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Collective Action Dynamics in Urban Neighborhoods: A Study of Urban Community Gardens

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by

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ABSTRACT OF THE DISSERTATION

A Dissertation on the Collective Action Dynamics in Urban Neighborhoods: A Study of Urban Community Gardens

by

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Professor Gautam Yadama, Chair

Lessons from various policies and programs both in the United States and international development have led to a knowledge base concluding that an engaged community is a critical component for developing a thriving community. This is based on a premise that even in the modernized world community still has a role to play along with government and the market in their own development. Community's role is further highlighted in areas such as low income urban neighborhoods where both the government and the market may not be able to fulfill all the needs.

Research has followed by trying to understand why people engage in community activities. Studies have highlighted various individual and organizational attributes that motivate people to engage. Most studies take a linear view and don't take into account how the dynamics of internal processes and external environment may affect motivation over time. Without a dynamic perspective, it is difficult to understand what sustains community engagement. Not only engagement, but sustained engagement, is critical to accrue benefits for both individual and the

community. This study is designed to shed light into that very question: what are the processes that lead to sustained or eroding engagement over time?

The study was conducted in the empirical context of community gardens in a low income urban neighborhood. Key informant interviews were conducted with gardeners from different community gardens in the neighborhood. The data was used to understand the context for the establishment of the gardens. The data was also used to revise a system dynamics model that was previously built based on theories of collective action, community garden literature, and other models. The system dynamics approach entails creating a structure of feedback loops, creating a computer model based on that structure, and analyzing the simulation results to understand the relationship between the structure and the behavior it produces.

Based on the narratives, the model had eight main structures: gardeners, land, activities, quality of community garden, rules, trust, social relationships, and partners. The interaction between these sectors was based on several feedback loops which were grounded in the narrative. The model was able to produce both sustained and eroding community engagement. Among others, developing partnerships and how the various attribute of the garden such as quality, amount of work, and social relationships played an important role in sustaining engagement.

Chapter 1: Introduction

In 1984, residents from one of the poorest neighborhoods in Boston came together to form the Dudley Street Neighborhood Initiative (DSNI). The organization was the community's response to the consequences of years of disinvestment through redlining practices, abandoned houses that were being burnt, and vacant lots used as a dumping ground. Their initial goal was to clean the vacant lots however; they continued their community organizing efforts and developed a comprehensive revitalization plan in 1987. They collaborated with local community development corporations, banks, and the government to invigorate their neighborhood. Cleaning vacant lots catalyzed the process of building social capital. They were able to leverage their social capital to create a shared vision for the community and initiate other projects (Alves, Settles, & Webb, 1994). The organization is still in operation today; engaging residents in solving a variety of issues in the neighborhood.

This is an example of sustained community engagement, where people participate in community activities for a long period of time. Researchers, policymakers, and practitioners all understand that engaging local residents is important. Policies for urban community development now require residents to be an active part of the process. In most cases, funding is dependent on meeting this criterion. Consequently, there is a burgeoning literature on the benefits of participation in neighborhood activities. However, the manifestation of the intended benefits of community engagement requires sustained participation. If people engage for a short period, the benefits for either the participating individual or the community may not be realized. The goal of this dissertation is to understand how community engagement is sustained or erodes over time.

1.1 Community Gardens: An empirical context

A study to understand the process of individuals participating in community activities can be based on various types of neighborhood organizations. This study is grounded on community gardens because they are manifestations of residents actively engaging in their neighborhoods, they are beneficial to individuals and communities, and there is a dearth of studies that focus on engagement by community groups.

Unlike neighborhood organizations where residential involvement is a part of the organization, community gardens would not have existed without community engagement. During the latter part of 20th, century many cities in the US experienced a decline in population, resulting in vacant lots and abandoned buildings (Goldstein, Jensen, & Reiskin, 2001; Pagano & Bowman, 2000). Niedercorn and Hearle (1964) conducted a study of 48 US cities and estimated that in the early sixties on average 20.7% of the land was vacant. Some of these lots were used to dump waste, and became a hotbed for crime (Lawson, 2005). These plots became a symbol of environmental injustice and socio-economic isolation. Urban communities were trapped in a vicious cycle where abandoned lots created a perception of social disorder, which reinforced the perception that nobody in the community cared and reduced the attractiveness of the community (Kubrin & Weitzer, 2003; Sampson & Groves, 1989). Community groups identified this problem and subsequently came together to reclaim these spaces. They cleaned the lot, planned, designed, and converted the land to community gardens (Schukoske, 1999).

Understanding the underlying processes that sustain community gardens also has the potential to benefit individuals and communities. Although not definitive, evidence suggests that community gardens can increase access to and consumption of fruits and vegetables among the gardeners (Alaimo, Packnett, Miles, & Kruger, 2008; Barnidge et al., 2013; Litt et al., 2011;

McCormack, Laska, Larson, & Story, 2010). Studies have also indicated that community gardens provide space for social interactions, build social ties in the neighborhood, and create a sense of community (Comstock et al., 2010; Kingsley & Townsend, 2006; Lewis, 1994; Saldivar-Tanaka & Krasny, 2004; Shinew, Glover, & Parry, 2004; Teig et al., 2009). Sustaining community gardens for the long term is essential to realize these benefits.

Furthermore, Ferguson and Stoutland (1999) argue that most research and policy conversations around community engagement are focused on processes where governmental and non-profit organizations initiate the actual participation process. Much less work has been done to understand how urban community groups work together to solve their problem. Community garden is one such form of bottom up engagement where residents work together to design, build, and manage small plots of land.

Like other neighborhood initiatives, community gardens too can suffer from an eroding level of participation. As fewer people engage in a community garden, the level of engagement begins to decline, resulting in abandonment of the garden. A recent publication by the American Community Garden Association estimated that while there are new community gardens being built at a rapid pace, almost 1615 gardens had been abandoned in the past five years (Lawson & Drake, 2012). Initiating a garden requires a community to work together, but its sustainability is not guaranteed (Lawson & Drake, 2012).

1.2 Research Aim

To sustain continued participation in a community project, one must ensure that fewer people are leaving the project than joining. In other words, the attrition rate should be less than the recruitment rate. Then, the obvious question becomes: what motivates people to join

community efforts and what discourages people enough to leave? Most research has been dedicated to using demographical and psychosocial variables to predict the motivation for participating. Emerging literature focuses on the organizational and neighborhood context in an attempt to understand why people participate. Almost all the research ignores the dynamics that occur after people start participating in the community activity. Consequently we know much less about why people leave (Foster-Fishman, Collins, & Pierce, 2013; Louis, Terry, & Fielding, 2005). As such, studies have not focused on the dynamic processes of community engagement. Without understanding these processes, it becomes difficult to explain why things are working or not. The aim of this research is to fill that gap and understand what happens when people join a particular community activity, how they interact, how they achieve goals, how these processes affect their motivation for future participation, and encourage others to participate.

1.3 A feedback perspective

Almost every examination of community engagement is from a linear perspective. When the sense of community is high, community engagement is high; when self-efficacy is high, engagement is high; and when community efficacy is high, engagement is high. Although this provides insights regarding factors affecting community engagement, it doesn't shed any light on why these factors and community engagement would change over time. A group can collaborate and work together but as internal processes and the external environment change, the level of engagement also changes (Ostrom, 2000a; Ostrom & Ahn, 2009).A linear perspective is not able to provide insights into the dynamic processes that result in eroding or sustained engagement over time (see Figure 1).

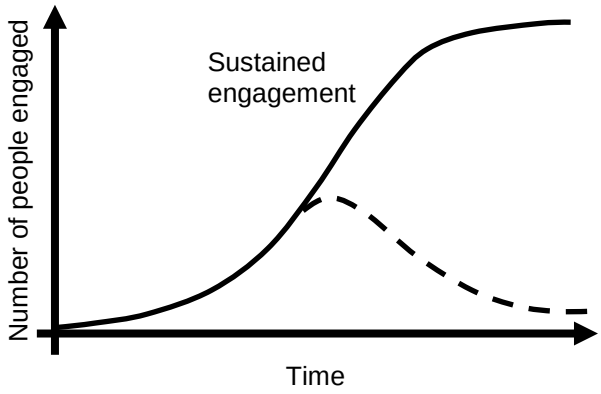


Figure 1: Sustained (solid) and eroding (dashed) community

A feedback perspective recognizes that various factors affect community engagement and engagement in turn can affect those factors. For example, if a sense of belongingness to the community drives an individual to participate in community related activities, that participation can reinforce that sense of community. If there was a change in leadership and the individual was not able to participate fully, it could reduce their sense of community. An open loop linear model without endogenous mechanisms is not able to capture these changes, which are essential in explaining how community engagement changes over time.

When one looks at a behavior of interest from a linear perspective, the effect size of various factors is important. The factors with larger effect sizes are considered to be more influential. However, when one looks at a phenomenon from a feedback perspective the types of feedback loops and how they are arranged is more important (Hovmand, 2014). Unlike the effect of factors, the effect of feedback loops changes over time. The nature of this change in effect of feedback loops determines the behavior.

In this study, a system dynamics modeling approach is used to understand how different feedback loops affect community engagement over time. The feedback mechanisms that affect community engagement are defined as a set of non-linear differential equations. These equations

are solved numerically as opposed to analytically. The model is then analyzed to understand the role of different feedback loops in producing the behavior at different times. This study will use the system dynamics modeling approach to fill the research gap by identifying the feedback processes that produce sustained and eroding community engagement in the context of community gardens.

1.4 Organization of the Dissertation

The goal for this chapter was to lay out the motivation and the approach for the study. It argues that most studies of community engagement focus on motivations for participation and ignore the dynamic processes that occur after someone participates. Chapter 2 covers the extant literature on community engagement including its definitions, benefits, challenges, and a review of the empirical and theoretical arguments for why people participate in community activities. Chapter 3 provides a background on the method including data collection, use of data to revise the model, and building and analysis of the system dynamics model. Chapter 4 will provide descriptive results of the community garden including its location, neighborhood context, and historical timeline of its development. Chapter 5 will unfold the model development process and show how each piece of structure was added to the model and its impact on model behavior. Chapter 6 will describe the results of model analysis and explain the reasons behind the behavior produced by the model. It will also provide results from experiments to understand the sensitivity of model behavior to various assumptions about the structure and parameter estimates. Finally Chapter 7 will conclude the dissertation with a summary, implications of the study and next steps.

Chapter 2: Review of Literature

2.1 Overview

Community engagement in this study is situated in the context of poor urban neighborhoods. Therefore, this chapter provides a historical perspective of community engagement in urban development and its significance in poor urban neighborhoods today. It also highlights how community engagement occurs in the context of community gardens. Illustrating these layers of context within which groups of people engage not only helps to focus the study but also will help to interpret the results and discuss its implications. This chapter will also provide some theoretical perspective on why people engage in community activities. Using these discussions as the basis the chapter will end with the description of the conceptual model built from a feedback perspective.

2.2 Community Engagement

Community engagement is defined as the "collaboration by groups of people defined by geographic proximity, social category membership, political views, and so on to address issues that influence their wellbeing" (CDC, 1997). Two main components of community engagement are the idea of collaboration and the meaning of "groups of people". Both of these vary resulting in a wide array of processes and activities that are referred to as community engagement. Consequently, community engagement is viewed as a continuous concept. As a spectrum community engagement can lie anywhere between passively filling out surveys for feedback to actively participating in planning, design and implementation of programs (Kumar, 2002). The goal of each program and policy may not be to engage communities at the highest level. Various factors such as funding, time horizon, flexibility of partnering organizations, and type of problem

can affect the level of engagement. However, the continuous perspective demands a more explicit definition of community engagement. Understanding the desired level of community engagement from the beginning can help design and evaluate the processes better. Even if the goal of a program is to reach the highest levels of engagement it may not start that way. A program could start with more passive forms of engagement, slowly build momentum and transfer the ownership of process and product to the community towards the end.

2.2.1 A Brief history of community engagement in urban development

Current issues with low income urban neighborhoods and their existence itself are inter-related with a long history of urban development in American cities. Early efforts to redevelop urban areas in the US were synonymous with renovation of the built environment (Gans, 1966; Naparstek & Dooley, 1997). The motivation for focusing on the physical infrastructure stemmed from the poor housing conditions in City centers (J. Q. Wilson, 1966). The dual incentive of using urban areas as the center of economic growth and providing families with a proper place to live, gave rise to the "bulldozer approach" to urban renewal (Anderson, 1966).

There were multiple criticisms of this approach. The focus on built environment ignored the social and psychological impact of forced relocation of the poor to public housing units (Naparstek, Dooley, & Smith, 1997). The new buildings were not designed for social interaction and family life. The sense of community present in the slums were difficult to re-establish in the multi-storied public housing (Fried, 1966). Ethnic minorities, primarily African Americans inhabited most of the cleared areas. However, the redeveloped areas were mostly accessible to people of higher socio-economic status. The disparity between those who were removed and those who re-inhabited brought further criticisms. Many attacked the use of eminent domain to take property from and individual and giving it to somebody else for private gains. At a

community level, the critics highlighted the destruction of social fabric of urban neighborhoods through demolition and subsequent dispersal of neighbors (Jacobs, 1961).

Various discriminatory practices during the urban renewal era made the situation worse. The Federal Housing Administration (FHA) from 1945 to 1965 designed insurance and mortgage regulations that favored new buildings in the suburbs. The new mortgages had lower interests, longer terms, and lower down payments. African American households were excluded from these policies. Even white households wanting to buy a house in urban neighborhoods did not have access to the new plans. Banks used redlining to exclude poor urban neighborhoods from getting loans. They also used a mix of tactics including denial of mortgage, longer processing times, and under-appraisal to refuse investment in the redlined neighborhoods. Schelling (1971) argued that choices made by individual white households based on their preferences regarding their neighbors would result in segregated neighborhoods. Individual preferences combined with location of public housing, redlining practices, and opportunities to migrate to suburbs created highly segregated neighborhoods (Logan & Zhang, 2010). These neighborhoods became concentrated pockets of poor and marginalized populations in the City (Naparstek & Dooley, 1997). City

The failures of the earlier "bulldozer approach" and a new understanding of the role of residents manifested into the integration of local communities in the process of community development (Naparstek & Dooley, 1997). Community Development Corporations (CDCs) were one of the earlier efforts that incorporated community engagement in the urban development process. CDCs are non-profit organizations that aim to reinvest in poor urban communities to reverse their decline. Their goal is to bring place based and people based strategies together in the revitalization process (Gittell & Vidal, 1998). CDCs are mainly community based such that

they are initiated by community members, located in a particular neighborhood, and are governed by the members of the community (Vidal, 1995). The CDC's approach is significantly different than earlier development efforts. First, they implement the development projects through participation of members of the community. Second, they focus on strengthening the individuals and their social networks. CDCs can directly provide services and other resources through the already existing networks within the community. At other times, CDCs act as brokers between the local community and the broader network of individuals and organizations. They also directly conduct community-organizing activities that results in some form of advocacy or collective action towards a community need (Vidal, 1995). The interests of outside investors is balanced by engaging the local actors who value investments that improve the neighborhood for the residents (Stoecker, 1997).

Even federal policies for urban development such as the Empowerment Zones/Enterprise Community (EZ/EC) and the Housing Opportunities for People Everywhere (HOPE VI), utilize a community oriented approach to create thriving inner City neighborhoods. The EZ/EC program provided incentives for businesses to locate in inner City and employ people living there. The aim of this program was to help startup businesses and improve the economic vitality of distressed communities. The EZ/EC program encouraged broader community involvement and governance, which sets it apart from previous policies (Gittell & Vidal, 1998). Various organizations such as local businesses, government bodies, universities, and non-profits had to come together to design a strategic plan for their community. By encouraging a collective effort, the federal government intended to create an environment for a more sustainable development (Hyman, 1998).

The HOPE VI program was initiated in 1992 with the aim of replacing dilapidated public housing with well-designed mixed income housing. Almost 20% of the initial funding of $300 million was dedicated to social services for residents. This included activities for youth, job training, and day care (Popkin et al., 2004). HOPE VI also encouraged participation of residents along with local governments and real estate developers in the design and implementation of the program. The intention was to empower residents and increase feelings of ownership of new development. Residents are often wary of dislocation during projects such as these. Engaging them can increase their control over the process and dissipate fear (Popkin et al., 2004).

2.2.2 Community Engagement in poor urban neighborhoods

The US Census defines areas of concentrated poverty as census tracts with poverty rate of 40% or more and poor neighborhoods as census tracts with poverty rate of 20-40%. Compared to the 1990, the 2000 census reported a 29% decline in number of census tracts with concentrated poverty (Kneebone, Nadeau, & Berube, 2011). However, according to the American Community Survey 5 year estimates (2005-2009), there was a 36% increase in areas of concentrated poverty compared to the 2000 census (Kneebone et al., 2011). These numbers suggest a re-emergence of concentrated poverty areas. Metropolitan areas in the Midwest led this re-emergence with 79.4% increase in percent of tracts with concentrated poverty. Saint Louis, where this research project will be conducted, added eight census tracts to the list of areas with concentrated poverty since 2000 (Glaeser & Vigdor, 2012; Kneebone et al., 2011).

Poor neighborhoods face multiple complex problems. High unemployment rates (William Julius Wilson, 2011), which improves less compared to other neighborhoods even when the economy is doing better (Dickens, 1999). High unemployment rates lead to financial instability and a poor housing stock (Rosen & Dienstfrey, 1999). Coupled with years of disinvestment

(Naparstek & Dooley, 1997), neighborhoods with concentrated poverty have a weak tax base. Less taxes result in poorer services, including the quality of schools, which increases the likelihood of school closures, a well-known phenomenon (Stone, Doherty, Jones, & Ross, 1999). Even if schools don't close they are poorly funded and children have lower levels of educational attainment and achievement. These schools also face transitional students, less experienced teachers, and a student population with additional needs (Sampson, Sharkey, & Raudenbush, 2008).

Poor neighborhoods also suffer from a vicious cycle of social and physical disorder and crime. Among other things crime can reduce trust among members of the community, which erodes the informal social controls necessary to limit deviant behavior (Sampson, 1999, 2001). Sampson, Raudenbush, and Earls (1997) argue that the presence of such informal social control can explain varying levels of crime in urban neighborhoods while controlling for the social and economic conditions. Crime also reduces the level of attractiveness of an area to new homeowners and businesses, which in turn affects the financial stability of the neighborhood (Gittell & Thompson, 1999). People moving into these neighborhoods are mostly renters and will transition out within a couple of years. The shorter time frame of residency reduces the build-up of social networks that facilitate the control of deviant behavior. Short term residents are also less likely to commit to engage in community activities (DiPasquale & Glaeser, 1999).

Living in poor neighborhoods can adversely affect its residents. One of the major drawbacks as discussed by William J. Wilson (1987) is the issue of social isolation, which refers to the lack of bridging ties to the external world. Bridging ties, with an individual outside the close circle, can bring valuable information regarding jobs and other opportunities (Granovetter, 1973). These connections also help communicate the norms of work and education that is

apparent in the mainstream society. Without the proper information and norms, it becomes more difficult to get jobs. Poor schools, combined with the adverse effects on mental health (Aneshensel & Sucoff, 1996), child and adolescent development (Brooks-Gunn, Duncan, Klebanov, & Sealand, 1993), and overall health (Pettit, Kingsley, & Coulton, 2003) can stun the growth of human capital among residents of poor neighborhoods.

Solving such complex problems requires both tangible and intangible resources (Institute of Medicine, 2012; Morecroft, 2002, 2008) . Tangible resources refer to physical things like money, houses, schools, community centers, parks etc. Intangible resources are non-physical, such as knowledge of a community, cultural practices, sense of community, and social capital (Nam, Huang, & Sherraden, 2008). Engaging the community has the potential to mobilize and enhance intangible resources. Infrastructure development, financial assistance, educational programs are crucial for the development of poor neighborhoods, however, intangible assets like social capital and sense of community can increase the mobilization and effective management of tangible resources (Warren, Thompson, & Saegert, 2001). Efforts to improve tangible resources of individuals and the community will not be sustainable unless community members have the ability to act collectively and maintain resources. Dilapidated public housing complexes and parks filled with trash, which become hotbed for crime, are examples of unsustainability of tangible resources without the social fabric to hold it together. Without a sense of community and social ties, there is no incentive to maintain their property and the common spaces (Keyes, 2001). Saegert and Winkel (1998) in their comparison of different property rights and socio-economic status found that social capital, even among poor tenants, can add value to the quality of housing. Strong ties within a community can bring residents together to design and enforce rules for the maintenance of a public space (Naparstek et al., 1997). Residents cooperating and

acting collectively to solve problems is essential for community development. Without such collaboration is difficult to identify issues and sustain a program beyond its funding period.

2.2.3 Significance of community engagement

Many health initiatives engage residents during the design and implementation of programs and have found that it can help develop programs that are effective in improving health outcomes (CDC, 2012; O'Brien Caughy, O'Campo, & Brodsky, 1999; Wakefield & Poland, 2005). Participants from the communities where the program is implemented can provide valuable information regarding the needs, cultural norms, and outreach. They can also help create buy-in for the program among other members in the community. Engaging communities is also beneficial for entire neighborhoods (Boyte, 2003; Lutenbacher, Cooper, & Faccia, 2002). Building assets to improve the quality of neighborhoods is facilitated when such programs engage residents in the community. It helps to identify existing assets and needs. Engaging communities is one of the ways to ensure sustainability of such assets. Communities that were part of the process have more ownership and are willing to maintain it after the funding period. The process of engaging in community activities is in itself beneficial for the individuals. When community members work with partner organizations for positive social change they realize that they have the power and ability to improve their own lives (Speer, Peterson, Armstead, & Allen, 2013). They feel more empowered to tackle other problems in their neighborhood. One of the barriers to engagement is the perception that others in the community do not care about the issue. The opportunity cost of devoting your efforts into a process that others don't appreciate is very high. However, when multiple residents work together it creates a sense of community, which helps to build the norm of trust and reciproCity which is essential for collaboration (Florin & Wandersman, 1990).

2.2.4 Community engagement in the context of community gardens

Community gardens are not a new phenomenon in the urban landscape. Some of the earliest accounts of community gardens are from Detroit during the 1893 depression. The program allocated vacant land in the City to the unemployed for growing and selling food. During World War I, millions of gardeners across the US grew food and the surplus was exported to Europe, which was facing a food-crisis. During the depression of 1930s, people once again turned to community gardens to grow food. The government, both state and federal, supported these efforts by providing various resources including seeds and training. During World War II, the federal government started the "Victory Gardens" campaign. The goal was to grow food, boost morale, and provide an avenue to support the country. During this period, it is estimated that these gardens produced almost 42% of the total vegetable supply in US.

The latest community garden movement started in the 1970s as a response to the disinvestment and decline of inner City neighborhoods. As the population began to shift, vacant lots started to become more prominent. Vacant lots were viewed as places that enable deviant behavior limiting the activities of other residents. These empty lots were also a public health hazard. They were being used as dumping sites for trash and toxic substances. Community gardens became one of the strategies to deal with vacant lots. By engaging the citizens and building a community garden, these otherwise neglected lots become "defensible spaces".

There are various reasons why people become involved in a community garden. Getting to know your neighbors, growing your own food, and spending time outside generally motivate people to participate. Most gardens donate part of the grown food to the food pantries creating a sense of giving back to the community. The two main motivations for participating in

community gardens – access to food and community connectedness – have also been major topics for research. Emerging literature connects community gardens to increased access to food and community building.

Extant research has primarily focused on the related benefits and has not paid much attention to what happens within a community garden especially, as it relates to building community. How or why does community garden produces these benefits. Teig et al. (2009) identified this gap and conducted a qualitative study asking participants about their experience with community gardens. The paper highlights some of the mechanisms that contribute to community building. Engaging in community gardens is different than participating in other neighborhood based organizations. Rather than sit around and talk, most of the time is spent working in the garden. Individuals may tend to their own plot; but there are many tasks that need people to work collaboratively. Individuals working together can often results in conflict, which is why community gardens encourage collective decision making. Before taking action, individuals can first come to a consensus. Making decisions and working collaboratively helps develop social relationships and norms of reciprocity and mutual trust. As these norms develop, they further reinforce the ability of the group to work together.

2.3 Why do communities engage?

2.3.1 Theories of collective action

Low income inner City neighborhoods suffer from many issues including crime, neglected physical spaces, and social disorder. However, there are community groups that have been able to initiate the process of identifying and trying to solve these problems. Community policing (Garnett, 2012), revitalization of vacant lands (Schukoske, 1999), renewal of parks (Lehavi, 2004) are some examples of community groups working together to overcome social

and physical disorder. In essence, these are examples of community groups acting collectively to solve a social dilemma. A social dilemma exists when individuals take action that maximizes their benefit but results in an undesirable outcome for the group. For an individual it might be beneficial not to contribute to the informal social control in their neighborhood and not get into trouble. However, that decision produces an undesirable collective outcome; lack of public safety. In social dilemmas, cooperation in the long run leads to benefits for both the group and the individual however, short term interest of individuals results in failure to act collectively (Dawes, 1980).

Social dilemmas in urban neighborhood take the form of public good dilemma or common goods (commons) dilemma. These dilemmas relate to the production and management of public goods and commons in urban neighborhoods. Non excludability and non-rivalrous are the two attributes used to define whether a good is public good or a commons. Non-excludibility as an attribute refers to the inability to exclude people from using a good. For example, a private club is only open to members only, which is a way to exclude non-members. However, one cannot exclude people from breathing air, enjoying the benefits of a safe neighborhood, or going into a public park. Non-rivalrous goods are such that their use by some does not reduce the availability to others. For example, more people breathing air does not reduce the availability of air for others. Some people benefitting from a safe neighborhood does not reduce others' ability to benefit from it. However, if more people use the public park, it becomes less available for others. Goods that are non-excludable and non-rivalrous are referred to as public goods. Goods that are non-excludable but rivalrous are referred to as commons or common goods (Olson, 1971; Ostrom, 1990). In urban neighborhoods overcoming these social dilemmas requires individuals to cooperate and produce public goods and commons that are beneficial for everyone.

Social dilemmas involving public goods and commons can often be inter-related. For example, a park in the neighborhood is open to everyone. But if drug-dealers frequent the parks, residents in the neighborhood might hesitate to use it. In this case the park is a commons: people cannot be excluded but it is rivalrous. The problem becomes worse as the reduced use by neighbors and families makes it easier for drug dealers to use that space, creating a vicious cycle of social and physical disorder. A single family or resident might hesitate to act on it because the cost outweighs the benefits. If the community does not solve this social dilemma, it loses control over its common good (the park) and consequently cannot create a safe environment in the neighborhood, a public good.

Solving social dilemmas to produce commons and public goods in urban neighborhoods also suffers from the 'free rider' problem (Foster, 2011). A free rider is an individual who gains benefits without their own contribution. Because commons and public goods are non-excludable, even individuals who have not contributed can benefit. A person who is never involved in community policing activities will reap its benefits. In the context of a neighborhood, free riders increase the cost of solving the social dilemma because there are fewer people. In addition, seeing people not contributing can tempt others to do the same.

Earlier scholars of cooperation such as Mancur Olson (1971) and Garett Hardin (1968) argued that left to their own devices individuals would not be able to cooperate and solve social dilemmas. They concluded that the only way to solve social dilemmas is through external forces like government sanctions, establishment of private property rights, and mediations for group processes. However, these solutions to the commons dilemma do not represent the people's ability to organize and act collectively for self-governance. Elinor Ostrom (1990, 2009), has shown that communities can come together, organize, and self-govern. She used the empirical

context of common pool resources (CPRs) such as forests and irrigation channels to support her theory. Common pool resources cover large areas so that one cannot build a fence around it to exclude outsiders. They are reducible because one person's use results in less availability for others. The resource users come together to create formal and informal rules that would monitor its use. An important part of the process includes sanctions levied on people for not following the rules designed by the group. She highlights forests, irrigation canals, and pastures that were sustainably managed by local people without help from external forces. She cautions that this empirical evidence does not completely falsify the collective action theory developed earlier. Nevertheless, it shows that in certain context collective action is plausible.

Ostrom (1998) developed a model that explicates the underlying processes of collective action (see Figure 2). The model begins with face to face communication. In smaller groups there is more face to face communication. This form of communication reduces the cost of arriving at an agreement. As groups get larger, face to face communication is less frequent, making it harder to arrive at an agreement. A group with symmetrical interests and resources also makes it easier to agree on decisions. If there are factions within the group with different goals and resources, more time is spent reaching a consensus. More face to face communication leads to the development of shared norms among members. It also allows for the transfer of information regarding past actions. This enables people to know their reputation and make a decision on whether to trust others. Trust plays a foundational role in collective action. When a person contributes to the collective, they trust that other individuals will do the same. If others don't reciprocate, trust in others might erode. Reciprocity is a social norm that humans learn based on their interactions with others. Ostrom (1998, p.10) notes that "Reciprocity refers to a family of strategies that can be used in social dilemmas involving (1) an effort to identify who

else is involved, (2) an assessment of the likelihood that others are conditional cooperators, (3) a decision to cooperate initially with others if others are trusted to be conditional cooperators, (4) a refusal to cooperate with those who do not reciprocate, and (5) punishment of those who betray trust." Reciprocity is central to collective action because it is embedded in a reinforcing process with reputation and trust. People's decisions to reciprocate or not depends largely upon other's actions. If individuals in the group act positively towards the group's goal, it facilitates reciprocity from others. However, if individuals act negatively it will elicit similar a reaction. The reinforcing process can become virtuous through positive actions or vicious when people start acting more for self-interest. The tragedy of commons occurs when this process is vicious. In mismanaged urban commons, neighbors are not willing to contribute resources because they don't trust that others will reciprocate. In a scenario, where people trust each other, it can increase the willingness to reciprocate. The accumulation of reputation and trust facilitates reciprocal activities in the future. As reciprocities increases between members of the group the levels of cooperation also increases. The cooperation results in increased benefit for both individuals and the group.

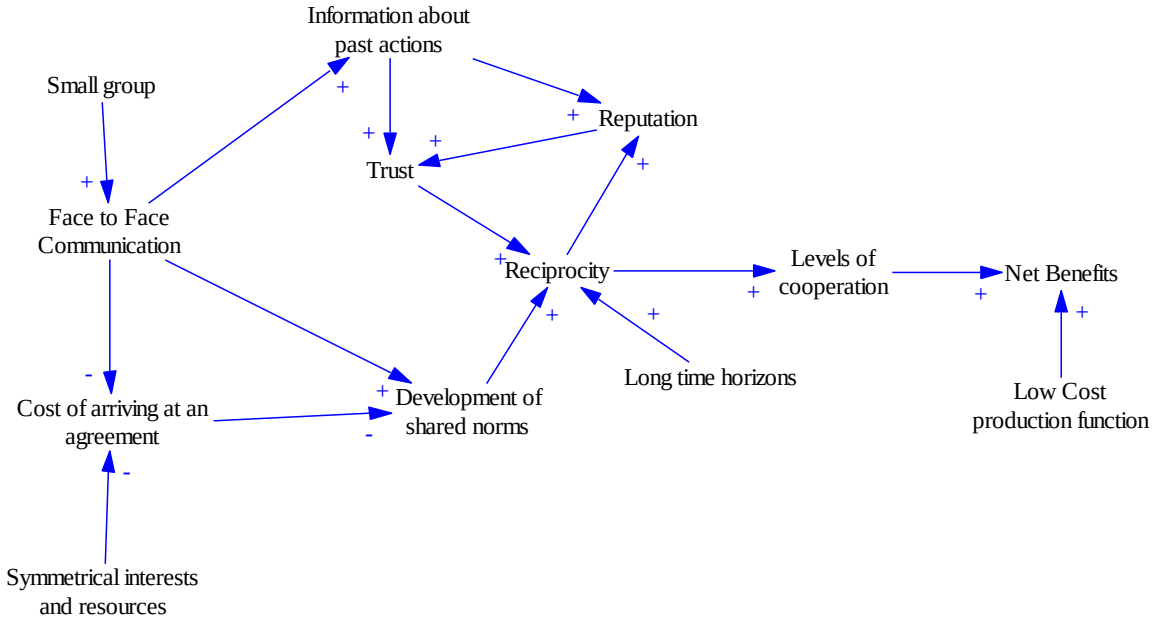


Figure 2: Processes of collective action Source: (Ostrom, 1998)

Applying the theory of collective action in the urban neighborhood context of U.S. cities poses some challenges. One of the issues is residential turnover. Reciprocity is based on sense of community and social networks which are disrupted by residential instability (Sampson, Morenoff, & Earls, 1999). Any effort to build social connectedness and increase community engagement must consider people moving in and out of the neighborhood (Kubisch, Auspos, Brown, Buck, & Dewar, 2011). Consequently this affects how sanctions can operate in urban neighborhoods. According to Ostrom (1990), levying graduated sanctions is an important aspect of collectively managing the commons. It is important to note that there are two kinds of sanctions: formal and informal. Formal sanctions are based on written rules and laws and informal sanctions occur through social expectations and norms. For example, in regards to crime, a formal sanction could involve being arrested and taken to jail by police, informal sanctions would involve shaming and social ostracization by community members. Community

gardens also have turnover, therefore, will provide a good empirical context to understand the dynamics between turnover, reciprocity, and informal sanctions.

2.3.2 Social Capital and Collective action

Robert Putnam (1995) popularized the term *social capital* in his book *Bowling Alone: America's declining social capital.* He defined social capital as "features of social organizations, such as networks, norms, and trust that facilitate action and cooperation for mutual benefit." Social capital is a contested concept and has been defined in a variety of ways. But at its core, it is understood as a resource embedded in the social network of individuals. Much of the confusion can be attributed to the two levels of social capital. At one level, social capital solves problems for individuals. At another level, it solves problems for the entire group. Individuals use their social capital to find a job or a small loan. This occurs when two or more individuals in an inter-personal network cooperate to share resources. Such cooperation is essential to solve issues that we face in our daily lives. People borrow cars to get to a job interview, ask their neighbors for childcare, and borrow a lawn mower. Such cooperation requires that individuals have a social tie, some level of trust, and a norm of reciprocity. One would need to trust their neighbor to leave their child with them and understand that they need to reciprocate in order to sustain the relationship. In this case, social capital is solving problems for individuals. But some problems exist at the group level. The 'tragedy of the commons' is one such problem. It demands the group of individuals work together, whereas at an individual level only two people could cooperate to solve the problem. Social capital at the group level is essential because it facilitates collective action.

Within every community are actors and institutions interacting with each other. These interactions produce mutual trust and norms of reciprocity. Actors can mobilize resources and

information to benefit individuals or the community. Reoccurring interactions reinforces mutual trust, which then lowers the transaction costs for future interactions. The members of the community with high social capital find it easier to cooperate for individual or community benefits (Putnam, 1993). This cycle of trust and reciprocity can also be vicious. Lowering levels of interactions decreases trust and norms of reciprocity making it harder to cooperate. When people have fewer ties, they lack access to resources and information that can benefit them. These processes of social capital are in play among many poor urban communities.

A community with low social capital has sparse network connections as well as low levels of trust and reciprocity. Such communities also have a decreased ability to act collectively. Collective action is needed to solve social dilemmas, which occur when individual interests get precedence over community interests. For example, it is beneficial for the community to have a clean and safe park. But an individual can enjoy the park without putting an effort to its maintenance. The non-excludability of the park reduces the motivation to contribute. Social capital is a latent concept contained within the theories of collective action. The face to face interaction and the buildup of trust and reciprocity are necessary for individuals to act collectively. Social capital can be thought of as the potential to act collectively and is a latent attribute of a group that is mobilized when needed.

How we understand social capital has implications for interventions designed to have impact on particular outcomes by building social capital. If we understand social capital at the inter-personal network level then the intervention should seek to engage all the residents in the neighborhood. If they are not engaged, they cannot benefit from the social capital. However, if we understand social capital at the community level (i.e. networks, norms, trust) then even

engaging a smaller subset of the residents can have an impact on the neighborhoods and those not connected to the network (Alaimo, Reischl, & Allen, 2010).

2.3.2 Self efficacy and collective action

At an individual level, self-efficacy is one of the most prominent concepts in explaining participation in collective activities. Self-efficacy is defined as an individual's perception of their ability to take action and attain goals (Bandura, 1997). An individual with low self-efficacy is often overwhelmed with new challenges and does not believe that they can overcome challenges. Whereas, individuals with high self-efficacy perceive that they can be very effective in resolving issues and overcoming barriers. Within the context of collective action, self-efficacy refers to an individual's perception of agency to affect their environment and improve their own well-being and that of others. An individual's self-efficacy can determine whether he or she participates in collective activities in the neighborhood.

According to Bandura (1997), there are four sources of self-efficacy: enactive mastery experience, vicarious experiences, verbal persuasion, and physiological and affective state. Enactive mastery experiences provide individuals with information regarding their ability from past experiences. Successful experiences bolster one's self efficacy, whereas failures can erode it. Unsuccessful experiences, especially the ones before self-efficacy is formed can be especially detrimental. Self-efficacy is not limited to own experiences but can also be built vicariously. Observing a similar person be successful can bolster one's belief that they too can be successful. On the other hand, other's failures can also affect the observer's self-efficacy.

Social persuasion can also be an effective means of developing self-efficacy. Telling people that they have the capability to accomplish given tasks can reduce their self-doubts. They

can be persuaded to give more effort and sustain it even when challenges arise. Successful experiences through such persuasion and can eventually build more self-efficacy.

An individual's physiological and affective state also shapes their self-efficacy. A person's physical abilities might affect their belief regarding their ability to be successful at certain activities. Any disability or even fatigue and pain can become barriers and affect perception of ability. Similarly, stress and mood can also affect self-efficacy. People can have different stress reactions to the same activity or challenge. Current level of stress and the stress reaction can both affect the belief of being successful. It is important to note that people with varying levels of self-efficacy not only react differently but interpret their reactions differently. People with high self-efficacy may interpret the stress in a way to further channel their motivation and mobilize resources, whereas, with low self-efficacy the stress can be debilitating.

An individual's self-efficacy relates to whether people participate in neighborhood organizations or not (Chavis & Wandersman, 1990). In various settings such as tenant associations (Conway & Hachen, 2005), grass-roots community organizations (Perkins, Brown, & Taylor, 1996), and even larger institutions such as schools and hospitals (Greenberg, 2001) evidence shows a strong relationship between individuals perception of their own abilities (self-efficacy) and participation. When individuals have higher self-efficacy and identify a need, they are more likely to contribute their time and effort to ameliorate the problem.

2.3.3 Collective efficacy and collective action

Collective efficacy at a community level is similar to self-efficacy at an individual level. Self-efficacy refers to a person's belief regarding his or her abilities to work towards achieving a

particular goal. Similarly, collective efficacy is the collective belief of individuals in a community or a neighborhood that they can cooperate with each other to solve a problem.

Collective efficacy, therefore, is "the linkage of cohesion and mutual trust with shared expectations for intervening in support of neighborhood social control" (Sampson & Raudenbush, 1999, pp. 612-613). Although self-efficacy is important, the interdependence of modern society and the complex nature of problems will require more collective efficacy (Bandura, 2000). Collective efficacy consists of two components. First is the level of trust among neighbors, second is the likelihood of intervention to solve an issue. These two components combine to produce informal social control of deviant behavior. Unlike formal control from government authorities, informal social control comes from within a community or a group. If individuals act in certain ways that deviates from the desired behavior of the community, others will act to correct that behavior (Sampson et al., 1997). For example, teenagers vandalizing and creating nuisance for others could be monitored and corrected by other people from that community. Sampson et al. (1997) argue that unlike the forced change of behavior from authorities, informal social control is geared towards reproducing collective norms.

The theory of collective efficacy has mainly been developed to understand the role of social processes in mediating crime in urban neighborhoods. Sampson et al. (1997) found that collective efficacy was negatively associated with crime even after controlling for various confounding factors. Their study concluded that two urban neighborhoods could have the same amount of concentrated poverty but one can have lower levels of crime if it possesses collective efficacy. The theory has recently been utilized to explain variation in quality of built environment, health outcomes, and overall wellbeing. In these cases collective efficacy can refer to the ability of a community to connect with resources both within and outside the community

to fulfill the voids of cutback in government services. For example recently in Detroit a group of people started mowing and cleaning the parks after the City went into bankruptcy and cut funding in order to maintain the parks. The premise of these studies is that when neighbors are socially connected and trust each other they are willing to contribute to the overall wellbeing of their neighbors.

2.4 Conceptual model: Feedback Perspective

The theoretical and empirical discussions provide a foundation for the conceptual model. As mentioned in Chapter 1, the model in this study is based on a feedback perspective. Such a perspective is essential for understanding sustainability of community engagement as the outcomes of engagement itself is an important factor affecting the motivation for engagement. Before discussing the conceptual model, it is important to clarify a few terms, including feedback mechanisms.

2.4.1 What are feedback mechanisms

Feedback mechanisms are often represented visually through a set of variables and causal connections referred to as a causal loop diagram (CLD). It is important to understand two symbols: the polarity (+/-) on the arrows and the R and B labels to understand a feedback loop and consequently the CLD. The polarity describes the direction of the relationship between two variables. The plus sign indicates that two variables move in the same direction or if the causal variable increases the effect also increases and vice versa. The minus sign indicates that two variables move in the opposite direction or if the causal variable increases the effect decreases.

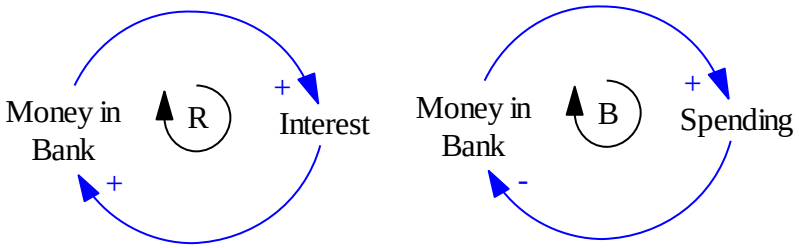


Figure 3: Examples showing reinforcing (R) and balancing (B) feedback loops

The R label within a feedback loop indicates that it is a reinforcing loop. A reinforcing loop pushes the variables in a loop in the same direction. If a variable within a reinforcing loop is increasing, it will continue to increase and vice versa. For example, when the amount of money in the bank increases, the interest gained would increase, further increasing the amount of money in the bank (see Figure 3). The B label within a feedback loop indicates that it is a balancing loop. A balancing loop pushes the variables in the loop in the opposite direction. For example, if money in the bank increases, spending can increase, which reduces the money in bank and consequently limit spending (see Figure 3).

2.4.2 A working feedback model of collective action dynamics

The set of feedback mechanisms hypothesized to result in sustained community engagement is shown as a CLD (see Figure 4). One of the most important concepts in the theory of collective action is reciprocity (Castillo & Saysel, 2005; Ostrom, 1990; Saldarriaga-Isaza, 2013). In this model, reciprocity rather than being a variable is presented as a reinforcing feedback loop (R1). As individuals contribute there are more collective activities to improve the quality of the community garden. As the individuals cooperate with each other, the group earns a reputation for acting collectively. This reputation helps increase trust amongst members that others in the group will reciprocate the cooperative activities. Development of both reputation and trust takes time, which is represented through hash marks on the arrows. Trust enables

individuals to contribute to the collective without worrying the others in the group will not do the same. This concern stems from the temptation to free ride (Castillo & Saysel, 2005; Ostrom, 1990; Saldarriaga-Isaza, 2013). As more individuals contribute and there is an adequate amount of collective activities, some individuals might feel that they can gain the benefits of the collective even if they do less (B1). This balancing loop works to constrain individual effort. To ensure that individuals contribute to the collective, community gardens setup rules (Armstrong, 2000; Irvine, Johnson, & Peters, 1999). These rules ensure that the individuals devote enough effort to maintain the desired garden quality (B2). Another factor that adds to individual contribution is the norms regarding collective activities within the garden. These norms work differently than formal rules in B2. The norms are levied on individuals through the relationships they have built with other gardeners. One can imagine a situation where there are no formal rules of cooperation but because of the social obligations associated with their relationships, gardeners feel the pressure to contribute towards the collective goal. This is a reinforcing loop (R2), as working collectively increases interactions among the gardeners, further increasing the social relationships (Dudley, 2004; Ostrom, 1998).

Apart from these external factors, individuals may contribute for their own benefits. Motivation to work in the community garden could be to get fresh fruits and vegetables, physical activity, or to get to know their neighbors. This is represented by the profit maximization loop (B3) where the individual increases their contribution until they get to a desired payoff level (Castillo & Saysel, 2005; Saldarriaga-Isaza, 2013). Both rules for collective activities and strength of norms can increase individual contribution. However, if the rules are excessive it can increase perception of constraint (Dudley, 2004). If there are rules regarding what vegetables to plant or specific time one should work in the garden, following all the rules can become

burdensome which can increase gardener turnover. When there are fewer gardeners, the garden might have to increase individual effort to maintain the garden. This can act as a vicious cycle by increasing the perception of constraint and garden turnover (R3).

Community gardens require multiple resources such as funding, volunteers, and expertise. Building partnerships is seen as a vital strategy to access these resources (Kegler, Painter, Twiss, Aronson, & Norton, 2009). Partnerships are built based on the needs in the garden. In the model, this need is conceptualized as the difference between the quality of the garden and the desired quality of the garden. Quality of the garden is a latent variable consisting of many components based on the community garden. Quality might be defined by the cleanliness of the garden, the type of social interactions and events, satisfaction of gardeners, or the amount of food given to local food banks etc. To maintain this quality, the community garden will have to build and sustain partnerships with various organizations. Having such partnerships is viewed as enabling collective activities, whether it's through funding or having volunteers help out in the garden. Increased collective activities improve the quality of garden, reducing the gap in quality (B4). As the quality of the garden increases, more people will want to get involved with the garden. However, as the number of gardeners increase, it can be more difficult to manage them, potentially creating conflicts and reducing the number of collective activities. As the garden becomes unable to manage its members, the quality of garden decreases, reducing new people wanting to join and can also increases turnover creating a balancing process (B5). In addition, the number of available plots constrains how many people can join the garden. As new members join there are less plots available (B6). Similarly, the number of plots that can be built is also limited by the amount of land available. As new plots are built less and less land becomes

available (B7). Both of these feedback loops are based on the idea of limits to growth (Meadows, Meadows, & Randers, 2004).

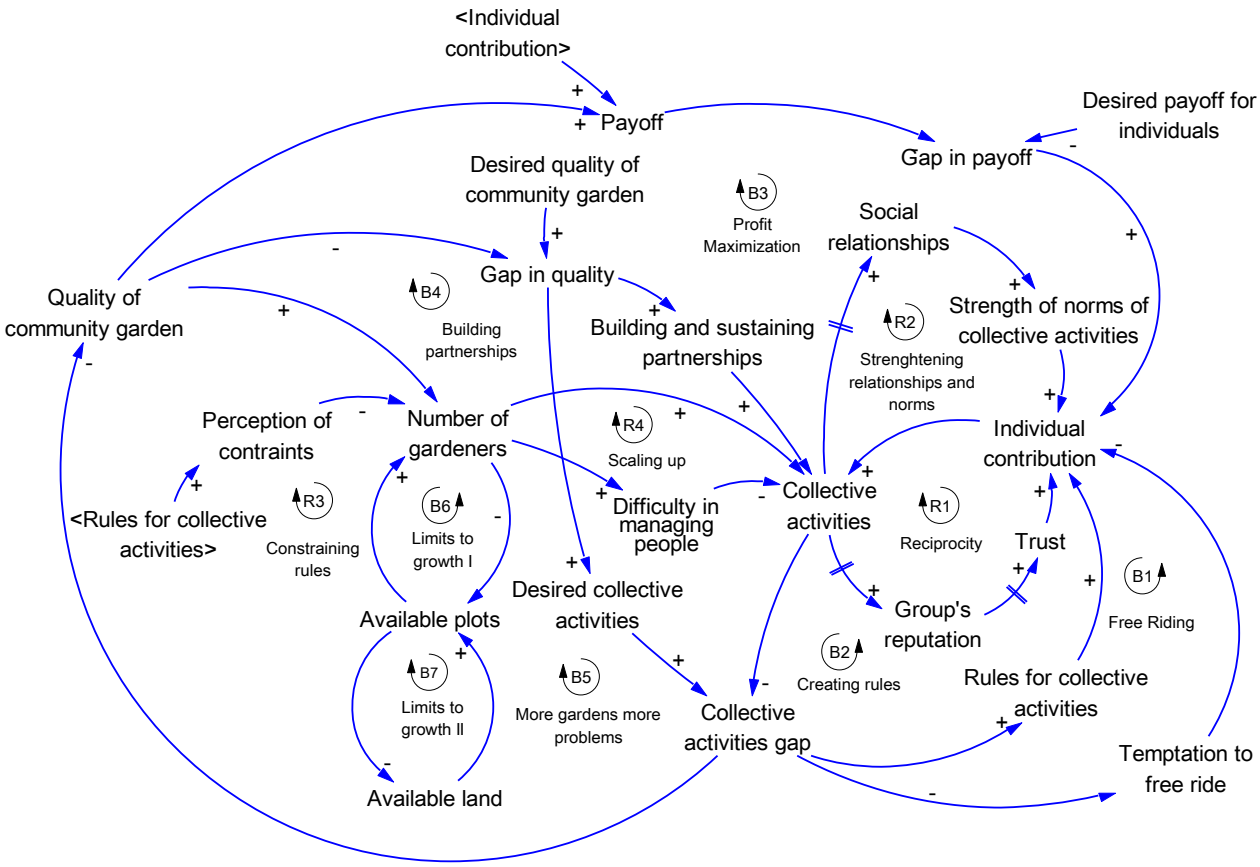


Figure 4: Working theory of feedback mechanisms that are hypothesized to produce sustained and eroding community engagement (i.e. Dynamic Hypothesis)

There are three research questions that follow the development of the dynamic hypothesis. These are 1) what evidence is there to ground these feedback mechanisms in the context of community gardens , 2) what other feedback mechanisms may be relevant for producing the sustained community engagement over time , 3) can these feedback mechanisms logically produce the behavior of sustained community engagement over time . To answer these research questions, this study will pursue the following two aims:

Aim 1: Refine the underlying feedback mechanisms that are hypothesized to produce sustained community engagement in community gardens

The model presented in figure 4 will be refined using qualitative data from key informant interviews with garden leaders and other members of the community gardens. At this stage, the model is based on literature. Developing a model that is also based on empirical evidence will provide more confidence in the feedback mechanisms. It will also identify the limitations in applying theories of collective action in the context of community gardens.

Aim 2: Develop a system dynamics model to determine whether the feedback mechanisms can produce sustained community engagement in community gardens

The causal loop diagram is complex with multiple feedback loops and time delays. This makes intuitively inferring system behavior impossible (Homer & Oliva, 2001). Therefore, the model will be specified as a set of nonlinear differential equations using Vensim DSS Software (Ventana Systems). The model will then be examined using a set of confidence building tests as described by Sterman (2000). Better understanding of the feedback mechanisms that produce sustained community engagement can help community practitioners understand the dynamics of participation and develop strategies to engage communities in urban neighborhoods.

2.5 Conclusion

This chapter has set the stage for this study. It discussed what community engagement means and its significance for the success of policies and programs. It also highlighted that the community engagement in this study will be situated in the empirical context of community gardens in a poor urban neighborhood. Various theories including social capital theory and theory of collective efficacy have been applied in this context. This chapter argued that theories of

collective action has the potential to explain how communities come together to solve problems in this particular context. Finally it laid the ground work for the feedback perspective, a novel approach to studying community engagement. Based on previous theories and models, feedback mechanisms that have the potential to explain sustained and eroding community engagement were also discussed. With a working feedback theory of community engagement, this chapter asked three main questions: what evidence is there to ground these feedback mechanisms in the context of community gardens (Aim 1), 2) what other feedback mechanisms may be relevant for producing the sustained community engagement over time (Aim 1), 3) can these feedback mechanisms logically produce the behavior of sustained community engagement over time (Aim 2).

Chapter 3: Methods

3.1 Overview

One can surmise from the literature on community engagement that almost all the studies have a linear perspective. In other words, community engagement is viewed from a unidirectional perspective. Individuals' motivation drives to engage, the organizational characteristics incentivizes people to engage, or the community context motivates people to engage. Engagement of individuals in a community context however, is more dynamic. Individual's motivation, organizational characteristics, and community context can change over time. People join and leave, conflict arises, and attributes of the environment change. Linear approaches cannot account for the impact of these dynamics on the sustainability of community engagement. This study conceptualizes community engagement in community gardens from a feedback perspective. As argued earlier, a feedback perspective states that the act of participating and working together with others can itself impact the motivation for further participation. Traditional statistical techniques assume linear relationships between variables making them inadequate to study a system from a feedback perspective. Qualitative approaches are able to take into account the dynamic nature of a system. However, without mathematically defining variables and relationships, it is impossible to understand how the feedback mechanisms produce sustained or eroding engagement. Therefore this study will use system dynamics modeling technique that is particularly focused on understanding how the underlying feedback mechanisms affect the behavior of the system. This chapter will outline the methods to collect data, develop and revise the model, and analyze the feedback structure.

3.2 Research Design

This research project built a system dynamics model using an embedded multiple case study design to understand the feedback structure of collective action dynamics in different community gardens. Case studies are particularly useful to understand and develop theories of the underlying processes (George & Bennett, 2005; Yin, 2009).

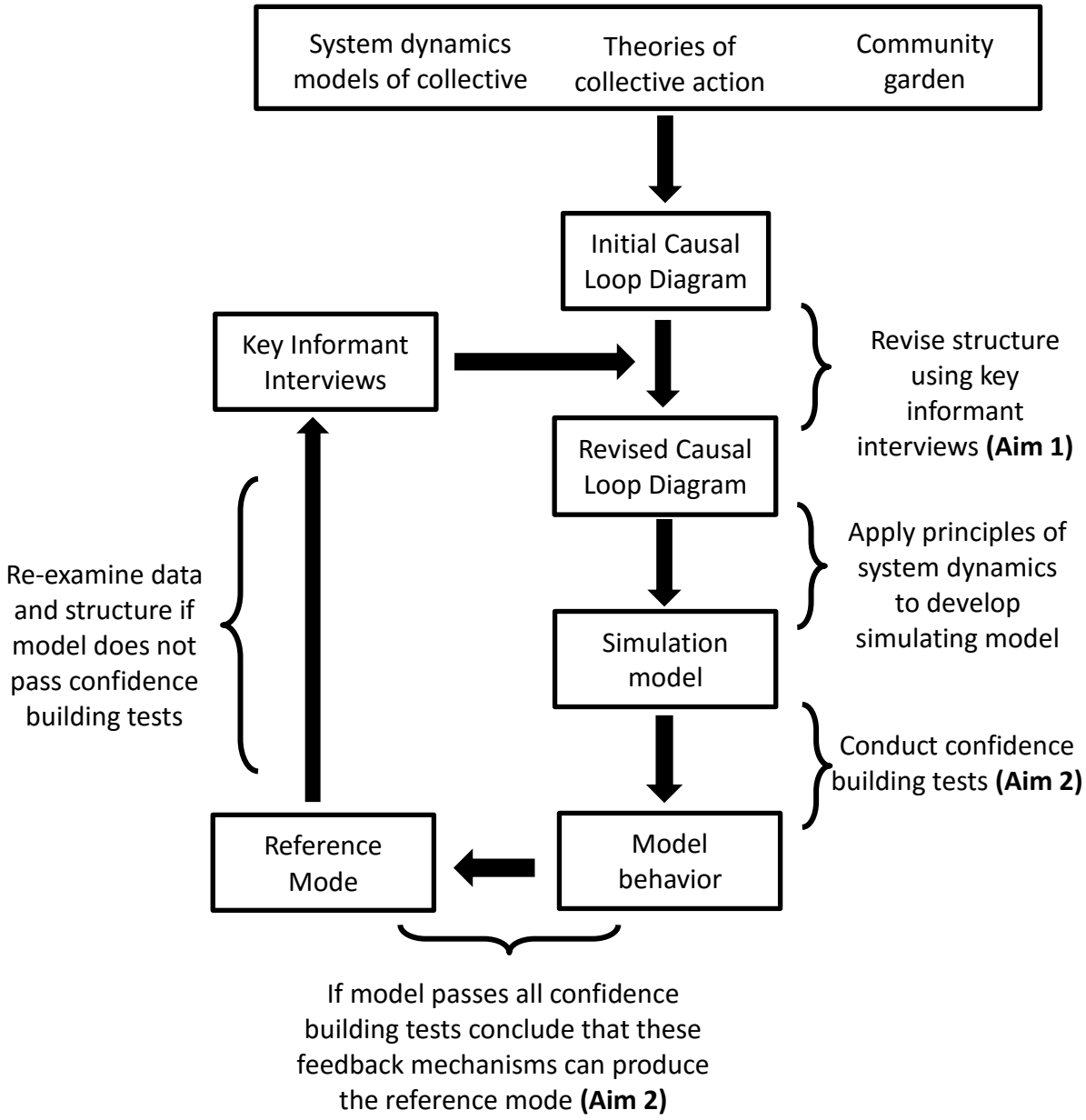


Figure 5: Overview of modeling process

3.3 System Dynamics Modeling

System dynamics is a method that attempts to understand a particular problem from a feedback perspective. Richardson (2011, p.241) defines system dynamics as "the use of informal maps and formal models with computer simulation to uncover and understand endogenous sources of system behavior." The goal in system dynamics is to understand the impact of feedback mechanisms on system behavior. A set of feedback mechanisms can be illustrated as a causal loop diagram (such as one in figure 1). However, one cannot infer the system behavior that might result from the feedback mechanisms. In system dynamics, all the relationships are defined as a set of differential equations. A differential equation describes how the rate of change in one variable is related to another variable. The differential equations can either be linear or non-linear. When these differential equations are solved computationally, the change in each variable over time can be determined. The rate of change and consequently the change in each variable is based on the feedback mechanisms affecting that particular variable. However, not all feedback mechanisms affect a variable at once. Different feedback loops will affect the dynamic behavior at different points in time, also referred to as shift in loop dominance. The system behavior emerges as a result of the loop dominance shifts from one feedback loop to another. The goal of system dynamics modeling is to understand how the set of feedback loops generate the dynamic behavior of interest.

3.3.1 Foundations of System Dynamics

There are three aspects of system dynamics that are crucial to understanding the foundations of the method: 1) endogenous perspective, 2) operational thinking, 3) accumulation and delays.

Endogenous perspective:

In an article about the foundations of system dynamics, George Richardson (2011) notes, "The endogenous point of view is a crucial foundation of the field of system dynamics"…and even defined system dynamics as "the use of informal maps and formal models with computer simulation to uncover and understand endogenous sources of system behavior" (p. 22). A behavior produced by a system dynamics model should be governed by the variables endogenous to the model.

Endogenous perspective has invited some criticisms (Hayden, 2006) . From a systems theory perspective, any system can be open or closed. A closed system does not interact with its environment, whereas an open system exchanges information and materials with its environment. Any human system, such as a community, organization, or even a City, is considered an open system. A system dynamics model, with endogenous perspective can appear as a closed system. This confusion may have started with the principle of closed boundary that Forrester (1968, p.4) laid out in his book *Principles of Systems*:

> In concept, a feedback system is a closed system. Its dynamic behavior arises within its internal structure. Any action which is essential to the behavior of the mode being investigated must be included inside the system boundary.

However, it must be noted that the "closed system" from Forrester's point of view is causally closed. The model can still exchange material and information with its environment. The clouds at the end of a stock-flow structure (see Figure 6) represent the environment outside the system boundary. Materials or information may flow from outside of the boundary (i.e. the clouds) to inside (stocks). In other words, a closed system from a system dynamics point of view is similar to an open system in systems theory.

From an endogenous point of view, the effort will be to determine feedback structures around community engagement from within the community gardens. Since it is an open system, people, money, and other materials can move in and out of the system. However, the reason for these movements is mostly generated from within the system.Increasing funding available for community gardens is an exogenous factor that may impact community gardens. However, which community garden gets the funding depends on the capabilities and organization of those active with the community garden. Therefore, it is not to say that exogenous factors do not matter. Rather, the impact of exogenous factors is mediated by endogenous processes.

Operational Thinking

Operational thinking is one of the fundamental tenets of system dynamics modeling. Operational thinking helps to uncover how agents and processes within a system actually work. Olaya (2012) discusses models of milk production in United States to explain operational thinking. He compares a non-operational thinking (correlational) based model and an operational thinking based model. In the paper, he describes a statistical model, which uses longitudinal data on milk production and other variables such as seasons to predict milk production in the future. This model of milk production, however, does not include the variable “cows”. From an operational point of view, cows are an essential part of the milk production model. System dynamics models are from an operational thinking point of view. Consequently, the idea of causation in system dynamics models is very practical. One cannot produce milk without milking the cows and one cannot milk the cows without having any cows. Therefore, more cows leads to more milking, which leads to more milk.

Thinking operationally about community engagement in community gardens entails opening the "black box" of how gardeners join the community garden, interact with people, work together, and how that in turn affects their motivation for participation.

Accumulation and delays

The main structure of system dynamics models are based on stocks and flows. Stocks are variables that accumulate over time. Stocks can increase or decrease based on the rate of inflows and outflows. For example, population of people living in this world is a stock which increases by births and decreases by deaths (see Figure 6).

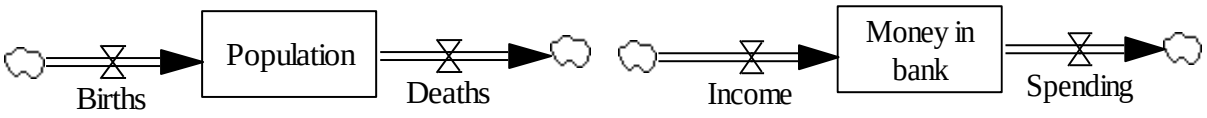


Figure 6: Examples of stocks and flows

There are two ways in which to distinguish a stock variable from other variables. First, if we stopped the inflow to the stock there would still be something left in the stock. If there were no more people being born into this world, there would still be many people in the world. This is different from other variables because if we stopped all of the causes of "births" then birth would be zero. Second, even if the rate of inflow decreases the level of stock keeps increasing. For example, if the birth rate begins to decrease, the population in the stock will still increase but at a slower pace, (assuming the death rate is lower). Comparatively, if another variable affecting birth decreased, birth rate would also decrease (Sterman, 2000).

Several of the variables in the initial model are stocks. Number of gardeners is a stock because it can accumulate over time and if there were no gardeners joining or leaving there would still be some gardeners left. Similarly, variables like trust (Ostrom & Ahn, 2009; Portes,

1998; Putnam, 1993) and social relationships are also stocks. Both of these variables accumulate and depreciate over time. If trust or social relationships in a community are neither built nor eroded (i.e. both inflow and outflow are zero), there would still be some trust and social relationships within the community.

3.4 Case selection

This study is based on a census of community gardens within the West End Neighborhood in St. Louis, Missouri. The list of community gardens to be included in the study was obtained from a report on community gardens in the neighborhood (SSDL, 2014). Further information about the gardens was obtained from Gateway Greening, a hub organization for community gardens in the St Louis region. Rather than purposefully sampling successful and unsuccessful community gardens, the focus will be on understanding how the community gardens fall on the continuous successful-unsuccessful spectrum. There are 13 community gardens in the neighborhood that vary in size, function, and condition. One of those 13 has been abandoned and some have only one or two people involved. These cases will provide adequate variance and opportunity for replication, which provides strength for drawing analytic conclusions in case study research (Yin, 2009).

3.5 Sampling and Recruitment

Gateway Greening maintains a list of gardens along with the contact information of the garden leaders. Garden leaders from each of the gardens were contacted explaining the study, their roles, and commitments (see Appendix A for recruitment email and phone script). At the end of the interview, the garden leader was asked for a name and contact information of one of the garden members. The garden members were then recruited using the same script.

3.6 Data collection

The study utilized key informant interviews to revise the model structure presented in Figure 4. The community garden leaders and garden members were interviewed individually over the telephone. A semi-structured interview guide (see appendix B) developed based on the initial model was used to conduct the interview. The guide covers various aspects of the model such as reciproCity, building partnerships, social relationships, and norms. Towards the end the gardeners were asked to add their own thoughts regarding sustained or eroding engagement in community gardens. The interviews lasted between 45 to 60 minutes. The interviews were recorded and transcribed for analysis.

3.7 System Dynamics Model building process

The process of building a system dynamics model is iterative. Model development is a continuous process where the modeler builds and tests new hypothesis. The process of model building is as important as the final product because the modeler can gain valuable insights about the problem at different phases. Sometimes insights can help re-conceptualize the problem. The process of building a system dynamics model described below is based on Sterman (2000) and Randers (1980).

3.7.1 Problem Formulation

Defining a problem is the first and the most important step in building a SD model. Understanding the problem provides much needed guidance for model development. It also helps develop the purpose of the model, which can define the boundary of the model.

In SD, reference modes are used to define a problem. Reference modes are graphs with the problem variable on the y-axis and time on the x-axis. These graphs represent how a particular problem develops over time. The problem variable and the time horizon are important

components of a reference mode. The problem variable helps to communicate the problem and how it is changing over time.

3.7.2 Formulation of dynamic hypothesis

There are two parts to a dynamic hypothesis: the reference mode and the system structure consisting of multiple feedback loops. The dynamic hypothesis posits that the system structure endogenously produces the system behavior as described in the reference mode. The dynamic nature of the system structure arises from the interacting feedback loops. The word "hypothesis" emphasizes the focus of system dynamics on learning from the model, using the model to think about the world, and treating it as "work in progress." The knowledge for formulating a dynamic hypothesis can come from conversations with stakeholders, a literature review of the substantive area, and other SD models. The system structure can be developed using a causal loop diagram with or without using stock flow structure.

The most important aspect of the dynamic hypothesis is that the system structure endogenously produces the reference mode. Exogenous variables can be included in the dynamic hypothesis but should not be the source of the system behavior. The system behavior rather than depending on a particular parameter estimate should depend on the system structure. The focus on endogenous structure helps to define the system boundary, which guides the decision making regarding what to include or exclude in the model.

The initial system structure hypothesized to generate the dynamics behavior was revised based on the data from key informant interviews. Two approaches were used to refine the feedback mechanisms. First a deductive approach was used to analyze the data using themes based on existing feedback loops. For example, reciprocity (R1) was one of the themes and narrative related to variables as such relationships within the loop were coded under that theme

(Akcam, Guney, & Cresswell, 2011). Narratives that support existing feedback loop increases confidence in that structure. Second, a grounded theory approach was used to generate new structure and was added to the existing set of feedback mechanisms.

The two approaches are applied simultaneously such that narratives that are related to feedback structures are coded in existing themes and new themes are generated for narratives that do not fit existing themes. These new themes will form the basis for additional structure. Coding will be focused on text with causal arguments that reveal the mental models of people about how the system works. The identified text is further analyzed to elicit key variables, behavior of these variables, and relationships between variables. The variables and their relationships are then converted into words and arrows (Kim & Andersen, 2012). At this stage, variables from different community gardens with the same meaning will be consolidated to generate a single causal loop diagram. This deductive and inductive approach to data analysis will provide evidence for the existing mechanisms and generate new mechanisms, grounding the model in the community garden context. **Revising the model based on qualitative data is the first aim of this study.**

3.7.3 Formulation of a simulation model

The qualitative causal loop diagram can be very insightful and immensely helpful. However, there are three important limitations of qualitative CLDs, which form the basis for a simulation model. First, CLDs do not capture the relationships of stock and flow variables. For example, there is a connection between population and death rate; as population increases death rate increases and as death rate increases population decreases. However, even when death rate increases population can increase depending on the birth rate. Second, it is impossible to infer the system behavior from a qualitative CLD with multiple interacting feedback loops. Finally, a

qualitative CLD cannot be used to test scenarios, conduct policy experiments, and find leverage points in the system. Therefore, the choice to build a qualitative model or a simulation model is based on the problem, the purpose of the model, and available resources.

The first step is to identify the stocks in the model. Stock is a special type of variable that represents information or materials that accumulate over time. Stocks can be tangible like money or intangible like reputation of a group. Stocks are first quantified by defining their units of measurement followed by the addition of inflows and outflows that affect how the stock will change over time. Number of gardeners can be defined as a stock that represents number of people that are gardeners. The inflow to this stock would be new gardeners and outflow would be gardeners leaving. The stock would then be defined as:

$$G_t = \int_{t0}^{t} (NG - GL) + G_{t0}$$

Where G_t is the number of gardeners at time t, NG is the inflow of new gardeners, GL is the outflow of gardeners leaving, and G_{t0} is the number of gardeners at time zero. The net flow (NG-GL) is integrated from time zero to time t. The flows are defined based on variables that affect them. Let us assume that there is an average time that the gardeners remain with the garden. The outflow would then be defined as:

$$GL_t = G_t / TL_t$$

Where GL_t is the rate of gardeners leaving at time t, G_t is the number of gardeners at time t, and TL_t is the average time to leave. The inflow can be thought of as a recruitment process based on how many gardeners are needed and how many gardeners are in the garden. The inflow can then be defined as:

$$NG_t = (DG_t - G_t) / TR_t$$

Where NG (new gardeners) is the rate of gardeners joining the community garden effort at time t, DG_t is the desired number of gardeners required in sustaining the effort, G_t is the number of gardeners at time t, and TR_t is the time it takes to recruit a new community gardener. Once the equations are defined they are solved computationally to produce simulated behavior (see Figure 7 for the stock flow diagram and the simulated behavior produced by that diagram). The parameter "average time for gardener to leave" was varied from 1-3 years to produce different behaviors. Parameters used in this example (average time for gardener to leave, time to recruit gardener, desired numbers of gardeners) are assumed to be constant.

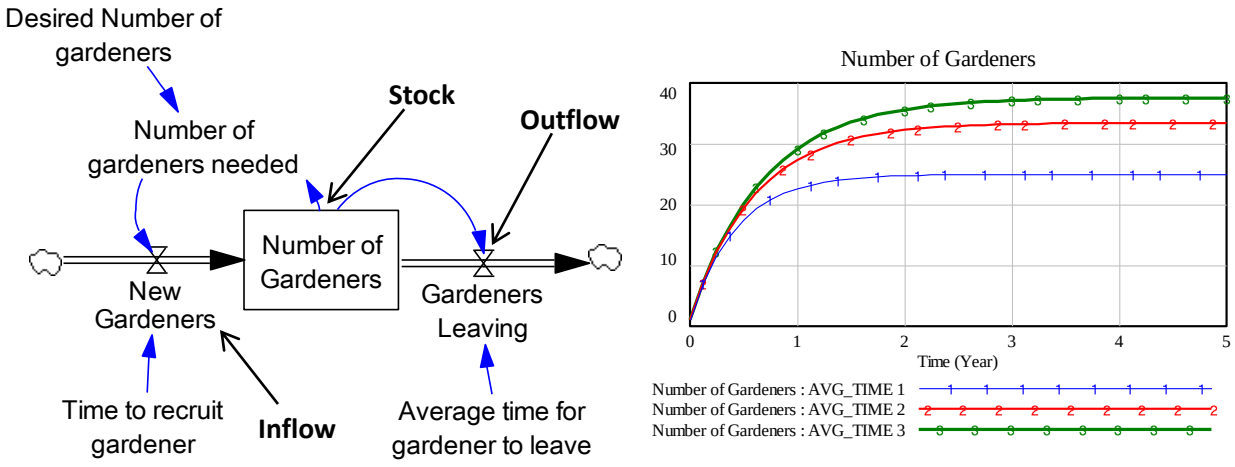


Figure 7: The stock flow diagram (left) that was simulated to produce the behavior over time (right)

Once the initial structure was built, model development proceeded through a step wise process. Structure affecting the initial piece was developed and connected. For example, the land available structure both affects and is affected by the gardeners structure. The number of plots for gardening determines the desired number of gardeners and as gardeners leave more plots become available. Once this structure is added, the goal is to understand how the system

behavior is affected by this additional structure. In this manner, small structures are added and the behavior is examined.

3.7.4 Model Testing

The goal of testing a system dynamics model is not to show that the model is correct. The process of testing often involves finding errors, becoming aware of assumptions, and gaining insights. Hence, the goal of model testing is to gain confidence in the model and further improve our understanding of the system. Model testing is an integral part of model development. As such, model testing and development are done simultaneously. The confidence building tests used to scrutinize the model based on Sterman (2000) are as follows:

Dimensional Consistency: The purpose of this test is to check if the dimension for each equation is consistent. It tests whether the units defined for each equation are the same for the left and right hand side of the equation. Let's look at the units (dimensions) of the equation for the rate of gardeners leaving.

$$GL_t = G_t / TL_t$$

(People/year) = (People) / (year)

Both the right and left side of this equation have balanced units (people/year). If GL_t was defined as $G_t * TL_t$, the units on the right side would be people*year. The equation would be dimensionally inconsistent. When there are dimensionally inconsistent equations the software will produce an error message showing the equations with the errors. These errors can be an indicator for errors in how the equations were defined. All the errors should be fixed before moving forward as this is one of the primary tests the model should pass.

Extreme Condition: A model should produce logical behavior even in scenarios that are rare or impossible in the real world. For example, if the land for community garden is forced to suddenly become zero, the number of gardeners should also go down to zero. If it doesn't, it suggests that there are gardeners even when there is no community garden which isn't logical. The modeler will trace back the relationship between the behavior and the parameter with the extreme condition and determine which equations are responsible for producing the incorrect behavior. Once the equation is fixed the modeler will run the test again. The process is repeated until the model produces logical behavior under extreme conditions.

Behavior Reproduction: The purpose of this test is to check whether the model can reproduce the behavior of interest or the reference mode. The two behaviors of interest are growth and sustained community engagement and initial growth and eroding community engagement. The model should be able to produce both these behaviors. If it doesn't, the first step is to understand what is causing the current behavior. This is done by tracing the causal pathway from the variable of interest to other variables. During this process, the equations for each variable are assessed for errors. If the model doesn't produce the behavior after assessing all the equations, one can assume that some feedback mechanisms are missing. Additional key informant interviews and data analysis are done to elicit the missing feedback mechanisms.

Sensitivity analysis: The purpose of sensitivity analysis is to test the robustness of the model based conclusions to various assumptions. This is especially useful for understanding how changes in parameter values will affect the behavior. Using Monte Carlo Simulations, parameters can be set to vary based on a defined probability distribution. The model can then produce simulations with confidence intervals (50%, 75%, and 95%) that show how the model varies based on the assumption of the parameter value. Let's assume that the average time for the

gardener to leave the garden is 3 years. The modeler would then vary this parameter +/- 50% (1.5 to 4.5 years) to understand the impact of uncertainty of the parameter (+/-50% is the generally accepted range for varying parameters in system dynamics). If such variation results in similar behavior across the range, only differing in the rate at which the change occurs, we can conclude that the model is not very sensitive to the changes in this parameter. If the model behavior changes drastically, such as for 1.5 years it produces eroding engagement and for 4.5 years it produces sustained engagement, the model is sensitive to changes in the parameter. If the model behavior is sensitive to changes in a parameter, the first step is to determine the source of this sensitivity. Understanding why the model is sensitive can reveal logical flaws in the model. If the model is truly sensitive to the changes in the parameter, it is an indication that the parameter should be measured carefully in subsequent studies to reduce uncertainty.

3.8 Protection of human subjects

The Washington University in St. Louis Human Research Protection Office (HRPO) has determined that this study does not involve activities that are subject to Institutional Review Board (IRB) oversight. This decision was made because the study does not collect identifiable information about individuals. Rather, it collects information regarding the system under study (i.e. community gardens) (see Appendix C for letter from HRPO). The guiding question that HRPO uses to determine this is “about whom is the information”. So when the key informant is asked questions regarding the initiation and history of the community garden, the information is not about that individual but about the community garden. Although the source of the information is a human being, the information is about the community garden. Therefore, it was concluded that this study does not entail human subjects.

3.9 Conclusion

This chapter laid out the research design for achieving the two aims for the study. In doing so it discussed the foundations of system dynamics modeling and why one would use this method to answer research questions. It also described the various stages of system dynamics modeling from problem formulation to model testing. A crucial part of this study is the collection and analysis of qualitative data from key informant interviews. This chapter laid out a plan for how gardeners will be recruited, interviewed, and how the data will be analyzed to revise the model.

Chapter 4: Description of the Community Context

4.1 Overview

This study of community engagement is embedded within multiple contexts. First people are engaged in community gardens, which are further embedded in a poor urban neighborhood. The goal of this chapter is to shed some light into these layers to create a foundation for discussing how the context shapes community engagement in future chapters. First it will briefly describe the West End neighborhood and then it will focus on providing a historical background and the daily functioning of each of the community garden in the neighborhood.

4.2 West End Neighborhood

The West End neighborhood is located on the North side of St. Louis City, Missouri (see Figure 8). As part of a community based system dynamics project the community members were asked to share their mental model of the West End neighborhood boundary. Their version of the neighborhood boundary is larger compared to the boundary defined by St. Louis CCity (see Hovmand (2014) p. 7-8 for a discussion on this topic). The immediate implication of the different boundary for this study is that six of the community gardens outside the City defined boundary are included in this study (see Figure 11). It should also be noted that the data used to describe this neighborhood is based on tract level data. As the tract boundaries do not coincide with the neighborhood boundary (City or community), the data represents a larger area than the neighborhood. Although not exact, it provides a general idea of the neighborhood.

According to the American Community Survey in 2013 (5 year estimate), almost 28% families had income below the poverty level. The population of the neighborhood has declined 71% since 1950. This trend is similar to the population decline for St Louis CCity which hass seen a 62% drop since 1950 (see Table 1).

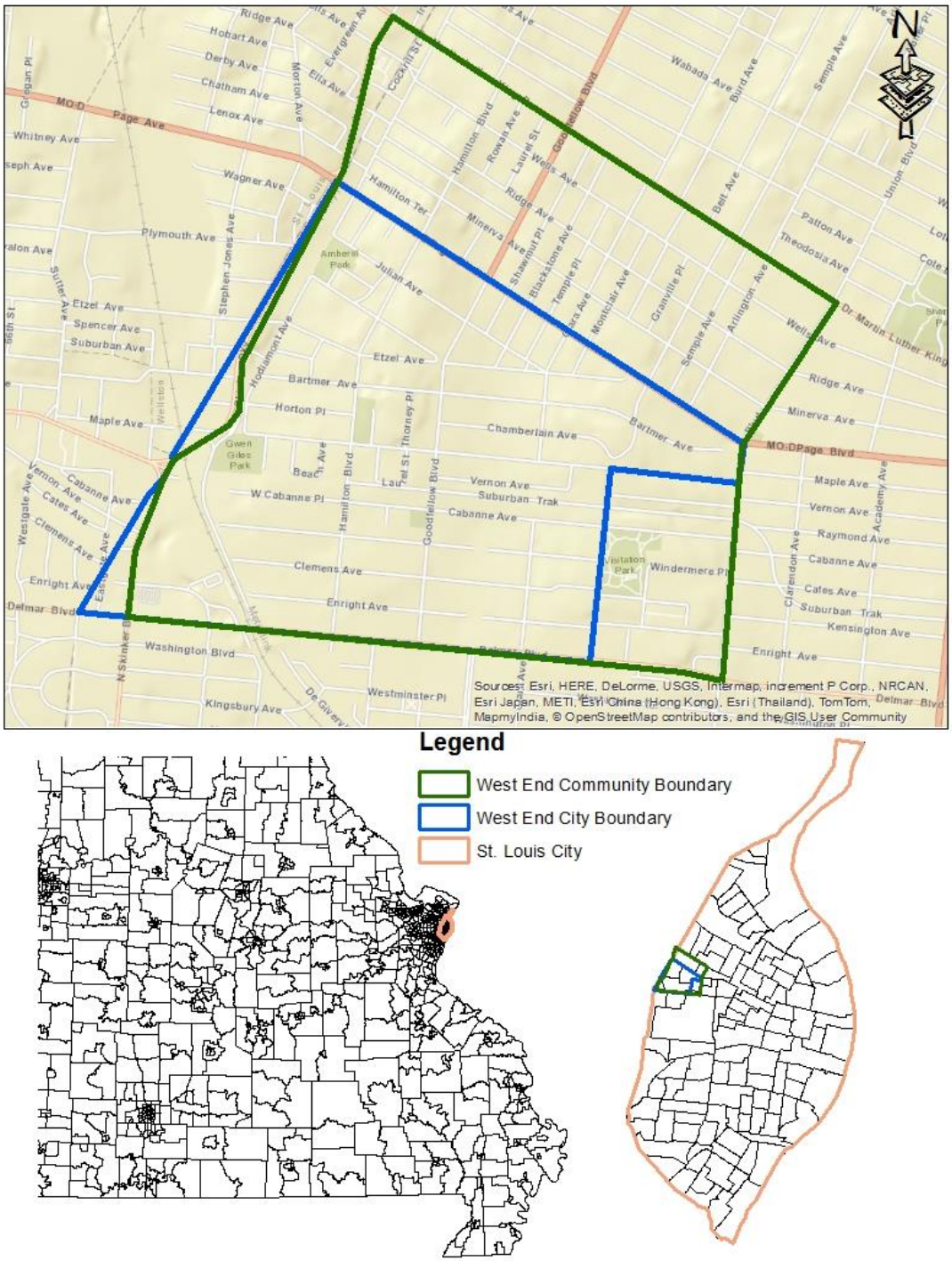


Figure 8: Map of the West End neighborhood as defined by the city and community members. Neighborhood map adapted from (SSDL, 2014)

Table 1: Change in population demographics in the region

	West End Neighborhood			St Louis City			Missouri		
Year	White	Black	Total	White	Black	Total	White	Black	Total
1950	97.12%	2.71%	58802	81.97%		856796	92.44%		3954653
1960	34.45%	65.27%	57031	71.20%	28.58%	750026	90.81%	9.05%	4319813
1970	9.73%	89.89%	49455	58.76%	40.86%	622236	89.43%	10.26%	4676501
1980	10.83%	88.50%	32383	53.54%	45.55%	453085	88.38%	10.46%	4916686
1990	11.00%	88.48%	25004	50.94%	47.50%	396685	87.67%	10.71%	5117073
2000	14.14%	82.70%	18901	43.85%	51.20%	348189	84.86%	11.25%	5595211
2010	17.68%	76.15%	16891	43.93%	49.22%	319294	82.80%	11.58%	5988927

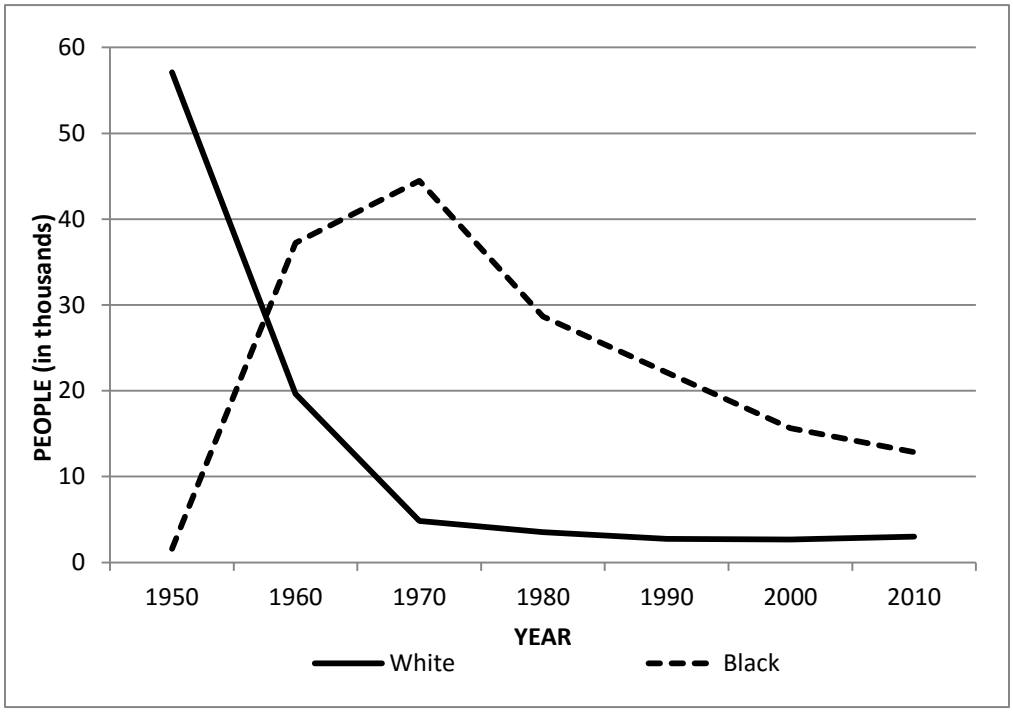


Figure 9: Change in population and racial composition in West End Neighborhood

The population in the neighborhood not only declined but also changed in racial composition, with Black people moving in and White people moving out. After the 1970s, some of the Black population also started moving out (see Figure 9). Recently the number of people who identified as Asian in the census has seen steady rise. As recently as the 1980 census, there

was not a single Asian person recorded in the neighborhood. In 1990, there were 101 Asians, which rose to 432 by 2010. Although the population decline in the neighborhood is similar to the City, the change in demographic composition is not. Unlike the neighborhood, the City is more balanced in terms of racial composition in the past couple of decades. The state has not seen similar population decline, as the percent of White people is much higher compared to the neighborhood and the City (see Table 1)

With the declining population, the number of occupied housing units began to decline resulting in dilapidated houses. Many of these houses were torn down. There were so many houses being abandoned that the City of St. Louis started the Land Reauthorization Authority (LRA) that would hold the land and clear the titles. It became a repository for abandoned buildings and lots. The LRA has been leasing vacant lots at $1 per year on a five year contract to groups wanting to start community gardens. Many of the community gardens in this study are on LRA property. This story of decline and leasing land from LRA was one of many familiar stories with the initiation of a community garden.

> It was a mixed neighborhood and then all the White moved out and Black moved in. In the corner lot it used to be a Dairy Queen and it stayed there till 1964 and then they moved too. The Dairy Queen went out of business. People then started dumping stuff in the corner. I decided I am so sick of these people dumping trash in the corner I went to the LRA in ‘85 and leased the lot for dollar per year.

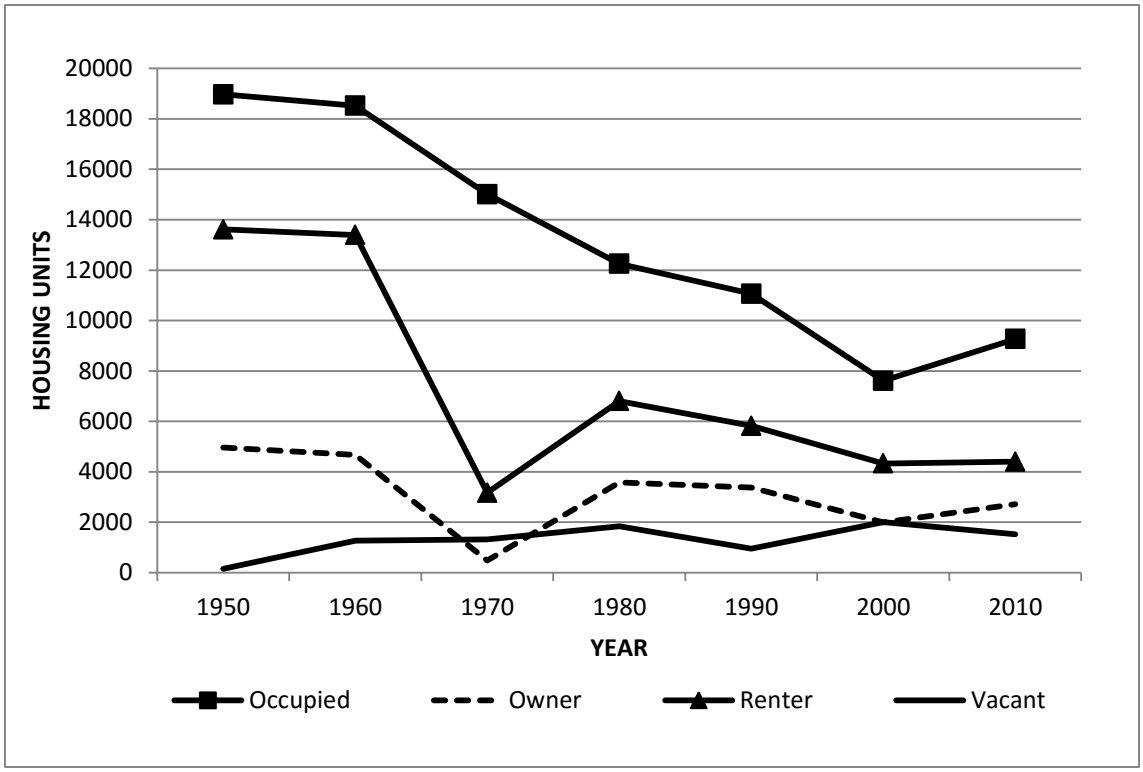


Figure 10: Decline in occupied housing units in West End Neighborhood

Figure 10 illustrates the decline in occupied housing units and the increase in vacant housing units over the years. It should be noted that the number of renters is higher in the neighborhood. This was brought up by one of the gardeners when discussing why it is difficult to get people in the neighborhood interested in the community garden.

> Our block is maybe like 60% rental and 40% owners. The owners all have their own yards and so they take care of their own yards. With renters some people don't really see this as home, so they are not really interested in getting invested in anything around the neighborhood.

4.3 Community Gardens Background

There are thirteen community gardens within the neighborhood boundary defined by the communities (see Figure 11). This section provides a brief background on each of these gardens based on key informant interviews, documents from Gateway Greening, and a garden report from the Social System Design Lab. Pictures for each of the garden have been added for visual context. These pictures were taken by research assistants working at the Social System Design Lab as part of a larger project in 2013.

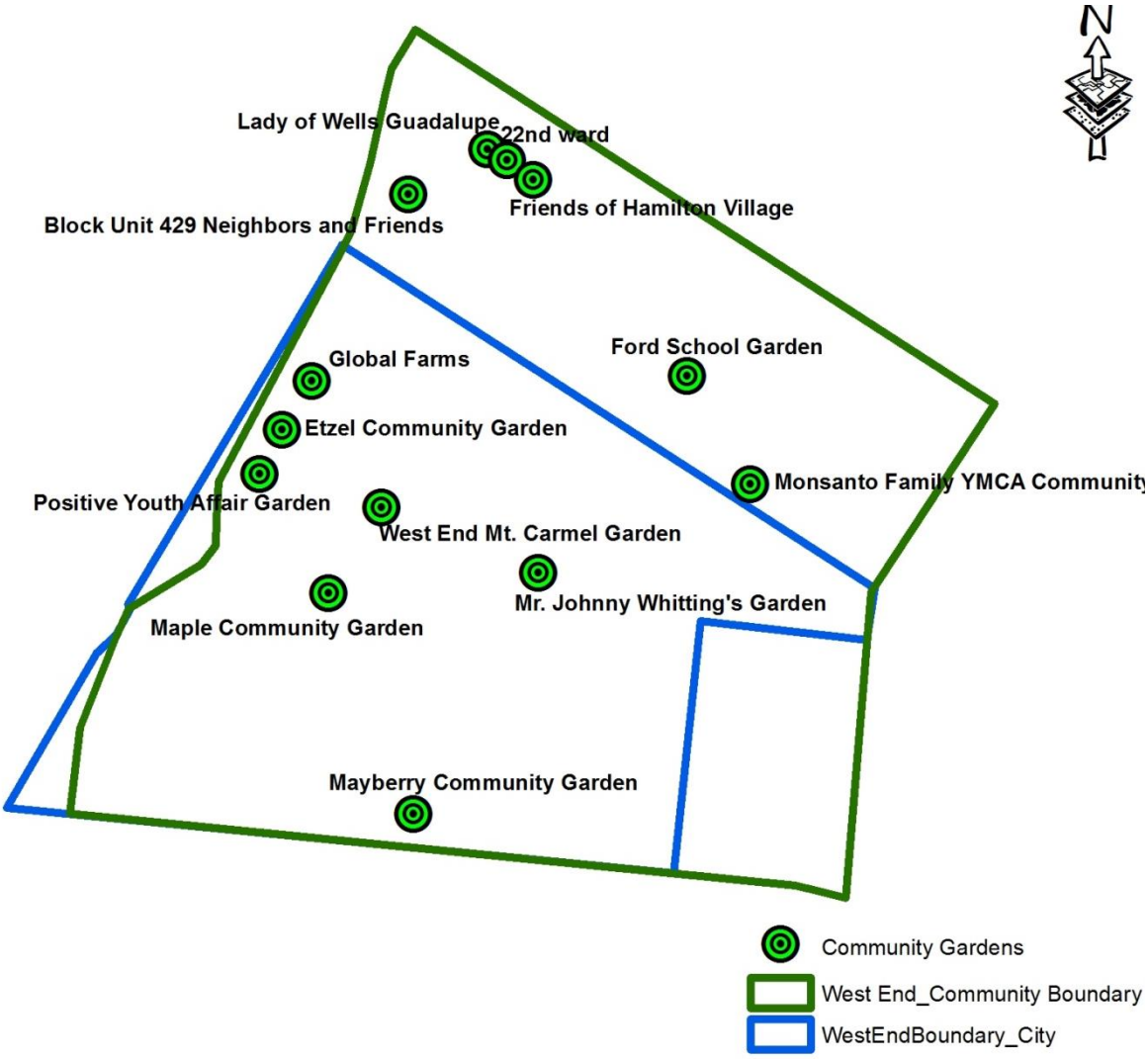


Figure 11: Location of the community gardens in the West End neighborhood

4.3.1 22nd Ward Community Garden

22nd Ward Community Garden is located in 5934 Wells Avenue, St Louis MO. One of the families in the neighborhood has been taking care of this garden for since 1960s. When the family moved to the neighborhood in 1968, the house on the garden lot was being torn down. Once it became vacant people started to park cars and throw junk in the lot. The family wanted to maintain the beauty of the neighborhood. They would clean the vacant lots and mow the grass. Working with some of the neighbors they collaborated with Brightside, a local organization that provided necessary materials to start a garden in the vacant lot. Even though they started planting flowers in the lot years ago, they officially became a Gateway Greening garden officially in 1998. When asked why the chose a garden, the gardener responded:

> I grew up in the South on a farm. I had bought some sweet potato vines and stuck down among the flowers. My son was raking the garden lot during fall. The rake became tangled with the sweet potato vines. Then they started pulling the vines and saw the sweet potatoes. That was the first time he had seen something grow. He was so excited. He said, "Come here. What is this?" "Looks like a sweet potato." Ever since that day he took interest in planting things and seeing them grow. He became entangled with growing things.

Unlike other community gardens, this one doesn't have personal plots. It has general plots with flowers and fruit trees. Recently, they transplanted 22 fruit trees in the garden. Last year the trees were full of fruits but people took the fruits and it did not have enough time to ripen. One of the greatest challenges for the community garden is the lack of support from its neighbors. The responsibility for maintaining the garden is on this single family. They also help to keep the adjacent areas and the alleys clean. Initially when they started the garden there were

couple of neighbors who helped. But now some of them have passed away, moved out of the neighborhood, or can't help because of their health. When asked what the neighbors think or say about the garden the respondent said, "They think a lot about it when there are fruits so they can take them but they don't think enough to pull any weeds."

This garden is facing another recent challenge. The St. Louis Land Reutilization Authority is charging liability insurance for gardens that are leasing its property. However, the gardener was having a hard time comprehending why they should pay the City when:

> All these years we have been taking care of our area and that's why I was opposed to paying $100 liability insurance for the garden. I told them I would just forget the garden. I don't understand why I have to pay liability insurance on a City property that I am keeping clean.

Figure 12: The 22nd Ward Community Garden

4.3.2 Block Unit 429 Neighbors and Friends

The Block Unit 429 Neighbors and Friends garden is located at 1372 Hodiamont Ave. The lot with this garden used to have a Dairy Queen. The neighborhood was in decline and by 1964 the Dairy Queen had moved out. People started dumping trash in the corner lot. During the 1980s the neighbors got together and started a block unit. Members of the block unit went to the LRA in 1985 and leased the lot for a dollar per year. They built a garden in that lot with seven raised beds. The block unit was given several awards by the Urban League of St Louis for neighborhood beautification. One of the major challenges for the garden is declining

membership. Until 1999 it used to have 30 active members, but currently there are only 8. The active members started to get old, some passed away, and some moved out of the neighborhood. Volunteer groups from churches and Brightside come to help them. This garden is also facing the similar challenge of paying liability insurance. The gardener mentioned:

> LRA wants you to pay $ 100 liability insurance on the lots and I refuse to pay the $100 insurance out of my pocket. I can't see myself paying $100 when most of the time I myself have to go pick up junk off of the lot. The only reason I do this is because I want my neighborhood to be a place where everyone wants to live to beautify the neighborhood.

Most of the neighbors seem disinterested in working in the garden or helping to keep the neighborhood clean. When asked why this might be, the gardener responded, "People are not involved because they are not homeowners, they just rent. If you renting a place all you want is a place to lay your head. You are not worried about beautifying the neighborhood."

Figure 13: Block Unit 429 Community Garden

According to the gardener, not only neighbors but the City is also disinterested. She mentions:

> The City used to cut the LRA owned property around the neighborhood but they don't do that no more. There are prostitutes right by my garden. The inspectors use to come by and

give you a citation but they don't do that no more. People are afraid to say something they are scared somebody is going to cause a problem in their house.

The gardener says that the garden still adds value to the neighborhood both by adding beauty and a place to bring people together. Once a year they organize a block party. A group from the New City Fellowship Church organizes a picnic with food and balloons that is open to all the neighbors.

4.3.3 Friends of Hamilton Village

Friends of Hamilton Village Community Garden is located at 1444 Hamilton Ave. When the dilapidated houses on that lot were torn down by the City, one of the neighbors worried that the vacant lot will attract negative elements. The gardener mentioned, "I just didn't want to see the land over there with needles and whiskey bottles and beer bottles and stuff over there."

So the neighbor went to the City to buy the lot. As it would be too expensive to buy it, they referred her to the LRA. She leased the land but couldn't start a garden because the lot was not graded and it had lots of bricks and other materials left over from the house. She organized a volunteer group through her church and cleared the land of all debris. She knew about two organizations; Gateway Greening and Brightside that helped people who wanted to start a garden. She contacted them and they gave her necessary materials to start a garden.

The garden currently has 12 raised beds. The neighbors use some of the beds while some are free for all. Any person can come and harvest from the "free for all" beds but are expected to help in the garden. The garden leader used to do most of the work. But since 2007, the leader has been unable to work as much. Several volunteer groups regularly come to the garden to help her out. One of the groups is called Restore St. Louis, which is under the New City Fellowship

Church. This group also connected the garden with another church group from St Louis County. This church has a group called Mercy Mondays that goes to the garden almost every other week and helps with weeding and cleaning. Some of the members from this group have been helping in the garden for the last eight years.

Figure 14: Friends of Hamilton Village Community Garden

This group also works with Brightside and Gateway Greening to help with the logistics of organizing the gardening materials every year. Other groups like the Girls Scouts and area school groups also provide occasional assistance. Sustaining a garden would be impossible if not for groups offering assistance. Groups don't just come once but build relationships with the gardeners, which enable them to keep coming back.

> Not to have individuals be in the garden individually but having it be some kind of a team kind of thing. We BBQ and eat at the garden. It makes more of a social event as well as being in the garden. If you build relationship among the people that are involved then people want to come back. People keep coming back and people bring other people with them because of the bonds developed over the years. It's a way to open up relationships and create a community.

4.3.4 Ford School Community Garden/ Miss Ellen's Garden

Ford School Community Garden is located at 1370 Clara Avenue. It was established in 1998 on a piece of land adjacent to the Ford School. The garden was established to provide children with a different outdoor activity. The garden was built on a vacant lot, part of which was owned by the St Louis Land Revitalization Authority (LRA) and part of it by a neighbor. The plot was donated to the school to develop a community garden in collaboration with Gateway Greening. In the beginning, the garden was more affiliated with the school than the community. The teachers and students from the school maintained the garden and harvested the vegetables. After a few years, the leadership within the school decided to discontinue the garden. At this stage, the garden opened its gates to its neighbors and became a community garden. One of the retired teachers helped to manage the garden with others.

This garden has about five to ten gardeners every year. There are about three or four core members and other people come in and go. They have been working to develop a system of working together and maintain the garden:

> Usually each person is responsible for what they put in their own beds and then we have been working out ways, and its mainly been through trial and error, to share the remainder of the obligations of the garden. So taking care of the lawn areas, cleaning up the alleys, which is an ongoing nightmare because people take advantage of vacancy and use that as a dumping area, maintenance of water, and maintenance of the physical structure like the fence, benches and table.

But the gardeners realized that plans are much easier to design than to implement, as one of the gardeners explained:

> The first year that we gardened with them there wasn't a good plan in place for taking care of the lawn. So it would just happen sort of like catch as catch can. So I put forward a recommendation that maybe each participating family could take on the lawn maintenance for a time. The growing season is a certain number of weeks and if we did it every other week that would be eight opportunities to cut the grass and we would split it between the families. But not everyone did their obligation. Last year the garden leader hired a lawn service and ended up footing the bill largely out of own pocket.

In recent years, the garden has had to solve one problem after another. First they had to obtain a meter and create a system for paying the City for the use of water. They decided to split the bill evenly even though some people used more than others. After doing this for a year, they wrote the grant through Gateway Greening to the City of St Louis and received funding that

covered for the water expenses. Then they had a pipe burst over the winter. They were receiving conflicting information on how to resolve it. One of the options was to completely redo the pipe system which would cost them a lot. They hadn't been able to solve the problem for a while, when one day a gardener noticed that somebody had come and fixed the pipes. A new issue is around a house that was torn down on the southern side of the garden, creating a gap in the fence. They have yet to decide how to fix it. Among all these issues, figuring out how to cut the grass is not yet fully resolved.

Figure 15: Ford School Community Garden (also known as Miss Ellen's garden)

It seems it would be hard to have written rules for some scenarios like a gardener not maintaining their plot. If a gardener doesn't maintain their own plot, instead of kicking them out directly, one of the garden leaders contacts them and tries to understand what's going on. If they are not well or have some issues, other gardeners will take care of the plot and treat them as their own. But they will not harvest from that plot. If the person doesn't return after a long time the plot gets reabsorbed by other members. If they come back after that period the gardeners work something out.

One of the gardeners said that the rules about working together in the garden could be much more codified so that they don't have to guess their responsibilities. It would also help reduce confusion and misunderstanding regarding who is going to do what and when. In the absence of these codified rules trust plays an important role as the gardener explained:

> The trust factor is huge because that is entirely what we are operating on. If you say you are doing XYZ you will get that part done. Having that desire to get something taken care of as you see it is not something that you do out of a desire to keep score and be able to say I did this so next time you have to do that. But it just sort of ebbs and flows with the understanding that we each have a contribution to make and there are a lots of needs that must be met so everybody tries to do something and try to be grateful and gracious when you see that someone else has taken care of one of those things.

The gardeners knew each other before joining the garden and would use their networks to recruit new gardeners. As one of the gardeners mentioned, "Most of the people are friends before they get there. You want to get people that you already know. We tried to get people we didn't

know. But seems like people who end up joining are friends." However, the initial level of trust is cultivated further through interactions in the garden:

> We consider each other friends. Because we are working together we are not competing. We are each willing to share gardening information, tools, time and effort. I come through the garden and see that plants need watering so I water their plants. We are friendly enough where we say; hey these tomatoes look droopy lets water them. Or this bed is overrun with leaves so you just knock down some of the leaves for the other person. Each person is willing to share what they have grown. We are also willing to share techniques for using the vegetables, or preserving them or improving our harvesting techniques to extend the life of the plants. I feel like I have learned a lot and have given a lot.

The gardeners are also constantly looking to expand their garden by working with different groups and organizing events. They have reached out to the Ford School and were able to engage a Boy Scout troop for opportunities to get badges affiliated with community service. They were also able to organize a cleanup day where parents whose children go to Ford School would bring their kids and help out in the garden. In an effort to reach out to the community, they organized an event where people from the neighborhood helped clean the garden.

4.3.5 Global Farms

Global Farms is located at 1188 Hodiamont Avenue. It was established in 2009, and is not a Gateway Greening garden. Global Farms is part of the effort by the International Institute of St Louis to provide recently settled refugees an opportunity to engage in farming.

> A group of refugees said to us that they really need a garden space because our 'tradition is in our blood.' That was approximately 9 years ago. So they started a small garden close to our offices. However that garden was a long way away from where they live. About 2 years later we got a small grant from Monsanto to start a garden right across the street where many refugees were resettled.

This is also referred to as the North Farm because it is located in North side of St Louis. They have another farm called South Farm on the southern side. The North Farm started out small, about quarter of an acre. In 2013, they expanded the garden to almost an acre. The garden has expanded both in terms of size and diversity. It is difficult to estimate how many people are involved because they talk in terms of not individuals but involved families. Currently there are 21 families that grow vegetables on that land. Although people from Burundi were mainly involved in establishing the garden, now there are Congolese, Tanzanians, Kenyans Liberians, Mexicans, Hondurans, and Burmese people involved. It is becoming very diverse.

The gardeners have rules, assigned tasks and work cooperatively. They have a leadership committee of 5 gardeners that is primarily responsible for managing tasks and resources for the garden.

> We have different rules in the garden. If you turn the water on for watering you have to water everybody's vegetables and not just yours. Also if you use tools you are responsible for cleaning them and putting them back in their place. You also have to help with cleaning the garden and weeding.

Similar to other gardens, trust plays an important role. They trust that people will not take vegetables that don't belong to them. They also trust that the gardener will act to protect the

garden if they see people harming the garden or stealing vegetables. Last year they has some new families who joined the garden. When asked how trust works with new families that they do not know the gardener explained:

It is difficult with new people. But we will first trust the new families that join our garden. If they are respectful, follow the garden rules, and work cooperatively then we trust them more. If they don't then we may not trust them as much.

Figure 16: Global Farms

They have a strong relationship with New City fellowship church. They especially work with the group Restore St. Louis. Through the church they have tried to get others (non-refugee families) to join the garden but there was a lack of motivation. Some of the interactions have not been positive. One of the problems has been the theft of the vegetables. That has been an ongoing issue. They are trying to apply for a grant to get a fence to impede people from just walking in.

The gardeners have organized themselves from the very beginning and now the International Institute has completely handed over all the responsibilities to them, including the cost for the lease and the insurance. However, International Institute is still involved because the lease is in their name and the City requires that the property is maintained to a certain level. International Institute also organizes volunteer groups who want to help in the garden.

4.3.6 Ladies of Wells Community Garden

The Ladies of Wells community garden is located in 5920 Wells Avenue. This garden is managed by the same family that established the 22nd Ward community garden. This garden was an expansion after a building was torn down near their house.

Figure 17: Ladies of Wells Community Garden

4.3.7 Maple Community Garden

Maple Community Garden is located at 5928 Maple Avenue. It was established in 2010 by a group of people in the neighborhood block group. The group was aware of the vacant lot in their block that was owned by LRA. One of the group members knew of Gateway Greening and suggested that they should build a community garden in the lot. One of the gardeners attributes

their existing relationships with their neighbors through church and the block group to the establishment of the garden as she said, “I would say about 50% or more of the people in those meetings are from my church. We had far more community and trust. We were already friends.” When asked if and how past relationships were helpful in establishing the garden the gardener responded, *“*Absolutely. I knew they were all hard workers. I knew they were going to be there if they say they are committed they will be there.”

The gardener mentioned that the block group was really excited about the community garden idea. The block group had been working on other projects including neighborhood beautification. The gardener explained that the location of the lot and the idea of community garden resonated with the group.

> Everybody was excited about the location. It was near the middle of the block. It was open not between two buildings. Not a corner lot. The main benefit being that we were going to be able to talk to each other while we were gardening. There was an impetus to do something chore-like but with a purpose of being in community with each other. They like the social aspect of it. The difference was that we were doing an on-going activity together. It had a lot of benefits: health benefits, exercise benefits, and social benefits and we were all aware of that.

The gardeners who knew each other through church and block group activities not only helped establish the garden but also helped with the day to day functioning of the garden. The members have built in trust which has allowed them to follow the various formal and informal rules in the garden. When someone is deviating from the rules like not maintaining the garden

they work cooperatively to solve the problem rather than thinking about removing the person from the garden.

> All of us know each other so we trust that we are not going to harm each other's supplies or harvest each other's food without asking without knowing that it's going to be OK to take from someone else's bed. We have rules that we send out in the beginning part of the year but don't really discuss it. If someone is not maintaining their beds we will ask them to clean up the bed. We try to work with they and the co-leaders will help them.

Relationships the gardeners had built through their interactions in the church and the block group played an important role in the establishment and the management of garden. However, their interactions through the garden were different. It allowed them to get a better understanding of each other and deepened that bond. As one of the gardeners explained, this deeper bond in turn affected their interactions and ability to work together in the block group.

> When we had the neighborhood group and we met in meetings, that was different, sitting around talking about safety or whatever issues that came up in the neighborhood cleanup and beautification projects. It's nice to have a garden where you are constantly meeting each other, in a more work like setting. It's also continuous. It's not like you are sitting around talking about what you need to do and what you want to do. It's more natural, spontaneous way to build relationships with your neighbors. It's more relaxing. You are building relationships with your neighbors and sometimes meeting new people, getting to know the people that you have met through the meetings (referring to the block group meetings). You get to know them better. It has cohesified our group in relationship. I think we are much more relaxed and trusting. There is more reason for conversation and

more things to talk about. Also, over time you are building relationships. It's just a bonus to have the community garden.

The garden started out with lots of excitement and engagement. The existing connections to people had with block group and the church seem to have played an important role in the beginning. However, in the past year interest seems to have gone down. They are facing some challenges with membership. They are also worried that one of the active garden co-leaders might be leaving, which means the burden of the work on each of the members is going to increase.

> The first year there were more people involved and over time…last year there were fewer beds that were not claimed that were previously claimed. "The membership has been dwindling. People lose interest over time. People are just really busy and everybody is getting older too.

There are 4-5 core gardeners that take a lot of the responsibility to maintain the garden. Other gardeners will help but the core group does most of the work to maintain the communal space. Dwindling membership is an issue but not all gardeners are equal. Losing a gardener from the core group can have a much higher impact on the garden. Like other gardens, the Maple community garden is also having some impact because of the liability insurance levied by the LRA.

> The key to having it successful and look well is the person who is maintaining the grass…he has been maintaining grass…another co-leader has been weeding regularly and taking care of the community beds….if they decided not to do that anymore that is going to impact how well we can keep the garden going. Other gardeners also help out but not

as much on a regular basis and the co-leaders end up doing a lot of the work. This year the person who mows our grass said that he cannot do it anymore partially because we had to pay out maybe $100, which is a significant sum of money in order to have insurance. So he said he is stepping down and is no longer doing it so we don't know what we are going to do about that.

Figure 18: Maple Community Garden

4.3.8 Mayberry Community Garden

Mayberry Community Garden was located at 5838 Enright Avenue. It was established in 1999 and was closed in 2012. The garden was established by a local family who lived adjacent to the plot. The family leased the land from St Louis Land Revitalization Authority (LRA) to initiate a garden. This garden is perhaps the largest in the neighborhood with 40 raised beds including three beds for elderly and people with disabilities. The story of this garden is very much tied to the land it existed on. Here is how a gardener explained how they ended up getting the land:

> In the St. Louis area, it was sad to see, there are a whole lot of neighborhoods with derelict homes and lands and grass was growing 5-6 ft. They would only come to cut the grass around holidays; like the Memorial Day and July 4th. It was trashy and horrible. If you were interested in a community garden you could rent from the LRA for 1$ a year for 5 years. When the 5 years were up the gardener who leased the property went to put a bid down. She got a first chance because that land was next to her existing property. She bid $200 so the alderman said ok. It blew Gateway Greening's mind because some of other gardens ended up losing land to the LRA but we got there in time. I talked to the alderman and he helped us. It's a shame to put 5 years in and then somebody just take it away. Some of the gardens ended up losing the land because the City came and took 'em because banks were trying to put new homes in these lands to make a lot of money. In fact the lady with the LRA that I talked with said that you can't do that because the aldermen don't want you to get it. So I called the alderman. If your alderman is there to represent you, you get to go first and there were 50 people down there. It would have been an all-day process. He showed up and they called us first. They asked him a couple

of questions he couldn't answer because he was new in office. But there was a lady from Gateway Greening she would answer the questions. Gateway Greening could not believe how it turned out for us.

Unlike other gardens, this garden had strict rules about participation. The garden leader was very clear and upfront about taking responsibility for maintaining individual plots and the surrounding area. If people failed to properly maintain their plots they would lose their membership for the next season. They didn't want people who were not serious about gardening because there were others who were more committed. She explained that being interested in gardening and being able to work in a community garden are two very different things.

We talked about why you would like to be part of the garden. People say yes but I don't think they realize how much work really goes into the garden. It's not couple of weeks or even couple of months. You can start at March and go as long as November for the harvest. Can you really commit yourself for all that time?

The strict rules regarding contributions to the garden has had an impact on the number of people involved in the garden. When the garden started they had 10 people. This was partly because Gateway Greening requires that there are 10 people to show commitment to the garden. At some point, they had as many as 40 gardeners in the garden. But not all of them were as committed so when the garden closed in 2012 they only had 10 members. Maintaining a big garden with only 10 members seems daunting. However, the gardener explained that it was not only the gardeners; their friends, relatives, grandchildren would come out to help. The garden also had a huge list of organizations that would send groups to volunteer including groups of young people from the Police Department's Alternative Sentencing Program, students from

various high schools, grade schools, and Universities, and volunteers from Gateway Greening and the neighborhood. She explained that it was not just volunteers helping them out, rather, it was a two way street. She said, “It was like an interchange. They helped us out and they enjoyed it also. I can’t tell you how many kisses and hugs we would get from people because they enjoyed it so much.”

Figure 19: Mayberry Community Garden

They were constantly working to improve the garden. They had started a compost program, planted a rose garden, and bought a shed with help from donations. However, this is the only garden in the neighborhood that is completely closed. This garden was not "abandoned" in the sense that people slowly stopped being involved. The group of gardeners was out bidden when the LRA auctioned the land. From the perspective of the LRA, leasing the land to a group of gardeners is a temporary way to manage the property before the land is developed. This precarious arrangement of land tenure is perhaps the greatest challenge to sustainability of community gardens. When I asked the garden leader, she had no doubt that she and other gardeners would continue to garden if they had the piece of land. Even other gardeners tried to secure the property by bidding on it.

> He (the person who won the bid) bid $57,000 and I just couldn't go that high. Just to show how precious the garden was, one of the gardeners bid $40,000 and another gardener ended up bidding $25,000. My son was going to get out a loan to do that.

4.3.9 Monsanto Family YMCA Garden

The Monsanto Family YMCA community garden is located at 5555 Page Boulevard, within the YMCA property. Unlike other community gardens that were started by the residents of the neighborhood this was initiated by the members of the YMCA. The YMCA has a wellness program that collaborated with Gateway Greening to design and develop a community garden for its members.

Membership in the garden has not been consistent. In 2010 they had 21 gardeners. That was their most active year. With so much interest they added about 6 raised beds to accommodate all the new comers. However, since last year the interest has fallen off. Now they

have four people who are committed for year round gardening but are hopeful that once the garden is cleaned and the flowers begin to bloom more people will be interested. One of the main reasons for gardeners leaving is that their harvest being stolen. As one gardener explained:

> Last year one of the gardeners planted watermelon. They were huge and beautiful. Just before it was time for harvesting someone came in and took them and pulled up the vines. We had string bean vines taken up when they were blooming and filled with green beans that were not ready to be harvested. Somebody would just come through and pull up the vines. We had a lot of unhappy people.

There were also other issues that could have triggered people leaving the garden. During the peak of interest, the gardeners developed various plans for the garden and delegated responsibilities to individual gardeners. They had developed a butterfly garden, herb garden, floral beds, greenhouse, composting program, berry garden, and planted fruit trees. They had monthly meetings and each individual was given a responsibility. They also were practicing organic gardening which meant gardeners had to spend more time and effort tending their plants. For some of the gardeners this probably was more than what they were willing to do. Also, some gardeners didn't have prior experiences so they did not realize that gardening is hard work, and is year round.

> Sometimes people that are beginning to garden just want to have fun and gardening is fun but you have to realize that gardening in a community garden is more than maintaining your own bed. And many people might just want to garden for some time. When I first came I didn't know gardening was year round. By November 20th we were preparing the

entire garden for winter. People need to enlarge their view of gardening really as a year round concept.

Even as gardeners come and go the core group keeps working and believes that building relationships is important. Otherwise it is hard to trust people and without trust the garden will not function properly.

We were having general meetings once a month. We would talk to each other and we got to know each other. It's helpful when you know people, when you know their likes, dislikes, and interests and that's when we built our comradery…we would go around to each bed and you had to tell us about your bed…so you got a chance to discuss your bed.

I think trust played a huge role. You had to trust other gardeners not to take your produce. Trust them to not use chemicals. We also had to trust one another not to take the tools. So we had to trust one another. Also if you used the spade you had to clean the dirt off it before you put it back to extend the life of it

4.3.10 Mr. Jesse Spivey Memorial Garden

Mr. Jesse Spivey Memorial Garden is located at 1142 Hodiamont Avenue. It was established in 2003 by the New City Fellowship Church within its property. It was formerly known as the Etzel Community Garden, but was later renamed as a dedication to Mr. Jesse Spivey, a long time gardener who recently passed away. The garden was initiated because there were a lot of people who lived in the neighborhood and went to the church who were interested in gardening. Initially they thought that people in the retirement community, which is right across the street, would be involved. However, only Mr. Jesse Spivey took the lead to take care of the garden. He would organize volunteer groups from the church to help him maintain the

garden. Recruiting new members from the neighborhood has been difficult as the gardener explained:

> I have tried to get other people involved and invited many neighbors, talked to people personally made flyers, talked to people in the retirement community. People say they would be interested but don't actually get involved. People pretty much come and pick the food but they wouldn't actually plant or weed or anything.

She mentioned that the neighbors like the idea of the garden there. They think it adds to the beauty but nobody seems to be interested enough to lend a hand.

> Almost anybody that I have talked to about the garden, or when the garden has come up in conversations, or maybe I am walking to the garden with my tool, most people tell me that I am doing a great job with it, and occasionally somebody will stop roll down their window and say it's looking great and keep up the good work. People are always encouraging to me. People like the idea of the garden being there.

Currently there are 11 raised beds in the garden and due to lack of members most of them are covered by mulch. Even the ones that are used have perennials for low maintenance. The gardener mentioned that one of the perks of being a Gateway Greening garden is that you have access to the Great Perennial Divide, an event where people from around the region share their perennials. The garden does get volunteer teams from the church and Gateway Greening once or twice a year to help with composting, planting, weeding, and picking up trash. When asked why it was difficult to get the neighbors to help out she gave several possible explanations:

> Our block is maybe like 60% rental and 40% owners. The owners all have their own yards and so they take care of their own yards. With renters some people don't really see

this as home so they are not really interested in getting invested in anything around the neighborhood. Some people just don't have time. For some people it's not in their experience in their background to work with the ground and grow things. There is not a very good water source. You have to drag the hose to a nearby building or you get a hook to fire hydrants. Also the spot where the garden is a little bit foreboding. We are across from a corner store. It does provide some service but at the same time there is also drug dealing that goes on there. I think maybe that could also put people off.

Figure 20: Mr. Jesse Spivey Community Garden (Formerly known as Etzel Community Garden)

4.3.11 Mr. Johnny Whiting's Community Garden

Mr. Johnny Whiting's garden is located at 5664 Chamberlain Avenue. The vacant lot owned by the St Louis LRA was tended by Mr. Johnny Whiting. He would grow vegetables in the lot and shared it with other neighbors. After he passed away in 2013, St. Vincent Greenway bought the property and named it in his honor. For the past two years, St. Vincent Greenway has been partnering with local churches and neighbors to revitalize it as a community garden.

Currently there are about 5-6 gardeners involved. They have organized workdays every weekend to clean and weed the plots. When St. Vincent Greenway procured the land it had lots of debris, trash, and weed. The gardeners have actively tried to get more neighbors interested in the garden by distributing flyers and going to community meetings. Similar to other gardens, the neighbors seem interested but are not willing to commit. Few neighbors are interested in the garden especially during late spring when it looks clean and vegetables begin to grow.

They have created rules to help with the functioning of the garden. To begin with, they charge $5 per season to become part of the garden. Other rules are to ensure that everybody maintains their own plot and contributes to the overall garden maintenance. However, since they are in the initial stage with small number of people, they work together to solve problems rather than enforcing rules. They do try to make sure that gardeners with under-maintained plots are aware of the situation.

> Yes there are rules of maintaining the garden. Currently when people don't maintain their plots or contribute as much to the overall maintenance others chip in. We can't afford to kick people out. Sometimes we will put red flags in the plots that look like they are not being taken care of.

Currently they don’t have an organizational structure with garden leaders or core group of gardeners. They hope that a natural leader will emerge from their current group.

Figure 21: Mr. Johnny Whiting's Community Garden (formerly known as Chamberlain Community Garden)

4.4 Conclusion

In this study, community engagement is shaped by the context of the community gardens and neighborhood within which these are located. The goal of this chapter was to briefly describe the community in order to begin understanding how the community context might affect engagement in the gardens. Although there are similarities, each community garden is unique and shapes how its members and others engage with it. Two of the gardens; West End Mount Carmel Community Garden and Youth Affairs Garden were not included in the study. There were multiple attempts to contact them without success.

Chapter 5: Model Description

5.1 Overview

This chapter has two goals. First it will show a revised causal loop diagram (CLD) based on the key informant interviews. It will discuss how this revised CLD is different from the earlier version and why the changes were made. The revised CLD fulfills Aim 1 of this study. Second, it will describe the model development process including the various modeling decisions and formulation of equations in the model. The community garden system includes several subsystems that interact with each other. For example the gardener subsystem determines how gardeners move in and out of the garden while the land subsystem constraints the number of gardeners. The model was built in a stepwise manner where each subsystem was built separately and then combined, one structure at a time. As the chapter proceeds, new subsystems will be added to the model followed by a discussion of how that structure affects the overall behavior of the model. In essence, this chapter aims to show the structure behavior relationship. The development of the simulation model partially fulfills Aim 2 of this study. In the next chapter, model analysis and results will be presented to complete Aim 2.

5.2 Revised Causal Loop Diagram

The causal loop diagram (CLD) presented in chapter 2 (see Figure 4) was revised based on the key informant interviews. Some of the concepts such as reciprocity, free riding, and creating rules still exist but the specific mechanisms have been modified. The feedback mechanisms were hypothesized based on literature and revised based on data collected through the key informant interviews. In this section these changes will be discussed. Herein, the older model is referred to as Community Garden Sustainability Model I (CGSM I) and the revised model is referred to as Community Garden Sustainability Model II (CGSM II) (see Figure 22).

The reciprocity and building social relationship feedback loops (R1 & R2) were combined to create a single feedback loop (see Table 2). In CGSM I, the processes for building relationships and build trust to increase the contribution by gardeners were separate. During the key informant interviews, it was highlighted that social relationships were key to building trust and ensuring that people followed through on their commitments to contribute to the garden.

The developing rules and free riding feedback loops (B1 & B2) were combined to form a single loop. In CGSM I, both creation of rules and temptation to free ride came from a gap in collective activities. When more activities needed to be completed, more rules were created. When activities to be completed decreased, temptation to free ride would increase. However, it made more logical sense to combine these two, so that when quality of garden was low, more rules were created. This would increase the gardeners' effort and reduce free riding.

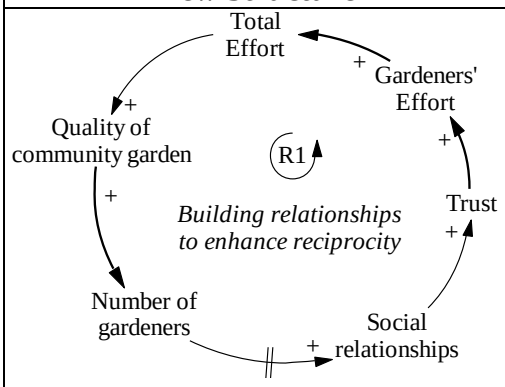
The constraining rules feedback loop (R3) has two changes in the revised model. It is now labeled as R2 and the impact, rather than coming from rules, comes from gardeners' effort. If the gardeners have to do more work, they will stay with the garden for shorter period of time. In the key informant interviews, this story was told as some people not understanding how much work it takes to be part of the garden and leaving after one season.

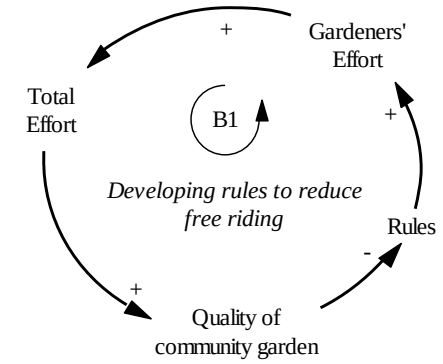
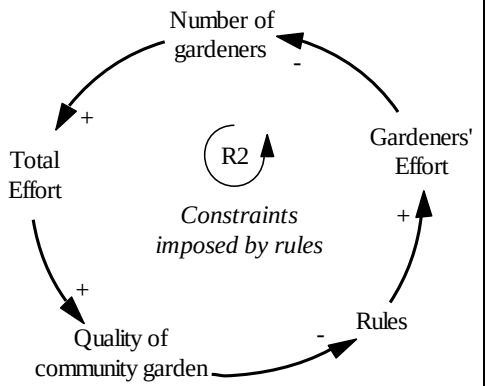
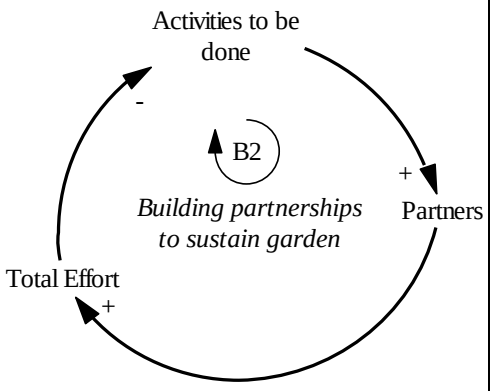
The building partnership feedback loop has not gone through extensive revision. In CGSM I, partnerships were built when the quality of garden would begin to decrease. In CGSMI, new partnerships are built when activities to be done increases. This change was made because it made logical sense that partners (conceptualized mainly as volunteer groups) would contribute to the effort to maintain garden. People would not wait for the quality of the garden to go down before building partnerships. In an interview, one of the gardeners explained that they will have

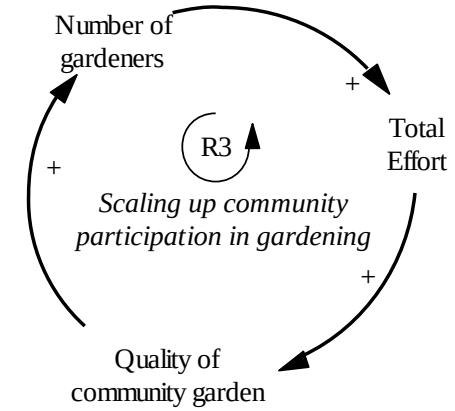
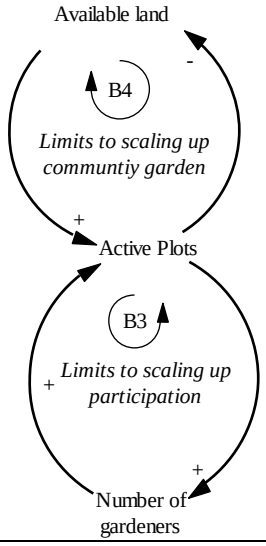
to start working with a partner because one of the gardener who has been mowing the lawn is about to leave.

The scaling up feedback loop has not been changed in the revised model. The profit maximization loop has been removed because it was simpler to represent this idea by creating a constant for the level of effort gardeners are willing to put forth and comparing that with the actual effort they had to give. If they had to give more effort than they intended the amount of time they stayed with the garden would start to decrease, which is part of the constraining rules feedback loop. The "more garden more problems" loop was also removed because none of the gardens in the study were facing the situation of having too many people. Therefore, it was difficult to collect stories that would represent this feedback loop. The two limits to growth loops have not been changed.

Table 2: The feedback loops from the revised model and supporting key informant stories

New Structure	Stories
	"It's not like you are sitting around talking about what you need to do and what you want to do. It's more natural spontaneous way to build relationships with your neighbors." "The trust factor is huge because that is entirely what we are operating on. If you say you are doing XYZ you will get that part done." "I knew they were all hard workers…I knew they were going to be there…if they say they are committed they will be there"

	"We have different rules in the garden. If you turn the water on for watering you have to water everybody's vegetables and not just yours. Also if you use tools you are responsible for cleaning them and putting them back in their place. You also have to help with cleaning the garden and weeding."
	"Sometimes people that are just beginning to garden..they just want to have fun…and gardening is fun…but people don't realize that it is hard work…. gardening in a community garden is more than maintaining your own bed." "I didn't know gardening was year round…last date November 20th was putting entire garden to bed….I think as we began to enlarge our view of our gardening it's really a year round concept."
	"Some of the members are getting older and it's very hard work. So we have to get some community service groups to help us out." "It's very helpful because it's a lot of work to maintain the garden. So volunteers are very helpful." "I think it's (i.e. partnerships) really important especially now because going into the growing season and losing the person who maintained your lawn. It's not that they are going to help us maintain it. But just to have additional support to keep us going."

	"It seems that neighbors get more interested in the garden once it looks nice and there are vegetables growing" "We have 4 people committed. But once the garden is clean and the flowers start blooming others will come and join us."
	"If a new person was interested and we did not have space I would refer them to other gardens." "If you saw a neighbor working in the garden you would ask them and they would tell you to contact one of the co-leaders and one of us will look into what beds are available."

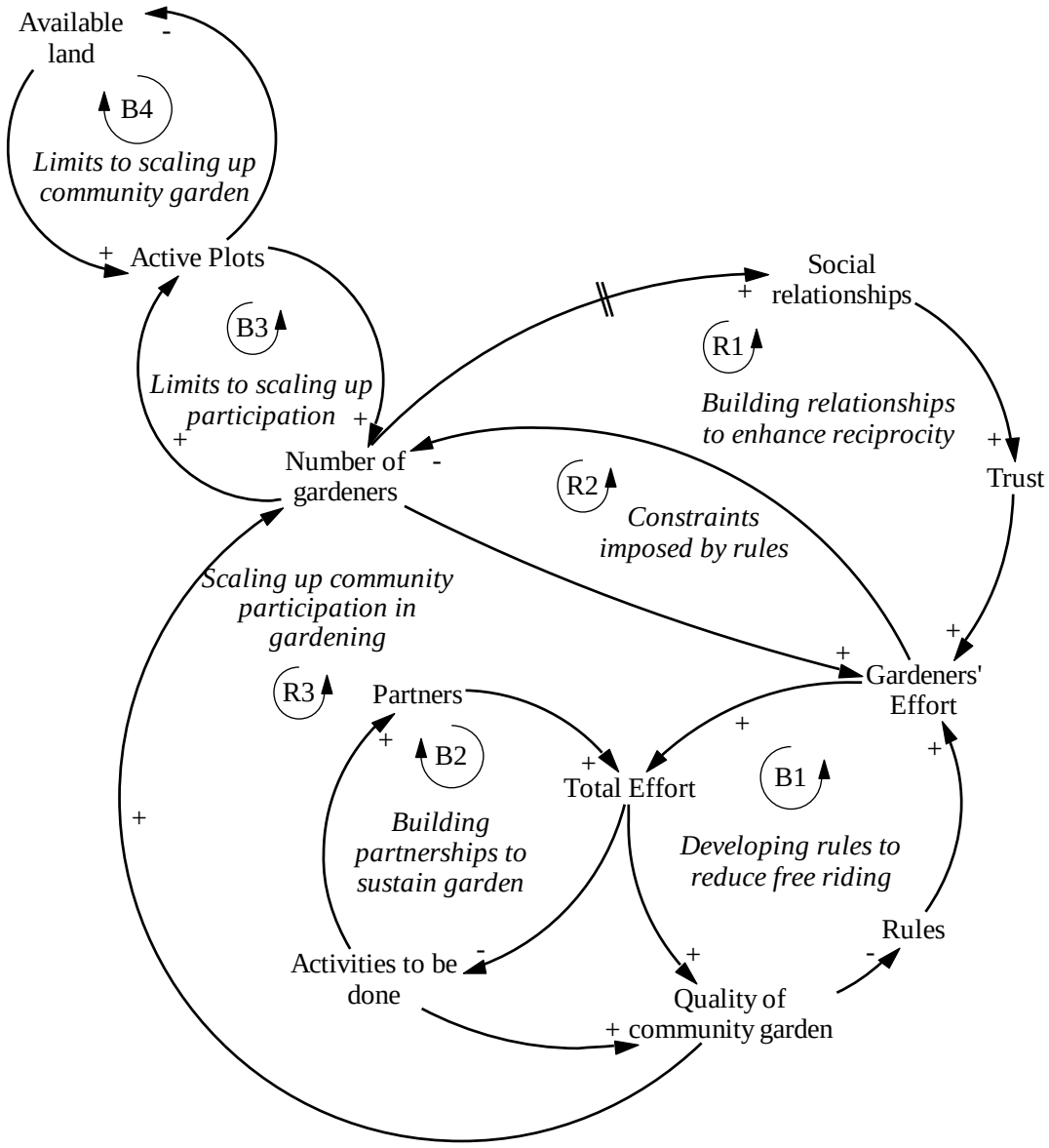


Figure 22: Revised Causal Loop diagram showing feedback mechanisms that are hypothesized to produce sustained and eroding community engagement

5.3 Developing the system dynamics model

The revised CLD was used as the starting point for developing a system dynamics model. This section describes how each small structure of the model was developed and combined with other structures. Building small structures also enabled tests be to conducted including dimensional consistency, parameter sensitivity, and extreme condition tests in a much smaller

scale. Although the higher level feedback mechanisms are the same, the simulation model has more structure. These structures are necessary to build the model and are based on insights from key informant interviews.

5.3.1 Gardener Structure

The first sub-structure developed was the gardeners sub structure. This structure determines how people move in and out of the garden. The model begins before there is any community garden or gardeners. In the beginning there are people involved in the community. This assumption is based on multiple narratives where people talk about already being involved, either through their block unit or their church, in the community and then starting a community garden. As one gardener explained, *"*On my block there is already a neighborhood group that had been meeting once a month during most of the year. And I have always had a vegetable garden so I wanted to do a community garden.*"*

Therefore, at the beginning of the model there are some people in the stock *Number of people involved in community but not involved in community garden.* People from this stock will move to another stock *Number of people interested in establishing a garden* through two major processes. Someone in the group may come into contact with a local organization that creates an interest in starting a garden. That person then talks with other peers and gets them interested in establishing a garden through word of mouth. The people interested in initiating a garden, begin to build plots and move to the stock of *Core group gardeners* (see Figure 23).

The behavior produced by the simplified structure shown in Figure 23 mainly depends on the number of new people getting involved in the community. Figure 24 shows the difference between no new people getting involved in the community (Net People 0) and one new person

getting involved every month (Net People 1). The graph shows how the number of gardeners (y-axis) changes over time for the two different scenarios. When new people are getting involved in the community (Net People 1) the number of gardeners keep increasing as the gardeners who leave are being continuously replaced. When there are no new people getting involved in the community (Net People 0), the number of gardeners begin to decline after a while, as there are no replacements to the initial group of people. At this stage the number of people involved in the community is the major constraint for number of gardeners.

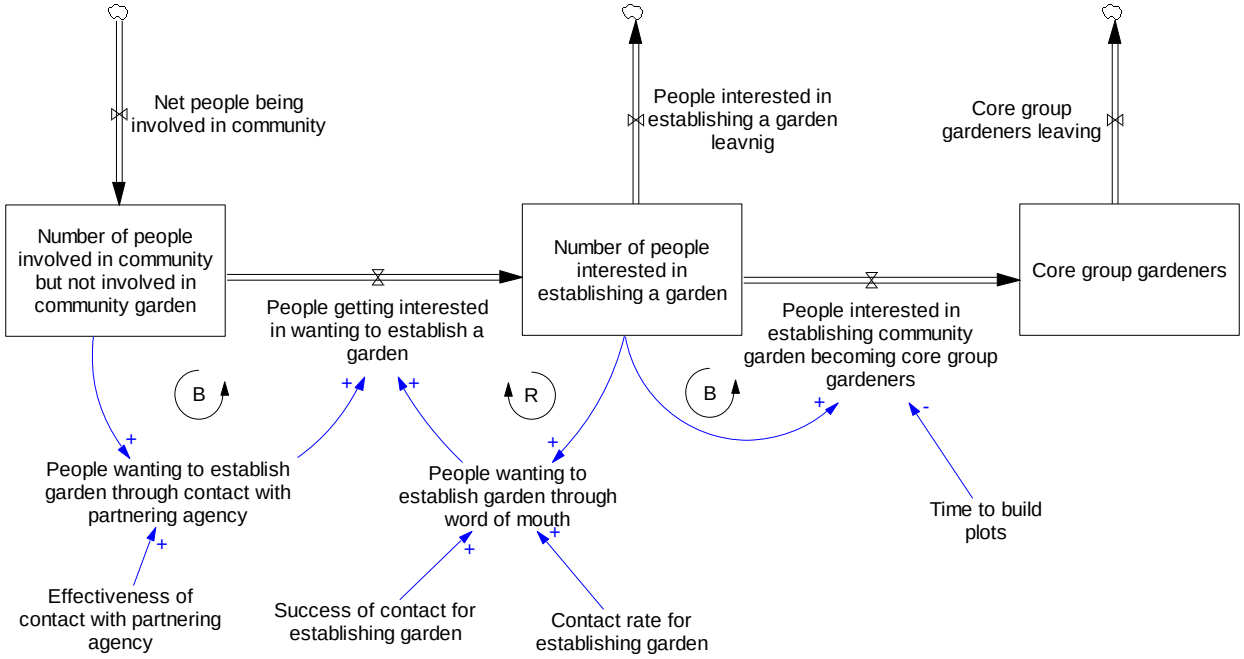


Figure 23: Flow of people from being involved in community to being a gardener

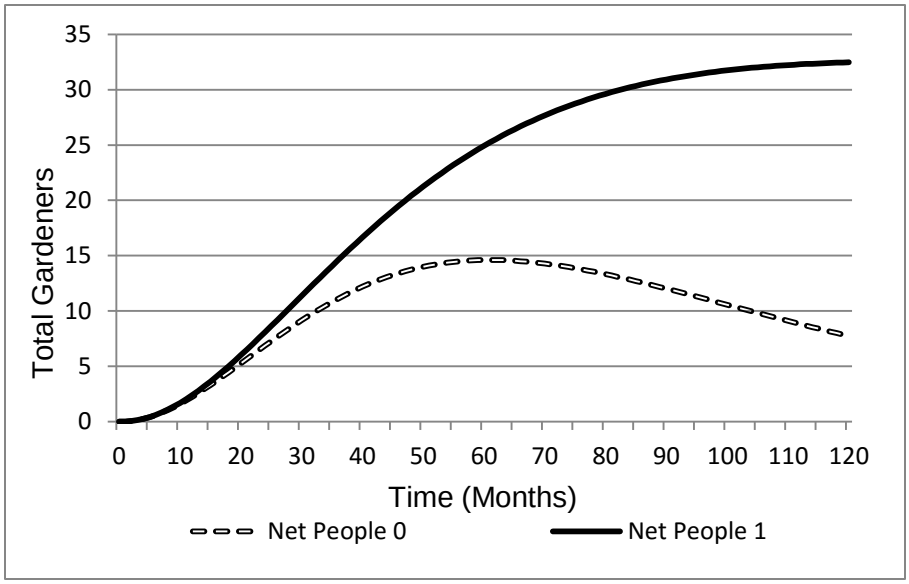


Figure 24: The variation in number of gardeners caused by changing number of people getting involved in the community

The amount of land being developed as community garden also acts as a constraint. As the land is developed into plots there is less need for recruiting people to establish the garden (see Equation 4). Similarly, when there is less land available fewer plots can be built, which constraints the rate of people becoming gardeners. The flow that moves people between these two stocks is formulated as:

People getting interested in wanting to establish a garden = People wanting to establish garden through word of mouth + People wanting to establish garden through contact with partnering agency (1)

People wanting to establish garden through contact with partnering agency = Number of people involved in community but not involved in community gardens*Effectiveness of contact with partnering agency*Effect of ratio of land available to initial land available on people getting interested in (2)

gardening wanting to establish a garden

People wanting to establish garden through word of mouth = (Number of people involved in community but not involved in community gardens*Contact rate for establishing garden)*(Number of people interested in establishing a garden/(Number of people interested in establishing a garden + Number of people involved in community but not involved in community gardens))*Success of contact for establishing garden (3)

Contact rate for establishing garden = Initial contact rate for establishing garden*Effect of ratio of land available to initial land available on people getting interested in gardening wanting to establish a garden (4)

In Equation 2, *Effectiveness of contact with partnering agency* determines success rate of the interaction between the community member and the agency partner. If ten community members come into contact with the agency and the effectiveness parameter is 0.1 per month then one person will become interested in establishing the garden every month. The *effect of ratio of land available to initial land available on people getting interested wanting to establish a garden* ensures that when there is no land available for gardening no one will move to the next stock. When there is land available then people can move to the *Number of people interested in establishing a garden* stock and begin the process of building initial plots for the community garden. In equation 3, members of the community come in contact with people who are

interested in establishing a garden. Whether this contact is successful is determined by *Success of contact for establishing garden*. The contact rate is also affected by the land availability such that when there is no land available there is no contact regarding establishing a garden as shown in equation 4. When people are interested in establishing the community garden they start building plots. As the plots are built, the people who helped establish the garden move to the stock of *Core group gardeners.* This process assumes that those who worked to establish the garden become the core group gardeners. This is supported by the narrative where people who formed the core group were generally the ones who established the garden. The model assumes that a single plot is assigned per gardener. As such, if there were two initial plots built, two people would move to the stock of core group gardeners. This flow to the stock of core group gardeners is formulated as:

People interested in establishing community garden becoming core group members = Building initial plots/Plot per gardener (5)

Once we consider the limitation created by the amount of land available, the behavior looks much different. Unlike the behavior shown in Figure 24, even when there are new people getting involved in the community (Net people 1) the number of gardeners begins to decline (see Figure 25). As the land is developed into plots and a community garden is established, people involved in the community cannot become interested in establishing a garden. There could be many people involved in the community but they cannot move to become gardeners in the current structure as shown in Figure 23, which assumes that there is no other way to join the garden.

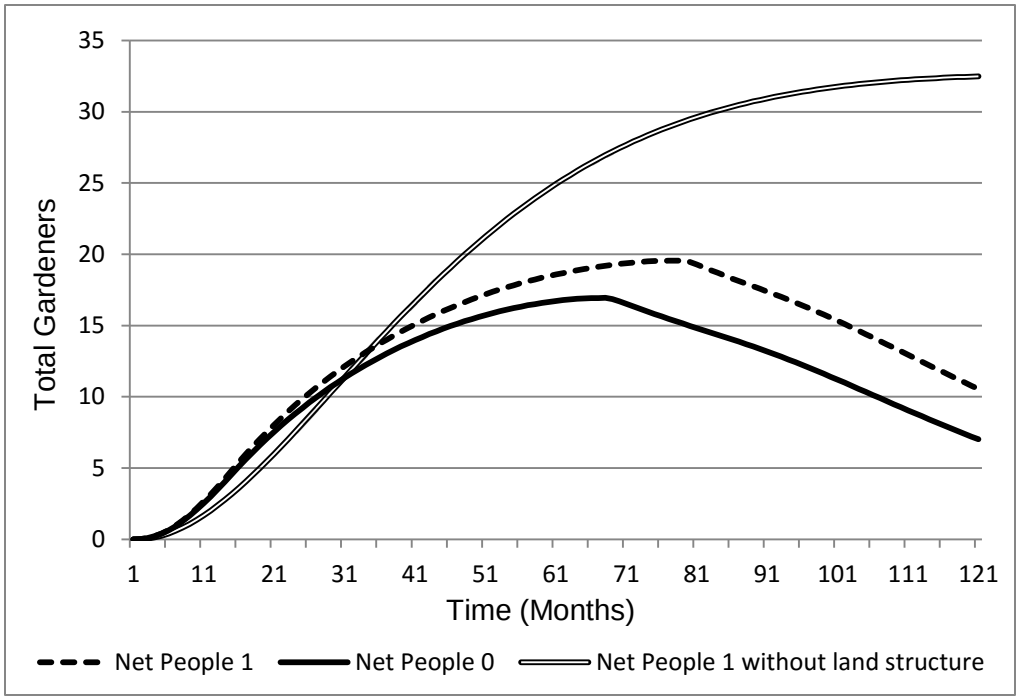


Figure 25: Variation in total gardeners while considering the constraints of availability of land

The other way to become part of the garden is by joining the already established garden. People who were not involved in establishing the garden may become interested in joining the garden based on interaction with some of the core group gardeners (word of mouth) and move to the stock of *Number of people wanting to join community garden* (see Figure 26).

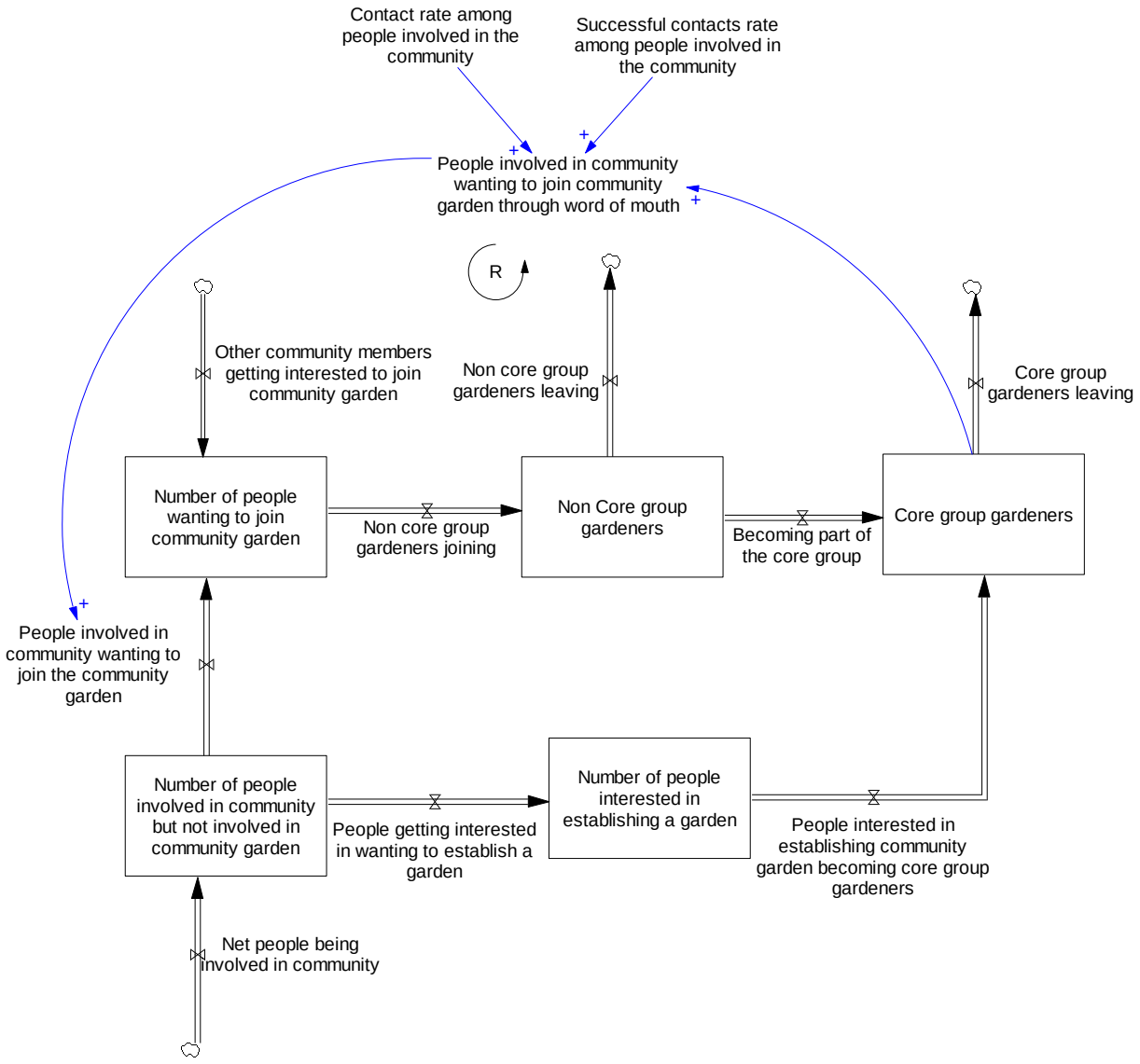


Figure 26: Structure showing people involved in the community joining the garden through word of mouth process with core group gardeners

The word of mouth for recruiting people involved in the community is formulated as:

*People involved in community wanting to join community garden through word of mouth= (Number of people involved in community and interested in community garden*Contact rate with people involved in the community)*(Core group gardeners/ (Core group gardeners+ Number of* (6)

*people involved in community and interested in community garden))*Successful contact rate among people involved in the community*

The core group gardeners and people wanting to join the community garden interact at a particular rate defined by *Contact rate among people with people involved in the community.* The variable contact rate determines how many people are contacted per month whereas the successful contacts determines what percent of those contacted will join the garden. Whether people actually want to join or not depends on the *successful contact rate among people involved in the community* which is defined as the fraction of contacts that will actually be interested in joining. The base value for contact rate is 0.1, which means that only 10% of people contacted will actually join the garden. Getting people involved, even those you know, might be difficult as this gardener mentioned, "I have tried to get other people involved and invited many neighbors, talked to people personally made flyers, talked to people in the retirement community. People say they would be interested but don't actually get involved." Another gardener talked about the difficulty in recruiting new members, "We have been trying to recruit some of the neighbors by distributing flyers and going to community meetings. People seem interested but are not willing to commit to the work."

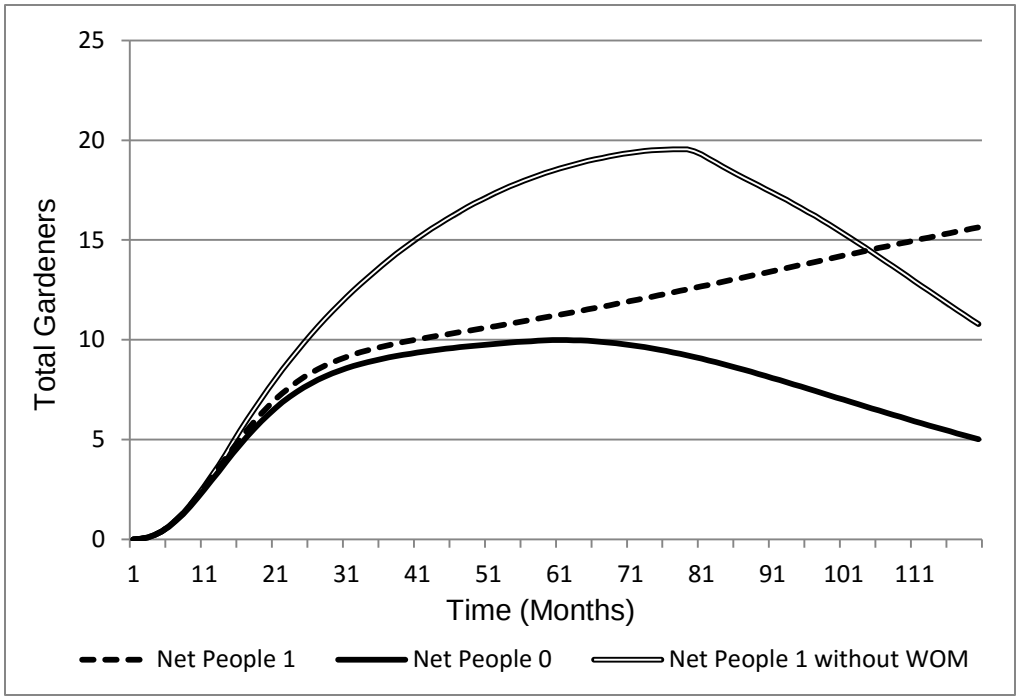


Figure 27: Variation in total gardeners when community members can join established garden through word of mouth process

In the earlier simulation run, the number of people involved in the community did not affect the rate of decline in gardeners. Once community members can join the garden through word of mouth, the number of people involved in the community makes a difference (see Figure 27). The community members joining the already established garden provide replacements for the gardeners who are leaving. In other words, if there are people for replacement the number of gardeners is sustained otherwise begins to decline. Through a similar word of mouth process, other people who are not involved in the community can also join the garden. This process takes into account the people outside of community groups that may decide to join the group. The contact rate with people not involved in the community is assumed to be lower than those involved in the community.

The word of mouth process is also affected by the quality of the garden. If the quality of the garden is high then the rate of people wanting to join the community garden will higher and vice versa. The successful contact rate will be higher. This process is formulated using a graphical function referred to as a table function in Vensim software. A table function is a user defined relationship between two variables, an input and an output. In this case the input is the *Ratio of quality of community garden to desired quality of community garden.* When the quality of the community garden is equal to the desired level the ratio is one. If the ratio is 0.5 it means that the quality of community garden is only half of what is desired. Through the function, the user can determine the output value which is represented by the *Effect of ratio of quality of community garden to desired quality of community garden on successful contact rate*. As seen in Figure 28, the input (x axis) has corresponding values for the output (y axis). Therefore, the *Initial successful contact rate* is 0.5 (i.e. 50 percent of those contacted will be interested) and the quality of garden is one, the *Successful contact rate* will be 0.5 (0.5*1). If the quality of community garden was 0.5; the successful contact rate would be 0.25 (i.e. 25% of those contacted will be interested). The impact on the behavior of total gardeners from the quality of garden will be discussed later.

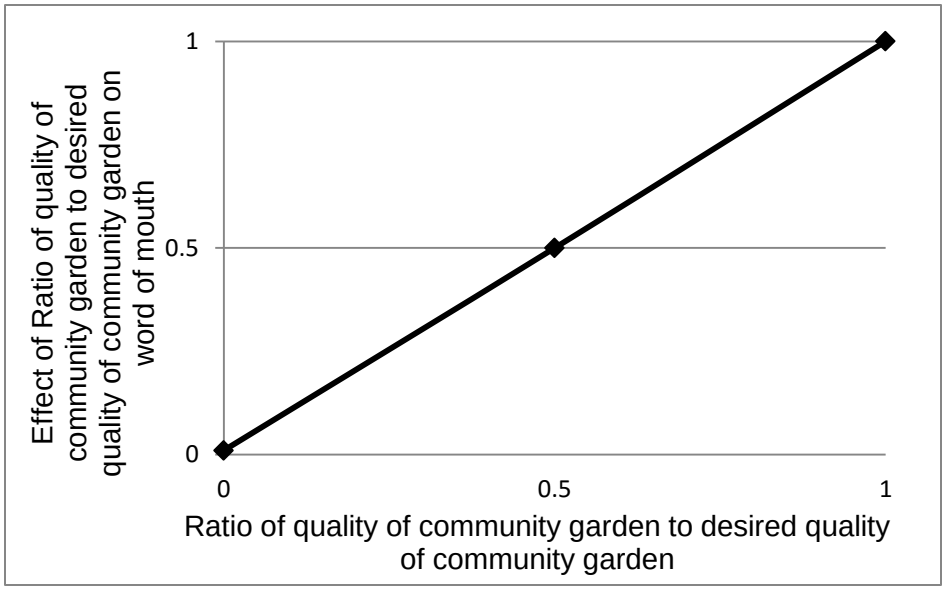


Figure 28: Table function determining the effect of ratio of quality of community garden to desired quality of community garden on word of mouth

If the garden needs new gardeners, the people can move from *Number of people wanting to join community garden* to *Non-Core group gardeners.* After spending some time at the garden they can become part of the core group. The model assumes that new gardeners don't join the garden and immediately become part of the core group. The separation of gardeners into non-core group and core group has two main functionalities. The model assumes that core group gardeners stay longer and contribute more effort than non-core group gardeners. The core group also takes responsibility for more garden maintenance activities. The new members may help out and take part in common work days but the core group is the backbone of the garden. As one gardener explained, "Other gardeners also help out but not as much on a regular basis but the co-leaders end up doing a lot of the work."

People can also leave the system once they join the garden. The process of leaving is dependent on three main factors. Gardeners will leave the garden faster if they have to put in more effort than their initial levels, if the quality of garden is low, and if the density of social

relationships is low. Both the process of core and non-core group gardeners leaving the garden is affected by the same factors. The only difference is that the average time the gardeners stay is higher for core group gardeners than non-core group. The process of gardeners leaving is formulated as:

Core group gardeners leaving = Core group gardeners/Time core group gardeners to stay (7)

*Time core group gardeners to stay = Average time core group gardeners stay * Effect of quality of community garden on gardeners leaving * Effect of core gardener effort on core gardeners leaving * Effect of ratio of social relationships to maximum relationships on gardeners leaving* (8)

The time that a gardener will stay with the garden is firstly affected by *Average time core group gardeners stay.* This is an average time, defined initially in the model and can change throughout the simulation based on three factors. When the quality of garden is high the time a gardener will stay is also high. If the quality is low then the gardeners will leave at a faster rate. When the number of social relationships is low and the effort is high, gardeners will stay with the garden for less time.

5.3.2 Land Structure

The model assumes that in the beginning there is a certain amount of land available for building community gardens. This availability of land affects the movement of people from *Number of people involved in community and but not involved in community garden* to *Number*

of people interested in establishing a garden. Once people get to this stock they begin to build initial plots to establish the garden (see Figure 29). The building of initial plots is formulated as follows:

Building initial plots = Number of people interested in establishing a garden*Plot per gardener/ Time to build initial plots (9)

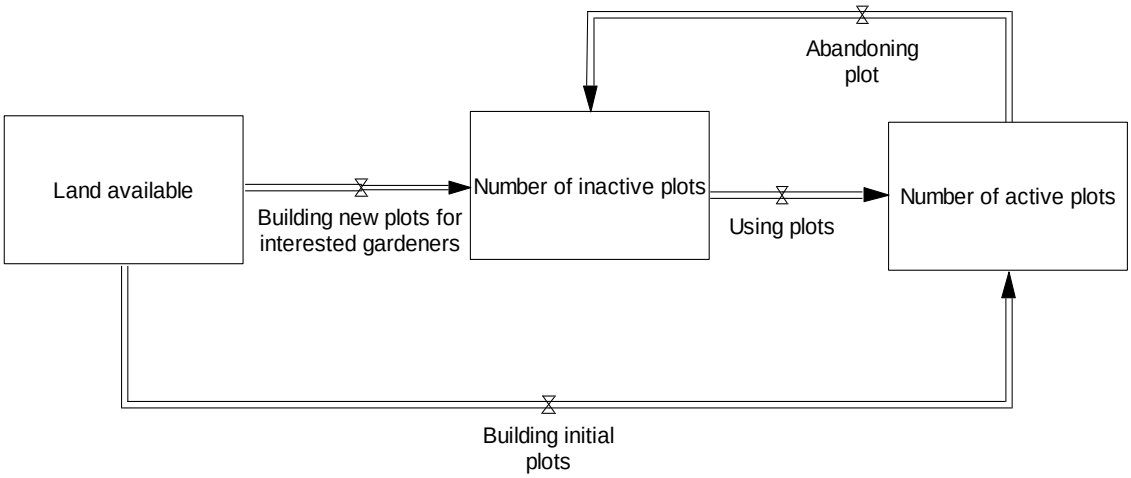


Figure 29: Three stock land sub structure representing the changing attributes of the land in the community garden

When the plots are built they move from the stock of *Land available* to the stock of *Number of active plots.* The flow of *Building initial plots* initiates the movement of the first gardeners into the core group. These core group gardeners interact with other people to recruit them as new gardeners. This word of mouth process adds people to the stock of *Number of people wanting to join community garden.* As this stock increases the *Number of new plots desired* also increases which initiates the process of *Building new plots for interested gardeners.* This is formulated in the model as follows:

Building new plots for interested gardeners = (Number of new plots desired/Time to build new plots for interested gardeners)*Ratio of land available to initial land available (10)

As new plots are built, the ratio of *Land available to initial land available* becomes smaller, decreasin the rate of the process. Having less land available for building plots slows down the effort to build new plots. The newly built plots move to a stock of inactive plots because specific gardeners have not been assigned to it. When there are active plots, it will increase *Number of gardeners needed* which will initiate the process of *Non-core group gardeners joining.* This process is formulated as follows:

Non-core group gardeners joining = (Number of gardeners needed/Time to join a garden)*Effect of ratio of number of people interested in community gardening to number of gardeners needed (11)

Therefore, when there are new plots built, it increases the number of inactive plots which increases the number of gardeners needed to initiate the process of non-core group gardeners joining. The *Effect of ratio of number of people interested in community gardening to number of gardeners needed* variable compares the number of interested people and number of new gardeners needed to determine how many non-core group gardeners can join. For example, if there are ten gardeners needed and ten people are interested the effect variable will be one. This means ten gardeners will be joining. However, if ten gardeners are needed but only five are interested the effect variable will be 0.5, resulting in five new gardeners joining. As the gardeners join, plots are assigned to them moving the plots from the stock *Number of Inactive*

plots to *Number of Active plots.* When the gardeners leave, the active plots are abandoned and plots move back to *Number of inactive plots* which increases the *Number of new gardeners needed*. This starts the entire process again.

The gardener and the land structure are interrelated through a series of feedback loops. Most of the feedback loops are balancing loops which work to constrain the number of gardeners and plots. When there are more people interested, more plots are built. This reduces the amount of land available, constraining the number of gardeners that can join.

5.2.3 Activities Structure

In the model, activities are conceptualized as hours of work and are generated from different aspects of the garden. The hours of work generated from the community garden accumulates in the stock *Activities to be done.* This can be thought of as a backlog that increases with *New activities* and is drained through *Completed activities* (see Figure 30). *New activities* are generated from five different sources: building of plots, maintenance of plots, general maintenance of the garden, work done on new projects, and the time spent with partners in the garden. The activities for building plots are generated from the two processes discussed earlier: *building initial plots* and *building new plots for interested gardeners*. As these processes begin, the act of building plot is converted into hours of activities by a parameter *Effort per plot to be built* which is quantified as hours/plots. Therefore, the A*ctivities for building plots* is formulated as:

Activities for building plots = (Building new plots for interested gardeners + Building initial plots)*Effort per plot to be built (12)

Activities are also generated from both active and inactive plots. The amount of activities generated from these plots depends on the number of plots and the activity per plot. The model assumes that there is a desired level of activities per plot which is the needed amount to maintain and improve the quality of the garden. The actual level of activities per plot is, however, dependent on the effort available in the garden. If there are only two gardeners but there are 20 plots, they may not be able to put as much effort on the plots compared to 20 gardeners. The activities for active plots are formulated as follows:

Activities per used plot = Desired activities per used plot*Effect of effort ratio on activities per used plot (13)

When the available effort is greater or equal to the activities, the *Effect of effort ratio on activities per used plot* will be one, and the *Activities per used plot* will be equal to *Desired activities per used plot.* If the available effort is half of the activities to be done then the effect variable will be 0.5, which means the *Activities per used plot* will be half of *Desired activities per used plot.* The *Effect of effort ratio on activities per used plot* variable is dependent on the *Ratio of total potential effort per month to activities to be done per month*, which is a ratio between the total potential effort and the activities to be done. Total potential effort is the total effort that is available in the community garden through gardeners and partnering organizations. The actual effort that reduces the backlog of activities is based on the activities to be done and the potential effort. If there are 100 hours of activities to be done and 200 hours of potential effort available the actual effort that occurs is 100 hours. The potential effort by gardeners is a combination of effort from core group gardeners and non-core group gardeners. The potential effort by core group gardeners is formulated as follows:

Potential effort by core group gardeners = Core group gardeners*Potential effort per core group gardener (14)

Potential effort per core group gardener = Initial potential effort per core group gardener*Codified rules ratio*Ratio of trust among gardeners to maximum trust among gardeners (15)

The *Potential effort per core group gardener* is affected by three factors in the model. *Initial potential effort per core group gardener* is a parameter which represents the amount of effort from a core group gardener at the beginning of the simulation. As the simulation progresses, rules created in the garden and the level of trust among the gardeners affects this initial effort. If the total potential effort is less than activities to be done, the quality of the garden declines. When the quality of the garden is less than what is desired by the community gardeners, it initiates the process of creating rules geared towards increasing effort. The codified rules ratio represents the ratio of the number of rules to the number of rules at the initial stage. If currently there are two rules, the codified rules ratio will also be two resulting in doubling of the effort from gardeners. However, just creating rules doesn't mean that they will be implemented. This depends on the ratio of trust which is the level of trust to the maximum level of trust achievable (i.e. 1). If the ratio of trust is 0.5 then only half of the rules will be implemented. Both the trust and rules structure will be discussed in more detail later.

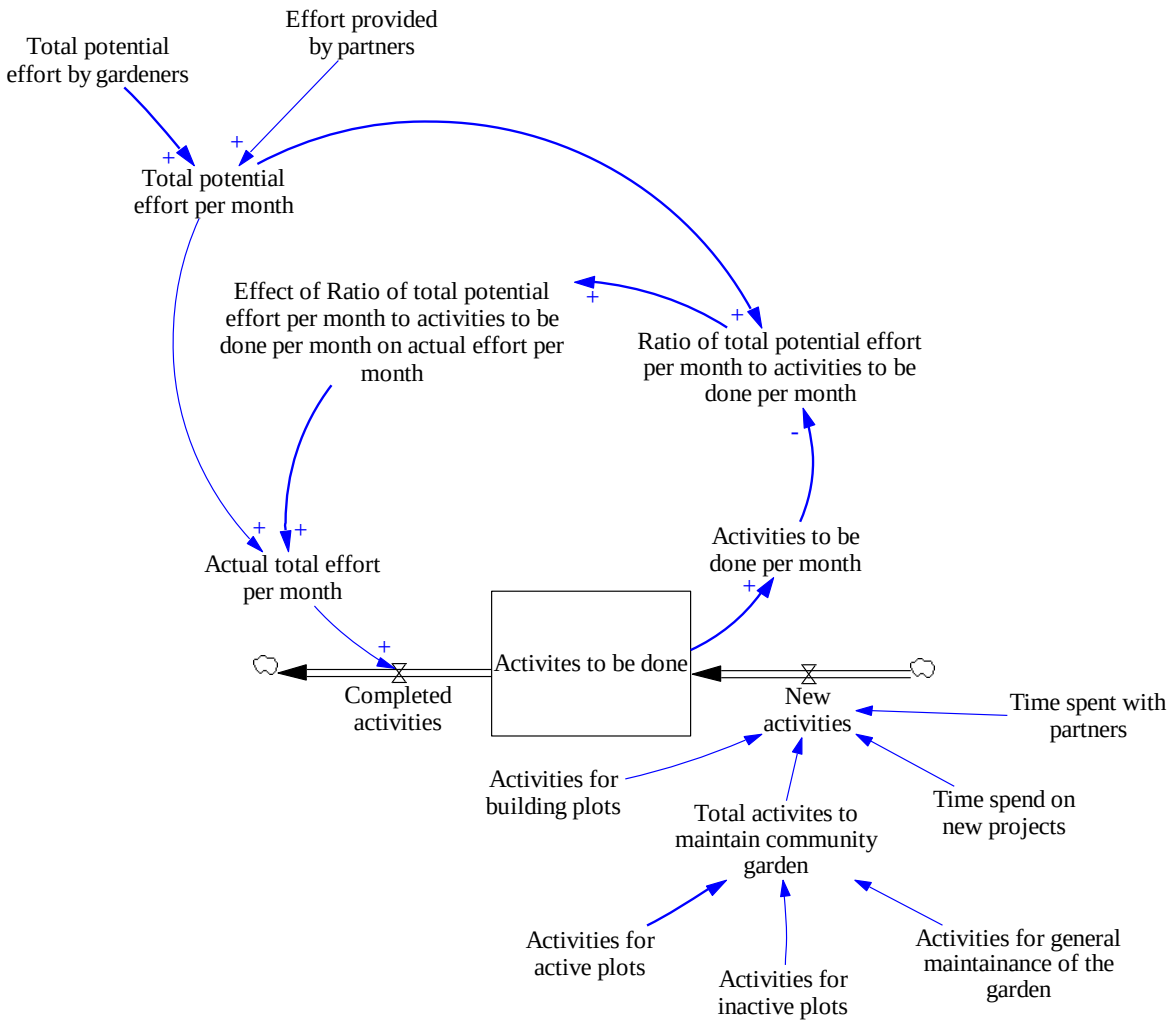


Figure 30: The activities structure along with factors that contribute to the effort and activities

5.3.4 Quality of Community Garden Structure

Quality of garden in this model is an index which ranges from zero to one, where one is also the *Desired quality of the garden*. The quality of garden is defined through the level of effort that is available as compared to the level of work needed to be done. If there are more hours of work that needs to be done to maintain the garden than the hours of work provided by gardeners and partners, then the quality of garden will be low. The quality of garden is represented as a stock and the change in this stock is formulated as:

Changing quality of garden = (16)

(Desired quality of community garden Effect of Ratio of actual time spent on activities to total desired time spent on activities -Quality of community garden)/Time to change quality of garden*

According to this formulation, the *Quality of community garden* always wants to move towards the desired quality (i.e. 1) because the *Changing quality of garden* is based on the difference between the desired quality and the actual quality. If *Effect of ratio of actual time spent on activities to total desired time spent on activities* is one, then the quality of community garden would reach the desire quality within the time frame defined in the parameter *Time to change quality of garden.* However, if *Effect of ratio of actual time spent on activities to total desired time spent on activities* is 0.5 (i.e. only half the time is spent compared to the desired time) then the quality of community garden can only reach 0.5. Furthermore, if the *Effect of ratio of actual time spent on activities to total desired time spent on activities on quality of garden* is lower than *Quality of community garden*, the flow *Changing quality of garden* will become negative, resulting in declining *Quality of community garden*.

Quality of garden affects four processes in the model: the leaving of gardeners, recruitment of new gardeners through word of mouth, creation of rules, and number of partners. Each of these processes is affected by the variable *Ratio of quality of community garden to desired quality of community garden.* When this ratio is higher (i.e. the garden is close to the desired quality) the rate of gardeners leaving is slower, rate of recruitment is higher, the rate of creating rules is smaller, and the number of partners needed is higher. The effect of quality of garden on gardeners leaving is defined by the table function as shown in the Figure 31. Based on

this function, when the ratio of quality of garden is zero the effect will be 0.1. Therefore if the average time a core group garden stays is 48 months, it will decrease to 4.8 months. If the ratio is one, the effect will be 1.5 and the time core group gardeners stays will be 72 months.

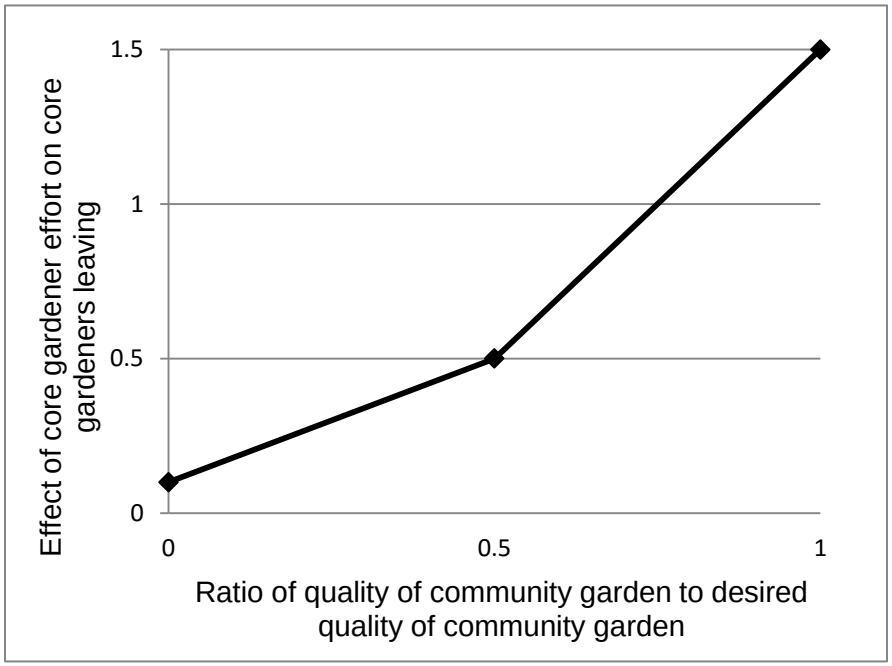


Figure 31: Table function determining the effect of core gardener effort on core gardeners leaving

The four structures discussed are related in a feedback loop. When there are more gardeners, the effort they can provide becomes higher than the effort needed in the garden. This allows them to put more effort into maintaining the garden to increase the quality of the garden. Higher quality of garden further increases the number of gardeners by increasing both retention and recruitment. This reinforcing loop can be both virtuous and vicious as smaller number of gardeners will result in lower levels of effort and declining quality. This process is controlled by a balancing loop. When the gardeners can put more effort the activities to be done is reduced, balancing the ratio between effort and activities. This process allows gardeners that don't have adequate support to lower the level of activities and sustain the garden. However, lowering the

effort too much can affect the quality of garden and make it harder to maintain the number of gardeners.

Figure 32 shows the impact of different effort from gardeners on number of gardeners over time. The two scenarios, Effort 100% and Effort 110%, refer to the amount of effort relative to the gardener's initial effort. When the effort is lower (i.e. effort 100%) the ratio of effort to activities decreases, which lowers the amount of effort dedicated to maintaining the garden. It should be noted that the base values in the model for effort per core group gardener is equal to the sum of effort needed to maintain a plot and the desired effort for new projects. The base value of effort for non-core gardener is equal to effort needed to maintain a plot. The lower effort decreases the quality of garden making it harder to recruit and retain gardeners. When the effort is increased by 10% the vicious loop acts in a virtuous manner increasing the number of gardeners over time (Effort 110%). The base value for effort from gardeners (i.e. 100%) is currently not adequate to maintain the quality of the garden and sustain it over time. One of the ways the effort level of gardeners can be increased is by creating rules.

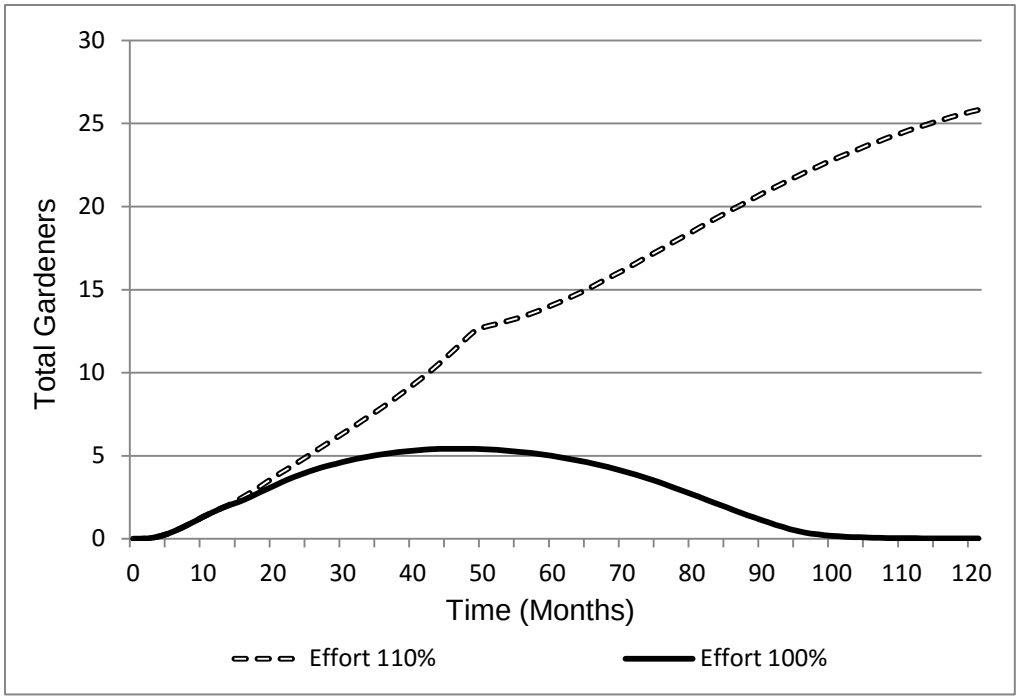


Figure 32: Variation in number of gardeners caused by changing the gardeners effort from 100 to 110 percent

5.3.5 Rule Structure

The formation of rules in the model is described with two stocks: *Verbally discussed rules* and *Codified rules* (see Figure 33). This structure is based on key informant interviews where gardeners talked about their rule making approach to solving problems. As issues arose affecting the community garden, they would create rules for working together to alleviate them.

> The first year that we gardened there wasn't a good plan in place for taking care of the lawn. So it would just happen sort of like catch as catch can. What it looked like historically is the grass is getting a bit tall and it would rain and the grass would get a foot tall. It's difficult to walk through. It would start like OK its about 6 inches we need to do something but then there would be this rain and it would just take off.

So I put forward a recommendation that maybe each participating family could take on the lawn maintenance for a time. The growing season is a certain number of weeks and if we did it every other week that would be eight opportunities to cut the grass and we would split it between the families. But not everyone did their obligation.

In the model, the discussion of new rules is driven by the *Ratio of quality of community garden to desired quality of community garden*. When this ratio is low more rules are discussed. , which increase the effort from gardeners and the quality of the garden. The process of discussing new rules is formulated as follows:

*Discussing new rules = Maximum number of new rules that can be discussed per month*Effect of Ratio of quality of community garden to desired quality of community garden on discussing new rules* (17)

The *Maximum number of new rules that can be discussed per month* limits the number of rules that can be discussed per month. This reflects a group's ability to discuss new rules within a given time period. When the quality of the garden is zero, the *Effect of Ratio of quality of community garden to desired quality of community garden on discussing new rules* is one, which means that new rules will be discussed at the maximum level. As the quality increases, the effect will decrease consequently decreasing the discussion of new rules.

When the new rules are discussed, they accumulate in the stock *Verbally discussed rules*, but do not have any impact on gardener effort. These rules have not been formally accepted in the garden. In other words, they have not been codified. Rules then move from the stock of *Verbally discussed* to *Codified rules.* The process of codifying rules takes time, which is represented by the parameter *Minimum time to codify rules*. However, if the level of trust among

the gardeners is low, this process can take longer. This process is such that when the level of trust is at the maximum level the *Time to codify rules* will equal the *Minimum time taken to codify rules.*

*Time to codify rules = Minimum time taken to codify rules*Effect of ratio of trust among gardeners to maximum trust among gardeners on time to codify rules* (18)

As the rules flow into the stock of *Codified rules* it increases the *Codified rules ratio,* which is a ratio of *Codified rules* to *Initial codified rules.* As this ratio increases, it increases the potential effort from gardeners. The stock of *Codified rules* is drained by the outflow *Abandoning codified rules.* This outflow is dependent on the *Ratio of total potential effort per month to activities to be done per month* such that when there is more effort than activities to be done, the rate of abandoning rules is higher. If there is enough effort, some of the rules intended to increase effort will be abandoned. The abandonment of rules is formulated as:

*Fractional rate of abandoning codified rules = Maximum fractional rate of abandoning codified rules*Effect of ratio of total potential effort per month to activities to be done per month on Fractional rate of abandoning codified rules* (19)

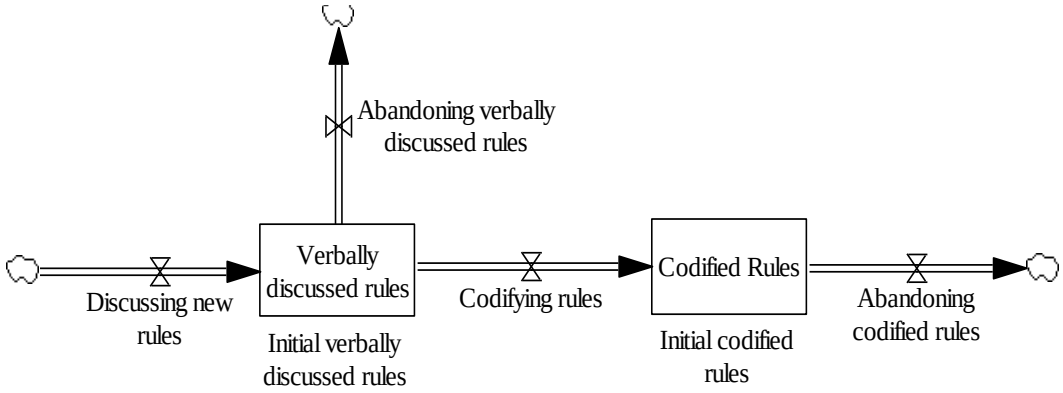


Figure 33: Mechanism for developing rules in the community garden

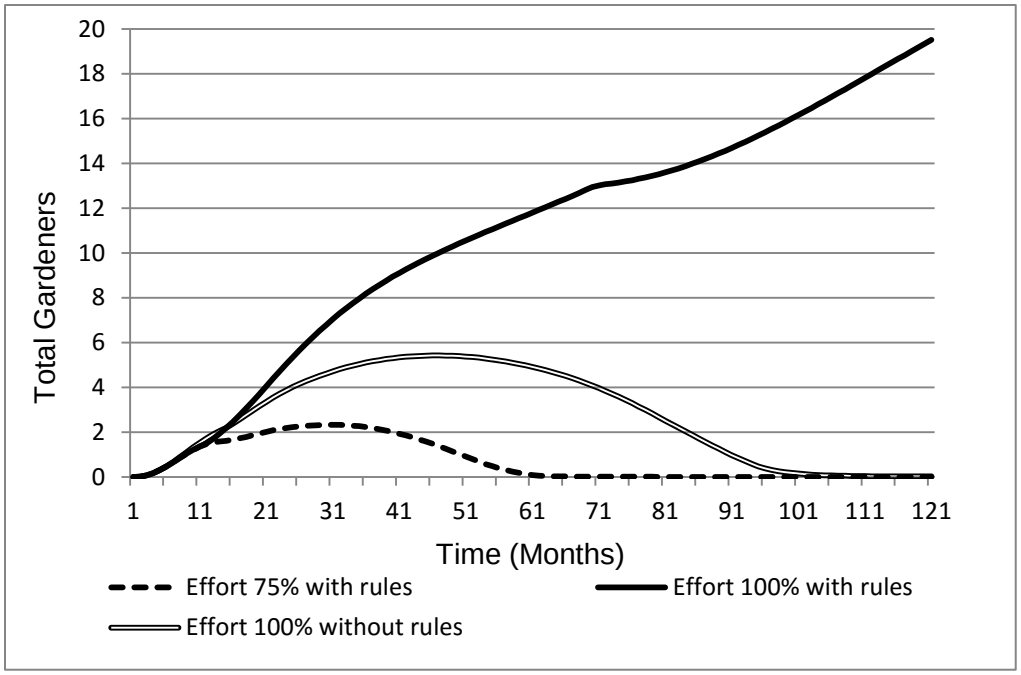


Figure 34: Impact of changing effort level with the addition of rules structure

With the rules structure there is a new balancing loop added, which helps to control the effects of the vicious loop. When the quality of the garden declines, new rules are added to increase the effort from the gardeners. More effort will improve the quality of garden and sustain the number of gardeners. However, increasing rules can only work to a certain extent. If too many rules are created, the extra effort will increase the gardener turnover.

The impact of changing initial effort level from gardeners from 100% (base value) to 75% is seen in Figure 34. Without the rules structure, the scenario with 100% effort was not able to sustain the garden. With the rules structure, the same values produce a very different behavior. However, when the initial effort is reduced to 75%, the garden is not sustained as the extra effort increases the gardener turnover rate.

5.3.6 Trust

The variable trust is conceptualized as a stock with a minimum of zero and maximum of one. Trust within this context has a specific meaning. Trust grows as social relationships within the garden grow. Having trust helps with implementing rules. No matter how many rules are created, without trust, the effort from the gardeners will not change. One of the gardeners explained:

> I think trust played a huge role. You have to trust other gardeners not to take your produce, trust them to not use chemicals. We also had to trust one another not to take the tools. Also if you used the spade you had to clean the dirt off it before you put it back to extend the life of it.

The stock of trust changes based on the flow *Changing trust among gardeners*, which is formulated as:

*Changing trust among gardeners= (Maximum trust among gardeners*Effect of ratio of social relationships among gardeners and maximum social relationships among gardeners on changing trust among gardeners-Trust among gardeners)/Time to change trust* (20)

When the *Effect of ratio of social relationships among gardeners and maximum social relationships among gardeners on changing trust among gardeners* is one this formulation will increase trust to the maximum level within the time frame specified by *Time to change trust.* The effect variable is dependent on the density of social relationships represented by *Ratio of social relationships among gardeners and maximum social relationships.* If there are only half the

relationships of all the possible relationships, the ratio will be 0.5 and consequently the effect variable will also be 0.5. In this case, trust can only increase up to 0.5. If the effect variable is less than the level of trust, the flow *Changing trust among gardeners* will become negative and decrease the trust.

5.3.7 Social Relationships

Social relationships in the model are conceptualized as a stock of relationships as they accumulate over time (see Figure 35). Based on the key informant interviews, it is clear that people who established the garden have prior relationships. One of the gardeners explained, "We are a pretty tight knit group of people through our participation in the block group. Many of us attend the same church. We had relationships prior to the garden."

Relationships are not developing from joining a garden. Instead relationships are carried over from other community activities to community gardens. To capture this idea, the social relationships structure has three stocks. The first stock, *Social relationships among people involved in community but not involved in community garden* represents those pre garden relationships among people. Since they already have the relationships before the garden is established, the initial value for this stock is based on *Initial number of people involved in community but not involved in community garden.* The model assumes that every person in that initial group had social relationships with each other. The second stock *Social Relationships among those involved in community garden* represents the relationships among all the people involved in the garden including the people who are interested in establishing the garden. The social relationships structure is connected with the gardener structure as a co-flow. When people move from one stock to another, their relationships follow them. For example, when people move from *Number of people involved in community but not involved in community garden* to

Number of people interested in establishing a garden their social relationships move with them from the first stock to the second. Similarly, as the gardeners leave the system, they carry their social relationships with them.

Social relationships are carried from one stock to another but as people establish the garden and start working together, new relationships can also be built. One of the gardeners explained the forming of social relationships in the context of community gardening.

> It's nice to have a garden where you are constantly meeting each other in a more work like setting. It's continuous. It's not like you are sitting around talking about what you need to do and what you want to do. It's a more natural spontaneous way to build relationships with your neighbors. It's more relaxing. You are building relationships with your neighbors and sometimes meeting new people and getting to know the people that you have met through other meetings. You get to know them better. It has cohesified our group in relationships.

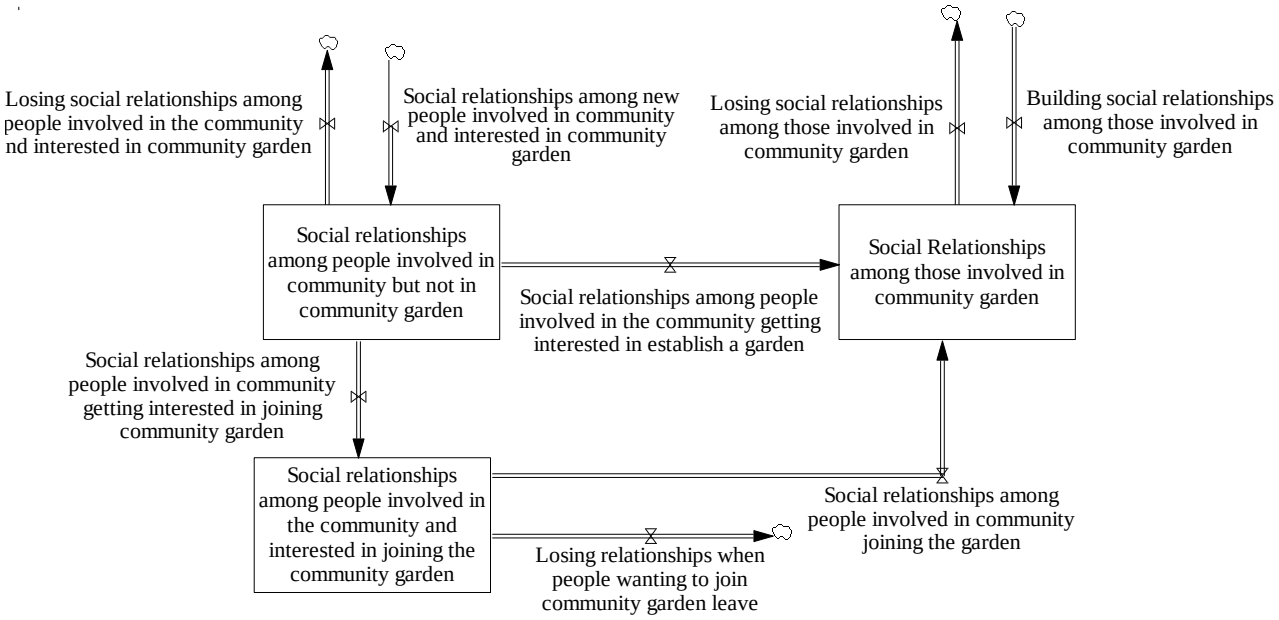


Figure 35: Flow of social relationships among people involved in the community garden

The building of new relationships is formulated as follows:

Building social relationships among those involved in community garden = (21)

*IF THEN ELSE(Maximum relationships among people involved in the community garden>Social Relationships among those involved in community garden,(((**Maximum relationships among people involved in the community garden-Social Relationships among those involved in community garden)/Maximum relationships among people involved in the community garden)*Total social interactions among people involved in the community garden*Rate of relationship formation per interaction**), 0)*

The equation is formulated as an "IF THEN ELSE*"* statement. This statement follows the syntax of *Condition, True Value, False Value*, such that if the condition is met it will have the true value else it will have the false value. In this equation, the condition is given by *Maximum*

relationships among people involved in the community garden>Social Relationships among those involved in community garden. The condition for this *if then else* statement will be satisfied only when the maximum relationships for people in the stock is greater than the actual social relationship. The maximum relationships is defined as

Maximum relationships = $\frac{N*(N-1)}{2}$ *; where N = total number of people in the stock*

Therefore, if there are three gardeners, the maximum total relationships possible would be three and if there are four gardeners, maximum total relationships possible would be six. Without having this maximum limit, the number of relationships would keep growing even when the number of people is constant. If this condition is not met, the value for building relationships will be zero. If this condition is met, the value will be determined by the true value (shown in bold in the equation). The true value has two parts. The first part is:

(Maximum relationships among people involved in the community garden-Social Relationships among those involved in community garden)/Maximum relationships among people involved in the community garden

As the social relationships for a stock of people approaches the maximum level, this terms helps to slow down the process of relationship building and ensure that social relationships do not exceed the maximum level. Since a system dynamics model is built at an aggregate level, it is not possible to differentiate between people in a stock. Therefore, two people can keep forming relationships. The second part of the true value is:

*Total social interactions among people involved in the community garden*Rate of relationship formation per interaction*

Total social interaction is a product of number of people in the stock and their rate of interactions. A group of 10 people who interact twice per month will produce 20 total social interactions. The rate of relationship formation defines the percent of those interactions that form into a relationship. If the rate of relationship formation is 0.1, 20 social interactions would produce one relationship.

The stock of relationships decreases only when gardeners leave. The model assumes that every person forms the same amount of relationships. It would seem that average number of relationships would be calculated as number of relationships divided by the number of people. However, this is not true. If this was the case, when everyone had a relationship with each other in a group of three people the average relationship would be 1.5 instead of two. In this model, the average relationship is calculated as:

*Average relationships among gardeners = (Social relationship among gardeners/Max relationships)*Max relationship per person* (22)

In a group of three people the maximum relationship per person would be two (defined as number of people-1). If the group has formed the maximum number of relationships (i.e. three), the ratio of social relationships and maximum relationships would be one and the average relationship would equal two. If the group has not reached the maximum number of relationships, then the ratio would be smaller than one, resulting in a smaller average relationship. The figure below shows the impact on the number of relationships when a single gardener leaves. For gardens that don't have any gardeners or only has one gardener the number of social relationships is zero. When there are two gardeners, the social relationships increases to one. However, when one gardener leaves in 20th month, the number of social relationships goes

back to zero. Similarly, when there are four gardeners and they have formed six relationships, one gardener leaving results in only three relationships remaining among the three gardeners.

The density of social relationships affects building of trust in the community garden. When the level of trust is high the rules designed by the garden are implemented. Therefore, increasing the effort to maintain quality of garden by creating new rules is only possible when there is a high level of social relationships and trust among the gardeners. Figure 36 shows the impact of different interaction rates on number of gardeners. When the interaction rate is higher (i.e. Effort 100% interaction rate 3), relationships are formed at a faster rate, enabling the building of trust among gardeners. With higher level of trust, rules designed to increase effort can be implemented. With higher level of effort, the quality of garden is maintained and the number of gardeners continue to grow. When the interaction rate is lower, the number of gardeners begin to decline. The two scenarios differentiate much later in the simulation because in the earlier stages the gardeners already have social relationships. The effect of a low interaction rate is truly seen when new gardeners come in and the social relationship density is lower.

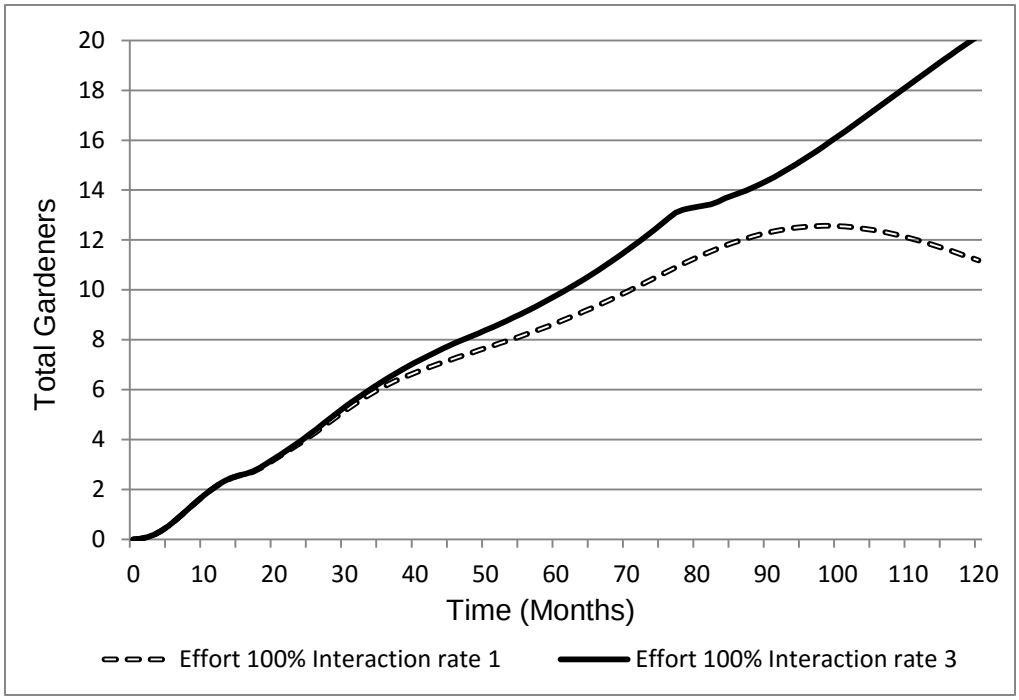


Figure 36: Effect of different interaction rates among gardeners on number of gardeners through formation of social relationships, building of trust, and implementation of rules

Until now the effort needed in the garden has primarily come from the gardeners. However, partnering agencies play a vital role in supplementing effort in community gardens and building partnerships, which is crucial for sustaining gardens.

5.3.8 Building Partnerships

Every garden is built and sustained with help from partnering agencies. These partners can be local community organizations, church groups, police departments, schools and universities. These groups partner with community gardens in many different ways. The most common and perhaps the most important partnerships are with volunteer groups who come to the garden and help with the garden work, reducing work load for the gardeners. Building partnerships adds another feedback loop so that when the effort is low new partnerships are created supplementing the effort. This reduces the burden for the gardeners and helps maintain the quality of garden.

As the number of partners for a garden can accumulate over time, it is conceptualized as a stock in the model (see Figure 37). The number of partners increases when the effort from gardeners is not enough to meet the needs of the garden. As one of the gardeners explained,

> I think it's (i.e. partnerships) really important especially now because going into the growing season and losing the person who maintained your lawn. It's not that they are going to help us maintain it. But just to have additional support to keep us going.

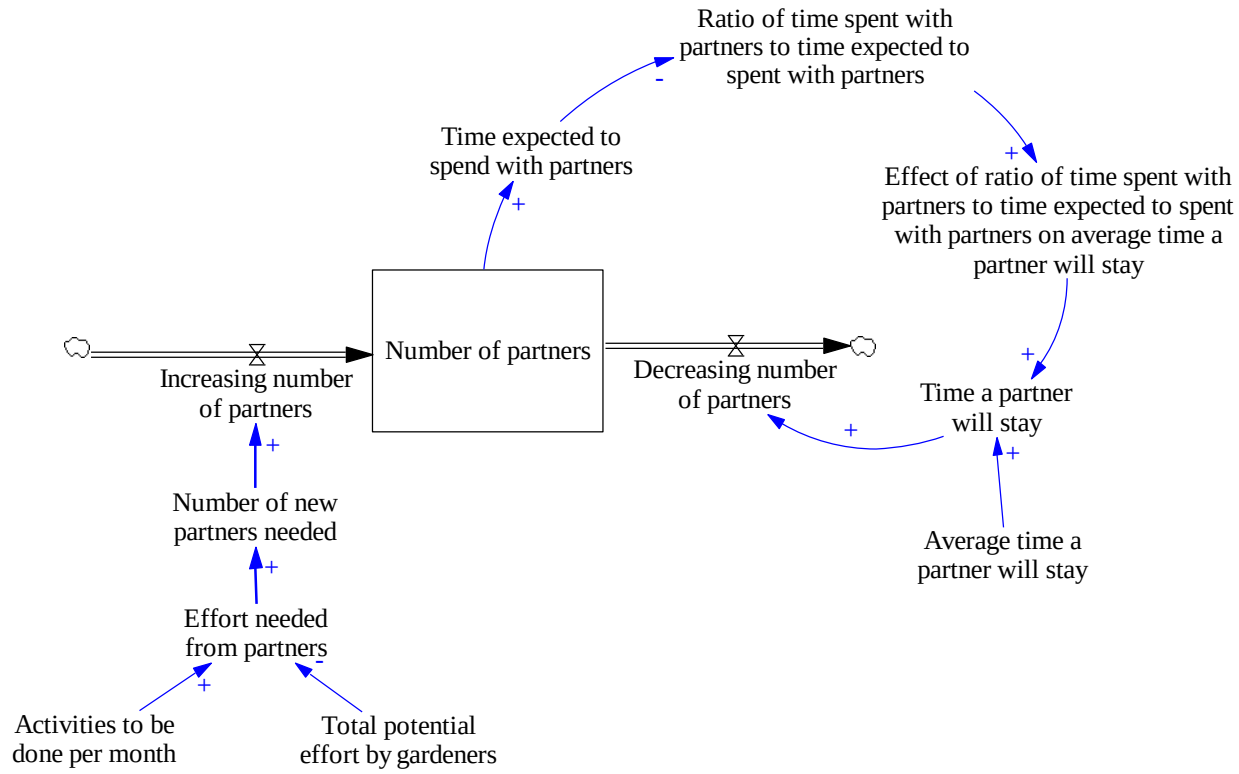


Figure 37: Simplified processes governing the inflow and outflow of partners in a community garden

The amount of *Effort needed from partners* is the difference between the effort needed for the garden and the effort provided by the gardeners. Therefore, partners can supplement the effort to maintain the quality of the garden. The number of new partners needed is based on the total effort needed and the amount of effort provided by each partner. This process is also

affected by the quality of garden through the variable *Effect of ratio of quality of garden to desired quality of garden on number of partners needed*. When the ratio of quality of garden is one, the *Number of new partners needed* equals *Effort needed from partners/Effort per partner*. When the ratio of quality of garden is 0.5, the effect variable is 1.5 resulting in a 50% increase in number of partners needed. This process is formulated as:

Number of new partners needed = (Effort needed from partners/Effort per partner)*Effect of Ratio of quality of garden to desired quality of garden on number of partners needed (23)

The model assumes that a particular garden can only have a certain number of partners at any given time. As a result, the inflow, *Increasing number of partners* is formulated such that the rate of flow begins to slow down as the number of partners reaches the maximum level. This rate control occurs through the expression *Maximum number of partners per garden-Number of partners/Maximum number of partners per garden*, which is a ratio that moves closer to zero as *number of partners* gets closer to *Maximum number of partners per garden*. The *Number of new partners needed* is divided by *Time needed to find a partner* to represent the time taken between needing a partner to the partner providing supplemental effort.

*Increasing number of partners = ((Maximum number of partners per garden-Number of partners)/Maximum number of partners per garden)*Number of new partners needed/Time needed to find a partner* (24)

Partners also leave the garden through the outflow *Decreasing number of partners*. The model assumes that there is an average duration that a partner will work with the garden. This

average time can increase or decrease based on how much time the gardeners spend cultivating the relationship. One of the gardeners explained the effort it takes to maintain relationships with partners, "lot of times _____ would call me in and say we have a group that would like to volunteer. I would tell them yeah and ask when…they would say now. It took 3-4 hours to accommodate them." Once the partnership is built the garden has to sustain it. This takes a lot of effort in terms of organizing and supervising. As some of the gardeners explained, *"*They need the understanding that they are coming to help the garden and they need to be respected and make them feel valued and welcome. So far as volunteers go, I think when people stop being appreciated or wanted or needed then they start to fall away.*"* The time a partner will stay is formulated as:

Time a partner will stay = (25)

*Average time a partner will stay*Effect of ratio of time spent with partners to time expected to spent with partners on average time a partner will stay*

The *Effect of ratio of time spent with partners to time expected to spent with partners on average time a partner will stay* depends on the ratio of time expected and actual time spent with the partner. If the gardeners spent as much time as expected (i.e. the ratio = one) then the partner will stay for the average duration. If the ratio is 0.5, the partner will stay for half of the average duration. The time gardeners spent with partners is in turn dependent on the amount of effort available from the gardeners compared to the amount of activity that needs to be done. The time spent with a partner per month is formulated as:

Time spent per partner per month = (26)

*Time expected to spend per partner per month *Effect of Ratio of total potential effort by gardeners to activities to be done per month*

The *Effect of ratio of total potential effort by gardeners to activities to be done per month* is dependent on the ratio of effort by gardeners and activities to be done. Therefore, if the effort by gardeners is equal to the activity to be done (i.e. ratio =one), *Time spent per partner per month* will equal *Time expected to spend per partner per month.* If there is twice as much activities to be done than effort from gardeners (i.e. ratio =0.5), *Time spent per partner per month* will be half of what was expected.

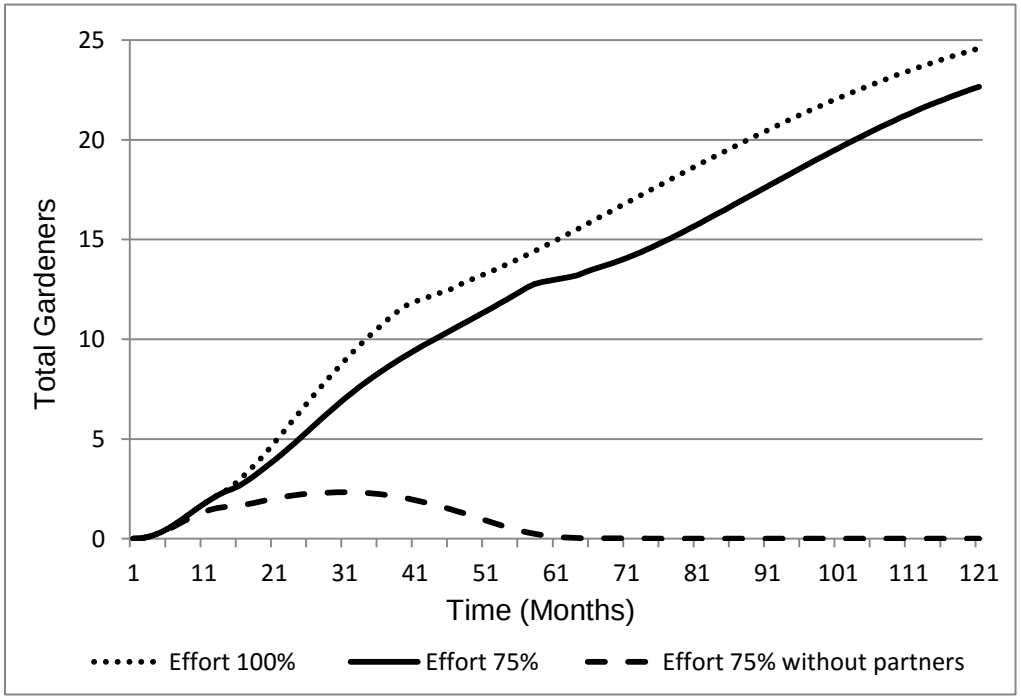


Figure 38: Impact of varying gardener effort level of total gardeners with the partners structure

The variation in total number of gardeners caused by changing the effort level of gardeners is shown in Figure 38. In an earlier experiment reducing the effort by 75% had caused

the total number of gardeners to decline over time. With the addition of the partners structure, the lower effort is compensated through the number of partners that supplement the effort. However, when the effort level is decreased further to 50%, gardeners begin to decline. This is because there is a limit to how many partners can work in the garden.

5.4 Reproducing the reference mode

The goal of system dynamics modeling is to understand the underlying feedback processes that produce a dynamic behavior. The dynamic behavior for this study was presented earlier in Figure 1. This figure assumes that the number of people engaged in the beginning is zero and slowly increases and sustains or erodes away. The two behavior patterns presented in the reference mode were conceptual and the goal was to make revisions based on data collected from key informant interviews. However, the key informants were not able to recollect how the number of gardeners changed over time. After asking for general patterns, they tried to remember number of gardeners at different points in time such as " we started out with 10 people…near the end it was no more than 10…at one time we had 40 people." With the difficulty of generating trends with such narratives, a decision was made to use the initial reference mode to represent the general trends of sustained and eroding engagement. In Figure 39, the two behaviors in the reference mode (RM) are presented without markers. The simulations (S) from the model are presented with markers. As shown in figure, the model is capable of reproducing the general behavior pattern of sustained and eroding engagement.

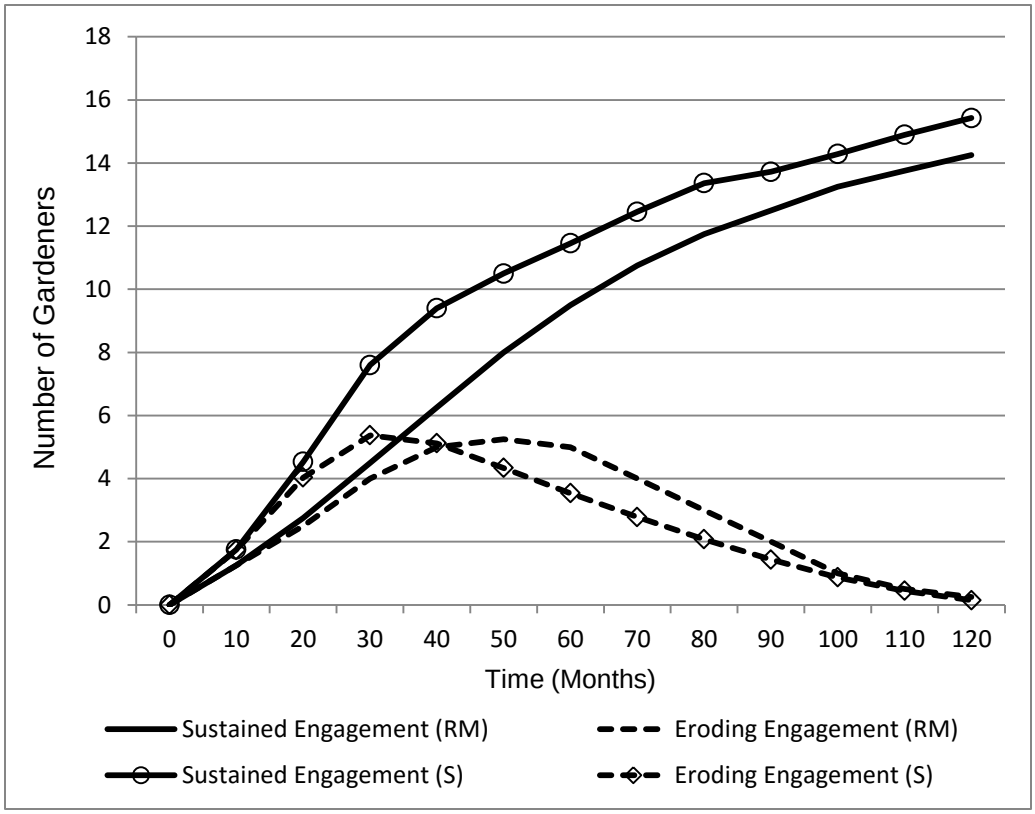


Figure 39: The two scenarios of sustained and eroding engagement from the reference mode (RM) and the simulation (S)

5.4 Conclusion

This chapter described how the feedback mechanisms presented earlier were revised based on qualitative data from the key informant interviews. In doing so, this chapter fulfilled Aim 1 of this study and provided a better understanding of what feedback mechanisms could be operating within the community gardens. The final model developed in this study is quite complicated with 152 variables. One of the goals of this chapter was to show how this model was developed in a step-wise manner. Smaller pieces of structure were developed, tested, and explained to provide a clearer understanding of how individual model structures work. These smaller model structures were then combined with others structures to understand how each structure affects the behavior produced by the model.

Chapter 6: Model Analysis

6.1 Overview

The goal of analyzing a model in system dynamics is to understand the underlying assumptions of the model and recognize how the results of the model are sensitive to these assumptions. This chapter will focus on understanding the impact of uncertain parameters on the model behavior and describe how these parameters affect model behavior. A specific technique called statistical screening will be used to understand the magnitude of influence of a particular parameter. The process entails conducting multiple simulations within the range of any given parameter and calculating the correlation coefficient between the parameter and the outcome variable (i.e. number of gardeners). The magnitude of the correlation coefficient signifies the strength of the relationship between the parameter and the outcome variable. Both the magnitude and direction of the coefficient can change during the period of the simulation. In other words, a parameter could be highly influential in the beginning of the simulation but its impact can slowly decline over the course of the simulation or vice versa.

6.2 Sensitivity to uncertain parameters

The model has many parameters whose exact value is uncertain. This section will describe how each of these parameters affects the model results. Three pieces of information will be provided to reach this goal: 1) a table with uncertain variables, their model values and the range of values tested, 2) a graph with sensitivity results showing the impact of the uncertain parameters on total number of gardeners, and 3) a graph showing the impact of each of the uncertain parameters over time. This will be repeated for each of the substructures. The first structure (land structure) will cover more details to explain the process.

6.2.1 Land Structure

The land structure has two uncertain parameters as shown in Table 3. This structure has other parameters such as *Initial number of active plots* and *Initial number of inactive plots.* Since the model begins before a garden is established, these parameters are set at zero, and not included in the analysis. Sensitivity analysis was conducted to understand how the values of these parameters affect the output of the model. Vensim DSS has the ability to conduct a Monte Carlo simulation, which makes the sensitivity analysis procedure automatic. The software runs a predefined number of simulations (50 in this study), varying the values of the parameters based on a given range. In system dynamics, it is customary to vary the parameter by +/- 50%. The software also requires the user to define the type of probability distribution that determines how the values will be picked. In this case, a random uniform distribution was used to ensure equal likelihood that any value from the range may be picked. The software also requires the user to define a sampling technique. In this study, the Latin Hypercube Sampling (LHS) was used because of its efficiency. This technique divides the range of values of the uncertain parameter into 50 stratas (50 simulations defined by user) with equal probability (A. Ford & Flynn, 2005; Taylor, Ford, & Ford, 2010).

Table 3: Uncertain parameters, model values, and range values for testing the land structure

Uncertain Parameters	**Units**	**Base Value**	**Range**
Initial land available	Plots	30	15-45
Time to build a plot	Plots/month	12	6-18

The result of the simulation is shown in Figure 40. The graph shows 50 simulation runs with two bands representing the 50% and 100% of the simulation runs. In the beginning, there is

less variation caused by the uncertainty in the parameters. As the simulation progresses, there is more variation. However, all of the simulation runs are showing similar pattern of behavior. This suggests that the model as formulated is not sensitive enough to the uncertainty of these two variables within the given range to generate different patterns of behavior. In other words, based on this structure, how big the land is or how long it takes to build a plot will affect the number of gardeners but will not be the difference between sustaining and eroding participation in the community garden.

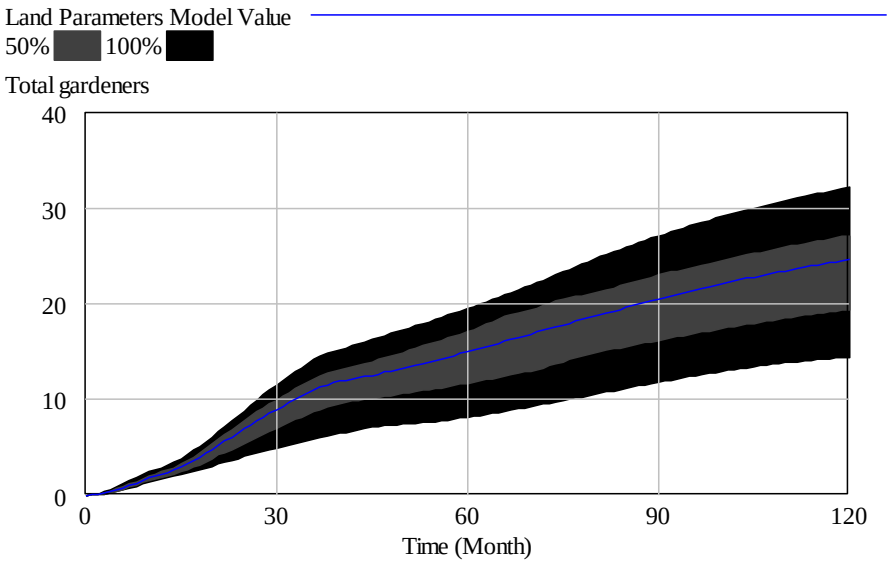


Figure 40: Results of sensitivity analysis for the land structure

The above graph provides information regarding the variation in the output variable. It doesn't show how each of the parameters affect the output over time. Using statistical screening (A. Ford & Flynn, 2005; Taylor et al., 2010), it is possible to disentangle the effect of each of these parameters. This technique calculates the correlation coefficient between the varying parameter and the output over the 50 simulations across time. The result of the sensitivity analysis was exported into a Microsoft Excel template which is available freely through Dr.

Andrew Ford's website (see http://public.wsu.edu/~forda/CCTemplate.html). The template is designed to calculate the correlation coefficients and produce a graph.

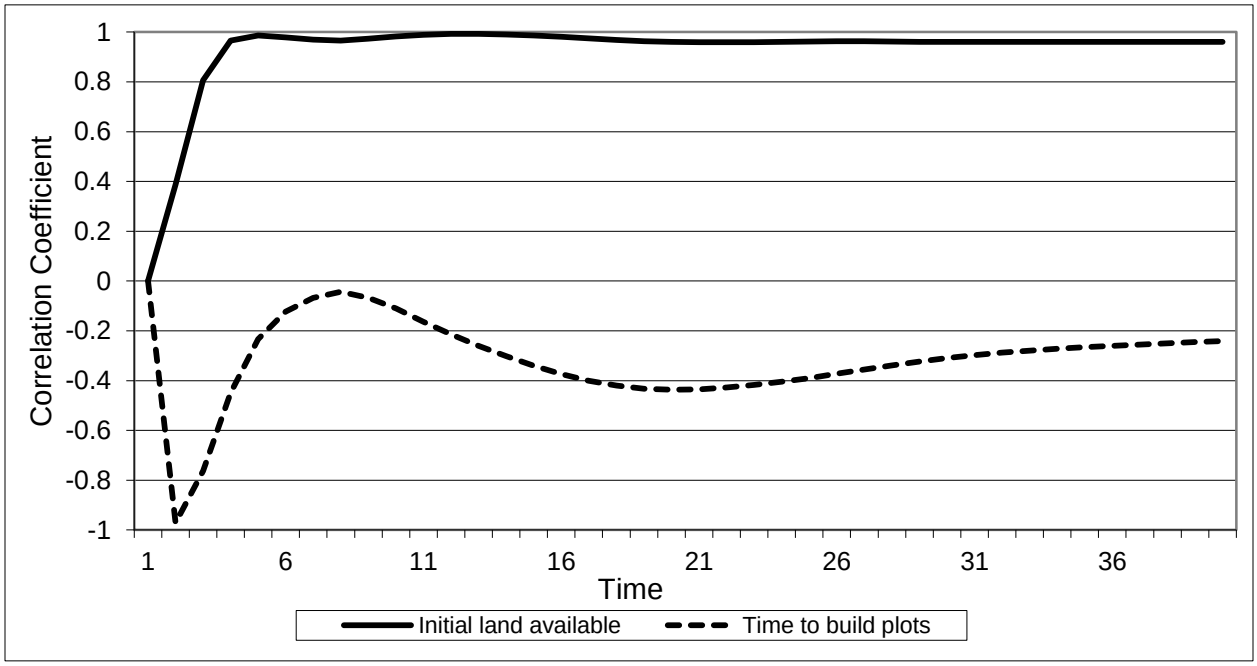


Figure 41: Correlation coefficients over time between uncertain parameters in the land structure and total gardeners

Figure 41 shows how each of the parameters impact the number of total gardeners over time, with time on x-axis and correlation coefficients between the parameters and total gardeners on y-axis. The sensitivity analysis produces a lot of data therefore only data for every 3 months was saved and presented in the graph. A simulation run for 120 months is synthesized and represented in 40 time points. Correlation coefficients for both of the parameters start at zero because the initial number of gardeners is set to zero. Since there is no variation in the outcome variable the coefficients for any of the parameters cannot be calculated. Based on the values of the coefficients, *Time to build plots* has a negative relationship with *Total number of gardeners*. When *Time to build plots* is higher, it takes longer to build the plots and for new gardeners to join, which increases the number of gardeners. Whereas, *Initial land available* has a positive

relationship with total number of gardeners. When the amount of land available is higher, more people can initially become interested in establishing the garden. This results in higher number of core group members. Higher numbers of core group members results in higher recruitment rate and consequently more gardeners. Figure 42 shows the impact of varying *Initial land available* between 15, 30, and 45 plots. It also shows that initially there is no variation, which corresponds to the smaller correlation coefficients in the beginning for *Initial land available*. The patterns produced here is similar to the bands of simulation runs shown in Figure 40, suggesting that changes in *Initial land available* causes most of the variation in total gardeners, which matches the high correlation coefficients for this parameter.

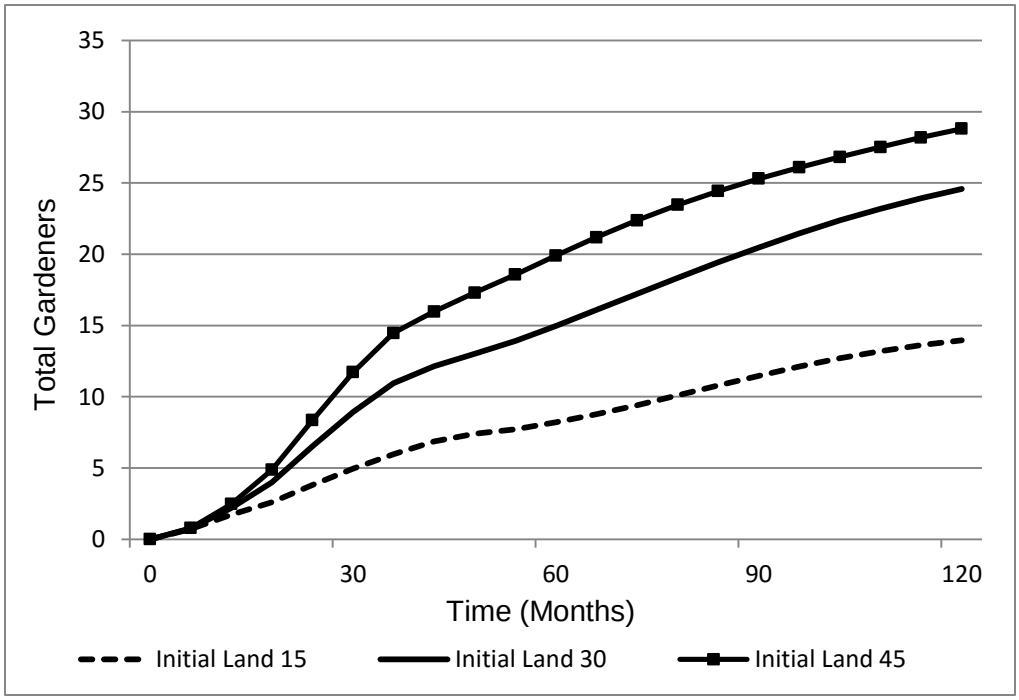


Figure 42: The impact of varying initial land available between 15, 30, and 45 plots on the total number of gardeners

6.2.2 Gardener Structure

The gardener structure has 14 uncertain parameters as shown in Table 4. The result of varying these uncertain parameters using the Monte Carlo simulation is shown in Figure 43.

Uncertain Parameters.	Units	Base Value	Range
Initial number of people involved in community but not involved in community garden	People	50	25-75
Net people being involved in community	People/month	0.25	0.12-0.37
Average time non-core group gardeners stay	Month	24	12-36
Average time core group gardeners stay	Month	48	24-72
Contact rate among people involved in the community	Contact/Month	1	0.5-1.5
Initial Successful contact rate among people involved in the community	1/Contact	0.1	0.05-0.15
Contact rate with other community members	Contact/Month	0.5	0.25-0.75
Initial Successful contact rate with other community members	1/Contact	0.1	0.05-0.15
Initial contact rate for establishing garden	Contact/month	3	1.5-4.5
Time to become part of the core group	Month	24	12-36
Time to join a garden	Month	12	6-18
Success of contact for establishing garden	1/contact	0.1	0.05-0.15
Time for people interested in establishing a garden to leave	Month	24	12-36
Time for people wanting to join community garden to leave	Month	12	6-18

Table 4: Uncertain parameters, model values, and range values for testing the Gardener structure

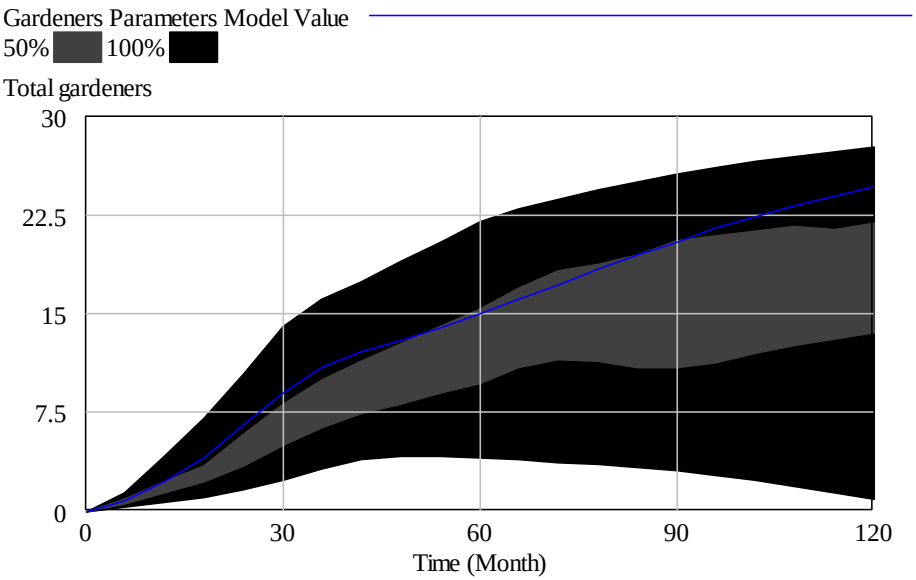


Figure 43: Results from sensitivity analysis for gardener structure

The variation in uncertain parameters in the gardener structure produces a wide ranging result. The model behavior is sensitive to variations in these parameters, as it can produce both sustained and eroding engagement behaviors. To understand how each of the parameters affects the behavior, the result from statistical screening has been shown in two different figures. The first figure shows parameters that initially impact the behavior and the second figure shows parameters whose impact increases as the simulation progresses. Some of the parameters that had relatively less impact (< +/- 0.2 correlation coefficient) are not presented in the graph.

As shown in Figure 44, all three parameters have more impact on the outcome variable at the initial stages. As the simulation progresses their impact decreases. The *Initial number of people involved in community but not involved in community garden* determines the initial number of people who became interested in establishing the garden. When this number is higher, there are more people who establish the garden and become core members. They also interact with others to recruit them as non-core group gardeners. Its impact is still high in the middle

phases of the simulation because they are the ones who join the already established community garden. The impact begins to decline later because as the initial people become gardeners, there are less people in the stock to impact the outcome variable. The *Initial contact rate for establishing the garden* is important early on for the same reason as *Initial number of people involved in community but not involved in community garden*. Both of them affect the number of people that are initially working to establish the garden and become core group members. The impact of the contact rate declines quicker because once the garden is established; it doesn't have any impact on the flow of people. The impact of *Initial successful contact rate among people involved in the community* increases slowly as the process of joining garden takes effect later than the process of establishing the garden. Its impact begins to decline because there are less people involved in the community who are available to join the garden.

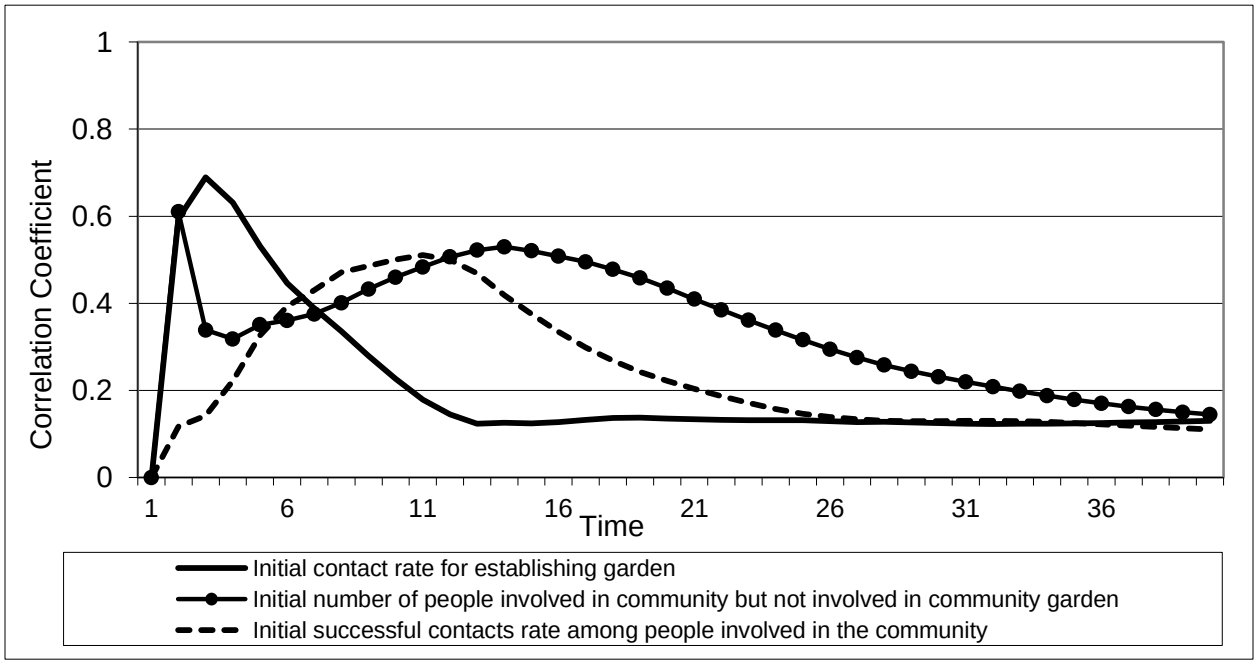


Figure 44: Correlation coefficients over time between uncertain parameters in the gardener structure and total gardeners (High impact on the earlier part of the simulation)

Figure 45 shows the parameters that had high impact on the outcome variable as the simulation progressed. Both *Average time core group gardeners stay* and *Average time non-core group gardeners stay* affect the outcome variable positively and their impact increases as the simulation progresses. As the simulation progresses, the core group and non-core group gardeners accumulate. Higher average times will reduce the rate of them leaving the garden, contributing to overall higher number of total gardeners. The impact of *Initial successful contact rate among other community members* steadily increases over time. It doesn't play a role in the beginning because the number of gardeners is determined by the initial group of people who established the garden and number of people involved in the community. As the simulation progresses, the higher value of this parameter means that more new people are joining the garden.

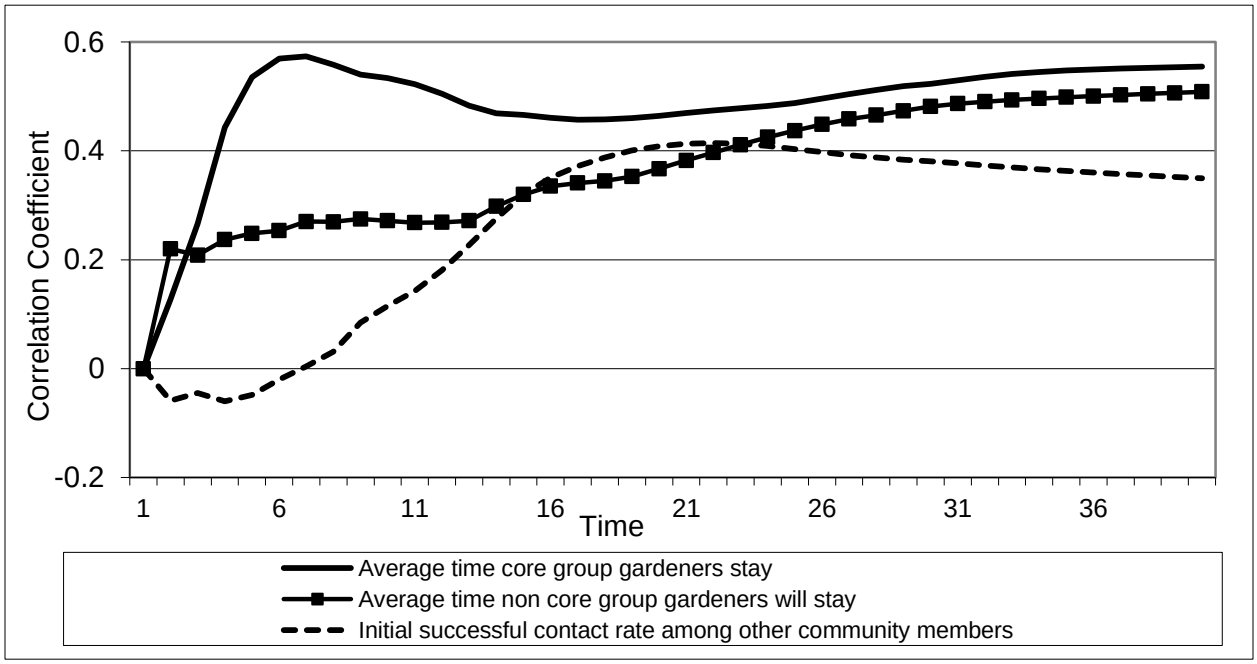


Figure 45: Correlation coefficients over time between uncertain parameters in the gardener structure and total gardeners (High impact on later part of the simulation)

Figure 46 shows how changing the parameter *Average time core group gardeners stay* affects the total number of gardeners. In both scenarios (month 48 and 72) the number of gardeners steadily increases. When the average time drops to 24 months, the number of gardeners increases in the beginning, but the rate of increase slows down. However, it doesn't produce the eroding pattern. When we combine this scenario with average time non-core members stay as 12 months it produces the eroding pattern. These two parameters are highly impactful on the outcome variable, as shown by this figure and the correlation coefficients. To better understand their impact we can also look at the definition of these two parameters. Based on the model, the time a gardener (both core and non-core) stays is defined by its relationships to the quality of garden, density of social relationship, and the effort they put forth. When the average time for a core group gardener to stay is 48 months, for the actual time a garden stays in the garden to be 48 months, the quality of garden should be one, density of social relationships should be 75%, and the effort put forth should equal the effort they initially wanted to put forth.

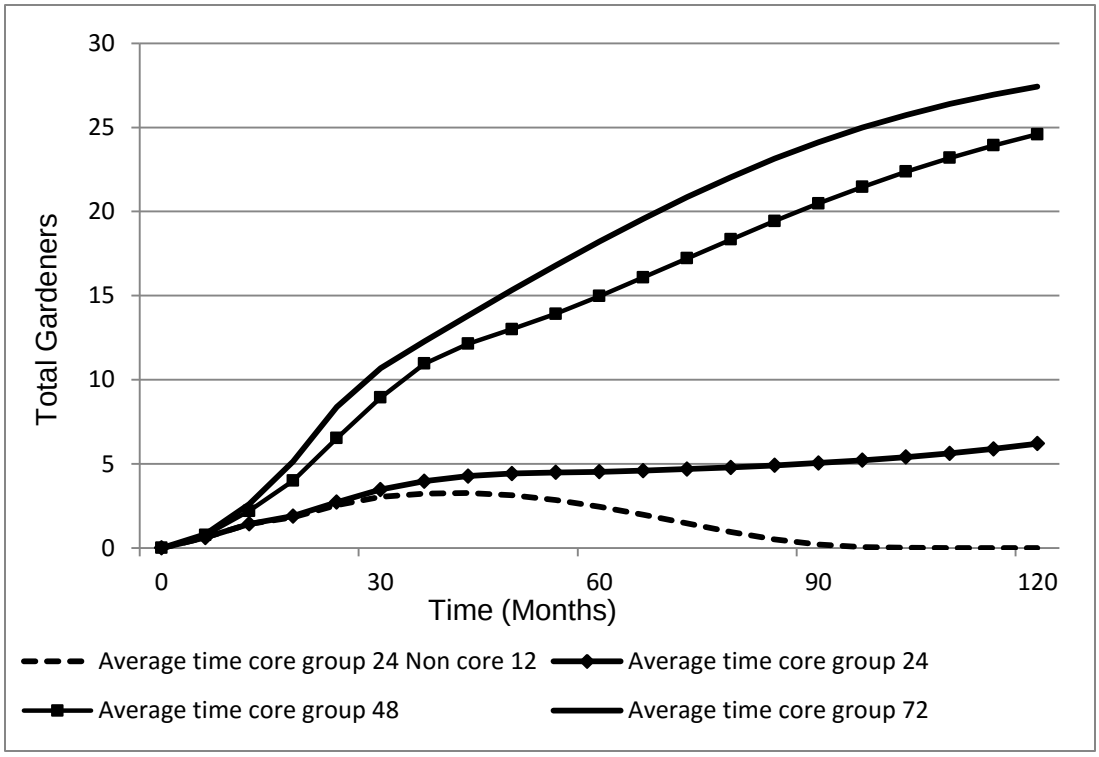


Figure 46: Impact of changing average time core group gardener stays between 24, 48, and 72 months and combination of average time core group 24 months with average time non-core group 12 months

6.2.3 Activities Structure

The activities structure has six uncertain parameters as shown in Table 5. The impact of these parameters on the outcome total gardeners is shown in Figure 47. These parameters don't have an impact on the outcome in the earlier part of the simulation. As the simulation progresses, the variation is more evident. Within the given ranges of the parameters, from the activities structure, the model produces both sustained and eroding engagement patterns of behavior. However, it should be noted that 90% of the simulation runs produce a similar pattern of behavior. This suggests that the model is sensitive to changes in the values of these parameters but only in few cases.

Table 5: Uncertain parameters, model values, and range values for testing the activities structure

Uncertain Parameters	**Units**	**Base Value**	**Range**
Activities per plot to be built	Hours/Plot	20	10-30
Desired activities per unused plot	Hours/Month/Plot	15	7-23
Desired activities per used plot	Hours/Month/Plot	20	10-30
Desired activities for the general maintenance of the garden	Hours/Month	30	15-45
Initial potential effort per non-core group gardener	Hours/Month	20	10-30
Initial potential effort per core group gardener	Hours/Month	30	15-45

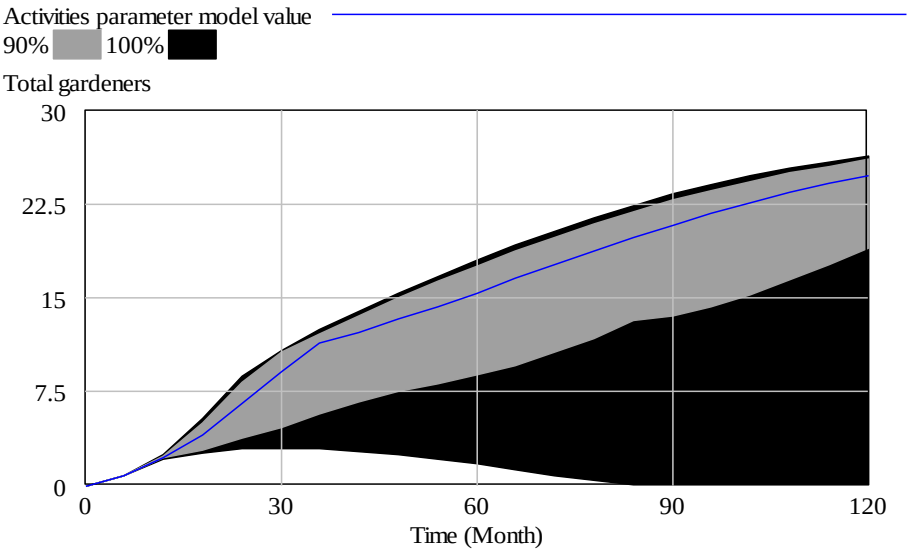


Figure 47: Variation in total gardeners caused by the changes in parameters in the activities structure

Three out of the six parameters in the activities structure impact the outcome (see Figure 48). The parameter *Activities per plot to be built* is more impactful in the beginning stages of the

simulation but its effect wanes as the simulation progresses. The earlier impact is due to the building of initial plots, during the establishment of the garden. In the later stages, fewer plots are being built, which results in less impact of this parameter on the outcome variable. *Initial potential effort per core group gardener* is impactful throughout the simulation. This suggests that the variation in effort by the core group results in very different outcome behaviors. The effort by core group members is much more impactful than the effort by non-core groups because there are more core member gardeners than non-core members. The parameter *Desired activities per used plot* negatively impacts the outcome behavior. When the desired activities is high, it generates more work, which decreases there will be a bigger gap between what is desired and actual level of effort reducing the quality of the garden.

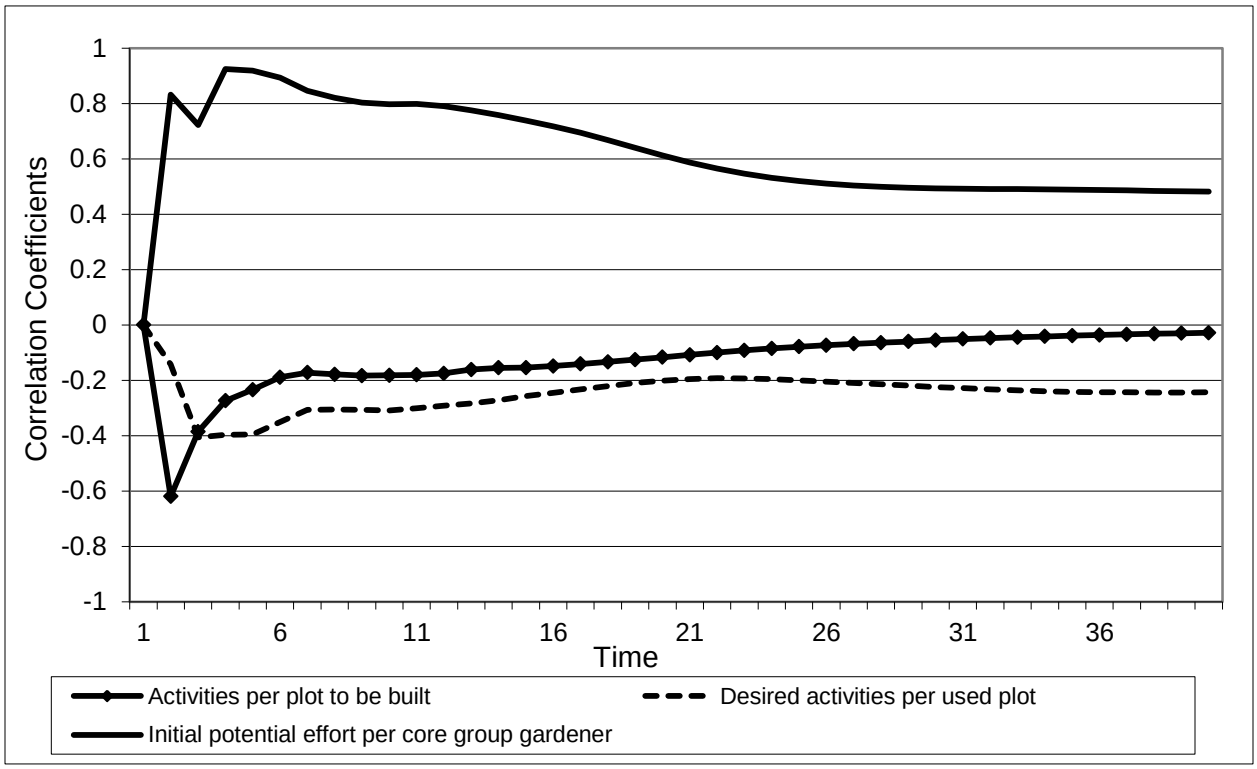


Figure 48: Correlation coefficients over time between uncertain parameters in the gardener structure and total gardeners

The two impactful parameters, *Desired activities per used plot* and *Initial effort per core group gardener*, can explain much of the variation shown in Figure 47. The figure below shows how these parameters affect the outcome behavior. In the top three scenarios, the *Desired activities per used plot* is kept constant at the base value (i.e. 20 hours/month) and the *Initial effort per core group gardener* is changed between 45, 30, and 15 hours per month. This causes variation in the outcome variable but does not produce the eroding engagement behavior. In the fourth scenario, the effort was kept at 15 hours/month and the *Desired activities* was increased to 30 hours per month. This scenario, where the core group gardeners are doing less work than desired for an active plot, produces an eroding engagement behavior.

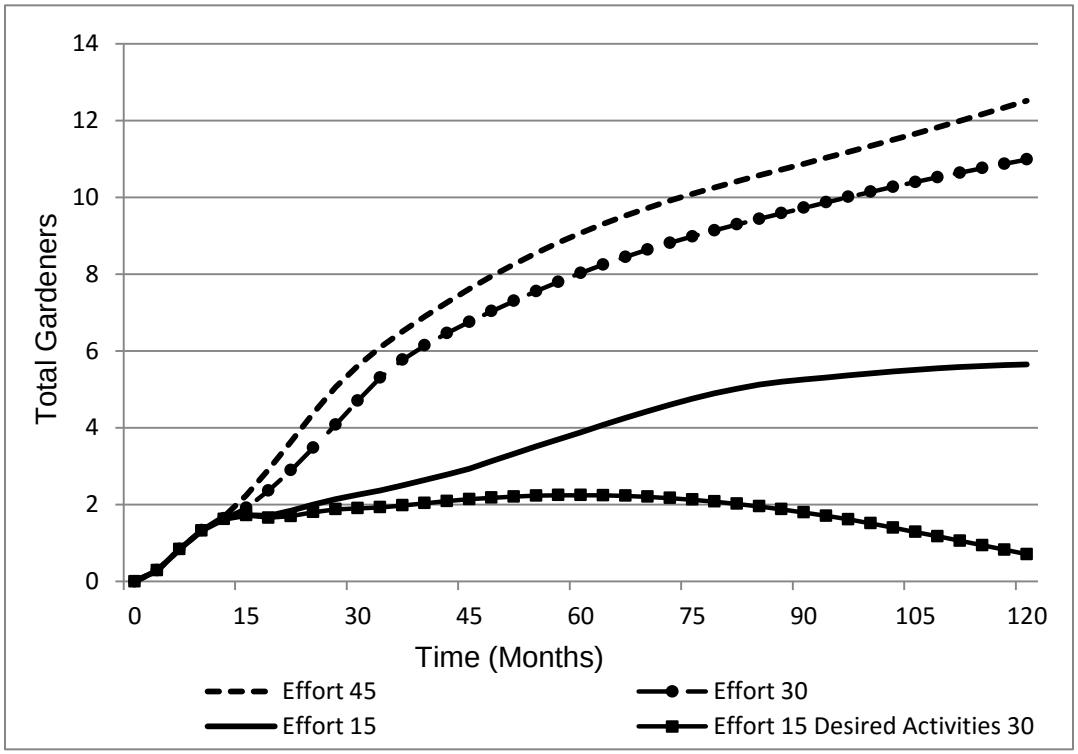


Figure 49: Variation in total gardeners when effort is changed from 15, 30, 45 and desired activities is increased from 20 to 30

6.2.4 Quality of community garden structure

The quality of community garden structure has only one uncertain parameter as shown in Table 6. The sensitivity of the outcome to variations in these parameters is presented in Figure 50. The variation in these parameters affects the outcome, however, the total number of gardeners is moving in the same direction for all the simulation runs. This suggests that under the given ranges, the outcome is not sensitive to the parameters in this structure.

Table 6: Uncertain parameters, model values, and range values for testing the Quality of community garden structure

Constants		**Units**	**Base Value**	**Range**
Time to change quality of garden	Months	12	6-18	

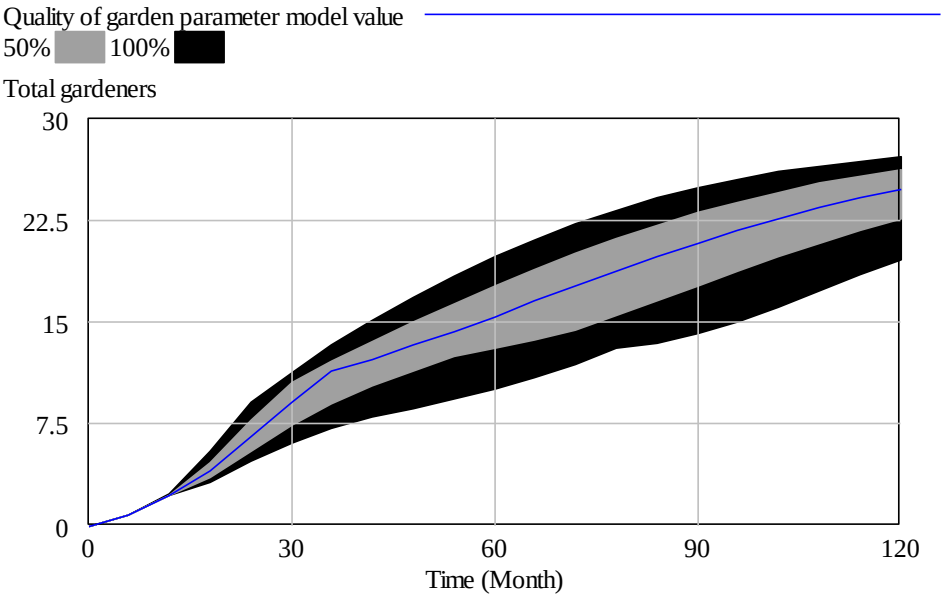


Figure 50: Variation in total gardeners caused by the changes in time to changes quality of garden

Figure 50 shows that *Time to change quality of garden* causes variation in total number of gardeners; however, the variation is not qualitatively different. In other words, all of the simulation runs produce sustained engagement behavior. Since there is only one parameter in

this structure, we know that the variation is caused by that parameter. Therefore, there is no need to do statistical screening analysis.

6.2.5 Rules structure

The rules structure has four uncertain parameters as shown in Table 7. The impact of these uncertain parameters on the outcome is shown in Figure 51. The parameters don't create much variation in the outcome in the early parts of the simulation. It should be noted that most of the simulation runs produce behavior in the same direction. There is not a big decline in number of gardeners. This suggests that the model outcome is somewhat robust to variations in these parameters.

Table 7: Uncertain parameters, model values, and range values for testing the rules structure

Uncertain Parameters	**Units**	**Base Value**	**Range**
Fractional rate of abandoning rules	1/Month	0.1	0.05-0.15
Maximum number of new rules that can be discussed per month	Rules/Month	0.25	0.125-0.375
Maximum fractional rate of abandoning codified rules	1/Month	0.01	0.005-0.015
Minimum time to codify rules	Months	12	6-18

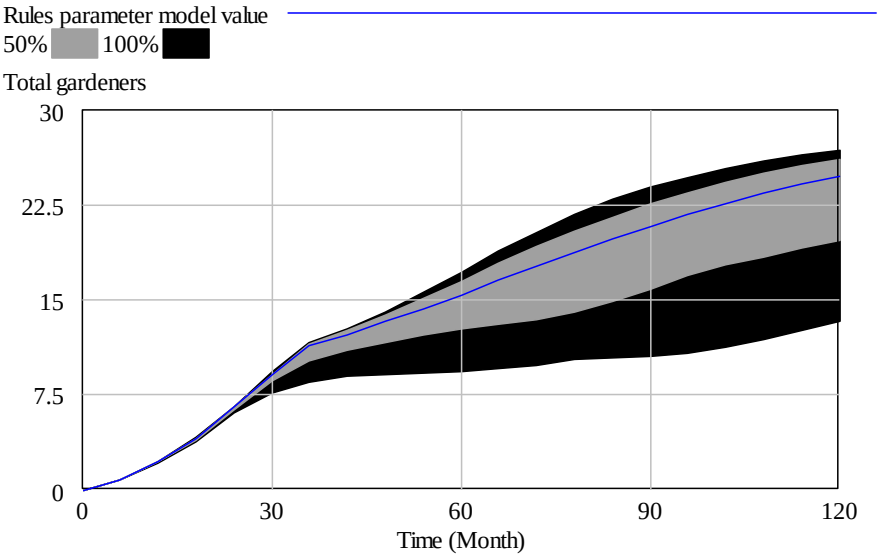


Figure 51: Impact of uncertain parameters in the rules structure on total gardeners

Figure 52 shows the relative impact of the four parameters. Initially, there are a lot of drastic changes in the direction of the impact of these parameters. Before explaining why, it should be noted that this fluctuation occurs before time 10, which corresponds to month 30. As we can see in Figure 51, before month 30 there is not a lot of variation. Therefore, although the parameters have high correlation coefficients, they don't cause a lot of variation.

Correlation coefficients for *Maximum number of new rules that can be discussed per month* and *Minimum time to codify rules* share an opposite but similar pattern. Both impact the process of creating new rules where the first increases the number of rules and the second decreases the number of rules. The first should affect the outcome variable negatively and the second should affect the outcome variable positively. When more rules are created, it increases effort and increases the rate of gardeners leaving. However, for a brief period of time they have an opposite impact. When there are more rules, it increases the effort from gardeners. More effort helps to improve the quality of garden, which reduces the rate of gardeners leaving. After that period, the high effort results in gardeners leaving faster.

Both *Fractional rate of abandoning rules* and *Maximum fractional rate of abandoning codified rules* work to reduce the number of rules. They are generally positively related to the outcome variable but for a brief time they change direction. This is because when there are fewer rules, effort does not increase. This reduces the quality of garden and increases the number of gardeners leaving. The change in direction for all four parameters occurs at a period when due to increased effort, the effect of higher quality of the garden outweighs the effect of gardeners leaving due to increased effort.

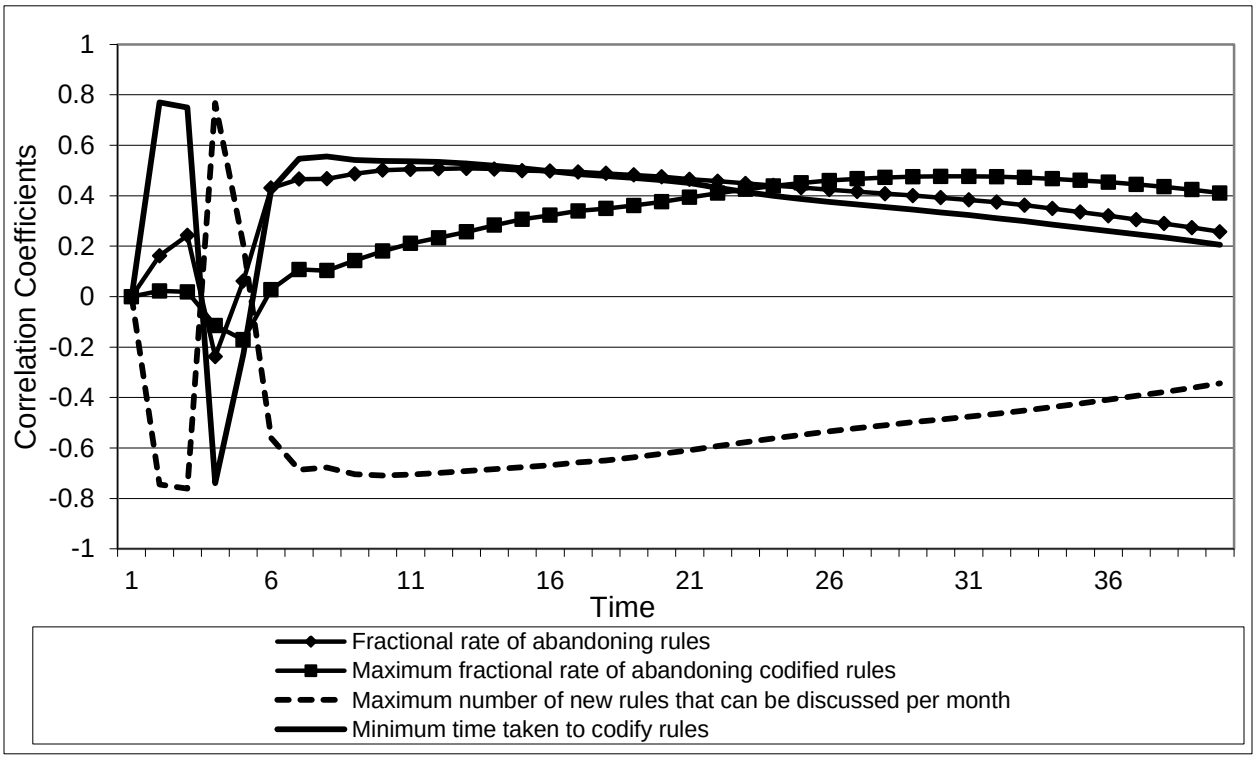


Figure 52: Correlation coefficients over time between uncertain parameters in the rules structure and total gardeners

6.2.6 Trust structure

The trust structure has one uncertain parameter as shown in Table 8. As shown in Figure 53, changes in the parameter *Time to change trust*, doesn't have much impact on the outcome variable. This is because under the given model values; trust is increasing. Changing the parameter only changes the rate at which trust increases but does not change the pattern of the behavior.

Table 8: Uncertain parameters, model values, and range values for testing the trust structure

Uncertain Parameters	**Units**	**Base Value**	**Range**
Time to change trust	Month	12	6-18

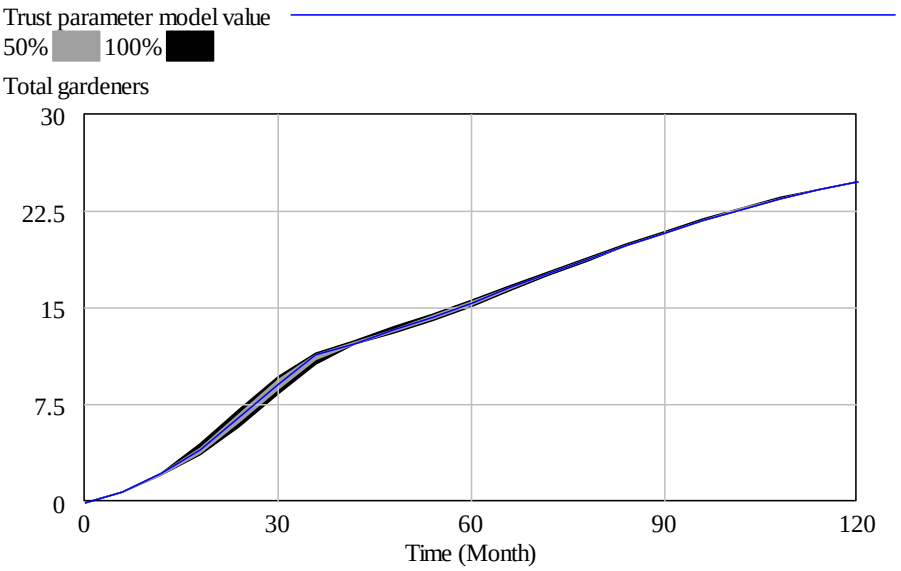


Figure 53: Impact of uncertain parameters in the trust structure on total gardeners

6.2.7 Social Relationships structure

There are two parameters in the social relationship structure as shown in Table 9. The impact of variation in these parameters on the outcome is shown in Figure 54. Until the first half of the simulation period, there is not much impact on the outcome. Simulation runs in the later stages however, show some variations. This is because both of these parameters determine the rate at which relationships are built. However, the initial group of gardeners have prior relationships and are not affected by the value of these parameters. As other people from the community who do not have relationships join, the rate of building relationships affects the outcome behavior.

Table 9: Uncertain parameters, model values, and range values for testing the social relationship structure

Constants	**Units**	**Base Value**	**Range**
Interaction rate per person	Contacts/Month/People	3	1.5-4.5
Rate of relationship formation per interaction	Relationships/Contacts	0.3	0.15-0.45

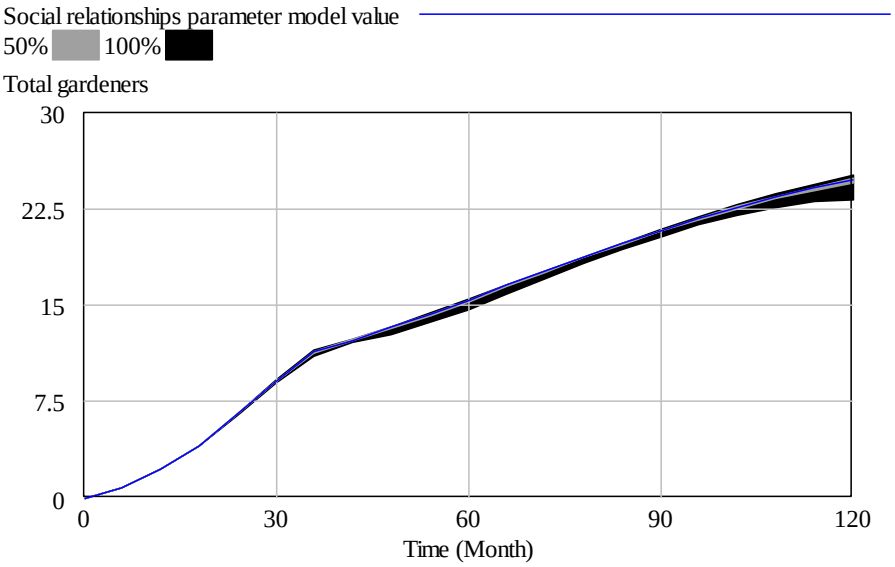


Figure 54: Impact of uncertain parameters in the social relationship structure on total gardeners

Both of the parameters have similar impact on the outcome because both contribute towards relationship formation in the garden, as can be seen in Figure 55.

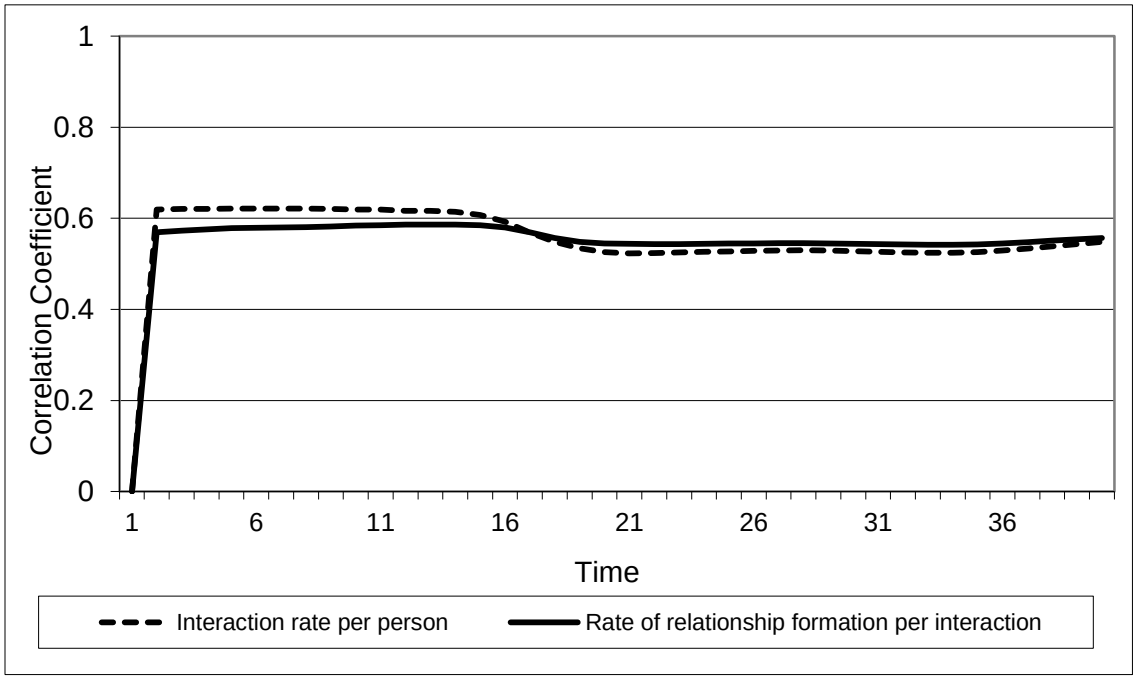


Figure 55: Correlation coefficients over time between uncertain parameters in the social relationship structure and total gardeners

6.2.8 Partners structure

There are five uncertain parameters in the partners structure as shown in Table 10. The impact of these parameters on the outcome is shown in Figure 56. Within the given range, the parameters cause some variation on the outcome variable. However the pattern is not qualitatively different. This suggests that the model behavior is robust to changes in parameters in the partners structure.

Table 10: Uncertain parameters, model values, and range values for testing the social relationship structure

Uncertain Parameters	**Units**	**Base Value**	**Range**
Average time a partner will stay	Month	24	12-36
Effort per partner	Hours/Partners/Month	50	25-75
Maximum number of partners per garden	Partners	4	2-6
Time expected to spend per partner per month	Hours/Partners/Month	10	5-15
Time needed to find a partner	Month	12	6-18

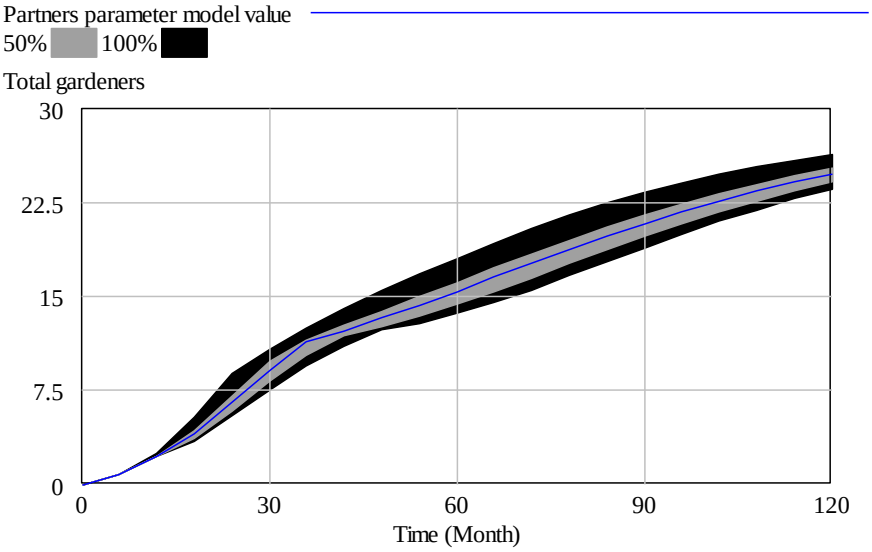


Figure 56: Impact of uncertain parameters in the partners structure on total gardeners

Two parameters that have the most impact on the variation are *Average time a partner will stay* and *Time needed to find a partner.* They affect the number of partners in an opposite way. When higher, the first will reduce the outflow of partners; whereas the latter will reduce the inflow of partners. To increase the number of gardeners, the time that the partner will stay should be longer and time needed to find a partner should be smaller. As shown in Figure 57, *Average*

time a partner will stay has a positive impact, whereas *Time needed to find a partner* has a negative impact on the outcome. Relatively, *Time needed to find a partner* is much for impactful. This is because how *Average time a partner will stay* will impact *Number of partners* depends on other factors in the model. Even when *Average time a partner will stay* is fixed at 12 months, the actual time a partner will stay can increase based on how much time the gardeners spend with the partners. *Time needed to find a partner*, on the other hand, directly affects the *Number of partners*.

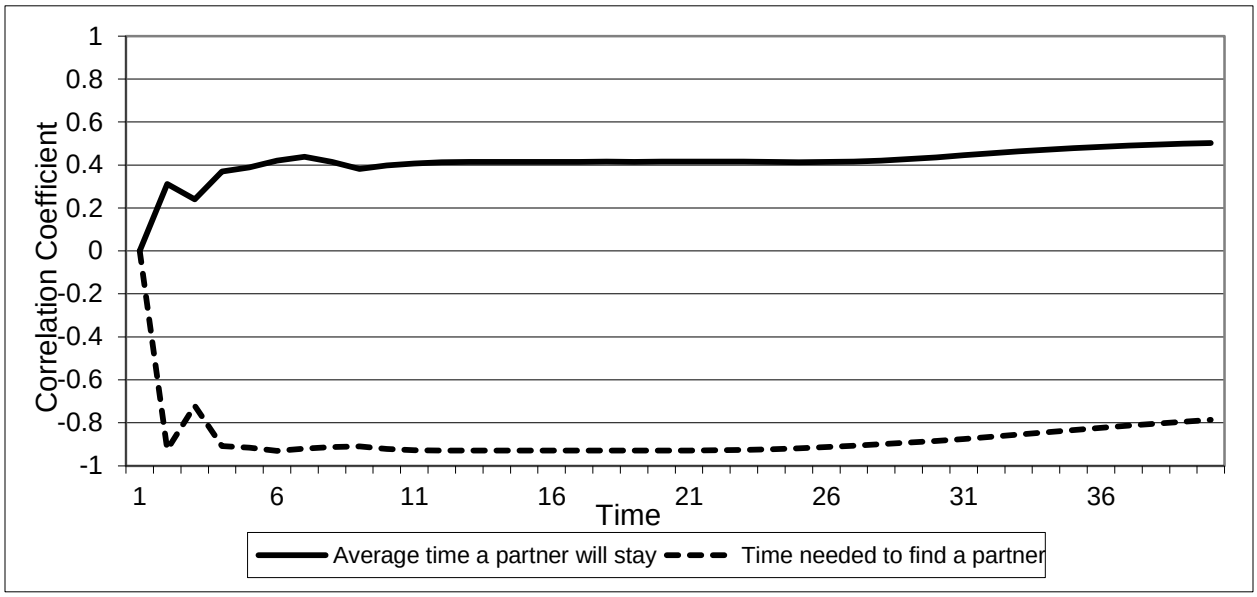


Figure 57: Correlation coefficients over time between uncertain parameters in the partners structure and total gardeners

6.2.9 Sensitivity to parameters from different structures

The sensitivity analysis has focused on parameters from one particular structure at a time. While the parameters in one structure were varied, parameters in other structures were at their base value. This section will look at the impact of varying parameters from different structures at the same time. Fourteen different parameters from the model were chosen, based on their impact

on the outcome (see Table 11). The impact of varying these parameters on the outcome is shown in Figure 58.

Table 11: Uncertain parameters, model values, and range values for most impactful parameters in the model

Uncertain Parameters	Units	Base Value	Range	Sub Structure
Initial number of people involved in community but	People	50	25-75	Gardener
Average time non-core group gardeners stay	Month	24	12-36	Gardener
Average time core group gardeners stay	Month	48	24-72	Gardener
Initial successful contact rate among people involved in the	1/contact	0.1	0.05-0.15	Gardener
Initial successful contact rate among other community	Contact/Month	0.1	0.05-0.15	Gardener
Time to become part of the core group	Month	24	12-36	Gardener
Initial land available	Plots/month	12	15-45	Land
Initial potential effort per core group gardener	Hours/Month/People	30	15-45	Activities
Desired activities per used plot	Hours/Month/Plot	20	15-20	Activities
Minimum time taken to codify rules	Months	12	6-18	Rules
Maximum number of new rules that can be discussed per	Rules/Month	0.25	0.125-0.375	Rules
Interaction rate per person	Contacts/Month/People	3	1.5-4.5	Social Relationship
Rate of relationship formation per interaction	Relationships/Contacts	0.3	0.15-0.45	Social Relationship
Time needed to find a partner	Month	12	6-18	Partner

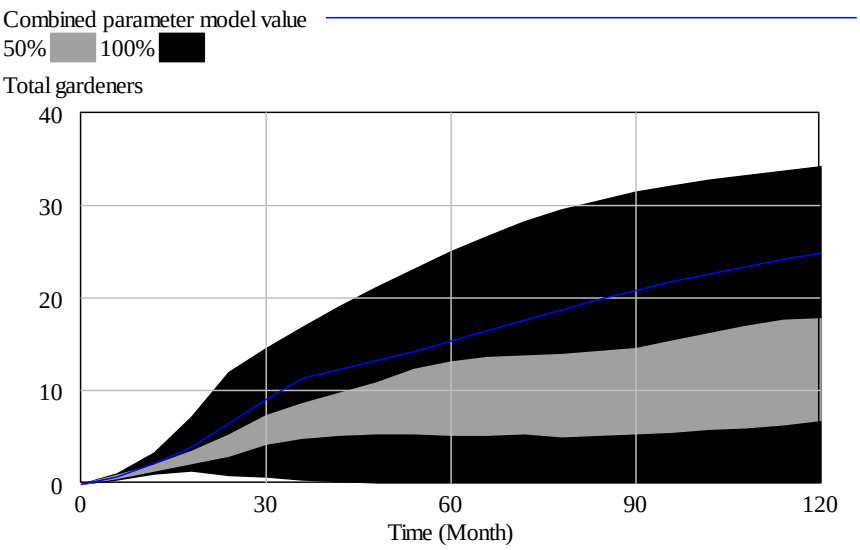


Figure 58: Impact of uncertain parameters in the model on total gardeners

The impact of different parameters from various sectors of the model is shown in Figure 59 and Figure 60. The first figure shows the parameters with initial impact and the second shows the parameters with increasing impact. The mechanism for how these parameters impact the model behavior has already been discussed earlier. To summarize, the length of time the two groups of gardeners stay play an important role for sustaining number of gardeners throughout the simulation. Similarly, the amount of effort provided by the core group gardeners and the time taken to find partners are crucial for sustaining the garden.

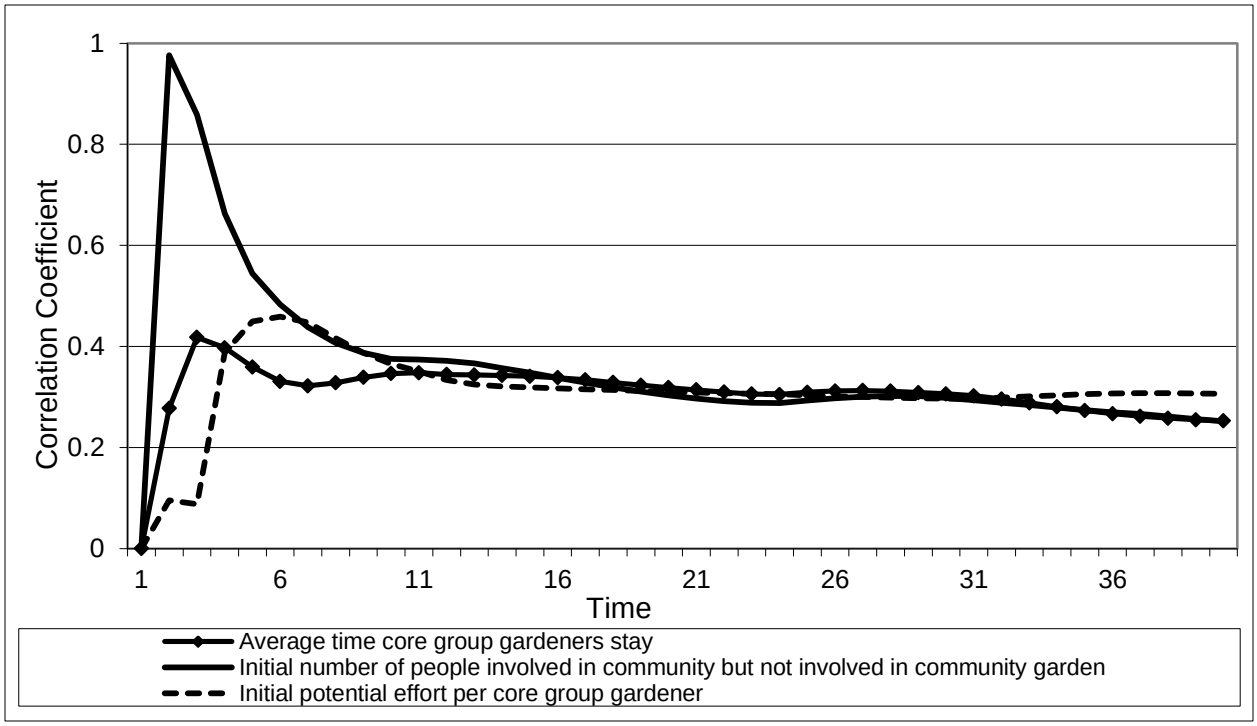


Figure 59: Correlation coefficients over time between uncertain parameters in the model and total gardeners (Early impact)

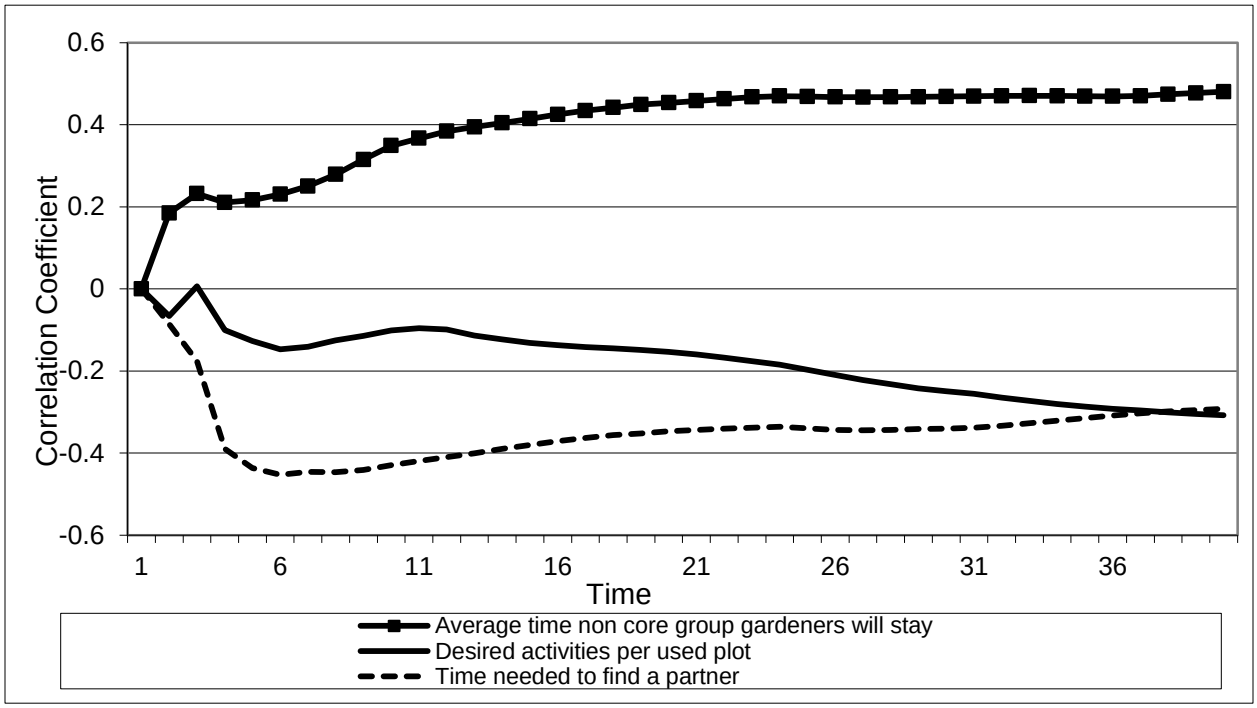


Figure 60: Correlation coefficients over time between uncertain parameters in the model and total gardeners (Later impact)

6.3 Conclusion

This chapter explored how changes in the values of some of the parameters determine the behavior of the model. The model is particularly sensitive to changes in some of the parameters than others. For example, changing values for the parameter *Time to change trust* did not have much impact on the outcome, whereas changing *Average time core group gardeners will stay* had a significant impact. The goal is not only to identify the high impact parameters, but to understand how they impact the behavior.

Chapter 7: Conclusion

7.1 Overview

This chapter will conclude this study by summarizing the findings based on the model and key informant interviews and locating it with extant literature. A table is presented (see Table 12) to highlight the sources of different findings. It will also discuss limitations of the study and future directions that could address these limitations. It also discusses the implications for community practice.

7.2 Findings and discussions

Not all gardeners are created equal. It is clear from the key informant interviews and the model that core group gardeners play an important role in sustaining a community garden. The core group of gardeners has been referred to as the "spine" of the garden that supports it when other gardeners come and go. Olson (1971) has argued that certain individuals will always carry a higher burden for collective action, while others choose to free ride. The higher level of commitment by the core group of gardeners provides strength to the *Scaling up community participation in gardening* reinforcing loop (R3) ensuring higher levels of quality of garden, which helps reduce turnover.

Rules serve an important function. Ostrom (1990) provided a response for the free riding problem through self-monitoring and sanctions levied by the group. In the model, the balancing loop (B1) *Developing rules to reduce free riding* works in a similar fashion. When the effort is low, rules are created to increase the level of effort. In the community gardens, the process of sanctioning is based on having conversations with individuals who haven't been contributing to the garden as much. Unlike managing common pool resources such as forests and irrigation channels, which is a matter of securing livelihood, participating in community gardens is mostly

a leisure activity. Severe sanctions therefore may not provide a high enough incentive. Also, most of the community gardens in the study had a difficult time finding new recruits. Harsh sanctions on gardeners would not make logical sense.

The concept of free riding based on common pool resources may not apply as easily in an urban context. At first glance, neighbors and other people who enjoy the garden but do not contribute to its maintenance seem to be free riding. They are enjoying the benefits of the common space but not putting in any effort. Ostrom applied her theories in the context of common pool resources such as forests, fisheries, underground water, irrigation channels etc. When there are more users, there is less resource available for others to use. As mentioned earlier, the resources are rivalrous. In the context of a community garden, however, having neighbors around and enjoying the garden doesn't really subtract from the utility. It can add to the richness of the resource. Without neighbors, the garden would be a less socially appealing place. It would almost not fulfill its purpose of providing a place for neighbors to know each other. Its value depends on how it's being used. Borch and Kornberger (2015) argue that people (users) add to the atmosphere and the vibrancy of the City and its resources. The value of a mall or a state fair would seem less if there were only handful of people roaming around. The density of people in the City adds to the value of its common resources. To surmise, whether people are free riders or contributors to the resource depends on the product. If the product is fruits and vegetables grown by a handful of gardeners, the people who steal them are free riding. However, if the product is a beautiful social place for gathering, the people other than gardeners who come and enjoy the garden are not free riders but are contributing to the resource.

Simply creating rules doesn't mean anything. Some of the key informants talked about designing new rules that didn't work because people didn't fulfill the obligations. One of the key

aspects of collective action is social capital, which refers to the trust and social networks among a group of people (Ostrom, 2000b; Ostrom & Ahn, 2009). Therefore, rules should be created on a foundation of strong relationships. The concept of social capital in the model is represented as stock of social relationships that affect the level of trust among members of the group. Trust, in the model, enables the rules to be implemented. As rules are implemented and people fulfill their commitments (i.e. increase effort) they increase the stock of social relationships, reinforcing the level of trust as depicted in the *Building relationships to enhance reciprocity* feedback loop (R1).

Building partnerships is crucial: Multiple key informants have highlighted that building and maintaining a community garden requires hard work and would be very difficult without partnerships and collaborations. In the model, partners help to maintain the garden by supplementing effort. Although this is a simplification of different kinds of support provided by partners (i.e. financial, technical), it captures the importance of building partnerships. The collective action literature based on common pool resources has primarily focused on self-governance, but local non-governmental organizations (NGOs) can also play a critical role in sustaining the collective effort (Barnes & van Laerhoven, 2014). This is, not a new insight in the context of urban community gardening. Gateway Greening understood the importance of this started and subsequently started a *Building and Sustaining Partnerships Workshop* for community garden leaders.

Social capital is both a need and an outcome. Community gardens have the potential to play an important role as a place based strategy for community development in inner city neighborhoods. Emerging literature provides a picture of how community gardens can be a catalyst for active citizenry and community building. In essence, community gardens provide a place for residents to interact with each other and build relationships. However, community

gardens do not emerge in a void of social capital. Glover (2004) argues that social capital is both a pre-requisite and an outcome of community gardens. Many of the community gardens in the neighborhood were established by groups of people who already knew each other through block units or churches. Their social capital was crucial in establishing and maintaining the community garden. The model clearly shows the difference between a group of people with and without prior relationships and their success in sustaining a garden. Ostrom (2000b; 2009) has always argued that social capital is a pre-requisite for developing social capital. From a feedback perspective, however, it is not only social capital that leads to collective action, but collective action itself can improve social capital. This is true for community gardens as well. Social capital is a necessity to initiate and sustain a community garden, but interactions through the garden can contribute to improve the social capital.

Table 12: Findings organized based on three sources: key informant interviews, feedback perspective, and system dynamics modeling

	Key informant Interviews	**Feedback Perspective**	**System Dynamics Modeling**
Gardeners	There are individuals that form a core group and contribute more to the garden than other members.	Gardeners contribute to quality of garden which in turn helps to retain and recruit gardeners.	Core group gardeners are vital for sustaining a community garden
Rules	Rules help to provide a plan rather than responding to issues as they arise. Social capital is needed to properly implement the rules.	Rules can increase effort but can create more work than individuals are willing to, causing turnover.	The ability of a group to create and implement rules ensures that the level of effort matches the amount of work needed.
Partnerships	Partners play a very important role for community gardens from initiation to continued maintenance.	The need for partnerships changes as the level of effort within the garden changes.	Developing partnerships can be a difference between sustained versus eroding engagement in community garden.

Social capital	People who work together at the garden have prior relationships in community activities. Working in the garden can build deeper relationships.	More gardeners will not result in proportional increase in effort unless social capital is built	Continued focus on maintaining social relationships is vital for long term sustainability.
Land	Without proper land tenure it is difficult to sustain even the most well-functioning community garden. Since most land belongs to the Land Reauthorization Authority the need to pay liability insurance can demotivate gardeners.	Number of gardeners cannot increase indefinitely and is limited by the size of the land available for gardening.	

7.3 Implications for practice

This study was based in a particular urban neighborhood and within the context of community gardens. Implications for practice are contingent on the community engagement context. Nonetheless, general implications can be inferred.

Community gardens are thought of as a community building strategy in urban neighborhoods. A vacant piece of land can be seen as waiting to be converted into a garden that will help neighbors build stronger relationships among other benefits. It should be considered that establishing and sustaining a garden requires pre-existing relationships among the individuals involved. Once established, the garden may contribute to strengthening relationships. However, it should be noted that community gardens may not thrive without social capital.

Sustaining gardens is necessary to gain benefits. Having a core group of people committed to the garden is an important aspect in sustaining a garden. The core group provides resilience against turnover and makes sustained engagement possible. If turnover is high, outreach (i.e. the contact rate outside garden in model) is important to get new recruits as replacements. To reduce turnover, it is important to emphasize the outcomes of the group's effort. In the model the *Scaling up community participation in gardening (R3)* feedback loop ensures that when gardeners put in the effort to maintain the quality of the garden, it has a reinforcing effect by reducing turnover. In a community garden context, the outcome of effort might be more visible than other community engagement efforts. Therefore, it might be even more important to highlight this feedback loop by celebrating the achievements of the group. Publicizing these achievements can help create awareness about the group's effort, which can be essential for recruiting.

Social capital seems to play an important role in encouraging people to fulfill their commitments. The reinforcing feedback loop *Building relationships to enhance reciprocity (R1)* should be strengthened through activities that allow people to build relationships. Having a community garden where individuals do not interact may not be sustainable. Designing ways for gardeners to interact with each other can help build relationships that are essential to sustain the garden. Building relationships not only among gardeners but with partnering agencies is also important. Partnering agencies help sustain the garden by providing various resources. However, the relationship is bi-directional. Care should be taken to foster these relationships for the long-term success of the garden.

Issues beyond the control of the community gardeners were also highlighted in the key informant interviews. Most of the plots of land developed as community gardens didn't belong to

the gardeners or an individual. The land is owned by the City of St Louis and managed through the St. Louis Land Revitalization Authority. Allowing residents to use the plot of land was ideal, as the City government would not have to spend resources managing the property. Leases were given out for five years. However, if there is development opportunity the land would be sold to a developer. The community gardeners are, in essence, managing the plot of land for the government before it can be developed. In New York City, residents protested the auctioning of their gardens and were successful in securing tenure for some of the gardens. Similarly, in Seattle, securing land tenure involves continuous activism by gardeners and non-profit organizations (Schukoske, 1999). If sustainability of community gardens is a concern then the impermanence of land tenure must be addressed.

Another issue was that the St. Louis LRA started charging liability insurance for the gardens to cover any legal costs from a third party. Although most of the gardens were part of Gateway Greening and got a group price of $100 a year, it is still an additional burden to the gardeners (H. Reinhart, personal communication, May 13th 2015). Moving forward, especially if land tenure for community gardens is transferred from City to individuals, groups, or non-profit organizations, liability insurance will be more important to cover any legal expenses. It will be important to design strategies to protect the garden and gardeners without increasing financial burden on the gardeners.

The concept of community engagement in this study is framed from a historical perspective of urban development. Decades of urban revitalization has provided a valuable insight that community based development can work better than top down, command and control type of development. Experiences from international settings further corroborate this concept that community should be at the center of their own development. Engaging local residents is at

the center of community based development. Although this study focused on community gardens, few insights can be gleaned that will have broader implications. Sustaining community engagement for a long period is challenging. The urban context, where engaging in community activities may not be directly tied to people's livelihoods, adds to this challenge. Networks of trust and reciprocity, not only among community members but also between community members and local organizations, can play an important role . As shown earlier, without support from partnering agencies it was difficult to sustain community gardeners.

Community based development does not mean that only local residents are responsible. While the residents are at the center, various organizations can play a supporting role. Organizations can provide financial assistance, technical knowledge, and access to external networks that might be necessary for the change effort. Although partnering agencies can play a vital role, they should support the community in developing their own goals and processes. The emphasis should be on empowering the community through greater role in decision making (Narayan, 1995).

Community efforts such as community gardens can increase social capital, however they also require social capital to initiate and sustain. One of the assumptions in community based development is that the community is ready and able to work collaboratively. Without social capital, it could be difficult to hand control over to the community. For example, handing partial of a large development project to an inexperienced community could result in poor outcomes. Identifying the level of community readiness should be a vital part of community engagement. Community building strategies such as community gardens can be helpful to create that network of trust and reciprocity based on collaborative work. The cost of handing control of a community garden is small relative to the benefits of building community.

Production of public and common goods is at the heart of community engagement. Individuals in a community generally do not engage to produce solely private goods. Whether it is to increase public safety, clean the parks, beautify the neighborhood, or be part of a tenant association, the goal is to provide goods and services beneficial to the larger group. The fact that few individuals may contribute to goods that is enjoyed by others creates the biggest challenge for community engagement. Who contributes to the goods and who doesn't? In the case of community gardens, the social capital prior to the foundation of the gardens was necessary for people's engagement. Networks of trust and reciprocity can act as a catalyst for individuals to come together and commit to being part of a communal activity.

Another important question is whether community has a role to play in the production of goods and services. It is generally argued that community plays the most important role where both government and markets have failed to reach. Community gardens are an example. The vacant lots in poor urban neighborhoods are too costly to maintain for the government. Due to high levels of crime and years of disinvestment, these neighborhoods are not financially viable for private development either. But for the community members, the vacant lots are an issue that is not being solved either by the government or the private sector. However, in the current interdependent world it would be problematic to conceptualize community development as a zero-sum game. Government and non-government organizations, private companies, educational institutions, and community groups can add value in their own ways. In this study, it was clear that local partners, whether they were non-profit organizations, churches, or schools played a very important part in the community garden. Gardening hub organizations such as Gateway Greening was crucial for providing resources (financial, technical, and volunteers) to establish and maintain the gardens. Volunteer groups from churches and schools came several times a year

to help maintain the garden. Collaborations, with community groups in the center, can be more effective and sustain will be able to sustain community based development for a long period.

7.3 Limitations

Data for reference mode: This study set out to understand the processes resulting in sustained versus eroding community engagement in the context of community gardens. The number of gardeners was chosen as the indicator. However, collecting data on the number of gardeners in a garden through time was much more difficult that assumed. Gardeners didn't remember the number of gardeners at various points in time and there was no record keeping. Without this data, the model was not calibrated, which would have helped with estimating the ranges of the uncertain parameters. However, the goal was to reproduce the general pattern of behavior for sustained and eroding engagement, which this study was able to do.

Generalization: Although this study was based on multiple community gardens, all of them were located within the context of a particular neighborhood. This was an intentional decision so that the community gardens were not situated within drastically different contexts. The results of this study may not be applicable for community gardens in all neighborhoods. The goal would be to replicate the study in varying contexts to understand how the underlying processes would be different.

Model boundary: Although the neighborhood context is important it was not explicitly modeled in this study. The choice of model boundary was created at the community garden level, to keep the model at a reasonable size (current model has 152 variables with 13 stock variables). However, the community context has been taken into consideration through availability of land (increase in vacant lots in the neighborhood), difficulty in finding new recruits (high proportion

of renters in the neighborhood), and existing social relationships that led to the establishment of the garden (high number of initial social relationships among the initial gardeners).

7.5 Direction for future research

One of the themes in community garden literature has been regarding the spillover effects. In other words, what happens in a community garden doesn't stay within a community garden. If two neighbors build a relationship through their interaction in the garden, that relationship will continue outside its boundaries. Similarly, people involved in the garden will not only talk about the garden but will also start talking about other issues in the neighborhood. Therefore, one of the possible directions for a future study would be to expand the model boundary to explicitly look at how the community context affects a community garden and vice versa. This would also address one of the limitations of this study regarding model boundary.

The model analysis has mainly focused on parameter sensitivity and some structural assumptions. Although this is adequate to explain the model behavior based on particular mechanisms, one cannot explain which feedback loop is responsible for a given behavior at particular periods of time. Future research will apply the technique of feedback loop dominance (D. N. Ford, 1999) to understand the emergence of model behavior based on shifting loop dominance.

The model suggests that social relationships are important to sustain community engagement. However, social relationships in the model are presented at an aggregate level. The model doesn't consider social relationships between and among the partners. Future research should consider a more nuanced approach to social networks among gardeners, between

gardeners and partners, and between partners, to understand how these networks contribute to sustaining community gardens.

Social relationships and trust among the gardeners is necessary to implement rules that are designed to maintain the garden. Reputation of both the individuals and groups also play an important role in implementation of rules (Ostrom, 1990). Individuals in a community garden are likely to play roles in other community activities as well. Following rules and contributing to the garden may be necessary for them to preserve their reputation in the community. Similarly, the group of individuals involved in a community garden may have a reputation in terms of working collectively and maintaining the garden. Preserving this reputation could be a motivation to follow rules and contribute to the garden. How the reputation of individuals and groups affect their effort in the community garden is a question that needs further exploration.

Partnerships with organizations are recognized as playing an important role in sustainability of a community garden. Both the organizations and gardeners have incentives to build partnerships. More effort is needed to better understand the incentives motivating the two sides to build partnerships. Future research study can delve deeper into the mechanisms responsible for initiating and sustaining a partnership. A key informant mentioned that their personal relationship with Gateway Greening was vital for establishing the garden. Understanding how social ties affect partnership building and development will be significant in order to improve our knowledge base on sustaining community gardens.

This author will continue to explore some of these questions in the West End Neighborhood in St Louis. However, the neighborhood is primarily African American. Would collective action in the context of community gardens look different with individuals from

varying ethnic backgrounds? The Twin Cities (Minneapolis and St. Paul in Minnesota), where the author currently resides has neighborhoods with people from diverse cultural backgrounds including Native Americans, Hmong, Karen, Somalis, African Americans, and Hispanics. Understanding how people of different ethnic backgrounds work together can provide insights into community building in diverse urban neighborhoods.

7.6 Conclusion

Community gardens provide a unique context for community engagement. The desire for participation is reinforced through benefits to individuals, group, and the larger community. Rather than engaging community members through long meetings, neighbors collaborate while working in the garden. Although community gardens have the potential to increase social capital, it needs to be recognized that social capital is also a pre-requisite for initiating community gardens.

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APPENDIX A: Recruitment Materials

The recruitment materials include 1) a recruitment email addresses to community garden leaders and 2) a script to be used for recruiting community garden leaders. The reason for having two modes of recruitment is just to ensure initial communication with the garden leaders.

Garden leader recruitment email

Dear <Insert Name>,

We hope this letter finds you well. My name is Nishesh Chalise and I am a PhD student at the Brown School of Social Work. I am writing this letter to invite you to participate in a research study which will inform my dissertation. This work is being done under the supervision of Gautam Yadama, PhD.

The main purpose of the study is to understand the processes that result in a successful community garden. American Community Garden Association estimated that while there are new community gardens being built almost 1615 gardens had been abandoned in the past five years. We believe that this study will contribute valuable insights to sustain community gardens so that they can continue to provide valuable benefits to urban neighborhoods.

Participating in this study would entail an approximately 60 minute long phone conversation. The conversation will be based on an interview guide and it will be recorded for future reference. The interview will focus on various aspects of the community garden that you were/are part of and interaction between its members. We want to learn from your experience as the leader of the community garden. Your participation in this study is voluntary and you can stop the interview at any point.

If you have questions or would like to set up a time to talk about this study in more detail, please contact Nishesh Chalise at 314-412-9839 or nchalise@wustl.edu. Thank you in advance for your consideration. We will look forward to hearing from you.

Best Regards,

Nishesh Chalise, MSW Gautam Yadama, PhD

Garden leader recruitment phone script

My name is Nishesh Chalise and I am a PhD student at the Brown School of Social Work. I am calling to invite you to participate in a research study which will inform my dissertation regarding community engagement in community gardens. This work is being done under the supervision of Dr. Gautam Yadama. Do you have a few minutes to talk? (If yes, continue. If no, then leave *contact information so that they can reach me at a more convenient time).*

The main purpose of the study is to understand the processes that result in successful community garden. American Community Garden Association estimated that while there are new community gardens being built almost 1615 gardens had been abandoned in the past five years. We believe that this study will contribute valuable insights to sustain community gardens so that they can continue to provide valuable benefits to urban neighborhoods.

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If you have questions or would like to set up a time to talk about this study in more detail, please contact Nishesh Chalise at 314-412-9839 or nchalise@wustl.edu. Thank you in advance for your consideration. We will look forward to hearing from you.

APPENDIX B: Semi-structured interview guide

Thank you for taking the time to participate in this study. Your input will provide valuable information for this study. My goal for this study is to understand the processes that create a successful community garden. By successful I am referring to a garden that people continue to engage in and not abandon it. I am certain there are different ways to think about a successful garden and we should certainly talk about those. I will ask you a series of questions regarding the initiation of the garden, the rules of working collectively, the dynamics between the members, and the partnerships you might have developed. I will also be asking some questions to clarify a point or to get to more specific details.

Questions	**Probing Questions**
Garden background	
Can you tell me the story of the establishment of the garden	When was the garden established? What was the land used for before the garden? What is the tenure system for the land? How many people were there in the beginning? How many people are there now? How many plot were there in the beginning? How many plots are there now? What resources are necessary to initiate the garden?
What are some of the biggest challenges in sustaining a garden?	
ReciproCity	
Do individuals contribute to overall garden maintenance?	Could you describe or give an example of how that works?
Do individuals help each other?	Could you describe or give an example of how that works?
What are the different ways in which individuals help each other or contribute to the overall garden maintenance?	Do individuals help each other just within the garden or outside the garden too?
How does trust among members play a role in the functioning of a community garden?	
Rules and free riding	
What are some of the rules in the garden?	Are these formal i.e. written or informal?
How do rules get established?	
How are decisions regarding the garden made?	
What happens if someone does not follow a rule?	
What happens if someone does not contribute to overall garden maintenance?	

Social relationships and norms	
Do people form social bonds at the garden?	How does this generally happen?
How do these bonds affect the functioning of the garden?	
Do these social relationships have a negative effect	Do they constrain people, add social obligations?
Profit Maximization	
What motivates people to engage in the community garden?	
What are some of the reasons people leave a garden?	
Building partnerships	
What role do collaborations and partnerships play in a community garden?	
How do garden members decide to build a new partnership?	

APPENDIX C: Letter from HRPO

Washington University in St. Louis
Human Research Protection Office
FWA00002284

Barnes-Jewish Hospital
St. Louis Children's Hospital
Washington University

January 28, 2014

PI: Nishesh Chalise
Department: Brown School of Social Work

HRPO number: N/A
Project Title: Collective Action Dynamics in Urban Neighborhoods: A Study of Urban Community Gardens
Funding Source: None

Dear Dr. Chalise:
The Washington University Human Research Protection Office (HRPO) reviewed your project and determined that it does not involve activities that are subject to Institutional Review Board (IRB) oversight.

HRPO complies with federal regulations of the Department of Health and Human Services (HHS) and the Food and Drug Administration (FDA) which limit IRB review and approval to any activity that represents *research involving human participants* (HHS) or a *clinical investigation* of a *test article* involving one or more *human participants* (FDA). (See HRPO Policies & Procedures Section II.G. for complete definitions.)

Because you will only collect factual information to understand the underlying feedback structure that produces community engagement in urban community gardens, that is, you will not collect any individually identifiable information about individuals, but will collect information about the structure itself, this activity is not considered to meet federal definitions under the jurisdiction of an IRB and therefore falls outside the purview of the HRPO.

Continuing review of this activity is not necessary. However, if activities change such that they may be considered to meet the above definitions, please contact HRPO before implementing those changes.

If further information is necessary, or if you believe we have misunderstood the intent or scope of your planned activity, please contact our office at 314.633.7400.

Sincerely,

Jackie Cleary

Jackie Cleary
Expedited Review Specialist

Physical Address: 22 N. Euclid, Suite 233, St. Louis, MO 63108
Mailing Address: 660 South Euclid Ave., Campus Box 8089, St. Louis, MO 63110