Systems Thinking in Communities:

Understanding the Causes of Inactivity, Poor Diet/Nutrition, and Childhood Obesity in DeSoto, Marshall, and Tate Counties, Mississippi

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Introduction

Healthy Kids, Healthy Communities DeSoto, Marshall, and Tate Counties (HKHC DeSoto-Marshall-Tate) 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 *HKHC DeSoto-Marshall-Tate* project was to introduce systems thinking at the community level by identifying the essential parts of the DeSoto, Marshall, and Tate Counties, Mississippi 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., government, advocacy agencies, foundations, businesses, academic institutions, community-based organizations, youth 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.

Desoto-Marshall-Tate, Mississippi: Background and Local Participation

DeSoto, Marshall, and Tate Counties are located in the Delta region of Northwestern Mississippi. With a total population of 227,282, the counties are part of the Memphis Metropolitan area. DeSoto County, which includes the cities of Hernando and Horn Lake, is a suburban area with a population of 161, 252. Marshall County is a rural area with a population of 37, 144 that includes the city of Holly Springs. Tate County, which includes the cities of Senatobia and Coldwater, is also a rural area with a population of 28,886. Mississippi has one of the highest rates of childhood obesity, although a recent study shows a decline in the rate among students in grades K-5 .

The lead agency was the Community Foundation of Northwest Mississippi. The foundation was started in 2002 and serves eight counties in Northwest Mississippi. As a non-profit organization, governed by a board of 20 volunteer civic leaders, the foundation prioritizes children, education, and health. In 2007, the Get a Life! My Life, My Health, My Choice program started through the Community Foundation of Northwest Mississippi to provide change, education, and advocacy on childhood obesity in the eight counties. As a result of the program and established Community Health Councils, a multidisciplinary partnership was formed for the Healthy Kids, Healthy Communities initiative. The Project Director, Peggy Linton, and Project Coordinator, Shelly Johnstone, have led the partnership since its inception.

HKHC DeSoto-Marshall-Tate's Priorities and Strategies

The partnership and capacity building strategies of *HKHC DeSoto-Marshall-Tate* included:

- **Training and Technical Assistance:** The Community Foundation of Northwest Mississippi provided training opportunities and technical assistance on active living and healthy eating policy and environmental changes. The opportunities included annual summits or conferences and several presentations.
- **DeSoto County Community Health Council's Youth Health Ambassadors:** The HKHC partnership collaborated with the DeSoto County Health Council to develop the Change4Life! program that was designed to provide support and training to youth and school staff to implement health councils.

The healthy eating and active living strategies of *HKHC DeSoto-Marshall-Tate* included:

- **Comprehensive Plans:** The Cities of Olive Branch and Holly Springs revised and expanded their Comprehensive Plans to include recommendations for active living.
- **Active Transportation:** The cities of Holly Springs, Byhalia, Senatobia, and Hernando adopted a Complete Streets Policy. Design standards were created for sidewalks in Byhalia and Holly Springs and a grant was received from the Mississippi Department of Transportation to upgrade sidewalks in Senatobia. Since 2010, Hernando has added bike lanes and a new stretch of sidewalk that connects the east and west sides of the city. In addition, an agreement with the Mississippi Department of Transportation and Hernando was signed for the use of an underpass to connect the city and a new walking track was installed at Senatobia Middle School.
- **Greenways/Blueways:** In 2011, DeSoto County and local municipal officials received $2.26 million from the Mississippi Department of Transportation for greenway projects. The projects included pavement of the Johnson Creek trail; an extension of the Bass Landing Park trail; design and construction of a new trailhead and trails at the Crockrum Civic Center; construction of an asphalt bicycle path/walking trail from the Central Park. In 2012, a set of rules and regulations was created for the DeSoto County Greenways. A comprehensive update of the Greenways Plan is currently underway and will be completed after December 14, 2013.
- **Parks and Play Spaces:** To increase active living in the tri-county area several environmental changes were made. New play equipment was installed at parks in DeSoto, Marshall, and Tate Counties. New signs identifying the park name were placed in ten DeSoto County parks and improvements were made to the walking trail in Byhalia. Land donations were received to develop a new park in Senatobia, expand a park in DeSoto County, and to build a skate park in the City of Hernando. In addition, a DeSoto County Parks and Recreation District was established.
- **Farmers' Markets:** The City of Holly Springs and City of Olive Branch established farmers' markets. Two existing markets, Tate County Farmers' Market and Hernando Farmers' market received certification from the Mississippi Farmers' Market Certification Program. In 2013, the markets were able to start accepting Supplemental Nutrition Assistance Program (SNAP) and Senior Vouchers.
- **Other Healthy Eating Strategies:** To increase access to healthy foods in the tri-county area, the partnership supported several community initiatives including the creation of a regional food hub, development of learning gardens, establishment of a mobile food pantry, and providing community health partner awards for healthy restaurants.

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

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Systems Thinking in Communities: DeSoto, Marshall, and Tate Counties, Mississippi

"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 DeSoto, Marshall, and Tate Counties, Mississippi 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.

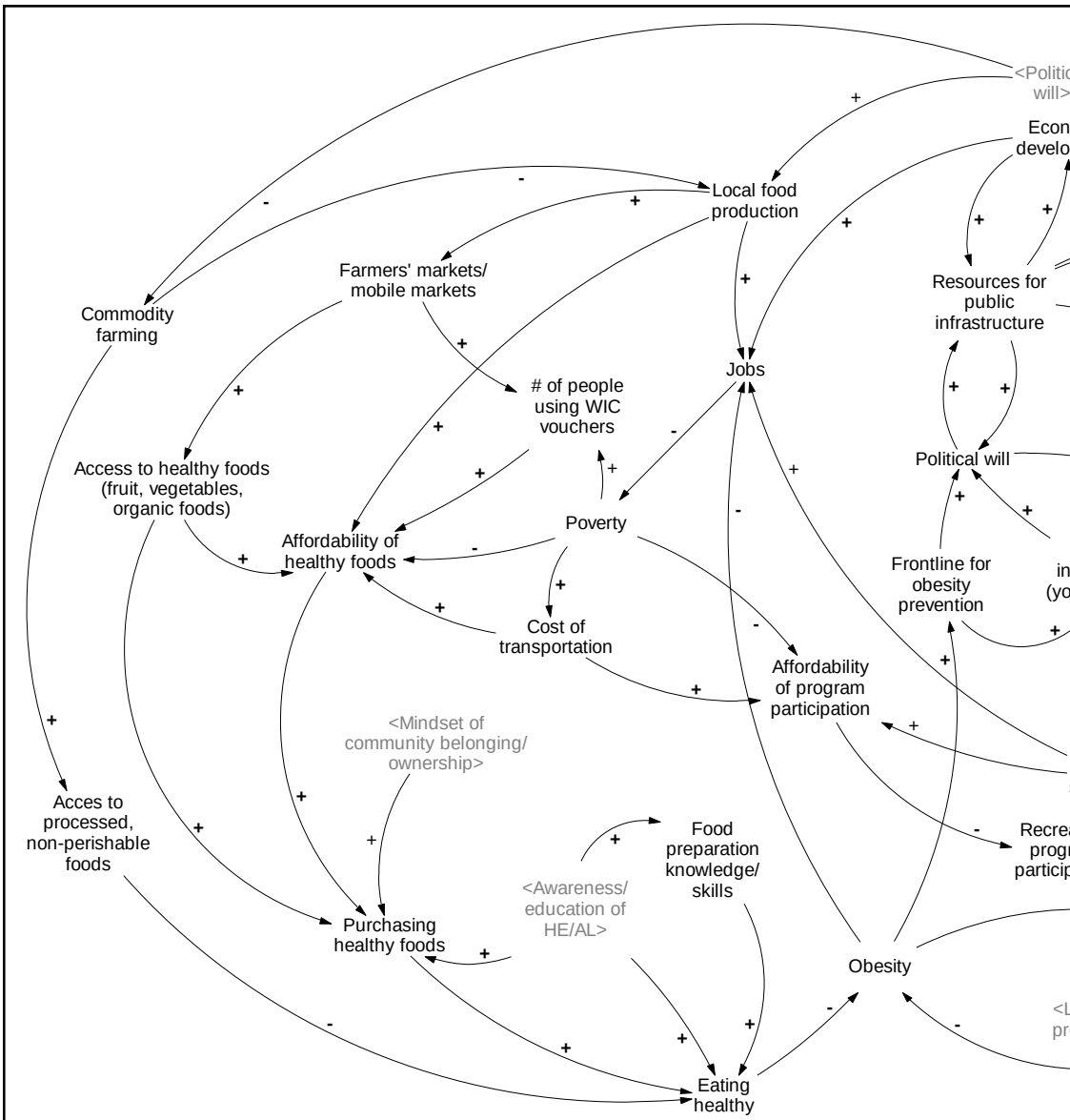


Figure 1: *HKHC DeSoto-Marshall-Tate* Causal Loop Diagram

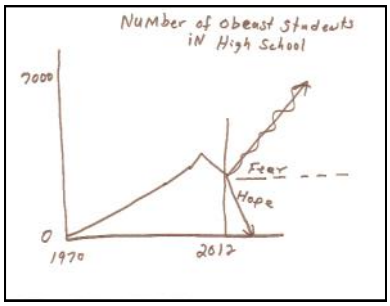
Group Model Building

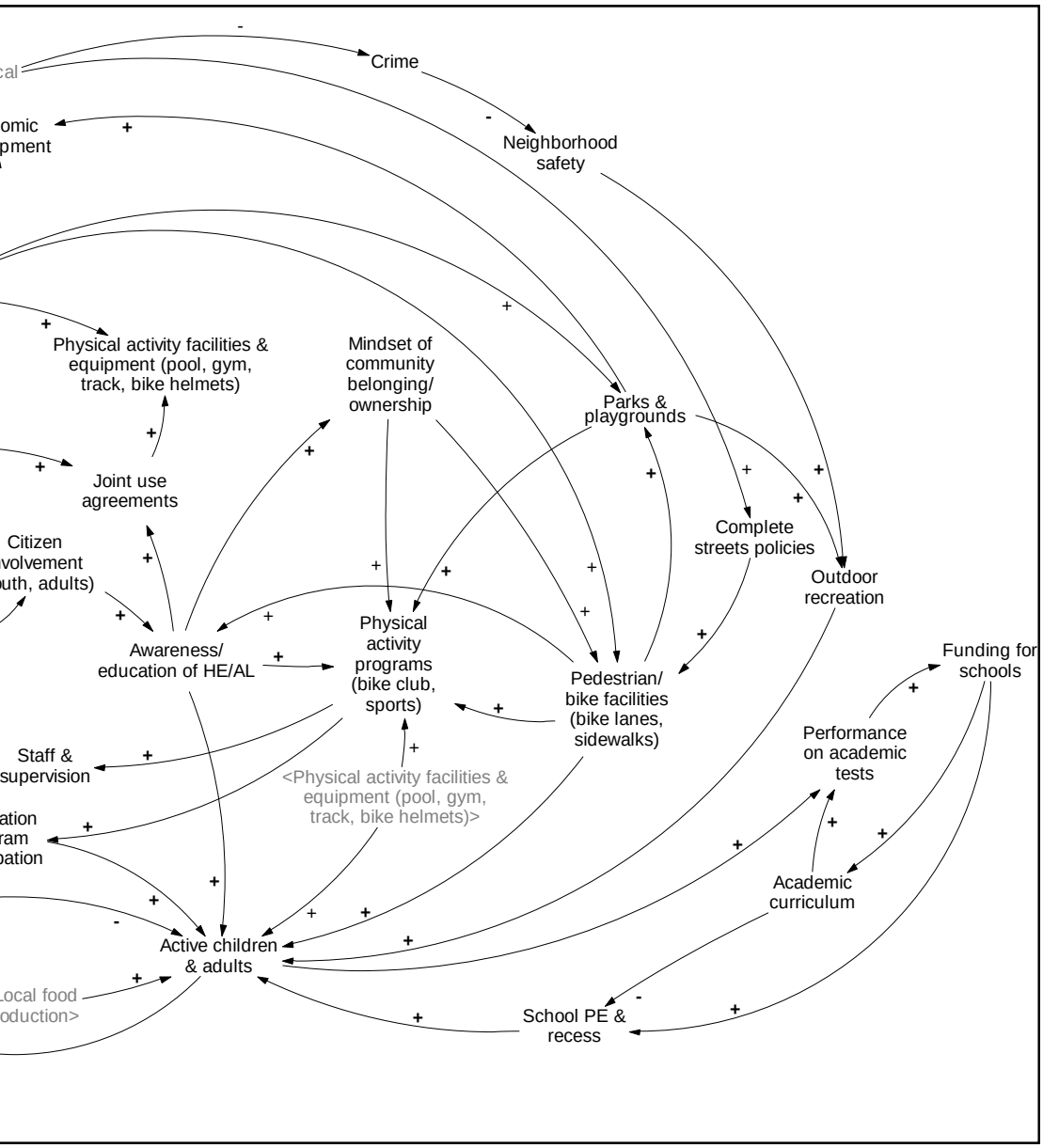
Members of the *HKHC DeSoto-Marshall-Tate* partnership participated in a group model building session in June, 2012 and generated this system. also referred to as a causal loop diagram (Figure 1). Participants in the group model building session included representatives from government and advocacy agencies, foundations, businesses, academic institutions, and community-based and youth organizations. 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 DeSoto-Marshall-Tate 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 the number of obese students in high school has increased from 1970 to 2012 and the participant hopes that obesity will decrease and change into the future. 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 pedestrian/bike facilities (bike lanes, sidewalks) in this causal loop diagram. One feedback loop is: pedestrian/bike facilities → awareness/education of healthy eating and active living → mindset of community belonging/ ownership → pedestrian/bike facilities. A second feedback loop is: pedestrian/bike facilities → parks and playgrounds → economic development → resources for public infrastructure → pedestrian/bike facilities.

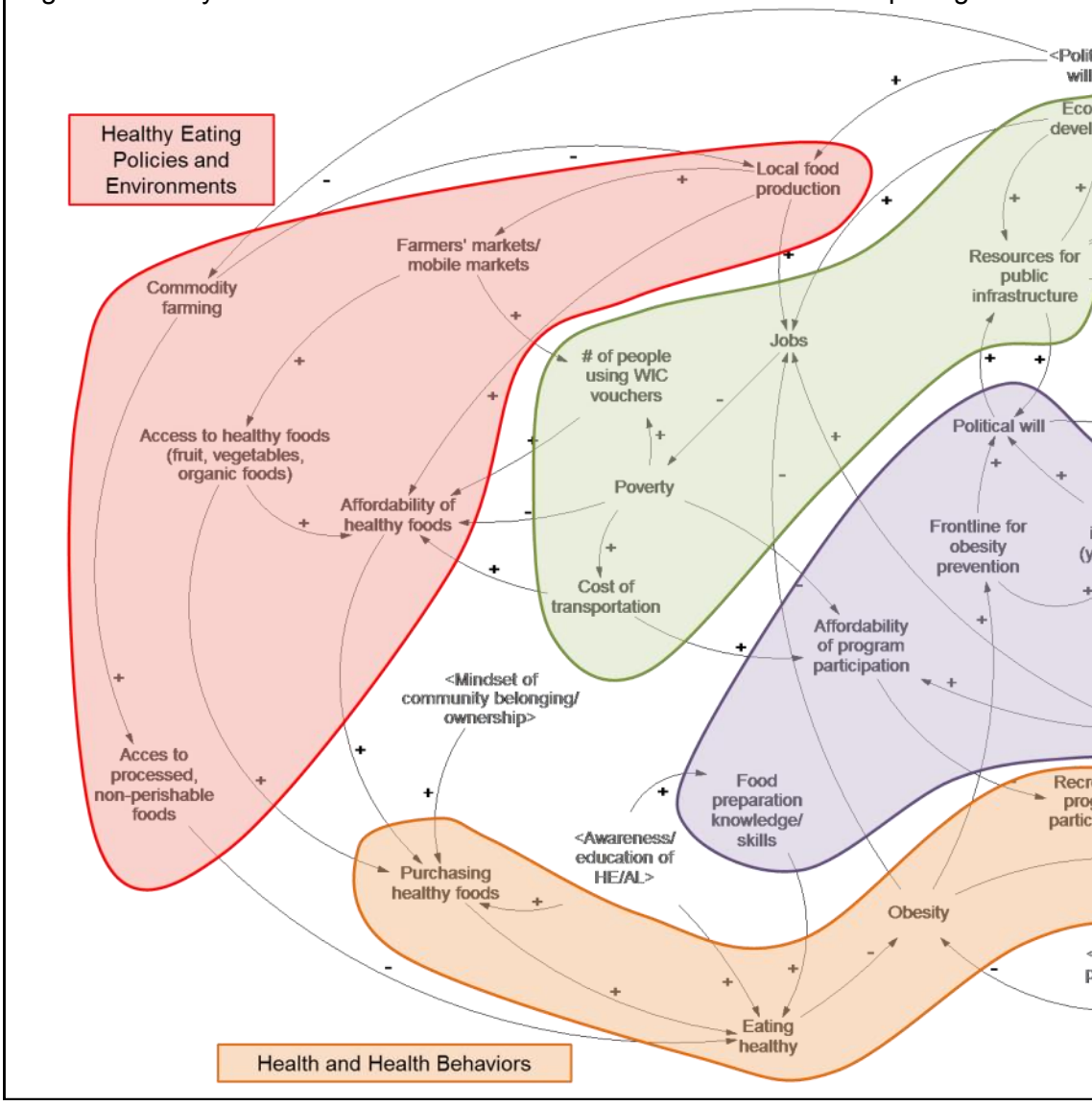
What is important to notice in these examples is that there are two different feedback loops interacting simultaneously to influence or to be influenced by pedestrian/bike facilities (bike lanes, sidewalks). Some variables may increase pedestrian/bike facilities while other variables limit pedestrian/bike facilities. 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 *HKHC DeSoto-Marshall-Tate* 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 DeSoto, Marshall, and Tate Counties, Mississippi and to stimulate greater conversation related to DeSoto-Marshall-Tate'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 DeSoto, Marshall, and Tate Counties, Mississippi. 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).

Figure 2: Subsystems in the *HKHC DeSoto-Marshall-Tate* Causal Loop Diagram



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 (e.g., commodity farming, local food production), food distribution and procurement (e.g., affordability of healthy foods), and food retail (e.g., farmers' markets/ mobile markets). During the behavior over time graphs exercise, the participants generated twelve graphs related to policy or environmental strategies (e.g., farmers' markets/ mobile markets) or contexts (e.g., affordability of healthy foods) that affected or were affected by the work of *HKHC DeSoto-Marshall-Tate*. 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 nine graphs related to policy or environmental strategies (e.g., complete streets policies) or contexts (e.g., outdoor recreation) that affected or were affected by the partnership's work.

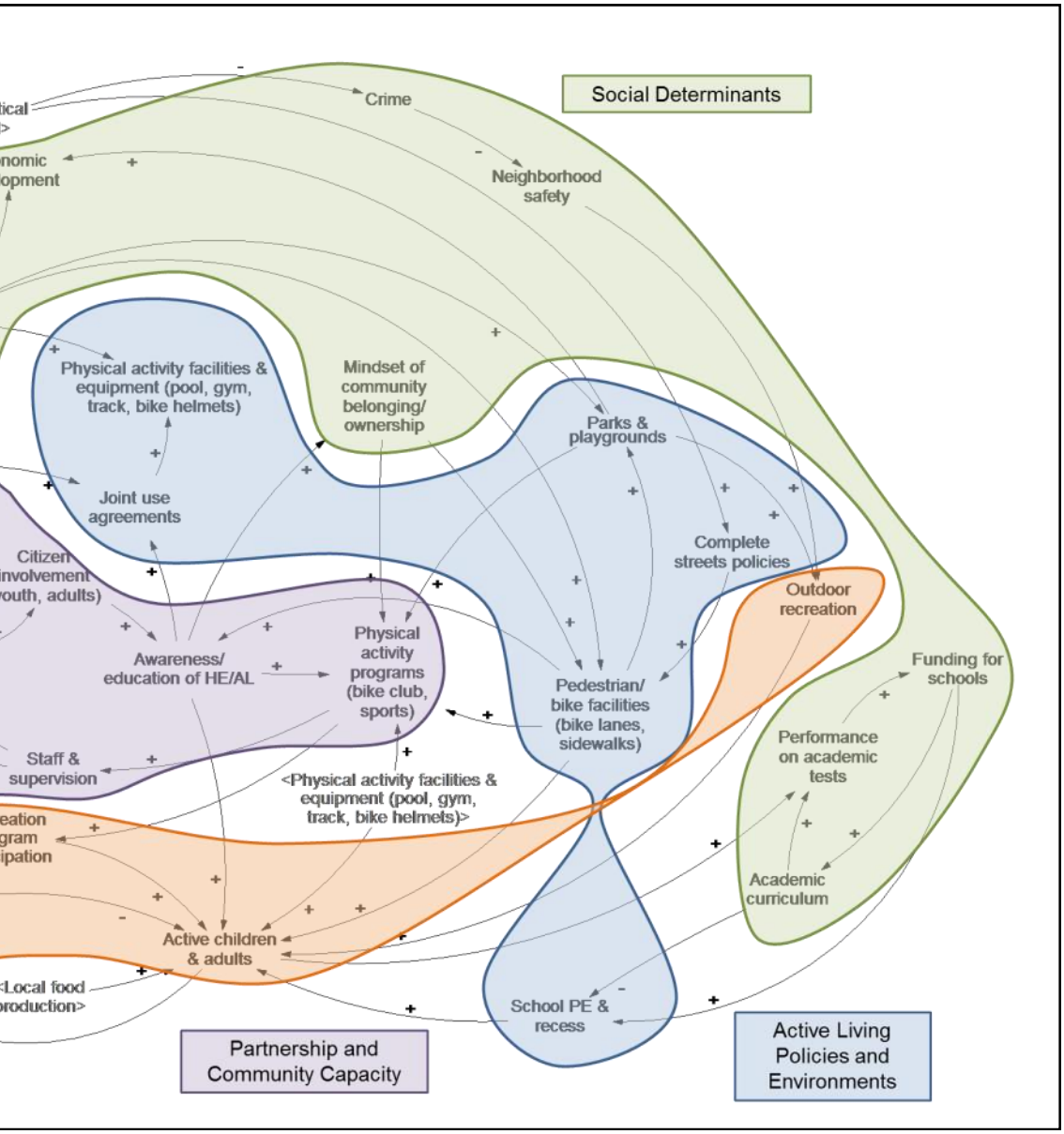
Health and Health Behaviors (Orange)

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., recreation program participation, purchasing healthy foods).

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, *HKHC DeSoto-Marshall-Tate* partnership involved citizens and youth in the process to create changes in the community. This subsystem also includes community factors outside the partnership that may influence or be influenced by their efforts, such as affordability of program participation or political will.



Social Determinants

Finally, the social determinants subsystem denotes societal conditions (e.g., crime, jobs, funding for schools) and psychosocial influences (e.g., neighborhood safety, mindset of community belonging/ ownership) 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 *HKHC DeSoto-Marshall-Tate* partners or by other representatives in DeSoto, Marshall, and Tate Counties, Mississippi. 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 pedestrian and bike facilities, political will, and citizen involvement (youth, adults).

The next sections begin to examine the feedback loops central to the work of *HKHC DeSoto-Marshall-Tate*. 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.

Youth Health Ambassadors Feedback Loop

To simplify the discussion about feedback loops, several loops drawn from the *HKHC DeSoto-Marshall-Tate* CLD (see Figures 1 and 2) are highlighted in Figures 3-7. While the CLD provides a theory of change for the childhood obesity prevention movement in DeSoto, Marshall, and Tate Counties, Mississippi, 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 Youth Health Ambassadors (green highlighted loop in Figure 3). DeSoto, Marshall, and Tate Counties, Mississippi Youth Health Ambassadors, which was designed to provide support and training to youth and school staff on healthy eating and active living implementation activities. Participants described how more citizen involvement (youth and adults) there is more awareness and education about healthy eating and active living efforts in the community. With more awareness and education, there are more active children and adults, which decreases obesity. In turn, when obesity rates decrease, then obesity prevention efforts decrease, which decreases citizen involvement.

Story B: While the preceding story reflected a positive scenario for DeSoto, Marshall, and Tate Counties, Mississippi, the same feedback loop also tells the opposite story. With less citizen involvement (youth and adults) there is less awareness and education about healthy eating and active living efforts in the community. With less awareness and education, children and adults are less active, which increases obesity. In turn, when obesity rates increase, then obesity prevention efforts increase, which increases citizen involvement.

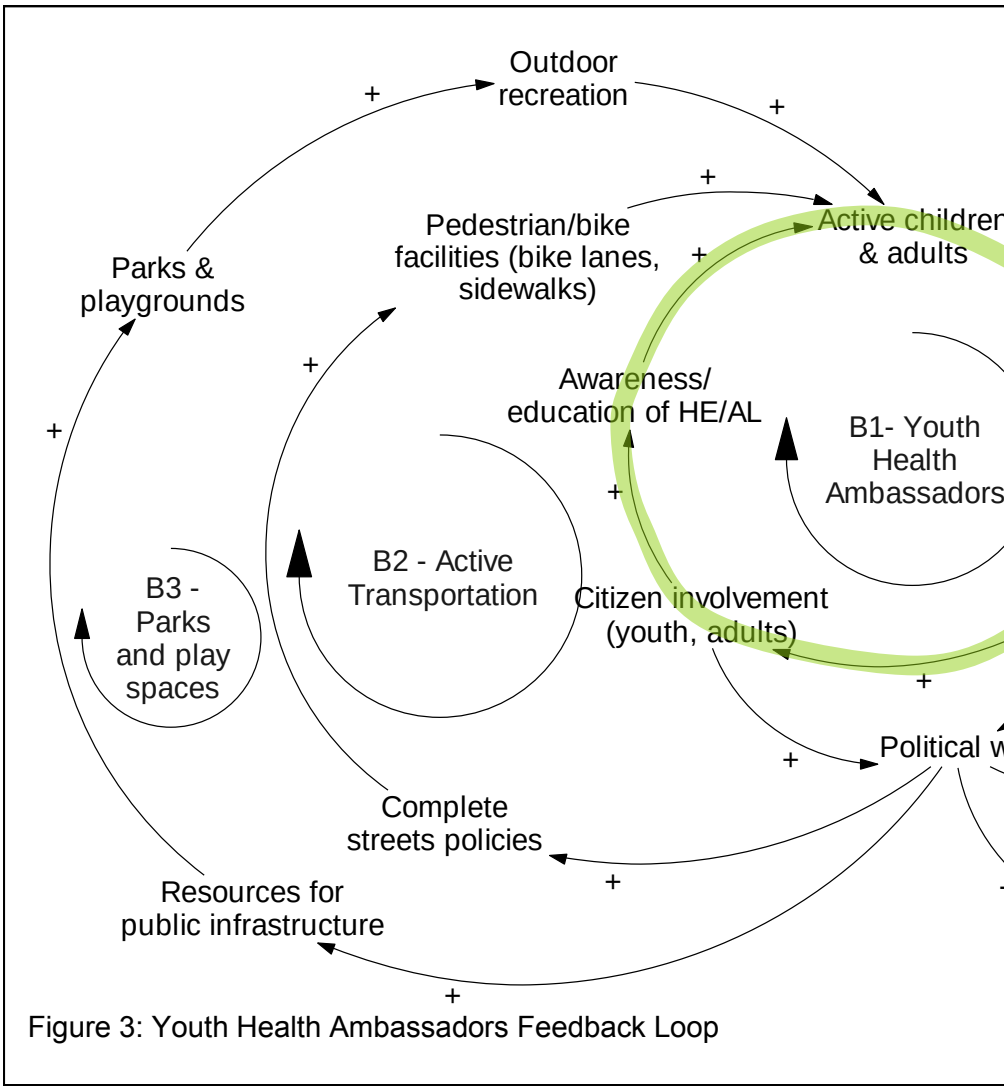


Figure 3: Youth Health Ambassadors Feedback Loop

Balancing Loop and Notation

These stories represent a balancing loop, and the notation in the feedback loop identifies it as a reinforcing/ balancing loop (see "B1 — Youth Health Ambassadors" 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

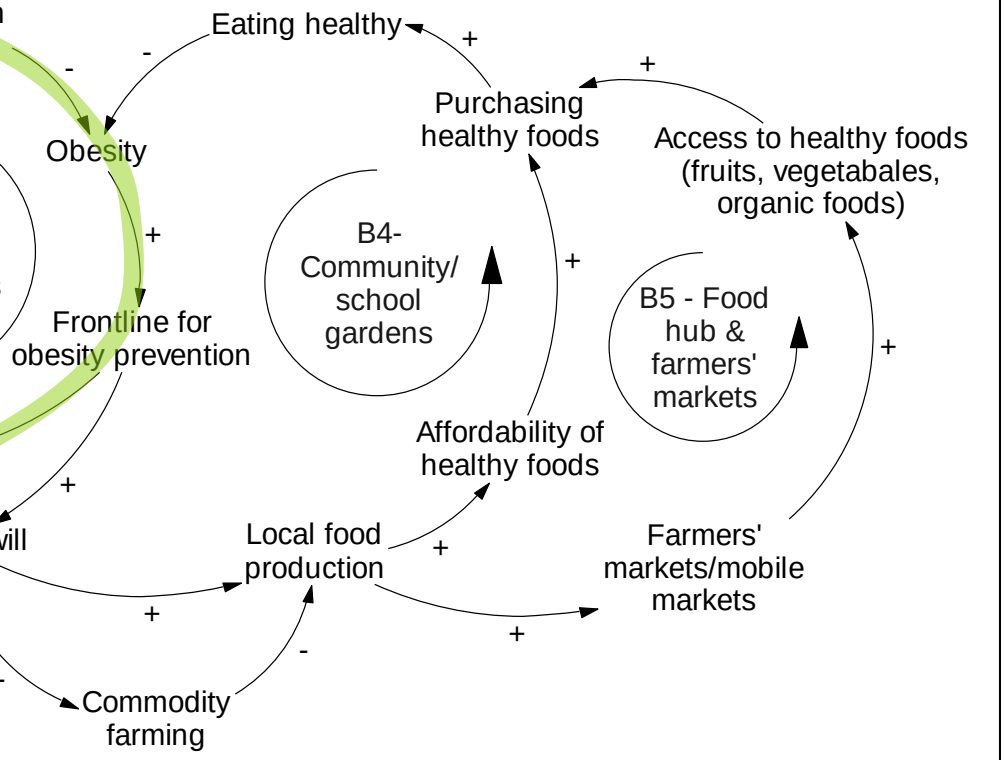
"Schools now have better awareness of healthy food choices, active lifestyles for children, and they are implementing so many minutes of recess and/or implementing less fried food, no sugary drinks. But, when [children] get home to the parents, especially down in the delta, it all comes apart. You have your mountain dew, and your fried foods and that's just how it is … I believe that parents' awareness has completely decreased. And now children that are plump, or chunky, they think it's cute, or it's hereditary. And so my hope is that the parents come to realize, no that's not really the way it should be." (Participant)

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 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.

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

In addition, it is important to remember that this balancing 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.

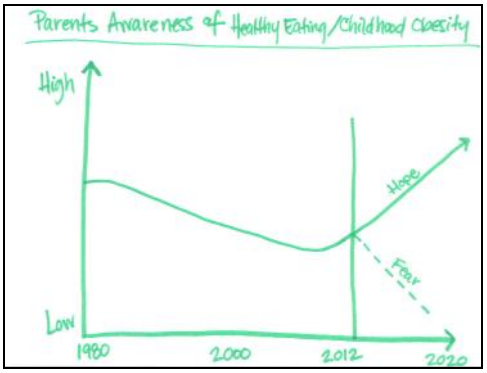


System Insights for *HKHC DeSoto-Marshall-Tate*

Participants identified parents awareness of healthy eating and childhood obesity as decreasing from 1980 to 2012 with the hope that it will change and increase into the future (see behavior over time graph bottom right).

From the systems thinking exercises, several insights can inform future structure and training efforts for the youth health ambassadors strategy, including:

- Parent knowledge and awareness 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.
- Higher rates of childhood obesity increase resident engagement and attention to this issue; as rates of obesity decline, it may be difficult to maintain these advocacy efforts in order to sustain improvements that have been made.



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 is the influence of an increasing number of advocacy initiatives in the community on community knowledge and empowerment?

Active Transportation 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 active transportation.

Causal Story for Feedback Loop

Story A: In this case, the story is about Active Transportation. DeSoto-Marshall-Tate partners had several strategies to engage residents and involve them in planning, designing, and implementing active transportation strategies. As there are more complete streets policies, there is an increase in pedestrian and bike facilities (bike lanes, sidewalks). With more pedestrian and bike facilities, there are more children and adults are active, which reduces obesity. When obesity rates decrease, then obesity prevention efforts decrease. There is a decrease in political will, which decreases complete streets policies.

Story B: Alternatively, as there are less complete streets policies, there is a decrease in pedestrian and bike facilities (bike lanes, sidewalks). With less pedestrian and bike facilities, there are less children and adults are active, which increases obesity. When obesity rates increase, then obesity prevention efforts increase. There is an increase in political will, which increases complete streets policies.

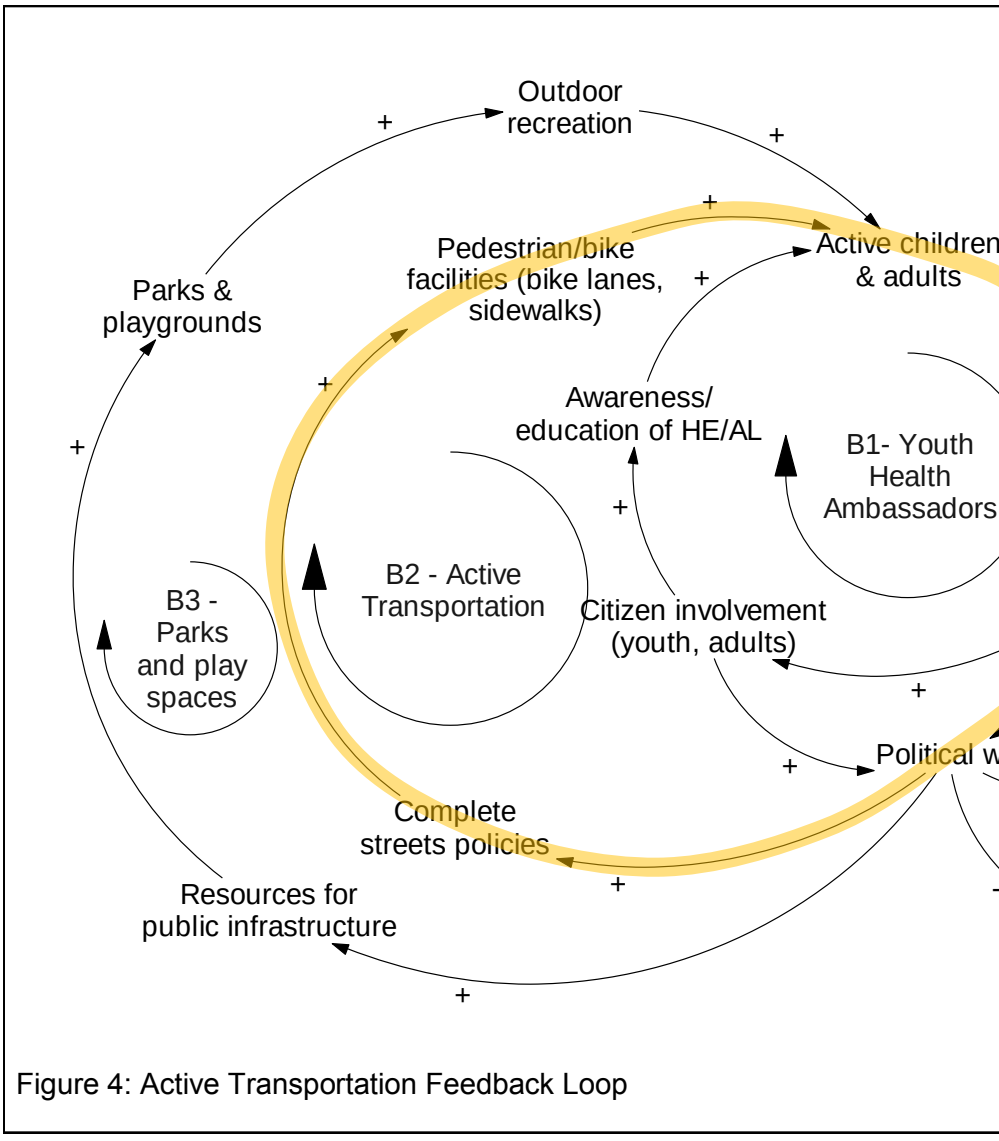


Figure 4: Active Transportation Feedback Loop

Balancing Loop and Notation

Similar to the previous loop, the youth health ambassadors loop in Figure 3, has one "-" sign or polarity; because this is an even number, it is still a reinforcing loop (see B2—Active Transportation in Figure 4).

Some of these causal relationships may have more immediate effects (e.g., pedestrian and bike facilities influence on active children and adults) and other relationships may have delayed effects (e.g., the influence of obesity on frontline for obesity prevention). This delayed effect is noted using two hash marks through the middle of the arrow line (not included in Figure 4).

System Insights for *HKHC DeSoto-Marshall-Tate*

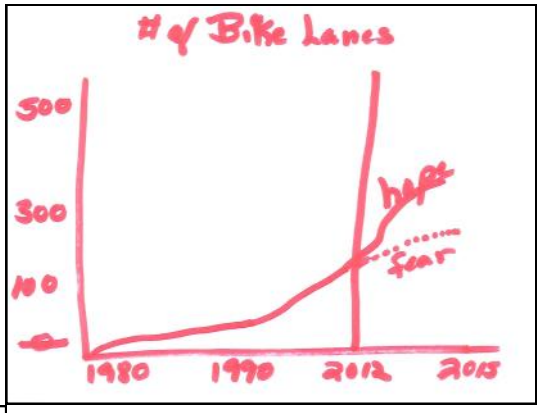
In the behavior over time graphs, participants identified the number of bike lanes have increased from 1980 to 2012 with the hope that the number of bike lanes will continue to increase into the future (see behavior over

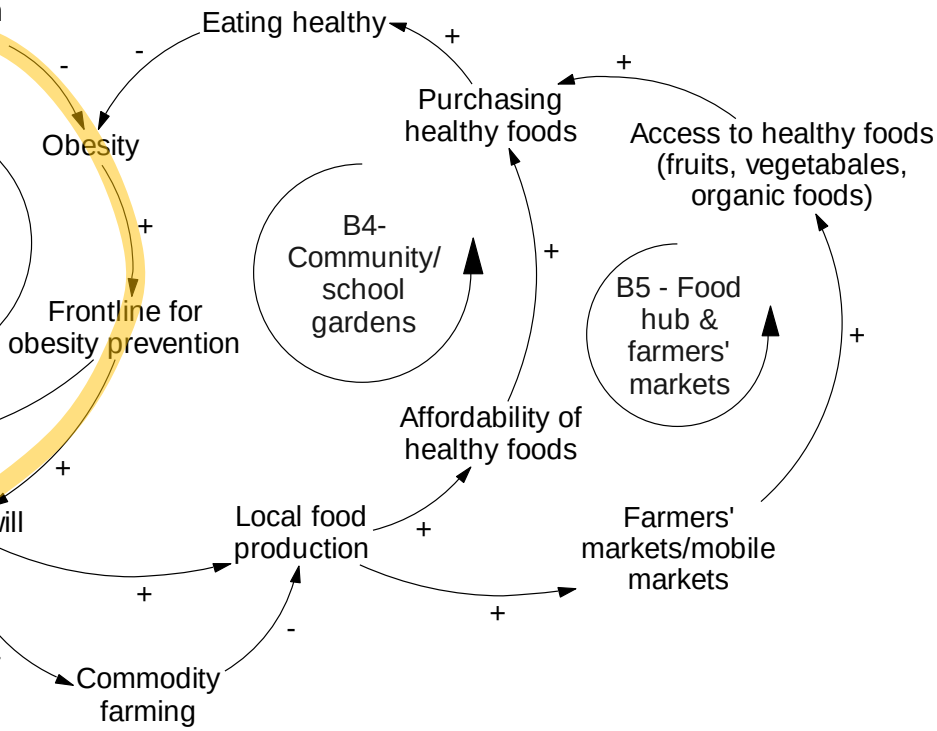
"Biking is good for recreation; biking is good for physical activity. You can have all the bicycle lanes in the world, but if you [don't] promote the system, or the policy changes to educate, especially our young people, on the safety of riding bikes and also the general public on watching out for bikers and being aware of bikers, then you're not going to have a safe community, and that's it." (Participant)

time graph on next page top right). Additionally, participants described safety in biking as increasing from 1980 to 2012 with the hope that safety in biking will continue to increase into the future.

System insights can inform the partnership's next steps with active transportation, including:

- 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.

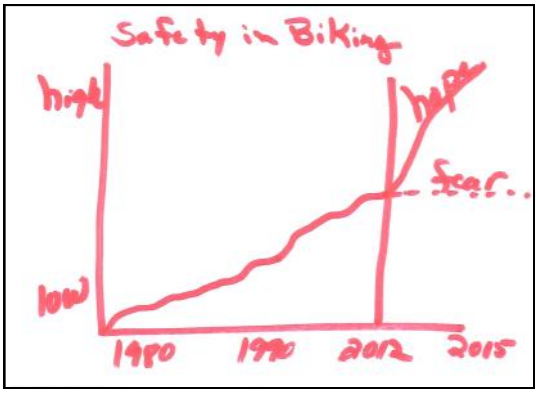




- New collaborations forged with city agency representatives or community organization leaders generates more political will in various sectors of the community for those whose voices are not well represented.
- Families spending more time together in physically active pursuits encourage more active lifestyles for children.

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 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)?
- What are unintended benefits of families being active together (e.g., improvements in family dynamics and relationships, children learning to better navigate their environments)?
- How do residents' perceptions of safety influence their use of motorized vehicle for transportation or discourage their use of biking or walking for transportation?



Parks and Play Spaces Feedback Loop

Highlighted in blue in Figure 5, the parks and play spaces feedback loop represents one of the *HKHC DeSoto -Marshall-Tate* strategies to increase active living in DeSoto, Marshall, and Tate Counties, Mississippi.

Causal Story for Feedback Loop

Story A: With more resources for public infrastructure, there are more parks and playgrounds facilities in the community, With more parks and playgrounds, there is an increase in outdoor recreation, which increases the children and adults that are active. With more active children and adults, there is a reduction in obesity. When obesity rates decrease, then obesity prevention efforts decrease, which also decreases in political will. In turn, with less political will, there are less resources for public infrastructure.

Story B: Alternatively, with less resources for public infrastructure, there are less parks and playgrounds facilities in the community, With less parks and playgrounds, there is a decrease in outdoor recreation, which decreases the children and adults that are active. With less active children and adults, there is an increase in obesity. When obesity rates increase, then obesity prevention efforts increase. When obesity becomes frontline for prevention, then there is an increase in political will. In turn, with more political will, there are more resources for public infrastructure.

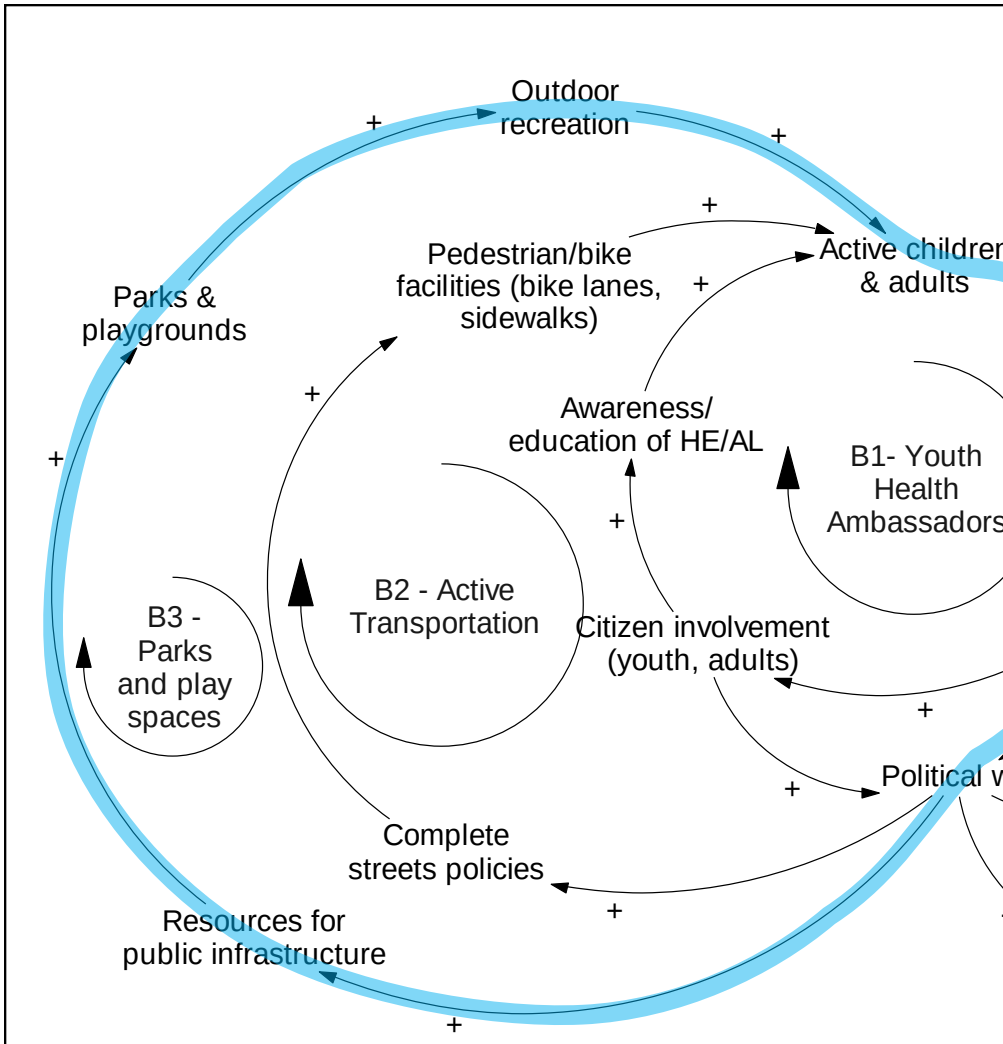


Figure 5: Parks and Play Spaces Feedback Loop

Balancing Loop and Notation

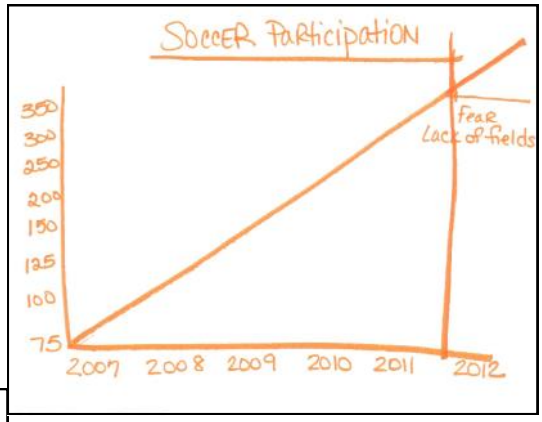
Similar to the previous loops, this one also represents a balancing loop (one "-" sign). In addition, it includes causal relationships representing more immediate effects (e.g., parks and playgrounds influence on outdoor recreation), and, potentially, delayed effects (e.g., political will influence on resources for public infrastructure).

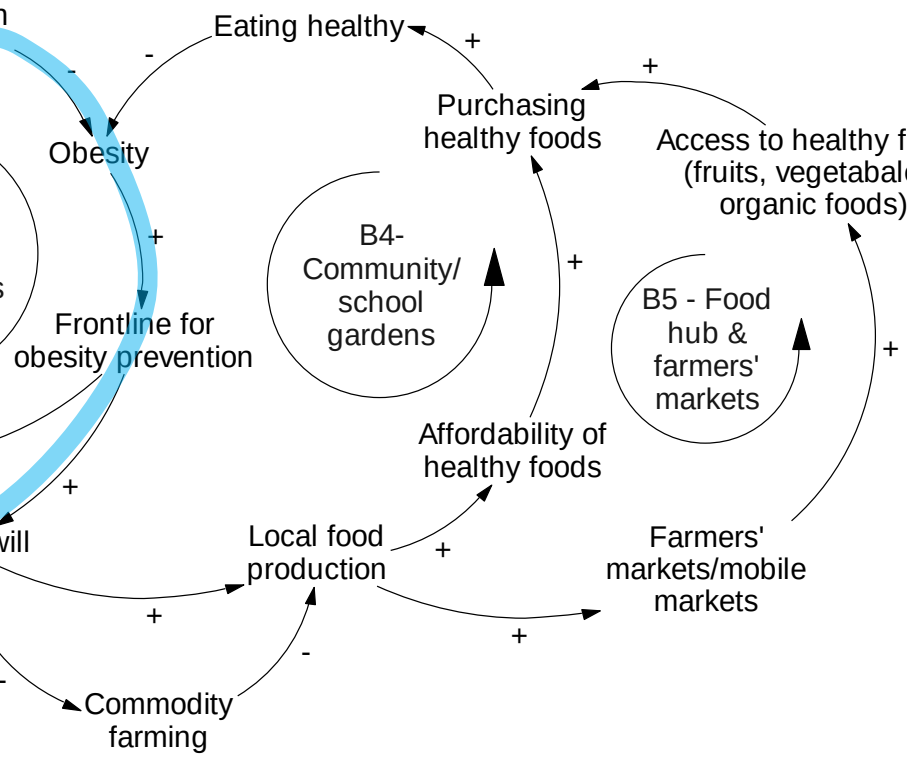
Story A provides a good illustration of the reason why it is not advantageous to separate the feedback loops from the causal loop diagram (see Figures 1-2). For instance, while the resources for public infrastructure may have an influence on parks and playgrounds, many other factors influence parks and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

"Since soccer started in this community in 2007, we increased in participation every season. And the opportunity to have more kids participate in soccer two times a year has resulted in having over 300 kids this past season. My fear is that if we don't have enough facilities available for them, that we're either going to plateau or decline, because we are basically at capacity where we are right now. So, there needs to be some change in acquiring more fields. But we have some land that needs to be funded to build them, so that we can continue to grow and get more children to participate in them." (Participant)

System Insights for *HKHC DeSoto-Marshall-Tate*

In the behavior over time graphs exercise, participants described increase in soccer participation since 2007 to 2012 with the hope that soccer participation will continue to increase into the future (see behavior over time graph at the top right). Participants also identified an increase in availability of physical activity opportunities since 1990 to 2012 with the hope that the availability of physical activity opportunities will continue to increase into the future (see behavior over time graph bottom right).



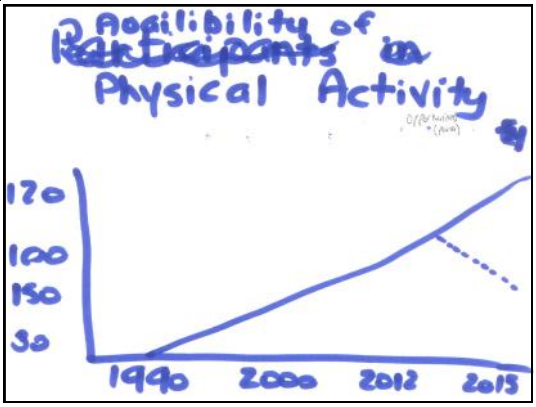


System insights for the partnership's parks and play spaces efforts include:

- Parks and play spaces that facilitate both opportunities for physical activity and resident interaction and engagement support sustainability of the quality of these spaces by increasing collaboration of local partners that can generate resources to invest in these spaces.
- Public recreation facilities increase the health of community members and beautify their neighborhoods.

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

- Who lives within a one– or two–mile radius of safe, quality parks and recreation facilities? Who does not?
- What are the optimal numbers and types of public recreation facilities for a neighborhood or urban area?
- What funds have collaborators successfully secured for parks and play spaces? How can these resources be sustained into the future?
- What public recreation facilities are used by what groups in the community (e.g., children, adolescents, people in poverty)? Are surrounding residents more or less active?



Community/School Gardens Feedback Loop

Highlighted in red in Figure 6, the community/school gardens feedback loop represents one of the *HKHC DeSoto-Marshall-Tate* strategies to increase healthy eating in DeSoto, Marshall, and Tate Counties, Mississippi.

Causal Story for Feedback Loop

Story A: With more local food production (e.g., community or school gardens), there is an increase in the affordability of healthy foods in the community. As foods are more affordable, there is an increase in the purchasing of healthy foods, which increases the number of people eating healthy. With more healthy eating, there is a reduction in obesity rates. With less obesity, obesity prevention as a frontline issue will decrease, which decreases citizen involvement (youth, adults). With less citizen involvement, there is a reduction in the political will, which decreases local food production (e.g., community or school gardens).

Story B: Alternatively, with less local food production (e.g., community or school gardens), there is a decrease in the affordability of healthy foods in the community. As foods are less affordable, there is a decrease in the purchasing of healthy foods, which decreases the number of people eating healthy. With less healthy eating, there is an increase in obesity rates. With more obesity, obesity prevention as a frontline issue will increase, which increases citizen involvement (youth, adults). With more citizen involvement, there is an increase in the political will, which increases local food production (e.g., community or school gardens).

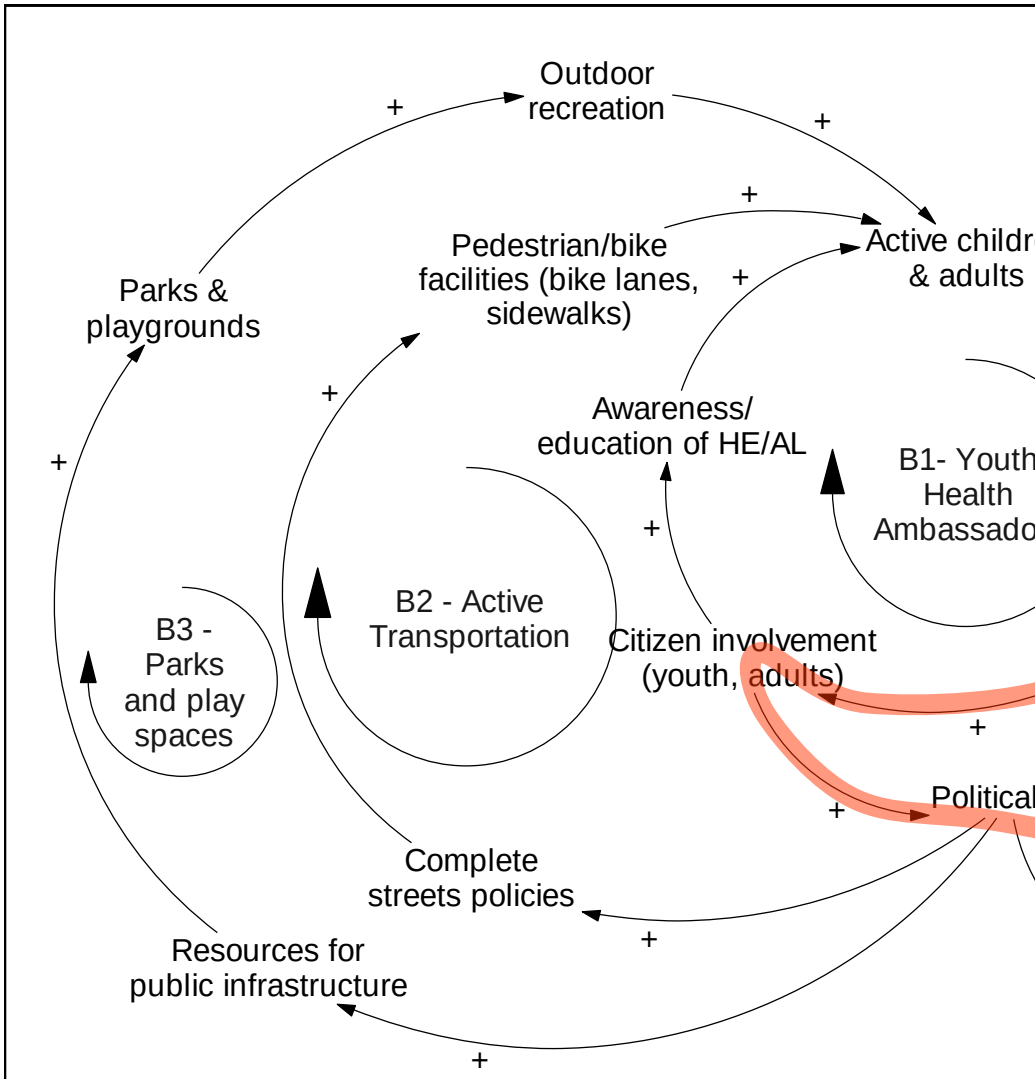


Figure 6: Community/School Gardens Feedback Loop

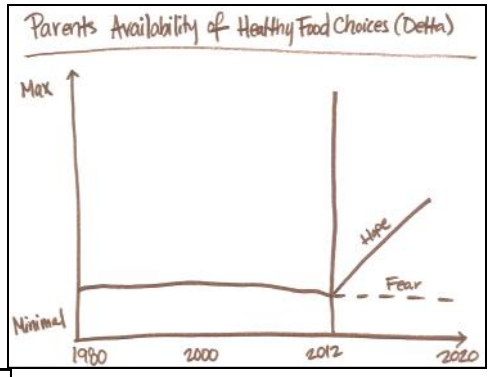
Balancing Loop and Notation

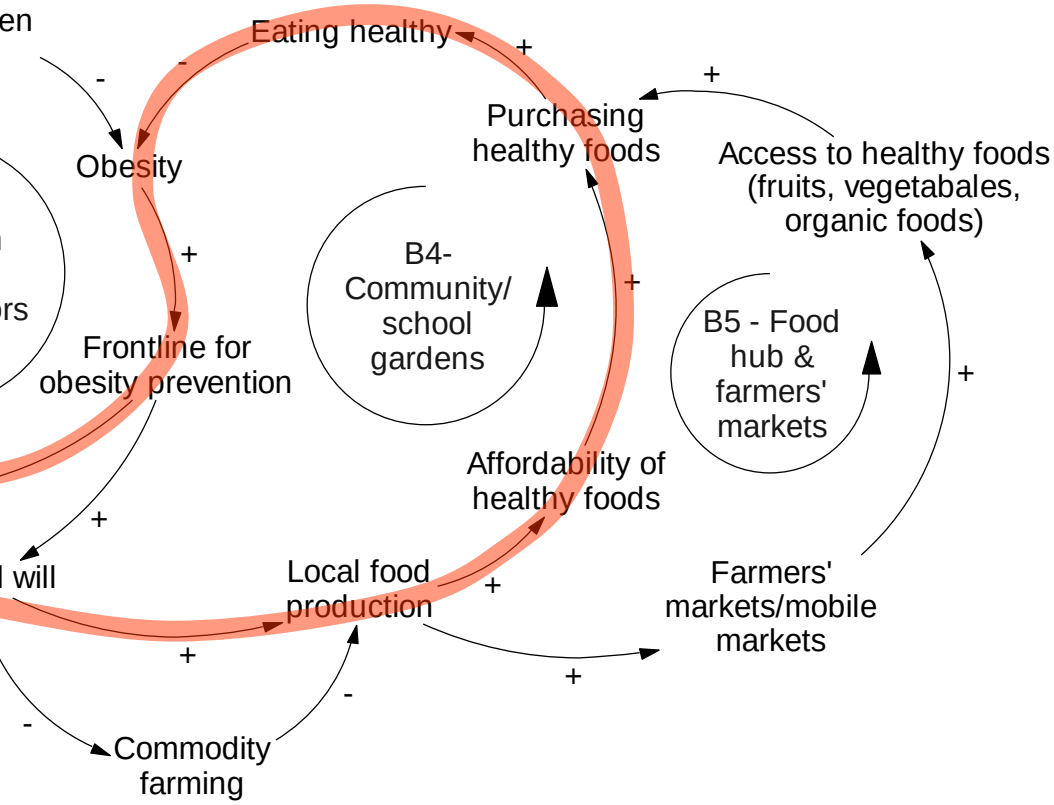
Similar to the previous loops (see Figure 3-5), this is a balancing loop (one "-" sign). In addition, it includes causal relationships representing more immediate effects (e.g., purchasing healthy foods influence on eating healthy), and, potentially, delayed effects (e.g., influence of political will on local food production).

"If you're eating inexpensive foods, that's all you can afford, whether you have [government] benefits, or don't, you're eating food that's not nutritious in a dense way, then you don't feel good, and you're overweight. I mean, this is not just for people that are poor. This is what food quality, and the lack of food quality does to everyone. Whether you're poor or not, bad food quality is bad for everybody. It makes feel lethargic, it makes you feel like don't have any hope, like you can't do anything. Being overweight hurts people's self-esteem." (Participant)

System Insights for *HKHC DeSoto-Marshall-Tate*

In the behavior over time graphs exercise, participants described no change or a stable trend in parents availability of healthy food choices since 1980 to 2012 with the hope that parents availability of healthy food choices will change and increase into the future (see behavior over time graph at the top right). Participants also described an increase in the cost of healthy food choices since 1980 to 2012 with the hope that the cost of healthy food choices will continue change and decrease into the future (see behavior over time graph at the bottom right).



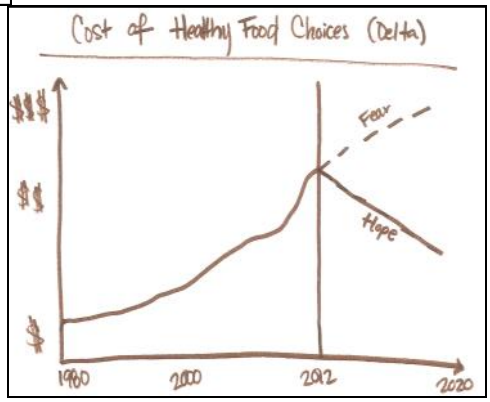


System insights for the partnership's community/school gardens efforts include:

- 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.
- Community and school gardens increase youth exposure to healthy fruits and vegetables and increase their likelihood of purchasing healthy food (or advocating to parents to purchase healthy foods).

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 healthy foods and beverages are most likely to purchased and consumed in communities? Does this vary by subpopulation?



Food Hub and Farmers' Markets Feedback Loop

Highlighted in yellow in Figure 7, the food hub and farmers' markets feedback loop represents one of the *HKHC DeSoto-Marshall-Tate* strategies to increase healthy eating in DeSoto, Marshall, and Tate Counties, Mississippi.

Causal Story for Feedback Loop

Story A: With more local food production (e.g., community or school gardens), there is an increase in the number of farmers' markets and mobile markets in the community. With more farmers' markets and mobile markets, there is greater access to healthy foods (fruits, vegetables, and organic foods). With greater access to healthy foods, there are more people purchasing healthy foods, which increases the number of people eating healthy. With more healthy eating, there is a reduction in obesity rates. With less obesity, obesity prevention as a frontline issue will decrease, which reduces the political will. In turn, with less political will, there is more commodity farming and less local food production.

Story B: Alternatively, with less local food production (e.g., community or school gardens), there is a decrease in the number of farmers' markets and mobile markets in the community. With less farmers' markets and mobile markets, there is less access to healthy foods (fruits, vegetables, and organic foods). With less access to healthy foods, there are less people purchasing healthy foods, which decrease the number of people eating healthy. With less healthy eating, there is an increase in obesity rates. With more obesity, obesity prevention as a frontline issue will increase, which increases the political will. In turn, with more political will, there is less commodity farming and more local food production.

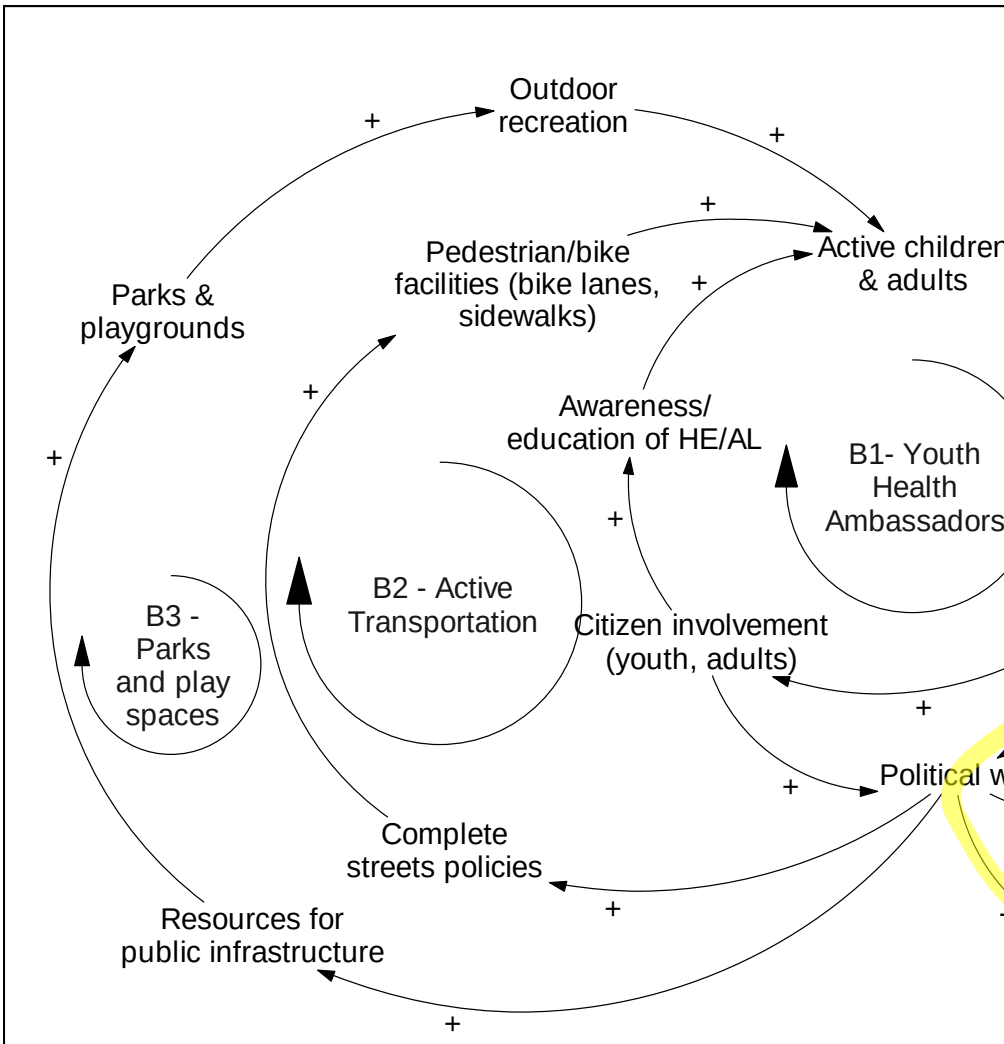


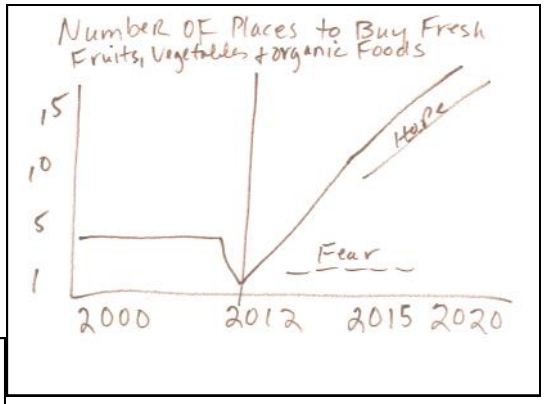
Figure 7: Food Hub and Farmers' Markets Feedback Loop

Balancing Loop and Notation

Similar to the previous loops (see Figure 3-7), this is a balancing loop (three "-" signs). In addition, it includes

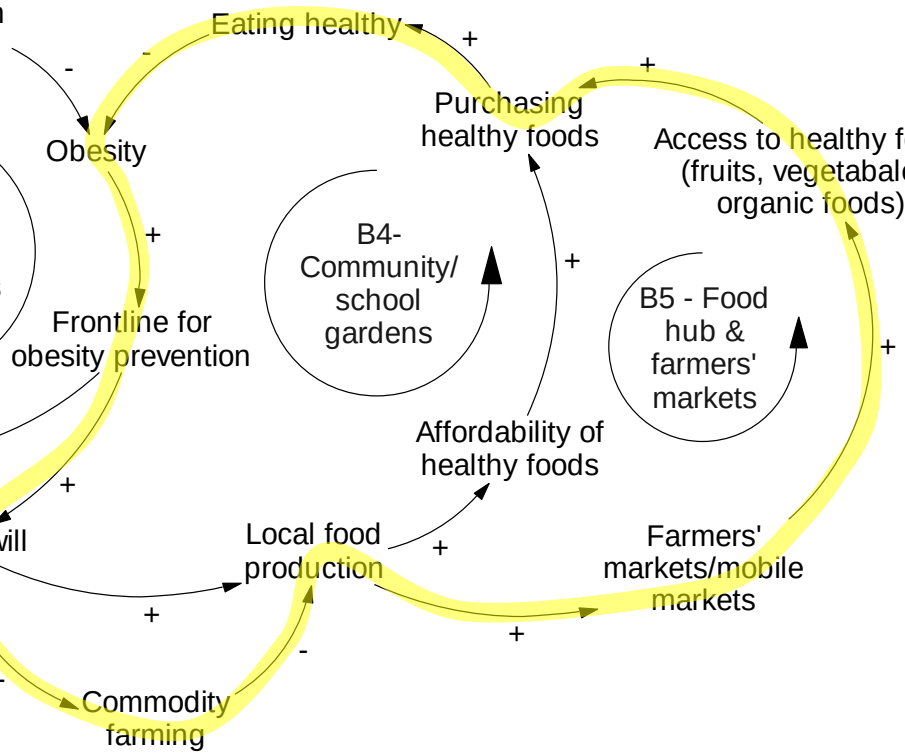
"Once WIC participants utilize farmers' market vouchers, [the next step] is understanding how to use that fresh produce. WIC participants are traditionally people who are not feeding their children properly. And I think that's why that program that was created; to help those mothers and provide proper nutrition for their children. So, even though we provide this [fresh produce], a lot of them don't understand how to cook it. And they'll either go to their grandmother, or their mother, ones that have traditionally cooked like that before, and actually give the food to them instead of taking it home and providing to their own children. So I think providing education to those participants will help them in time utilize those farmer's market vouchers better." (Participant)

causal relationships representing more immediate effects (e.g., access to healthy foods influence on purchasing healthy foods), and, potentially, delayed effects (e.g., influence of frontline for obesity prevention on political will).



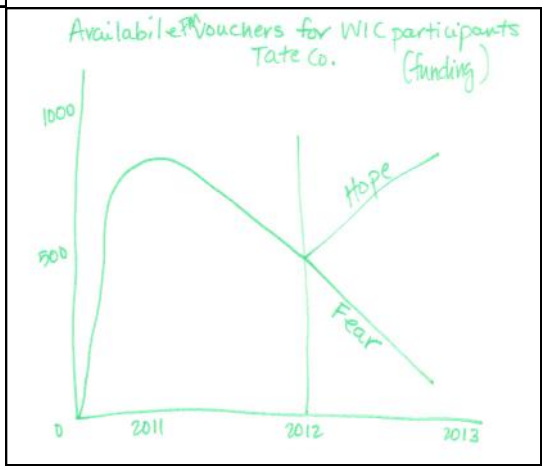
System Insights for *HKHC DeSoto-Marshall-Tate*

In the behavior over time graphs exercise, participants described no change and then a decrease in the number of places to buy fresh fruits, vegetables, and organic foods in the community since 2000 to 2012 with the hope that the number of places to buy fresh fruits, vegetables, and organic foods will change and increase into the future (see behavior over time graph at the top right). Participants also described an increase and then a drastic decrease in the availability of farmers' market vouchers for WIC (Women, Infants, Children) participants in Tate County since 2010 to 2012 with the hope that the availability of farmers' market vouchers for WIC participants will change and increase into the future (see behavior over time graph at the bottom right).



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

- The dramatic decline in healthy food retailers alongside the dramatic increase in unhealthy food retailers may be, in part, attributable to discriminatory practices associated with increasing rates of obesity; efforts to eliminate these discriminatory practices may help to increase access to fresh, healthy foods in marginalized communities.
- With the low numbers of food vendors accepting WIC or SNAP benefits, strategies to engage residents in advocacy initiatives to demonstrate demand for these services in the community may push this agenda forward; at the same time, residents need to be made aware of the food vendors accepting WIC or SNAP benefits so that vendors view these services as a good investment of their time and effort.



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

- What factors lead to an increase in demand for healthy foods and beverages in communities?

Opportunities for Systems Thinking in DeSoto, Marshall, and Tate Counties, Mississippi

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 *HKHC DeSoto-Marshall-Tate* partners, this storybook also summarized the healthy eating, active living, partnership and community capacity, social determinants, and health and health behaviors subsystems in the DeSoto-Marshall-Tate causal loop diagram as well as six 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 DeSoto, Marshall, and Tate Counties, Mississippi to promote healthy eating and active living as well as preventing childhood overweight and obesity.

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

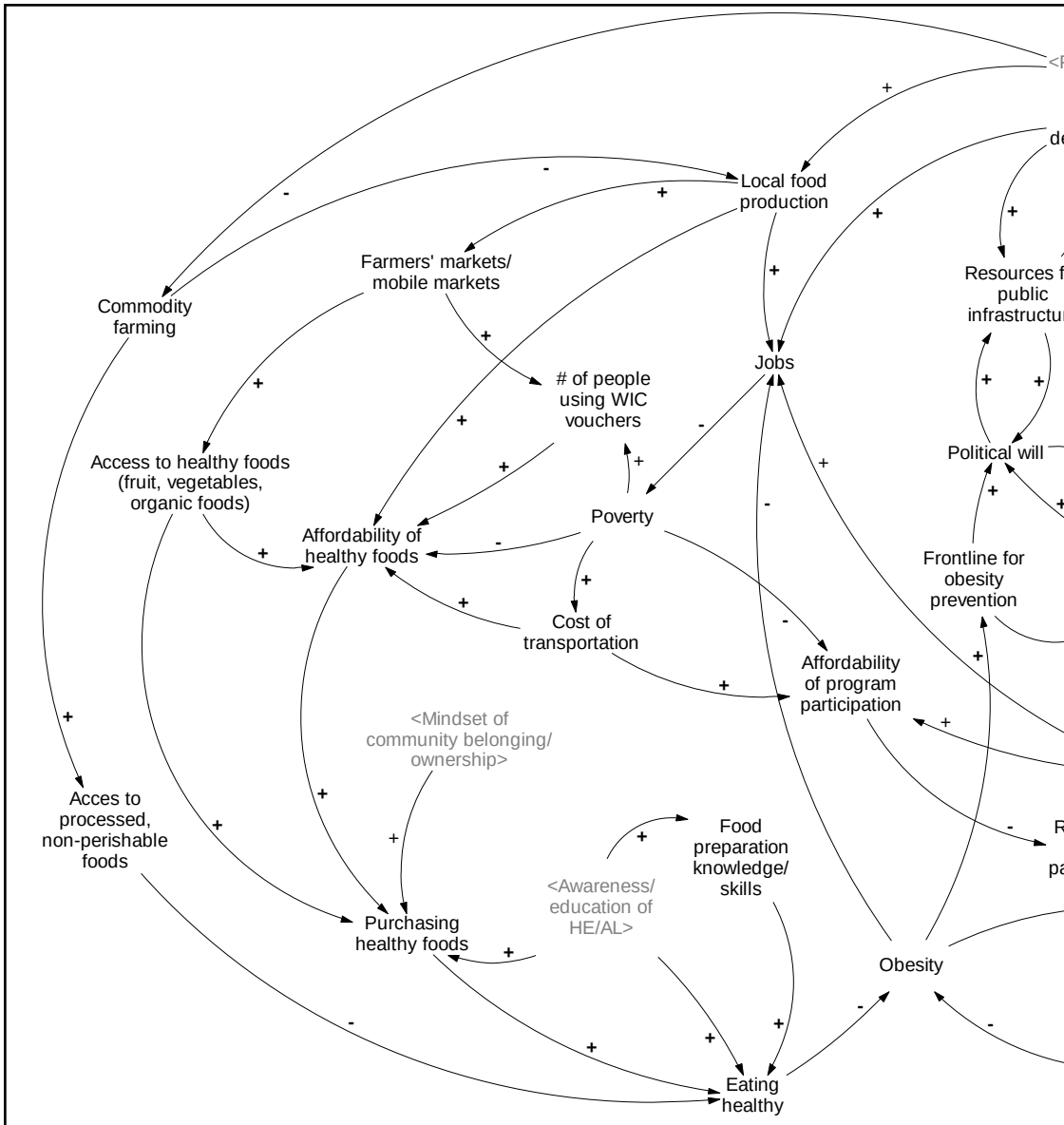


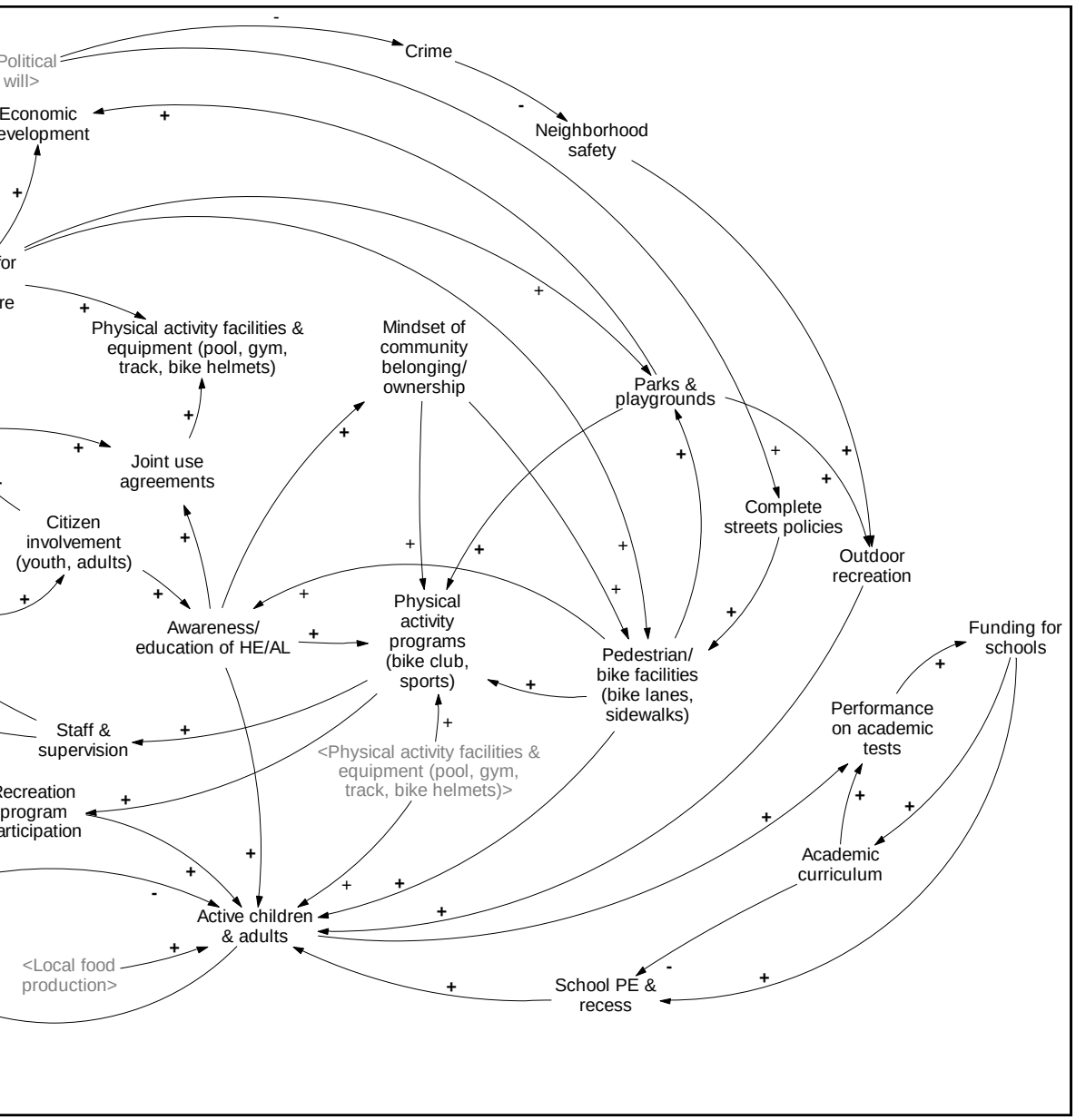
Figure 8: *HKHC DeSoto-Marshall-Tate* Causal Loop Diagram

- the participants represent a sample of the *HKHC DeSoto-Marshall-Tate* 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 healthy foods/ beverages in schools, gas stations, grocery stores, fast food restaurants, restaurants, school health council, screen time/technology, SNAP program, food pantries, educational attainment, state/federal funding, diverse school performance criteria, traffic safety, distance to destinations (food vendors, programs); 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 DeSoto-Marshall-Tate 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 *HKHC DeSoto-Marshall-Tate* 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.

Hovmand, P. S., et al. (2012). "Group model building "scripts" as a collaborative tool." Systems Research and Behavioral Science 29: 179-193.

Institute of Medicine (2012). An integrated framework for assessing the value of community-based prevention. Washington, DC, The National Academies Press.

Meadows, D. (1999). Leverage points: places to intervene in a system. Retrieved from http://www.donellameadows.org/archives/leverage-points-places-to-intervene-in-a-system/

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.

System Dynamics in Education Project. (1994). Road maps: A guide to learning system dynamics. Retrieved from http://www.clexchange.org/curriculum/roadmaps/

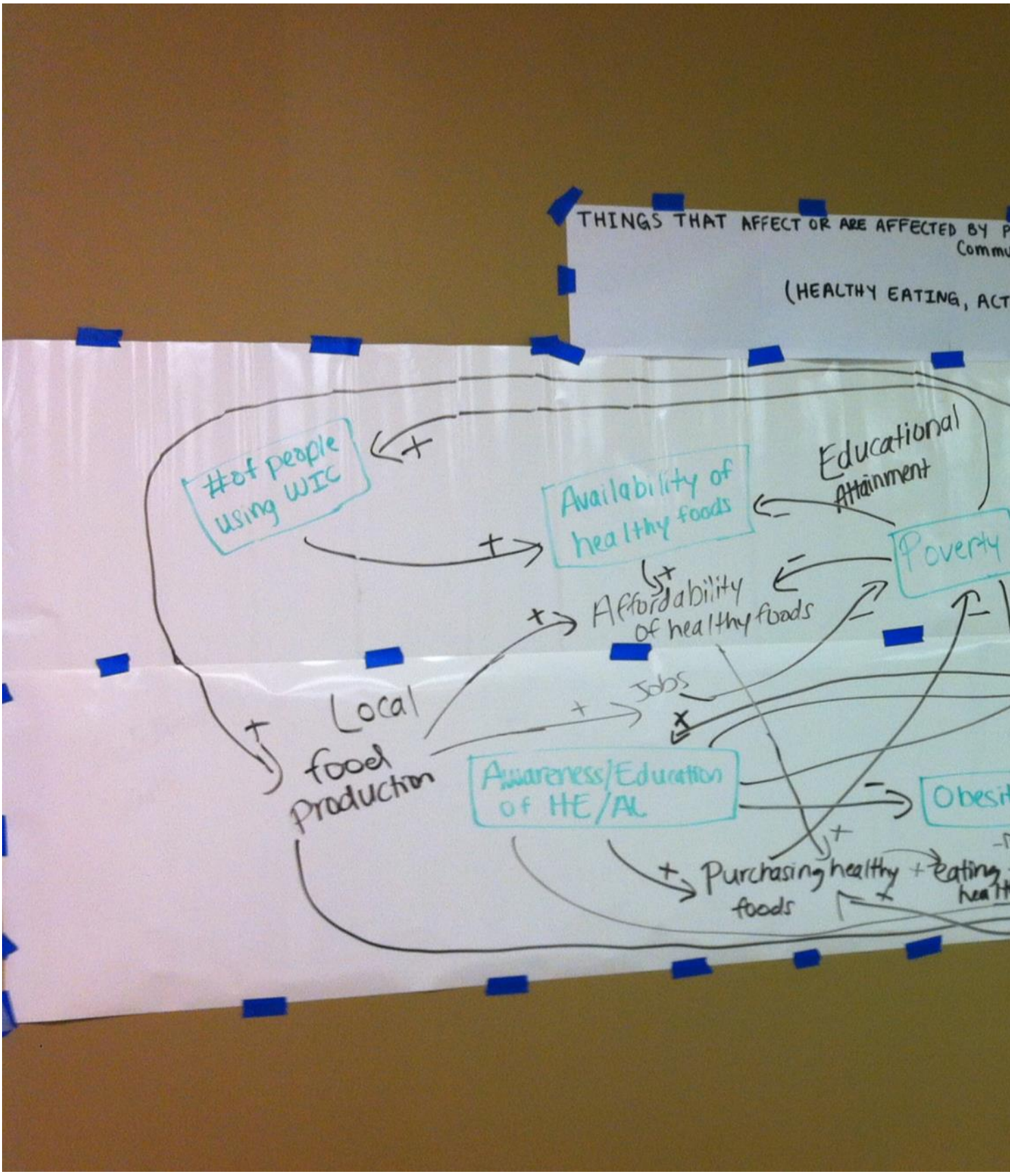
Vennix, J. (1996). Group model building. New York, John Wiley & Sons.

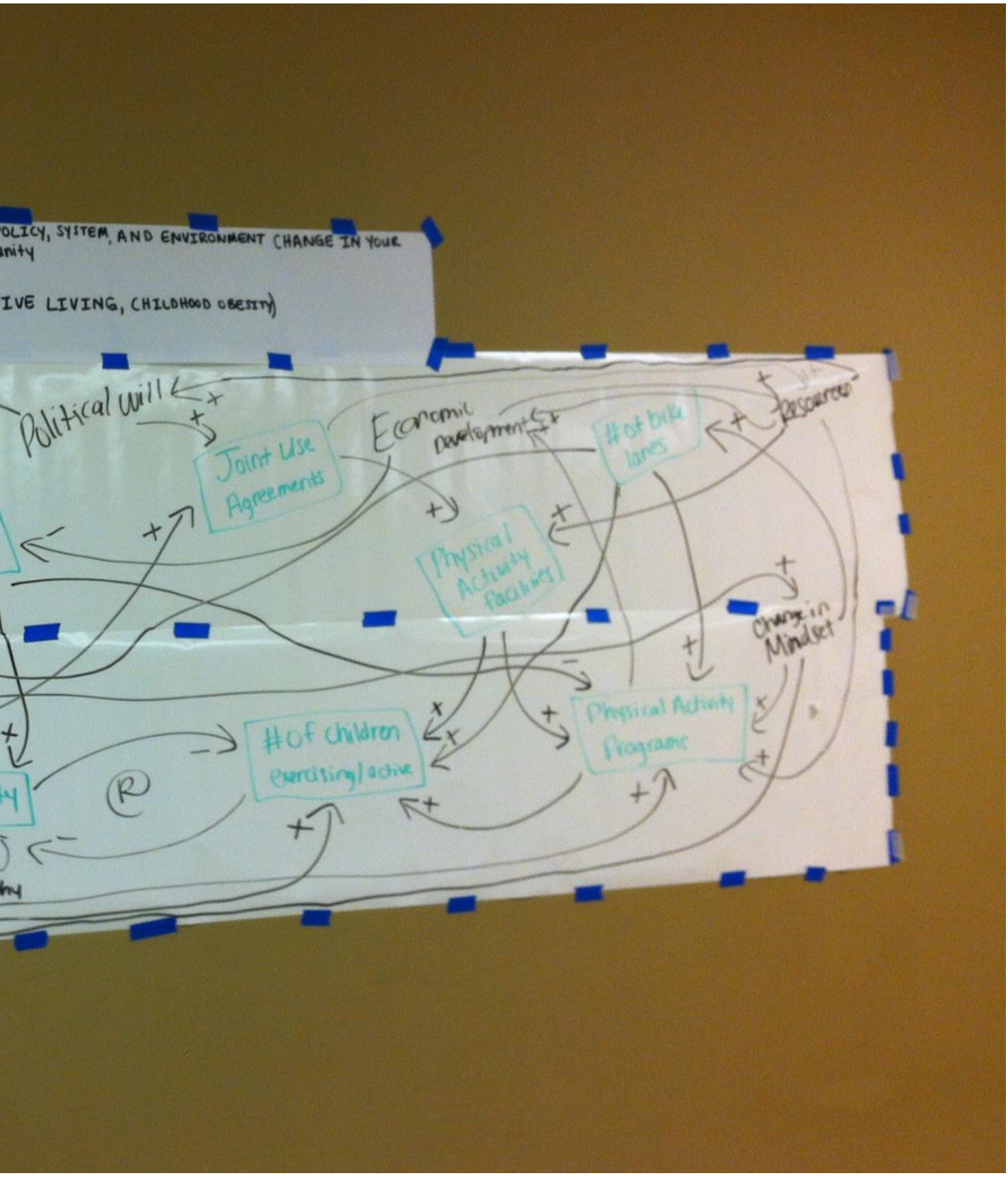
Zagonel, A. and J. Rohrbaugh (2008). Using group model building to inform public policy making and implementation. Complex Decision Making. H. Qudart-Ullah, J. M. Spector and P. I. Davidsen, Springer-Verlag: 113-138.

Appendix A: Behavior Over Time Graphs Generated during Site Visit

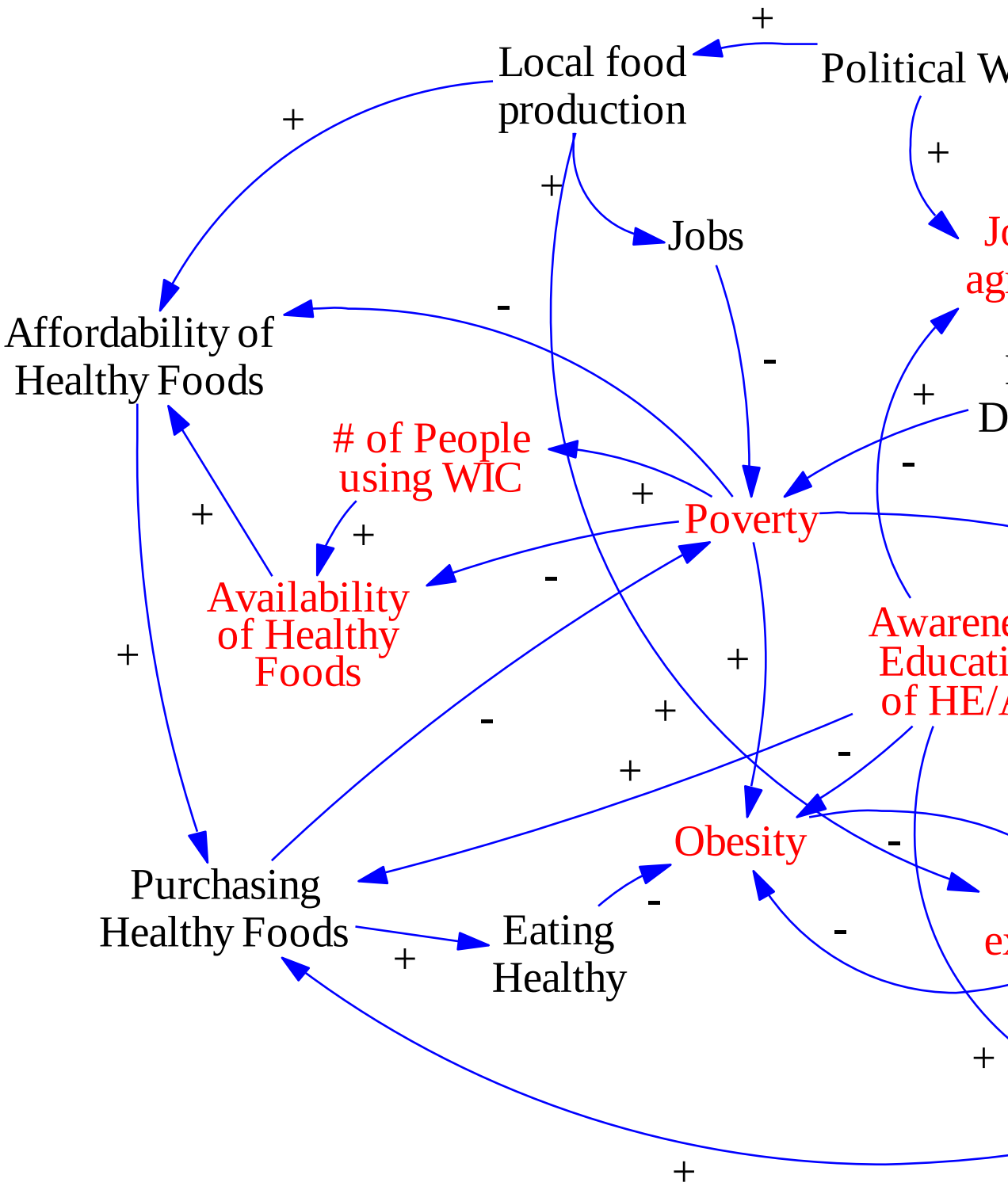
DeSoto, Marshall, and Tate Counties, Mississippi: *HKHC DeSoto-Marshall-Tate*	
Categories	**Number of Graphs**
Active Living Behavior	9
Active Living Environments	3
Funding	0
Healthy Eating Behavior	2
Healthy Eating Environments	4
Marketing and Media Coverage	0
Obesity and Long Term Outcomes	1
Partnership & Community Capacity	1
Policies	1
Programs & Promotions (Education and Awareness)	4
Social Determinants of Health	1
Total Graphs	**26**

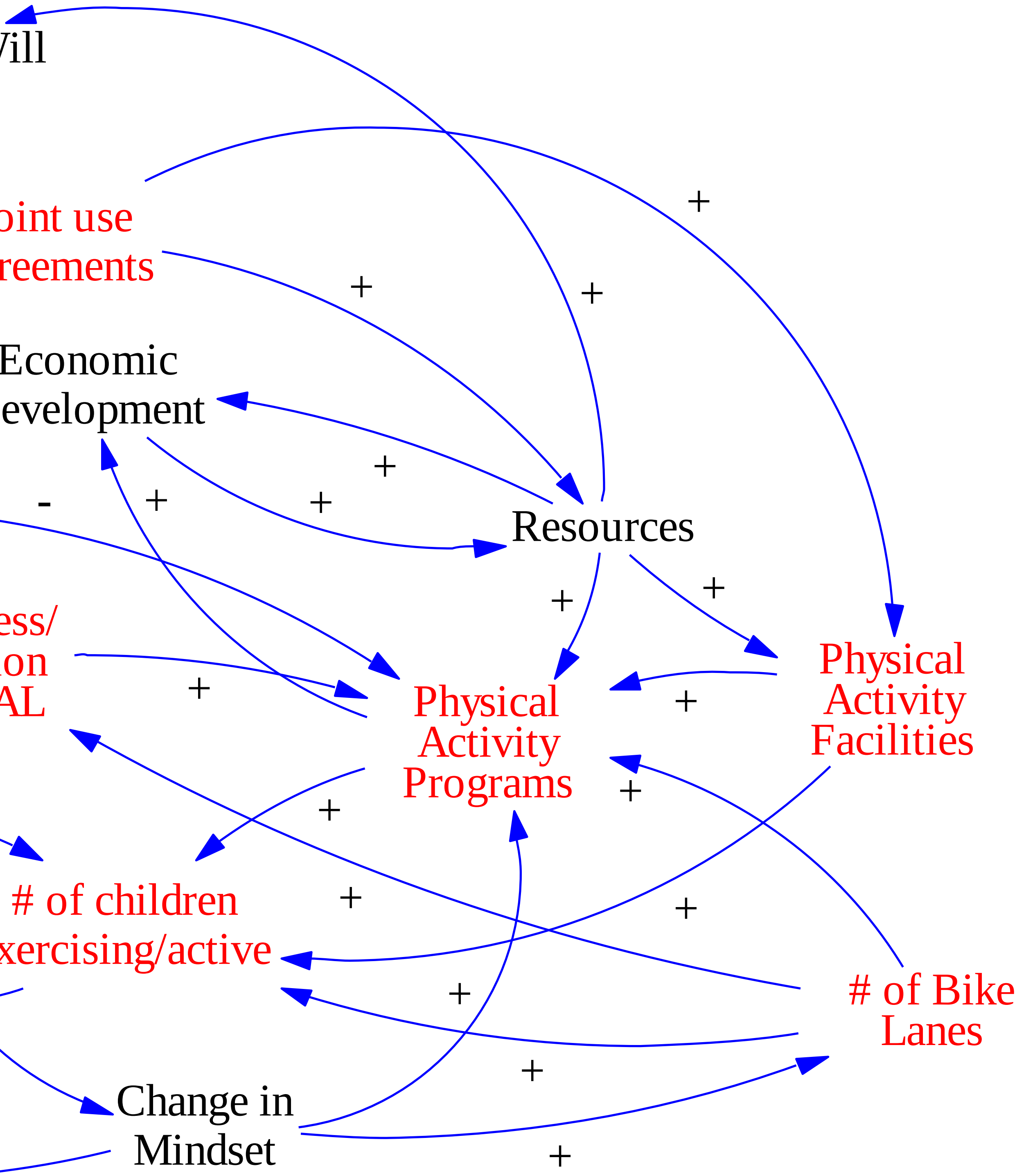
Appendix B: Photograph of the Original Version of the *HKHC DeSoto-Marshall-Tate* Causal Loop Diagram




OLICY, SYSTEM, AND ENVIRONMENT CHANGE IN YOUR
nity
IVE LIVING, CHILDHOOD OBESITY)
Political will
Joint Use Agreements
Economic development
# of bike lanes
resources
Physical Activity facilities
Change in Mindset
# of children exercising/active
Physical Activity Programs

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




Vill
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reements
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evelopment
Resources
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ion
AL
Physical
Activity
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Physical
Activity
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xercising/active
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Lanes
Change in
Mindset
+
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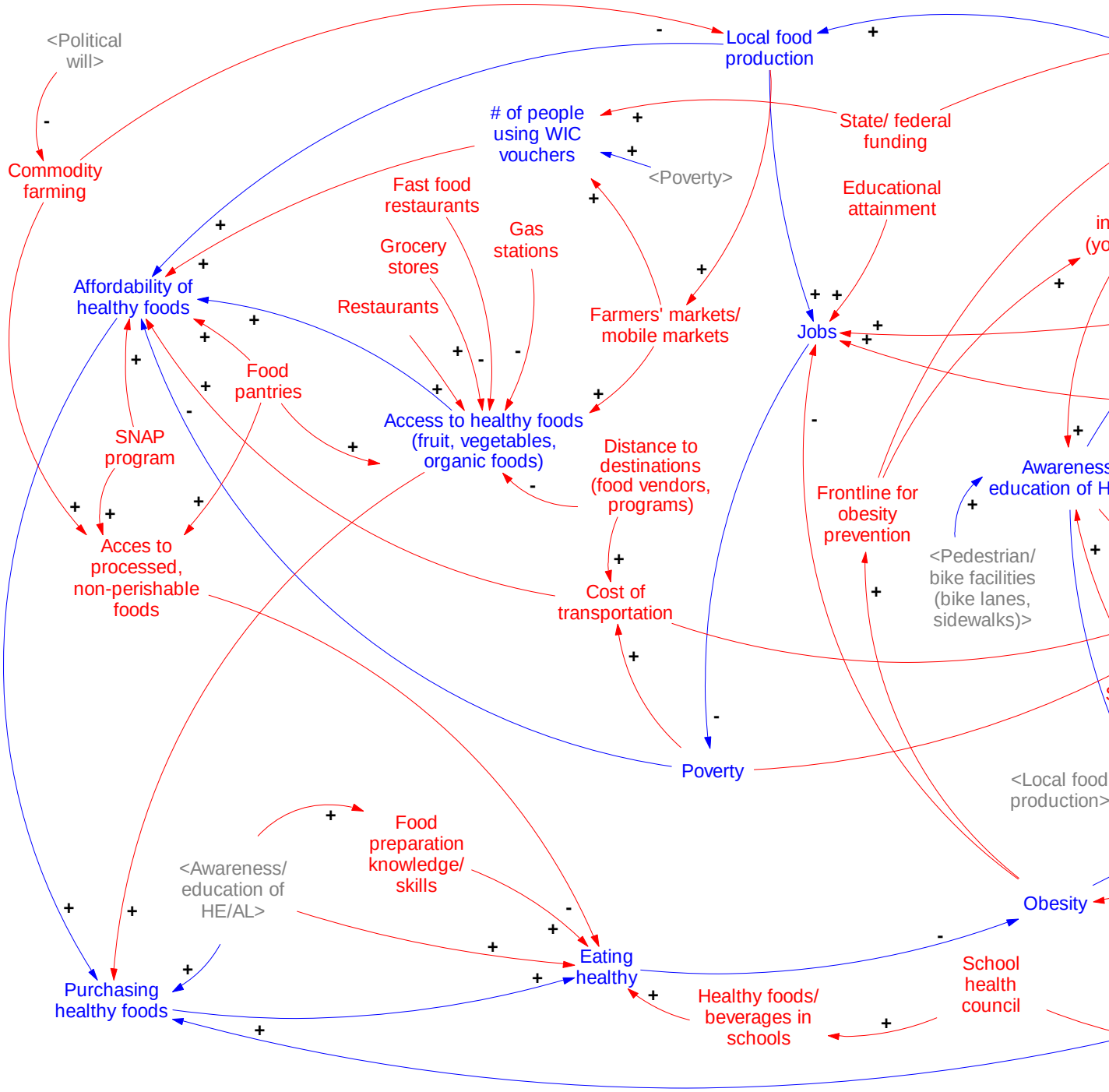
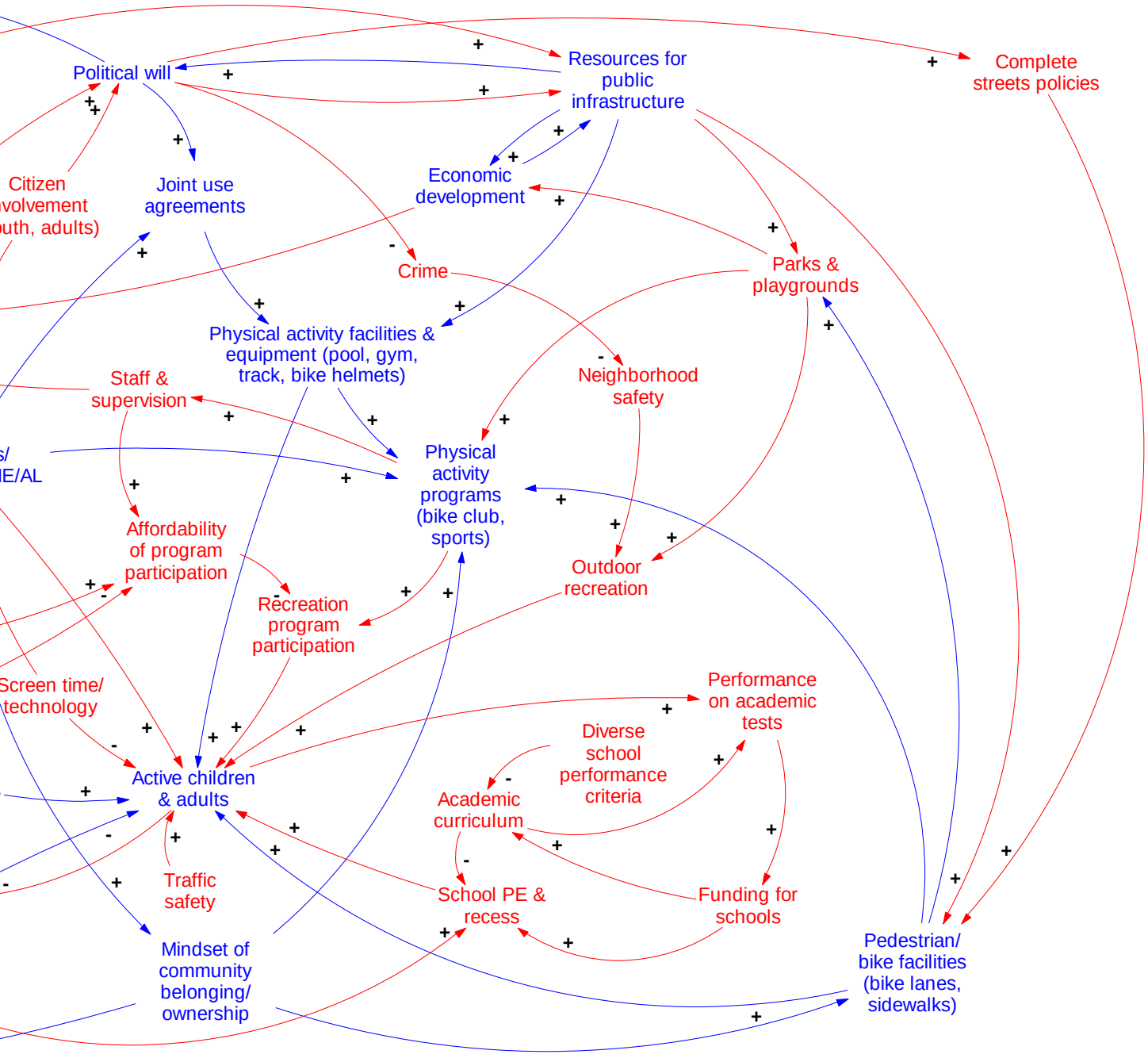
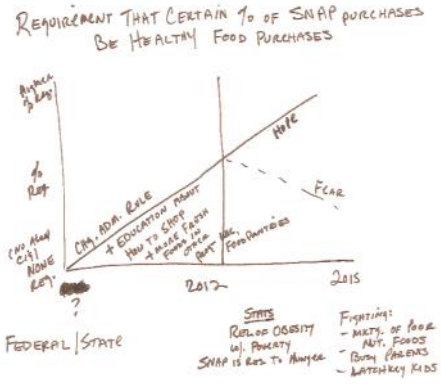
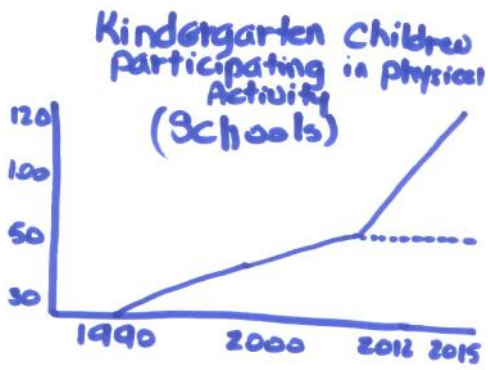
Appendix D: Transcript Translation of the Causal Loop Diagram into Vensim PLE

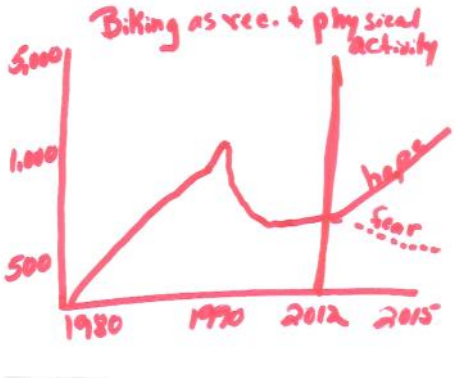


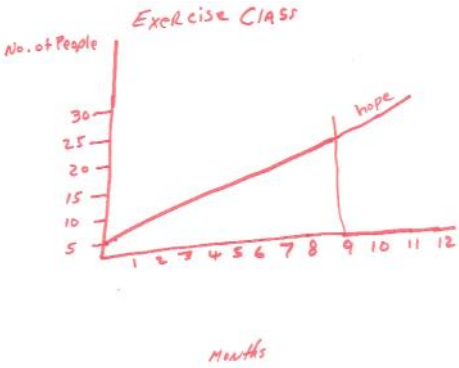

Political will
Resources for public infrastructure
Complete streets policies
Citizen involvement (youth, adults)
Joint use agreements
Economic development
Crime
Parks & playgrounds
Physical activity facilities & equipment (pool, gym, track, bike helmets)
Staff & supervision
Neighborhood safety
Physical activity programs (bike club, sports)
Affordability of program participation
Outdoor recreation
Recreation program participation
Screen time/ technology
Performance on academic tests
Diverse school performance criteria
Active children & adults
Academic curriculum
Traffic safety
School PE & recess
Funding for schools
Mindset of community belonging/ ownership
Pedestrian/ bike facilities (bike lanes, sidewalks)

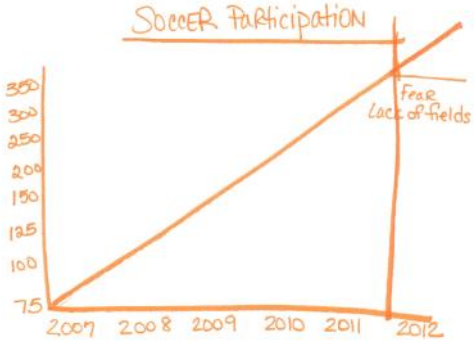
Appendix E: Behavior Over Time Graphs not Represented in the Storybook 2.5x1.99

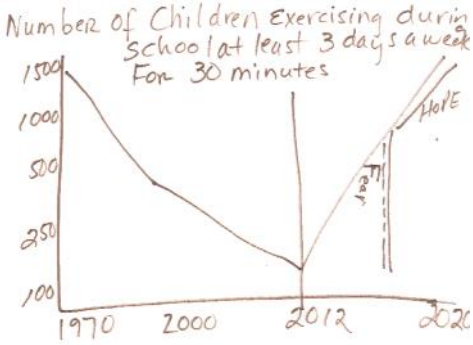


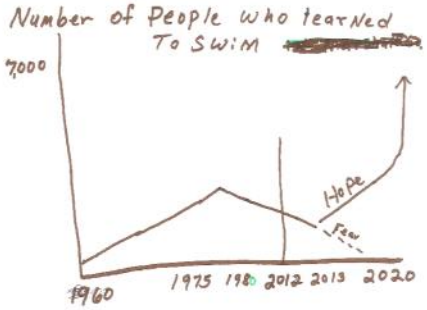


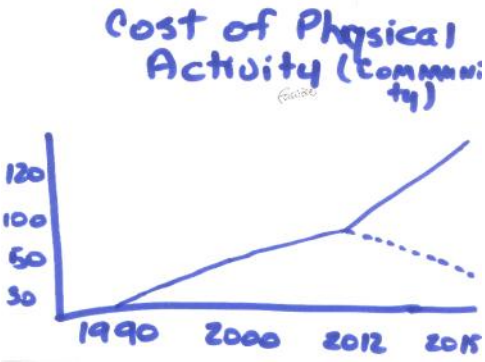


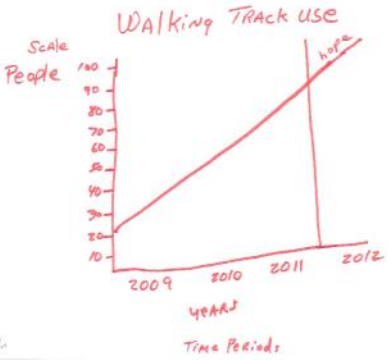


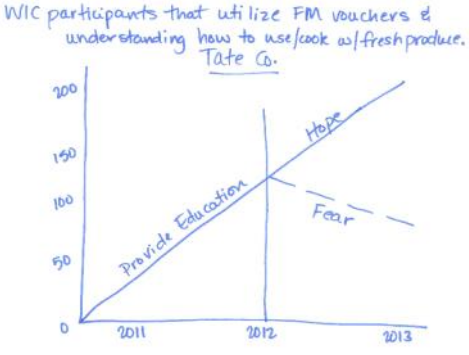


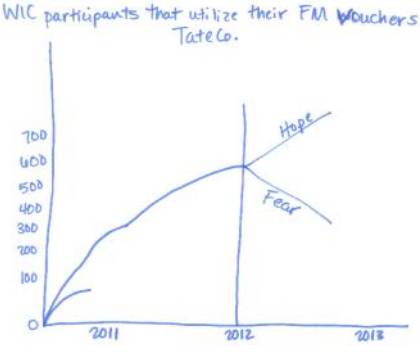


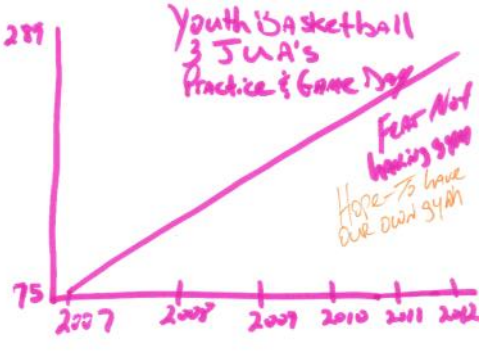


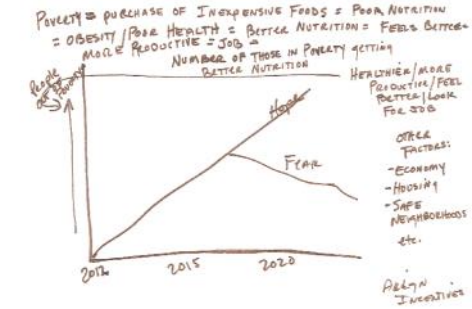












SUSTAINABLE- JOB CREATION