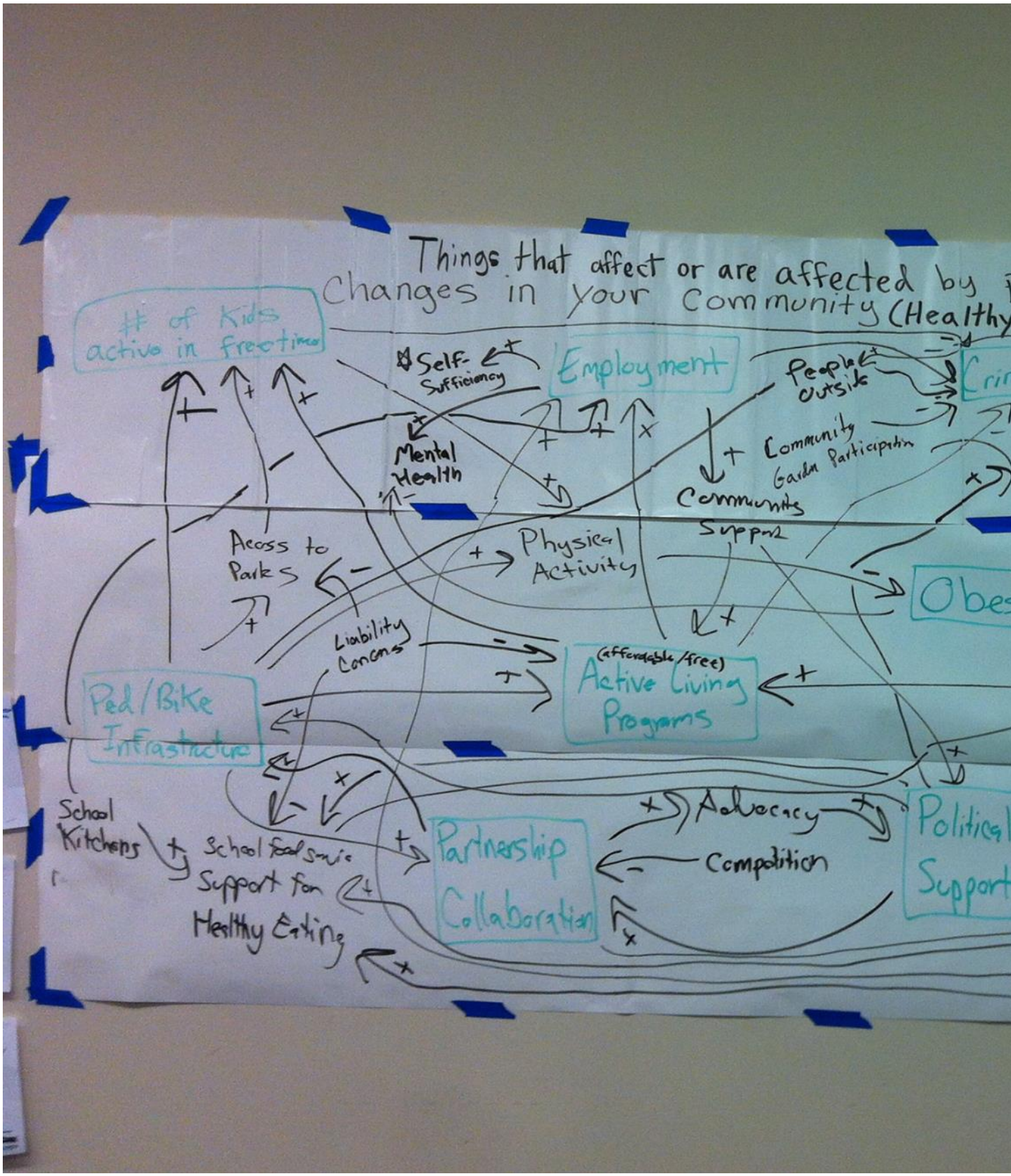
Vennix, J. (1996). Group model building. New York, John Wiley & Sons.

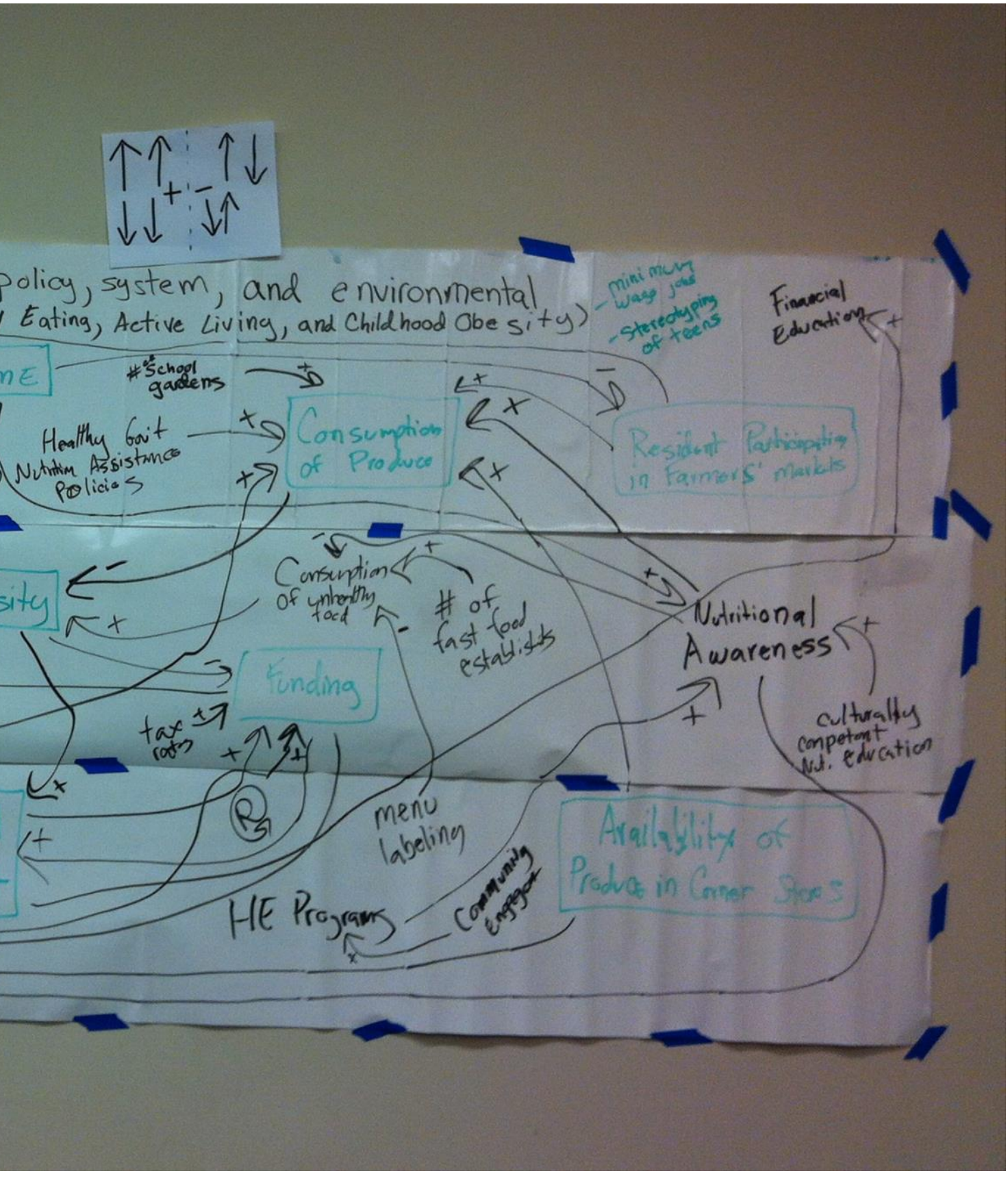
Zagonel, A. and J. Rohrbaugh (2008). Using group model building to inform public policy making and implementation. Complex Decision Making. H. Qudart-Ullah, J. M. Spector and P. I. Davidsen, Springer-Verlag: 113-138.

Appendix A: Behavior Over Time Graphs Generated during Site Visit

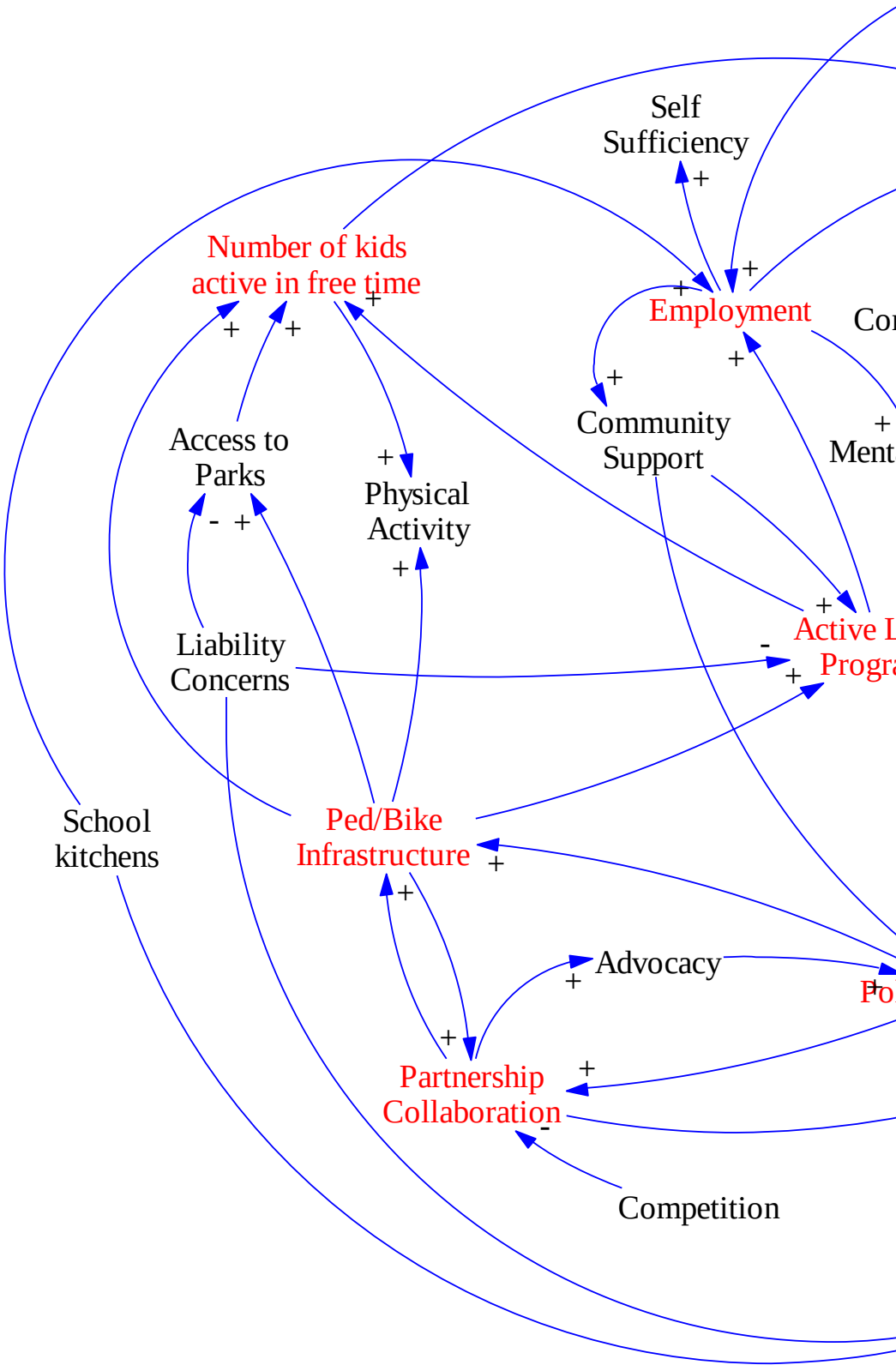
Kingston, New York: *HKK*	
Categories	**Number of Graphs**
Active Living Behavior	3
Active Living Environments	3
Funding	1
Healthy Eating Behavior	8
Healthy Eating Environments	3
Marketing and Media Coverage	1
Obesity and Long Term Outcomes	3
Partnership & Community Capacity	7
Policies	3
Programs & Promotions (Education and Awareness)	6
Social Determinants of Health	3
Total Graphs	**41**

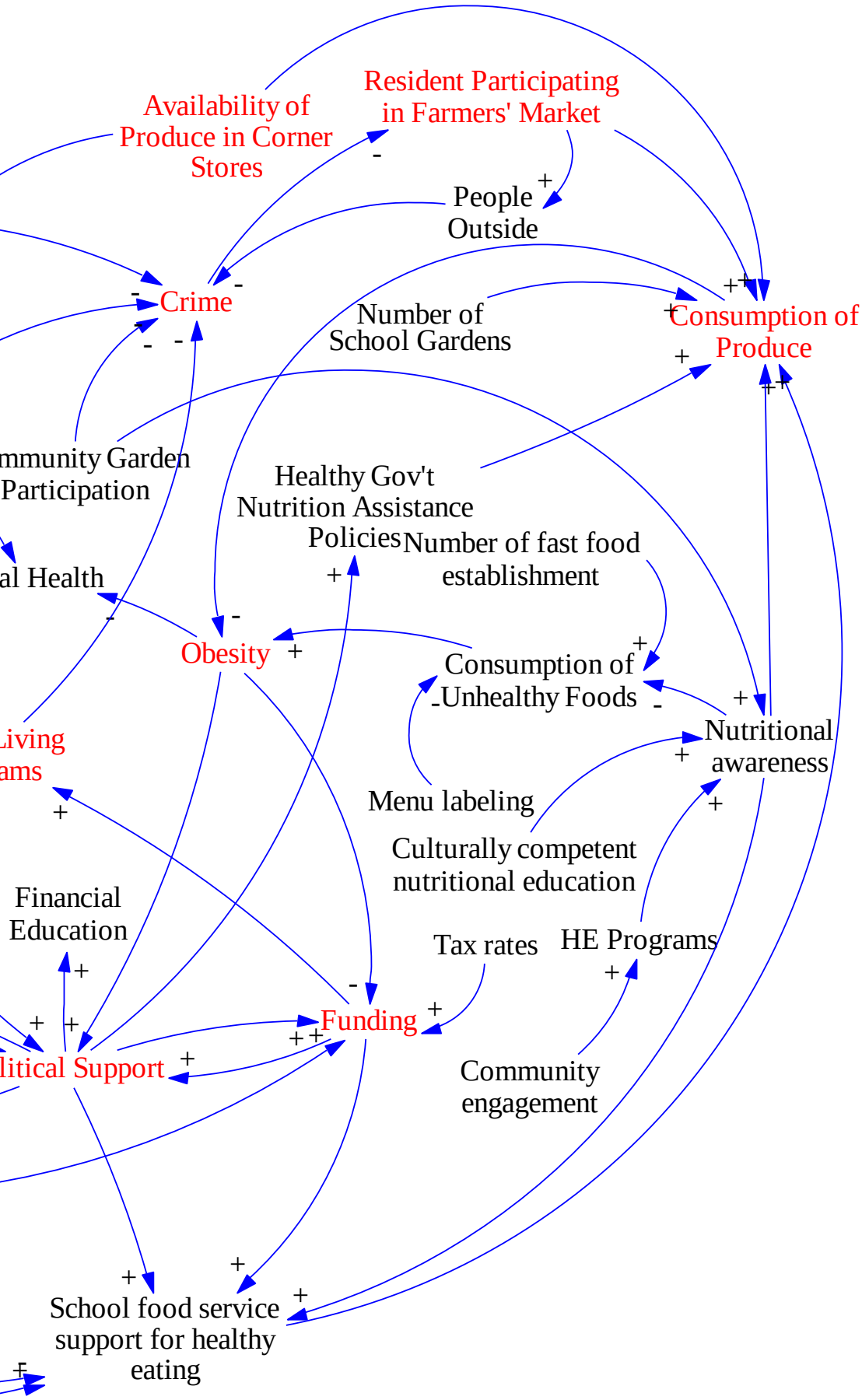
Appendix B: Photograph of the Original Version of the *HKK* Causal Loop Diagram



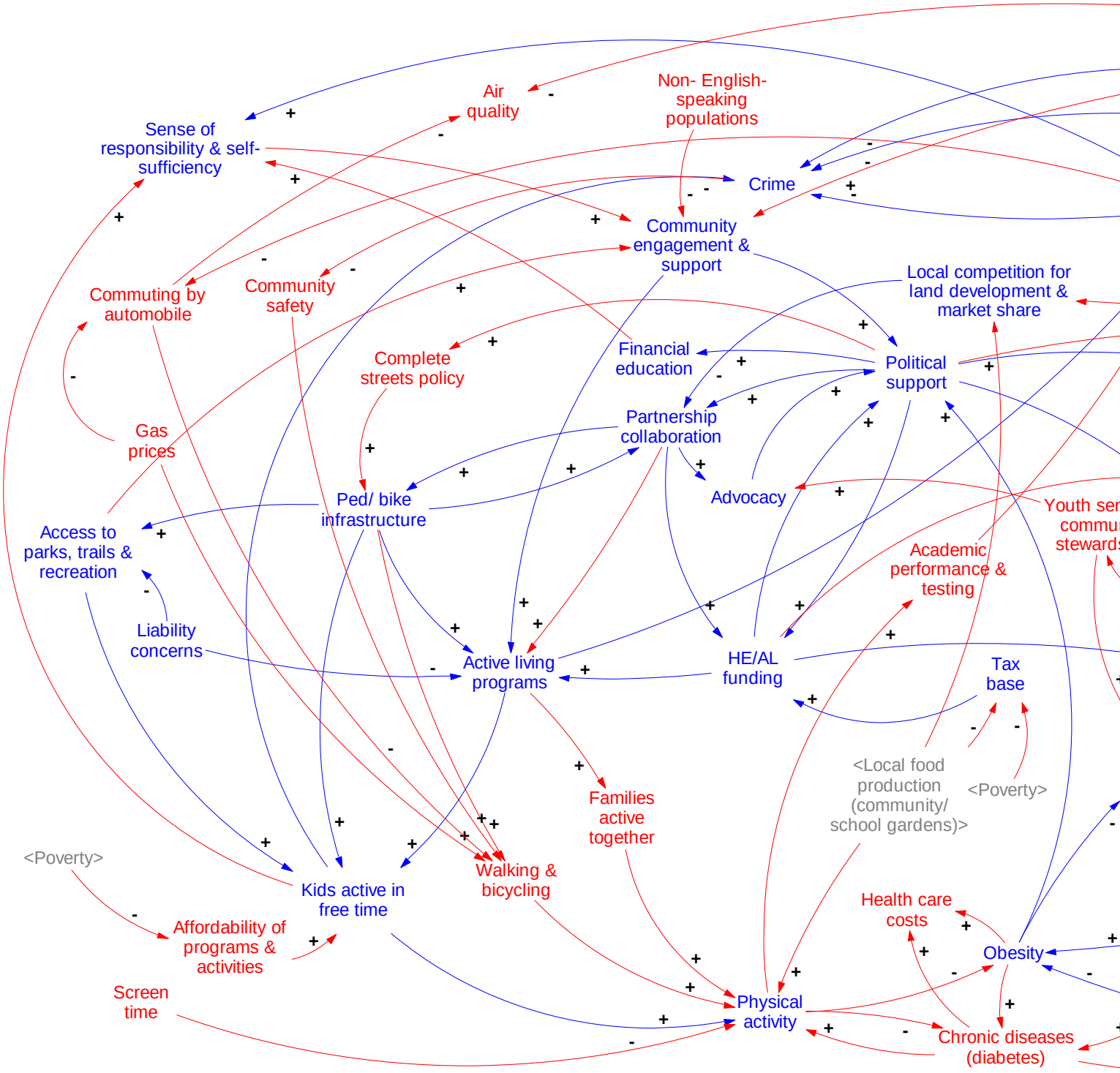

policy, system, and environmental
Eating, Active Living, and Childhood Obesity)
# of school gardens
Healthy Food Nutrition Assistance Policies
Consumption of Produce
- minimum wage jobs
- stereotyping of teens
Financial Education
Resident Participation in Farmers' markets
Consumption of unhealthy food
# of fast food establishments
Nutritional Awareness
culturally competent Nut. education
Funding
tax rates
menu labeling
HE Programs
Availability of Produce in Corner Stores

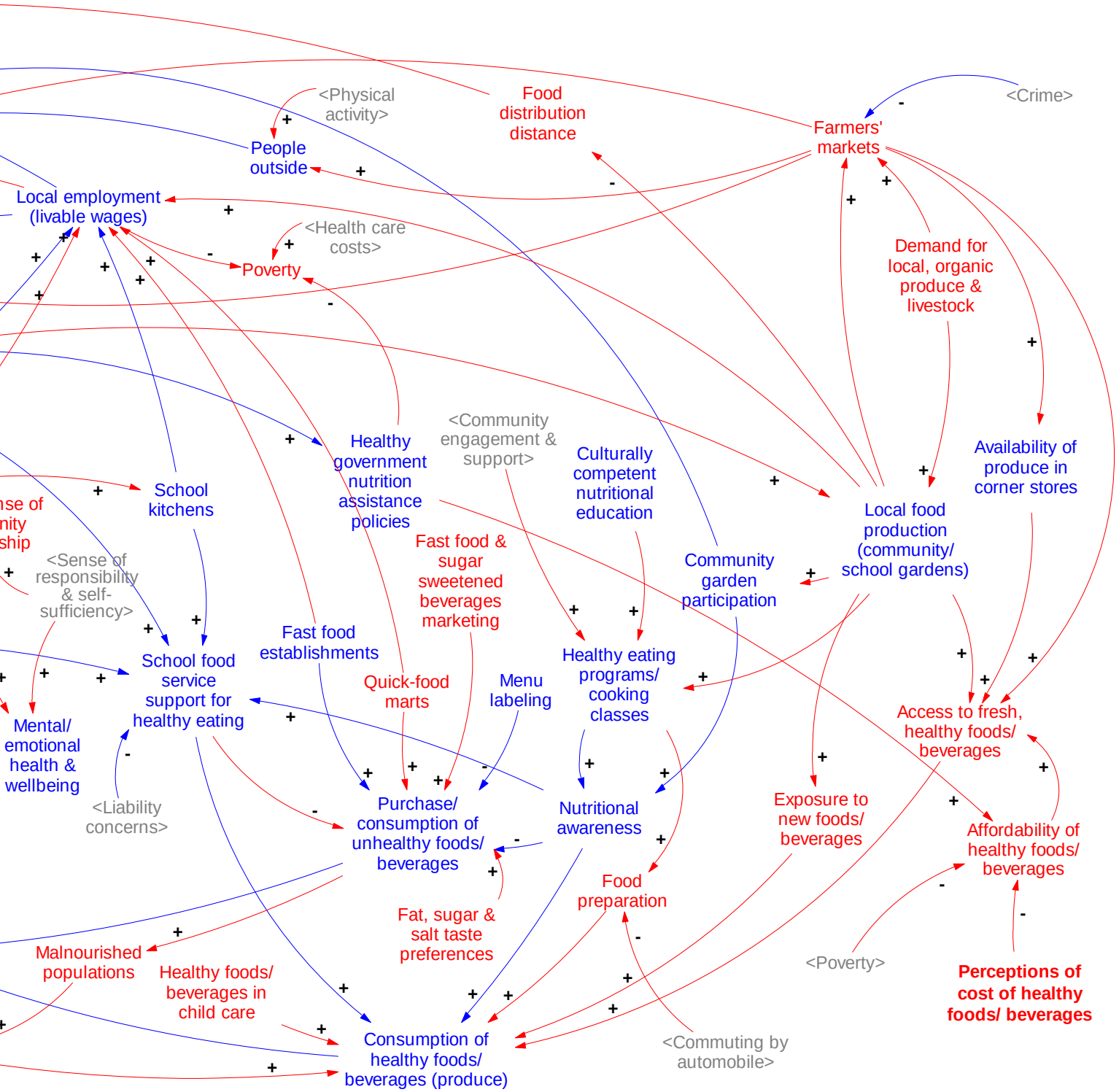
Appendix C: Original Translation of the Causal Loop Diagram into Vensim PLE



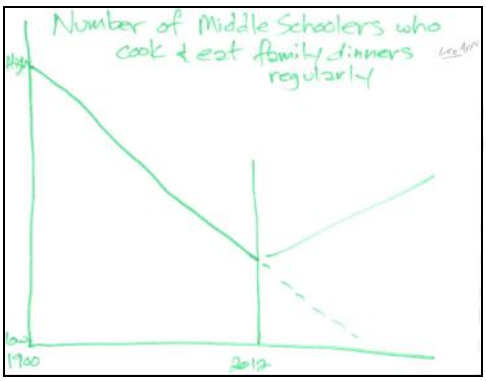

Availability of Produce in Corner Stores
Resident Participating in Farmers' Market
People Outside
Crime
Number of School Gardens
Consumption of Produce
mmunity Garden Participation
Healthy Gov't Nutrition Assistance Policies
Number of fast food establishment
al Health
Obesity
Consumption of Unhealthy Foods
Nutritional awareness
Living ams
Menu labeling
Culturally competent nutritional education
Financial Education
Tax rates
HE Programs
Funding
litical Support
Community engagement
School food service support for healthy eating

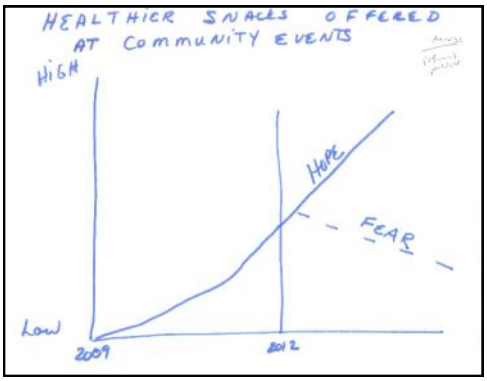
Appendix D: Transcript Translation of the Causal Loop Diagram into Vensim PLE

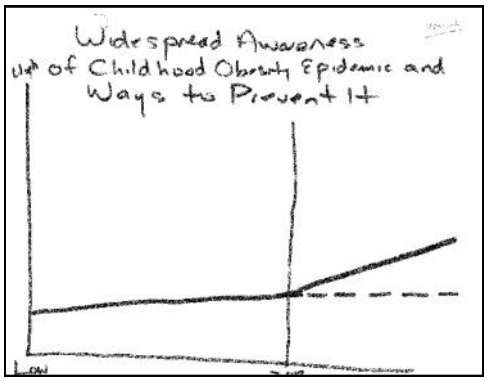


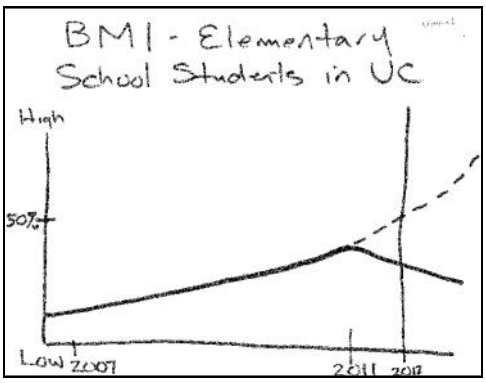

Food distribution distance
<Physical activity>
<Crime>
Farmers' markets
People outside
Local employment (livable wages)
<Health care costs>
Poverty
Demand for local, organic produce & livestock
Availability of produce in corner stores
Healthy government nutrition assistance policies
<Community engagement & support>
Culturally competent nutritional education
School kitchens
Local food production (community/ school gardens)
Community garden participation
Fast food & sugar sweetened beverages marketing
<Sense of responsibility & self-sufficiency>
Fast food establishments
School food service support for healthy eating
Quick-food marts
Menu labeling
Healthy eating programs/ cooking classes
Access to fresh, healthy foods/ beverages
Mental/ emotional health & wellbeing
<Liability concerns>
Purchase/ consumption of unhealthy foods/ beverages
Nutritional awareness
Exposure to new foods/ beverages
Affordability of healthy foods/ beverages
Food preparation
Fat, sugar & salt taste preferences
Malnourished populations
Healthy foods/ beverages in child care
<Poverty>
Perceptions of cost of healthy foods/ beverages
Consumption of healthy foods/ beverages (produce)
<Commuting by automobile>

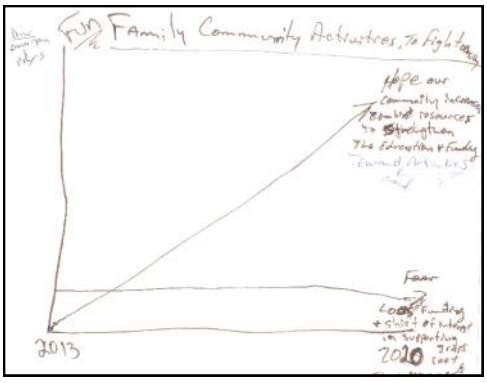
Appendix E: Behavior Over Time Graphs not Represented in the Storybook

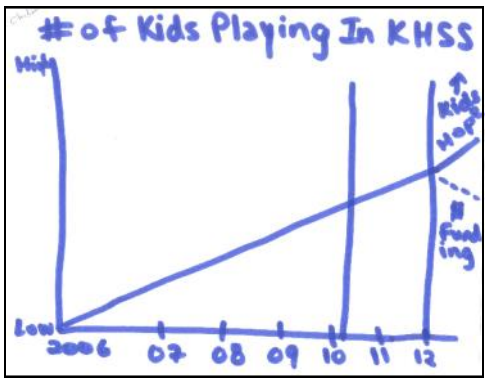


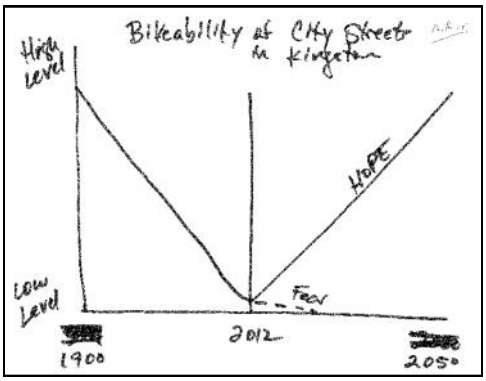


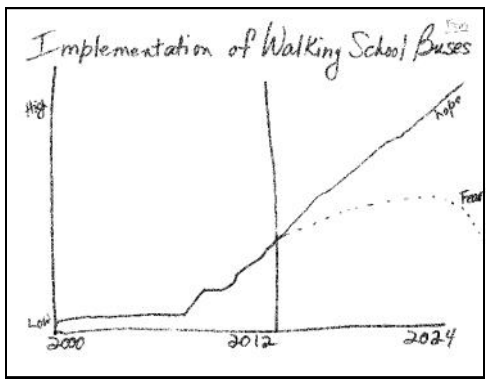


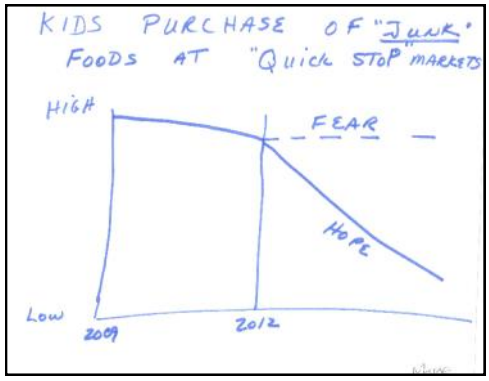


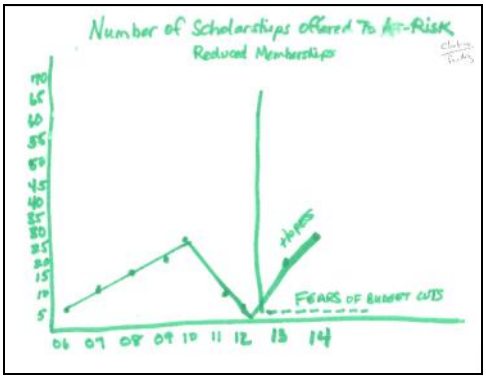


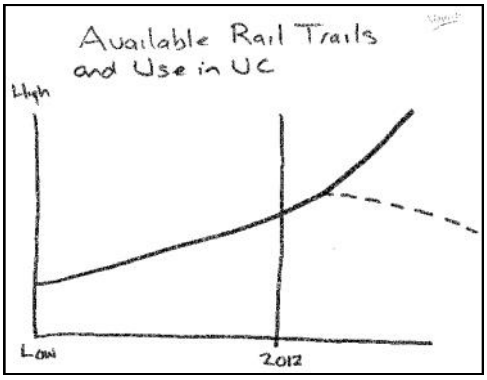


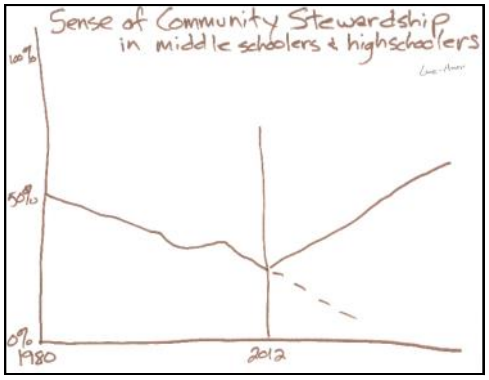


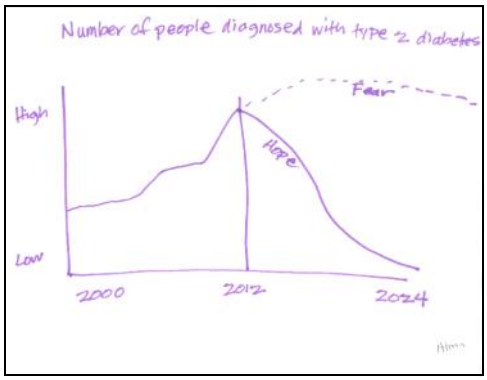


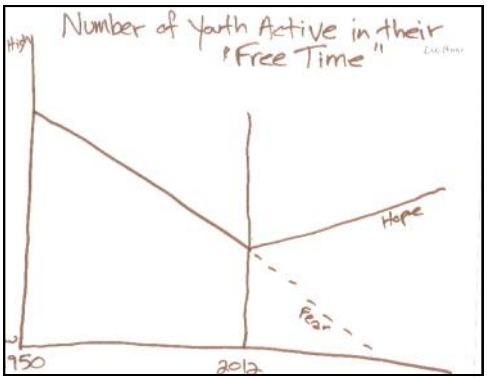


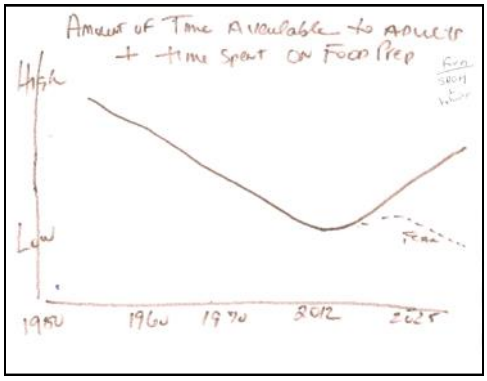


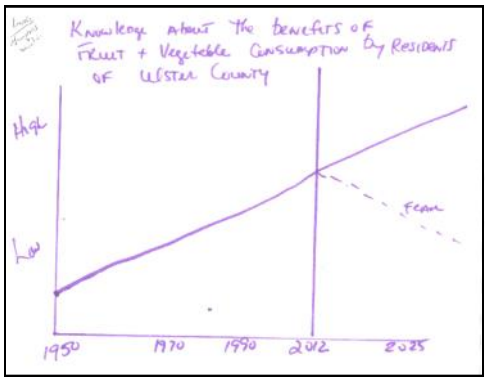


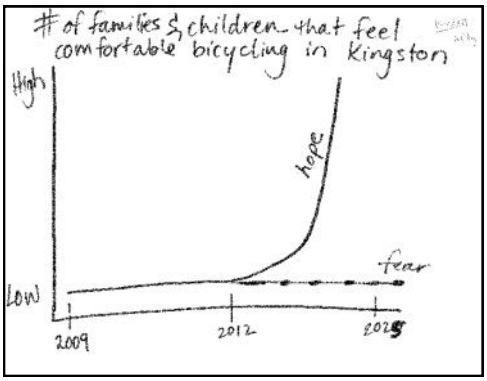


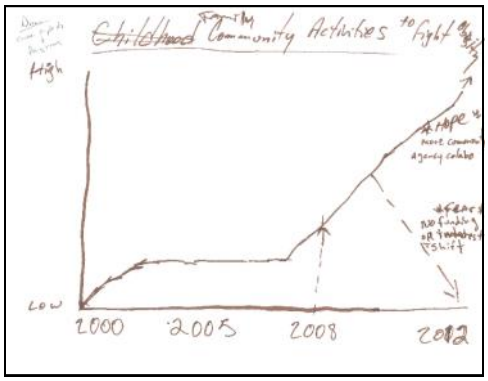

Number of people diagnosed with type 2 diabetes
High
Low
Fear
Hope
2000
2012
2024

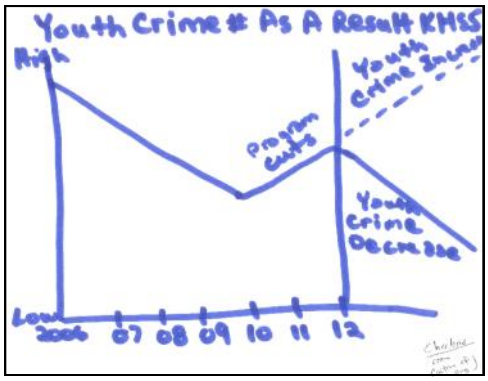

Number of Youth Active in their "Free Time"
High
Hope
Fear
1950
2012

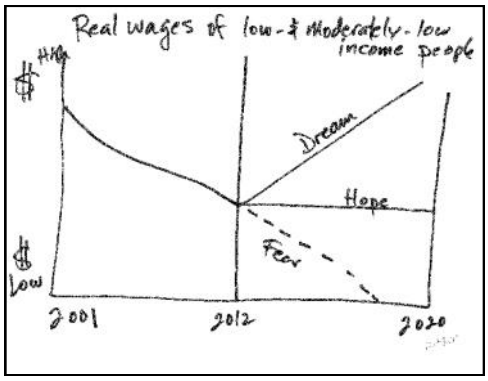

Amount of Time Available to Adults + time spent on Food Prep
High
Low
Fear
1950
1960
1970
2012
2024

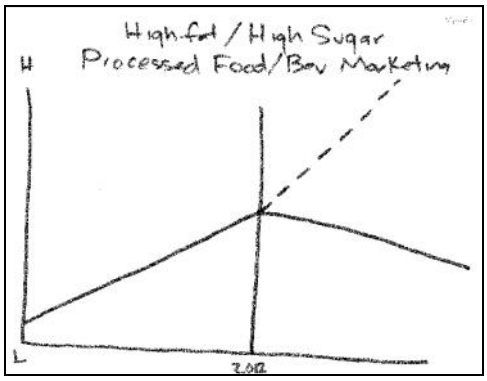

Knowledge about the benefits of Fruit + Vegetable Consumption by Residents of Ulster County
High
Low
Fear
1950
1970
1990
2012
2025

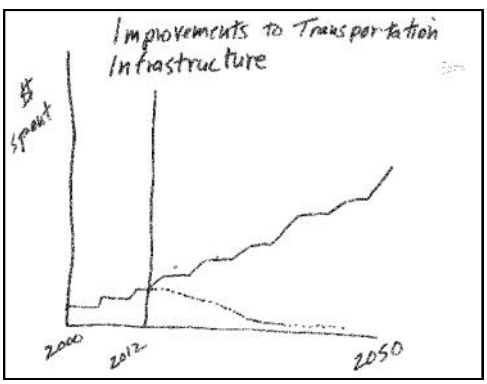

# of families & children that feel comfortable bicycling in Kingston
High
Low
hope
fear
2009
2012

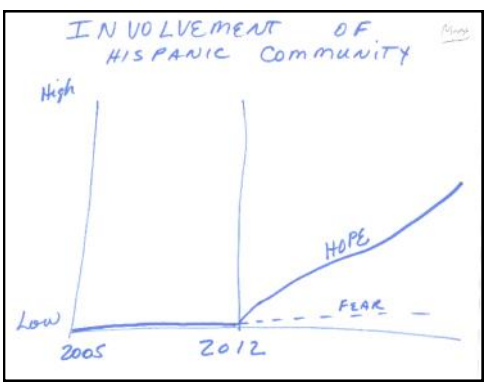

Childhood Community Activities to fight
High
Low
2000
2005
2008
2012

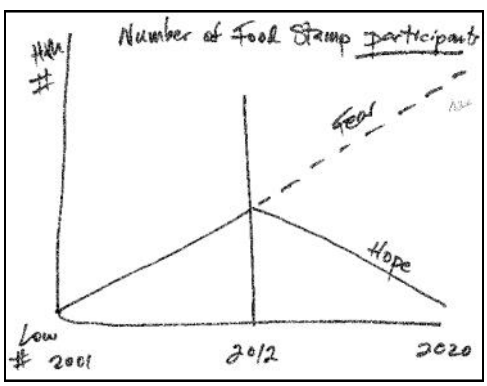

Youth Crime # As A Result KHSS
High
Low
program cuts
Youth Crime Increase
Youth Crime Decrease
2006
07
08
09
10
11
12


Real wages of low- & moderately-low income people
High
Low
Dream
Hope
Fear
2001
2012
2020


High-fat / High Sugar Processed Food/Bev Marketing
H
L
2012


Improvements to Transportation Infrastructure
$ spent
2000
2012
2050


INVOLVEMENT OF HISPANIC COMMUNITY
High
Low
HOPE
FEAR
2005
2012


Number of Food Stamp participants
#
Fear
Hope
Low
2001
2012
2020

Appendix E (continued): Behavior Over Time Graphs not Represented in the Storybook